FACTORS INFLUENCING THE EMIGRATION OF JUVENILE BONGA FROM THE CROSS RIVER ESTUARY

D. AMA-ABASI, E. R. AKPAN & S. HOLZLÖHNER
Institute of Oceanography
University of Calabar
P. M. B. 1115 Calabar
540004 Cross River State
Email: amaabasi2@yahoo.com

ABSTRACT

Studies were conducted to identify and quantify the proximate factors responsible for the emigration of juvenile bonga Ethmalosa fimbriata (Bowdich, 1825) from the Cross River Estuary. A time series of bonga cpue, salinity, turbidity and plankton abundance was undertaken. Juvenile bonga was abundant in the Estuary when salinities ranged between I and 9 ppt. At salinities outside this range, they were absent. We conclude that salinity is the proximate factor that initiates the emigration of juvenile bonga from the Estuary.

INTRODUCTION

The Cross River Estuary is nursery for commercially important fish species, including bonga (Ama-Abasii & Holzlöhner, 2002). Bonga, *Ethmalosa fimbriata* enters into the Estuary from November/December and departs in May during it annual migration. Ama-Abasi (2002) observed that emigration of juvenile bonga from Cross River Estuary in May is a spontaneous event with massive congregations of the fish while in the downstream movement. The proximate factors responsible for this migration and the levels at which the emigration is initiated have not been studied. This work was done to identify and quantify the proximate factors that trigger off the spontaneous emigration of juvenile bonga from Estuary.

STUDY LOCATION

The Cross River Estuary takes its rise from the Cameroon Mountains. It meanders Westwards into Nigeria and then southwards through high rainforest formations before discharging into the Atlantic Ocean at the Gulf of Guinea. Within the lower brackish water reaches of the River, the vegetation changes to mangrove forest.

The climate of the study area has been described previously (Akpan & Offem, 1993). It is characterized by a long wet season from April to October and a dry season from November to March. Mean annual rainfall is about 2000 mm. A short period of drought occurs in the wet season around August/September which is called the August drought. There is usually a cold, dry and dusty period between December and January referred to as the harmattan season. Temperatures generally range from 22^{0}C in the wet to 35^{0}C in the dry season. Relative humidity is generally above 60% at all seasons with close to 90% during the wet season.

The Cross River Estuary is the main shipping route to the Eastern Port of Calabar and the associated Export Processing Zone. Several tributary rivers inundate the Estuary, the most important ones are the Calabar, the Great Kwa and Akpa Yafe. The Estuary and its tributaries represent the largest source of inland fisheries in Nigeria (Enin, 1989) with bonga - *Ethmalosa fimbriata* as one of the most important species of artisanal fishery (Moses, 1979).

The Cross River Estuary (brackish water system) covers a distance of about 80 km from Inua Abasi at the mouth to Itu Bridge Crossing (Fig.1).

METHODOLOGY

The main study location is within the mid Estuary at Parrot Island (Fig.1). Study locations were also selected at UNICEM jetty and Adiabo along the Calabar River to track the seasonal migration of bonga and relevant environmental parameters.

Physicochemical measurements:

Physicochemical parameters measured include water temperature, turbidity, salinity (as conductivity) and dissolved oxygen. Samples were collected from the surface using plastic bucket and sub-sampled into polyethylene bottles for laboratory analysis. Temperature and dissolved oxygen were measured on site electrometrically using SCHOTT instruments model CG867. Conductivity was measured with field conductivity meter model WTW LF90. Turbidity was measured in the laboratory using HACH 3000 direct reading spectrophotometer.

Plankton analysis:

Samples were collected from the surface using 10 plastic bucket and filtered using 30-µm mesh nitex net. The residue was washed with the filtrate into glass vials to which was added Lugol's reagent for preservation.

Stomach/gut contents of bonga were evacuated from fresh stomachs into glass vials to which was added clean tap water and Lugol's reagent for preservation.

