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Husbandry and Captive Breeding of the Travancore Tortoise (*Indotestudo travancorica*) at the Wildlife Conservation Society

James McDougal Christina Castellano
Department of Herpetology, Wildlife Conservation Society, 185th Street and Southern Boulevard, Bronx, New York 10460-1099 USA

INTRODUCTION

The Travancore tortoise (*Indotestudo travancorica*) is a species rarely seen in captivity. Little is known of it's ecology, life-history, or population levels in nature. The occurrence of seemingly similar forms in two widely separated geographic regions has led to confusion regarding the taxonomy of the species (Hoogmoed and Crumly, 1984). Although this species is now usually classified as *Indotestudo forstenii*, we will continue to use *I. travancorica* for the Western Ghats population of India (Boulenger, 1907) until molecular variation study of the *Indotestudo* complex has elucidated the taxonomic status of this species.

The Herpetology Department at the Wildlife Conservation Society(WCS) has maintained an adult pair of *I. travancorica* since 1980 (though both specimens have longer captive histories). These specimens have reproduced repeatedly and their progeny have been successfully reared and distributed to other collections in the United States. Since the breeding of this species in captivity is uncommon and has not been documented in detail, this paper briefly reviews salient aspects of the species' biology and presents husbandry and breeding data gathered from Herpetology Department records and our own observations. This information may provide a basis for further investigation of the biology and husbandry requirements of this little-known species.

Description

Indotestudo travancorica is a moderately-sized species with a straight-line carapace length reaching just over 33 cm (Das, 1991). The carapace is elongate and somewhat flattened dorsally (Fig. 1). A prominent supracaudal scute is present posteriorly. A cervical (= nuchal) scute is absent, and the interpectoral seam is usually less than 70% as long as the interhumeral seam (Ernst and Barbour, 1989). These latter two characteristics are diagnostic and serve to differentiate *I. travancorica* and *I. forstenii* (Indonesia) from the elongated tortoise (*Indotestudo elongata*). Currently there are no reliable methods to differentiate *I. travancorica* and *I. forstenii*. Juvenile *I. travancorica* are nearly spherical with distinctly serrate rear marginals.

Distribution and Habitat

Indotestudo travancorica occurs in southwestern India, from Karnataka south to the western Ghats of Kerala and Tamil Nadu (Moll, 1989; Das, 1991). A similar form, *I. forstenii*, is found on Sulawesi (= Celebes) and Halmahera Island, Indonesia, the latter of which is the type locality (Iverson, 1992). The presence of this species on these islands may be

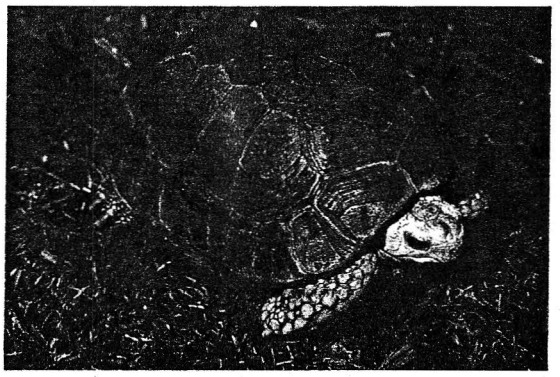

Figure 1. Adult *I. travancorica* at the WCS. (Photo by D. Demello, WCS).

the result of human introductions from India (Hoogmoed and Crumly, 1984). This notion is highly speculative and at present the relationship between these two forms is unclear. *Indotestudo travancorica* is reportedly an inhabitant of moist evergreen and semi-evergreen forests (Moll, 1989; Das, 1991). Das (1991) states that a rocky habitat is preferred, and that tortoises utilize rock clefts along rivers and streams, and burrow under boulders within forested areas. A detailed description of the species' habitat has not been published.

