

CHAPTER NINE

FEEDING AND CARE OF INFANT BATS

General Information Regarding Bat Pups

Orphaned bats should be housed in incubators or humidity chambers as described in Temporary Housing. Close attention should be paid to temperature and humidity levels as described in Temperature, Humidity and Lighting.

Pups that are naked (furless), or that have tiny, sharp-hooked milk teeth should be fed milk formulas. Orphaned bats are typically dehydrated when received, so they will need to be rehydrated with an electrolyte solution (see Dehydration and Fluid Replacement Therapy). Emaciated infants should be rehydrated and then fed as soon as fluids are absorbed, usually within 10 to 20 minutes. **Do not dilute formula** when feeding infant bats (e.g. do not attempt to hydrate the pup orally by diluting milk with LRS, Normasol or Pedialyte). Emaciated infants require maximum nutrition in order to fill caloric deficits; diluting milk formulas for starving infants only increases the risk of nutritional deficiencies such as Metabolic Bone Disease (MBD).

Pups that are fully furred or have adult teeth (i.e. canines rather than milk teeth) are juveniles. Juveniles that are underweight should be fed the intermediate mealworm diet in this section. Juveniles that are not underweight should be fed the mealworm diets for adult bats, including both live mealworms and the complete soft food diet (see feeding Juvenile Bats on page 107). Juvenile bats old enough to eat the soft food diet should be completely rehydrated before food is offered. Failure to restore bodily fluids before introducing solid foods can be fatal (see Dehydration and Fluid Replacement Therapy).

In addition to medical attention and food, orphaned bat pups need nurturing. Gentle handling and soothing tones must be used when caring for these animals. In the author's experience, insectivorous bat pups do not imprint. Surrogates, such as puppets, are impractical given the small size of bat pups and their highly gregarious nature. Pups spend a great deal of time in physical contact with their mothers and with conspecifics; therefore, direct handling is recommended for pups' well being and sense of security. For the same reason, bat pups should not be housed alone.

The composition of milk varies from species to species. Composition varies throughout the course of lactation (Table 9-1). Most commercial milk replacers developed for other mammals do not appear to provide the necessary nutrition for bat pups. In 2007, bat care specialists across the U.S. reported a sudden increase of health issues with hand-reared orphans, including chronic dehydration, kidney failure, vomiting, hardening of the skin on the back, pneumonia, diarrhea, anemia, MBD, and bones (shoulders, elbows and knees) fracturing under weight of the pup's own body. The common denominator was commercial milk replacement formulas. Bat World Sanctuary had two separate sources of the suspected formula tested at two different laboratories. The report on the formulas came back as high in cadmium, mercury, arsenic, and lead. Both samples had very little calcium, and one formula contained traces of an anti-malarial drug. We then sought a safe alternative to commercial formulas, and one was developed for us by Mark Finke, PhD Nutritional Scientist. To date, over 600 insectivorous bat pups of various species have been raised successfully to adulthood using our formulas (Table 9-2).

Once a milk formula has been prepared, an electric coffee cup or candle warmer can be used to keep it the milk warm during feeding sessions. Note that milk formula will scald if the container is placed directly on the warmer. Instead, place the container of formula inside a bowl of warm water, and place the bowl of water on the coffee warmer (Figure 9-1). Constantly monitor the temperature. Bat pups typically prefer milk at a temperature that feels somewhat warmer (115° to 120° Fahrenheit) on the wrist than that appropriate for human infants.



Figure 9-1. A coffee warmer works well to warm milk .
Photo by A. Lollar

If the formula becomes too hot, remove it from the heated water for a few moments until it cools. Bat pups need to be kept warm (between 90° to 100° Fahrenheit) during feeding. Never expose a pup to drafts from fans or air-conditioners. Crevice pups should be placed on a warm, clean cloth on top of a heating pad for feeding. Tree bat pups should be held in the hand.

Feeding Schedule

It takes only a small amount of milk to fill the stomachs of most pups. Because some infants are naked or sparsely furred for the first few weeks of life, milk can clearly be seen through the skin of the abdomen. Depending on the size, age, and condition of an infant, it will take anywhere from a few drops to 1.0ml of milk per feeding. Pups of most species should not be allowed to drink more than 1.0ml per feeding; serious gastric disturbance can result from overfeeding. Pups taking 1.0ml of formula per feeding should not be fed more than four times per day (once every six hours). Because foam feeding tips (see page 97-98) preclude exact measurement of formula consumed, visual or tactile examination should be used to determine when a pup is full. The stomach should be slightly rounded, but not bulging with milk. A distended abdomen indicates the pup has been allowed to drink too much, a condition that can be fatal (see Overfeeding on page 105).

