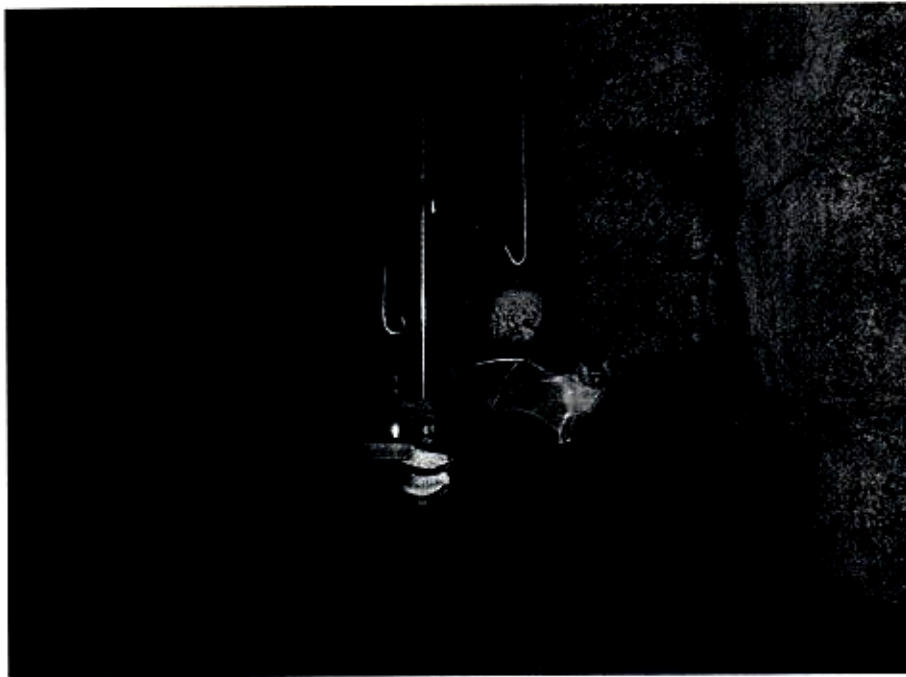


Nectarivorous bat Husbandry Manual



Glossophaga soricina (Michel Delorme)

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1. Natural History

There are about 900-950 recognized species of bats (order Chiroptera) worldwide. Among living mammals, bats are highly diversified creatures. This characteristic is greatly assignable to their choice of diets. Bats feed on a great diversity of food such as insects, fruits, leaves, flowers, nectar, pollen, fish, other vertebrates, and blood. Nearly 30 % of the known species of bats feed almost exclusively on plants, taking floral resources (pollen and nectar), fruit and leaves. Specialized bats that feed on nectar and pollen belong to the following suborders of bats, the Megachiroptera and the Microchiroptera. The Megachiroptera, comprising the Old World fruit bats of the family Pteropodidae, contains approximately 11 species of specialized nectarivores. As for Microchiroptera, nearly 40 species of nectarivores are found in the neotropical family Phyllostomidae which include the hereby species, *Glossophaga soricina*.

In North America, *G. soricina* is currently kept in captivity at the Montreal Biodome in Quebec, Canada and at the Organization for Bat Conservation's facility (OBC) in Haslett, Michigan. The species is also found in Europe at Erlangen University in Erlangen, Germany for research purposes. For the most part, the information contained hereafter is based on the expertise of keeping the nectar-feeding bat, *G. soricina* in captivity at the Montreal Biodome and the OBC facility.

1.1 Physical characteristics

G. soricina is a delicate bat, small in size (mass about 11 g; total length, 48-65 mm). The adult forearm is < 42 mm and wingspan averaging 275 mm. In general, males are larger than females. The fur is quite dense, soft and grayish brown. The muzzle is slightly elongated and houses a long and narrow extensible tongue with filiform papillae at the tip. The cheek teeth are narrow and elongate. The ears are relatively short and blunt. These bats have an interesting manoeuvrability in dense vegetation owing to their broad and highly cambered wings. They can also hover for a few moments and get the copious energy-rich nectar and pollen from flowers.

1.2 Range and habitat

G. soricina is common and widespread. These nectar-feeding bats are found from northern Mexico to Paraguay and northern Argentina, and also in Jamaica and Bahamas. They are found throughout the tropical rainforest and in secondary forest, deciduous forest, savana, disturbed sites, plantations and dry stream beds. *Glossophaga* are opportunistic roosters. They like to roost in hollow trees, caves, and man-made structures such as culverts, buildings, drains, tunnels, or under bridges. Typical roosting colonies size varies between a half-dozen to many hundreds of individuals.

