

Hornbill Basic Care Guidelines

Introduction

In some cases, Ex Situ management of threatened species has proven to be an effective tool (IUCN/SSC (2014). Guidelines on the Use of Ex Situ Management for Species Conservation. Version 2.0. Gland, Switzerland: IUCN Species Survival Commission). Before considering this step, many factors must be considered, including the facility required to house individuals.

Hornbills have been housed in managed care for more than a hundred years, but in order to properly care for them and maintain their welfare, all aspects of their housing, diet, care and veterinary needs must be carefully considered. These guidelines are intended to be a brief overview of the various considerations that must be taken into account when planning the construction of a facility for housing hornbills. They are not intended to be a full husbandry guide and those considering the construction of such a facility are encouraged to reach out to professional zoological associations such as WAZA (World Association of Zoos and Aquariums), EAZA (European Association of Zoos and Aquaria), and AZA (Association of Zoos and Aquariums, based in North America) for more specific recommendations. These organizations and their member institutions have a wealth of experience and knowledge in care and welfare of hornbills.

Housing

Hornbills are active birds and their enclosure should be large and diverse enough to allow them to carry out the full range of natural behaviors. Depending on the species held, dimensions of the enclosure can vary, but elongated enclosures are ideal as it allows the birds to fly some distance. In general, a minimum width of four times the wingspan of the species and a minimum length of 2-4 times the width is recommended. Since most hornbills are found high in the forest canopy, offering them the opportunity to perch as high as possible is encouraged. Minimum enclosure heights of 4m are recommended, with 5m recommended for the largest species.

Table 1 Recommended minimum enclosure sizes

Small Hornbills (<i>Tockus</i> , <i>Penelopides</i> and some <i>Bycanistes</i>)	20 m ² x 4m high
Medium-sized hornbills (<i>Anthracoseros</i> , some <i>Bycanistes</i>)	40 m ² x 4m high
Large Hornbills (<i>Buceros</i> , <i>Rhyticeros</i>)	80m ² x 5m high
<i>Bucorvus</i>	100m ² x 5m high



Figure 1: Wrikled Hornbill enclosure, Sedgwick County Zoo, Wichita, KS, USA

In order to make birds feel as secure and secluded as possible, limit the sides of the enclosure that are open to viewing, and place enclosures as far away from roads and footpaths as can be managed.

The size of the mesh used for the enclosure should be small enough so as not to allow the hornbill's beak or casque to fully fit through it. Ideally, it should also exclude, pests or predators native to the area. Hornbills can be destructive, so the mesh should be strong enough to withstand damage from birds (as well as any pests/predators that are native to the area).

For larger species (*Bucorvus*, *Buceros*, *Berenicornis*, *Rhyticeros*, *Aceros*, *Ceratogymna*, *Bycanistes*) stainless steel mesh is ideal, and an aperture of 2.5 cm will prevent most vermin (except mice) from entering the aviary. The mesh can be welded or woven, with the latter usually having the added benefit that, because of the way it is attached, it sometimes has a little "give" if the bird somehow collides with the mesh; this can soften/prevent some injuries. Galvanized mesh can be equally used but it requires more maintenance and tends to have a shorter lifespan in humid weather.



Figure 2 Rhinoceros Hornbil enclosure, Jacksonsville Zoo, Jacksonville, FL, USA

Smaller species (*Tockus*, *Lophoceros*, *Horizoceros*, *Penelopides*) can be housed in smaller mesh, the same type that would be adequate for starlings. Flexible mesh is preferred.

Knitted mesh (“Invisimesh”) can be used for the smaller species, but it is less resistant and more prone to be damaged by falling branches, overgrown vegetation (both inside and outside the aviary) and wild animals trying to get inside. It is not safe to use with larger species as they can easily tear through it if they so desire.

Vertical wire (“piano wire”) has been associated with beak and casque injuries and is not recommended.

Always ensure that bits of wire/nails/screws have been picked up before placing any birds into an enclosure. Hornbills are inquisitive by nature and will play with items on the ground. This could lead to them ingesting items that could lead to metal poisoning.

Vegetation and perching are a crucial part of any hornbill enclosure. Perching should allow the birds to perch at a variety of heights, while still leaving plenty of flight space in the enclosure. An assortment of perches of different sizes, diameters and materials (e.g. natural branches, rope, wood) are important as well. Having at least a couple of sturdy, long, horizontal perches seems to play an important role. They can act as stable platforms for the male to mount the female, as well as allow the birds to bounce on or shake them as part of displays.