Qualitative and quantitative plankton analyses for water and stomach/gut contents were performed using Zeiss Inverted Plankton microscope..

Sub-samples were mixed by gentle swirling and filled into 5 ml plankton chambers to which was added one drop of Lugol's solution, which served as a fixative and also aided sedimentation of organisms. After allowing for complete sedimentation (~ 4 hours) microscopic analysis was performed according to UNESCO (1978) using identification schemes of Edmonton (1958), Prescott (1970) and Sharma (1986).

Fisheries analysis:

Time series of juvenile bonga catch-per-unit effort in the Cross River Estuary easterly of Parrot Island for the months of January-June 2004 were determined by sampling drift gill net catches. Drift net of 100 x 2 m with mesh size of 40 mm was used. This fishing gear can effectively trap juvenile bonga of emigrational size (10-18 cm) total length. The net was set perpendicular to the shore and allowed to drift for 40 minutes after which it was hurled into the boat for sampling. Fish caught were analyzed to determine the species composition. Total weight of bonga samples was measured with spring balance while total length was measured with measuring board. Time series of phytoplankton count and species composition were collected simultaneously with the CPUE.

RESULTS

Fig 2 shows the seasonal distribution of physicochemical parameters at Parrot Island. Temperature and dissolved oxygen did not show any significant seasonal trend. Conductivity increased from 0.02 mS/cm in June to a maximum of 23 mS/cm in April. Turbidity ranged from 7 FTU in January to 120 FTU in March with the maximum coinciding with the period of maximum salinity.

Fig 3 shows the distribution of phytoplankton density during the study at Parrot Island. The main peak of phytoplankton was encountered in January/February followed by a collapse in March/April. A second but much smaller peak occurred in May.

Fig 4 shows the distribution of catch and catch-per-unit effort (CPUE) superimposed on salinity (as conductivity) at Parrot Island during the study. Catch showed negative correlation with salinity and positive correlation with phytoplankton density (Fig. 5 and 6). Juvenile bonga was more abundant in the Cross River Estuary during the emigration occurrence in May. The juvenile was fairly abundant in January/February but dropped markedly in March reaching zero values in April. The second peak in CPUE, which occurred in May, was followed by a marked drop to zero levels in June (Fig. 4).

Table 1 shows the distribution of dominant phytoplankton species during the study. Bacillariophyceae (diatoms) was the most dominant accounting for 60% to 100% of all planktonic organisms in water and stomach/gut of bonga. The most dominant species included *Skeletonema costatum*, *Actinocyclus sp.*, *Aulocadiscus sp.* and *Melosira granulata* (Table 1). The stomach/gut contents of bonga did not show selectivity in food intake. The most abundant plankton species in stomach/gut corresponded closely to the most abundant species in water.

DISCUSSION

The observed distribution of physicochemical parameters at Parrot Island is similar to that of previous studies in the Cross River Estuary (Akpan & Offem, 1993). The marked seasonal variation in salinity is attributed to seasonal changes in salt-water intrusion and freshwater discharge, a direct consequence of rainfall regimes. The corresponding increase in turbidity with salinity (Fig.2) is attributed to strong erosional forces of flood tides during dry season when freshwater discharge secedes (Akpan, 1998). This results in resuspension of sediments and corresponding increase in turbidities.

Seasonal trends of phytoplankton in the Cross River Estuary system have previously been reported (Akpan, 1993). The present trend off Parrot Island is similar to that of previous studies characterized by a large peak in January/February followed by diatom collapse in March/April and a second smaller peak in May. The dominance of diatoms in the plankton of the Cross River in the dry season is in consonance with the earlier report of Akpan, 1993.

Two major factors seem responsible for bonga migration in the Estuary, namely salinity and food (phytoplankton) The first peak in cpue is associated with bonga migration into the Estuary while the second peak is that of migration out of the Estuary (Fig 4). The bonga seems to follow a pocket of salinity of approximately 5.0 ± 4.0 ppt. Young bonga migrates away from salinities outside this range. Phytoplankton seems to be a secondary factor. Its positive correlation with seasonal regimes of CPUE (fig.5) notwithstanding, spatial migration of bonga did not show a strict relationship to phytoplankton density.