1.3 Feeding behavior

Nectar feeding bats are important for the environment because they pollinate and assist in the reproduction of certain plant species. *G. soricina* feed primarily on the nectar of night flowering plants. Although they are well adapted to feed on pollen and nectar, this species also includes fruit and insects in their diet. The elongated snout is well adapted to allow the bats to slip their heads into the flowers. The long and narrow tongue is very useful to get the rich nectar but also to lick the pollen stuck on specialized hairs on and around the head of the bat during grooming period. As pollen is a rich source of protein, this behavioral strategy allow the bats to meet their protein requirements.

2. HOUSING

Before deciding to obtain a colony of this species many factors need to be considered to assure a healthy and happy population. These factors include; adequate enclosures, appropriate lighting/temperatures, accommodating cage furniture, and proper diet as well as daily enhancement.

2.1 Exhibits

Like other bats, *G. soricina* are very prone to wing injuries so it's imperative that the enclosures be adequate. The cage should be made of a soft-sided material and be free of any sharp projections. It has been found that these bats housed even for a short while in hard

sided cages incur wing tip injuries quickly. Most *G. soricina* are displayed in artificial cave-like structures constructed of concrete (e.g., the shot crete wet mix design), in extremely large exhibits (tropical building) or in enclosures made of soft side concrete wall. For bat cave exhibit, it is important to create a vault which is semi-rough to facilitate roosting. It is also recommended to have small concave pockets in the vault to offer multiple visual barriers and ensure the establishment of social structure in the colony. For enclosures made of soft side concrete wall, it is necessary to rely on a roof designed to provide them with proper perches. Polyethylene netting (Vexar)¹ of 1 cm mesh hang on the ceiling provides adequate toeholds for bats. Enclosures with glass fronts or traversed by a glassed-in corridor present no special problems. The enclosure should always be large enough to allow for free flight and hovering. An enclosure size for a population of 33 bats should measures around 4 m L x 2 m W x 2 m H.

¹ Du Pont Canada Inc., Mississauga, Ontario.

2.2 Furnishings

Nectar feeding bats like to roost in either the open, from the top of the cage, or in roost boxes. Therefore, the top of the enclosure should be mesh and a roost box or two should be provided. Many nectar-feeding bats are colonial, however they do not cluster. Roost boxes should be large enough for all bats to comfortably use and spread out. The construction of roost boxes is important. They should be constructed of nontreated wood. The inside of the front, the top and all four sides should be lined with polyethylene mesh or grooved. The mesh or grooves provide an area for the bats to easily grasp and roost comfortably. It is also necessary to have a long landing platform, which should also be meshed or grooved. No light should be able to penetrate into the roost box. For a colony of 33 individuals, two roost boxes (35 cm L x 21 cm W x 31 cm H with a landing platform of 12 cm) are suggested. It's necessary for *G.sorcina* to have a dark place to retreat. In very large exhibit such as tropical building, it is important to provide at least two darkened roost area because females tend to segregate into maternity colonies.

In addition to providing roost boxes in the enclosure, many other types of cage furniture, or cage accessories, should be provided to offer the bats a more natural environment. The cage furniture should consist of natural branches from a non-toxic tree, various types of foliage that can range from artificial silk flowers, leaves and vines to real non-toxic plants. In

tropical buildings, *G. soricina* like to feed on flowers such as the following species; Satin leaf (*Chrysophyllum oliviforme*), Firebush (*Hamelia patens*), Astrocaryum (*Astrocaryum alatum*), Zebra plant (*Aphelandra tetragona*), Calathea (*Calathea crotalifolia*), Goldfish plant (*Columnea spp.*) and Spiral ginger (*Costus spiralis*). Also, *G. soricina* is greatly attracted by the foliar nectaries secretion of *Inga* trees. It seems that *G. soricina* enjoy roosting on a wicker-non coated fan. The foliage offered in the enclosure should be altered or rotated often so that it not only acts as a replica of their natural environment but also as a source of additional stimulus or form of enhancement.

2.3 Temperature/humidity

Although *G. soricina* can be found in the warm and humid climate of lowland regions as well as in cool climate of higher elevations, this tropical do best in temperature ranging between 21 and 29°C. The relative humidity recommended for that species is between 75 and 85 %.

2.4 Ventilation

An exhibit well ventilated with a certain amount of fresh air entering is necessary to avoid the buildup of unpleasant odors. For fruit bat, it is recommended to have 6 to 10 air exchanges per hour with 25 % fresh air (Fascione, 1995).