Figure 3: Rhinoceros Hornbill Enclosure, Minnesota Zoo, Apple Valley, MN, USA

Hornbills use smaller, pointed twigs to clean their bills, so it is important to have perching with side branches if possible, especially if there are no living trees in the exhibit. A well planted exhibit can be very important to creating a good environment for hornbills. Trees and other vegetation can act as perching, as well as creating visual barriers. Visual barriers allow birds to get out of each other's line of sight (thus reducing aggression) as well as hide from humans, which can reduce stress. Shrubs and other lower vegetation are recommended as well, so that a female can escape a male when attacked. Vegetation can also provide important shade, although birds should be able to have access to full sun if desired. Hornbills are also very fond of sunbathing. Lastly, hornbills often "bathe" in the foliage of wet trees and shrubs.

Most hornbills are primarily arboreal but will occasionally come to the ground to forage. As a result, a substrate should be used that allows the birds to land and take off smoothly without sliding. Hornbills do

not typically drink from pools or water bowls, so a pool is not necessary, but small African hornbills have been known to bathe on occasion.

Ground hornbills, as their name implies are primarily terrestrial, and as such their enclosures have different requirements. Natural substrate is needed, as spending long periods on it can lead to foot problems. Some low vegetation is recommended, as long as it doesn't take up too much of the ground space. Long grasses should be used sparingly. While perching is important for resting or roosting, walking space should be maximized as they will spend most of the day on the ground. Ground hornbills (as well as some other species) are fond of sand or dust bathing for parasite control, so an appropriate area for that is recommended.

Although it can vary with individuals, certain species are more prone to be highly arboreal, rarely coming to the ground unless there is something wrong with them or the environment, while other species can spend some time foraging on the ground.

The table below is merely indicative:

Table 2 General enclosure usage

Terrestrial	Ground Hornbills (<i>Bucorvus</i> spp.) – although they can fly and must perch/roost and/or nest higher up
Regularly foraging on the ground	<i>Tockus</i> spp. / <i>Lophoceros</i> spp.
Occasionally foraging on the ground	<i>Anthracoceros</i> spp. / <i>Bycanistes</i> spp.
Mostly arboreal	<i>Buceros</i> spp. / <i>Berenicornis comatus</i> / <i>Rhinoplax vigil</i> / <i>Horizoceros</i> spp. / <i>Rhyticeros</i> spp. / <i>Rhabdotorhinus</i> spp. / <i>Penelopides</i> spp. / <i>Aceros</i> spp. / <i>Ceratogymna</i> spp.

In addition to the main enclosure, having an adjacent enclosure can be very important for managing the birds. An adjacent enclosure can act as a holding space if birds need to be separated due to aggression (aggression between the breeding pair or between the breeding pair and older offspring). It can also facilitate introduction of birds to form new breeding pairs. One or preferably two connection or sliding doors may be useful, to make escaping possible when introducing birds. Ideally, these doors would be situated off of the ground, making it easier for the birds to fly or hop through them. When designing multiple habitats, it is important to not place these side by side, or at least to have sufficient planting or other sight barriers between aviaries, to prevent aggression between males.

If possible, keeper entrances into the enclosure should be positioned away from the nesting/breeding area so that staff can enter the enclosure when necessary with minimal disturbance to the birds. Also, having a two-door “double containment” style entrance is preferred so that birds cannot escape from the enclosure when staff is entering the enclosure.

Care routines

In general, routine cleaning of enclosures is important to maintain good hygiene, reduce parasites and disease, and prevent pests. However, this must be balanced with the desire to minimize disturbance of the birds. Routine cleaning of heavily planted exhibits can be difficult and may be more of a disturbance than a benefit. In these cases, opportunistic cleaning of areas under favored perches and feeding areas should be the main focus.

Feeding areas should be cleaned regularly (daily if possible) in order to reduce pests and prevent ingestion of old or spoiled food. A different substrate immediately below the feeding area (concrete or similar) may be useful in facilitating this. Other areas of the enclosure can be cleaned less frequently in order to reduce disruption of birds. In particular, extra care should be taken during the beginning of the nesting season, as females have been known to abandon nests before eggs are laid.