ACKNOWLEDGMENT

This work was sponsored by International Foundation for Science, Stockholm, Sweden through a grant provided to Dr Daniel Ama-Abasi (grant no. A/2914-2).

REFERENCES

Akpan, E. R. (1993) Seasonal cycles of Phytoplankton and grazing activity in the Cross River of South Eastern Nigeria Tropical Ecology 34 (2): 143-149.

Akpan, E. R. (1998) Possible environmental impact of channelization and dredging on the ecology of the Cross River Estuary system-Nigeria. Tropical Freshwater Biology 7:53-61.

Ama-Abasi, D. (2002) Aspects of Population biology of the bonga, *Ethmalosa fimbriata* (Bowdich, 125) in the Cross River Estuary, Nigeria. Ph.D. Thesis, University of Calabar, Calabar. 179 pp.

Ama-Abasi, D. & Holzlöhner, S. (2002) Length frequency distribution of *Ethmalosa fimbriata* (Bowdich) in Cross River Estuary and adjacent coastal waters. Global Journal of Pure and Applied Sciences. 8 (3): 299-304.

Akpan, E. R. & Offem, J. O. (1993) Seasonal variation in water quality of the Cross River, Nigeria. Revue de Hydrobiologie Tropicale 26 (2) 95-102.

Enin, U. E. Löwenberg, U. & Künzel, T. (1989) The artisanal inshore shrimp fishery of the Cross River Estuary. Fishbite 7 (3): 6-10.

Edmonton, W. T. (1959) Freshwater biology. 2nd Edition. John Wiley & Sons Inc. New York. 1248 p.

Moses, B. S. (1979) The Cross River, its ecology and fisheries. In Proceedings of the international conference on Kainji Lake and River Basin Developments in Africa. Kainji Lake Research Institute, New Bussa, Nigeria. Pp 355-371.

Prescott, G. W. (1970) How to know freshwater algae. W. M. C. Brown Company Publishers. Iowa, 348 p.

Sharma, O. P. (1986) Textbook of algae. Tata Mcgrawhill Publishing company Ltd. New Delhi. 396. p.

UNESCO (1978) Phytoplankton manual. Unesco, Paris. 337 p.

Table 1: Relative abundance of dominant phytoplankton species in water samples and stomach/gut of bonga from Parrot Island.

Sample date	Water	Stomach/Gut contents
15/1/04	LT (4, 360 cells) Diatom –99.2%, *Skeletonema costatum*-97.3% HT (12, 152 cells/1) Diatom-99%, *Skeletonema costatum*-98.1%	Diatom: 92-97%. *Actinocyclus* sp (32-585), *Skeletonema c.* (25 – 465).
21/1/04	LT (870 cells/1) Diatom –, 100%, *Skeletonema costatum*-99.2% HT (178,872 cells/1) Diatom-99.9%, *Skeletonema costatum*-99.2%	Diatom: 80-100% *Actinocyclus* sp (67.6-98.2%). *Skeletonema c.* (60-81.8%)
13/2/04	HT, (72, 210 cells/l) Diatom – 96.02%, *Actinocyclus* sp. –68.3, *Eucampia viridis*-16.69, *Skeletonema costatum*-13.68%	Diatom: 66.4-96.6%. *Actinocyclus* sp (9.9-65.7%), *Skeletonema c.* (24.7-67.4%), *Gyrosigma* (1 sample-27%)
20/2/04	LT (106, 082 cells/1) Diatom – 99.29%, *Skeletonema costatum* – 99.12%. HT (21,820 cells/1) Diatom – 99.52%, *Skeletonema costatum* – 94.55%	Diatom: 90.5-100% *Skeletonema c.* (34.42-97.7%)
11/3/04	LT (7,419 cells/1) Diatom – 96.9%, *Skeletonema costatum*-86.5% HT (6,168 cells/1) Diatom-99.52%, *Skeletonema costatum* – 69.48%	Diatom: 34.3-99% *Actinocyclus* sp (8.1-58.3%), *Skeletonema c.* (1 sample 84.8%). *Dytillum brightwelli* (2 samples 19-26.3%), *Gyrosigma* sp. (2 samples 23.4-51.42%)
19/3/04	LT (1,826 cells/1) Diatom – 100%, *Skeletonema costatum* – 57.61%. HT (17,169 cells/1) Diatom- 99.82%, *Skeletonema costatum* – 96.56%	Diatom: 96.72%. *Gyrosigma* sp. (87.2-96.7%, dominated by detritus.
13/4/04	LT (1,889 cells/1) Diatom – 93.44%,	