Reproduction

Although little information on the ecology of this species is available, some observations on reproductive behavior do exist. Most of the information that follows was first reported by Auffenberg (1964b) who recognized that in many tortoise species courtship may be divided into three phases. These are: a) sex and species recognition; b) immobilization of the female by the male; and c) mounting and intromission. Male *I. travancorica* recognize females by olfaction (Auffenberg, 1964b). During the breeding season the skin on the head of the male (and to a lesser degree the female) develops a distinctive deep pink coloration, particularly around the orbits, nasal area, and temporal region. Auffenberg (1964a) suggested that this color change is associated with increased vascularization of the sensory system(s) which serve in sex recognition, in this case olfaction. Upon recognition, the male pursues the female and attempts to immobilize her by repeated ramming with the gular projection of the plastron. If successful, mounting and copulation follow. At this point the male is often positioned with neck outstretched and mouth agape (McDougal, pers. obs.). It has been reported that vocalizations by the male also occur at this stage (Das, 1991), however we have not observed this. In this species, sexual dimorphism is marked in adults; males have a distinct plastral concavity, as well a long, horny tail-tip (Fig. 2). It has been suggested that this structure may serve to correctly position and steady the mounted male prior to, and during, copulation with the female. This is accomplished by aligning the long tail-tip with a medial depression in the female's plastron.

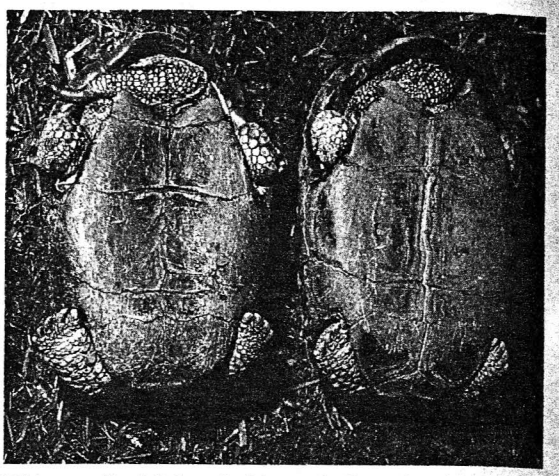

Figure 2. Male (left) and female (right) *I. travancorica* are sexually dimorphic; males have a concave plastron and a long, horny tail-tip. Females lack these characters. (Photo by D. Demello, WCS).

Breeding is reported to take place from November to January (Auffenberg, 1964b) which corresponds to the onset of the monsoon season. Das (1991) however, believes there is evidence that the species may breed at other times of the year as well. Clutch sizes of from one to three eggs have been reported (Vijaya, 1983; Sane and Sane, 1989; Das, 1991), though Tikader and Sharma (1985) state that six small to medium-sized eggs are laid in a single clutch. Eggs (at least in captivity) are reported to be deposited on the soil surface or in shallow depressions in leaf litter (Das, 1991).

Status and Conservation

The status of *I. travancorica* populations in nature is not clear. Moll (1989) states that the species is not rare in upland forests of Kerala which have not been heavily logged. In addition, Das (1991) considers it "not uncommon" in certain hill ranges in the Western Ghats, though with the caveat that the extensive clearing of primary forest for agriculture and hydroelectric projects could threaten the species in the near future. *Indotestudo travancorica* is occasionally eaten by some local people in the Ghats. In some cases it may be an important source of protein for the local human popula-

tion (Groombridge, 1982; Tikader and Sharma, 1985; Das, 1991). This species is listed under Schedule IV (exploitation with permit) of the Indian Wildlife (Protection) Act of 1972, and it is listed in Appendix II of CITES which allows for trade if a permit is obtained from the country of origin. The IUCN *Red Data Book* classifies the southwestern Indian population of *Indotestudo* (listed as *Geochelone travancorica*) as "Insufficiently known", and the Indonesian population (listed as *G. forsteni*) as "Rare" (Groombridge, 1982).

MATERIALS AND METHODS

Data presented are based on observations of the behavior and reproduction of two *I. travancorica* (sex ratio = 1.1) maintained on exhibit in the Reptile House of the WCS. Both specimens were captured in Kerala, India, and brought to the United States by Dr. Walter Auffenberg of the Florida State Museum. The female has been in the zoo's collection since 1964,the male has only been there since 1980. As of March, 1996, the female weighed 2.9 kg and had a carapace length of 26.8 cm, while the male weighed 2.5 kg and had a carapace length of 24.3 cm.