Regardless of the species or the age of an infant, feeding schedules should be determined by the amount of time it takes for an individual pup's stomach to almost empty. To determine an infant's feeding schedule, first become familiar with the look and the feel of the pup's abdomen both before and after its first feeding. Take note of the visual appearance and how the abdomen feels when gently palpated with the fingertips. Note the time and check the pup each hour thereafter. Do not let the stomach empty completely and appear concave. Keep enough formula in the pup at all times to keep the abdomen flat to slightly rounded. Feed the pup again when the milk is nearly gone (i.e., when the stomach is almost flat, or only a small amount of milk is visible in the stomach). If the pup is already furred, milk will not be visible through the abdomen and the handler will need to rely solely on tactile examination. Note the time it took for the stomach to partially empty in order to estimate when the next feeding will be due. Feeding infants too often can result in bloat, i.e., distention of the stomach and severe abdominal distress, which can lead to death (see Complications in this section). Most pups will initially require feedings every four to six hours (four to six times a day) depending on their condition, although some pups' stomachs may empty in as little as two hours. Younger pups and pups that are emaciated will need to be fed more often than older pups that are healthy. In other words, as pups grow older and become healthier, the number of feedings per day will decrease.

Additional Notes

Pups can aspirate fluids or choke on food while being hand fed. A bat may be choking if it suddenly gags and/or appears to gasp for breath during feeding. If aspiration is suspected, keep the bat's head down with the abdomen against the palm of the hand. Gently but firmly tap the bat's back with your index finger, just below the shoulder blades to force the substance from the airway. Force of tapping should be no more than that of fingertips lightly drumming a tabletop. Fluid in the nasal passages should be cleared by applying gentle pressure with a cotton swab on the nasal passages just below the eye and down the bridge of the nose. Wipe away any fluid that is expelled from the nose, and repeat the process until the nose is clear. Normal respiration will sometimes be restored immediately. However, if liquids or food enters the lungs, the bat is likely to develop aspiration pneumonia. Signs of respiratory distress include soft squeaky, wheezy, or rattling sounds with each breath, often audible even without a stethoscope. Treat as described in Respiratory Disorders.

After feeding, the face and chin should be gently wiped clean with a foam sponge dipped in warm water. Never put a pup away with milk on its face or body. Doing so will result in eye infections and/or skin infections, that may result in death. Some pups, such as red bats (*L. borealis*), will also need to be stimulated to initiate urination/defecation. Gently dab at the pup's anus and genitals with a soft square of gauze that has been dipped in warm water (cotton swabs are too rough for this purpose). Gently rub the area until the pup urinates or defecates. While newborn tree bats require stimulation, most of the crevice species do not. (Also see Bathing and Grooming Tree Bat Pups on page 101)

Feeding Crevice Bat Pups

Vespertilionidae

Bat pups in the family Vespertilionidae will typically lap fluids and accept a drop-by-drop method of feeding. Begin by holding the pup upside down. This is extremely important because infants are likely to aspirate fluid into the lungs when learning to lap formula if the head is not kept lower than the rest of the body. Placing a small amount of warm formula onto the pup's mouth typically induces a lapping response. Continue to dispense the formula drop-by-drop as the pup drinks (Figure 9-2). Vespertilionidae pups that do not readily lap milk should be allowed to nurse from foam tips (Figure 9-4B) as described below.



Figure 9-2. An orphaned big brown pup lapping milk formula from a cannula. *E. fuscus*. Photo by D. Wilkins.

Molossidae

Molossidae species will not lap liquids. It is critical that milk be offered to these pups through soft foam sponges. Natural or white foam eye-shadow applicator tips (Figure 9-3A) are used for this purpose (Lollar, 1994). Remove the foam tip from the plastic wand by immersing the wand in hot water to loosen the foam from the plastic wand, then slide the foam tip off the wand.

The foam tip has a seam that runs along the entire edge of the tip (Figure 9-3B1). While the tip is still wet, tear the tip in half along the seam to form two matching halves (Figure 9-3B2). Use small scissors to cut the tip of the foam into a wedge shape (Figure 9-3B3). This size and shape is readily accepted by bat pups.

When nursing from foam tips, pups should be placed abdomen down inside a folded wash cloth, and on a heated surface to keep them warm. Heating pads set low to medium can be utilized for this purpose. There should be two layers of wash cloth between the pup and the heating pad to prevent accidental burns. Allow the wash cloth to warm before placing the pup into the folds for feeding. Cover the pup's body with the cloth, leaving only the head exposed, as shown in Figure 9-4B. Use a clean, dry cloth for each feeding.

Begin by positioning the forceps on the foam (Figure 9-3C) so that the prongs are somewhat buried in the foam. This protects the pup's mouth. Dip the foam tip into warmed formula. The tip should remain in the formula for several seconds to absorb heat. Remove excess formula by dabbing the tip on a paper towel. Excess formula on foam tips can cause choking or be uncomfortable to the pup. Test the temperature of the tip against the inside of the wrist before placing it into the pup's mouth.