Hornbills can become very aggressive, particularly during nesting. Therefore, staff should take care when entering and working in enclosures. In some places, staff will wear head and eye protection to prevent injury from birds who may approach them. If a connected holding cage is part of the set-up, birds can easily be trained to enter that for feeding and the door closed behind them to allow staff to service the enclosure safely. If birds are particularly aggressive, using two or more staff members to service an enclosure might be needed.

Diet and Nutrition

Nutrient requirements of hornbills have yet to be identified (except for crude protein in certain species) so diet recommendations are based on best practices. Interestingly, hornbills also span the ecological niche spectrum from frugivorous to carnivorous. While field studies have shown slight variations in the amount of fruit vs animal protein taken within different species, in reality most of the nutritional needs for Hornbills can be covered using three base diets that can be adjusted to meet specific needs:

Diet A: Mostly frugivorous / Fruit-biased Omnivores (*Anorhinus*, *Oocyceros*, *Anthracoceros*, *Buceros*, *Penelopides*, *Rhyticeros*, *Ceratogymna*, *Bycanistes*, *Anorhinus*)

Diet B: Meat-biased Omnivores (Most *Tockus*, *Horizoceros*, *Berenicornis*)

Diet C: Carnivorous (*Bucorvus*)

These specific diets may be used in zoological institutions for the maintenance period (below) but will require an enhanced version of the diet for breeding and rearing. Frugivorous species do well with more food availability as well as the abundance of very colorful foods that they can parade around with and feed to their mate. Carnivores do well with more insects and pieces of meat during this period. It is important to increase the calcium of the diet during these periods as well. Rescue centers will need to use easily available and affordable food items and focus on maintaining health at the lowest possible cost.

Table 3: Maintenance diet composition recommendations for the three different diet types for zoological institutions. These diets allow for a significant shift of diet for breeding season.

Diet Component	A	B	C
Fruits	70	30	
Low iron softbill pellets	30	20	
Insects			
Meat/whole prey		50	100

Fruits may include (but not limited to): papaya, apples, pears, oranges, bananas, all kinds of berries, melons, kiwi, etc.

Table 4: Maintenance diet composition recommendations for the three different diet types for rescue centres.

Diet Component	A	B	C
Watery Fruits	30	30	
Fibrous, forest fruits	30	30	
Root vegetables	25	0	
Concentrate	15	10	
Insects/egg			
Meat/whole prey		30	100

Watery fruits include: banana, papaya, melons, mango, kiwi, pineapple etc.

Fibrous fruits include: rambutan, jackfruit, durian, longan, sapodilla, persimmon, guava etc.

Root vegetables include: taro, sweet potato, carrot, etc.

Make sure that fruits are rinsed well and larger fruit cut into cubes small enough for the bird to manipulate and ingest.

Ideally fruit salads will be supplemented with commercial, good quality, low-iron pellets. Alternatively, if these are not available, other possible “concentrates” include: toasted or sprouted soybeans, tofu, tempeh, sunflower seeds, pili nuts, any boiled or sprouted beans, hard boiled eggs with shell, dog or cat food (low iron), dry baby cereals. Some of these may not be palatable to the hornbills and should be ground up and mixed with the fruits as a coating

Good protein sources include insects, minced meat (be careful in hot, humid weather as it can spoil very fast), hard boiled eggs and whole prey such as mice, lizards, frogs, chicken chicks etc. Always include a calcium supplement when feeding meat or insects.

During the breeding season, an increase in protein or lipids in the diet may act as a stimulant to hornbills in captivity. In addition, birds feeding offspring will need additional sources of protein to meet the needs of the growing chicks.

Reproduction

The formation of a compatible pair is probably the most important factor for breeding success in human care. Giving birds a choice of mates may be more likely to result in a compatible pairing. Regardless, care should be taken during any introduction of birds as serious aggression can result. Ideally, the birds will be in adjacent enclosures so they can see and hear each other but not come into direct contact.

Enclosures should be perched so that the birds can sit side-by-side on opposite sides of the separating mesh. Wait for pair-bonding/affiliative behaviors (e.g. sitting side by side, duet calling, offering and acceptance of food) before birds are finally introduced to each other. Initial introductions should be closely monitored, so that staff can intervene in the event of severe aggression. Ideally the introduction should be done in a neutral space; if this is not possible the individual most likely to be the aggressor should be introduced into the other's enclosure.

