Milkfish Bibliography

A Compilation of Abstracts on Milkfish Studies

Dissemination and Adoption of Mikfish Aquaculture Technology in the Philippines Project
Funded by the DA - Bureau of Agricultural Research

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This Milkfish Bibliography is a joint publication of The WorldFish Center and SEAFDEC

Aquaculture Department

The Southeast Asian Fisheries Development Center (SEAFDEC) is established to promote fisheries development in the region.

SEAFDEC conducts research on fisheries problems; generates appropriate fisheries technologies; trains researchers, technicians, fishers and aquafarmers, and managers; disseminates information on fisheries science and technologies; and recommends policies pertaining to the fisheries sector.

SEAFDEC/AQD is mandated to:

- conduct scientific research to generate aquaculture technologies appropriate for Southeast Asia
- develop managerial, technical, and skilled manpower for the aquaculture sector
- produce, disseminate, and exchange aquaculture information

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We aim for:

- poverty eradication;
- a healthier, better nourished human family;
- reduced pressure on fragile natural resources; and
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A way to achieve this:
Through research, partnership, capacity building and policy support, we promote sustainable development and use of living aquatic resources based on environmentally sound management.
The research thrusts are:

- improving productivity;
- protecting the environment;
- saving biodiversity;
- improving policies; and
- strengthening national programs

We believe this work will be most successful when undertaken in partnership with national governments and nongovernmental institutions, and with participation of users of the research results.

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WorldFish Center Contribution No: 1813

The WorldFish Center is one of the 15 international research centers of the Consultative Group on International Agricultural Research (CGIAR) that has initiated the public awareness campaign, Future Harvest.

PREFACE

Milkfish, *Chanos chanos* (Forsskål, 1775) is one of the major fish species in Southeast Asian aquaculture with a total production of 568,222 mt in 2004 (valued at US$706 million), nearly all of which come from Indonesia, Philippines and Taiwan. In the Philippines, milkfish production consists of nearly 53% (269,931 mt) of the total national production of fish and shellfish from aquaculture. Milkfish is similarly the largest aquaculture species in Indonesia contributing 23% (241,438 mt) to total fish and shellfish aquaculture production. However, in Taiwan, milkfish ranks second to tilapia (*Oreochromis spp*) with contribution reaching 24% (56,853 mt) of its total aquaculture production.

Consumer preference for milkfish has traditionally been very strong in all of these countries. Existence of a large domestic market and technological development for fry production and culture techniques has enabled the milkfish aquaculture industry to maintain its dominance and sustain competition over the culture of other fish and shellfish species. Although natural availability of milkfish fry in coastal waters provided the incentives for widespread and extensive adoption of milkfish aquaculture in these countries in the earlier decades, limited and unstable supply of wild fry were considered as major constraints to the sustenance of the milkfish aquaculture industry during the last two decades. With the growing domestic market as well as expansion of markets internationally, the future growth of milkfish production in the region is expected from increased and steady supply of hatchery-bred fry and adoption of multiple and high-input production systems.

A collaborative project entitled "The Dissemination and Adoption of Milkfish Aquaculture Technology in the Philippines" by The WorldFish Center and the National Integrated Fisheries Technology and Development Center (NIFTDC) of the Bureau of Fisheries and Aquatic Resources (BFAR), together with the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC-AQD) and the University of the Philippines in the Visayas (UPV) was initiated in 2004 with funding from the Bureau of Agricultural Research (BAR) of the Department of Agriculture. The study focused on the current structure of the milkfish industry by examining the development and changes in the production and processing technologies, product demand, markets and institutions over the past decade. Specifically, the project looked into the policy structure, the role of research and technology, and identification of parameters that has enhanced and/or hindered technology adoption by the smallholder operators in production and processing activities.

Milkfish Bibliography: A Compilation of Abstracts on Milkfish Studies is one of the outputs of the Milkfish Project. The WorldFish Center and SEAFDEC-AQD joined together to produce this collection of milkfish references from 1949 to 2005. Entries from the SEAFDEC-published Milkfish Abstracts in 1988 are also included in this **Milkfish Bibliography.**

Milkfish Bibliography covers 700 references on milkfish biology; broodstock management and fry, fingerling and egg collection and production; milkfish culture systems; health and nutrition; post harvest technology; socioeconomic and related studies; and environment and ecology. Included references range from published/unpublished documents, theses, journal articles, to project reports and conference papers.

Entries are arranged alphabetically by author and numbered sequentially according to topic classification. Author, subject, taxonomic and geographic indexes are provided to facilitate cross-referencing. An important feature of this bibliography is the cross-listing of abstracts falling under two or more classifications. Cross-referencing of such materials are provided at the end of each section and are indexed using their main entry number.

The project team hopes that **Milkfish Bibliography** will serve as a useful source of references to researchers, scientists and anyone who is interested in milkfish research.

ACKNOWLEDGEMENT

The hardwork and enthusiasm of all the people who contributed towards the compilation of this bibliography are gratefully acknowledged. This Milkfish Bibliography would not have materialized without the support of the following people: Mr. Boris Fabres for encouraging the Milkfish team to publish such a bibliography; Engr. Christopher G. Villalva for documenting and indexing all the materials in this bibliography; Dr. Nicolas Bailly for his valuable suggestions and comments; Dr. Reynaldo L. Tan for providing the structure of the abstracts' classifications and; Ms. Daisy J. Irabon who helped in editing the entries. We would also like to thank Mr. Joey M. Junio and Ms. Joan R. Glorioso for their assistance in the layout of the cover. The financial support from the Bureau of Agricultural Research of the Department of Agriculture is gratefully appreciated.

The WorldFish Center Milkfish Project Team

- Dr. Yolanda T. Garcia
  Project Leader and Visiting Scientist

- Ms. Catherine T. Aragon
  Sr. Research Assistant

- Ms. Marjorie Ann L. Dator
  Research Assistant

CONTENTS

Classification of Milkfish Abstracts

DOCUMENT LISTING

MILKFISH BIOLOGY

1 Ako, H., C.S. Tamaru, C.S. Lee. 1994. Chemical and physical differences in milkfish (*Chanos chanos*) eggs from natural and hormonally induced spawns. Aquaculture 127(2-3):157-167.

Fatty acid and amino acid analyses were performed on milkfish (*Chanos chanos*) eggs from natural (n = 8) and hormonally induced (n=12) spawns. No significant differences were observed in amounts of 18:1n-9, 18:3n-3, 22:1n-11, and 22:6n-3 in eggs. However, all other fatty acids were significantly higher in naturally spawned eggs. No significant differences were observed in non-essential amino acids between eggs from natural and hormonally induced spawns; however, the majority of essential amino acids were found to be significantly higher in naturally spawned eggs. The mean egg diameter was significantly larger in naturally spawned eggs, while the number of eggs per spawning event was found to be significantly higher from hormonally induced spawns. Using the relationship ED = 1.069 (ID) +0.372 (P < 0.001, r super(2) = 0.493), where ED = spawned egg diameter in mm and ID = initial oocyte diameter in mm, the oocyte size at which a female that will spawn naturally and initiates final maturation was estimated to be 0.849 mm. Collectively, the data indicate that the initial oocyte diameter (0.750 mm) previously used as the standard size for induced spawning of milkfish is premature.

Keywords: induced breeding; fish eggs; sex hormones; natural populations; biochemical analysis; fatty acids; amino acids; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Environ. Biochem., Univ. Hawaii, Honolulu, HI 96822, USA

2 Almendras, J.M.E. 1982. Changes in the ionic and osmotic content in milkfish (*Chanos chanos* Forsskal) fry and fingerlings during abrupt transfer to different test salinities. 42 p. M.S. thesis.

Changes in ionic and osmotic concentrations were determined in milkfish fry and fingerlings after transfer to 0, 8, 16, 32 and 45°/00 salinities from a base salinity of 32°/00. Milkfish fry showed stable ionic and osmotic concentrations within 12 to 24 hours after transfer. On the other hand, fingerlings showed stable plasma osmolality and chloride content at 36 to 60 hours when transferred to the low salinities, and 60 to 84 hours when transferred to 45°/00. Muscle chloride content of fingerlings followed the same curve as that of plasma chloride, while stable levels of muscle potassium and sodium were attained at 12 to 24 hours after transfer. Furthermore, muscle moisture content of fingerlings transferred to 8 and 0°/00 salinities stabilized at 12 hours while that of fingerlings in 45°/00 continued to decrease until 60th hour. Extracellular space of fingerlings in 0°/00 showed significant decreases at 6 to 12 hours but was subsequently returned to pre-transfer levels. On the other hand, extracellular space of fingerlings in 45°/00 increased at 6 to 12 hours and was stabilized at a level significantly higher than initial value.

Keywords: ionic and osmotic content; transfer; different salinities
Location: University of the Philippines, Quezon City.

3 Anon. 1983. Milkfish bibliography: a classified list of materials available at the SEAFDEC Aquaculture Department Library. Bibliography Series of Brackishwater Aquaculture Information System, No. 3, 174 p.

Bibliographic citations are presented under the following major section headings: 1) abstracts and bibliographies; 2) general weeks; 3) biology; 4); development and growth; 5) ecology, geographical distribution, population dynamics; 6) culture; 7) diseases, pests and parasites, predators; 8) feeding and feeds; 9) fertilizers and fertilization; 10) reproduction; 11) law and policy; 12) research and resource development; 13) socioeconomic aspects; and 14) indices.

Keywords: fish culture; bibliographies; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

4 Anon. 1988. Milkfish abstracts. Bibliography series. Brakischwater Aquaculture Information System No. 9, SEAFDEC Aquaculture Department, Tigbauan, Iloilo City, Philippines. 104 p.

The publication covers 231 references on milkfish (*Chanos chanos*) ecology, biology, nutrition, fishery, culture and pathology. Entries are arranged alphabetically by author, and author, title, subject, taxonomic and geographic indexes provided.

Keywords: abstracts; fish culture; autecology; animal nutrition; fishery biology; pathology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

5 Anon. 2002. Fisheries Research Institute collected reprints. Fisheries Research Institute, Vol. 1.

This issue contains reprints of the following articles: Regulation of pituitary gonadotropin II and growth hormone content by sex steroids and pituitary extract in the aquacultured Japanese eel, *Anguilla japonica*. By Shan-Ru Jeng, Guan-Ru Chen, Jong-Yih Lai, Yung-Sen Huang, Sylvie Dufour, Chang-Fong Chang. Effects of dietary protein level on growth performance, carcass composition and ammonia excretion in juvenile silver perch (*Bidyanus bidyanus*). By Shuenn-Der Yang, Chyng-Hwa Liou, Fu-Guang Liu. Timing and factors affecting cannibalism drum, *Sciaenops ocellatus*, larvae in captivity. By I. Chiu Liao, Emily Y. Chang. Roles and contributions of fisheries science in Asia in the 21st century. By I. Chiu Liao. Effects of size difference and stocking density on cannibalism rate of juvenile grouper *Epinephelus coioides*. By Jinn-Rong Hseu. Hepatopancreas and ovary are sites of vitellogenin synthesis as determined from partial cDNA encoding of vitellogenin in the marine shrimp, *Penaeus vannamei*. By Deng-Yu Tseng, Ying-Nan Chen, Kuan-Fu Liu, Guang-Hsiung Kou, Chu-Fang Lo, Chang-Ming Kuo. Selectivity and accessibility of prey in captive juvenile red drum, *Sciaenops ocellatus* Linnaeus. By I. Chiu Liao, Emily Y. Chang. Inducing effects of hormones in metamorphosis-arrested grouper larvae. By Jinn-Rong Hseu, Hui-Fen Chang, Yun-Yuan Ting. Histological changes in the thyroid and digestive glands during spontaneous and artificially-induced metamorphosis of larvae of the grouper (*Epinephelus lanceolatus*). By Ying-Mei Lin, Jinn-Rong Hseu, Tsung-Han Lee. Docosahexaenoic acid is superior to eicosapentaenoic acid as the essential fatty acid for growth of grouper, *Epinephelus malabaricus*. By Feng-Cheng Wu, Yun-Yuan Ting, Houng-Yung Chen. The exotic American eel in Taiwan: ecological implications. By Y.-S. Han, C.-H. Yu, H.-T. Yu, C.-W. Chang, I. Chiu Liao, W.-N. Tzeng. An evaluation of two probiotic bacterial strains, *Enterococcus faecium* SF68 and *Bacillus toyoi*, for reducing edwardsiellosis in cultured European eel, Anguilla anguilla L.. By C.-I. Chang, W.-Y. Liu. Technical innovation in eel culture systems. By I. Chiu Liao, Ya-Ke Hsu, Wu-Chang Lee. Technical responses to challenges in milkfish aquaculture. By Mao-Sen Su, Cheng-Sheng Lee, I. Chiu Liao. Aquaculture development strategies in Asia for the 21st century. By I. Chiu Liao. Determination of in situ target strength of yellowfin tuna (*Thunnus albacares*) aggregated around sub-surface fish aggregating devices by acoustics. By Long-Jing Wu, Wei-Cheng Su, Jiun-Chern Lin, Le-Min Chen. Geographic distribution and area demarcation on the fisheries resource of South Atlantic albacore. By Chi-Lun Wu, Shean-Ya Yeh.

Keywords: fishery organizations; documents; fishery sciences; fish physiology; fish culture; aquaculture development; disease control; microbiology; marine ecology; target strength; tuna fisheries; fishery resources; commercial species; *Bidyanus bidyanus*; *Sciaenops ocellatus*; *Anguilla japonica*; *Epinephelus coioides*; *Litopenaeus vannamei*; *Epinephelus malabaricus*; *Enterococcus faecium*; *Bacillus toyoi*; *Chanos chanos*; *Thunnus albacares*; *Thunnus alalunga*; Taiwan; Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

6 Bagarinao, T. 1994. Systematics, distribution, genetics and life history of milkfish, *Chanos chanos*. Environmental Biology of Fishes 39(1):23-41.

Chanos chanos belongs to a monotypic gonorynchiform family and is most closely related to the freshwater *Ostariophysi*. At present, milkfish occurs near continental shelves and around oceanic islands throughout the tropical Indo-Pacific. Milkfish populations throughout the range show high genetic variation but low genetic divergence, similar to many other commercially important teleosts. The natural life history of milkfish is one of continual migration. Adults are relatively large (to 1.5 m or 15 kg), long-lived (to 15 years), pelagic and schooling. They spawn offshore near coral reefs or small islands. The eggs, embryos and larvae are pelagic and relatively larger than those of most marine species. Larvae greater than or equal to 10 mm long and 2-3 weeks old move inshore via a combination of passive advection and active migration. Passing shore waters and surf zones, they settle in shallow-water depositional habitats such as mangrove swamps and coral lagoons, where they metamorphose and spend a few months as juveniles. Some juveniles may enter freshwater lakes where they grow into sub-adults but do not mature. Both small juveniles and large sub-adults go back to sea when they reach the size limit supportable by the habitat. Little else is known of the dynamics of wild populations of milkfish. A fishery on inshore larvae supports the centuries-old aquaculture of milkfish in Southeast Asia. During the past ten years, milkfish have matured and spawned under various conditions of captivity, and hatcheries have produced larvae to supply the culture ponds. Much remains to be learned concerning the milkfish, particularly its ecology and physiology.

Keywords: spawning behavior; ecological distribution; dispersal; life history; phylogeny; genetic variance; *Chanos chanos*; Indo-Pacific Region
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

7 Bagarinao, T. 1994. The natural life history of milkfish. SEAFDEC Asian Aquaculture 16(3):3-6.

Following brief descriptions of the various phases in the natural life history of the milkfish (*Chanos chanos*), namely adults, eggs and embryos, larvae, fry and metamorphosis, juveniles and sub-adults, a summary is provided of the life history, providing also a schematic diagram.

Keywords: life history; developmental stages; fish culture; biological development; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC/AQD, P.O. Box 256, 5000 Iloilo City, Philippines

8 Bagarinao, T. and K. Thayaparan. 1986. The length-weight relationship, food habits and condition factor of wild juvenile milkfish in Sri Lanka. Aquaculture 55(3):241-246.

Wild juvenile milkfish (*Chanos chanos*) were obtained from Negombo lagoon in Sep. 1984. Thirty-one specimens (92-186 mm FL) had a fork length-body weight relationship of log W = -5.6083 + 3.2598 log L. These fish were caught in the early morning and had empty guts. The mean condition factor (K) was 8.7. The intestine length to fork length ratio (I) was 3.7. Two large specimens (245 mm and 340 mm FL) caught around mid-day from the ocean off Negombo had full guts. Food was mostly blue-green algae, diatoms and detritus, with a number of *copepods* and nematodes. These fish had K values of 11.7 and 13.6 and I values of 8.1 and 8.5. The age and the month of spawning of these fish were back-calculated using known milkfish growth rates. It seems that in Sri Lanka, milkfish spawn from January to at least November.

Keywords: length-weight relationships; condition factor; juveniles; fish culture; seed (aquaculture); food organisms; coastal lagoons; growth; age at recruitment; spawning; feeding behavior; *Chanos chanos*; ISW, Sri Lanka, Negombo Lagoon
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256 Iloilo City, Philippines

9 Banasihan, E.T. 1978. Levels of alpha-tocopherol and the development of rancidity in milkfish (*Chanos chanos*). University of the Philippines in the Visayas, Miag-ao, Iloilo. 89 p. M.S. thesis.

Muscle tissues from fresh round milkfish (*Chanos chanos*) was examined for the estimation of alpha-tocopherol content. Two chemical indices of fat deterioration, peroxide and iodine values were adopted to analyze the extent of fat rancidity at varying storage times. An attempt to correlate the detectable rancidity in stored round fish samples to the above objective tests was also simultaneously done. The estimated tocopherol content of milkfish was approximately 5.05 mg % which is high compared to other fishes. This is probably responsible for its known stability and rancidity. Milkfish stored at 0 deg C was observed to be rancid at its 91st hour storage. Peroxide and iodine values at this time were 19.17 meq/1000 g of fat and 63.57 g/100 g of fat respectively. Tochoperols were still present in the iced milkfish. A very high coefficient correlation was observed between the estimated tocopherols, iodine and peroxide numbers. A decrease in iodine content of the fish was found to run parallel to the decrease in the tocopherol levels. An inverse relationship was observed between the loss in tocopherol content and an increase in peroxides. The rate at which the former decrease was more rapid than the rate of increase in the latter until the 60th hour of storage. No correlation was obtained between the objective rancidity tests and the organoleptic test.

Keywords: alpha-tocopherol; rancidity; milkfish
Location: SEAFDEC Aquaculture Department Library

10 Bandonil-Tiro, L.D. 1980. Studies on the digestive proteases of juveniles and marketable-sized milkfish, *Chanos chanos* Forsskal. University of the Philippines, Quezon City. 54 p. M.S. thesis.

The distribution of total proteases, trypsin and chymotrypsin in the digestive tract of the milkfish, *Chanos chanos* is presented. The major sites of protease secretion in milkfish are the pyloric caece, intestines and pancreas. In general, protease activity is higher in fishes fed with "lablab" (a biological complex of minute plants and animals) than those fed with "lumot" (*Chaetomorpha*). The protease activities were observed to be maximal at 50°C to 60°C and at pH 9.0 to 10.5. Tryptic activities were observed only in the fishes fed with "lablab". In these fishes tryptic activity was always higher than the chymotryptic activity. Inhibition of tryptic activity by the "lumot" extract was detected. The presence of trypsin and chymotrypsin in the digestive tract of milkfish is confirmed by the inhibition of chymotryptic and tryptic activity by L-tosylamide-2-phenylchloromethyl ketone (TPCK) and soybean trypsin inhibitor respectively.

Keywords: digestive proteases; juveniles; marketable-sized; milkfish; *Chanos chanos*
Location: University of the Philippines, Quezon City

11 Banno, J.E. 1980. The food and feeding habits of milkfish fry *Chanos chanos* (Forsskal) collected from two habitats along the coast of Hamtik, Antique. University of the Philippines in the Visayas, Miag-ao, Iloilo. 77 p. M.S. thesis.

Milkfish fry were collected weekly and daily from the marine and estuarine habitats for food habit, feeding periodicity and abundance studies during the 1977 and 1978 fry seasons in Hamtik, Antique. Gut content analyses of the milkfish fry, 13.4 ± 0.9 mm total length and 7.5 ± 1.9 mg body weight, indicated that 71 of the 636 and 34 of the 391 collected weekly from the marine and estuarine habitats, respectively, contained plankton in their guts. Likewise, only 40 individuals of the 1289 marine samples and 71 of the 1377 estuarine samples collected daily, ingested plankton. Five genera of the diatoms, three of *copepods*, two types of foraminiferans, and sand grains were found in the guts of the milkfish fry. The most common were *Coscinodiscus sp., Oithona sp., Paracalanus sp.,* and *Calanus sp.* Milkfish fry started feeding on plankton at 0600 hours and stopped at 1900 hours, with active feeding at 0700 to 1300 hours, 1400 to 1700 hours and 0000 to 0200 hours which were the highest, the intermediate and the least pronounced peak feeding, respectively. The data indicate a low incidence of feeding on plankton in both habitats. This could be due to the small quantity of

plankton during fry collection. However, this also strongly suggests that the primary sources of food for the fry are the vast quantities of detritus and inorganic nutrients which abound along coastal areas and which the fry could easily utilize for their nutritional requirements. Milkfish fry abundance is not related to the height of tide, per se.

Keywords: food; feeding habit; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo, Philippines

12 Benitez, L.V., L.B. Tiro and Y.N. Chiu. 1982. The digestion process of milkfish in relation to its natural food. Presented at the Second International Symposium on Marine Biogeography and Evolution in the Pacific, 5-7 July 1982, Sydney, Perth, Australia.

The digestion process of milkfish (*Chanos chanos*) grown in brackishwater ponds was studied in relation to its natural food base of which there are two distinct types: (1) a complex community of unicellular algae and other planktons and (2) filamentous green algae and its associated organisms. Carbohydrate digestion occurred primarily in the pyloric caeca and intestines. Fish that fed on filamentous algae had general higher carbohydrase activity. A study of intestinal amylase activity and feeding index over a 24-hour period showed that amylase activity peaked once daily at about noon when milkfish gut was full. This suggests that enzyme secretion is in phase with feeding activity. Protease activity was observed mainly in the pyloric caeca, intestines and pancreas. Fish that fed on unicellular algae has a consistently higher protease activity. The activity of chymotrypsin was observed in fish grown on both types of natural food. In contrast, tryptic activity was observed only in fish grown in unicellular algae. Milkfish trypsin was strongly inhibited by crude extract from filamentous algae. This inhibition may account for the poor growth rate of fish grown on this natural food.

Keywords: digestion; natural food; milkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Aquaculture Department, SEADEC P.O. Box 256, Iloilo City, Philippines

13 Bensam, P. 1987. Early developmental stages of some marine fishes from India. 2. *Ilisha melastoma*, I. *megaloptera*, *Thryssa dussumieri*, *T. mystax* and *Chanos chanos*. Umi/la mer (Tokyo) 25(2):43-52.

Four *clupeiform* species and one *gonorhynchiform* species in the important marine fish fauna of Porto Novo, India, are described in stages of egg, larva, postlarva and juvenile, along with their diagnostic characters.

Keywords: developmental stages; marine fish; *Clupeiformes*; ISW, India, Tamil Nadu, Porto Novo
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI Reg. Cent., Mandapam Camp, 623-520 Ramnad Dist., Tamil Nadu, India

14 Bhaskar, B.R. and K.S. Rao. 1990. Use of haematological parameters as diagnostic tools in determining the health of milkfish, *Chanos chanos* (Forsskal), in brackishwater culture. Aquaculture and Fisheries Management 21(1):125-129.

The species studied in this investigation, milkfish, *Chanos chanos*, has a wide distribution in the Indo-Pacific region and is cultured extensively in the brackishwater fish farms of India and most of the Southeast Asian countries. The present investigation is aimed at assessing changes in blood values of milkfish, subjected initially to overstocking and starvation and later restocked under normal density and provided with normal feed. The information gathered is useful to determine haematological changes due to nutritional deficiency or other adverse conditions, like overstocking, leading to semistarvation or malnutrition in a cultured fish stock.

Keywords: haematology; fish physiology; stocking density; starvation; nutrient deficiency; physiology; aqua culture; nutrients; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Andhra Univ., Waltair, Visakhapatnam, India

15 Borlongan, I.G. 1990. Studies on the digestive lipases of milkfish, *Chanos chanos*. Aquaculture 89(3-4):315-325.

Milkfish (*Chanos chanos*) grown on two natural foods were examined to determine the distribution pattern of the digestive lipases along the digestive tract and to identify the optimum condition for lipase activity. One food consisted of a biological complex of unicellular algae and diatoms (Food A) and the other consisted of fibrous filamentous green algae, predominantly *Chaetomorpha brachygona* (Food B). The major sites of lipase secretion in milkfish digestive tract were the intestines, pancreas and pyloric caeca. Lipase activity was somewhat higher for fish grown on Food A than those grown on Food B. Intestinal lipase activity was observed to be maximal at 45 degree C and at pH 6.8 and 8.0. Activity of pancreatic lipase was observed to be maximal at 50 degree C and at pH 6.4 and 8.6. The detection of two well-defined pH optima, one at slightly acidic and the other at alkaline pH for both the intestinal and pancreatic lipases suggests a physiological versatility for lipid digestion in milkfish.

Keywords: feeding experiments; food organisms; diets; lipids; enzymatic activity; algae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

16 Borlongan, I.G. 1991. Arginine and threonine requirements of milkfish (*Chanos chanos* Forsskal) juveniles. Aquaculture 93(4):313-322.

Growth studies were conducted with milkfish (*Chanos chanos*) juveniles to determine the quantitative requirements for arginine and threonine. The amino-acid diets (40% crude protein) contained casein and gelatin supplemented with crystalline L-amino acids to provide an amino-acid profile similar to milkfish protein except for the test amino acid. Break-points in the growth curves which represent the optimum dietary concentration of arginine and threonine for fish growth were determined by the broken-line regression method. Based on dry diet, the requirement of milkfish juveniles for arginine is 2.10% and for threonine, 1.80%. These values correspond to 5.25% arginine and 4.50% threonine when expressed as a percentage of dietary protein.

Keywords: arginine; threonine; diets; proteins; juveniles; nutrient requirements; *Chanos chanos*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

17 Buri, P. 1979. The skull of milkfish, *Chanos chanos* Forsskal. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 3(4):1-4.

The skull of the milkfish, *C. chanos*, is described so that it may be used as a tool in identifying the effect of artificial propagation in terms of skeletal malformations.

Keywords: skull; animal morphology; induced breeding; mutations; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

18 Buri, P. 1981. Pigmentation pattern in the early developmental stages of milkfish (*Chanos chanos*): A key for larval identification. Fisheries Research Journal of the Philippines 6(1):51-55.

Pigmentation patterns are presented for 5 - 20 day old milkfish (*Chanos chanos*) and are discussed in terms of their use in larval identification.

Keywords: developmental stages; fish larvae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

19 Buri, P., V. Banada and A. Trino. 1981. Developmental and ecological stages in the life history of milkfish *Chanos chanos* (F.). Fisheries Research Journal of the Philippines 6(2):33-58.

Seven stages in the life history of milkfish *Chanos chanos* are suggested: embryonic, yolksac larval, larval, postlarval, juvenile, sub-adult and adult stages. These were based on morphological differences and on their particular ecological requirements. The latter include: behavioral pattern, food and feeding habits, and habitat requirements. Throughout the life cycle of milkfish, the stronger driving force which determines particular behavioural strategies can be attributed to the evolutionary response of the organism of food distribution (availability) followed by predation pressure.

Keywords: life history; developmental stages; ecology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

20 Cahu, C., J. Zambonino-Infante and T. Takeuchi. 2003. Nutritional components affecting skeletal development in fish larvae. Aquaculture 227(1-4):245-258.

Marine fish larvae undergo major functional and morphological changes during the developmental stages and several factors can interfere with the normal development of larvae and affect fry quality. Skeletal malformations, such as spinal malformation-scoliosis, lordosis, coiled vertebral column-, missing or additional fin rays, bending opercle or jaw malformations, are frequently observed in hatchery-reared larvae. This paper reviews the effects of some nutritional components on skeletal development in larvae of a number of fish species. In the dietary lipid fraction, for instance, it was proven that the phospholipid concentration affected the spinal malformation rate in sea bass fed a compound diet from mouth opening onwards. Phosphatidylinositol, in particular, seems to prevent skeletal deformities. Highly unsaturated fatty acids, and particularly DHA enrichment in live prey, induce a decrease of opercular deformities in milkfish. It is known that highly unsaturated fatty acids have profound effects on gene expression, leading to changes in metabolism, growth and cell differentiation, and these effects are worth investigating in developing fish. The nature of the dietary protein fraction also affects the quality of fish larvae development. It appears that dietary incorporation of 20 amino acid peptides or di- and tripeptides leads to a reduction of spinal malformations in sea bass. Among vitamins, the teratogenic effect of retinoic acid is now well documented in vertebrates. High dietary retinoic acid levels result in higher incidence of bone deformities, such as vertebral curvature, central fusion and compression of vertebra in Japanese flounder larvae. The teratogenic effect of retinoic acid observed in embryonic and postembryonic stages were explained by a depression of shh expression. As for vitamin C, opercular abnormalities in milkfish larvae, associated with distortion of gill filament cartilages, were reduced by 50% when feeding larvae with ascorbic acid enriched rotifers and *Artemia*, compared to control fish.

Keywords: animal nutrition; bones; skeleton; fish larvae; abnormalities; complex lipids; proteins; amino acids; polyunsaturated fatty acids; gene expression; vitamin C; vitamins; food organisms; nutritional requirements; biological development; *Chanos chanos*; *Paralichthys olivaceus*; *Dicentrarchus labrax*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: UniteMixte INRA IFREMER de Nutrition des Poissons, B.P. 70, 29280 Plouzane, France, [mailto:Chantal.Cahu@ifremer.fr]

21 Cariño, V.S., R. Umaly, A.A. Casauay. 1984. Effects of tritiated water (HTO) and hyperthermia on bangus fry: I. Survival, growth and gross morphology. Natural and Applied Science Bulletin 36(3/4):253-261.

Bangus fry were reared in water HTO at 10E-11, 10E-6, 10E-7 and 10E-5 Ci/l (0.37, 3.7x10E3, 3.7x10E4, and 3.7x10E5 Bq;1, respectively) under two temperature condition, namely normal (27+/- 1C) and hyperthermic (34+/- 1C). Percent survival growth and gross morphology were looked into. Percent survival in all experimental groups was negatively affected even at the lowest treatment dose of 0.37 Bq/1. Percent survival was, in general, higher in fish reared at hyperthermic conditions at all tritium levels compared to those reared at normal water temperature. Growth of fry reared at normal and hyperthermic conditions revealed no notable differences between control and treated groups. Likewise, no notable malformations in gross morphology were observed among control and treated groups exept for an eye abnormality encountered in one particular batch of fry where its incidence was prevalent among tritium reared fish under normal and hyperthermic conditions.

Keywords: tritiated water; hyperthermia; bangus fry; milkfish
Location: SEAFDEC Aquaculture Department Library

22 Carreon, J.A. 1976. Fish biology and hatchery management. Aquaculture - research papers. First PCAR Fisheries Research Congress, 7-10 March 1975, Legaspi City, Philippines.

A brief note, resubmitting comments made at the previous Research Congress in 1972, but with some additional notes relating to the problems of increasing fish production. One sp mentioned is *Chanos chanos*, where problems of supply of juveniles have been particularly severe. Other spp considered are *Crassostrea spp*, *Clarias macrocephalus*, *Tilapia*, *siganus*, *Scatophagus* and *Mugil*. The last 3 are recommended for study as potential aquaculture spp, together with oysters, shrimps and prawns.

Keywords: hatcheries; fish culture; shellfish culture; *Chanos chanos*; *Clarias macrocephalus*; *Tilapia*; *Siganus*; *Scatophagus*; *Mugil*; *Crassostrea*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

23 Chandy, M. and M.G. George. 1960. Further studies on the alimentary tract of the milkfish *Chanos chanos* in relation to its food and feeding habits. Proceedings of the National Academy of Science, India 26B (3):126-134.

In the alimentary tract of fish *Chanos*, a pair of complicated pharyngeal pockets, spiral mucosal folds in the oesophagus, a spacious corpus with giant mucous cells and massive gastric glands and highly muscular triturating pylorus are peculiar features. There are special adaptations to a diet consisting of algae and molluscs mixed with mud and sand particles. Analysis of the gut contents of different age groups of the genus *chanos*, points out the feeding habits change from fry through juvenile to adult, and that the adult fish is not exclusively a plankton feeder.

Keywords: alimentary tract; feeding habits; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

24 Chaudhuri, H. and J.V. Juario. 1977. Use of hormones in breeding cultivated warm-water fishes with special reference to milkfish, *Chanos chanos* (Forsskal). Fisheries Research Journal of the Philippines 2(2):1-6.

The role of hormones in the controlled reproduction of a few test fishes is well documented. However, information on the mechanisms of endocrine regulation of ovulation in cultivated warm-water fishes is very meager. Hormones, especially the gonadotropic hormones of piscine origin, are increasingly being used in modern aquaculture to produce the seed of many important cultivated fishes. While chorionic gonadotropin and other exogenous mammalian hormones are used in spawning the channel catfish, fish pituitary hormones are usually needed to induce spawning in the

difficult-to-spawn Asiatic carps. In mullets, however, either homoplastic pituitary gland or human chorionic gonadotropin (HCG) or a mixture of HCG and a threshold dose of the former is ordinarily injected to precipitate spawning. Of late, semi-purified salmon gonadotropin (SG-G100) has been used to induce spawning in several species of food fishes. While several marine fishes have been artificially bred by administration of hormones, induced spawning of the milkfish, *C. chanos* has been tried with little success. The milkfish is a widely distributed food fish extensively cultivated in ponds in Southeast Asia. Recently, significant results have been obtained in spawning mature milkfish captured from the wild by hormone injections. The experiments conducted on induced breeding of milkfish leading to the successful fertilization and hatching of milkfish eggs are briefly described.

Keywords: induced breeding; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

25 Chaudhuri, H., J. Juario, R. Samson and L. Tiro. 1976. Notes on the external sex characters of *Chanos chanos* (Forsskal) spawners. Fisheries Research Journal of the Philippines 1(2):76-85.

In the present study, no visible differences between the sexes of *C. chanos* with reference to external features such as coloration, shape of head, snout and operculum, presence of tubercles or nasal pores, length, size and shape as well as any roughness in the various fins, could be found. However, the anal region of the mature milkfish (sabalo) exhibits discernible anatomical differences in the male and female. The male has two main openings visible externally: the anterior anus and the posterior urogenital opening at the tip of the urogenital papilla. The female has three main openings instead of two: the anteriormost anus, followed by the genital pore and the urinary pore located posterior to the genital pore at the tip of the urogenital papilla. Internal examinations were also made on both sexes. In ripe sabalo, it is easier to distinguish the sexes since milk oozes out of the urogenital pore by pressing the abdomen of the ripe male fish. Gravid females are identified by their distended abdomens.

Keywords: sexual dimorphism; seed collection; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

26 Chaudhuri, H., J. Juario, R. Samson and R. Mateo. 1977. Notes on the external sex characters of *Chanos chanos* Forsskal spawners. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center (2):17-20.

In this study, the authors did not find any visible differences between the sexes with reference to external features such as coloration, shape of head, snout and operculum, presence of tubercles or nasal pores, length, size and shape as well as any roughness in the various fins. However, the anal region of the mature milkfish exhibits discernible anatomical differences in the male and female. In the males, there are 2 main openings visible externally. These are the anterior anus and the posterior urogenital opening at the tip of the urogenital papilla. Internally, the vasa deferentia (male genital ducts) from the testes join into a common duct about 5-10 mm from the urogenital pore. The urinary pore opens into this common duct from the dorsal side. In addition, there are 2 small pores situated on each side of the base of the urogenital papilla opening ventrally into the coelom. In the females, there are 3 main openings in the anal region instead of 2 as found in the males. The anteriormost opening is the anus followed by the genital pore. The third opening is the urinary pore which is posterior to the genital pore located at the tip of the urogenital papilla.

Keywords: morphology (organisms); sex determination; reproductive organs; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

27 Chen, C.N. and T.H. Lee. 2001. Morphological features and Na super(+)/K super(+)-ATPase immunolocalization of gills in euryhaline milkfish, *Chanos chanos*, p. 309. In: Asian Fisheries

Forum (6th: 2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, 25-30 November 2001, Kaohsiung, Taiwan: Asian fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

The morphology of gills was studied by light and scanning electron microscope on the euryhaline milkfish, *Chanos chanos* adapted to either seawater (SW) or fresh water (FW). The gill of milkfish consists of arches, long, fine and closely spaced rakers, filaments, lamellae, and the expanding septum. The epithelium of the filament could be distinguished into afferent region, interlamellar region, and efferent region. Filaments exhibit more than four types of epithelial cells: mucus cell, mitochondria-rich(MR) cell, pavement cell, and undifferentiated cell and lamellae have at least two types of cells: pavement cell and pillar cell. In order to realize the distribution of MR cells in the gill epithelium, the combined ZIO fixation was used to label MR cells. The results show that MR cells of the milkfish were found in the afferent side of interlamallar region of the gill filament. Furthermore, to confirm the functions of MR cells, Na super(+)/K super(+)-ATPase was localized by immunofluorescent staining and observed by the confocol microscope in gills of FW- and SW-adapted fish.

Keywords: gills; fresh water; saline water; cell morphology; enzymes; sodium; potassium; epithelia; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Zoology, National Chung-Hsing University, Taiwan, [mailto:thlee@dragon.nchu.edu.tw]

28 Chen, C.S., C.Y. Tsao, S.T. Jiang. 1989. Purification and characterization of proteases from the viscera of milkfish (*Chanos chanos*). Journal of Food Biochemistry 12(4):269-288.

Proteases in acetone powder prepared from milkfish (*Chanos chanos*) viscera were extracted with deionized water and purified by ammonium sulfate fractionation, Sephadex G-75 gel filtration, repeated DEAE-Sephadex A-50 and CM Sepharose CL-6B chromatography. Four fractions with caseinolytic activity, named A, B, C and D, were obtained from CM-Sepharose CL-6B and DEAE Sephadex A-50 chromatography. The four proteases were purified to electrophoretic homogeneity. Substrate specificity studies indicated that proteases A and B were carboxypeptidase A-like and chymotrypsin-like enzymes, respectively; C and D were trypsin-like enzymes.

Keywords: digestion; proteins; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

29 Chen, C.S., D.C. Hwang and S.T. Jiang. 1988. Purification and characterization of milkfish (*Chanos chanos*) myosin. Bulletin of Japanese Society of Scientific Fisheries 54(8):1423-1427.

Milkfish (*Chanos chanos*) myosin was isolated and purified. Milkfish myosin contained a 200 Kd heavy chain and three light chains with molecular weights of 22, 19, and 16 Kd. The amino acid composition was similar to those of cod and tilapia. The total SH group content of myosin, 34-38 mol/5 x 10 super (5) g, was higher than those of cod and tilapia, and close to that of rabbit myosin. According to the inactivation rate constant of myosin Ca-ATPase (Kd), the thermal stability of milkfish myosin was higher than that of tuna, but lower than that of carp. The intrinsic viscosity was 2.4 dl/g, close to that of carp and rabbit myosin.

Keywords: myosin; physicochemical properties; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Grad. Sch. Mar. Food Sci., Natl. Taiwan Coll. Mar. Sci. and Technol., Keelung 20224, Taiwan

30 Chen, C.Y. and H.N. Chou. 2001. Ichthyotoxicity studies of milkfish *Chanos chanos* fingerlings exposed to a harmful dinoflagellate *Alexandrium minutum*. Journal of Experimental Marine Biology and Ecology 262(2):211-219.

Milkfish (*Chanos chanos* Forsskal) fingerlings were treated with toxic, nontoxic dinoflagellate *Alexandrium minutum* cells or toxic algal extract in the water medium without any aeration. Mortality of fish increased with increasing concentrations of toxic, nontoxic algal cells and water-soluble toxic algae extract. Milkfish fingerlings, which were exposed to toxic algae (1.5 x 10 super(4)-3.0 x 10 super(4) cells/ml) or algal extract [5.13 x 10 super(3)-2.05 x 10 super(4) cells/ml, 0.195 MU/10 super(4) cells (toxin concentration)] for 24 h, revealed by light microscopic observations a noticeable edema, hyperplasia and necrosis of secondary gill lamellae. The same toxicological symptom was observed in fish exposed to pure saxitoxin (STX) (6.475 x 10 super(-2) mu g/ml) in the water medium. A higher critical oxygen pressure and oxygen consumption rate were also found in the milkfish fingerlings exposed to toxic algae extract (5.13 x 10 super(3)-2.05 x 10 super(4) cells/ml) and STX (6.475 x 10 super(-2) mu g/ml). The cells of nontoxic A. minutum did not cause the gill damage to milkfish, and the extract of nontoxic algae did not cause an increase in oxygen consumption rate or critical oxygen demand of milkfish. From these results, we infer that toxic cells and its extract cause nonspecific response in gill tissues of milkfish. An instant increase in oxygen consumption rate and oxygen demand may be one of the major causes of fish death.

Keywords: biological poisons; toxicity; algal blooms; histopathology; fingerlings; oxygen consumption; fish culture; aquaculture; toxins; dinoflagellates; mortality; algae; *Alexandrium minutum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Science and Technology Information Center, National Science Council, 15F, No. 106, Hoping E. RD., Sec. 2, Taipei 106-36, Taiwan, ROC, [mailto:cychen@mail.stic.gov.tw]

31 Chen, W.L., C.J. Chow and Y. Ochiai. 1998. Effects of acid and alkaline reagents on the color and gel-forming ability of milkfish kamaboko. Fisheries Science 64(1):160-163.

The ordinary muscle of fresh milkfish *Chanos chanos* was ground with different concentrations of alkaline reagent (sodium carbonate), acid (malic and citric acid), and glucono- delta -lactone, and processed into kamaboko gel through setting and heating. In the presence of sodium carbonate, the whiteness of kamaboko was decreased dependent on the concentration, though the gel-strength was not much affected. The addition of malic or citric acid could improve the whiteness of kamaboko, but the gel-strength was greatly deteriorated. On the other hand, glucono- delta -lactone, when added up to 0.4%, lightened the kamaboko without deteriorating the quality, and was thus considered to be an effective whiteness improver for milkfish kamaboko.

Keywords: pH; colour; organic acids; gels; food technology; processing fishery products; minced products; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Foo Yin Inst. Technol. Ta-Liao Hsiang, Kaohsiung Hsien, 831 Taiwan, R.O.C.

32 Chiou, S.F. and M.C. Chang. 1994. Correlation between extracellular enzymes and virulence of *Aeromonas hydrophila*. Journal of the Fisheries Society of Taiwan 21(4):369-379.

Aeromonas hydrophila is an opportunistic pathogen which causes the hemorrhagic septicemia of fish. This study examined the influence of extracellular enzymes of the bacteria in fish and mouse cells in vitro. The plasmid containing deoxyribonuclease (DNase) gene or lipase gene or protease gene from A. hydrophila was transformed into *Escherichia coli*. After these *E. coli* were cultured for 12 hours, the supernatant was analysed for enzyme activity and was examined for its cytotoxic effect on cell lines of milkfish *Chanos chanos* and mouse fibroblast. The results showed that fish cells died after exposed to the culture supernatant of A. hydrophila for 6 hr. However, cells treated with the culture supernatant of *E. coli* containing DNase or lipase gene showed little change, while cells treated with the culture supernatant of E. coli containing protease gene showed some morphological change with the appearance of small spots. The similar effect was also observed on mouse fibroblast cells treated with cloned protease. Therefore, it is suggested that DNase or lipase has little contribution on the virulence of the bacteria, while protease does. Nevertheless, protease is not the sole virulence factor. It has to interact with other factors to be effective.

Keywords: virulence; enzymes; plasmids; *Aeromonas hydrophila*; *Escherichia coli*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Mar. Resour., Natl. Sun Yat-sen Univ., Kaohsiung, Taiwan 804

33 Chiou, T.K., C.Y. Shiau and T.J. Chai. 1990. Extractive nitrogenous components of cultured milkfish and tilapia. Bulletin of Japanese Society of Scientific Fisheries 56(8):1313-1317.

The nitrogenous components extracted from the homogeneous fillets of cultured milkfish *Chanos chanos* and *Tilapia Oreochromis* were analysed and compared. There was significant difference in the profile of free amino acids between milkfish and tilapia. Histidine was the most prominent and accounted for about 80% of the total free amino acids in milkfish. On the other hand, tilapia was rich in taurine and glycine, but contained only a small amount of histidine. The pattern of the extractive components of milkfish was found to be similar to that of red-fleshed fish, and tilapia seemed to be analogous to white-fleshed fish.

Keywords: chemical extraction; amino acids; fish culture; *Chanos chanos*; *Oreochromis*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., P.O. Box 25280, Honolulu, HI 96825, USA

34 Chiu, Y.N. and L.V. Benitez. 1982. Studies on the carbohydrases in the digestive tract of the milkfish *Chanos chanos*. Marine Biology 61(2-3):247-254.

Crude extracts from various regions of the digestive tract of pond grown milkfish were tested for their ability to catalyze the hydrolysis of various carbohydrates. The most active carbohydrases were those involved in the hydrolysis of alpha -glucosidic bonds. Maltose, trehalose, dextrin, starch and glycogen were rapidly hydrolyzed in the presence of crude extracts from the intestines and the pyloric caeca. These results are consistent with earlier observations that the milkfish is a daytime feeder and suggest further that intestinal amylase secretion is in phase with the feeding activity of the milkfish. Although the fishes used in this study fed mostly on the naturally occurring algae in the ponds, no cellulase activity was detected in any region of the digestive tract. Less active carbohydrases that were detected include a beta –glucosidase and beta -galactosidase, both of which were of limited substrate specificity.

Keywords: enzymatic activity; metabolism; carbohydrates; diurnal variations; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dept., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

35 Chiu, Y.N., M.P. Macahilig and M.A.S. Sastrillo. 1986. Preliminary studies of factors affecting the feeding rhythm of milkfish (*Chanos chanos* Forsskal), p. 547-550. In: Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society. Manila, Philippines.

Milkfish (*Chanos chanos*) raised in brackishwater fishponds have been observed to be daytime feeders. Three experiments were conducted to investigate the effects of DO, artificial feed and light on the feeding rhythm of milkfish. Fish were reared in covered and uncovered circular canvas tanks supplied with water flowing through at different rates from an adjacent pond and were either fed or not fed with artificial feed. Varying flow rates resulted in different DO patterns. Fish were sampled at regular intervals for 24 hours and feeding index determined. The 3 experiments consistently demonstrated feeding behavior patterns: (1) regardless of any of the experimental parameters, peak feeding occurs during the day and the gut is completely devoid of food between 10 p.m. and 2 a.m.; (2) in the presence of both natural and artificial food, natural food is preferred during the light hours while artificial feed is preferred during dark; (3) below a certain limiting DO of about 1.5 ppm, milkfish stop feeding.

Keywords: fish culture; pond culture; environmental factors; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Brackishwater Aquacult. Cent., Univ. Philippines in the Visayas, Leganes, Iloilo, Philippines

36 Coburn, M.M. and P. Chai. 2003. Development of the anterior vertebrae of *Chanos Chanos* (*Ostariophysi: Gonorynchiformes*). Copeia (1):175-180.

The development of the anterior vertebrae were examined in late larval and early juvenile *Chanos chanos*, with a focus on character states that have been used in ostariophysan systematics such as the expansion of dorsal cartilages of the anterior neural arches. In *Chanos*, these changes take place in juvenile fishes beginning at about 12.0 mm SL. This contrasts sharply with the ontogeny of the otophysan Weberian apparatus, which occurs in early to midlarval stages. A supraneural space is present in *Chanos*, between neural arch 1 and the occiput. It is into this space that the cartilages of neural arch 1 and the supraoccipital expand. We also found paired nodular cartilages are present in the supraneural space but are incorporated into the supraoccipital cartilage by about 15.5 mm SL. These cartilages may represent an accessory neural arch (ANA).

Keywords: biological development; larval development; ontogeny; cartilage; bones; skeleton; osteology; vertebrae; *Ostariophysi*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Biology Department, John Carroll University, University Heights, Ohio 44118; and (PC) University School, 2785 SOM Center Road, Hunting

37 Coloso, R.M. and I.G. Borlongan. 1999. Significant organotin contamination of sediment and tissues of milkfish in brackishwater ponds. Bulletin of Environmental Contamination and Toxicology 63(3):297-304.

Organotin pesticides, triphenyltin acetate or hydroxide have long been used as an inexpensive method to control the population of brackish water snails *Cerithidea cingulata* in the pond culture of milkfish (*Chanos chanos* Forsskal), and important food fish in the Philippines. The use of organotin pesticides has been banned for several years now because the chemical renders the soil sterile, is nonbiodegradable and bioaccumulates, and is hazardous to humans. Despite the ban, the clandestine use of the pesticide in milkfish ponds continues to threaten the environment and humans.

Keywords: organotin compounds; sediment pollution; water pollution; brackish water; ponds; bioaccumulation; tin compounds; pollution monitoring; fish; public health; contamination; organic matter; sediment contamination; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Pharmacology and Physiology, New Jersey Medical School, University of Medicine and Dentistry of New Jersey, University Heights, 185 South Orange Avenue, Newark, NJ 07103, USA

38 Crear, D. 1981. Observations on the reproductive state of milkfish populations (*Chanos chanos*) from hypersaline ponds on Christmas Island (Pacific Ocean), p. 548-556. In: Proceedings of the Eleventh Annual Meeting, 5-8 March 1980. World Mariculture Society, New Orleans, Louisiana.

Specimens collected from one isolated population showed a mean gonadosomatic index (GSI) of 3.6. Virtually all males from this population were running ripe. Several mature females with GSI values ranging from approximately 15 to 25 were captured. One was running ripe. The high GSI maintained by this population and observations of running ripe fish and fingerlings in other ponds with salinities ranging from 60 to 130 ppt indicated that the milkfish spawn on a year-round basis in these landlocked lagoons. Milkfish in hypersaline ponds matured sexually in spite of severely stunted growth. Mature fish from several hypersaline ponds (normal salinity 100-130 ppt) had mean weights of only one kilogram. Several adult milkfish were observed at salinities up to 158 ppt. Reproductive readiness in the fish appeared to be determined by the interaction of diet and salinity with the effect of diet prevailing. Inclusion of the brine shrimp (*Artemia salina*) in the diet of the

milkfish was the strongest stimulant to the production of reproductive tissue. Stunted populations of milkfish on Christmas Island offer an attractive opportunity to study the reproductive physiology of the species due to the relative ease in handling the smaller fish.

Keywords: coastal lagoons; salinity effects; sexual maturity; spawning; *Chanos chanos*; ISE, Christmas I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: AECOS, Inc., 46-132 Kahuhipa St., Kaneche, HI 96744, USA

39 Crim, L.W. and C.S. Lee. 1988. Characterizing the stage of maturity most receptive to an acute LHRH-analogue therapy for inducing milkfish (*Chanos chanos*) to spawn. Aquaculture 74(1-2):147-163.

This paper discusses two factors critical to the effective use of acute LHRH-a therapy in the induced spawning of milkfish, *Chanos chanos*: (1) the stage of maturity at which female milkfish respond to a single injection of LHRH-a, and (2) the minimum effective dosage of LHRH-a. The in vivo pattern of oocyte growth was found to be consistent between and within individuals. A predictive model of egg growth, i.e. egg size = 359.077 + 28.796 (days) -0.475 (days super(2)), was formulated from the current data and validated with growth rates from a 1985 study. Changes in serum levels of estradiol-17 beta and testosterone were highly correlated with egg growth. The endocrine profile that occurs at the stage of maturity most receptive to inducing milkfish to spawn is discussed. The minimum effective dosage of LHRH-a ranged between 1 and 5 mu g/kg body weight. Dosages administered to the male milkfish (20-65 mu g/kd body weight) were not correlated with the occurrence of fertilized spawns.

Keywords: induced breeding; spawning; sexual reproduction; sexual maturity; sex hormones; animal physiology; aquaculture; oocytes; luteinizing hormone-releasing hormone; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA

40 Crosby, M.D., M.C. Cremer, W.L. Shelton and J.S. Ramsey. 1982. Synopsis of biological data on milkfish *Chanos chanos* (Forsskal) 1775. 152 p. (Final report submitted to the National Fishery Researh Laboratory, USFWS)

The taxonomy and biology of milkfish *Chanos chanos* are comprehensively discussed.

Keywords: milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

41 Cruz, E.R. and C.T. Tamse. 1986. Histopathological response of milkfish *Chanos chanos* Forsskal fingerlings to potassium permanganate. Fish Pathology 21(3):151-159.

Static 96 h bioassays were conducted on milkfish fingerlings at concentrations ranging from 1.00 to 1.80 mg/l KMnO sub(4). Histopathological analyses of gills, liver, and kidney tissues revealed significant changes even in non-lethal concentrations tested. Damage became severe with increasing concentration and longer exposure to the chemical. Partial to complete recovery was observed in gills, liver, and kidney cells of fish exposed to KMnO sub(4) for 96 h and then maintained in KMnO sub(4)-free seawater for 240 h.

Keywords: histopathology; bioassays; toxicity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

42 Dayaratne, P. 1988. Age and growth estimates of milkfish (*Chanos chanos* Forsskal) using growth rings in the otoliths. Journal of Inland Fisheries 4:11-15.

Some observations made on the otoliths of *Chanos chanos* fingerlings collected from the coastal waters of Sri Lanka are presented. The age of the fingerlings were estimated by counting the growth rings in the otoliths and an attempt was made to determine the spawning season of this species by back calculations. The pattern of ring deposition in otolith and the estimates of growth and spawning season indicate that the primary rings in the otoliths are formed daily.

Keywords: age determination; otolith reading; spawning seasons; fingerlings; *Chanos chanos*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Natl. Aquat. Resour. Agency, Crow Island, Mattakkuliya, Colombo 15, Sri Lanka

43 De Jesus, E.G.T., F.G. Ayson, Y. Amemiya, S. Moriyama, S. Hyodo, T. Hirano and H. Kawauchi. 2002. Milkfish (*Chanos chanos*) growth hormone cDNA cloning and mRNA expression in embryos and early larval stages. Aquaculture 208(1-2):177-188.

In an attempt to understand growth regulation in milkfish, the milkfish growth hormone (GH) and its cDNA were characterized and the expression of GH mRNA in embryos and larvae was examined by RT-PCR. The milkfish GH was purified from an alkaline extract of the pituitary by reverse-phase high-performance liquid chromatography and detected as an immuno-positive protein with anti-salmon GH serum. The complete sequence of milkfish pre-GH was determined by cDNA cloning and nucleotide sequencing. On the basis of the N-terminal amino acid analysis of the native protein, the pre-GH was found to consist of a signal peptide of 22 amino acids and a mature protein of 188 amino acids. Milkfish GH shows higher amino acid sequence identity with GHs of carps (91-94%) and salmonids (70%) than with GHs of more advanced teleosts (60%) in good accordance with its taxonomic position in teleosts. It has five half Cys residues, four of which are at positions homologous with those of other known GHs and the extra Cys with those of carp GHs. The molecular weight of milkfish GH was estimated to be 22 kDa, which is comparable to the theoretical value. This suggests that milkfish GH is a simple protein, although it has two potential N-glycosylation sites. Semiquantitative RT-PCR showed that GH mRNA expression was relatively weak in embryos and newly hatched larvae but was already strong in 2-day old and older larvae.

Keywords: mRNA; growth hormone; embryos; larvae; RNA; hormones; DNA; nucleotide sequence; gene expression; amino acid sequence; fish larvae; growth regulators; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA), SEAFDEC Aquaculture Department Library
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

44 De Jesus, G.E. 1994. Thyroid hormone surges during milkfish metamorphosis. Israeli Journal of Aquaculture/Bamigdeh 46(2):59-63.

Both thyroxine (T sub(4)) and triiodothyronine (T sub(3)) were detected in fertilized eggs and larvae of milkfish (*Chanos chanos*). The concentration of T sub(4) was lower than that of T sub(3) only in fertilized eggs and newly-hatched larvae. The total body concentrations of both thyroid hormones decreased after hatching. The T sub(4) concentration fluctuated at relatively low levels during the first week after hatching, increased gradually during the next 2 weeks and was highest in 4-week-old larvae. On the other hand, T sub(3) was undetectable in samples taken between days 3 and 11, showed a gradual increase beginning on day 13 and was highest in 27 day old larvae. The concentrations of both T sub(4) and T sub(3) declined again in 31-day-old juveniles. The peak corresponds with the development of silver coloration in hatchery-reared milkfish and the inshore milkfish and the inshore migration of larvae in the wild, suggesting a role for thyroid hormones during early development of this species.

Keywords: hormones; metamorphosis; fish larvae; thyroid; fish culture; growth regulators; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

45 Duldoco-Requintina, P.J. 1979. Lactate dehydrogenase isozyme patterns of milkfish, *Chanos chanos* (Forsskal), and their sequential variations during development. University of the Philippines in the Visayas, Miag-ao, Iloilo. 40 p. M.S. thesis.

The lactate dehydrogenase (LDH) isozyme pattern for fry (0.0050-0.0080 g), fingerling (6-12 g), pond-size (150-250 g) and adult milkfish (6000-9000 g) obtained by polyacrylamide disc gel electrophoresis are presented. The patterns were tissue-specific; the different tissues examined namely, eyes, liver, heart and skeletal muscle had different expression of their LDH isozymes. The LDH patterns resolved for milkfish appeared to be products of LDH gene loci A, B and C. The A and B sub-units were found in all tissues; A_4 was predominant in the skeletal muscle while B_4 was predominant in the heart muscle. The A_4 and B_4 associated *in vivo* in a non-random manner forming only heteropolymers A_3B and AB_3. The L4 which was assumed to be coded by the C locus was found predominant in the liver of the fingerling, pond-size and adult milkfish. A cathodally migrating band, X_4, was found in the fry (homogenized as whole individuals) and in the ovary of a sexually mature female but disappeared in the fingerling stage. Several explanations are advanced to account for the X_4 band.

To understand the physiology of stunting as practiced with milkfish, the LDH patterns of normal fingerlings were compared with that of the six-month old stunted fingerlings and the eleven-month old stunts. The LDH patterns of the six-month old stunts were the same as those of the normal fingerlings for all tissues. In contrast, the eye of the eleven-month old stunts had an LDH pattern similar to the adult, while the rest of the tissues had patterns similar to the normal fingerlings.

A change in salinity did not cause a change in the LDH isozyme pattern of the fish. The same pattern for LDH isozyme was observed for milkfish stunted for six months in different salinities (0-5 ppt, 15-20 ppt, 32-35 ppt).

Keywords: lactate dehydrogenase isozyme; sequential variations; development; breeding
Location: University of the Philippines in the Visayas Main Library Miag-ao, Iloilo.

46 Dwivedi, S.N., D.V. Reddy, O.P. Bohra and K.K. Pillai. 1980. Observations on the growth rates of milkfish (*Chanos chanos)* in relation to the abiotic factors at Kakinada fishfarm. Comparative Physiology and Ecology 5(4):285-287.

The method of rearing milkfish at Kakinada Fish farm is discussed in this article. Physico-chemical parameters are monitored weekly.

Keywords: growth rates; abiotic factors; milkfish
Location: SEAFDEC Aquaculture Department Library

47 Emata, A.C. and C.L. Marte. 1992. The use of a visual implant tag to monitor the reproductive performance of individual milkfish *Chanos chanos* Forsskal. Journal of Applied Ichthyology 8(1-4):314-317.

Nine-year old milkfish (*Chanos chanos*) (3.8 kg., average body weight) were individually marked with Visible Implant (VI) tags to monitor their reproductive performance following hormonal induction. All tags were retained after one year; only 5 out of 64 tags were not readable due to improper implantation. The advantages of using VI tags include: less tagging time (less than one minute), high retention rate, longer retention, infection-free, and easily readable.

Keywords: sexual reproduction; tagging; growth; marking; sex hormones; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

48 Farag, A.A.A., M.T. Hashim and O.A.H. Abuzinadah. 1997. Histological studies on the bucco-pharynx of the milkfish *Chanos chanos* (Forsskal) from the Red Sea. Journal of King Abdulaziz University: Marine Sciences, Jeddah 8:177-191.

The mucosal epithelium of buccal and pharynx cavities of the milkfish, *Chanos chanos* is a stratified one, provided with numerous secretory cells and taste buds. The formers become more numerous as one passes caudally towards the pharynx while the taste buds show a reverse tendency. The epithelium lining the epibranchial organs is greatly similar to that of pharynx. The lamellar structure that is in the entrance canal of these organs can be considered as modified gill filament according to its histological structure, and the epibranchial organs function principally as accessory to the digestive system. The vascular's supply to both the core and the mucosa that covers the rakers makes us believe that they are respiratory gill filaments.

Keywords: histology; marine fish; epithelia; alimentary organs; mouth parts; taste organs; *Chanos chanos*; ISW, Red Sea
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Biological Dept., King Abdulaziz University Jeddah Saudi Arabia

49 Ferraris, R.P., J.M. Almendras and A.P. Jazul. 1988. Changes in plasma osmolality and chloride concentration during abrupt transfer of milkfish (*Chanos chanos*) from seawater to different test salinities. Aquaculture 70(1-2):145-157.

Milkfish juveniles (*Chanos chanos*), (40, 120 or 260 g) were acclimated to 32 ppt seawater, then abruptly transferred to water with salinities of 0, 16, 32 (control) or 48 ppt. Survival rate was 95% or greater in all salinities. Plasma osmolality in fish exposed to salinities other than 16 or 32 ppt deviated from control values immediately after transfer but were subsequently regulated to near normal levels after several days. Plasma chloride values generally followed the same pattern of changes as plasma osmolality. Results indicate that small milkfish tend to adapt better to fresh than to hypersaline water while larger milkfish are more likely to find hypersaline water less stressful than freshwater. Like other organ systems previously studied in milkfish, these size-dependent adaptations in osmoregulatory mechanisms reflect natural habitat shifts during development.

Keywords: haematology; osmoregulation; habitat selection; acclimation; survival; life history; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

50 Gandhi, V., G. Mohanraj, R. Thiagarajan. 1986. Biology and biometry of milkfish *Chanos chanos* (Forsskal). Journal of the Marine Biological Association of India 28(1-2): 169-177.

Observations made on the length-weight relationship for adult milkfish (*Chanos chanos*), ova-diameter frequency distribution, relationship between fecundity and total length, fecundity and standard length, and weight and fecundity are presented. The regression lines for 17 morphometric characters in relation to the standard length were worked out. Snout to anal origin grows faster than snout to ventral origin. Head length shows faster rate of growth than head depth. The stomach content revealed the presence of diatoms predominantly. Fecundity varied between 1,424-5,321 thousands in the fish in the size range of 1,100-1,340 mm.

Keywords: length-weight relationships; fecundity; biometrics; *Chanos chanos*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Cochin 682 031, India

51 Garcia, L.M.B. 1988. Fisheries biology of milkfish (*Chanos chanos* Forsskal). In: H. Tanaka, K.R. Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). Proceedings of the regional workshop on milkfish culture development in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific aquaculture Development project. FAO/UN, Suva, Fiji. (IS)

Milkfish (*Chanos chanos* Forsskal) is one of the most important food fish species in the world. In Indonesia, Taiwan and the Philippines, more than a quarter of a million tonnes of milkfish are harvested annually in brackishwater ponds, contributing roughly 60% of the total fish production from aquaculture in Southeast Asia. This tremendous level of production from a single fish commodity is projected to further increase in the coming years to meet the dietary protein needs of an ever-growing population in Southeast Asia. To address vital research gaps afflicting the milkfish industry, research has correspondingly intensified over the past 15 years particularly in the Philippines, Taiwan and Hawaii. Results of such research projects have widespread application not only among Southeast Asian nations but also among many untapped areas in the Pacific, the Middle East, Africa and Central America where milkfish culture is feasible. A sound approach to initiate a milkfish aquaculture project is to have an adequate knowledge of the basic biology of this species. Several researchers have presented in great technical detail some of these biological aspects at numerous symposia (Juario et al., 1984, Lee, Gordon and Watanabe, 1986). This paper will therefore summarize in moderate detail some recent additional information on several aspects of milkfish biology: taxonomy, distribution, life history and habitat, food and feeding habits, growth, reproduction and tolerance to environmental conditions. Aside from increasing our understanding of milkfish, it is hoped that this short review will goad others to undertake further scientific research on many unknown aspects of the species, thus contributing to both the quality and the quantity of milkfish served on our dinner tables.

Keywords: fisheries; biology; milkfish; *Chanos chanos*
Location: http://www.fao.org
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

52 Garcia, L.M.B. and R.S.J. Gapasin. 1988. An inexpensive tag for short-term studies in milkfish (*Chanos chanos* Forsskal) and in seabass (*Lates calcarifer* Bloch). Journal of Applied Ichthyology 4(3):101-104.

An opercular tag for marking adult milkfish (*Chanos chanos* Forsskal) and seabass (*Lates calcarifer* Bloch) is described. High tag retention and relatively low mortality rates were observed in adult fish handled two to ten times during 14- to 60-day tests. The features and advantages of the tag for marking large-sized fish in short-term studies are discussed.

Keywords: tags; size distribution; methodology; *Teleostei*; *Chanos chanos*; *Lates calcarifer*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

53 Gerochi, D.D., P.G. Padlan, I.D. Buenconsejo, J.N. Paw and E.M. Rodriguez. 1978. Minimum dissolved oxygen tolerance of four different sizes of milkfish. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(4):7-10.

Four size groups of milkfish were tested, 4-18 g, 20-34 g, 35-95 g and 200-300 g. A number of fish from each group were placed separately in identical 1.2 mSUP-2 wooden tanks containing seawater filled up to 30 cm depth. The aggregate weight of fish per size group was approximately 1 kg. The fish were held for 72 h, fed with lab-lab and provided with continuous aeration to allow recovery from stress during transport and handling. After the recovery period, aeration was stopped and 200 g of the fine rice bran was spread over the water in each tank creating a film of bran particles on the water surface. This was designed to speed up depletion of dissolved oxygen considering the combined effects of the screening-off of sunlight, the reduction of air-water interface and the breakdown of the bran particles. It is probable that stress on milkfish in brackishwater ponds could start when oxygen level drops to about 1.4 ppm. A further decrease to 0.04 ppm could produce a total kill of all specimens above 4 grams with marketable size and bigger size fish dying first.

Keywords: fish culture; oxygen consumption; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

54 Gordon, M.S. and L.Q. Hong. 1986. Biology (milkfish culture), p. 1-35. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of Milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

A summary is given of present knowledge on the biology of wild milkfish (*Chanos chanos*) in their natural environments.

Keywords: cultured organisms; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Biol., Univ. California, Los Angeles, CA 90024, USA

55 Grover, J. H. and R.O. Juliano. 1976. Length-weight relationship of pond-raised milkfish in the Philippines. Aquaculture 7(4):339-346.

Milkfish (*Chanos chanos*) from culture ponds in the provinces of Bataan, Iloilo and Pangasinan in the Philippines were measured and weighed during the period December 1970 to November 1971. The overall length-weight relation was computed from 6304 measurements and gave the equation log W = -5.0463 + 2.98895 log L, where W = weight in g and L = total length in mm. A table is presented giving calculated weights for milkfish in the length range 80 to 400 mm, which can be used to compute relative condition factors.

Keywords: fish culture, *Chanos chanos*, Philippines
Location: CAB Direct Database
Author Affiliation: Dep. Fisheries and Allied Aquacultures, Auburn Univ., Agricultural Experiment Station, Auburn, Ala. 36830, USA.

56 Herrera, A.A., E.A Amparado and M.D. Santos. 1995. Laboratory studies on the effect of heavy metals (Zn and Cu) and on organophosphate (Gusathion) on *Chanos chanos*. Third National Symposium in Marine Science of the Philippine Association of Marine Science, 23-24 May 1994. Iloilo, Philippines.

This project aims to determine the histopathological effects of chronic zinc, copper and organophosphate (Gusathion) exposure on the homeostatic organs of *Chanos chanos* reared in the laboratory. In fry, LC50 for CuSO sub(4) is 96h at 0.06 mg/L. In fingerlings, LC50 for ZnCl sub(2) is 96h at 25 mg/L. Tissue bioaccumulation with chronic exposure and water quality testing are determined by Atomic Absorption Spectrophotometry. Light and electron microscope processing are ongoing.

Keywords: marine fish; heavy metals; toxicity; bioaccumulation; fish physiology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ. Philippines, 1101 Diliman, Quezon City, Philippines

57 Hsieh, S.L. and C.M. Kuo. 2001. Physiological responses to cold shock in milkfish and grass carp, p. 305. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Milkfish is an economically important cultured teleost in Southeast Asian region, and its industry in Taiwan has played a significant role in the fisheries development in the past. However, they are known to be a tropical teleost, less tolerant to the cold temperatures. Mass mortality of milkfish has repeatedly reported during the severe cold. In order to comprehend the cold adaptation mechanisms of stenothermic teleost (i.e., milkfish) and eurythermic teleost (i.e., grass carp), the physiological responses of these species under cold shock were compared. The experimental fish were acclimated at 25 degree C and then exposed directly to cold-shocked at 15 degree C. Their physiological responses were monitored at varying time intervals 1 week for milkfish, and for 3 weeks for grass

carp. Remarkable hyperglycaemic responses of milkfish were detected, increasing rapidly from the initial level of 85 plus or minus 4.88 to 458.2 plus or minus 14.57 mg/dl at 15 degree C on day 1. Although glycemic responses of cold tolerant grass carp at 15 degree C were evident, plasma glucose elevation was insignificantly different from the control. Besides, the significant elevation of plasma lactate contents in milkfish were observed on days 1 and 2, and then followed by a rapid decline from day 3 on, in which the plasma lactate maintained at level insignificantly different from that of day 0. By contrast, in grass carp plasma lactate showed a gradually and steady increase. Plasma lipid, contents in milkfish increased from 44.8 plus or minus 2.48 to 191 plus or minus 9.08 mg dl super(-1) over 5 days period, followed by a decreasing trend down to 125.6 plus or minus 6.55 mg dl super(-1) on day 7. In grass carp, they increased continuously and were all significantly higher than that at 25 degree C. Moreover, liver microsome stearoyl-CoA desaturase activities in milkfish at 15 degree C were also all significantly higher than those at 25 degree C, but in grass carp, the changes in the activities were insignificant in initial 7-day period, and the desaturase activities increased dramatically on days 14 and 21. The proportions of both monounsaturated and polyunsaturated fatty acids in milkfish dramatically increased to the peak on day 3 followed by a decreasing trend, and the proportion of saturated fatty acid decreased steadily to the lowest followed by an increasing trend. Differently, the proportions of fatty acids in grass carp, neither saturated nor unsaturated, did not change significantly before day 7 but increased unsaturated fatty acids and decreased saturated fatty acid were observed at days 14 and 21 only. In summary, physiological responses to cold stress is evidently different in stenotherms and eurythems. The degree of the response also varies with the fish tolerability to the temperature changes.

Keywords: fish culture; temperature effects; temperature tolerance; cold resistance; fish physiology; *Chanos chanos*; *Ctenopharyngodon idella*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, National Pingtung University of Science and Technology, Pingtung 912, Taiwan, [mailto:cmkuo@mail.npust.edu.tw]

58 Hshieh, S.L. and C.M. Kuo. 2005. Stearoyl-CoA desaturase expression and fatty acid composition in milkfish (*Chanos chanos*) and grass carp (*Ctenopharyngodon idella*) during cold acclimation. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 141(1):95-101.

Desaturation of fatty acids is an important adaptation mechanism for fish to maintain membrane fluidity under thermal stress. To comprehend the temperature adaptation mechanism in fish, we investigated the difference in the changes of stearoyl-CoA desaturase expression and fatty acid composition between milkfish and grass carp under cold acclimation. We find that in both fish the proportions of unsaturated fatty acids at 15 degrees C are all higher than those at 25 degrees C. In milkfish Delta(9)-desaturation index (ratios of 16:1/16:0 and 18:1/18:0) increases significantly in the beginning of cold acclimation at 15 degrees C and decreases afterward, but in grass carp it increases slightly in the beginning of cold acclimation followed by a sustained dramatic increase. Similarly, activity of stearoyl-CoA desaturase in milkfish increases significantly in the beginning, peaks at day 4, and then decreases constantly, but in grass carp it increases gradually in the first week, rises dramatically afterward, and then maintains a very high level. The change of stearoyl-CoA desaturase activity is parallel to the change of Delta(9)-desaturation index in both milkfish and grass carp, but it is one day earlier than Delta(9)-desaturation index in milkfish. The difference of adaptation capability between milkfish and grass carp under cold stress is further evidenced by RT-PCR and Northern blot analysis of stearoyl-CoA desaturase gene expression.

Keywords: stearoyl; desaturase fatty acid; milkfish; milkfish culture
Location: http://www.ncbi.nlm.nih.gov
Author Affiliation: Department of Nutrition and Health Science, Fooyin University, Kaohsiung 831, Taiwan

59 Hsieh, S.L., H.T. Chang, C.H. Wu and C.M. Kuo. 2004. Cloning, tissue distribution and hormonal regulation of stearoyl-CoA desaturase in tilapia, *Oreochromis mossambicus*. Aquaculture 230(1-4):527-546.

The stearoyl-CoA desaturase cDNA in tilapia (*Oreochromis mossambicus*) was cloned by RT-PCR and RACE, and it was compared with those in grass carp, common carp and milkfish. Nucleotide sequence analysis revealed that the full length of cDNA (1172 bp) clone encompasses 1008 bp open reading frame (ORF) encoding 336 amino acid residues. The deduced amino acid sequence shares 78-82% identity with the teleosts and 64-66% with mammals compared, and like these fish, the cloned tilapia stearoyl-CoA desaturase amino acid sequence conserves three histidine cluster motifs (one HXXXXH and two HXXHH), which functioned as non-heme iron binding sites, essential for stearoyl-CoA desaturase activity. RT-PCR and Northern blot analysis reveal that tilapia stearoyl-CoA desaturase is expressed only in liver, but the stearoyl-CoA desaturase expression in multiple tissues was observed in milkfish, grass carp and carp. Further, the hormonal regulation of stearoyl-CoA desaturase gene expression was investigated by a single injection of 17 beta -estradiol and testosterone. The results showed that the administration of 17 beta -estradiol to tilapia led to a greater increase in desaturase activity than testosterone, and higher doses of steroids produced greater increases in enzyme activity. The comparative RT-PCR analysis showed that the stearoyl-CoA desaturase mRNA level increased significantly in 17 beta -estradiol treated animals, especially in the groups receiving a single injection of 50 mg 17 beta -estradiol. This was reflected in the decrease in the saturated fatty acids and the increase in the monounsaturated fatty acids. The proportion of the polyunsaturated fatty acids was not affected.

Keywords: enzymes; tissues; liver; DNA; amino acid sequence; gene expression; hormones; enzymatic activity; fatty acids; polyunsaturated fatty acids; chemical composition; phylogeny; stearoyl-CoA desaturase; *Oreochromis mossambicus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Marine Research Station, Institute of Zoology, Academia Sinica, I-lan 262, Taiwan, [mailto:cmkuo@gate.sinica.edu.tw]

60 Hsieh, S.L., W.L. Liao and C.M. Kuo. 2001. Molecular cloning and sequence analysis of stearoyl-CoA desaturase in milkfish, *Chanos chanos*. Comparative Biochemistry and Physiology 130(4):467-477.

Stearoyl-CoA desaturase (EC 1.14.99.5) is a key enzyme in the biosynthesis of polyunsaturated fatty acids and the maintenance of the homeoviscous fluidity of biological membranes. The stearoyl-CoA desaturase cDNA in milkfish (*Chanos chanos*) was cloned by RT-PCR and RACE, and it was compared with the stearoyl-CoA desaturase in cold-tolerant teleosts, common carp and grass carp. Nucleotide sequence analysis revealed that the cDNA clone has a 972-bp open reading frame encoding 323 amino acid residues. Alignments of the deduced amino acid sequence showed that the milkfish stearoyl-CoA desaturase shares 79% and 75% identity with common carp and grass carp, and 63%-64% with other vertebrates such as sheep, hamsters, rats, mice, and humans. Like common carp and grass carp, the deduced amino acid sequence in milkfish well conserves three histidine cluster motifs (one HXXXXH and two HXXHH) that are essential for catalysis of stearoyl-CoA desaturase activity. However, RT-PCR analysis showed that stearoyl-CoA desaturase expression in milkfish is detected in the tissues of liver, muscle, kidney, brain, and gill, and more expression sites were found in milkfish than in common carp and grass carp. Phylogenic relationships among the deduced stearoyl-CoA desaturase amino acid sequence in milkfish and those in other vertebrates showed that the milkfish stearoyl-CoA desaturase amino acid sequence is phylogenetically closer to those of common carp and grass carp than to other higher vertebrates.

Keywords: open reading frames; fatty acids; cell membranes; stearoyl-CoA desaturase; phylogeny; DNA; nucleotide sequence; polyunsaturated fatty acids; enzymes; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, National Pingtung University of Science and Technology, Pingtung 912, Taiwan, ROC, [mailto:cmkuo@mail.npust.edu.tw]

61 Hsieh, S.L., Y.N. Chen and C.M. Kuo. 2003. Physiological responses, desaturase activity, and fatty acid composition in milkfish (*Chanos chanos*) under cold acclimation. Aquaculture 220(1-4):903-918.

Physiological responses of milkfish (*Chanos chanos*) under cold shock and acclimation were investigated. The experimental milkfish, a warm-water teleost, were initially acclimated at 25 degree C and then transferred directly to 15 degree C; stress responses of this species were monitored for 1 week. Parameters monitored included plasma glucose, lactate, and lipids, as well as stearoyl-CoA desaturase activity and fatty acid compositions of hepatic membranes. All parameters showed significant changes in the process of cold acclimation. A hyperglycemic response indicated by a notable and steady increase in plasma glucose levels from 85 mg dl super(-1) to the highest level of 458.2 mg dl super(-1) in 24 h was followed by a rapid decline thereafter. The elevation in plasma glucose content under cold shock resulted from gluconeogenesis and glycogenolysis, indicated by correlated changes in plasma glucose with fructose-1,6-biphosphatase and phosphorylase a activities. Plasma lactate concentrations remarkably increased from 47 mg dl super(-1) on day 0 to 149.6 and 120.4 mg dl super(-1) on days 1 and 2, respectively, and then rapidly declined to the same level as the control thereafter. In contrast, plasma lipids increased gradually from 44.8 mg dl super(-1) to 191 mg dl super(-1) over the 5-day acclimation period, followed by a declining trend from day 6 on. Furthermore, changes in monounsaturated fatty acids were highly correlated with those of stearoyl-CoA desaturase activities in hepatic microsomes of milkfish during cold acclimation. Results indicate that in milkfish subjected to cold stress, plasma hyperglycemic and hyperlactemic responses can be used as acute stress indicators, and plasma lipids can be used as a chronic stress indicator.

Keywords: temperature effects; low temperature; fatty acids; acclimation; fish physiology; chemical composition; biological stress; enzymatic activity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, National Pingtung University of Science and Technology, Ping-tung 912, Taiwan, [mailto:kuocm@mail.npust.edu.tw]

62 Hung, N.K., C.P. Dung, N.K. Buc, L.T. Ha and D.T. Nga. 1980. Biochemical composition of milkfish (*Chanos chanos* Forsskal) and mullet (*Mugilidae*) in Phu Khanh. Tuyen Tap Nghien Cuu Bien 2(1):43-52.

Milkfish (*C. chanos* Forsskal) and 4 mullet species (*Mugil cephalus*, *M. strongylocephalus*, *M. troscheli*, *M. dussumieri*) live in lagoons along the coast of Phu Khanh province; their chemical composition in muscle was analysed according to the growth, sexual maturity and various environment. Milkfish of under 1 yr had a water content of 72.52-78.26%; protein: 17.20-20.88%, lipid: 0.19-1.83%; and ash: 1.38-1.71%. Protein and lipid content increased according to the annual increment level of fish. In mullet, the water content varied from approximately equals 72.23-77.92%; protein: 17.71-20.29%; lipid: 0.56-6.33%; and ash: 1.27-1.70%. Particularly the lipid content in the mullet female of sexual development in the third stage rose higher than that in the male in the same period.

Keywords: muscles; proteins; lipids; biochemical composition; *Chanos chanos*; *Mugil*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Oceanogr., Nha Trang, Viet Nam

63 Hwang, P.P., S.M. Wu, J.H. Lin and L.S. Wu. 1992. Cortisol content of eggs and larvae of teleosts. General and Comparative Endocrinology 86(2):189-196.

The whole-animal content of the cortisol was measured in embryos and larvae of tilapia (*Oreochromis mossambicus*), rainbow trout (*Oncorhynchus mykiss*), ayu (*Plecoglossus altivelis*), milkfish (*Chanos chanos*), and yellowfin bream (*Acanthropagrus latus*) by radioimmunoassay following the validation of an extraction method. The total cortisol content in tilapia was 50.3 plus or minus 19.1 pg immediately following fertilization, then decreased abruptly and maintained a lower level of 10-17 pg until larval hatching; after hatching the cortisol content increased to 47.2 plus or

minus 11.9 pg by the seventh day. The presence and clearance of cortisol during early development of fertilized eggs of tilapia suggest a maternal origin of the hormone. The possible role of cortisol in larval development is discussed.

Keywords: endocrinology; hormones; fish eggs; fish larvae; embryonic development; larval development; eggs; larvae; *Teleostei*; *Oreochromis mossambicus*; *Oncorhynchus mykiss*; *Plecoglossus altivelis*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Zool., Acad. Sin., Nankang, Taipei 11529, Taiwan

64 Jiang, S.T., Y.H. Her, J.J. Lee and J.H. Wang. 1993. Comparison of the cathepsin D from mackerel (*Scomber australasicus*) and milkfish (*Chanos chanos*) muscle. Bioscience, Biotechnology and Biochemistry 57(4):571-577.

Muscle proteases from mackerel and milkfish were purified to electrophoretical homogeneity by concanavalin A-Sepharose and Sephadex G-100 chromatographies. Both proteases appear to be an aspartic protease, cathepsin D (EC 3.4.23.5). The molecular weights of the purified cathepsin D's from mackerel and milkfish were 51,000 and 54,000, estimated by Sephadex G-100, and 59,000 and 61,000 by SDS-PAGE, respectively. Both cathepsin D's were completely inhibited by pepstatin, but not affected by leupeptin, N-ethylmaleimide, dithiothreitol, or glutathione beta -Mercaptoethanol, iodoacetic acid, p-chloromercuribenzoate, phenylmethylsulphonyl fluoride, and sodium dodecyl sulfate partially or completely inhibited both cathepsin D's. Na super(+) and K super(+) partially activated the cathepsin D from milkfish. Both cathepsin D's were inhibited by Mg super(2+), Sr super(2+), Fe super(2+), and Hg super(2+), but activated by Ca super(2+), Co super(2+), Ni super(2+), Cu super(2+), Zn super(2+), and Cd super(2+). The pI and optimal temperature of the cathepsin D's from mackerel and milkfish were 5.04 and 4.91, 45 degree , and 50 degree C, respectively. The temperatures for inactivating 50% activity of the cathepsin D's from mackerel and milkfish during 20 min of incubation were 53 degree and 48 degree C, respectively. Both cathepsin D's had similar optimal pHs near 3. The activity of that from milkfish markedly decreased when the pH was higher than 4, and was almost completely lost at pH above 6, while that from mackerel still had at least 40% activity at pH 6.

Keywords: muscles; enzymes; comparative studies; food technology; purification; characterization; *Scomber australasicus*; *Chanos chanos*; cathepsin D
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Grad. Sch. Mar. Food Sci., Natl. Taiwan Ocean Univ., Keelung 20224, Taiwan

65 Johannes, R.E. (n.d.) *Chanidae* (milkfish family). SEAFDEC/AQD Library Compilation. 4 p.

This article provides information on the spawning behaviour of milkfish as observed by fishermen. Observations made by the fishermen were compared with published data.

Keywords: *Chanidae*; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

66 Juario, J.V., R.P. Ferraris and L.V. Benitez. 1984. Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Centre, Metro Manila, Philippines. 244 p.

Abstracts of the 17 papers presented at the conference are cited individually in this issue.

Keywords: fish culture; aquaculture development; conferences; brackishwater aquaculture; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

67 Kafuko, T. and Y. Kuwatani. (n.d.) Biological meanings of epibranchial organ of milkfish from the point of their ontegy. SEAFDEC/AQD Library Compilation. 3 p.

The findings of the authors concerning the epibranchial organ of the milkfish are given. Reports by other authors are also included.

Keywords: epibranchial organ; milkfish
Location: SEAFDEC Aquaculture Department Library

68 Katz, S.L., R.E. Shadwick and H.S. Rapoport. 1999. Muscle strain histories in swimming milkfish in steady and sprinting gaits. The Journal of Experimental Biology 202:529-541.

Adult milkfish (*Chanos chanos*) swam in a water-tunnel flume over a wide range of speeds. Fish were instrumented with sonomicrometers to measure shortening of red and white myotomal muscle. Muscle strain was also calculated from simultaneous overhead views of the swimming fish. This allowed us to test the hypothesis that the muscle shortens in phase with local body bending. The fish swam at slow speeds [U<2.6 fork lengths s̃1 (=FLs̃1)] where only peripheral red muscle was powering body movements, and also at higher speeds (2.6>U>4.6FLs̃1) where they adopted a sprinting gait in which the white muscle is believed to power the body movements. For all combinations of speeds and body locations where we had simultaneous measurements of muscle strain and body bending (0.5 and 0.7FL), both techniques were equivalent predictors of muscle strain histories. Cross-correlation coefficients for comparisons between these techniques exceeded 0.95 in all cases and had temporal separations of less than 7 ms on average. Muscle strain measured using sonomicrometry within the speed range 0.9–2.6FLs̃1 showed that muscle strain did not increase substantially over that speed range, while tail-beat frequency increased by 140 %. While using a sprinting gait, muscle strains became bimodal, with strains within bursts being approximately double those between bursts. Muscle strain calculated from local body bending for a range of locations on the body indicated that muscle strain increases rostrally to caudally, but only by less than 4 %. These results suggest that swimming muscle, which forms a large fraction of the body volume in a fish, undergoes a history of strain that is similar to that expected for a homogeneous, continuous beam. This has been an implicit assumption for many studies of muscle function in many fish, but has not been tested explicitly until now. This result is achieved in spite of the presence of complex and in homogeneous geometry in the folding of myotomes, collagenous myosepta and tendon, and the anatomical distinction between red and white muscle fibers.

Keywords: fish; swimming; *Chanos chanos*; milkfish; sonomicrometry; locomotion; musculo-skeletal mechanics; biomimetics
Location: http://jeb.biologists.org
Author Affiliation: Center for Marine Biotechnology and Biomedicine and Marine Biology Research Division, Scripps Institution ofOceanography, La Jolla, CA 92093-0204, USA

69 Kawamura, G. 1985. The sense organs and behaviors of milkfish fry in relation to collection techniques, p. 69-84. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

This paper describes the sense organs and some of the behavioural characteristics of milkfish (*Chanos chanos*) fry, based on studies conducted at the Aquaculture Department, SEAFDEC, Philippines and at Kagoshima University, Japan in 1982. Based on the experimental results obtained and the observations made in the Philippines, Indonesia, and Taiwan, existing fry collection techniques such as the employment of fish lamps and scare lines are considered effective and rational. Several recommendations are made for improvements of the collection gear and for research on fry behavior.

Keywords: sense organs; fry; biological sampling; fish culture; collecting devices; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fac. Fish., Kagoshima Univ., Kagoshima, Japan

70 Kawamura, G. and N. Washiyama. 1984. Age determination of wild-captured milkfish larvae as indicated by daily growth increments of otolith. Bulletin of Japanese Society of Scientific Fisheries 50(1):174.

The authors investigated daily growth of otolith of milkfish larvae *Chanos chanos* from the shore waters in Tenega Is., Japan in July-August. In 8 out of 76 larvae examined, the increments of otolith could be counted accurately, and these larvae (12.5-14.0 mm in total length) were considered to be 18-20 days old. The daily growth rate of otolith decreased with days and was found to be very low after the 10th or 11th increments.

Keywords: age determination; otolith reading; growth; fish larvae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fac. Fish., Kagoshima Univ., Shimoarata 890, Japan

71 Kawamura, G. and N. Washiyama. 1984. Development of sense organs of milkfish fry and juveniles. Mini review and data file of fisheries research. Fisheries Research Laboratory, Kagoshima University 3:39-43.

Development of the sense organs with growth of milkfish *Chanos chanos* was studied. Fry were caught in Kumano Bay, Tanegashima Island (Japan) and some of them were fixed on the beach and the others were reared in the laboratory for observation of the developmental change in the sense organs. Eye, lateral line, inner ear, olfactory organ and taste bud were examined by scanning electron microscopy and histological techniques.

Keywords: sense organs; fry; juveniles; biological development; animal morphology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Lab. Fish. Technol., Fac. Fish., Kagoshima Univ., Shimoarata 4, Kagoshima 890, Japan

72 Kawamura, G. and S. Hara. 1980. The optomotor reaction of milkfish larvae and juveniles. Bulletin of Japanese Society of Scientific Fisheries 46(8):929-932.

The development of the optomotor reaction (OMR) in milkfish (*Chanos chanos*), from the larval, through the metamorphic, to the juvenile stage was observed. The period from the appearance of the pelvic fins until the complete disappearance of the finfold was named "metamorphic stage". While the larvae showed strong rheotactic responses, their OMR was somewhat weak. It was clear that the OMR underwent a big change through the metamorphic stage, and became strong and almost perfect in the juveniles.

Keywords: developmental stages; visual stimuli; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Lab. Fish. Technol., Fac. Fish., Kagoshima 890, Japan

73 Kawamura, G. and W. Nishimura. 1980. S-potential from the retina of milkfish, *Chanos chanos* Forsskal. Bulletin of Japanese Society of Scientific Fisheries 46(11):1421.

The S-potentials were recorded from the isolated light-adapted retinae of the young milkfish (*Chanos chanos*) of 12.5 and 14.0 cm in fork length. The specimens used were originally caught in fry stage in Kumano Bay, Tanega Island in Kagoshima Prefecture, and reared firstly in sea water and then in half-seawater. The amplitude of the S-potentials recorded was small. The authors found two kinds of L-responses, one (L-a) having a maximum response at wavelength between 492-522 nm

and the other (L-b) between 582-612 nm. From two specimens, fourteen L-a and five L-b responses were recorded. Together with the L-responses four C-responses were recorded. Then it can be concluded that the milkfish has color sense.

Keywords: retinas; vision; electrophysiology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fac. Fish., Kagoshima Univ., Kagoshima 890, Japan

74 Kawamura, G. and Y. Shinoda. 1980. Change in phototactic behaviour with growth of milkfish, *Chanos chanos* (Forsskal). Memoirs of the Faculty of Fisheries, Kagoshima University 1(1):75-85.

Phototactic behaviour of milkfish larvae and juveniles was observed in the sea and laboratory, and their retinae were observed histologically. Larvae collection by using a lamp at night and tank experiments revealed that the larvae have strong positive phototaxis. Throughout their growth, there were three shifts in phototactic behaviour in a tank. The photopositive behaviour of the larvae becomes weak by degrees through a methamorphic stage, and juvenile showed photonegative behaviour. On the 39th day from capture, their behaviour became photopositive again. After they were transferred into a larger tank, on the 139th day, any significant photopositive or photonegative behaviour could not be observed. The larvae on capture have duplex retinae. The rods were found to be a few in number, and a clear retinomotor response was observed on the day of capture. The first change in behaviour from photopositive to photonegative seemed to relate with the development of the rods.

Keywords: phototactic behaviour; milkfish
Location: SEAFDEC Aquaculture Department Library

75 Kinoshita, I. 1981. Feeding habit and development of digestive system in juvenile milkfish, *Chanos chanos* (Forsskal). SEAFDEC/AQD Library Compilation. 28 p.

The paper deals with the feeding behaviour and development of the digestive system in milkfish, *Chanos chanos* from fry to juvenile stage. Results indicate intensive feeding of fry in the afternoon on *copepods* (mainly OTHIONA), observing a 12.1% general feeding rate. Likewise, observed was the shifting of milkfish feeding behaviour from being a zooplankton to phytoplankton feeder, and then finally to an omnivorous fish. In addition, milkfish was found to be at the transition stage between larva and juvenile during the period when gizzard, gastric glads and pyloric caeca can be differentiated.

Keywords: feeding habit; feeding; digestive system; juvenile; milkfish
Location: SEAFDEC Aquaculture Department Library

76 Kohno, H., R. Ordonio-Aguilar, A. Ohno and Y. Taki. 1996. Morphological aspects of feeding and improvement in feeding ability in early stage larvae of the milkfish, *Chanos chanos*. Ichthyological Research 43(2):133-140.

The osteological development of elements comprising the oral cavity and fins was examined in early stage larvae of laboratory-reared milkfish, *Chanos chanos*, from hatching to 200 hours after hatching. Fundamental elements of the oral cavity had developed by the time of initial mouth opening, 54 hours after hatching. The oral cavity was long and cylindrical, with a short, robust Meckel's cartilage, and robust quadrate and symplectic-hyomandibular cartilages. The initial ossification of existing elements and addition of new elements occurred between 120-146 hours after initial mouth opening (HAMO), whereas the cartilaginous basihyal and caudal fin-supports appeared at 37.5 and 61.5 HAMO, respectively. Based on the morphology and developmental patterns of characters examined in this study, the feeding mode of early stage larval milkfish was considered to be "straining," with an improvement in feeding ability occurring between 120-146 HAMO.

Keywords: commercial species; cultured organisms; fish culture; developmental stages; food consumption; osteology; organogenesis; functional morphology; feeding behavior; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tokyo Univ. Fish., 4-5-7 Konan, Minato-ku, Tokyo 108, Japan

77 Kumagai, S. and N.M. Castillo. 1980. Changes in the length and weight of milkfish, *Chanos chanos*, larvae preserved in formalin. Fisheries Research Journal of the Philippines 5(1):17-23.

Shore-caught milkfish *Chanos chanos* fry (late postlarvae) and artificially-bred, laboratory-reared larvae (0- to 20-days old) were preserved in 5% and 10% freshwater-and/or seawater-formalin solutions after measuring their initial weights and/or lengths. The changes in length and weight were observed at regular intervals. Shrinkage in freshwater-formalin (FWF) was less than in seawater-formalin (SWF). The difference in 5% and 10% concentrations of the same solution was not significant. Wild fry showed a final shrinkage of 5.13% of the initial length in 5% SWF and 5.07% in 10% SWF. Shrinkage in laboratory-reared larvae from 5.09-8.35% according to the age and/or developmental stage, for the same preservation period of 14 days.

Keywords: fish larvae; fixation; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

78 Kumagai, S., T. Bagarinao and A. Unggui. 1985. Growth of juvenile milkfish *Chanos chanos* in a natural habitat. Marine Ecology Progress Series 22(1):1-6.

A population of juvenile milkfish, *C. chanos* (Forsskal) was studied in a small mangrove lagoon in Naburut Island, central Philippines. Several size groups of milkfish occurred in the lagoon as a result of its periodic connection with the sea. Some 903 specimens were collected in Mar to Nov 1979, covering a fork length range of 12 to 180 mm. Body-weight to fork-length relation was: log W = 05.2991 + 3.2388 log L, similar to that of pond-cultured specimens. Variations in condition factor and gut weights of samples taken at different times of day and night indicate diurnal feeding. The condition factor of fish caught during the day from May to Nov stayed constant, indicating that lagoon conditions for growth in terms of food did not change markedly during the year. The monthly size-frequency distribution shows that juvenile milkfish in the lagoon grew at a rate of 7 to 9 mm wk super(-1) in 1979. The limited area and depth of Naburut Lagoon probably set the limit to the size of juvenile milkfish; these can be sustained there to just 150 to 180 mm fork length.

Keywords: growth; length-weight relationships; food consumption; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Kagawa Saibai Cent., Yashima, Takamatsu, Kagawa, Japan 760-01

79 Kuo, C.M. and C.E. Nash. 1979. Annual reproductive cycle of milkfish, *Chanos chanos* Forsskal, in Hawaiian waters. Aquaculture 16(3):247-251.

The monthly mean values of gonadosomatic index (GSI) over a continuous 36-month period show that the population of milkfish, *C. chanos*, in Hawaiian waters has a short breeding season between June and August. In these months, the GSIs of the mature individual males are between 3.19 and 5.36%, and of the mature individual females between 7.07 and 9.76%. These figures plus histological data suggest a synchronous spawning behavior for the species. Mature oocytes (stage III) are larger than 0.7 mm in diameter, which increases to about 1.2 mm at the time of ovulation and about 1.35 mm at the time of spawning.

Keywords: spawning seasons; *Chanos chanos*; ISE, Hawaii
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Waimanalo, HI 96795, USA

80 Kuwatani, Y. and T. Kafuku. 1978. Morphology and function of epibranchial organ studied and inferred on milkfish. Bulletin of Freshwater Fisheries Research Laboratory 28(2):221-236.

Anatomical and histological studies were made on the epibranchial organ of milkfish, *Chanos chanos*. It was found that a duct or canal lies outside along the modified gill-rakers which separate the duct from the ordinary canal passage. This duct continues to the siphon or flat tube and opens inside the gill cavity. This structure suggests that water and food organisms are first filtered by modified gill-rakers which trap the organisms, while the water is expired through the duct, siphon and its opening into the gill cavity. Thus, the results strongly suggest that the epibranchial organ is an accessory of the digestive system rather than of respiration.

Keywords: anatomy; alimentary organs; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

81 Lacanilao, F.J., C.L. Marte and T.J. Lam. 1985. Problems associated with hormonal induction of gonad development in milkfish (*Chanos chanos*), p. 1247-1253. In: B. Lofts (ed.) Current Trends in Comparative Endocrinology. Hongkong University Press, Hongkong.

This paper presents the experiments done on induced gonad development of sexually immature milkfish and rematuration of regressed fish by the use of hormones. The problems encountered during the course of the experiment are discussed.

Keywords: hormonal induction; gonad development; milkfish
Location: SEAFDEC Aquaculture Department Library

82 Lee, C.S. 1985. Environmental factors in the reproduction of milkfish, p. 99-114. In: C.S. Lee and I.C. Liao (eds.). Reproduction and culture of milkfish: Proceedings for a workshop at the Tungkang Marine Laboratory, Taiwan, 22-24 April 1985. Oceanic Institute, Hawaii and Tungkang Marine Laboratory, Taiwan.

The environmental factors required for the maturation and spawning of milkfish (*Chanos chanos*) are not yet defined. Possible effects of these factors, such as temperature, photoperiod, salinity, lunar cycle, space, tank shape, and stress, are discussed. Long daylight regimes and warm water temperatures seem to be suitable for final maturation. In nature, water temperature determines the length of the spawning season. The spawning cycle is related to the lunar cycle in nature but there is no relation under culture conditions. Maturation and spawning are not inhibited in a 25 m super(2) tank.

Keywords: environmental factors; reproductive behaviour; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

83 Lee, C.S. 1986. Reproduction (milkfish). Aquaculture of milkfish (*Chanos chanos*): state of the art, p. 57-81. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). The Oceanic Institute, Honolulu, Hawaii.

The information available on the reproduction of milkfish is sparse despite its importance to the control of propagation of this species. A summary of the current available information is given.

Keywords: spawning; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean Inst., Makapuu Point, Waimanalo, HI 96795, USA

84 Liao, I.C. and T.I. Chen. 1983. Gonadal development and induced breeding of captive milkfish in Taiwan, p. 41-51. In: Advances in Milkfish Biology and Culture. Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983. Iloilo City, Philippines.