Position the index finger on one side of the pup's face and the thumb on the opposite side. While softly immobilizing the pup's head, use the other hand to gently guide the foam tip into the pup's mouth.



Figure 9-3. A: Foam eye shadow applicators available at cosmetic stores.



B: Foam tip removed from the wand and slightly separated at the seam. **2:** the foam tip torn in half at the seam. **3:** The tip has been trimmed to resemble a wedge shape.



C: Prongs must be buried in the foam to protect the pup's mouth as the tip is introduced. Photos by A. Lollar.

You can also encourage the pup to take the tip by gently stroking the pup's mouth with the warmed tip while making clicking sounds. Soft clicking mimics the directive calls some mother bats use to locate their pups. Occasionally, a pup will immediately make a clicking sound in return, grab the sponge with its mouth and start nursing. At this point, release the forceps from the sponge tip, as the pup will keep it clamped between its teeth (Figure 9-4A). As the pup begins nursing, dispense warmed formula, one drop at a time, onto the foam sponge with a syringe or dropper. Be careful to drop the formula onto the portion of the foam tip that is furthest from the pup's face, so that any excess milk drips away from the infant.

Continue dispensing warmed formula to the foam tip. Most pups will either begin nursing, or at least swallow some of the formula. The tragus will move up and down slightly each time the pup swallows. If the pup begins nursing, stop dispensing formula until the tip is less saturated. As the pup continues to nurse, warm formula can be added to the tip one drop at a time.

Some pups are difficult to feed and will spit the foam tip out of their mouth. Some will swallow a few drops of formula but will not begin sucking. These pups will eventually start nursing once they overcome initial fear of the handler.

Some pups will discard the foam tip as soon as they are full; others will hang onto the tip even after they have stopped drinking milk (Figure 9-4C). Do not try to remove the tip from a pup's mouth. Any remaining formula in the tip may be accidentally forced down the pup's throat, causing it to aspirate. These pups will eventually discard the tip after being returned to the incubator. Foam nursing tips should be disposed of after use and replaced with new ones for each feeding.

It is important to note that when some pups are first handled, they will immediately grasp the cloth or fabric that encloses them with their milk teeth, refusing to let go. Do not attempt to remove the pup's teeth from



Figure 9-4. A: New born free-tailed pup nursing from a foam tip. *T. brasiliensis*. Bat World facility. Photo by A. Lollar.



B: Big brown pups nursing from foam tips. *E. fuscus*. Bat World facility. Photo by A. Lollar.



C: Evening bat pup clutching a foam tip. *N. humeralis*. Bat World Lone Star facility. Photo by D. Hyatt

the fabric. Instead, carefully dispense warmed formula onto the cloth just below the pup's mouth and allow the pup to suck the formula from the fabric.

Caring for large numbers of orphaned pups requires some modifications in care procedures. Over the course of several days, some pups can be conditioned to being fed in groups (Figure 9-5). Pups that lap formula can be taught to drink from shallow dishes. Hold a pup over a shallow dish of warmed formula while feeding it from a catheter or dropper. While the pup is lapping, move the catheter away and carefully lower the pup until it drinks from the shallow dish. Be careful not to immerse the bat's nose in the formula. Once a group has been individually taught to lap formula from a shallow dish, they can be fed in groups on top of a heating pad.

When feeding pups from foam tips, each pup should be nursing from its tip and covered before the next pup is placed into position.



Figure 9-5. A row of orphaned free-tailed pups nursing from a foam tips.
T. brasiliensis. Photo by R. Myers.

Housing Crevice Bat Pups

Unfurred infants require warm temperatures and high humidity, and should be housed in humidity chambers as described in Temperature, Humidity & Lighting. Caging described for adult crevice bats in Temporary Housing is also appropriate for crevice pups. A heating pad should be attached to the top and sides of the enclosure for additional warmth. Infant crevice bats should be placed in a pouch positioned close to a heat source. Be sure to leave at least two of the walls of the enclosure clear of the heating pad so that infants can move away from the heat source if needed. A thermometer should be placed inside the enclosure and close to the heat source to monitor the internal temperature at all times. Heating pads can be adjusted and added or removed according to the temperature reading inside. Appropriate temperatures for many species of bat pups are 90° to 100° Fahrenheit and appropriate humidity levels range from 70% to 90%. Hand-raised crevice pups should be moved into full-sized flight cages with padded floors by eight to ten weeks of age to ensure development of proper flight ability.

Feeding Tree Bat Pups

Unlike crevice pups, tree bat pups must be fed formula while being hand held. The pup should be fed under a heat source, such as a lamp, for warmth. It is **critical** to keep these pups clean during the feeding process. Tree bats are furred at a very young age. If formula drips into the fur and dries on the skin, it can result in serious skin infections that often lead to death. Additionally, matted and dirty fur can interfere with a bat's ability to thermoregulate. A pup can die within just a few hours if it cannot thermoregulate. Pups that become soiled must be bathed and dried as described on the following page. As a general rule it takes about 30 seconds to feed a tree bat pup when fed correctly; it takes about 30 minutes to clean the pup when fed incorrectly.

