

## CHAPTER NINE

# FEEDING AND CARE OF INFANT BATS

### GENERAL INFORMATION REGARDING BAT PUPS

Orphaned bats should be housed 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), toothless (Figure 9-1), or those 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 formula 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).



**Figure 9-1.** The mouth of an orphaned free-tailed pup. *Bat World facility. Photo by A. Lollar*

Pups that are fully furred but that have elongated joints in the wings 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 in this section). 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 appear to 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 the pups' well being and sense of security. For the same reason, bat pups should not be housed alone.

Bat pups need to be kept warm (between 90° and 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 (Figure 9-8). Tree bat pups should be held in the hand (Figure 9-9)

The composition of milk varies from species to species. Composition also varies throughout the course of lactation (Table 9-1). Commercial milk replacers developed for other animals 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) appearing to fracture under the pup's own weight. The common denominator seemed to be commercial milk replacement formulas. The widely publicized contamination of domestic animal feeds in recent years has raised serious questions about the safety of some manufactured animal food in general. Bat World Sanctuary sought a safe alternative to commercial milk replacement formulas, and one was developed at our request by a nutritional scientist. To date, over

300 insectivorous bat pups of various species have been raised successfully to adulthood using the Bat World Sanctuary Milk Replacement Recipe (Table 9-2).

Once a milk formula has been prepared, an electric coffee cup or candle warmer can be used to keep it warm during feeding sessions, although formula will scald if the container is placed directly on the warmer. Instead, place the container of formula in a shallow bowl of warm water and place the bowl of water on the coffee cup warmer (Figure 9-2).

Constantly monitor the temperature. Bat pups typically prefer milk formula at a temperature that feels somewhat warmer (115° to 120° Fahrenheit) on the wrist than that considered appropriate for human infants. If the formula becomes too hot, remove it from the heated water for a few moments until it cools sufficiently. Feeding tools that become clogged with thickened formula during feeding can be rinsed clean in the warmed water.



**Figure 9-2.** A coffee warmer works well to warm milk . Photo by A. Lollar

## FEEDING SCHEDULE

It takes only a small amount of milk formula to fill the stomachs of most pups. Because some infants are naked or sparsely furred for the first few weeks of life, milk formula 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 formula 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 moderately rounded, but not bulging with milk (Figure 9-3). A distended abdomen indicates the pup has been allowed to drink too much, a condition that can be fatal (see Overfeeding in this section).



**Figure 9-3.** A male red bat orphan after being fed the proper amount of milk formula, which resulted in the abdomen being moderately rounded without being distended. *L. borealis*. Bat World facility. Photo by A. Lollar

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 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 moderately rounded (Figure 9-2). Feed the pup again when the milk formula is nearly gone (i.e., when the stomach is almost flat, or only a small amount of milk formula 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 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.

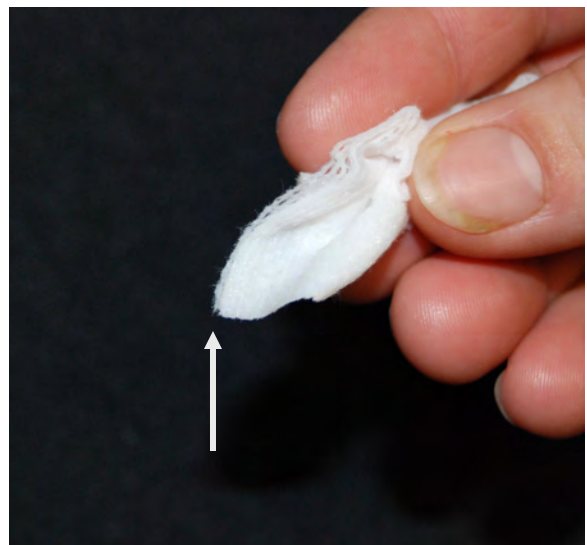
### ***Important Notes***

Pups can aspirate fluids or choke on food while being hand-fed. A bat may be choking if it suddenly coughs, 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 body should be gently wiped clean. Use soft make-up sponges or gauze pads dampened with warm water for this purpose. Be extremely gentle when wiping the faces of pups. Avoid using so much pressure that the pup's head moves with the gauze or sponge. In other words, the pup's head should remain stationary as its face is being wiped cleaned. In addition to causing discomfort to the pup, too-aggressive cleaning may damage tissue or force food particles into the pelage, resulting in skin infection or lesions.