The induced breeding of milkfish (*Chanos chanos*) has been attempted by many institutes in the Philippines, Taiwan, Tahiti, Indonesia, and Hawaii. So far, a few successful trials have been achieved only in the Philippines and Taiwan, although different sources of spawners were used. In Taiwan the spawners used were reared from fry to sexual maturity in ponds and concrete tanks. This paper summarizes the gonadal development of captive milkfish at various stages of sexual maturation investigated from 1975 to 1980 and describes three successful trials of induced breeding in 1979, 1982, and 1983 in Taiwan. Finally, the problems that need further study are discussed.

Keywords: fish culture; induced breeding; sexual maturity; animal reproductive organs; brackishwater aquaculture; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Tungkang, Pingtung, Taiwan

85 Lin, C.H. and T.H. Lee. 2005. Sodium or potassium ions activate different kinetics of gill Na, K-ATPase in three seawater and freshwater-acclimated euryhaline teleosts. Journal of Experimental Zoology 303(1):57-65.

The effects of [Na(+)] or [K(+)] on Na, K-ATPase activity of FW-acclimated and SW-acclimated tilapia, puffer and milkfish were examined in gill homogenates. [Na(+)] or [K(+)] stimulated Na, K-ATPase hydrolyzing ATP in all experimental groups. ATP hydrolysis stimulated by [Na(+)] or [K(+)] followed Michaelian-Menten kinetics. Km values for [K(+)] (i.e., Km(K)), were lower in SW- than FW-acclimated tilapia and puffer fishes (tilapia: 8.69+/-0.22 vs. 11.93+/-1.17 mM; puffer: 13.51+/-1.39 vs. 30.52+/-2.66 mM). Km values for [Na(+)] (i.e., Km(Na)), were lower in FW- than SW-acclimated milkfish (3.76+/-0.54 vs. 7.55+/-1.08 mM). These data suggest that [K(+)] stimulates ATP hydrolysis to rates higher in SW- than FW-acclimated tilapia and puffer fishes, while [Na(+)] stimulated ATP hydrolysis at rates higher in FW- than SW-acclimated milkfish. This is the first demonstration that Na, K-ATPase activity of euryhaline tilapia, puffer, and milkfish modulated by [Na(+)] or [K(+)] have different effects between FW- and SW-acclimated groups. Such responses as changes in properties of branchial Na, K-ATPase may contribute to improve the osmoregulatory capacity of tilapia, puffer and milkfish to acclimate in seawater and fresh water.

Keywords: milkfish; *Chanos chanos;* kinetics
Location: http://www.ncbi.nlm.nih.gov
Author Affiliation: Department of Life Sciences, National Chung-Hsing University, 250, Kuo-Kuang Road, Taichung, 402 Taiwan.

86 Lin, Y.M., C.N. Chen and T.H. Lee. 2001. Physiology of salinity adaptation in the milkfish, *Chanos chanos*, p. 151. In: Asian Fisheries Forum (6th: 2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, 25-30 November 2001, Kaohsiung, Taiwan: Asian fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

The milkfish occurs in the Indian and on the both sides of the tropical Pacific. The farming of the milkfish is an important aquaculture industry in the Philippines, Indonesia and Taiwan. In Taiwan, milkfish culture has a history of over 300 years and the farms are distributed along the southwestern coast. Traditionally, the milkfish are captured in months from spring to fall and then cultivated in brackishwater ponds. Being an important economic species, the milkfish tolerates salinities from 0 to 158. Thus it is intriguing to realize the mechanisms of salinity-adaptation in the milkfish. In the present study, milkfish fingerlings are transferred from 10‰ to 0%(fresh water), 20‰, and 35‰(seawater), respectively. After one-week adaptation in each medium, morphological observations and biochemical assays were applied to depict the physiology of salinity adaptation in the milkfish. Paraffin sections and immunohistochemical studies reveal that the gill Na super(+),K super(+)-ATPase is mainly localized in the MR cells. Moreover, the freshwater fish exhibit the

highest specific activity of gill Na super(+),K super(+)-ATPase and the lowest activity is found in seawater-adapted fish. The abundance of Na super(+),K super(+)-ATPase alpha -subunit protein show similar profiles. On the other hand, no significant difference is found in serum osmolarity of fish adapted to various salinities. Obviously, to sustain stable levels of osmolarity in different salinity, the milkfish must express various amounts of Na super(+),K super(+)-ATPase as well as MR cells in gills to meet the physiological demand.

Keywords: salinity effects; salinity tolerance; acclimation; fish physiology; histochemistry; enzymatic activity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Zoology, National Chung-Hsing University, Taichung, 402, Taiwan, [mailto:thlee@dragon.nchu.edu.tw]

87 Macaranas, J.M., J.R. Pante and L.V. Benitez. 1990. Heterogeneity in Philippine milkfish populations, p. 477-481. In: R. Hirano and I. Hanyu (eds.). Proceedings of the Second Asian Fisheries Forum, 17-22 April 1989, Tokyo, Japan. Asian Fisheries Society, Manila, Philippines.

Twelve milkfish (*Chanos chanos*) populations from 6 coastal areas in the Philippines, collected at the fry stage and reared until fingerling size, were analysed for electrophoretic variation at 28 presumptive loci. Seven loci were polymorphic at the 0.99 level (5 at the 0.95 level) while 21 were monomorphic. Significant departures from the expected Hardy-Weinberg genotype distributions were observed only at the Pgm locus in samples 843 and 862. G-tests for heterogeneity revealed significant differences in genotype distributions at the Est-1, Gpi-1, Gpi-2, Mp-2 and Pgm loci within each year of sampling, within one location at different sampling years, and within two geographical areas east and west of the Philippines.

Keywords: biopolymorphism; subpopulations; electrophoresis; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mar. Sci. Inst., Box 1, Univ. Philippines, Diliman, Quezon City 1101, Philippines

88 Maclean, J.L. 1975. Milkfish (*Chanos chanos*). Potential of aquaculture in Australia. Canberra, Australian Government Publishing Services. p. 101. (Australian Fisheries paper; no. 21)

The distribution, habitat, hardiness, reproduction, fecundity, growth and food of the milkfish (*Chanos chanos*) in Australia are briefly discussed.

Keywords: milkfish aquaculture; milkfish; Australia
Location: SEAFDEC Aquaculture Department Library

89 Marte, C.L. and T.J. Lam. 1992. Hormonal changes accompanying sexual maturation in captive milkfish (*Chanos chanos* Forsskal). Fish Physiology and Biochemistry 10(4):267-275.

Steroid hormone profiles accompanying sexual maturation in captive milkfish are described. There were no significant differences in levels of serum estradiol 17- beta (E sub(2)) and testosterone (T) between immature male and female fish. Mean E sub(2) levels rose from 0.54 plus or minus 0.11 ng/ml in immature females (Stage 1) to 4.53 plus or minus 1.16 ng/ml in vitellogenic females (Stage 5), while T levels increased from 2.06 plus or minus 0.28 ng/ml to 38.4 plus or minus 9.26 ng/ml. E sub(2) and T levels were positively correlated to GSI and oocyte diameter. In males, serum T levels increased from 2.5 plus or minus 0.40 ng/ml in immature males to 27.73 plus or minus 5.02 ng/ml in spermiating males. A significantly higher T level was found in males with thick and scanty milt (spermiation index, SPI, 2) compared to males with scanty milt (SPI, 1) or males with copious, fluid milt (SPI, 3). Serum levels of E sub(2) ant T, and the GSI in females rose significantly during the breeding season (April-June 1983). The levels of both steroids dropped below 1 ng/ml in spent females sampled in succeeding months. In immature males, T levels ranged from 1.11 ng/ml to 2.78

ng/ml and rose significantly to 21.52 plus or minus 8.38 ng/ml during the breeding season when GSI peaked. Serum T levels dropped to around 10 ng/ml in the succeeding months when only spent or regressed males were sampled.

Keywords: hormones; sexual maturity; sexual reproduction; reproductive cycle; seasonality; fish culture; seasonal variations; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

90 Mathew, S., T.V. Sankar and M.K. Mukundan. 1998. Purification and characterisation of collagen of *Chanos chanos*, p. 345-349. In: Advances and Priorities in Fisheries Technology. Society of Fisheries Technologists, Cochin, India.

Collagen extracted individually from the muscle, skin and waste comprising bones and viscera of *Chanos chanos* was partially purified and fractionated to acetic acid soluble collagen (ASC) and pepsin digestible collagen (PDC). Fish waste had only ASC while skin and muscle had small amounts of PDC in addition to ASC. The yield of partially purified ASC and PDC were 0.38 and 0.09% respectively from muscle and 20.14 and 5.6% from skin. Yield of ASC from waste was 0.2%. Total nitrogen, amino acid composition, electrophoretic pattern and approximate molecular weight of the partially purified collagens are reported.

Keywords: fish physiology; biochemical composition; collagen; brackishwater fish; amino acids; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Central Institute of Fisheries Technology Cochin 682 029 India

91 Narayanan, K.R. and A.U. Buch. 1977. Observations on the milkfish, *Chanos chanos* (Forsskal), and the occurrence of their young ones in the estuaries of Okhamandal in Gujarat. Seafood Export Journal 9(7):9-14.

C. chanos is reported to be very common in the peninsular region of India, from Oriss and Andhra on the east coast up to South Canara on the west coast. However, no significant fisheries for *C. chanos* exist at present. Surveys by the authors observed large shoals of *C. chanos* fingerlings in wide tidal pools. Length frequency for these shoals is reported. The authors contend that the occurrence of this species may be of significance for mariculture in the Okhamandal coast region.

Keywords: geographical distribution; fish culture; seed (aquaculture); *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tata Chemicals Limited, Mithapur (Gujarat), India

92 Ravago, R.G., V. Monje and M.A. Juinio-Menez. 2002. Length and sequence variability in mitochondrial control region of the milkfish, *Chanos chanos*. Marine Biotechnology 4(1):40-50.

Extensive length variability was observed in the mitochondrial control region of the milkfish, *Chanos chanos*. The nucleotide sequence of the control region and flanking regions was determined. Length variability and heteroplasmy was due to the presence of varying numbers of a 41-bp tandemly repeated sequence and a 48-bp insertion/deletion (indel). The structure and organization of the milkfish control region is similar to that of other teleost fish and vertebrates. However, extensive variation in the copy number of tandem repeats (4-20 copies) and the presence of a relatively large (48-bp) indel, are apparently uncommon in teleost fish control region sequences reported to date. High sequence variability of control region peripheral domains indicates the potential utility of selected regions as markers for population-level studies.

Keywords: population genetics; mitochondrial DNA; mitochondria; brackishwater fish; DNA; nucleotide sequence; biomarkers; biotechnology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

93 Requintina, P.D., L.M. Engle and L.V. Benitez. 1981. Lactate dehydrogenase isozyme patterns during the development of milkfish, (*Chanos chanos* Forsskal). Kalikasan 10(2-3):289-299.

Polyacrylamide disc gel electrophoresis was done to determine the lactate dehydrogenase (LDH) isozyme patterns for fry (5-3 mg), fingerling (6-12 g), pond-size (150-250 g) and adult (6-9 kg) milkfish (*C. chanos*). The patterns were tissue specific; the different tissues examined, viz., eye, liver, heart, and skeletal muscle had different expressions of LDH isozymes. The resolved patterns appeared to be products of LDH gene loci A, B, and C. Subunits A and B were present in all tissues. A sub(4) and B sub(4) were predominant in skeletal and heart muscle, respectively; the two associated non-randomly in vivo and formed only the heteropolymers A sub(3)B and AB sub(3).

Keywords: dehydrogenases; electrophoresis; isoenzymes; developmental stages; tissues; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

94 Richter, H.C., C. Lueckstedt, C. Schlechtriem, U. Focken and K. Becker. 2002. Evidence of violation of a basic assumption in models currently used for food consumption estimation in fish. Archive of Fishery and Marine Research 49(3):171-188.

The quantification of food consumption in fish is essential for the development of quantitative trophic models of aquatic ecosystems and in aquaculture. Four models and their derivatives have mainly been used to estimate daily ration by modelling change in stomach contents over time, namely the Bajkov, Elliott-Persson, Olson-Mullen and MAXIMS models. In spite of their widespread application, none of these models have so far been adequately tested to ascertain whether the assumptions they are based on are fulfilled and the daily ration predictions are accurate. Two original datasets, one obtained from milkfish, the other from tilapia hybrids, were used here to apply these four models and compare the consumption estimates with the quantities known to be ingested. In both species, all the model predictions were close together (1.76 to 1.81 % Body Mass Equivalent (% BME) for milkfish; 0.79 to 0.82 % BME for tilapia) but distinctly lower than the known consumption levels (3.15 % BME for milkfish, 1.90 % BME for tilapia). A comparison of the stomach contents observed in the feeding phase with those expected on the basis of the evacuation rate calculated in the non-feeding phase and assuming complete consumption of the food provided strongly suggested that the rate of stomach evacuation in the feeding phase was significantly higher than that when the fish were no longer feeding. When the consumption estimates were recalculated with all models on the assumption that the evacuation rate doubles in the feeding period compared to the non-feeding phase, the model predictions increased to 2.73 to 3.58 % BME for milkfish and 0.98 to 1.58 % BME for tilapia, supporting the validity of this assumption. The present findings cast doubt on one of the fundamental assumptions of all food consumption models and therefore also on the results obtained with the aid of these models.

Keywords: food consumption; stomach content; mathematical models; *Chanos chanos*; *Oreochromis niloticus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. fuer Tierproduktion in den Tropen und Subtropen, Fachgebiet Tierernaehrung und Aquakultur, Universitaet Hohenheim Fruwirthstr. 12, D-70599 Stuttgart FRG, [mailto:inst480@uni-hohenheim.de]

95 Schroeder, K. 1997. Laboratory investigations on the energy metabolism of milkfish (*Chanos chanos* Forsskal) under simulated environmental conditions. Shaker Verlag, Aachen (FRG). 147 p.

In the Philippines, milkfish is the most important fish cultivated in aquaculture systems. Despite a growing human population, no extension of the production area can be expected. Thus, a continuous supply of this relatively cheap protein source becomes more and more difficult to achieve. For improvement of existing production methods detailed knowledge of the feed requirement, feed

utilisation and energy metabolism are necessary. There is very little information on the influence of body mass and environmental conditions on the energy metabolism and growth performance of milkfish. This project was a DFG/BMZ funded research cooperation between Hohenheim University and the Southeast Asian Fisheries Development Center (SEAFDEC), Iloilo, Philippines. Its aim was to determine characteristic metabolic rates of milkfish juveniles through measurement of oxygen consumption (indirect calorimetry). Another target was to establish protocols for data acquisition. All experiments were conducted using fish with a body mass ranging from 40-100 (BMG 1), 100-200 (BMG 2) or 200-400 g (BMG 3) at a salinity of 32 ppt and at three temperature levels (TLs) (23.5 plus or minus 0.5, 27.5 plus or minus 0.5 or 32.5 plus or minus 0.5 degree C). In the first experiment a specially formulated fish diet (gross energy content 17.2 kJ/g) was offered at levels of 2.5, 5.0 and 7.5 g/kg super(0.8)/d to determine the energetic maintenance requirement (EMR).

Keywords: fish culture; recirculating systems; environmental factors; diets; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

96 Sherief, P.M. and P.A. Kurup. 1994. Glycosaminoglycans in tissues of mrigal (*Cirrhinus mrigala*) and *chanos* (*Chanos chanos*), p. 119-124. In: K. Devadasan (ed.). Nutrients and bioactive substances in aquatic organisms. Papers presented in the symposium held in Cochin, India, 16-17 September 1993. Society of Fisheries Technologists, Cochin, India.

The glycosaminoglycan composition of liver, kidney, heart, gill, air bladder, fin, scales, skin, operculum and intestine of the freshwater fish mrigal (*Cirrhinus mrigala*) and the brackish water milkfish *chanos* (*Chanos chanos*) was studied. All the above tissues of *chanos* contained more glycosaminoglycans than those of mrigal. The composition of glycosaminoglycans was different in different tissues. In both fish, tissues like heart and gill were rich in chondroitin sulphate, where as air bladder was rich in heparin and heparan sulphate. Heparin was found to be predominant glycosaminoglycans in intestine. Exploitation of these tissues for the isolation of biologically active components like chondroitin sulphate, heparin and heparan sulphate is suggested.

Keywords: polysaccharides; freshwater fish; brackishwater fish; tissues; drugs; biochemical composition; pharmacology; *Cirrhinus mrigala*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Biochem., Univ. Kerala, Thiruvananthapuram - 695 581, India

97 Sherwood, N.M., B. Harvey, M.J. Brownstein and L.E Eiden. 1984. Gonadotropin-releasing hormone (Gn-RH) in striped mullet (*Mugil cephalus*), milkfish (*Chanos chanos*) and rainbow trout (*Salmo gaidneri*): comparison with salmon Gn-RH. General and Comparative Endocrinology 55(2):174-181.

Immunoreactive gonadotropin-releasing hormone (Gn-RH) was extracted from brains of striped mullet, milkfish and chum salmon with acetone/HCL and petroleum ether. High pressure liquid chromatography and cross-reactivity studies show mullet, milkfish and trout brains to contain a peptide chromatographically and immunologically identical to synthetic salmon Gn-RH is present in immature 7-month-old and 4-year-old milkfish. A second immunoreactive peptide is separable by HPLC in all the fish studied. This 'early eluting' form of Gn-RH is unlikely to be a precursor; its cross-reactivity with anisera R-42 and #185 suggests that any modification is in the C-terminal region. Several possible roles for this peptide are advanced.

Keywords: gonadotropin; Gn-RH; *Salmo gaidneri*; *Mugil cephalus*; milkfish
Location: SEAFDEC Aquaculture Department Library

98 Smith, A.C. 1977. Immunologic reactions of the sea cucumber, *Holothuria cinerascens*, to serum from the milkfish, *Chanos chanos*. Journal of Invertebrae Pathology 29(3):326-331.

The sea cucumber, *H.cinerascens*, considered in an echinoderm class close to the vertebrate evolutionary line, was tested for immunologic responses against the serum of the milkfish, *C.chanos*.

A naturally occurring precipitin in coelomic fluid was evident; and tissue-binding transferable sensitizing substance (s), remindful of vertebrate IgE (immunoglobulin E), was demonstrated. There was no evidence of an induced circulating precipitin as might have occurred in a vertebrate or of any pathological effect.

Keywords: Immunology; *Holothuria cinerascens*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ.Hawaii, John A.Burns Sch.Med., Dep.Pathol., 1960 East-West Road, Honolulu, HI 96822, USA

99 Smith, A.C. 1978. Pathology and biochemical genetic variation in the milkfish, *Chanos chanos*. Journal of Fish Biology 13(2):173-177.

Milkfish, *C. chanos*, were sampled from two geographical areas in the Hawaiian Islands approximately 200 miles apart, from Pearl Harbor on Oahu, and Puako on Hawaii. Differences in the incidence of gastritis, a stomach inflammation, and electrophoretic patterns of nuclear lens proteins from fish of the two areas suggested they were separate populations. Genetically, the pattern frequencies indicated homogeneity in the Pearl Harbor fish and heterogeneity in the Puako fish. The former may be a small population in which homozygosity was produced through genetic drift. The genetic heterogeneity of the Puako fish may indicate a single large population or a mixture of populations. These observations support the hypothesis, previously deduced from field studies, that milkfish have many nearshore spawning areas over a wide geographical range and, therefore, little opportunity for genetic interchange between the fish from widely separated areas. Pearl Harbor fish had the highest incidence of gastritis, which appeared to be due to a combination of polluted water and a possible genetic susceptibility to disease from inbreeding.

Keywords: racial studies; diseases; *Chanos chanos*; ISEW, Hawaii
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mar. Pathol. Lab., Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA

100 Swanson, C. 1996. Early development of milkfish: effects of salinity on embryonic and larval metabolism, yolk absorption and growth. Journal of Fish Biology 48(3):405-421.

During embryogenesis of *Chanos chanos*, more than half of the yolk was consumed and the majority of it was converted into larval tissue. Salinity affected both yolk absorption and embryonic and larval growth. Larvae hatched in 20ppt had larger yolk reserves but were smaller and grew more slowly than larvae in 35 and 50ppt. Larvae hatched in 35 and 50ppt had equal amounts of yolk but those from 35ppt were larger. Oxygen consumption rates increased during development (from 0.06 plus or minus 0.01 mu l O sub(2) egg super(-1) h super(-1) by blastulae to 0.37 plus or minus 0.01 mu l O sub(2) egg super(-1) h super(-1) by prehatch embryos and 0.43 plus or minus 0.03 mu l O sub(2) larva super(-1) h super(-1) by newly-hatched larvae) and were significantly affected by salinity. Eggs and yolk-sac larvae incubated in 35ppt consumed more oxygen than those in the low and high salinities. Salinity affected both the rate and pattern of yolk utilization but salinity-related differences in metabolism, yolk absorption, and growth were not related directly to the osmotic gradient. Low salinity retarded yolk absorption while high salinity reduced yolk utilization efficiencies. Differences in oxygen consumption rates were probably related to variations in the relative amounts of metabolically active embryonic and larval tissue and/or higher activity levels rather than differential osmoregulatory costs. 35ppt is probably the most suitable salinity for incubation and larval rearing of milkfish.

Keywords: salinity effects; embryonic development; fish larvae; animal metabolism; growth; oxygen consumption; osmoregulation; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Wildl., Fish, and Conservation Biol., Univ. California, Davis, CA 95616, USA

101 Swanson, C. 1998. Interactive effects of salinity on the metabolic rate, activity, growth and osmoregulation in the euryhaline milkfish (*Chanos chanos*). The Journal of Experimental Biology 201:3355-3366.

The euryhaline milkfish (*Chanos chanos*) is an excellent subject for studies of the physiological and behavioral processes involved in salinity adaptation. In this study, energy partitioning for metabolism, activity and growth, maximal activity performance and blood osmotic concentrations were assessed at two activity levels in juvenile milkfish fed equal rations and maintained at a relatively constant temperature (26±2 °C) and at salinities (15, 35 and 55 ‰) that represented a wide range of osmoregulatory challenges. Changes in the measured parameters were not consistently related to the magnitude of the trans-integumentary osmotic gradients. Routine oxygen consumption rates were high in 35 ‰ salinity (mean±1 S.E.M. 167±8mgO2 kg˜1 h˜1) and comparably low in 15and 55 ‰ salinity (133±6 and 127±3mgO2 kg˜1 h˜1, respectively). Routine activity levels (relative swimming velocity) were highest in 35 ‰ salinity (0.96±0.04*L*s˜1), where *L* is standard length, intermediate in 15 ‰ salinity (0.77±0.03*L*s˜1) and lowest in 55‰ salinity (0.67±0.03*L*s˜1). Growth was significantly higher in 55‰salinity (3.4±0.2 % increase in wet body mass per day) thann 35 ‰ salinity (2.4±0.2 % increase per day) andintermediate in 15 ‰ salinity (2.9±0.5 % increase per day).Maximum swimming velocities decreased with increases in salinity, from 9.9±0.7*L*s˜1 in 15 ‰ salinity to 6.6±0.5*L*s˜1 in 55 ‰ salinity. Sustained swimming activity above routine levels for 2 h resulted in an increase in bloodosmotic concentrations in milkfish in 55 ‰ salinity, but osmoregulation was re-established during the second 2 h of activity. Thus, patterns of variation in metabolic rate and growth were largely parallel to variations in routine activity although, comparing 15 and 55% salinity, elevated maintenance costs for osmoregulation at the high salinity were detectable. Reduced osmoregulatory abilities and reductions in maximal swimming performance suggest that high salinity may constrain activity. The results demonstrate that investigations of salinity adaptation in euryhaline fishes should take into account the interactive effects of salinity on physiology and behavior.

Keywords: fish, salinity; energy partitioning; metabolism; growth; swimming; osmoregulation; milkfish; *Chanos chanos*
Location: http://intl-jeb.biologists.org
Auhtor Affiliation: Department of Biology, University of California, Los Angeles, CA 90095, US

102 Swanson, C. 1992. Culture of a euryhaline fish: Effects of salinity on metabolism, activity, and growth in the milkfish, *Chanos chanos*, p. 213-214. In: Aquaculture '92: Growing Toward the 21st Century (Conference), 21-25 May 1992, Orlando, Florida, USA.

The euryhaline milkfish, *Chanos chanos*, can be cultured in a wide range of salinities (0-100+ ppt) but it is generally assumed that growth will be highest in salinities which minimize osmoregulatory costs (10-15 ppt). The author measured metabolism (oxygen consumption), activity (swimming speed), and growth in spontaneously active juvenile milkfish acclimated to 15, 35, and 55 ppt and fed a uniform ration. Routine metabolism and activity were highest in 35 ppt. Metabolic rates in 15 and 55 ppt were equally low, but milkfish swam slower in 55 ppt than in 15 ppt. Growth was significantly higher in 55 ppt than in 35 ppt and intermediate in 15 ppt. Differences in metabolism and growth were attributable to salinity-related variations in spontaneous activity and, to a lesser extent, osmoregulatory costs. Osmoregulatory costs were probably small relative to overall maintenance costs, and in 55 ppt may have been compensated by decreased activity. Depressed growth observed in hypersaline culture conditions is probably not related to high osmoregulation costs but rather high stocking densities and/or reduced food availability and/or quality.

Keywords: fish culture; animal metabolism; growth; activity patterns; salinity effects; osmoregulation; bioenergetics; food availability; euryhalinity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Biol., Univ. California, Los Angeles, CA 90024-1606, USA

103 Swift, D.R. 1993. Aquaculture training manual. 2nd ed. Fishing News Books, Oxford, U.K. 158 p.

The manual provides a practical introduction to aquaculture for those who are new to fish farming or have become involved in farming a different species. The first part covers the basic biology of those fish, crustaceans and molluscs that are commonly farmed, their growth, nutrition and health, and also outlines the various methods of farming. The second part explains the husbandry of farmed aquatic animals, outlining all the major production systems. The third part deals specifically in more detail with the farming of salmonids, catfish, tilapia, carp, milkfish, mullet, turbot, marine shrimp, freshwater prawns, oysters, mussels, eels, and scallops. This second edition has been reorganized, enlarged, reset and updated to reflect the new developments that have occurred worldwide.

Keywords: aquaculture; aquaculture systems; aquaculture techniques; manuals; fish culture; shellfish culture
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

104 Taki, Y., H. Kohno and S. Hara. 1986. Early development of fin-supports and fin-rays in the milkfish, *Chanos chanos*. Japanese Journal of Ichthyology 32(4):413-420.

Development of fin-supports and fin-rays was observed in larval and juvenile *Chanos chanos*. Chondrification of the caudal complex started at 4.70 mm SL. Ossification of the caudal element started at 7.8 mm SL and was nearly complete at about 30 mm SL. Cartilagenous fusion of caudal elements, which occurs in hypurals of higher teleostean fishes but is not seen in lower teleosts was observed between the neural arch of the preural centrum 1 and that of the ural centrum 1 via a small cartilage bridging the distal tips of the two arches. Caudal fin-rays bean to develop at 6.60 mm SL, and an adult complement of principal rays was attained at 7.35 mm SL. Dorsal and anal pterygiophore elements were first evident at 6.7 mm and 6.65 mm SL, respectively. All proximal radials were formed at 8.15 mm SL in both pins. Formation of dorsal and anal-finrays started simultaneously at 8.6 mm SL, and adult fin-ray complements were attained at 10.00 mm SL and 10.7 mm SL, respectively. In the fectoral fin, the cleithrum, coraco-sacapulat cartilage (fin plate) had already been formed at 4.65 mm SL. The mesacoracoid was observed to originate from the coraco-scapular catilage and become detached from it in the course of ossification. Pectoral fin-ray formation started at 13.80 mm SL and was completed in number of rays at 20.00 mm SL. In the pelvic fin, the basipterygium was first evident at 13.00 mm SL. Pelvic pin-rays appeared at 13.80 mm SL and attained their adult count at 17.15 mm SL.

Keywords: fin-supports; fin-rays; milkfish
Location: SEAFDEC Aquaculture Department Library

105 Tamaru, C.S. 1986. Population structure, p.37-55. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

The need to analyse the genetic diversity and population is discussed. Protein variation in milkfish was presented as an example of the type of data needed in defining stock structure. A study using protein electrophoresis indicates three to four intraspecific groups depending on data interpretation. Future work should focus on the Philippines due to questions on the sampling scheme used in this study.

Keywords: population; structure; milkfish
Location: SEAFDEC Aquaculture Department Library

106 Tampi, P.R.S. 1953. On the structure of the pituitary and thyroid of *Chanos chanos* (Forsskal). Proeedings of the National Institute of Science, India 19:247-256.

A histological account of the pituitary and thyroid of the early stages of *Chanos chanos* is given. A connection between the buccal cavity and the anterior region of the pituitary is observed in fish up to 55 mm in length. Changes in the nature of the cells in the anterior, middle and posterior glandular regions take place gradually so that in the later stages the anterior and middle lobes consist of acidophilic cells, while both acido bulk and the fish grows, but under normal environmental conditions the gland does not show any mark degree of activity.

Keywords: structure; pituitary; thyroid; milkfish
Location: SEFDEC Library

107 Tan, J.D. 1985. Histological study of the hypophysial-gonadal system during sexual maturation and spawning in the milkfish. Journal of Fish Biology 26(6):657-668.

The pituitary gland of the milkfish, *Chanos chanos*, was studied at different stages of sexual maturation and spawning. Consecutive median saggital sections were treated with a range of stains to demonstrate the different cell types and regions. The milkfish pituitary consists of neural component, the neurophyposis, and anepithelial component, the adenohypophysis, which in turn consists of the three regions: the rostral pars distalis (RPD), proximal pars distalis (PPD), and par intermedia (PI). However, unlike most teleost, the pituitary gland of the milkfish is encased in a bony chamber, has dorsal and ventral lobes and extends anteriorly from its point of origin at the base of the brain. PAS (+) basophils are found in all regions of the adenohypophysis, but mostly in the proximal pars distalis. These cells undergo hypertrophy and hyperplasia during sexual maturation, shrinkage and degranulation during spawning.

Keywords: hypophysial-gonadal; sexual maturation; spawning; milkfish
Location: SEAFDEC Aquaculture Department Library

108 Tsai, S.F., J.H. Wang, S.T. Jiang. 1989. Stability of muscle proteins from some subtropic fish. Journal of Agricultural and Food Chemistry 37(3):749-752.

The stability of actomyosin (AM) from some subtropic fish, tilapia hybrid (*Tilapia nilotica x Tilapia aurea*), tilapia (*Tilapia mossambica*), carp (*Cyprinus carpio*), and milkfish (*Chanos chanos*) was investigated. According to the inactivation rate constant (K sub(D)) of AM Ca-ATPase at 0 to 45 and -10 to -40 degree C, the stabilities of tilapia hybrid and tilapia AMs were higher than those of milkfish and carp AMs. All AMs of these species were stable at pH 6.5-7.9 and had two maximum Ca-ATPase activities at pH 5.8-6.1 and 9.2, which were lower than other species inhabiting cold areas. No significant difference in K sub(D) values among these species was observed when stored at -40 degree C for 6 months. The tilapia hybrid and tilapia were the most stable storage temperatures of -10, -20, and -30 degree C.

Keywords: comparative studies; stability; fish fillets; aquaculture products; muscles; proteins; *Tilapia*; *Cyprinus carpio*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Mar. Food Sci., Natl. Taiwan Coll. Mar. Sci. Technol., Keelung, 10114, Taiwan

109 Tzeng, W.N. and S.Y. Yu. 1988. Daily growth increments in otoliths of milkfish, *Chanos chanos* (Forsskal), larvae. Journal of Fish Biology 32(4):495-504.

The formation of daily growth increments of otoliths was studied in the reared larvae of milkfish, *Chanos chanos*. The first growth increment was formed during the yolk-sac reabsorption period c.2 days after hatching, and increment formation continued on a daily schedule regardless of growth rate. The initial incremental zone was of amorphous structure, and the subsequent incremental zone was of needle-shaped crystalline structure; the former structure was formed in the yolk-sac reabsorption period of the larva and the latter in the exogenous feeding period. Accordingly, ageing

of milkfish larvae is possible by counting growth increments, and timings within the developmental stage of the larvae can be understood by examining the otolith microstructure.

Keywords: growth; ageing methods; otoliths; age determination; otolith reading; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Natl. Taiwan Univ., Taipei, Taiwan 10764, Rep. China

110 Tzeng, W.N. and S.Y. Yu. 1989. Validation of daily growth increments in otoliths of milkfish larvae by oxytetracycline labeling. Transactions of the American Fisheries Society 118(2):168-174.

The formation of growth increments in the otoliths of wild-captured larvae of milkfish *Chanos chanos* was validated by the oxytetracycline-labeling method. Immersion of the fish in 400-500 mg oxytetracycline/L for 24 h is recommended for marking the otoliths of milkfish larvae. A golden-yellow band and the newly deposited growth increments in the otolith were both discernible after marking. Otolith growth increments were deposited at the rate of about one per day, and their formation rate was unaffected by the growth rate of the fish. However, increment width varied with the growth rate of fish. Therefore, otolith growth increments are a valid characteristic for determining daily age and for studying the growth history of wild milkfish larvae.

Keywords: otolith reading; fish larvae; coastal waters; methodology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Natl. Taiwan Univ., Taipei 10764, Taiwan

111 Villaluz, A.C. and A. Unggui. 1984. Effects of temperatures on behaviour, growth, development and survival in young milkfish, *Chanos chanos* (Forsskal). Aquaculture 35(4):321-330.

Effects of three temperature treatments on activity, feeding, growth, development and survival of young milkfish (*Chanos chanos*) were investigated. Low temperature (< 22.6 degree C) and hypoxial condition (< 1 ppm O sub(2)) decreased activity, responsiveness and food intake; high temperature (up to 33 degree C) had the opposite effect. Growth and development were fastest in fish maintained in high temperature (xu- = 29.5 degree C). Fish in low temperature (xu- = 20.7 degree C) had the least growth and were inhibited from developing into juveniles during the 30 month period. Highest survival (xu- = 99.7%) was obtained in high temperature but was not significantly different (P > 0.05) from ambient temperature (xu- = 97.7%).

Keywords: temperature effects; fish culture; growth; biological development; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquaculture Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

112 Villaluz, A.C. and H.R. MacCrimmon. 1988. Meristic variations in milkfish, *Chanos chanos* from Philippine waters. Marine Biology 97:145-150.

Variations in meristic characters occur within and between samples of milkfish, *Chanos chanos* Forsskal collected on June 1977 from five localities in Philippine waters. The unbranched anal and ventral fin rays are the most plastic, and vertebral number is the most stable of nine meristic characters examined. The number of ventral fin rays is the only meristic features which differed consistently enough to suggest distinct population groups: South China Sea, comprising samples from Ilocos and Panay Island; Pacific Ocean from Bicol; and Celebes Sea, from Zamboanga and Davao. A discriminant analysis which incorporated generalized distance and percent overlap of a reduced set of characters indicated several morphometric subgroups of milkfish in Philippine waters, although geographic subgroups were not clearly demonstrated.

Keywords: meristic variations; milkfish; Philippines
Location: SEAFDEC Aquaculture Department Library

113 Walsh, W.A., C. Swanson and C.S. Lee. 1991. Effects of development, temperature and salinity on metabolism in eggs and yolk-sac larvae of milkfish, *Chanos chanos* (Forsskal). Journal of Fish Biology 39(1): 115-125.

Oxygen uptake rates and yolk-inclusive dry weights were measured during the egg and yolk-sac larval stages of milkfish, *Chanos chanos*. Oxygen uptake by eggs and yolk-sac larvae was measured to assess the effects of four salinities (20, 25, 30, 35 ppt) at 28 degree C. The effects of three temperatures (23, 28, 33 degree C) on oxygen uptake by yolk-sac larvae were determined at a salinity of 35 ppt. Dry weights were measured throughout embryonic development at 28 degree C and the yolk-sac stage at 23, 28 and 33 degree C. Oxygen uptake rates of eggs increased more than fivefold during embryogenesis (0 multiplied by 07 plus or minus 0 multiplied by 03 to 0 multiplied by 04 plus or minus 0 multiplied by 03 mu l O sub(2)/egg/h, blastula to prehatch stage). Larval oxygen uptake did not change with age but was affected by rearing temperature (0 multiplied by 33 plus or minus 0 multiplied by 08, 0 multiplied by 44 plus or minus 0 multiplied by 07 and 0 multiplied by 63 plus or minus 0 multiplied by 13 mu l O sub(2)/larva/h at 23, 28 and 33 degree C, respectively; Q sub(10) = 1 multiplied by 93). Acute temperature changes from 28 to 33 degree C caused significant increases in oxygen uptake by embryos (Q sub(10) = 1 multiplied by 69-3 multiplied by 58) and yolk-sac larvae (Q sub(10)=2 multiplied by 55). Salinity did not affect metabolic rates.

Keywords: fish eggs; fish larvae; temperature effects; salinity effects; ontogeny; oxygen consumption; dry weight; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., P.O. Box 25280, Honolulu, HI 96825, USA

114 Wang, T.Y. 2002. Study on the oxygen tolerance of milkfish (*Chanos chanos*), mullet (*Liza macrolepis*) and Tilapia (*Oreochromis mossambicus*). M.S. thesis.

Dissolved oxygen (DO) level is a critical factor for the survival of fishes and sustainable management of an aquatic ecosystem. This study aims to investigate the lethal thresholds of three major fish species in the Love River, Kaohsiung, S. W. Taiwan, in an attempt to provide ecological points of view for the further improvement of the river-water quality, as well as for the restoration of its fish community. Laboratory tolerance experiments of fish fries, including mullet (*Liza macrolepis*), milkfish (*Chanos chanos*) and tilapia (*Oreochromis mossambicus*), exposed to low levels of dissolved oxygen were conducted in the period of January 2002 to April 2003. At water temperature of 23 degrees Celsius, median lethal times (LT50) and 48 hours median lethal concentrations (48h LC50) at the salinity of 10‰, 20‰ and 30‰ were determined, respectively. We also carried out a lethal DO experiment to mullet fry in a sudden drop of salinity from 30‰ to 20‰, which is always the case when the sewage gate of the Love River interception system is opened to avoid flooding after heavy rainfall. Under the condition of 20% salinity, the tolerance of low dissolved oxygen for the three species of fish fries were significantly different. Among them, milkfish was found to be the most sensitive species, followed by mullet, whereas tilapia was the most tolerant species. The 48h LC50s of milkfish, mullet and tilapia were 15.7, 8.6 and 7.8% air saturation, respectively, which were 1.16, 0.63 and 0.57 mg/l at 23degrees Celsius. Similarly, the LT50s also showed species-specific differences. At DO level of 0.52 mg/l, the LT50s were 77.9 minutes for milkfish, 245.7 minutes for mullet and over 1000 minutes for tilapia. The changing of salinity affecting the tolerance of low dissolved oxygen in fish fries was species depending. The DO lethal concentrations of mullet fry increased with the decrease of salinity, but not the case for milkfish fries. The 48h LC50 of mullet fries in 30‰ saline water was 11.5% air saturation (0.8 mg/l), which was higher than those in 10‰ and 20‰ saline water. However, no significant difference in 48h LC50 was found between milkfish kept in 10‰ and 20‰ saline water. The 48h LC50 for the former was 14.9% air saturation while the latter was 15.7%. Both are equivalent to 1.16 mg/l at water temperature of 23 degrees Celsius. A rapid change of salinity reduced the low DO

tolerance of fish fry. When mullet fry were introduced to 20‰ saline water from acclimated salinity of 30‰, its 48h LC50 raised significantly (13.9% air saturation; 1.02 mg/l). Under the DO concentration of 0.52 mg/l, the LT50 also dropped to 7.6 minute. It means that the opening of sewage interception gate largely challenges the survival of fish fry. Based on the results of current study, the DO level of Love River is suggested to be maintained beyond 2.19 mg/l (28 % air saturation, 48h LC50 of milkfish at 10‰ salinity and 23 degrees water temperature), in order to achieve a sustainable environment for the present fish community. In cases when DO occasionally fall to the above level, it is strongly recommended that a manual aeration system should be operated within 100 minutes.

Keywords: *Chanos chanos*; milkfish
Location: http://www.etd.lib.nsysu.edu

115 Wu, S.M., P.P. Hwang, C.L. Hew, and J.L. Wu. 1998. Effect of antifreeze protein on cold tolerance in juvenile tilapia (*Oreochromis mossambicus* Peters) and milkfish (*Chanos chanos* Forsskal). Zoological Studies 37(1):39-44.

The effects of administration of antifreeze protein (AFP) via anal injection, or by feeding, on the mortalities of juvenile tilapia (*Oreochromis mossambicus* Peters) and milkfish (*Chanos chanos* Forsskal) exposed to low temperature were examined. Tilapia juveniles (2.5-3.0 g body weight) were administrated via anal injection 0 (control) or 20 mu g AFP/g body weight every 2 d for 6 doses, and later were subjected to cold-tolerance test. The mortality of tilapia, 24 h after the transfer from 26 degree C to 13 degree C, was 53.3% in the control and 14.3% in the AFP group. Milkfish juveniles (0.9-1.1 g body weight) were given via anal injection 100 mu g AFP/g body weight, 100 mu g BSA/g body weight or saline every 2 d for 6 doses. After injections, milkfish were treated by gradually decreasing temperature within 4-5 d from 26 degree C to 16 or 13 degree C. At the end of the experiment the mortality of milkfish was 66.7%-100% in the controls (BSA and saline groups) and 13.3%-33.3% in the AFP group. In the feeding experiment, artificial eel feed was given at a level of 0 (control), 100, or 1000 mu g AFP/g body weight to feed tilapia juveniles (0.01-0.02 g body weight) at a rate of 20% body weight per day for 12 d. The mortality at 24 h after the transfer to 13 degree C was 60% in the control, 41.9% in the 100 mu g/g AFP group and 3.4% in the 1000 mu g/g AFP group. These results suggest that AFP is able to enhance the tolerance of tilapia and milkfish juveniles to exposure to low temperatures.

Keywords: temperature tolerance; antifreezes; proteins; exposure tolerance; mortality causes; *Oreochromis mossambicus*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Zoology, Academia Sinica, Taipei, Taiwan 115, R.O.C., [mailto:zophwang@ccvax.sinica.edu.tw]

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BROODSTOCK MANAGEMENT AND FRY, FINGERLING AND EGG PRODUCTION AND COLLECTION

BROODSTOCK MANAGEMENT

116 Angelos, H.G. 1971. A preliminary report on the observation and possibilites of induced spawning in mullet and milkfish. Occasional Paper, Indo-Pacific Fisheries Council 71(8):1-12.

The mullet (*Mugil dussumieri*) fishery in Naujan Lake, Oriental Mindoro, is described. Preliminary experiments on induced spawning in *M. dussumieri*, using injections of fish pituitary gland hormone, were performed at the Naujan Sabalo Hatchery Experimental Station. The results indicate that *M. dussumieri*, and also *M. cephalus*, could be extensively propagated artificially and used as a substitute for bangus in brackish and freshwater fishponds in the Philippines. The possibility of induced spawning in *Chanos chanos* is discussed.

Keywords: induced spawning, milkfish, mullet
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Philippines Fish. Comm., PO Box 623, Intramuros, Manila, Philippines

117 Anon. 1980. Milkfish grown in captivity sexually mature. Philippine Farmers' Journal 21(12):18-19.

Bangus has never breed in captivity. That is why the country has depended on the seasonal spawning of the sabalo, Bangus mature breeder, which scatter fry in various shores of the country. As a result, there has not been a steady and dependable source of fry to make the country's bangus industry grow faster. Two experts from SEAFDEC, Dr. Flor Lacanilao and Clarissa Marte, however found that milkfish grown in captivity mature sexually in at least three years and lay eggs without intervention from people.

Keywords: sexually mature milkfish; captive milkfish; breeding; spawning; bangus; milkfish; *Chanos chanos*
Location: PCAMRD-DOST Library, Los Baños, Laguna

118 Collart, A. 1978. Guide to the construction of tide fed coastal fish farms and for fish breeding of *Chanos chanos* in Madagascar. FAO, Antananarivo, Madagascar. 63 p.

This guidebook gives the principal criteria to be followed in the selection of tide fed aquaculture sites for the breeding of *Chanos chanos*. The first part deals with the planning and construction of the site. The second deals with the techniques of breeding *C. chanos*.

Keywords: site selection; brackishwater aquaculture; fish culture; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

119 Emata, A.C. and C.L. Marte. 1993. Broodstock management and egg production of milkfish, *Chanos chanos* Forsskal. Aquaculture and Fisheries Management 24(3):381-388.

The milkfish, *Chanos chanos* Forsskal, industry in the Philippines suffers from a limited supply of wild fry. The demand for milkfish fry has spurred research in artificial propagation to supplement the natural seed supply. Spontaneous maturation and spawning of milkfish beginning at 5 years of rearing in floating net cages or concrete tanks coupled with improved egg collection technique have increased daily egg collection to a maximum of 3 million eggs and provided adequate volumes of eggs for mass fry production. Annual egg collection and number of spawnings were markedly higher in cage-reared stocks older than 9 years old than stocks less than 9 years old. Egg collections of tank-reared stocks were comparable to those collected in cages. As feed constitutes a major portion of the operating expenses for establishing and maintaining milkfish broodstock, further studies must be geared towards defining optimum dietary requirements and ration size for gonadal maturation and spawning. Also environmental manipulation studies must be conducted for year-round spawning. Developments in these areas should ensure the production of maximum numbers of high quality eggs and fry year-round.

Keywords: fish culture; broodstocks; fish eggs; induced breeding; feed composition; conferences; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

120 Emata, A.C. and C.L. Marte. 1994. Natural spawning, egg and fry production of milkfish, *Chanos chanos* (Forsskal), broodstock reared in concrete tanks. Journal of Applied Ichthyology 10(1):10-16.

Gonadal maturation, rematuration, and spawning of nine- (1982 stock) and ten-year-old (1981 stock) milkfish (*Chanos chanos*) reared in 150 and 200 m super(3) concrete tanks were observed in 1990 and 1991. From 23 September to 9 November 1990, the 1981 stock spawned 15 times with an average daily collection of 61,000 plus or minus 21, 000 eggs. From 4 larval rearing trials, the mean overall survival rate (from eggs to 21-day-old fry) was 9.68 plus or minus 4.3 %. From 25 April to 31 October 1991, the stock spawned a total of 108 times. Mean daily egg collection increased to 305,000 plus or minus 32,000. Successful rearing trials conducted during the latter part of the spawning season had a mean overall survival rate of 17 plus or minus 3 %, (n = 17) indicating that mass fry production techniques can be improved. Spawning of milkfish broodstock in concrete tanks provides an alternative to other existing methods of seed production.

Keywords: induced breeding; rearing; culture tanks; survival; spawning seasons; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

121 Emata, A.C., C.L. Marte and L.M.B. Garcia. 1992. Management of milkfish broodstock. Aquaculture Extension Manual. Aquaculture Department, Southeast Asian Fisheries Development Center 20. 22 p.

The manual on milkfish (*Chanos chanos*) broodstock management covers the following topics: reproductive biology; sources of broodstock; holding facilities for broodstock; feeding;

determination of gonadal development; spawning and egg collection; transport of spawned eggs; determination of percent viable eggs; and determination of hatching rate.

Keywords: fish culture; broodstocks; aquaculture techniques; manuals; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

122 Garcia, L., G. Hilomen-Garcia and A. Emata. 2000. Survival of captive milkfish *Chanos chanos* Forsskal broodstock subjected to handling and transport. Aquaculture Research 31(7):575-583.

The survival of milkfish broodstock (body weight range 1-11 kg) was determined until 30 days after handling and transport in open tanks or in sealed oxygenated bags containing chilled sea water (20-25 degree C). Maintenance of cool sea water was achieved by the gradual addition of ice chunks or frozen gel packs. A survival rate of 50% after transporting fish at a loading density of 45 kg m super(-3) for 4 h in open tanks was not significantly different from those that were handled but not transported (86%). Similarly, survival rates (67-83%) among broodstock confined for 8 h in chilled sea water at 40 and 60 kg m super(-3) were not significantly different from each other or from a group not subjected to confinement. Nevertheless, low dissolved oxygen (DO) and accumulation of total ammonia-nitrogen beginning 1 h after transport and confinement may be responsible for low survival rates of milkfish in open tanks. In contrast, all milkfish survived 10 h of overland transport in sealed bags with chilled and diluted (28 g L super(-1)) sea water. Likewise, all milkfish survived after being bagged and immediately transferred to a communal rearing tank, or bagged and placed in a styrofoam box for 10 h. Except for total ammonia-nitrogen levels, which increased slightly (0.7-0.8 mg L super(-1)) above background, seawater temperature (20-24 degree C), salinity (28 g L super(-1)) and DO (6 to > 20 mg mL super(-1)) titres in transport bags were maintained during the 10-h test. The effectiveness of handling and transporting milkfish broodstock in sealed bags containing chilled seawater was verified in actual field trials. Spawning of sexually mature milkfish subjected to these stressors was not impaired. These results demonstrate that mortalities of large milkfish broodstock can be minimized when fish are handled and transported in sealed oxygenated bags containing chilled seawater.

Keywords: fish culture; biological stress; handling; transport; aquaculture techniques; mortality causes; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

123 Juario, J.V. and M.N. Duray. 1983. A guide to induced spawning and larval rearing of milkfish *Chanos chanos* (Forsskal). Technical Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 10, 27 p. Tigbauan, Iloilo City, Philippines.

The techniques for the artificial propagation of milkfish (*Chanos chanos*) developed at SEAFDEC are presented. These include: 1) capture and transport of spawners; 2) determination of sex and weight and maturity of fish; 3) induced spawning (preparation of injection, males, females); 4) fertilization and incubation; 5) larval rearing; and 6) mass production of larval food.

Keywords: induced breeding; fish culture; brackishwater aquaculture; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

124 Juario, J.V., G.F. Quinitio, J.E. Banno and M. Natividad. 1980. Effects of exogenous hormone injections on milt consistency in newly caught, wild milkfish. Kalikasan 9(2-3):321-326.

The study was conducted to study the effects of single injections of Human Chorionic Gonadotropin (HCG) (Ayerst Laboratories, Inc) and Durandron Forte 250, a long-acting androgen preparation (N.V. Organon Oss, Holland), on sperm motility, vitality and density and on the consistency of milt in newly caught, wild, mature milkfish (*Chanos chanos*). There is an advantage in using Durandron

Forte 250 in inducing thinning of milt in mature milkfish during the natural breeding season to facilitate fertilization of eggs. Aside from its long-lasting effect which minimizes handling of fish, it is much cheaper than HCG.

Keywords: hormones; roes; biological fertilization; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

125 Juario, J.V., G.F. Quinitio, J. Banno and M. Natividad. 1981. Effects of exogenous hormone injections on milt consistency in newly caught, wild milkfish. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 5(4):1-4.

A study was conducted to determine the effects of single injections of human chorionic gonadotropin (HCG) and Durandron Forte 250 on sperm motility, vitality and density and also on the consistency of milt in newly caught, wild, mature milkfish (*Chanos chanos*). In contrast to HCG, single injections of Durandron Forte 250 were effective not only in inducing spermiation but also in maintaining newly caught mature males in good running condition for a maximum of 7 days, despite daily handling and collection of approximately 3ml milt.

Keywords: roes; sex hormones; induced breeding; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

126 Kanashiro, K. and S. Asato. 1985. Mature milkfish, *Chanos chanos*, caught in Okinawa Island, Japan. Japanese Journal of Ichthyology 31(4):434-437.

Mature milkfish have been known from Indonesian waters and the southern part of Taiwan, but have never been recorded from Japanese waters. The authors had the opportunity to examine large size milkfish which were caught with a set net in Nakagusuku Bay of Okinawa Island. The specimen had well developed ovaries or testes. This is the first record of mature milkfish from Japanese waters, strongly suggesting possible spawning of milkfish around Okinawa Island.

Keywords: new records; distribution records; gonads; spawning; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Okinawa Prefect. Fish. Exp. Stn., Itoman 901-03, Japan

127 Kelley, C. and C.S. Lee. 1986. Artificial propagation (milkfish culture), p. 83-116. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of Milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

A description is given of current techniques in the Philippines for obtaining and handling milkfish broodstock, reviewing also present information regarding broodstock management. Natural and induced maturation and spawning are discussed in particular.

Keywords: induced breeding; brood stocks; aquaculture techniques; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

128 Kuo, C. 1985. A review of induced breeding of milkfish, p. 55-57. In: C.S. Lee and I.C. Liao (eds.) Reproduction and culture of milkfish: Proceedings for a workshop held at the Tungkang Marine Laboratory, 22-24 April 1985, Tungkang, Taiwan.

The progress and present status of the artificial spawning of milkfish (*Chanos chanos*) is reviewed. The mature broodstock were established in various types of confinements, e.g. ponds, lagoon, concrete tanks and floating cages. Environmental conditions and associated factors in these confinements are summarized, and the importance of environmental factors and dietary requirements for the gonadal maturation of captive milkfish are briefly discussed. Encouraging results in the gonadal maturation by the method of LH-RH analog implantation have recently been achieved.

Keywords: aquaculture techniques; induced breeding; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Int. Cent. Living Aquat. Resour. Manage. (ICLARM), Manila, Philippines

129 Kuo, C.M. 1984. Natural spawning of captive milkfish in Taiwan. ICLARM Newsletter 7(4):18-19.

The culture of milkfish in Taiwan is discussed with respect to work undertaken at the Tung Shin hatchery regarding natural spawning in captivity. Broodstock maintenance and husbandry techniques used are described.

Keywords: fish culture; hatcheries; spawning; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM, Taipei, Taiwan

130 Kuo, C.M., C.E. Nash and W.O. Watanabe. 1979. Induced breeding experiments with milkfish, *Chanos chanos* Forsskal, in Hawaii. Aquaculture 18(2):95-105.

The hormones SG-G100, CPH, and HCG were used to induce spawning of the milkfish. A total of 22 potentially receptive females were injected. Females with oocytes 0.7 mm in diameter or above offer the greatest chance for success. A priming dose of hormone injected immediately after capture reduces the effects of stress or atresia. Under optimal conditions, the spawning of milkfish can be induced by two or three injections of total dose up to 200 mg CPH with 25,000 IU HCG. Mature females respond more readily to injections without the added stress of salinity adjustment.

Keywords: induced breeding; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Waimanalo, HI 96795, USA

131 Lee, C.S., C.S. Tamaru and G.M. Weber. 1987. Studies on the maturation and spawning of milkfish *Chanos chanos* Forsskal in a photoperiod-controlled room. Journal of the World Aquaculture Society 18(4):253-259.

Progress in propagation of milkfish (*Chanos chanos*) has been impeded by the shortage of mature broodstock. This study was a first step toward revealing the environmental cues for the maturation of milkfish. Experiments were carried out during 1978-1985 in an indoor tank under photoperiod control and in an outdoor tank. In two controlled, long-photoperiod regime experiments, 86 and 83% of the fish matured, the highest percentages yet reported. In these experiments, milkfish matured one month earlier than the normal spawning season, two months after the fish were exposed to the long daylight regime.

Keywords: fish culture; sexual maturity; induced breeding; photoperiods; light effects; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: The Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA

132 Lee, C.S., C.S. Tamaru and L.W. Crim. 1985. Preparation of a luteinizing hormone-releasing hormone cholesterol pellet and its implantation in the milkfish (*Chanos chanos* Forsskal), p. 215-226. In: C.S. Lee and I.C. Liao (eds.). Reproduction and culture of milkfish: Proceedings for a workshop at the Tungkang Marine Laboratory, 22-24 April 1985, Taiwan.

A guide is given for the production of a cholesterol LHRH pellet for use in inducing gonad maturity in milkfish (*Chanos chanos*). Details are given for the biopsy of the gonads to monitor changes in ovarian development and for the implantation of the pellet into the milkfish.

Keywords: induced breeding; sex hormones; aquaculture techniques; *Chanos chanos*

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Waimanalo, HI, USA

133 Lee, C.S., C.S. Tamaru, C.D. Kelley and J.E. Banno. 1986. Induced spawning of milkfish, *Chanos chanos*, by a single application of LHRH-analogue. Aquaculture 58(1-2):87-98.

Current procedures for induced spawning in milkfish, *Chanos chanos*, involve the injection of pituitary homogenate and human chorionic gonadotropin followed by hand stripping of the hydrated eggs. This procedure results in the loss of valuable broodstock, low fertilization rates and unpredictable time of spawning. A reliable method for inducing spawning is essential. In this study, luteinizing hormone-releasing hormone analogue (LHRH-a) was tested for its effectiveness as an ovulatory and spawning agent. A single administration of LHRH-a via pellet implantation or liquid injection induced spontaneous spawning 48 or 24 h after application, respectively. The average dosage used was 41.7 plus or minus 3.3 mu g/kg body weight for pellet implant and 58.7 plus or minus 9.3 mu g/kg body weight for injection. The spontaneous release of eggs was achieved in all spawning attempts when the initial egg diameter was at least 800 mu m on average and had a single mode distribution. Seven of 15 attempts with natural fertilized spawns were successful and resulted in an average of 83.8% fertilization.

Keywords: induced breeding; sex hormones; fish culture; spawning; aquaculture; luteinizing hormone-releasing hormone; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA

134 Lee, C.S., C.S. Tamaru, J.E. Banno and C.D. Kelley. 1986. Influence of chronic administration of LHRH-analogue and/or 17 alpha-methyltestosterone on maturation in milkfish, *Chanos chanos*. Aquaculture 59(2):147-159.

Five chronic hormone therapies; cholesterol pellets containing 200 mu g of LHRH-a (LHRH-a pellet); silastic tubing packed with either 250 mu g of dissolved 17 alpha -methyltestosterone (liquid 17 alpha –MT capsule) or 10 mg crystalline 17 alpha –methyltestosterone (crystalline 17 alpha -MT capsule); or the combinations of LHRH-a pellets plus a liquid 17 alpha -MT capsule or LHRH-a pellets plus a crystalline 17 alpha -MT capsule, were tested to determine the best treatment for inducing maturation in captive milkfish (*Chanos chanos*). Results show that the combination of LHRH-a pellets plus liquid 17 alpha-MT capsules is the most effective hormone therapy for enhancing the maturation of both sexes. Fifty percent of these fish matured in April, 1 month after implantation, and close to 90% of the fish in this treatment matured by July. The combination of LHRH-a pellets plus crystalline 17 alpha -MT capsules enhanced the maturation of male milkfish but not female. LHRH-a alone was also effective in the maturation of females, but was the least effective of all treatments in maturing males. 17 alpha-MT capsules alone, in either form, did not induce maturation in female milkfish.

Keywords: steroids; therapy; sexual maturity; experimental research; comparative studies; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

135 Lee, C.S., C.S. Tamaru, J.E Banno, C.D. Kelley, A. Bocek and J.A. Wyban. 1986. Induced maturation and spawning of milkfish, *Chanos chanos* Forsskal, by hormone implantation. Aquaculture 52(3):199-205.

The milkfish, *Chanos chanos* Forsskal, does not reach gonadal maturity easily in captivity. In an attempt to induce maturation, exogenous hormones, LHRH-A and 17 alpha -methyl-testosterone, were implanted into adult milkfish either alone or in combination. The combination of LHRH-A and 17 alpha -methyl-testosterone induced significantly more maturing fish than LHRH-A alone or sham controls; 88% 38%, and 13%, respectively. Fish with average egg diameters between 768 mu m and

905 mu m, spawned 48 h after hormone implantation. These results indicate that the maturation and spawning of milkfish in tanks can be induced and accelerated 1-2 months earlier than the beginning of the normal spawning season through hormone implantation.

Keywords: induced breeding; spawning; hormones; sexual maturity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

136 Lee, C.S., G.M. Weber and C.S. Tamaru. 1986. Effect of orally-administered 17 alpha-methyltestosterone on spermatogenesis in immature milkfish, *Chanos chanos* Forsskal. Journal of Fish Biology 29(5):567-572.

Diets containing 17 alpha-methyltestosterone (17 alpha-MT) were fed to milkfish, *Chanos chanos*, both during the spawning season (experiment 1) and after (experiment 2). The daily dosage of 17 alpha-MT per kg of body weight was either 25 mg or 12.5 mg in experiment 1, and either 12.5 mg or 6.25 mg in experiment 2. The fish in both experiments were smaller than the minimum mature size previously reported. After 12 weeks of treatment, the treated fish had GSIs that were four times higher than the control fish in both experiments. Histologically, the testes of the control fish had only spermatogonia, in contrast to spermatozoa in the treated fish. However, no male possessed running milt. So 17 alpha-MT induced spermatogenesis but not spermiation in the immature-sized milkfish. (DBO)

Keywords: sex hormones; spermatogenesis; breeding seasons; sperm; food additives; histology; aquaculture techniques; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Pt., Waimanalo, HI 96795, USA

137 Liao, I.C., J.V. Juario, S. Kumagai, H. Nakajima, M. Natividad and P. Buri. 1979. On the induced spawning and larval rearing of milkfish, *Chanos chanos* (Forsskal). Aquaculture 18(2):75-93.

A female milkfish, captured at sea, was injected with two hormonal injections of acetone-dried salmon pituitary powder and human chorionic gonadotropin, plus Vitamin B complex. It was stripped, and produced 128,000 ripe eggs with an average diameter of 1.15 mm. Fertilization rate was 38% following artificial fertilization with milt from an uninjected male. A total of 36,000 larvae hatched (74% of fertile eggs) after 26-32 h at 34 o/oo salinity and 27-32 C. The newly hatched larvae measured 3.4 mm in mean total length and possessed a large yolk sac. The mouth of the larvae opened about 54 h after hatching. The larvae were fed with fertilized oyster eggs, rotifers, *copepods*, brine shrimp, flour and prepared feed, together with *Chlorella*. A critical period was between the 4th and 6th days with mortality over 80%. The larvae started increasing in length by Day 8, and had the appearance of the wild fry by Day 11. On Day 13 a pigmentation pattern developed and the biggest larva measured 10.0 mm. By Day 18 the larvae measured 12.5 mm, and 14.5 mm by Day 21. A total of 2859 fry was obtained; the highest larval survival rate obtained from different experimental groups was 46.8%.

Keywords: induced breeding; rearing; fish culture; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Tungkang, Pingtung 916, Taiwan

138 Lin, M.N. and D.T. Lu. 1976. Observations on adult milkfish (*Salmon blanco*) in the Gulf of Fonseca, Honduras, C.A. China Fisheries Monitor (238):2-6.

Central America has no report on the occurrence of white salmon (*Chanos chanos*) until the authors were able to collect 8 specimens with sizes of more than 60 cm, and 15 specimens more of different inferior sizes (minimum of 5 cm) from November 1974 to 1976. Five of the eight large ones were

already eviscerated and dried by the fisherman at the moment they are found. Observations on the remaining three are presented.

Keywords: adult milkfish; *Salmon blanco*; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

139 Marte, C.L. and F. Lacanilao. 1986. Spontaneous maturation and spawning of milkfish in floating net cages. Aquaculture 53(2):115-132.

Milkfish (*Chanos chanos*) reared from wild-caught fry and from hatchery-bred fry matured at 3.5-5.5 years (2.3-4.9 kg). Maturation and spawning of the hatchery-bred fish marks the first time the milkfish life-cycle has been completed in captivity. Milkfish at various stages of gonadal development were obtained in Jul-Oct 1980 and Mar-Jun 1981 derived from wild-caught fry, and in Feb-Jun 1983 from the hatchery-bred fish. The fish were held in floating net cages 9 m and 10 m diameter by 3 m deep, located in 7 m deep water off Igang, Guimaras Island, Philippines. Annual ranges of temp. and salinity were 25-33 degree C and 25-38 ppt, respectively. The fish were fed commercial feed pellet (42% protein) at 1.5-2% of body weight twice daily. Sexual maturation occurred during the natural breeding season of wild milkfish in the nearby waters. Data on gonadosomatic index, spawning times, fecundity, fertilization and hatch rate for the two groups are given. Factors affecting spontaneous maturation, spawning and rematuration are discussed. The results indicate the potential for hatchery production of milkfish fry from captive broodstock and for restocking of waters deprived of naturally occurring fry.

Keywords: cage culture; sexual maturity; spawning; life cycle; captivity; fish culture; fecundity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

140 Marte, C.L., G.F. Quinitio, L.M.B. Garcia and F.Lacanilao. 1984. A guide to the establishment and maintenance of milkfish broodstock. Technical Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 11, 36 p. Tigbauan, Iloilo City, Philippines.

The manual describes methods used at the SEAFDEC Aquaculture Department in order to establish milkfish broodstock. It is presented under the following major section headings: Establishing broodstock farms; Farms for rearing bangus juveniles; Maturation cages for rearing broodstock to maturity; Gathering data; Spawning and egg collection; and Larval rearing.

Keywords: induced breeding; broodstocks; aquaculture techniques; manuals; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

141 Marte, C.L., L.W. Crim and N.M. Sherwood. 1988. Induced gonadal maturation and rematuration in milkfish: Limited success with chronic administration of testosterone and gonadotropin-releasing hormone analogues (GnRH-A). Aquaculture 74(1-2):131-145.
Nine experiments were conducted to investigate the influence of chronic administration of testosterone (T) and gonadotropin-releasing hormone (GnRH) analogues on first maturation of 4- to 6-year-old fish, *Chanos chanos*, and rematuration of 6- to over 9-year-old spent/regressed fish. Implantation of T or T in combination with luteinizing hormone-releasing hormone analogue (LHRH-A) had no marked effect on maturation rate of 4-year-old milkfish. Tank-reared maturing 4-year-old females, about half the size of older first maturing females, were induced to spawn. This is the first case of maturation and spawning of 4-year-old milkfish reared in tanks. The factors which may have influenced the results of these experiments include age and reproductive history of the fish, timing of hormone implantation, experimental and holding conditions, and stress.

Keywords: sexual reproduction; sexual maturity; sex hormones; animal physiology; rearing; culture tanks; spawning; aquaculture; induced spawning; testosterone; luteinizing hormone-releasing hormone; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

142 Marte, C.L., N. Sherwood, L. Crim and J. Tan. 1988. Induced spawning of maturing milkfish (*Chanos chanos*) using human chorionic gonadotropin and mammalian and salmon gonadotropin releasing hormone analogues. Aquaculture 73(1-4):333-340.

The response of maturing female milkfish to D-Ala super(6)-des Gly super(10) mammalian GnRH ethylamide (MGnRH-A), D-Arg super(6)-des Gly super(10) salmon GnRH ethylamide (sGnRH-A) and human chorionic gonadotropin (hCG) was investigated. The GnRH analogues and hCG were equally effective when administered by intramuscular injection at doses of 10 mu g/kg and 100 mu g GnRH-A/fish or 1000 IU hCG/fish. Fish implanted with mGnRH-A or sGnRH-A showed responses which varied from oocyte hydration to spawning. Only 3/7 implanted with mGnRH-A and 1/7 implanted with sGnRH-A spawned; in the latter group, the average egg diameter was 11-17% smaller at the time of treatment compared with the other treated groups. Except for one, all fish with egg diameters above 0.65 mm had hydrated/ovulated oocytes or spawned. Females which spawned had egg diameters above 0.71 mm.

Keywords: induced breeding; sex hormones; females; spawning; fish culture; aquaculture; oocytes; sexual maturing; chorionic gonadotropin; luteinizing hormone-releasing hormone; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

143 Marte, C.L., N.M. Sherwood, L.W. Crim and B. Harvey. 1987. Induced spawning of maturing milkfish (*Chanos chanos* Forsskal) with gonadotropin-releasing hormone (GnRH) analogues administered in various ways. Aquaculture 60(3-4):303-310.

The response of mature female captive milkfish (*C. chanos*) to mammalian and salmon gonadotropin-releasing hormone analogues (mGnRH-A and sGnRH-A) was investigated. Prior to spawning, six groups of three females received (1) 10-16 mu g mGnRH-A from an osmotic pump implanted intraperitoneally (IP); (2) 100 mu g mGnRH-A from a cholesterol/cellulose pellet implanted IP; (3) 10 mu g/kg mGnRH-A as an intramuscular (IM) injection; (4) 10-16 mu g sGnRH-A from an osmotic pump implanted IP; (5) 100 mu g sGnRH-A from a cholesterol/cellulose pellet implanted IP, and (6) a cholesterol/cellulose pellet without analogue implanted IP. The most effective treatment was 100 mu g sGnRH-A/fish given in a cholesterol/cellulose pellet; all (3/3) of the fish spawned. However, mGnRH-A was more effective (2/3) compared with sGnRH-A (1/3) if osmotic pumps were used to administer GnRH-A.

Keywords: fish culture; aquaculture techniques; induced breeding; hormones; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

144 Prijono, A., Tridjoko, I.N.A. Giri, A. Poernomo, W.E. Vanstone, C. Lim, and T. Dulay. 1988. Natural spawning and larval rearing of milkfish in captivity in Indonesia. Aquaculture 74(1-2):127-130.

Sixty-seven milkfish, *Chanos chanos*, broodstock were transported by truck from Jepara, Central Java, to Gondol, Northern Bali, over six trips. The duration of transport was 15-17 h. The stocking density in the canvas transport tanks was approximately 15 kg/m super(3). Conditions of transport were low temperature (24-26 degree C), decreased salinity (20 ppt) and continuous aeration. Natural

spawning occurred on nine occasions 4 months after stocking, and took place between the end of the major and beginning of the minor milkfish fry season in Indonesia. Weight of spawning fish ranged from 2.1 to 4.9 kg. Larvae, fed a regime of mixed live food, were reared to 21 days of age at a survival rate of 2.2-51.1%. Currently, 400 fish are being reared in four concrete and four canvas tanks on a commercial pelletized feed.

Keywords: spawning; rearing; culture tanks; fish larvae; fish culture; transportation; diets; aquaculture; fisheries; larvae; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Stn. Coast. Aquacult., Gondol, Bali, Indonesia

145 Sukumaran, K.K. 1979. Indonesia. Induction of maturation and spawning of milkfish, *Chanos chanos* (Forsskal). A report prepared for the brackishwater shrimp and milkfish culture applied research and training project. FAO, Rome, 19 p.

This work conains background information on the organization and implementation of a work programme for Indonesia aimed at the induction of gonadal maturation and spawning of milkfish including collection, transport and maintenance of adult brood stock. The development of hatchery methods is also discussed together with the mass rearing of larvae. The training of staff is considered.

Keywords: induced breeding; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

146 Tamaru, C.S., C.S. Lee, C.D. Kelley and J.E. Banno. 1988. Effectiveness of chronic LHRH-analogue and 17 alpha-methyltestosterone therapy, administered at different times prior to the spawning season on the maturation of milkfish (*Chanos chanos*). Aquaculture 70(1-2):159-167.

Milkfish (*Chanos chanos*) were chronically exposed to the LHRH-a plus 17 alpha-methyltestosterone therapy. A significantly higher percentage of mature females was found among fish receiving hormone implants, by the onset of the natural spawning season. Eighty-five percent of the hormone-implanted females reached a stage of maturity in which induced spawning trials could be initiated. The data also suggested that the response of individuals to the therapy exhibits seasonal variation. Chronic exposure to the hormonal therapy appeared to be more effective when initiated closer to the start of the natural breeding season.

Keywords: induced breeding; hormones; spawning seasons; sexual maturity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., Makapuu Point, Waimanalo, HI 96795, USA

147 Tamaru, C.S., C.S. Lee, P.Y. Ha, J.M. Ginoza, K. Aida and I. Hanyu. 1990. Release rates of steroids from silastic tube implants in vitro and in vivo with juvenile milkfish, *Chanos chanos*. Aquaculture 87(1):91-101.

The release rates of three steroids (testosterone, 11-ketotestosterone, and estradiol-17 beta), from silastic tube implants at varying dosages were investigated in vitro and in vivo with juvenile milkfish (*Chanos chanos*). In vitro results demonstrated that androgen steroids were released in a dose-dependent fashion. The release rate of estradiol at the highest dosage was significantly higher than that of the two lower dosages tested. All steroids exhibited significantly different, but relatively constant, rates of release over 21 days. Testosterone was released at the fastest rate and estradiol at the slowest. All steroid implants significantly elevated serum steroid levels in juvenile milkfish for an extended period of time (at least 35 days). Serum profiles mirrored those found in vitro. Serum steroid values corresponded with physiological values observed in adult milkfish.

Keywords: sex hormones; steroids; induced breeding; biotechnology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Oceanic Inst., P.O. Box 25280, Honolulu, HI 96825, USA

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(See abstract, keywords, location and author's affiliation in entry no. 197)

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(See abstract, keywords, location and author's affiliation in entry no. 206)

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(See abstract, keywords, location and author's affiliation in entry no. 207)

Emata, A. 2001. Updates in the Philippines. Where are the captive milkfish breeders? SEAFDEC Asian Aquaculture 23(3-4):31.
(See abstract, keywords, location and author's affiliation in entry no. 210)

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(See abstract, keywords, location and author's affiliation in entry no. 24)

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(See abstract, keywords, location and author's affiliation in entry no. 233)

148 Anon. 1974. New method increases bangus fry catch: "bamboo bulldozer". Philippine Daily Express, 24 February 1974:1.

The modified 'baka-baka' fishing gear known as the bamboo bulldozer increases fry catch by 10 to 20 times. This gear consists of a fine net attached to a bamboo raft which may be operated using a motor boat. This innovation will give a tremendous boost to the milkfish fry industry.

Keywords: fry catch; bamboo bulldozer; fishing gear; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

149 Bagarinao, T. 1986. The milkfish seed resources survey in Sri Lanka: status, problems and recommendations. Journal of Inland Fisheries 3:96-107.

A summary is provided of information concerning the milkfish (*Chanos chanos*) seed resources of Sri Lanka, highlighting problems related to seed collection. Various recommendations are made to overcome these problems and the following areas are covered: logistic aspects; technical aspects; seed supply; demand for seed; uneven sizes of seed; storage techniques; mortality; collection season; shore waters and other new collection grounds; development of collection methods and gear; and, identification of milkfish fry.

Keywords: fish culture; fry; seed collection; aquaculture techniques; aquaculture development; *Chanos chanos*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

150 Bagarinao, T. and S. Kumagai. 1987. Occurrence and distribution of milkfish larvae, *Chanos chanos* off the western coast of Panay Island, Philippines. Environmental Biology of Fishes 19(2):155-160.

The occurrence and distribution of milkfish (*Chanos chanos*) larvae (similar to 3-17 mm TL) off western Panay Island, Philippines are reported based on 594 plankton net tows made in April and May 1980. Forty-two tows yielded 44 larvae, together with 1149 milkfish eggs by 98 tows. About 70% of the larvae of all stages came from stations less than 100 m deep and 1-2 km from land. Younger larvae up to 6 mm and about 1-week-old occurred at stations of various distances from shore, while older larvae occurred only near shore. About 48% of larvae of all stages were caught by surface tows; younger larvae occurred also in deeper layers (20 and 30 m). Larval abundance increased towards May. Younger larvae tended to occur during the quarter moon periods and older ones during the full and new moon periods.

Keywords: fishery surveys; seed collection; resource availability; fish larvae; moon phases; spawning grounds; *Chanos chanos*; *Chanidae*; *Pisces*; ISEW, Philippines, Panay I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: A-008 Univ. California at San Diego, La Jolla, CA 92093, USA

151 Baliao, D.D., E.M. Rodriguez and D.D. Gerochi. 1980. Growth and survival rates of hatchery-produced and wild milkfish fry grown to fingerling size in earthen nursery ponds. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(4):11-14.

Growth and survival rates of hatchery-produced and wild milkfish (*Chanos chanos*) fry grown to fingerling size were compared. Data show no significant difference between the 2 fry. At a recommended stocking density of 30 fry/m super (2), hatchery-produced milkfish fry could attain fingerling size of almost 2g with a survival of 68%. The study indicates that hatchery-produced fry/fingerlings can equal the culture performance of the wild fry. Comparative performance of

hatchery-bred and wild fry should encourage intensified research on milkfish broodstock development and refinement of induced spawning methods.

Keywords: fish culture; growth; survival; pond culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

152 Banada, V.C. 1980. The occurrence of postlarval and juvenile stages of some economically important fishes in three milkfish fry collecting grounds in Panay Island. University of the Philippines, Quezon City. 103 p. M.S. thesis.

Samples of postlarval and juvenile stages of some economically important fishes in three milkfish fry collecting grounds in Panay Island were collected with the use of a seine net in Hamtik and Pandan, and with a sweeper net in Tigbauan, Iloilo. Sampling was done once in two weeks for ten months. Prior to the collection of samples, ecological parameters such as surface water temperature, salinity and type of bottom were determined. Samples were preserved in 5% formalin solution. Forty species of postlarval and juvenile fishes belonging to 31 families have been identified in this study.
Surface water temperature and salinity did not show a positive correlation to abundance. The variety of species collected was however affected by the type of bottom and the proximity of the sampling area to feeding grounds such as eel grass beds and coral reef flats which was shown in the samples collected in Pandan.
Of the species collected only *Ambassis sp., Chonophorus sp., Elops machnata, Mugil sp., Stolephorus commersonii, Therapon jarbua, Leiognathus fasciatus* and *Apogon sp.* showed high percentages of occurrence. Most of these species had their peaks of abundance on the months of April to June and August to October. The rest of the species collected appeared once or many times but with very few individuals.

Keywords: postlarval; juvenile stage; milkfish fry collection; Panay Island; Philippines
Location: University of the Philippines, Diliman, Quezon City

153 Banada, V.C. 1983. Larval and early juvenile fishes associated with milkfish fry at Malandog, Hamtik, Antique. Fisheries Research Journal of the Philippines 8(2):51-59.

From 5 May 1981 to 7 November 1981 a total of 122,841 specimens of milkfish fry and early juvenile fishes was collected with the use of a milkfish fry sweeper. Of these, 66,361 or 54.02% consisted of early juvenile stages of 30 species of finfish and the rest were 56,480 milkfish fry or 45.98% of the total collection. The most abundant finfish excluding milkfish fry was *Ambassis sp.* comprising 59.43% of the total fish catch, followed by *Elops machnata*, 12.7%; *Sillago sihama*, 8.66% *Gobiidae,* 6.11%; *Therapon jarbua,* 5.49% *Stolephorus sp.,* 2.06%; *Chonoporus sp.,* 1.53%; mullet, 0.97% and *Scatophagus argus,* 0.32%.

Keywords: fish larvae; marine fish; seed collection; check lists; juveniles
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

154 Bensam, P. 1996. Occurrence of milkfish *Chanos chanos* (Forsskal) postlarvae in the continental slope northwest of Cochin, as collected by FORV Sagar Sampada. Indian Journal of Fisheries 43(4):417-421.

Postlarvae of *Chanos chanos* were collected in April 1985 by FORV Sagar Sampada from the continental slope at a distance of 52 km off Cochin, Kerala, India where the depth to bottom measured 1,125 m. Three stages of development were available, measuring 5.23, 8.38 and 8.36 mm in total length, which are about 3 to 10 days old and hitherto undescribed from India. The diagnostic characters by which the present postlarvae can be distinguished from those of allied groups such as *Elops*, *Megalops* and *Clupeidae* are given. The present record highlights their occurrence in the oceanic regions thereby suggesting that the spawning grounds of this fish might extend to such distant and deep areas.

Keywords: marine fish; juveniles; distribution records; developmental stages; animal morphology; spawning grounds; continental slope; *Chanos chanos*; ISW, India, Kerala, Cochin
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Cochin-682 014, India

155 Buri, P. and G. Kawamura. 1983. Mechanics of mass occurrence and recruitment strategy for milkfish *Chanos chanos* (Forsskal) fry in the Philippines. Memoirs of the Faculty of Fisheries, Kagoshima University 3(2):33-55.

The daily and hourly catch of milkfish *Chanos chanos* (Forsskal) fry in the coast of Hamtik, Panay Island in the Philippines was recorded over the period of 16 weeks and correlated with time, location, types of gear, and lunar and tidal variatons. About 4000 fry were marked and release, scanning electron microscopy was employed to examine the feeding habit of the fish. The results obtained suggest an active process governing the occurrence and movement of fry is related to the developmental stage of the fry and is subject to lunar modulation. Interaction with predators in coastal waters has produced diverse and selective antipredator adaptations, such as body transparency, the use of timing (seasonality, tidal conditions), and distribution patterns. The maximization of resource utilization and minimization of resource sharing also occurs in seasonal basis. High mortality rates in shallow coastal waters is counteracted by high recruitment rate and specific behavioural and physiological adaptations to ensure successful and fast colonization of backwaters. It is suggested that higher food availability in the nursery ground exerts a stronger selective pressure over predation, and act as a major force in the migration from offshore to shore waters.

Keywords: mass occurrence; recruitment strategy; milkfish
Location: SEAFDEC Aquaculture Department Library

156 Collart, A. and A. Rabelahatra. 1978. Preliminary results on the prospecting for and the breeding of *Chanos chanos* in Madagascar. FAO, Antananarivo, Madagascar, 31 p.

This study gives the preliminary results of surveys for the larvae and fry of the milkfish, *Chanos chanos*, carried out along the northwest coast of Madagascar and in the Antsiranana Bay. The results of experimental culture of *C. chanos* are also reported.

Keywords: fish culture; experimental culture; aquaculture development; seed collection; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

157 Dela Cruz, E. 1997. Potential of milkfish farming development in Fiji. FAO, Suva, Fiji. 42 p.

The findings presented are of a milkfish (*Chanos chanos*) survey carried out in Fiji in the framework of the FAO South Pacific Aquaculture Development Project. The survey aimed to locate sites of potential milkfish fry collection, to perform trial collections and also to teach Fisheries staff how to find sites, catch, transport, and store the fry, and to farm them into a salable fish product. Information obtained indicated that there are milkfish available in Fiji waters to start a food and tuna bait industry. Government agencies, like the Fisheries Department, will have a role to play in educating villagers to collect fry at sites where commercial collections are possible, and the Government could concentrate on developing farms for producing tuna bait or food.

Keywords: fry; aquaculture development; seed collection; fish culture; bait fish; bait culture; tuna fisheries; report literature; *Chanos chanos*; ISEW, Pacific, Fiji
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

158 Dorairaj, K., G. Mohanraj, V. Gandhi, A. Raju, V.S. Rengaswamy, J.X. Rodrigo. 1984. On a potentially rich milkfish seed collection ground near Mandapam along with the methods of collection and transportation. Indian Journal of Fisheries 31(2):257-271.

A potential ground for milkfish (*Chanos chanos*) seed collection has been located at Manoli Island in the Gulf of Mannar, where fry and fingerlings of the species congregate in large numbers in the tidal pools under the dense shades of the mangrove bushes in April-May. The ecology of the ground, the methods and results of fry and fingerlings collection, handling, and packing and transportation are mentioned.

Keywords: seed (aquaculture); seed collection; resources; collections; transportation; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

159 Encina, V.B. and A.R. Gatus. 1977. Preliminary report on milkfish fry floating trawl experiment in Balayan Bay. The Philippine Journal of Fisheries 15(2):174-216.

This paper describes an experiment that confirmed a theory that milkfish fry can be caught by a special gear operated at depths beyond the reach of fisherman using indigenous gear for catching milkfish fry. How the gear was designed and constructed is also described and illustrated. Observations and results are discussed. The experiment proved that milkfish fry could be caught by a floating trawl towed by a motorized banca.

Keywords: floating trawl; milkfish fry; catching gear; indigenous gear; Balayan Bay
Location: PCAMRD-DOST Library, Los Baños, Laguna

160 Garcia, L.B.M., C.L. Marte and V.S. Travina. 1988. A collecting gear for naturally-spawned milkfish (*Chanos chanos* Forsskal) eggs in circular floating net cages. Aquaculture 68(1):83-86.

A collecting gear for naturally-spawned milkfish (*Chanos chanos* Forsskal) eggs in circular floating net cages is described. The gear has been shown to be effective in collecting large numbers of eggs. The collecting gear can be adopted for other broodstock fish species held in circular floating net cages.

Keywords: collecting devices; fish eggs; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

161 Kawamura, G., D.R. Monintja and K. Manguskarto. 1983. Occurrence of young milkfish *Chanos chanos* (Forsskal) in Indonesia. Memoirs of the Faculty of Fisheries, Kagoshima University 3(2):23-32.

A field survey was conducted to verify the occurrence of young milkfish in coastal waters. Results include information obtained from interview with small-scale or subsistence fisherman, supported by capture of the fish in shore waters and rivers in 25 locations in Madura, Bali and Java, Indonesia.

Keywords: occurrence; young milkfish; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

162 Kawamura, G., S. Hara and T. Bagarinao. 1980. Fundamental study on the behavior of milkfish fry for the evaluation of the efficiency of traditional fry collecting gears in the Philippines. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(2):23-28.

The response of *Chanos chanos* fry to moving and stationary nets of different mesh size and colour, underwater visibility of the nets and water filtration were studied. Results indicate that milkfish fry may be driven by nets of mesh size larger than that presently used; larger mesh size decreases the net resistance in the water so that collectors may move the equipment easily. The large mesh nets should be of a dark colour, preferably black for effective driving; however, white mosquito net is best for the core end, since the fry are more easily visible on a white background.

Keywords: fishing gear; mesh selectivity; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

163 Kumagai, S. 1978. Milkfish fry occurrence pattern in two localities along the western coast of Panay Island. Quarterly Research Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 2(3):1-2.

The results are presented of a study of milkfish fry occurrence in the Philippines, namely at Magaba and at Tubog. There were 2 peaks of fry occurrence in the latter, one in May and another in October, whereas only one peak occurred in the former in May. The possible influence on light intensity on the fry seasons is examined.

Keywords: fry; stock assessment; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

164 Kumagai, S. and T.U. Bagarinao. 1979. Results of drift card experiments and considerations on the movement of milkfish eggs and larvae in the Northern Sulu Sea. Fisheries Research Journal of the Philippines 4(2):64-81.

For a period of one year beginning December 1977, drift card experiments were conducted off the western and southern coasts of Panay Island to determine the surface currents in the area. Of a total 2,384 drift cards released during the study, 382 (16.02%) were recovered, 92% of them within 30 days following dispatch. The surface currents in the study area are strongly influenced, in direction and speed, by the prevailing monsoon winds. During the NE monsoon period, the surface currents move away from the coast; during the SW monsoon, toward and/or parallel to the coast. Based on the results, the probable movement and transport of milkfish (*Chanos chanos*) eggs and larvae from the spawning ground to the fry collection ground are also discussed.

Keywords: fish larvae; drifters; water currents; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

165 Kumagai, S., N.M. Castillo and V.C. Banada. 1978. Spawning periodicity of milkfish, *Chanos chanos*. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(2):10-12.

Daily samplings were conducted in the waters of Batbatan Island from April 17 to June 11, 1977 in order to collect milkfish (*Chanos chanos*) eggs. The numbers of eggs collected is tabulated by lunar period. Milkfish fry are more abundant during the new and full moon periods, and periodicity does exist, during the first and last quarter periods.

Keywords: spawning; periodicity; seed collection; *Chanos chanos;* ISEW, Philippines, Batbatan I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

166 Kumagai, S., T. Bagarinao and A. Unggui. 1980. A study on the milkfish fry fishing gears in Panay Island, Philippines. Technical Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 6, 34 p. Tigbauan, Iloilo City, Philippines.

This study was conducted to obtain information for evaluating the present fry fishing practices and for understanding the behaviour of the fry. A description of the milkfish, *Chanos chanos*, fry fishing gears is presented. Each gear is illustrated and its operation explained.

Keywords: seed collection; fry; fishing gear; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

167 Liao, I.C., H.Y. Yan and M.S. Su. 1977. Studies on milkfish fry. 1. On morphology and its related problems of milkfish fry from the coast of Tungkang, Taiwan. Journal of the Fisheries Society of Taiwan 6(1):73-83.

The morphological descriptions were based on newly caught fry (*Chanos chanos*). The features of the outer and inner organs were described in detail. The fork length of the fry sampled ranged from 12.19 mm to 15.70 mm, and body weight from 3.20 mg to 11.20 mg. There were significant differences in fork length and body weight frequency distributions between the early and the late fry seasons. The relationships of predorsal length, trunk length, head length, body depth and total length to fork length were in linear equations, while the relationship of body weight to fork length was an allometric equation. Among the characters mentioned above, the trunk length, head length and total length revealed significant differences between the early and the late fry seasons. The vertebrae counts ranged from 42 to 45. The fry with 43 and 44 vertebrae accounted for 63.70% and 33.56%, respectively of total specimens examined. There was no significant difference in vertebrae number between the early and the late fry seasons.

Keywords: morphology (organisms); fry; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Taiwan Fish. Res. Inst., Pingtung, Taiwan, 916, China

168 Marte, C.L. 1988. An improved method for collecting naturally spawned milkfish eggs from floating cages. Aquaculture 71(4):387-392.

Natural spawning of captive milkfish (*Chanos chanos*) held in floating cages were observed in 1980, 1981, 1983 and 1985. Various collectors and collection methods were tried with only slight improvements in number of eggs collected. The most urgent problem was egg predators inside the floating cages during the spawning season. This paper presents an improved method of egg collection using fine-mesh net cages ("hapa" nets, 1 mm mesh) which effectively prevented entry of egg predators. With the new method mass-scale production of milkfish fry can be achieved.

Keywords: cage culture; fish eggs; aquaculture techniques; collecting devices; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

169 Marte, C.L., J. Toledo, G. Quinitio and A. Castillo. 1986. Collection of naturally-spawned milkfish eggs in floating cages, p. 671-674. In: Asian Fisheries Forum (1st: 1986: Manila, Philippines). Proceeding of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila, Philippines.

Natural spawning of milkfish from floating cages were obtained from different stocks of 5-7 year-old milkfish in 1980, 1981, 1983 and 1985. The maximum number of eggs collected in 1980, using a series of 1-m diameter stationary plankton nets, was about 900. Increased collections were obtained in succeeding years with different types of egg collectors and methods. Egg collection, however, is inferior when based on the expected number of eggs spawned by a single female. Although no systematic study was attempted to compare efficiency of various egg-collecting gears and methods, the problems associated with the use of each gear are presented. The experience may be used as a guide in future designs of efficient gears of collecting naturally-spawned eggs of milkfish or other fish species in floating cages.

Keywords: fish culture; spawning; seed collection; aquaculture techniques; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquacult. Dep., P.O. Box 256, Iloido City, Philippines

170 Martosudarmo, B., S. Noor-Hamid and S. Sabaruudin. 1976. Occurrence of milkfish, *Chanos chanos*, spawners in Karimun Jawa waters. Bulletin of the Shrimp Culture Research Center 2(1-2):169-176.

Observations of adult milkfish in Karimun Jawa off the north coast of Central Java, Indonesia, over a period of more than two years, using gill net as fishing gear and obtaining 49 specimens of milkfish in various sizes is described. It was revealed that most of the milkfish were captured between midnight to early morning in sandy and coralline bottom of 2-10 m in depth. Physiological stress seems to be a major factor causing mortality of the fish after removal from the net.

Keywords: spawning; stocking (organisms); *Chanos chanos*; ISEW, Karimun Jawa
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Shrimp Cult. Res. Centre, Jepara, Indonesia

171 Mohan, R.S.L. 1980. Research and management of *Chanos* fry resources of India. CMFRI Special Publication (40):63.

Chanos fry is available along the southeast coast of India during the months of April-June though less numbers are reported from other parts of the country during various seasons. Along the southeast coast of India they occur in the low lying areas, tidal flats and in the creeks. The size ranges from 2 to 10 cm weighing 1 to 10 gr. The methods of fishing, types of gear used and methods of disposal of the catch are discussed. Seasonal abundance, catch rates, transport and the rate of survival during transport are also described. Conservation measures such as regulated fishing operation, regulation of mesh size, declaration of close season, and the notification of closed areas are discussed.

Keywords: marine aquaculture; fishery management; seed collection; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Mar. Fish. Res. Inst., Calicut Res. Cent., Calicut, India

172 Morioka, S., A. Ohno, H. Kohno and Y. Taki. 1993. Recruitment and survival of milkfish *Chanos chanos* larvae in the surf zone. Japanese Journal of Ichthyology 40(2):247-260.

The majority of *Chanos chanos* larvae collected from the surf zone at Villa and Tigbauan, Iloilo, Philippines, fell within a narrow range for total length (TL; 12.0-15.0 mm in 96% of 2,386 larvae) and had otolith increment counts of 15-20 (78%). The increment counts showed serial increases representing 5-10 days in some samples, at increase rates of 0.5-0.6/day, but such increases were not accompanied by increases in total length. Based on the low frequency (7.3%) of surf-zone larvae possessing food items in the gut, milkfish larvae occurring in the surf zone were considered to be under deficient feeding conditions. Otolith increments were formed at a rate of 1/day in well-fed larvae and 0.4/day in starved, captive larvae, in which stagnation of TL growth was also observed. The retardation of otolith increment formation and overall body growth in the surf zone larvae were considered to have resulted from deficient feeding conditions of a larval group entering and remaining in the surf zone for a certain period and/or from the concurrent recruitment and disappearance of larvae in the surf zone. The maximum duration of stay of the larvae in the surf zone was estimated to be about 10 days, from about day 15 to day 25 after hatching. Consequently, it is necessary for the larvae to move to juvenile nursery grounds within this period.

Keywords: fish larvae; recruitment; survival; surf zone; *Chanos chanos*; ISEW, Philippines; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tokyo Univ. Fish., 4-5-7 Konan, Minato-ku, Tokyo 108, Japan

173 Noor Hamid, S., B. Martosudarmo and M. Mardjono. 1977. Report on the status and occurrence of milkfish fry in Indonesia. Bulletin of Brackishwater Aquaculture Development Center 3(1-2):237-246.

The intensive culture of milkfish in brackishwater ponds in Indonesia is faced by the problem of the availability of fry for stocking. These milkfish fry are gathered from natural waters along the coast of certain islands in Indonesia. A survey was conducted to known fry collecting centers including search for new fry grounds in South Sumatra. This paper reviews the status of occurrence of milkfish fry in Indonesia. The channels of fry marketing are also discussed.

Keywords: availability; seed collection; marketing; fry; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwat. Aquacult. Dev. Cent., Jepara, Indonesia

174 Paler, R.P. 1981. Performance evaluation of the modified milkfish fry gear sweeper. University of the Philippines in the Visayas, Miag-ao, Iloilo. 45 p. M.S. thesis.

The performance of a modified milkfish fry gear sweeper was evaluated through field trials. Initial test on the performance of standard sweeper with different collecting bag support netting reveals the 0.20 mm mesh size, nylon. Generally, however, survival in all treatments was low. Based on the results of this test, a modified sweeper was designed and constructed. Intermediate and collecting bag tests in the modified sweeper show that 0.20 mm mesh size, cotton and 0.40 mm mesh size, polyester gave better survival compared to 0.70 mm mesh size, nylon as intermediate bag netting while 0.20 mm mesh size, cotton gave the highest survival as collecting bag netting. On the otherhand, result of the dragging time compared namely; 4, 8 and 12 minutes in terms of fry survival. A comparison of the standard and modified sweeper reveals that the latter is best in terms of fry survival.

Keywords: Performance evaluation; milkfish fry, gear sweeper; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo, Philippines

175 Patnaik, K.C. and P.M. Mishra. 1988. Distribution of milkfish, *Chanos chanos* (*Pisces: Chanidae*) fry in Rushikulya Estuary. Mahasagar 21(4):239-243.

The *Chanos* fry were available both during low and high tides in the Rushikulya estuary. However, the catch was higher during the high tide than the low tide. There were two peak periods of availability of the fries; one in April and the other in August. The catch of the fries was highest in August and lowest in December. The occurrence of the fry throughout the year indicated its protracted breeding behaviour.

Keywords: ecological distribution; seasonal variations; tides; estuaries; fry; tidal cycles; *Chanos chanos*; India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Bhanja Bihar, Berhampur 760 007, Orissa, India

176 Phuong, N.D., D.X. Loc, P.T. My and N.T. Le. 1980. Milkfish *Chanos chanos* (Forsskal) in the Hon Khoi of Van Phong and Ben Goi Bay. Tuyen Tap Nghien Cuu Bien 2(1):175-185.

The milkfish (*C. chanos*) is most extensively cultured in brackishwater ponds and lagoons in Southeast Asia, particularly in the Philippines, Indian Indonesia, Taiwan, and South of Vietnam. While the milkfish culture in Southeast Asia is rapidly expanding, there is inadequate seed supply. Some primary results are given of milkfish fry in Van Phong and Ben Goi Bay; the aim of the research was to determine the spawning grounds and the natural conditions so that rearing the mature milkfish and inducing them to spawn by artificial conditions could be carried out. Milkfish were concentrated in Van Phong and Ben-Goi Bay. Milkfish fry, were collected, which were more than 2-days old, their size being from 3.2 mm to 4.5 mm. The spawning-ground of milkfish is not far from the seashore, possibly in the Van Phong – Ben Goi Bay.

Keywords: fish culture; induced breeding; spawning grounds; brackishwater aquaculture; *Chanos chanos*

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Oceanogr. Nha Trang, Viet Nam

177 Quinitio, G.F. and G. Kawamura. 1980. A comparison between the catching efficiency of two milkfish fry collecting gears and their respective modifications. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(4):7-10.

An experiment was conducted along the shore of Culasi, in Panay to compare the milkfry (*Chanos chanos*) catching efficiency of the ordinary fry seine against its innovation and the ordinary sweeper against its 2 modifications. Results show that it is possible to replace the wings of the presently used sweeper and the ends of the fry seine with a coarse-meshed netting. This improvement decreases the water resistance of the gears and thus enables fry gatherers to use larger ones thereby giving more catch.

Keywords: fry; collecting devices; catchability; seed collection; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

178 Rajyalakshmi, T. and D.M. Reddy. 1985. Dispersal and recruitment of fry and juveniles of *Chanos chanos* (Forsskal) in Kakinada Bay area (India). Journal of Indian Society of Coastal Aquaculture Research 3(1):43-53.

Results of a study on dispersal and recruitment of fry and juveniles of *Chanos chanos* in Kakinada Bay area is presented for the years 1980-1983. During neap tides, the fry (14-16mm) were found in the shallow sand pools at the edge of the high tide mark while juveniles (30.40mm) were found farther inland. The major peak of occurrence is during March-June and a second brief occurrence was during September to November. Distribution of the fry, their abundance and growth are briefly described. The general pattern of dispersal is interpreted in terms of the hydrography of the Bay of Bengal and its influence on the east coast of India. An attempt is made to interpret the index of abundance at each region in relation to the breeding grounds of the species along the east coast. It is also shown that the density of the fry is too low for developing any commercial-scale fry industry in India. It also precludes development of an area-extensive *Chanos* culture system based on natural fry.

Keywords: population dynamics; recruitment; fry; juveniles; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Inland Fish. Res. Inst., Puri Res. Cent., Puri-2, India

179 Ramanathan, S. and D.E.S. Jayamaha. 1972. On the collection, transport and acclimatization of the fry of *Chanos chanos* for brackish water pond culture in Ceylon, p. 244-250. In: T.V.R. Pillay (ed.). Coastal Aquaculture in the Indo-Pacific Region. Fishing News Books, London.

An account of the survey conducted, during March to June 1969, in the District of Mannar, of the collection, transport and acclimatization of *Chanos* fry is given. Observations made on the tidal and lunar periodicity in relation to fry abundance are discussed. Most of the fry were collected from 2 tidal pools in 2 regions. The numbers of fry collected were generally more on the full moon and new moon days and in areas where the salinity of the water was about 36-38 ppt. The methods used in the packing, transport and acclimatization of the fry are also briefly described.

Keywords: collection, transport, *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Fish. Exp. Stn. Pitipana, Negombo Sri Lanka

180 Schmittou, H.R. 1977. A study to determine the spawning grounds of milkfish and the environmental conditions that influence fry abundance and collection along the coast of Panay Island, Philippines, p.91-105. In: Proceedings of the Eighth Annual Meeting [of the] World Mariculture Society, 9-13 January 1977, San Jose, Costa Rica.