2.5 Lighting

Lighting is a factor to consider when keeping bats in captivity. For exhibition purposes, light cycles should be controlled to reverse day and night activity patterns of the bats. Day-time activity of *G.soricina* is easily stimulated by reversing normal high and low light intensities. *G.soricina* do well on lighting systems composed of fluorescent during day cycles and halogen with blue filters during nocturnal cycles. A dim lighting system is appropriate to prevent the shock of immediate bright light or complete darkness. *G.soricina* seem to adapt well on a 10 :14, 12 :12 or 14 :10 light/dark cycle.

3. MANAGEMENT

3.1 Feed sources

In addition to specialized housing, Long-tongued bats have specialized dietary requirements. A nutritionally complete diet for nectarivorous bats is composed of a liquid diet of fruit juice/nectar and fresh fruits such as cantaloupe and banana. Table 1 present a successful diet currently in use at the Biodome and the Organization for Bat Conservation's facility (OBC). The diet is offered to a colony of 100 individuals of *G. soricina* on a daily basis. In developing a balanced diet for nectar-feeding bats, we tried to meet target nutrient ranges defined by the AZA Chiropteran Taxon Advisory Group (Table 2)

Table 1. Liquid diet for nectarivorous bats

Food components	Quantity
Tropical Passion Oasis unsweetened (Juice)*	960 ml
Corn oil	20 ml
Purina High Protein Monkey Chow 5045	15 g
Nektar-plus†	55 g
Nectar powder mixture	30 g

Sources of diet components

* A.Lassande Inc., Rougemont (Quebec), Canada

† Nekton, Pforzheim, West Germany

Nectar powder mixture

Components	Quantity
Mixed cereal	500 g
Fructose	500 g
Powder milk	300 g
Wheat germ oil	160 g
Vitadol Plus§	40 g

§ Upjohn Company, Animal Health Division, Orangeville, Ontario, Canada.

Table 2. Composition of selected nutrients by nectar-feeding bats *Glossophaga soricina* (n=100) at the Biodome de Montreal, Quebec, Canada. All the nutrients (except water) on a dry matter basis. Diets comprised (as-fed basis) : 71.3% bat nectar and 28.7% fruit.

Nutrient	Biodome de Montreal diet (May 2001)	Chiropteran Taxon Advisory Group diet recommendation ²
	Calculated analysis ¹	
Water (%)	79.0	n.a.
Protein (%)	4.8	2 to 15
Fat (%)	8.8	5 to 9
Soluble carbohydrate (%)	80.0	n.a.
Ash (%)	2.5	n.a.
Vitamin A (IU/g)	6.4	4 to 14
Vitamin D (IU/g)	1.5	0.2 to 2.0
Vitamin E (mg/kg)	45.1	11 to 56
Ca (%)	0.14	0.5 to 1.0
P (%)	0.12	0.4 to 0.9
Mg (%)	0.06	n.a.
Cu (mg/kg)	3.29	n.a.
Fe (mg/kg)	71.0	n.a.
Mn (mg/kg)	10.7	n.a.
Zn (mg/kg)	12.5	n.a.

Diet composition (by fresh weight) for 1) bat nectar : 88.9% fruit juice, 1.8% corn oil, 1.4% high protein monkey chow, 5.1% nektar plus (Nekton, Pforzheim, West Germany), 2.8% Biodome nectar powder, 2) nectar powder : 33.3% baby food, 33.3 % sucrose, 20% dry milk, 10.7% wheat germ, 2.7% stress aid (Vitadol Plus, Upjohn Company, Animal Health Division, Orangeville, Ontario, Canada) 3) fruits : 61.4% bananas, 38.6% cantaloupe.

n.a. = not analysed or not available

¹Nutrient values in diet quantified by calculated analysis. Quantified using Zootrition dietary management software, Wildlife Conservation Society, 1999.

²Fruit Bat Husbandry Manual, AZA Chiropteran Taxon Advisory Group, 1995.

The diet is mixed with a variable speed electric blender. The prepared diet keeps for at least 2 days (and even longer) when refrigerated. The liquid diet of *G. soricina* comes with fruits such as cantaloupe and banana. A less labor-intensive diet could also be used for nectarivorous species. The diet in question, is used by the Wildlife Conservation society for their nectar-feeders and is composed of a single nectar product called "Roudybush hummingbird nectar" (web site address: <http://www.roudybush.com>). It should be observed that nectar-feeders are housed jointly with frugivorous species, so they have access to the salad mix as well.

3.2 Feed presentation

Dietary presentation is almost as important as the diet itself. Nectar solution can be offered in a variety of hummingbird feeders. It is important to take into consideration when choosing a feeder whether or not it will be accommodating and easily used by the nectar-feeding bat. The feeder must not have bee guards or obstructions around the opening. The opening must also be as close as possible to the nectar itself to ensure that the bat will be able to reach the fluid with its tongue. The daily feeders used at OBC and Biodome are, respectively, the Little Beginner Hummingbird Feeders by Perky-Pet Products Co. (2201 South Wabash street, Denver, Co 80231, U.S.A.) and the Oriole Feeders by Opus Incorporated (P.O. Box 525, Bellingham, MA, 02019, U.S.A.). Open-topped feeders, such as a plate with an extension in the middle hung from the ceiling, are favorites among the bats.