Position the pup so it lies prone on the thumb, secured by the forefinger and middle finger resting on the pup's shoulder blades. Using a glass medicine dropper, dispense formula drop by drop as the pup laps. Although some tree pups squirm when first being held in this position, most catch on quickly and sit quietly on the thumb thereafter to be fed. Some enthusiastic pups attempt to crawl forward, appearing intent on swallowing the entire dropper. These pups can be controlled with gentle pressure of the fingertips on the pup's shoulder blades.

Both the pup and the medicine dropper should be tilted in a "V" position, so that the pup's mouth and the dropper meet at the bottom of the V (Figure 9-6). This position helps to keep air bubbles from forming in the dropper and prevents soiling by allowing excess milk to drop away from the pup's face. **Note: the pup's head must extend past your thumb**, as pictured, so that milk drops away from both the thumb and the pup. Otherwise, milk will wick between your thumb and the pup and saturate the pup's chin, neck and chest.



Figure 9-6. An orphaned red bat drinking milk formula from a medicine dropper. *L. borealis*. Photo by L. Crittenden.

Housing Tree Bat Pups

Infant tree-bats require warm temperatures and high humidity, and should be housed in humidity chambers as described in Temperature, Humidity & Lighting. Caging described for adult tree bats in Temporary Housing is appropriate for tree bat pups. A heating pad should be attached to the top and sides of the enclosure for additional warmth. Be sure to leave at least two of the walls of the enclosure clear of the heating pad so that the infant can move away from the heat source if needed. A thermometer should be placed inside the enclosure and close to the heat source in order to monitor the internal temperature at all times. Heating pads can be adjusted and added or removed according to the temperature reading inside. Appropriate temperatures for bat pups of many species are 90° to 100° Fahrenheit with humidity levels of 70% to 90%.

Infant tree bats should be positioned so they can hang by their feet from the ceiling of the enclosure, **not the sides**. Hanging from the ceiling allows pups to urinate and defecate without becoming soiled. Position the pups so that several can hang together in a cluster. Hand-raised tree bat pups should be moved into full-sized flight cages with padded floors by eight weeks of age to ensure development of proper flight ability.

As mentioned earlier, tree bat pups should be stimulated after each feeding with a soft piece of gauze to encourage urination/defecation. If not stimulated, pups tend to urinate and defecate on themselves, which, if not cleaned and dried immediately, is likely to cause hypothermia and death.

Be careful not to contaminate the oral or nasal cavities with fecal material by touching the face with the same gauze pad used to stimulate the pup. This can result in serious bacterial infection from *Providencia rettgeri*, resulting in a build-up of fluid in the thoracic cavity and death (D. Cottrell, DVM., pers. comm.). Also be sure to keep wing tips free of feces to prevent fungal infection. If wing tips become soiled, clean with warm water and dry with a soft gauze pad. (Fungal infections will cause wing tips to become discolored and oily in appearance. This condition is very painful and should be treated with daily applications of Nolvasan suspension as described in Skin Conditions.)

Bathing and Grooming Tree Bat Pups

Items required for cleaning and grooming a bat include a heating pad, a bowl of warm water, a curve-tipped syringe, an interdental brush (a small tapered brush used for cleaning between human teeth), gauze pads, soft, absorbent cloths for drying, and a travel-size hair dryer (see Products page). Pre-warm a few absorbent drying cloths by placing them on a heating pad. Keep the heating pad on a medium setting. Water may need to be replaced periodically throughout the procedure as it cools or becomes soiled.

Begin cleaning by holding the bat securely in the palm of the hand, keeping its head higher than the rest of the body so that no water gets near the nose or mouth. If only a small section of the bat is soiled, dip a gauze pad into warm water, then saturate the soiled area on the bat and slide off any foreign particles. For bats that are extremely soiled with feces or other matter, use a curve-tipped syringe to saturate the soiled area. Do not squirt water on or near the bat's head. When thoroughly saturated, feces and other foreign particles will slide easily from the fur as the area is gently wiped with a damp gauze pad. If the hair is not damp enough, it will be pulled out when attempting to remove feces from the fur. Also be sure to clean the wings of badly soiled bats. Hold the bat in a horizontal position, extend one wing, use the curve-tipped syringe to squirt water liberally over the surface, and again gently slide off any particles of food or feces that adhered to the membrane. Use the same procedure for the other wing and the tail membrane.

As soon as the fur is clean, quickly place the bat in a pre-warmed, absorbent drying cloth on top of the heating pad. Wrap the cloth around the bat and gently dab the wet areas of its body with the cloth to absorb excess moisture. Replace the cloth with another warmed one when it becomes damp. After gently towel drying the fur, wrap the bat inside another dry cloth and turn it upside down, keeping the head lower than the rest of the body, and carefully wipe the mouth and face with a damp piece of gauze. Make sure the gauze is only slightly dampened so that no excess water can be inhaled during cleaning.