**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.

Tree bat pups will need to be stimulated to initiate urination and defecation. Cotton swabs are too rough for this purpose. Instead, use the corner of a gauze pad that has been dipped in warm water (Figure 9-4) to gently flick the pup's anus and genitals. Use only the corner to softly flick the area. Flick repeatedly 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 in this section).



**Figure 9-4.** Use only the corner of a dampened gauze pad to stimulate tree bat pups to urinate and defecate. Cotton swabs are too rough for this purpose. *Bat World facility. Photo by A. Lollar*



## 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 9-5). Vespertilionidae pups that do not readily lap milk should be allowed to nurse from foam tips (Figure 9-6B) as described below.



**Figure 9-5.** 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 9-6A) 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 9-6B2). Use small scissors to cut the tip of the foam into a wedge shape (Figure 9-6B3). This size and shape is readily accepted by bat pups.

When nursing from foam tips, pups should be placed abdomen down on a heated surface to keep them warm. Heating pads can be utilized for this purpose. The medium setting appears to be the most comfortable for crevice pups. There should be two layers of cloth between the pup and the heating pad to prevent thermal burn. Fold a clean, absorbent cloth on top of the pad to absorb excess formula during each feeding. Allow the 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 on the following page. Use a clean, dry cloth for each feeding.

Begin by positioning the forceps on the foam (Figure 9-6C) 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.

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



**Figure 9-6. A:** Foam eye shadow applicators available at cosmetic stores.



**Figure 9-6. B:** A 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.



**Figure 9-6. C:** The prongs must be buried in the foam to protect the pup's mouth as the tip is introduced. Photos by A. Lollar.

Encourage the pup to take the tip by gently lifting the pup's head, which usually causes the pup to open its mouth. If the pup does not open its mouth, use the foam tip to very gently push the lower jaw down while sliding the tip into the mouth. Making soft clicking sounds during this process. Soft clicking mimics the directive calls some mother bats and pups use to locate each other. 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.) When the pup begins to nurse, release the forceps from the sponge tip as the pup will keep it clamped between its teeth (Figure 9-7A and B).

As the pup continues to nurse, warm formula can be added to the tip one drop at a time. 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 formula drips away from the infant.

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 9-7C). 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 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.



**Figure 9-7. A:** A new born free-tailed pup nursing from a foam tip. *T. brasiliensis*. Bat World facility. Photo by A. Lollar.



**Figure 9-7. B:** Big brown pups nursing from foam tips. *E. fuscus*. Bat World facility. Photo by A. Lollar.



**Figure 9-7. C:** An evening bat pup clutching a foam tip. *N. humeralis*. Bat World Lone Star facility. Photo by D. Hyatt.



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 9-8). 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 9-8.** A row of orphaned free-tailed pups nursing from 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 and Lighting. Caging described for adult crevice bats in Temporary Housing is also appropriate for crevice bat pups. A heating pad should be attached to the top and sides of the cage 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 cage clear of the heating pad so that infants can move away from the heat source if needed. A thermometer should be placed inside the cage 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%. Infant crevice bat pups and tree bat pups can be housed together when conspecifics are not available. Hand-raised crevice pups should be moved into full-sized flight cages with padded floors by six to eight 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 may 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 bat 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 9-9). 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. If the pup's head does not extend past the end of your thumb, milk will wick between the thumb and the pup, and saturate the fur on the chin, neck and chest. Therefore, it is critical that the pup's head extend past the thumb tip so that milk drops away from both the thumb and the pup.



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

## HOUSING TREE BAT PUPS

Infants 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 cage for additional warmth. Be sure to leave at least two of the walls of the cage 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 cage 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 cage, 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. Infant crevice bat pups and tree bat pups can be housed together when conspecifics are not available. Hand-raised tree bat pups should be moved into full-sized flight cages with padded floors by four to six 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 make-up sponge 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 sponge used to stimulate urination and defecation. This can result in serious bacterial infection from *Providencia rettgeri*, resulting in a build-up of fluid in the thoracic cavity and subsequent 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, gently clean with warm water and dry with a soft cloth. (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). 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 have 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 pup 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 that the bat remains passive, enjoying the warmth.