Yet another form of presentation includes open shallow dishes placed in hanging baskets. More unique forms of presentation are a good source of daily enhancement but this should be done with extra nectar so that it is guaranteed that the entire population receives enough to eat each night. This can be done by using hummingbird feeders in the shape of artificial flowers placed in a pot. Drowning is an important factor to consider when contemplating various ideas of presenting food to smaller bats. To deter drowning, it is helpful to place a variety of marbles in the open dishes to allow an area for footing should an individual accidentally fall into the dish.

We also offer our bats a variety of fresh fruits. It's important that they have fresh melon (watermelon, honeydew melon, cantaloupe) and ripe bananas every day. We present the melon to the bats by hanging it on metal skewers. We cut the melon up into wedges

(removing the seeds) and then spear the melon with the hooks through the rind. This allows the melon to hang securely and freely so it's easily accessible to the bats. The bananas offered must be ripe. We have found that it is often times difficult for them to eat the banana if it's not soft and ripened. The melon and bananas can be frozen, thawed and then presented to the bats but is always preferred fresh. Having frozen fruit on hand in case of an emergency is always a good idea. Many other types of fruits are offered to the bats as enhancement. These include; slices of mango, papaya, as well grapes and strawberries that are cut in half and strung on skewers. Finally, a small, shallow dish of fresh water should be placed on the floor or on a ledge in the enclosure daily.

Each day the feeders and fruit skewers should be placed as far apart as possible as well as in a different location so that the bats are forced to actively forage as they would in nature. There has been some territorial behaviors observed so it's important to have the nectar and fruit as spread out as possible to ensure adequate consumption by each individual.

3.3 Feeding schedule

The liquid diets have a tendency to sour or ferment when left out overnight especially in warm environments. The bats must be fed at the end of the light cycle to minimize fermentation of the food prior to feeding.

3.4 Water

Although water requirements are not well defined in bats, it is likely that nectar feeding bats drink fresh water in order to prevent dehydration from consumption of hypertonic solutions. A small, shallow dish of fresh water should be placed on the floor or on a ledge in the enclosure daily.

3.5 Identification

A well-tried method of individual identification for nectarivorous bats is the electronic system that utilizes a transponder implanted under the bat's skin. This method is permanent and eliminates disfigurement of the animal. Generally, the transponder is implanted in the

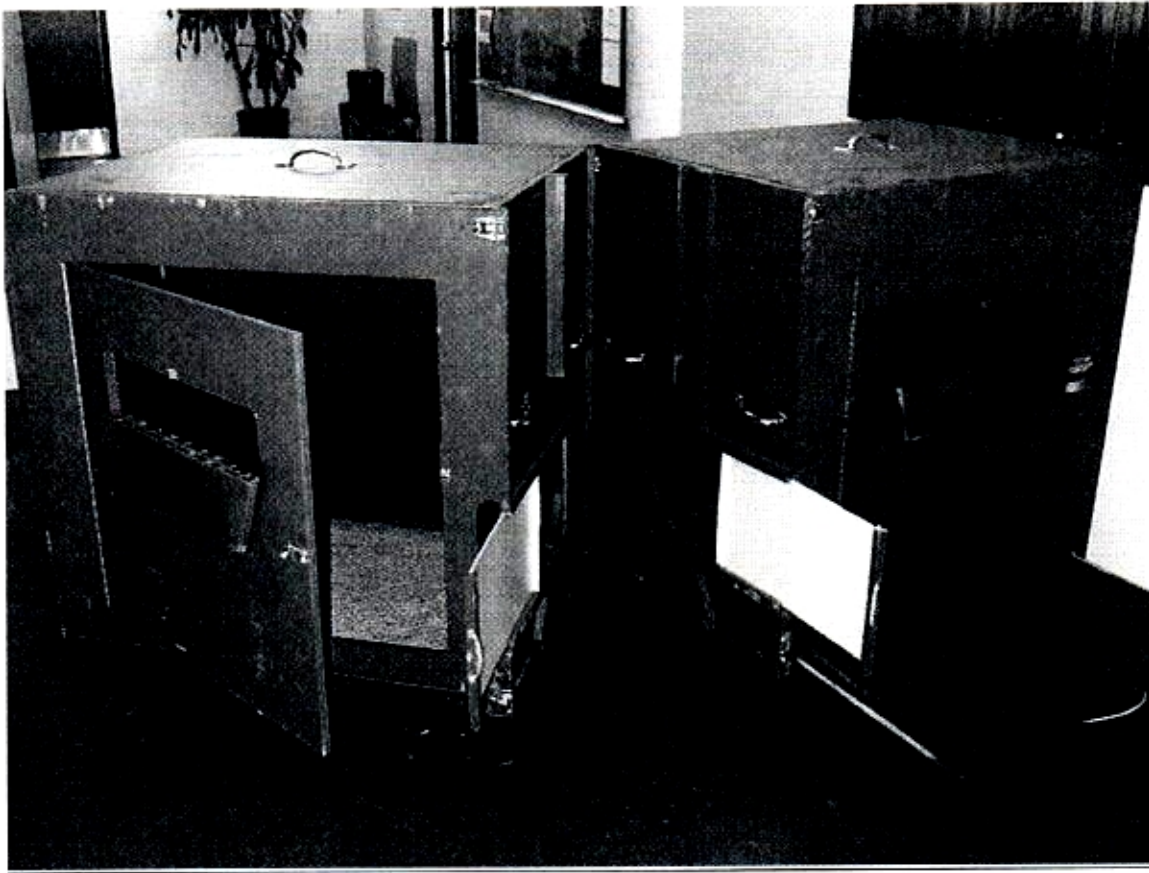
posterior dorsal region. It is not recommended to place the transponder between the shoulder blades of the bat. Although transponders are the size of a grain of rice, it may interfere with movements associated with flight.