	Skeletonema costatum – 36.82%, *Gyrosigma* sp.- 21% HT (1,520 cells/1) Diatom – 85.72%, *Skeletonema costatum*-56.95%	
19/4/04	LT (7.703 cells/1) Diatom-98.79%, *Skeletonema costatum*-83.33%	
10/5/04	LT (8, 352 cells/1) Diatom – 95.83%, *Skeletonema costatum*-60.87%, *Actinoclyclus* sp.-28.99%.	
19/5/04	LT (16,025 cells/1) Diatom – 97.1%, *Melosira granulata*-79.92%, *Skeletonema costatum* - 7.2%	Diatom: 100% *Melosira granulata* (76.92%), *Cyclotela comta* (28.9%)
17/6/04	LT (185 cells/1) Diatom – 83.33%, *Melosira granulata*-100%	Diatom: 89.7%. Dominated by Melosira granulata. 79.5% dead
LT = low tide, HT = high tide.		

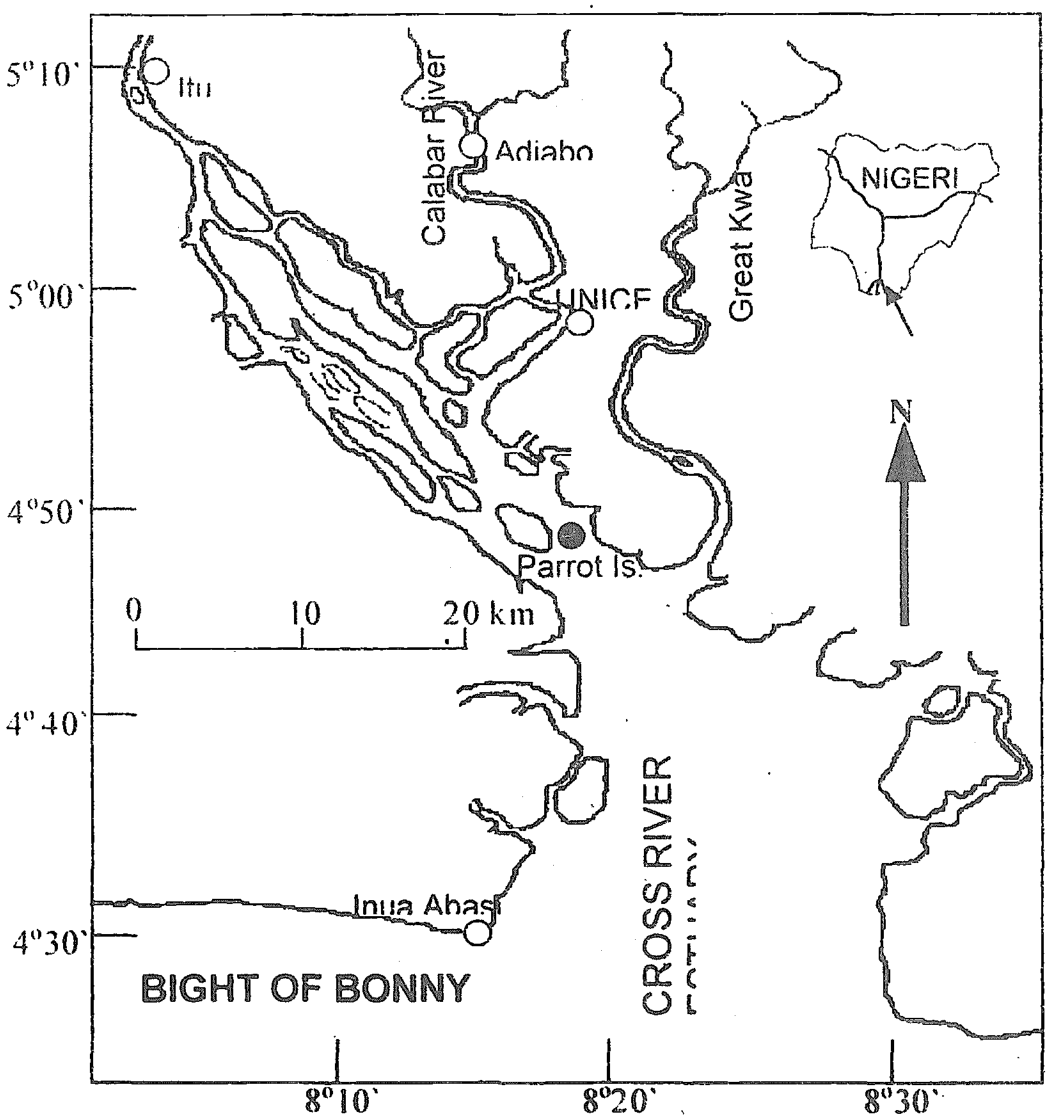

Fig. 1: Map of Cross River Estuary showing study location at Parrot Island

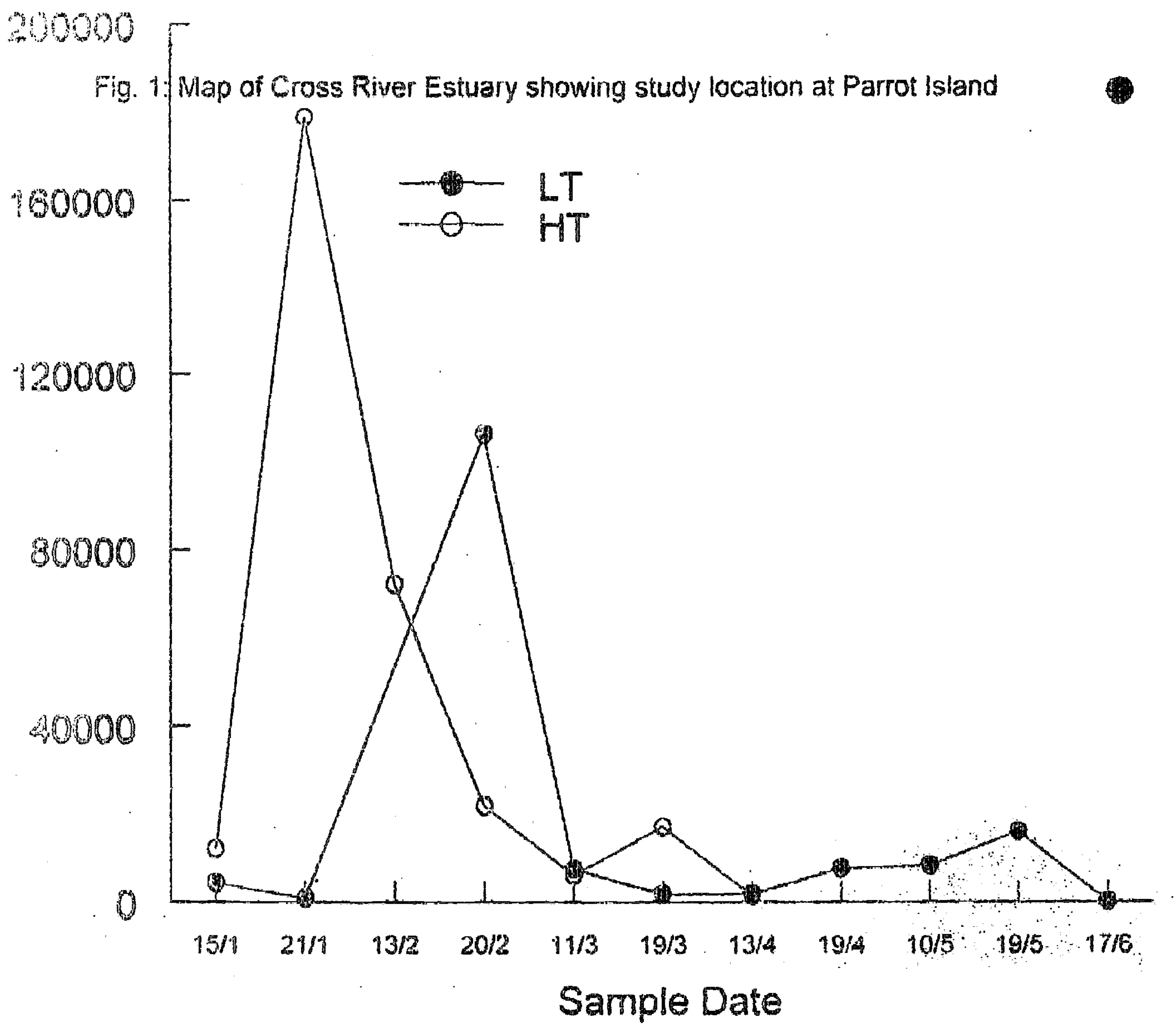

Fig. 2: Seasonal variation in physicochemical properties of Cross River Estuary at Parrot Island