The most serious problem affecting the milkfish (*Chanos chanos* Forsskal) farming industry throughout its range (Philippines, Indonesia and Taiwan) is inadequate supply of fry. For example, the requirement for milkfish fry in the Philippines in 1974 was approximately 875 million, but the supply was less than one-half of the demand. Demands for fry are expected to continue to increase. Milkfish have never been artificially reproduced, and milkfish farmers depend entirely on fry captured from coastal waters for their stock. The objectives of this study were to determine the environmental conditions influencing milkfish fry abundance and capture and to determine the location of the spawning grounds of milkfish that supply the fry collected along the coast of Panay Island, Philippines. Some environmental factors influencing milkfish fry abundance and capture are reported. Conclusions were: (1) milkfish fry collected along the coast are spawned far from the collecting grounds, (2) surface oceans currents transport the fry from the spawning grounds to the coast, and are responsible for the seasonality of milkfish fry there.

Keywords: spawning grounds; seed collection; fish culture; *Chanos chanos*; ISEW, Philippines, Panay I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Int. Cent. Aquacult., Dep. Fish. Allied Aquacult., Auburn Univ., Auburn, AL 36830, USA

181 Senta, T. and A. Hirai. 1981. Seasonal occurrence of milkfish fry at Tanegashima and Yakushima in Southern Japan. Japanese Journal of Ichthyology 28(1):45-51.

Milkfish fry, (*Chanos chanos*), ranging from 10 to 16 mm TL, commonly occur at Tanegashima and Yakushima Islands from the late June to early November. They are especially abundant in July and August. While no clear relationship was observed and tidal phases and the abundance of fry occurring along the beaches, the fry were much more abundant on days with the wind blowing towards the coast than on days with the wind of other directions. The fry occurred much more abundantly at Kumano, which is located on the east of Tanegashima and faces the Kuroshio than the Shimama on the west coast of the island and Miyanoura of Yakushima.

Keywords: fry; abundance; environmental effects; seasonal variations; juveniles; *Chanos chanos*; Japan; INW, Japan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Nagasaki Univ., Nomo Fish. Stn., Nomozaki, Nagasaki-ken 851-05, Japan

182 Senta, T. and S. Kumagai. 1983. Variation in the vertebral number of the milkfish *Chanos chanos*, collected from various localities. A Compilation of Southeast Asian Fisheries Development Center-Aquaculture Department technical papers on milkfish and other finfishes 2:3-9.

A total of 2497 milkfish fry were collected in 1976 from nine localities in six countries, viz. India, Thailand, Indonesia, Philippines, Taiwan and Tahiti. Vertebral counts ranged from 40 to 45. The general trend of geographical gradient in vertebral counts in the milkfish was observed to be lower in the west (or otherwise, along continents) and higher in the east (or around oceanic islands). Extremes in the means of vertebral counts by localities were seen in the samples from India with 43.08 and from Tahiti with 43.82. It was suggested that there maybe at least four subpopulations among the milkfish throughout the tropical Indo-Pacific waters.

Keywords: vertebral numbers; fry collection; geographical gradient; milkfish, *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library, WorldFish Center-Library Philippine Office

183 Senta, T., S. Kumagai and N.M. Castillo. 1983. Occurrence of milkfish, *Chanos chanos* (Forsskal) eggs around Panay Island, Philippines. A Compilation of Southeast Asian Fisheries Development Center-Aquaculture Department technical papers on milkfish and other finfishes 2:19-29.

A total of 551 milkfish eggs was collected by horizontal tows with a fish larval net in the waters around Panay Island during the period from April 1976 to June 1979. The maximum number obtained by a single tow was 33 eggs. Most of the eggs were collected from Cuyo East Pass, with some eggs from the waters around the Cagayan Islands and a single egg from the Sibuyan Sea. Almost all the eggs were collected during the period from March to June, with a peak in April, one month ahead of the peak of fry occurrence.
Very often milkfish eggs occurred in shallow waters around islands or close to the coast, while there were sometimes found at the locations remote from land and as deep as 900 meters. Water temperatures and salinities at locations where milkfish eggs were found ranged from 26.7 to 30.8 degrees Celcius and from 32.9 to 34.5 ppt. The eggs were rather evenly distributed from the surface to at least 20 m down. The eggs found in the early morning collections were in the early stages of development; those found later in the day were more advanced. It seems that spawning of milkfish takes place at midnight, and that the incubation period of eggs in the wild is about 20 hours.

Keywords: milkfish occurrence; milkfish collection; milkfish eggs; Panay Island, Philippines
Location: SEAFDEC Aquaculture Department Library; WorldFish Center Library Philippine Office

184 Thayaparan, K. and R.D. Chakrabarty. 1984. Milkfish aquaculture in Sri Lanka, p. 161-169. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Milkfish (*Chanos chanos*) fry and fingerlings are abundant in coastal and brackishwater areas in Sri Lanka, yet the industry remains in a stage of underdevelopment. The main seed collection centers are Mannar and Kalpitiya in the northwest and the season is from March to June. The annual fry production potential of the Mannar tidal flats is estimated to be about 4 million. The brackishwater aquaculture potential of Sri Lanka is estimated to be about 120,000 ha. In the past, returns from fry collected from tidal pools and stocked into perennial tanks have been very poor. The recently initiated seed resources survey and investigations into scientific collection, transport, and culture including pen culture should help develop farming of milkfish in Sri Lanka. Polyculture of the species with other fish and shrimp and its culture in salterns are being attempted.

Keywords: brackishwater aquaculture; fish culture; aquaculture development; *Chanos chanos*; Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Minist. Fish., Colombo, Sri Lanka

185 Toledo, I.T. 1984. Fry sweeper "baka-baka". General Information Series, Library of Bureau of Fisheries and Aquatic Resources, Philippines 7(2):2.

"Baka-baka" is the local name for the modified bangus (*Chanos chanos*) fry sweeper. The gear was developed to suit the gentle and sloping shore profiles and moderate water current of Western Visayas. It can be operated at almost any depth, time and tidal condition. List of materials, construction and operation procedure, and cost analysis are presented.

Keywords: fry sweeper; "baka-baka"; milkfish
Location: SEAFDEC Aquaculture Department Library

186 Trino, A.T., H. Sitoy, V.C. Vanada and W. Esteba. 1984. Effect of light on the milkfish fry catch efficiency of moving gears with and without fish lamp. Fisheries Research Journal of the Philippines 9(1/2):14-18.

The daily and hourly catch of milkfish fry in the coast of barangay Tubog, Hamtik, was recorded over a period of 121 hrs using two similar gears along the shoreline on opposite directions of each other. One gear (gear A) was without light and the other gear (gear B) was with light at night time.

The results obtained revealed no significant differences among catches of both gears at day time and at night time by hour or by day at 5% and 1% confidence level. Apparently, the result suggests that the use of fish lamp fixed in mobile gear at night time will not increase the milkfish fry collection efficiency of the gear.

Keywords: light; catch efficiency; moving gears; fish lamp; milkfish; Philippines
Location: SEAFDEC Aquaculture Department Library

187 Tzeng, W.N. and S.Y. Yu. 1990. Age and growth of milkfish *Chanos chanos* larvae in the Taiwanese coastal waters as indicated by otolith growth increments, p. 411-415. In: R. Hirano and I. Hanyu (eds.). Proceedings of the Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April 1989. Asian Fisheries Society, Manila, Philippines.

Age and growth of milkfish *Chanos chanos* larvae collected from the surf zones of the coasts of Taiwan, April-July 1986 was studied by examination of otolith microstructure. The size (TL) of milkfish larvae at entering surf zone of the coastal waters was similar, ranged from 12.5 to 16.0 mm, averaged 14.0 mm. Age of the larvae ranged between 14 and 29 days old, averaged 20-days old. Mean daily age of the larvae in the eastern coast (16-20 days old) was smaller than that in the southwestern coast (20-24 days old). The daily growth rate of the otoliths of milkfish larvae dropped down suddenly to a low level from approximately 10-13 days after hatching. Somatic and otolith growths were uncoupling for the milkfish larvae from the southwestern coast; the otolith diameter increased while fish length remained constant.

Keywords: fish larvae; age determination; otolith reading; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Natl. Taiwan Univ., Taipei 10764, Taiwan

188 Villaluz, A.C. 1985. Collection, storage, transport, and acclimation of milkfish fry and fingerlings, p. 85-96. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

The present methods of collecting fry and fingerlings involve filtration by mobile or stationary devices. The bottom topography of the fry ground, wind direction, and tidal fluctuations are the most important considerations in the design and construction of fry and fingerling catching gear. The behaviour of young milkfish (*Chanos chanos*) in the different environments where they are exploited determines the catching methods to be employed. Collection, handling, storage, and transport activities expose the fish to undue stress, which contributes to poor survival. The simple method of lowering the salinity of the water medium considerably reduces mortality. Prior acclimation history has significant effects on subsequent survival and adaptation. Although it appears that milkfish fry are hardier than the fingerlings, both have the same capability for resisting subsequent environmental stress provided sufficient time is given for the fish to recover from previous stress.

Keywords: collecting devices; fry; fingerlings; fish handling; aquaculture techniques; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

189 Villaluz, A.C. 1986. Fry and fingerling collection and handling (milkfish), p. 153-180. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

A review is made of methods and practices of collection, storage, transport and acclimation of milkfish (*Chanos chanos*) fry and fingerlings in various countries. Factors affecting catch and survival are examined.

Keywords: seed collection; fingerlings; fry; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., Tigbauan, Iloilo, Philippines

190 Villaluz, A.C., H.P. Amandakoon and A. De Alwis. 1982. Milkfish fry and fingerling resources of Sri Lanka. Journal of Inland Fisheries 1:7-16.

Sri Lanka has the milkfish (*Chanos chanos*) seed and water resources for the development of milkfish aquaculture as a new industry. Milkfish fry and fingerlings are present in all surveyed coastal wet lands, but are abundant in Mannar and Puttalam regions. The species enter tidal pools as larvae and develop into juveniles of about 50 mm. FL in one month. The fry and fingerlings are caught with seine net in tidal pools, transported in plastic bags and stocked in ponds and/or lakes. Mortality ranges 2-100% during transport; 2-15% during acclimatization; and 40-50% after 3 weeks in holding tanks. Careful handling and the application of appropriate transportation, acclimatization and nursing procedures would reduce mortality considerably.

Keywords: fish culture; fry; fingerlings; seed (aquaculture); *Chanos chanos*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo, Philippines

191 Villaluz, A.C., W.R. Villaver and R.J. Salde. 1984. Milkfish fry and fingerling industry of the Philippines: methods and practices. Technical Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 9, 81 p. Tigbauan, Iloilo, Philippines.

Milkfish (*Chanos chanos*) fry catch from Philippine waters can still be increased. Intensified collections in traditional fry grounds and exploitation of new areas may lead to a reduction of adult stock and the possible collapse of the milkfish fry fishery. The implementation of rational conservation and management measures are of immediate concern not only to increase the productivity and number of fry grounds but also to conserve this important aquatic resource.

Keywords: fish culture; seed collection; aquaculture techniques; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

192 Wainwright, T. 1982. Milkfish fry seasonality on Tarawa, Kiribati, its relationship to fry seasons elsewhere, and to sea surface temperatures (SST). Aquaculture 26(3-4):265-271.

Milkfish (*Chanos chanos* Forsskal) fry seasonality on Tarawa, Kiribati, was found to be from late December to early February and from May to September, with a fall in abundance in August. Fry were available throughout the year however. It was found that this seasonality is related to other seasons around the Pacific, and that the timing of these seasons was initiated and ended by rising and falling SST. A correlation was also found between the annual average SST and the length of fry occurrence in each country.

Keywords: population dynamics; water temperature; *Chanos chanos*; Indo-Pacific Region
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: 57 Rosebery Rd., Langley Vale, Epsom Downs, Surrey, UK

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Smith, I.R. 1981. The economics of the milkfish fry and fingerling industry of the Philippines. ICLARM Technical Report 1, 148 p.
(See abstract, keywords, location and author's affiliation in entry no. 594)

Smith, I.R., F.C. Cas, B.P. Gibe and L.M. Romillo. 1979. Inter-regional trade and price relationships for Philippine milkfish fry, p. 43-60. In: A.R. Librero and W.L. Collier (eds.). Economics of Aquaculture, Sea-Fishing and Coastal Resource Use in Asia : Proceedings of the Second Biennial Meeting of the Agricultural Economics Society of Asia, Tigbauan, Iloilo, Philippines, 3-6 November 1977. Agricultural Development Council, and Philippine Council for Agriculture and Resources Research, Los Baños, Laguna, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 606)

Taki, Y., C.A. Saclauso, L.V. Laureta, H.J. Gonzales, A. Ohno, H. Kohno, S. Morioka and M. Muto. 1990. Feeding of milkfish *Chanos chanos* larvae in the surf zone, p. 441-444. In: R. Hirano and I. Hanyu (eds.). Proceedings of the Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April 1989. Asian Fisheries Society, Manila, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 491)

Tamaru, C.S., F. Cholik, J.C.M. Kuo and B. Fitzgerald. 1993. From Discovery to commercialisation. Special Publication, European Aquaculture Society (19): 296-297.
(See abstract, keywords, location and author's affiliation in entry no. 653)

Tan, E.O., D.L. De Guzman, L.C. Darvin and M.C. Balgos. 1984. Milkfish research in the Philippines, p. 161-169. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 654)

Tekinaiti, T. 1996. Milkfish farming in Kiribati, p. 161-166. In: Present and future of aquaculture research and development in the Pacific Island Countries, Ministry of Tonga, Nukualofa (Tonga).
(See abstract, keywords, location and author's affiliation in entry no. 655)

Tokoragi, L. 1978. Milkfish culture in French Polynesia. Appropriate Technology 4(4):23-25.
(See abstract, keywords, location and author's affiliation in entry no. 657)

Toledo, J.D. and A.G. Gaitan. 1992. Egg cannibalism by milkfish (*Chanos chanos* Forsskal) spawners in circular floating net cages. Journal of Applied Ichthyology 8(1-4):257-262.
(See abstract, keywords, location and author's affiliation in entry no. 380)

FRY, FINGERLING AND EGG PRODUCTION

193 Alikunhi, K.H., B.S. Ranoemihardjo, A. Poernomo and E. Hamami. 1975. Preliminary observations on rearing of milkfish fry on plankton in cement tanks and plastic pools. Bulletin of the Shrimp Culture Research Center 1(1):40-45.

Successful rearing of *Chanos* fry on a predominant diet of zooplankton at various densities of stocking was carried out in plastic pools and cement tanks, 2.5 to 40 sq.m. in surface area and 2 to 60 cu.m. in water content. Manuring with an initial dose of 100 ppm cowdung, 20 ppm coconut oil cake, and 2 ppm each of urea and triple superphosphate produced swarms of the rotifer *Brachionus* sp which could be maintained at high density by repeating application of the same manures at half the original dose at 5-6 days intervals. *Chanos* fry (11 to 14 mm long) stocked in these manured pools and tanks at densities ranging from 500,000 to 2,500,000 per hectare yielded, during a rearing period of 20-30 days, 67 to 98% survival and satisfactory growth.

Keywords: fish culture; rearing; fry; growing ponds; plankton; feed; habitat improvement; *Chanos*; *Brachionus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Shrimp Culture Res.Cent., Jepara, Indonesia

194 Anon. 1975. Bangus fry mass production studied. Visayan Tribune 17(44):1, 3.

This article reports on the research program aimed towards the mass production of milkfish fry in the laboratory in Pandan, Philippines. Little is known of the spawning behaviour of the other bangus. This program hopes to "domesticate" the mother bangus and eventually to induce her to breed under captive conditions.

Keywords: milkfish fry; mass production; broodstock; milkfish
Location: SEAFDEC Aquaculture Department Library

195 Anon. 1977. Bangus fry produced in the lab. Philippine Daily Express 6(10):1, 6.

The article reports on the production of milkfish fry in the laboratory of SEAFDEC through artificial fertilization. An overview of the operation is provided.

Keywords: milkfish fry; milkfish production; milkfish
Location: SEAFDEC Aquaculture Department Library

196 Anon. 1981. Re-occurrence of milkfish spawning at Igang. Aquaculture Department News, Southeast Asian Development Center 4(7):1, 4, 8.

Re-occurrence of spawning was observed in milkfish broodstock stocked in cages at SEAFDEC Aquaculture Department's Igang Research Sub-Station in Guimaras. Spontaneous spawning occurred in May-July 1981. Fertilized eggs accounted for 83-98% and hatching rate ranged from 11% to 80%. Larvae were reared at the Tigbauan Station.

Keywords: spawning; milkfish
Location: SEAFDEC Aquaculture Department Library

197 Anon. 1985. Rematured milkfish spawns. Asian Aquaculture 7(5):1-2.

The first recorded spontaneous spawning of rematured milkfish took place on April 22, 1985, at SEAFDEC AQD Igang substation with 2983 eggs collected. The fishes which spawned were 7-year old milkfish raised entirely under captive conditions. The rematuration of milkfish under captive condition may shed light with regards to fry scarcity. Researchers are also trying to develop egg collection methods to increase collection efficiency.

Keywords: rematured milkfish; spawning; egg collection; milkfish
Location: SEAFDEC Aquaculture Department Library

198 Anon. 1999. Promoting appropriate aquaculture technology for more fish in Southeast Asia-a report. SEAFDEC - Aquaculture Department, Tigbauan, Iloilo City, Philippines. 24 p.

A 24-page report that discusses SEAFDEC/AQD's technology verification trials on (1) milkfish hatchery, pond culture using hatchery-raised fry, and polyculture of milkfish and seaweeds; (2) the use of environment-friendly schemes in tiger shrimp culture; (3) mudcrab culture in ponds and net enclosures in mangroves; (4) cage culture of hybrid tilapia; (5) catfish hatchery technology; and (6) oyster and mussel culture in rafts.

Keywords: aquaculture technology; milkfish
Location: SEAFDEC Aquaculture Department Library

199 Bagarinao, T. 1986. Yolk resorption, onset of feeding and survival potential of larvae of three tropical marine fish species reared in the hatchery. Marine Biology 91(4): 449-459.

This paper provides basic early life-history information on milkfish (*Chanos chanos*), seabass (*Lates calcarifer*) and rabbitfish (*Siganus guttatus*) which may explain in part the observed differences in their survival performance in the hatchery. Egg size larval size, amount of yolk and oil reserves and mouth size are all greater in milkfish than in seabass, and greater in the latter than in rabbitfish. During the first 24 h after hatching, rabbitfish larvae grow much faster than milkfish and seabass larvae at similar ambient temperatures (range 26 degree -30 degree C, mean about 28 degree C). The eyes become fully pigmented and the mouths open earlier in seabass and rabbitfish (32-36 h from hatching) than in milkfish (54H). Seabass larvae learn to feed to earliest. Yolk is completely resorbed at 120 h from hatching in milkfish, and yolk plus oil at 120 h in seabass and 72 h in rabbitfish at 26 degree to 30 degree C.

Keywords: survival; feeding; hatcheries; larval development; *Chanos chanos*; *Siganus guttatus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Southeast Asian Fish. Dev. Aquacult. Cent., P.O. Box 256, Iloilo City 5901, Philippines

200 Baliao, D.D. 1982. Management of brackishwater pond for milkfish fingerling production in Sri Lanka. Journal of Inland Fisheries 1:17-29.

The author reviews the present methods of milkfish (*Chanos chanos*) fry collection and presents his observations and recommendations of improvement.

Keywords: fish culture; brackishwater aquaculture; nursery ponds; aquaculture development; seed (aquaculture); aquaculture techniques; *Chanos chanos*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC Leganes Res. Stn., 5021 Iloilo, Philippines

201 Baylon, J.C. 1983. Factors affecting survival of milkfish, *Chanos chanos* fry and fingerling: different pH-salinity and temperature-salinity combinations. Fisheries Research Journal of the Philippines 8(1):44-49.

Survival of milkfish (*C. chanos*) fry and fingerling was determined at different pH-salinity and temperature-salinity combinations after 96 hours of exposure. Highest survival (93.5%) of fry was obtained at pH 7.0 in 15 ppt. salinity. For the fingerling, highest survival (95.7%) was at pH 8.0 in 30 ppt. salinity and lowest (18%) at pH 5.0 with 45 ppt. salinity. A 100% survival of fry was observed at a cold water temperature (21-23 degree C) of 15 ppt. salinity and a lower survival of 70% was obtained at a warm water temperature (32-35 degree C) of 30 ppt. salinity.

Keywords: fish culture; survival; environmental conditions; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Univ. Philippines, Quezon City, Philippines

202 Bombeo-Tuburan, I. 1988. The effect of stunting on growth, survival, and net production of milkfish (*Chanos chanos* Forsskal). Aquaculture 75(1-2):97-103.

The seasonal abundance of milkfish (*Chanos chanos*) fry in the Philippines has led to the practice of buying a sufficient supply during the peak season to compensate for the shortage during slack periods. Milkfish farmers believe that stunted fingerlings grow faster than newly grown ones and therefore yield extra croppings. To assess the efficiency of production schemes, stunted and non-stunted milkfish fingerlings were cultured in twelve 144-m super(2) ponds for a 3-month period. The treatments employed were: Treatment I, 2-month-old fingerlings; Treatment II, 3-month-old fingerlings; and Treatment III, 6-month-old fingerlings, with the weights of 3.3 g, 7.8 g, and 43.1 g, respectively. Survival, net production, cumulative and monthly weight gains did not differ significantly among the three treatments. The results indicate that stunting did not illicit a significant increase, nor did it adversely affect the growth, survival, and net production of milkfish in a straight

culture system. Stunting can therefore provide an adequate supply of fingerlings for year-round operation.

Keywords: growth; survival; stocking density; fry; fish culture; pond culture; fingerlings; yield; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., Leganes Brackishwater Stn., Leganes, Iloilo, Philippines

203 Buri, P. 1978. Notes on the pigmentation pattern in the larval developmental stages of laboratory-reared milkfish. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(3):26-32.

Milkfish fry were artificially bred and reared in the laboratory and the pigmentation pattern of the different developmental stages of the larvae are described in detail, with illustrations.

Keywords: fish culture; induced breeding; rearing; larval development; chromatic pigments; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

204 Chang, S.L., M.S. Su and I. Liao. 1993. Milkfish fry production in Taiwan, p. 157-171. In: C.S. Lee, M.S. Su and I.C. Liao (eds.). Finfish Hatchery in Asia: Proceedings of finfish hatchery in Asia, 17-19 December 1991, Tungkang Marine Laboratory, TFRI, Keelung, Taiwan.

In Taiwan, the demand for milkfish (*Chanos chanos*) fry is more than 100 million per year. These fry are either supplied by hatcheries, collected from coastal areas, or imported from Southeast Asian countries. The milkfish hatchery industry in Taiwan is usually subdivided into two: farms that specialize in broodstock maintenance for egg production and farms that specialize in larval rearing. Total sales are either equally shared between these two types of farms or shared at a 4:6 ratio. Such well-organized setups enhance the efficiency of fry production in milkfish. The important factors affecting egg production of milkfish are broodstock maintenance and management, weather, and salinity. Semi-intensive outdoor pond systems for larval rearing are widely used by hatchery operators. Various cultivated microorganisms in outdoor ponds are collected as main food fauna for larvae. Oyster eggs could also be supplied as a supplementary food for early-stage milkfish larvae. The most critical factors affecting the survival rate of larvae in outdoor systems are heavy rainfall at early larval stage and diatom bloom. From 1991, the mass production of fertilized eggs and a well-established larval rearing system have made possible the production of milkfish fry to meet the domestic market demands. The success of mass milkfish fry production is a milestone in its culture history.

Keywords: fish culture; hatcheries; fry; seed production; fish larvae; rearing; aquaculture development; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Taiwan Fish. Res. Inst., Pingtung, Taiwan 928

205 Chaudhuri, H., J. Juario, J.H. Primavera, R. Mateo, R. Samson, E. Cruz, E. Jarabejo and J. Canto Jr. 1977. Artificial fertilization of eggs and early development of the milkfish *Chanos chanos* (Forsskal). Technical Report. Aquaculture Department, Southeast Asian Fisheries Development Center 3:21-38.

Hydrated eggs obtained from a female milkfish were artificially fertilized with the milt collected from a male injected with acetone-dried pituitaries of salmon. The fertilized eggs (1.1 to 1.25 mm in diameter) developed normally in seawater in basins and Petri dishes at a salinity of 30-34 ppt and successfully hatched in 25 to 282 h at 26.4-29.9 C. The yolk was completely absorbed in about 22 days and at this period many postlarvae died. A few larvae were reared up to 5 days but all died

within 6 days. Effects of feeding the postlarvae from the third day with freshly hatched trochophore larvae of oysters obtained from eggs artificially fertilized in the laboratory could not be ascertained.

Keywords: induced breeding; larval development; fish culture; rearing; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

206 Chaudhuri, H., J.V. Juario, J.H. Primavera, R. Samson and R. Mateo. 1978. Observations on artificial fertilization of eggs and the embryonic and larval development of milkfish, *Chanos chanos* (Forsskal). Aquaculture 13(2):95-113.

Hydrated eggs obtained from a female milkfish, *C. chanos*, were artificially fertilized with the milt collected from a male injected with acetone-dried pituitaries of salmon. The fertilized eggs (1.1-1.25 mm in diameter) developed normally in seawater in basins and petri dishes at a salinity of 30-34 SUP-o / SUB-oo , and successfully hatched in 25-28.5 hours at a temperature of 26.4-29.9 degree C. The yolk was completely absorbed in about 2 . 5 days and during this period many postlarvae died. A few larvae were reared up to 5 days but all died on the 6th day. Attempts were made to feed the postlarvae with freshly hatched trochophore larvae of oysters obtained from eggs artificially fertilized in the laboratory.

Keywords: fish culture; experimental culture; induced breeding; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

207 Corrales, R.S. 1985. Management plan for milkfish fingerling production at the Bayawan fish seed bank. South China Sea Fisheries Development and Coordinating Programme, 31 p.

The experience in the management of fish seed bank for milkfish during a one-and a half year of operation is described. Since it is at early stages of operation, the results should be taken as preliminary. However, it can serve as a basis for subsequent operation of this component of Bayawan Small-Scale Fisheries Project and possibly for other projects of similar nature. It will be necessary that improvements and modifications should be made in future operations as more experiences are gained in order to put this type of venture on a firm base.

Keywords: management plan; fingerling production; Bayawan; fish seed bank; milkfish
Location: SEAFDEC Aquaculture Department Library

208 Cruz, E.R. and C.L. Pitogo. 1989. Tolerance level and histopathological response of milkfish (*Chanos chanos*) fingerlings to formalin. Aquaculture 78(2):135-145.

Static 96-h bioassays were conducted on milkfish (*Chanos chanos*) fingerlings with formalin at concentrations ranging from 50 to 500 ppm. The 24-, 48-, 72-, and 96-h median lethal concentration values (LC50) were 322, 260, 241, and 232 ppm formalin, respectively. Histological analyses of gills, liver, and kidney tissues revealed significant pathological changes even with the sublethal concentrations. The intensity of cell damage increased with increasing concentration and exposure to the chemical. Formalin treatments caused hyperplasia, epithelial separation, and necrosis in the gills; cloudy swelling, hemorrhage, deposition of pigments, and necrosis in liver parenchyma; and degeneration of renal tubules. Partial recovery of tissue was observed in fish after 10 days in formalin-free seawater.

Keywords: histopathology; fingerlings; pollution effects; bioassays; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

209 Eda, H., R. Murashige, B. Eastham, L. Wallace, P. Bass, C.S. Tamaru and C.S. Lee. 1990. Survival and growth of milkfish (*Chanos chanos*) larvae in the hatchery. 1. Feeding. Aquaculture 89(3-4):233-244.

Eight larval-rearing trials were conducted to evaluate the growth and survival of milkfish (*Chanos chanos*) larvae under an untested feeding regime. The feeding regime consisted of phytoplankton, rotifers and brine shrimp nauplii. An average survival of 32.7% at 30 days posthatch was reached. Final harvest density for the eight trials ranged from 4.1 to 6.8 juveniles per l. The percentage of survival at 30 days posthatch was negatively correlated to initial stocking density. The greatest mortality occurred between days 5 and 10. The average total length at day 30 for each of the trials was 17.3 plus or minus 0.12 mm. The growth curve was expressed by the following equation: Ln(TL) = 0.039(day) + 1.627. Under this feeding regime, rotifers were first observed in the digestive tract at 80 h posthatch. Growth of fed and unfed larvae did not differ until 124 h posthatch. A linear regression, relating satiation level and normal feeding to larval size during the first 11 days posthatch, was determined.

Keywords: feeding experiments; food organisms; prey selection; growth; survival; mathematical models; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., Makapuu Point, P.O. Box 25280, Honolulu, HI 96825, USA

210 Emata, A. 2001. Updates in the Philippines. Where are the captive milkfish breeders? SEAFDEC Asian Aquaculture 23(3-4):31.

A map is provided showing the location of milkfish rearing facilities in the Philippines. Most of the 17,443 milkfish broodstocks are located in central Philippines. A table shows details as to the rearing facility (cage, pen, pond, tank), number of broodstocks, and age. There are 13,420 broodstocks in ponds; 2,081 in cages; 842 in tanks and 1,100 in pens. The youngest is 3 years, the oldest 23 years old.

Keywords: fish culture; fish larvae; aquaculture facilities; fry; aquaculture systems; hatcheries; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC/AQD, [mailto:acemata@aqd.seafdec.org.ph]

211 Gapasin, R.S.J. and C.L. Marte. 1990. Milkfish hatchery operations. Aquaculture Extension Manual. Aquaculture Department, Southeast Asian Fisheries Development Center. Tigbauan, Iloilo, Philippines 17. 24 p.

The manual is intended primarily for practicing prawn hatchery operators who would like to diversify their operations to include larval rearing of milkfish (*Chanos chanos*). Only those procedures important in the daily operations of a milkfish hatchery are described in detail, under the following headings: Essential facilities – tanks and equipment; Production of natural food - *Chlorella* culture and *Brachionus* culture; Production of milkfish fry - preparation of hatching and larval rearing tanks, hatching of milkfish eggs, stocking of larvae, larval rearing, and harvesting.

Keywords: fish culture; fish larvae; rearing; hatcheries; aquaculture techniques; manuals; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

212 Hara, S., J.T. Canto Jr. and J.M.E. Almendras. 1982. A comparative study of various extenders for milkfish, *Chanos chanos* (Forsskal), sperm preservation. Aquaculture 28(3-4):339-346.

Various extenders, containing potassium chloride, sodium chloride, glucose, sodium citrate, Ringer's solutions, cow serum and milkfish serum were used to preserve milkfish (*Chanos chanos*) sperm at

near-zero temperatures (0-4 degree C) and in liquid nitrogen (-196 degree C). Milkfish serum was a superior extender in both cases. After 5 days, comparatively good motility (> 30%) and fertilizing capacity (6.7 - 18.9%) were observed in the near-zero liquid samples, while in other extenders, sperm ceased to show motility after 2 days. The fertilization success of 4-5 days cryopreserved sperm averaged 67.5% (n = 2) with milkfish serum, 60.5% (n = 2) with 400 mM glucose, 58.0% (n = 2) with 150 mM sodium chloride, 41.2% (n = 1) with Ringer's solution and 31.9% (n = 2) with cow serum.

Keywords: fish culture; preservatives; extenders; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

213 Hilomen-Garcia, G.V. 1998. Sensitivity of fertilized milkfish (*Chanos chanos* Forsskal) eggs to mechanical shock and simulated transport. Aquaculture 159(3-4):239-247.

Naturally-spawned milkfish eggs are routinely subjected to physical manipulation during collection and transport. To avoid unnecessary mortalities, sensitivity of milkfish eggs to mechanical shock was determined at different times after fertilization. Shock sensitivity was assessed in terms of egg mortality within 8 h after a free fall over calibrated heights. The LD50 and LD10 (drop height resulting in 50% and 10% mortality) were estimated for 11 stages of embryonic development. The corresponding force (F) imparted to eggs on impact after a free fall was also computed. LD10 estimates (cm) and their corresponding F (erg per egg) showed that shock sensitivity of milkfish eggs was high during cleavage until the early segmentation stage, rapidly declined as segmentation proceeded until the head and tail started to separate from the yolk, but returned to high levels when the embryo begun twitching and the heart beating until near-hatching. To determine the sublethal effects of mechanical shock, C-shaped embryos were subjected to a free fall over varying heights and transported to a hatchery for further incubation and hatching. The effects of varying periods of simulated transport (mobile or stationary periods) were also examined. At C-shaped embryo stage, neither mechanical shock (F, 13-127 erg per egg) nor prolonged shaking (3-9 h) simulating mobile periods of egg transport affected hatching rate, larval mortality, and incidence of deformed larvae. Exposure to still water (unshaken) simulating stationary periods of egg transport, however, tended to lower hatching rate and significantly increased the incidence of deformed larvae and the combined mortalities and deformed larvae. These results indicate that the sensitivity of milkfish eggs to mechanical shock varies during incubation and that C-shaped embryos may be manipulated or transported with minimum risk of injury. Some recommendations are given regarding proper handling and transport of fertilized eggs.

Keywords: fish culture; fish eggs; fish storage; biological stress; mortality causes; fish handling; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

214 Hong, W. and Q. Zhang. 2003. Review of captive bred species and fry production of marine fish in China. Aquaculture 227(1-4):305-318.

The artificial breeding of marine fish in China has been developed over a period of more than 50 years. Both species diversity and fry production have greatly increased since the 1980s. By the year 2000, at least 52 species belonging to 24 families of marine fish had been successfully bred. Large quantities of cultured fry can meet the needs of both sea cage culture and pond culture for most species. Fish fry production has entered a period of sustainable development. The number of artificially produced fry of large yellow croaker (*Pseudosciaena crocea*) exceeded 1.3 billion in year 2000. The species for which more than 10 million fry is produced annually through aquaculture are: red drum (*Sciaenops ocellatus*), Japanese sea perch (*Lateolabrax japonicus*), redeye mullet (*Liza haematocheila*), cuneate drum (*Nibea miichthioides*), red seabream (*Pagrosomus major*), milkfish (*Chanos chanos*) and three-banded sweetlip (*Plectorhynchus cinctus*). Several millions of artificial fry are cultured annually for the following species: Japanese flounder (*Paralichthys olivaceus*), black

porgy (*Sparus macrocephalus*), silver sea perch (*Lates calcarifer*), Russell's snapper (*Lutjanus russelli*), javelin grunt (*Pomadasys hasta*), miiuy croaker (*Miichthys miiuy*), Chinese black sleeper (*Bostrichthys sinensis*) and skewband grunt (*Hapalogenys nitens*). Fishes belonging to the family *Sciaenidae* are now the major species for artificial propagation.

Keywords: seed production; fry; literature reviews; marine fish; fish culture; rearing; *Pseudosciaena crocea*; *Lateolabrax japonicus*; *Lates calcarifer*; *Nibea miichthioides*; *Liza haematocheila*; *Pomadasys hasta*; *Hapalogenys nitens*; *Bostrichthys sinensis*; *Lutjanus russelli*; *Miichthys miiuy*; *Plectorhynchus cinctus*; *Pagrosomus major*; *Chanos chanos*; *Paralichthys olivaceus*; *Sparus macrocephalus*; *Sciaenops ocellatus*; China, People's Rep.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Oceanography, Xiamen University, Xiamen 361005, PR China, [mailto:Wshong@jingxian.xmu.edu.cn]

215 Juario, J.V. 1978. Experiments on the induced breeding of milkfish, *Chanos chanos* (Forsskal) in 1978. Quarterly Research Report. Aquaculture Department Southeast Asian Fisheries Development Center 2(4):1-3.

Results indicated that a female having eggs with an average diameter of <0.7 mm did not respond well to the hormone injections.

Keywords: induced breeding; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

216 Juario, J.V. 1979. Status and problems of milkfish propagation. Paper presented during the PCARI Symposium-Workshop on Fish Hatchery/Nursery Development and Management, 7-28 September 1979, Aberdeen Court, Makati, Metro Manila.

Paper subtopics include maturation of milkfish in captivity, hormonal control of ovulation and spawning, larval rearing, preservation of sperms and problems of milkfish propagation.

Keywords: status; problems; maturation; milkfish propagation; hormonal control; larval rearing; ovulation; sperm preservation; milkfish; *Chanos chanos*
Location: PCAMRD-DOST Library, Los Baños, Laguna

217 Kohno, H., M. Duray, A. Gallego and Y. Taki. 1990. Survival of larval milkfish, *Chanos chanos*, during changeover from endogenous to exogenous energy sources, p. 437-440. In: R. Hirano and I. Hanyu (eds.). Proceedings of the Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April 1989. Asian Fisheries Society, Manila, Philippines.

Survival of laboratory-reared larvae of milkfish, *Chanos chanos*, during transition from the prelarval to postlarval stages was examined in relation to the changeover of energy sources. The prelarval and early postlarval stages of the fish can be divided into 5 phases; 1) rapid growth corresponding to rapid yolk less rapid yolk resorption; 3) stagnant growth with rapid yolk resorption, yolk being still the only nutrient for the larvae; 4) stagnant growth based on both yolk and exogenous food, from the onset of feeding to the complete exhaustion of yolk; and 5) rapid growth based solely on exogenous food. The survival rate decreased when the larvae depended solely on yolk, then leveled off when they had both endogenous and exogenous energy sources, and again declined when they came to depend totally on exogenous food. Feeding during the period from the onset of feeding to complete yolk resorption seems important for the successful survival of milkfish larvae thereafter.

Keywords: larval development; survival; feeding; yolk; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Fish., Univ. Tokyo, 1-1-1 Yayoi, Bungkyo-ku, Tokyo 113, Japan

218 Kuo, C.M. 1982. Progress on artificial propagation of milkfish. ICLARM Newsletter 5(1):8-10.

Work carried out on the artificial spawning of milkfish (*Chanos chanos*) in captivity and mass propagation of the larvae in Hawaii and the Philippines is summarized. The collection of the broodstock and their maturation are outlined. The use of hormone injections to induce spawning is also discussed. It is concluded that the larval rearing of milkfish should be a relatively simple task compared with that of many other marine fish. Mass production of milkfish fry is anticipated for the future.

Keywords: induced breeding; hormones; rearing; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM, Manila, Philippines

219 Kuo, J.C., F.G. Liu and I.C. Liao. 2001. The production analysis of milkfish hatcheries in Taiwan, p. 133. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

The milkfish hatcheries have been playing a significant role in the development of milkfish aquaculture in Taiwan. The milkfish industry in Taiwan has now evolved into a highly developed specialized sectors, such as: spawner owner, hatchery operator, fry market, and grow out farmer, etc. Among them, hatchery operator is the most important one and it will greatly influence the relevant activities of other sectors. Therefore, the production performance of milkfish hatcheries has great impact on the economy of milkfish industry. This paper aims to analyze the production structure to understand the production efficiency of milkfish hatcheries in Taiwan. It focuses on the factors affecting production efficiency from different sizes of hatcheries. By using various financial assessment techniques on surveyed data, we found that most of the hatcheries could obtain high rate of return on their investment. It also showed that the production efficiency of hatcheries size over 0.3 ha is better than that of size smaller than 0.3 ha. The production efficiency of milkfish hatcheries could be enhanced through the improvement of marketing channels to stabilize the market price, and to reduce production cost.

Keywords: hatcheries; fish culture; industrial production; aquaculture statistics; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Taihsi Branch, Taiwan Fisheries Research Institute, 271 Chung-Yang Rd., Taihsi, Yunlin 636, Taiwan, [mailto:kuo54@kimo.com.tw]

220 Lam, T.J. 1985. Artificial propagation of milkfish: present status and problems, p. 21-39. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Milkfish (*Chanos chanos*) has been extensively cultured in Indonesia, Taiwan, and the Philippines. At present, the only source of fry for fish farmers is the coastal waters during the spawning season. The supply of fry is therefore often irregular and inadequate. Since the early 1970s attempts have been made to breed milkfish in captivity, particularly in Hawaii, Taiwan, and the Philippines. This paper reviews the progress, problems and suggested future research direction of the following areas: induction of ovulation/spawning, sperm preservation, larval rearing, and induction of gonadal maturation.

Keywords: brackishwater aquaculture; fish culture; extensive culture; induced breeding; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Natl. Univ. Singapore, Singapore

221 Lee, C.A. and P.J. O'Bryen. 2001. Advanced biotechnology in hatchery production: Proceedings of an Aquaculture Exchange Program Workshop, Honolulu, Hawaii, 6-9 December 1999. Aquaculture ser. 200(1-2). Elsevier, Amsterdam. 250 p.

The following papers are included in this journal: 1. Techniques in finfish larviculture in Taiwan. C. Liao, et al. pp. 1-31. 2. Production of juvenile marine finfish for stock enhancement in Japan. H. Fushimi pp. 33-53. 3. Larviculture of marine finfish in Europe. R. J. Shields pp. 55-88. 4. Current status of marine finfish larviculture in the United States. C.S. Lee and A. C. Ostrowski pp. 89-109. 5. Live food production in Japan: recent progress and future aspects. A. Hagiwara, et al. pp. 111-127. 6. Advancement of rotifer culture and manipulation techniques in Europe. P. Dhert, et al. pp. 129-146. 7. Use of the brine shrimp, *Artemia spp.,* in marine fish larviculture. P. Sorgeloos, et al. pp. 147-159. 8. Substitution of live food by formulated diets in marine fish larvae. C. Cahu and J. Zambonino Infante pp. 161-180. 9. Digestive enzymes in fish larvae and juveniles-- implications and applications to formulated diets. S. Kolvoski pp. 181-201. 10. A review of feed development for early life stages of marine aquaculture. J. A. Olafsen pp. 203-222. 11. Interactions between fish larvae and bacteria in marine aquaculture. J. A. Olafsen pp. 223-247. 12. General discussion on Advanced Biotechnology in Hatchery Production. C.S. Lee pp. 249-250. Eleven lengthy papers comprise this compilation of the proceedings of a workshop on Advanced Biotechnology in Hatchery Production. Information on technologies for mass-producing healthy fish fry, culture techniques for live food organisms, and the use of formulated diets with fish larvae and juveniles are presented. Interactions between fish larvae and microorganisms are also considered. Finfish species discussed at the workshop include halibut, turbot, Japanese flounder, yellowtail, seabream, seabass, Pacific threadfin, mahimahi, milkfish, mullet, summer flounder, southern flounder, and eel. Live feed organisms discussed include brine shrimp, rotifers, and *copepods*. Research was carried out in Australia, Belgium, France, Japan, Norway, Taiwan, the UK, and the USA.

Keywords: fish culture; marine aquaculture; stocking (organisms); hatcheries; fish larvae; food organisms; *Teleostei*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

222 Lin, L.T. 1985. My experience in artificial propagation of milkfish studies on natural spawning of pond-reared broodstock, p. 185-203. In: C.S. Lee and I.C. Liao (eds.) Reproduction and Culture of Milkfish : Proceedings for a Workshop held at the Tungkang Marine Laboratory, 22-24 April 1985, Tungkang, Taiwan.

A broodstock of 110, 10- to 11-year-old milkfish was reared with a formulated diet. The body weights ranged from 3.0-7.5 kg. The dimension of the three broodstock ponds was 750 m super(2) or 1,000 m super(2) by 1.3 m-1.5 m in depth. The natural spawning and fertilization of eggs occurred 62 times between April 8 and September 21, 1984. The numbers of eggs collected from all of the spawns were estimated to be 61,836,000. Fertilization rates from individual spawning events ranged from 10% to 95%. The total number of hatched larvae from all of the spawns was estimated at 27,765,000.

Keywords: pond culture; rearing; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tung Hsing Fish and Shrimp Hatchery, Pingtung, Taiwan

223 Lin, L.T., H.H. Lin, J.L. Yu, C.M. Kuo and S. Shih. 1988. Studies on the induced breeding of milkfish (*Chanos chanos* Forsskal) reared in ponds - natural spawning of pond-reared broodstock in 1986, p. 199-210. In: Proceedings of the Symposium on Fish Reproduction and its Endocrine Control: Basic and Practical Aspects, Academia Sinica, 19-29 June 1987, Nankang, Taipei, Taiwan.

A broodstock of 250 8- to 13-year-old milkfish (*Chanos chanos*) was reared with a formulated diet in the 5 seawater ponds of 750 m super(2) and 1000 m super(2) with 1.3 m in depth. The number of eggs spawned by each female in these 2 ponds was estimated to be 4,954,000 and 4,260,000 in

average with the growing rates of the spawns reaching 187.50% and 381.78% in comparison with those in 1984. This fact indicates that the maturation and spawning of pond-reared broodstock is practical and that at the same time the spawners have strong breeding ability.

Keywords: pond culture; induced breeding; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tsung Hsing Fish and Shrimp Hatchery, Pingtung, Taiwan

224 Marte, C.L. 2001. Marine fish breeding and larviculture research at the Aquaculture Department, Southeast Asian Fisheries Development Center, p. 167. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Breeding and seed production of marine fish is a major research program of the SEAFDEC Aquaculture Department since it was established as a regional institution more than two decades ago. Studies on the reproductive physiology and larval biology of commercially important species in Southeast Asia were carried out to develop breeding and larviculture techniques for species such as milkfish (*Chanos chanos* Forsskal), sea bass (*Lates calcarifer*), rabbitfish (*Siganus guttatus*), orange-spotted grouper (*Epinephelus coiodes*), and mangrove snapper (*Lutjanus argentimaculatus*). Early studies developed methods to induce spawnings in wild and captive breeders by hormonal intervention. With the availability of captive broodstock, important aspects of the reproductive biology of these species are now known, and spontaneous maturation and spawning of these species have been obtained. Current breeding research focus on developing and improving broodstock management techniques through nutritional enhancement to improve egg production and quality of spawned eggs, and to develop techniques for controlled breeding. The development of larviculture techniques requires an understanding of larval biology, and environmental and physiological requirements of the various phases of larval development of these marine species. In addition, to support larval nutritional requirements, culture techniques of the appropriate live prey to feed the larvae had to be developed. Based on information derived from the early work on the larval biology of milkfish and sea bass, together with the development of propagation techniques for microalgae such as *Chlorella sp.* and the rotifer *Brachionus sp.*, basic larviculture techniques for milkfish and sea bass were developed and is now being modified for more technically demanding species such as grouper and snapper. The present thrust of larviculture research includes supplementation of live food with essential nutrients, development of artificial diets for larvae, and application of hormones to enhance growth and metamorphosis of larvae and fry.

Keywords: marine fish; aquaculture development; seed production; induced breeding; fish culture; fish larvae; aquaculture techniques; commercial species; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:clmarte@aqd.seafdec.org.ph]

225 Nash, C.E. 1976. Research in artificial propagation of milkfish. Annual Report, 1975-76. Oceanic Foundation, 35 p.

The objective is to breed *Chanos chanos* in captivity and consequently raising egg to fry. Eight mature milkfish were captured and made ready for induced spawning. One fish with eggs 0.818 mm in diameter hydrated and was partially ovulated by two injections of 25 mg salmon gonadotropin. No fertilization occurred. Due to handling and sampling, two fishes died and three experienced early atresia of the oocytes. Two fishes were immature having eggs below 0.6 mm in diameter. It appears that oocytes of about 0.7 mm are more suitable for reacting positively to injections.

Keywords: artificial propagation; milkfish
Location: SEAFDEC Aquaculture Department Library

226 Patadjai, R.S. 2001. The technology for milkfish hatchery in Indonesia. SEAFDEC Asian Aquaculture 23(3-4):28-30.

The culture of milkfish (*Chanos chanos*), which is the oldest fish cultured in Indonesia, has spread to almost all the provinces in the country. In order to answer the demand of milkfish fry, without decreasing production and wild fry supply, artificial fry production in big and small-scale hatcheries is being practiced. Details are given of the milkfish hatchery system, listing also the major criteria to be taken into account for site selection. Operation of the hatchery is described, outlining the following activities: broodstock rearing; hormone implantation; broodstock maintenance; egg production and harvest; and, larval rearing.

Keywords: fish culture; fish larvae; induced breeding; hatcheries; aquaculture systems; aquaculture techniques; rearing; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Fisheries, Halouleo University, Kendari Indonesia

227 Poernomo, A., W.E. Vanstone, C. Lim, T. Daulay, N.A. Giri, Trijoko and A. Prijono. 1985. Natural spawning and larval rearing of the milkfish (*Chanos chanos*) in Indonesia. Paper prepared for the workshop on milkfish reproduction, 22-24 April 1985, Bali, Sub-Balai Penelitian Perikanan Air Payau, Taiwan, 20 p.

Following the termination of an experiment at Jepara, Central Java, sexually maturing adult milkfish was transported to Gondol, Northern Bali, by truck. The duration of transport was 15 to 17 hours. The fish were stocked in 6 m diameter outdoor canvass tanks with flowing sea water and aeration and fed with pellets (56% trash fish and 44% chick starter) or chopped marine trash fish. Between 25 January and 23 Mar 1985 the fishes spawned naturally eight times in these tanks. Some of the resultant larvae have been reared past 21 days of age.

Keywords: natural spawning; larval rearing; milkfish; Indonesia
Location: SEAFDEC Aquaculture Department Library

228 Quimpo, B. 1981. To answer many more questions about the elusive mature milkfish. Farming Today 7(2):11-16.

The SEAFDEC through a grant from IDRC of Canada achieved in 1977 the first spawning of milkfish in captivity. Milkfish that matured in cages are young compared to those caught in the wild. Salinity and transparency of the water are pointed as important factors for early maturation and spawning. However, more questions must be answered before production and profitability can be taken into consideration.

Keywords: elusive mature milkfish; milkfish
Location: SEAFEC Library

229 Ranoemihardjo, B.S. and A.M. Pirzan. 1977. Effect of stocking density on the rate of growth of milkfish fry (*Chanos chanos*). Bulletin of Brackishwater Aquaculture Development Center 3(1-2):247-257.

Survival rate of milkfish fry in nursery pond is usually about 20-40%. With intensive preparation, the survival could be increased to about 60-80%. Culture of fry in small compartments is much easier to control and mortality could be reduced. More intensive care and management in the nursery pond makes the fry more healthy, results in higher survival and makes transfer easier to the rearing pond. The result of the experiment in the wooden-box as nursery had shown that the fry grew from 14.62 mm in total length and 7.88 mg in weight to an average of 29.49 mm in total length and 180.85 mg in weight or an increment of 14.87 mm and 172.97 mg, respectively, after four weeks rearing. Stocking density ranged from 35 to 95 fry/mSUP-2 with an average survival rate of 97%. Rabanal et al (1952) noted the size of fry reached 28.28 mm in total length and 0.415 g in weight

with stocking density of 50-100 fry/mSUP-2 . Also, slow growth of fry had been noted if the stocking rate was around 100 pieces/mSUP-2.

Keywords: stocking density; fry; growth; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwat. Aquacult. Dev. Cent., Jepara, Indonesia

230 Rosario, W.R., C.B. Nipales and E.C. Roxas. 2004. Commercial production of milkfish fry (Hatchery Operations). National Integrated Fisheries Technology and Development Center, Bureau of Fisheries and Aquatic Resources, Manila, Philippines.

The NIFTDC hatchery in Bonuan Binloc, Dagupan City and the Regional BAR hatchery in Calape, Bohol and Guian, Eastern Samar, serve as the Central Bangus Hatcheries. These CBH will supply eggs to the satellite hatcheries, called Municipal Bangus Hatcheries (MBH), at nominal price.
Ideally, 40% of eggs produced by CBH will be sold to MBH at P10T per million of good eggs or D1 larvae. The remaining 60% of eggs will be hatched by the CBH. Initially, MBH may be helped by the CBH in the marketing of fry. Private hatcheries who will agree to adapt this concept will be allowed to participate and ensured of technical assistance from BFAR-NIFTDC.

Keywords: hatchery; production; milkfish culture; milkfish
Location: National Integrated Fisheries Technology and Development Center, BFAR.
Author Affiliation: BFAR-NIFTDC

231 Santiago, C.B., J.B. Pantastico, S.F. Baldia and O.S. Reyes. 1989. Milkfish (*Chanos chanos*) fingerling production in freshwater ponds with the use of natural and artificial feeds. Aquaculture 77(4):307-318.

Milkfish (*Chanos chanos*) fry were reared to fingerling size in freshwater ponds. For the first experiment, fish were fed the blue-green algae *Oscillatoria* inoculated and grown in the ponds, *Oscillatoria* supplemented with a fishmeal-based formulated diet, and the formulated diet alone. Milkfish fed the formulated diet alone had a significantly higher mean weight gain than milkfish given the combination of *Oscillatoria* and formulated diet. Growth was lowest for fish fed *Oscillatoria* alone. The feeding treatments in the second experiment were: combination of Spirulina powder and formulated diet alone, and rice bran alone. All feeds promoted some growth but the milkfish fed the formulated diet alone invariably had the highest weight increment, followed by fish given the feed combination. Rice bran alone gave the lowest growth response.

Keywords: feeding experiments; food organisms; artificial feeding; pond culture; growth; fish larvae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Southeast Asian Fish. Dev. Cent. (SEAFDEC), Aquacult. Dep., Binangonan, Rizal, Philippines

232 Ushadevi, V.K. and M.P. Mohamed. 1985. Low ambient oxygen tolerance in fry and fingerlings of *Chanos chanos* (Forsskal) and *Mugil cephalus* Linnaeus. CMFRI Special Publication 53:152-156.

In the present study, the experiments were performed at ambient oxygen concentrations near air saturation down to the asphyxial level of oxygen (concentration at which the fish begin losing its equilibrium) of *Chanos chanos* and *Mugil cephalus* which are always subjected to transportation from the collection area or hatchery to culture sites. Total metabolic rates (oxygen consumption; carbon dioxide production and ammonia excretion) of the fishes concerned subjected to ambient oxygen concentrations below air saturation in 15 and 30 ppt salinity at 30 and 35 degree C with concurrent measurement of breathing rate (opercular movement) were investigated.

Keywords: fish culture; environmental effects; fingerlings; fry; oxygen consumption; *Chanos chanos*; *Mugil cephalus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Ernakulam, Cochin 682 014, India

233 Vanstone, W.E., L.B. Tiro Jr., A.C. Villaluz, D.C. Ramsingh, S. Kumagai, P.J. Dulduco, M.M.L Barnes and C.E. Duenas. 1977. Breeding and larval rearing of the milkfish *Chanos chanos* (*Pisces: Chanidae*). Induced spawning, artificial fertilization of eggs and larval rearing of the milkfish *Chanos chanos* (Forsskal) in the Philippines. Technical Reports. Aquaculture Department, Southeast Asian Fisheries Development Center 3. Tigbauan, Iloilo City, Philippines.

Two sexually maturing female milkfish were induced to spawn by means of acetone-dried Pacific salmon pituitary powder. The eggs were fertilized and incubated and the resultant young reared to 74-day old, 11 cm long fingerlings. Newly fertilized eggs averaged 1.16 mm in diameter and each had a narrow perivitelline space containing several cortical granules which disappeared within a few minutes. The yolk was slightly yellowish, devoid of oil globules and very finely granulated. Embryonic development was very similar to that of other pelagic fish eggs and hatching occurred between 35 to 36 h at a salinity of 32 ppt and a temperature range of 28.4-29.2 C.

Keywords: brackishwater aquaculture; fish culture; induced breeding; embryonic development; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

234 Watanabe, W.O. 1986. Larvae and larval culture (milkfish), p. 117-152. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art.The Oceanic Institute, Honolulu, Hawaii.

A review is made of the present status of larval biology and culture of milkfish (*Chanos chanos*). Morphology, behavior, nutrition and environmental conditions for rearing are described.

Keywords: fish larvae; rearing; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

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Alava, V.R. 1986. Combinations of dietary fat sources in dry diets for *Chanos chanos* fingerlings, p. 519-521. In: L.B. Dizon, L.V. Hostillos and J.L. Maclean (eds.). The first Asian fisheries forum: Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila.
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CULTURE SYSTEM

POND

235 Amandakoon, H.P., K.B. Shantha and B.N.B.O. Perera. 1983. Culture of milkfish in fish farm ponds of Pitipana. Journal of Inland Fisheries 2:112-120.

Details are given of experimental studies carried out in Sri Lanka to raise marketable milkfish (*Chanos chanos*) in ponds of the brackishwater fisheries station at Pitipana, near Negombo. The culture methods used and production figures obtained are described.

Keywords: fish culture; pond culture; aquaculture systems; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwat. Fish Breed. and Exp. Stn., Pitipana, Negombo, Sri Lanka

236 Anon. 1974. Recommended procedure in propagating lablab in bangus ponds. SEAFDEC/AQD Library Compilation. 2 p.

Procedure of growing 'lablab' in milkfish ponds is enumerated. The process is divided into 2 stages, pond preparation and fertilization.

Keywords: lablab; ponds; pond preparation; fertilization; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

237 Anon. 1976. Planning, design and construction of a coastal fish farm. FAO, Rome, Italy. 27 p.

The present approach and guiding principles related to planning, design, construction and criteria for site selection of milkfish (*Chanos chanos*) tide-fed fish farms are described. Emphasis is placed on the requirements for water control structures, physical features of potential farm sites, and regional climatic conditions. In selecting suitable sites for tidal fish farms, consideration should be given to: ground elevation, soil type, type and density of vegetation, stability of shore banks, vulnerability to flooding, physical obstructions (rocks, mounds) and social and economic factors. Other important factors include the pond management system to be used, pond environment and weather. In planning the layout of ponds and other physical structures, maximum advantage should be taken on topographical features of the site, not only to economize on the cost of earthwork in construction, but also to preserve the soil fertility and provide a better environment for immediate operation of the farm. Information is provided on quantifying the water requirements, providing adequate drainage facilities, design of main watergate structures, design of water canals, design of perimeter dikes, and cost of construction.

Keywords: pond construction; marine aquaculture; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: FAO Technical Conference on Aquaculture, Kyoto (Japan) Food and Agriculture Organization of the United Nations, Rome (Italy)

238 Anon. 1999. Milkfish pond culture: the modular method. Aquaculture Extension Manual. Aquaculture Department, Southeast Asian Fisheries Development Center 25. 18 p.

An 18-page manual that describes a better way of raising milkfish in brackishwater ponds. The modular method is an improvement of the traditional extensive method.

Keywords: pond culture; milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

239 Anon. 1999. Semi-Intensive culture of milkfish. Department of Agriculture, Quezon City, Philippines.

The article talks about site selection, pond layout and design, pond preparation and food requirements, production strategy, pond water management, harvesting, packing and transport, ecological considerations and support services.

Keywords: pond layout; milkfish processing; milkfish; pond preparation
Location: http://www.da.gov.ph

240 Anon. (n.d.) Fishpond fertilizer and pesticide management. SEAFDEC/AQD Library Compilation. 9 p.

A factor to be considered in producing milkfish is fertilizer and pesticide management. Characteristic of fishpond soils is discussed thoroughly because the amount of fertilizer is dependent on the soil nutrients. Method of eradicating pests is discussed.

Keywords: fishpond; fertilizer; pesticide
Location: SEAFDEC Aquaculture Department Library

241 Aquino, J.M. 1977. Relationships between primary productivity and milkfish production in fertilized brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 69 p. M.S. thesis.

Experiments were conducted to determine the correlation between primary productivity and milkfish production; to determine the influence of the different fertilizer inputs on gross primary productivity; to correlate the quantity of phytoplankton to primary productivity and the phosphate-phosphorus content of pond water to standing crop of algae. Water samples were collected from nine 0.1 ha ponds on 19 sampling dates from 1 July to 15 September 1976 at 2 to 7 day intervals for measurements of primary productivity (light-and-dark bottle oxygen technique), phytoplankton standing crop (cell count) and phosphate-phosphorus concentration. Results indicated that primary productivity (gross and net) was not correlated with milkfish production ($r = -0.15, -0.28$; $P>0.05$). The gross primary productivity (mg C/1 for 4 hours) in Treatment I (chicken manure at 2,500 kg/ha) was significantly greater ($P <0.05$) than Treatments II (rice straw at 2,500 kg/ha + urea) and III (rice straw at 5,000 kg/ha + urea). There was no correlation between primary productivity (gross and net) and phytoplankton standing crop ($r = 0.05, 0.05$; $P >0.05$). No significant correlation was observed between the standing crop of phytoplankton and the phosphate-phosphorus content of pond waters ($r = 0.13$; $P >0.05$).

Keywords: primary productivity; milkfish production; fertilized brackishwater ponds
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

242 Baliao, D.D. 1984. Milkfish nursery pond and pen culture in the Indo-Pacific region, p. 97-106. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

In culturing milkfish (*Chanos chanos*) to marketable size, the fry (total length = 12-15 mm) are usually reared first in nursery ponds or pens (hapa nets) until they become fingerlings (total length = 2 cm or more). The fingerlings are then transferred to the grow-out ponds or pens where they are reared to marketable size. In some countries like the Philippines, fingerling production has become an industry by itself. This paper reviews the state of the art and constraints to and suggests future research directions for milkfish fingerling production in nursery ponds and pens.

Keywords: brackishwater aquaculture; fish culture; pond culture; rearing; aquaculture techniques; fry; fingerlings; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)***:***
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

243 Baliao, D.D., M.A. de los Santos and N.M. Franco. 1999. The modular method. Milkfish pond culture. Aquaculture Extension Manual. Aquaculture Department, Southeast Asian Fisheries Development Center 25:1-18.

The modular method of milkfish culture (*Chanos chanos*) described in the manual is an improvement over the traditional extensive method. The manual is intended for the use of fish farmers and aquaculturists, extensionists, and students of aquaculture not only in the Philippines, but also in other milkfish-producing countries in Southeast Asia and the world. It covers the following: Interesting facts about milkfish -- biological characteristics, artificial breeding of milkfish; Design and operation of modular pond system -- pond preparation, stocking in the nursery or transition ponds, stocking in the rearing ponds, care of stock, pond utilization and production schedule, harvest and post-harvest; and, Economics and costing.

Keywords: fish culture; pond culture; aquaculture systems; aquaculture techniques; *Chanos chanos*; ISEW, Philippines; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

244 Baliao, D.D., R.B. Ticar and N.G. Guanzon Jr. 1986. Effect of stocking density and duration on stunting milkfish fingerlings in ponds. Journal of Aquaculture in the Tropics 1(2):119-126.

The paper discusses the effect of stocking density and holding periods in stunting milkfish fingerlings in brackish water ponds using twelve units of 144 sqm earthen ponds. With 15, 20, and 25-fingerlings/ sqm, growth and survival rates were not significant ($P<0.05$) averaging 13.60 g and 83.4%, respectively. Lowest survival (54.52%) and growth rates (10.80 g) were obtained in treatment with highest density level of 30 fingerlings/sqm. Using the density of 20 fingerlings/sqm different stunting periods of 6,9, and 12 months were tried. Survival and growth rates were not significant for 6 and 9 months stunting periods, averaging 79.98% and 13.21 g. At longest (12 months) stunting period, however, survival was lowest (52.05%). In stunting milkfish fingerlings, a density of 15 to 25pcs/sqm could be tried at a stunting period of 6 to 9 months in order to obtain an optimum survival of 81.7% and growth rate of 13.4 g.

Keywords: stocking density; stunting milkfish; fingerlings; milkfish
Location: SEAFDEC Aquaculture Department Library

245 Belvis, E.V. 1979. The effect of a stock-manipulation technique on the growth and production of milkfish in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 32 p. M.S. thesis.

The effect of a stock-manipulation technique on the growth and production of milkfish in ponds was examined. Results showed that production in stock manipulated ponds averaged 854.1 kg/ha, compared with 645.7 kg/ha in the control ponds. The difference was significant at the 0.05 level. Mean final weight of the first fingerling group (F_1) was 143.6 g, while that of its equivalent group in the control ponds was 230.9 g. Significant difference in growth ($P<0.01$) probably was caused by the imbalance between food supply and food demand in the stock-manipulated ponds. Growth patterns of the various groups of fish and variations in the physical and chemical parameters in the experimental and control ponds are described.

Keywords: stock-manipulation; growth; production; milkfish
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

246 Bensam, P. and R. Marichamy. 1981. An experiment on culture of milkfish *Chanos chanos* (Forsskal) in salt-pans at Veppalodai, Tuticorin. Indian Journal of Fisheries 28(1-2):266-269.

Constructing ponds in a primary reservoir storing sea water in production of common salt, an experiment was carried out during 1973-74 on culture of *Chanos*, without undertaking much management procedures or supplementary feeding. In one pond with stocking rate of about 75,490/ha, survival was about 44% and production was about 857 kg/ha/14 months, while in another pond with stocking rate of about 7,820/ha, survival was about 85% but production was only 318 kg/ha/11 months.

Keywords: fish culture; fish ponds; stocking density; saline water; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Mar. Fish. Res. Inst., Tuticorin Center, India

247 Bombeo-Tuburan, I. 1989. Comparison of various water replenishment and fertilization schemes in brackishwater milkfish ponds. Journal of Applied Ichthyology 5(2):61-66.

The study was undertaken to determine the optimum combination of the frequency of water replenishment and fertilization that can yield the highest growth, survival, and gross production of

milkfish (*Chanos chanos*). Results indicated that mean body weight and survival were not significantly different among the treatments. Gross fish production was higher in biweekly fertilization if considered as a single factor. However, when this was in combination with the weekly or biweekly water replenishment, similar gross fish production was attained. In any case, because biweekly fertilization has a better effect than a weekly schedule, the former should be used in combination with any other level of replenishment. Weekly water replenishment, however, is impractical in big pond areas of 5-10 ha compartments.

Keywords: biological production; water management; feeding experiments; water quality; habitat improvement (fertilization); pond culture; *Teleostei*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Southeast Asian Fish. Dev. Cent., Aquacult. Dep., Leganes Brackishwater Stn., Leganes, Iloilo, Philippines

248 Bombeo-Tuburan, I., R.F. Agbayani and P.F. Subosa. 1989. Evaluation of organic and inorganic fertilizers in brackishwater milkfish ponds. Aquaculture 76(3-4):227-235.

The study was conducted in twelve 144-m super(2) ponds to evaluate the effect of different organic and inorganic fertilizers on the growth, survival, gross production, and profitability of marketable milkfish, *Chanos chanos*. No significant difference ($P > 0.05$) existed in the harvest and production of milkfish among the treatments. However, economic indicators such as return-on-investment (ROI), payback period, and marginal analysis ranked the performance of the fertilizer treatments in the order of I, II, III and IV.

Keywords: fertilizers; economic analysis; brackishwater aquaculture; pond culture; organic matter; inorganic compounds; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, Leganes Brackishwater Stn., Leganes, Iloilo, Philippines

249 Chang, M.H., S.S. Chen, K.Y. Lin and S.C. Chen. 1977. Experiment on application of tobacco (sic) waste as fertilizer and pesticide in milkfish pond. Bulletin of Taiwan Fisheries Research Institute (29):39-46.

The milkfish *Chanos chanos* is one of the most important and successfully cultured marine fish in Taiwan. The total area of milkfish ponds is estimated to be about 16 000 ha, and the yield of about 2000 kg/ha per year is being achieved. To promote the growth of benthic algae and control of pests are two important problems in milkfish farming. The present experiment is to verify the efficiency of tobacco wastes applied to the milkfish pond as fertilizer and pesticide. The results obtained are as follows: tobacco which contains 1.32% of nicotine can be used as pesticide in milkfish pond. The effective concentration is 1.25 ppm. For tilapia fish, the 48 hr TLm is 1.20 ppm of black tobacco waste and 1.12 ppm of yellow tobacco waste, the latter is a little better than the former one. Two kinds of the tobacco waste are of no use in killing the chironomid larvae on the pond bottom up to 13 ppm. Tobacco waste with the elements of N, P205 and K20 may be applied as fertilizer to culture the benthic algae when the pond is drying. Yellow tobacco waste is better than black one in promoting growth of benthic algae, the difference is not significant.

Keywords: tobacco; fertilizer; pesticide; milkfish pond; milkfish
Location: SEAFDEC Aquaculture Department Library

250 Chen, H.C. 1971. Increase of benthic algae in milkfish ponds by application of silicate. Fisheries Series. Chinese-American Joint Commission on Rural Reconstruction 11:71-83.

Conditions provided in the winter preparation of the milkfish ponds are favorable for bottom algal growth, especially diatoms which might reach 90% of the total bottom algal population. Such continuous growth would eventually deplete the nutrients of the pond and in Taiwan the problem of

silicate deficiency is critical. An experiment was designed and carried out, therefore, to test if this deficiency could be made up with silicate application. Two ponds were treated with sodium silicate and 2 others used as control. The result was that the ponds with added Na sub(2) SiO sub(3) yielded chlorophyll 1.72 to 2 times as much as that of the control. In milkfish ponds the limiting level of SiO sub(3)-Si for algal production is 0.25ppm, but during the winter preparation of ponds SiO sub(3)-Si might be depleted to somewhere between 0 and 0.4ppm. Inference from experimental data shows that by an application of 100 kg/ha of Na sub(2) SiO sub(3), the SiO sub(3)-Si conc could be raised to > 0.25ppm. But besides this essential element, organic matter is also needed to bring down the pH value and to supply other elements for algal growth.

Keywords: milkfish ponds; milkfish; benthic algae
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Rockefeller Foundation Fish Culture Res. Proj., Taiwan, China

251 Chiu, C.C. 1985. Deep-water pond system for milkfish culture, p. 211-214. In: Lee, C.S. and I.C. Liao (eds.). Reproduction and culture of milkfish: Proceedings for a Workshop at the Tungkang Marine Laboratory, Taiwan 22-24 April 1985. Oceanic Institute, Hawaii & Tungkang Marine Laboratory, Taiwan.

An improved modern culture system recently has been developed by taking advantage of the euryhaline characteristics of milkfish. Fresh water is used to culture the fish in 2m deep ponds. Aerators and artificial feed are applied. Hence, the unit stocking density is allowed to increase to 3 to 4 times. This modern culture method has proven to be a great success.

Keywords: pond culture; aquaculture systems; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

252 Chiu, Y.N. and V.L. Estilo. 1987. Effect of water exchange rates on nutrient levels and productivity of brackishwater milkfish ponds. Presented at the 7th PCARRD Annual Coordinated Review of On-going and Completed Research Projects for Fisheries, 22-25 April 1987, La Ganja, La Carlota City, Negros Occidental, Philippines.

Approximately 90 percent of brackishwater milkfish ponds in the Philippines are tide fed. The removal and addition of pond water is commonly practiced every spring tide, yet its effectivity has not been evaluated. In this study, its effect on nutrient levels, primary productivity and fish yield was determined at three exchange rates (2/3) pond volume, 1/3 pond volume; and no exchange with milkfish stocked at 3000/ha in three replicate 500 sqm ponds. Concentrations of orthophosphate, nitrate and total ammonia were monitored before and after each tidal flushing. Orthophosphate and nitrate decreased significantly (P 0.01) after each tidal flushing. Only nitrate was observed to be significantly affected (P 0.05) by water exchange rate. Total ammonia levels did not significantly change before and after water replacement at different exchange volumes over subsequent flushing. Ponds with no water exchange have higher primary productivity but this was not statistically significant (P 0.05). Fish production and survival did not differ among the three exchange rates. The result indicates that at the mean standing crop of 282 kg/ha, water exchange does not have any significant effect on pond productivity.

Keywords: exchange rates; nutrient levels; productivity; brackishwater; ponds
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Brackishwater Aquaculture Center, UP Visayas, Leganes, Iloilo, Philippines.

253 Chong, K.C., M.S. Lizarondo, Z.S. Dela Cruz, C.V. Guerrero and I.R. Smith. 1984. Milkfish production dualism in the Philippines: a multidisciplinary perspective on continuous low yields and constraints to aquaculture development. ICLARM Technical Report 15, 70 p.

This report determines and measures the constraints to the adoption of more intensive fertilizer application rates among Philippine milkfish (*Chanos chanos*) farmers. It hypothesized 56

explanatory variables, categorized into socioeconomic, institutional, physical and biotechnical parameters to explain variations in fertilizer use. It focused on farmer's perception of constraints. Data from 447 milkfish farmers in seven provinces and from a previous survey of 324 farmers in seven provinces are presented. (DBO)

Keywords: fish culture; pond culture; yield; habitat improvement; brackishwater aquaculture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

254 Djajadiredja, R. and A. Poernomo. 1972. Requirements for successful fertilization to increase milkfish production, p. 398-409. In: T.V.R. Pillay (ed.). Coastal Aquaculture in the Indo-Pacific Region. Fishing News Books, London.

As part of a continuing study on the effect of urea and triple superphosphate fertilizer on the yield of fish, experiments were conducted at the Brackishwater Experimental Station, Kamal, Djakarta. The bottom soil of the pond used for the experiments had high phosphorus and potassium contents, but was low in nitrogen. Application of 130 kg/ha urea, 65 kg/ ha triple superphosphate and 1,000 kg/ha chaff, locally called 'sekam', gave the highest yield. In these experiments, 'Complesal' containing 20 per cent N and 20 per cent P sub(2)O sub(5) did not appear to be superior to urea combined with triple superphosphate. Major factors affecting the success of fertilization are discussed.

Keywords: fertilization; milkfish; production
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inland Fish. Res. Inst. Bogor Indonesia

255 Djajadiredja, R. and T. Daulay. 1982. Aspects of design and construction of coastal ponds for milkfish seed production (SCS/82/CFE/CP-5), p. 92-100. In: Report of Consultation/ Seminar on Coastal Fishpond Engineering, 4-12 August 1982, Surabaya, Indonesia. South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines.

A review is presented of experience on the innovation of an improved type of nursery pond incorporating features of local and Philippine designs. It is believed that with better designed and constructed nursery facilities, an improvement of 20% in fry survival could be achieved.

Keywords: fish ponds; seed (aquaculture); brackishwater aquaculture; design; ISEW, Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inland Fish. Res. Inst., Agency for Agricult. Res. and Dev., Bogor, Indonesia

256 Dwivedi, S.N., J. Somalingam, B.N. Tiwari and M.N. Murty. 1977. A note on the culture of *Chanos chanos* (Forsskal) at Brackishwater Fish Farm, Kaninada. Journal of the Indian Fisheries Association 7(1-2):57-63.

The culture of *Chanos chanos* to marketable size within a 3-month period is described. Procedures involved include phased manuring coupled with proper water management to keep up enhanced primary productivity. Results show that, under monoculture, with low-input technology it is possible to produce 3000kg fish per hectare per year.

Keywords: fish culture; monoculture; brackishwater aquaculture; *Chanos chanos*; India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Inst. Fisheries Education, Bombay-61, India

257 Edra, R.B. 2000. Pag-aalaga ng bangus, gabay sa negosyo. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, Pilippines.

The article discusses milkfish aquaculture, hatchery management and processing.

Keywords: milkfish culture; milkfish; *Chanos chanos*
Location: PCAMRD Library
Author Affiliation: PCAMRD, Los Baños, Laguna, Philippines

258 Gandhi, V. and G. Mohanraj. 1986. Results of experimental monoculture of milkfish in marine fishfarm at Mandapam. Journal of the Marine Biological Association of India 28(1-2):63-73.

The results of the experiments conducted during 1980-82 on the monoculture of milkfish (*Chanos chanos*) at the marine fishfarm, Mandapam, Tamil Nadu, India, are presented. In a 0.25 ha earthern pond, each experiment was conducted for a period of 10 months. Fertilization with 1000 kg/ha of chicken manure and 400 kg/ha of N-P-K (12-24-12) was carried out in the first experiment. Supplementary feed at the rate of 5-10% body weight of the fish was given in the second experiment. The stocking density of 4000 fingerlings/ha yielded 216 kg/ha in the fertilized pond with a survival rate of 89.7%, and 852 kg/ha in the unfertilized pond with 63% of survival.

Keywords: pond culture; experimental culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Cochin 682 031, India

259 Gerochi, D.D., M.M. Lijauco and D.D. Baliao. 1988. Comparison of the silo and broadcast methods of applying organic fertilizer in milkfish, *Chanos chanos* (Forsskal), ponds. Aquaculture 71(4):313-318.

The efficacy of the silo and broadcast methods of applying organic fertilizers in ponds for the production of pond-floor, microbenthic biological complex, a natural food source known as lablab, was tested in 1-ha ponds, replicated thrice in time. Although there were no statistically significant differences ($P > 0.05$) in milkfish *Chanos chanos* growth, survival and production between the two treatments tested, after 90 days production tended to be higher in ponds prepared with the silo method. Advantages of the silo method are that it is less laborious, cheaper, and less time consuming than the broadcast method and results in consistent lablab growth until the end of the culture period.

Keywords: feeding equipment; pond culture; fertilizers; growth; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

260 Hsiao, S.M. and L.C. Tseng. 1980. Induced Spawning of pond reared milkfish, *Chanos chanos* Forsskal. China Fisheries Monitor (330):7-13.

Sixteen 8-year old milkfish, *Chanos chanos*, were examined for gonadal maturation and later induced to spawn by injecting HCG and Phenobarbital. The fertilization of the first and second stripping was 5.71% and 1.95%, respectively. Twenty-four days after hatching, 36 fry were collected having an average length of 15.2 mm.

Keywords: spawning; pond reared milkfish; milkfish culture
Location: SEAFDEC Aquaculture Department Library

261 Jamandre, E.V. 1977. Integrated piggery and milkfish culture-some problems and constraints. Technical Reports 2. Joint SCSP/SEAFDEC Regional Workshop on Aquaculture Engineering (with emphasis on small-scale aquaculture projects), 27 Nov 1977, Tigbauan, Iloilo, Philippines. South China Sea Fisheries Development Coordinating Programme. Manila, Philippines.

Although an efficiently and scientifically managed piggery will be a profit-making concern on its own, the manures could be used to improve and increase production in a brackishwater fishpond project if the two are established together. Construction of the ponds for the milkfish is described and the livestock project is separately discussed. Problems and constraints are also considered.

Keywords: ponds, milkfish
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Western Visayas Fed. Fish Producers, Inc., Iloilo City, Philippines

262 Joseph, A. and K.J. Vadhyar. 1994. Milkfish production and ecology of brackishwater ponds treated with organic versus inorganic fertilizers in Cochin, India. Fisheries Technology Society 31(2):95-101.

The paper deals with a comparative study of growth, survival and yield of milkfish as well as the ecological characteristics of two brackishwater culture ponds (0.042 ha each), one treated with organic fertilizer (cowdung) and the other with inorganic fertilizers (superphosphate and urea). Milkfish, *Chanos chanos*, of 6 g average weight were stocked at a rate of 4500 fingerlings ha/l in both the ponds. Remarkably better growth of fish (238 g), 86% of survival and gross and net productions of 852 kg ha/l respectively, were obtained after 120 days of culture from the pond treated with cowdung, than from the pond treated with inorganic fertilizers which showed a growth of only 63 g, survival of 82% and gross and net production of 226 and 199 kg ha/l, respectively during the same period. The operational economics of milkfish production from the ponds has been compared. The rate of return on operational costs works out to be 298% in the pond treated with cowdung and 3% in the pond treated with chemical fertilizers.

Keywords: fish culture; growth; survival; pond culture; fish ponds; fertilizers; fisheries; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

263 Juliano, R.O. 1985. Biology of milkfish, *Chanos chanos* (Forsskal), and ecology and dynamics of brackishwater ponds in the Philippines. University of Tokyo, Japan. 227 p. Ph.D. dissertation.

This study aims to provide solutions to some problems faced by the milkfish industry in the Philippines. Recommendations on how to improve or increase production based on field surveys and research results are given.

Keywords: milkfish biology; milkfish
Location: SEAFDEC Aquaculture Department Library

264 Juliano, R.O. and R. Hirano. 1986. Growth rate of milkfish, *Chanos chanos* in brackish ponds in the Philippines, p. 63-66. In: L.B. Dizon, L.V. Hosillos and J.L. Maclean (eds.). Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila, Philippines.

Experimental data on mean weight of milkfish, *Chanos chanos*, taken at intervals during its culture from fry to fingerlings and from fingerling to marketable juveniles in several yield experiments using organic and inorganic fertilizers at the Brackish Water Aquaculture Center, College of Fisheries, University of the Pilippines in the Visayas in Leganes, Iloilo, reveal that absolute growth rate, a regression of mean weight to time, varies with pond carrying capacity and fish population density. Pond carrying capacity in this study was influenced by the type and quantity of natural food organism (plankton and lablab of benthic organisms) in the ponds. In the nursery ponds, fry were grown to fingerling with an absolute growth curve that was exponential at stocking density of 16 000/ha with lablab as food. At a higher stocking density of 29 000/ha, fry growth was linear and slower. Absolute growth of milkfish in the ponds from fingerlings to juveniles varied from power function, linear to log regression curve, depending on the natural food biomass in the pond and fish stock densities of 3 000-5/sqm, absolute growth curve could be linear or log regression, indicating slower growth compared to steeper linear growth at lower stocking density of 2000/sqm. Better growth of milkfish was produced by lablab as food compared to plankton as evidence by slightly steeper regression slopes of the growth curve in lablab ponds.

Keywords: growth rate; brackishwater ponds; milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

265 Krishna, G.G. 1989. Extensive and semi-intensive culture of milkfish *Chanos chanos* (Forsskal), p. 235-240. In: U.S. Srivastava (ed.). Proceedings of the National Symposium on Utilization of Living Resources of the Indian Seas, Central Institute of Fisheries Education, Bombay, 19-21 December 1987. Central Institute of Fisheries Education, Bombay.

Experiments have been conducted in 1987 on 2 farming systems for milkfish (*Chanos chanos*) under extensive and semi-intensive management. The common factors such as plankton-biomass, physico-chemical parameters that may influence production for each system are also discussed. It is observed that the milkfish culture practiced under extensive management resulted in 1.6 to 1.9 tonnes/ha whereas semi-intensive management yielded 3.8 to 4.0 tonnes/ha. The economics of the experiment indicates that rural masses who cannot afford to take up prawn culture can very well go for milkfish culture.

Keywords: aquaculture systems; extensive culture; intensive culture; aquaculture economics; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Fish Farm, C.I.F.E., ICAR, Kakinada, A.P., India

266 Lazarus, S. and K. Nandakumaran. 1986. Studies on the monoculture of milkfish in artificial ponds. Journal of the Marine Biological Association of India 28(1-2):84-95.

The results of 2 sets of milkfish (*Chanos chanos*) culture experiments conducted in the polyethylene film-lined ponds at Calicut sea shore are given. Maximum instantaneous growth rate (1.8219-1.2155) was observed for fish which were stocked at a smaller size (16.3 mm-53.6 mm) and minimum (0.5433-0.3727) for the fish which were stocked at a bigger size (104 mm and 107 mm). A maximum survival rate of 88.8% in 180 days was observed for the fish which were stocked at 16.3 mm size under 1/m super(2) stocking density; whereas for fish which were stocked at a higher stocking size of 130.5 mm it was 99.0% for 107 days under the same stocking rate. Highest production of 1882 kg/ha/181 days under 2/m super(2) stocking density and 1751 kg/ha/180 days under 1/m super(2) stocking density was obtained. The economics of the culture operation were studied and optimum stocking size, stocking density, pond size and culture period are suggested. Earlier reports on the culture of milkfish are compared with the present results.

Keywords: pond culture; stocking density; experimental culture; growth; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Cochin 682 031, India

267 Lazarus, S. and K. Nandakumaran. 1987. Culture of milkfish in polyethylene film-lined ponds, p. 9-12. In: Marine Fisheries Information Service Technical and Extension Series, no. 76.

Details are given of experiments conducted at Calicut to culture milkfish (*Chanos chanos*) in ponds dug out in sandy beaches and lined with polyethylene film. Methods involved in the preparation of the ponds, seed collection, feed, growth and survival of the fish are described. The production rates of the fish in the ponds and the economics of the culture operation are analyzed. Recommendations for maximum growth and survival for milkfish in such ponds are included.

Keywords: pond culture; aquaculture systems; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Calicut Res. Cent., CMFRI, Calicut, India

268 Liang, J.K. and C.Y. Huang. 1972. Milkfish production in newly reclaimed tidal land in Taiwan, p. 417-428. In: T.V.R. Pillay (ed.). Coastal Aquaculture in the Indo-Pacific Region. Fing News Books, London.

A 1,600-ha area of tidal land was reclaimed for milkfish (*Chanos chanos*) production in Tseng Wen tidal land of south-western Taiwan, in order to demonstrate to local farmers pond construction and management techniques. The land has been found to be suitable for milkfish farming. The time of the year most suitable to build ponds, and materials needed for construction, have been indicated. Application of organic fertilizers and a low rate of stocking for the first few years are essential for the improvement of productivity of the ponds. Supplemental feeding is necessary when the benthic algae begin declining. The low annual yield, 406 kg/ha, for the first year was mainly due to the delay of pond construction and low fertility of the new ponds. The yield was increased to 1,338 kg/ha in the second year under proper management. Under unfavourable conditions and poor management in the first year, a conversion ratio of 1.7 kg chicken manure plus 3.4 kg rice bran to 1 kg fish was considered high for commercial production of milkfish. However, a ratio of 1.5 kg chicken manure and 1.5 kg rice bran to 1 kg of fish was soon attained in the second year. With a gradual increase of yield and decrease of conversion ratio, the ponds can be operated economically within a few years.

Keywords: milkfish production; milkfish; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tainan Fish. Cult. Stn., Taiwan Fish. Res. Inst. Tainan Taiwan

269 Librero, A.R., E.S. Nicolas, E.O. Vasquez and A.M. Nazareno. 1977. An assessment of the fishpond technology and management in the production of milkfish (bangus) in the Philippines. Research Paper Series. Socio-Economic Survey on Aquaculture Industry (Philippines) no. 4.

This report is published as part of the program 'A Socioeconomic Survey of the Aquaculture Industry in the Philippines', jointly undertaken by the Southeast Asian Fisheries Development Center and the Philippine Council for Agricultural and Resources Research. This report presents information on the milkfish (bangus) production industry. Some 1175 fishponds were surveyed. Almost all the operators (95%) were male, and had an average age of 52 years. Caretakers were on average 46 years old. Most of the operators had received formal education, 96% for owners and 89% for caretakers. The average number of yrs of schooling was directly proportional to the size of the farm, ranging from 6.1 years in small farms to 11.7 years in large farms. In general, both owners and caretakers were economically active throughout the year, spending a little more than 50% of their time in fishpond operation. About 4 months were spent in other occupations, and for 2 months of the year they were not gainfully employed. The desire to take other employment was inversely related to the size of farm. Though the oldest of the farms dated back to 1908, the majority had begun since 1960. The average size of farm varied among regions. The overall average for the Philippines was 13.39ha. Details are included of cultural practices.

Keywords: pond culture; fish culture; sociological aspects; economic analysis; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Philippine Council for Agricultural Resources Research, Los Baños (Philippines) Southeast Asian Fisheries Development Center, Los Baños (Philippines)

270 Lijauco, M., J.V. Juario, D. Baliao, E. Grino and G. Quinitio. (n.d.) Milkfish culture in brackishwater ponds. Aquaculture Extension Manual. Aquaculture Department, Southeast Asian Fisheries Development Center 4. 23 p.

The manual is intended as a guide for operation in milkfish farming. It is presented under the following major sections: 1) Handling of fry - counting, storage and transport; 2) Pond layout and construction - selection of farm site, layout, construction, plan and specification; 3) Pond operation, culture and management - nursery pond management and rearing pond operation; 4) Harvest and postharvest-harvest, post harvest, and processing; and 5) Economics and costing - cost of construction, cost of operation, and production/yield.

Keywords: fish culture; pond culture; aquaculture systems; aquaculture techniques; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

271 Lijauco, M.N. 1978. A preliminary study on the growth and survival of stunted and non-stunted milkfish fingerlings. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(3):35-36.

A study was conducted comparing the growth of stunted and non-stunted milkfish.

Keywords: fish culture; growth; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

272 Luceña-Olaño, V. 1982. Evaluation of burnt rice hull on the production of milkfish in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 71 p. M.S. thesis.

The experiment was carried out in twelve rectangular earthen ponds about 100 m^2 at the Brackishwater Aquaculture Center, Leganes, Iloilo from March 12 to July 26, 1981 to evaluate the effects of burnt rice hull on milkfish and natural fish food production and some chemical and physico-chemical properties of soil and water. The four treatments namely: I (control), II (16-20-0), III (burnt rice hull) and IV (16-20-0 plus burnt rice hull) were evaluated in a Completely Randomized Design with three replications per treatment.
Results showed that Treatment II and IV both with 16-20-0 inorganic fertilizer consistently maintained significantly higher phosphorus levels in the water and gross community productivity than Treatments I and III. On the other hand, Treatments III and IV both with burnt rice hull consistently maintained significantly higher silica concentrations than Treatments I and II throughout the study.
Average percent survival were high ranging from 93.33 to 100.00%. Highest mean fish yield was obtained in Treatment IV with mean fish yield of 733.2 kg/ha. Differences in mean fish yield among treatments were significant at the 5% level. Correlation analyses showed significant correlations between total fish production and reactive phosphorus ($r = 0.76$), dissolved oxygen ($r = 0.70$). Similarly, gross community productivity was significantly correlated with reactive phosphorous ($r = 0.82$) and dissolved oxygen ($r = 0.64$). A high positive but non significant correlations were obtained between total fish production and silica concentration, pH and percent survival.

Keywords: burnt rice hull; production; milkfish production, *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

273 Olunuga, A.O. 1982. Effect of eutrophication pond system on milkfish production in brackishwater pond. University of the Philippines in the Visayas, Miag-ao, Iloilo. 71 p. M.S. thesis.

The effect of eutrophication pond system on milkfish production in brackishwater ponds was carried out at the University of the Philippines Brackishwater Aquaculture Centre, Leganes, Iloilo. Fifteen 250m^2 ponds were used for this study with 9 of the ponds modified to contain the eutrophication ponds. Milkfish were grown from fingerlings to marketable size. The study took 120 days, 8th January to 10th May 1982. Ratio of the eutrophication to grow-out pond is 1:4. There were 5 treatments - I - the control, no eutrophication pond with 3,000 pcs/ha; II - eutrophication ponds with 3,000 pcs/ha; III - eutrophication pond with 4,500 pcs/ha; IV - eutrophication pond with 6,000 pcs/ha and V - no eutrophication pond but same inputs as IV. At harvest time, the percent survival were I - 59.80%, II - 87.73%, III - 53.97%, IV - 61.84% and V - 70.10% and net production of milkfish was 240.85 kg/ha, 284.63 kg/ha, 237.47 kg/ha, 290.68 kg/ha and 335.76 kg/ha for treatments I to V. Of the treatments with eutrophication ponds (II, III and IV) treatment IV had the highest production of 290.68 kg/ha closely followed by treatment II with 284.63 kg/ha, however, the latter had a larger size fish (106.44g to 97.31g). There was no significant differences in survival,

production and mean weight gain at the 5% probability level. Treatments I, III and IV had isometric growth while II and V were allometric being too heavy for their length. Correlation between length and weight were highly positive, (0.9762, 0.9863, 0.9772, 0.9877 and 0.9743) for treatments I to V.

Keywords: eutrophication; ponds; system; milkfish culture; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

274 Padlan, P.G. 1979. Indonesia. Improvement of milkfish pond production in Jepara, Central Java. A report prepared for the Brackishwater Shrimp and Milkfish Culture Applied Research and Training Project. FAO, Rome, 49 p.

The Government of Indonesia, assisted by UNDP and FAO, is engaged in a project aimed at improving the brackishwater fishpond industry. The main target is to raise milkfish (*Chanos chanos*) production from the average 340 kg/ha/year to about 2,000 kg/ha/year and shrimp production from 200-1,000 kg/ha/year. As part of the project, operation the author was assigned to organise and conduct experimental brackishwater fish culture leading to the development of improved techniques for commercial production, including (1) developing intensive methods of nursery rearing of milkfish fry, ensuring least mortality and rapid growth up to fingerling stage; (2) evolving techniques of high production of commercial crops of milkfish; (3) developing polyculture species combination for optimum production; and (4) demonstrating improved techniques for training and extension. This work is reported with information on field and laboratory experiments and trials. Comments and recommendations are made in respect of the Shrimp Culture Research Centre and Jepara milkfish ponds. Appendices include a suggested management programme, a stocking schedule for a milkfish pond, and income and cost estimates. Appropriate data is presented in tabular form.

Keywords: fish culture; aquaculture development; *Chanos chanos*; Java; Jepara
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

275 Padlan, P.G., B.S. Ranoemihardjo and E. Hamami. 1975. Improved methods of milkfish culture. 1. Increasing production in shallow, undrainable brackish-water ponds. Bulletin of the Shrimp Culture Research Center 1(1):33-39.
Production in shallow drainable brackish water *Chanos* ponds has reached the level of 2,500 kilograms per hectare per year through improved methods. Tests to find out if shallow, undrainable ponds could be made to produce high yields by adoption of some of the techniques have been conducted at the Shrimp Culture Research Centre, Jepara, Indonesia since 1973 and results appear encouraging. This paper presents details of continuing trials made during the latter half of 1974.

Keywords: fish culture; biological production; brackishwater aquaculture; yield; habitat improvement; *Chanos*; ISEW, Indonesia, Jawa, Jawa Tengah, Jepara
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Shrimp Culture Res. Cent., Jepara, Indonesia

276 Pedini, M. 1977. Indonesia. Milkfish culture and pond management. A report prepared for the Project on Shrimp and Milkfish Culture Applied Research and Training. FAO, Rome, 25 p.

The Government of Indonesia, assisted by UNDP and FAO, is engaged in a project whose main purpose is to develop improved methods for the expansion of shrimp and fish production on a national scale; to establish data collection programmes and to provide requisite training. As part of the project, the author was assigned to assist in investigations relating to the improvement of milkfish culture, participate in the organisation of extension workers training, and assist in the location of seed collection centres and the production and distribution of seed. In this report he describes experiments on food preferences for milkfish fry, and milkfish pond management. Also included is a complexiметric method for the determination of dissolved O Sub(2) in water.

Keywords: fish culture; fry; dissolved oxygen; water analysis; seed (aquaculture); *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food and Agriculture Organization of the United Nations, Rome (Italy)

277 Rabanal, H.R., R.S. Esguerra and M.N. Nepomuceno. 1952. Studies on the rate of growth of the milkfish *Chanos chanos* (Forsskal), under cultivation. Proceedings of Indo-Pacific Fisheries Council, 4th Meeting, 23 October-7 November 1952, Manila, Philippines, 2(2):10 p.

These studies were undertaken at the Dagat-dagatan Salt-Water Fishery Experimental Station fish-pond situated in Malabon and Navotas municipalities, Rizal province, Luzon. In actual practice ,bangus cultivation covers two phases, namely the rearing of the bangus fry and fingerlings in the nursery ponds and the rearing of the fish to marketable size in the larger rearing ponds. Due to the fact that these phases form two distinct stages, each being an industry in itself, we have found it convenient to breakdown the work into two parts.

Keywords: growth rate; milkfish cultivation; rearing; milkfish fry; fingerlings; marketable size
Location: PCAMRD-DOST Library, Los Baños, Laguna

278 Ranoemihardjo, B.S. and E. Hamami. 1976. Improved methods of milkfish culture. 2. Increasing production in shallow undrainable brackishwater ponds. Bulletin of the Shrimp Culture Research Center 2(1-2):107-113.

Filed tests on milkfish culture were conducted in shallow undrainable ponds with the application of 825 kg/ha of cowdung, 300 kg/ha of fine rice bran, 130.4 kg/ha of urea, and 134.4 kg/ha of triple superphosphate. A total of 160 kg/ha of rice bran was also introduced as supplementary feed. Brestan 60 at a rate of 0.5 ppm was applied to the pond during preparation to eradicate *Cerithidea*; BHC 6% and Diazinon 60 EC at a rate of 0.08 ppm active ingredient was applied to eradicate chironomid larvae. Total number of 3044 post fingerlings per hectare with weight ranging from 23.6-160 g were stocked in the rearing pond. The rearing period was 93 days and a net production of 401.4 to 455.8 kg/ha was realized.

Keywords: fish culture; brackishwater aquaculture; habitat improvement; stocking (organisms); *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Shrimps Cult. Res. Cent., Jepara, Indonesia

279 Sato, G.H. 1991. The Manzanar Project on mangroves, mullet, milkfish and molluscs, p. 57. In: Program and Abstracts. Second International Marine Biotechnology Conference '91, 13-16 October 1991, Maltimore, MD, USA.

The Manzanar Project will allow indigenous peoples who are facing famine and who live on coastal desert areas to feed themselves. The plan offers a unique formula for eventually ending world hunger. We predict that the Manzanar Project could eliminate the recurrent cycles of famine in Ethiopia by the end of 1996. This pilot project in Eritrea has been highly successful. At the present time, 1000 acres of ponds (using a natural bay) are producing fish at the rate of 7000 tons per year.

Keywords: aquaculture; mangroves; fish ponds; mangrove swamps; development projects; aquaculture development; marine aquaculture; marine molluscs; *Crustacea*; *Mugilidae*; *Chanos chanos*; Ethiopia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: W. Alton Jones Cell Sci. Cent., Lake Placid, NY 12946, USA

280 Shen, S.L. and Y.M. Chaing. 1971. Notes on organism causing brown water in milkfish ponds. Fisheries Series. Chinese-American Joint Commission on Rural Reconstruction 11:84-86.

Formation of brown water in milkfish ponds used for wintering purpose was found to have been caused by a bloom of *Olisthodiscus carterae*. The taxonomy and characteristics of this species are discussed.

Keywords: milkfish ponds, milkfish, *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tainan Fish Culture Stn., Taiwan Fisheries Res. Inst., Taiwan, China

281 Spennemann, H.R. 2003. Traditional milkfish aquaculture in Nauro. Aquaculture International 10(6):551-562.

The article describes the methods and practice of milkfish aquaculture in Nauru.

Keywords: milkfish culture; *Chanos chanos*, Nauru
Location: **http://www.csu.edu.au/research/jcentre/project_summaries**

282 Su, B.T. and Y.Y. Ting. 1980. Study of improvement of the milkfish culture in deep-water pond. Annual Report Taiwan Fisheries Research Institute (1980), 12 p.

Two deep-water ponds, one stocked with 4000 and the other 12000 fingerlings were used in this study. Another pond with a depth of 30-40 cm, stocked with 2000 large size fingerlings and 2000 smaller size fingerlings, was used as control. Diets used were formulated by the Tungkang Marine Laboratory and manufacture by Taiwan Sugar Corp. Mean production and profit of utilizing deep-water ponds are higher than those of the control pond.

Keywords: deep-water; milkfish culture; milkfish
Location: SEAFDEC Library

283 Sudjiharmo, K. 1987. Results of nursery pond of milkfish at BADC in April/May 1986. Bulletin of the Brackishwater Aquaculture Development Centre 8(2):81-85.

Milkfish *Chanos chanos* nursery pond operation in Indonesia can be characterized by low stocking density (less than 50 pcs/m super(2)) and low survival rate < 70%). Experiments at BADC shows that survival rate in ordinary earthen nursery ponds can be increased, even at a higher stocking density by seeing to it that the dikes and gates are in good order; eradicating unwanted organisms; fertilization; and using supplementary feed when the natural food appears to be exhausted. By so doing a survival rate of > 90% was obtained at a stocking density of 85 pcs/m super(2) after a culture period of one month.

Keywords: fish culture; pond culture; stocking density; aquaculture techniques; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

284 Sumagaysay, N., D. Balio, E. Rodriguez, R. Coloso and C. Luckstaedt. 1998. AQD recommends semi-intensive milkfish culture. SEAFDEC Asian Aquaculture 20(3):28-29.

Details are given of a system for semi-intensive milkfish (*Chanos chanos*) culture recommended by the SEAFDEC Aquaculture Department, under the following headings: 1) Pond preparation; 2) Pest (snails) control; 3) Pest (tilapia and other fish) control; 4) Fertilizer application; 5) Stocking density in nursery ponds; 6) Stocking density in grow-out ponds; and, 7) Water management.

Keywords: fish culture; pond culture; intensive culture; aquaculture systems; aquaculture techniques; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

285 Sumagaysay, N.S. and Y.N. Chiu. 1988. Recent developments toward intensification of milkfish culture. Paper presented during the Workshop on Prospects and Future Directions for the Milkfish Industry, Co-sponsored by SEAFDEC AQD and U.P. in the Visayas, Tigbauan, Iloilo City, Philippines, 7 April 1998. 21 p.