3.6 Capture, handling and restraint

In general, it is recommended to avoid manipulating the animals against any rigid-walled enclosures. In large areas, nectar-feeding bats can be caught with an insect net having a deep nylon bag and a telescoping aluminium handle. In large, free flight aviaries, mist nets can also be used to capture bats. In more confined spaces, an aquarium net custom fitted with a deep nylon bag can be used. Nectar-feeding bats can be handled with very thin and flexible goatskin leather gloves. These bats are so delicate that it is not recommended to wear thick, stiff gloves. Never squeeze the bats when holding them, but rather loosely cup your hand around them. When the bats bite the gloves, do not pull them free because this can easily damage their teeth. Blowing puffs of air into their faces usually induces them to release the gloves. Do not hold any bat by the wing tips during restraint and always fold the wings close to the body. To remove bats that are hanging on wire or perches, unhook their nails rather than pulling on the bat (Fascione, 1995).

The Biodome de Montreal has designed a bipartite wood cage to maintain several small nectar-feeding bats off display for a short period of time (Figure 1). It is comparable in design to those utilized in some previous studies (Rasweiler, 1972; 1977). Dimensions of the cage are: total cage- 41 cm high, 30 cm deep, 80 cm wide. The cage is split into two equal sections of 41 cm high, 30 cm deep, 40 cm wide. The two sections are hermetically connected by snap-locks around the edge of each section. Each section has a removable ceiling so that one can be closed to create a dark area for roosting and the other can be open to create at night a dark feeding area. A hole of 10 cm in diameter was made in each section in order to allow the bats flight from one section to the other. A sliding door in front of each hole can be used to close and restrain the bats in one section. The whole cage can be moved easily thanks to the wheels fixed under the cage. A sliding floor allows the keeper to clean the floor without disturbing the bats. Each section has its own access door and viewing panel.

Figure 1



Bipartite wood cage for nectar-feeding bats (Michel Delorme)

3.7 Pest control

The best control is to exclude pests. Cleanliness in and near bat enclosures is of the utmost importance. Be sure the area around your bat enclosure is free of places that harbor pests, such as cardboard boxes or piles of trash. Seal all cracks and holes into the exhibit (Fascione, 1995). Cockroaches are the most common pest found in and around nectar-feeding bat exhibits. Roach traps, boric acid baits and ivermectin in peanut butter have been used successfully to control roach populations. Ants are particularly attracted to the sweet nectar and fruits. Ant populations can be suppressed in the vicinity of the bat food by using various types of ant baits. Hummingbird feeders and fruits should be hung from the ceiling to reduce access and if necessary, an entomological glue such as Tangletrap can be applied (1 cm wide)

on the wire as an additional barrier to the ants. However, the Tangletrap must be shielded from bats.

3.8 Sanitation

Bats prefer to live in a less than sanitary environment and frequent hosing may distress the animals. Using bedding on the floor of the exhibit will allow dry or spot cleaning on a daily basis. Scrubbing waste from surfaces is necessary, however, on at least a weekly basis, and more frequently for large colonies. It is important to scrub exhibit walls because feces frequently adhere to them. Food and water dishes should be cleaned and sanitized daily to remove urine and feces (Fascione, 1995). When disinfectants or bleach are used to clean dishes or exhibits, it is critical to rinse them well as these chemicals are potentially harmful to bats (Wilson, 1988). Following is the sanitation procedure of the bat cave at the Biodome de Montreal. A large colonies of 400 fruit-eating bats lives in a large flight bat cave. The cave is cleaned every day.