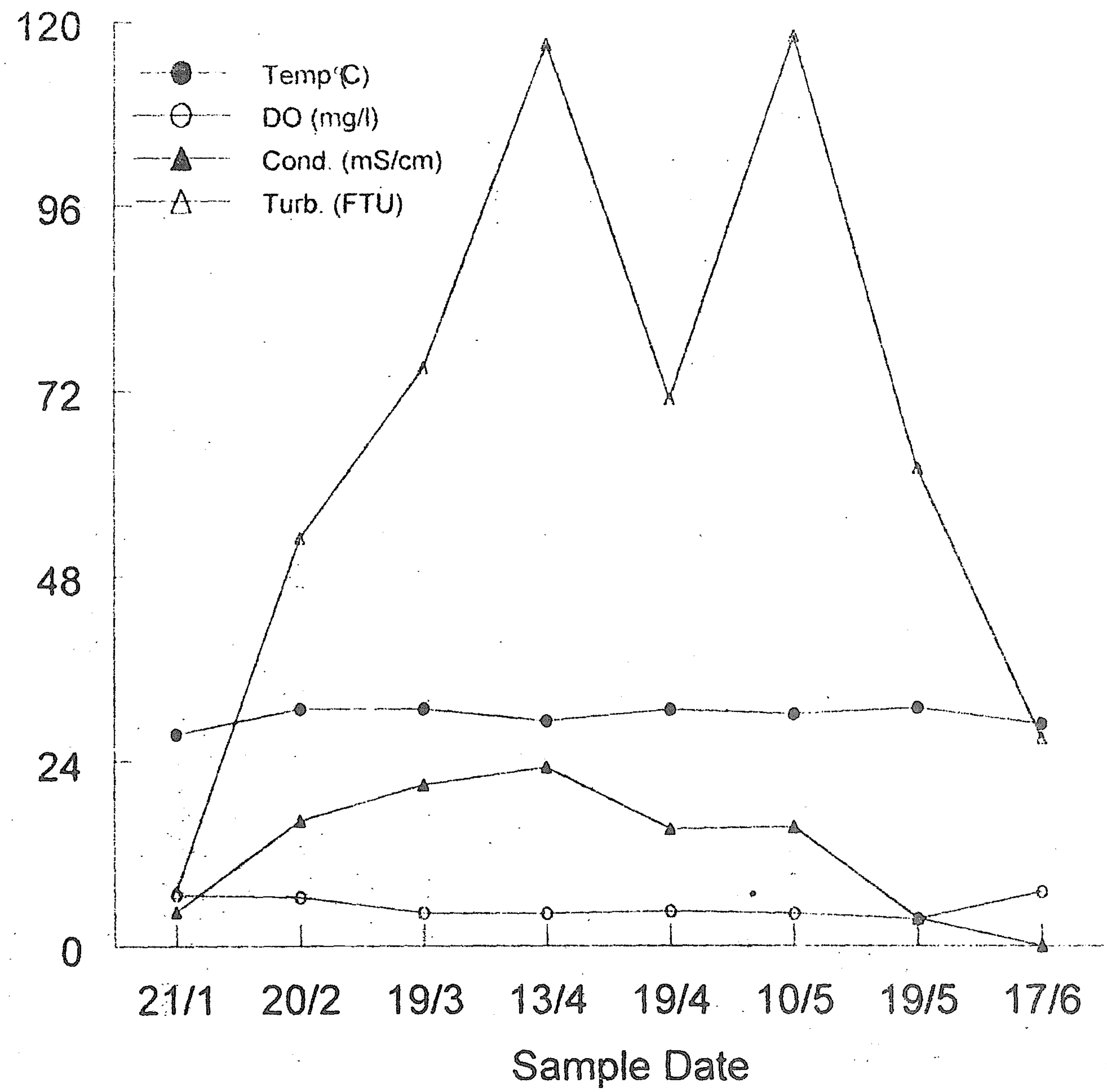

Fig.3: Seasonal variation of phytoplankton in Cross River Estuary at Parrot Island