Specimens were housed in a large enclosure (3.7 x 1.8 x 3.0 m [l x w x h]) which has traditionally been used to exhibit Asian tropical forest species. Other species living in the exhibit were Asian spiny turtles (*Heosemys spinosa*), jagged-shell turtles (*Pyxidea mouhotti*), blood pythons (*Python curtus*), and eastern water dragons (*Physignathus lesueurii*). Temperature was maintained at approximately 29°C during the day and 24°C at night. In basking areas the temperature reached approximately 34°C. The photoperiod was 10L:14D, however greater ambient light levels in the building during late spring and summer may have effectively extended day length. Fluorescent and incandescent lights provided cage lighting and basking areas, respectively. Various brands of fluorescent bulbs were used, all of which emitted ultraviolet irradiation, which has been shown to be important for proper calcium metabolism in some reptile species. Water was always available in a shallow pool. Cage humidity was maintained by daily misting. Sections of the enclosure provided dense cover in the form of artificial plants, tree trunks and limbs, and low-relief rock formations. Other areas were relatively open to facilitate public viewing.

The tortoises were maintained on a salad diet which included a mixture of various leafy vegetables (as available) such as dandelion, kale, carrots, zucchini, apples, and collard, turnip, and mustard greens. The salads also included alfalfa-based pellets. Salad was offered, *ad libitum*, three times per week. Earthworms (*Lumbricus terrestris*) and crickets (*Acheta domestica*) were fed to the various species in the exhibit once weekly, and *I. travancorica* were often observed feeding on the former.

RESULTS

Breeding in this pair of tortoises was asynchronous and took place with great frequency throughout the year (F. Indiviglio, pers. comm.). As a result, eggs were produced in each month, however most eggs were laid between October and March (Fig. 3). Clutch size for 51 clutches discovered between 1980 and 1995 ranged from one to three, with a modal value of one (51% contained one egg, 43%-two eggs, and 6%-three eggs). Eggs varied in size, with lengths ranging from 37 to 66 mm ($\bar{x}$ = 58 mm), widths from 35 to 46 mm ($\bar{x}$ = 42 mm), and weights from 32.9 to 82.6 g ($\bar{x}$ = 65.0 g). Eggs were generally deposited on the surface of the substrate with no attempt at excavating a nest, although some were found in shallow depressions and/or concealed by

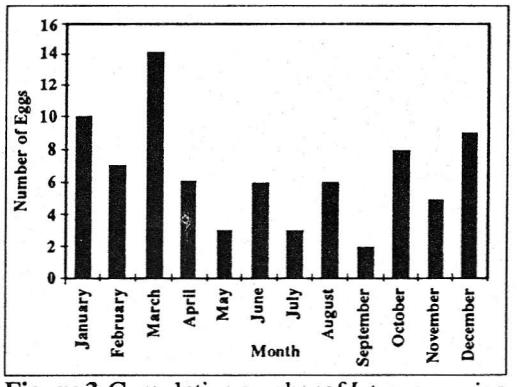

Figure 3. Cumulative number of *I. travancorica* eggs laid monthly between 1980 and 1995.

artificial plants.

Eggs were incubated in plastic containers (1-3 L in volume, depending on clutch size) that were approximately one-quarter filled with a mixture of vermiculite and water at a 1:1 ratio, by weight. Containers were sealed with tight-fitting lids to conserve moisture, and were placed into one of a number of types of commercially available incubators. Containers were opened frequently to check on condition of eggs and to facilitate gas exchange. Incubation temperatures ranged from 27°-32°C. In those cases where adequate data was available (N = 20), incubation periods ranged from 102-187 days ($\bar{x}$ = 148 days). Available data did not allow us to correlate incubation temperature with length of incubation period.

Once an egg pipped it was monitored closely. Even after most of the surrounding eggshell had broken away the hatchling was kept in the incubating container (with the lid removed) and in the incubator until the yolk sac was almost completely absorbed; this was usually in two to three days. In our experience, hatchlings often had relatively large yolk sacs. Upon removal from the incubator they were placed individually in terraria (50 x 26 x 30 cm) lined with damp paper towels until the umbilical scar healed. Various substrates were used with success in the hatchlings' terraria. Eucalyptus mulch, soil/peat mixes, and sheet moss all were suitable. Generally, hatchlings were provided with the same temperature, lighting, and diet as the adult tortoises, though they were fed more frequently.