Cleaning method :

Floor and pane of glass :

1 cup (8oz) of Sparkleen;

400 ml of concentrated bleach;

Add Sparkleen and bleach to a 5 gallon bucket;

Fill with hot water;

Scrub waste from surfaces. We use Scotchbrite 3M, pad holder to clean and scrub;

Rinse off following application.

With the high temperature and humidity inside the bat cave, some black spots (moisture) may appear on floors and walls. Here is the cleaning procedure for the moisture :

Mix 400 ml of concentrated bleach to 600ml of hot water;

Spray this liquid on the black spots normally 1 or 2 times per week);

Scrub the black spots;

Rinse off following application

Concentrated bleach : 5.8% Sodium hypochlorite

Sparkleen : Fisher Scientific Co. Pittsburg, PA 15219

3.9 Crating and transport

Nectar-feeding bats can be shipped communally. Mothers with nursing infants should not be shipped. Zoos must follow IATA standards for all international shipments (web site address: <http://www.iata.org>). When shipping within the United States, IATA standards are still recommended by the Center for Disease Control (CDC), the United States Department of Agriculture (USDA), Animal Plant Health Inspection Service (APHIS) and the United States Department of the Interior (USDI) (Fascione, 1995).

Nectar-feeding bats can be transported in quart-sized cardboard cartons¹. These containers, which can be purchased from paper goods companies, measure about four and one-quarter inches (10.8 cm) in diameter at the top, three and one-half inches (8.9 cm) in diameter at the bottom, and are six inches high. They should be moisture-resistant and have slip-on-lids. To give the bats something to hang on to, line the interior by stapling in one-eighth inch (3.2 mm) square mesh plastic aquaculture netting². Punch air holes in the sides with a cork borer. Up to three nectar-feeding bats (*Glossophaga* sized bats) can fit in one carton.

Fourteen of these cardboard cartons can be placed inside a screen-lined cardboard mouse shipping cage (with the partitions removed).³ For extra protection, the mouse cages can be placed inside a strong protective container constructed of one inch (2.5 cm) square, hollow aluminium tubing that is lined on the sides with one-quarter inch (6.2 mm) galvanized wire mesh and has a plywood roof and floor.⁴

Bats should have access to food just prior to shipping. Ideally they should not remain in the shipping container for more than 15 hours (Fascione, 1995).

¹Information was provide by Dr. John J. Rasweiler, The New York Hospital-Cornell Medical Center.

²Naltex, Austin, Texas

³Jackson lab, Bar Harbor, Maine.

⁴Corners Limited, Kalamazoo, Michigan.

3.10 Record Keeping

All bats should be included in ISIS records as individuals rather than as a group count. It is also recommended that all neo-natal deaths, stillborns, and aborted fetuses be included in ISIS records. While this is not always an easy task, especially with large colonies of microbats, it is an important tool in determining population demographics (Fascione, 1995).

4. BEHAVIOR AND SOCIAL ORGANIZATION

4.1 Groupings

Nectar-feeding bats are social animals. In the wild, typical roosting colonies vary between a half-dozen to many hundreds of individuals. Therefore, it is not recommended to maintain single animals for a long period of time. A suggested number of individuals and sex ratio to set a breeding colony of nectar-feeding bat such as *G.soricina* consists of 2 or 3 adult males and 12 adult females. In larger colonies, it is likely that females tend to segregate into maternity colonies (Dalquest, 1953; Rasweiler, 1970).

4.2 Introductions and removals

There is little information available on the introduction or the removal of nectar-feeding bats into existing colonies. There appears to be no major problem in introducing or removing males or females into existing colonies. The Biodome de Montreal has removed some *G.soricina* for shipment to other facilities with no adverse effects on the remaining bats in the colony. However, it should be observed that all introductions and removals of *G. soricina* have been experienced only on large colonies.

4.3 Mixed species exhibits

Nectar-feeding bats do well in mixed species exhibit. At the Biodome de Montreal, as many as 3 species of phyllostomid bats share the cave with a large colony of *G. soricina*. Indeed, about 100 specimens of *G.soricina* live with 150 *Carollia perspicillata*, 150 *Artibeus jamaicensis* and 6 *Anoura geoffroyi* without any problem. The cave has a surface area of 82 m² or 875 ft² and is traversed by a glassed-in corridor. Nectar-feeding bats can also be

exhibited in large aviaries with other taxa. The only problem that should be taken into consideration is the potential predation of nocturnal reptiles (snake, basilisk lizards, etc). There has been one case reported of predation in the tropical building of the Biodome, where a basilisk (*Basiliscus basiliscus*) caught a bat in flight (Routhier, pers comm.).