Milkfish, the most widely eaten fish, is a cheap source of protein compared to chicken, pork and beef. To meet the need of the populace, increasing milkfish production and maintaining it price have to be given attention. Milkfish production has increased as demonstrated by the increase in stocking rates and supplemental feeding. In an intesive system, feed is considered a major and expensive output. To decrease cost of production and increase profit, it is recommended that maximum utilization of natural food, improvement of feed efficiency and formulation of low cost feed be major factors to be considered in an intensive system.

Keywords: intensification; milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

286 Sumagaysay, N.S., G.V. Hilomen-Garcia and L.M.B. Garcia. 1999. Growth and production of deformed and nondeformed hatchery-bred milkfish *(Chanos chanos*) in brackishwater ponds. Israeli Journal of Aquaculture/Bamidgeh 51(3):106-113.

This study evaluated the growth and survival of morphologically deformed and nondeformed hatchery-bred milkfish in brackishwater ponds. It compared the size-frequency distribution of the nondeformed fish with the deformed ones, and determined the effects of different types of deformity on growth. The deformities include the absence of an upper jaw, a folded operculum with gills exposed, a cleft branchiostegal membrane, scoliosis, etc. The results were compared with production of wild stock. Hatchery-bred and wild milkfish fry were grown separately in nursery ponds (500 m super(2)/pond) at 10 individuals/m super(2). After a month, the juveniles (average weight hatchery-bred 6.0 g; wild 9.5 g) were transferred to seven rearing ponds of 1000 m super(2) each (stocking density 3000/ha). Three ponds were stocked with selected, nondeformed hatchery-bred fish (unmixed stock), three ponds with a combination of deformed and nondeformed hatchery-bred fish (1:2 ratio; mixed stock), and one pond with wild fish. The final weight, specific growth rate and survival of the nondeformed fish (mixed and unmixed stock) after four months of culture were significantly higher ($p<0.05$) than those of the deformed fish. Production, however, did not significantly differ between the unmixed nondeformed (433 kg/ha) and the mixed deformed and nondeformed (377 kg/ha) fish. Survival of the deformed stock (56%) was significantly lower ($p<0.05$) than that of the nondeformed stock (86-88%). Approximately 92% of the deformed stock and 17-20% of the nondeformed were below 150 g. Severe deformities such as the absence of an upper jaw and exposure of all or most of the gills hindered fish growth, while widening of the operculum or branchiostegal membrane, scoliosis, or absence of the anal fin had less effect on growth. To lower the incidence of deformities in grow-out ponds, milkfish fry should be reared to the early juvenile stage in nursery ponds for at least a month. The harsh natural conditions in the nursery ponds (e.g., presence of predators, abrupt changes in salinity, temperature and dissolved oxygen) and stress during transfer to rearing ponds may eliminate most of the weak fish and those with severe deformities.

Keywords: fish culture; salinity effects; abnormalities; biological stress; mortality causes; stocking density; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA) SEAFDEC
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

287 Sumagaysay-Chavoso, N. 2003. Milkfish grow-out culture in ponds. SEAFDEC Asian Aquaculture 25(3):22.

Milkfish farming is regarded as the backbone of Philippine aquaculture. In 2001, nearly 50% of the Philippines' aquaculture production was milkfish cultured from brackishwater ponds. It has 3 major culture systems: extensive; semi-intensive and intensive. A brief outline is given of the stocking and feeding procedures, providing also some details as to investment costs and returns.

Keywords: fish culture; brackishwater aquaculture; pond culture; aquaculture systems; aquaculture economics; investments; *Chanos chanos*; ISEW, Philippines

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: [mailto:nss@aqd.seafdec.org.ph]

288 Sumagaysay-Chavoso, N.S. and M.L. San Diego-McGlone. 2003. Water quality and holding capacity of intensive and semi-intensive milkfish (*Chanos chanos*) ponds. Aquaculture 219(1-4):413-429.

This study determined the holding capacity of semi-intensive and intensive milkfish ponds and water quality in relation to fish biomass and feed input. Six units of 1000 m super(2) brackishwater ponds were used, three ponds for intensive system (20,000 fish ha super(-1)) and three for semi-intensive system (8000 fish ha super(-1)). Average production was significantly higher in intensive pond (3652 kg ha super(-1)) than in semi-intensive pond (1352 kg ha super(-1)) after a desired marketable size of fish was reached. Highest concentrations in effluents (mg l super(-1)) of rearing water measured every 2 weeks were 0.369 and 0.289 for chlorophyll a (chl a), 0.485 and 0.512 for PO4-P, 0.279 and 0.811 for TAN, 0.094 and 0.082 for NO2-N, and 14.040 and 8.649 for NO3-N, 216 and 142 for total suspended solids (TSS), 15.0 and 21.7 for biological oxygen demand (BOD), in intensive and semi-intensive ponds, respectively. Lowest morning dissolved oxygen (DO) in intensive pond was 2.2 mg l super(-1), and did not decrease further because of aeration. In unaerated, semi-intensive pond, morning DO ranged from 1.3 to 5.0 mg l super(-1) but occasionally went below 1.0 mg l super(-1) resulting to fish mortalities at biomass of 835, 1206, and 1489 kg ha super(-1). Levels of NO3-N and dissolved inorganic N are linear functions of fish biomass or feed input in all systems (P0.05). The buildup of nutrients is more pronounced at biomass of 1610 kg ha super(-1) and above while nutrient transformation (conversion of PO4-P or TAN to phytoplankton or vice versa) is apparent at biomass below 1419 kg ha super(-1). The holding capacity of unaerated, semi-intensive pond is below 1348 kg ha super(-1) or 54 kg feed ha super(-1) day super(-1) based on DO concentration of less than 1.0 mg l super(-1). However, the holding capacity can be lower than 835 kg ha super(-1) or 33 kg feed ha super(-1) day super(-1) during very calm weather or during rainy days when water column is stratified. Based on the results of regression analysis, the holding capacity of intensive pond should be set below 5107 kg ha super(-1) or 110 kg feed ha super(-1) day super(-1) so as not to exceed the acceptable levels for water quality variables in effluent waters.

Keywords: fish ponds; water quality control; intensive culture; stocking density; aeration; dissolved oxygen; nutrient cycles; recirculating systems; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:nss@aqd.seafdec.org.ph]

289 Sumitra-Vijayaraghavan, J., J.M.P.K. Jayasinghe, S.C. Jayamanne and W.A. Sumanadasa. 1985. Milkfish (*Chanos chanos*) culture in a brackishwater pond adjoining the Negombo Lagoon, p. 87-96. In: Aquaculture Related Papers, NARA Occasional Paper 1.

Culture of milkfish (*Chanos chanos*) was attempted in one of the brackishwater ponds near Negombo Lagoon. Fingerlings (av: 7.5 g and 90 mm length) were stocked in Oct. 1983 and harvested after 8 months. Average monthly increment in length and weight amounted to 23.1 mm and 17.81 g, respectively. The productive capacity of the fish pond estimated by C super(14) techniques was 31680.6 gC for the entire culture period. Fish production rate worked out to be 700 kg/ha. Increase of fish production by use of fertilizer and supplemented feeding have been indicated.

Keywords: fish culture; brackishwater aquaculture; pond culture; aquaculture systems; fertilizers; yield; growth; *Chanos chanos*; ISW, Sri Lanka, Negombo Lagoon
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

290 Tang, Y. A. 1979. Planning, design and construction of a coastal milkfish farm, p. 104-117. In: Advances in Aquaculture. Fishing News Books Ltd.

The present approach and guiding principles related to planning, design, construction and the criteria for site selection of milkfish tide-fed farms are described, emphasis being placed on the requirements for water control structures, physical features of potential farm sites, and regional climatic conditions. Information on the general layout and typical design of a tide-fed fish farm is provided.

Keywords: aquaculture; design; fish farms; planning; *Chanos chanos*
Location: CAB Direct Abstracts
Author Affiliation: Dep. of Fisheries, FAO, 00100 Rome, Italy

291 Ting, Y.Y. 1972. Milkfish experiment in wintering. Bulletin of Taiwan Fisheries Research Institute (30):479-486.

The experiments were undertaken to improve the traditional methods to raise the water temperature in the wintering canal. Two kinds of PE plastic were tried to cover the wintering canal. The water temperature of wintering canal covered with gray-bubbled PE plastic (over 2/3 of the surface area) is 0-0.8 deg C higher than that of the traditional canal. The water temperature of canal completely covered with transparent PE plastic and supplied with heated air blowing is 0.3-1.3 deg C higher. Milkfish in such improved wintering canal could survive during the cold spell in winter. The surface water temperature of the wintering canal green-house with transparent PE plastic with heated air blowing is 0.7-2.6 deg C higher than that of the traditional. The parasite of milkfish, *caligus sp.*, is sensitive to freshwater, high-salinity water (60%) and poison abate (o.1 ppm). In the milkfish pond the high salinity water (26%) or 0.2 ppm Abate of the pond water is effective to kill the *caligus sp.*

Keywords: milkfish; wintering; milkfish culture
Location: SEAFDEC Aquaculture Department Library

292 Zhuang, Q., H. Yu, G. Liu and Q. Chen. 1992. Experiment on the milkfish culture in ponds in Guam. Shandong Fisheries 2:26-28.

An experiment was made on the milkfish (*Chanos chanos*) culture in the ponds in Guam in order to study the technique of breeding the fingerlings of the milkfish in the ponds, feeding with diets and controlling the water quality. The other study subjects, such as the growth speed of the milkfish, its adaptability to the temperature and the salinity, and the feasibility of introducing it to the coastal area of Shandong were also further probed.

Keywords: fish culture; pond culture; temperature tolerance; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mar. Cultiv. Res. Inst. Shandong Prov., Qingdao 266000, People's Rep. China

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293 Anon. 1998. Milkfish success with SeaStation. Fish Farming International 25(1):34.

SeaStation is a self-tensioned and self-supporting cage. Flotation, stability and rigidity are provided by the spar buoy, which in turn is connected to the rigid steel rim with ropes and netting.

Keywords: cage culture; marine aquaculture; fish culture; aquaculture equipment
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

294 Anon. 1999. Filipino design boost. Fish Farming International 26(3):29.

The thriving fish cage farming industry in southern Philippines is expected to receive a boost following successful production of two locally designed cages. Philip Cruz, an aquaculture expert, has established a pilot project with his cages, stocked with milkfish and other high-value species. The flexible cages are 60 metres in circumference and mainly constructed of durable ultraviolet-treated plastic flotation pipes. His design uses locally sourced plastic materials but the structures are similar to standard Scandinavian and Australian fish cages. Some local operators prefer to use expensive European-made fish cages reportedly because of their capability to withstand typhoons and convenient features such as walkways and work area that make on-site management more efficient. Most fish cages in the country use bamboo poles as support structures with a shorter lifespan and are naturally vulnerable, especially during the monsoon season. Cruz says his cage is easy to set up, can be towed to another area, is resistant to strong winds and waves, and can be installed in deeper open water, away from sensitive reef eco-systems.

Keywords: aquaculture systems; fish culture; cage culture; monsoons; cages; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

295 Delmendo, M.N. 1987. Milkfish culture in pens: an assessment of its contribution to overall fishery production of Laguna de Bay. ASEAN/UNDP/FAO, Manila, Philippines. 17 p.

The development of fish pens as a system for culturing milkfish (*Chanos chanos*) in Laguna de Bay is discussed, considering in particular the contribution of the fishpens to the overall fishery production of the lake. Problems concerning fish pen operations and fish pen development regulation are also examined.

Keywords: fish culture; cage culture; aquaculture development; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

296 Gapasin, R. and D.S. Bantala. 1984. Preliminary report on milkfish maturation in floating cages in Parang, Maguindanao, p. 66-74. In: Research Journal. Bureau of Fisheries and Aquatic Resources XII, Philippines.

This study was conducted at Parang cove, Parang, Maguindanao from August 1981 to Sept 1983 using three 10 m (diameter) x 3 m (depth) circular cages. The maturation of milkfish broodstock was evaluated on some physico-chemical parameters, growth rate, and gonadal development. The pH concentration was almost stable at 7.7, surface and bottom temperatures decreased afte 23 months while transparency ranged from 3.1-5.9. The weight of gonads of 29-month old milkfish broodstock is about 1.4 g with a corresponding GSI of 0.21%.

Keywords: milkfish maturation; floating cages; milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

297 Islam, S. Md. 2005. Nitrogen and phosphorus budget in coastal and marine cage aquaculture and impacts of effluent loading on ecosystem: review and analysis towards model development. Marine Pollution Bulletin 50(1):48-61.

Being an essentially open system, cages are usually characterized by a high degree of interaction with environment and cage systems are highly likely to produce large bulk of wastes that are released directly into the environment. Therefore, large-scale cage aquaculture development has been put into question and concerns have been raised that cage aquaculture produces large bulk of wastes that are rich in organic matter and nutrients and are released into coastal and nearshore environment. Recent information on cage aquaculture nutrient budget is scarce and most published reports are dated. This paper reviews cage aquaculture nutrient budget and nutrient loadings and propose a model for nutrient (nitrogen, N and phosphorus, P) budget in a hypothetical cage aquaculture farm with values of feed loss, FCR (feed conversion ratio) and nutrient contents in feed and fish taken from published literature in order to calculate the amount (kg) of N and P produced and released to the environment for each ton of fish produced. The paper proposes, in addition, a critically analyzed nutrient budget based on the dry matter conversion rate instead of the usual feed conversion rate. The conceptual model shows that 132.5 kg N and 25.0 kg P are released to the environment for each ton of fish produced; these values are as high as 462.5 kg N and 80.0 kg P when calculated on the basis of dry matter conversion rate instead of usual feed conversion rate. Thus, the annual global N and P loadings from cage aquaculture (10,000 tons fish and 3000 tons dry matter) are 1325 tons N and 250 tons P and 1387.5 tons N and 240.0 tons P based on usual feed conversion rate and dry matter conversion rate respectively. The paper also proposes, by analyzing the existing data, an FCR-based regression model for predicting nutrient loadings for a given diet. Finally, attempt was made to calculate the annual global loading and release of N and P from cage aquaculture to the coastal and marine environment, the potential impacts of nutrient loading on the ecosystem were discussed and critical points to be considered for minimizing nutrient output in cage aquaculture were suggested.

Keywords: nutrient budget; effluent nutrient loading; cage aquaculture; nitrogen; phosphorus; FCR; mariculture; milkfish
Location: http://www.sciencedirect.com
Author Affiliation: Division of Applied Biosciences, Faculty of Fisheries, Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan

298 Lal Mohan, R.S. 1983. Experimental culture of *Chanos chanos* in fishpens in coastal lagoon at Mandapam. Indian Journal of Fisheries 30(2):287-295.

Chanos was experimentally cultured in three fishpens, fabricated with palmyra poles and enclosed with 20 mm mesh nylon webbing, of area 2 500 sq.m each. The methods of construction of the pens, the hydrological conditions and general topography of the lagoon are described. *Chanos* fingerlings of length 80-146 mm were stocked in the pens respectively at a rate of 4000, 6000 and 8000 per ha, and their rate of growth was observed. The *Chanos* fingerlings belonging to the secondary spawning, during October to November, were also stocked in a pen at a rate of 3,460/ha. The stock attained a length of 260 mm, weighing 137 g, during 132 days. Constraints met with the pen culture are also discussed briefly.

Keywords: experimental culture; fish pens; milkfish; India
Location: SEAFDEC Aquaculture Department Library

299 Mandac, J.I. and R.C. Gonzales. 1983. Preliminary observations on the growth of milkfish (*Chanos chanos* Forsskal) cultured in floating cages off the coast of Ilocos Norte. Ilocos Fisheries Journal 1(2):182-186.

This report concerns the growth of milkfish cultured in floating cages in Ilocos Norte from 7 Jan 1982 to Aug 1983 as part of the joint project of MNR, BFAR and SEAFDEC to produce breeders. The activities undertaken within a period are discussed and results are given.

Keywords: growth; milkfish; Ilocos
Location: SEAFDEC Aquaculture Department Library

300 Martosudarmo, B., B.S. Ranoemihardjo and S. Sabaruddin. 1976. Net enclosures and fish pens for rearing of milkfish for spawners. Bulletin of Shrimp Culture Research Center 2(1-2):99-106.

In the procurement of milkfish spawners for induced breeding work fish pens and net enclosures were used for milkfish rearing to mature size. Details on materials used, method of construction and the problems encountered in establishment of fish pens and net enclosures were discussed.

Keywords: rearing; cage culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Shrimp Cult. Res. Cent., Jepara, Indonesia

301 Mohan, R.S.L. 1980. Evaluation of large-scale culture of milkfish, *Chanos chanos*, in fish pens in a lagoon. Central Marine Fisheries Research Institute (India) Special Publication (40):63-64.

Field trials were conducted from 1981 to 1986 on the culture of milkfish in large fish pens made of nylon webbing in the Pillaimadam Lagoon, near Mandapam. *Chanos* seed of length 75-145 mm weighing 4-18 g were stocked at various rates and reared. Production ranging from 220 to 450 kg/ha was obtained without giving artificial feed. Details of cost of pens and income from pens are discussed. The main advantage of the system is the availability of the water area and the seed. The constraints of the system such as damage to the webbing due to barnacles, predation by birds, poaching and unfavourable weather conditions are discussed.

Keywords: coastal lagoons; cage culture; aquaculture systems; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Mar. Fish. Res. Inst., Calicut Res. Cent., Calicut, India

302 Siriwardena, P.P.G.S.N. 1986. Milkfish pen culture in Sri Lankan lagoons, p. 92-98. In: Asian Fisheries Forum (1st: 1986: Manila, Philippines). Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila.

This paper records preliminary observations on milkfish (*Chanos chanos*) pen culture in the Puttalam lagoon on the west coast of Sri Lanka. The experiments were carried out in 0.25-ha rectangular fishpens made of polypropylene nets of 2.5-cm stretched mesh and bamboo pole frameworks. The extrapolated production was 1,600 kg/ha of two cycles. At a stocking rate of 10,000/ha, average growth rates were 0.6 g/day and 0.54 g/day in trials with and without supplementary feeding, respectively. The specific growth rates showed no significant differences. A low-cost feed of 20% protein (rice bran 8 fishmeal 2) was used. The von Bertalanffy parameters estimated were: K = 0.925/year and L sub(infinity) = 47.89 cm in trials with supplementary feeding and K = 0.807/year and L sub(infinity) = 50.61 cm in trials without supplementary feeding.

Keywords: fish culture; cage culture; coastal lagoons; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inland Fish., Minist. Fish., Colombo 10, Sri Lanka

303 Yu, O.K., A.T. Vizcarra and H.S. Sitoy. 1979. Development of circular floating cages for milkfish broodstock at the SEAFDEC Aquaculture Department. p. 107-117. In: International Workshop on Pen and Cage Culture of Fish, 11-12 February, Tigbauan, Iloilo City, Philippines.

The present attempt to develop floating cages for holding milkfish, *Chanos chanos*, broodstock at SEAFDEC was prompted by the need, of the department to have more fish for experimentation. This paper briefly presents the departments experience in developing the cage culture system designed for

holding milkfish for broodstock purposes. The following points are discussed: (1) site location; (2) biological factors; (3) floats; (4) netting; (5) framework; (6) layout and mooring; (7) maintenance; (8) cost. Designs are given for the net cage cover, frame and floats.

Keywords: fish culture; cage culture; aquaculture techniques; experimental culture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

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(See abstract, keywords, location and author's affiliation in entry no. 472)

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(See abstract, keywords, location and author's affiliation in entry no. 380)

Wanninayake, W.M.T.B., H.K.M.A. Kumarasinghe and U. Edirisinghe. 2001. Experimental studies on polyculture of tiger shrimp *Penaeus monodon* with milkfish *Chanos chanos* in Sri Lanka, p. 264. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.
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TANK

304 Carreon, J.A., L.V. Laureta, F.A. Estopacio and T.U. Abalos. 1984. Milkfish seedling survival in raceways of freshwater recirculating system. Aquaculture 36:257-272.

Wooden and concrete raceways in closed recirculating systems were tested for rearing milkfish (*Chanos chanos*) fry up to 2 to 3 cm total length. Artificially produced detritus and natural plankton were tested separately as food. Growth, health and survival were good for larvae supplied natural plankton, but poor for those reared in detritus.
Precipitation, temperature and intensity of solar insulation had no adverse effects on the production of natural plankton cultivated in the outdoor closed systems. Fish growth was better in experiments in June to July than in August and September.
The concrete raceways, 86 cubic meter at fixed water depth, could produce an estimated 405,000 viable seedlings of 2 to 3 cm length in a 10-month period. Average survival was 70%. Water flow in the raceways was 10cm/s.

Keywords: seedling; raceways; recirculating system; mlkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Institute of Fisheries Development and Research, University of the Pilippines in the Visayas, Diliman, Quezon City, Phils

305 Gerochi, D.D., P.G. Padlan, I.D. Buenconsejo, J.N. Paw and E.M. Rodriguez. 1978. Minimum dissolved oxygen tolerance of four different sizes of milkfish. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(4):7-10.

Milkfish (*Chanos chanos*) were kept in tanks at 31 deg to 34 deg C and salinity 20 to 30/1000. Fish of bodyweight 4 to 18 g, 20 to 34 g, 35 to 95 g or 200 to 300 g showed the first signs of anoxia when the dissolved oxygen concentration in the water fell from 7.2 to 8.0/106 initially to average of 0.96,

1.00, 0.18 or 1.36/106; medium lethal concentration (TL50) was 0.12, 0.18, 0.24 and 0.40/106 and total fish kill (TL100) was at 0.04, 0.12, -0.17 [sic] and 0.27/106. Fish died 11 to 15 min after the first signs of anoxia, in any group by size. Tables give also the temperature, pH, free carbon dioxide, ammonia nitrogen and nitrate N of the water, which were about the same for all groups.

Keywords: anoxia; tropics; Philippines; *Chanos chanos*
Location: CAB Direct Abstracts

306 Ranoemihardjo, B.S., A. Poernomo and K.H. Alikunhi. 1975. Observations on milkfish culture in deep water, encouraging plankton growth. Bulletin of the Shrimp Culture Research Center 1(1):12-18.

Maintaining water at a depth of 1.5 m and producing swarms of phyto and zooplankton by application of organic and inorganic fertilizers, 40sq.m. area cement tanks stocked with a combination of milkfish, mullets and scats at 150 to 420 kg/ha yielded in the course of 2 months a net production of 2184 to 3824 kg/ha/yr. Application of comparable inputs in shallow brackish water ponds with the fluctuating water level never exceeding 40 cm in depth resulted in combined production of benthic algae and plankton as major sources of fish food and yielded a maximum production of marketable size milkfish at 1858 kg/ha/yr. Application of tobacco dust at 200 to 300 kg/ha in rearing ponds had the double effect of eradicating unwanted fish from the pond and providing adequate fertilizer for rapid growth of milkfish fingerlings.

Keywords: fish culture; plankton; habitat improvement; yield; controlled conditions; growing ponds; *Chanos*; *Mugil*; *Scatophagus*; ISEW, Indonesia, Jawa, Jawa Tengah, Jepara
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Shrimp Culture Res. Cent., Jepara, Indonesia

307 Villaluz, A.C. and A. Unggui. 1981. Effects of temperature on behavior, growth, development and survival of young milkfish, *Chanos chanos* Forsskal. Quarterly Research Report. Aquaculture Department Southeast Asian Fisheries Development Center 5(3):1-4.

The effects of 3 temperature treatments on activity, feeding, growth, development and survival of young milkfish (*Chanos chanos*) were investigated under laboratory conditions. It is believed that the results may be applied to develop a land-based mass production technology in rearing milkfish fry to fingerlings.

Keywords: fish culture; rearing; temperature effects; controlled conditions; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

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POLYCULTURE

308 Agbayani, R.F. 2001. Production, economics and marketing of mud crabs in the Philippines. Asian Fisheries Science 14(2):201-210.

The current price of mud crabs in the local market is relatively higher than fish and mollusks and is projected to increase in the world market. This increasing trend in domestic and export markets are expected to step-up the demand for crab seeds. In the Philippines, the technology of mud crab grow-out culture is already being transferred to resource-poor fisherfolks for adoption as an alternative livelihood. However, buying competition among big and small crab farmers is foreseen to be disadvantageous to small farmers. There is a need to hasten the development and transfer of technology on mud crab breeding and hatchery to stabilize the supply and price of crab seeds. This

paper discusses the economic viability of four grow-out culture methods for mud crabs, namely: pond monoculture, polyculture with milkfish, culture in mangroves, and fattening in ponds. The marketing system of mud crabs covers product development, pricing, distribution channels, and promotion activities.

Keywords: aquaculture systems; crab culture; marketing; aquaculture economics; economic analysis; pricing; seed (aquaculture); cultured organisms; *Scylla serrata*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

309 Alcantara, L.B., H.P. Calumpong, M.R. Martinez-Goss, E.G. Menez and A. Israel. 1999. Comparison of the performance of the agarophyte, *Gracilariopsis bailinae*, and the milkfish, *Chanos chanos*, in mono and biculture. Hydrobiologia 398/399:443-453.

The performances of the agarophyte, *Gracilariopsis bailinae*, and the milkfish, *Chanos chanos*, under monoculture and biculture conditions in aquaria and ponds were studied from May 1997 to March 1998. Water quality of both systems was monitored. The two species have reciprocal characteristics in their biological requirements and by-products. Both species attained higher growth rate in biculture: in aquaria *Gracilariopsis* obtained a mean daily growth rate of 4.72 plus or minus 1.64% for biculture and 3.44 plus or minus 2.74% in *Gracilariopsis* monoculture while *Chanos* had a mean daily growth rate of 4.81 plus or minus 2.13% in biculture and 4.13 plus or minus 2.13% in *Chanos* monoculture. In ponds, *Gracilariopsis* obtained a mean daily growth rate of 3.68 plus or minus 0.39% in biculture and 2.46 plus or minus 0.38% in *Gracilariopsis* monoculture while *Chanos* had a mean daily growth rate of 4.81 plus or minus 0.33% in biculture and 2.9 plus or minus 0.1% in *Chanos* monoculture. The growth rates for both *Gracilariopsis* and *Chanos* decreased weekly through one month of culture. Higher dissolved oxygen levels were observed in *Gracilariopsis* monoculture and in biculture and significantly lower in *Chanos* monoculture. *Chanos* did not control epiphytism in *Gracilariopsis*. There was no difference in epiphytism in either culture systems in aquaria, but a significant growth of green algae occurred in ponds with monoculture of *Gracilariopsis*.

Keywords: fish culture; algal culture; polyculture; primary production; biomass; pond culture; ponds; algae; aquaculture; *Chanos chanos*; *Gracilariopsis bailinae*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Silliman University Marine Laboratory, Dumaguete City 6200, Philippines

310 Apud, F.D. and S.H. Benagua. 1981. Survival, growth and production of *Penaeus monodon* and *P. indicus* at different density combinations with milkfish. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 5(1):5-9.

Penaeus monodon and *P. indicus* juveniles were stocked and reared for about 3 months in earthen ponds at different density combinations with *Chanos chanos*. The presence of either *Penaeus* species at any density ratio did not affect significantly the *C. chanos* survival. Survival rates of the penaeids indicated that intraspecific and interspecific competition occurred and were reduced with the reduction in stocking rate. It is concluded that further studies on higher density ratios and feeding and economic consideration would be of help to the development of this kind of fishpond management system.

Keywords: polyculture; shrimp culture; stocking density; *Penaeus monodon*; *Penaeus indicus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

311 Cruz, E.M. and I.L. Laudencia. 1981. Polyculture of milkfish (*Chanos chanos* Forsskal) all-male Nile tilapia (*Tilapia nilotica*) and snakehead (*Ophicephalus striatus*) in freshwater ponds with supplemental feeding. Aquaculture 20(3):231-237.

Results showed that all-male Nile tilapia can be cultured in milkfish ponds without affecting the growth and production of milkfish, at ratios of 1-3 tilapia to 5 milkfish; 2:5 is the optimum ratio. Supplemental feeding with fine rice bran or copra meal at a daily rate of 5% of the biomass increased the net production of milkfish but had no influence on all-male Nile tilapia. Standing crop of about 890 kg/ha in 135 days was obtained in a polyculture system of milkfish, all-male Nile tilapia and snakehead when fed rice bran.

Keywords: polyculture; *Tilapia nilotica*; *Ophicephalus striatus*; stocking density
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Freshwater Aquacult. Cent., Central Luzon State Univ., Nueva Ecija, Philippines

312 Dela Cruz, C. 2003. Sawah tambak rice-fish system in Indonesia. Integrated agriculture-aquaculture: A primer. FAO Document technique sur les peches. Integration Agriculture-aquaculture: Principes de base et Exemples (407):74-76.

A brief account is given of the 'sawah tambak' rice-fish culture system used in Indonesia, which involves both brackish and freshwater. Fish species grown, are a combination of milkfish (*Chanos chanos*) and silver barb (*Barbodes gonionotus*) and sometimes common carp (*Cyprinus carpio*) if available. Details are provided of the operation of the system, considering the following: field components, water supply, prevention of fish escape during floods, preparation of rice-field area, nursery/holding and transition areas, fertilization, culture management and harvesting.

Keywords: agropisciculture; rice field aquaculture; fish culture; plant culture; aquaculture systems; aquaculture techniques; *Chanos chanos*; *Barbodes gonionotus*; *Oryza sativa*; *Cyprinus carpio*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: International Center for Living Aquatic Resources Management Philippines

313 Eldani, A. and J.H. Primavera. 1981. Effect of different stocking combinations on growth, production and survival of milkfish (*Chanos chanos* Forsskal) and prawn (*Penaeus monodon* Fabricius) in polyculture in brackishwater ponds. Aquaculture 23(1-4):59-72.

C. chanos and *P. monodon* were stocked in 500 mSUP-2 earthen ponds from 12 Nov 1978 to 15 Mar 1979 at the following combinations: 2000 milkfish fingerlings/ha (treatment I); 2000 milkfish fingerlings plus 4000 prawn juveniles/ha (treatment II); and 2000 milkfish fingerlings plus 8000 prawn juveniles/ha (treatment III), with three replicates /treatment. Highest combined net milkfish and prawn production was obtained in treatment III with 492.1 kg/ha followed by treatment II with 404.1 kg/ha, and treatment I (milkfish only) with 280 kg/ha. Differences in combined net production between treatments III and I and between treatments II and I were statistically significant at the 5% level. Average net production of milkfish alone was also highest in treatment III followed by treatment II and treatment I, although differences were not significant. Average net production for prawn was also better in treatment III than in treatment II but the difference was not significant. However, mean weight of prawn was higher in treatment II compared to treatment III. Average survival rates were high for milkfish in all treatments ranging from 90 to 96%, but low for prawn at around 50% for both treatments. There was no significant difference in survival rates of milkfish among treatments and of prawn between treatments II and III. The competition index between milkfish and prawn at the given stocking combinations was negative indicating a positive, advantageous influence of prawn on milkfish production.

Keywords: brackishwater aquaculture; stocking density; polyculture; *Chanos chanos*; *Penaeus monodon*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mindanao State Univ., Sulu Coll. Technol. and Oceanogr., Bongao, Tawitawi, Philippines

314 Eldani, A.A. 1979. Polyculture of milkfish (*Chanos chanos* Forsskal) and prawn (*Penaeus monodon* Fabricius) at different stocking combinations in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 77 p. M.S. thesis.

A study was conducted on the polyculture of milkfish (*Chanos chanos* Forsskal) and prawn (*Penaeus monodon* Fabricius) in nine 500 sq. m. earthen ponds of the SEAFDEC Leganes station, from November 12, 1978 to March 15, 1979. The different stocking combinations tested were: 2,000 milkfish fingerlings per ha (Treatment I); 2,000 milkfish fingerlings plus 4,000 prawn juveniles per ha (Treatment II); and 2,000 milkfish fingerlings plus 8,000 prawn juveniles per ha (Treatment III), with three replicates per treatment.
Results indicated that highest combined net milkfish and prawn production was obtained in Treatment III with 492.1 kg per ha followed by Treatment II with 404.1 kg per ha and then Treatment I (milkfish only) with 280.5 kg per ha. The difference in combined net production between Treatments III and I and between Treatments II and I was statistically significant at the 5% level. Average net production of milkfish alone was also highest in Treatment III followed by Treatment II and then Treatment I, although differences were not significant. For prawn, average net production was also better in Treatment III than Treatment II but the difference was not significant. However, mean weight of prawn was higher in Treatment II compared to Treatment III. The average survival rates of milkfish for all treatments were high ranging from 90 to 96%. In the case of prawn, average survival rates were low at around 50% for both treatments. There was no significant difference in the survival rate of milkfish among treatments. Likewise, there was no significant difference in the survival rate of prawn between Treatments II and III.
The competitive relationship between milkfish and prawn were negative values as indicated by the competition index. The economic analysis indicated that polyculture was better than monoculture in terms of profitability.

Keywords: milkfish polyculture; stocking combinations; brackishwater ponds; milkfish culture; *Chanos chanos*
Location: University of the Philippines in the Visayas, Miag-ao, Iloilo

315 Estudillo, C.B., M.N. Duray and E.T. Marasigan. 1998. Growth and survival of milkfish (*Chanos chanos*), seabass (*Lates calcarifer*) and rabbitfish (*Siganus guttatus*) larvae reared at the same density in different sized tanks. Israeli Journal of Aquaculture 50(1):20-24.

Growth and survival of the larvae of milkfish (*Chanos chanos*), seabass (*Lates calcarifer*) and rabbitfish (*Siganus guttatus*) in 40, 200 and 500 liter rearing tanks were evaluated at day 14. Milkfish larvae survived better (46%) in 500 l than in 200 l (7%) tanks. All larvae died on day 6 in the 40 l tanks. Growth was better in the 200 l tanks than in the 500 l tanks. The survival rate of the seabass larvae was significantly different in the 40 l (47%), 200 l (61%) and 500 l (75%) tanks, but growth was highest in the 40 l tanks. Rabbitfish larvae had the highest survival in 500 l tanks (7%) but the same growth in all tank sizes. The optimum tank size may vary for different fish species. However, small containers are more convenient to use because they require less manpower, are easily manipulated and more cost-effective.

Keywords: fish culture; rearing; stocking density; culture tanks; fish larvae; survival; *Chanos chanos*; *Lates calcarifer*; *Siganus guttatus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

316 Fortes, R.D. 1985. Tarpon as biological control in milkfish-tilapia polyculture. Fisheries Journal. College of Fisheries, University of the Philippines in the Visayas, Miag-ao, Iloilo. 1(1):47-55.

Two experiments were designed to evaluate the efficiency of tarpon (*Megalops cyprinoides*) to control the young of tilapia (*Tilapia mossambica*) in polyculture with milkfish (*Chanos chanos*). One experiment assessed the production of marketable-size milkfish and tilapia and without tarpon.

The other experiment compared fish yields from milkfish-mixed-sex tilapia-tarpon combination with that obtained from milkfish-all-male-tilapia polyculture. Tarpon predation on young tilapia resulted in larger percentages of marketable-size fish (25% adult tilapia, 66% adult milkfish) than when young tilapia were uncontrolled (22% adult tilapia, 37% milkfish). Total fish production from milkfish-mixed-sex tilapia-tarpon polyculture was higher than mixed-sex tilapia-milkfish combination without tarpon by 32.6%; production in the former was also higher than all-male tilapia-milkfish combination by 4%. Milkfish-mixed-sex tilapia combination in the presence of tarpon appeared more desirable than milkfish-all-male tilapia polyculture in terms of milkfish production.

Keywords: polyculture; population control; biological control; *Megalops cyprinoides*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Aquacult. Cent., Univ. Philippines in the Visayas, Leganes, Iloilo, Philippines

317 Gandhi, V., A. Raju, V.S. Rengaswamy, G. Mohanraj and K. Dorairaj. 1988. Further observations on the suitability of the marine fish farm at Mandapam for the culture of milkfish and grey mullets. Indian Journal of Fisheries 35(3): 178-185.

The paper gives an account on the culture of milkfish *Chanos chanos* and the grey mullet *Valamugil seheli* under mono and polyculture systems in the saltwater ponds at Mandapam, Tamil Nadu, India during the period 1982-1983. Ponds of 2,400 m super(2) (two ponds), 450 m super(2) (2 ponds) and 200 m super(2) (3 ponds) were used for conducting the culture experiments. The stocks were fed with a supplementary feed. The growth of fish was better in polyculture experiments. The rate production of *C. chanos* was 354-443 kg/ha with a survival of 73.2-79.9% in monoculture and 422-872 kg/ha with 56.7-70.0% survival in polyculture experiments. *V. seheli* indicated a production of 200-290 kg/ha and 67-89 kg/ha with the survival rates of 22-91% and 13.3-20,7% in mono and polyculture experiments respectively.

Keywords: fish culture; crustacean culture; feeding; survival; pond culture; *Chanos chanos*; *Valamugil seheli*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mandapam Reg. Cent., CMFRI, Mandapam Camp, India

318 Gomez, E.D. 1982. Potential for polyculture of *Gracilaria* with milkfish or crustaceans, p. 91-93. In: Report on the training course on *Gracilaria* Algae. A training subproject under FAO/UNDP project RAS/79/041 implemented trough RAS/74/013, 1-30 April 1981, Manila, Philippines.

Some fish may be reared in seaweed ponds as a management tool in the control of undesirable "weeds". *Gracilaria* pond culture practised in Taiwan is discussed. At an early state in the culture, milkfish may be introduced to control green algae (*Enteromorpha, Chaetomorpha*) which may be pests. Many *Gracilaria* farmers stock *Penaeus monodon* or *Scylla serrata* to obtain additional income. The practices of shrimp culture are also considered to show the different requirements. Despite these differences, limited numbers of shrimps may be stocked in *Gracilaria* ponds as a supplement to the seaweed crop.

Keywords: polyculture; pond culture; pest control; *Gracilaria*; *Chanos chanos*; *Penaeus monodon*; *Scylla serrata*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

319 Grover, J.H., R.D. Recometa and V.A. Dureza. 1976. Production and growth of milkfish, common carp, and catfish in fertilized freshwater ponds. Kalikasan, Philippine Journal of Biology 5(2):193-206.

Production and growth of milkfish (*Chanos chanos*), common carp (*Cyprinus carpio*) and native catfish (*Clarias macrocephalus*) in newly constructed earthen ponds was determined. The ponds received either no fertilization, chicken manure fertilization, inorganic (N,P) fertilization, or a combination of manure and inorganic fertilization. Fertilized ponds gave much higher yields than unfertilized ponds but without any 1 fertilization system being overall superior. On a computed annual basis, the fertilized ponds on the average produced 991 kg/ha milkfish, 716 kg/ha common carp, or 295 kg/ha catfish.

Keywords: growth; biological production; nutrients (mineral); biomass; environmental factors; fish ponds; fertilizers; habitat improvement (fertilization); fish culture; *Chanos chanos*; *Cyprinus carpio*; *Clarias macrocephalus*; *Pisces*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Central Luzon State Univ., Freshwater Aquacult. Cent., Munoz, Nueva Ecija 2320, Philippine Is.

320 Guanzon, N.G., T.R. De Castro-Mallare and F.M. Lorque. 2004. Polyculture of milkfish *Chanos chanos* (Forsskal) and the red seaweed *Gracilariopsis bailinae* (Zhang et Xia) in brackish water earthen ponds. Aquaculture Research 35(5):423-431.

Growth, net production, and survival rates of milkfish cultured with *Gracilariopsis bailinae* at two stocking density combinations (Tsub(1)- 30 fingerlings 100-m super(-2) pond+1-kg G. bailinae 4-m super(-2) net cage, T sub(2)- 30 fingerlings 100-m super(-2) pond+2-kg G. bailinae 4-m super(-2) net cage) in brackish water earthen ponds over four culture periods were determined. The control (T sub(3)) was stocked at 30 fingerlings 100-m super(-2) pond. Specific growth and production rates of G. bailinae were also calculated. There were no significant differences in mean growth, survival, and net production rates of milkfish between the three treatments. Irrespective of stocking singly or in combination with *G. bailinae*, significantly higher mean growth and mean production rates for milkfish were obtained during the third culture period of year 1 than those obtained from the other culture periods. Survival rates were not significantly different among the four culture periods. There were no significant differences in mean specific growth and mean net production rates between the two stocking densities of *G. bailinae*. Significantly higher mean specific growth and mean net production rates of red seaweed were also obtained during the third culture period of year 1 than those obtained from other culture periods. The production of milkfish and red seaweed was higher during the dry season. Growth rates of milkfish was positively correlated with temperature and salinity, while net production rates were positively correlated with temperature and total rainfall, but was inversely correlated with dissolved oxygen. *G. bailinae* growth and net production rates were positively correlated with water temperature and salinity. Results show that milkfish can be polycultured with *G. bailinae* grown in net cages in brackish water ponds at stocking density combination of 30 fingerlings 100-m super(-2) pond+1-kg G. bailinae 4-m super(-2) net cage.

Keywords: polyculture; seaweed culture; fish culture; stocking density; growth rate; brackish water; temperature effects; dry season; salinity effects; survival; rainfall; yield; cage culture; dissolved oxygen; *Gracilariopsis bailinae*; *Rhodophyta*; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA), WorldFish Center HQ Library
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:nicolasguanzon@yahoo.com]

321 James, P.S.B.R. 1996. Technologies and potential for sea farming in India. Part 2. Aquaculture Magazine 22(3):30-43.

Milkfish (*Chanos chanos*) and mullets (*Mugil* spp.) were mostly cultured experimentally in saltwater ponds at Mandapam (southeast coast). Polyculture of *Chanos*, *Valamugil seheli*, *Liza macrolepis* and the white prawn, *Penaeus indicus* gave a production of 1364.40-1864.50 kg/ha. Mixed culture of V. seheli and *Chanos* yielded 1422.2-1600 kg/ha. Monoculture of *V. seheli* or *Chanos* did not yield a production of more than 358.20 kg/ha. At Tuticorin (southeast coast), an estimated production of

499-739 kg/ha/yr of milkfish, mullets and shrimp was obtained in polyculture. *Chanos, L. macrolepis* and the mud crab, *Scylla serrata* gave production of 1644 kg/ha/yr at the same place. In the derelict salt-pans, 857.47 kg/ha of milkfish were harvested in 14 months. Pen culture in a hyper saline lagoon at Mandapam was attempted for *Chanos*.

Keywords: marine aquaculture; fish culture; aquaculture development; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

322 Kuntiyo and D.D. Baliao. 1987. Comparative study between mono and polyculture systems on the production of prawn and milkfish in brackishwater ponds. Network of Aquaculture Centres in Asia, Thailand. 26 p.

The growth, survival, production and economic feasibility of milkfish and prawn singly and in combination are described. Stocking density combination involved 20,000 prawn juvenile/ha with 2000 milkfish fingerlings/ha for polyculture; 20,000 prawn/ha in monoculture; and 2,000 milkfish fingerlings/ha in monoculture. After 109 culture days, result showed no significant difference ($P<0.05$) on growth and survival rates of both commodities in two culture schemes. Mean weight gain was 30.88 g for prawn and 263.33 g for milkfish in monoculture and 31.85 g and 210.75 g for prawn and milkfish respectively, in the polyculture system. Mean survival rates were 94.03% for prawn and 99.0 percent for milkfish in polyculture; and 82.13% for prawn and 92.33% for milkfish for the polyculture system. Net aggregate production, however, was highly significant in polyculture, attaining 923.5 kg/ha/crop. Economic feasibility revealed encouraging results for polyculture over monoculture, with return on investment (ROI) valued at 45% for polyculture.

Keywords: polyculture system; milkfish production; brackishwater pond; milkfish
Location: SEAFDEC Aquaculture Department Library

323 Kusnendar, E. and S. Saimun. 1985. Milkfish and Shrimp culture in ponds. (Budidaya bandeng dan udand di tambak), p. 112-155. In: A Guide to Pond Culture. (Pedoman Budidaya Tambak). Brackishwater Aquaculture Development Center, Jepara, Indonesia.

The culture operation in milkfish consists of the nursery, stunting and grow-out. The management activities such as drying, pesticide application, growing of natural food subsequent stocking are discussed.

Keywords: milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

324 Lee, C.S. 1998. Technical efficiency of the milkfish monoculture and polyculture farming in Taiwan, p. 322. In: Aquaculture '98 Book of Abstracts. Aquaculture '98 Conference, 15-19 February 1998, Las Vegas, Nevada, USA.

Milkfish in Taiwan has been maintained for about three hundred years. It always has played a significant role in the aquaculture development. The ratio of milkfish cultivated area to the total aquaculture area is always on the top three in aquaculture production, even though the cultivated areas decreased from 16,802 hectares in 1975 to 10,421 hectares in 1995. There are two major types of milkfish production, namely: monoculture and polyculture cultivation. Two important factors which making a great influence to the production of milkfish are the man-made factors such as the ability of operator, and the natural factors such as weather. This paper aims to estimate the technical efficiency of milkfish monoculture and polyculture cultivation, and to identify the factors affecting the variation of technical efficiency of the milkfish farming in Taiwan. Stochastic production frontier model was specified and estimated by using data from a recent field survey with different types and sizes of cultivation. Empirical results indicate the size of farms and types of rearing were the primary source of the technical efficiency in milkfish production. The large farms (over 3 hectares) and polyculture rearing farms have a higher rates of technical efficiency in production. With regards to the factors determining the variation of technical efficiency in milkfish farms, the results show that

working experience, stocking rate and size of cultivated area were found to be the most significant determinant in milkfish monoculture farming. Age, working experience and professional characteristics of operator were quite significant in milkfish polyculture farming.

Keywords: fish culture; monoculture; polyculture; aquaculture techniques; rearing; efficiency; stochastic processes; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Agricultural Economics, National Chung Hsing University, 250 Kuo-kuang Road, Taichung, Taiwan

325 Lijauco, M.M., O.Q. Prospero and E.M. Rodriguez. 1980. Polyculture of milkfish (*Chanos chanos*) and mud crab (*Scylla serrata*) at two stocking densities. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(4):19-23.

Mud crabs (*Scylla serrata*) were cultured singly and in combination with milkfish (*Chanos chanos*) to compare growth, survival and production rates. Net production of crab was higher in polyculture than monoculture, but the reverse was observed for milkfish.

Keywords: polyculture; stocking density; fish culture; crab culture; *Chanos chanos*; *Scylla serrata*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

326 Marichamy, R. and S. Rajapackiam. 1982. The culture of milkfish, mullet and prawn in an experimental marine fish farm at Tuticorin, p. 256-265. In: Proceedings of the symposium on Coastal Aquaculture, held at Cochin from 12-18 January 1980. Part 1: Prawn Culture. Marine Biological Association of India, Cochin, India.

Preliminary experiments were carried out in fish farm of saltpan reservoir for polyculture of *Chanos chanos*, *Mugil cephalus* and *Penaeus indicus*. The seeds were collected from nearby estuarine areas and stocked at different intensities. The important problem facing the experiment was the prevalence of competitors and the maintenance of quality of water. Of the three varieties cultured, mullet appeared to grow well with better survival rate resulting in an increased rate of production. Marketable size at 31 cm was attained in a period of 9 months. A marked difference in the rate of growth and production of the species under culture was well noticed in three sets of experiments carried out during 1977-1979. The estimated rate of production in polyculture increased from 499 kg to 731 kg/ha/year in the present status.

Keywords: polyculture; aquaculture systems; shrimp culture; fish culture; *Penaeus indicus*; *Chanos chanos*; *Mugil cephalus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Mar. Fish. Res. Inst., Cochin 682 018, India

327 Mesa, R.C. 1986. Growth and survival of milkfish (*Chanos chanos*, Forsskal) fry in combination with prawn (*Penaeus monodon*, Fabricius) fry at varying stocking ratio in brackishwater nursery pond. University of the Philippines in the Visayas, Miag-ao, Iloilo. 50 p. M.S. thesis.

Growth and survival of milkfish fry stocked singly or in combination with prawn (*Penaeus monodon,* Fabricius) fry at varying stocking ratios were studied using twelve 144 sq. m. earthen nursery ponds at SEAFDEC Leganes Research Station, Leganes, Iloilo. Four treatments namely Treatment I (all milkfish), Treatment II (2:1) milkfish to prawn, Treatment III (3:1) and Treatment IV (5:1) were tested in a Completely Randomized Design with three replicates.
Highest growth of milkfish fry, measured in terms of mean gain in weight was obtained in Treatment II with mean gain in weight of 2.63 g after 45 days of culture, followed by Treatment III with mean gain in weight of 2.00 g. Treatment IV gave lower gain in weight of 1.81 than Treatment I, 1.85 g. Similarly, highest percent survival of 89.5% was obtained in Treatment II. Treatments IV, III and I gave almost the same survival of 85.9, 85.8 and 85.2% respectively.

On the other hand, mean gain in weight of *P. monodon* fry was highest in Treatment III with a value of 1.13 g followed by Treatment IV, 1.05 g. Treatment II gave the lowest mean gain in weight of 0.96 g. Statistical analysis, however, showed no significant differences in growth and percent survival among treatments.
Physico-chemical parameters of the pond soil and water measured in all treatments during the 45 days culture period were within the critical values for milkfish and prawn fry culture. Gross community productivity for all treatments had the same trend and were not significantly different.
Based on the results of this study the economic analysis showed that Treatment II (2:1 ratio of milkfish to prawn) is the most profitable stocking ratio. This treatment gave a net profit of P3,585.10 with a cost-benefit ratio of 1.76.

Keywords: growth; survival; prawn; stocking ratio; brackishwater pond
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

328 Nammalwar, P. and M. Kathirvel. 1988. Preliminary experiments on monoculture of *Chanos chanos* (Forsskal) and its polyculture with *Penaeus monodon* Fabricius. Indian Journal of Fisheries 35(3):197-204.

Preliminary experiments on monoculture of milkfish, *Chanos chanos* and its polyculture with tiger prawn, *Penaeus monodon* were carried out in the grow-out pond system at mariculture farm, Muttukadu near Madras, India. During the six-month rearing, *C. chanos* attained an average size of 234.6 mm (76.9 g) in the monoculture trial and 159.8 to 231.8 mm (39.0 to 90.9 g) in the polyculture experiments. In the case of tiger prawn, the growth was poor and the sizes recorded at harvest were 119.4 to 135.1 mm (12.8 to 17.8 g). The rate of recovery ranged from 8.4 to 87.0% for fish and 20.6 to 35.3% for prawn. The reasons for poor growth and survival of fish and prawn in relation to environmental and other factors are discussed.

Keywords: marine fish; marine crustaceans; experimental culture; monoculture; polyculture; *Chanos chanos*; *Penaeus monodon*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, Cochin, India

329 Popper, D., T. Lichatowich, R.T. Pine and N. Gundermann. 1975. Preliminary experiments in mixed culture of milkfish, tilapia and carnivorous fish, p. 16-19. In: SPC Fisheries Newsletter 13.

One pond of 5 acres was stocked with 2,000 *Tilapia mossambica* (Peters) and 3,500 *Chanos chanos* (Forsskal). Only organic fertilizers were applied. During the 1st month 150 *Elops hawaiensis* and 50 *Megalops cyprinoides* were introduced. After 165 days 880 kg of marketable fish were harvested.

Keywords: fish culture; stocking density; stocking (organisms); biological production; growing ponds; growth rate; freshwater aquaculture; *Tilapia mossambica*; *Chanos chanos*; *Elops hawaiiensis*; *Megalops cyprinoides*; Fiji, Viti Levu, Ravi Ravi
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: c/o FAO, Via delle Terme di Caracalla, 00100 Rome, Italy

330 Primavera, J.H. and A. Eldani. 1981. Effect of different stocking combinations on growth, production and survival of milkfish (*Chanos chanos* Forsskal) and prawn (*Penaeus monodon* Fabricius) in polyculture in brackishwater ponds. Aquaculture 23(1-4):59-72.

Milkfish (*Chanos chanos*) and prawn (*Penaeus monodon*) were stocked in 500 m super(2) earthen ponds from 13 November 1978 to 15 March 1979 at the following combinations: 2000 milkfish fingerlings per ha (treatment I); 2000 milkfish fingerlings plus 4000 prawn juveniles per ha (treatment II); and 2000 milkfish fingerlings plus 8000 prawn juveniles per ha (treatment III), with three replicates per treatment. Highest combined net milkfish and prawn production was obtained in treatment III with 492.1 kg/ha followed by treatment II with 404.1 kg/ha, and treatment I (milkfish

only) with 280 kg/ha. Differences in combined net production between treatments III and I and between treatments II and I were statistically significant at the 5% level. Average net production of milkfish alone was also highest in treatment III followed by treatment II and treatment I, although differences were not significant.

Keywords: fish culture; crustacean culture; growth; survival; polyculture; *Chanos chanos*; *Penaeus monodon*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquaculture Dept., Southeast Asian Fish. Dev. Ctr., P.O. Box 256, Iloilo City, Philippines

331 Pudadera, B., Jr. and C. Lim. 1980. Evaluation of milkfish (*Chanos chanos* Forsskal) and prawn (*Penaeus monodon* Fabricius) in polyculture systems. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(3):1-6.

The growth, survival and profitability of *C. chanos* and *P. monodon* grown in 5 different combinations for 100 days in 500m super(2) brackish water ponds were assessed. Differences in the growth and production of prawns cultured singly or in combination with milkfish at increasing stocking density strongly suggests that the presence of milkfish exerts some negative effect on prawn. However, growth production and competition index data suggest that the presence of prawn do not significantly affect milkfish. While the maximum production of prawn can be attained in monoculture, its polyculture with 2000 milkfish/ha is also economically feasible.

Keywords: polyculture; aquaculture economics; *Chanos chanos*; *Penaeus monodon*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

332 Ranoemihardjo, B.S. and E. Kusnendar. 1980. The effect of stocking density on the rate of the growth of tiger shrimp (*Penaeus monodon*, Fabricius) and milkfish (*Chanos chanos*, Forsskal). Bulletin of the Brackishwater Aquaculture Development Center 6(1-2):454-461.

Polyculture of tiger shrimp (*Penaeus monodon* Fabricius) and milkfish (*Chanos chanos* Forsskal) was studied in wooden boxes (1.0 x 1.0 x 0.4 m). Each box contained fertilized pond soil. Box A was stocked with 30 shrimp juveniles; box B, 25 shrimp and 5 milkfish fingerlings; box C, 20 shrimp and 10 milkfish; box D, 15 shrimp and 15 milkfish; box E, 30 milkfish only. The stock were reared in their respective boxes for 60 days. Depth of water in the boxes was 20 cm (volume of water was 0.2 m super(3)).

Keywords: stocking density; growth; crustacean culture; fish culture; polyculture; *Penaeus monodon*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Aquacult. Dev. Cent., Jepara, Indonesia

333 Ranoemihardjo, B.S., A. Kahar and J.V. Lopez. 1979. Results of polyculture of milkfish and shrimp at the Karanganyar provincial demonstration ponds. Bulletin of Brackishwatater Aquaculture Development Center 5(1-2):334-350.

Polyculture of *Chanos chanos* and *Penaeus monodon* in brackishwater ponds is a promising venture. Remarkable growth of these compatible species was noted over the rearing period of 4 months during which a total of 506 kg of milkfish (359.39 kg) and shrimp (146.64 kg) was produced in a 0.8 hectare pond compartment or 1.265 kg/ha/yr of milkfish (898.48 kg) and shrimp (366.6 kg). Activities and results relative to the rearing of these cultivable, compatible and economic species are briefly discussed in this paper.

Keywords: brackishwater aquaculture; polyculture; *Chanos chanos*; *Penaeus monodon*; ISEW, Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Culture Technique Div., Brackishwater Aquacult. Dev. Cent., Jepara, Indonesia

334 Tabbu, M.Y. 1981. Polyculture of milkfish. (*Chanos chanos* Forsskal) with green mussel (*Perna viridis* Linnaeus) in brackishwater ponds. University of the Philippines, 52 p. M.S. thesis.

A preliminary study was conducted to find out the feasibility of culturing green mussel with milkfish in brackishwater ponds. The treatments were: a) monoculture of milkfish at 3000 fingerlings per ha b) polyculture of milkfish and mussels at 3000 fingerlings/ha and 680,000 mussel spat/ha. Culture was by plankton method (60 cm water depth) for milkfish and horizontal hanging for the mussels. A significant difference in the mean body weight of milkfish between the two treatments was obtained. The monoculture yielded a mean total milkfish production of 332.13 kg/ha, while in polyculture, 310.45 kg/ha of milkfish production was harvested. In one polyculture pond, a recovery of 52.1% was obtained from the mussels for a total harvest of 110 kg. The mussel condition index was 38.87% which is a little below the marketing level of above 40%. Based on the final harvest of milkfish, the total yield was found to be lowest where the recovery of the mussel was highest. This could be a result of insufficient food supply. A relation between the gross photosynthesis measured by the openwater method and milkfish yield was observed in both treatments. The linear correlation was significantly higher in indication that mussels could be grown together with milkfish in brackishwater ponds. It was noted that for milkfish-mussel polyculture to be successful, proper water exchange and circulation should be observed through tidal flushing and with the use if necessary of water pump.

Keywords: milkfish polyculture; green mussel; milkfish
Location: SEAFDEC Aquaculture Department Library

335 Thampy, D.M., S. Jose, M.V. Mohan and M.S.S.I. Koya. 1988. Short-term biculture of tiger prawn *Penaeus monodon* Fabricius and milkfish *Chanos chanos* Forsskal in a low saline pond, p. 139-141. In: M. Mohan Joseph (ed.). The First Indian Fisheries Forum, Proceedings, 4-8 December 1987, Mangalore, Karnataka.

A short-term bi-culture experiment on tiger prawn *Penaeus monodon* with milkfish *Chanos chanos* demonstrated potential of their bi-culture in utilization of brackishwater areas during low saline periods. The pond (size 440 m super(2)) prepared after liming (500 kg/ha) and manured was stocked with nursery reared prawn and fish at a stocking density of 21,000/ha at a ratio of 20:1. Stocking size of prawn was 45 mm (2.4 g) and fish 80 mm (5 g). They were fed with compounded feed from 30th day after stocking onwards. At harvest (72 days after stocking) *P. monodon*) had a size of 134.27 mm and 30 g and *C. chanos* 308.5 mm and 217 g. The high survival rates of *P. monodon* (91.25%) and *Chanos* (95.45%) demonstrated the compatibility. The extrapolated total production was 812.045 kg/ha for 72 days, of which the contribution of *P. monodon* was 488.63 kg/ha/72 days, this being the highest so far recorded for a short-term culture.

Keywords: shrimp culture; polyculture; fish culture; aquaculture systems; pond culture; *Penaeus monodon*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Coll. Fish., Kerala Agric. Univ., Panangad, Cochin - 682 506, Kerala, India

336 Villegas, C.T. and D.D. Baliao. 1980. Polyculture of milkfish (*Chanos chanos*) and tiger prawn (*Penaeus monodon* Fab.) with and without supplemental feeding. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 4(3):12-14.

Twelve 1,000 m super(2) earthen ponds were used to compare the growth rates, survival and production of milkfish (*Chanos chanos*)) and prawn (*Penaeus monodon*) in monoculture and polyculture systems in shallow brackishwater ponds and without supplemental feeding. The low production and survival rates obtained were attributed to the lack of natural food; the high salinity during the first month of culture could be one of the causes of the high mortality of prawn observed in both mono and polyculture systems. Although the results of the trial were not encouraging, it is

possible that high yields may be obtained from the combination of the 2 species given enough natural food and favourable water conditions.

Keywords: polyculture; artificial feeding; *Chanos chanos*; *Penaeus monodon*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

337 Wanninayake, W.M.T.B., H.K.M.A. Kumarasinghe and U. Edirisinghe. 2001. Experimental studies on polyculture of tiger shrimp *Penaeus monodon* with milkfish *Chanos chanos* in Sri Lanka, p. 264. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Experimental studies on polyculture of shrimp (*Penaeus monodon*) with milkfish (*Chanos chanos*) were carried out at the Regional Aquatic Resource Centre of the Northwestern province (NWP) of Sri Lanka. The main purpose of this study was to determine the suitability of such culture systems to utilize the brackish water environments. Although, shrimp culture as a monoculture system is being practiced over a total area of 3,500 ha. in NWP, there is potential for it to be practiced as a polyculture by combining with milkfish, to achieve the target benefits of the culture system. In addition, it will be an alternative for small-scale farmers to minimize the risk of shrimp culture due to widespread of disease outbreaks. The experiment was carried out in cages (10 x 5m) which were floated on a brackish water pond. These pond system was connected to the Chilaw Lagoon by an underground pipeline. Control treatments in triplicate were the monoculture cages having *P. monodon* and *C. chanos* at the stocking density of 25 PLS/m super(2) and 8 fingerlings/m super(2) respectively. In other three cages, polyculture was practiced with the same density. A formulated feed was given only for shrimps in both type of cages to fulfil the nutrient requirement, while milkfish were allowed to grow on phytoplankton (mainly lablab). Ponds were fertilized with urea at weekly intervals and culture system continued 80 days. Daily fluctuations of temperature, pH and DO were measured at 7:00 am and 3:00 pm. Salinity, total Ammonia and Nitrite were also measured. Weight of milkfish and shrimp were taken for randomly selected samples at weekly intervals. Mean average body weight of shrimp in poly and monoculture systems were 32.3 g and 20.2 g while in milkfish it was measured as 113.1 g and 80.2 g respectively. Results showed that the significant difference ($P<0.05$) in the growth of both shrimp and milkfish grown in the polyculture and monoculture system. Results indicated that the polyculture of *P. monodon* and *C. chanos* could be successfully carried out in Sri Lanka under existing environmental conditions.

Keywords: brackishwater aquaculture; shrimp culture; fish culture; cage culture; pond culture; polyculture; *Chanos chanos*; *Penaeus monodon*; ISW, Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo - 15, Sri Lanka, [mailto:wanninayake@hotmail.com]

338 Yamashita, M. and Sutardjo. 1977. Shrimp and milkfish culture in the World Bank IDA credit area, Indonesia. In: First ASEAN Meeting of Experts on Aquaculture. Semarang, Indonesia, 31 January to 6 February 1977. Technical Report. 1. Proceedings of technical sessions. 2. Working papers.

The IDA credit for small-scale brackishwater pond culture was started in the 1974-1975 fiscal year, covering a total area of 15,000 ha and located in 4 provinces: West, Central and East Java and South Sulawesi. This paper deals with culturing operation data from 13 fish farmers (12 located in Pagkep, South Sulawesi, and 1 in East Java) whose ponds were stocked with milkfish (*Chanos chanos*) (monoculture) or milkfish and shrimp (polyculture). Much information is presented in tabular form.

Keywords: aquaculture; financing; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: IDA Brackishwater Pond Culture Credit Project, Directorate Gen. Fish., Jakarta, Indonesia

Cross-referenced:

Anon. 1999. Promoting appropriate aquaculture technology for more fish in Southeast Asia-a report. SEAFDEC - Aquaculture Department, Tigbauan, Iloilo City, Philippines. 24 p.
(See abstract, keywords, location and author's affiliation in entry no. 198)

Chen, T. P. 1976. Culture of milkfish (*Chanos chanos*) as a means of increasing animal protein supply. Journal of the Fisheries Research Board of Canada 33 (4/II):917-919.
(See abstract, keywords, location and author's affiliation in entry no. 617)

Mmochi, A.J., A.M. Dubi, F.A. Mamboya and A.W. Mwandya. 2002. Effects of fish culture on water quality of an integrated mariculture pond system. Western Indian Ocean Journal of Marine Science 1(1):53-63.
(See abstract, keywords, location and author's affiliation in entry no. 691)

Morissens, P. (n.d.) The dynamics of aquaculture in the Philippines: Intensification and extensification in the milkfish and tilapia production sector. http://www.ag.arizona.edu.
(See abstract, keywords, location and author's affiliation in entry no. 640)

Muroga, K., G.D. Lio-Po, C. Pitogo and R. Imada. 1984. *Vibrio sp.* isolated from milkfish (*Chanos chanos*) with opaque eyes. Fish Pathology 19(2):81-87.
(See abstract, keywords, location and author's affiliation in entry no. 371)

Rice, M.A. 1998. Aquaculture in Dagupan City, Philippines: 20 Years of change. Journal of Shellfish Research 17(1):361-362.
(See abstract, keywords, location and author's affiliation in entry no. 643)

Thayaparan, K. and R.D. Chakrabarty. 1984. Milkfish aquaculture in Sri Lanka, p. 161-169. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 184)

Thomforde, H. 1987. Effects of chicken manure and supplementary feed on production of milkfish and red tilapia in polyculture in brackishwater earthen ponds at different stocking densities. University of the Philippines in the Visayas, Miag-ao, Iloilo. 64 p. M.S. thesis.
(See abstract, keywords, location and author's affiliation in entry no. 497)

HEALTH AND NUTRITION

PEST AND DISEASES

339 Almendras, J.M.E. 1987. Acute nitrite toxicity and methemoglobinemia in juvenile milkfish (*Chanos chanos* Forsskal). Aquaculture 61(1):33-40.

Nitrite was approximately equals 55 times more toxic to milkfish juveniles in fresh water than in 16 ppt brackish water: the 48-h median lethal concentrations were 12 mg NO sub(2)-N/l (95% confidence limit = 7.4-19.6) and 675 mg NO sub(2)-N/l (95% confidence limit = 435.8-1,045.5) respectively. Methemoglobin levels were higher for a given concentration of nitrite in milkfish kept

in fresh water than in the brackish water. Methemoglobin decreased to a normal level within 24-26 hours of the removal of nitrite.

Keywords: fish culture; excretory products; toxicity; nitrites; juveniles; lethal limits; fresh water; brackish water; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

340 Amparado, E.A., A.A. Herrera and M.D. Santos. 1995. Field studies on the effect of toxicants on the bangus (*Chanos chanos*). Third National Symposium in Marine Science of the Philippine Association of Marine Science, 23-24 May 1994, Iloilo, Philippines.

Field studies were conducted at selected fishpond sites located in the vicinity of the Navotas-Malabon-Tullahan-Tenejeros river systems. The study focuses on the effect of two metals, particularly Cu and Zn, on the liver, gills, and kidney cells of the bangus. The study includes toxicity tests, histopathological analysis using light and electron microscopy, tissue bioaccumulation, water quality testing and determination of physico-chemical factors. Using Atomic Absorption Spectrophotometry, heavy metal content of water from the three stations were determined to be <0.005 Cu and <0.02 Zn for station I, <0.005 Cu and <0.02 Zn for station II and <0.005 Cu and <0.02 Zn for station III. Tissue analysis revealed that copper and zinc were present in the liver, kidney and gills with the liver having the highest concentration (>1018 mg/kg).

Keywords: toxicants; toxicity; freshwater fish; heavy metals; bioaccumulation; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Biol., Univ. Philippines, 1101 Diliman, Quezon City, Philippines

341 Anon. 1978. How to prevent bangus kills. Republic News, 1 p.

The article reports on the probable cause of bangus kills in fishponds. A recommendation on how to prevent the occurrence of this problem is given.

Keywords: bangus kills; milkfish kills; milkfish
Location: SEAFDEC Aquaculture Department Library

342 Azanza, R.V. 2005. *Prorocentrum minimum* bloom and its possible link to a massive fish kill in Bolinao, Pangasinan, Northern Philippines. Harmful Algae 4(3):519-524.

For the first time, a *Prorocentrum minimum* bloom at a maximum cell density of 4.7×10^5 cells/L was recorded on January 31 to February 4, 2002 at Bolinao, Pangasinan, Northern Philippines where intensive and extensive aquaculture of *Chanos chanos* (milkfish) in fish pens and cages has been practiced for years now. The fish kill, which lasted almost simultaneously with the bloom of the organism had its peak when the organisms bloom was declining. Lack of oxygen in the cages and pens was the fundamental cause of the fish kill. Losses due to the fish kill were estimated at six million pesos (equivalent to US$ 120,000), which includes only the worth of dead cultivated fish. Lack of oxygen in the cages and pens was the fundamental cause of the fish kill, and toxicity of the *Prorocentrum* could not be confirmed. The cells had minute spinules equally all over the surface of valves. Intercalary striae were wide with many ridges perpendicular to valve margin. Outline of cells was rounder than typical *P. minimum* cells and similar to *P. balticum*. Recommendations for future research on the organism are incorporated together with monitoring and management interventions in order to mitigate or possibly prevent damages in similar future events.

Keywords: anoxia; Bolinao; Northern Philippines; fish kill; harmful algal bloom; hypoxia
Location: http://www.sciencedirect.com

343 Bagarinao, T. 2001. Biology and management of the snail, a pest in milkfish ponds, p. 14. In: Asian Fisheries Forum (6th: 2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Pesticide use in agriculture and aquaculture is a major source of pollution of coastal waters and a major cause of concern for long-term human health and environmental integrity. The triphenyltin (TPT) pesticides Aquatin and Brestan have been used since the 1970s against the snail *Cerithidea cingulata,* long considered a pest in brackishwater ponds in the Philippines because they compete with milkfish for food and growing space. TPT is also toxic to other invertebrates, fishes, algae, bacteria, and people, and high TPT residues occur in sea foods including milkfish. Thus, control of snails in milkfish ponds should be shifted from reliance on TPT to an integrated pest management (IPM) strategy. To formulate a responsible IPM, studies were conducted on *C. cingulata* in ponds and mangroves and the available data were synthesized with the relevant information from the literature. The deposit-feeding *C. cingulata* is a native resident of mangrove areas and becomes a problem in mangrove-derived ponds where the lack of competitors and predators results in 'ecological release' and population explosion. Snail densities range 1-470 m super(-2) in the mangroves and 100-5000 m super(-2) in ponds. All stages of the snail life cycle are found in ponds: eggs strings laid on the sediment and algal mat, veligers in the water column, and juveniles and adults 2-40 mm in shell length. Snails 25 mm long and 8 mm wide weigh 1 9 on average, with 150 mg flesh. Snails mature at 20 mm long and reproduce the whole year with a peak in Mar-Sep at water temperatures of 24-36 degree C. Enriched sediments and stagnant water in ponds allow fast growth and reproduction, low dispersal, and high recruitment of snails. Snails tolerate hypoxia and adverse conditions, but are killed within a week by sun-drying or by salinities of 48-70ppt and within 3 days by ammonium phosphate at 10 9 I super(-1) or by urea at 5 91 super(-1). IPM is the appropriate and environment-friendly solution to pest problems, but it is not readily accepted by farmers. IPM of snails requires changes in farmer mindsets and farm practices and management. Fish farmers must think green and produce organic, and they must internalize the lesson that use of pesticides in the long run hurts consumers and damages the farm environment. Given the worldwide trend towards organic products, green productivity, and eco labeling, the milkfish industry should stop using pesticides now, make the entire production process clean and efficient, and market milkfish as a health food and a certified 'green' product. The pond snails must be viewed as a resource, a pond product from which some income can be made. In some ponds, the weight of snails may equal the weight of the fish harvested over the year. For example, at an average adult size of 25 mm and 1 9 and a density of 1000 m super(-2), the standing biomass of *C. cingulata* in ponds could be 10 mt ha super(-1) (or 1.5 mt of snail flesh), on top of the milkfish crop and without any added input. Harvest of snails for shell craft, lime-making, and other enterprises effectively removes the spawning population. Complete draining and sun-drying of ponds after harvest kills the adult snails and the egg strings on the bottom. Sundrying used to be a common practice, but farmers now want more crops in one year, reduce or skip the sun-drying phase, use feeds, and have more snails. Ponds that could not be completely drained retain snails in puddles - these snails may be killed by the usual nitrogen fertilizers and lime applied during pond preparation. Water input may be timed with periods of low veliger counts in the supply water. Where available and cost-effective, botanical molluscicides may be used – an equivalent nicotine concentration of about 24 kg ha super(-1) kills nearly all snails after 3 days, but not juvenile milkfish after 7 days. Compatible fishes and crabs may be stocked with milkfish to eat the snails, egg strings, or veligers, then harvested for additional income. These IPM recommendations must be verified at research stations and private milkfish farms since human health and safety are at stake.

Keywords: biology; management; ponds; pest management; milkfish; snail
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

344 Bagarinao, T. and I. Lantin-Olaguer. 1998. The sulfide tolerance of milkfish and tilapia in relation to fish kills in farms and natural waters in the Philippines. Hydrobiologia 382(1-3):137-150.

Fish kills of milkfish *Chanos chanos* and tilapia *Oreochromis spp.* now occur frequently in brackish, marine, and freshwater farms (ponds, pens, and cages) in the Philippines. Aquafarms with high organic load, limited water exchange and circulation, no aeration, and high stocking and feeding rates can become oxygen-depleted and allow sulfide from the sediments to appear in the water column and poison free-swimming fish. The sulfide tolerance of 2-5 g milkfish and 5-8 g *O. mossambicus* was determined in 25-liter aquaria with flow-through sea water (100 ml min super(-1)) at 26-30 degree C and sulfide stock solutions pumped in at 1ml min super(-1). Total sulfide concentrations in the aquaria were measured by the methylene blue method and used in the regression against the probits of % survival. Four experiments showed that the two species have similar sulfide tolerance. In sea water of pH 8-8.5, about 163 plus or minus 68 mu M or 5.2 plus or minus 2.2 mg l super(-1) total sulfide (mean plus or minus 2 se) or 10 mu M or 313 mu g l super(-1) H sub(2)S was lethal to 50% of the fish in 4-8 hours, and 61 plus or minus 3 mu M total sulfide or 4 mu M H sub(2)S in 24-96 hours (to convert all sulfide concentrations: 1 mu M = 32 mu g l super(-1)).

Keywords: fish kill; pond culture; fish culture; water quality; sulphur; sulphides; agricultural runoff; pollution surveys; pollution tolerance; fish physiology; aquaculture; fisheries; sulfides; oxygen depletion; poisoning; toxicity testing; Philippines; *Chanos chanos*; *Oreochromis mossambicus*; *Oreochromis*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department, 5021 Tigbauan, Iloilo, Philippines

345 Bagarinao, T. and I. Lantin-Olaguer. 2000. From triphenyltins to integrated management of the 'pest' snail *Cerithidea cingulata* in mangrove-derived milkfish ponds in the Philippines. Hydrobiologia 437(1-3):1-16.

The potamidid snail *Cerithidea cingulata* is considered a pest in brackishwater milkfish ponds in the Philippines and has been controlled by the triphenyltin (TPT) compounds Aquatin and Brestan. But TPT is also toxic to other invertebrates, fishes, algae, bacteria and people, and high TPT residues occur in sea foods including milkfish. Thus, control of snails in milkfish ponds should be shifted from reliance on TPT to an integrated pest management (IPM) strategy. To formulate a responsible IPM, studies were conducted on *C. cingulata* in ponds and mangroves and the available data were synthesized with the relevant information from the literature. The deposit-feeding *C. cingulata* is a native resident of mangrove areas and becomes a problem in mangrove-derived ponds where the lack of competitors and predators results in 'ecological release' and population explosion. Snail densities ranged 1-470 m super(-2) in the mangroves and 100-5000 m super(-2) in ponds. In ponds, snails ranged 2-40 mm in shell length; those 25 mm long and 8 mm wide weighed 1 g on average, and had 150 mg flesh. Snails matured at 20 mm long and reproduced the whole year with a peak in Mar-Sep at water temperatures of 24-36 degree C. Enriched sediments and stagnant water in ponds allowed fast growth and reproduction, low dispersal and high recruitment of snails. Snails were very tolerant to hypoxia and adverse conditions, but were killed within a week by sun-drying or by salinities of 48-70ppt and within 3 d by ammonium phosphate at 10 g l super(-1) or urea at 5 g l super(-1). IPM of snails requires changes in mindsets and perspectives of milkfish farmers and industry supporters and changes in farm practices and management. Snails must be viewed as a resource from which income can be made and employment can be generated. Harvest of snails for shellcraft and other enterprises also effectively removes the spawning population. Complete draining and sun-drying of ponds after harvest kills the adult snails and the egg strings on the bottom. Snails in puddles in the ponds may be killed by the usual nitrogen fertilizers and lime applied during pond preparation. Water input may be timed with periods of low veliger counts in the supply water. These IPM recommendations have yet to be verified.

Keywords: chemical control; ponds; pests; toxins; management; Philippines; *Molluscicides*; pest control; water pollution; pollution effects; pollutant persistence; bioaccumulation; mangrove swamps; aquaculture facilities; Tin compounds; *Cerithidea cingulata*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:dorisb@aqd.seafdec.org.ph]

346 Chen, C.Y. and H.N. Chou. 2001. Paralytic shellfish poisoning toxins accumulation in purple clam *Hiatula rostrata* and toxic effect on milkfish *Chanos chanos* larval fish. Journal of Natural Toxins 10(4):299-305.

In an attempt to feed purple clams (*Hiatula rostrata*) with dinoflagellate *Alexandrium minutum*, the maximal accumulation toxicity of paralytic shellfish poisoning (PSP) toxins reached 40.6 MU/g on day 5 of feeding. Subsequently, the toxicity increased no further, although purple clams ingested more toxic algae. Furthermore, when milkfish (*Chanos chanos*) larvae were treated with toxic, nontoxic *A. minutum* or PSP toxin-containing extract in the water medium, it was found that the mortality of fish increased with the increasing concentrations of toxic algae. PSP toxin-containing extract did not show any toxic effect on milkfish larvae.

Keywords: mortality; algae; toxins; dinoflagellates; paralytic shellfish poisoning; biological poisons; bioaccumulation; toxicity tests; red tides; *Hiatula rostrata*; *Chanos chanos*; *Alexandrium minutum*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Science and Technology Information Center, National Science Council, 15F, No. 106, Hoping E. Rd., Sec. 2, Taipei, Taiwan (106-36), Republic of China

347 Chen, M.M. 1990. Characteristics of a birnavirus isolated from *Chanos chanos*. COA Fisheries Series (24):46-59.

This study attempts to investigate the characteristics and pathogenicity of milkfish virus (designated as MV) isolated from cultured milkfish (*Chanos chanos*). When MV was inoculated into CCT (color carp testis) cell culture system and observed using electron microscope, inclusion bodies and non-enveloped icosahedral free virions with a diameter of 55-65 nm were observed. MV was demonstrated to be stable in neutral and acidic solution, as well as in organic solvents. Metabolic inhibitor studies show that this virus possesses RNA as their genetic materials. The results obtained from nucleic acid electrophoresis, neutralization, and immunoblotting tests revealed that MV is Ab strain of Infectious Pancreatic Necrosis virus (INPV).

Keywords: fish diseases; viral diseases; pathology; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

348 Chen, S.N. and G.H. Kou. 1987. Results of field test on vaccination trials against vibriosis of milkfish (*Chanos chanos*) and edwardsiellosis of eel (*Anguilla japonica*). The Memoir of Bacteriology and Immunology in Fish Diseases 1:238-242.

The results of field tests showed that significant protection against vibriosis in milkfish (*Chanos chanos*) and edwardsiellosis in Japanese eel (*Anguilla japonica*) vaccinated by single immersion of formalin-killed bacterin was obtained. A better protection was obtained in milkfish after vaccine administration. The duration of protective immunity could last for approximately equals 4-5 mo in experimental milkfish and eels.

Keywords: bacterial diseases; disease control; bacterins; vaccination; vibriosis; fish culture; *Vibrio anguillarum*; *Chanos chanos*; *Anguilla japonica*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Natl. Taiwan Univ., Taipei, Taiwan

349 Chou, H.N., Y.C. Chung, W.C. Cho and C.Y. Chen. 2003. Evidence of paralytic shellfish poisoning toxin in milkfish in South Taiwan. Food Additives and Contaminants 20(6):560-572.

Natural phytoplankton blooms of the dinoflagellate *Alexandrium minutum*, milkfish (*Chanos chanos*) exposed to natural blooms, sediment and mangrove crab (*Scylla serrata*) were analysed for

paralytic shellfish poisoning toxins by high-performance liquid chromatography. The toxin profiles of milkfish and mangrove crab were similar to that of *A. minutum* collected from blooming fishponds. In a laboratory *A. minutum*-blooming environment, the stomach and intestine of milkfish accumulated paralytic shellfish poisoning toxins during the exposure period. The non-visceral tissues were non-toxic. However, milkfish lost their entire body burden of toxin on the first day of transferring to a toxic algae-free environment. The result shows that milkfish concentrate paralytic shellfish poisoning toxins in digestive organs and did not retain toxins.

Keywords: poisoning; milkfish; *Chanos chanos*
Location: http://www.ncbi.nlm.nih.gov
Author Affiliation: Institute of Fisheries Science, National Taiwan University, Taipei, Taiwan 106, ROC.

350 Cruz, E.R. 1981. Acute toxicity of un-ionized ammonia to milkfish (*Chanos chanos*) fingerlings. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 5(4):16-18.

The acute toxicity of un-ionized ammonia to milkfish (*Chanos chanos*) fingerlings was determined using a static bioassay system. Median lethal concentrations found show that milkfish fingerlings have a high tolerance to ammonia and it is unlikely that levels as high as those employed for the acute exposure would be found to occur under natural conditions. Although the threat of acute toxicological effects induced by ammonia are remote, such conditions might be encountered in stressed natural environments or in heavily loaded aquaculture systems.

Keywords: toxicity tests; bioassays; ammonia; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

351 Cruz, E.R. and C.T. Tamse. 1989. Acute toxicity of potassium permanganate to milkfish fingerlings, *Chanos chanos*. Bulletin of Environmental Contamination and Toxicology 43(5):785-788.

Potassium permanganate (KMnO sub(4)) is a strong oxidizing agent and is commonly used in aquatic systems to improve available oxygen, treat infectious diseases and parasites, detoxify fish poisons, and control algae. The following study was undertaken to determine the 24- and 96-h median lethal concentration (LC50) of milkfish (*Chanos chanos*)) fingerlings to KMnO sub(4). The study was also designed to evaluate the histopathological response of fish tissues to KMnO sub(4) but was reported in another paper (Cruz and Tamse 1986).

Keywords: toxicity; lethal limits; toxicity tests; lethal effects; fingerlings; fish culture; brackishwater fish; marine fish; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fish Health Sect., Aquacult. Dep., Southeast Asian Fish., Dev. Cent., Tigbauan, Iloilo, Philippines 5021

352 Cruz, E.R. and G.L. Enriquez. 1983. Gill lesions associated with acute exposure to ammonia, p. 107-117. In: A compilation of Southeast Asian Fisheries Development Center-Aquaculture Department technical papers on milkfish and other finfishes 2.

The hispatological effects of the 96 hr LC50 at 20.65 ppm NH3-N on the gills of milkfish fingerlings were examined qualitatively. Lesions observed were hyperthrophy, hyperplasia. fusion of the lamellae, epithelial lifting, lamellar telangiectasis, disruption of the epithelial layer, lamellar detachment, vacuolation of the lamellae and the blood cells, and presence of several mitotic cells. The physiology of the hispathological lesions observed is discussed.

Keywords: gill; gill lesions; exposure; ammonia; pathology

Location: SEAFDEC Aquaculture Department Library; WorldFish Center Library Philippine Office

353 Cruz-Lacierda, E.R. 1990. Toxicity of rotenone to milkfish, *Chanos chanos* and tilapia, *Oreochromis mossambicus*, p. 419-423. In: M. Shariff, R.P. Subasinghe and J.R. Arthur (eds.). Diseases in Asian Aquaculture 1: Proceedings of the First Symposium on Diseases in Asian Aquaculture, Bali, Indonesia, 26-29 November 1990. Fish Health Section, Asian Fisheries Society, Manila, Philippines.

Milkfish (*Chanos chanos*) and tilapia (*Oreochromis mossambicus*) were exposed to varying concentrations of rotenone to determine the LC sub(50). The 1, 6, 12, 24 and 96 hours LC sub(50) were 64, 36, 36, 30 and 25 mu g/l for milkfish and 172, 123, 91, 86 and 80 mu g/l for tilapia, respectively, at 28 +/- 1 C. In another experiment, *O.mossambicus* were exposed to a lethal concentration of rotenone (100 mu g/l) that had been allowed to age for selected periods of time to determine whether significant degradation occurs within 24 hours. Mortality after 3 to 24 hours exposure in 0 (no aging), 3 and 6 hour aged rotenone solutions were significantly higher than in 12 to 24 hour aged solutions. Mortality in 12 hour or longer aged rotenone solutions were not significantly different from the control test even after 24 hours of exposure. These results indicate that the treated water was no longer toxic to the fish after 12 hour and that acute toxicity of rotenone ceased towards the end of 12 hours at 27 +/- 1 C.

Keywords: rotenone; toxicity tests; pollution effects; *Chanos chanos*; *Oreochromis mossambicus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

354 Cruz-Lacierda, E.R., Y. Maeno, A.J.T. Pineda and V.E. Matey. 2004. Mass mortality of hatchery-reared milkfish (*Chanos chanos*) and mangrove red snapper (*Lutjanus argentimaculatus*) caused by *Amyloodinium ocellatum* (*Dinoflagellida*). Aquaculture 236(1-4):85-94.

Outbreaks of heavy infestation by the parasitic *dinoflagellate Amyloodinium ocellatum* in hatchery-reared milkfish (*Chanos chanos*) and mangrove red snapper (*Lutjanus argentimaculatus*) caused 100% mortality events in hatcheries in the Philippines. Parasites were recorded on the body surface in 14-day-old milkfish fry and on both skin and gills in 2-month-old snapper. Trophonts of *A. ocellatum* caused local erosions of fish skin and degeneration of epithelial cells at the sites of the parasite's attachment to the body surface. Separation and hyperplasia of gill epithelium and fusion of secondary lamellae at the distal parts of the gill filaments were common. High pathogenicity of *A. ocellatum* to fish may be attributed to the severe alterations of the fish gills, the disruption of the host's skin, and feeding of trophonts on hosts' epithelial cells. In-vivo treatments of *A. ocellatum*-infested snapper with a 1 h freshwater bath and 200 ppm H2O2 showed promising results. This is the first report of *A. ocellatum* infestation in milkfish and mangrove red snapper in the Philippines.

Keywords: fish kill; noxious organisms; mangroves; marine fish; parasitic diseases; new records; mortality causes; infestation; fish culture; hatcheries; ectoparasites; parasitology; *Lutjanus argentimaculatus*; *Chanos chanos*; *Amyloodinium ocellatum*; *Dinoflagellida*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:eclacier@aqd.seafdec.org.ph]

355 Dinesan, K.C. and K.C. George. 1993. Histopathological studies on zinc toxicity in milkfish *Chanos chanos* Forsskal. Mariculture Research under the Post Graduate Programme in Mariculture, p. 22-27. In: K. Rengarajan, A. Noble, Prathiba, V.Kripa, N. Sridhar and M. Zakhriah (eds.). Mariculture Research under the Post Graduate Programme in Mariculture, Part 3. CMFRI Special Publication 54.

Industrial pollution is the problem very often faced by aquatic systems. Among the industrial pollutants, heavy metals are of a major problem. Zinc is a major effluent from the industries such as

soft drink flavouring, fur dressing and dyeing, fish processing, laundry, etc. Many studies conducted involving heavy metal pollution were limited to the estimation of pollutants in water, its accumulation in aquatic organisms and its lethal effects. Literature is limited regarding the effects of pollutants on various vital systems of cultivable organisms at cellular level. Therefore, this study was taken up with a view to investigate the damages caused by zinc at cellular level on various organs of milkfish.

Keywords: marine fish; toxicity tolerance; pollution effects; zinc; histopathology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, P.B. No. 1603, Ernakulam, Cochin 682 014, India

356 Fernandez, R.D., E.A. Tendencia, E.M. Leano and M.N. Duray. 1996. Bacterial flora of milkfish, *Chanos chanos*, eggs and larvae. Fish Pathology 31(3):123-128.

Aerobic bacterial flora of eggs and larvae of milkfish, *Chanos chanos*, was investigated. Microflora in the incubating water of egg, rearing water of larvae, water source, and larval food was also analyzed. Aerobic bacterial flora of milkfish eggs was largely influenced by the bacterial flora in the incubating water. Both in eggs and in the incubating water, *Pseudomonas* species were the dominant bacteria. During milkfish larval rearing, intestinal aerobic bacterial flora was examined at days 1, 3, 7, 10, 15, 18, and 21. Bacterial number in the larvae and rearing water significantly increased during the culture period up to day 18 but dropped significant at day 21. *Pseudomonas* species were detected from yolk-sac larvae (day 1) as the dominant bacteria, similarly to the normal flora in the rearing water. However, intestinal bacteria were predominated with Vibrio species when the yolk-sac was absorbed on day 3. Larval rearing water, water source, and larval food contained predominantly *Pseudomonas* species.

Keywords: eggs; larvae; microflora; aquaculture; *Chanos chanos*; *Vibrio*; *Pseudomonas*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

357 Hilomen-Garcia, G.V. 1997. Morphological abnormalities in hatchery-bred milkfish (*Chanos chanos* Forsskal) fry and juveniles. Aquaculture 152(1-4):155-166.

Morphological abnormality has been observed in hatchery-bred milkfish *Chanos chanos* juveniles. To characterize and quantify the occurrence of these anomalies, hatchery-bred milkfish juveniles from commercial nursery ponds were sampled, and the development of abnormalities in tank-reared fry and juveniles was monitored. Small specimens were cleared and stained using a KOH-alizarin technique for osteological examination. The occurrence of gross abnormalities in hatchery-bred milkfish juveniles reared in commercial ponds was highly variable (3-26%). These abnormalities were predominantly a cleft on the branchiostegal membrane (CBM) and a deformed operculum (DOp), which was mostly folded. CBM was commonly associated with a deformity or the partial to total absence of its supporting branchiostegal rays (DABr). DOp and DABr, but not CBM, were first detected during the early juvenile stage. Reference samples of wild fry did not develop similar proportions of abnormalities when reared in tanks, indicating that these abnormalities are predetermined or induced before the fry stage. Slow growth and development were observed in fish with opercular and branchiostegal abnormalities. A high mortality rate (70%) of abnormal fish was also observed after handling and transfer of stock. These results demonstrate that morphological abnormalities such as CBM and DOp do not only affect the appearance of milkfish but also interfere with its growth and survival.

Keywords: fish culture; biological membranes; abnormalities; osteology; husbandry diseases; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

358 Huang, Y.H. 1977. Preliminary report of the studies on bacterial disease of milkfish, *Chanos chanos* during winter. JCCR Fisheries Series (29):50-54.

The epidemic 'red-spot disease' which breaks out heavily among *C.chanos* during winter is described. The causative organism was found to be a gram-negative, motile, curved rod bacterium. On the basis of biochemical characteristics, it was identified as *Vibrio anguillarum*. The organism grew well in the culture media containing 1-7% NaCl. The isolated strains were highly sensitive to chloramphenical and tetracycline.

Keywords: aquaculture; diseases; *Chanos chanos*; *Vibrio anguillarum*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

359 Huang, Y.H. 1987. Preliminary report of the studies on bacterial disease of milkfish, *Chanos chanos* during winter. The Memoir of Bacteriology and Immunology in Fish Diseases 1:7-11.

The epidemic "red-spot disease" which breaks out heavily among milkfish, (*Chanos chanos*) during winter is described. The causative organism was found to be a Gram-negative, motile, curved rod bacterium. On the basis of biochemical characteristics, it was identified as *Vibrio anguillarum*. The organism grew well in the culture media containing 1 similar to 7% NaCl. The isolated strains were highly sensitive to chloramphenicol and tetracycline.

Keywords: aetiology; fish culture; bacterial diseases; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

360 Lavina, E.M. 1977. The biology and control of *Caligus sp.*, an ectoparasite of the adult milkfish *Chanos chanos* Forsskal. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center (2):12-13.

One unidentified species of copepod belonging to the genus *Caligus* of the family *Caigidae* was found to infest the adult milkfish broodstock. To control the parasites infesting the adult milkfish, tests were made using the chemical (2,2,2-trichloro-1-hydroxyl)-phosphonic acid-dimethylethol (Neguvon) at a concentration of 0.25 ppm. It is noted that a concentration of 0.25 ppm of Neguvon maintained for 12-24 hours in the sabalo-containing tanks in a closed water system but with aeration is effective in controlling the parasites. Fish mortality during the experiment was due to inadequate aeration in the tanks.

Keywords: parasitism; chemical control; disease control; aquaculture; *Chanos chanos*; *Caligus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

361 Lavina, E.M. 1978. A study on certain aspects on the biology and control of *Caligus sp.*, an ectoparasite of the adult milkfish *Chanos chanos* (Forsskal). Fisheries Research Journal of the Philippines 3(2):11-24.

One unidentified species of copepod belonging to the genus *Caligus* was found to infest the adult milkfish broodstock kept in canvas tanks at the SEAFDEC research station in Mag-aba, Pandan, Philippines. This report describes the morphology of the adult and early larval stages of this copepod. A highly effective method of control using the chemical Neguvon (2,2,2-trichloro-1-hydroxyl-phosphoric acid-dimethylethol) at a concentration of 0.25 ppm is recommended.

Keywords: parasites; ectoparasites; parasite control; *Caligus*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

362 Liao, I.C., F.R. Yang and S.W. Lou. 1987. Preliminary report of effect of Panfuran-S bath on the and growth of milkfish fry. The Memoir of Virology and Pharmacology in Fish Disease 3:101-107.

In Taiwan, many milkfish (*Chanos chanos*) fry are imported from Southeast Asia for culture. The imported milkfish fry are not allowed to pass customs unless they have been treated with Panfuran-S. However, according to culturists' experiences, such treated fry do not grow well. Thus in 1976 and in 1977 a study was undertaken with the purpose to find out the effect of Panfuran-S on milkfish fry. The 24-hr TLm of Panfuran-S for milkfish fry is 6.4 ppm. The results also indicate that the health conditions of milkfish fry seems to be related to the effect of Panfuran-S.

Keywords: disease control; prophylaxis; antibiotics; toxicity tests; fry; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Taiwan Fish. Res. Inst., Pingtung, Taiwan, 916

363 Lin, C.L. and J. Ho. 1998. Two new species of *Ergasilid copepods* parasitic on fishes cultured in brackish water in Taiwan. In: Proceedings of the Biological Society of Washington, 6 April 1998. 111(1): 15-27.

Ergasilus lobus and *Diergasilus kasaharai* are described based on the specimens obtained from the gill filaments of the moribund fishes cultured in brackish water in southern part of Taiwan. The former species was obtained from Malabar reef-cod (*Epinephelus malabaricus*) and the latter, from milkfish (*Chanos chanos*) and Borneo mullet (*Liza macrolepis*). A key to the 22 species of Ergasilus occurring on the coastal, brackish water fishes of the world is provided.

Keywords: fish culture; new species; ectoparasites; parasitic diseases; disease control; husbandry diseases; disease detection; *Diergasilus kasaharai*; *Epinephelus malabaricus*; *Ergasilus lobus*; *Chanos chanos*; *Liza macrolepis*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, National Chiayi Institute of Technology, Chiayi, Taiwan, 60083

364 Lin, C.L. and Y.Y. Ting. 1987. Effect of chemotherapeutic agents by medicated bath on the red spot disease (vibriosis) of milkfish (*Chanos chanos*). The Memoir of Virology and Pharmacology in Fish Disease 3:140-150.

The bacteriophage which infect and lyse *Vibrio anguillarum*, the pathogen of milkfish vibriosis, was isolated from the overwintering ponds and was named AS10. AS10 had wide spectrum of host range by showing 100% of the virulence in 18 strains of *V. anguillarum* isolated from the Taiwan area. The optimal stable salinity range of AS10 is 15-45%. By exposing to ultraviolet irradiation, the loss of AS10 infectivity is linearly correlated with U.V. fluence. The pathogenicity of *V. anguillarum* was almost completely eliminated after 4 hours. by AS10 infection at an M. O. I.-1. In the field trial, it is proved that the vibriosis can be inhibited by AS10 application in milkfish overwintering ponds.

Keywords: fish diseases; bacterial diseases; vibriosis; disease control; biological control; bacteriophages; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Zool., Acad. Sin., Nankang, Taipei, Taiwan

365 Lin, C.L., Y.Y. Ting and M.N. Lin. 1981. Studies on the prevention and treatment of the red spot disease (Vibriosis) in the milkfish (*Chanos chanos*). Bulletin of Taiwan Fisheries Research Institute (33):629-636.

Hivax *Vibrio anguillarum* bacterin was used to prevent vibriosis. Two kinds of disenfetants: Iodofore (2% available Iodine) and San-o-Fec-50 (50% Quarternavy ammonium: 40% methyl dodecyl benzyl trimethyl ammonium chloride, 10% methyl dodecyl xylylene bis) used to treat vibrosis were also studied. The results are summarized as follows: with Hivax bacteria immersed milkfish fingerlings (body weight from 0.3 g to 0.57 g) was absolutely safe. After one week being immersed, the immune system of fingerling have been set up. The immunification of hivax vibrio anguillarium bacterin in *Chanos chanos* could continue to five months at 12 deg C to 38 deg C. With

available concentration 2 ppm of iodofore and available concentration 1ppm of San-o-Fec-50 to treat vibriosis had actual effect. The two kinds of disenfectant could reduce mortality rate from 15%-50% to only 0.7% in being treated over winter pond.

Keywords: prevention; treatment; red spot disease; vibriosis; milkfish
Location: SEAFDEC Aquaculture Department Library

366 Lin, C.L., Y.Y. Ting and Y.L. Song. 1987. Proceeding evaluation of HIVAX *Vibrio anguillarum* bacterin in the vaccination of milkfish (*Chanos chanos*) fingerlings. The Memoir of Bacteriology and Immunology in Fish Diseases 1:221-224.

The HIVAX *Vibrio anguillarum* bacterin in the vaccination of milkfish (*Chanos chanos*) fingerlings was evaluated and the results were summarized as follows: *V. anguillarum* bacterin was proven to be safe in the vaccination of milkfish fingerlings (body weight from 0.3 g to 0.57 g); The immune response of fingerlings was onset one week after vaccination; and the immunity of milkfish immunized with V. anguillarum bacterin was still solid after 5 mo at 12-38 degree C.

Keywords: fish diseases; bacterial diseases; disease control; bacterins; vaccination; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tainan Branch Stn., Taiwan Fish. Res. Inst., Tainan, Taiwan

367 Lio-Po, G. 1984. Diseases of milkfish, p. 147-153. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Although the history of *Chanos chanos* culture has been quite long, reports of major epizootics have been few. Trained manpower and disease diagnostic services in most milkfish growing areas have not been readily available. Hence, earlier reports of etiologic agents of these epizootics were limited mostly to direct microscopic examination of specimens. Significant disease cases reported were attributed to bacterial, myotic, parasitic, and toxic causes. Bacterial infections, primarily due to Vibrio *sp.*, have been frequently associated with mortality. To a lesser, extent fungal infections have also been reported. Intoxication of stock in freshwater systems by Microcystis toxins has caused massive fish kills in Laguna de Bay, Philippines. In most instances, affected fish were predisposed by environmental stress incurred in handling storage and transport. The fry and fingerling stages seemed severely affected compared with the older stages. Control of these infections must include assessment of fish husbandry practices first, before the use of chemotherapeutic agents like antibiotics is considered.

Keywords: fish culture; fish diseases; disease control; husbandry diseases; brackishwater aquaculture; infectious diseases; epidemiology; aquaculture techniques; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

368 Lio-Po, G. and R. Duremdez-Fernandez. 1986. The pathogenicity of bacteria associated with transport-stressed *Chanos chanos* fingerlings, p. 223-226. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Two isolates of Aeromonas hydrophila biovar hydrophila and 2 isolates of *Pseudomonas* -like bacteria cultured from milkfish, *Chanos chanos*, fingerlings stocked in Laguna Lake (Philippines) pens after transport were tested for virulence against healthy milkfish fingerlings. Various

combinations of bacterial concentration and different routes of inoculation were tested. Bacterial entry in the pathogenesis of the test bacteria to challenged fish is more effective in fishes with scales removed than in uninjured fish or through intraperitoneal injection. The minimum lethal dose of *A. hydrophila* to scaled fish appeared less than 10 super(5) cells/ml of water medium. For *Pseudomonas*-like isolates, the minimum lethal dose was at the level of 10 super(5) cells/ml of water medium. Fish mortalities significantly increased on day 2 in all bacteria but *A. hydrophila* was significantly more virulent than the *Pseudomonas* -like *inocula*.

