Taxon Management Account for King Cobra *Ophiophagus hannah*

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At the Central Zoo Authority International conference held February 21-24, 2008 and reported in April 08 ZPM, Working Groups discussed mostly threatened species selected by CZA for intensive management. One of these was the King Cobra Ophiophagus hannah *(Cantor, 1836), which is biologically important for its uniqueness and size. In the discussion it was noted that improved techniques for keeping, displaying and breeding King Cobra were required.*

Dr. Robert C. Lacy, a resource person at the meeting, suggested after the conference via email that the AZA Taxon Management Account for King Cobra might be useful and sent a copy to some of the concerned persons. We offered to run this in ZOOS' PRINT if permission could be obtained and Bob convinced those responsible to give permission and here it is !

The American Zoo Association had sent ZOO a whole collection of their standards and guidelines for keeping a large number of different species and at that time we distributed these far and wide ... as print outs, in ZOOS' PRINT and maybe ZOO ZEN also. Now, those guidelines are very much outdated and many of the TAGs (Taxon Advisory Groups) are revising them. We will obtain those which are complete and appropriate and publish some of them from time to time.

In the meantime, I note that some of the references in this TMA are a bit old and, for some of the information, it doesn't matter as it is historical. However, many things change over years and it may be that someone in the field in India has knowledge of new publications and even unpublished but reliable information that supercede what is here. It would be a good exchange of expertise -- husbandry expertise for most recent field information - ***Editor Emeritus***

Introduction and Natural History:

The king cobra, *Ophiophagus hannah* (Cantor, 1836), belongs to a unique monotypic genus of the family Elapidae. It is considered to be the largest venomous snake in the world, capable of attaining a length of 5.5 - 6 meters (Campden-Main, 1970; Cox, 1991; Daniel, 1983; Schmidt and Inger, 1957; Zug, 1993).

Ophiophagus can be distinguished from cobras of the genus *Naja* by the presence of a pair of enlarged occipital shields, and the absence of a cuneate scale between the third and fourth lower labials (Campden-Main, 1970; Daniel, 1983; Zhao and Adler, 1993).

Ophiophagus is distributed over much of southern Asia including peninsular India south of the Himalayas, Bangladesh, Burma, Thailand, Kampuchea, Laos, Vietnam, Malaysia, southern China, Indonesia (Sumatra, Java, Borneo) and the Philippines (Harding and Welch, 1980; Schmidt and Inger, 1957; Welch, 1988). There is a single record of its occurrence from eastern Pakistan (Daniel, 1983). Preferred habitat consists of tropical moist forest, forested stream banks, mangrove swamps and bamboo thickets (Liat, 1979; Loveridge, 1946; A. Alcala, pers. comm.; R. Whitaker, pers. comm.).

Currently, there are no recognized subspecies of *Ophiophagus*, however, several distinct pattern and color morphs exist. Specimens from the western part of the range are blackish brown to light brown with 43-56 indistinct dark bands that become increasingly more obscure with age, (Daniel, 1983). In the southern part of the range individuals are brown to light green gray with no distinct bands (Campden-Main, 1970; Liat, 1979), while those in the northern parts of the range retain more of the juvenile pattern with a light green to brown ground color with distinct white crossbands (Campden-Main, 1970; Cox, 1991). Juveniles are black with white or yellowish crossbands (Campden-Main, 1970; Cox, 1991; Daniel, 1983). Specimens from the southern part of the range tend to attain a larger size than those from the northern extension of the range (Cox, 1991), the largest known specimen coming from the Malay Peninsula (Loveridge, 1946).

Ophiophagus is a diurnal predator and feeds almost exclusively on other reptiles, especially snakes and lizards of the genus *Varanus*. (Cox, 1991; Daniel, 1983).

Ophiophagus is oviparous and one of the very few snakes that actually constructs a nest (Campden-Main, 1970; Cox, 1991; Daniel, 1983; Loveridge, 1946; Schmidt and Inger, 1957). The nests are invariably located in bamboo thickets and this might be an important habitat requirement of the species (Cox, 1991; Whitaker, pers. comm.). In the wild, female *Ophiophagus* are reported to construct a two-chambered nest from leaf litter and other plant material, the eggs being deposited in the lower chamber while the female, at times, may reside in the upper chamber (Loveridge, 1946; Schmidt and Inger, 1957). Female *Ophiophagus* are reported to brood their eggs (Zug, 1993) and/or guard the eggs from potential predators (Campden-Main, 1970; Cox, 1991; Daniel, 1983; Loveridge, 1946).