The nest is very important in stimulating hornbills to breed and a variety of designs (from natural cavities to wooden boxes, to barrels, to boxes from composite materials) have been successful. Nests should be located high in the enclosure and since some artificial nest boxes can be difficult for birds to cling to, a perch allowing inspection of the cavity (as well as allowing the male to feed the female through the opening) is important. Dimensions of the box and nest cavity obviously vary depending on the species but there are some general guidelines to follow (see appendix A). The internal dimensions of the box should be large enough for the female to incubate eggs/brood chicks and turn her body, but not too large. It should also be tall enough to allow the female to jump up if she so desires. Cavity entrances are generally tall and narrow. The entrance to the box should be wide enough for the female to be able to squeeze in and out, but if it is too wide, it can be difficult for the birds to seal. Entrance should be placed on lower half of nestbox, so that female can look out of nest, and female and chicks can defecate outside of nest.

Nest substrate (e.g. leaves, wood shavings, turf...) should be present and can serve multiple functions. First, it allows the birds to keep a good grip and not slide. Birds, particularly young chicks, may be prone to splayed legs if they are unable to get a good grip on the floor of the cavity. Secondly, substrate helps absorb feces and is sometimes used as part of the cavity sealing process. Lastly, the proper substrate can play an important role in helping to regulate humidity in the cavity, which can be very important.

Hornbills should be supplied with a variety of material for sealing up the nest cavity during breeding. Some birds will simply use a mixture of feces and the nest substrate. However, others will use a variety of other material, including mud, leaves, soft fruit and other food items. It is good practice to offer a variety of suitable materials during the sealing process to ensure that the birds have what they feel most comfortable with. The nesting strategy for ground hornbills is slightly different, as they don't seal themselves in like other hornbill species.

When designing a nest box, it is important to consider the need for staff to access the cavity. While, we strive to keep disturbance to a minimum and the goal is always to allow the birds to incubate eggs and raise young on their own, situations might arise when access to the cavity would be desired. If eggs or chicks are in some sort of distress, the presence of an access door in the box is an invaluable resource. Any such door should be large enough so that even older chicks could be safely removed. However, the door must be able to be completely sealed, as any light leaking through might dissuade the pair from using the box. Placing a camera high inside the nest cavity can also be a great tool and allow close monitoring of the female, eggs and chicks. A data logger to record humidity and temperature in the nest will help in collecting important data as well. The birds are usually aware of the camera and hit it with their beaks, so placing it out of reach towards the top of the box is recommended. Again, there are

additional considerations for the ground hornbills. The floor of their box should be thick, sturdy and well attached because bashing the floor of their nest is part of their courtship display. In addition, it is important that boxes for *Bucorvus* sp. are placed in good light so that parents have adequate lighting to see and care for their chicks. Therefore, placing their boxes under a roof is not recommended.

Hand-rearing hornbill chicks is not preferred, for a number of reasons, but being willing and able to intervene in the case of a struggling chick can be called for in some circumstances. In general, the goal should be to provide supportive care and return the chick to the parents. As long as the female remains in the cavity - perhaps caring for another chick(s) – a chick can often be returned to her a few hours or a few days later and be accepted. If a chick must be permanently pulled for hand-rearing, as many precautions as possible must be taken to try and avoid imprinting on humans. Some of those precautions include using a puppet for feeding, raising multiple chicks together and visual and auditory access to adult hornbills as soon as possible. In some cases, if some aspect of parental care is lacking, but the chicks are still being cared for, it may be possible to do a combination of parent-rearing and hand-rearing. Chicks can be taken out for supplemental feedings and returned to the nest afterwards, so they continue to get the benefits of parental care during rearing.

An example of a successful hand-rearing protocol is provided in appendix B.

Individual Identification

The most common and useful methods for identifying individual birds are microchips (inserted in the pectoral muscle) and leg bands.

The microchip has the advantage to be a safer and more difficult to tamper method. They do, however, require the bird to be conditioned to come quite close for reading or to be physically caught.

Leg bands can be made of different colors to help identify animals in a flock or clutch and should be placed in the metatarsal area. Because of the hornbills breeding biology close-ringing is not always an option (unless the chicks are hand-reared or the female is particularly calm and accepting of nest inspections), but open rings work just as well.

When possible, it is recommended that both microchip and leg band are used. Leg bands should be monitored because they can cause injury if they become too small or constricted. Microchips can migrate from their original injection site, so be sure to scan the entire body when trying to read one.