Keywords: pathogenic bacteria; fish diseases; husbandry diseases; pathology; *Pseudomonas*; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

369 Lio-Po, G., R. Duremdez-Fernandez and A. Villaluz. 1986. Disease investigation of transported *Chanos chanos* in Laguna Lake, Philippines, p. 227-230. In: L.B. Dizon, L.V. Hostillos and J.L. Maclean (eds.). Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila, Philippines.

Milkfish, *Chanos chanos* fingerlings transported by boat (petuya) for 7-8 hours were observed for stress-inducing factors during transport, and daily for 10 days after stocking in pens in Laguna Lake, Philippines. Handling, hauling, and crowding of fish contributed to stressful conditions. Likewise, the transport procedure of closing the water entry hole at the bottom of the boat to block water exchange was associated with decreased dissolved oxygen and increased turbidity, with respective values of 2.4 mg/l and 79 Formalin Turbidity Units when water change was possible. In addition, marked and abrupt fluctuations in salinity from 15 to 30 ppt then 0 ppt within 1 to 3 hrs were observed during transport. Although mortalities during transport were minimal, subsequent deaths after stocking in pens mounted to not less than 2.4%. Reddish snout, scale loss and hemorrhagic areas along the lateral body surface were observed. Bacterial counts of water increased significantly during transport when water exchange was stopped.

Keywords: fish culture; transportation; mortality causes; pathogenic bacteria; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquacult. Dep., P.O. Box 256, Iloilo City, Philippines

370 Madhu, K. and D.S. Rao. 1993. Studies on the biotoxicity of the mangrove vegetation on the fingerlings of *Liza macrolepis*, *Tilapia mossambica* and *Chanos chanos*, p. 61-63. In: K. Rengarajan, A. Noble, Prathiba, V. Kripa, N. Sridhar and M. Zakhriah (eds.). Mariculture Research under the Post Graduate Programme in Mariculture, Part 2. CMFRI Special Publication 53.

The mangrove ecosystem with its complex canals, plants, pneumatophores and aerial roots provide food and shelter to a number of juvenile fishes. But, so far no scientific work has been carried out on the toxicity of mangrove vegetation on the aquatic organisms which inhabit these regions. The present work has been taken up to study the biotoxicity of mangrove plants on the fish fingerlings of *Liza macrolepis*, *Tilapia mossambica* and *Chanos chanos*.

Keywords: marine fish; fingerlings; toxicity; mangrove swamps; *Liza macrolepis*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CMFRI, P.B. No. 1603, Ernakulam, Cochin 682 014, India

371 Muroga, K., G.D. Lio-Po, C. Pitogo and R. Imada. 1984. *Vibrio sp.* isolated from milkfish (*Chanos chanos*) with opaque eyes. Fish Pathology 19(2):81-87.

Several milkfish (*Chanos chanos*) juveniles polycultured with the Indian prawn (*Penaeus indicus*) in earthen ponds at the Leganes Station of the Aquaculture Department, SEAFDEC, Philippines, manifested eye abnormalities. Signs observed varied from unilateral and bilateral opaque eye

coverings/eye balls, exophthalmia and hemorrhagic eyes. A vibrio was predominantly isolated from the opaque eye coverings and eye balls, and it was proved pathogenic to milkfish, Japanese eel (*Anguilla japonica*) and mouse by injection experiments. The opaqueness of eye coverings of milkfish was likewise reproduced by a combination of injury and contact with the pathogen. The bacterium, though seemingly closely related to *Vibrio parahaemolyticus* or *V. alginolyticus*, was not identified to any known *Vibrio* species.

Keywords: fish diseases; bacterial diseases; eyes; exophthalmia; polyculture; haemorrhage; pathogenic bacteria; *Chanos chanos*; *Penaeus indicus*; *Vibrio*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Faculty of Applied Biological Science, Hiroshima University Fukuyama 720 Japan

372 Pillai, C.T. and D.M. Thampy. 1991. Occurrence of pin heads in the fry of the milkfish *Chanos chanos*. Fish Chimes 11(3):27.

A brief account is given of the occurrence of pin heads in cultured milkfish (*Chanos chanos*) fry from Puduveyppu, Cochin, India. The clinical signs of this disease are imbalance in swimming, lying on its side, isolation, anorexia, cachexia and weakness; it is believed that water pollution may be the cause of this syndrome.

Keywords: fish diseases; abnormalities; aetiology; pollution effects; fry; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Coll. Fish. (Kerala Agric. Univ.), Panangad, Cochin-682 506, Kerala, India

373 Pitogo, C. 1984. Pathogenicity of bacterial isolate from the eyes of the juvenile milkfish, *Chanos chanos* Forsskal, exhibiting verying degrees of opacity. University of the Philippines, 78 p. M.S. thesis.

Bacteria were isolated from the eyes of juvenile milkfish, *Chanos chanos*. Morphological, biochemical, and physico-chemical characterization showed that the isolates are gram negative, oxidase positive rods with single polar flagellum which ferment glucose without the production of gas and are sensitive to the vriostat 0/129. The properties exhibited by the isolates justify their inclusion in the genus VIBRIO. Pathogenicity tests done via both injection and immersion challenge techniques showed high mortality of fingerlings. Juveniles tested by immersion challenge method, on the otherhand, exhibited varying degrees of eye opacity ranging from eye cover opacity, formation of cataract-like tissue around the lens, and failure of the injured site to heal. A very low mortality rate of juveniles was observed.

Keywords: pathogenicity; juvenile milkfish, opacity; milkfish
Location: SEAFDEC Aquaculture Department Library

374 Regidor, S.E. and J.R. Arthur. 1986. Parasites of juvenile milkfish, *Chanos chanos*, p. 261-264. In: L.B. Dizon, L.V. Hostillos and J.L. Maclean. (eds.). Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila, Philippines.

From September 1985 to April 1986, 200 juvenile milkfish (*Chanos chanos*) collected from three Philippine localities were examined for protozoan and metazoan parasites and yielded 5 Protozoa, 4 *Digenea*, 1 *Copepoda* and 1 *Isopoda*. Parasites believed to be previously unreported from *Chanos chanos* include *Cryptobia branchialis*; *Apiosoma sp.*; *Ambliphrya sp.*; *Leptotheca sp.*; *Transversotrema laruei*; *Caligus epidemicus* and an as yet unidentified juvenile gnathiid isopod. Prevalences and intensities of infection for species of parasites encountered were typically low. Only *Trichodinidae* gen. *sp.*, T. laruei, *digenean metacercariae* and *C. epidemicus* were common in any of the collections. The potential threat to milkfish culture posed by these parasites and by other species recorded in the literature is discussed.

Keywords: parasites; fish culture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: BFAR/IDRC Fish Health Proj., Bur. Fish. Aquat. Resour., 880 Quezon Ave., Quezon City, Metro Manila 3008, Philippines

375 Regidor, S.E. and J.R. Arthur. 1992. A survey of the parasite fauna of milkfish *Chanos chanos* (Forsskal), in the Philippines, p. 313-322. In: M. Shariff, R.P. Subasinghe and J.R. Arthur (eds.). Diseases in Asian Aquaculture 1: Proceedings of the First Symposium on Diseases in Asian Aquaculture, Bali, Indonesia, 26-29 November 1990. Fish Health Section, Asian Fisheries Society, Manila, Philippines.

A survey of the parasites of milkfish (*Chanos chanos*) in the Philippines was conducted during May 1986 to January 1988. From the examination of 30 fry, 300 juveniles, and 49 subadult/adult milkfish, 19 different parasite taxa were recovered. These include 8 *Protozoa* (*Ceratomyxa sp.*; *Cryptobia branchialis*; *Leptotheca sp.*; *Scyphidia sp.*; *Trichodina sp.* 1; *Trichodina sp.* 2; *Tripartiella sp.*; and *Vorticella sp.*); 6 *Digenea* (*Heterophyopsis expectans metacercaria*; *Isorchis parvus*; *Pseudobunocotyla awa*; *Transversotrema laruei*; *Digenea* gen. *sp.* adult and *Digenea* gen. spp. *metacercaria*); one *Nematoda* (*Nematoda* gen. *sp.* larva); one *Acanthocephala* (*Cavisoma magnus* (Southwell, 1927)); 1 *Cestoda* (*Scolex pleuronectis plerocercoid*); 1 *Copepoda* (*Caligus epidemicus*); and 1 *Isopoda* (*Gnathiidae* gen. *sp.*). Seven of the species identified have not been previously reported from the Philippines (*Ceratomyxa sp.*, *Trichodina sp.* 1, *Tripartiella sp.*, *I. parvus, P. awa, C. magnus* and *S. pleuronectis*), 2 species appear to be new to science (*Tripartiella sp.* and *Trichodina sp.* 1), and 3 are new reports for *C. chanos* (*H. expectans, S. pleuronectis* and *C. magnus*). A comprehensive list of the parasite infecting milkfish from the various collection localities, including their prevalences and intensities of infection, is included. The changes in the parasite fauna of milkfish cultured from fry to marketable size are also analyzed.

Keywords: parasites; checklists; comparative studies; new records; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Bureau of Fisheries and Aquatic Resources, 880 Quezon Avenue, Quezon City, Metro Manila 3008, Philippines

376 Somga, J.R., S.S. Somga and M.B. Reantaso. 2002. Impacts of disease on small-scale grouper culture in the Philippines, p. 207-214. In: Primary aquatic animal health care in rural, small-scale, aquaculture development. Technical proceedings of the Asian Regional Scoping Workshop, 27-30 September 1999, Dhaka, Bangladesh.

A farm-level participatory survey of the impacts of disease in small-scale grouper (*Epinephelus spp*.) culture in the Philippines was conducted from July to September 1999. A total of 72 fish farmers and one co-operative with a membership of 65 families engaged in small-scale fish production from Cavite and Capiz provinces in Luzon and the Visayas Islands, respectively, were interviewed. Grouper culture is carried out in pens and cages along coastal bays and adjoining tributaries. It contributes significantly to local livelihoods, particularly of those carrying out small-scale fishing activities as the main source of income. It requires low capital investment (as little as US$250, 1 US$=39 Pesos) with potentially high returns. Being an export commodity, live grouper commands a good market price of US$7-11/kg, similar to the price of shrimp. Grouper seed, from natural sources; are either purchased from traders or caught by the farmers themselves. The culture period ranges from 6-12 months, depending on the size of fry or fingerlings at stocking. Fish farmers recognise health problems as a significant constraint to grouper culture. Unidentified diseases exhibiting a range of clinical signs such as ulceration, fin rot, tail rot, scale loss, white spots, haemorrhages and cataract; leech parasitism; or a combination of these abnormalities were found to cause high mortalities, especially among fry. Proliferation of grouper and milkfish pens and cages, oyster and mussel farming, unstable climatic conditions and run-off following heavy rains contributed to the deterioration of the quality of the aquatic environment, which is believed to be associated with the problems reported. For beginners, the lack of proper husbandry knowledge intensified existing

problems. An inadequate supply of fry was another important constraint identified by farmers. Farmers experiencing large losses due to disease temporarily cease operations and resume production when they acquire sufficient capital. Other species, such as snapper (*Lutjanus sp.*), seabass (*Lates calcarifer*), and milkfish (*Chanos chanos*), are also cultured in the majority of farms; however, they are not considered good alternative species. Although these species are quite resistant to the diseases affecting grouper, they have a low market value. Even though disease poses a high risk to grouper culture, farmers are not discouraged from continuing this activity, as they believe that the high market price of grouper will contribute to the advancement of their household status.

Keywords: fish culture; small scale aquaculture; fish diseases; husbandry diseases; epidemiology; socioeconomic aspects; *Epinephelus*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fish Health Section, Bureau of Fisheries and Aquatic Resources, 860 Arcadia Bldg., Quezon Avenue, Quezon City, 1103 Philippines, [mailto:jrsomga@mail.super.net.ph]

377 Son, Y.L., S.N. Chen, G.H. Kou, C.L. Lin and Y.Y. Ting. 1987. Evaluation of HIVAX *Vibrio anguillarum* bacterium in the vaccination of milkfish (*Chanos chanos*) fingerlings. The Memoir of Bacteriology and Immunology in Fish Diseases 1:198-205.

The HIVAX *Vibrio anguillarum* bacterin in the vaccination of milkfish (*Chanos chanos*) fingerlings was evaluated. The optimal concentration on the waterborne infection of milkfish fingerlings with *V. anguillarum* was about 10 super(7) cells/ml. The infection rate of milkfish fingerlings with *V. anguillarum* increased by depressing the temperature. The immunity of milkfish immunized with *V. anguillarum* bacterin was onset as small as 0.38 g and solid after three months at room temperature. The bacterin was proven to be safe and effective in the vaccination of milkfish fingerlings experimentally.

Keywords: bacterial diseases; disease control; bacterins; vaccination; fish culture; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Zool., Natl. Taiwan Univ., Taipei, Taiwan

378 Tamse, C.T. and R.Q. Gacutan. 1994. Acute toxicity of nifurpirinol, a fish chemotherapeutant, to milkfish (*Chanos chanos*) fingerlings. Bulletin of Environmental Contamination and Toxicology 52(3):346-350.

Nifurpirinol (trade name Furanace and originally known as P-7138), is a nitrofuran derivative synthesized by the Dainippon Pharmaceutical Co. Ltd., Japan, and was developed exclusively as a broad-spectrum antibiotic for fish and other aquatic organisms (Shimizu and Takase 1967). It has been shown to have bactericidal and fungicidal action in vitro and in vivo (Shimizu and Takase 1967; Amend and Ross 1970; Pearse et al. 1974; Mitchell and Plumb 1980), and was used because of its excellent potential in controlling prawn diseases (Delves-Broughton 1974; Gacutan and Llobrera 1977). Milkfish (*Chanos chanos* Forsskal) is a widely-reared species and a very important aquaculture food crop in most parts of Southeast Asia. Thus, it was the logical choice as test animal for investigating the LC50 toxicity levels of nifurpirinol (6-hydroxymethyl-2-[2-(5-nitro-2-furyl) vinyl] pyridine) after 96 hr exposure. Changes in the normal gill architecture of milkfish after exposure to the drug were also studied (Tamse et al., in preparation).

Keywords: Southeast Asia; population exposure; acute toxicity; fish; antibiotics; aquaculture; gills; toxicity tests; fish culture; toxicity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Marine Biological Laboratory, Woods Hole, MA 02543, USA

379 Tamse, C.T., R.Q. Gacutan and A.F. Tamse. 1995. Changes induced in the gills of milkfish (*Chanos chanos* Forsskal) fingerlings after acute exposure to Nifurpirinol (Furanace; P-7138). Bulletin of Environmental Contamination and Toxicology 4:591-596.

The need for a chemotherapeutant used specifically for fish disease became increasingly apparent with intensive fish culture practices, and with the possibility of bacterial resistance against drugs used for human and animal medicine (Austin 1985). With this in mind, Nifurpirinol (trade name Furanace; P-7138) was developed by the Dainippon Pharmaceutical Co., Ltd., Japan, and is currently manufactured in the United States as Prefuran. Studies have proven that the drug is effective against bacterial and fungal pathogens in a wide variety of aquatic animals. Most of the Nifurpirinol studies done in the past have dealt on its antimicrobial activity, tissue uptake, and effective treatment levels ranging from 0.5-2.5 mg/L. The 96-hr median lethal concentration (LC50) to channel catfish (*Ictalurus punctatus Rafinesque*) has also been determined at 0.945-1.90 mg/L, and at 1.70 mg/L for milkfish, *Chanos chanos* Forsskal. However, there have only been two studies that have examined the histological effects on treated fish. Histopathologically, Mitchell et al. (1978) found hypertrophy and hyperplasia of the lamellar epithelium in channel catfish gills exposed to 0.5 mg/L for 4 d or longer at 24 plus or minus 2 degree C, while Amend and Ross (1970) working at 21 plus or minus 1 degree C observed no apparent changes in the gills of coho salmon (*Oncorhynchus kisutch*) exposed intermittently to 1 mg/L of Nifurpirinol. This paper describes the histological changes observed in the gills of milkfish fingerlings used in static, 96-hr Nifurpirinol toxicity tests. Milkfish was used because of its economic importance as a widely cultured food fish in Asia. The gills were chosen as target organs.

Keywords: acute toxicity; tissue analysis; catfish; salmon; drugs; pathogens; animal pathology; histology; gills; antibiotics; aquaculture; histopathology; fish culture; intensive culture; drug resistance; lethal limits; toxicity tests; antimicrobial agents; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Mar. Biol. Lab., Woods Hole, MA 02543, USA

380 Toledo, J.D. and A.G. Gaitan. 1992. Egg cannibalism by milkfish (*Chanos chanos* Forsskal) spawners in circular floating net cages. Journal of Applied Ichthyology 8(1-4):257-262.

Egg cannibalism by milkfish (*Chanos chanos*) spawners in a circular floating net cage was investigated. The cage was lined with a fine mesh hapa net to retain spawned eggs and to prevent the entry of fish egg predators. Water samples were collected from the surface (0 m), middle (1.5 m), and bottom (3.0 m) of a 10 m diameter by 3 m deep floating net cage at the time of initial detection of spawning (0 min) and at 30, 60 120 and 240 min thereafter. The mean number of spawned eggs at the surface significantly decreased ($P < 0.05$) 60 min after spawning and very few eggs were recovered 240 min later. There was no significant difference ($P > 0.05$) in the mean number of spawned eggs collected from the middle and bottom of the net cage at various times after spawning. Eggs were found in the digestive tract of all milkfish sampled ($n = 6$) at about 5 hours after spawning, indicating that captive milkfish eat their own eggs.

Keywords: cage culture; fish eggs; cannibalism; experimental research; spawning; collecting devices; stomach content; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

381 Torres, C.S. 1979. The effects of furanace on the gill structure of milkfish *Chanos chanos* (Forsskal) fingerlings. University of the Philippines in the Visayas, Miag-ao, Iloilo. 49 p. M.S. thesis.

The 96 h LC50 of Furanace to milkfish (*Chanos chanos*) fingerlings was calculated at 1.70 ppm with 95% confidence limits of 1.52 - 1.89 ppm. Histologically, the effects of 0.25, 0.50, 1.00, 1.50, 2.00, 2.30, and 2.50 ppm drug concentration on the gills were examined. Fish exposed to all these test levels for 96th and transferred to untreated seawater for 240 h exhibited an initial characteristic reaction of slight hyperplasia of the epithelium, together with clubbing at the tips of the gill lamellae. Histological findings, however, do not warrant application of the estimated 96 h LC50 which lies between 1.50 and 2.00 ppm. These two test levels manifested irreversible damage until after 240 h of recovery in fresh seawater.

Keywords: furanace; gill; gill structure; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

382 Tsai, S.C. 1978. Control of chironomids in milkfish (*Chanos chanos*) ponds with Abate RegTM (Temephos) insecticide. Transactions of the American Fisheries Society 107(3):493-499.

Larval chironomids *Chironomus longilobus* (Kieffer) are serious competitors with milkfish *C. chanos* (Forsskal) for benthic algae in commercial milkfish ponds in Taiwan. Chironomid larvae were effectively killed with temephos (Abate RegTM, O,O,O',O'-tetramethyl O,O'-thiodi-p-phenylene phosphorothioate) 50% emulsifiable concentrate when it was diluted 1:2,000 with seawater and applied to milkfish ponds to establish a concentration of 0.050 mg/liter of the active ingredient. This treatment did not harm milkfish and benthic algae. Residues found in the edible portions of milkfish after seven applications of Abate 50% emulsifiable concentrate ranged from 0.02 to 0.08 mg/kg, well below the 1.0 mg/liter approved by the World Health Organization for presence in human drinking water. The acute toxicicity of Abate 50% EC to 13 other species of aquatic animals was determined in the laboratory.

Keywords: chemical control; fish culture; competitors; plankton feeders; pest control; *Chironomus longilobus*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Taiwan Fish. Cult. Stn., Taiwan Fish. Res. Inst., Tainan, Taiwan

383 Tung, M.C. and G.H. Kou. 1986. Pathology (milkfish culture), p. 243-262. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

Milkfish (*Chanos chanos*) diseases and their control are discussed in detail, being considered under the following headings: viral infections, bacterial diseases, mycotic diseases, parasitic infections and miscellaneous disorders.

Keywords: infectious diseases; disease control; pathology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Vet. Med., Natl. Pingtung Inst. Agric., Pingtung, Taiwan

384 Tung, M.C., S.S. Tsai and S.C. Chen. 1987. Study of *Vibrio anguillarum* infection in cultured milkfish (*Chanos chanos*) in Taiwan. The Memoir of Bacteriology and Immunology in Fish Diseases 1:158-168.

From Nov 1984 to Mar 1985, 3 epizootics of *Vibrio anguillarum* infection (red spot disease) broke out in cultured milkfish (*Chanos chanos*) ponds in the Tainan area. The disease episodes occurred always after the cold snap in overwintering ditches with the stocking density of 1.3 Kg/M super(3) or more. Mortalities were 21.5%, 23.2% and 25.1% respectively. The affected fish generally swam sluggishly at the water surface and had a darkening of the trunk. The diseased fish showed characteristic reddish spots on the surface of the body and internal hemorrhages of viscera as well. Histopathologically, hemorrhagic septicemia of the infected fish was revealed. The causative bacterium isolated was identified as *V. anguillarum* II and was resistant to most antimicrobial agents tested. The isolate produced mortality readily and only in the group of inoculated milkfish under 15 degree C with LD sub(50) of 2.4 x 10 super(4) CFU/0.1 ml.

Keywords: bacterial diseases; vibriosis; fish culture; epidemiology; *Vibrio anguillarum*; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Vet. Med., Natl. Taiwan Pingtung Inst. Agric., Pingtung, Taiwan

385 Velasquez, C.C. 1984. Pests/parasites and diseases of milkfish in the Philippines, p. 155-159. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and

culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines.

This paper presents all known parasites of milkfish (*Chanos chanos*) in the Philippines. The major parasitic groups include *acanthocephalans*, *copepods*, *isopods*, and *heterophyid* flukes. The number of parasitic species found in ponds is small compared with those harbored by the fish in its natural environment. Parasites with a direct life cycle usually survive in ponds as *flagellates*, *ciliates*, *myxosporidians*, *coccidia*, and parasitic arthropods under improper management. The methods of treatment, prevention and control of these parasites are discussed.

Keywords: fish culture; fish diseases; parasites; husbandry diseases; disease control; brackishwater aquaculture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Natl. Acad. Sci. and Technol., Metro Manila, Philippines

386 Wang, W.S., D.H. Wang, H.T. Hung and C.I. Liu. 1995. Enhancement of bacterial disease resistance in bighead carp *Aristichthys nobilis* and milkfish *Chanos chanos* by glycans in vivo. p. 171-182. In: C.M. Kou, J.L. Wu and P.P. Hwang (eds.). Proceedings of the International Symposium on Biotechnology Applications in Aquaculture, Taipei, Taiwan, 5-10 December 1994, Taipei, Taiwan, ROC. Asian Fisheries Society Special Publication 10, Manila, Philippines.

The aim of this study was to evaluate the efficacies of 11 polysaccharides, Barley, curdlan, dextran sulfate, inulin, krestin, laminaran, levan, *Pleurotus ostreatus*, seleroglucan, yeast glucan, and zymosan, in protecting bighead carp *Aristichthys nobilis* and milkfish *Chanos chanos* against bacterial infections. The results of injection with Aeromonas hydrophila revealed that 5 glycans (Barley, curdlan, krestin, scleroglucan, and zymosan) significantly increased the survival rates of bighead carp and milkfish. The data for infection with *Edwardsiella tarda* indicated that 4 glycans (Barley, krestin, scleroglucan, and zymosan) significantly raised the survival rates of bighead carp and milkfish. Results of the Adherence/NBT (nitroblue tetrazolium) Assay suggested that Barley, krestin, seleroglucan, and zymosan significantly increased the number of NBT-positive staining cells.

Keywords: bacterial diseases; fish diseases; disease resistance; polysaccharides; *Aristichthys nobilis*; *Chanos chanos*; *Aeromonas hydrophila*; *Edwardsiella tarda*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Veterinary Medicine, National Chung Hsing University Taichung 400 Taiwan

387 Wu, J.L. and W.J. Chao. 1984. The epizootic of milkfish vibriosis and its biological control by bacteriophage AS10. COA Fisheries Series 1:34-46.

The bacteriophage which infects and lyses *Vibrio anguillarum*, the pathogen of milkfish vibriosis, was isolated from the overwintering ponds and was named as AS10. Bacteriophage AS10 had a wide spectrum of host range showing 100% of the virulence in 18 strains of *V. anguillarum* isolated from the Taiwan area. It is stable in the temperature range of 4 to 20 degree C and easily inactivated by raising temperature to 30 degree C and above. The optimal stable pH values for AS10 in pH 6 to 9, and optimal stable salinity range 15 to 45 ppt. The pathogenecity of *V. anguillarum* was almost completely eliminated after 4 hours by AS10 infection at an M.O.I. = 1. In a field trial, it was proved that vibriosis can be inhibited by AS10 application in milkfish overwintering ponds.

Keywords: bacterial diseases; biological control; bacteriophages; fish diseases; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Zool., Acad. Sin., Nankang, Taipei, Taiwan

388 Wu, J.L., H.C. Lin, Y.L. Hsu and S.J. Tzou. 1986. Control of milkfish vibriosis by bacteriophage ASIO which infect *Vibrio anguillarum*. COA Fisheries Series 8:28-33.

The characters of bacteriophage AS10, which infect and lyse *Vibrio anguillarum*, the pathogen of milkfish vibriosis are that had a wide spectrum of host range by showing 100% of virulence in 16 strains of *V. anguillarum* isolated in 1986 from Tainan area. The pathogenicity of *V. anguillarum* was almost completely eliminated at an M.O.I. greater than or equal to 1 after bacteriophage AS10 infection for 4 hours. In the field test, the mortality due to milkfish vibriosis of the prevention groups were much lower than the control groups by 18.0% and 28.8% individually in the overwintering ditch of Tainan Branch Station, Taiwan Fisheries Research Institute and Chi-Cu area, Tainan. The bacteriophage AS10 also showed a very effective therapeutic result by this biological control system for milkfish vibriosis.

Keywords: fish culture; bacteriophages; vibriosis; *Vibrio anguillarum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Zool., Acad. Sin., Nankang, Taipei 11529, Taiwan

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(See abstract, keywords, location and author's affiliation in entry no. 659)

389 Acosta, B.O. 1984. Biological evaluation of *Brachionus plicatilis* fed with *Chlorella sp. Tetraselmis tetrahele* and *Isochrysis galbana* and their combinations as feed for milkfish (*Chanos chanos*, Forsskal) fry. University of the Philippines in the Visayas, Miag-ao, Iloilo. 74 p. M.S. thesis.

Two sets of experiments were conducted to evaluate the quality of *Brachionus plicatilis* grown on single species of unicellular algae, *Chlorella sp.*, *Isochrysis galbana* and *Tetraselmis tetrahele* and their combinations as feed for milkfish fry. In experiment I, growth was best among fry fed with *Brachionus* grown on *Isocrysis* followed by those fed with *Brachionus* grown on *Tetraselmis*; the poorest growth was obtained among fry fed with *Brachionus* grown on *Chlorella*. Electron microscopy supported these findings and revealed that the hepatocytes of fry reared on *Brachionus* feed with Isochrysis had optimum ultra structural traits. The liver cells were regular in size, the nuclei were of light density and the ground plasm abounds in glycogen particles; while the hepatocytes of those fed with *Brachionus* grown on *Chlorella* showed abnormalities. Th cells were smaller in size with dark shrunken nuclei, diminished amounts of glycogen and globular and pale mitochondria. In experiment II, the fry fed with *Brachionus* grown on a combination of the three algal species had significantly better growth than those fed with *Brachionus* grown on any combinations of the two algal species. Milkfish fry fed with *Brachionus* grown on combined species of phytoplankton had faster growth than those fed *Brachionus* grown on single species of phytoplankton. Survival rates were remarkably high in all treatments. Differences in the survival rates of fry were not significant.

Keywords: *Brachionus plicatilis*; biological evaluation; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo, Philippines

390 Adeyemi, F.F. 1983. A comparative study of the effects of supplementary feeding and artificial substrates on the production of milkfish fingerlings in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 79 p. M.S. thesis.

The growth and survival of milkfish fry in response to supplementary feeding and artificial substrate were evaluated at stocking densities of 75 and 100 fry/sq. m for a period of 56 days from August 21 to October 15, 1982. The study was conducted in eighteen 40 sq. meter experimental nursery ponds of the University of the Philippines Brackishwater Aquaculture Center, Leganes, Iloilo. A 3x2 factorial experiment in completely randomised design was used and six treatment combinations between level of inputs (no inputs, supplementary feeding or artificial substrate) and stocking density (75 or 100 fry/sq.m) were investigated with three replicates per treatment. The best fish growth was obtained in treatment VI (100/ fry/sq.m with substrate) with mean final weight and length of 1.59 gm. And 5.36 cm. respectively while treatment IV (100 fry/sq.m without feeding or substrate) gave the poorest fish growth with mean final weight and length of 0.83 gm. and 4.60 cm., respectively. Differences in mean weight and length among treatmentswere however, not statistically significant. Mean percentage survival was significantly higher at a stocking density of 75 fry/sq.m (82.8%) than 100 fry/sq.m (64.1%) but supplementary feeding or artificial substrate did not show any statistical significant effect on survival. At either 75 or 100 fry/sq.m stocking density, supplementary feeding gave a numerically higher percentage survival than artificial substrate. Economic analysis revealed that a stocking density of 75 fry/sq.m without supplementary feeding or artificial substrate was the most profitable treatment with a return on invesment of 39.2%. At a stocking density of 100fry/sq.m, supplementary feeding on rice bran was more profitable than the use of artificial substrate with returns on invesment of 22.6% and 9.1%, respectively.

Keywords: supplementary feeding; feeding, milkfish, *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo, Philippines

391 Aduma, I.A. 1984. Effect of cow and chicken manures on milkfish *Chanos chanos* (Forsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 98 p. M.S. thesis.

A study using chicken and cow manures with basal application rates of 0.5, 1,2 and 4 tons/ha was conducted. The effect of both manures on some selected physico-chemical properties of the pond soil and water, primary productivity, and milkfish *Chanos chanos* (Forsskal) yield were compared.
Using 8 treatments with 3 replicates each in a completely randomized design, 24 units of 40 m^2 ponds were stocked with 20 fingerlings/pond. The fish were cultured from September 22 to December 20, 1983 at the Brackishwater Aquaculture Center of the University of the Philippines in the Visayas, College of Fisheries, Leganes, Iloilo, Philippines.
The differences among treatments in terms of all physico-chemical parameters monitored were not significant except for the reactive phosphorus. Primary productivity in all treatments was at its peak during the 5th week, after which, it declined gradually apparently due to the combined effects of cloudy weather and low concentration of reactive phosphorus in the pond water.
The highest mean net fish yield (680.9 kg/ha) and mean growth rate (1.54 g/day) were obtained in treatment 3 with 1 ton/ha of chicken manure. Treatment 2 (0.5 ton/ha of cow manure) had the lowest mean net fish yield (343.6 kg/ha) and likewise the lowest growth rate (0.80 g/day). The survival in all treatments was high, ranging from 95 to 100%. In general, chicken manure was superior to cow manure, however, fish production from the treatment with 2 tons/ha of cow manure was comparable to that of 2 tons/ha of chicken manure suggesting that cow manure could be used as organic fertilizer in brackishwater ponds for milkfish production.

Keywords: feeding; cow manure; chicken manure; milkfish production; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

392 Ako, H. 1996. Algae in the aquaculture of marine fishes and shrimps, p. 7-14. In: PACON. Proceedings of the PACON Conference on Sustainable Aquaculture '95, 11-14 June 1995. Honolulu, Hawaii.

The fatty acid chemistry of several red, brown, green, blue-green, and diatomaceous algae was determined. There was a special interest in the essential fatty acid DHA (22:6n-3) because it is required by many marine animals. Among the algae studied, DHA was most abundant in the diatom (*Navicula*). It was present in low amounts in the red algae (*Hypnea* and *Acanthophora*), the blue-green (*Lyngbya*), and one of the browns (*Sargassum*). DHA could not be detected in the two greens analyzed (Ulva, *Enteromorpha*) and another of the browns (*Dictyota*). These data were supported by the extensive but qualitative fatty acid profiles in the literature. The absence of substantial quantities of DHA in most algae implies that trophic biochemistry is more complex than once thought. Herbivores must not only convert plant biomass to animal biomass but must also convert algal fatty acids to DHA. Several herbivorous molluscs appear to be able to convert shorter chain, more saturated precursors to DHA. The herbivorous milkfish (*Chanos chanos*) and the rabbitfish (*Siganus randalli*) also seem to have this ability. However, the rotifer *Brachionus plicatilis* has difficulty converting shorter precursors to DHA. Consideration of fatty acid metabolism patterns in aquaculture systems can probably yield a more productive sustainable aquaculture. This might include better control of algal species in aquaculture ponds in some cases and supplementation of algae-based diets with DHA in others. Agronomic production of macrophytic algae to be used in feeds for aquacultured animals must await enhancement of DHA biosynthetic abilities among the algae.

Keywords: marine aquaculture; shrimp culture; algal culture; aquaculture techniques; fish culture; diets
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ. Hawaii, Honolulu, HI, USA

393 Alava, V.R. 1986. Combinations of dietary fat sources in dry diets for *Chanos chanos* fingerlings, p. 519-521. In: L.B. Dizon, L.V. Hostillos and J.L. Maclean (eds.). The first Asian

fisheries forum: Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Asian Fisheries Society, Manila.

A study was conducted to determine the effects of 1:1 ratio of several dietary fat sources added in semi-purified diets at 10% level on milkfish (*Chanos chanos*) fingerlings. Results showed that the cod liver oil + coconut oil diet promoted significantly the highest growth rate. However, beef tallow + coconut oil and pork lard + coconut oil also gave good growth, feed conversion and survival. The hepatosomatic index of milkfish did not differ significantly among treatments. Proximate analysis of whole milkfish body showed that as body fat increased, body protein, ash and moisture levels decreased. Weight gains were positively correlated with body fat. Also, the various groups of fatty acids in diets and in milkfish have positive correlations. Diets containing high levels of saturated fatty acids resulted in low levels of milkfish polyunsaturated fatty acids.

Keywords: fish culture; artificial feeding; diets; fatty acids; fingerlings; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquacult. Dep., P.O. Box 256, Iloilo City, Philippines

394 Alava, V.R. 1998. Effect of salinity, dietary lipid source and level on growth of milkfish (*Chanos chanos*) fry. Aquaculture 167(3-4):229-236.

Six semi-purified microparticulate diets containing coconut oil (CO), cod liver oil (CLO), and their 1:1 combination (CO+CLO) at 9% and 18% levels were fed to milkfish fry or late postlarvae in freshwater (0 ppt), brackishwater (16ppt), and seawater (34ppt) for 30 days. A three-factor factorial design (3 x 2 x 3) with three replicates per treatment was followed. Sixty-five milkfish fry (5 mg, 6 mm) were stocked per 15-l rectangular glass aquarium and fed with the experimental diets at 20% of biomass daily. Water temperature was 28 plus or minus 1 degree C during the culture period. Survival was not affected by water salinity, and lipid source or level. Among the 18 treatments, freshwater-reared milkfish fry fed with 9% CO+CLO had the highest specific growth rate, but this was not significantly different from those of freshwater-reared fish fed with 9-18% CO and 9% CLO diets or brackishwater-reared fish fed with 9% CO diet ($P>0.05$). As a main factor, salinity or dietary lipid level, but not lipid source, had significant effects on growth and feed conversion ratio of milkfish fry. Highest growth was observed in fish reared in freshwater and as salinity was increased, growth decreased ($P<0.05$). Overall, the 9% lipid diets promoted better growth than the 18% lipid diets ($P<0.05$). Except for the significant interaction between dietary lipid source and level indicating that milkfish fry fed with the 18% CLO was the shortest ($P<0.05$), no other significant effects of the two- or three-factor interactions were found.

Keywords: brackishwater aquaculture; fish culture; fry; feeding experiments; feed efficiency; nutritive value; diets; lipids; salinity effects; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

395 Alava, V.R. and A. Kanazawa. 1996. Effect of dietary fatty acids on growth of milkfish *Chanos chanos* fry in brackishwater. Aquaculture 144(4):363-369.

Five purified microbound diets containing 1% of 18:2n-6, 18:3 n-3, 20:4n-6, or n-3 highly unsaturated fatty acids (HUFA: 60 % 20:5n-3+40% 22:6n-3) in addition to 8% 18:1n-9, and a control diet containing 9% 18:1n-9 were fed to milkfish (*Chanos chanos*) fry or late postlarvae for 30 days (Trial 1) and 35 days (Trial 2). The salinity was 16-17 ppt and temperature was 27 plus or minus 1 degree C during the culture periods. A completely randomized design with three replicates per treatment per trial was followed. In each trial, 60 fish (5 mg, 6 mm) were stocked per 30 l oval plastic tank and fed the experimental diets at 20% of biomass per day. Survival of 100% observed for all groups in both trials demonstrated that the milkfish fry reared in brackish water utilized the test diets. Specific growth rates did not differ significantly among treatments ($P>0.05$), with values of 9.5-9.9% and 10.0-10.3% in Trials 1 and 2, respectively. Weight, length and feed conversion ratio of milkfish fry fed the various diets also did not differ significantly ($P>0.05$). Although not

significantly differentiated in Trial 1 (P>0.05), incidence of eye abnormality was highest in milkfish fry fed the 18:1n-9 diet in Trial 2 (P<0.05).

Keywords: brackishwater aquaculture; fish culture; fry; fish larvae; diets; nutritive value; fatty acids; growth; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

396 Alava, V.R. and C. Lim. 1988. Artificial diets for milkfish, *Chanos chanos* (Forsskal), fry reared in seawater. Aquaculture 71(4):339-346.

Milkfish (*Chanos chanos*) fry obtained from the wild were stocked at 200 individuals in each of 18 fiberglass tanks containing 30 l of filtered aerated seawater. The fry were fed with six artificial dry diets containing a mean crude protein of 40.8%. Results indicated that there were no significant differences among the treatment means. Milkfish fry had mean body weights of 0.173-0.202 g, mean total lengths of 29-31 mm, mean feed efficiency values of 0.94-1.16, and mean survival rates of 92-98%. The remarkably similar response of milkfish fry to the six diets demonstrated that the diets contain the essential nutrients necessary for a fast-growing fish. Soybean meal can replace corn gluten meal and meat and bone meal can substitute shrimp head meal for up to 8% of the crude protein.

Keywords: stocking density; diets; feed efficiency; growth; survival; nutritive value; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

397 Anon. 1994. Feeds and feeding of milkfish, Nile tilapia, Asian sea bass and tiger shrimp. SEAFDEC-Aquaculture Department, Tigbauan, Iloilo City, Philippines. 97 p.

A 97-page manual that discusses the nutrient requirements, sources and characteristics of feedstuffs, feed formulation, practical feed formulation, processing and preparation, storage and quality control and feeding management for various fishes and the tiger shrimp.

Keywords: Feeds; feeding; milkfish
Location: SEAFDEC Aquaculture Department Library

398 Bara, A. 1984. Effect of different levels of chicken manure and ammonium phosphate on milkfish (*Chanos chanos* Forsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 112 p. M.S. thesis.

This study was conducted at the University of the Philippines in the Visayas Brackishwater Aquaculture Center (UPV-BAC) Leganes, Iloilo from June 20 to November 30, 1983. Fifteen rectangular experimental ponds were used to determine the effect of different levels of chicken manure and ammonium phosphate (16-20-0) on milkfish production, gross primary productivity and some selected soil and water properties in a completely randomized design with three replications.
The highest net fish yield of 502.12 kg/ha was obtained in Treatment III (1000 kg/ha chicken manure plus 50 kg/ha basal 16-20-0). This was followed by Treatment II (2000 kg/ha chicken manure plus 50 kg/ha bas-1 16-20-0) with a net fish yield of 494.09 kg/ha. In treatment V (no chicken manure but 75 kg/ha basal 16-20-0) the net fish yield (238 kg/ha) was lowest. Generally, treatments with chicken manure application (III, II, and I) had higher mean net fish yield than without chicken manure application (IV and V).
Fish survival obtained in all treatments was low and ranged from 64.4% to 76.7 %. However, the difference in mean percent survival among treatments were not significant.

Keywords: chicken manure; ammonium phosphate; milkfish production
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

399 Bautista, M.N. and M.C. de la Cruz. 1988. Linoleic (omega 6) and linolenic (omega 3) acids in the diet of fingerling milkfish (*Chanos chanos* Forsskal). Aquaculture 71(4):347-358.

Feeding trials were conducted to determine the effects of linoleic and linolenic acids on growth, survival, fatty acid composition and liver histology of milkfish (*Chanos chanos*). There were no significant differences in growth or survival between fish fed the lipid-free and the LA diets in the five treatments tested. However, growth of fish fed with linoleic and linolenic acids was significantly higher than that obtained in fish fed lipid-free and LA diets. Fatty acid analyses of the total lipid showed that lipid-free and LA diets increased the levels of monoenoic acids in the fish. The addition of linoleic and linolenic acids, alone or in combination, suppressed the levels of these monoenes and increased the levels of polyunsaturated fatty acids (PUFA). Histological analyses using light microscopy revealed slight abnormalities in the hepatocytes of fish fed lipid-free and LA diets.

Keywords: feeding experiments; diets; biochemical composition; growth; survival; histology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

400 Bautista, M.N., M.J. del Valle and F.M. Orejana. 1991. Lipid and fatty acid composition of brackishwater and freshwater-reared milkfish (*Chanos chanos* Forsskal). Aquaculture 96(3-4):241-248.

Lipid and fatty acid composition of the various sections of brackishwater- and freshwater-reared milkfish (*Chanos chanos*) were determined by chromatographic methods. Lipids consisted mainly of the neutral type, triglycerides and cholesterol esters. Palmitic and stearic acids were the predominant saturated fatty acids, although the brackishwater-reared milkfish contained more palmitic acid and the freshwater-reared milkfish more stearic acid. Unsaturated fatty acids of C sub(16) and C sub(18) were more characteristic of the freshwater-reared milkfish lipid, while those of C sub(20) and C sub(22) were the major acids of the brackishwater-reared milkfish. Saturation and unsaturation in the fatty acid composition characterized both types of fish although the brackishwater-reared milkfish lipids had fatty acids of higher unsaturations (C sub(20) and C sub(22)).

Keywords: lipids; fatty acids; chemical extraction; biochemical analysis; brackishwater aquaculture; freshwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

401 Bengtson, D.A. 2003. Status of marine aquaculture in relation to live prey: past, present and future. Live Feeds in Marine Aquaculture. 16 p.

It is difficult to determine exactly where and when marine aquaculture began. Milkfish culture has been conducted in Asia for centuries, based on the capture of fry from the wild, so that modern rearing methods and live feed in the hatchery were not required. The efforts to repopulate the seas of Europe and North America in the late 1800s may provide a more useful starting point for a brief historical review of the modern methods. In response to the fishery crisis at that time, 'hatcheries' were constructed in several countries for the purpose of providing fertilised eggs, developing embryos and larvae for distribution back into the ocean. The hope was that these would thrive and be recruited into the commercial fisheries. Given the knowledge of freshwater fish culture in Europe and the Americas, especially of salmonid culture, which had been rapidly developing since the mid-1800s and the attendant propagation, transportation and introduction of salmonid populations, this was not an unreasonable hope for the times. By the 1890s, Britain, France, Canada and the USA all had fish hatcheries devoted to the propagation of commercially important species, such as cod (*Gadas morhua*), haddock (*Melanogrammus aeglefinus*), turbot (*Scophthalmus maximus = Psetta maxima*), winter flounder (*Pleuronectes americanus*) and lobster (*Homarus sp.*). The prevailing

practice was to obtain gravid adults of a given species, strip them of their gametes for purposes of controlled fertilisation, sometimes on-board ship (some of the hatcheries were in fact ships), sometimes on shore, and maintain them no longer than the prolarva stage prior to release back to the ocean. The reason for the release at such an early stage of development was simple: there was no convenient live feed with which to provide them for their postlarval survival and growth. Cod larvae were raised in concrete ponds in Floedevigen, Norway, in the 1880s on a diet of natural zooplankton and in the absence of predators, but apparently the results of this 'experiment' were interpreted to mean that the larvae should survive in nature, not that juveniles could be reared for release. It is only with the benefit of hindsight that we know that these ocean stocking efforts were doomed to fail, owing to the high mortality rates of fish early life-stages in the oceans. Nevertheless, many of these programmes were sustained for decades until the lack of evidence of any success from them became apparent. We will never know whether earlier discovery of easily culturable live feeds would have allowed hatchery culture of these species to a later stage when they might have had better chances of oceanic survival. Indeed, the field of stock enhancement might have been advanced by several decades had convenient live feeds been available in the late 1800s.

Keywords: historical account; fish culture; marine aquaculture; freshwater aquaculture; hatcheries; pond culture; rearing; fish larvae; developmental stages; feeding; food organisms; stocking (organisms); aquaculture techniques; *Gadus morhua*; *Melanogrammus aeglefinus*; *Scophthalmus maximus*; *Pleuronectes americanus*; *Homarus*; British Isles; Canada; France; Norway; USA
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

402 Benitez, L.V. 1985. Milkfish nutrition, p. 133-143. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines.

This paper reviews major contributions in the field of milkfish (*Chanos chanos*) nutrition since the First International Milkfish Aquaculture Conference in 1976. Substantial progress has been made toward understanding the digestion, foods, and feeding behavior of milkfish, which in its natural habitat apparently feeds on planktonic microorganisms and is most frequently designated as a microphagons planktivore. Vision seems to be the most important sensory mechanism for feeding in fry as well as in juveniles and larger milkfish. There is very scant information on nutrient requirements and other important aspects of milkfish nutrition. A preliminary study on protein requirement showed that a dietary level of 40% protein was required by fry. Other studies showed that fry responded positively and were easily trained to accept artificial diets. The "deep water method" of growing milkfish practised in Taiwan demonstrated that, with the use of formulated diets, productivity in milkfish aquaculture could be increased three-fold over traditional culture methods, which rely on natural food bases.

Keywords: brackishwater aquaculture; fish culture; artificial feeding; diets; nutritional requirements; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

403 Boonyaratpalin, M. 1997. Nutrient requirements of marine food fish cultured in Southeast Asia. Aquaculture 151(1-4):283-313.

The culture of marine and brackishwater fish has gained increased importance in the aquaculture industry, particularly in Southeast Asia. As feed accounts for the major portion of rearing costs, nutritional adequacy and cost-effectiveness is critical to the industry. This review will focus on the nutritional requirements of tropical marine food fish that include seabass (*Lates calcarifer*), grouper (*Epinephelus sp.*), milkfish (*Chanos chanos*) and rabbitfish (*Siganus sp.*). Culture practices of marine fish in Southeast Asia with special reference to Thailand will also be described.

Keywords: animal nutrition; nutritional requirements; feeding experiments; fish culture; *Lates calcarifer*; *Epinephelus*; *Chanos chanos*; *Siganus*; Thailand

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Fisheries, Jatujak, Bangkok 10900, Thailand

404 Borlongan, I.G. 1992. Dietary requirement of milkfish (*Chanos chanos* Forsskal) juveniles for total aromatic amino acids. Aquaculture 102(4):309-317.

The phenylalanine requirement of milkfish at two dietary tyrosine levels was determined using a 2 x 6 factorial feeding experiment. The amino acid test diets (45% crude protein) contained vitamin-free casein and gelatin supplemented with crystalline L-amino acids to provide an amino acid profile similar to milkfish tissue protein except for the test amino acid. The experimental diets consisted of 12 isonitrogeneous and isocaloric diets containing six graded levels of phenylalanine (1.18, 1.3, 1.6, 1.9, 2.2, and 2.5% of dry diet) at two levels of tyrosine (0.45 and 1.2% of dry diet). Each of the 12 diets was fed to triplicate groups of 15 milkfish juveniles (initial mean weight = 0.58 plus or minus 0.03 g) for 12 weeks. The optimum total aromatic amino acid requirement of milkfish obtained in the study was 5.22% of dietary protein and the replacement value of tyrosine for phenylalanine was computed to be about 46%. Total aromatic amino acid levels higher than 6.88% caused a significant depression of growth in milkfish juveniles.

Keywords: nutritional requirements; juveniles; amino acids; fish culture; phenylalanine; tyrosine; diets; feeding experiments; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquaculture Dep., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

405 Borlongan, I.G. 1992. The essential fatty acid requirement of milkfish (*Chanos chanos* Forsskal). Fish Physiology and Biochemistry 9(5-6):401-407.

The essential fatty acid (EFA) requirement of milkfish was examined by a 12-week feeding trial using defined, purified diets of water temperature of 28-29 degree C and salinity of 32 ppt. The test diets contained varying levels of 18:0 (triglyceride form, TG), 18:3(n - 3), 18:2(n - 6) and (n - 3) highly unsaturated fatty acids (n - 3 HUFA). Milkfish juveniles were starved for 7 days and were than fed lipid-free diet for 30 days before the initiation of feeding trials. Low growth and feed efficiency together with high mortalities were observed in fish fed the lipid-free diet as well as in the EFA-deficient diet. Supplementation of 2% 18:2(n - 6) to the tristearin based diet did not improve growth rate of milkfish as effectively as feeding with (n - 3) fatty acids. Thus, (n - 3) fatty acids, such as 18:3(n - 3) and (n - 3)HUFA were nutritionally more important than 18:2(n - 6) for milkfish. The fatty acid composition of the polar lipids from whole body of milkfish juveniles fed the various test diets were influenced by the composition of the dietary fatty acids.

Keywords: growth; juveniles; fatty acids; animal nutrition; fish culture; lipids; polyunsaturated fatty acids; feeding experiments; diets; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

406 Borlongan, I.G. and L.V. Benitez. 1990. Quantitative lysine requirement of milkfish (*Chanos chanos*) juveniles. Aquaculture 87(3-4):341-347.

A feeding experiment was conducted to determine the quantitative dietary requirement of milkfish (*Chanos chanos*) juveniles for lysine. The amino acid test diets contained white fish meal and zein supplemented with crystalline amino acids to provide an amino acid profile similar to milkfish proteins except for lysine. On the basis of the growth response, lysine requirement of juvenile milkfish was found to be 20 g/kg diet. This value corresponds to 4.0% when expressed as a percentage of the dietary protein. Survival (94-97%) was consistently high in all treatments. Except for loss of appetite resulting in low food intake and depressed growth, no nutritional deficiency signs were observed in fish given the lysine-deficient diets.

Keywords: nutritional requirements; dietary deficiencies; lysine; growth; survival; juveniles; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

407 Borlongan, I.G. and L.V. Benitez. 1992. Lipid and fatty acid composition of milkfish (*Chanos chanos* Forsskal) grown in freshwater and seawater. Aquaculture 104(1-2):79-89.

The lipid and fatty acid compositions of the various organs of milkfish (*Chanos chanos*) fed with an invariant diet and reared in seawater (SW) and freshwater (FW) were determined using column chromatography and gas chromatography. Phospholipid content of the gills, kidney, liver, intestines and depot fat was higher in SW than in FW while the organs from fish in FW had higher contents of neutral lipid. Fatty acid patterns of total lipids in the liver, intestines and depot fat of milkfish reared in FW and SW were similar. There were marked differences in fatty acid patterns of gills and kidney. The proportions of saturated to unsaturated fatty acids in gills and kidney were lower in SW than in FW. Likewise, the ratio of n-3 to n-6 fatty acids and total polyunsaturated fatty acids (PUFAs) of gills and kidney were higher in SW than in FW. The fatty acid patterns of the phospholipid fractions showed that SW-reared milkfish have higher total PUFAs, especially of the n-3 fatty acids, than the FW-reared milkfish not only in gills and kidney but in all organs examined.

Keywords: fish culture; fish physiology; biochemical composition; lipids; fatty acids; salinity effects; body organs; euryhalinity; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

408 Borlongan, I.G. and R.M. Coloso. 1994. Leaf meals as protein sources in diets for milkfish *Chanos chanos* (Forsskal), p. 63-67. In: Fish nutrition research in Asia: Proceedings of the Fifth Asian Fish Nutrition Workshop, Udorn Thani, Thailand, January 1993. Asian Fisheries Society, Special Publication 9, Manila, Philippines.

The potential of partial replacement of fish meal protein with protein from indigenous leaf meals in practical diets for milkfish, *Chanos chanos*, was studied. Five isocaloric (375 kcal/100 g diet), were formulated to contain leaf meals from isonitrogenous (40% protein), and isolipidic (10%) diets either swamp cabbage (kangkong, *Ipomea reptans*), sweet potato (kamote, *Ipomea batata*), ipil-ipil (*Leucaena leucocephala*), and cassava (kamoteng kahoy, *Manihot esculenta*), or a combination of swamp cabbage, sweet potato and cassava. The control diet contained fishmeal and soybean meal as sources of protein while the test diets contained fishmeal, soybean meal, and leaf meals replacing 15% of the fishmeal protein. The protein sources were incorporated at levels that gave optimal essential amino acid patterns to the diets. Each diet was fed to triplicate groups of fish (about 0.3 g) maintained at 20 ppt salinity and 29 degree C in a recirculating system for twelve weeks. Growth, feed conversion ratio (FCR), protein efficiency ratio (PER), and survival of fish fed the various diets were not significantly different from those of the control fish. However, fish fed the diet containing cassava leaf meal showed the best growth, FCR, PER and survival. The data suggest that these leaf meals can be used to partially replace fish meal in a diet for juvenile milkfish if the requirements for essential amino acids are met.(DBO)

Keywords: fish culture; diets; proteins; feeding experiments; feed efficiency; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquaculture Department, Southeast Asian Fisheries Development Center P.O. Box 256, Iloilo City Philippines

409 Borlongan, I.G. and S. Satoh. 2001. Dietary phosphorus requirement of juvenile milkfish, *Chanos chanos* (Forsskal). Aquaculture Research 32(1):26-32.

Seven isocaloric and isonitrogenous diets with graded levels of monopotassium phosphate to yield total phosphorus levels of 0.28 (no P supplementation), 0.43, 0.58, 0.73, 0.88, 1.03 and 1.18% were prepared and fed to five replicate groups of 10 juvenile milkfish (initial weight = 2.5 g). After 16 weeks of feeding, significant differences in growth (300-570%), survival rates (70-100%), and bone and scale mineralization were found among treatment groups. Weight gains of milkfish increased linearly up to the 0.88% dietary phosphorus concentration and levelled off beyond this dietary level. Bone and scale ash, calcium and phosphorus concentrations showed similar patterns as weight gain in response to dietary phosphorus concentration. Broken-line regression analyses of these data indicated that the dietary phosphorus level required for optimal growth and mineralization of juvenile milkfish is approximately 0.85% of dry diet.

Keywords: diets; feed composition; growth rate; animal nutrition; nutritional requirements; survival; bones; mineralization; feeding experiments; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:igb@aqd.seafdec.org.ph]

410 Borlongan, I.G., C.L. Marte and J.N. Nocillado. 1996. Development of artificial diets for milkfish (*Chanos chanos*) larvae, p. 116. In: Feeds for small-scale aquaculture: Proceedings of the National Seminar-Workshop on Fish Nutrition and Feeds, 1-2 June 1994, Tigbauan, Iloilo, Philippines.

This study aims to develop nutritionally balanced and cost- effective artificial diets for milkfish larvae. Two larval diets (Feed A and Feed B) were formulated and prepared to contain 45% protein and 10% lipid. Several larval diet preparation techniques were tried and diets produced were assessed in terms of feed particle size and buoyancy, water stability, and feed acceptability. The larval diet preparation that gave the best particle size and bouyancy as well as good water stability was the one prepared as microbound diet (using K-carrageenan as a binder) and flaked using a drum drier. A series of feeding experiments were then conducted to determine growth and survival of milkfish larvae reared on various feeding schemes involving the use of these artificial diets. The artificial diets were fed either alone or in combination with live foods. Larvae in control treatments were reared on live foods such as *Brachionus* and *Artemia*. Larvae were observed to ingest the diets indicating that the feeds had suitable physical characteristics and were attractive to the larvae. Over-all results of the feeding trials showed that the artificial diets could be fed to milkfish larvae in combination with the rotifer *Brachionus* starting Day 8 or could be fed alone to milkfish larvae starting Day 15 onward. These promising results would reduce dependence of milkfish larvae on live foods and would have significant economic benefits in the form of simplified milkfish hatchery procedures.

Keywords: fish culture; fish larvae; diets; artificial feeding; feed preparation; aquaculture economics; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

411 Borlongan, I.G., C.L. Marte and J.N. Nocillado. 2000. Development of larval diets for milkfish (*Chanos chanos*). Journal of Applied Ichthyology 16(2):68-72.

This study aimed to develop nutritionally balanced and costeffective processed diets for milkfish larvae (*Chanos chanos*). Two larval diets (feed A and feed B) were formulated and prepared to contain 45% protein and 10% lipid. Several larval diet preparations were tried such as microbound/unpelleted (freeze-dried), microbound /pelleted (oven-dried) and microbound/flaked (drum-dried) and assessed in terms of feed particle size and buoyancy, water stability and feed acceptability. The preparation that gave the best particle size and buoyancy as well as good water stability was prepared as the microbound diet (using K-carrageenan as a binder) and flaked using a drum drier. A series of feeding experiments were conducted to determine the growth and survival of milkfish larvae reared on various feeding schemes using these processed larval diets which were fed

either solely or in combination with live feed. Larvae in control treatments were reared on live foods such as *Brachionus plicatilis* and *Artemia nauplii*. Larvae were observed to ingest the diets, indicating that the feeds had suitable physical characteristics and were attractive to the larvae. The overall results of the feeding trials showed that the artificial diets could be fed to milkfish larvae in combination with *Brachionus* rotifers starting on day 2 or day 8, and could be fed alone starting from day 15. These promising results would reduce the dependence of milkfish larvae on live feed and would have significant economic benefits in the form of simplified milkfish hatchery procedures.

Keywords: balanced diets; fish larvae; feeding experiments; nutritional requirements; survival; food composition; *Chanos chanos*; *Brachionus plicatilis*; *Artemia*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:igb@aqd.seafdec.org.ph]

412 Borlongan, I.G., P.S. Eusebio and T. Welsh. 2003. Potential of feed pea (*Pisum sativum*) meal as a protein source in practical diets for milkfish (*Chanos chanos* Forsskal). Aquaculture 225(1-4):89-98.

A 12-week feeding trial was conducted to evaluate the use of feed pea meal as a dietary protein source for juvenile milkfish. Six isonitrogenous (30% crude protein) and isocaloric (16.5 kJ/g) practical diets were formulated. The control diet contained fish meal, soybean meal, meat and bone meal and copra meal as principal protein sources. Feed pea meal was progressively substituted at 0%, 5%, 10%, 15%, 20%, 25% and 30% of total protein. A leading commercial milkfish feed was also tested as an additional control. The experimental diets were fed to triplicate groups of milkfish fingerlings (mean initial weight of 0.42 plus or minus 0.01 g) at 10% body weight/day. Growth performance (expressed as percentage of weight gain and SGR), survival, feed conversion ratio (FCR) and protein efficiency ratio (PER) of milkfish fed diets with up to 10% substitution of the dietary protein with feed pea meal were not significantly different ($P>0.05$) compared to fish fed the control diet. Replacement with feed pea meal at 15% and higher levels led to milkfish fed these diets showing a significantly lower growth response compared to fish fed with the control without any feed pea meal. Nevertheless, it was observed that milkfish fed diets with up to 20% of total dietary protein substitution with feed pea meal showed better growth rates and feed conversion ratios than the commercial feed control. Whole body composition (crude protein, crude fat, crude fiber, nitrogen-free extracts and ash content) of milkfish fed the various test diets was not significantly different. Apparent digestibility coefficients of feed pea meal and experimental diets in milkfish were also determined. Results indicate that feed pea meal is an acceptable protein source and can replace up to 20% of the total dietary protein in milkfish diets.

Keywords: feeding experiments; diets; proteins; growth rate; survival; food conversion; digestibility; body conditions; feed composition; *Pisum sativum*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:igb@aqd.seafdec.org.ph]

413 Carolin, E. and S. Jose. 1995. Two novel protein sources of marine origins for the nursery rearing of *Chanos chanos* fry. Advances and Priorities in Fishery Technology, Society of Fisheries Technologists (India), 32(1):14-18.

Artificial feeds compounded from two new marine protein sources-clam meal (CM) and squid meal (SQM) were compared with the commonly used protein sources like fish meal (FM) and prawn head waste meal (PHM) for *Chanos chanos* fry. The food conversion ratio (FCR), protein efficiency ratio (PER) and protein and lipid digestibility coefficients of fish fed on various feeds for 42 days indicate that the protein from clam meal and squid meal were better utilized for growth purposes than others. The PER value ranged from 0.23 (PHM) to 1.43 (CM) and protein digestibility coefficient from 97.24 (CM) to 65.23% (PHM). Lipid digestibility values were also high for CM (98.08%) and SQM

(97.12%). The survival rate, gain in length and weight, and specific growth rate indicate the superior performance of the feed compounded from CM, followed by SQM, FM and PHM.

Keywords: feed preparation; fry; artificial feeding; fish meal; fish culture; proteins; comparative studies; *Chanos chanos*; India, Kerala
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Coll. Fish., Panangud, Cochin-682 506, India

414 Chiu, Y. 1985. Milkfish nutrition and feed development in grow out ponds: The state of the art. Presented at the workshop on "Fish and Crustaceans Nutrition and Feed Requirement", 25-26 February 1985, UP in the Visayas, Iloilo City.

There is a growing need to further intensify milkfish culture in the Philippines because of decreasing profitability. Basic differences in economic conditions with that in Taiwan necessitate the development of a technology different from the "deep water method" of growing milkfish. This method involves the expensive deepening of ponds from their traditional 30 cm water depth to 2-3 m, the use of pelleted diets containing 23.5%-29% protein, increase stocking rates to as much as 20,000/ha, and the use of paddlewheel aerators. It resulted in a fivefold increase in production and became widely practiced when the price of milkfish increased in Taiwan a few years ago. In contrast to Taiwan, the price of milkfish in the Philippines has steadily decreased in real terms adjusted for inflation. Brackishwater pond areas are much cheaper, the price of milkfish is more than twofold less, but the cost of energy is about five-fold higher. A less intensive technology would undoubtedly be more suitable in the Philippines. It is likely that this technology will involve stocking rates of about three-fold the present rates (2,500/ha), heavier use of fertilizers specially organic fertilizers, provision for aeration for a few hours before sunrise, gradual increase of water depth to more than 30 cm., and supplying a pelleted diet containing no less than 18% protein during the last quarter of the culture period. Although calculations show that the cost of feeding, assuming a conversion ration of 1:2 will at least be half of the market price of milkfish, this would still be a viable innovation if feeding would be limited to the period when natural food is limiting before the desired size is reached, the culture period becomes more predictable and production per unit area increases by more than three-fold.

Keywords: milkfish nutrition; feed development; growout ponds; milkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: UP Visayas, Leganes, Iloilo, Philippines

415 Chiu, Y.N. 1984. The challenge of feeding milkfish. Proceedings of the 17th Annual Convention Federation of Institutions of Marine and Freshwater Sciences.

There is a growing need to further intensify milkfish culture because of decreasing profitability. Basic differences in economic condition with Taiwan necessitate the development of a technology different from intensive "deep water method" of growing milkfish. This method, which became popular when milkfish prices increased, involves feeding, aeration and high stocking rates (20,000/ha). With cheaper brackish pond areas, milkfish prices at a two-fold less a five fold higher energy cost, a less intensive technology would be more suitable in the Philippines. It is likely that this technology will involve stocking rates of about three-fold the present rates (2,500/ha), heavier fertilization rates to maximize the use of natural food, provision for a few hours aeration, gradual increase in water depth to more than 50 cm and supplemental feeding. Although the cost of feeding a pelleted diet containing no less than 18% protein would be at least half the market price of milkfish, assuming a conversion of 1:2, feeding would still be viable if it is done only when food is limiting resulting in a more predictable culture period and at least a three-fold increase in production. The development of a feeding technology is challenged by: (a) the lack of basic data on which to base a rational determination of amounts and period to feed; (b) the need to develop methods for conducting feeding experiments in ponds; (c) the need to determine limiting nutrients in ponds and nutrient requirements of milkfish; and (d) the need to understand other limiting conditions, such as dissolved oxygen and ammonia.

Keywords: feeding; nutrition; milkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Brackishwater Aquaculture Center, UP Visayas, Leganes, Iloilo, Philippines.

416 Chiu, Y.N. 1987. Further studies on the protein requirement of milkfish (*Chanos chanos* Forsskal) fry. Presented at the 7th PCCARD Annual Review of On-going and Completed Research Projects for Fisheries, 22-25 April 1987, La Granja, La Carlota City, Negros Occidental.

The optimum dietary protein level for milkfish (*Chanos chanos* Forsskal) fry was investigated using five diets with dietary protein levels ranging from 26% to 54%. The basal diet consisted of practical protein sources, mainly fishmeal, while protein was varied using different levels of casein. Cassein was replaced by destrin in the diet with lower protein levels, and the replacements was made so that diets would be isocaloric based on the physiological fuel values of 4,2, 8.5 and 3 kcal/g for protein, fat and carbohydrate, respectively. On the basis of the weight gain, feed efficiency and protein efficiency ratio, optimum dietary protein for milkfish fry is estimated at 45%.

Keywords: protein requirement; milkfish; diet
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Brackishwater Aquaculture Center, UP Visayas, Leganes, Iloilo, Philippines.

417 Chiu, Y.N., A.S. Camacho and M.A.S. Sastrillo. 1986. Effect of amino acid supplementation and vitamin level on the growth and survival of milkfish (*Chanos chanos*) fry, p. 543-546. In: L. B. Dizon, L.V. Hostillos and J.L. Mclean (eds.). The First Asian Fisheries Forum: Proceedings of the First Asian Fisheries Forum, Manila, 26-31 May 1986. Manila. Asian Fisheries Society, Manila.

The ability to utilize crystalline amino acids varies among different species of fish. To assess this ability in milkfish (*Chanos chanos*) fry, a study was conducted to determine the response of the fish to amino acid supplementation of a corn-gluten meal-based diet containing 40% protein. Two practical diets, one supplemented with vitamins at moderate levels and the other with high levels of vitamins, were used as controls. Growth and the efficiency of feed conversion were significantly improved when corn-gluten meal was supplemented with the most limiting amino acid, lysine. Supplementation with five other essential amino acids, deficient relative to the amino acid profile of whole milkfish fry, did not further improve both parameters of measure after 16 weeks of exposure. Growth, survival and efficiency of feed conversion were not affected by the level of vitamins in the diet. No significant difference in the survival of milkfish fry was observed in any of the treatments but growth and efficiency of feed conversion of fish receiving the corn-gluten meal diets were significantly lower than those receiving the practical diets.

Keywords: fish culture; artificial feeding; diets; amino acids; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Aquacult. Cent., Univ. Philippines in the Visayas, Leganes, Iloilo, Philippines

418 Chiu, Y.N., N.S. Sumagaysay and M.A.S. Sastrillo. 1987. Effect of feeding frequency and feeding rate on the growth and feed efficiency of milkfish, *Chanos chanos* Forsskal, juveniles. Asian Fisheries Science 1(1):27-31.

The effect of feeding frequency on the growth and feed efficiency of milkfish (*Chanos chanos*) was investigated at 2 feeding rates (5% and 9% of body weight). The percentage weight gain ranged from 57% to 167%. Regardless of feeding rate, increasing feeding frequency from 4 to 8 times a day significantly increased growth and feed efficiency by about 20%. The results suggest that more frequent feeding over a wider spread of time would be a more efficient strategy for feeding milkfish in ponds.

Keywords: fish culture; feeding experiments; feed efficiency; growth; feeding behaviour; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Aquacult. Cent., Univ. Philippines in the Visayas, Leganes, Iloilo, Philippines

419 Coloso, R.M., L.B. Tiro and L.V. Benitez. 1992. Requirement for tryptophan by milkfish (*Chanos chanos* Forsskal) juveniles. Fish Physiology and Biochemistry 10(1):35-41.

Groups of milkfish (*Chanos chanos*) juveniles (mean initial weight 7.7 g) were fed semi-purified diets containing 0.9, 1.4, 2.1, 3.1, 4.1 and 6.1 g tryptophan/kg dry diet for 12 weeks. The mean crude protein content of the diets (containing white fishmeal, gelatin and free amino acid mixture to simulate the pattern of hydrolysed milkfish protein) was 49%. On the basis of the growth response, the tryptophan requirement of milkfish juveniles was estimated to be 3.1 g/kg diet. Fish fed low levels of tryptophan exhibited low weight gains and poor feed conversion ratios. Survival (92-100%) was consistently high in all treatments. Fish fed diets containing tryptophan levels > 3.1 g/kg had slightly lower survival rates. The activity of hepatic tryptophan pyrrolase showed no significant differences with increasing dietary tryptophan levels. No nutritional deficiency signs were observed other than the depression in growth rates in fish given the tryptophan deficient diets.

Keywords: fish larvae; enzymatic activity; protein synthesis; fish physiology; nutritional requirements; diets; feeding experiments; liver; amino acids; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo City, Philippines

420 Coloso, R.M., L.V. Benitez and L.B. Tiro. 1988. The effect of dietary protein-energy levels on growth and metabolism of milkfish (*Chanos chanos* Forsskal). Comparative Biochemistry and Physiology 89A(1):11-17.

Groups of milkfish (*Chanos chanos*) juveniles (mean weight, 2.8 g) were fed diets containing white fishmeal and gelatin with varying protein-energy to total metabolizable energy (PE: TME) ratios. Amino acids were incorporated in the diets to stimulate the pattern of milkfish protein. The control diet contained fishmeal as sole protein source and was not supplemented with amino acis. Among the amino acid supplemented diets, best growth was observed at PE: TME ratio of 44.4%. However, the control diet gave better growth rate than any of the amino acid supplemented diets. Specific activities of pyruvate kinase (PK) and glutamate dehydrogenase (GDH) increased significantly with increase in dietary protein-energy level.

Keywords: growth; animal metabolism; feeding experiments; bioenergetics; fish culture; amino acids; diets; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Div. Nutr. Sci., Dep. Anim. Sci., Cornell Univ., Ithaca, NY 14853, USA

421 Corre, V.L. and P.C. Natividad. 1985. Use of partially decomposed rice straw and mudpress as substrate to increase bangus production in brackishwater ponds. Technical Report. College of Fisheries, University of the Philippines in the Visayas, Miag-ao. Iloilo.

This experiment was conducted at the Brackishwater Aquaculture Center using twenty five (25) units of 100 sq.m. earthen ponds for Trial I and fifteen (15) units were used for Trial 2. Pond preparation included the repair and leveling of each pond, draining repair of leaks and seepages, installations of depth gauges, pond gauges, pond placards, stand pipes and screen enclosures.
Soil samples were taken randomly from each compartment before the experiment started and after the stock has been harvested. Wet pH, organic matter content, potential acidity and for its available phosphorus.
Lime was broadcast in each pond at rate of 2000 kg/ha for both trials. This experiment tested five treatments which was replicated five times for the first trial and three times each for the second trial.

It was distributed at random into each pond compartment. Treatment 1 served as a control wherein chicken manure was applied at a rate of 4000 kg/ha. In treatment II and III, rice straw was used at a rate of 3000 kg/ha and 6000 kg/ha, respectively. In treatment IV and V, mud press was used at 3000 and 6000 kg/ha also. These inputs were broadcasted in each respective compartments on July 31, 1984 and December 27, 1986 for Trial I and II, respectively. On the same dates, initial flooding of 5-10 cm was done to promote good growth of lablab. Inorganic fertilizer (16-20-0) was then added in each pond at a rate of 100kg/ha. after 15 days, water level was increased to 20-30 cm maintained at such depth for the whole culture period.

Keywords: rice straw; mudpress; substrate; bangus production; brackishwater ponds
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: College of Fisheries, UP in the Visayas, Leganes, Iloilo, Philippines.

422 Cruz, P.F.S. 1988. Dietary use of sex steroids and thyroid hormone as potential growth promoters for the spotted scat (*Scatophagus argus* Linnaeus) and milkfish (*Chanos chanos* Forsskal). University of the Philippines in the Visayas, Miag-ao, Iloilo. 51 p. M.S. thesis.

The study evaluates the potential use of 17 α-methyltestosterone (MT), estradiol-17β (E_2), and/or 3,5,3'-tiiodo-L-thyronine (T_3), as growth promoters for the spotted scat *Scatophagus argus* and milkfish *Chanos chanos* .
Scat fry were fed indoor diets containing 0, 0.1, 1.0, 5.0, and 10.0 ppm T_3. No effect on growth, feed efficiency, and survival was detected after 200 days. Increasing doses resulted to a decreasing trend in condition factor and body-tail ratio. Other abnormalities were evident at 5.0 and 10.0 ppm T_3. In adult scats, MT or E_2 at 10.0 and 20.0 ppm, or at 10.0 ppm combination with 5.0 ppm T_3. failed to improve growth after 70 days in pond cages. All hormone treatments had depressed growth and feed consumption. The control had the highest hepatosomatic index but was not significant to treatments 10.0 and 20.0 ppm E_2.
In milkfish, MT was tested indoor on juveniles at 0, 1.0, 5.0, 10.0, 20.0, and 40.0 ppm. After 112 days, MT at 1.0 ppm appeared to be anabolic, improving growth by 27.1%. Higher doses tended to depress food consumption and growth. Growth was significantly depressed at 40.0 ppm MT. No hormonal effect was observed on feed efficiency and survival. Increasing MT doses caused a trend of increasing condition factor.
There appears to be no anabolic potential of MT, E_2, and/or T_3 on scats. The study suggests species specificity on the anabolic potency of these hormones. Use of MT to enhance growth in juvenile milkfish appears to have promising commercial applications.

Keywords: milkfish diet; sex steroids; thyroid hormone; potential growth promoters; milkfish
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

423 Cruz, P.F.S. and Y.N. Chiu. 1990. Dietary use of 17 alpha-methyltestosterone as potential growth promoter for milkfish *Chanos chanos*, p. 307-310. In: Proceedings of the Second Asian Fisheries Forum, 17-22 April 1989, Tokyo, Japan. Asian Fisheries Society, Manila.
The study investigated the potential use of the anabolic hormone 17 alpha -methyltestosterone (MT) for improving growth in milkfish *Chanos chanos*. Milkfish is the most important foodfish cultured in the Philippines. Juveniles were fed diets containing 0, 1.0, 5.0, 10.0, 20.0 and 40.0 ppm MT. After 112 days, MT at 1.0 ppm appeared to be anabolic, improving growth by 27.1%. Higher doses tended to depress appetite and, consequently growth. Growth was significantly depressed at 40.0 ppm MT. There was no hormonal effect observed on feed efficiency and survival. The condition factor seemed to increase with increasing doses of the hormone. The study suggests promising commercial application of MT in milkfish culture.

Keywords: growth regulators; sex hormones; diets; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Coll. Fish., Univ. Philippines in the Visayas, 5000 Iloilo City, Philippines

424 De la Pena, L.D., Y.N. Chiu and F. Ganchero. 1987. Evaluation of various leguminous seeds as protein sources for milkfish, *Chanos chanos* Forsskal, juveniles. Asian Fisheries Science 1(1):19-25.

The nutritive value of 4 leguminous plant seeds: pigeonpea (*Cajanus cajan*), mungo (*Phaseolus radiatus*), kidneybean (*Phaseolus vulgaris*) and soybean (*Glycine max*), were evaluated as protein sources for milkfish (*Chanos chanos*) juveniles in isonitrogenous and isocaloric diets containing 40% protein.

Keywords: diets; artificial feeding; feed efficiency; *Chanos chanos*; *Cajanus cajan*; *Phaseolus vulgaris*; *Glycine max*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

425 Duray, M. and T. Bagarinao. 1984. Weaning of hatchery-bred milkfish larvae from live food to artificial diets. Aquaculture 41(4):325-332.

Two-week old milkfish (*Chanos chanos*) larvae (7.5 mm standard length, 2.3 mg wet body weight) previously fed only rotifers were weaned abruptly to six artificial diets (commercial feed TP, artificial plankton AS and BP, experimental SEAFDEC diets CT and CB, and moist egg diet) with control larvae fed *Artemia nauplii*. Survival rates ranged from 38% on moist egg diet to 63% on BP, with 42% in the control. On day 43, larvae attained mean lengths of 7.7 mm on moist egg diet to 13.4 mm on *Artemia*, with no significant differences between diets. The mean wet weights were highest in larvae fed *Artemia* (77.8 mg). Results show the feasibility of weaning (gradually) even younger milkfish larvae in hatcheries, using artificial diets.

Keywords: feeding; fish larvae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

426 Duray, M.N. 1995. The effect of tank color and rotifer density on rotifer ingestion, growth and survival of milkfish (*Chanos chanos*) larvae. Philippine Scientist 32:18-26.

The effect of tank color on rotifer ingestion, early growth and survival of milkfish larvae was assessed. The larvae were stocked at 30/L in 200-L fiberglass tanks coated black or unpainted (tan). Larvae were fed rotifers at densities of 5, 10, and 15/ml. Growth and survivals were higher in black tanks than in tan tanks. Rotifers ingested were also higher in larvae reared in black tanks. In black tanks, the survival of the larvae was enhanced at high rotifer density of 15/ml. Rotifer ingestion and growth of larvae improved at higher feeding levels.

Keywords: fish culture; food organisms; food consumption; food availability; survival; *Rotifera*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

427 Emata, A., C. Marte, I. Borlongan and J. Nocillado. 1996. The effect of dietary lipid and protein levels and ration size on the reproductive performance of cage-reared milkfish broodstock. Feeds for small-scale aquaculture, p. 122. In: Proceedings of the National Seminar-Workshop on Fish Nutrition and Feeds, 1-2 June 1994, Tigbauan, Iloilo, Philippines.

The effects of dietary lipid or protein levels and ration size on the reproduction and quality of eggs and larvae of cage-reared milkfish (*Chanos chanos*) broodstock were determined. In experiment I, broodstock fed low-lipid (6%) diet at 4% feed ration had the highest egg production (8.1 million eggs, n=9). There were no significant differences in the egg and larval quality of broodstock fed low- or high-lipid (10%) diet at 2 or 4% feed ration. In experiment II, broodstock fed diets containing 36% protein at 4% ration size had the highest egg production (7.1 million eggs in a season) and

mean number of eggs per spawning (0.51 million eggs, n=14). However, mean egg viability and hatching rate of broodstock fed diets containing 35% protein were lower than those of broodstock fed high protein (42%) diets irrespective of the ration size (2 or 4%). The results of these preliminary studies will lead into the determination of optimum dietary requirements and ration size of milkfish broodstock for the maximum.

Keywords: fish culture; cage culture; broodstocks; diets; artificial feeding; lipids; proteins; reproduction; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

428 Emata, A., I. Borlongan and J. Damaso. 2000. Dietary vitamin C and E supplementation and reproduction of milkfish *Chanos chanos* Forsskal. Aquaculture Research 31(7):557-564.

Milkfish *Chanos chanos* Forsskal broodstock (11 years old, average body weight 5.23-5.73 kg) reared in 10-m-diameter by 3-m-deep floating net cages (31-36 fish per cage) at SEAFDEC AQD's Igang Marine Substation in Guimaras Island, central Philippines, were fed daily at 3% of total body weight formulated diets (36% protein, 7-8% lipid) supplemented with 0.1% vitamin C, 0.05% vitamin E, both vitamin C and E or no vitamin supplementation (control) for 3 years. Reproductive performance was assessed in an attempt to determine the optimum nutrition for successful spawning of milkfish. The total egg production, mean number of eggs per spawning, number of spawns and mean egg diameter were not affected by dietary vitamin C and E supplementation. However, broodstock given dietary supplementation of vitamin C alone or in combination with vitamin E had a higher percentage of spawns with higher (> 90%) percentage egg viability, hatching and cumulative survival rate than those of the control. Broodstock given dietary vitamin E supplementation alone had few spawns, which made the results difficult to analyse. The results confirm the essentiality of vitamin C supplementation in producing more spawns with good egg and larval quality. The production of an adequate volume of good quality eggs and larvae to support hatchery operation is necessary to offset the huge investment in broodstock development, as it takes at least 5 years for milkfish to attain sexual maturation and spawning.

Keywords: fish culture; nutritional requirements; vitamin E; Vitamin C; fish larvae; fecundity; feeding experiments; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

429 Ferraris, R.P., M.R. Catacutan, R.L. Mabelin and A.P. Jazul. 1986. Digestibility in milkfish, *Chanos chanos* (Forsskal): effects of protein source, fish size and salinity. Aquaculture 59(2):93-105.

The true digestibility of casein, gelatin, fish meal, defatted soybean meal and *Leucaena leucocephala* leaf meal was measured in 60- and 175-g milkfish (*Chanos chanos* Forsskal) in fresh- and seawater. The diets contained 45% of these feedstuffs and 1.3% of the indicator substance, chromic oxide. Length of time between initial feeding and fish sacrifice did not significantly affect digestibility. Gelatin was the most digestible (90-98%) protein, regardless of size. Casein, defatted soybean meal and fish meal were moderately digestible (50-90%) and digestibility coefficients tended to increase as a function of fish size. L. leucocephala was the least digestible (10-40%). Rate of food movement was similar in both size groups, but was significantly faster when milkfish were in seawater rather than in freshwater. The effect of salinity on digestibility may in part be due to food motility changes necessitated by alterations in osmoregulatory processes when fish are in seawater.

Keywords: digestibility; proteins; salinity effects; artificial feeding; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

430 Figueroa-Bombeo, R. 1983. Growth and survival of *Penaeus monodon* and *Chanos chanos* fry fed with *Artemia* singly or in combination with artificial diet. University of the Philippines in the Visayas, Miag-ao, Iloilo. 48 p. M.S. thesis.

An experiment was conducted to compare growth and survival of prawn and milkfish fry fed with *Artemia*, artificial diet and the combination of *Artemia* and artificial diet in a 1:1 ratio. *Penaeus monodon* postlarvae and *Chanos chanos* fry were reared for 30 days at 15/liter stocking density in aquaria and white basins respectively.
There was no significant difference in average final weight of prawn postlarvae fed with *Artemia* and moist diet (0.09 g) compared to other diets except with postlarvae fed with moist diet alone (0.02 g). Postlarvae fed with *Artemia* + moist diet had the highest average length (25.71 mm) but this was not significantly different from the average length of postlarvae fed with *Artemia* + pellet and *Artemia* alone. Postlarvae fed with pelletized diet had a feed conversion ratio of 1.52 which is significantly different from the feed conversion of postlarvae fed with *Artemia* but not with other treatments. Protein efficiency ratio of postlarvae fed with *Artemia* and pellet (4.09) was significantly higher than those of all other treatments. Survival of postlarvae was highest (64.45%) when fed with pellets which is significantly higher than other diets except those fed with *Artemia* and pelleted diet (54.07%). Prawn postlarvae (PL_{7-10}) prefer *Artemia* with a size ranging from 3 to 5 mm.
Artemia fed milkfish fry have the highest average body weight (0.14 g) and average total length (26.91 mm) which are significantly different from other treatments. Best feed conversion of 9.52 was obtained with fry fed pulverized diet which is significantly different from the feed conversion of fry fed with moist diet alone. Protein efficiency ratio of milkfish fry fed with *Artemia* is significantly higher than the other treatments. Survival was highest with those fed with *Artemia* (48%) but this is not significantly different from those fed with other diets. Milkfish fry with an average weight of 20.7 mg prefer *Artemia* with a size ranging from 1 to 2 mm.

Keywords: growth; survival; *Penaeus monodon*; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

431 Fong, S.C. and H.P. Ju. 1987. Energy value of biomass within benthic algae of milkfish ponds. Aquaculture 64(1):31-38.

The energy content of benthic algae in milkfish *Chanos chanos*, ponds was measured. Algae in fertilized ponds contained 3.8 times more energy than algae in unfertilized ponds. Differences in algal flora pattern and variation of light extinction coefficients were considered as the major factors affecting the energy content of the benthic algae. Energy content during Apr and Aug appeared to be higher than at other months.

Keywords: biomass; biological production; energy; phytobenthos; fish ponds; habitat improvement (fertilization); food organisms; benthos; algae; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Inst. Mar. Biol., Natl. Sun Yat-Sen Univ., Kaohsiung, Taiwan

432 Fortes, N.R., M.F. Oivares and M.G. Pajarillo. 1983. Effect of silica enrichment on the production of milkfish in brackishwater ponds. Technical Report, Brackishwater Aquaculture Center, University of the Philippines in the Visayas, Leganes, Iloilo, Philippines.

An experiment to evaluate the use of rice hull as silica source was conducted in 16 units of 100 sqm ponds of U.P.V. Brackishwter Aquaculture Center, Leganes, Iloilo. Four treatments were used as follows: without fertilizers (Control); burnt rice hull at 9 kg/100 sq.m. ponds; 16-20-0 at 50 kg/100 sq.m. ponds; burnt rice hull at 1.9 kg/100 sq.m. ponds 16-20-0. Bangus fingerlings were stocked at 3000/ha and cultured for three months. Silica and phosphorus concentrations in water and soil were monitored regularly.
The concentration of phosphorus silica in water in the 16-20-0 plus silica treatment were observed to be 0.724 mg/L and 2.106 mg/L, respectively.

In terms of fish production (kg/ha), the following were obtained: 365.07; 388.60; 349.19 and 431.72 for the control, burnt rice hull alone, burnt rice hull plus 16-20-0 alone treatments. These results indicated that rice hull as source of silica benefited milkfish production, however, further studies are needed to determine the effect of silica on fish production.

Keywords: silica; brackishwater ponds; production; milkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: Brackishwater Aquaculture Center, UP Visayas, Leganes, Iloilo, Philippines

433 Gapasin, R.S.J. and M.N. Duray. 2001. Effects of DHA-enriched live food on growth, survival and incidence of opercular deformities in milkfish (*Chanos chanos*). Aquaculture 193(1-2):49-63.

The use of commercial enrichers to improve the nutritional quality of live food in larviculture of milkfish was investigated. Fish were either fed rotifers cultured on *Chlorella sp.* and newly hatched *Artemia nauplii* (Control, Trt I) or rotifers and Artemia given DHA enrichment diets (DHA-treated, Trt II). Results showed survival was significantly better ($P<0.05$) in the DHA-treated fish than in the untreated fish after 25-day culture period. Although growth was not statistically different ($P>0.05$) between the control and DHA-treated fish during the hatchery phase, extensive rearing of the postlarvae (fry) in nursery ponds for another 60 days showed that DHA-treated fish exhibited significantly better ($P<0.05$) growth than the untreated fish. Opercular deformities in 85-day old milkfish juveniles were also significantly lower ($P<0.05$) in the DHA-treated fish than the control. Survival after nursery culture, however, was high for both treatments but not significantly different ($P>0.05$).The lack of a viable and reliable method of mass culturing *copepods* as live food in the hatchery makes the use of off-the-shelf commercial enrichment diets for rotifers and *Artemia* a practical option in the larval culture of milkfish.

Keywords: animal nutrition; rearing; fish larvae; food organisms; survival; growth rate; nutritive value; polyunsaturated fatty acids; *Chanos chanos; Rotifera; Chlorella; Artemia*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

434 Gapasin, R.S.J., R. Bombeo, P. Lavens, P. Sorgeloos and H. Nelis. 1998. Enrichment of live food with essential fatty acids and vitamin C: effects on milkfish (*Chanos chanos*) larval performance. Aquaculture 162(3-4):271-288.

The effects of essential fatty acids (EFA) and vitamin C-enriched live food on growth, survival, resistance to salinity stress and incidence of deformity in milkfish larvae reared in tanks were investigated. Larvae were either fed rotifers cultured on *Chlorella sp.* and newly hatched *Artemia nauplii* (control), highly unsaturated fatty acid (HUFA)-enriched rotifers and Artemia nauplii or HUFA+vitamin C-enriched rotifers and Artemia nauplii. Milkfish growth in outdoor nursery ponds was also assessed to compare with growth in indoor tanks. Milkfish fed rotifers/ Artemia enriched with HUFA (32-48 mg dry weight, DW) or HUFA+vitamin C (33-45 mg DW) exhibited significantly ($P<0.05$) higher growth than those given unenriched live food (24-27 mg DW) after 40 days of culture. Growth of milkfish in nursery ponds (albeit lower in stocking density) showed similar trends as those reared in tanks. When subjected to salinity stress (Day 25), mortality of the HUFA+vitamin C-treated fish and HUFA-treated fish were significantly lower ($P<0.05$) than the control fish. Survival of 26-day old milkfish, however, did not differ significantly ($P>0.05$) among the treatment groups. Forty-day-old milkfish fed HUFA+vitamin C-enriched live food had significantly lower ($P<0.05$) incidence of opercular deformity (mainly cleft branchiostegal membrane) (8.4-14.7%) compared with those given HUFA-enriched (15.8-23.5%) or unenriched (27.3-33.5%) live food. Results demonstrated the effect of HUFA enrichment in enhancing milkfish larval growth and resistance to salinity stress but not overall survival. Moreover, HUFA and ascorbate supplementation decreased but did not totally eliminate incidence of opercular deformity in milkfish larvae.

Keywords: diets; feed composition; food additives; fish culture; salinity tolerance; salinity effects; fish diseases; dietary deficiencies; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

435 Hastings, W. 1975. Indonesia. Preliminary testing of artificial feeds manufactured from local ingredients for milkfish and shrimps. A report prepared for the Brackish Water Shrimp and Milkfish Culture Research and Development Project. FAO, Rome, 12 p.

The Government of Indonesia, assisted by UNDP and FAO, are engaged in a project to develop improved methods for expansion of shrimp and fish production on a national scale, to establish data collection programmes, and provide requisite training. As part of this project the author was assigned to assist in undertaking surveys of locally available feed ingredients, formulate appropriate feeds for cultivated fish and shrimps, undertake experiments in the preparation of feeds and conduct efficiency tests, develop feeding techniques and suitable feed dispensers, and train local staff in the methods of formulation and preparation of feeds feeding methods. The author reports on this work, with particular emphasis on feeds for milkfish and shrimp culture, and presents the data obtained from feeding experiments using milkfish in plastic pools and in tanks, and shrimps in tanks. Processing and equipment specifications are given, and some general recommendations presented. The major feed ingredients available in the north-central Java area are listed and described, and the 1974 cost of several spp around Jepara are tabulated.

Keywords: artificial feeding; feeding equipment; fish culture; shellfish culture; shrimps; aquaculture; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food and Agriculture Organization of the United Nations, Rome (Italy)

436 Henson, R.M. 1979. Save those bangus fry. Modern Agriculture and Industry-Asia. 7(2):19.

Efficiency of *Chaetoceros sp.* as live food for milkfish fry was determined. *Chaetoceros sp.* was cultured in the laboratory and given to the fry at different concentrations. The results confirmed the findings that this alga makes an ideal natural food to improve growth of crustaceans and finfishes.

Keywords: bangus fry; milkfish fry; feeding; milkfish culture
Location: SEAFDEC Aquaculture Department Library

437 Ikotun, S.J. 1981. Frequency of inorganic fertilizer application and its effects on milkfish (*Chanos chanos*, Forsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 85 p. M.S. thesis.

This experiment was conducted to determine the effects of frequency of inorganic fertilizer (16-20-0) application on the milkfish production, on "lab-lab" production, to correlate “lab-lab" production and net fish production, to find the changes in physico-chemical properties of water and soil, and to make the cost benefit analysis. The experiment was carried out in 12 earthen ponds at the Brackishwater Aquaculture Centre, Leganes, Iloilo, from April 2, 1980 to July 1, 1980. The frequencies of fertilizer applications (300 kg/ha of 16-20-0) tested were: 1) applied 12 times at 25 kg/ha per application every week in a period of 12 weeks (treatment A); 2) applied 6 times at 50 kg/ha per application every two weeks in a period of 12 weeks (treatment B); 3) applied 4 times at 75 kg/ha per application every three weeks in a period of 12 weeks (treatment C); 4) applied 3 times at 100 kg/ha per application every four weeks in a period of 12 weeks (treatment D).
Results indicated that net production of milkfish was highest in treatment B (782.9 kg/ha) followed by treatment C (777.2 kg/ha) and treatment A (741.5 kg/ha); while the lowest production of 587.6 kg/ha was obtained in treatment D. Although these differences were not significant, economic analysis showed that treatment C was the most profitable. Average survival rates of milkfish for all treatments were high, ranging from 95.8-100%. There was a significant difference in the production of "lab-lab (Ash-free-dry-weight) among treatments at 5% level with treatment D being significantly

less than treatments A, B and C. The correlation between "lab-lab" production and fish yield was positive and highly significant (r = 0.87, P 0.05). Treatment D often showed lower concentration of dissolved oxygen, pH, alkalinity and PO_4-P water than in treatments B, C and A.

Keywords: inorganic fertlizer; effects; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

438 Jamandre, D.R.M. 1980. The survival and growth of milkfish fry (*Chanos chanos*, Forsskal) fed with three artificial diets in a flow through system. University of the Philippines in the Visayas, Miag-ao, Iloilo. 56 p. M.S. thesis.

In two feeding trials, milkfish fry (ave. wt.: 7 mg) from the wild were stocked at 4,000/m^3 in 300 liter fiberglass tanks using a flow-through system. The fry were fed with three artificial diets containing a minimum protein level of 42%.
Results indicated that growth and survival were satisfactory up to the third week of holding. At the end of the 28-day holding period (Experiment I) survivals were 58%, 62.9% and 38.7% for diets A, B and C, respectively. Diet B was found significantly higher than diet C, but not diet A. Average weights were 112 mg for diet A, 118.2 mg for diet B and 90 mg for diet C. No significant differences were found among treatments for growth ($P<0.05$).
Another experiment was run with a modification of aeration basically using an airlift system. After 42 days of holding, the survivals were 15.6% for diet A, 18.4% for diet B and 11.3% for diet C. Average weights were 88.7 mg, 76.66 mg and 70.73 mg for fish fed diets A, B and C, respectively. There were no significant differences among these values.
At the termination of experiments, some of the reared fry showed hemorrhages on the head and a crooked back syndrome.

Keywords: survival; growth; artificial diets; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

439 Jayasinghe, J.M., S.C. Jayamanne and Sumitra-Vijayaraghavan. 1985. Feeding experiments on fingerlings of some cultivable fishes using two formulated feeds, p. 78-86. In: Aquaculture and Related Papers, NARA Occasional Paper/1.

Fingerlings of *Chanos chanos*, *Labeo rohita*, *Labeo dussumieri* and *Etroplus suratensis* were fed with two types of formulated feed-containing low protein and high carbohydrate. The feeds used in this study gave high net and gross growth efficiency (K sub(1) and K sub(2)) indicating that the fingerlings were able to utilise the feed efficiently.

Keywords: fish culture; diets; artificial feeding; feed efficiency; fingerlings; growth; *Chanos chanos*; *Labeo rohita*; *Labeo dussumieri*; *Etroplus suratensis*; Sri Lanka
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

440 Juario, J.V. and V. Storch. 1984. Biological evaluation of phytoplankton (*Chlorella sp.*, *Tetraselmis sp.* and *Isochrysis galbana*) as food for milkfish (*Chanos chanos*) fry. Aquaculture 40(3):193-198.

Phytoplankton cultures of *Chlorella sp.*, *Tetraselmis sp.* and *Isochrysis galbana* were used alone as feed to rear separate batches of newly caught milkfish (*Chanos chanos*) fry (about 21 days old). Ultrastructural studies of fry hepatocytes and pancreatic acinar cells indicated that they cannot directly utilize *Chlorella*, which has a rigid cell wall. The fry can directly utilize *Tetraselmis* and Isochrysis, but neither is nutritionally adequate for growth and survival if used as the only feed. *Tetraselmis* is nutritionally inferior to Isochrysis.

Keywords: aquaculture; nutritive value; food sources; fry; fish culture; food organisms; *Chanos chanos*; phytoplankton; *Chlorella; Tetraselmis; Isochrysis galbana*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

441 Kawamura, G. and S. Hara. 1980. Visual feeding of milkfish larvae and juveniles in captivity. Bulletin of Japanese Society of Scientific Fisheries 46(11):1297-1300.

Feeding of milkfish *Chanos chanos* larvae and juveniles on *Artemia nauplii* in captivity was observed. The retinae of the larvae were observed histologically. Milkfish larvae could not take food in the dark. The juveniles could take food in the dark although less efficiently than in the lighted condition. Vision thus seems to be the most important sense for the milkfish larvae since feeding depends very much on it. The larvae were found to have already well-developed regionally differentiated retinae with all elements present. Vision, evidently, is developed foremost among the senses.

Keywords: Fish larvae; *Chanos*; *Osteichthyes*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Lab. Fish. Tech., Fac. Fish., Kagoshima Univ., Kagoshima, Japan

442 Lam, T.J., J.V. Juario and J. Banno. 1985. Effect of thyroxine on growth and development in post-yolk-sac larvae of milkfish, *Chanos chanos*. Aquaculture 46(3):179-184.

Post-yolk-sac larvae of milkfish, *C. chanos* (commonly referred to as "fry") were collected along the shore in the Philippines. Treatment of these long, slender and transparent larvae with L-thyroxine-sodium (Eltroxin, Glaxo) by immersing in 0.5 ppm solution (changed daily) markedly accelerated their growth and development. By day 15 of the treatment, the treated larvae had become silvery, opaque and adult-like in form, whereas the control larvae were still slender and transparent (or at best translucent) with incomplete silvering of the body. 0.1 ppm Thyroxine was less effective. Discontinuation of the treatment after 8 days was also less effective as judged by the appearance and weight of the larvae on day 15. Milkfish (*C. chanos*) fingerlings with an average weight of 16.3 g were stocked at 4000 per ha in twelve 500-m super(2) experimental brackishwater ponds. The duration of supplementary feeding using pelletized chick-starter (21.15% protein) at a ration of 5% of the biomass, was varied between 0 and 3 months. The duration of supplementary feeding had non significant effect on the survival, growth and production of milkfish. The results indicated that supplementary feeding of milkfish was not necessary at a stocking level of 4000 fish/ha, when adequate pond fertilization was carried out.

Keywords: artificial feeding; aquaculture; feeding; brackish water; growth; survival; yield; brackishwater aquaculture; aquiculture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fish. Div., Kainji Lake Res. Inst., P.M. Bag 666, New Bussa, Kwara State, Nigeria

443 Lim, C. 1978. Effect of feeding rate on the survival and growth of milkfish (*Chanos chanos*) fry in a controlled environment. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(4):17-20.

The optimum daily feed allowance varies with species, age, size, frequency of feeding, culture procedures, quality of feed and water quality. This experiment indicated that with a diet containing 40% protein and 3,450 kcal of M.E. per kg, a feeding rate of 16-20% of the biomass is optimum for satisfactory survival and growth of fry raised in a controlled environment. Increasing the feeding level beyond this value was not beneficial but in turn increased the ammonia-nitrogen concentration to a level which is harmful to the fish.

Keywords: fish culture; feeding; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

444 Lim, C., S. Sukhawongs and F.P. Pascual. 1979. A preliminary study on the protein requirements of *Chanos chanos* (Forsskal) fry in a controlled environment. Aquaculture 17(3): 195-201.

Milkfish (*Chanos chanos*) fry with an average weight of 40 mg per fish were stocked in 60-1 wooden-glass aquaria filled with 30 l of filtered sea water with a salinity of 32-34 p.p.t. and a temperature of 25-28 C. They were fed diets containing 20, 30, 40, 50 and 60% protein and 2740 kcal of digestible energy per kg art a daily rate of 10% of the biomass for a period of 30 days. Fish which were fed the diet containing 40% protein had the highest weight gain which was significantly higher ($P<0.05$) than those of fish receiving the lower dietary levels of protein. Slightly lower weight gains were obtained when fish were fed diets containing 50 and 60% protein. Although feed conversion values were not statistically different ($P<0.05$) among all treatments, the value for the 40% protein diet (1.96) was the best. The mean survival rates were low for all treatments but was highest for the 40% protein diet. No significant difference ($P<0.05$) was found in the survival rates of fish receiving different treatments. Results show that a dietary level of 40% protein was required by milkfish fry for maximum growth, efficient feed conversion and high survival rate.