4.4 Enrichment

Enrichment with nectar-feeding bats has been experienced in the large tropical aviary of the Biodome de Montreal. The complex vegetation, with numerous flowering species offer both olfactory and dietary enrichment. A variety of flowers such as Satin leaf (*Chrysophyllum oliviforme*), Firebush (*Hamelia patens*), Astrocaryum (*Astrocaryum alatum*), Zebra plant (*Aphelandra tetragona*), Calathea (*Calathea crotalifolia*), Goldfish plant (*Columnea spp.*) and Spiral ginger (*Costus spiralis*) are visited each night by the nectar-feeding bat *G. soricina*. For exhibits that are constructed as bat cave, flowers can be tied in bundles with plastic cable ties and hung in the cave (LeBlanc, 1999).

Diet presentation may also stimulate natural foraging behavior and exploration of nectar-feeding bats. In this regard, Oriole feeders* and fruits should be hung from the ceiling. Bats will hover and forage from Oriole feeders and fruits.

*Oriole Feeders by Opus Incorporated (P.O. Box 525, Bellingham, MA, 02019, U.S.A.).

4.5 Aggression

Because females tend to segregate into maternity colonies, it seems that aggression is minimized. To help avoid undue fighting among animals, be sure to have sufficient feeding and roosting areas in the enclosure.

5. Reproduction

5.1 Behavior

Female *G. soricina* exhibit menstruation and seems to have a reproductive cycle of 22-26 days (Rasweiler, 1972). Mating activity should normally occur during these 3 or 4 weeks. In

Central America, Flemming et al. (1972) reported that ovulation and mating may be biannual. Breeding success of *G. soricina* seems not to be affected by the environment and outside disturbance. Indeed, a few studies showed that *G. soricina* can mate and conceive despite being housed in small cages and subject to daily handling (Rasweiler 1972, 1974). According to Rasweiler (1974), a low male/female sex ratio may be advisable to ensure an efficient breeding success with *G. soricina*. Females give birth throughout the year, although the majority of births at the Biodome occur in the warmest period of the year (July and August). Males are slightly larger than females (Walker 1975). Nursing lasts approximatively 1 month before the young bat can fly.

5.2 Contraception

Little or no information is available on reversible, chemical contraceptive methods in bats. The most simple and inexpensive method of contraception recommended for nectar-feeding bats is to house them in single sex groups.

6.0 Health

6.1 Parasites

Ectoparasites: Common in all species of bat. Ectoparasites include ticks, mites and some species of parasite fly.

In general, there is no or few pathogens.

Some species of mites can be in a so great number that they can develop dermatitis in glabrous area denuded of hair.

We have previously observed some infestation of Streblidae (fly) which pursued more than 19 months in a colony of *G. soricina* maintained in laboratory (Rasweiler, 1986).

Endoparasites: Three routines test for parasites are indicated during the animal quarantine, even if endoparasites seem unfrequented in *G. soricina*. Different nematodes have been identified. Filarial for one have been frequently founded in the interior peritoneal cavity of *G. soricina*. As these infection are often important, it is always advisable to initiate a

treatment (Rasweiler, 1986). Different treatments have been effective (Wilson, 1988). Ivermectin (400 mg/kg) and Fenbendazole (50 to 100 mg/kg) have been used with success.

6.2 Illness

There are very few data available regarding the diseases that affect specifically *G. soricina*. Good captive conditions and a cleaning protocol are essential in order to avoid disease problems. For exemple, *Leptospira*, can be find in urine and *Salmonella* in feces and eventually may cause serious problems. Many virus have been isolated from salivary glands of chiroptera and many others are still discover (Constantine, 1993).

In the Biodome captive colony, many bats advanced in years (more than 10 years) have lost their teeth probably because of the high rate of sugar in the diet previously in used. Cases of weakness sometimes occurred and were resolved by rehydrating and feeding the animal.

6.3 Common injuries and treatments

In normal captive condition, *G. soricina* is not a species, which is especially aggressive. Few injuries du to intra or inter specific aggressions are observed.

In the Biodome captive colony, fractures at the wing level are the most frequent injuries. The most implicated bone is humerus. They are often complicated open fractures which, are not easy to treat. Moreover, as the animal hover during feeding, reducing of the fracture must be carefully accomplished. A warm chamber should be available in order to maintain weak or wet individuals.