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Male *Ophiophagus* have also been reported to participate in nest guarding (Loveridge, 1946; Schmidt and Inger, 1957). *Ophiophagus* may form pairs, at least during the breeding season, and possibly for longer periods of time (R.Whitaker, pers. comm.) however there are conflicting reports regarding this little known aspect of *Ophiophagus* reproductive behavior. In India, the nesting season for *Ophiophagus* extends from April to July (Daniel, 1983). In the wild, approximately 20-43 eggs may be laid in a single clutch (Cox, 1991; Liat, 1979).

Conservation Status

Very little is known about the status of wild populations of *Ophiophagus*, but it is generally considered to be uncommon throughout much of its range and to have a naturally low population density (Liat, 1979; Alcala, pers. comm.). As early as the 19th century king cobras were recorded as being "not frequently met with" (Ewart, 1878). *Ophiophagus* is described as being "not a common snake in India" (Daniel, 1983), " rare in India" (R. Whitaker, pers. comm.) and rare in the Philippines (Alcala, 1986). Conversely, Cox (pers. comm.) describes *Ophiophagus* as being "still relatively common" in Thailand but less so than *Naja* and the two sympatric large species of *Python*. Wild populations are reported to be declining in India (R. Whitaker, pers. comm.) and the Philippines (A. Alcala, pers. comm.).

The main threat to wild populations of *Ophiophagus* is the continuing destruction of the South East Asian tropical moist forest (A. Alcala, pers. comm.; R. Whitaker, pers. comm.) that is occurring throughout the snake's range. Dodd (1987) indicated that the leather trade represented a significant threat to *Ophiophagus*, however Alcala, Cox and Whitaker (pers. comm.) concluded that the leather trade did not utilize large numbers of skins from this species. Whitaker (pers. comm.) did report large numbers of *Ophiophagus* being taken in South East Asian countries for their meat and blood, which are used in traditional medicines. Currently, *Ophiophagus* is listed as CITIES Appendix II. The general paucity of information regarding the status and ecology of wild populations of *Ophiophagus* indicates a need for basic field studies of this species.

Captive Management

As of August 01 2002, there were 15.22.8 (45) *Ophiophagus* being held in 26 institutions in the US (Pfaff, 2002). Although captive reproduction of this species has been occurring sporadically since the 1950's (Oliver, 1956), the majority of captive specimens have come from the wild (Pfaff, 2002). Most of the imported specimens came from India during the 1960's and Thailand during the 1970's and 1980's. Occasionally specimens were imported from Malaysia and Hong Kong (L. Porras, pers. comm.).

Husbandry Parameters

Ophiophagus do not require especially narrow husbandry parameters and are not difficult to maintain in captivity.

An ambient temperature of ~ 22 - 27°C with a thermal gradient provided by substrate heating or basking lights should be provided. Some institutions have reported that *Ophiophagus* spend little time basking with a constant ambient temperature of 27°C. Photoperiods utilized vary widely from 12/12 hours to the natural photoperiod of the southern US. Although some institutions utilize full spectrum lighting, others have maintained the species for long periods of time with standard fluorescent and incandescent illumination. *Ophiophagus* may have difficulty shedding if relative humidity levels are below 60%. Misting or soaking a specimen which is in shed can help to alleviate this problem, however, *Ophiophagus* are still notorious for retaining corneal shields. Unshed eyecaps can be manually removed, however, if left in place, the corneal shields will likely come off during the next shedding cycle if higher humidity levels are provided (Odum, pers. comm.)