Keywords: feed; nutritional requirements; fry; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., P.O. Box 256, Iloilo City, Philippines

445 Lin, M.N., B.S. Tseng, K.Y. Lin and Y.Y. Ting. 1981. Some improvements (sic) of milkfish, *Chanos chanos*, over-wintering farming. Bulletin of Taiwan Fisheries Research Institute (33):695-701.

Some improvements of milkfish over-wintering farming are made in this paper. Using plastic cloth or plate to take place of couch grass and rice straw is better for building the wind shelter, due to the low cost, higher water temperature, and higher dissolved oxygen. The competitor of milkfish, tilapia, can be controlled by a trap made of nylon net. Artificial diet made from the powder of rice bran, peanut cake, wheat and flour is better compared with the traditional feeds (rice bran or peanut cake respectively). The fatty degree of milkfish feeding with the artificial diet mentioned above is 11.73 +/- 1.28, and the traditional one is 11.29 +/- 1.62, furthermore the artificial diet mixed with 3% of spirulina, the fatty degree can be increased to 12.04 +/- 1.00.

Keywords: improvements; over-wintering; farming; milkfish
Location: SEAFDEC Aquaculture Department Library

446 Lueckstaedt, C., U. Focken and K. Becker. 2001. Is there size-dependent feeding behaviour of milkfish *Chanos chanos* cultured semi-intensively in the Philippines?, p. 80. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Milkfish (*Chanos chanos* Forsskael) is the most important cultured finfish species in the Philippines. One of the management methods used in milkfish pond culture is the modified Taiwanese method, where fish are regularly restocked (every 6 to 8 weeks) in order to have different size classes in the pond simultaneously. It has often been claimed, that the food items ingested by milkfish differ according to the size of the fish. Therefore, using the modified Taiwanese method might reduce diet competition between fish and enable the resource natural food to be used optimally. The present study aimed to find out, if this also holds true for premarketable- and marketable juvenile milkfish from semi-intensive brackish water ponds. A commercially managed pond (9 ha) was monitored in Banate, Iloilo, Philippines in July 1998 (wet season). Growth of natural food was enhanced by fertilization. No supplemental feed was given to the fish. During the monitoring, 71 milkfish were caught using a cast-net every other hour (3 fish each) over a period of 48 hours, thus covering all hours of the day. Of the caught fish, 47 had a full stomach. The milkfish were distributed within

three weight-classes (< 100 g, 100-200 g, > 200 g) covering the premarketable- and marketable size of milkfish in the Philippines. Fish, stomachs and guts were measured and weighed to the nearest mm and 0.1 g respectively. Stomachs were removed and preserved in 70% alcohol. The stomach contents were later analysed microscopically according to the percentage of the microscope slide covered by each of the main diet components. The relative sizes of the stomachs were the same in all observed groups (39% of total body length). None of the dietary items of the fish in any of the three weight-classes was significantly different and there was therefore no evidence of any size-selective feeding in the monitored milkfish pond. On the basis of these results, it cannot be confirmed that natural food is more efficiently used by different size classes of fish.

Keywords: feeding behaviour; stomach content; diets; food organisms; pond culture; population structure; fish culture; age composition; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Animal Nutrition and Aquaculture, Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim (480b), 70593 Stuttgart, Germany, [mailto:focken@uni-hohenheim.de]

447 Lumasag, G.J. 1985. The effect of water flea, *Moina macrocopa* Straus, as food on the growth and survival of milkfish, *Chanos chanos* Forsskal, Fry. University of the Philippines in the Visayas, Miag-ao, Iloilo. 59 p. M.S. thesis.

Feeding trials were conducted at the Aquaculture Department, SEAFDEC on the effect of the water flea *Moina macrocopa* and the rotifer *Brachionus plicatilis*, in live or frozen forms in combination with the phytoplankton *Tetraselmis tetrahele*, on the growth and survival of wild milkfish, *Chanos chanos* Forsskal, fry in a 30-day rearing period. Two trials were conducted using glass aquaria in a completely randomized design of four treatments with three replicates. Stocking rate was 10 fry per liter and growth and survival rates were evaluated after the rearing period.
Highest mean survival rate (60.9%) and mean weight gain (61.2mg) were obtained in fry fed live *M. macrocopa*. This was followed by live *B. plicatilis*-fed fry with mean survival rate and mean gain in weight of 53.2% and 40.4 mg, respectively. Fry fed frozen *M. macrocopa* had the lowest mean survival rate of 32.8% and lowest weight gain of 39.3 mg. Survival rate of fry fed live *M. macrocopa* was significantly higher than other feeding experiments, however, mean weight gain of fry during a 30-day rearing period were not significantly different among treatments.

Keywords: water flea; *Moina macrocopa* Straus; growth; survival; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

448 Marasigan, A.N. 1981. The relationships of lab-lab production to milkfish production and nutrient levels in fertilized brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 39 p. M.S. thesis.

A study was conducted in sixteen 100 m^2 brackishwater ponds located at UPV-BAC to determine the efficacy of commercially available fertilizers, 45-0-0, 0-20-0 and 16-20-0, on lab-lab production and to provide information on the relationship of lab-lab production, fish production, and also the nutrient levels in the pond water.
The study was divided into two phases. Phase one estimated the standing crop of lab-lab utilizing a sampler while establishing the lab-lab community for the first 30 days prior to the stocking of milkfish into the ponds. Phase two monitored the primary productivity by means of light and dark bottles technique (for plankton) and the diurnal oxygen method (for the community metabolisms). Also the nutrient levels (PO_4-P, NO_3-N. NO_2-N and NH_3-N) of the water were determined.
Results of the first phase showed that urea and superphosphate gave high standing crop in terms of the mean ash-free dry weight, 70.42 g/m^2 and 60.19 g/m^2, respectively for the three sampling periods, February 1 - 12, 1979.
In the second phase, benthic production (lab-lab) accounted for the 60.25 percent of primary productivity while the phytoplankton component of the experimental ponds contributed 39.75% from March 8 to May 17, 1979.

There was low correlation between benthic production and nutrient levels except for nitrate for NO_3-N, r=0.473; for NO_2-N, r=0.171; for NH_3-N, r=0.62; for PO_4-P, r=0.198 at p=0.05).
Fish production was correlated with benthic (lab-lab) production (r=0.40, p=0.05). Superphosphate gave the highest fish yield and benthic production while the unfertilized pond gave the lowest fish yield and benthic production.

Keywords: lab-lab production; nutrient levels; milkfish production; nutrient levels; brackishwater ponds; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

449 Massaut, L. 1999. Cyanobacteria management in aquaculture ponds: a review. Marine Cyanobacteria. Bulletin de l'Institut Oceanographique (19):579-584.

Aquaculture is the production of fish, crustaceans, mollusks, and other aquatic organisms in confined environments. Aquaculture production has grown rapidly over the last 50 years and increasingly contributes to the growing demand for fisheries products. Fisheries catch from natural sources has stabilized at 80 to 90 million tons per year (FAO, 1996) and this supply falls short of an ever increasing demand. The current annual production of aquaculture products is 20 million tons and contributes about 18% of the total world fisheries production (FAO, 1996). The major organisms cultured in ponds are carps, shrimps, tilapia, milkfish, and catfish. Ponds typically vary from less than 1 ha to 10 ha in area with a water depth rarely exceeding 2 m. Ponds are filled with water from aquifers, runoff from watersheds, or from streams and estuaries. At the beginning of the grow-out period, fertilizers often are applied to increase phytoplankton growth and enhance availability of natural food organisms. Fertilization is supplemented with feed to achieve higher production and fish and crustaceans are provided a pelleted, high quality feed on a daily basis. Farmers obtain a feed conversion ratio (ratio of dry feed applied to net animal production) of about 1.8-3.5. Typically, fish and crustaceans consume the majority of the feed, but some uneaten feed reaches the pond bottom to be decomposed by microorganisms and converted to inorganic nutrients. Cultured animals convert part of the feed they eat to flesh, but excrete feces, ammonia, carbon dioxide, and other metabolites. As increasing amounts of feed and metabolic wastes enter the pond, concentrations of organic matter, nitrogen, and phosphorus increase in the water column. In catfish ponds, daily feed addition during the warmer months results in inputs of 200-400 mg N/m super (-3) d super (-1) and 30-60 mg P/m super(-3) d super(-1) (Tucker & van der Ploeg, 1993).

Keywords: biological control; ponds; fish culture; shrimp culture; aquaculture techniques; aquaculture; reviews; *Phytoplankton*; *Cyanophyta*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Fisheries and Allied Aquacultures, Auburn University, Alabama 36849 USA, [mailto:lmassaut@acesag.auburn.edu]

450 Marquez, F.E. 1987. Evaluation of rice bran and two pelleted diets as supplementary feed for milkfish (*Chanos chanos* Forsskal) reared in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 50 p. M.S. thesis.

The effects of supplementary feeding on milkfish growth, production, survival, water quality, and economic benefits in brackishwater ponds was evaluated by comparing the use of rice bran containing 11.3% protein and two pelleted diets containing 22.0% and 27.4% protein to an unfed control. The study was conducted for 142 days (January 27 to June 2, 1987) at the Brackishwater Aquaculture Center, Leganes, Iloilo. Four 800 sq m tide-fed ponds, subdivided into four quarters and containing water of 23-29°C and 35-47 ppt salinity were used. Each treatment was replicated in four pond compartments in a 4 x 4 completely randomized block design. Milkfish with initial average weight of 1 g and stocked at 8,000/ha fed on the natural food for the first 80 days after which the fish with feed treatments were given the experimental diets for the next 62 days. The average weight and standing crop were 57 g and 417 kg/ha respectively when feeding commenced. The use of any of the three supplementary feeds significantly ($P<0.05$) increased growth and production. The diets containing 22.0% and 27.4% protein had net profits higher by 35.3% and 46.7% respectively but rice

bran lower by 34.4% compared to inorganic fertilization (control). The growth of milkfish became significantly slower ($P<0.01$) than those fed the 27.4% protein diets when the standing crop of unfed and rice bran fed fish reached 535 kg/ha and fish fed 22.0% protein diet reached 972 kg/ha. Survival was not significantly different ($P>0.05$) among the treatments. At the maximum standing crops attained, the concentration of metabolites for all treatments was low but a significant increase ($P<0.05$) in levels of total carbon dioxide (CO_2) and nitrite-nitrogen (NO_2-N) was observed as biomass increased.

Keywords: rice bran; pelleted diets; supplementary feed; brackishwater ponds; milkfish
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

451 Minoso, M.G.G., I. Borlongan and S. Satoh. 1999. Essentiality of phosphorus, magnesium, iron, zinc, and manganese in milkfish diet. Fisheries Science 65(5):721-725.

Six semi-purified casein based diets were formulated to contain either a complete mineral mixture (control) or mineral premixes from which a specific test mineral was deleted to obtain phosphorus(P)-free, magnesium(Mg)-free, iron(Fe)-free, zinc(Zn)-free, or manganese(Mn)-free diets. These diets were fed to juvenile milkfish (mean initial weight 2.60 plus or minus 0.08 g) for a 22-week experimental period. Final mean percent weight gain ranged from 1022 to 1379% with P-free (1022%) and Fe-free (1066%) diets obtaining a significantly lower weight gain ($p<0.01$) than the control diet (1270%). Survival was greater than 90% and did not differ significantly among treatments. Upon termination of the growth experiment, milkfish flesh, bones, and combined samples of head, skin, and scales were dissected and analyzed for ash, P, Ca, Mg, Fe, Zn, and Mn content. The deletion of P or Fe from mineral mixture lowered P content in flesh and bone. Zn content in bone of fish was also lowered by exclusion of Zn, Mn, Mg or Fe. The result of this study demonstrated that it is necessary to supplement P and Fe even to semi-purified casein based diets.

Keywords: brackishwater aquaculture; fish culture; feeding experiments; feed composition; nutritional requirements; minerals; phosphorus; iron; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Lab. Fish Nutrition, Tokyo Univ. Fish. Konan, Minato, Tokyo 108-8477 Japan

452 Morioka, S., A. Ohno, H. Kohno and Y. Taki. 1996. Nutritional condition of larval milkfish, *Chanos chanos*, occurring in the surf zone. Ichthyological Research 43(4):367-373.

In order to clarify the nutritional conditions of larval milkfish in the surf zone, the following parameters were examined: 1) DNA and RNA content and RNA/DNA ratio of fed and unfed larvae collected from the surf zone and reared in the laboratory; 2) survival rate of the unfed larvae; and 3) total length, otolith increment counts and RNA/DNA ratio of wild larvae collected daily from the surf zone. The DNA and RNA content of the unfed larvae decreased, but increased in fed larvae. The RNA/DNA ratio decreased in unfed larvae, whereas in the fed larvae it decreased for the first three days after capture and increased thereafter. These results indicated that the values of DNA and RNA content and RNA/DNA ratio could be used as an indicator of nutritional condition of milkfish larvae after 6 days of starvation. Although total length of the wild-larvae did not show serial changes, their otolith increment counts showed continuous increases, indicating that the larvae sojourned in the surf zone for several days. In the same period, RNA/DNA ratios of the wild larvae decreased continuously, the ratios of larvae with fewer otolith increment counts being relatively higher than those of larvae with greater increment counts. Based on these results, the milkfish larvae remaining in the surf zone were concluded as being under insufficient nutritional conditions.

Keywords: surf zone; animal nutrition; fish larvae; otoliths; growth; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tokyo Univ. Fish., 4-5-7 Konan, Minato-ku, Tokyo 108, Japan

453 Nera, J.B. 1983. The effect of various sources of phosphorus on milkfish (*Chanos chanos* Forsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 121 p. M.S. thesis.

This study was conducted from September, 1981 to February, 1982 using 18 earthen ponds of approximately 40 m^2 at the Brackishwater Aquaculture Center (BAC) of the University of the Philippines in the Visayas (UPV), Iloilo City. The effects of various sources of phosphorus fertilizer were evaluated on the physico-chemical and chemical properties of the pond water and soil, primary productivity and fish yield. The study included six treatments: 1 (control), 2 (urea only), 3 (urea + rock phosphate), 4 (urea + solophos), 5 (urea + rock phosphate + solophos phosphate/double P_20_5 dosage) and 6 (monoammonium phosphate).

Highest concentrations of available phosphorus in the soil were obtained in the double P_20_5 dosage treatment. The available phosphorus was significantly correlated with soil pH and extractable iron. The average weekly concentrations of dissolved inorganic phosphate in water were significantly higher in the solophos (0.55 ppm), double P_20_5 dosage (0.45 ppm) and monoammonium phosphate (0.28 ppm) treatments than the rock phosphate (0.18 ppm), urea (0.20 ppm) and control (0.17 ppm) treatments. A positive and significant relationship of dissolved inorganic phosphate was observed with water pH, water-soluble iron and total alkalinity.

The average concentration of NH_3-N in water was significantly higher in the monoammonium phosphate treatment (0.29 ppm) than others that also received same amount of N though from urea. The concentrations in other treatments were: urea (o.13 ppm), solophos (0.11 ppm), rock phosphate (0.18), double P_20_5 dosage (0.11) and control (0.10 ppm).

The average weekly primary productivity measured by the three-point diel oxygen level was highest in the solophos treatment (16.72 ppm) and lowest in the double P_20_5 dosage treatment (14.79 ppm).

Highest net fish yields of 535.7 and 534.4 kg/ha were obtained in the control and urea treatments, respectively, but statistically they were not different from the yields obtained in other treatments. The average survival of the fish ranged from 83 to 100% where the control and double P_20_5 dosage treatments had 100% survival rate.

Cost benefit analysis showed that the application of various sources of phosphorus fertilizers on milkfish production was profitable except for the solophos treatment which showed a net loss. Except the control and urea only the profit in other treatments was marginal and they showed a cost benefit ratio of almost 1.0.

Keywords: phosphorus; milkfish production; milkfish culture; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

454 Nwosu, N.A. 1983. Effect of two basal application rates of monoammonium phosphate and different stocking densities on the milkfish (*Chanos chanos F*orsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 66 p. M.S. thesis.

The effect of two basal application rates of monoammonium phosphate (MAP) fertilizer and three different stocking densities on milkfish production, primary productivity and some selected soil and water properties were studied, using six treatments in a 2 x 3 factorial experiment in a completely randomized design with three replicates. The experiment was conducted from July 5, 1982 to December 2, 1982 at the University of the Philippines in Visayas Brackishwater Aquaculture Center, Leganes, Iloilo.

Treatment I (50 kg MAP/ha basal and 3,000/ha stocking density had the highest net production of 663.11 kg/ha, followed by Treatment III (50 kg MAP/ha basal and 6,000/ha stocking density) with a mean net production of 559.16 kg/ha. Treatment IV (75 kg MAP/ha basal and 3,000/ha stocking density) had the lowest net production of 304.09 kg/ha. Generally, treatments with 50 kg MAP/ha basal application had higher net production than treatments with 75 kg MAP/ha basal application. There were significant differences between the two basal fertilizer rates and the three stocking densities used in this study. Treatment I gave significantly higher net production than Treatments IV, V and VI.

Percent survival obtained in all treatments was high ranging from 88.9% to 100%. On the other hand, growth measured in terms of mean weight gain was significantly higher in Treatment I than the other treatment combinations.
Primary productivity had the highest and lowest means of 18.7 and 15.4 ppm - 0_2 in Treatments II and IV, respectively. The mean weekly primary productivity was not significantly different among treatments. Correlation analysis showed a high correlation coefficient of 0.71 between primary productivity and net fish yield.
Based on the results of this study, economic analysis showed that application of monoammonium phosphate (16-20-0) fertilizer at 50 kg MAP/ha basal and 30 kg MAP/ha subsequent application and 3,000/ha stocking density (Treatment I) is the most profitable with a net profit of P3,968.90/ha and a cost-benefit ratio of 1.65.

Keywords: basal application rates; monoammonium phosphate; stocking densities
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

455 Odunwa, H.I. 1986. Effects of chicken manure and pig manure (organic fertilizers) applied at different frequencies of milkfish production. University of the Philippines in the Visayas, Miag-ao, Iloilo. 97 p. M.S. thesis.

An experiment comparing the effects of different frequencies of application of the same amount of chicken manure and pig manure on brackishwater pond productivity, milkfish yield and physico-chemical parameters of pond water and soil was conducted at the Brackishwater Aquaculture Center, UPV College of Fisheries, Leganes, Iloilo, Philippines. The treatments were: 1 and 2, chicken and pig manure respectively, applied at 100kg/ha five times a week; 3 and 4, chicken and pig manures respectively, applied at 250 kg/ha two times a week; and 5 and 6, chicken and pig manures respectively applied at 500kg/ha once a week. The treatments were on moisture free or dry weight basis. All physico-chemical parameters monitored showed a general decrease in pH, increase in % organic matter, available phosphorus and total nitrogen for pond soil after the experiment while the water parameters fluctuated widely. Temperature and salinity plunged from 36.5 deg C and 40 ppt during the summer months to as low as 19.9 deg C and 15 ppt respectively with the onset of the rainy season. Significant differences were observed in pond water pH, temperature (before sunrise and sunset), dissolved oxygen (before sunrise and sunset) and primary productivity which also showed consistent higher values in treatments with chicken manure than those with pig manure. The pond watercolor was affected by the heavy manure loadings but never showed trends of becoming soap-like in consistency. The highest mean net fish yield of 547.63 kg/ha was obtained in treatment 5 while treatment 2 gave the lowest mean net fish yield of 454.63 kg/ha. Fish condition factor ranged from as high as 1.02572 to as low as 0.99715. Generally, these are lower than most published values for milkfish. The pecentage fish survival was considerably satisfactory ranging from 85% to 98.3%. Comparatively, the use of chicken manure resulted in higher yields than pig manure, and in terms of application frequency, the once a week treatment for both manures were better than the two times and five times a week treatments.

Keywords: feeding; organic fertilizers; milkfish production; milkfish
Location: SEAFDEC Aquaculture Department Library

456 Ogburn, D.M. and N.J. Ogburn. 1994. Use of duckweed (*Lemna sp.*) grown in sugarmill effluent for milkfish, *Chanos chanos* Forsskal, production. Aquaculture and Fisheries Management 25(5):497-503.

Oxidation treatment of sugarmill waste using duckweed (*Lemna sp.*) as part of the system, to reduce effluent nutrient concentrations and biological oxygen demand (BOD), was evaluated during a 6 month milling season in Negros Oriental, Philippines. Mean ammonia concentration in effluent water was reduced from 0.87 to 0.31 mg/l NH sub(3)-N and orthophosphate from 0.93 to 0.51 mg/l P sub(2)O sub(5), while mean BOD was reduced from 611 to 143 mg/l BOD sub(5), after treatment. Seasonal mass fish kills in the adjoining bay no longer occurred during the 3 years following introduction of this treatment. The mean duckweed production (dry weight) was 8.8 g/m

super(2)/day. Duckweed was harvested from a 1.9 ha area of the system and transferred to an adjacent milkfish, *Chanos chanos* Forsskal, farm. Its fertilization effect, in terms of lablab production (lablab is the biological complex of bluegreen algae, diatoms, bacteria and various animals which forms a mat at the bottom or floats in patches), was evaluated in the milkfish ponds. This was compared with ponds fertilized with either inorganic fertilizers or cow manure, in the traditional way. Lablab growth was significantly increased using duckweed, with ash-free dry weight production averaging 32 g/m super(2)/day following fertilization with duckweed compared with 4 g/m super(2)/day using inorganic fertilizers. Milkfish net production averaged 320 kg/ha/90-day crop in inorganically fertilized ponds, 545 kg/ha/90-day crop for cow manure and 820 kg/ha/90-day crop in duckweed-fertilized ponds. The system is described and the benefits of this integrated waste treatment-fish production facility are discussed.

Keywords: fish culture; fish ponds; waste utilization; wastewater treatment; pollution control; aquatic plants; water pollution control; *Chanos chanos*; *Lemna*; Philippines, Negros I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: NSW Fish., Locked Bag 9, Pyrmont, NSW 2009, Australia

457 Okoye, F.C. 1982. The effect of various rates of mono-ammonium phosphate (16-20-0) fertilizer application on milkfish production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 94 p. M.S. thesis.

The effects of various rates of basal and subsequent inorganic fertilizer (16-20-0) application on milkfish production, gross productivity, changes in the physical and chemical properties of the pond water and soil were studied using six treatments in a completely randomized design with three replicates. The treatments consisted of two basal application rates, 50 and 60 kg/ha and three subsequent application rates, 30, 40 and 50 kg/ha.
The experiment was conducted from July 28 to October 27, 1981 in eighteen 100 m^2 brackishwater ponds of the University of the Philippines Brackishwater Aquaculture Center, Leganes, Iloilo.
In general, treatments with basal fertilizer application of 60 kg/ha gave higher fish yield than treatments with basal application of 50 kg/ha. The highest fish yield of 595.g kg/ha was obtained in Treatment D (60 kg/ha basal and 50 kg/ha at five subsequent applications), followed by Treatment E (60 kg/ha basal and 30 kg/ha at five subsequent applications), 593.6 kg/ha and Treatment F (60 kg/ha basal and 40 kg/ha at five subsequent fertilizer applications), 507.3 kg/ha. Differences in fish yield among the treatments were not significant. The effect of subsequent fertilization in both 60 and 50 kg/ha basal applications did now show any differences. However, economic analyses showed that application of 60 kg/ha basal and 30 kg/ha at five subsequent applications with a total of 210 kg/ha is the most profitable with the highest net profit of P1,909.52/ha. The control treatment (50 kg/ha basal and 50 kg/ha at five subsequent applications with a total of 300 kg/ha) gave a net profit of P785.30/ha. Percent survival, growth, measured in terms of mean gain length and weight of milkfish among treatments were not significant.
Average weekly gross productivity was higher in treatments with 60 kg/ha basal application than in treatments with 50 kg/ha basal application. Correlation analysis showed significant correlation between gross productivity and total fish yield.

Keywords: mono-ammonium phosphate; fertilizer application; milkfish production; brackish water ponds
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

458 Omoloyin, O.J. 1981. Evaluation of commercial fertilizers for milkfish (*Chanos chanos* Forsskal) production in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 84 p. M.S. thesis.

The effects of commercial Fertilex (Fx-LBECM) and diammonium phosphate (18-46-0) on milkfish (*Chanos chanos*) yield, 'lab-lab' quality, and physico-chemical properties of water and soil, were evaluated using four different treatment levels in a randomized complete block design with three replications. The treatments include I - Control, II - Fertilex, III - Fertilex with 18-46-0, IV -18-46-0,

in experimental ponds of the Brackishwater Aquaculture Centre, Leganes, Iloilo. The study began on 25 January and ended in 1 July 1980.
Average dissolved inorganic phosphorus concentration in the treatments with Fertilex plus 18-46-0 and 18-46-0 was 0.20 ppm and 0.33 ppm, respectively, higher than in the control; while average concentration in the treatment with Fertilex alone was 0.03 ppm lower than control.
Ammonia nitrogen concentrations were significantly higher in the 18-46-0 and Fertilex alone treatments than in the control and Fertilex with 18-46-0 treatments. Numerically, average pH, total alkalinity and sunrise dissolved oxygen was higher in the control and 18-46-0 treatments. Numerically, average pH, total alkalinity and sunrise dissolved oxygen was higher in the control and 18-46-0 treatments than in the Fertilex alone or Fertilex with 18-46-0 treatments.
The reduction in soil organic matter at the end of the experiment was higher in the control (0.7%) and 18-46-0 (0.6%) treatments than in the Fertilex alone (0.4%) and Fertilex with 18-46-0 (0.4%) treatments. The increase in soil available phosphorus was higher in the Fertilex with 18-46-0 treatment than in other treatments. The total nitrogen and soil pH differed little among treatments. There was a positive relationship between organic matter and total nitrogen in the soil (r = 0.586) and between phosphorus level in water and in soil (r = 0.408). Ash-free dry weight of 'lab-lab' was lower (17.8%) in the Fertilex with 18-46-0 treatment than other treatments.
The highest net fish yield (828.2 kg/ha) was obtained in the 18-46-0 treatment. It was followed by the control (701.2 kg/ha), Fertilex alone (667.9 kg/ha), and Fertilex with 18-46-0 (596.3 kg/ha) treatments. Differences in fish yield between treatments were not significant, however. Milkfish growth, from length-weight relationship, was isometric in the control, negatively allometric in the Fertilex alone and Fertilex with 18-46-0 treatments, and positively allometric in the 18-46-0 treatment. The use of Fertilex alone or with 18-46-0 did not increase the milkfish production in this experiment and was negatively profitable. The cost benefit ratio in the control and 18-46-0 treatments was about double that in the Fertilex alone and Fertilex with 18-46-0 treatments.

Keywords: evaluation; commercial fertilizers; milkfish culture; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo.

459 Otubusin, S.O. 1982. The effect of duration of feeding on the production of milkfish (*Chanos chanos* Forsskal) in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 35 p. M.S. thesis.

Twelve 500 sq. meters experimental ponds of the Brackishwater Aquaculture Center, Leganes, Iloilo, Philippines were stocked with milkfish fingerlings (16.3 g average weight) at a rate of 4,000/ha to evaluate the effect of feeding duration on production of milkfish for culture period of 82 days (March 9 to May 29, 1981). Four treatmrents with three replicates each were used as follows: (I) Control, no supplementary feeding, (II) supplementary feeding during the 3rd month of culture, (III) supplementary feeding during the last two months and (IV) supplemental feeding throughout the whole culture period (3 months), in a completely randomized design. The duration of a supplemental feeding did not have any significant effect on the survival, growth, production and condition factor of milkfish. The average survival rates for treatments I, II, III and IV were 96.4%, 95.5%, 92.8% and 95.6%, respectively, while the growth rates were 1616.1%, 1158.7%, 1147.4% and 1417.1%, respectively. The gross milkfish production/ha/harvest was highest in treatment I, 967.5 kg followed by treatment III, 816.8 kg; treatment II, 616.3 kg, and treatment IV, 611.9 kg which was affected by a heavy intrusion of *Tilapia mossambica*. The mean condition factor values were the same for treatments I and II (0.86), but 0.84 and 0.85 for treatments III and IV, respectively. Cost and return analysis showed that milkfish production under the different durations of feeding at the stocking rate of 4000 fingerlings/ha was not profitable. Return on operating cost was highest in treatment I, 42.95%. Losses were incurred in treatments II, III and IV and were 12.18%, 16.75% and 10.13%, respectively. The abundant growth of natural food in the ponds and the low stocking density of 4,000 fingerlings/ha among other factors were advanced as the causes of the non-profitability of milkfish production under the different durations of feeding.

Keywords: duration of feeding; feeding; milkfish production; milkfish
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo, Philippines

460 Pantastico, J.B., J.P. Baldia and D.M. Reyes Jr. 1986. Feed preference of milkfish (*Chanos chanos* Forsskal) fry given different algal species as natural feed. Aquaculture 56(3-4):169-178.

Acclimated milkfish fry (mean wet weight, 6.0 mg) were fed with unialgal cultures of five species of freshwater algae: *Oscillatoria quadripunctulata*, *Chroococcus dispersus*, *Navicula notha*, *Euglena elongata* and *Chlorella ellipsoidea*. In the first experiment, the filamentous blue-green alga, *Oscillatoria*, appeared most acceptable to milkfish fry throughout the growing period, while feeding milkfish fry with the unicellular species, *Chroococcus*, resulted in lower weights and survival. In the second experiment, increases in weight of milkfish fry fed with *Oscillatoria* alone or in combination with *Chroococcus* were comparable. However, a significant increase in survival was obtained with the combination feeding. A third experiment showed that high density cultures of *Oscillatoria* resulted in significantly large weight increments in all growth stages. The other algae tested did not support growth of milkfish fry. Super(14)C-Labeled algae of the same species were fed to milkfish fry. Significantly high assimilation rates were observed in almost all growth stages of milkfish fry with *Oscillatoria* alone or *Chroococcus* alone. Negligible amounts of *Navicula*, *Chlorella* and *Euglena* were assimilated.

Keywords: food preferences; fish culture; fry; diets; feeding experiments; algae; growth; survival; *Chanos chanos*; *Oscillatoria quadripunctulata*; *Chroococcus dispersus*; *Navicula notha*; *Euglena elongata*; *Chlorella ellipsoidea*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Binangonan Res. Stn., SEAFDEC Aquacult. Dep., Binangonan Rizal, Philippines

461 Parreño, C.B. 1986. Comparison of cow manure and chicken manure as fertilizers on the production of milkfish in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 178 p. M.S. thesis.

The study tested the following treatments: Treatment I (chicken manure only), Treatment II (cow manure only), Treatment III (16-20-0 only), Treatment IV (chicken manure plus 16-20-0), Treatment V (cow manure plus 16-20-0) and Treatment VI (control, no fertilization). Each was replicated three times following a completely randomized design to determine the effects of cow manure on milkfish production and pond productivity in comparison to the effects of the chicken manure as an attempt to evaluate cow manure as source of fertilizer. Eighteen units of 252 m^2 were stocked each with 76 (stocking density of 3,000/ha.) milkfish on June 15 and grown until September 15, 1984 for a total of 90 culture days at the Iloilo State College of Fisheries Brackishwater Fish Farm, Barotac Nuevo, Iloilo.

Available phosphorus, D.O. before sunset and pH were significantly greater in ponds fertilized with cow manure only. Ammonia-nitrogen was significantly higher in ponds fertilized with chicken manure plus 16-20-0. Temperature and salinity did not vary among treatments.

Primary productivity was highest in Treatment II (cow manure only) and in Treatment IV (chicken manure plus 16-20-0). Survival in all treatments was high ranging from 88 to 98%.

Fertilization with organic manure generally increased fish production. The highest mean net fish yield (286.38 kg/ha) and mean growth rate of 1.082 g/day were obtained in Treatment II (cow manure only). Treatment IV (chicken manure plus 16-20-0) produced 279.84 kg/ha with a mean growth rate of 1.051 g/day. Treatment I (chicken manure only) obtained 242.22 kg/ha with a mean growth rate of 0.928 g/day; Treatment V (cow manure plus 16-20-0) had 228.49 kg/ha with a mean growth rate of 0.852 g/day; Treatment III (16-20-0 only) had 181.19 kg/ha with a mean growth rate of 0.766 g/day and Treatment VI (control) obtained the lowest production of 126.19 kg/ha with a mean growth rate of 0.498 g/day which signifies that fertilizer affected milkfish production.

The results demonstrated that of all fertilizers used in this study, cow manure was relatively the most effective in enhancing milkfish production. Chicken manure plus 16-20-0 showed the second best results.

Keywords: cow manure; chicken manure; feeding; diet; comparison; fertilizers; milkfish production
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

462 Pascual, F.P., N.S. Sumagaysay and I.G. Borlongan. 1991. Modular method of rearing milkfish with artificial feed, p. 159-167. In: S.S. De Silva (ed.). Fish nutrition research in Asia: Proceedings of the Fourth Asian Fish Nutrition Workshop, Udorn Thani, Thailand. Asian Fisheries Society, Special Publication 5. Asian Fisheries Society, Manila, Philippines.

The study was conducted to determine the effectiveness of a practical diet, the profitability of feeding during 2 seasons, and the effect of a diet with coconut oil on the fatty acid profile of milkfish (*Chanos chanos*) fingerlings. Milkfish fingerlings of average weight 6.2 g and 10.2 g were reared in earthen ponds of 3 compartments (550, 1,100 and 2,200 m super(2)) using the modular culture system. One month prior to harvest, fish in Treatment 1 were fed a practical diet containing 42% crude protein, 13.1% crude fat and 33.2% nitrogen-free extract while fish in Treatment 2 depended solely on the natural food in the pond. The fish fed during the last month of culture were heavier (141 g) than the unfed fish (100 g) in Experiment 1 (dry season) but had similar weights (44 and 41 g) in Experiment 2 (rainy season). Weight gain of fish in Experiment 1 was significantly higher than in Experiment 2. Varying temperature and salinity during different seasons influenced fish growth and production. Feeding milkfish was not profitable during the cooler months. Fatty acid profile in depot fat of fed fish reflected that of the diet. Palatability tests showed that fed fish were preferred to the unfed fish.

Keywords: fish culture; diets; artificial feeding; fatty acids; rearing; fingerlings; *Chanos chanos*.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

463 Raj, R.P. and A.R. Thirunavukkarasu. 1987. Lipid requirements of milkfish (*Chanos chanos*) fry. Indian Journal of Fisheries 34(4):455-463.

Feeding experiments conducted in the laboratory on the fry of milkfish, *Chanos chanos*, with purified diets containing graded levels of lipids showed that 6%-lipid level induces the optimum food intake, maximum growth and best utilization of food and protein. Whereas the lipid levels higher than this optimum have led to increased fat deposition in the tissues, the lower levels have caused reduced growth and poor utilization of food and protein. An inverse relationship is observed between the moisture and lipid contents of the experimental fish. The diet containing 6% lipid has provided the fish with 1.09% saturated fatty acids, 1.56% mono-unsaturated acids, and 3.195% of poly-unsaturated fatty acids. The omega super(6)/ omega super(3) ratio of the diet was 2.43/0.762. (DBO)

Keywords: marine fish; food; feeding; nutritional requirements; lipids; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: CAS in Maricult., CMFRI, Cochin 682 031, India

464 Samsi, S. 1979. Effects of various protein sources on the growth and survival rates of milkfish (*Chanos chanos* Forsskal) fingerlings in a controlled environment. University of the Philippines in the Visayas, Miag-ao, Iloilo. 42 p. M.S. thesis.

Chanos chanos (Forsskal) fingerlings averaging 0.57 g each were fed diets containing various major protein sources, namely fish meal, meat and bone meal, shrimp-head meal, soybean meal, copra meal and ipil-ipil leaf meal at a rate of 6% (dry matter) of the total body weight daily, six days a week for a period of six weeks. Fish were stocked in eighteen 60-liter aquaria using a flow through system with a flow rate of 0.6 to 0.8 L/minute. Experimental diets were formulated to contain equal quantities of all essential nutrients with approximately 20% protein level and 2,400 kcal of digestible energy per kg diet.
Results of the experiment indicated that animal proteins were better utilized by milkfish fingerlings than were plant proteins. Fish fed diets containing fish meal and meat and bone meal essentially gave significantly ($P<0.05$) higher average weight gains than other treatments. Animal protein sources also gave significantly higher survival rates than did plant protein. No significant differences in survival rate were noted among those fed the three animal proteins. Among the plant proteins,

only soybean meal provided an acceptable level of growth and survival to the fish, while copra and ipil-ipil leaf meal apparently are not good protein sources, since the fish that received these diets lost weight and had very low survival.

The feed conversion values of the animal protein diets were better than those of plant protein. Fish meal diets provided the best feed conversion. Likewise, fish meal diet gave the highest PER value and was followed by meat and bone meal, shrimp-head meal and soybean meal. Copra meal and ipil-ipil leaf meal diets provided negative PER values.

Keywords: protein sources; growth; survival rates; controlled environment
Location: University of the Philippines in the Visayas

465 Santiago, C.B. 1986. Nutrition and feeds (milkfish), p. 181-207. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

A review is made of present information on digestive organs and enzymes, food and feeding habits of different age groups, digestibility of feed and nutrient requirements of milkfish (*Chanos chanos*). Recommendations are included for applications to milkfish culture.

Keywords: fish culture; nutritional requirements; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Southeast Asian Fish. Dev. Cent., Aquacult. Dep., Binangonan Res. Stn., Binangonan, Rizal, Philippines

466 Santiago, C.B., M. Banes-Aldaba and E.T. Songalia. 1984. Effect of artificial diets on growth and survival of milkfish fry in fresh water. Aquaculture 34(3-4):247-252.

Wild milkfish (*Chanos chanos*) fry (mean weight = 15 mg) were reared in fresh water for 5 weeks using four artificial dry diets, Moina or blended water hyacinth leaves as feed. The fry fed with artificial diets attained 83-95% mean survival rates and 0.16-0.18 g mean weight gains. Those fed with Moina and blended water hyacinth leaves had much lower growth and survival. The four dry diets containing 40% crude protein appeared adequate for the fry. Substitution of up to 5% crude protein by soybean meal and/or ipil-ipil leaf meal did not affect growth, but diets containing ipil-ipil leaf meal gave slightly lower survival rates.

Keywords: feed; growth; survival; fry; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., Southeast Asian Fish. Dev. Cent., Binangonan Res. Stn., Binangonan, Rizal, Philippines

467 Segner, H., B. Orejana-Acosta and J.V. Juario. 1984. The effect of *Brachionus plicatilis* grown on three different species of phytoplankton on the ultrastructure of the hepatocytes of *Chanos chanos* (Forsskal) fry. Aquaculture 42(2):109-115.

The effect of the rotifer, *B. plicatilis*, grown on unialgal cultures of *Isochrysis galbana*, *Tetraselmis sp.* and *Chlorella sp.* on the hepatocytes of milkfish (*C. chanos*) fry was evaluated by electron microscopy. Rotifers grown on the three different species of phytoplankton brought about different ultrastructural features in milkfish fry hepatocytes. Best results were obtained from fry reared on Isochrysis -fed rotifers. The use of marine *Chlorella* -red rotifers as feed for fry resulted in the poorest hepatocyte ultrastructure, indicating that this was nutritionally the least adequate culture food. None of the three diets, however, produced an optimal hepatocyte ultrastructure similar to that obtained by feeding the fry with a mixture of artificial feed and newly hatched *Artemia nauplii*.

Keywords: food organisms; fry; liver; algae; hepatocytes; ultrastructure; nutrient status; *Brachionus plicatilis*; *Chanos chanos*

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Univ. Heidelberg, Im Neuenheimer Feld 230, 6900 Heidelberg, FRG

468 Segner, H., P. Burkhardt, E.M. Avila, J.V. Storch and V. Storch. 1987. Effects of *Chlorella*-feeding on larval milkfish, *Chanos chanos*, as evidenced by histological monitoring. Aquaculture 67(1-2):113-116.

Milkfish, *Chanos chanos*, larvae were found to suffer 100% mortality within 6 days of feeding when reared on *Chlorella sp.* According to the liver ultrastructure, *Chlorella*-fed fish underwent starvation. Likewise, no signs of lipid absorption were observed in the intestine of *Chlorella* -fed larvae. On the other hand, *Chlorella*–related histological alterations of the enterocytes in the anterior part of the intestine were different from starvation-related alterations. It is concluded that *Chlorella* -feeding creates a starvation for larval milkfish.

Keywords: fish larvae; starvation; mortality causes; histopathology; artificial feeding; digestibility; *Chlorella*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Zool. Inst., Univ. Heidelberg, Im Neuenheimer Feld 230, D-6900 Heidelberg, FRG

469 Segner, H., P. Burkhardt, E.V. Avila, J.V. Juario and V. Storch. 1987. Nutrition-related histopathology of the intestine of milkfish *Chanos chanos* fry. Diseases of Aquatic Organisms 2(2):99-107.

A histopathological study was conducted on the intestine of milkfish larvae *Chanos chanos*, subjected to different nutritional conditions. Newly caught milkfish fry, ca 20 days old, were starved for 7 days and then fed with either *Artemia nauplii* or *Chlorella sp.* The latter diet, as already shown in other studies, is detrimental to young milkfish. A third, control, group of fry was starved for a further 2 days. In larvae fed with Artemia, 1 to 2 hours after feeding, intensive lipid absorption was noted in the first part of the intestine. The second part of the intestine was characterized by pinocytotic activity and the presence of large supranuclear vacuoles. *Chlorella*-fed larvae, although containing broken algae within the gut lumen, displayed no signs of nutrient absorption as detectable by electron microscopy. In Intestine I, enterocytes contained bizarre nuclei, an enhanced number of lysosomes and occasionally large intracellular vacuoles. In addition, intercellular spaces were dilated. Histological alterations were similar to those for starved fry.

Keywords: intestines; histopathology; animal nutrition; food organisms; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Zool. Inst., Univ. Heidelberg, Im Neuenheimer Feld 230, D-6900 Heidelberg, FRG

470 Sembrano-Timbol, A. 1974. Observations on the growth of young bangus, *Chanos chanos* (Forsskal) on two types of pelleted food. Philippine Journal of Science 103(4):199-206.

Pre-fingerling, fingerling and juvenile bangus were seined from inshore Oahu (Hawaii) waters and raised in tanks on different pelleted foods to determine relative growths and mortalities, and the feasibility of totally artificial rearing. Collection efforts showed that young bangus occurred locally in shallow inshore waters. Bangus were graded into 3 size-groups (< 7, 7-11, > 11 g). Each group was divided into paired lots (700, 1000, 1150 g, respectively) that were placed in identical 0.56 cum tanks with seawater flowing through 10 liters/min. In 2 feeding trials, one series of fish was fed high-protein trout pellets (fish-meal base), the other was fed low-protein rabbit pellets (alfalfa base) costing only 1/4 as much as the former. Those fed with trout pellets showed higher wt gain. Also, mortality was lower among those fed with trout pellets (avg 8% vs 16% for rabbit pellet diet). The surviving fish showed average wt gains of 27% (trout pellet fed) and 11% (rabbit pellet fed) in 8 wks. Diseases and temp effects are considered. It is concluded that trout pellets are nutritionally superior to rabbit pellets under conditions of the experiment.

Keywords: fish culture; artificial feeding; nutrition; growth; mortality; proteins; diseases; temperature effects; *Chanos chanos*; ISEW, Hawaii, Oahu
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ.Hawaii, HI (USA). Dep.Zool.

471 Seneriches, M.L.M. and Y.N. Chiu. 1988. Effect of fishmeal on the growth, survival and feed efficiency of milkfish (*Chanos chanos*) fry. Aquaculture 71(1-2):61-69.

This study was undertaken to determine whether the nutritional value of milkfish fry diets could be improved by partially replacing corn gluten meal by white fishmeal and supplementing diets containing corn gluten meal as the sole protein source with either the inorganic or lipid-soluble fractions of white fishmeal. It is concluded that the nutritional value of protein from white fishmeal is higher than that of protein from corn gluten meal for milkfish fry. Also, diets for milkfish fry should contain not less than 15% of the protein from fishmeal to support good growth, survival and feed efficiency.

Keywords: feeding experiments; fish meal; feed efficiency; nutritive value; survival; growth; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Aquacult. Cent., Coll. Fish., Univ. Philippines, Visayas, Iloilo City 5000, Philippines

472 Seraspe, E.B. 1979. Intensive feeding of milkfish fry (*Chanos chanos* Forsskal) in net enclosures using complete and incomplete diets at various protein levels. University of the Philippines in the Visayas, Miag-ao, Iloilo. 61 p. M.S. thesis.

Twenty-six net enclosures (approximately 1 m^3) suspended in a brackishwater pond were used to grow milkfish fry (0.01 g average weight) to fingerlings (0.75 g average weight) for 64 days to determine whether supplemental feeding will increase growth and survival of fry; whether it is best to give vitamin-enriched feed and what level of protein is considered optimal for milkfish fry. Suitability of net enclosures for rearing milkfish fry was also assessed. Four levels of crude protein (20%, 30%, 40% and 50%) in complete and incomplete formulations were evaluated and assigned randomly among the experimental units. Feeds were given in fine crumbles, at 8% to 6% of total body weight on a dry weight basis for six days a week. Survival was higher in complete diet regime than in incomplete diet regime but there was no significant difference with regards to growth. Forty percent was found to be the optimum level of protein for maximum growth of the milkfish fry. Limitations for rearing fry in cages were met such as fouling of the net, low water interchange in the net, increased labor costs for handling, feeding and cage maintenance.

Keywords: intensive feeding; feeding; net enclosure; milkfish diets; protein levels; milkfish; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

473 Shiau, C.Y., Y.J. Pong, T.K. Chiou and Y.Y. Ting. 2001. Effect of starvation on free histidine and amino acids in white muscle of milkfish *Chanos chanos*. Comparative Biochemistry and Physiology 128(3):501-506.

Milkfish (*Chanos chanos*) decreased their body weight from 47 to 28 g over the 60-day period of starvation. Starvation also resulted in the reduction of muscle lipid and protein, and hepatosomatic index. The predominant free amino acid (FAA) in white muscle of milkfish was histidine, followed by taurine and glycine. In the first 25 days of starvation, no significant change in histidine was found. After 40 days of starvation, however, the histidine concentration was significantly decreased by 46%, and remained unchanged thereafter. As compared to control group fish, the 60-day-starved fish possessed only half the amount of histidine. Taurine and glycine, on the other hand, showed no significant changes throughout starvation. Taurine became the most predominant in the FAA pool after 40 days of starvation, and the concentration of 60-day-starved fish was two times higher than

that of control group fish without starvation. The ratios of histidine, taurine, and glycine to total FAAs remained approximately the same although the individual contributions varied considerably to the total FAAs during starvation. The results of this study suggested that a good strategy would be to keep taurine and glycine in milkfish muscle at relatively high levels for physiological function as histidine decreased drastically for energy source under conditions of food deprivation.

Keywords: starvation; amino acids; muscles; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Food Science, National Taiwan Ocean University, Keelung, Taiwan, ROC, [mailto:cyshiau@mail.ntou.edu.tw]

474 Shiau, S.Y., B.S. Pan, S. Chen, H.L. Yu and S.L. Lin. 1988. Successful use of soybean meal with a methionine supplement to replace fishmeal in diets fed to milkfish *Chanos chanos* Forsskal. Journal of the World Aquaculture Society 19(1):14-19.

An experimental feeding trial was conducted to study the feasibility of using soybean meal to replace fish meal as a protein source for milkfish (*Chanos chanos*) feeds containing 30% and 40% dietary protein. The replacement levels were 0%, 33%, 67% and 100%. In each replacement level, methionine was supplemented to the amount that the fishmeal control group contained. The data suggest that up to 67% of fishmeal in milkfish feed could be replaced by commercial hexane-extracted soybean meal and a methionine supplement without any adverse effect on milkfish growth and feed conversion rate.

Keywords: artificial feeding; diets; proteins; feed efficiency; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Mar. Food Sci., Natl. Taiwan Coll. Mar. Sci. Technol., Keelung, Taiwan 20224

475 Sorgeloos, P., P. Leger and P. Lavens. 1988. Improved larval rearing of European and Asian seabass, seabream, mahi-mahi, siganid and milkfish using enrichment diets for *Brachionus* and *Artemia*. World Aquaculture 19(4):78-79.

The findings presented are of studies conducted to evaluate the effect of feeding enriched live food (*Artemia* and *Brachionus*) to different marine fish species: *Dicentrarchus labrax*, *Sparus aurata*, *Lates calcarifer, Coryphaena hippurus, Siganus guttatus* and *Chanos chanos*. Results showed enriched *Artemia*-fed larvae erform better than non-enriched treatments, with higher survival and better growth rates.

Keywords: fish culture; diets; feed efficiency; food organisms; *Artemia*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Artemia Ref. Cent., State Univ. Ghent, Rozier 44, B-9000 Ghent, Belgium

476 Storch, V. and J.V. Juario. 1984. The effect of starvation and subsequent feeding on the hepatocytes of *Chanos chanos* (Forsskal) fingerlings and fry. Journal of Fish Biology 23(1):95-103.

Excised liver sections of the milkfish, *Chanos chanos*, fry and fingerlings were studied by transmission electron microscopy. The hepatocytes underwent marked ultrastructural alterations in response to food deprivation of 10-day starvation for fry and 2 months for the fingerlings. The prominent features characterizing the hepatocytes of starved fish were: a reduction of cell and nucleus size; apparent loss of nucleoli; condensation of chromatin material in fry; loss of stored glycogen; reduction of ER profiles; increase in the number of electron-dense bodies containing large amounts of iron in fingerlings; and an increase in mitochondrial size. These changes were reversible following short periods of re-feeding, i.e. 2 days for fry and 4 days for fingerlings, using natural food for the fry and formulated diet for the fingerlings.

Keywords: starvation; liver; histology; ultrastructure; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Zool. Inst., Univ. Heidelberg, Im Neuenheimer Feld 230, 69 Heidelberg, FRG

477 Storch, V., F. Sotto and N. Rau. 1979. Electron microscopic investigations on the liver of milkfish (*Chanos chanos*). Philippine Scientist 16:77-83.

The liver of *C. chanos* in Cebu kept under different nutritional conditions was investigated by transmission electron microscopy. The ultrastructural changes in the hepatocytes induced by starvation are described. A rapid breakdown of the carbohydrate depot, a decline in the size of cells and cell nuclei and a gradual rise of lysosomes throughout the starvation period are the main features found electron microscopically. The significance of the modifications observed is discussed.

Keywords: liver; food availability; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

478 Storch, V., W. Staehlin and J.V. Juario. 1984. Effect of different diets on the ultrastructure of hepatocytes of *Chanos chanos* fry (*Chanidae*: *Teleostei*): An electron microscopic and morphometric analysis. Marine Biology 74(1):101-104.

The hepatocytes of milkfish fry offered different artificial diets (carbohydrate-, lipid-, protein-oriented) and live food (*Artemia* spp., *Brachionus plicatilis*) differ considerably both qualitatively and quantitatively as was shown by means of transmission electron microscopy and planimeter. Food deprivation, too, resulted in ultrastructural alterations of milkfish fry hepatocytes. Thus, this cell type might be used as an indicator of quality and quantity food in teleosts.

Keywords: liver; ultrastructure; feed composition; diets; fry; artificial feeding; *Artemia*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Universitaet Zool. Inst., Im Neuenheimer Feld 230, 6900 Heidelberg 1, FRG

479 Suhenda, N. 1982. Quantitative dietary protein requirements of milkfish (*Chanos chanos*) fingerlings in a controlled environment. Bulletin Penelatian Perikanan 2(1):59-66.

Milkfish fingerlings with an average weight of 0.68 g were stocked in a 60 liter wooded glass aquaria filled with 40 liter of filtered seawater with salinity ranging from 25 to 31 ppt and temperature ranging from 28 deg C to 29 deg C at a rate of 50 fish per aquarium. They were fed diets containing 25, 30, 35, 40, 45, and 50% protein and 3,795 kcal of D.E./ kg at a rate of 8% (dry matter) of the total body weight daily, for a period of four weeks. The growth rate of fish is directly related to the dietary level of protein. Fish fed the highest protein diet had the highest weight gain and was significantly higher than any other treatments except for the 40% protein diet. No significant differences were found among the feed conversion, P.E.R. value and survival rates of fish receiving different diets. However, the 45% protein diet exhibited best feed conversion, acceptable P.E.R. (Protein efficiency ratio) value and survival rate. Thus, this preliminary result showed that a dietary level of 45% protein is optimum milkfish fingerlings.

Keywords: feeding; dietary protein; feeds; milkfish
Location: SEAFDEC Aquaculture Department Library

480 Sumagaysay, N. 1993. Growth, daily ration, and gastric evacuation rates of milkfish (*Chanos chanos*) fed supplemental diet and natural food. Journal of Applied Ichthyology 9(2):65-73.

Growth, daily ration, and gastric evacuation rates of milkfish (*Chanos chanos*) that fed on natural food and supplement diet were evaluated. Milkfish fingerlings (5.5 g) were stocked at 1.5 fish/m super(2) in ten 12 m super(2) concrete tanks layered with 15-cm thick earthen bottoms. All tanks were regularly fertilized (16-20-0 and chicken manure) to maintain natural food production; 4 of the

tanks additionally received a supplemental diet containing 34.3% protein and 4290 kcal/kg gross energy. Estimates of daily ration (based on dry weight of stomach contents) were calculated using the Elliot and Persson (1978) and Eggers (1977) models. Gastric evacuation rate was lower in fish that fed on natural food (1.57) compared to fish fed a supplemental diet (1.79). Consequently, the lower rate resulted in lower food intake and slower fish growth. When fish were provided a high quality supplemental diet, daily rations for fingerlings (35 g) to marketable size (116 g) ranged approximately from 0.60 to 19.68 kcal/fish/day.

Keywords: growth; digestion; feeding experiments; food consumption; diets; culture tanks; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

481 Sumagaysay, N.S. 1988. Effects of dietary energy and fiber on protein utilization of supplemental feeds of milkfish (*Chanos chanos* Forsskal) reared in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 46 p. M.S. thesis.

The study explores the nutritive value of fiber in supplemental feeds for milkfish. The experiment was designed so that all four treatments involved equal loads of protein-N (6 g/kg fish/day) at two energy levels and varying fiber loads. The use of fresh chicken manure, containing 17% protein served as the control treatment (1). Treatment 2 involved the use of diet with protein and energy content similar to that of chicken manure. Chicken manure and diet 2 were given at a higher rate (3.5% compared to 2.4 % of body weight as ash-free dry matter), so that the daily protein-N load would be similar to the 25% protein diets in Treatments 3 and 4. Nitrogen-free extract (NFE) in diet 4 was largely replaced by fiber in diet 3 so that if fiber has the same energy value as NFE, diets in Treatment 3 and 4 would be isocaloric and Treatment 2 would have the highest energy load. Rice hull provided the bulk of dietary fiber. The experiment was conducted in four units of 800 sq m earthen ponds, divided into four quarters. Milkfish juveniles with an average initial weight of 29 g were stocked at 7000/ha. After three months of culture, milkfish growth and production and protein efficiency ratio were significantly higher ($P<0.05$) in fed ponds compared to manured ponds. Average yield and manure conversion ratio in manured ponds were 436 kg/ha and 14.5, respectively. Highest yield (624 kg/ha) was attained with fish fed diets containing 20% fiber (Treatment 3), but no significant difference ($P>0.05$) was observed with other feed treatments (600 kg/ha - Treatment 2; 619 kg/ha - Treatment 4). Poorer feed efficiency (5.8) was observed in fish exposed to 17% protein diet compared to those exposed to 25% protein diet (3.6).
The lack of difference between Treatments 3 and 4 suggests that energy is not limiting in the high fiber diet (Treatment 3) but additional fiber (Treatment 2) does not further improve growth. Higher feed and manure load did not adversely affect water quality. It is concluded that adequate protein is needed for the proper utilization of fiber and that the final choice of protein and fiber levels to use in the diet would depend on cost.

Keywords: dietary energy; diet; protein; supplemental feeding; brackishwater ponds; milkfish culture; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

482 Sumagaysay, N.S. 1991. Utilization of feed and rice straw compost for milkfish, *Chanos chanos*, production in brackishwater ponds. Journal of Applied Ichthyology 7(4):230-237.

The study was undertaken to determine the effect of 0, 25, 50 and 75% replacement of organic matter in the feed with rice straw compost on milkfish (*Chanos chanos*) growth and production. Treatments have similar organic matter and nitrogen loads. Up to 50% substitution (Treatments 1 to 30) was possible without significantly affecting fish growth and yield (668-725 kg/ha). A significant reduction in growth and yield (456 kg/ha) with 75% substitution (treatment 4) implies that organic matter from compost did not contribute much to fish growth. Low phosphorus content of compost and inadequate phosphorus load in spite of increasing mineral input from compost resulted in similar primary productivity in all treatments. It appeared that compost was not a satisfactory feed substitute

and that the fish derived most of their nutrition from the feed. The results further suggest that yield could be economically increased by using a low protein diet (23.8%) given at a lower rate (1.75% of body weight).

Keywords: organic matter; feed efficiency; growth; nitrogen; phosphorus; biological fertilization; economic analysis; primary production; *Teleostei*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquacult. Dep., SEAFDEC, P.O. Box 256, Iloilo City, 5000 Philippines

483 Sumagaysay, N.S. 1998. Milkfish (*Chanos chanos*) production and water quality in brackishwater ponds at different feeding levels and frequencies. Journal of Applied Ichthyology 14(1-2):81-85.

This study evaluated the effects of different feeding levels and frequencies on milkfish (*Chanos chanos*) growth, feed efficiency, and water quality in brackish water ponds. Milkfish juveniles (average weight, 1 g) were stocked in 500 m super(2) ponds at 8000/ha and reared for 132 days. Fish were fed daily after 34 days from stocking (initial average weight, 22 g) either at 3 % of body weight, 3 times daily; at 4 %, 3 or 6 times daily; or at 6 %, 6 times daily. There were no differences (alpha = 0.05) in production (780-960 kg/ha), final weight (125-168 g), and survival (81-85 %) among treatments. Maximum feed ration (kg/ha/days) ranged from 23.8 at the 3 % feeding level to 61.4 at 6 %. The feed conversion ratio (FCR) significantly increased (alpha = 0.05) in proportion to feeding rate, while the percentage nitrogen assimilated by milkfish decreased from 41 % at low feeding rate to 21 % at high rate. Partial budgeting analysis showed that increasing the feeding rate from 3 to 4 % resulted in a positive net benefit, but further increase to 6 % had a negative benefit. Dissolved oxygen (DO) concentrations at dawn were always higher at the lower feeding level compared to other treatments. Although there were no differences in nitrogenous nutrients and total suspended solids among treatments, pH, total ammonia, nitrogen, and phosphorus increased and DO at dawn decreased with increasing biomass and feed input. Results suggest that supplemental feeding for milkfish grown in brackishwater ponds should not be more than 4 % of body weight and 38 kg feed/ha/days for maintenance of good water quality and for economical operation.

Keywords: water quality control; culture media; brackishwater aquaculture; fish culture; pond culture; feeding; stocking (organisms); juveniles; length-weight relationships; dissolved oxygen; pH; economic feasibility; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

484 Sumagaysay, N.S. 1999. Feed ration for different sizes of wild and hatchery-bred milkfish (*Chanos chanos* Forsskal). Aquaculture Research 30(10):789-792.

Intensified production of fish involves stocking at high densities and the use of artificial feeds. These practices result in eutrophication and environmental degradation mainly because of feed wastage and fish excreta. To minimize waste, the maximum amount of feed consumed by fish must be known. Food consumption and utilization, however, may vary with the size and physical condition of the fish. Milkfish *Chanos chanos* Forsskal and some hatchery-produced fish, such as seabass *Dicentrarchus labrax* L. have been observed to have morphological defects that could affect normal food intake and utilization. Jaw abnormalities in hatchery-bred milkfish interfere with feeding and result in very slow growth. In the Philippines, milkfish fry for production in ponds and cages are caught from the wild or produced through artificial spawning. Studies have been conducted to estimate the feed ration for milkfish reared in brackish water ponds where natural food contributes significantly to the nutrition of the fish. In ponds and marine cages, where fish are largely dependent on artificial feeds, daily feed ration has to be estimated. This study determined the maximum feed ration for different sizes of wild and hatchery-bred milkfish based on assimilation of energy.

Keywords: diets; feed; aquaculture techniques; food consumption; feeding behaviour; fish culture; *Chanos chanos*

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

485 Sumagaysay, N.S. and I.G. Borlongan. 1995. Growth and production of milkfish (*Chanos chanos*) in brackishwater ponds: Effects of dietary protein and feeding levels. Aquaculture 132(3-4):273-283.

The most economical combination of dietary protein and feeding levels for milkfish culture in brackishwater ponds was determined. Milkfish juveniles (average weight, 5 g) were stocked at 7000/ha and fed two diets containing 24% or 31% dietary protein at 2 or 4% of body weight. There was no interaction between feeding level and dietary protein on growth, feed efficiency, and energy assimilation of milkfish. This indicates that the response of milkfish to change in protein levels is not influenced by ration size. Regardless of protein levels, the final weight, weight gain, specific growth rate, and production of milkfish were significantly higher (alpha =0.05) when fed at 4% body weight than at 2%. As culture progresses, differences in weights of fish fed varying protein levels were still insignificant. This could be attributed to the balanced amino acid profile of both diets. The higher growth at the 4% feeding level could be due to the higher amount of amino acids available for protein synthesis. Higher energy assimilated by milkfish at higher feeding rate demonstrates that energy supply also influences growth. Partial budgeting analysis shows that bigger profits can be earned by using a 24% protein diet with balanced amino acids at a feeding rate of 4% of body weight. The greater amount of feed given at higher rate can be compensated by faster growth and higher production.

Keywords: brackishwater aquaculture; diets; proteins; feed efficiency; bioenergetics; aquaculture economics; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

486 Sumagaysay, N.S. and Y.N. Chiu-Chern. 1991. Effects of fiber in supplemental feeds on milkfish (*Chanos chanos* Forsskal) production in brackishwater ponds. Asian Fisheries Science 4(2):189-199.

The study explores the nutritive value of fiber in supplemental feeds for milkfish (*Chanos chanos*). The feeding rates were adjusted so that all treatments involved equal protein-N load (6 g/kg fish/day), and varying energy and fiber loads. Rice hull provided the bulk of dietary fiber. The results indicate that energy was not limiting in the high fiber (24%) treatment compared to low fiber (15%), but additional fiber (33%) did not further improve growth; and fiber in low protein diets was utilized further as a direct or indirect source of energy. Thus, a low protein/high fiber diet can be an economical way of increasing milkfish production in brackishwater ponds.

Keywords: pond culture; fish culture; feed composition; nutritive value; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

487 Sumagaysay, N.S., F.E. Marquez and Y.N. Chiu-Chern. 1991. Evaluation of different supplemental feeds for milkfish (*Chanos chanos*) reared in brackishwater ponds. Aquaculture 93(2):177-189.

The effects of supplemental feeding on milkfish (*Chanos chanos*) growth, production, survival, water quality, and economic benefits in brackishwater ponds were evaluated by comparing a rice bran diet, containing 11.3% protein, and two pelleted diets, containing 22.0% and 27.4% protein, with an unfed control. All supplemental feeds significantly increased growth and production. Feeding diets containing 22.0% and 27.4% protein resulted in 35.3% and 46.7% higher net profits, respectively, whereas feeding rice bran resulted in a 34.4% lower net profit. Survival was not significantly different among the treatments. The concentration of metabolites in the culture water

for all treatments was low but a significant increase in level of total carbon dioxide and nitrite-nitrogen was observed as biomass increased.

Keywords: feeding experiments; diets; brackishwater aquaculture; aquaculture economics; growth; survival; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

488 Sumagaysay, N.S., Y.N. Chiu-Chern, V.J. Estilo and M.A.S. Sastrillo. 1990. Increasing milkfish (*Chanos chanos*) yields in brackishwater ponds through increased stocking rates and supplementary feeding. Asian Fisheries Science 3(2):251-256.

Brackishwater milkfish (*Chanos chanos*) culture in the Philippines is normally practiced at fish stocking rates of 2,000-3,000/ha with fertilizers as the sole nutrient input. Supplementary feeding is not common. Two 1-ha ponds with 6,000 fish and another 2 1-ha ponds were stocked with 9,000 fish with an average weight of 2 g. The fish at each stocking rate were given diets with 2 different energy levels (2,950 and 3,265 kcal/kg) at 3% body weight, on the second and third month of culture. An average of 0.69 and 1.04 tons were produced at 6,000 and 9,000/ha, respectively. Low temperature and dissolved oxygen levels appeared to limit the growth of milkfish masking the effect of dietary energy. The results suggest that supplementary feeding can have a marked effect on milkfish yield when stocking rates are 6,000/ha or above.

Keywords: fish culture; pond culture; stocking density; artificial feeding; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

489 Sumagaysay-Chavoso, N.S. 2003. Nitrogen and phosphorus digestibility and excretion of different-sized groups of milkfish (*Chanos chanos* Forsskal) fed formulated and natural food-based diets. Aquaculture Research 34(5):407-418.

This study determined the digestibility of nitrogen and phosphorus, and the excretion rate of different-sized groups of milkfish fed a commercial diet, a SEAFDEC formulated diet or lab-lab (natural food-based diet). Fish (31.2-263.0 g) were stocked in 12 units of 300-L fibreglass tanks filled with aerated seawater. The postprandial total ammonia-nitrogen (TAN) and phosphate (PO sub(4)-P) excretion of fish were estimated from changes in TAN and PO sub(4)-P concentrations in water for 24 hours. Digestibility was determined from the nitrogen, phosphorus and Cr sub(2)O sub(3) content of the diets, and pooled feces after the fish had been fed diets marked with chromic oxide. TAN excretion rate (mg TAN kg super(-1) fish day super(-1)) was significantly lowest ($P < 0.05$) in medium to very big fish fed the lab-lab diet (60.8-124.4) and highest in small and medium fish fed the SEAFDEC diet (333.3-331.6) and small fish fed the commercial diet (280.1). Regardless of size, fish fed lab-lab excreted (mg PO sub(4)-P kg super(-1) fish day super(-1)) significantly lower PO sub(4)-P (36.2) but did not differ with fish fed the commercial diet (64.8). Excretion rates decreased exponentially as fish weight increased but positively increased with feed ration. Excretion pattern of milkfish revealed two peaks: the first peak occurred 6 h after feeding and the second peak at 18 h for TAN and 21 h for PO sub(4)-P, coinciding with the start of the daylight hours. TAN and PO sub(4)-P excretion accounted for 20.5-34.6% of total N consumed and 18.7-42.6% of P consumed respectively. Approximately 27.9-42.5% of N consumed and 47.2-58.5% of P consumed were lost as faeces. Total nutrient losses were lower using the lab-lab diet (0.31 g N and 0.14 g P kg super(-1) fish) compared with the formulated diets (0.47-0.48 g N and 0.17-0.19 g P kg super(-1) fish); the losses decreased per kg of fish as fish size increased. Results suggest that the diet and size of fish influence wastage of N and P to the environment with greater losses in small fish and when artificial diets are used. Such measurements will provide valuable information for the preparation of N and P budgets for milkfish in grow-out systems.

Keywords: diets; body size; feed composition; digestibility; nitrogen; phosphorus; aquaculture effluents; excretion; feeding experiments; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:nss@aqd.seafdec.org.ph]

490 Syam, R. 1984. Growth and survival of milkfish *Chanos chanos* (Forsskal) fry in a closed recirculating system with various food sources. University of the Philippines, in the Visayas, Miag-ao, Iloilo. 68 p. M.S. thesis.

A 45-day feeding experiment using a water-recirculating system was conducted to determine the growth, survival and body composition of milkfish (*Chanos chanos* Forsskal) from fry to fingerling in a 45-day culture period utilizing formulated feed, *Artemia, Chlorella* as food sources, singly or in combination with each other. The experiment had a total of seven treatments with four replicates.
The formulated feed only or in combination with *Artemia* and *Chlorella* (Treatments A, B, C, and D) resulted in higher weight gains of 129.22 mg, 94.83 mg, 77.64 mg, and 73.94 mg, respectively, and percentage weight gains of 648.12%, 476.77%, 396.30%, and 362.27%, respectively. Those fed *Artemia* singly (Treatment F) and in combination with *Chlorella* (Treatment G) had weight gains of 55.48 mg and 36.50 mg, respectively, and percentage weight gains of 280.89% and 202.37%, respectively. Those differences were found to be highly significant ($P<0.01$).
Fry fed Diets F (*Artemia* only), G (*Artemia* plus *Chlorella*) and C (*Artemia* plus formulated feed) had higher survival rates of 44.78%, 42.38%, and 39.12%, respectively, which were not significantly different from each other ($P>0.05$). They were significantly different ($P<0.01$) from Diets A (24.74%), B (19.57 %), and D (29.57%). Fry given Diet E (*Chlorella* only) suffered from complete mortality during the fifth week culture period.
The level of water parameters were considered to be within optimal ranges for the milkfish fry. The correlation coefficients between the level of each, ammonia, dissolved oxygen, nitrite, nitrate and mortality rate were not significant ($P>0.05$).
With Diets F, G, and C, the level of body fats of the fingerlings were 2.94%, 2.01%, and 1.96%, respectively, and moisture contents were 70.43%, 68.69%, and 68.11%, respectively. These were found to be higher than those in Diets A, B, and D.
The over-all results showed poor growth and survival of the fry. Among the factors identified which contributed to low survival are lack of any prophylactic treatment and residual level of ammonia which resulted from insufficient replacement of water in the sumps.

Keywords: growth; survival; milkfish culture; aquaculture; milkfish
Location: University of the Philippines, in the Visayas, Miag-ao, Iloilo

491 Taki, Y., C.A. Saclauso, L.V. Laureta, H.J. Gonzales, A. Ohno, H. Kohno, S. Morioka and M. Muto. 1990. Feeding of milkfish *Chanos chanos* larvae in the surf zone, p. 441-444. In: R. Hirano and I. Hanyu (eds.). Proceedings of the Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April 1989. Asian Fisheries Society, Manila, Philippines.

Most larvae of the milkfish *Chanos chanos* collected from the surf zone of Panay Island, Philippines contained no substance in the gut. Based on the survival of larvae in delayed feeding experiments, the point of irreversible starvation for these larvae was found to occur on the 5th day after the day of their capture. Survival rate after 14-day rearing was nearly 100% for larvae fed *Artemia nauplii* or rotifers, more than 60% for those fed zooplankton or lab-lab, and less than 10% for those fed lumut or kept starved. These results indicate that food organisms available for milkfish larvae in the surf zone may not be sufficient. While larvae depend primarily on planktonic food organisms in the surf zone, they can also feed on benthic particulate organisms but not fibrous algae.

Keywords: feeding behaviour; diets; survival; surf zone; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tokyo Univ. Fish., 4-5-7 Konan, Minato-ku, Tokyo 108, Japan

492 Tamaru, C.S., H. Ako, C.S. Lee and P. Bass. 1993. Fatty acid composition of rotifers cultured on various combinations of phytoplankton and baker's yeast and its effect on the growth and survival of larval milkfish (*Chanos chanos*), p. 97-108. In: Finfish hatchery in Asia: Proceedings of Finfish Hatchery in Asia, 17-19 December 1991, Tungkang, Taiwan.

The rotifer *Brachionus plicatilis* (S-type Hawaiian strain) was cultured on 5 different combinations of phytoplankton and/or baker's yeast (*Nannochloropsis oculata*, *Tetraselmis tetrathele*, baker's yeast, *N. oculata* + baker's yeast, and *T. tetrathele* + baker's yeast). Fatty acid profiles varied depending upon the algal species and/or the amount of baker's yeast incorporated into their culture. In general, the shorter chain (C18:2n-6 and C18:3n-3) fatty acids predominated when *T. tetrathele* and/or baker's yeast were used and the long chain PUFAs (C20:4n-6, C20:5n-3, and C22:2n-6) were elevated when *N. oculata* was used in culturing. The resulting rotifers were incorporated into large scale (5,000 liter) larval-rearing trials for milkfish. No significant differences in larval growth and survival were detected among the various treatments. Fatty acid profiles of 30-day-old milkfish carcasses from the various treatments exhibited elevated levels of the long chain PUFAs in all groups which suggests that the milkfish larvae are capable of chain elongation and desaturation of precursor fatty acids. The implications of the result with regard to the larval rearing of milkfish are discussed.

Keywords: zooplankton culture; larvae; rearing; diets; food organisms; fatty acids; *Brachionus plicatilis*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapu'u Point, Waimanalo, HI 96795, USA

493 Tamaru, C.S., R. Murashige, C.S. Lee, H. Ako and V. Sato. 1993. Rotifers fed various diets of baker's yeast and/or *Nannochloropsis oculata* and their effect on the growth and survival of striped mullet (*Mugil cephalus*) and milkfish (*Chanos chanos*) larvae. Aquaculture 110(3-4):361-372.

The rotifer *Brachionus plicatilis* (S-type Hawaiian strain) was cultured with various combinations of baker's yeast and *Nannochloropsis oculata*. There were no significant differences in the daily rotifer production and amino acid profiles of the resulting rotifers. The significantly lower levels of fatty acids (C14, C16, C20:4n-6, C20:5n-3 and C22:6n-3) observed in the rotifers were found to correspond with the amount of yeast presented in their diet. The low survival and growth of striped mullet larvae recorded at Day 15 posthatching indicates that rotifers fed only yeast were nutritionally deficient in fatty acids. The fatty acid requirements of mullet, however, appeared to be satisfied with rotifers cultured on a combination of yeast and *N. oculata*. In contrast, no significant differences in larval milkfish survival and growth at Day 10 posthatching were detected when using rotifers fed the various diets in the larval rearing protocol.

Keywords: diets; nutritive value; growth; survival; fish larvae; food organisms; animal nutrition; yeasts; fatty acids; *Nannochloropsis oculata*; *Mugil cephalus*; *Chanos chanos*; *Brachionus plicatilis*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., Makapu'u Point, Waimanalo, HI, USA

494 Tamse, A.F. 1983. The regular application of fresh pig manure for milkfish culture in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 75 p. M.S. thesis.

The effects of regular broadcasting of fresh pig manure in brackishwater milkfish ponds were studied. Two treatments (unfertilized control and manured), replicated four times and assigned in a completely randomized design, were conducted in eight 100 m^2 earthen ponds of the Brackishwater Aquaculture Center, Leganes, Iloilo, Philippines. Safe maximum daily manuring dosage was determined in micropond (plastic enclosures set in a pond) experiments with laboratory BOD_1 and total solids of the manure as guide. BOD_1 was measured at three temperature regimes (25°, 30° and

35-37°C) and three salinity levels (15, 30 and 45 ppt), and three levels of dry matter content of manure (26, 32, and 36%).
The BOD_1 of manure intensified salinity up to 30 ppt (but inhibited at higher salinity), and with increasing dry matter content. The dry matter (X = 28%) and other physical characteristics of pig manure during a one-year period was relatively uniform.
Calculated manuring dosage based on BOD_1 did not reduce early morning oxygen saturation in microponds. Addition of higher amounts of manure (0.01 g organic matter/1 to 2.12 g/1) in microponds indicated that 0.01 g/1 reduced next day's early morning oxygen saturation by 20% (1mg 0_2/1). Its use in calculating manure dosage for regular manuring of milkfish ponds showed varying oxygen saturation response which seemed to be correlated with the manuring dosage in g fresh wt/1 of pond water and the number of days of application due to residual effect of previous loading. Multiple regression analysis generated this equation which was significant at the 10% level (n = 76):

$$0_2 \text{ Saturation} = 24.65 + (176.56 \pm 158) \text{ manuring dosage reduction} + (0.2 \pm 0.1) \text{ number of days}$$

Regular manuring effected higher fish production (285.6 kg/ha in 70 days) than in controls (183.5 kg/ha), with milkfish survival of 97.5% and 100%, respectively. Manured ponds had higher phosphorus levels (in water) and gross primary productivity values. However, exposure to longer diurnal pulse of low oxygen saturation may have affected growth rate (0.89 g/day), aside from other environmental factors.
Inherent pond characteristics influenced manuring effect. Ponds with slightly acidic water reduced phosphorus levels in water which lead to relatively lower primary productivity values. The same ponds also had erratic morning oxygen saturation with values ranging from very low (12%) to quite high (120%).

Keywords: feeding; fresh pig manure; milkfish culture
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

495 Tamse, C.T., F. Piedad-Pascual and M.C. De la cruz. 1983. Some histological observations on the opaque eyes of milkfish *Chanos chanos* Forsskal. Fisheries Research Journal of the Philippines 8(2):69-72.

In a study on energy-protein requirements of milkfish fingerlings using semi-purified diets, several gross observations were made on individual milkfish such as fin and tail rot, yellowish coloration of the abdomen, opacity and swollen adipose membrane of the eyes. The latter abnormality occurred four to five weeks after feeding semi-purified diets. Milkfish eyes with the abnormality were processed for histological analysis. Opacity of the cornea and lens and degeneration of the eye tissue, thickening of the corneal epithelium and oedema of the stomach layers were seen. Necrosis of the iris, slight thickening of the lens capsule, detachment and destruction of the retina layers were also observed.

Keywords: histological observations; opaque eyes; milkfish
Location: SEAFDEC Aquaculture Department Library

496 Teshima, S.I., A. Kanazawa and G. Kawamura. 1984. Effects of several factors on growth of milkfish (*Chanos chanos* Forsskal) fingerlings reared with artificial diets in aquaria. Aquaculture 37(1):39-50.

This paper presents the effects of feeding level, feeding frequency, salinity of water, kind and particle size of diets, and stocking density on the growth of milkfish (*Chanos chanos*) fingerlings which were reared with artificial diets in laboratory tanks. The milkfish fingerlings showed the best growth in terms of both weight gain and increase in body length when reared on a purified diet containing 35% casein and 15% gelatin as protein sources under the following conditions: feeding level, 30-50% of body weight; feeding frequency, twice a day; particle size of diets, 125-250 mu m diameter; and stocking density, 5 fish/5-liter tank.

Keywords: feeding experiments; stocking density; growth; fingerlings; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fac. Fish., Univ. Kagoshima, 4-50-20 Shimoarata, Kagoshima 890, Japan

497 Thomforde, H. 1987. Effects of chicken manure and supplementary feed on production of milkfish and red tilapia in polyculture in brackishwater earthen ponds at different stocking densities. University of the Philippines in the Visayas, Miag-ao, Iloilo. 64 p. M.S. thesis.

The use of fresh chicken manure and pelleted feed of similar proximate composition as nutrient inputs in brackishwater ponds, was evaluated using milkfish (*Chanos chanos* Forsskal) and red tilapia (*Oreochromis spp*., Philippine strain) in polyculture (about 1:1 ratio) at two stocking rates (6254 and 9673 fish/ha). The fish were cultured for 99 days in 137m^2 quadrants of six 550 m^2 earthen ponds, divided by nets and polyethylene sheets, in a 2x2 factorial incomplete block design (each pond stocked at a single density). Fish were exposed to the treatments when natural food became apparently limiting after 42 days of culture. Pond water temperature was 27° -39°C and salinity was 35-37 ppt. Significantly higher production and harvest weight was observed in the feed treatment for both tilapia and milkfish. The differences in daily growth of tilapia between the feed and manure input was larger at high density (44% vs. 24% difference). Growth of milkfish on feeds (1.6 g/day) was significantly greater than on manure (1.3 g/day) only at high density. Manure conversion, at 2.75 kg dry input/kg yield, was significantly higher than feed conversion (1.67) but both values were not affected by stocking rate. Milkfish exposed to feed exhibited significantly higher feeding and hepatosomatic indices but no such difference was observed for tilapia. Significantly higher fiber digestion was observed with manure loads. Tilapia survival (70-89%) was significantly lower with manure at high density. Milkfish survival (83-97%) was not affected by feed or manure loads but was significantly lower at high density. The results indicate better utilization of manure by milkfish than tilapia. Cost analyses of the use of feed and manure in fishpond culture show that within the range of current prices in the Philippines use of manure is more profitable, but the advantage of one over the other would depend upon regional and seasonal differences in availability and cost. Error within treatments was reduced by using randomized complete block design with ponds as blocks. The effect of treatments on water quality parameters is discussed.

Keywords: chicken manure; supplementary feed; milkfish production; brackishwater; earthen ponds; milkfish culture
Location: University of the Philippines, in the Visayas, Miag-ao, Iloilo

498 Vicencio, Z.T. 1977. Studies on the food habits of milkfish, *Chanos chanos* (Forsskal). Fisheries Research Journal of the Philippines 2(1):3-18.

Fry and breeders taken from the sea and premarketable and marketable fingerlings, collected from three fishponds situated in the municipalities of Malabon and Navotas were studied to determine the food habits of *Chanos chanos* or milkfish. Fifty-three algal species were eaten by the milkfish as well as those in the ponds during the time of samplings. A comparison is made to see the relationship between the food eaten and the food available in the ponds. Fry and fingerlings feed mainly on phytoplankton, the premarketable fish on plankton and filamentous green algae, the marketable ones on filamentous green algae, and the breeders on plankton.

Keywords: fish culture; feeding; fingerlings; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Inland Fish., Coll. Fish., Univ. Philippines System, Diliman, Quezon City, Philippines

499 Villegas, C.T. and G.L. Lumasag. 1991. Biological evaluation of frozen zooplankton as food for milkfish (*Chanos chanos*) fry. Journal of Applied Ichthyology 7(2):65-71.

Milkfish (*Chanos chanos*) fry with an average standard length and weight of 13.88 mm and 3.95 mg, respectively, were reared for 30 days using live and frozen *Moina macrocopa* and *Brachionus*

plicatilis at feeding densities of 10-20 individuals per ml. Growth, survival and yield were used as indicators of the overall performances of the various treatment groups. Fry fed live *M. macrocopa* showed gains (both length and weight), growth and survival rates and yields significantly higher than fry fed with other treatment groups ($P < 0.05$). However, significant reductions in growth and survival rates resulted when fry were fed frozen M. macrocopa. On the other hand, there were no significant differences in growth and survival rates ($P > 0.05$) in fry fed live or frozen *B. plicatilis*.

Keywords: feeding experiments; food organisms; fry; zooplankton; survival; growth; *Moina macrocopa; Brachionus plicatilis*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

500 Villegas, C.T. and I. Bombeo. 1981. Effects of increased stocking density and supplemental feeding on the production of milkfish fingerlings. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 5(2):7-11.

Experiments were conducted to determine the effects of increased stocking density and supplemental feeding on survival and growth of milkfish (*Chanos chanos*) fry to fingerling stage and also to evaluate the profitability of supplemental feeding in the milkfish fry nursery. Results showed that increased stocking density from 50 to 75 fry/m super (2) increased net income and is profitable. Survival was further increased through supplemental feeding with rice bran, which is cheap and easily obtainable.

Keywords: fish culture; stocking density; feeding; fingerlings; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

501 Villegas, C.T., O. Millamena and F. Escritor. 1990. Food value of *Brachionus plicatilis* fed three selected algal species as live food for milkfish, *Chanos chanos* Forsskal, fry production. Aquaculture Fisheries Management 21(2):213-219.

The effects of three selected algal species, *Tetraselmis tetrahele*, *Isochrysis galbana* and marine *Chlorella sp.* on the population growth of *Brachionus plicatilis* was evaluated after 3, 5 and 7 days of culture. The rotifers fed on *T. tetrahele* showed superior growth with mean peak density of 92 multiplied by 5 individuals per ml to those fed on *I. galbana* (48 multiplied by 2 individuals per ml) and *Chlorella sp.* (47 multiplied by 2 individuals per ml) in 5 days. In another experiment, milkfish, *Chanos chanos* Forsskal, fry with initial mean body weight and standard length of 6 multiplied by 26 plus or minus 1 multiplied by 07 mg and 13 multiplied by 04 plus or minus 1 multiplied by 40 mm, respectively, were fed *B. plicatilis* reared on the three algal species for 30 days. Results showed that growth, measured in terms of gain in weight and length, was significantly different ($P < 0$ multiplied by 05) among treatments.

Keywords: nutritive value; fry; growth; fish culture; *Brachionus plicatilis*; *Chanos chanos*; *Isochrysis galbana*; *Chlorella*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

502 Wang, J. 2000. A review: nutrition requirements of the principal fishes cultivated in brackish and seawater. Journal of Dalian Fisheries College 15(3):215-222.

Dietary protein, lipid, vitamin and mineral requirements of sea bass (*Lates Calcarifer*), *Epinephelus sp.*, milkfish (*Chanos chanos* Forsskal), *Giganus spp* and others cultivated in brackish water and sea water are discussed to provide basic information on their pelleted feed. Dietary optimal protein requirement ranged from 45%-55% depending on species, size and culture pattern. Dietary lipid requirement was 8%-10%, especially n-3 series highly unsaturated fatty acids. Optimal vitamin and mineral requirements are discussed in detail.

Keywords: cultured organisms; nutritional requirements; pellet feeds; *Lates calcarifer*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, Dalian Fisheries University Dalian 116023 People's Rep. China

503 Yamasaki, S. and J. Canto Jr. 1979. Culture experiments on the copepod, *Tisbintra elongate* Mori, and evaluation of that species as food organism for milkfish larvae. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 3(4):17-20.

Five types of food were used to culture *T. elongata*: rice bran, cow dung, bread, cow dung, bread yeast, fermented fish solubles and Spirulina. Bread yeast was found to give the highest densities. An evaluation was also made of the effectivity of rice bran and fermented fish solubles for the outdoor mass culture of *T. elongata*. A comparative study on the growth and survival rate of milkfish fry (*Chanos chanos*) fed with *T. elongata* and *Artemia* showed there to be no significant differences between the diets.

Keywords: crustacean culture; food organisms; diets; fish culture; growth; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Lab. Aquacult. Physiol., Kagoshima Univ., Japan

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POSTHARVEST TECHNOLOGY

HANDLING AND PACKING

504 Anggawati, A.M. 1987. Effect of storage methods on keeping quality of milkfish (*Chanos chanos*). ASEAN Food Journal 3(2):60-65.

The effect on keeping quality of handling milkfish (*Chanos chanos*) in the way commonly practiced in Indonesia was investigated by storage trials at ambient temperature (28-32 degree C), partial chilling (4 days at 10 degree C prior to ambient temperature storage) and iced storage. The shelf-life of milkfish kept at ambient temperature was up to 20 hours, whereas the total shelf-life of fish partially chilled for 4 days at 10 degree C and subsequently stored at ambient temperatures was 111 hours. Fish stored properly in ice remained acceptable for up to 20 days. Thus, chilling proved to be

a very effective way of reducing fish spoilage in tropical areas. The major microflora in tropical milkfish was comprised of mesophiles which could not grow at 0 degree C or grow well at 10 degree C.

Keywords: storage effects; chilling storage; storage life; quality control; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Inst. Mar. Fish., Palmerah, Jakarta, Indonesia

505 Anon. 1974. Bangus transfer from one salinity to another. SEAFDEC/AQD Library Compilation. 3 p.

Only one out of four milkfish fry will be able to reach marketable size due to stress. In this paper, symptoms of stress are enumerated. The behaviour of milkfish under the state of stress is described. Procedure on how to avoid salinity stress is given.

Keywords: transfer; salinity; milkfish fry; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

506 Anon. 1978. Milkfish (Bangus) as food: handling, freezing and processing of milkfish (*Chanos chanos*, Forsskal). National Science Development Board, Manila, Philippines. 203 p.

This volume is presented as a manual for the food technologist and for the layman. An introductory chapter deals with the science of fish as food, and detailed chapters are devoted to milkfish (*Chanos chanos*) and its parts, standardization (of handling, icing and freezing), processing (smoking, fermentation and pickling) and the utilization of by-products. A variety of appendices include standards for fish, a fish classification for the Philippines (based on total length), formulations of canned milkfish products, and a glossary of scientific and Philippine names for fish.

Keywords: fishery products; processing fishery products; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

507 Anon. 1981. Aquaculture: ways of harvesting. Modern Agriculture and Industry. Asia 9(1):8-9.

Quality of fish depends greatly on harvesting and handling methods. The following are the commonly used methods: a) total drainage b) current method c) electric shock d) gill netting e) seining f) stationary fish coral and g) cast nets. After harvest, fish should be washed and be submerged in ice-water before packing. Tubs (banera) of wooden boxes are used in transporting fishes depending on the distance. In transporting to long distance, fish should be packed with crushed ice.

Keywords: harvesting; transport; handling; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

508 Anon. 1985. Canning of smoked "bangus". Technology 7(4):1-16.

Details are given of a technique for the canning of smoked bangus (milkfish (*Chanos chanos*)) that results in the improvement of the quality of the product and its shelf life. Economic returns of the process are also considered.

Keywords: cured products; canning; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

509 Basu, S. and D.I. Khasim. 1985. Studies on the effect of leaching on the quality of ice-stored fish. Advances and Priorities in Fishery Technology, Society of Fisheries Technologists (India) 22(2):105-108.

A comparative ice storage study of milkfish (*Chanos chanos*) in direct contact and out of contact (in 200 gauge polyethylene bag) with ice was taken up to assess the effect of leaching on quality of ice-stored fish. It was observed that the leaching effect was more significant on TVN and NPN than that on proportional to amino nitrogen components while there was very little effect on bacterial load. It is concluded that under similar conditions of icing, fish out of contact with ice will have longer shelf life and more acceptability than the fish preserved in contact with ice.

Keywords: fish storage; cold storage; quality control; storage effects; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Cent., Cent. Inst. Fish. Technol., Kakinada-533 002, India

510 Bersamin, S.V., O.N. Gonzalez and J.I. Sulit. 1955. Availability of calcium in bagoong alamang dried alamang, canned bangus, oyster shell and balut. The Philippine Journal of Fisheries 3(2):85-93.

Calcium occupies a prominent place in the human body's mineral composition. Since it is essentially useful in the maintenance of bones and teeth, most of it is found in the bony skeleton. It is not found in the same proportion in all foods. Many of the foods commonly liked by people are entirely lacking in calcium or contain small of it. The Oriental diet is poor in calcium. This is typically true of the Filipino who generally lives on cereals, fish, and vegetables. Calcium deficient diets have also been noted in the United States, England, Scotland and other European Countries.

Keywords: canned milkfish; processing; nutrition; calcium content; milkfish; *Chanos chanos*
Location: PCAMRD-DOST Library, Los Baños, Laguna

511 Beza, C.G. and E.C. Sison. 1978. Flavour changes during the storage of milkfish (*Chanos chanos* Forsskal) in ice and at -12.2 C: Proceedings of Indo-Pacific Fisheries Council, 18th Session, Manila, Philippines, 8-17 March 1978, Manila, Philippines. Indo-Pacific Fisheries Council. Proceedings 18(3):204-212.

Sensory evaluation, chemical and microbiological tests were carried out on brackishwater and freshwater milkfish during storage in ice and at -12.2 C in order to monitor flavour changes. The results indicated that freshwater milkfish deteriorated faster than brackishwater milkfish, characteristic flavour in freshwater milkfish correlated well with IMP levels. However, undesirable flavours were detected at day 12 due to the accumulation of volatile bases and rancidity by-products. The formation of volatile bases and the rise in pH were attributed to bacterial activity and development of rancidity was due to lipolytic activities. In brackishwater milkfish, flavour scores correlated well with hypoxanthine levels. Undesirable flavours detected at days 21 and low TVN levels were found. The characteristic flavour of milkfish was maintained during storage at -12.2 C, and after 6 months of storage the fish were still edible. The predominant microflora found in milkfish were *Alcaligenes*, *Achromobacter*, *Citrobacter*, *Flavobacter*, *Pseudomonas*, *Bacillus*, *Micrococcus* and *Vibrio*. Microbiological counts increased during storage in ice but the counts did not change significantly during storage at -12.2 C.

Keywords: organoleptic properties; storage effects; microbiology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Food Sci., Technol., Coll. Agric., Univ. Philippines at Los Baños, Laguna 372, Philippines

512 Bruce, C. 1984. Milkfish - bony, bountiful and willing producer. INFOFISH Marketing Digest (5):27-30.

An account is given of the current use and potential for milkfish (*Chanos chanos*). Handling and processing, consumer usage, preparation methods, and canned products are discussed.

Keywords: product development; fishery products; *Chanos chanos*

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

513 Budiono, M., N. Hamid, M. Marjono. 1985. Technic (sic) of catch and handling of fish fry. A guide to pond culture. Jepara Brackish Aquaculture Development Center. p. 33-62.

The different kinds of gear for collecting milkfish fry introduced in Indonesia are discussed. Mode of operation for each gear is provided. Factors to be considered in relation to milkfish fry are explained in this article.

Keywords: handling; milkfish fry; technic; fry; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

514 Carteciano, L.T. 1982. Icing of milkfish. Technology, PCARRD, Los Baños, Laguna Philippines 4(6):16 p.

A brief description of how icing enhances the quality and price of milkfish (*Chanos chanos*) is presented.

Keywords: cold storage; fish storage; ice; economic analysis; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

515 Chen, W.L., C.J. Chow and Y. Ochiai. 1996. Effects of washing media and storage condition on the color of milkfish meat paste. Fisheries Science 62(6):938-944.

Fresh samples of milkfish *Chanos chanos* were stored in ice for up to two weeks or frozen at -20 degree C for up to two months. At due time intervals, the dorsal part of ordinary muscle excised was subjected to washing by various media (water, 40 mM phosphate buffers of pH 5.6-8.0, alkaline wash), and the effects of washing media on the extracting efficiency of pigment (myoglobin) and the tristimulus color values (L, a and b) of the extract and the meat paste (washed mince) were investigated. The results obtained showed that the pigment extracting efficiency decreased during ice or frozen storage. On the other hand, as the pH values of washing media were raised, the L values of both the extract and washed mince decreased, while a and b values became higher for the extract and tended to be lower for the washed mince.

Keywords: fishery products; processing fishery products; processed fishery products; minced products; colour; freezing storage; storage effects; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Foo Yin Junior Coll. Nursing and Medical Technol., Ta-Liao Hsiang, Kaohsiung 811, Taiwan, R.O.C.

516 Dolendo, A.L., R. Roncal, C. Alameda and E. Tongco. 1977. Standardization of handling, icing and freezing of milkfish. Fisheries Research Journal of the Philippines 2(2):62-81.

The study deals with the proper handling and icing of bangus to preserve its quality during transport, freezing preservation and storage. Pre-chilling, ice to fish ratios, suitable containers and mode of transport were studied considering such factors as economy, length of the trip and ease of handling. Freezing rates that conform to the British Code of Quick Freezing using two types of blast freezers were established. Effect of storage at -10 degree C and –20 degree C on microbial count, general acceptability, odour, and texture were investigated.

Keywords: processing fishery products; freezing storage; fish handling; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food Res. Processing Dep., Food Terminal, Inc., Taguig, Metropolitan, Manila, Philippines

517 Dureza, V.A., R.C. Aure and R.V. Unarce. 1982. Development of improved techniques of catching, holding and transport of bangus fry. I. Investigation of present methods for collection, sorting, holding and transport of milkfish fry. Technical Report. Brackishwater Aquaculture Center, University of the Philippines in the Visayas, Leganes, Iloilo, Philippines.

Intensive studies were done on the identification of the cause of mortality of the milkfish fry. Based on the findings of the partial investigation conducted for the aforementioned study, the greater bulk of fry mortality occurred in the catcher's bodega and in transport from concessionaire's bodega were overcrowding, length of holding and the care during holding. During transport, the suspected causes of mortality were water salinity, density of fry per container and the length of transport.
This study determined the density of fry, its optimum salinity requirement, optimum frequency of water exchange, and the most efficient feeding techniques during holding of mikfish fry in the catcher's bodega/warehouse and during transport. Based on the previous study, improvements of the design of "sweeper" gear, used extensively in fry gathering and standardization of dragging speed and dragging time was also being determined.

Keywords: aquaculture techniques; catching; holding; transport; milkfish fry; milkfish
Location: University of the Philippines in the Visayas, Research Abstracts (1980-1987)
Author Affiliation: UP Visayas, Leganes, Iloilo, Philippines

518 Gupta, S., S. Basu, D.I. Khasim and C.C.P. Rao. 1985. Part 3: Finfish Culture, p. 846-851. In: Proceeding of the Symposium on Coastal Aquaculture held at Cochin, India, 12-18 January 1980. Marine Biological Association of India, Cochin, India.

Ice storage shelf-life of milkfish (*Chanos chanos*) was studied with daily replenishment of ice and maintaining the temperature of fish at 0 degree C-1 degree C. The quality of fish was assessed periodically by organoleptic, bacteriological and chemical parameters. The fish were found to be acceptable up to 19 days. Amenability of fresh, one-day ice stored, two-day ice stored and three-day ice stored to frozen stored fish was studied. Frozen fish were stored at -18 degree C and their quality was studied periodically by organoleptic, chemical and bateriological tests. All the frozen fish were found to remain in good condition even after one year.

Keywords: storage life; freezing storage; quality control; fish storage; *Chanos chanos*
Author Affiliation: Kakinada Res. Cent., CIFT, Kakinada, India

519 Mane, A.M., R.D. Guerrero III and V. Soesanto. 1982. Harvesting, post-harvest technology and marketing of milkfish in pens (SCS/PCC/WP-7), p. 69-73. In: Report of the Training Course on Small Scale Pen and Cage Culture for Finfish, Los Baños, Laguna, Philippines, 26-31 October 1981 and Aberdeen, Hongkong, 1-13 November 1981. South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines.

Time to harvest and methods of harvesting (seining, gillnetting and cast netting) of *Chanos chanos* are discussed. Post-harvest technology is considered, outlining the treatment of fish transported both on land vehicles and on water craft. After the fish has been packed in containers at the landing place, they are then ready for the market; methods of sale and outlet and the sale of fish are described.

Keywords: fish culture; cage culture; harvesting; marketing; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Laguna de Bay Fishpen Development Proj., LLDA, Los Baños, Laguna, Philippines

520 Murai, T. and M.R. Catacutan. 1981. Effect of 20-phenoxy ethanol and MS-222 on milkfish fingerlings (*Chanos chanos*) as anaesthetic agents. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 5(3):19-21.

An experiment was undertaken in order to determine an adequate anaesthetic and optimum concentrations for use in the handling of fingerling milkfish (*Chanos chanos*). The compounds 2-phenoxy ethanol and MS-222 were investigated. Results show the latter to be adequate with optimum concentrations between 100 and 200 ppm.

Keywords: anaesthetics; fish handling; fish culture; methodology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

521 Openiano, P.L. Jr. 1985. Transport stress-related changes in juvenile milkfish, *Chanos chanos* (Forsskal). University of the Philippines in the Visayas, Miag-ao, Iloilo. 67 p. M.S. thesis.

Juvenile milkfish (mean weight=204.89 g) were transported for two hours and examined at different time intervals after transport. The first phase showed the chemical profile of the skin mucus of transported milkfish having significant elevations ($p<0.05$) in Blood/Hemoglobin and Protein levels at 0 hours and 6 hours, respectively, and significantly decreased at 96 to 168 hours. The bacterial loads of the eye cover, liver, and kidney were significantly high at 12 to 96 hours returning to near normal levels at 144 to 168 hours. The predominant bacteria isolated from these organs were consistently the same and identified as belonging to the genus *Vibrio*. Eye cover histological examination revealed necrotic changes associated with varying levels of opacity.
The second phase showed that fish transport under low water temperature (19-20°C) had significantly high survival of 100% ($p<0.1$) at 0 hours compared to the test transport methods with anesthetic, antibiotic, and without treatment. The incidence of stress symptoms, i.e. abnormal behavior: lethargy and belly-up condition; and external body changes: eyecover opacity and hemorrhage, were significantly high ($p<0.05$) immediately after transport until 96 hours. These were more apparent on the control fish and least on those transported under low water temperature. The provision of a low holding water salinity (12±1 ppt) did not have significant effect on survival and incidence of stress symptoms on transported milkfish. Results of the physico-chemical determinations of the transport water are also presented.
Transporting fish under low water temperature was the most efficient test method in lessening stress and mortalities while the transport with untreated water was the least efficient method. A treatment combination of low water temperature and antibiotic during transport may be an important procedure for milkfish transports.