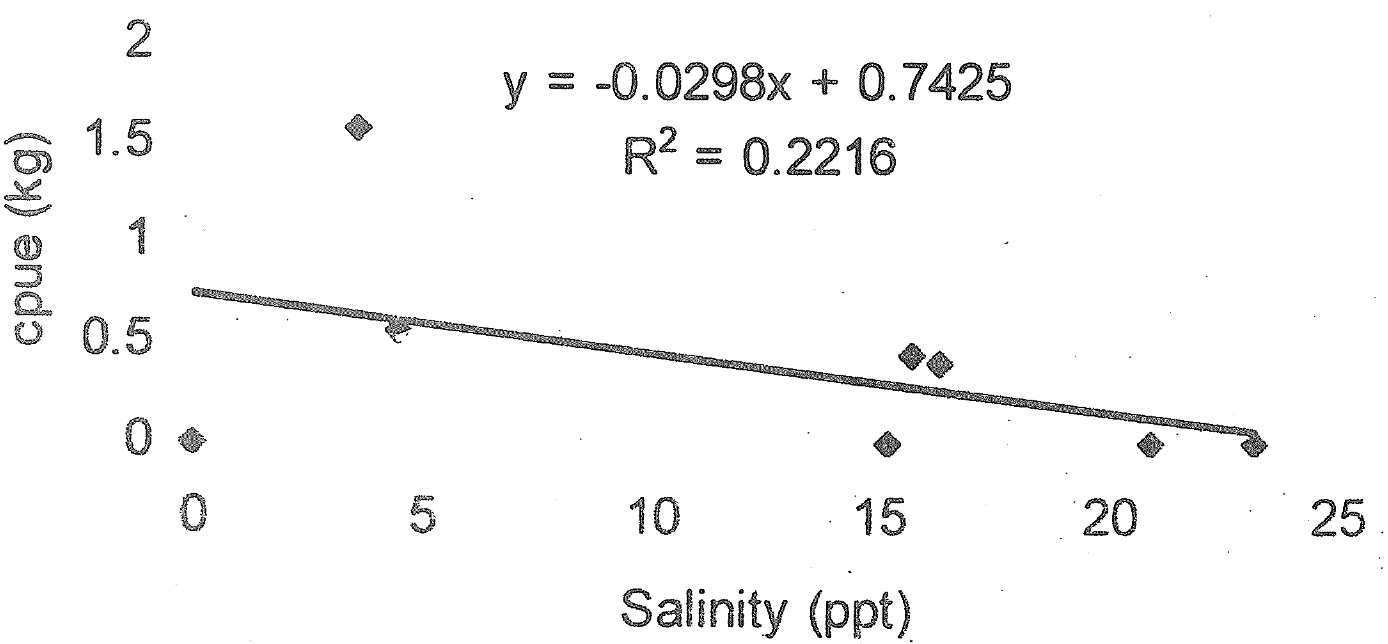

Fig.4: Seasonal variation of CPUE superimposed on salinity (as conductivity) in Cross River Estuary at Parrot Island