6.4 Immobilization

For short intervention and when gas anesthesia is not possible, ketamine has been used successfully (10 to 35 mg/kg, intra muscular (IM)), but the muscular relaxation is poor and the wake up is agitated. A combination of xylazine (2mg/kg, IM) and ketamine (10 mg/kg, IM) give better results and a smoothest wake up.

The choice anesthesia remain the isoflurane (induction at 5%, maintain at 2.5-3%). Induction and wake up are fasts and secure.

6.5 Innocations

There are no vaccinations presently recommended for bats. Bats should not be vaccinated against rabies for two reasons. First, there is no vaccine legally licensed for use in bats, and second, the vaccine may interfere with tests for rabies detection (Fascione, 1995).

6.6 Physiological reference values

Normal resting body temperature for *G. soricina* has been reported to be approximately $37.2 \pm 0.3^{\circ}\text{C}$ (Rasweiler, 1973). Table 3 presents normal blood values of *G. soricina*.

6.7 Necropsy protocol

All bats that die should be necropsied. Gross necropsy should be accompanied by submission of representative tissues (brain, skeletal muscle, heart, lung, liver, stomach, pancreas, small and large intestine, kidneys, gonads, bone and bone marrow) for pathology. Accurate necropsy records should be made, and mortality rates should be tracked on a yearly basis (including neonatal deaths) (Fascione, 1995). The Center for Disease Control (CDC) has recommended that all bats that die be tested for rabies.

6.8 Zoonotic diseases

Rabies

Rabies is the most important zoonotic disease associated with bats. Rabies can infect any mammal but is commonly transmitted by bats and other carnivores such as dogs, fox and racoon. Rabies is rare among rodents and cannot be spread by birds, reptiles, amphibians, fish or insects. Rabies is a viral disease that affects the central nervous system. It is almost always fatal once symptoms are evident. The rabies virus lives in the saliva and nervous tissue of infected animals and is spread when they bite or scratch. The virus can also be transmitted if infected body fluids come in contact with broken skin or mucous membranes.

The incubation period for rabies, the time from exposure to signs of symptoms, is extremely variable. The average time is 2-12 weeks but can range from less than 10 days to over 6 months (Sikes, 1970). Human symptoms of rabies are irritability, fever, inability to sleep, throat spasms, apprehension, headache, hydrophobia and paralysis (AAZK, 1990). The symptoms of rabies in bats are generally characterized by anorexia, dehydration, restlessness, disorientation, sensitivity to light, sound or touch, and paralysis (Bernard, 1995). In order to protect personnel that work around bats, the CDC recommends they receive pre-exposure vaccinations for rabies and have their titers checked regularly. Each facility should establish a bite protocol and keep records of all bites. In addition bats that die should be tested for rabies.

Source: Vampire bat husbandry manual.

Histoplasmosis

Histoplasmosis infection is an airborne disease caused by a fungus, *Histoplasma capsulatum*. Histoplasmosis needs certain conditions to flourish. The fungus is generally found in areas with large concentrations of birds or bats and where accumulated bird or bat droppings have existed for 3 or more years. The spores become airborne when soil containing the fungus is disturbed. It is contracted by breathing this dust. The fungus occurs primarily in the Mississippi Basin of the United States, the tropics and subtropics. Histoplasmosis infection is not commonly associated with captive bats because fecal material is removed on a regular basis.

Source: Vampire bat husbandry manual.

6.9 Quarantine

When captive-born bats are received from another institution, ideally they should be quarantined for 90 days. However, this may vary depending on the source of the animals and their previous standard of care and medical testing. Minimally, they should be quarantined for 30 days. If at all possible the bats should be quarantined in groups rather than as single animals or their social behavior may be adversely affected. The quarantine environment should be the same as the bats' natural ambient conditions. All bats should be examined as soon as possible after shipping for evidence of disease. An additional exam should be performed before the animals are removed from quarantine. Any bats that die during quarantine must have a complete necropsy (see necropsy recommendations) including rabies testing. If a bat dies during quarantine and the cause is unknown, the quarantine period should be extended to allow sufficient time for detection of disease in the remaining animals. Ideally, wild-caught animals should be held in captivity for one month prior to shipping from their country of origin. This has the benefit of allowing detection and removal of any sick animals, and it allows the animals to adapt to captivity prior to shipping. During the holding period prior to shipment, the bats should be examined by a veterinarian, and treated for ecto- and endoparasites. Wild-caught bats should be quarantine for a minimum of 6 months. Following completion of quarantine, it is recommended that wild-caught animals placed on

exhibit be isolated from other animals for at least 1 year and housed in cages that protect the public from bat urine and feces.

Source: Fruit bat husbandry manual

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