Keywords: juvenile milkfish transport; stress; *Chanos chanos*
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

522 Palomares, T.S., K.M. Apolinario, L.G. Cruz, E.A. dela Santos and O.N. Gonzales. 1977. Standardization of canning procedures for milkfish (*Chanos chanos* Forsskal). Fisheries Research Journal of the Philippines 2(1):88-101.

A series of formulation studies were conducted for the standardization of canning procedures for several bangus recipes, such as (1) sardine style, (2) salmon style, (3) relleno, (4) paksiw na bangus, (5) smoked bangus in oil, (6) escabeche, and (7) curried bangus. These recipes were first tested and then modified to obtain highly acceptable products. These were then packed in tin cans, exhausted to an internal temperature of 180 degree F and sealed immediately. The canned products were then subjected to thermal death time (TDT) studies using P.A. 3679 as the test organism. Heat penetration tests were, likewise, performed on all the products. The minimum processing time at 240 degree F and 250 degree F were calculated based on these tests. The processes were calculated to allow a spoilage rate of one can per 10,000 cans.

Keywords: quality control; processing fishery products; canning; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food Technol. Res. Div., Ind. Res. Cent., Natl. Inst. Sci. and Technol., NSDB, Manila, Philippines

523 Quinitio, G.F. and J.V. Juario. 1980. Effect of various salinity levels and stock manipulation methods on the survival of milkfish fry (*Chanos chanos*) during storage. Fisheries Research Journal of the Philippines 5(2):11-21.

The survival and growth of milkfish (*Chanos chanos*) fry stored in plastic basins at different salinity levels and stock manipulation methods without aeration and fed with hard-boiled chicken egg yolk over a period of 14 days were determined. Results showed that survival rate and increase in body weight did not differ significantly ($P > .05$) at different salinity levels nor with different stock manipulation methods. Moreover, there was no evidence of a significant interaction between salinity and stock manipulation method. The highest survival rate was 97.8% with stock manipulation 1 and 8 ppt salinity, while the lowest was 95.% with stock manipulation 1 at 32 ppt salinity. Results indicated that there was no need to reduce the salintiy of water used in storing fry in order to obtain higher survival rates as commonly believed. Sufficient food and maintenance of good water quality appeared to be more important than salinity for higher survival of fry during storage.

Keywords: storage; salinity effects; survival; fish culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

524 Rao, C.C.P., T.K. Govindan, S.S. Gupta and D.I. Khasim. 1985. Studies on transportation of *Chanos chanos*, Part 3: Finfish culture, p. 856-860. In: Proceedings of the Symposium on Coastal Aquaculture, held at Cochin. 12-18 January 1980. Marine Biological Association of India 6, Cochin, India.

The paper presents the results of studies undertaken to dervise suitable methods of transportation of fresh and frozen *Chanos chanos* to distant places by rail. Freshly harvested and frozen fish were transported to Calcutta, Delhi and Madras in different types of containers with different insulation materials. Plywood boxes with expanded polystyrene slab as well as multi-layer gunny insulations, aluminium box with insulation and a dismantable type galvanised iron box with polystyrene slab insulation were tried for transportation of the iced fish from Kakinada to Calcutta. The journey lasted 40 h. The fish reached the destination in fair to good condition and fetched Rs. 3.50 to Rs. 7.00 per kg. Frozen *C. chanos* in the form of blocks were also transported successfully from Kakinada to Calcutta and Delhi, a journey of 50 hours. A few consignments of iced fish sent to Delhi and Madras also reached the destination in good condition. Conventional bamboo baskets with palmyra leaf mat and dry leaf linings inside and gunny wrapping outside were found suitable for transporting iced fish to Madras by rail, fetching Rs. 3.25 to Rs. 4.75 per kg.

Keywords: fishery products; transportation; storage conditions; quality control; *Chanos chanos*; India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

525 Sarnita, A.S., F. Cholik and A. Hanafi. 1982. Transportation (sic) of yearling milkfish in Java and Bali, Indonesia. Bulletin Penelatian Perikanan 2(2):141-146.

Transport of milkfish yearling is studied. Three kinds of containers and two methods of aeration were used. Density ranged from 1 to 8 specimen per 100 liters seawater. Water quality was analysed. Highest mortality 40%, occurred in milkfish stocked in plastic bags with pure oxygen. Milkfish carried in canvas tanks with pure oxygen resulted to only 3% mortality.

Keywords: transportation; yearling milkfish; Indonesia; milkfish
Location: SEAFDEC Aquaculture Department Library

526 Segner, H. and J.V. Juario. 1986. Histological observations on the rearing of milkfish, *Chanos chanos*, fry using different diets. Journal of Applied Ichthyology 2(4):162-173.

Six different diets, commonly used in the Philippines for rearing milkfish, *Chanos chanos*, fry, were tested by means of growth, survival and histology. These diets included: a) live food (*Artemia*

nauplii); b) two different dry feeds; c) natural feed supplements (rice bran, egg yolk); d) a mixture of live and dry feeds. The mixed diet was found to give the best results, closely followed by liver food. The dietary value of one of both artificial feeds improved with increasing age of the fish, whereas the other was clearly inadequate. The same was true for the natural compounds. Results obtained from statistical and histological analyses were congruent; the latter provided additional insights not obtained with statistic data alone.

Keywords: histology; diets; nutritive value; growth; mortality; fry; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Zool. Inst. I (Morphol./Oekol.), Im Neuenheimer Feld 230, D-6900 Heidelberg, FRG

527 Thippeswamy, S., K. Ammu and J. Joseph. 2002. Biochemical changes during iced storage of Indian milkfish (*Chanos chanos*). Journal of Food Science and Technology (Mysore) 39(2):144-148.

Milkfish collected live from brackishwater culture ponds were used for the ice storage studies. Biochemical parameters like changes in sulphydryl (SH) group, salt soluble nitrogen (SSN), free amino acids (FAA), alpha amino nitrogen (ANN) and electrophoretic studies were carried out. During iced storage, levels of alpha amino nitrogen, non protein nitrogen, total nitrogen, salt soluble nitrogen and SH groups decreased. Taurine, glutamic acid, glycine and histidine which contributed to 87% of the total FAA, decreased to a great extent, which also lead to decreased acceptability. Salt soluble nitrogen as percentage of total nitrogen increased. High correlation was observed between alpha amino nitrogen and total free amino acids and between salt soluble nitrogen and SH group.

Keywords: fish spoilage; chilling storage; storage effects; biochemical composition; fish storage; aquaculture products; cultured organisms; fish culture; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Central Institute of Fisheries Technology, Matsyapuri P.O., Kochi - 682 029, India

528 Uyenco, V. 1990. Handling and processing of bangus or post harvest practices of the private sector. Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines.

The speaker will take up Local or Regional practices of our bangus producers from the time the fish are lifted from fish pens and fishponds. The handling methods differ slightly except certain modifications to suit (1) distances from the market; (2) volume and quality of catches; (3) further processing to be done if any (4) etc.

Keywords: handling; processing; post harvest practices; private sector
Location: PCAMRD-DOST Library, Los Baños, Laguna

529 Wang, S.J., J.H. Chen and J.J. Fan. 1994. Quality changes in fresh tilapia and milkfish during refrigerated (4 degree C) and frozen (-15 degree C) storage. Journal of Food and Drug Analysis 2(4):311-316.

Fresh tilapia (*Oreochromis*) and milkfish (*Channa*) sampled from a traditional market were randomly divided into 10 groups and well wrapped with PS/PVC film. All samples were stored at 4 degree C or –15 degree C for 0 (fresh), 4, 8, or 12 days. By microbial detection methods, no *Salmonella* nor *Vibrio* was detected in any sample during storage. The total aerobic plate counts (APC), amino acid nitrogen (AA-N), volatile base nitrogen (VB-N) and acid value (AV) changed slightly during storage at -15 degree C and during four days storage at 4 degree C. The APC, AA-N, VB-N and AV increased, while the pH decreased during prolonged storage at 4 degree C.

Keywords: food spoilage; storage; storage conditions; cold storage; biodegradation; temperature; aquaculture products; storage life; microbial contamination; microbiological analysis; *Pisces*; *Salmonella*; *Vibrio*; *Oreochromis*; *Channa*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Chia-Nan Junior Coll. Pharm., Tainan 710, Taiwan

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(See abstract, keywords, location and author's affiliation in entry no. 623)

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Kumagai, S. and N. Castillo. 1983. Changes in length and weight of milkfish, *Chanos chanos*, larvae preserved in formalin. A compilation of Southeast Asian Fisheries Development Center-Aquaculture Department technical papers on milkfish and other finfishes 2:11-18.
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(See abstract, keywords, location and author's affiliation in entry no. 270)

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Thayaparan, K. and R.D. Chakrabarty. 1984. Milkfish aquaculture in Sri Lanka, p. 161-169. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 184)

Villaluz, A.C. 1985. Collection, storage, transport, and acclimation of milkfish fry and fingerlings, p. 85-96. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 188)

Villaluz, A.C. 1986. Fry and fingerling collection and handling (milkfish), p. 153-180. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.
(See abstract, keywords, location and author's affiliation in entry no. 189)

Villaluz, A.C., H.P. Amandakoon and A. De Alwis. 1982. Milkfish fry and fingerling resources of Sri Lanka. Journal of Inland Fisheries 1:7-16.
(See abstract, keywords, location and author's affiliation in entry no. 190)

PROCESSING AND UTILIZATION OF OTHER FISHERY BY PRODUCTS

530 Anon. 1964. Fish-sausage and smoked soft-boned bangus. Philippine Fisheries Commission, Manila.

The procedure in making fish-sausage and soft-boned bangus is given in this manual. Methods are based on the Japanese fish cake preparation.

Keywords: fish sausage; smoked milkfish; soft boned bangus
Location: SEAFDEC Aquaculture Department Library

531 Anon. 1974. Procedure of deboning bangus. Bureau of Fisheries and Aquatic Resources, Cagayan de Oro City, Philippines. 1 p.

Process involved in deboning bangus is given. Materials needed are enumerated.

Keywords: deboning; bangus; milkfish; processing
Location: SEAFDEC Aquaculture Department Library

532 Anon. 1977. Bangus deboning. SEAFDEC/AQD Library Compilation. 1 p.

Provides procedural guidelines on deboning of milkfish (*Chanos chanos*), commonly called "boneless bangus" in the market.

Keywords: deboning; milkfish; bangus
Location: SEAFDEC Aquaculture Department Library

533 Anon. 1984. Kiribati. Pole and line tuna fishing with cultured milkfish bait. A report prepared for the Tuna and Baitfish Resources Evaluation Project, 135 p.

The report provides descriptions of the activities covered by the project which involved culturing milkfish (*Chanos chanos*) in intertidal areas of the lagoons of South Tarawa for use as live bait for pole and line tuna fishing. Exploratory fishing operations are outlined and recommendations of the project given.

Keywords: tuna fisheries; bait fishing; bait culture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

534 Anon. (n.d.) Canning of bangus. Bureau of Fisheries and Aquatic Resources, Cagayan de Oro City, Philippines. 1 p.

Procedure of canning bangus is being presented. Two recipes are included, salmon style and sardines style.

Keywords: Canning of milkfish
Location: SEAFDEC Aquaculture Department Library

535 Arroyo, P.T., K.M. Apolinario, T.D. Santos, L.G. dela Cruz and E.A. Santos. 1976. Relationship of percent meat yield to round weight of milkfish (*Chanos chanos* Forsskal). Fisheries Research Journal of the Philippines 1(1):44-51.

Several studies have been conducted from the standpoint of assessing the nutritional value of the habitat of milkfish but not on the meat yield-round weight relationship of bangus. Information on the meat yields of fish in relation to round weight is important particularly in its cooking and processing as food. Fish processors are interested in the percent edible portion of each delivery of a certain size of fish. Fish farmers would make use of meat yield-round weight data in the determination of the

ideal fish round weight for harvest, considering other biological factors of fish production. Consumers are also concerned with market weight of fish that could provide them with the maximum edible portion of fish as purchased. A total of 240 milkfish obtained directly from a commercial fish pond were used in this study. The average percent meat yield at different round weight intervals was determined. Linear regression analyses of the percent meat yield versus round weight at each of these round weight intervals showed that percent meat yield increases linearly at 201 to 600 g round weight (p 0 . 5%) but not at other round weight intervals. Based on the results, it is shown that milkfish yields the maximum percent meat yield at 600 g round weight, beyond which the increase is no longer statistically significant.

Keywords: weight; aquaculture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food Res. Dep., IRC, NIST, Manila, Philippines

536 Bell, J.D. and M. Gervis. 1999. New species for coastal aquaculture in the tropical Pacific-constraints, prospects and considerations. Aquaculture International 7(4):207-223.

The proximity of many Pacific countries to seafood markets in Asia, the high value of species associated with coral reefs, and the increased demand for marine aquarium species, has prompted many nations in the region to investigate opportunities for coastal aquaculture. There are, however, several constraints to consider throughout much of the Pacific, including, transport problems, fragile ecosystems, lack of suitable sites, limited economies, and the effects of customary marine tenure on access to growout sites. To overcome these problems, coastal aquaculture in the Pacific will need to focus either on species of high value, or those that yield non-perishable products. Valuable industries have been established for pearl oysters, penaeid shrimps, and the microalgae, Spirulina, in tropical Australia, the French territories and Hawaii, whereas enterprises for cultured giant clams, milkfish (*Chanos chanos*) as tuna bait, the macroalgae, *Eucheuma*, and sponges are emerging in the small island developing states. Species demanded by the aquarium trade, groupers for live reef fish markets, tropical abalone (*Haliotidae*), mangrove crabs (*Scylla spp*.) and a variety of invertebrates as sources of bioactive compounds are promising new species for intensive farming. Aquaculture technology is being applied to the restocking and stock enhancement of valuable, sedentary species low in the food chain, and there are active programmes in several small island developing states to assess the scope for releasing cultured giant clams, *Trochus*, green snail and sea cucumbers to replenish and enhance wild stocks. There is a growing awareness that the potential benefits of increased aquaculture, restocking and stock enhancement need to be balanced by the risks associated with culturing additional species, i.e. introduction of diseases, dilution of gene pools and increased biological interactions with other species, and that sustainable aquaculture, restocking and stock enhancement are most likely to be achieved with responsible application of technology and the use of indigenous species.

Keywords: pearl oysters; clam culture; fish culture; aquaculture development; aquaculture economics; cultured organisms; shrimp culture; sponge culture; marine aquaculture; *Trochus*; *Tridacna*; *Holothuroidea*; *Scylla*; *Haliotidae*; *Eucheuma*; *Penaeidae*; *Spirulina*; *Chanos chanos*; I, Pacific
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM Coastal Aquaculture Centre, PO Box 438, Honiara, Solomon Islands, [mailto:j.bell@cgiar.org]

537 Chen, W.L., C.J. Chow and Y. Ochiai. 1999. Effects of some food additives on the gel-forming ability and color of milkfish meat paste. Fisheries Science 65(5):777-783.

The dorsal part of ordinary muscle excised from fresh milkfish was salt-ground in the presence of eleven food additives, i.e., egg white, sorbitol, CaCl sub(2), CaCO sub(3), H sub(2)O sub(2), KBrO sub(3), ascorbic acid, sodium ascorbate, sodium erythorbate, cystine, and cysteine. Kamaboko was made through setting and heating procedures, and then, the gel strength (maximum stress and deformation), the amount of expressible drip, pH, and tristimulus color values (L, a and b) of these

products were compared. The results obtained showed that the addition of 1% sorbitol was effective enough to obtain kamaboko of high lightness and gel strength, whereas addition of H sub(2)O sub(2), ascorbic acid, sodium erythorbate, and cystine improved the lightness of kamaboko. On the other hand, egg white, CaCl sub(2), and KbrO sub(3) were found to be ineffective for the improvement of quality. Calcium carbonate decreased the lightness of the products.

Keywords: brackishwater fish; food technology; processing fishery products; food additives; colour; minced products; gels; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fooyin Inst. Technology Ta-Liao Hsiang, Kaohsiung Hsien 831 Taiwan ROC

538 Jiang, S.T., D.C. Hwang and C.S. Chen. 1988. Denaturation and change in SH group of actomyosin from milkfish (*Chanos chanos*) during storage at -20 degree C. Journal of Agricultural and Food Chemistry 36(3): 433-437.

The formation of disulfides, effects of the addition of reductants before freezing, and denaturation of milkfish (*Chanos chanos*) actomyosin (AM) during storage at -20 degree C were investigated. In the freezing process, aggregation-denaturation was mainly caused by the formation of hydrogen, hydrophobic, and disulfide bonds; during storage, more disulfides formed. The addition of NaNO sub(2) and NaBH sub(4) before freezing accelerated the denaturation of AM during storage. However, when added to freeze-denaturated AM, NaNO sub(2) and NaBH sub(4) recovered AM's solubility in 0.6 M KCl and the total SHs and decreased the sum of NaBH sub(4)-soluble and -insoluble fractions.

Keywords: actomyosin; freezing storage; organoleptic properties; deterioration; *Chanos chanos*; quality; proteins
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Grad. Sch. Mar. Food Sci., Natl. Taiwan Coll. Mar. Sci. and Technol., Keelung 20224, Taiwan

539 Jiang, S.T., D.C. Hwang and C.S. Chen. 1988. Effect of storage temperatures on the formation of disulfides and denaturation of milkfish actomyosin (*Chanos chanos*). Journal of Food Science 53(5):1333-1335.

The effects of frozen storage temperatures on the formation of disulfides and the denaturation of actomyosin (AM), extracted from milkfish (*Chanos chanos*) dorsal muscle, were investigated. The activities of Ca-ATPase and Mg(Ca)-ATPase, Ca-sensitivity and AM solubility in 0.6M KCl decreased at a higher rate at -20 degree C than at -35 degree C. The total NaBH sub(4)-soluble and insoluble proteins increased at a much higher rate at -20 degree C than at -35 degree C. During the freezing process, the total SHs decreased significantly; the total SHs decreased with a faster note at -20 degree C than at –35 degree C, suggesting that more disulfides formed in samples at –20 degree C than at -35 degree C. During storage, disulfides formed at -20 degree C but not at -35 degree C.

Keywords: sulphides; freezing storage; muscles; actin; myosin; deterioration; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Grad. Sch. Mar. Food Sci., Natl. Taiwan Coll. Mar. Sci. and Technol., Keelung 20224, Taiwan

540 Joseph, J., P.A. Perigreen, C. George and T.K. Govindan. 1980. Iced and frozen storage characteristics of cultured *Chanos chanos* (Forsskal). Advances and Priorities. Fishery Technology, Society of Fisheries Technologists (India) 17(1):21-25.

Freshly harvested *C. chanos* were stored in crushed ice and their storage life estimated by following biochemical, bacteriological and organoleptic changes occurring during storage. Samples of the fish were withdrawn at various intervals of storage, quick frozen, glazed and held in frozen storage at -18

C. Shelf-life in frozen storage was determined in relation to period of ice storage prior to freezing by determining biochemical and organoleptic characteristics up to 30 weeks.

Keywords: storage effects; freezing storage; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Inst. of Fish. Technol., Cochin-682 029, India

541 Ko, W.C. 1996. Effect of high pressure on gelation of meat paste and inactivation of actomyosin Ca-ATPase prepared from milkfish. Fisheries Science 62(1):101-104.

Milkfish was used as a raw material to establish and obtain fundamental data about the gelation of meat paste and inactivation of actomyosin Ca-ATPase by means of high pressure-treatment. Suwari, a setting phenomenon at low temperature, occurred at 5O degree C, while modori, a disintegrating phenomenon at high temperature, occurred at 60-70 degree C. The suwari temperature of meat paste treated at 3,000 atm for 1 hour decreased from 50 to 30 degree C. Excellent gel was obtained after pressurizing at 1,000, 3,000, and 5,000 atm for 1 hour and subsequently heating at 9O degree C for 10 min. Heat-induced suwari was improved and modori was inhibited after pressuring at 3,000 atm for 1 hour. The activity of Ca-ATPase was almost lost by treating at 3,000 atm for 5 min. Different patterns in Ca-ATPase inactivation were observed when actomyosin was treated by pressurizing, heating after pressurizing, or pressurizing combined heating. Liability to denaturation of the protein indicated that pressure treatment was applicable to milkfish processing.

Keywords: gels; pressure; minced products; ATP; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Food Sci., Natl. Chung Hsing Univ., 250 Kuokuang Road, Taichung, Taiwan

542 Ko, W.C. and M.S. Hwang. 1995. Contribution of milkfish sarcoplasmic protein to the thermal gelation of myofibrillar protein. Fisheries Science 61(1):75-78.

This research investigated sarcoplasmic protein (Sp-P) contribution to the thermal gelation of meat paste and myofibrillar protein. The Sp-P was recovered by an ultrafiltration unit from the wash water of milkfish (*Chanos chanos*) meat paste preparations. Washed meat paste showed gel strength 1.4-2.0 times that of unwashed paste. This may be caused by the concentration effect of myofibrillar protein. Adding Sp-P increased gel strength in both washed and unwashed meat pastes. The larger the amount of Sp-P added, the stronger the effect. Suwari occurred at 40-50 degree C and modori occurred at 60-70 degree C for milkfish meat pastes irrespective of the addition of Sp-P. Sp-P addition (10 mg/g) caused suwari indices to change from 41 to 51, and modori indices from 37 to 33. These results show that the addition of Sp-P improves thermal gelation, has a promotive effect on suwari and a restrictive effect on modori.

Keywords: gels; heating; proteins; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Food Sci., Natl. Chung Hsing Univ., Kuokuang Rd., Taichung, Taiwan

543 Ko, W.C. and S.Y. Shieh. 1995. Relationship between the initial activity and thermal inactivation of Ca-ATPase from milkfish actomyosin and myosin. Fisheries Science 61(2):369-370.

Actomyosin and myosin with different Ca-ATPase specific activities were prepared from milkfish, *Chanos chanos* by storing the proteins in ice for various periods and the relationship of initial activity of Ca-ATPase and its thermal inactivate was investigated. The Ca-ATPase activity of milkfish declined from 0.468 to 0.264 mu mol Pi/min mg protein for actomyosin and 0.266 to 0.165 mu mol Pi/min mg protein for myosin during 21 days of iced storage. The heating temperature affected the rate of Ca-ATPase decrease for both actomyosin and myosin. Linear plots obtained indicate that those inactivation rates of Ca-ATPase activity can be expressed as a first order rate

constant, K sub(d), as in case of other fish species. Resistance of Ca-ATPase to thermal inactivation was also found to be closely related with its initial activity from those figures.

Keywords: enzymatic activity; ATP; myosin; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Food Sci., Natl. Chung Hsing Univ., Kuokang Rd. 250, Taichung, Taiwan

544 Kumagai, S. and N. Castillo. 1978. Changes in length and weight of milkfish fry preserved in formalin. Quarterly Research Report. Aquaculture Department, Southeast Asian Fisheries Development Center 2(1):5-8.

Fry shrank immediately after they were preserved in formalin, but from the second week onwards shrinkage was almost nil. Fry in freshwater formalin solutions shrunk less than those in seawater formalin solutions. It is recommended that milkfish *Chanos* fry be preserved in formalin solutions for 1 wk prior to length measurement and at least for 3 wks before determining body weight.

Keywords: preservatives; storage effects; fish larvae; *Chanidae*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

545 Kumagai, S. and N. Castillo. 1983. Changes in length and weight of milkfish, *Chanos chanos*, larvae preserved in formalin. A compilation of Southeast Asian Fisheries Development Center-Aquaculture Department technical papers on milkfish and other finfishes 2:11-18.

Shore caught milkfish fry (late postlarvae) and artificially bred, laboratory reared larvae (0-to-20 day) were preserved in 5 percent and 19% freshwater and/ seawater formalin solution after measuring their initial weights and/lengths. The changes in length and weight were observed at regular intervals.
Shrinkage in freshwater formalin (FWF) was less than those in seawater formalin (SWF). The difference in 5% and 10% concentration of the same solution was not significant. Wild fry showed a final shrinkage of 5.13% from the initial length in 5% SWF and 5.07% to 10% SWF. Shrinkage in laboratory-reared larvae varied from 5.09-9.35% according to the age and/or development stage, for the same preservation period of 14 days. In estimating the natural length of milkfish larvae preserved in 5-10% SWF, a 5% shrinkage must be considered. The specimens must be kept in the preservative for at least a week for shrinkage to stabilize. Nothing definite could be said, as yet, for the weight changes in milkfish larvae.

Keywords: larvae preservation; preservative; length; weight; milkfish fry; formalin; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library; WorldFish Center Library Philippine Office

546 Lin, K., R. Huang, C.W. Lai and Z.L. Kong. 2001. Ex/in vivo immune bioactivity of the hot water extracts of Haliotis diversicolor, *Chanos chanos* and Tilapia (*Oreochromis niloticus x O. aureus*), p.322. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

We found the growth and the immunity promoting substance from food components by using mammalian cell lines with serum-free medium under animal experiment model. Here, we reported the growth and the immunity promoting substances from fish species. Fresh material were homogenized and then boiled at 100 degree C for 30 mins. After centrifugation, the supernatant was concentrated by vaccum evaporation. Through 30%-50% ammonium sulfate saturation precipitation (WG30-50). Those dialysates (ultrafilitration M.W.10Kda cut off) were lyophilized. The result show sthat extracts of Tilapia, milkfish enhanced cell proliferation toward human-human hybridoma cell line HB sub(4)C sub(5) and enchanced cell proliferation toward human marrow cell lines HL-60. Furthermore, Taiwan small abalone, Haliotis diversicolor was selected for immunological function

assessment. After small abalone was removed from the viscus, the pulp was treated by either hot water (100 degree C, 30 mins) or 40% alcohol, then through 50% ammonium sulfate saturation precipitation. Both hot-water extracts and ethanol extracts of small abalone promoted cell proliferation toward human hybridoma cell line HB sub(4)C sub(5) as well as macrophage-like cell lines (U-937, U-M, THP-1 and J774.1). We mixed Tilapia WG3050, *Chanos chanos* WG3050 and abalone, which show the immune bioactivity and named three in one. Balb/c mice were fed with different dose of three in one. One and two percent of mice daily eating were supplied by the three in one. Three in one significantly increased almost three-fold proliferation of spleen cell which is stimulating with LPS, either in specific or non-specific group is acceptable, and be stimulating with PHA in specific experiment. It increased one-fold to three-fold proliferation of PEC which is stimulating with PHA and LPS in specific or non-specific animal experiment. Two percent of mice daily eating is supplied by three in one also significantly increased in secretion of antibody IgG in specific or non-specific group. Through Phenyl column and Amicom ultrafiltration, we purify bioactive substances from those extracts. These results obtained in this study indicated that the extract of three in one should be good candidate for health food development.

Keywords: cell lines; immunity; extracts; food supplements; bioactive compounds; metabolites; food technology; cell culture; food additives; human food; defence mechanisms; haliotis diversicolor; *Chanos chanos*; *Oreochromis niloticus; Oreochromis aureus; Tilapia*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cellular Immunology Laboratory, Department of Food Science, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung 20224, Taiwan, R.O.C.

547 Lung, S.C.C., C.F. Chen, S.C. Hu, and Y.P. Bau. 2003. Exposure of Taiwan Residents to Polychlorinated Biphenyl Congeners from Farmed, Ocean-Caught, and Imported Fish. Environmental Science & Technology 37(20):4579-4585.

This study is to assess PCB levels in five frequently consumed fish species in Taiwan, tilapia, milkfish, white pomfret, hairtail, and cod. Seventeen congeners were measured in fillet samples purchased from major markets in northern, central, and southern Taiwan. All 136 samples had traces of PCBs. The median concentrations were 0.18, 0.46, 0.62, 0.69, and 7.34 ng/g wet wt and 1.01, 0.28, 1.14, 5.06, and 19.3 pg-WHO-TEQ/g lipid in tilapia, milkfish, white pomfret, hairtail, and cod samples, respectively. Cod (the imported fish) had the highest wet weight PCB concentrations. The fish caught off-shore (white pomfret and hairtail) had higher levels than the farmed fish (tilapia and milkfish). The congener profiles varied among species. PCB 105/153 and 126 accounted for more than 28% and 53% of the 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents (WHO-TEQs) in hairtail and cod, respectively; while PCB 156 was the major TEQ contributor in the other species. The estimated median PCB intake of the general public from consumption of the five species ranged from 0.000023 to 0.048 pg-WHO-TEQ/kg/day. It was also found that samples farmed or caught along the southern coast had higher PCB levles than those from other parts of Taiwan, indicating possible elevated PCB contamination around that area.

Keywords: food; seafood; PCB; fish consumption; pollution effects; bioaccumulation; aquaculture products; fishery products; public health; food fish; industrial wastes; food contamination; environmental health; PCB compounds; aquaculture; International trade; air pollution effects; *Pisces; Gadus; Oreochromis; Trichiurus; Bramidae*; *Chanos chanos*; Taiwan; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Public Health, Chung Shan Medical University, Taichung, Taiwan 402, ROC, [mailto:sclung@earth.sinica.edu.tw]

548 Miao, S. and H. Tang. 2002. Bioeconomic analysis of improving management productivity regarding grouper *Epinephelus malabaricus* farming in Taiwan. Aquaculture 211(1-4):151-169.

The management productivity of grouper farming in Taiwan was studied on the basis of considering two major factors, geographical location and pond structure. The best choice with regard to

profitability is to locate a farming system with a concrete design in Pindong area. The feeding management indicated that hair shrimp used as a diet source is much better than tilapia and milkfish. Additionally, controlling salinity between 29 and 30 is optimal for water management. Although the varied stocking densities (SD) applied presently had no impact on the survival rate (SR), increasing the stocking density but within this safe range may still cause a negative effect on the bioeconomic mechanism. Finally, there were six indices that were statistically computed based on the farming data. A better management of increasing the productivity could be achieved by jointly evaluating the six indices.

Keywords: marine aquaculture; fish culture; feeding experiments; food organisms; aquaculture techniques; aquaculture economics; *Epinephelus malabaricus*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Aquaculture, National Taiwan Ocean University, Keelung, Taiwan, ROC

549 Nair, P.G.V. and K. Gopakumar. 1985. Selective release of fatty acids during lipid hydrolysis in frozen-stored milkfish (*Chanos chanos*). Advances and Priorities in Fishery Technology, Society of Fisheries Technologists (India) 22(1):1-4.

Lipid hydrolysis and the nature of fatty acids lost as a result of lipid hydrolysis in milkfish (*Chanos chanos*) during frozen storage at-20 degree C is discussed in this paper. There was a preferential loss of saturated acids during the first 3 weeks of storage. This was followed by loss of polyunsaturated acids during the next 7 weeks. Sharp decrease in the levels of monounsaturated acids was observed from the 10th week of frozen storage. These observations are due to the preferential hydrolysis of phospholipids with relatively high proportion of saturated acids during the first 3 weeks, followed by the hydrolysis of phospholipids with high proportions of polyunsaturated fatty acids from the 3rd to the 10th week.

Keywords: freezing storage; storage effects; lipids; hydrolysis; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Inst. Fish. Technol., Cochin-682 029, India

550 Peng, C.Y. and S.Y. Su. 1993. Effect of sterilization condition on the quality of canned milkfish. Journal of Taiwan Fisheries Research 1(2):73-79.

The chemical and organoleptic quality of seasoned, canned Tankuei milkfish (*Chanos chanos*) which was heat processed at two different temperatures 115 degree C and 125 degree C, to attain Fo values of 6 and 12, were evaluated. The moisture and crude protein content of canned milkfish calculated on a dry basis were lower than that of raw milkfish. The color of canned milkfish was light yellowish-brown and turned dark brown as the Fo value increased. The SDS-polyacrylamide gel electrophoresis pattern of canned milkfish showed myosin, actin, tropomyosin and troponin-C bands mostly disappeared. Available lysine content and in vitro protein digestibility of canned milkfish were not significantly inferior to that of raw milkfish. Sensory evaluations of canned milkfish using four sterilization conditions were not significantly different. From these results, it could be concluded that the quality of canned milkfish processed using four different sterilization conditions were not significantly different.

Keywords: processed fishery products; canned products; sterilization; quality control; organoleptic properties; proteins; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Kaohsiung Branch, Taiwan Fish. Res. Inst., 1-1 North 1st Rd., Chien-Chen Fishing Port, Kaohsiung, Taiwan 806

551 Peng, C.Y., S.Y. Su and W.C. Su. 1993. Optimization on the processing conditions and quality change of seasoned softened-bone milkfish during storage at 5 degree C and –20 degree C. Journal of Taiwan Fisheries Research 1(1):61-68.

Tan-Kuei and Wei-Tseng seasoned softened-bone milkfish (*Chanos chanos*) products were prepared by removing the head and viscera, soaking in seasoning, retorting, and drying. The optimal conditions were: soaking at 5 degree C overnight, retorting at 125 degree C for 50 min and drying at 65 degree C for 60 min. The aerobic plate count (APC) of fresh fish, Tan-Kuei and Wei-Tseng seasoned products were 5.30 x 10 super(7), 5.90 x 10 super(1), and 1.96 x 10 super(2) CFU/g, respectively. The coliform test of all products had negative results. During six months storage at 5 degree C and -20 degree C, no significant changes in APC, pH, acid value, peroxide value and color of the vacuum-packed products were observed. These data suggested that the vacuum-packed and seasoned softened-bone milkfish developed in the study was stable when refrigerated and frozen.

Keywords: processing fishery products; cold storage; freezing storage; storage life; quality control; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Kaohsiung Branch, Taiwan Fish. Res. Inst., 1-1 North 1st Rd., Chien-Chen Fishing Port, Kaohsiung, Taiwan 806

552 Peng, C.Y., S.Y. Su, W.C. Su. 1994. Effects of various binders and ingredients on the quality of restructured milkfish fillet. Journal of Taiwan Fisheries Research 2(2):69-77.

The effects of two binders, algin mixture (sodium alginate: calcium carbonate: adipic acid = 2.5: 0.45: 0.09) and milkfish surimi, and four ingredients, water, salad oil, low protein flour, and sodium tripolyphosphate on the quality of restructured milkfish fillet (RMF) were investigated. When mixing 0.2% algin mixture into the RMF, the tensile strength of RMF was increased significantly, but the tensile strength of RMF did not significantly increase when the addition of algin mixture exceeded 1.2%. The tensile strength of RMF significantly increased proportionality with the level of milkfish surimi. The L value of RMF with algin mixture added increased, but the a and b values decreased. The L and a values of RMF mixed with milkfish surimi decreased. The addition of water, salad oil and low protein flour could improve the texture and flavor of RMF, but the optimum levels of their addition were 10%, 15% and 7%, respectively. Sodium tripolyphosphate also increased the tensile strength of RMF significantly, but its optimal level of addition was 0.25%.

Keywords: fishery products; processing fishery products; food technology; quality control; tensile strength; food additives; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Kaohsiung Branch, Taiwan Fisheries Research Institute, 1-1 North 1st Road, Chien-Chen Fishing Port, Kaohsiung, 806, Taiwan

553 Peralta, J.P. 2001. Milkfish industry alternative: products from cultured baitsize, p. 195. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

In the Philippines, milkfish (*Chanos chanos* Forsskal), local name bangus, is one of the most important cultured fish species. The author advocates the creation of an industry that is not currently present, the baitsize industry. Milkfish hatcheries have a critical role to play in this endeavor. The streams of the fry supply, both from the wild and from the hatcheries, would fragment into two. One major stream will be for the normal commercial size milkfish, and the other stream will be for the baitsize milkfish. The projected demand for baitsize, the other stream, would dramatically increase as support to this alternative milkfish industry increase. Estimates suggest that pond production cost from fry to baitsize, is lower by as much as 60%, relative to commercial size. Turn-around period is shorter; it only takes 45 days. Risk Factor due to natural calamities, and other unforeseen low productivity, is reduced; as production cycle is increased to about 8 instead of 4 times per year. Pond area requirements would eventually be reduced or a more efficient production systems would eventually emanate. The project introduces translation of the baitsize milkfish into several product prototypes; frozen, bottled, canned, smoked, dried and fermented products.

Keywords: bait culture; aquaculture development; fish culture; fishery products; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Fish Processing Technology, College of Fisheries and Ocean Sciences, U. P. Visayas, 5023 Miag-ao, Iloilo, Philippines, [mailto:jperalta@iloilo.net]

554 Peralta, J.P. 2001. Process accounting (PA) and its application, p. 196. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Process Accounting (PA) is a method that defines alternative process streams suitable for the conversion of raw material/s to products with the end result of, increasing utility of the raw materials; minimizing losses as wastes; and implicitly mitigating and protecting the environment. Process accounting defines as many product conversion streams as possible in a production process, with the intent of minimizing the accumulation of wastes. It also defines the utility value of the products by clustering it as upstream products and downstream products. This is a break away from the normal practice of designing a processing plant with only one product or limited products. Process Accounting as a management tool, is being advocated as a protocol in the design of food processing operations. This paper discusses its application in milkfish (*Chanos chanos* Forsskal) processing.

Keywords: management; process plants; processing fishery products; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Fish Processing Technology, College of Fisheries and Ocean Sciences, U. P. Visayas, 5023 Miag-ao, Iloilo, Phillipines, [mailto:jperalta@iloilo.net]

555 Samarakoon, J.I. 1972. On the experimental culture of milkfish *Chanos chanos* (Forsskal) as tuna bait in Ceylon, p. 454. In: T.V.R. Pillay (ed.). Coastal Aquaculture in the Indo-Pacific Region, Fishing News Books, West Byfleet, England.

Preliminary investigations have indicates that *C. chanos* is suitable for tuna bait. An experiment aimed at achieving a production of 500 kg/ha in 0.12-ha ponds during a 6-month period, and comparing the total yield from (1) selective harvesting and (2) selective harvesting with replenishment of stock, is described. The yields of 99.9 kg and 144.9 kg recorded for a 6-month period in the ponds correspond to 799 and 1,159 kg/ha per annum respectively. The latter figures relate to the method of selective harvesting followed by replenishment.

Keywords: milkfish, *Chanos chanos*, Ceylon
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwater Fish. Stn. Pitipana, Negombo Sri Lanka

556 Santos, L.M. and F. Magno-Orejana and M.N. Bautista. 1977. Utilization of by products of milkfish processing. Preparation of fish meal and silage. Fisheries Research Journal of the Philippines 2(1):56-69.

The study involved an investigation into the factors which affect the quality of meal and silage prepared from milkfish offal. In the preparation of fish meal, the wet and dry reduction processes were compared and results showed that the wet reduction process is more applicable for milkfish offal consisting of head, tail, fins, and internal organs. The dry method has an adverse effect on the product as it destroys vitamins and certain essential amino acids. In the preparation of fish silage, the experiment was designed to determine the concentration of sulphuric acid to be added to milkfish offal to produce silage of good quality within the shortest time possible. Results showed that all concentrations produced a pH close to 2 with no significant differences as a result either of acid concentration or ensilaging time. However, the rate of hydrolysis was significantly affected by the

concentration of sulphuric acid as judged objectively by higher values for amino -N and volatile bases, and subjectively by the presence of lesser solids relative to the liquid.

Keywords: processing fishery products; fish meal; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Fish. Technol., Coll. Fish., Univ. Philipp., Diliman, Q.C., Philippines

557 Thippeswamy, S., K. Ammu and J. Joseph. 2001. Changes in protein during drying milkfish (*Chanos chanos*) at 60 degree C. Advances and Priorities in Fishery Technology 38(2):97-101.

Milkfish collected from brackish water culture ponds was dressed and dried at 60 degree C for 24 hours and biochemical changes taking place during drying were studied. Alpha amino nitrogen (AAN) showed a slight increase but total free amino acids (FFA) showed significant reduction during 24-hour drying. The variation in individual free amino acid was found to be different for each amino acid. Salt soluble nitrogen and SH group decreased considerably as a result of drying. Electrophoretic study showed a decrease in the number of high molecular weight and low molecular weight protein fractions, but intermediate molecular weight proteins did not show considerable change.

Keywords: dried products; drying; aquaculture products; food technology; proteins; amino acids; biochemical phenomena; *Chanos chanos*; ISW, India, Kerala, Ernakulam Dist., Cochin
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Central Institute of Fisheries Technology, Cochin-682 029 India

558 Trachet, N. 1989. Adding value to the products of aquaculture: The smoking of giant clams from Palau and milkfish from Kiribati. RAS/116/JPN-field-doc-90/10, 24 p.

The document includes 2 study reports. The first covers trials on smoked products made from giant clam (*Tridacna derasa*) at the Micronesian Mariculture Demonstration Centre at Koror, Palau. Seven experiments were conducted using different size samples of live and frozen clams of different age and using Japanese style and European style smoking techniques. The second study report involves the smoking of milkfish (*Chanos chanos*) in Tarawa, Kiribati. The state and potential of milkfish smoking in Tarawa is examined and the improvement of smoking techniques under local conditions is discussed. Future development possibilities of smoked milkfish products and preliminary marketing trials are also considered briefly.

Keywords: aquaculture products; processing fishery products; cured products; product development; *Tridacna derasa*; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

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Anon. 1978. Milkfish (Bangus) as food: handling, freezing and processing of milkfish (*Chanos chanos*, Forsskal). National Science Development Board, Manila, Philippines. 203 p.
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Bagarinao, T. 1998. Economic value of the milkfish industry. SEAFDEC Asian Aquaculture 20(1):5-6.
(See abstract, keywords, location and author's affiliation in entry no. 567)

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Chen, W.L., C.J. Chow and Y. Ochiai. 1998. Effects of acid and alkaline reagents on the color and gel-forming ability of milkfish kamaboko. Fisheries Science 64(1):160-163.
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(See abstract, keywords, location and author's affiliation in entry no. 516)

Edra, R.B. 2000. Pag-aalaga ng bangus, gabay sa negosyo. Philippine Council for Aquatic and Marine Research and Development, Los Baños, Laguna, Pilippines.
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Tekinaiti, T. 1996. Milkfish farming in Kiribati, p. 161-166. In: Present and future of aquaculture research and development in the Pacific Island Countries, Ministry of Tonga, Nukualofa (Tonga).
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SOCIO-ECONOMIC AND RELATED STUDIES

SOCIO-ECONOMIC STUDIES

559 Agbayani, R.F. 1988. Economics of milkfish culture in the Philippines. In: H. Tanaka, K. Roger Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). Proceedings of the regional workshop on milkfish culture development in in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific Aquaculture Development Project, FAO/UN, Suva, Fiji.

This paper discusses the costs and returns of three phases in milkfish culture as practiced in the Philippines namely: Nursery, Stunting or retarding the growth of milkfish fingerlings, Modular culture system. The economic indicators used are average rate of return or return on investment and payback period. The economic analysis was based on experiments undertaken at the Leganes Research Station of SEAFDEC Aquaculture Department and verified in three sites located in the provinces of Negros Occidental (2 sites) and Cebu (1 site).

Keywords: economics; milkfish culture; Philippines
Location: http://www.fao.org
Author Affiliation: Forum Fisheries Agency, Honiara, Solomon Islands

560 Agbayani, R.F., D.D. Baliao, N.M. Franco, R.B. Ticar and N.G. Guanzon Jr. 1989. An economic analysis of the modular pond system of milkfish production in The Philippines. Aquaculture 83(3-4):249-259.

In 1980, the annual yield of milkfish (*Chanos chanos*) ponds in The Philippines was 800 kg/ha while the potential yield is estimated to be 2000 kg/ha. The modular pond system analyzed in this study can largely close the gap between actual and potential yield through more efficient use of pond capacity to increase the number of croppings up to 7/l year. Scale of operation ranged from 2.7 ha to 7.9 ha. From 2 to 7 production runs were recorded with per hectare outputs ranging from 278 kg to 341 kg per run. Input costs were based on actual figures and the ex-farm milkfish price as P21.00 (4 to 6 fish/kg). The average return on investment and payback period for all sites was 68.81% and 1.25 years, respectively.

Keywords: pond culture; aquaculture economics; potential yield; cost analysis; pricing; *Chanos chanos*; ISEW, Philippines

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

561 Anon. 1975. Mature bangus (sabalo) culture and breeding farm. Bureau of Fisheries and Aquatic Resources, Region 4-A. 11 p.

A feasibility study on the establishment of a milkfish culture and breeding farm in Naujan, Oriental Mindoro, Philippines, is presented.

Keywords: mature bangus; mature milkfish; breeding farm; sabalo; milkfish
Location: SEAFDEC Aquaculture Department Library

562 Anon. 1983. Philippines recommends for bangus. PCARRD, Los Baños, Laguna. 77 p.

Culture of milkfish in brackish water ponds and fishpens in the Philippines is discussed. Biology, handling, marketing, economics and fry fishery are included. Problems and prospects of the milkfish industry are given.

Keyword: bangus; milkfish
Location: SEAFDEC Aquaculture Department Library

563 Anon. 1983. Record keeping suggestions for the Temaiku milkfish farm (Kiribati). EWC, Honolulu, Hawaii, USA. 38 p.

A recent review of the milkfish farm in Tarawa was done by the aquaculture team of the Pacific Islands Development Program (PIDP). The review uncovered certain weaknesses in the current farm record keeping system. This follow-up report is an attempt to address some of the deficiencies uncovered in the original review. Examples and alternatives of records and schedules are provided with brief comments. These can be considered by the Fisheries Division when it addresses the weaknesses in the current data collection system at the farm.

Keywords: aquaculture economics; fish culture; information handling; *Chanos chanos*; Kiribati
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

564 Anon. 1983. Record keeping suggestions for the Temaiku milkfish farm. Pacific Island Development Program, Honolulu, Hawaii, USA. 38 p.

A review of milkfish (*Chanos chanos*) farm in Tarawa (Kiribati) uncovered certain weaknesses in the current farm record keeping system. This report is an attempt to address some of the deficiencies. Examples and alternatives of records and schedules are provided with brief comments. These can be considered by the local authorities to rectify current data collection system at the farm. (DBO)

Keywords: fish culture; aquaculture facilities; aquaculture economics; aquaculture techniques; records; statistics; management; *Chanos chanos*; ISEW, Pacific, Kiribati, Gilbert Is., Tarawa
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

565 Anon. 1984. Milkfish farming for West Pacific Island. Fish Farming International 11(9):9.

Interest in raising milkfish is growing in Guam, the largest of the Marianas Islands in the Pacific Ocean. But before this species can become an important cultured fish on the Island, a number of problems will have to be solved, says the University of Guam in a recent newsletter.

Keywords: milkfish farming; Guam; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

566 Anon. 1995. Socioeconomic studies of milkfish (*Chanos chanos*) farming in Taiwan. Tungkang Marine Laboratory Conference Proceedings 5. 132 p.

Milkfish (*Chanos chanos*) is a major species for aquaculture in Southeast Asia, primarily in three countries: Taiwan, Indonesia and the Philippines. The future development of this industry depends not only on biotechnical improvements but also on socioeconomic viability. There is a need of socioeconomic study to guide the development strategies in these countries. The International Economic Cooperation Development Fund (IECDF) of the Republic of China provided financial support for such a socioeconomic study. The major objective of the first phase of this study is to assess the socioeconomic status of the milkfish industry in the three major producing countries in terms of fry supply, milkfish growth-out, market demand and prospects of future development. The focus of the second phase is to evaluate the socioeconomic impacts of transferring milkfish hatchery technology in the major producing countries. The results of the study in Taiwan is reported and is divided into three major parts: 1) estimate the production cost of both hatchery-produced and wild-catched milkfish fry; 2) estimate the factor market effects of transferring the milkfish hatchery technology by using input-output analysis to estimate the economy-wide effects on output, employment and income. The investment and operating expenditures of thee hatchery operation as well as the displaced activities of fry collection from the wild are also estimated; 3) estimate the product market effects of transferring the milkfish hatchery technology by applying Hayami and Herdt's model. This model allows estimating the economic welfare effects of transferring the hatchery technology to the participating countries. (DBO)

Keywords: aquaculture; fish culture; aquaculture economics; marketing; market research; seed collection; fingerlings; cost analysis; socioeconomic aspects; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Research Institute of Agricultural Economics, National Chung Hsing University Taichung, Taiwan Taiwan (Province of China)

567 Bagarinao, T. 1998. Economic value of the milkfish industry. SEAFDEC Asian Aquaculture 20(1):5-6.

A brief description is given of the milkfish (*Chanos chanos*) farming industry in the Philippines. Over the past 20 years, the relative importance of milkfish has declined with the expansion of tilapia, tiger shrimp and seaweed farming. In 1975, some 141,461 mt of milkfish made up 10% of the total fish production, whereas in 1995, the total milkfish harvest of 150,858 mt made up only 5.5% of the total fish production. Milkfish is harvested and marketed mostly fresh or chilled, whole or deboned, but some are canned or smoked. The domestic markets, mainly in Metro Manila, absorb most of the production. Milkfish is also absorbed in different product forms: dried, canned, smoked, or marinated. An export market for quick-frozen deboned milkfish fillets has begun to develop and fish processing companies are responding fast. The milkfish farming industry has important linkages with the various sectors that supply the inputs, and those that transport, store, market or process the harvest. For intensive milkfish farming to be both profitable and sustainable, more value-added products must be developed and marketed.

Keywords: fish culture; fishery industry; aquaculture statistics; aquaculture products; marketing; trade; aquaculture economics; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

568 Baliao, D.D., N.M. Franco and R.F. Agbayani. 1987. The economics of retarding milkfish growth for fingerling production in brackishwater ponds. Aquaculture 62(3-4):195-205.

Two experiments were conducted to measure the economic viability of retarding milkfish (*Chanos chanos*) growth (stunting) in brackishwater ponds. In the first experiment, 2-month-old fish were reared for 6 months in ponds with initial stocking densities of 15, 20, 25, and 30 fish/m super(2). The second experiment had a common stocking density of 20 fish/m super(2) with rearing periods of 6, 9, and 12 months. All experiments followed the lab-lab method of growing natural food plus

additional substrates. Supplemental feeding using rice bran mixed with ground trash fish started 60 days after initial stocking. Under Philippine conditions, stunting milkfish fingerlings at 20 fish/m super(2) for 6-9 months is most cost effective; this permits the production of milkfish fingerlings for lower cost than they can be purchased.

Keywords: growth; fish culture; fingerlings; pond culture; brackishwater aquaculture; stocking density; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquacult. Dep., Leganes Res. Stn., Leganes, Iloilo, Philippines

569 Chan, H.S.A. 1991. Socio-economics of two coastal communities engaged in milkfish fry gathering, La Union, Philippines. Towards a integrated management of tropical coastal resources. Proceedings of the ASEAN/US technical workshop on integrated tropical coastal zone management, 28-31 October 1988, Temasek Hall, National University of Singapore, Singapore.

This study investigated the milkfish (*Chanos chanos*) fry gathering industry in 2 adjacent communities in Lingayen Gulf, Philippines. One site has beaches classified as part of the national seashore park and the other falls under municipal management and is concessioned at present to a group of resident small-scale fishermen. Differences in the economic structure of the 2 communities were identified and evaluated. Market systems employed were defined and analyzed in terms of maximum returns to milkfish fry gatherers. Significant economic and social contributions of milkfish fry gathering were enumerated and their implications probed. The major problems ranged from gear inefficiency and storage to dwindling annual catch. Recommendations included the regulation of net types, which capture spawning milkfish, the development of stocking ponds near fry grounds to minimize mortality rates and the adoption of more efficient economic arrangements for marketing.

Keywords: coastal fisheries; fishing gear; seed collection; economics; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Coll. Soc. Work and Community Dev., Univ. Philippines, Diliman, Quezon City, Philippines

570 Chen, C.C. and C.L. Wang. 1998. A welfare evaluation on price stabilization of milkfish in Taiwan, p. 103-104. In: Aquaculture '98 Book of Abstracts. Aquaculture '98 Conference, 15-19 February 1998, Las Vegas, Nevada, USA.

This paper focuses on the study of welfare evaluation on price stabilization program of Milkfish in Taiwan in recent two decades. We obtain important results that there actually exists unstable prices of milkfish in fish markets at both producing and consumption areas by Michaely index and Von-Neumann ratio. So do quantity produced and revenue. By using Murry's approach, the gross variance of revenue (farmers income) of milkfish was contributed from the variance of quantity produced more than 90%. And the result of negative covariance of price and quantity produced stated that the price fluctuation of milkfish apparently comes from the factors of supply side rather than those of demand side. In order to evaluate the welfare loss of price fluctuation, this paper constructs an econometric model of market demand and supply of milkfish, which involves supply response function, identity equation, demand and derived demand functions. After the model was estimated and tested, we set three different policy prices for evaluation welfare changes, that is, case 1 is the average of monthly prices of fish market at producing locality during 1994 and 1995, case 2 is the stabilization price announced by government; case 3 is the price of the average of case 1 and case 2. In case 1, producer surplus was positive, and consumer surplus and total social welfare were negative. In case 2, we obtained the perfect reversal compared with case 1. The result of case 3 was between case 1 and case 2. As long as the increase of farmer income and long development of milkfish industry are the key points of fishery policies to be considered by government, the ongoing stabilization price of milkfish seems to be lower.

Keywords: fish culture; aquaculture products; marketing; pricing; sociological aspects; aquaculture regulations; legislation; policies; governments; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Fisheries Economics, National Taiwan Ocean University, 2 Pei-ning Road, Keelung, Tawian 202, R.O.C.

571 Chen, C.C. and J.C. Kuo. 2001. An economic analysis of milkfish fry culture in Taiwan, p. 43. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Fry is the most important factor for all kinds of aquaculture. Milkfish has been one of the two most important species in Taiwan. Therefore, the study of milkfish fry culture should be very important to Taiwan's aquaculture economy. This paper aims to deal with the following three items: (1) a historical review of the development of milkfish fry culture in Taiwan. (2) A behaviour model analysis of fry in the whole system of milkfish industry. (3) A cost and revenue analysis of milkfish fry farming. Time series data of milkfish and fry are used to review the development of milkfish fry culture and to construct the behaviour model between fry and milkfish. Additionally, a field survey of 30 fry culture farms was conducted to carry a cost revenue analysis. The success of artificial hatchery technique of milkfish fry in early 1980's resulted in the rapid development of milkfish fry culture in the following years. Maturity of hatchery operations and the significant process in culture technique improved the survival rate of fry and profits of farming of milkfish fry. This high development of milkfish aquaculture in Taiwan in the recent years has been due to the increase of production and decrease of price of fry. Milkfish fry culture has become a special type of aquaculture that provides fry for milkfish grow-out operations and also the bait for tuna long-line fishing. The behavior models are used to measure the coefficient among various variables in the model. Based on the farm survey data, some costs and revenues are obtained and the return rate of investment is also calculated to describe the economic structure of fry culture farms. Finally, we conclude the fry culture is very important to Taiwan's aquaculture. It is also a very technical and capitalization industry.

Keywords: seed production; fry; aquaculture economics; historical account; bait culture; Aquaculture techniques; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Applied Economics, National Taiwan Ocean University, 2nd Paining Road, Keelung, 202, Taiwan

572 Chiang, F., C. Sun and J. Yu. 2004. Technical efficiency analysis of milkfish (*Chanos chanos*) production in Taiwan - an application of the stochastic frontier production function. Aquaculture 230(1-4):99-116.

Milkfish has been farmed in Taiwan for over 300 years. Faced with limited land resources, a labor shortage, decreasing demand, and growth of imported fisheries products, the industry is looking at the problem of how to maintain a sustainable and efficient production. This study specifies a stochastic production frontier function to estimate potential milkfish farm output and efficiency by using 1997-1999 data from a survey of 433 aquaculture milkfish farms. Both Translog and Cobb-Douglas frontier production models are estimated using the maximum likelihood estimation method. Empirical results show that the Translog stochastic production function model fits the data better and that milkfish farming in Taiwan exhibits diminishing returns to scale. We also compare estimated maximum potential milkfish production per hectare under various pond conditions to provide managers with information about how to boost efficiency. In addition, this study estimates substitution elasticities and complementarity of input factors for milkfish farms to provide helpful information for milkfish farmers on how to reallocate input resources and help raise milkfish productivity through improvements in technical efficiency.

Keywords: aquaculture economics; costs; efficiency; fish culture; aquaculture techniques; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Applied Economics, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung 202, Taiwan, ROC, [mailto:frank@mail.ntou.edu.tw]

573 Chong, K.C. 1980. Philippine milkfish production economics study underway. ICLARM Newsletter 3(1):6, 13.

The main purpose of the study is to collect information on the input-output relationships in milkfish (*Chanos chanos*) production in the Philippines. The data (analysis of which will be complete in mid-1980) can then be used to improve production operations.

Keywords: fish culture; fishery economics; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM, Manila, Philippines

574 Chong, K.C. and M.S. Lizarondo. 1982. Input-output relationships of Philippine milkfish aquaculture, p. 35-44. In: Aquaculture Economics Research in Asia: Proceedings of a Workshop held in Singapore, 2-5 June 1981. The Research Centre, Ottawa, Canada.

The existing gap between experimental yield and potential yield under field conditions and actual yield is highlighted. The determinants of actual yield are investigated by estimating a Cobb-Douglas production function relating yield to 11 explanatory variables. The inputs found to have a significant impact on output were stocking of fry and fingerlings, age of pond, farm size, fertilizers, and miscellaneous operating costs. Estimates of the marginal physical productivity of the inputs are used to study the optimization of input allocation, e.g., the optimum stocking rate at the given input prices. It is concluded that, at current prices, a profit-maximizing milkfish (*Chanos chanos*) farmer in the Philippines should raise the stocking rate in deeper ponds and increase the use of supplementary inputs.

Keywords: economic analysis; brackishwater aquaculture; potential yield; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Int. Cent. for Living Aquat. Resour. Manage., MCC, P.O. Box 1501, Makati, Metro Manila, Philippines

575 Chong, K.C., A. Poernomo and F. Kasryno. 1984. Economic and technological aspects of the Indonesian milkfish industry, p. 199-213. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

A broad overview is presented of the economic and technological aspects of Indonesian milkfish (*Chanos chanos*) aquaculture covering information on the economic importance of milkfish, fry capture and distribution, milkfish grow-out system, economics of production, and milkfish marketing and distribution. In Indonesia, milkfish is regarded as a high value food item. Because of various constraints to high milkfish yield, Indonesian milkfish ponds are still grossly underutilized. As a consequence, these constraints and the resulting present low per hectare yield level would not be able to support the government's drive toward self-sufficiency in fish in the near future. Understanding socioeconomics of milkfish production such as the attitudes of producers toward present low yield and the reasons why they are not using more inputs is of importance. Government assistance should not be narrowly focused on production alone but should also encompass organized marketing and distribution involving as much as possible the private sector in moving the fish, and continuous follow-up monitor progress of government projects.

Keywords: brackishwater aquaculture; fish culture; aquaculture development; aquaculture economics; sociological aspects; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Inst. Inland Fish. (RIIF), Indonesia

576 Chong, K.C., I.R. Smith and M.S. Lizarondo. 1982. Economics of the Philippine milkfish resource system. Resource Systems Theory and Methodology Series, United Nations University, no. 4. 66 p.

In the Philippines, milkfish from ponds and pens represents approximately 10% of total fisheries production and 18% of the total fresh and frozen fish consumed. Other countries in the Indo-Pacific region, where milkfish is not yet a popular food fish, are also introducing milkfish husbandry. Milkfish has become one of the major cultured species in the Indo-Pacific region. Beyond its importance, the Philippine milkfish resource system is of interest because of alleged inefficiencies. These include: high fry mortalities during catching and transport; low use of supplementary inputs by extensive fish farms; low efficiency even of intensive units; inadequate annual fry catch to meet annual fish pond and fish pen stocking requirements; high price mark-ups by marketing middlemen.

Keywords: fish farming; efficiency
Location: CAB Direct Abstracts

577 Chong, K.C., M.S. Lizarondo, V.F. Holazo and I.R. Smith. 1982. Inputs as related to output in milkfish production in the Philippines. ICLARM Technical Report 3, 82 p.

The possibilities of improved economic efficiency and profitability of milkfish farming in the Philippines through the determination of optimum input combinations and optimum production or output level are reported in this study. It is concluded that milkfish farming in the Philippines is not sufficiently intensive, although supplementary inputs are used. A potential exists for much higher output and profits by application of more inputs, especially in deeper ponds. The inputs which significantly explain milkfish output are stocking rates of fry and fingerlings, age of pond, miscellaneous operating costs, organic and inorganic fertilizers, and farm size. The optimum stocking rates for milkfish fry and milkfish fingerlings, and application rates for organic and inorganic fertilizers are also calculated. As expected, privately-owned milkfish farms are more efficient than government-leased farms. Larger farms are more efficient than medium and small farms. Climate also has a decided influence on milkfish yield.

Keywords: fish culture; aquaculture development; production cost; aquaculture economics; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM, Makati, Metro Manila, Philippines

578 Cremer, M.C. 1983. Economic appraisal of marketing alternatives for brackishwater aquaculture products from Aceh Province, Indonesia. Auburn University Ann Arbor, Michigan, U.S.A. 81 p. Ph.D. dissertation.

Marketing activity of milkfish produced in Aceh Province, Indonesia is restricted to inner-province sales, though external and national market demand existed. This is because distribution cost is prohibitive. Consumer demand in Aceh is considerably less than production potential (54% of existing production area). The need for the government to recognize and act on these constraints is highly recommended.

Keywords: Economic; marketing; brackishwater aquaculture; milkfish
Location: SEAFDEC Aquaculture Department Library

579 Fu-Sung, C., C.H. Sun and J.M. Yu. 2003. Technical efficiency analysis of milkfish (*Chanos chanos*) production in Taiwan-an application of the stochastic frontier production function. Aquaculture 230(1-4):99-116.

Milkfish has been farmed in Taiwan for over 300 years. Faced with limited land resources, a labor shortage, decreasing demand, and growth of imported fisheries products, the industry is looking at the problem of how to maintain a sustainable and efficient production. This study specifies a stochastic production frontier function to estimate potential milkfish farm output and efficiency by using 1997–1999 data from a survey of 433 aquaculture milkfish farms. Both Translog and Cobb–Douglas frontier production models are estimated using the maximum likelihood estimation method. Empirical results show that the Translog stochastic production function model fits the data better and that milkfish farming in Taiwan exhibits diminishing returns to scale. We also compare estimated maximum potential milkfish production per hectare under various pond conditions to provide managers with information about how to boost efficiency. In addition, this study estimates substitution elasticities and complementarity of input factors for milkfish farms to provide helpful information for milkfish farmers on how to reallocate input resources and help raise milkfish productivity through improvements in technical efficiency.

Keywords: technical efficiency; stochastic frontier production function; translog production function; substitution elasticity; milkfish; Taiwan
Location: http://www.sciencedirect.com
Author Affiliation: Institute of Applied Economics, National Taiwan Ocean University, 2 PeiNing Road, Keelung 202, Taiwan, ROC

580 Garcia, L.M.B., R.F. Agbayani, M.N. Duray, G.V. Hilomen-Garcia, A.C. Emata and C.L. Marte. 1999. Economic assessment of commercial hatchery production of milkfish (*Chanos chanos* Forsskal) fry. Journal of Applied Ichthyology 15(2):70-74.

The economic viabilities of two types of commercial hatchery milkfish (*Chanos chanos*) fry operations were assessed and compared. Based on the actual cost of input, the physical facilities, and the potential production yields, four commercial hatcheries previously used for shrimp (*Penaeus monodon* fry production were classified as either large or smallscale operations. Cost-return analysis revealed high profits for both types of operation. The return on investment (54-61 %) and the payback period (approximately 1.5 years) were comparable between the two types, although a large-scale operation (476 %) had double the working capital return of a small-scale hatchery (221 %). Benefit-cost analysis over a 5-year period also revealed positive and above-baseline discounted economic indicators [net current value = 0.2-2.2 million Philippine Pesos (1 US Dollar = 25 Philippine Pesos); internal rate of return = 88-107 %]. The net benefit-cost ratio of a large-scale operation (2.0) was higher than that of a small-scale hatchery (1.4), suggesting a slight edge in the investment viability of a large-scale hatchery. Compared with a large-scale operation, a small-scale hatchery was more sensitive to changes in the acquisition price of eggs or newly hatched larvae and in the price of selling hatchery fry. Both types of operation are viable nonetheless when the acquisition cost is P6000 per million eggs or larvae and hatchery fry are sold at P0.50 each. Together, profit and investment in milkfish hatchery fry production appear viable, making milkfish an alternative commodity for production in many abandoned shrimp hatcheries. The limited availability of spawned eggs and larvae for rearing and the quality of hatchery fry are issues requiring urgent attention.

Keywords: economic feasibility; hatcheries; *Penaeus monodon*; *Chanos chanos*; Philippines, Panay I.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

581 Gerochi, D.D. and N.M. Franco. 1984. Techno-economic paper on milkfish polycultures in ponds. Business Aspects of Aquaculture. Part I. Selected Aquaculture Systems: Techno-economic studies. Presented at the seminar-symposium held at the Hotel Intercontinental,

Makati, Manila, 10-12 Oct. 1984. Manila Financial Executives Institute of the Philippines, Aquaculture Department, SEAFDEC. Tigbauan, Iloilo. 16 p.

Aquaculture industry development in the Philippines today has identified polyculture as the most profitable technique. In this paper, the polyculture of prawn-milkfish, shrimp-milkfish and crab-milkfish was considered.

Keywords: milkfish polyculture; aquaculture systems; milkfish
Location: SEAFDEC Aquaculture Department Library

582 Kam, L.E., F.J. Martinez-Cordero, P. Leung and A.C. Ostrowski. 2003. Economics of milkfish (*Chanos chanos*) production in Hawaii. Aquaculture Economics & Management 7:95-124.

Economic evaluations of commercial milkfish (*Chanos chanos*) growout systems were made based on current Hawaiian fishpond, pond and tank culture techniques in Hawaii. Based on the observed practices of milkfish culture as a secondary or tertiary crop, capital costs and several operating costs were pro-rated to accurately depict current farm practices. For a target harvest weight of 0.80 lb, the study estimates the total production cost for milkfish production at $3.31/lb for the pond system, $3.81/lb for the tank system and $1.84/lb for the Hawaiian fishpond system. At a sale price of $3.00/lb and seed cost of $0.25/fingerling, only the Hawaiian fishpond system is profitable under a 20-year project life. When considering variable costs alone, the production cost is $1.78/lb for the pond system, $2.33/lb for the tank system and $1.53 for the Hawaiian fishpond system, yielding returns on variable costs of 67%, 30% and 59% respectively. Analyses of profit sensitivity to sale price, production yield, labor, feed and stocking indicate that sale price, as expected, has the largest impact on profitability, followed by feed. The results of this study are consistent with the Hawaii farmers' view of milkfish as secondary species to core production based upon current market conditions and input requirements.

Keywords: brackishwater aquaculture; fish culture; pond culture; culture tanks; aquaculture systems; recirculating systems; aquaculture economics; yield; marketing; pricing; aquaculture products; *Chanos chanos*; USA, Hawaii
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Molecular Biosciences and Bioengineering, University of Hawaii-Manoa, 3050 Maile Way, Gilmore 123, Honolulu HI 96822, USA,

583 Lai, C.M., M.H. Chang and K.T. Ni. 1976. Experiment report of economical milkfish culture. Bulletin of Taiwan Fisheries Research Institute (27):67-71.

Fry shortage occurred in 1975 with decreasing in fry collection around the island. The process of evaporation, drying and fertilization should be repeated twice before stocking. Wild fish and tilapia remain the problem of milkfish culture.

Keywords: economics; report; milkfish
Location: SEAFDEC Aquaculture Department Library

584 Latouche, J.P. 1999. Riiki lakes. Reflections on a traditional milkfish aquafarming in Nikunau (Kiribati), p. 161-174. In: Small-scale fishing activities in the South Pacific, IRD, Paris, France.

Some years ago as Jean-Paul Latouche was staying in Nikunau Island, Micronesia Republic of Kiribati (ex-Gilbert islands), his attention was drawn by a traditional milkfish aquafarming put into practice along Riiki lakes and fallen into abeyance in the fifties. He ponders over the reasons which have led to this situation apparently not justified on economic grounds but which, according to oral accounts, could be due to social disputes. A thorough analysis leads him to conclude that fish breeding was supported by an important ritual based on a complex cosmogony. One of the functions of myths being to legitimate the status and power of social ruling groups, their articulation with

reality was operated through lineages and places, along a geography of ancestral routes and spatial networks. Stocking with young fish as well as fishing were considered as reviving the myth of origin and gave place to a complicated ceremonial made of trajectories, precedences and preliminary exchanges. As such, they were a constant source of conflicts and these tensions have probably aggravated with changes in social life and new social constraints. However that may be, the cessation of a successful and well-controlled activity underlines the importance of cultural factors and their repercussions on other aspects of life.Original Abstract: Au cours de plusieurs annees d'enquetes de terrain dans un milieu atollien ou la mer est omnipresente, je n'ai paradoxalement que tres peu etudie les questions halieutiques en elles-memes. Comme Marie-Claire BATAILLE (1994), avec Raymond Firth, l'a fort justement note dans sa recherché sur la representation du milieu marin a Tonga, "les pecheurs ont trop souvent ete considere comme de simples cueilleurs, predateurs, alors que les agriculteurs ou les chasseurs ont ete etudies avec une methodologie de plus en plus fine". Il ne serait peut-etre pas sans interet d'examiner les motivations profondes de ce detournement collectif d'attention. Plutot que des descriptions de peche et de techniques de peche, les propos qui suivent presentent des reflexions sur les attitudes ou representations des habitants de Kiribati vis-a-vis de la peche ou du poisson. Ancienne colonie britannique devenue independante en 1979, Kiribati a ete qualifiee de "nation of water" (RONITI, 1983). C'est en effet une immense contree de plus de 3 500 000 km super(2), dont les trente-trois iles, en quasi-totalite des atolls, presentent moins de 1 000 km super(2) de terres emergees. Longtemps restee a l'ecart des reseaux majeurs de communication du Pacifique, la republique de Kiribati est habitee aujourd'hul par une population de plus de 70 000 habitants, qui se caracterise par un taux eleve de croissance demographique et un revenu national par tete parmi les plus bas du monde. Elle se concentre a la fois dans l'archipel des iles Gilbert et, au sein de cet archipel, dans la partie meridionale de l'ile de Tarawa ou se trouve la capitale politique, administrative et economique du pays. Cette agglomeration est devenue le foyer – en meme temps que l'objet -- d'une urbanisation rapide qui n'est pas sans consequence sur l'exploitation des ressources naturelles de la mer.

Keywords: freshwater aquaculture; fishermen; fishing gear; sociological aspects; lakes; *Chanos chanos*; ISEW, Pacific, Kiribati
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Maison d'archeologie et d'ethnologie -- MAE, Universite de Paris X et de Paris 1 21, allee de l'Universite, 92023, Nanterre Cedex France

585 Lee, C.S. 1982. Economics of Taiwan milkfish system, p. 45-56. In: Aquaculture Economics Research in Asia: Proceedings of a Workshop held in Singapore, 2-5 June 1981. The Research Centre, Ottawa, Canada.

This paper examines the entire milkfish (*Chanos chanos*) system in Taiwan, including fry gathering and marketing, baitfish production, market-size rearing, and marketing. A constant elasticity of substitution (CES) production function is used to estimate input-output relationships for baitfish and market-size production systems, with all inputs classified into labour and capital. An important finding is that the elasticity of substitution between labour and capital exceeds unity indicating rather easy substitutability between the two inputs. Rates of return to marketing intermediaries were found to be high for both fry and market-size milkfish.

Keywords: brackishwater aquaculture; economic analysis; marketing; product development; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Inst. Agricult. Econ., National Chung Hsing Univ., Taichung, Taiwan 400, ROC

586 Lee, C.S. 1984. Production and marketing of milkfish in Taiwan: an economic analysis. ICLARM Technical Report 6, 41 p.

Economic aspects of the Taiwanese milkfish (*Chanos chanos*) resource system and its major subsystems of fry procurement, baitfish rearing, market-size rearing and marketing are presented.

Fry gathering takes place primarily in the southern and eastern coasts of the island with transfer through middlemen to a small number of dealers in Tainan City. Gatherers receive 80% of the price paid by fishpond operators. However, due to instability of domestic supply, fry prices are also highly unstable. Baitfish farms rear milkfish fingerlings for the use of tuna longliners based in Tungkang and Kaohsiung. The benefit-cost ratio, factor productivity and rate of baitfish farm income were found to be high, but with demand for baitfish levelling off, there is only limited potential for expansion of this sector of the system. In contrast, farms that rear milkfish for the consumer market were found to be much less profitable and efficient. Producers of market-size milkfish receive, on average, 74% of the retail price. The relative importance of milkfish in Taiwanese aquaculture is declining in the face of higher profitability of other species, particularly shrimps, crabs and tilapia.

Keywords: fish culture; bait culture; seed collection; marketing; economic analysis; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Inst. Agricul. Econ., Natl. Chung Hsing Univ., Taichung, Taiwan

587 Lee, C.S., M.S. Su, P.S. Leung. 1995. Biological and economic evaluation of different fry production systems from milkfish (*Chanos chanos*), p. 199-200. In: K. Pittman, R.S. Batty and J. Verreth (eds.). Mass Rearing of Juvenile Fish. Selected Papers from a Symposium in Bergen, 21-23 June 1993. The Oceanic Institute, Hawaii.

Milkfish (*Chanos chanos*) is one of the most important brackishwater fish species cultured in Southeast Asia. Total annual production from the Philippines, Taiwan, and Indonesia exceeds 300 ppp tonnes. To replace the wild caught fry from the hatchery has been one of the major research topics during the past two decades. Through international cooperation, milkfish fry production technology has been established in both intensive and extensive systems. An intensive system requires higher capital investment and more labour and utility costs, but provides consistent and higher unit production (10 fry l super(-1) water volume). An extensive system, on the other hand, requires less energy input and labour, but provides less control of the system. In Taiwan, eight hatcheries produced more than 116 million fry in 1991. In this report, we present a state-of-the-art milkfish fry production system and compare the production cost of milkfish fry using a hatchery economic model.

Keywords: aquaculture economics; fish larvae; brackishwater aquaculture; hatcheries; *Chanos chanos*; *Chanidae*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Oceanic Inst., HI, USA

588 Lee, C.S., P.S. Leung and M.S. Su. 1997. Bioeconomic evaluation of different fry production systems for milkfish (*Chanos chanos*). Aquaculture 155(1-4):371-380.

Milkfish (*Chanos chanos*) is one of the most important brackish water finfish species being cultured in Southeast Asia. Annual total production from the Philippines, Indonesia, and Taiwan has been exceeding 300,000 metric tons since 1980. The industry has relied on wild-caught milkfish fry, which is unpredictable, until hatchery fry became available in 1987. Two milkfish fry production systems, intensive and semi-intensive system, are available. This paper compares the operational procedures as well as production costs in both systems in Taiwan. Without considering the fertilized eggs cost, the production cost for 1000 fry is US$27.40 for the intensive and US$6.67 for a semi-intensive system. Under the intensive system, the production has to exceed 1 million fry/cycle to earn a profit, considering no cost for fertilized eggs. To pay for fertilized eggs and achieve a profit, the production has to be more than 1.4 million fry and the cost of fertilized eggs must be less than 10% of total production. The semi-intensive system has a higher profit margin. A profitable operation can still be achieved at gross harvest sharing of 60% or more, even if the fry production level reaches 50% of the targeted number of 2 million. At the target number of fry production and 60% gross harvest sharing, the hatchery operator has a profit income no matter if self-supplying

rotifers or not. It is concluded that semi-intensive or outdoor system is a profitable operation for milkfish fry production in Taiwan.

Keywords: fish culture; fry; fish larvae; fish eggs; larvae; eggs; Philippines; Indonesia; Taiwan; *Chanos chanos*; ISEW
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: The Oceanic Institute, Makapuu Point, Waimanalo, Hawaii, 96795, USA

589 Ling, B.H. 2003. Price cointegration in spatial markets: an application to milkfish markets in Taiwan. Aquaculture Economics & Management 7(1-2):85-94.

The objectives of this study are to analyze the interdependent behavior of lead-lag milkfish price adjustments between vertically-related markets (from production to consumption) as well as between five major horizontally-related wholesale markets. Empirical results show that there is a two-way lead-lag cointegrating price relationship between milkfish wholesale and retail markets. Since the fish wholesale market cannot completely and quickly assimilate the retail market information, the speed of response of wholesale prices to retail price changes is relatively slow, inducing low pricing efficiency. The Taipei wholesale market appears to cause the greatest leadership impact on the milkfish price formation compared to other wholesale markets in both the long-run and short-run. The results also reveal that there is a high degree of integration relationship between the horizontally integrated wholesale markets (Chiayi, Changhwa and Taichung) for milkfish in the southwestern region within a short distance.

Keywords: brackishwater aquaculture; fish culture; aquaculture products; marketing; pricing; aquaculture economics; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Marketing, National Chung-Hsing University, 250 Kuo Kuang Road, Taichung, Taiwan, ROC, [mailto:bhling@dragon.nchu.edu.tw]

590 Shang, Y.C. 1976. Economic comparison of milkfish farming in Taiwan and the Philippines, 1972-1975. Aquaculture 9(3):229-236.

Economic surveys of milkfish (*Chanos Chanos*) production in ponds in Taiwan and the Philippines for 1972 are compared and the economic changes that occurred in the milkfish industry during 1972-1975 in both countries are discussed. The relative costs of production in these countries are evaluated in terms of output per unit of input (land and labour), and by comparing differences in production and marketing per unit of output. The advantages and disadvantages of the different milkfish farming practices in these countries are also explained.

Keywords: brackishwater aquaculture; fish culture; biological production; aquaculture statistics; economic analysis; *Chanos chanos*; Taiwan; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ.Hawaii, Hawaii Inst.Mar.Biol., Honolulu, HI 96822, USA

591 Shang, Y.C. 1986. Economic aspects of milkfish farming in Asia, p. 263-277. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of Milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

Development trends in the milkfish (*Chanos chanos*) aquaculture industry in Taiwan, the Philippines and Indonesia are described. An examination is made of major factors affecting production economics: major cost items, farming intensity, deepwater ponds, farm size polyculture. Market potential for the 3 industries is also discussed.

Keywords: aquaculture economics; aquaculture development; *Chanos chanos*; Southeast Asia
Location: Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Agric. and Resour. Econ., Univ. Hawaii, Honolulu, HI 96822, USA

592 Shang, Y.C. 1976. Indonesian milkfish farming-an economic evaluation. Fish Farming International 3(4):42-44.

The author evaluates the economics of various development opportunities facing the milkfish (*Chanos chanos*) culture industry in Indonesia. The principal possibilities are those of intensive or extensive culture, and polyculture as opposed to monoculture. The rate of return on operating capital is higher for intensive than for extensive operation, and for intensification than extensification under proper pond management. The priority of milkfish farming in the short term programme seems to be to increase the productivity of the existing ponds through intensification. This is considerably more expensive than extensification, however. The shortage of long-term low-interest loans with simplified borrowing procedures and appropriate credit channels therefore operates as a major constraint on intensification. The 2 available types of loan (other than high interest credit from private sources) are from the government and the World Bank. The features of both types of loan are discussed.

Keywords: fish culture; economic analysis; aquaculture development; *Chanos chanos*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Univ. Hawaii, Inst.Mar.Biol., HI, USA

593 Smith, I.R. 1978. An economic analysis of the structure and performance of the milkfish (*Chanos chanos* Forsskal) fry industry in the Philippines and related aquaculture development policies. Dissertation Abstracts International 39(4):5057.

The fry industry of the milkfish (*Chanos chanos* Forsskal) in the Philippines is alleged to suffer from certain imperfections. Primary among these are an annual shortage of catch to meet the stocking requirements of the 176,000 ha. of fishponds, high fry mortality rates in transport, the failure of the pricing system to perform its spatial and form allocative functions, and exploitation of fry gatherers and pond operators by middlemen. These alleged imperfections provide the rationale for government policies affecting the fry industry. Contrary to allegations, research indicated a higher level of industry performance than hitherto supposed. Fry catch was estimated at 1,350 million for 1974, adequate to meet annual stocking requirements. The large volume of inter-regional trade in 1976 (745 million) and low fry prices in 1977 provided additional support.

Keywords: fish farming; Philippines
Location: CAB Direct Abstracts

594 Smith, I.R. 1981. The economics of the milkfish fry and fingerling industry of the Philippines. ICLARM Technical Report 1, 148 p.

The purpose of this study was to evaluate allegations regarding imperfections in the Philippine fry industry and to determine the effects of related fisheries policies. This technical report is the first of several that deal with the economics of various aspects of the milkfish, *Chanos chanos*, industry. It concentrates on the fry and fingerling industries in the Philippines.

Keywords: fish culture; fishery economics; fry; aquaculture development; seed collection; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Int. Ctr. Living Aquatic Resources Mgmt., Manila (Philippines); Southeast Asian Fisheries Development Ctr., Tigbauan (Philippines). Aquaculture Dept.

595 Smith, I.R., K.C. Chong and R.P. Ferraris. 1985. Southeast Asian milkfish culture: economic status and prospects, p. 1-20. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Historically, milkfish (*Chanos chanos* Forsskal) has been the premier aquaculture product in Indonesia, the Philippines, and Taiwan. However, there are significant differences in the industry's performance among and within these places, especially in terms of yield. These differences can be explained by different factor (land, labor, capital) endowments and by the fact that producers have generally been responsive to these conditions. In Taiwan and the Philippines, milkfish production is becoming less profitable over time. In both places, brackishwater pond producers of milkfish are caught in a cost-price squeeze as input costs have increased more rapidly than market prices. Indonesian producers also face market constraints because high regional transport costs often isolate them from major market centers. In response to declining profitability of milkfish, producers have been changing their production techniques and shifting to the culture of other species such as tilapia that currently have greater domestic or export market potential. Although total milkfish production continues to increase, in the Philippines and Indonesia at least, milkfish's traditional share of total aquaculture production in all these places has declined quite dramatically over the last 10 years, and this trend is likely to continue.

Keywords: aquaculture; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: ICLARM, Metro Manila, Philippines

596 Tamaru, C.S., F. Cholik, J. Ching-Ming Kuo and W.J. FitzGerald Jr. 1995. Status of the culture of milkfish (*Chanos chanos*), striped mullet (*Mugil cephalus*), and grouper (*Epinephelus sp.*). Reviews in Fisheries Science 3(3):249-273.

The milkfish (*Chanos chanos*), striped mullet (*Mugil cephalus*), and grouper, especially species in the genus *Epinephelus*, are all targeted for domestication. While milkfish and mullet have relatively long (i.e., several centuries) culture histories, groupers have steadily gained in popularity only during the last 2 decades. The current status of the hatchery technologies for each of these species is presented, and recent developments regarding their culture are addressed.

Keywords: fish culture; aquaculture development; hatcheries; *Chanos chanos*; *Mugil cephalus*; *Epinephelus*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Hawaii C's Aquacult. Consultant Serv., 1157 Lunaapono Pl., Kailua, HI 96734, USA

597 Taufiq, M. 1991. Input-output relationship of prawn and milkfish culture in West Nusa Tenggara Indonesia. University of the Philippines in the Visayas, Miag-ao, Iloilo. 94 p. M.S. thesis.

A Cobb Douglas productions were used to estimate three culture methods, namely extensive, semi-intensive and intensive. Under extensive culture method 46.28% of the variations in output could be explained by variations in input (stocking rate, labor, fertilizer and farm size). Under semi-intensive and intensive culture methods, 90.73% and 96.10% of the variations in output respectively, could be explained by variations in inputs (stocking rate, labor, fertilizer, pesticide, farm size, supplementary feed and lime). Summations of all the production coefficient under intensive culture indicate that if output increases by larger percentage than the increase of all inputs but under extensive and semi-intensive are vice versa. Under extensive culture, if the stocking rate, fertilizer and farm size were increased by 1%, the output will increase by 0.2473%, 0.2553% and 0.2283%, respectively. In semi-intensive culture method if the stocking rate and fertilizer were increased by 1%, the output will increase by 1.3106% and 0.2764%, respectively. In intensive culture method if the stocking rate, labor, fertilizer, artificial feeding, lime were increased by 1%, the output will increase by 2.1632%, 0.6220%, 4.3376% and 0.4052%, respectively.

Keywords: input-output relationship; milkfish culture; mikfish; Indonesia
Location: University of the Philippines in the Visayas Main Library, Miag-ao, Iloilo

598 Uwate, K.R. 1988. Economics of milkfish culture in the Pacific islands. Forum Fisheries Agency Report of South Pacific Forum of Fisheries Agency, no. 82, 14 p.

Milkfish *Chanos chanos* culture has been a traditional aquaculture in some Pacific island countries and very little has been done on its economics. In fact, the only work located was that on the fish farm in Kiribati which is briefly described in this report. The report also discusses economic considerations of commercial and subsistence projects. (DBO)

Keywords: fish culture; economic analysis; aquaculture economics; aquaculture development; *Chanos chanos*; Pacific Ocean Is.; ISEW, Pacific, Kiribati
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Cross-referenced:

Adeyemi, F.F. 1983. A comparative study of the effects of supplementary feeding and artificial substrates on the production of milkfish fingerlings in brackishwater ponds. University of the Philippines in the Visayas, Miag-ao, Iloilo. 79 p. M.S. thesis.
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*(See abstract, keywords, location and author's affiliation in entry no. **237**)*

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MARKETING STUDIES

599 Anon. 1984. Milkfish give way to other species. Fish Farming International 11(5):2.

In the Philippines and Taiwan, the farmers are faced with the problem of the prices of inputs like milkfish fry and fertilizers which are rising faster than the market prices. In Indonesia, cost of transportation often isolates producers from the market centers. Because of these, the farmers are shifting to polyculture of milkfish and shrimp of monoculture of shrimp. However, milkfish could be canned or sold as "boneless bangus" which is very popular in the Philippines.
Keywords: milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

600 Anon. 1987. Milkfish. Priority Exports Commodities Series no. 57.

The book tackles about milkfish marketing and fish trade.

Keyword: milkfish; milkfish marketing; fish trade
Location*:* SEAFDEC Aquaculture Department Library

601 Guerrero, C.V. 1977. Bangus (*Chanos chanos*) marketing in the Philippines, p. 431-446. In: Proceedings of IPFC, Inland Fishery Resources. FAO Regional Office for Asia and the Far East, Bangkok, Thailand.

Based on 13 economic surveys of food consumption in the 1970-75 period, bangus represented 20% of the total fresh and frozen fish consumed. The data used in this paper were obtained from studies on bangus production and marketing conducted by the Special Studies Division, Department of Agriculture. Of the farms studied, 38 were in Luzon, 35 in Visayas and 27 in Mindanao, and of the dealers, 62, 23 and 29 respectively. Sales average 4,601 kg per farm in Luzon, 3,529 in Visayas and 2,607 in Mindanao. The average selling prices were P.Ps 3.63, P.Ps. 3.19 and P.Ps. 3.46 per kg respectively and deducting the costs of production and marketing gave an average return of P.Ps. 0.68 per kg. Bangus dealers reported total purchases of 300,810 kg for the last day's purchase, of which 74% was in Luzon, 14% in Visayas and 12% in Mindanao. Of this total amount, 36% was handled by brokers, 21% by wholesalers, 2% by wholesaler-retailers and 42% by retailers. The net returns (for operator's labour, management and profit) ranged from P.Ps. 0.19 to P.Ps. 1.21, P.Ps. 0.10 to P.Ps. 0.86, and P.Ps. 0.19 to P.Ps. 1.14 per kg respectively for the different dealers in the three regions. The major flow of bangus from all areas was to Manila. In Luzon, minor flows were from the Pangasinan, area to Northern Luzon, from Bicol and Palawan to Manila and from Laguna Lake to Pangasinan. In Visayas, minor flows were largely to other islands in the area and to Mindanao (Cagayan de Oro and Davao). Minor flows in Mindanao were largely to Cagayan de Oro.

Keywords: marketing; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Special Stud. Div., Dep. Agric., Diliman, Quezon City, Philippines

602 Ling, B.H. 1998. Pricing efficiency between production and consumption markets with implications for Taiwan milkfish, p. 330-331. In: Aquaculture '98 Book of Abstracts. Aquaculture '98 Conference, 15-19 February 1998, Las Vegas, Nevada, USA.

Milkfish (*Chanos chanos*) was the traditional farming species and was raised primarily for the domestic consumption in Taiwan. In 1995, a total of 12,147 hectares of milkfish farming area accounted for 34.2% of total finfish aquaculture. The majority of milkfish production were provided in the southwestern region of Taiwan, mainly Kaohsiung (57.7%) and Tainan (31.9%). And, the consumption markets for milkfish production are dominated by Taipei and numbers of other medium-sized cities such as Taichung and Chiayi. Wholesale fish markets in Taiwan play an important key role in the marketing channels for milkfish assembling, wholesaling, and distributing from producers to consumers. Moreover, milkfish market price is a crucial component of market

information, since it is common to every trading transaction and is the market signal reflecting demand for and supply of milkfish in the market place. The abilities of milkfish marketing agencies to assimilate or respond to milkfish price changes may differ from one fish market to another. However, milkfish price series of all wholesale fish markets in Taiwan must be related and linked to each other. The main objective of this study is to quantify the long-run and short-run price adjustments of Taiwan milkfish between two spatially wholesale fish markets and further to evaluate the degree of pricing efficiency and market integration in the marketing systems of Taiwan milkfish. A cointegration approach using the Engle-Granger two-stage procedure is applied to provide insights into the causal relationships between the time series of market prices for Taiwan milkfish at different wholesale market locations, including three fish markets in the production area and four fish markets in the consumption area.

Keywords: fish culture; aquaculture products; marketing; pricing; consumers; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Agricultural Marketing, National Chung Hsing University, 250 Kuo-Kuang Road, Taichung City 402, Taiwan, Republic of China

603 Lizarondo, M.S. 1981. The mechanisms of milkfish distribution in Bulacan, p. 3, 5, 81. In: Agricultural Marketing Report, Bureau of Agricultural Economics Philippines.

This study describes the flow of fish in Bulacan as it changes hands from the fishpond operator to the traders and eventually to consumers. Tracing the flow of the product in this way generates vital information on volume, prices and margins at each level, and marketing functions performed and costs involved. Respondents at the farm were taken from the list of on-going record keeping projects of ICLARM, FIDC and BAEcon, provides which is a cross section of the fishpond operators in the province. The fishpond operators were questioned regarding the disposition of catch, volume and prices, and their specific buyers. The survey covered 15 fishpond operators.

Keywords: fish farming; marketing techniques
Location: CAB Direct Abstracts

604 Salayo, N.D. 2001. Price relationships in Philippine milkfish markets: univariate and causality analysis, p.218. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Milkfish production in the Philippines was recorded at 195 thousand metric tons in 2000, 23% less than 1982 production level of 252 thousand mt, the highest attained by the country so far. The current production level is alarming considering the increasing demand of the growing population. It is also ironic considering the development in milkfish research in the country (SEAFDEC 2001). Today, milkfish comprised 59% of the aquacultured finfish production and is mainly traded and consumed in the domestic market. It has become an alternate crop for aquaculturists displaced during the problematic years of the shrimp industry in the Philippines. Of the 67 milkfish grow-out farmers interviewed for an on-going study of the input-market for the Philippine aquaculture, fluctuation of product prices was reported as a constraint to efficient resource use. That is, when the prevailing output price is generally low, milkfish producers tend to be reluctant in investing in inputs and technologies recommended to boosts production. The industry wants to know the state and behavior of milkfish prices. Thus, econometric models were estimated to determine price movements and relationships within and among wholesale and retail markets, and between producing and consumption centers. These models attempt to provide some basis for farm level decision-making among aquaculturists.

Keywords: fishery economics; aquaculture products; aquaculture economics; pricing; *Chanos chanos*; Philippines

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:ndsalayo@aqd.seafdec.org.ph]

605 Smith, I.R. and K.C. Chong. 1984. Market constraints inhibit milkfish expansion in Southeast Asia. Aquaculture Magazine 10(6): 28, 30+.

Market constraints are emerging as the major problem facing the Southeast Asian milkfish industry. Dramatic increases in aquaculture production, changes in real per capita incomes and consequent shifts in consumer preferences and magnitude of distances separating available production areas from major markets plus increasing transportation costs are all involved in the current marketing problems. Production trends, and per capita consumption and prices are detailed, considering implications for the industry.

Keywords: fish culture; aquaculture economics; marketing; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

606 Smith, I.R., F.C. Cas, B.P. Gibe and L.M. Romillo. 1979. Inter-regional trade and price relationships for Philippine milkfish fry, p. 43-60. In: A.R. Librero and W.L. Collier (eds.). Economics of Aquaculture, Sea-Fishing and Coastal Resource Use in Asia : Proceedings of the Second Biennial Meeting of the Agricultural Economics Society of Asia, Tigbauan, Iloilo, Philippines, 3-6 November 1977. Agricultural Development Council, and Philippine Council for Agriculture and Resources Research, Los Baños, Laguna, Philippines.

A survey was undertaken, March-August 1977, to follow milkfish (*Chanos chanos*) fry from fry grounds through the marketing chain of concessionaires, dealers, agents, brokers and nursery pond operators to rearing pond and fishpen operators. Initial findings from the survey and other data obtained from regional and district offices of the Bureau of Fisheries and Aquatic Resources regarding interregional trade flows and the relationship between average monthly fry prices in the major market areas of the Philippines are presented. Results show the existence of a milkfish fry system in the Philippines that is national in scale, with a predominant role played by concessionaires and dealers in Mindanao and by nursery pond operators in Bulacan and Rizal.

Keywords: trade; pricing; fry; fish culture; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Agric. & Resour. Econ., Univ. Hawaii, USA

607 Sullivan, G. 1981. Marketing study for milkfish and shrimp from brackish water tambaks in Aceh Province, Sumatra, Indonesia. Auburn, Alabama, Agricultural Experiment Station, Auburn University. 81 p.

This marketing study was done at the request of the Directorate General of Fisheries – Indonesia and the United States Agency for International Development. The study focuses on marketing of milkfish and shrimp from tambak in Ace Province with secondary considerations given to fish marketing infrastructure at the national level. Field research was primarily done in Aceh and North Sumatra Province. Side trips at Padang in West Sumatra, to visit a marketing project, Jakarta and Pekalongan were conducted to supplement the market research. The study was started November 5 and was completed on December 14, 1980.

Keywords: marketing study; marketing; milkfish; Indonesia
Location: SEAFDEC Aquaculture Department Library

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(See abstract, keywords, location and author's affiliation in entry no. 558)

INDUSTRY STUDIES

608 Ahmed, M., G. Magnayon-Umali, R.A. Valmonte-Santos, J. Toledo, N. Lopez and F. Torres. 2001. Bangus fry resource assessment in the Philippines. ICLARM Technical Report 58, 47 p.

Bangus or milkfish is the national fish of Philippine. Bangus culture is traditionally based on fry collected from the wild. Due to growing demand for fry the bangus industry. The Philippines Bureau of Fisheries and Aquatic Resources (BFAR), the Philippine Council of Aquatic and Marine Research and Development (PCAMRD), the Southeast Asian Fisheries Development Centre (SEFDEC) and ICLARM embarked of the conditions prevailing in the milkfish fry sector, a project workshop was held in 1999. The present report is the outcome of the workshop. Report highlights on the issues on milkfish production, fry production in hatcheries, fry gathering activities, marketing issues, management of fry gathering grounds and its marketing and the related policy issues.

Keywords: fish culture; fishery resources; stock assessment; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA), WorldFish Center-HQ Library

609 Anon. 1982. State of the art: Milkfish research. Fisheries Series. Philippine Council for Agriculture, Forestry and Natural Resources Research No. 3, 41 p.

The report aims to review, consolidate and update the state of the art regarding milkfish (*Chanos chanos*) production in the Philippines.

Keywords: fish culture; aquaculture development; literature reviews; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

610 Anon. (n.d.) Notes on the milkfish, *Chanos chanos*, p. 82-83. In: SEAFDEC/AQD library compilation.

The article enumerates problems (e.g. spawning, availability of fry, survival rate, fry transport, growth rate, pond fertilization, salinity, tolerance, etc.) faced by the milkfish industry. The author suggests that studies should be directed toward solving the constraints.

Keywords: spawning; survival rate; fry transport; growth rate; pond fertilization; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

611 Arteza, O.V. (n.d.) How most Filipinos produce bangus, p.34. In: Greenfields.

Findings of a survey to review the culture and management practices of Filipino bangus producers are presented.

Keywords: Filipinos; bangus; production; milkfish
Location: SEAFDEC Aquaculture Department Library

612 Bernardino, R.B. 2002. Feasting on the Philippine milkfish industry. Philippine Fisheries Review and Digest (July 2003).

The article contains production statistics, the products derived from milkfish and the different process made to the caught milkfish in order for it to be available as consumer goods. It also talks about certain economic aspects and prospects and challenges ahead.

Keywords: milkfish production; culture; processing; milkfish products; milkfish; *Chanos chanos*
Location: The WorldFish Center-Philippine office
Author Affiliation: Center for Food and Agribusiness, University of Asia and the Pacific

613 Bernasor, R.C. 1983. Bangus fishpond industry in selected towns of eastern Bohol: its prospects for further development. Cebu State College of Science and Technology. 143 p. M.S. thesis.

The paper discussed the status of bangus fishpond industry in Bohol, Philippines, specifically the fish farmers and their farming techniques. The problems and prospects of the industry are also analysed.

Keywords: fishpond industry; Bohol; milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

614 Bravo, S. 1976. Study of the bangus industry: prospects and problems, benefit or cost analysis approach. Research paper submitted in partial fulfilment of the requirements of the 11th session U.P. Program in Development Economics, School of Economics, University of the Philippines, 41 p.

This study provides an economic appraisal of the prospects and problems of the bangus fishing industry. The prospects have been appraised in the light of the cost benefit flows using the standard investment criteria of NPV and IRR. Results showed that the project is economically feasible. Benefits start accumulating during the second year from the social viewpoint. The liquidity and stability of the project lend assurance of loan paying capacities and generation of working capital. The assumptions are valid and realistic to the project. The prospects of the bangus fishing culture industry are bright. The problems are mostly on technology of raising, fry shortage and fund sources.

Keywords: bangus industry; benefit/cost analysis; milkfish economics; milkfish
Location: SEAFDEC Aquaculture Department Library

615 Bueno, P.B. 1983. What's preventing RP fish farmers from producing 2000 kilograms of milkfish a hectare a year? Popular Aquaculture Report Series 1. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines.

Milkfish technologies in the Philippines presented themselves with the challenge of increasing milkfish yield from 600kg/ha/year to 2000 kg/ha/year. The task, however, is hampered by problems such as shortage of fry, fertilization and liming, poor pond conditions, etc. Many of the problems arise because technologies have not been modified for the practical application of the fish farmers. Existing problems are enumerated and discussed.

Keywords: production; shortage; fertilization; poor pond condition; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

616 Chen, F.H. 1985. My experience in traditional milkfish culture, p. 204-210. In: C.S. Lee and I.C. Liao (eds.). Reproduction and culture of milkfish: Proceedings for a Workshop at the Tungkang Marine Laboratory, Taiwan, 22-24 April 1985. Oceanic Institute, Hawaii and Tungkang Marine Laboratory, Taiwan.

Improvement of the traditional practices of shallow-water milkfish (*Chanos chanos*) culture are discussed. Stocking density and fish production have fluctuated annually, and increases in production have resulted in the drop of fish prices. Hence, the management of milkfish culture should be adjusted accordingly. Suggestions focused on the improvement of the marketing and processing of the milkfish are presented.

Keywords: aquaculture systems; aquaculture development; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

617 Chen, T. P. 1976. Culture of milkfish (*Chanos chanos*) as a means of increasing animal protein supply. Journal of the Fisheries Research Board of Canada 33 (4/II):917-919.