Veterinary Matters

For the most part hornbills are quite resilient and resistant birds and present few medical problems. A good prophylactic veterinary program, with regular parasite checks and a healthy diet should ensure minimal health issues.

General supportive care and emergency care for hornbills is similar to that of other bird species. There are a few medical conditions that seem to be relatively prevalent with Hornbills, and they are briefly described below:

Infectious Diseases

Hornbills are susceptible to the same type of infectious diseases as most other birds and these can be caused by viruses, bacteria, fungi or parasites (both protozoan and metazoan).

Depending on the country and/or region, institutions may choose to vaccinate their birds against certain agents. The most commonly used vaccines in Hornbills include:

- Avian Influenza
- Newcastle Disease
- Yersiniosis

It should be noted that vaccinated birds may have problems being transferred between facilities in different countries, depending on the vaccine used and the pre-import country requirements (this is because of the presence of vaccinal antibodies).

Yersiniosis, a bacterial infection caused by *Yersinia pseudotuberculosis* and *Y. enterocolitica*, deserves special mentioning as some hornbill spp. seem to be particularly prone to it. The source of infection is contaminated food and water via droppings of rodents or eventually wild animals (including other birds). The disease is usually quite rapidly fatal, with fulminating multi-focal necrotizing hepatitis being the most common lesion. Similar lesions can also frequently be seen in the spleen.

While the infection is usually fatal with minimal symptoms, in case it is diagnosed (even presumptively) in vivo treatment with effective antibiotics (e.g. Enrofloxacin, Marbofloxacin, Amoxicillin-clavulanic acid) along with supportive care therapy may be successful depending on the damage to organs (liver).

In endemic areas with high prevalence of the disease it may be considered to vaccinate the birds.

Rodenticide Poisoning

Because of curiosity exhibited by many hornbills, secondary poisoning with rodenticides is a problem that can be encountered in facilities with rodent control programs that rely on poisoning. The birds get intoxicated when they ingest poisoned rodents that make their way inside their enclosures or ingest poison carried into enclosure by rodents.

There are different types of rodenticides, but those that work as Vitamin K antagonists remain the most popular.

Clinical signs are not specific, and it is important to realize that hemorrhages / bleeding is only one possible (and less common) sign shown. Lethargy, vomiting, diarrhea, seizures and shock have all been described. Treatment is palliative and supportive, and includes fluids, Vitamin K (for Vitamin K antagonists only) and eventual plasma/blood transfusion.

Prevention is key here, and a pest control program that does not use poison is very effective in not having to face the risk of the birds getting secondary poisoning.

Hemochromatosis (Iron Storage Disease)

Some Hornbill species, in particular those that are more heavily frugivorous, may be predisposed to Hemochromatosis, a metabolic disease where excess iron in the diet is deposited in the liver cells, leading to cell disruption and organ failure. While the etiology of Iron Storage Disease (ISD) is complex, it is believed that species that feed mostly on iron-poor fruits have a gut that is adapted to maximize iron uptake, and this may lead to excess iron being absorbed by the bird when the diet is richer. Besides from the liver, the heart is also frequently affected. Ascorbic Acid (Vitamin C) potentiates iron absorption and as such food items rich in it (e.g. citrus fruits) should be avoided for ISD prone species. Over supplementation with Vitamin A has also been linked to increase in iron uptake.

Prevention of Hemochromatosis is key, as treatment (phlebotomy and/or chelating agents such as deferoxamine) is often unrewarding. It is important the diets are formulated to have a low iron content (ideally less than 50 ppm). Items such as raisins and meat / meat-based products should be minimized or avoided as they are known to be very high in iron. Avoid over supplementing with vitamin A (recommended 1000-1500 IU Vit A/Kg of diet).

Signs of liver / heart failure and diet information can be used to make a presumptive diagnostic in vivo; this can be further confirmed with endoscopy / liver biopsy.

Post-mortem diagnosis comes from macroscopic changes (swollen, coppery color to the liver) in the affected organs and is confirmed by histopathology.

Beak Trauma

This is a problem most often seen in Ground Hornbills (*Bucorvus* spp.) and its etiology is generally unknown but most certainly multi-factorial. Possible causes include poor exhibit design where beaks can get trapped in wire mesh / bars, substrates too rich in rocks where the birds may damage their beaks while naturally foraging for food or aggression both intra-specific or extra-specific (in particular those mixed with ungulates).