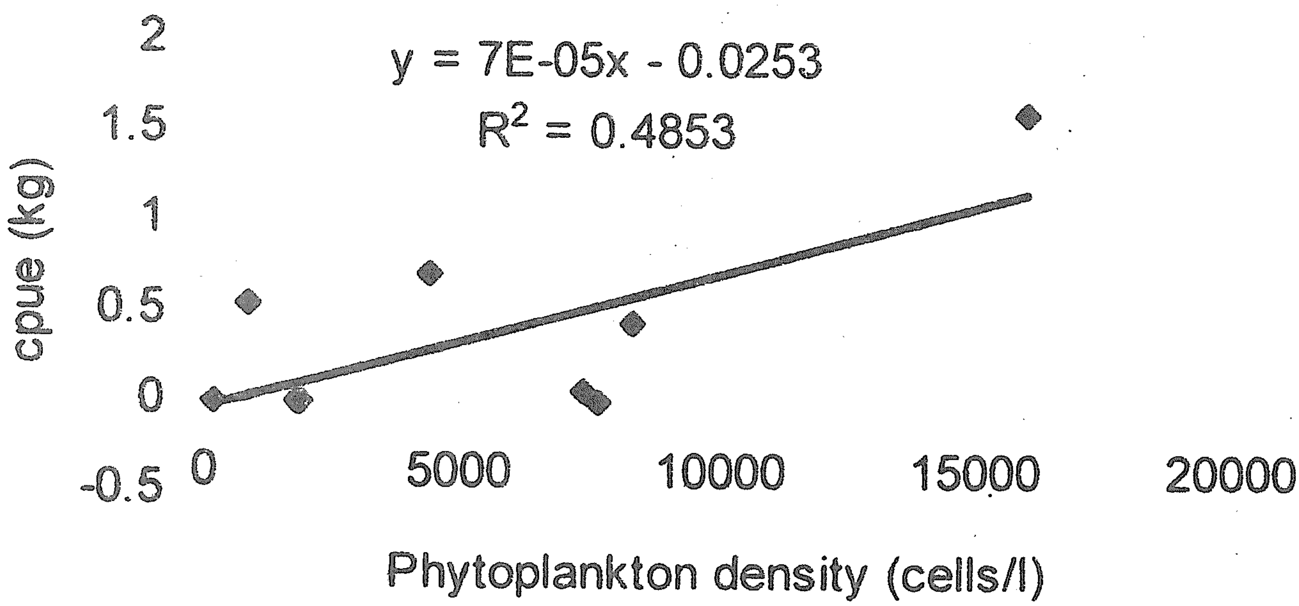

Fig. 6: Regression plot of CPUE versus phytoplankton density in the Cross River Estuary at Parrot Island