Milkfish (*Chanos chanos*) is a marine fish that is most successfully cultured in ponds. It is an important food product in Taiwan, the Philippines and Indonesia. There is opportunity to increase production. It is recommended that future research should put emphasis on the production of young for stocking, feeding habits and nutritional requirements, modification of cultural practices to permit polyculture in the ponds and the processing of milkfish into products that will be widely accepted.

Keywords: fish culture; tropics, *Chanos chanos*. Taiwan
Location: CAB Direct Abstracts
Author Affiliation: Taiwan Fisheries Consultants, Inc., Taipei, Taiwan

618 Cuyvers, L. 1984. Milkfish: Southeast Asia's protein machine. Sea Frontiers 30(3):173.

Known as bangus, *Chanos*, and a variety of other names, the white-fleshed milkfish (*Chanos chanos*) is a very important part of the diet of millions of people in Southeast Asia. Though it is widely distributed throughout tropical and subtropical waters of both the Pacific and Indian oceans, fishermen are not its main suppliers - farmers are. Milkfish are currently cultured on a large scale in Indonesia, the Philippines, and Taiwan. Their rapid growth, resistance to disease, and ability to tolerate a wide range of salinities superbly suits them for brackishwater culture. As herbivores at the bottom of the food chain, they are efficient manufacturers of protein.

Keywords: fish culture; human food; *Chanos chanos*; Indonesia; Malaysia; Philippines; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Univ. Delaware, Newark, DE 19711, USA

619 FAO. 1990. Country reports (Milkfish Culture in Cook Islands, Federated States of Micronesia, Guam, Hawaii, Kiribati, Nauro, Solomon Islands, Palau, Tonga and Tuvalu). In: H. Tanaka, K.R. Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). Proceedings of the Regional workshop on milkfish culture development in in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, Suva, Fiji.

This includes country reports regarding milkfish aquaculture development in the respective countries. It also cites different culture and production methods, constraints and recommendations. Present situation of milkfish culture is also elaborated.

Keywords: reports; milkfish culture; Cook Islands; Federated States of Micronesia; Guam; Hawaii; Kiribati; Nauro; Solomon Islands; Palau, Tonga; Tuvalu
Location: http://www.fao.org
Author Affiliation: Forum Fisheries Agency, Honiara, Solomon Islands

620 FAO. 2001. Production, accessibility, marketing and consumption patterns of freshwater aquaculture products in Asia [Bangladesh, China, India, the Philippines and Thailand]: a cross-country comparison. FAO Fisheries Circular 973. FAO, Rome. 275 p.

The document includes a cross-country synthesis, which examines the production, accessibility, marketing and consumption patterns of aquaculture products (with emphasis on freshwater aquaculture) in Bangladesh, China, India, Indonesia, Philippines, Thailand and Viet Nam. It also includes individual country reports for Bangladesh, China, India, the Philippines and Thailand. Asian countries have both similarities and dissimilarities in fisheries and fish farming. Broad sectoral macro-policies are similar, although with differing strategies. All the countries aim to increase fish production, improve export earnings, provide more animal protein and expand employment opportunities. In general, the contribution of fisheries is increasing, except in Thailand, although the contribution from India, Indonesia, the Philippines and Thailand to total world freshwater production is gradually decreasing. Farm and pond sizes differ markedly between countries. While polyculture is a general practice in all the countries, monoculture is widely practised in China and the Philippines for cage culture and in Thailand for culture of carnivorous species such as walking catfish. Integration of animals with fish is also common in China, Thailand and Viet Nam. Rice-fish farming is also practised in these last two countries as well as in Indonesia and to some extent in the Philippines. Culture of fish (common carps) in running water systems is unique to Indonesia. Bangladesh and India have major (Indian) carp (rohu, catla and mrigal) and silver carp as the dominant species. Tilapia is popular in Thailand and the Philippines, while milkfish and seaweeds are dominant in the Philippines, and walking catfish and Thai silver barb are important in Thailand. China differs in species composition, culture intensity, productivity and marketing. Fish farmers in Viet Nam culture both Indian major carps (rohu) and Chinese carps (common carp, silver carp and silver barb), but with differences between the northern and southern parts. Yields, costs and returns vary considerably among countries, reflecting variations in intensity, production environments and systems, and culture practices. In general, involvement of womenfolk in the fields of fish production, processing and marketing has been on the increase in all the countries, although their participation is highest in fish marketing. Fish has become an increasingly important source of protein in most of these countries, except in the Philippines, with the annual rate of per caput fish consumption generally increasing. Fish consumption preferences vary across countries, but in general: a) higher-income groups consume more fish, though the proportion of the food budget allocated to fish expenditure is higher among low-income groups; b) rural people consume more than urban dwellers; c) fish producers in general consume more fish than non-producers; and d) demand for fish is very sensitive to price changes. Religious beliefs and ethnic and geographical differences also explain variations in fish consumption across countries. Marketing is organized almost entirely by the private sector, with some degree of government intervention in China and the Philippines. Transport appears to be a very big problem. Flow of institutional credit for production and marketing of fish is

low in most of the countries, as it is dominated by the private sector. Common constraints faced by freshwater fish farmers, especially in Bangladesh and India, include: pluralities in ownership, lack of credit facilities, lack of technical know-how, illegal poaching, deliberate poisoning and inadequate marketing opportunities. It is concluded that freshwater aquaculture can make a significant contribution to bridging the widening gap between demand for and supply of fishery products in Asia, in the face of declining capture fisheries production and growing populations.

Keywords: freshwater aquaculture; aquaculture development; aquaculture systems; fishery products; marketing; aquaculture products; fish culture; agropisciculture; Asia; Bangladesh; China, People's Rep.; India; Philippines; Thailand
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

621 Felix, S.S. 1959. Report on the census of bangus caught with all kinds of fishing gears as basis for a preliminary survey of the bangus fisheries of the Laguna de Bay. Fisheries Gazette 3(8):15-22.

Laguna de Bay, Philippines, has been stocked with a total number of 684 240 fish of all sizes and stages. Out of this number 608 000 are bangus fingerlings. Surveys on fish landing later showed 177,705 market bangus landed. The fish were caught mostly with gill nets and purse seines, fish corals and motor bancas. Mortalities amounted to approximately 17,000.

Keywords: fishing gears; survey; bangus; milkfish; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

622 Fortes, R.D. 1985. Milkfish culture techniques generated and developed by the Brackishwater Aquaculture Center, p. 107-119. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

This paper reviews the work on milkfish (*Chanos chanos*) culture techniques conducted from 1973 to 1983 by the Brackishwater Aquaculture Center, the aquaculture research arm of the College of Fisheries, University of the Philippines in the Visayas at Leganes, Iloilo, Philippines. Significant findings and innovative techniques dealing with milkfish fry collection and fingerling production such as those obtained from survival studies of fry during collection, sorting, handling acclimation storage, transport, and rearing in nursery ponds or land-based nurseries are reviewed. Fingerling production utilizing improved methods and techniques is discussed. Results of work on pond culture techniques are presented and discussed.

Keywords: brackishwater aquaculture; fish culture; pond culture; aquaculture techniques; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Brackishwat. Aquacult. Cent., Univ. Philippines in the Visayas, Leganes, Iloilo, Philippines

623 Gatus, A.R. 1977. The milkfish culture industry in the Philippines and its problems. In: First ASEAN Meeting of Experts on Aquaculture. Semarang, Indonesia, 31 January to 6 February 1977. Technical reports. 1. Proceedings of technical sessions. 2. Working papers. South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines.

A summary account of milkfish (*Chanos chanos*) aquaculture methods, development, etc. in the Philippines is presented. The present status of the industry is described, and the climatic and weather conditions affecting it noted. Information is presented on fish farm layout, physical structures for stock control, fish farm management practices, stock manipulation, harvesting, post-harvest handling, and the economic and marketing aspects of milkfish culture. Some problems are briefly noted.

Keywords: fish culture; aquaculture development; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Bureau Fisheries and Aquatic Resourc., Manila, Philippines

624 Guerrero, R.D. III. 2000. Freshwater aquaculture in the Philippines. World Aquaculture 31(4):30-33.

The Philippines was the world's fifth largest producer of aquaculture products in 1997 with a production of 957,390 metric tons (Food and Agriculture Organization 1998). Freshwater aquaculture contributed 11 percent to the total aquaculture production in 1999, with an estimated value of 2.95 billion pesos (P28=US$ 1) (Bureau of Fisheries and Aquatic Resources 2000). In 1999, 14,531 ha of freshwater ponds produced 38,779 metric tons of fish. In Laguna de Bay (the country's largest lake) 5,000 ha of fishpens yielded 21,930 metric tons, and approximately 2,000 ha of cages in lakes and reservoirs yielded 31,114 metric tons. The main food fishes produced were the Nile tilapia (*Oreochromis niloticus*) in ponds and cages, and the milkfish (*Chanos chanos*) in pens. The mudfish (*Channa striata*), bighead carp (*Aristichthys nobilis*), and the African catfish (*Clarias gariepinus*) also contributed to total production.

Keywords: aquaculture products; lakes; ponds; water reservoirs; freshwater fish; aquaculture statistics; *Oreochromis niloticus*; *Channa striatus*; *Chanos chanos*; *Clarias gariepinus*; *Aristichthys nobilis*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Philippine Fisheries Association, Los Baños, Laguna, Philippines 4030, [mailto:aquabios@laguna.net]

625 Guerrero, R.D., M.M. Lijauco and V. Dureza. (n.d.) Available technology and technological gaps in milkfish farming in the Philippines. SEAFDEC/AQD Library Compilation. 5 p.

Available aquaculture techniques of the culture of milkfish in the Philippines are presented. Furthermore; technological gaps were identified and discussed.

Keywords: technology; milkfish farming; techniques; milkfish technology; milkfish
Location: SEAFDEC Aquaculture Department Library

626 Hastings, W.H. 1993. In search of history. Milkfish in Indonesia. Aquaculture Magazine 19(2):49-53.

Whenever I read a news release proposing that a certain food product can eradicate hunger and malnutrition in developing countries, I suspect that some one is projecting laboratory data into unrealistic production. In practice, a resource necessary for success will become limited or economically infeasible, or the population density will soon require further goals of efficiency. The culture of a specific fish is often the target for sensational claims to recycle primary food-chain components into high-quality protein. I will not combat this hypothesis--only I would like to recall my experiences with milkfish in Java and focus on a product which could almost meet drawing board expectations.

Keywords: fish culture; aquaculture development; brackishwater aquaculture; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

627 Juario, J.V. 1990. Milkfish culture in the Philippines. In: H. Tanaka, K.R. Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). Proceedings of the regional workshop on milkfish culture development in in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, Suva, Fiji.

This paper discusses the different culture techniques of milkfish propagation in the Philippines. It includes different ponds used in milkfish culture and its preparation.

Keywords: milkfish culture; pond; pond preparation; Philippines
Location: http://www.fao.org
Author Affiliation: University of the Philippines, Diliman, Quezon City

628 Lee, C.S. 1984. The milkfish industry in Taiwan, p. 183-198. In: J.V. Juario, R.P. Ferrraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

This paper attempts to explain empirically the entire milkfish (*Chanos chanos*) industry in Taiwan, convering 1) the gathering and marketing of milkfish fry - the procurement subsystem; 2) the production of milkfish fingerlings for the baitfish industry; 3) the production of market-size milkfish - the transformation subsystem; and 4) the marketing of market-size milkfish - the delivery subsystem. A constant elasticity of substitution production function is used to estimate the input-output relationship for baitfish and market-size production systems, with all inputs classified into labor and capital. An important finding is that the elasticity of substitution between labor and capital exceeds unity, indicating rather easy substitution between the two inputs in the milkfish industry in Taiwan. The area for aquaculture has expanded rapidly during the past two decades, but the milkfish production area has remained at 15,000 ha and yields have increased slowly compared with those of other cultured species.

Keywords: brackishwater aquaculture; fish culture; aquaculture development; *Chanos chanos*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Res. Inst. Agric. Econ., Natl. Chung Hsing Univ., Taichung, Taiwan

629 Lee, C.S. and A.C. Ostrowski. 2001. Current status of marine finfish larviculture in the United States. Aquaculture 200(1-2):89-109.

Twenty or more species of marine finfish have been reared experimentally for stock enhancement or aquaculture purposes in United States (US) hatcheries. The development of larviculture techniques for marine finfish in the US historically has focused on the restoration of recreational and commercial fisheries rather than on development of new agribusiness opportunities to produce food for domestic consumption or export. The situation has changed in recent years in response to increasing demand for fresh seafood. Some representative species being considered for aquaculture include striped mullet (*Mugil cephalus*), milkfish (*Chanos chanos*), mahimahi (*Corphaena hippurus*) and the Pacific threadfin (*Polydactylus sexfilis*) in Hawaii; the southern flounder (*Paralichthys lethostigma*), summer flounder (*P. dentatus*) and red drum (*Sciaenops ocellatus*) along the Atlantic coast and the Gulf of Mexico; and the white sea bass (*Atractoscion nobilis*) along the West coast of the US. Spawning is controlled by exogenous hormones and/or photothermal controls. Larviculture is conducted mainly by extensive and intensive methods. In this paper, the factors influencing marine finfish production from intensive larval rearing are discussed, based on the species cultured in the US. Hatchery techniques for two regionally emerging, high-value species, the Pacific threadfin and southern flounder, are presented. In the foreseeable future, larviculture in the US will continue to pursue development of high-value species to meet fisheries management goals and to offset the high costs of aquaculture production.

Keywords: fishery resources; rearing; aquaculture techniques; aquaculture products; intensive culture; fish larvae; *Paralichthys lethostigma*; *Paralichthys dentatus*; *Polydactylus sexfilis*; *Sciaenops ocellatus*; *Atractoscion nobilis*; *Coryphaena hippurus*; *Chanos chanos*; *Mugil cephalus*; INE, USA; ANW, USA; ASW, ISE, Hawaii
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: The Oceanic Institute, Makapuu Point, 41-202 Kalanianaole Highway, 96795 Waimanalo, HI USA

630 Lee, C.S. and J.E. Banno. 1988. Milkfish culture and production in Southeast Asia present and future. In: H. Tanaka, K.R. Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). Proceedings of the regional workshop on milkfish culture development in in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, Suva, Fiji.

The paper is divided in the following sub topics: World finfish aquaculture, geographic distribution, milkfish culture, the fry industry, culture methods and production in Taiwan, culture methods and production in the Philippines and culture methods and production in Indonesia.

Keywords: milkfish culture; production; Indonesia; Taiwan; Philippines
Location: http://www.fao.org
Author Affiliation: The Oceanic Institute, Honolulu, Hawaii, USA

631 Lee, C. and P.J.C. O'Bryen. 2002. Aquaculture growout systems--challenges and technological solutions. Reviews in Fisheries Science 10(3/4):391-620.

The following papers are included in this proceeding: 1. Improved shrimp growout systems for disease prevention and environmental sustainability in Asia. Chen-Sheng Lee pp. 391-402. 2. Flatfish farming systems in the Atlantic Region. Nick Brown pp. 403-419. 3.
Flounder culture and its challenges in Asia. Tadahisa Seikai pp. 421-432. 4. Technical innovations in eel culture systems. I. Chiu Liao, et al. pp. 433- 450. 5. Technical responses to challenges in milkfish aquaculture. Mao-Sen Su, et al. pp. 451-464. 6. Tilapia production systems in the Americas: technological advances, trends, and challenges. Wade O. Watanabe, et al. 7. Channel catfish farming in ponds: lessons from a maturing industry. John A. Hargreaves pp. 499-528. 8. Current and future technological trends of European seabass-seabream culture. John A. Theodorou pp. 529-543. 9. Rainbow trout--challenges and solutions. Gary Fornshell pp. 545-557. 10. Yellowtail culture development and solutions for the future. Makoto Nakada pp. 559-575. 11. Farming salmon: an example of aquaculture for the mass market. John Forster pp. 577-591. 12. General discussion on 'Aquaculture Growout Systems--challenges and technological solutions.' Cheng-Sheng Lee pp. 593-600. 13. Marine shrimp farming in the western hemisphere: past problems, present solutions, and future visions. Shaun M. Moss pp. 601-620. Thirteen papers are compiled here from a workshop convened to discuss technical solutions to challenges faced in the past by different aquaculture production systems, and to use the lessons learned to predict what technological improvements or innovations will be needed in the future. Topics included disease prevention, environmental sustainability and a variety of region- and animal-specific issues. Marine shrimp, turbot, halibut, Japanese flounder, eel, milkfish, tilapia, carp, channel catfish, European seabass and seabream, trout, yellowtail, and salmon are covered.

Keywords: freshwater aquaculture; marine aquaculture; shrimp culture; fish culture; aquaculture techniques; aquaculture systems; disease control; water quality control; aquaculture effluents; environment management; conferences; *Penaeidae; Platichthys flesus; Paralichthys olivaceus; Anguillidae; Chanos chanos; Tilapia; Ictalurus punctatus; Dicentrarchus labrax; Sparidae; Scophthalmus maximus; Oncorhynchus mykiss; Seriola quinqueradiata; Salmonidae*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

632 Lee, C.S., M.S. Gordon and W.O. Watanabe (eds.). 1986. Aquaculture of Milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Waimanalo, Hawaii. 284 p.

Abstracts of the 10 papers included in this edition are cited individually.

Keywords: aquaculture development; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

633 Liao, I.C. 1985. Milkfish culture in Taiwan, p. 164-184. In: C.S. Lee and I.C. Liao (eds.) Reproduction and culture of milkfish: Proceedings for a Workshop held at the Tungkang Marine Laboratory, 22-24 April 1985, Tungkang, Taiwan.

Continuous modification for almost 300 years gives milkfish culture in Taiwan a traditional style of its own. It is called the shallow-water pond culture system, or fertilizing culture method. Another culture style has recently been developed and improved. It is called the deep-water pond culture system, or feeding culture method, in which the unit productivity reach four to five times that of the traditional style. A brief introduction and comparison of the above-mentioned culture systems are made to investigate their advantages and disadvantages.

Keywords: pond culture; aquaculture systems; *Chanos chanos*; ISEW, Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Taiwan

634 Liao, I.C. 1998. Achievements and prospects of fisheries research in Taiwan. Aquaculture and Fisheries Resources Management (4):15-32.

Fisheries research in Taiwan began at the time of Japanese occupation, having a history of 90 years long. There used to be three main research areas: marine fisheries, aquaculture, and marine food technology. Recently, fisheries biology, aquaculture biotechnology, fisheries information, and fisheries economics have been added among the research areas. The building of the 43-ton research vessel Ryo Kai Maru in 1909 marked the beginning of marine fisheries research in Taiwan. The vessel engaged in the investigation of fishing environments and fisheries resources in the coastal areas. Up to the present, the important achievements in marine fisheries include: making an inquiry into krill resources in the Antarctic Ocean; estimating and investigating the resources of tuna fisheries; and cooperating with international organizations on tuna resource administration, such as the Indian Ocean Tuna Commission (IOTC), International Commission for the Conservation of Atlantic Tunas (ICCAT), South Pacific Commission (SPC), Inter-American Tropical Tunas Commission (IATTC), and Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Recently, the Taiwan Fisheries Research Institute (TFRI) joined the FAO in the investigation of deep-sea fishes off the east coast of the Philippine Island of Luzon, which was used in the publication of the identification guidebook "The Living Marine Resources of the Western Central Pacific", and itself explored the spawning ground of Japanese eel. In addition, improvement of fishing gears and fishing methods, research on the automation of fishing mechanics, and application of ultrasonics and satellite telemetry on exploration of fishing grounds have also been implemented with good results. In aquaculture, significant results had been achieved in Chinese carps in the early years of research on artificial propagation. The subsequent expansion of aquaculture in Taiwan is based on the technology established for the artificial propagation of species such as grass carp (Ctenopharyngodon idellus) and silver carp (*Hypophthalmichthys molitrix*) in 1963, grass prawn (*Penaeus monodon*) in 1968, grey mullet (*Mugil cephalus*) in 1969, and milkfish (*Chanos chanos*) in 1978. At present, there are more than 120 species for aquaculture in Taiwan. The application of biotechnology on aquaculture highlights recent research direction. Significant accomplishments have been obtained so far in sperm cryopreservation, chromosome manipulation, and viral disease research for preventing finfish and prawn diseases. In marine food technology, artificial feeds have been developed successfully which promoted aquaculture into a high profit enterprise. Furthermore, the processing of dry fish products in the early years and the recent development of functional seafood products show the advancement in the fishery product technology. Under the pressure of population increase and the advantage of vast surrounding seas, Taiwan can do many fisheries ventures in the future. Research works where vital results may be obtained include: elucidation of the oceanographic conditions and their relations with the dynamics of fisheries resources; development of environment-friendly fisheries such as sea cage aquaculture and stock enhancement; and deep ocean water utilization. Super-intensive recirculating aquaculture techniques can be improved further and applications of biotechnology can be explored even more. In addition to the

health seafood product development, other important researches on the utilization of remnants from processing, the enhancement of value-added fishery products, and so on may also be investigated.

Keywords: marine fisheries; krill fisheries; tuna fisheries; biotechnology; International cooperation; fishery biology; genetics; fishing gear; processing fishery products; aquaculture techniques; disease control; feed composition; food technology; selective breeding; fishery oceanography; historical account; aquaculture development; reproduction; disease detection; sperm; freezing storage; *Mugil cephalus*; *Penaeus monodon*; *Chanos chanos*; *Ctenopharyngodon idella*; *Hypophthalmichthys molitrix*; Taiwan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Taiwan Fisheries Research Institute, Keelung 202, Taiwan

635 Liao, I.C. 2005. Aquaculture practices in Taiwan and its visions. Journal of the Fisheries Society of Taiwan 32(3):193-206.

Aquaculture in Taiwan began more than 300 years ago. In general, the history of aquaculture development in Taiwan can be divided in three stages: 1) Traditional stage (1661-1962); 2) Prosperous stage (1963-1987); and Transitional stage (1988-present). At present, Taiwan is recognized as one of the countries with the most advanced and practical aquaculture technologies in the world. The significant achievements of aquaculture in Taiwan are the development of mass propagation and culture techniques for many aquaculture species including grass prawn, grey mullet, milkfish, tilapia, eel, and cobia among others. Biotechnological achievements are also noteworthy and these include the production of transgenic fish for the aquarium industry (e.g. zebrafish), development of molecular diagnostic techniques for most viral disease prevention in prawns.
As aquaculture continued to prosper which contributed significantly to the country's fisheries production, food supply, rural livelihood, employment generation and socio-economic growth, problems were also encountered which resulted in the partial collapse of the industry. And the fact that most aquafarmers are too profit-oriented, overseeing these problems in exchange for higher production also resulted in negative effects on the aquaculture industry in the long run. Some government rules and policies, as well as bureaucracy, hinder the advancement of the industry towards sustainable aquaculture. With the current situation of the aquaculture industry in Taiwan, which is somehow not in harmony of what is happening in the world aquaculture, there is an urgent need to propose strategies that can sustain the industry in the future, including: strengthening of traditional techniques (e.g. on mass larval production); scientific research on nutrition and health; development of environment-friendly aquaculture system; value-addition among processed aquaculture products; and, institutional cooperation locally, nationally and internationally.

Keywords: aquaculture development; problems; management strategies; sustainable production
Location: WorldFish Center-Philippine Office
Author Affiliation: National Taiwan Ocean University, Keelung, Taiwan and National Pingtung University of Science and Technology, Pingtung Taiwan. E-mail: icliao@mail.ntou.edu.tw

636 Liao, I.C. and T.I. Chen. 1986. Milkfish culture methods in Southeast Asia, p. 209-242. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.) Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii, USA.

An overview is given of the milkfish fry industry in Southeast Asia, covering pond design and construction, culture methods and management, marketing and processing. Recent technological progress from work conducted in Taiwan, the Philippines and Indonesia is described.

Keywords: aquaculture techniques; *Chanos chanos*; Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Tungkang Mar. Lab., Tungkang, Pingtung, Taiwan

637 Librero, A.R., E.S. Nicolas, A.L. Banasihan, R.M. Fabro, L.P. Lapie, A.M. Nazareno and E.O.

Vasquez. 1977. Milkfish farming in the Philippines: a socio-economic study. SEAFDEC/PCARR Research Paper Series 8. Southeast Asian Fisheries Development Centre Los Baños, Laguna, Philippines.

As part of the project on socio-economics of the aquaculture industry in the Philippines, a survey was conducted of 1175 sample bangus fishpond operators throughout the country. The sample covered 526 barrios from 156 municipalities in 40 provinces. Respondents in the personal interviews were either the owner or the caretaker. This extensive report is based on the results of the survey, and is divided into major sections on the fishpond operator and his farm, cultural practices, stocking patterns and fishpond productivity, capital investment and costs and returns in milkfish production, marketing and prices, labour requirements and labour relations, and social conditions of fish farmers and caretakers. A summary chapter contains recommendations on each of the preceding sections.

Keywords: brackishwater aquaculture; sociological aspects; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

638 Marte, C.L. 2003. Larviculture of marine species in Southeast Asia: current research and industry prospects. Aquaculture 227(1-4): 293-304.

The increased requirement for food fish, the lucrative market for expensive seafood, and the need to conserve marine resources, have motivated the rapid pace of larviculture research in Southeast Asia. Various research and academic institutions in Southeast Asia such as the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC AQD) are carrying out research on commercially important marine species including 10 fish, 6 crustacean, and 7 mollusk species. Since fry availability is a major constraint in the development of culture systems, a major research thrust of SEAFDEC AQD is the development of commercially viable technologies for breeding and seed production of commercially important marine fish and crustaceans such as milkfish, groupers, snappers and mud crabs, in addition to the production of fry and juveniles of endangered and depleted species such as the sea horse and the tropical abalone for stock enhancement and sea ranching. Although hatchery production of milkfish and sea bass are now commercially viable enterprises, research is being pursued to improve fry quality through feed supplementation and to lower production cost by using alternative live or artificial feeds. Larviculture techniques are being developed for technically demanding species such as groupers and snappers. The recent success in larviculture of the mud crab *Scylla serrata* is expected to stimulate the growth of the mud crab industry in the region. Similarly, encouraging developments in the breeding and larviculture of the sea horse and mollusks such as the tropical abalone will provide the necessary support to carry out future stock enhancement and sea ranching programs for these species.

Keywords: fish larvae; crustacean larvae; molluscan larvae; seed production; fish culture; mollusc culture; crustacean culture; rearing; *Scylla serrata*; *Chanos chanos*; *Dicentrarchus labrax*; *Lutjanidae*; *Epinephelus*; *Syngnathidae*; *Haliotis asinina*; ISEW, Southeast Asia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

639 Marte, C.L., P. Cruz and E.E.C. Flores. 2000. Recent developments in freshwater and marine cage aquaculture in the Philippines, p. 83-96. In: Cage aquaculture in Asia: Proceedings of the First International Symposium on Cage Aquaculture in Asia, 2-6 Nov 1999, Tungkang, Pingung, Taiwan.

Fish production from freshwater cages and pens, and marine cages and pens constitute 19% of the total foodfish produced from aquaculture in the Philippines. In 1998, production from freshwater cages and pens contributed about P 2.5 billion or about 10% of the total revenues from aquaculture. Freshwater cage and pen culture is practiced in most of the major lakes and reservoirs in the country. The most important species cultured in freshwater cages are tilapia and bighead carp (*Aristichthys nobilis*) while milkfish (*Chanos chanos*) is farmed in freshwater pens at Laguna de Bay. Small water impoundments intended for the irrigation of upland farms are also being used to culture tilapia and

other freshwater fish in cages. The unregulated expansion of cages and pens, use of high stocking densities, and excessive feeding has resulted in the deterioration of the water quality in many areas. This has prompted the more informed local government authorities to adopt measures limiting further expansion of cage and pen culture activities beyond the carrying capacity of freshwater bodies to prevent periodic occurrences of mass fish kills. While cage mariculture of groupers has been practiced in the Philippines since the 1980's, it was only in the early 1990's that much of the growth and expansion of the industry occurred with the popularization of milkfish mariculture. In the last five years, no less than 1,000 cages with an aggregate capacity in excess of 10,000 metric tons a year have been invested in milkfish sea farming. The species now acounts for about 90% of the production from marine cages. In recent years, a drop in milkfish prices has motivated the industry to focus its attention on other fishes, primarily grouper (*Epinephelus spp*.), snapper (*Lutjanus spp*.), sea bass (*Lates calcarifer*) and siganid (*Siganus spp*.). Currently, imported species such as red tilapia, yellow-wax pompano (*Trachinotus blochii*) and red drum (*Sciaenops ocellatus*) are also being tested by the private sector.

Keywords: cage culture; fish culture; *Teleostei*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines

640 Morissens, P. (n.d.) The dynamics of aquaculture in the Philippines: Intensification and extensification in the milkfish and tilapia production sector. http://www.ag.arizona.edu.

Philippine aquaculture ranks 4th in the world in terms of volume produced. Without including the productions of seaweeds and shellfish, this sector is dominated by three species: milkfish (*Chanos chanos*), tilapia (*Oreochromis niloticus*) and prawn (*Penaeus monodon*), with respective productions evaluated in 2002 at 230,000, 122,000 and 35,000 m.yr-1. While milkfish and tilapia productions have increased spectacularly over the last ten years, prawn industry collapsed due to pathological diseases. A closer observation of these developments reveals a trend towards an extensification of the farming systems for these three species: less inputs and lower stocking densities. The main production tool of fish farming in the Philippines is the brackish water coastal pond, with over 250,000 ha, 85% of the milkfish production, the entire prawn production and a slowly rising tilapia production. An extensive polyculture is being practised with an association of milkfish, prawn, crabs and, in certain regions, tilapia. An attempt to intensify the prawn production systems on wide areas of fishponds with the development of monoculture between 1982 and 1995 ended in dramatic failure. The return to extensive polyculture is now the rule with an increasing role of tilapia in prawn oriented polyculture. The fairly recent introduction of the Nile tilapia *Oreochromis niloticus* in 1972 led to the development of mostly intensive monoculture. By 1993, the Philippines was the number one tilapia producer in the world with nearly 100,000 mt yr-1, densely stocked cages in open water being the main farming system. A combination of unfavourable factors rapidly led to a lowering of productions in the vicinity of 70,000 mt.yr-1. Nevertheless, in the late 90's a new farming system developed in the central plain of Luzon Island where thousands of small fishponds were built, mainly on rice farms. This tilapia monoculture in ponds is characterised by lower production cost than in cages and its development induced to a new increase of the national tilapia production to over 120,000 mt in 2002. Today, fishponds of the central region of Luzon contribute to one third of the tilapia production in the Philippines.

Keywords: milkfish; *Chanos chanos*; milkfish aquaculture
Location: http://ag.arizona.edu

641 Mounsey, R. 1998. Wild milkfish just waiting to be caught. INFOFISH International (5):20-22.

Wild milkfish (*Chanos chanos*) along the Northern Territory coast of Australia, is an untapped resource as no viable market yet exists for the species. Barramundi fishermen continually catch large milkfish in their gillnets, but nearly all of these are unrecorded and released at sea, since there is no viable market for them. Only a tiny amount of immature milkfish are landed by the coastal net licence holders and sold locally to the small Filipino community in Darwin. A Darwin-based

company has recently found good market potential for milkfish in the Philippines, Indonesia and other countries in the region. The company believes that fry taken from the pristine waters of northern Australia would be well accepted by Asian farmers, and in addition mature milkfish herded into seawater enclosures and induced to spawn would produce a similar high grade marketable fry. It is concluded that the Northern Territory barramundi and coastal net fishers, operating in conjunction with aquaculturists, could diversify into catching milkfish if market demand for broodstock or fry improves.

Keywords: marine aquaculture; fish culture; gillnets; coastal fisheries; fishery development; aquaculture development; cage culture; *Chanos chanos*; ISEW, Australia, Northern Terr.
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Primary Industry and Fisheries, N.T. Australia

642 Pamplona, S.D. and R.T. Mateo. 1985. Milkfish farming in the Philippines, p.141-163. In: C.S. Lee and I.C. Liao (eds.) Reproduction and culture of milkfish: Proceedings for a Workshop held at the Tungkang Marine Laboratory, 22-24 April 1985, Tungkang, Taiwan.

A detailed account is given of milkfish farming procedures generally practised in the Philippines. The following phases are identified: 1) collection and/or procurement of seed for fry phase; 2) fry rearing; 3) culture and production in grow-out ponds; 4) milkfish culture and production in freshwater fish pens. Harvesting and post-harvest handling are described. Problems and constraints of milkfish farming in the Philippines are also examined.

Keywords: aquaculture techniques; *Chanos Chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Naujan Res. Substn., SEAFDEC, Philippines

643 Rice, M.A. 1998. Aquaculture in Dagupan City, Philippines: 20 Years of change. Journal of Shellfish Research 17(1):361-362.

The metropolitan area of Dagupan City, Pangasinan, Philippines (16 degree 00'N, 120 degree 15'E) is well known for the culture of bangus or milkfish, *Chanos chanos*. The milkfish are typically grown in traditional shallow extensive ponds reclaimed from mangrove wetland areas, using techniques widely used in the area since the 19 super(th) century. There are about 11,300 hectares of extensive milkfish ponds stocked typically at 4,000 fingerlings/ha, requiring minimal supplemental feed, allowing a three-month growing period before reaching market size of 400-500g. In the mid-1980s, some operators began semi-intensive culture of milkfish with stocking in excess of 25,000 fingerlings/ha using aeration and prepared feeds. A few operators diversified their crops by growing shrimp, (*Peneaus monodon*) in monoculture with crop rotation or as a polyculture species with milkfish. Aquaculture of Asian mangrove oysters, *Crassostrea iredalei*, based on collection of natural spatfall has been important in the estuary. Data collected in 1983 showed that secondary productivity of shucked oyster meats oysters in the farms was 2.5 kg m super(-2)yr super(-1). In 1983, the culture of serranid groupers was introduced into the estuary using floating cage techniques, and by 1993, aquaculture production of groupers reached 15,000 kg yr super(-1). Up until the early 1990s, the aquaculture production in the Dagupan City area could be described as having a high degree of species and technological diversity but a number of events and sociopolitical changes affected the way aquaculture was to be conducted.

Keywords: fish culture; aquaculture development; pond culture; oyster culture; *Chanos chanos; Penaeus monodon*; *Crassostrea iredalei*; ISEW, Philippines, Luzon I., Pangasinan, Dagupan
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: University of Rhode Island, Department of Fisheries, Animal and Veterinary Science, Kingston, RI 02881, USA

644 Ronquillo, I.A. 1986. Advances in milkfish and tilapia culture. Paper presented at the National Conference on Prawn-Fish Farming Technology 23-24 Oct 1986, Manila.

Discussed in this paper is the status of the tilapia and milkfish industry in the Philippines. Previous studies and recent advances are given.

Keywords: milkfish culture; milkfish
Location: SEAFDEC Aquaculture Department Library

645 Ruddle, K. 1982. Brackishwater aquaculture in South-East Asia. Mazingira 6(4):58-67.

The article examines the potential for aquaculture in South East Asia, and takes the Indonesian example to illustrate operations related to brackish water aquaculture and to examine constraints (e.g. related to restocking). Measures to increase productivity are suggested (e.g. improvements in supply and quality of milkfish fry, improvements in marketing channels). Problems of property rights are discussed, particularly in relation to extending aquaculture, and intensified and improved productivity in existing ponds is recommended.

Keywords: aquaculture; production possibilities; fish farming; ponds
Location: CAB Direct Abstracts
Author Affiliation: National Museum of Ethnology, Osaka, Japan.

646 Samaranayake, R.A.D.B. 1982. *Chanos chanos* (milkfish) farming in the Philippines. Journal of Inland Fisheries 1:126-132.

A description of milkfish (*Chanos chanos*) farming in the Philippines is provided.

Keywords: fish culture; brackishwater aquaculture; *Chanos chanos*; ISEW, Philippines
Location: CAB Direct Abstracts
Author Affiliation: Inland Fish. Div., Minist. Fish., Sri Lanka

647 Samson, E. 1984. The milkfish industry in the Philippines, p. 215-228. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Milkfish (*Chanos chanos*) is the most commercially important fish species in the Philippines. Milkfish production from the marine fisheries and aquaculture sectors has increased at an average rate of 22%. In 1981, production was valued at 1.9 billion Philippine dollars (212,000 t), representing 14% of total fish production value. About 73% of milkfish production came from brackishwater ponds, while the rest was contributed by fishpens (26.3%) and marine fisheries (0.5%). The national yield average was 870 kg/ha per year. Local marketing is handled by brokers, who distribute the fish to wholesalers, cooperatives, retailers, and consumers. Exports experienced a more than 600% increase from 1977 to 1980 and a slight decrease in 1981. Despite inherent problems of the industry include, the potential for further growth of the industry is strong in view of recent research on intensive farming, induced spawning, rearing in controlled conditions, and polyculture techniques. The government is providing support through the establishment of infrastructure facilities, strengthening of extension and training, provision of credit, and development of efficient marketing.

Keywords: brackishwater aquaculture; fish culture; aquaculture development; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fish. Ind. Dev. Counc., Metro Manila, Philippines

648 Santiago, A.C. Jr. 1983. Bangus: a mainstay in Philippine aquaculture. Philippine Fisheries Annual Report p. 32-41.

The milkfish industry in the Philippines is discussed. Aspects covered are: fishpen production, pond culture system, milkfish fry, marketing, researches on milkfish, and milkfish broodstoock.

Keywords: milkfish; Philippines
Location: SEAFDEC Aquaculture Department Library

649 Smith, I.R., F.C. Cas, B.P. Gibe and L.M. Romillo. 1978. Preliminary analysis of the performance of the fry industry of the milkfish (*Chanos chanos* Forsskal) in the Philippines. Aquaculture 14(3):199-219.

The fry industry of the milkfish in the Philippines is alleged to suffer from certain inefficiencies, principal among which are an annual shortage to meet the stock requirements of the 176,000 ha of fishponds in the country, and the failure of the pricing system to direct and allocate the fry resources geographically. Contrary to these and other allegations, this paper presents a preliminary analysis that indicates a higher level of performance for the industry than hitherto supposed. Specifically, fry catch is estimated to be 1.35 billion, sufficiently high to meet present stocking requirements; less than 3% of trade flows between regions overlap; and monthly average fry prices between trading regions are significantly correlated, indicating the system responds to supply and demand changes and other stimuli.

Keywords: seeding (aquaculture); pond culture; fry; marketing; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Agric. Resour. Econ., Univ. Hawaii, USA

650 Su, M.S., C.S. Lee and I.C. Liao. 2002. Technical Responses to Challenges in Milkfish Aquaculture. Reviews in Fisheries Science 10(3-4):451-464.

Milkfish (*Chanos chanos*) has been cultured in Asia for centuries. In 1999 the total world production of cultured milkfish was estimated at 381,930 metric tons. To meet the production target with less available land for farming, traditional culture in shallow-water ponds, which relied on wild-caught fry from coastal waters and on benthic algae as the main food, had to be modified. To increase unit production, a deep-water pond culture system was developed in the mid-1970s. As a result of the increased water depth and stocking density, in addition to the use of formulated feed and aeration devices, unit production underwent a 5- to 8-fold increase. In the Philippines, pen and sea cage culture methods were developed to increase production. The life cycle of milkfish was completed in captivity before technology for mass production in the hatchery was established in the late 1980s. Preventing overproduction of milkfish is currently an important issue in milkfish producing countries. The improvement in processing technology, the diversification of products, and the establishment of international marketing networks are important challenges to the industry. The extension of milkfish aquaculture technology to other countries is a goal that may greatly benefit mankind.

Keywords: pond culture; water depth; feed; aeration; stocking density; aquaculture techniques; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author affiliation: Taiwan Fisheries Research Institute, 199 Hou-Ih Road, Keelung 202, Taiwan, [mailto:cslee@oceanicinstitute.org]

651 Sundararaj, V., P. Natarajan and M.D.K. Kuthalingam. 1981. Scope of *Chanos* farming. Seafood Export Journal 13(12):9, 11+.

The potential importance of the brackishwater culture of *Chanos chanos* in India is discussed in detail.

Keywords: fish culture; brackishwater aquaculture; resource surveys; potential resources; *Chanos chanos*; ISW, India

Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Fish. Coll., Tuticorin, India

652 Tamaru, C. (n.d.) Aquaculture in Hawaii–past, present and future. http://www.uhh.hawaii.edu

This article discusses the horizons of Hawaii aquaculture.

Keywords: milkfish; *Chanos chanos*, Hawaii
Location: http://www.uhh.hawaii.edu

653 Tamaru, C.S., F. Cholik, J.C.M. Kuo and B. Fitzgerald. 1993. From Discovery to commercialisation. Special Publication, European Aquaculture Society (19): 296-297.

The striped mullet, Mugil cephalus, represents substantial fisheries and has been cultured in many parts of the world for centuries. Research activities have resulted in a hatchery technology that results in the production of striped mullet fry at a harvest density of 10 fry/liter after 35 days in the hatchery at a cost of $US 72.20/1000 fry. Investigations of the grow-out characteristics of striped mullet fry from Taiwan and Hawaii being conducted in Guam demonstrate that the faster growth rate (i.e. 2x) of the fry from Taiwan is innate. Mullet grow-out activities in Taiwan have been extended from the normal one year period to three years, specifically for harvest of the ovaries. The culture of milkfish, *Chanos chanos*, as a food source has been ongoing for centuries in Southeast Asia. Tolerant of wide range of salinities (i.e. 0-110 ppt), rapid growth, and ability to feed at the lowest trophic levels are major reasons for its popularity. Currently, three countries (Indonesia, Philippines and Taiwan) produce approximately 330,000 metric tons total per year. The source of fry for nursery and grow-out phases has until recently been exclusively from the wild. Intensive research has focused on developing a suitable hatchery technology. A rearing protocol for the production of milkfish fry from the hatchery results in an average density of 8 fry/liter and fry are being sold at a price ranging between $US 63.55 - 15.00/1000 fry. The culture of grouper has received considerable interest during the last ten years because of its high market value ($US 6.00-$8.00/kg). Some of the species under culture are Epinephelus tauvina, E. fuscoguttatus, and E. microdon. Grow-out of the grouper is easily accomplished in net cages or ponds. The seed for stocking has until recently remained exclusively from the wild. The problems encountered in developing suitable hatchery technologies are sexuality (i.e. protogynous hermaphrodites), spawning in captivity and precarious larval culture. Administration of 17 alpha -methyltestosterone (orally or by implantation) has been successful in transforming female brooders into functional males. Induction of spawning with HCG (80-1050 IU/kg BW) has resulted in successful production of fertilized eggs in a number of grouper species. Natural spawnings of captive grouper broodstock have been achieved for a number of species. The major obstacle remaining for all groupers cultured is their larval stage. Encouraging results however have been reported by employing the S-type rotifer strain, packing the rotifers with *Nannochloropsis oculata*, and enrichment of Artemia with commercial preparations.

Keywords: fish culture; aquaculture techniques; aquaculture economics; aquaculture statistics; breeding; rearing; literature reviews; *Mugil cephalus*; *Chanos chanos*; *Epinephelus*; ISEW
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: INDECO d.u./Winrock Internatl., Agency Agric. Res. and Dev., Jalan Salak 22, Bogor 16151, Indonesia

654 Tan, E.O., D.L. De Guzman, L.C. Darvin and M.C. Balgos. 1984. Milkfish research in the Philippines, p. 161-169. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, 4-8 October 1983, Iloilo City, Philippines.

Development and directions in milkfish research in the Philippines from 1976 to the present are viewed and analysed. The problems of milkfish culture are dichotomous: low productivity vis-à-vis seasons of glut and price fluctuations. To intensify fish production, extensive research has been conducted on fertilizer management, reclamation of acid sulfate soil, and pond construction and

engineering. Research efforts have also been heavily directed toward increasing of fry production through artificial propagation, improvement of fry collecting gear, and increasing fry survival through nutrition, control of parasites and proper handling. Research on improved icing, packaging, and maximizing economic returns.

Keywords: milkfish research; milkfish; Philippines
Location: SEAFDEC Aquaculture Department Library

655 Tekinaiti, T. 1996. Milkfish farming in Kiribati, p. 161-166. In: Present and future of aquaculture research and development in the Pacific Island Countries, Ministry of Tonga, Nukualofa (Tonga).

Milkfish (*Chanos chanos*) farming as baitfish and foodfish proved to be a success. This paper discusses the detail practical aspects of the farming. It covers fry collection, feeding, growth and production results. Other research programmes such as eradication of tilapia, integrated farming and farming constraints are discussed. (DBO)

Keywords: aquaculture development; aquaculture techniques; hatcheries; fish culture; bait culture; *Chanos chanos*; ISEW, Pacific, Kiribati
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

656 Teroroko, T. 1988. Milkfish culture methods in Kiribati. In: H. Tanaka, K.R. Uwate, J.V. Juario, C.S. Lee and R. Foscarini (eds.). **Proceedings of the regional workshop on milkfish culture development in the South Pacific, Tarawa, Kiribati, 21-25 November 1988. South Pacific Aquaculture Development Project, Food and Agriculture Organization of the United Nations, Suva, Fiji.**

The farming of milkfish (*Chanos chanos*) at the subsistence level in Kiribati is an old tradition carried out at several locations by governmental or private initiative. Milkfish production supplies the local need for baitfish, mainly for the pole and line tuna fishing industry, as well as a food source for the village communities. Milkfish production for baitfish is carried out under extensive, semi-intensive, and intensive conditions.

Keywords: milkfish culture; pond; pond preparation; intensive; semi-extensive; Kiribati
Location: http://www.fao.org
Author Affiliation: Fisheries Division, Bikenebeu, Tarawa, Kiribati

657 Tokoragi, L. 1978. Milkfish culture in French Polynesia. Appropriate Technology 4(4):23-25.

This article gives some background information on the culture of *Chanos chanos*, including seed collection and pond management. A C.*chanos* culture project carried out on the Rangiroa Atoll is described.

Keywords: fish culture; seed collection; aquaculture development; brackishwater aquaculture; *Chanos chanos*; French Polynesia, Rangiroa Atoll
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Freezer Establishment, Avatoru, Rangiroa Atoll, Tuamotu Atoll, French Polynesia

658 Villanueva, R.S. 1978. Bangus pond industry. Asian Institute of Management. 58 p. M.S. thesis.

In this paper, pond culture of milkfish is analysed in detail. Possible measures on how to increase production to improve cost of returns are given.

Keywords: bangus; pond industry; ponds; milkfish
Location: SEAFDEC Aquaculture Department Library

659 Wong, V. 1981. Comparative study of the aquaculture of milkfish (*Chanos chanos*) in Southeast Asia Region with particular references to Indonesia, Philippines and Taiwan. Queen's Mary College, University of London. 108 p. PhD. dissertation.

This report deals with the culture of milkfish, *Chanos chanos* (Forsskal) in the Southeast Asian Region, concentrating particularly on the methods as employed in Indonesia, the Philippines and Taiwan. The subject is introduced, followed by a brief history on milkfish culture. The biology of the species is described (including the sex determination and life cycle). The layout of typical milkfish farms is described and illustrated. The construction and fertilization of these ponds are also elaborated upon. The collection of the fry and their subsequent introduction into the milkfish ponds are discussed. A disscusion on relevant pond fertilization experiments is included. Predators, pest, and their possible eradication are described. Economic comparisons of milkfish operations is compared between Indonesia, the Philippines and Taiwan, In conclusion, mention is made of induced breeding experiments and their possible significance on the future status of milkfish farming.

Keywords: milkfish aquaculture; Indonesia; Philippines; Taiwan; milkfish
Location: SEAFDEC Aquaculture Department Library

660 Yap, W.G. 1997. Can the Philippines produce enough fish for the multitude? Aquaculture Asia 2(3):32-38.

Philippine fishery statistics classified fish production into 3 major production sources: commercial, municipal and aquaculture. Of these, only commercial fisheries and aquaculture have shown positive growth; municipal fisheries has been declining since 1992, with the inland sector being the most affected. Alternative ways to lighten the current fish supply crises are considered. It is believed that a sustainable option is to raise more fish, rather than merely hunt for them. An examination is made of available resources, including physical, technical and financial, which would enable increased production. Particular reference is made to increased tilapia production, but milkfish, carps, groupers and seabass are also considered.

Keywords: fish culture; aquaculture development; food fish; fish consumption; aquaculture statistics; *Oreochromis*; *Chanos chanos*; *Cyprinidae*; *Dicentrarchus labrax*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquafarming Development Foundation, Inc. 26 Katipunan Road, White Plains, Quezon City Philippines

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Anon. 2004. Commodity road map: milkfish. Fisheries Policy and Economics Division, Bureau of Fisheries and Aquatic Resources, Manila, Philippines.
(See abstract, keywords, location and author's affiliation in entry no. 662)

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(See abstract, keywords, location and author's affiliation in entry no. 663)

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Chen, C.C. and J.C. Kuo. 2001. An economic analysis of milkfish fry culture in Taiwan, p. 43. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.
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LAWS AND POLICY STUDIES

661 Anon. 1949. Regulations for the conservation of "sabalo" (full-grown bangus or milkfish) and for the prohibition of the exportation to foreign countries of "kawag-kawag" (bangus milkfish fry) and "hatirin" (bangus fingerlings). Fisheries Administrative Order/Bureau of Fisheries and Aquatic Resources, no. 25, 3 p.

This fisheries administrative order no. 25 was issued to protect and conserve the mother milkfish. This also prohibits the exportation of fry and fingerlings. Rules and regulations are explained in detail.

Keywords: regulations; conservations; milkfish; *Chanos chanos*, Philippines
Location: SEAFDEC Aquaculture Department Library

662 Anon. 2004. Commodity road map: milkfish. Fisheries Policy and Economics Division, Bureau of Fisheries and Aquatic Resources, Manila, Philippines.

Milkfish is an important commodity in the Philippines. Its production has considerably increased by an average of 8.7% over the past 5 years. The milkfish industry however, is still confronted with problems such as inadequate fry supply, high cost of farm inputs, lack of technology for value-added, lack of manpower to effectively transfer technology, and multi-layered marketing system. Considering the high demand for milkfish, the Bureau of Fisheries and Aquatic Resources implements programs that will increase milkfish production, sustain milkfish fry requirements, generate livelihood opportunities, provide alternate markets for milkfish and improve quality of processed products. The programs include the establishment of milkfish hatcheries and processing plants, and creation of market for low quality milkfish as bait. 'Roadmaps" were already developed and to determine, among others, areas with low and high supply of milkfish. Regions with surplus production can supply these in regions with scarce milkfish supply.

Keywords: milkfish production; demand; production; trend; supply; milkfish
Location: The WorldFish Center-Los Baños Laguna

663 Anon. 2004. National Milkfish Development Program. Bureau of Fisheries and Aquatic Resources, Manila, Philippines.

The articles provide a summary and objectives of the project implementation, programs and strategies and expected impact.

Keywords: milkfish; milkfish project; development; milkfish program; milkfish culture
Location: National Integrated Fisheries Technology Development Center, BFAR, DA

664 Espejo-Hermes, J. 2004. Quality assurance of aquaculture products: milkfish and tilapia. Tawid Publications, Quezon City, Philippines. 180 p.

Chapter 1 discusses the recent status of the world and domestic (Philippines) aquaculture. Chapter 2 introduces the various safety and quality systems. Chapter 3 and 7 will guide the users (particularly

those who are not yet familiar with the system) through HACCP. Generic HACCP plans from various products using milkfish and tilapia are included to illustrate how to produce safe food from farm to plate (or fork). Chapter 4 and 6 focus on the potential hazards and the production steps of aquaculture products. It becomes necessary to initiate safety measures during farming, having in mind that any hazards introduced in aquaculture will have a impact on the finished products. Chapter 5 discusses the prerequisites to HACCP that can be applied to any processing plants that aim to produce foods safe for the consumers. Chapter 8 pertains to international regulations on safety and quality of foods.

Keywords: quality assurance; aquaculture products; domestic aquaculture; quality systems; hazards; international regulations; milkfish
Location: WorldFish Center Library-Philippine office

665 Israel, D.C. 2000. Hatchery-bred milkfish fry: a must for fisheries Development. Philippine Institute for Development Studies, Policy Notes, No. 2000-01.

PIDS Policy notes are observations/analyses written by PIDS researchers on certain policy issues. The treatise is wholistic in approach and aims to provide useful inputs for decision making. This notes also appears as PIDS Discussion Paper No. 2000-05 entitled 'The Milkfish Broodstock-Hatchery Research and Development Program and Industry: A policy study' by Dr. Israel. The views expressed are those of the author and do not necessarily reflect those of PIDS or any of the study's sponsors.

Keywords: policy; observations; fisheries development; Philippines
Location: WorldFish Center-Philippine Office
Author Affiliation: Philippine Institute for Development Studies

666 Lopez, N.A. 1994. The privatization process of the National Bangus (milkfish) Breeding Program in the Philippines. Socioeconomics of aquaculture. In: Proceedings of International Symposium '93, Keelung, Taiwan, 14-17 December 1993. 4:103-113.

The Bureau of Fisheries and Aquatic Resources (BFAR) implemented the National Bangus Breeding Program (NBBP) in twelve stations throughout the Philippines in 1981. The program primarily draws on the milkfish breeding experience pioneered and co-implemented by the Aquaculture Department (AQD) of the Southeast Asian Fisheries Development Center (SEAFDEC). The program's aim is to verify, on a national scale and in various ecological conditions, its research work on milkfish breeding. The end goal is to mass produce milkfish fry nationwide. In May 1986, the International Development Research Center (IDRC) of Canada provided a three-year external assistance grant to support at least four Regional NBBP Stations. The grant resulted in spontaneous stock spawning and limited fry production. The foreign assistance helped improve the broodstock facilities and the project operation and maintenance. However, after the grant expired, coupled with the government's consecutive administrative revamps, the NBBP suffered critical implementation setbacks, particularly in technical and administrative support. Consequently, under the Department of Agriculture's (DA) regional management supervision, the program has been lowly administered. In February 1991, in consonance with the economic policy, the DA finally decided to privatize the program. The privatization move was timely with the present clamor of the aquaculture sector to shift to finfish culture technology due to the pressing problems in the shrimp industry. The privatization move also hoped to curtail the growing scarcity of milkfish fry in the wild wild milkfish fry are presumed to be exploited or smuggled out of the country. With the current development, the government, through the DA, has set forth technical guidelines for privatization and prescribed criteria for selection and conditions to interested sectors.

Keywords: aquaculture; aquaculture development; marketing; market research; fish culture; technology transfer; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Bureau of Fisheries and Aquatic Resources Quezon City, Metro Manila Philippines

667 Lopez, N.A., M.V.E. Vicaldo, M.G. Trio and J.F. Fadriquela. 1986. The Philippine National Bangus (*Chanos chanos*) Breeding Program. In: Proceedings of the First Asian Fisheries Forum, Tokyo, Japan, 26-31 May 1986. Manila. Asian Fisheries Society. p. 75-78.

The National Bangus Breeding Program was implemented by the Bureau of Fisheries and Aquatic Resources in 1981 in 12 stations. Milkfish or bangus, *Chanos chanos*, broodstock were one-year old juveniles either grown in ponds maintained by the project or purchased from cooperators. Some 250 juveniles were stocked in each of the 10-m diameter circular floating cages. The fish were fed commercial formulated diets (fish pellets) with 20% protein content at 1.5-2.0% of the body weight given twice daily until they are three years old. The broodstock were then given crustacean feed pellets with 42% protein level at 2-3% body weight also given twice daily. Representative sampled specimens were sacrificed once the brookstock reached their 4th year to monitor gonadal development and to determine gonadosomatic indices. Early maturing fish were obtained in the samples in March and August 1985. Initial fecundity counts showed a range of 660,000-1,100,000 eggs per female.

Keywords: fish culture; rearing; development projects; *Chanos chanos*; Philippines
Location:
Author Affiliation: Bur. Fish. Aquat. Resour., Marcelo Build., 880 Quezon Ave., Quezon City, Metro Manila, Philippines

Cross-referenced:

Baconguis, S. (n.d.) Man and ANA help mangroves in Philippines. SPORE 84:7.
(See abstract, keywords, location and author's affiliation in entry no. 668)

Dela Cruz, E. 1997. Potential of milkfish farming development in Fiji. FAO, Suva, Fiji. 42 p.
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ENVIRONMENTAL AND ECOLOGICAL STUDIES

668 Baconguis, S. (n.d.) Man and ANA help mangroves in Philippines. SPORE 84:7.

Agri-nipa-aquaculture, or ANA is outlined as a sustainable use of mangroves in the Philippines. This system integrates three practices within a single mangrove plot: sugar palm plantation (*Nypa fruticans*), market gardening and aquaculture of tilapia and milkfish (*Chanos chanos*).

Keywords: mangrove swamps; agriculture; aquaculture; refuges; embankments; *Chanos chanos*; *Oreochromis*; *Nypa fruticans*; Philippines; ISEW
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: College 4031 Laguna Philippines, [mailto:erdb@laguna.net]

669 Bagarinao, T. 2001. The decline of native fishes and fisheries and the rise of aquaculture in lakes and rivers in the Philippines, p. 15. In: Asian Fisheries Forum (6th:2001: Kaohsiung, Taiwan). The 6th Asian Fisheries Forum, November 25-30, 2001, National Sun Yat-Sen University, Kaohsiung, Taiwan: Asian Fisheries: diversification and integration: book of abstracts. Asian Fisheries Society, Manila, Philippines.

Philippine lakes and rivers are poor in primary freshwater fishes because of the limited and temporary connection with the Asian mainland through land bridges between Bomeo, Tawitawi, Sulu, Basilan, Mindanao, Balabac, Palawan, Busuanga, and Mindoro, in which islands 28 native carp species were once recorded. The country's lakes and rivers instead have secondary freshwater fishes such as gobies, migratory marine fishes such as milkfish, and some snails, clams, and prawns. Fish biodiversity has been reduced by overfishing and the establishment of exotic fishes; many species described by Seale, Herre, and Filipino ichthyologists in the 1910-40s have not been recorded recently. The Laguna de Bay fishery in the early 1960s was largely dependent on the ayungin *Therapon plumbeus*, biyang puti *Glossogobius giurus*, and the kanduli Anus manilensis that together comprised 95% of the annual 83,000 mt; another 19,000 mt came from shrimps and 245,000 mt from snails. Fishing and snail-dredging were so intense that catches declined and the whole lake fishery collapsed around 1970. After the collapse, the primary production of the lake increased and milkfish and tilapia farming was established. Lake Lanao was famous for its species flock of 18 endemic carps, but these are now extinct, except 23 species. In 1963, these carps made up 981 mt of the fishery, other native fishes 269 mt, shrimps and snails 257 mt, and introduced fishes 479 mt. Twenty years later, endemic carps made up only 92 mt, native fishes 141 mt, shrimps and snails 164 mt, and introduced fishes 312 mt. The kadurog G. giurus, probably stocked in the lake with milkfish larvae in 1955, proliferated in the 1960s and apparently drove the endemic carps to extinction. The katolong *Hypseleotris agilis* was first seen in the lake in 1977 and has since outcompeted the kadurog and now makes up most of the fishery. In Lakes Taal and Naujan, migratory marine fishes supported large fisheries by fish corrals set across the outlets, but the catch along Pansipit River has fallen since the turn of the century and that in Butas River fell from 62 mt in 1977 to 17 mt in 1983. Catches of the endemic sardine Harengula tawilis in Lake Taal fluctuated between 4,400 mt in 1983 to 11,300 mt in 1990 and 1,400 mt in 1994. The tilapias *Oreochromis* spp. farmed in Lake Taal and stocked in Lake Naujan now make up the majority of the lakes' fish production. In Lakes Buhi and Bato, the endemic sinarapa *Mistichthys luzonensis* almost disappeared due to fine-net fishing and tilapia stocking; catches have been 50-90 mt in 1983-93 but zero in 1994.

Keywords: culture effects; man-induced effects; lakes; rivers; fishery resources; introduced species; endemic species; species extinction; overfishing; nature conservation; resource conservation; fish culture; ecosystem disturbance; *Therapon plumbeus*; *Leiopotherapon plumbeus*; *Chanos chanos*; *Oreochromis*; *Glossogobius giurus*; *Hypseleotris agilis*; *Gastropoda*; *Cyprinidae*; *Decapoda*; *Arius manilensis*; *Mistichthys luzonensis*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:dorisb@aqd.seafdec.org.ph]

670 Bagarinao, T.U. 1999. Ecology and Farming of milkfish-Manual. SEAFDEC-Aquaculture Department, Tigbauan, Iloilo City, Philippines.

This book is 171-page, reader friendly illustrated account of the life history of milkfish (*Chanos chanos*) in nature and in aquaculture. It describes the different farming systems and status of the milkfish industry, and recommends means to ensure sustainability.

Keywords: ecology; milkfish farming; milkfish
Location: SEAFDEC Aquaculture Department Library

671 Bajet, C.M., L.M. Varca and M. Ponavarro. 1999. Organochlorine residues in sediments from selected tributaries to Manila Bay, Philippines, p. 614-615. In: Symposium on Marine Pollution, 5-9 October 1998, Monaco.

Manila Bay, one of the Philippines' traditional fishing grounds, is located in the northwest-coast with an area of approximately 1,352 square kilometer and a coastline of 190 kilometer. Aquaculture activities in the Bay include the production of milkfish, tilapia, prawns, oyster and mussel. However tributaries to the Bay bring domestic sewage, solid wastes and agricultural and other chemicals from inland and aquaculture activities. Sediment borne pesticides are the major route of transport of pesticides in the marine environment and benthic dwellers, filter feeders and the flora/fauna closely associated with the sediments could greatly be affected. This paper focuses on the monitoring of organochlorine pesticides in sediment collected from the mouth of rivers draining to Manila Bay and relate to the contribution of inland activities to the overall pollution of the Bay.

Keywords: monitoring; pesticides; feeding; pollution; sampling; solid impurities; DDT; ISEW, Philippines, Manila Bay
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Pesticide Toxicology and Chemistry Laboratory, National Crop Protection Center, Laguna 4031 Philippines

672 Basu, N.C. and B.B. Pakrasi. 1976. On the occurrence of milkfish, *Chanos chanos* (Forsskal) larvae in the Bakkhali region of lower Sunderbans. Journal of Inland Fisheries Society of India 8:97-104.

The occurrence of *C. chanos* larvae on the eastern bank of the Hooghly estuary was recorded for the first time in 1974. The area of distribution has been delimited. The season of abundance has been specified with special reference to tidal range, lunar periodicity, date-wise variation, diurnal variation and locational variation. The intensity of larval catch has been correlated with the variation of salinity, temperature, clarity and velocity of water.

Keywords: new records; fish larvae; ecological distribution; ichthyoplankton; *Chanos chanos*; ISW, India, Hooghly Estuary
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Central Inl. Fish. Res. Substn., Calcutta-70, India

673 Bhaskar, B.R. and K.S. Rao. 1989. Influence of environmental variables on haematology, and compendium of normal haematological ranges of milkfish, *Chanos chanos* (Forsskal), in brackishwater culture. Aquaculture 83(1-2):123-136.

The influence of temperature, salinity, dissolved oxygen, and pH of water on 19 blood characteristics grouped under erythrocyte parameters, erythrocyte indices, leucocyte parameters, and plasma constituents of juvenile milkfish, *Chanos chanos*, from 3 different brackishwater fish farms, was evaluated in terms of total (TC) and partial correlation coefficients. There were no significant differences between fish grown under different farm conditions with regard to most blood values. The TCs were significant in relationships of salinity of water with total plasma proteins (negative), plasma sodium (positive), and potassium (positive). Under normal haematological ranges the distributions of most of the blood characteristics were not Gaussian. Two nonparametric methods, namely tolerance interval and percentile estimation, were used to estimate the normal ranges.

Keywords: brackishwater aquaculture; haematology; temperature effects; salinity effects; pH effects; dissolved oxygen; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Zool., Andhra Univ., Waltair, Visakhapatnam 530 003, India

674 Buri, P. 1980. Ecology on the feeding of milkfish fry and juveniles, *Chanos chanos* (Forsskal) in the Philippines. Memoirs of the Faculty of Fisheries, Kagoshima University (1): 25-42.

An extensive ecological survey was conducted in the Philippines to study the feeding of milkfish, *Chanos chanos* Forsskal. Types of environments examined included coral reefs, lagoons, mangroves and nipa swamps as well as estuarine systems. It was concluded that organic detritus was the basic nutrient for juvenile milkfish and that depositional environments constitute important nursery and feeding grounds for this species. The main pathway of energy flow in these coastal ecosystems is through the detritus rather than the grazing pathway. The feeding of milkfish was described in terms of habitat structures, stomach contents, feeding chronology and feeding behaviour. The result suggests that a better understanding of the function of the ecosystem will help improve present aquaculture practices as well as guidelines for resource management.

Keywords: feeding; ecology; milkfish fry; juveniles; Philippines; *Chanos chanos*
Location: SEAFDEC Aquaculture Department Library

675 Chen, C.M., S.Z. Lee and J.S. Wang. 2000. Metal contents of fish from culture ponds near scrap metal reclamation facilities. Chemosphere 40(1):65-69.

Milkfish (*Chanos chanos*) from four fish-culture ponds adjacent to different metal recovery facilities along the Er-Jen River area, Tainan, Taiwan, were sampled to determine their metal contents. Chemical analysis showed that fish tissue contained different concentrations of Cu: 0.71 similar to 6.37 mu g/g, Pb: ND (not detectable) similar to 41.04 mu g/g, Cd: ND similar to 0.41 mu g/g, Al: 6.75 similar to 64.11 mu g/g, Ni: 0.062 similar to 0.504 mu g/g and Zn: 16.11 similar to 41.86 mu g/g. The average concentrations of Cu, Al, Zn, Cd and Pb in fish samples from some of the ponds were significantly higher than those from the reference pond. In addition, there were variations in metal concentrations of fish collected from different ponds. Pond D had the highest mean values of Cu, Cd and Zn, and Pond B of Al and Pb. Further investigations are needed to determine the source of metal contamination in the fish.

Keywords: fish ponds; freshwater pollution; copper; aluminum; zinc; cadmium; lead; wastewater aquaculture; heavy metals; fish culture; bioaccumulation; pollution effects; Taiwan; aquaculture; wastewater; fish; *Chanos chanos*; fish (Unclassified); fishponds
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Department of Environmental Engineering and Health, Chia-Nan College of Pharmacy and Science, 60 Sec. 1, Er-Jen Rd., Jen-Der, Tainan, Taiwan, ROC

676 Chen, C.M., T.H. Ueng, H.W. Wang, S.Z. Lee and Wang J.S. 1998. Microsomal monooxygenase activity in milkfish (*Chanos chanos*) from aquaculture ponds near metal reclamation facilities. Bulletin of Environmental Contamination and Toxicology 61(3):378-383.

The Er-Jen River is one of the most heavily polluted rivers in Taiwan. Riverside industries include paper, sugar, electroplating and coating plants, with the metal reclamation business being concentrated in the downstream area, called Wan-Li. Untreated process effluents and wastes dumped into the river resulted in the famous "Green Oyster" event which was due to copper accumulation in the oyster tissue. Other environmental contaminants, such as PCDDs (polychlorinated dibenzo-p-dioxins)/PCDFs (polychlorinated dibenzofurans), PCBs and PAHs (polyaromatic hydrocarbons) were also detected in biological, soil, and sediment samples collected from the area (Lu et al. 1994a, 1994b, Hong et al. 1990, Pan et al. 1990).

Keywords: pollution; industrial effluents; heavy metals; polychlorinated dibenzo(p)dioxins; polychlorinated dibenzofurans; aquaculture; polycyclic aromatic hydrocarbons; microsomes; unspecific monooxygenase; monooxygenase; process plants; fish ponds; bioaccumulation; enzymatic activity; fish culture; Taiwan, Er-Jen R.; stream pollution; effluents; copper; oysters; pollutant identification; metals; downstream; organic compounds; hydrocarbons; rivers; freshwater pollution; wastewater discharges; waste disposal; biochemistry; pollution effects; contamination; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

Author Affiliation: Department of Environmental Engineering and Health, Chia-Nan College of Pharmacy and Science, 60 Sec. 1, Er-Jen Road, Jen-Der, Tainan, Taiwan, People's Republic of China

677 Delmendo, M.N. 1974. Plankton of Laguna de Bay, the primary basis of milkfish farming in enclosures in the area. Philippine Agriculturist 57:335-342.

The plankton composition of Laguna de Bay is enumerated. Because of the bulk of phytoplankton not fully utilized by the existing fish species in the lake, a pilot project on milkfish farming in pens was established. Stomach contents of milkfish stocked in pens were analysed to determine if they feed on the available phytoplankton. Benefits of the project are also mentioned.

Keywords: milkfish farming; Laguna de Bay; milkfish
Location: SEAFDEC Aquaculture Department Library

678 Duffy, J.M. and H.J. Bernard. 1985. Milkfish, *Chanos chanos* (Forsskal, 1775), taken in southern California adds new family (*Chanidae*) to the California marine fauna. California Fish and Game 71(2):122-125.

Six milkfish, *Chanos chanos*, taken in 1982 and 1983 establish the presence of the family *Chanidae* in California. On 22 March 1982 fisherman Luigi San Filippo caught an unusual fish while gill netting for striped mullet, *Mugil cephalus*, with a 31/2-inch mesh net, in the warm water discharge plume of a south San Diego Bay power plant (lat 32 degree 36' 30" N, long 117 degree 06' 30" W). One of us (JMD) was contacted and identified the fish as a 925 mm total length (TL), 680 mm standard length (SL), 5.6 kg, milkfish (Figure 1). The specimen is deposited at Scripps Institution of Oceanography. Division of Marine Vertebrates (SIO 82-22).

Keywords: distribution records; new records; *Chanos chanos*; *Chanidae*; INE, USA, California, San Diego Bay
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: California Dep. Fish and Game, 1350 Front St., Marine Res. Reg., San Diego, CA 92101, USA

679 Duursma, E.K. 1976. Indonesia-Role of pollution and pesticides in brackish water aquaculture in Indonesia-A report prepared for the Project on Shrimp and Milkfish Culture Applied Research and Training.

As a part of the development of aquaculture in Indonesia, the author was assigned to study the effect and extent of pollution, particularly pesticides on shrimp and milkfish culture, and to recommend suitable measures for controlling adverse effects if any. The study included observations on the effect of pesticides on fish and shrimp in brackishwater environments; studies on the effects of pesticides on shrimp and milkfish at various stages in their life; testing and monitoring of pesticides in natural environments, and formulation of control measures. Ancillary to this work was the preparation and installation of analytical equipment, study of the methodologies involved with the aim of their simplification, training of local scientists, bioassays on the toxicity and the residue concs of pesticides of interest of application in fish culture, and analysis of pesticide residues in environmental samples of interest for tambak cultures (brackishwater fish and shrimp culture). Descriptions of the work undertaken are given, with supporting data presented in annexes. A number of recommendations are detailed, dealing both with the studies conducted and other relevant work.

Keywords: Brackishwater aquaculture; fish culture; shellfish culture; pesticides; *Chanos chanos*; *Tilapia mossambica*; *Penaeus merguiensis*; *Metapenaeus monoceros*; Indonesia
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Food and Agriculture Organization of the United Nations, Rome (Italy)

680 Fast, A.W. and P. Menasveta. 2003. Mangrove forest recovery in Thailand. World Aquaculture 34(3:6-9).

Mangrove conversions or destruction has occurred over many centuries in many countries. In Indonesia, large-scale mangrove conversions for extensive milkfish ponds, called tambaks, began in the 15 super(th) century. Greatly increased mangrove destruction occurred during the past century in many tropical marine countries, although accurate estimates of these losses are lacking. Most losses relate to human population increases and pressures on limited resources; perhaps not unlike deforestation, wetland filling and draining, and other habitat losses in North America following increased immigration and settlement beginning in the 17th century. Several categories of human activities cause mangrove losses (Macintosh 1996): Conversions of mangroves to other uses including agriculture such as rice and coconuts, aquaculture ponds for fish and shrimp, salt evaporation ponds, industrial and urban sites, and landfills. Over-exploitation of mangroves for lumber, fuel wood and charcoal by local communities. Insufficient mangrove recovery or replanting following clear-cutting for wood products. Watershed influences such as chemical pollution by industry and agriculture, and freshwater diversions either into or away from mangroves. Many of these conversions or losses are reversible through appropriate restoration. Losses due to industrial or community development, freshwater diversions and salt production are not easily reversed, inasmuch as they typically cause significant changes in land elevation and/or soil properties. De-watering, compaction and oxidation of organically rich, acid sulfate mangrove soils create unsuitable conditions for mangrove survival. Most recently, resource managers, politicians, business people and the general public became more aware of overall mangrove values. This awareness has resulted in legislation and enforcement for mangrove protection. Emphasis is now on mangrove preservation and sustainable uses rather than on mangrove conversion. Mangrove destruction still occurs, but mangrove loss rates are much less, and in some cases have even reversed. Thailand's experience is an example of such a reversal.

Keywords: man-induced effects; pollution effects; agriculture; industrial wastes; salts; waste disposal sites; overexploitation; restoration; culture effects; transplantation; mangrove swamps; environmental protection; environment management; resource conservation; ISEW, Thailand
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

681 Gopalakrishnan, V. 1977. Atoll aquaculture- culture of milkfish, *Chanos chanos* (Forsskal), in the Gilbert Islands for production of live baitfish and as a means of increasing the supply of protein-rich food. SPC, Noumea, New Caledonia, 13 p.

The first series of culture of milkfish (*Chanos chanos*) on a fish farm in Tarawa (Kiribati) are described. The typical environmental conditions and the harsh climatic and soil conditions have been factors against the development of large-scale aquaculture in atolls. But the abundance of fish seed in the lagoons and availability of intertidal flats and mangroves suitable for the construction of farms/ponds prompted the initiation of the feasibility programme. The paper describes the trials, results and practical outcomes of the fish farms. (DBO)

Keywords: fish culture; hatcheries; brood stocks; tidal flats; mangrove swamps; aquaculture economics; bait culture; *Chanos chanos*; ISEW, Pacific, Kiribati
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

682 Holmer, M. 2002. Impacts of milkfish (*Chanos chanos*) aquaculture on carbon and nutrient fluxes in the Bolinao area, Philippines. Marine Pollution Bulletin 44(7):685-696.

Sediment oxygen consumption, TCO_2 production and nutrient fluxes across the sediment–water interface were measured in sediments within and along a transect from four fish pens with production of milkfish (*Chanos chanos*) in the Bolinao area, The Philippines. The four fish pens were each representing a specific period in the production cycling. There was a positive linear relationship between the rates of sedimentation inside the fish pens and the sediment oxygen consumption indicating that the benthic processes were controlled by the input of organic matter

from fish production. The nutrient fluxes were generally higher inside the fish pens, and nitrate was taken up (1.7–5.8 mmol m^{-2} d^{-1}) whereas ammonium (1–22 mmol m^{-2} d^{-1}) and phosphate (0.2–4.7 mmol m^{-2} d^{-1}) were released from the sediments. The sediments were enriched in organic matter with up to a factor 4 compared to outside. A mass balance for one crop of milkfish was constructed based on production data and on measured fluxes of nutrients in the fish pens to assess the loss of carbon and nutrients to the environment. There was a loss to the surroundings of carbon and nitrogen of 51–68% of the total input, whereas phosphorus was buried in the sediments inside the fish pens which acted as net sinks of phosphorus. The results obtained suggest that fish pen culture as practiced in the Bolinao area, leads to even greater impacts on benthic carbon and nutrient cycling than those found in suspended cage cultures.

Keywords: fish farming; milkfish; sediment; carbon and nutrient cycling; mass balances
Location: http://www.sciencedirect.com
Author Affiliation: Institute of Biology, University of Southern Denmark, Campusvej 55, DK-5230, Odense M, Denmark

683 Holmer, M., C.M. Duarte, A. Heilskov, B. Olesen and J. Terrados. 2003. Biogeochemical conditions in sediments enriched by organic matter from net-pen fish farms in the Bolinao area, Philippines. Marine Pollution Bulletin 46(11):1470-1479.

Sedimentation and sediment metabolism was measured at eight active milkfish fish pens and at one abandoned site in the Bolinao area, Philippines in order to examine the interactions between sediment and water in this shallow coastal zone. The rates of sedimentation were high in the area due to siltation, but the activities in the fish pens also contributed to enhanced sedimentation as indicated by the difference between the abandoned and active sites. The sediment metabolism appeared to decrease with increasing rates of sedimentation indicating that the microbial activity reached a saturation level in the fish pen sediments. Anaerobic processes dominated the organic matter decomposition, and sulfate reduction rates are among the highest measured in fish farm sediments. The rates decreased with increasing organic loading despite high concentrations of sulfate (>10 mM) at all sites. Presence of methane bubbles in the sediments suggests that sulfate reduction and methanogenesis were coexisting. The sediment metabolism was significantly reduced at the abandoned site indicating that the stimulation of microbial activities is due to active fish production. The anaerobic activity remained high at the abandoned site indicating that the sediment biogeochemical conditions remain affected long time after fish production has ceased.

Keywords: fish culture; cage culture; culture effects; aquaculture effluents; pollution effects; particulate flux; sedimentation; biogeochemistry; sediment chemistry; biogeochemical cycle; microorganisms; decomposers; anaerobic respiration; metabolism; biodegradation; organic matter; anoxic sediments; sediment-water exchanges; pollutant persistence; coastal zone; air pollution effects; Philippines, Bolinao; water pollution effects; fish farming; environmental effects; coastal waters; marine sediments; data collections; pollution (Water); fish farming (see also Aquaculture); environmental issues; marine deposits; ISEW, Philippines, Luzon I., Pangasinan, Bolinao
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Biology, University of Southern Denmark, Campusvej 55, DK-5230, Odense M, Denmark, [mailto:holmer@biology.sdu.dk]

684 Kumagai, S. 1985. The ecological aspects of milkfish fry occurrence, particularly in the Philippines, p. 53-68. In: J.V. Juario, R.P. Ferraris and L.V. Benitez (eds.). Advances in milkfish biology and culture: Proceedings of the Second International Milkfish Aquaculture Conference, Iloilo City, Philippines, 4-8 October 1983. Island Pub. House, SEAFDEC/AQD and International Development Research Centre, Metro Manila, Philippines.

Aspects of the time, place, and mechanism of occurrence of milkfish (*Chanos chanos*) fry, defined as the postlarvae 10-17 mm in total length and 3 weeks of age are considered. Fry occurrence shows seasonal patterns that differ by latitude. In the Philippines (15-21 degree N), fry appear earlier in the south (December-January) and later in the north (March-April); they disappear earlier in the north

(July-August) than in the south (December-January). Greater numbers of fry occur in shore waters during the full moon and new moon periods, largely as a consequence of the greater spawning activity during the quarter moon periods. Fry catch by various active and passive filtering gear is greater at floods and high tide than at low and ebb tide. Milkfish fry occur in and are collected mostly from sandy beaches, particularly the surf zone and in and around river mouths. They appear to be distributed mostly near the surface, with greater numbers nearer shore. It appears that larvae smaller than 9-10 mm are distributed in midwaters, but once they reach this size they come up and are carried inshore by tidal and wind-driven currents.

Keywords: fry; latitudinal variations; moon phases; distribution records; geographical distribution; seasonal variations; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Kagawa Saibai Cent., Yashima, Kagawa, Japan

685 Kumagai, S. and T.U. Bagarinao. 1981. Studies on the habitat and food of juvenile milkfish in the wild. Fisheries Research Journal of the Philippines 6(1):1-10.

Juvenile milkfish (*Chanos chanos*) were collected from several different wild environments in Panay Island and neighboring islands. The fish were measured and the food ingested examined. Conditions of milkfish habitats were also described. It was found that the fish can live and grow in almost any kind of coastal wetlands of calm and rich sediments, such as coralline lagoon, mangrove lagoon, estuary, and bay. In the waters where plant materials were rich at the bottom, the fish fed on them and their intestines were significantly long, while in other waters where less plant materials were available at the bottom, the fish fed but with considerable amount of animal elements and possessed shorter intestines. These differences are considered as adaptations of the fish to different habitats.

Keywords: habitat; stomach content; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC, Aquaculture Dep., P.O. Box 256, Iloilo, Philippines

686 Kutty, M.N. 2001. Evolution of eco-friendly coastal aquaculture/mariculture technologies. Perspectives in Mariculture. 34 p.

Global aquaculture production from marine waters, which accounts for 54% of total production, increased from 6.86 million metric tonnes in 1987 to 18.51 million mt in 1996, registering an increase of 270% over the decade. India's marine/coastal aquaculture production is almost restricted to shrimps, as the production of marine finfishes, molluscs and seaweeds are negligible. An index of Biodiversity Utilization for Aquaculture (BUA) calculated for India is quite low (0.13) when compared to the highest (0.51) for Taiwan and Korea (RoK). India's coastal aquaculture technologies for marine organisms, such as shrimps, crabs, lobsters, mussels, edible oyster, pearl oyster, sea bass, mullet and milkfish, *Gracilaria* and holothurians are yet to spread out. Serious efforts are needed to develop more applicable eco-friendly technologies and improved extension system to propagate them, and perhaps also through transfer of technologies from our Asian neighbours, who have proven expertise in specific areas. More recent researches have shown that improved management practices can ensure pollution-free and disease-free culture systems.

Keywords: marine aquaculture; aquaculture enterprises; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Prasadam Puthur, Palakkad 678 001, Kerala India

687 Lebata, M.J.H.L. 2001. Oxygen, sulphide and nutrient uptake of the mangrove mud clam *Anodontia edentula* (Family: *Lucinidae*). Marine Pollution Bulletin 42(11):1133-1138.

Oxygen, sulphide and nutrient (ammonia, nitrite and phosphate) uptake of Anodontia edentula was measured. Oxygen and sulphide were measured from sealed containers provided with 1 l fresh mangrove mud (sulphide source) and seawater (oxygen source) with two treatments (with and

without clam) at 16 replicates each. Oxygen, sulphide and other parameters were measured at days 1 (initial), 3 and 5 (final). Nutrients were measured from containers filled with 1.5 l wastewater from a milkfish broodstock tank with two treatments (with and without clam) at eight replicates each. Ammonia, NO sub(2) and PO sub(4) were measured at days 0 (initial) 3, 6, 9 and 12 (final). Results showed significantly decreasing oxygen and sulphide concentrations in treatment with clams (ANOVA, $p < 0.001$). A significantly higher ammonia concentration (ANOVA, $p < 0.05$) was observed in treatment with clams while no significant difference was observed in nitrite and phosphate between the two treatments. A decreasing ammonia and an increasing nitrite trend was also observed in both treatments starting at day 3.

Keywords: dissolved oxygen; sulphides; nitrites; phosphates; nutrients (mineral); ammonia; aquaculture effluents; wastewater treatment; fish culture; mangrove swamps; nutrient uptake; nitrate; Sulfide; oxygen; phosphate; sulfides; nutrients; seawater; bioaccumulation; marine organisms; path of pollutants; marine animals; clams; oxygen uptake; accumulation; experimental data; mangrove ecology; nutrients in marshlands; nitrogen compounds in seawater effects; ammonia in seawater; *Chanos chanos*; *Anodontia edentula*; *Lucinidae*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: SEAFDEC Aquaculture Department Tigbauan, 5021 Iloilo, Philippines [mailto:jlebata@aqd.seafdec.org.ph]

688 Leis, J.M. and S.E. Reader. 1991. Distributional ecology of milkfish, *Chanos chanos*, larvae in the Great Barrier Reef and Coral Sea near Lizard Island, Australia. Environmental Biology of Fishes 30(4): 395-405.

Plankton hauls captured 682 milkfish larvae (2.1-12.3 mm) in the Great Barrier Reef Lagoon and Coral Sea during 1979-1986. Larvae were present from November to March, and absent in April, July and October. We analyzed concentration, abundance and size-frequency data and concluded that spawning took place in the Coral Sea or at the outer edge of the continental shelf, apparently following an adult spawning migration of at least 50 km. Larvae then moved inshore to at least our most inshore routine sampling site near midshelf. Some larvae may have remained for a period in the lee of reefs along the shelf edge. Larvae apparently occupied the upper few metres of the water column, thereby becoming susceptible to shoreward movement in the wind-driven surface layer. Movement from spawning sites to midshelf probably required active maintenance of vertical position by larvae which enabled passive movement with favourable currents, and perhaps horizontal swimming. By the time larvae reach midshelf, continued inshore movement by horizontal swimming alone is possible.

Keywords: ichthyoplankton; migrations; spawning grounds; geographical distribution; *Chanos chanos*; ISEW, Coral Sea
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Div. Vertebr. Zool., Aust. Mus., POB A285, Sydney South, N.S.W. 2000, Australia

689 Lu, J.R., H. Miyata, C.W. Huang, H.T. Tsai, V.Z. Sheng, T. Nakao, Y. Mase, O. Aozasa and S. Ohta. 1995. Contamination levels of PCDDs, PCDFs and non-ortho chlorine substituted coplanar PCBs in milkfish and crab from culture pond and coastal area near open-air incineration sites for metal reclamation in Wan-Li, Taiwan, Republic of China. Chemosphere 31(3):2959-2970.

Samples of culture freshwater milkfish (*Chanos chanos*) from five ponds surrounding open-air waste incineration sites and from five markets in southern Taiwan were analyzed for PCDDs, PCDFs and coplanar PCBs (Co-PCBs). The total TEQ concentration of three chemicals in fish meat was in a wide range of 0.195 to 153 pg/g wet weight. In addition, the bioconcentration factors from sediment to fish meat and crab hepatopancreas biota were arranged in order of Co-PCBs >> PCDFs > PCDDs and Co-PCBs > PCDFs > PCDDs, respectively.

Keywords: PCDD; PCDF; PCB compounds; aquaculture; waste disposal sites; incineration; freshwater fish; *Crustacea*; coastal zone; water pollution; coastal waters; waste disposal; sediments; pollution effects; bioaccumulation; sediment pollution; polychlorinated biphenyls; crustaceans; cultured organisms; fish culture; crab culture; PCB; *Chanos chanos*; *Decapoda*; *Crustacea*; Taiwan, Wan-Li; ISEW
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Setsunan Univ., 45-1, Nagaotoge-cho, Hirakata, Osaka 573-01, Japan

690 Mmochi, A.J. and A.W. Mwandya. 2003. Water quality in the integrated mariculture pond systems (IMPS) at Makoba Bay, Zanzibar, Tanzania.Western Indian Ocean Journal of Marine Science 2(1):15-23.

The Makoba integrated mariculture pond system project (IMPS) has been on-going since 1998. Except for a period from mid 1999 to 2001, various water quality parameters, namely temperature, salinity, pH, dissolved inorganic nutrients and dissolved oxygen concentration and saturation, have been monitored continuously. In 2002, measurement of sediment oxygen demand (SOD) and consumption of oxygen by sediments was initiated. Dissolved oxygen concentration varied from the highest monthly average of 7.16 mg/l in October 1998, to 2.2 mg/l in March 2000 (r = -0.69). Nutrient concentrations remained more-or-less constant, except in the finfish ponds, where slight variations were recorded. The lowest concentration of ammonium-nitrogen (3.02 mu g-at N/l) was recorded in the Kiwani creek in December 2001, and the highest (18.02 mu g-at N/l), in the finfish ponds in December 1998. In 2002, the concentrations became much lower and the overall regression from 1998 to 2002 was negative. Dissolved inorganic phosphate concentration in the finfish ponds increased from 4.36 to 7.97 mu g-at P/l (r = 0.75) between August 1998 and April 1999. In 2002, however, the concentration was low, making the overall trend also negative. PH ranged from 7.07 in Kiwani creek to 8.54 in the outlet. There was no clear pattern in the pH trends at the individual stations. In 1998 and 1999, there was a general decrease in pH with a corresponding increase in nutrient concentrations and decrease in dissolved oxygen. The SOD values in the ponds and the outlet were higher than in the creek and the reservoir, and the half life of dissolved oxygen was lowest in the ponds compared to the rest of the sites. The nutrient concentrations at Makoba ponds are generally acceptable for the environment and fish farming.

Keywords: water quality; nutrients (mineral); dissolved oxygen; pH; biological half life; marine aquaculture; oxygen demand; *Chanos chanos*; ISW, Tanzania, Zanzibar, Unguja I., Makoba Bay
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Marine Sciences, University of Dar es Salaam, P.O. Box 668, Zanzibar Tanzania, [mailto:mmochi@zims.udsm.ac.tz]

691 Mmochi, A.J., A.M. Dubi, F.A. Mamboya and A.W. Mwandya. 2002. Effects of fish culture on water quality of an integrated mariculture pond system. Western Indian Ocean Journal of Marine Science 1(1):53-63.

Six mariculture ponds were flooded with seawater since 1996. During this time the ponds were stocked with finfish (milkfish and rabbitfish), which were fed on locally produced fish feed. Some water quality parameters such as temperature, salinity and oxygen saturation were measured twice a day for three years (1998-2000), while nutrient concentrations were measured weekly for one year. Both nutrient concentration and oxygen saturation levels have shown a trend indicating eutrophication. Oxygen concentration changed from an average of 7.16 mg/l in October 1998 to 2.2 mg/l in March 2000 with a negative linear regression of 0.69 during the morning hours. From August 1998 to April 1999, dissolved inorganic ammonia concentration increased by 9 mu g-at N/l, from 8.91 to 18.02 with a positive linear regression of 0.79. During this period, soluble reactive phosphorus increased by 3.55 mu g-at P/l from 4.36 to 7.91 with a positive linear regression of 0.75. In this paper, the rate of eutrophication and the limit at which the ponds have to be dried /limed before restocking are discussed.

Keywords: marine aquaculture; water quality; nutrients (mineral); eutrophication; dissolved oxygen; fish culture; seaweed culture; shellfish culture; marine pollution; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Institute of Marine Sciences, University of Dar es Salaam P.O.Box 668, Zanzibar Tanzania

692 Patnaik, K.C. and P.M. Mishra. 1990. Seasonal variation in the physico-chemical properties of Rushikulya Estuary and its effect on the occurrence of *Chanos* fry. Journal of the Indian Fisheries Association 20:69-71.

Seasonal variation in some physico-chemical properties of Rushikulya Estuary was studied. The surface water temperature varied from 20 to 34.5 degree C, the transparency of the water from 6.3 to 12 cm, the salinity from 28.3 to 32.8 ppt and the pH from 6.77 to 7.35. The transparency and salinity showed bimodal distribution. Occurrences of the *Chanos* fry were correlated to it.

Keywords: nursery grounds; temperature data; salinity data; seasonal variations; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Dep. Mar. Sci., Berhampur Univ., Berhampur 760 007, Orissa, India

693 Pillai, D., S. Jose, M.V. Mohan and A. Joseph. 2003. Effect of salinity on growth and survival of rohu, *Labeo rohita* (Ham.) under laboratory and field conditions. Advances and Priorities in Fishery Technology, Society of Fisheries Technologists (India) 40(2):91-94.

The limits of salinity affecting survival and growth performance of the Indian Major Carp, *Labeo rohita* was studied in laboratory and field conditions. A salinity range of 0 to 14 ppt was used at 2 ppt interval in the present study. Rohu could survive in waters upto 8 ppt salinity. Beyond 8 ppt, the fish showed signs of stress and mortality occurred. There was 100% mortality in 14 ppt salinity within 7-8 days. Although maximum growth was obtained at 0 and 2 ppt, growth was not markedly affected upto 6 ppt salinity. Rohu was cultured along with milkfish in brackish water pond, where salinity ranged from 1.9-8.9 ppt during the culture period of 120 days. As salinity increased above 8 ppt, Rohu showed stress signs and therefore, the culture was discontinued. The present study indicates that there is good potential for culturing these species in low saline areas, that otherwise remain unutilized.

Keywords: growth; survival; salinity tolerance; controlled conditions; *Labeo rohita*; India, Kerala, Ernakulam Dist., Cochin
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: College of Fisheries, Panangad, Kochi-682 506 India

694 Segner, H. and T. Braunbeck. 1988. Qualitative and quantitative assessment of the response of milkfish, *Chanos chanos*, fry to low-level copper exposure, p. 347-368. In: F.O. Perkins and T.C. Cheng (eds.). Pathology in marine science: Proceedings of the Third International Colloquium on Pathology in Marine Aquaculture Held in Gloucester Point, Virginia, October 2-6, 1988. Academic Press, San Diego.

The response of liver histological structure in milkfish, *Chanos chanos*, fry subjected to environmental concentrations of copper, which were without overt effects on organismic performance parameters of the fish, was investigated. The fry were exposed to 20 and 100 mu g/liter of waterborne copper under the regimen of two diets (live food vs. artificial food) over an experimental period of 27 days. Dry weight increase and survival rates of the fry were significantly influenced by the kind of diet, but not by copper exposure. Body copper concentrations were affected by the environmental concentration of copper, by diet, and by ontogenetic changes in body weight. Both exposure to 20 mu g Cu/liter and 100 mu g Cu/liter induced a significant increase in the number and size of hepatic lysosomes. In fry exposed to 100 mu g Cu/liter, an additional significant enlargement of liver glycogen fields could be measured. However, copper contamination did not evoke pathological alterations. Whereas lysosomal proliferation may be interpreted as a

specific detoxification response of the fry to the enhanced copper burdens, the liver glycogen increase may be regarded as a general stress response. The results of the study show that histology is capable of revealing sensitively and selectively even subtle effects of environmentally induced changes in fish. The crucial point is to predict the ecological significance of structural alterations evoked by low-dose exposure to toxins and xenobiotic compounds.

Keywords: copper; toxicity tests; liver; histology; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Zool. II (Physiol.), Univ. Karlsruhe, Kaiserstr. 12, D 7500 Karlsruhe, FRG

695 Silas, E.G., G. Mohanraj, V. Gandhi and A.R. Thirunavukkarasu. 1985. Spawning grounds of the milkfish and seasonal abundance of the fry along the east and southwest coasts of India, p. 916-932. In: Proceeding of the Symposium on Coastal Aquaculture, 12-18 January 1980, Cochin, India.

The fish seed resources surveys conducted along the east and southwest coasts of India have shown the occurrence of fry and fingerlings of *Chanos chanos* in appreciable quantities during different months. An attempt is made to present a quantitative distribution of fry of the milkfish in space and time in the study area. The occurrence of spawners and fry along some stretches of the coast indicate the proximity of spawning grounds of the milkfish and these are delineated. The research programmes on controlled breeding of *Chanos* and its culture aspects underway at the Central Marine Fisheries Research Institute are also discussed.

Keywords: spawning grounds; seed (aquaculture); fish culture; fry; quantitative distribution; abundance; *Chanos chanos*; ISW, India
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Cent. Mar. Fish. Res. Inst., Cochin-682 018, India

696 Tamaru, C.S. 1986. Population structure (milkfish genetics), p. 37-55. In: C.S. Lee, M.S. Gordon and W.O. Watanabe (eds.). Aquaculture of milkfish (*Chanos chanos*): state of the art. The Oceanic Institute, Honolulu, Hawaii.

The need to analyze the genetic diversity and population structure of milkfish (*Chanos chanos*) and any species that is being considered for domestication is discussed. The current method for estimating the degree of genetic diversity and population structure is starch-gel electrophoresis. A study utilizing protein electrophoresis indicates at least 3 and possibly 4 intraspecific groups. One consistent pattern that does emerge is the discreteness of the Philippine Islands from the equatorial Pacific Islands, versus the Hawaiian Islands. Further evidence suggests an additional subdivision within the Hawaiian Islands themselves.

Keywords: fish culture; *Chanos chanos*; ISEW, Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Ocean. Inst., Makapuu Point, Waimanalo, HI 96795, USA

697 Teshima, S., A. Kanazawa and A. Tago. 1981. Sterols and fatty acids of the lab-lab and snail from the milkfish-pond. Memoirs of the Faculty of Fisheries, Kagoshima University 30:317-323.

Lab-lab, a conglomerate of about 50% blue-green algae and plankton such as green algae, *copepods*, rotifers, diatoms and *Euglena sp.,* was collected from fish ponds on tidal flats in the Philippines used for milkfish (*Chanos chanos*), a marine fish feeding on filamentous green algae. Lab-lab adhering to the nets was considered to be live, floating lab-lab to be dead. Live lab-lab had cholesterol 40.5% of total sterols, dead lab-lab had 40.2% and snails from the fish ponds had 54.9%. Live and dead lab-lab had C16:0 36 and 44%, C16:1 14 and 20.5%, C18:2 omega 6 6.1 and 3.6%, C18:3 omega 3 4.5 and 4.5%, C20:3 omega 3 1.8 and 0.3%, C22:6 omega 3 0.3 and 0.5% and saturated fatty acids 49.8

and 51.8% of total fatty acids. The tables show the proportions of 14 sterols in lab-lab and snails and of 26 fatty acids in lab-lab.

Keywords: sterols; fatty acids; plankton; fish ponds; tropics; feeds; animal feeding; fish farms; fish farming; aquaculture
Location: CAB Direct Abstracts
Author Affiliation: Lab. Fisheries Chemistry, Faculty of Fisheries, Univ. Kagoshima, 4-50-20 Shimoarata, Kagoshima 890, Japan

698 Winans, G.A. 1980. Geographic variation in the milkfish *Chanos chanos*. 1. Biochemical evidence. Evolution 34(3):558-574.

Electrophoretic variation was examined at 38 loci in *C. chanos*. Samples were collected from 14 locations across the Pacific Ocean. Average heterozygosity per locus was 0.075 0.011. From 16 to 23% of the loci were polymorphic and the average number of alleles per locus was 1.45 0.08. No latitudinal changes in genic variation were found; instead, levels of genic variation increased slightly with increasing distance from the Philippine region. The Hawaii samples had a noticeable loss of variation at the polymorphic loci. The magnitude of interpopulation divergence was extremely low, even between samples separated by up to 10,000 km. The average genetic distance was 0.002 and the mean FSUB-ST was 0.041. Considerable population divergence at 4 polymorphic loci was seen between the samples taken in Hawaii. Explanations for this relatively abrupt change are discussed. The possibility that gene flow between the samples is reduced due to the presence of local oceanic gyres is emphasized. Patterns of geographic variation in allele frequency were assessed.

Keywords: population genetics; regional variations; *Chanos chanos*; I, Pacific
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Hawaii Inst. Mar. Biol. and Dep. Zool., Univ. Hawaii, Honolulu, HI 96822, USA

699 Yap, W.G. 1998. Who's afraid of El Niño? Aquaculture Asia 3(1):45-49.

An analysis is made of how the current episode of El Niño Southern Oscillation -- causing drought in the Eastern Pacific Rim – is affecting Philippine fisheries. Some species or systems have suffered, such as milkfish in brackish water ponds (due to high salinity); however, this is offset by gains in other systems, such as milkfish in pens (due to less typhoons) or higher tilapia cage production (for the same reasons -- less flooding and destruction of structures). The same negative-positive impacts have been noted among pelagic and demersal fisheries. It may be concluded that the occurrence of El Niño has not negatively affected aquaculture and fisheries. Production declines during the El Niño years were limited to a few species and even the declines were more than offset by production gains in other species, so that, overall, capture fisheries appeared to have been ahead during such episodes.

Keywords: El Niño phenomena; environmental impact; fisheries; fish culture; *Chanos chanos*; Philippines
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)
Author Affiliation: Aquafarming Development Foundation, Inc. Quezon City Philippines, [mailto:fredyap@ibm.net]

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700 Therezien, Y. 1979. Catalogue of references on *Chanos chanos* Forsskal. Bulletin Recherches Agronomiques de Gembloux, France no. 7.

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Keywords: selected bibliographies; *Chanos chanos*
Location: Aquatic Sciences and Fisheries Abstracts (ASFA), Cambridge Scientific Abstracts (CSA)

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K
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P
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Q
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R
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Research Paper Series. Socio -Economic Survey of Aquaculture Industry. Philippines

S
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SPC Fisheries Newsletter
SPORE

T
Taiwan Fisheries Research Institute. Aquaculture and Fisheries Resources Management
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The Oceanic Institute
The Journal of Experimental Biology
The Memoir of Bacteriology and Immunology in Fish Diseases
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U
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V
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W
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Z
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