Regardless of the original cause, most birds can cope well with smaller injuries, in particular if they are symmetrical (i.e. both upper and lower beak affected); larger, asymmetrical lesions may impair the bird's ability to pick up food items and corrective trimming of the intact half of the beak may be necessary. Prosthetics to the tip of the beak are unrewarding given the Ground Hornbills' habit of foraging by 'stabbing' the substrate. Prosthesis using acrylic (Technovit) have been used to repair damage to the upper beak.

One possible consequence of such beak injuries even when the birds cope well is the inability to feed chicks, and this should be held in consideration.

Appendix A

Sample hornbill nestbox dimensions (courtesy Wildlife Reserves Singapore)


Small Hornbill nest box

Quantity: 1

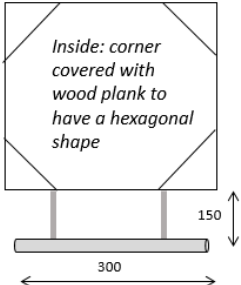
Material type: Marine Plywood
Thickness: 30mm

Additional note:

- Two hinges on the back of the box to hang it on the mesh



Top view



300 (internal)

180

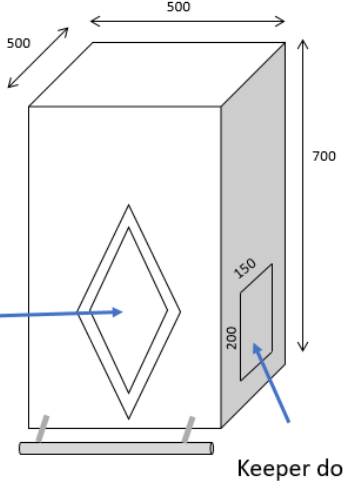
300

150

300

Thickness: 60 mm

Bird entrance



500

500

700

150

200

Keeper door


Large Hornbill nest box

Quantity: 1

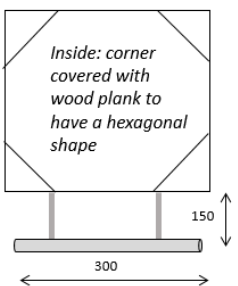
Material type: Marine Plywood
Thickness: 30mm

Additional note:

- Two hinges on the back of the box to hang it on the mesh



Top view



700 (internal)

230

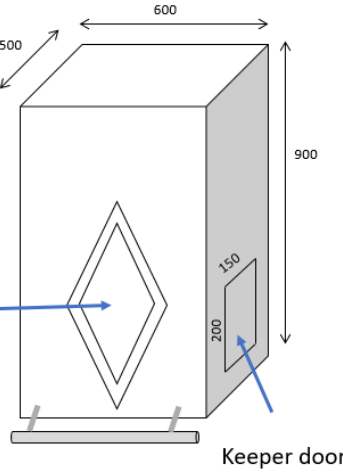
700

150

300

Thickness: 60 mm

Bird entrance



600

500

900

150

200

Keeper door

Appendix B

Sample hornbill hand-rearing protocol (courtesy Wildlife Reserves Singapore)

Day	Temp (°C)	Brooder set-up	Frequency of feedings	Diet (% by weight)	Intake	Notes
0	38	Cup with tissue & spongy mat. Watercup in brooder for humidity (~70% relative humidity)	Every 2 hours (7x per day)	60% pinkie mice 20% softbill pellets 20% papaya Moisten food with bottled drinking water See below for supplements	Feed 15-20% body weight	Hydration is most important. Alert vet if chick fails to defecate after more than 2 feedings.
1-4	37					
5-6	33	~65% relative humidity				When chick's eyes open, begin ghost/puppet feeding
7			Every 3 hours (5x per day)			
8-19	30					
20-29				50% pellets (ground) 16% minced beef 16% egg food 16% Uni Patee 2% papaya	Feed 6% body weight	Introduce meat balls. Mash all ingredients into balls together with nekton MSA
30+			Every 4 hours (4x per day)			

- All supplements can be given on multiple feedings if amount required does not fit on one feeding
- liquid vitamin B complex (Nature's Answer Hi potency liquid dietary supplement for humans) - Use 1cc/50g food fed
- Calcium carbonate (CaCO) - Use 1% of amount fed previous day
- Dicalcium phosphate (DiCal) - Use 1% of amount fed previous day