Fluff the fur with the interdental 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 your wrist or elbow, and then brush in one direction.) Make certain the pup is completely dry—both the fur and wing membranes—before returning it to its cage. Tree bat pups will usually begin grooming their bodies vigorously once they have been bathed and dried.



**BAT WORLD SANCTUARY MILK REPLACEMENT RECIPE****Vespertilionidae**

- 3.5 ounces (100ml) canned Meyenberg evaporated goats milk that has been reconstituted with filtered water
- 1.5ml organic or unrefined corn oil
- 0.5ml cold pressed flax oil
- 1.5 scoops (12.9g) Similac® Go & Grow, Soy-Based Powder
- 2 level tsp (4.3g) dried egg white.

Reduced oil formula for newborn to three weeks: Decrease oil by half if stools become loose.

Tree bats four weeks and older: Mix milk with an equal amount of soft food.

Use a small food storage container with a tight-fitting lid to mix and store. To the container add 3.5 ounces of Meyenberg goats milk that has been reconstituted with an equal amount of filtered water. Add 1.5 scoops Similac® Go & Grow Powder, 2 tsp dried egg white, 1.5ml corn oil and 0.5ml flax oil. Shake well to mix. (Makes about 1/2 cup. Divide the above measurements by half if a smaller amount is needed.) Store in the refrigerator. Do not freeze. Discard after 24 hours or sooner if it begins to thicken or smell spoiled. Wash container thoroughly and rinse well before mixing new batches of formula. Store goats milk in the refrigerator and discard any unused milk after five days or sooner if it begins to smell spoiled. Store Go & Grow Powder at room temperature and discard any unused powder after 30 days.

**Calculated Nutrient Values (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.

**Molossidae**

- 3.5 ounces (100ml) canned Meyenberg evaporated goats milk that has been reconstituted with filtered water
- 2 scoops (8.6g each) Similac® Go & Grow, Soy-Based Powder
- 2.0ml organic or unrefined corn oil
- 1.0ml cold pressed flax oil

Use a small food storage container with a tight-fitting lid to mix and store. To the container add 3.5 ounces of Meyenberg goats milk that has been reconstituted with an equal amount of filtered water. Add 2 scoops Similac® Go & Grow Powder, 3.0ml of corn oil and 1.0ml of flax oil. Shake well to mix. (Makes about 1/2 cup. Divide the above measurements by half if a smaller amount is needed.) Store in the refrigerator. Do not freeze. Discard after 24 hours or sooner if it begins to thicken or smell spoiled. Wash container thoroughly and rinse well before mixing new batches of formula. Store goats milk in the refrigerator and discard any unused milk after five days or sooner if it begins to smell spoiled. Store Go & Grow Powder at room temperature and discard any unused powder after 30 days.

**Calculated Nutrient Values (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.

**TABLE 9-1**  
**COMPARISON OF BAT MILK COMPOSITIONS**

	<b>Fat</b> %	<b>Protein</b> %	Carbohydrate %	Energy kJ/g
<b>Family: Vespertilionidae</b>				
<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
<b>Milk replacement recipe: Vespertilionidae</b>	8.2	7.3	9.8	5.6
<b>Family: Molossidae</b>				
<i>Tadarida brasiliensis</i>				
Early lactation	17.3	8.3	3.6	9.0
Peak lactation	25.8	7.7	3.4	12.1
<b>Milk replacement recipe: Molossidae</b>	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**  
**PUP SURVIVAL RATES FOR SELECT MILK REPLACEMENT FORMULAS<sup>◇</sup>**