After gently rubbing the bat's fur, and wing and tail membranes with a soft, dry cloth to absorb excess moisture, use a blow dryer to finish drying the fur. Pups can either be held in the palm of the hand while being dried, or placed in a BatHut in front of the blow dryer. The dryer should be placed at least one foot from the bat. If a pup squirms to get away while being held, the dryer is too close and the air stream is too forceful or too hot. Keep the dryer at an appropriate distance so the bat remains passive, enjoying the warmth.

Fluff the fur with the brush while drying the pup. Brush the dense fur backwards to dry the fur closest to the body, then brush the fur forwards in the natural direction it lays, to dry the top of the fur. Only minimal pressure should be used when brushing a bat. (To fully realize the small amount of pressure needed, place the bristles on a sensitive area of your body such as the inside of a wrist or elbow, then brush in one direction.) Make certain the pup is completely dry—both the fur and wing membranes—before returning it to its enclosure. Tree bat pups will usually begin grooming their bodies vigorously once they have been bathed and dried.

BAT WORLD SANCTUARY MILK REPLACEMENT RECIPE**VESPERTILIONIDAE, EXCLUDING TREE BAT SPECIES**

- 3.5 ounces (100ml) canned Meyenberg evaporated goats milk, reconstituted
- 1.5ml organic or unrefined corn oil
- 1.5 scoops Similac Neosure Baby Formula
- 1 tsp dried egg white

MOLOSSIDAE

- 3.5 ounces (100ml) canned Meyenberg evaporated goats milk, reconstituted
- 2 scoops Similac Expert Care Neosure Baby Formula
- 2.5ml organic or unrefined corn oil

Start by reconstituting the entire can of Meyenberg goat's milk with an equal amount of water. Store in a separate container in the refrigerator. To make either of the above recipes, use a small container with a tight-fitting lid and add 3.5 ounces of the reconstituted goat's milk, then add the Similac Neosure and corn oil. Also add dried egg white if required for the species. Shake well to mix. Makes about 1/2 cup. Store in the refrigerator. Do not freeze. Discard after 24 hours or sooner if it begins to thicken or smell spoiled. Wash the container thoroughly with soap and water before making new formula. Use bleach to disinfect if necessary. Rinse thoroughly. If the container has any residual smell then it has not been washed thoroughly enough and the next batch of formula will be contaminated. Discard any unused reconstituted goat's milk after seven days or sooner if it begins to smell spoiled. Store Neosure at room temperature and discard any unused powder after 30 days.

Calculated Nutrient Values for Vespertilionidae (As Is)

Energy 1.42 kcal/ml; Moisture 73.5%; Protein 7.3%; Fat 8.2%; Carbohydrate 9.8%; Calcium 0.20%; Phosphorus 0.15%; Vitamin A 3,340 IU/kg; Vitamin D 430 IU/kg.

Calculated Nutrient Values (Dry Wt)

Energy 5.36 kcal/ml; Protein 27.4%; Fat 30.9%; Carbohydrate 36.8%; Calcium 0.75%; Phosphorus 0.58%; Vitamin A 12,500 IU/kg; Vitamin D 1,650 IU/kg.

Calculated Nutrient Values for Molossidae (As Is)

Energy 1.60 kcal/ml; Moisture 72.2%; Protein 4.7%; Fat 10.7%; Carbohydrate 11.2%; Calcium 0.22%; Phosphorus 0.16%; Vitamin A 3,830 IU/kg; Vitamin D 540 IU/kg.

Calculated Nutrient Values (Dry Wt)

Energy 5.76 kcal/ml; Protein 17.0%; Fat 38.5%; Carbohydrate 40.3%; Calcium 0.79%; Phosphorus 0.59%; Vitamin A 13,700 IU/kg; Vitamin D 1,900 IU/kg.

RECOMMENDED MILK FORMULA FOR TREE BAT SPECIES

For reasons we do not yet understand, tree bats do not fare well on either of the above milk formula recipes. Instead, a successful formula for tree bats consists of the following ingredients (Kate Rugroden, pers. comm.).

- Fox Valley 32/40, 13.7g (7 teaspoons)
- Fox Valley Ultraboost, 5.74g (2.5 teaspoons)
- Body Boost Colostrum Plus (or similar brand), 1.24g (3/4 teaspoon)
- 1 Lactaid tablet [9,000 FCC Lactase units] (.27g), crushed to a fine powder
- 3.5 ounces (100ml) water

Tree bat orphans with developed canines should receive a milk formula mixed 50/50 with soft food (see Feeding Adult Bats). If the bat will accept live mealworms, feed milk formula and live mealworms on a 50/50 ratio.