The natural diet of *Ophiophagus* consists largely of snakes including members of the genera *Ahaetulla, Amphiesma, Boiga*, *Python, Ptyas* and *Trimeresurus* as well as lizards, including the genera *Calotes, Gekko* and *Varanus* (Cox, 1991; Whitaker, 1979). Captive specimens also readily accept snakes as food items including the genera *Agkistrodon, Crotalus, Drymarchon, Elaphe, Nerodia* and *Pituophis* (Burchfield, 1977*)*. One US institution reported that during the 1930's, a 4m *Ophiophagus* consumed "450 feet of indigo snakes" in four years. The frequency, amounts and types of food items fed to captive *Ophiophagus* varies widely between institutions. Many institutions have conditioned *Ophiophagus* to accept rodents as food. Although there has been some speculation *Ophiophagus* may not thrive on a diet of warm-blooded animals (Cox, 1991), specimens have been maintained for at least 20 years on a diet of domestic lab rats and are apparently healthy and capable of successful reproduction (Pfaff pers. ob.). *Ophiophagus* can initially be conditioned to accept rodents by scenting the food item with a more natural prey. This can be accomplished by suturing a section of a dead snake to the head of the rodent, dipping the rodent in "snake soup", a soup literally made by boiling pieces of snake in water, (A. Odum, pers. comm.) or simply rubbing the head of the food item with musk exuded from a live snake (C. Adams, pers. comm.). After a period of time most king cobras will begin to accept rodents as food without the need for scenting.

Due to the large size and active nature of *Ophiophagus*, relatively large enclosures are required to accommodate this species. Two institutions have maintained breeding pairs of *Ophiophagus* in enclosures measuring 3 X 2 X 2 M. Because the species has a reputation for being a

fast moving and dangerously aggressive snake, shift cages are usually incorporated into the exhibit design (Burchfield, 1977). At the Gladys Porter Zoo, light reversal shift cages were used successfully to move *Ophiophagus* on and off exhibit (Burchfield, 1977). At Riverbanks Zoo, however, they rarely utilize darkened retreats whether on exhibit or in off exhibit holding cages. At this institution, when the snakes need to be shifted, they can easily be guided into the shift cage using snake hooks. *Ophiophagus* can also be conditioned to shift by feeding them in the shift cage (A. Odum, pers. comm.).

Wild caught *Ophiophagus* or individuals that are fed live snakes invariably are infested with endoparasites. Freezing food snakes before they are offered can reduce the transmission of certain types of endoparasites (Burchfield, 1977). Other than that, no particular disease seems to be a significant problem with this species. Slavens (1993) reports longevities of more than 22 years.

Ophiophagus has been maintained successfully in pairs or small groups (Burchfield, 1977; Oliver, 1956), however, cannibalism in this species has been reported (Burchfield, 1977; Fife, 1978). This problem can be more acute when there is a disparate size difference between two specimens. Attempted cannibalism involving a previously compatible breeding pair has also been reported (Adams, pers. comm.).

The sex of *Ophiophagus* can be easily determined by caudal probing. In addition, there is some degree of sexual dimorphism in respect to size, with male specimens, on average, being larger than females.

Ophiophagus are seasonal breeders in the wild, with mating, nest construction and egg deposition occurring during the spring; April - June in India (Daniel, 1983; Whitaker, 1979). Likewise, in captivity, they are seasonal breeders (Burchfield, 1977). In four different US zoos, successful copulation has occurred between February and March with oviposition occurring late April - June (55 - 80 days). Breedings that occurred on April 26 at the Gladys Porter Zoo and July 3 at Riverbanks Zoo resulted in infertile eggs. Little or no environmental manipulation is necessary to induce reproduction in this species. Although some institutions reported slight manipulation in photoperiod and temperature cycles, others reported no seasonal variation at all. Successful reproduction has occurred at institutions that maintain pairs or small groups of *Ophiophagus* year round (Oliver, 1956), however, maintaining a pair separately and introducing them during the breeding season is the most common method of inducing mating. Courtship consists of the male pursuing the female accompanied by chin rubbing, closed mouth striking and short jabs to the sides of the female. Oliver (1956) reported male *Ophiophagus* delivering gentle jabs to the female, however at Riverbanks Zoo, a male was observed delivering jabs with his snout that were so forceful that the blows actually lifted the females body off of the exhibit floor. At the Houston and Toledo Zoos, adult male *Ophiophagus* would go off food during the breeding season (A. Odum, pers. comm.) which can possibly serve as a gauge as to when to introduce a pair. At other zoos, however, males will continue to feed throughout the breeding season.