Year	# of Pups	Species	Emaciated at intake	Injured at intake	Secondary complications	Died from secondary complications	Died from injury	Survival Rate (Number and (Percentage))	Formula used
1999	47	<i>T. brasiliensis</i>	22	5	MBD (4) Bloat (2)	3	4	40 (85.1%)	MH*
	5	<i>E. fuscus</i>	—	—	—	—	—	5 (100%)	MH*
	35	<i>L. borealis</i>	2	7	Bloat (3)	—	5	30 (85.7%)	
	3	<i>N. humeralis</i>	1	1	—	—	1	2 (66.7%)	MH*
2000	55	<i>T. brasiliensis</i>	31	7	MBD (12)	5	2	48 (87.3%)	MH*
	52	<i>L. borealis</i>	—	7	Bloat (4)	—	7	45 (86.5%)	MH*
2001	62	<i>T. brasiliensis</i>	27	10	MBD (11)	—	7	55 (88.7%)	MH*
	28	<i>L. borealis</i>	—	7	Bloat (4)	4	4	20 (71.4%)	MH*
2002	115	<i>T. brasiliensis</i>	67	22	MBD (24)	6	19	90 (78.3%)	MH*
	49	<i>L. borealis</i>	5	11	Bloat (1) MBD (3)	2	11	36 (73.5%)	MH* MH*
	1	<i>L. cinereus</i>	—	—	—	—	—	1 (100%)	MH*
	1	<i>P. subflavus</i>	—	—	—	—	—	1 (100%)	MH*
	9	<i>M. lucifugus</i>	9	—	SIDS (2)	2	—	7 (77.8%)	MH*
2003	76	<i>T. brasiliensis</i>	52	13	MBD (22)	4	1	71 (93.4%)	33/40**
	56	<i>L. borealis</i>	1	8	MBD (5)	2	4	50 (89.3%)	33/40**
	2	<i>N. humeralis</i>	2	—	—	—	—	2 (100%)	33/40**
2004	99	<i>T. brasiliensis</i>	42	22	MBD (30)	10	19	70 (70.7%)	33/40**
	25	<i>E. fuscus</i>	25	—	MBD (11) Bloat (5)	8	—	17 (68.0%)	33/40**
	72	<i>L. borealis</i>	3	10	MBD (1)	3	8	61 (84.7%)	33/40**
2005	70	<i>T. brasiliensis</i>	38	18	MBD (21)	9	10	51 (72.9%)	FV***
	64	<i>L. borealis</i>	—	14	Bloat (3)	—	12	52 (81.3%)	FV***
	7	<i>E. fuscus</i>	7	—	MBD (4)	—	—	7 (100%)	FV***
	1	<i>L. intermedius</i>	1	1	—	—	1	0 (0%)	FV***
2006	102	<i>T. brasiliensis</i>	44	2	MBD (25) Bloat (14) Other (16)†	25		77 (75.5%)	33/40**
	63	<i>L. borealis</i>	7	3	Bloat (22)	35	2	26 (41.3%)	33/40**
2007	87	<i>T. brasiliensis</i>	36	7	MBD (21) Bloat (17) Other (58)†	58	0	29 (33.3%)	33/40**
	26	<i>L. borealis</i>	2	1	Other (12)†	11	1	14 (53.8%)	33/40**
	3	<i>N. humeralis</i>	—	—	MBD (3)	—	—	3 (100%)	33/40**
2008	261	<i>T. brasiliensis</i>	99	83	MBD (0)** Bloat (7)	3	61	223 (85.4%)	BWS‡
	72	<i>L. borealis</i>	6	2	Bloat (27)	25	2	45 (62.5%)	BWS‡
	2	<i>N. humeralis</i>	—	—	Bloat (1)	—	—	2 (100%)	BWS‡
2009	230	<i>T. brasiliensis</i>	112	19	MBD (0)**	—	6	224 (97.4%)	BWS‡
	48	<i>L. borealis</i>	—	9	Bloat (4):•	1	1	46 (95.8%)	BWS‡
	1	<i>L. cinereus</i>	1	—	Bloat (1)	—	—	1 (100%)	BWS‡
	5	<i>N. humeralis</i>	5	—	—	—	—	5 (100%)	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) appearing to fracture under the weight of the pup's 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 indicates 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 formula dilution in place of regular feedings until feces appear normal.

### Overfeeding

A pup's abdomen should appear moderately rounded when adequately full (Figure 9-3). 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 (Figure 9-10). 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 (Figure 9-11). 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.