Table 9-1
Comparison of Bat Milk Compositions

	Fat %	Protein %	Carbohydrate %	Energy kj/g
Family: Vespertilionidae				
<i>Eptesicus fuscus</i>				
Early lactation	12.8	9.5	3.6	6.7
Late lactation	21.2	9.5	3.6	10.5
<i>Myotis lucifugus</i>				
Early lactation	12.4	9.4	3.9	7.4
Late lactation	15.8	8.5	3.9	8.6
Milk replacement recipe: Vespertilionidae	8.2	7.3	9.8	5.6
Family: Molossidae				
<i>Tadarida brasiliensis</i>				
Early lactation	17.3	8.3	3.6	9.0
Peak lactation	25.8	7.7	3.4	12.1
Milk replacement recipe: Molossidae	10.7	4.7	11.2	5.8

Note: The amino acid profile in the Molossidae milk replacement recipe is very good, thereby minimizing the need for excess protein.

Table 9-2
Ten Year Study on Pup Survival Rates Using Select Milk Replacement Formulas[◊]

Year	# of Pups	Species	Emaciated at intake	Injured at intake	Secondary complications	Died from secondary complications	Died from injury	Survived	Formula used
1999	47	<i>T. brasiliensis</i>	22	5	MBD (4) Bloat (2)	3	4	40	MH*
	5	<i>E. fuscus</i>	—	—	—	—	—	5	MH*
	35	<i>L. borealis</i>	2	7	Bloat (3)	—	5	30	
	3	<i>N. humeralis</i>	1	1	—	—	1	2	MH*
2000	55	<i>T. brasiliensis</i>	31	7	MBD (12)	5	2	48	MH*
	52	<i>L. borealis</i>	—	7	Bloat (4)	—	7	45	MH*
2001	62	<i>T. brasiliensis</i>	27	10	MBD (11)	—	7	55	MH*
	28	<i>L. borealis</i>	—	7	Bloat (4)	4	4	20	MH*
2002	115	<i>T. brasiliensis</i>	67	22	MBD (24)	6	19	90	MH*
	49	<i>L. borealis</i>	5	11	Bloat (1) MBD (3)	2	11	36	MH* MH*
	1	<i>L. cinereus</i>	—	—	—	—	—	1	MH*
	1	<i>P. subflavus</i>	—	—	—	—	—	1	MH*
	9	<i>M. lucifugus</i>	9	—	SIDS (2)	2	—	7	MH*
2003	76	<i>T. brasiliensis</i>	52	13	MBD (22)	4	1	71	33/40**
	56	<i>L. borealis</i>	1	8	MBD (5)	2	4	50	33/40**
	2	<i>N. humeralis</i>	2	—	—	—	—	2	33/40**
2004	99	<i>T. brasiliensis</i>	42	22	MBD (30)	10	19	70	33/40**
	25	<i>E. fuscus</i>	25	—	MBD (11) Bloat (5)	8	—	17	33/40**
	72	<i>L. borealis</i>	3	10	MBD (1)	3	8	61	33/40**
2005	70	<i>T. brasiliensis</i>	38	18	MBD (21)	9	10	51	FV***
	64	<i>L. borealis</i>	—	14	Bloat (3)	—	12	52	FV***
	7	<i>E. fuscus</i>	7	—	MBD (4)	—	—	7	FV***
	1	<i>L. intermedius</i>	1	1	—	—	1	0	FV***
2006	102	<i>T. brasiliensis</i>	44	2	MBD (25) Bloat (14) Other (16) [†]	25		77	33/40**
	63	<i>L. borealis</i>	7	3	Bloat (22)	35	2	26	33/40**
2007	87	<i>T. brasiliensis</i>	36	7	MBD (21) Bloat (17) Other (58) [†]	58	0	29	33/40**
	26	<i>L. borealis</i>	2	1	Other (12) [†]	11	1	14	33/40**
	3	<i>N. humeralis</i>	—	—	MBD (3)	—	—	3	33/40**
2008	261	<i>T. brasiliensis</i>	99	83	MBD (0) [•] Bloat (7)	3	61	223	BWS‡
	72	<i>L. borealis</i>	6	2	Bloat (27)	25	2	45	BWS‡
	2	<i>N. humeralis</i>	—	—	Bloat (1)	—	—	2	BWS‡
2009	230	<i>T. brasiliensis</i>	112	19	MBD (0) [•]	—	6	224	BWS‡
	48	<i>L. borealis</i>	—	9	Bloat (4) ^{••}	1	1	46	BWS‡
	1	<i>L. cinereus</i>	1	—	Bloat (1)	—	—	1	BWS‡
	5	<i>N. humeralis</i>	5	—	—	—	—	5	BWS‡

◊ Reflects wild orphaned bat pups raised by the author over one decade. *Mother's Helper Milk Replacer Puppy Formula™, Lambert Kay[®]; **Zoologic 33/40[®] milk replacement formula, Pet Ag; ***Fox Valley 32/40 milk replacement formula. [†]Symptoms observed outside of bloat and MBD: chronic dehydration, kidney failure, vomiting, hardening of the skin on the back, pneumonia, diarrhea, anemia, and bones (shoulders, elbows and knees) fracturing under the weight of the pup's own body; ‡Bat World sanctuary milk replacement recipe; •No cases of MBD developed in Molossidae using the milk replacement recipe; ••Bloat in Vespertilionidae bats was alleviated when increased protein was added to the recipe.