Captive, gravid females that are provided with nesting material will construct a crude nest in which to lay her eggs, but there have been no reports of an elaborate, two-chambered nest as sometimes reported being constructed by wild females. Females will also lay in a nest box that contains damp bamboo leaves, sphagnum moss or other nesting medium. Female *Ophiophagus* may become markedly more aggressive immediately before and after oviposistion. Males, if housed with nesting females, may also exhibit a heightened state of aggression after egg deposition, lending credence to reports of nest guarding by wild male *Ophiophagus*. Burchfield (1977) reported a female at the Gladys Porter Zoo exhibiting no protective behavior towards her nest and eggs.

In captivity, clutch sizes vary from 23 to 56 eggs (Burchfield, 1976; Oliver, 1956). Burchfield (1977) reported hatching 19 of 28 eggs incubated on damp paper towels at room temperature (23-27°C) after an incubation period of 74-76 days. At Riverbanks Zoo, three clutches of eggs were incubated on damp vermiculite at 27.2 - 27.8°C. Nearly 100% of the viable eggs hatched after an average incubation period of 71 days. Neonates averaged 18.3g and 505 mm TL (n = 80).

In the past, neonate *Ophiophagus* were problematic as captives and they often did not thrive. It is difficult to induce feeding, even on natural prey items, and if they do feed voluntarily, mortality can still be high (Burchfield, 1977; Cox, 1991; Oliver, 1956; Schmidt and Inger, 1957). Although a few neonates readily accept small food snakes, the majority do not and will refuse a variety of natural prey items to the point of starvation. Assist feeding the neonate for a period of time until it begins feeding voluntarily can alleviate this problem. At Riverbanks Zoo, neonate *Ophiophagus* are housed individually in small (16 x 31cm) containers. They are initially offered both live and dead snakes (*Elaphe* and *Nerodia*) as well as lizards (*Anolis*, *Eumeces*, *Hemidactylus*). If a neonate refuses food several times, it is assist fed pink mice. This is accomplished by gently holding the neonate behind the head and inserting the food item into the back of the mouth with a pair of tweezers. Usually the neonate will immediately begin to swallow the food item. This procedure continues once or twice per week until the animal voluntarily accepts food. Before an individual is assist fed, it is first offered a pink mouse that has been scented with "snake

soup" or pieces of a food snake. The length of time it takes a juvenile *Ophiophagus* to voluntarily accept food is variable. Some accept food after being assist fed several times, other individuals, however, have been assist fed for more than a year before they began to feed voluntarily. Neonate *Ophiophagus* do not seem to be unduly stressed by this procedure.

Riverbanks altered the captive management of neonate *Ophiophagus* based on observations of wild hatchlings climbing up into vegetation in the immediate vicinity of the nest (R. Whittaker, pers. comm.) In August of 2000, a small group of three neonate *Ophiophagus* were individually established in enclosures that were 46cm tall x 92cm long x 43cm deep. These enclosures included two live potted plants as tall as the enclosure, a shredded wood substrate, plastic hide box and water bowl. One of the potted plants was situated under a 100W incandescent spotlight providing a basking spot. The "hot spot" provided by the incandescent light was approximately 34°C. The neonates spent virtually all of their time in the plants and rarely if ever utilized the hide boxes or spent a significant amount of time on the floor of the enclosures. All three of the neonates fed voluntarily on live juvenile rat snakes (*Elaphe*) the first time they were offered. They next fed on pre-killed frozen rat snakes and then pink mice scented with pieces of snake skin and finally unscented pink mice. Of the 84 neonate *Ophiophagus* reared at Riverbanks Zoo, these were the only three to ever feed voluntarily without first having to be assist fed.

In July 2002, at the Live Oak Animal Clinic in Monck's Corner, South Carolina, five out of six neonate *Ophiophagus* voluntarily fed on live rat snakes (*Elaphe*) when maintained in similar enclosures that included tall live plants. These *Ophiophagus* had previously refused live rat snakes until the enclosures were provided with a specific small leaf bamboo. The neonates then fed on both live and dead rat snakes while perched in the bamboo (S. Seashole and M. Gonsalves, pers. comm.)

Juvenile *Ophiophagus*, once they are feeding on a regular basis, can grow rapidly and are capable of attaining a length of 2 meters in 18 months. Females can attain sexual maturity in as little as three years.

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