**Figure 9-10.** A free-tail pup with a distended abdomen from overfeeding. *T. brasiliensis*. Photo by A. Lollar.



**Figure 9-11.** Extracting milk from an overfed pup in respiratory distress. *T. brasiliensis*. Photo by A. Lollar.

### ***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. Probiotics may encourage growth of beneficial bacteria. To treat this condition, add 1/16 teaspoon Primadophilus powder (or another high quality beneficial flora product) to 3.5 ounces of milk formula. Continue adding probiotics until abdominal distention is relieved.

### ***Malnutrition***

Bloat from malnutrition, called hypoproteinemia, can be caused by decreased protein absorption, which causes the abdomen to fill with fluids. Proteins provide osmotic pressure in the blood and help in the retention of fluid. A decrease in protein creates decreased osmotic pressure, and fluids are therefore not retained within the capillaries and instead migrate to the abdominal cavity (ascites) and appears as distension of the abdomen.

Pups with this condition must be kept well hydrated, and should be fed the Vespertilionidae milk formula recipe mixed with the complete soft food diet (see page 76). For pups one day to two weeks old, mix three parts milk to one part soft food. Pups two weeks and older should receive a mixture of one part milk to one part soft food. If improvement is observed, continue to feed the Vespertilionidae milk formula/soft food mixture until the pup has reached juvenile stage, at which time mealworms can be introduced. If no improvement is observed within 48 hours, administer 0.01ml of Lasix orally (see Medications). The diuretic will help to eliminate excess fluid. If no improvement is observed within another 12 hours, administer a second dose of Lasix. Frequent, smaller feedings are also sometimes helpful in treating this condition, as well as the addition of probiotics such as Primadophilus powder (see Medications).

### ***Gastric Torsion***

Torsion of the stomach or intestines is life-threatening. The condition involves twisting of the stomach or the intestines, which causes the abdomen to expand with trapped air and gas. The etiology of this condition is not fully understood, although birth anomalies may be the cause. Trapped air can be manually removed using a 27gauge needle that is not attached to a syringe, which will allow air to escape the instant the needle is inserted (see Figure 9-11 for placement of the needle). Unfortunately, this will only offer temporary relief. Due to the nature of the condition, the stomach will again fill with air in a matter of hours. Surgery for this condition is typically not successful due to the propensity of the twist to reoccur, therefore, euthanasia is recommended.

### ***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 9-12), inflammation of the joints, muscle weakness, and neuromuscular hyperirritability often progressing to tetanic spasms and sometimes convulsions. 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.



**Figure 9-12.** A juvenile big brown bat with MBD. *E. fuscus*. Photo by D. Kinamon.

The author has raised approximately 2,700 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 was developed in 2008 by a PhD Nutritional Scientist. 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. Not only did the pups thrive, no pups developed MBD.

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<sup>®</sup> 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 Bat World Sanctuary's milk replacement recipe. For juveniles, add 1 gram (1/4 tsp) to every 3mls of soft food diet. Metacam<sup>®</sup> should also be administered for pain (see Medications). 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.

## OTHER COMPLICATIONS

### Injuries

Pups become injured for a variety of reasons in the wild, including bird attacks, falling from roosts, and from being bitten by adult bats. Fractures should be treated as described in Open and Closed Fractures. However, because the bones of a pup are relatively soft, a simple fracture often needs little intervention as the fracture will mend and straighten as the pup grows. Bites from other bats should be treated as described in Bite Wounds. Severely infected wings may require amputation. Most insectivorous bat pups respond extremely well to an amputation, both physically and psychologically.

## FEEDING JUVENILE BATS

Depending on the species, juvenile bats are ready to accept the complete soft food diet at three 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 8 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. Because wild juvenile bats are still nursing while learning to forage for insects, milk formula 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 not 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 bats to continue drinking milk formulas, 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 milk formula from a syringe or medicine dropper, for another week or two, at which time mealworms or soft food can again be offered. Juvenile bats that are ready to be weaned entirely will no longer accept milk formula.



## 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 fur 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 9-13). 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 with an interdental brush on a daily basis.



**Figure 9-13.** 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 cage 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.