Complications in Hand Raised Pups

BLOAT

Bloat is one of the most common causes of death in bat pups. It can be recognized by severe abdominal distention and, sometimes, the presence of bubbles in the digestive tract that are visible through the translucent skin of the abdomen. There are several reasons why this condition occurs in bat pups.

Feeding too Often

Abdominal distention accompanied by white or grayish feces indicated bloat caused by feeding a pup too often. This type of bloat should be treated by feeding a diluted mixture of one part milk formula to nine parts very warm water (115° to 120° Fahrenheit). Do not allow the pup to drink the normal amount it consumes at every feeding as this will cause additional distention. Rather, feed the pup about one-fourth of the normal amount taken. As the stomach empties of previously undigested milk, continue to feed the water and milk dilution until feces appear normal.

Overfeeding

Bloat caused from over-feeding will be obvious immediately after the pup has been fed as the stomach will appear dangerously distended. The stomach is distended with milk to the point that it covers the bottom two ribs and extends across the abdomen and down to the pelvis. This can normally be treated by skipping the next one to two feedings until the pup's stomach has returned to normal. The condition is life threatening if the stomach is marble-sized and hard, and/or the pup is in respiratory distress. When milk inside the stomach is clearly visible through the skin of pups that aren't yet furred, excess formula can be aspirated directly from the stomach using a 1ml syringe with a 28 gauge needle attached. In order to prevent damage to the pup or its stomach, it is critical to break the seal created between the barrel of the syringe and the plunger of the new syringe prior to the procedure. This can be accomplished by moving the plunger up and down inside the barrel of the syringe. This procedure must be done as aseptically as possible to prevent the development of peritonitis, which can be fatal.

This technique requires two caretakers for the procedure. Aseptically swab the abdomen with povidone iodine and 70% isopropyl alcohol. Position the pup on its back on a padded surface, such as a soft cloth. The pup must be held firmly and gently in position by one caretaker to prevent the pup from moving. The other caretaker then carefully inserts the needle 3 to 4mm directly into the stomach. Using a steady hand, slowly pull back on the plunger. Withdraw enough excess milk so the abdomen returns to a more normal size. Maintain slight pressure on the plunger as you withdraw the needle from the abdomen. Pups undergoing this procedure should receive oral administration of 0.02 ml SMZ-TMP two times a day for 10 days.

Lack of Beneficial Bacteria

The absence of beneficial organisms that normally reside in a healthy pup's intestinal tract can cause bloat. Absence of beneficial flora allows other organisms to grow out of control, resulting in a build-up of intestinal gas. To treat this condition, administer 0.01ml of simethicone for every gram of body weight every two hours (to relieve gas) and add 0.02ml of Bene-Bac™ gel or another high quality beneficial flora product to each feeding until abdominal distention is relieved. Probiotics may encourage growth of beneficial bacteria.

Malnutrition

Bloat from malnutrition can be caused by decreased protein absorption, which causes the abdomen to fill with fluids. Pups with this condition must be kept well hydrated, and should be fed the Vespertilionidae milk formula recipe. Frequent, smaller feedings are sometimes helpful in treating this condition, as well as the addition of probiotics such as Bene-Bac™ gel. If no improvement is observed within 24 hours, administer 0.01ml of Lasix orally (see Medication Section for dosage). The diuretic will help to eliminate excess fluid. If no improvement is observed within another 12 hours, administer a second dose of Lasix.

METABOLIC BONE DISEASE (MBD)

MBD that results from Vitamin D deficiency is called rickets in young individuals and osteomalacia in adults. MBD can also be caused by an inadequate intake or absorption of calcium. Vitamin D and fat are important dietary components because they facilitate calcium uptake.

Orphaned pups that have survived for a number of days without sustenance or that have been fed inappropriate diets are likely to develop growth abnormalities; however, these can be avoided if proper nutrition is provided. Rapidly growing bones like the long bones of the arm are often affected by nutritional imbalances such as MBD. Common clinical signs associated with MBD include swelling or curvature of the long bones of the wing (Figure 9-7), inflammation of the joints, muscle weakness, and neuromuscular hyperirritability often progressing to tetanic spasms and sometimes convulsions.



Figure 9-7. A juvenile big brown bat with MBD. *E. fuscus*. Photo by D. Kinamon.