Upon emergence from the egg, the carapace length, width, and weight were recorded for each hatchling (N = 20). Carapace lengths ranged from 50 to 62 mm ($\bar{x}$ = 57 mm), and carapace widths ranged from 43 to 60 mm ($\bar{x}$ = 53 mm). Weights of the hatchlings ranged from 33.0 to 59.0 g ($\bar{x}$ = 47.5 g). From a total of 51 clutches (79 eggs) on which records were kept, a total of 25 hatched successfully (31.6%). Five tortoises died within the first seven years; three of which died within the first 18 months. How this compares to the normal range of hatch rates in nature is unknown (Fig. 4). The hatchlings gained weight rapidly, and doubled their body weight within the first month. Lack of data prevents us from making any further statements about growth rates.

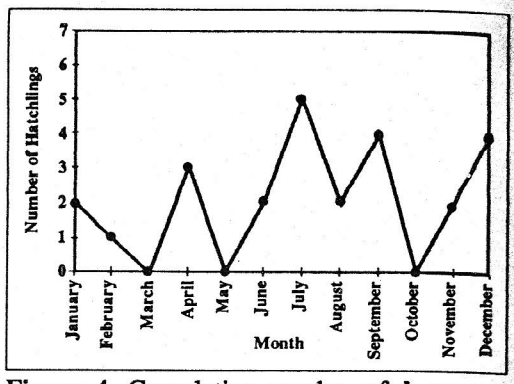

Figure 4. Cumulative number of *I. travancorica* hatched monthly between 1980 and 1995.

DISCUSSION

Adult *I. travancorica* are hardy in captivity and are relatively easy to maintain using husbandry techniques that are standard for most moderate to large-sized tortoises. Since this is a forest-dwelling form, temperature requirements may be lower, and humidity requirements higher, than those for species characteristically found in more xeric habitats. Our results indicate that the rearing of hatchlings is also relatively straightforward. We cannot attribute the 20% mortality rate of our captive-hatched specimens (within the first five years) to any specific factor(s). Clarification of the high mortality rate awaits further investigation and continued breeding of this species.

Given proper environmental conditions and diet, no specific manipulations seem to be required to induce this species to breed. Our pair is sexually active throughout the year, however a peak in egg production from about October to March suggests the possibility of either exogenous (environmental) or endogenous factors, important in reproduction, which we are not aware of. Since it is reported that breeding in nature coincides with the onset of the monsoon season, perhaps the daily misting of their enclosure provides at least one cue which triggers breeding behavior. This speculation is supported by the observation that the male rapidly seeks out and pursues the female while misting is in progress.

What effects day length has on their behavior is unknown, and knowledge of the gestation period of the species is needed before we can begin to understand what, if any, influence this factor may have on reproduction. The deposition of eggs essentially throughout the year is probably an artifact of captivity, and breeding in nature may be more closely tied to seasonal changes.

Clutch size and nesting behavior (or lack of it) in our experience seems to agree with published reports. Minimal effort is made at excavating a nest, and eggs are deposited either in shallow depressions in the substrate or on the surface; they are often at least partially concealed by logs, rocks, and artificial vegetation. The clutch size of between one and three is similar to that reported by other authors (Sane and Sane, 1989; Das, 1991). A clutch size of six (Tikader and Sharma, 1985) seems anomalous, particularly when the eggs are described as "small and medium sized". The possibly superior nutritional state of animals in captivity may result in increased clutch frequency rather than increases in clutch size.

The hatching success we observed (approximately 32%) seems rather low. Whether this is due to incubation techniques or a low fertility rate is unknown, however a complete lack of development in a relatively large proportion of eggs points to the latter. Further investigation is required on this subject. One possibility is cyclic or seasonal peaks in spermatogenesis and/or egg follicle development, which would result in a higher probability of successful fertilization and egg viability at certain times of the year.

Our success in breeding *I. travancorica* is probably due to a number of factors. Aside from the obvious ones such as proper diet and temperature regime, we believe that the size and design of the enclosure is also important. It provides a low-stress environment where the animals are rarely disturbed. They are able to select various microhabitats which differ in presumably salient environmental variables such as temperature, humidity levels, and light intensity. Daily misting of the enclosure and seasonal variability in ambient light levels may also be important, albeit not well-understood, factors in our success. Finally, the importance of a fortuitously compatible pair cannot be overlooked. Hopefully further work with *I. travancorica* will lead to a more complete understanding of the biology of this species.

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