The condition is painful. In severe cases, a bat will rest with its wings slightly extended at all times and may experience intermittent spasms of the wings in particular. Pups with MBD will sometimes cry out when touched.

The author has raised approximately 2,800 insectivorous bat pups of various species over the past two decades, and has observed many signs of nutritional deficiency in bat pups. MBD has frequently developed in severely emaciated pups raised on commercial milk replacement formulas, despite the addition of extra calcium as well as additional vitamin and mineral supplements. The Bat World Sanctuary milk replacement recipe, developed in 2008, eliminated all occurrences of MBD in *T. brasiliensis*, *L. borealis* and *N. humeralis* orphans. A total of 492 orphaned *T. brasiliensis* pups were raised on this recipe in 2008 and 2009, of these, almost half were severely emaciated upon arrival and many would have developed MBD if raised on commercial milk replacement formulas.

Treatment

While mild cases may be reversible in early stages, MBD cannot be reversed in later stages when curvature of the bone is visible. For pups exhibiting symptoms as described above, administer Calsorb® orally once a day until symptoms subside. (This medication should be mixed with a small amount of honey as it is very bitter.) Also add 1 gram (1/4 tsp) Calcium Carbonate to every 3.5 ounces of milk replacement recipe. For juveniles, add 1 gram (1/4 tsp) to every 3mls of soft food diet. Metacam® should also be administered for pain (see Medication section). Margaret A. Wissman, D.V.M., D.A.B.V.P. (ExoticPetVet.net), states that calcitonin-salmon is an effective treatment for MBD in many species of exotic animals.

Feeding Juvenile Bats

Depending on the species, juvenile bats are ready to accept the complete soft food diet at four to six weeks of age. Canine teeth should be fully developed before mealworms or soft food is offered. Soft food should be fed to the bat through the tip of a 3ml syringe. Crevice bats should be held in the hand, as described in Feeding Adult Bats. Tree bats should be positioned so the head is slightly lower than the rest of the body (the V position) as described for infants.

Juveniles may be fed 0.5 to 1.0ml of the soft food diet per feeding and should be fed every eight to 12 hours (two to three times per day). At three to six weeks of age juveniles can typically be allowed to eat as many mealworms or as much of the soft food diet as they will accept at each feeding, although small species (adult weight less than 10g) should not be allowed to eat more than 0.75ml per feeding, and medium-sized species (adult weight 10g to 20g) should not be allowed to eat more than 1.0ml per feeding. Milk should be offered after each feeding of mealworms or soft food. Although the author cautions against allowing significant abdominal distention in newborn pups, juveniles will normally have somewhat distended abdomens following each feeding.

Juveniles readily accept soft food or mealworms when they have reached the appropriate developmental stage. **Juveniles that refuse mealworms or soft food are not ready to be weaned and should never be forced to do so, regardless of their age or the fact that they may be adult sized.** It is not unusual for adult-sized juveniles to continue drinking milk, particularly if they have been nutritionally deprived as orphans. Juvenile bats sometimes accept mealworms or soft food initially, then attempt to “suck” on the syringe or the mealworm, or refuse the food entirely. These bats should be allowed to return to nursing from a tip, or lapping from a syringe or medicine dropper, for another week or two, at which time mealworms or soft food can again be offered. Some pups may go back and forth from milk formula to soft food/mealworms. Always follow their lead until they are ready to be weaned. Juvenile bats that are ready to be weaned entirely will no longer accept milk.

Caring for Geriatric Bats

Some species of bats have been successfully maintained in captivity for long periods of time. Old bats often have worn teeth, and their hair may turn gray or white. The joints of the fingers, ankles and knees may enlarge, possibly from swelling due to arthritis. These bats lose the ability to fly and often move very slowly.

In captivity, older bats are sometimes chased or crowded from roosting pouches and feeding trays by younger, more rambunctious roostmates. In order to protect these bats, it is best if they are caged with other geriatric bats, or other passive individuals. Roosting pouches, food and water trays should be placed within easy reach of older bats, and should be placed in the same position each day (Figure 9-8). These bats do not require diversity, and in fact are likely to become injured if anything in their living space is not where they have come to expect it to be. Enrichment can be provided by hand feeding special treats such as mealworm and waxworm viscera, and gentle grooming.

Feeding requirements may also change for some geriatric bats. That is, they may require more frequent feedings of smaller quantities. Most older bats will be on the complete soft food diet because their teeth will eventually become so worn that they will not be able to chew solid foods. These bats may need to be fed small quantities three times a day. Some geriatric bats will also have difficulty grooming. It is therefore important that they are kept clean and brushed on a daily basis.



Figure 9-8. An elderly pallid bat expecting her daily treat of mealworm viscera. This bat stays in a modified roost made of foam which sits on the enclosure floor, with her food and water dish in close proximity. A blue surgical towel covers the bottom of the roost and is changed daily. *A. pallidus*. Bat World facility. Photo by A. Lollar.