The captive husbandry and reproduction of the pink-eared turtle (Emydura victoriae) at Perth Zoo

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Abstract

In 1997, Perth Zoo acquired six pink-eared turtles (*Emydura victoriae*) from the wild for display in the reptile facility. There is very little documented information on pink-eared turtles in captivity. This article looks at the reproductive biology, ecology, behavior, diet, and captive husbandry of the species. Eight clutches of eggs were documented over a 2-year period with an average clutch size of 10 eggs. Egg size was recorded with three clutches incubated to hatching. Ten hatchlings were maintained for a growth and development study. Measurements of weight, carapace length, width, height, and plastron length were recorded weekly for about 12 months, and then monthly for approximately 2 years. The data were analyzed and showed positive growth curves in all animals. Sexual dimorphism was observed after 20 weeks and sexual maturity in males observed after 2 years.

Keywords: biology; ecology; behavior; diet; growth; development

Introduction

In 1997, six pink-eared turtles were taken from Lake Kununurra in the Kimberley Ord River drainage. Capture was achieved via drop nets baited with fish and long handled scoop nets after luring the animals closer with fish baits. They were brought to Perth Zoo and quarantined for 30 days before being displayed and housed in the Reptile Encounter. The sex ratio of the group was two males and four females of varying sizes and age. The captive husbandry of the pink-eared turtles was studied for more than 8 years, recording all behavioral, dietary, reproduction, and health information. There are poor data available in captive husbandry and wild biology and ecology on pink-eared turtles, and this article assists in documenting this information.

In 2003 and 2004, the species was captive bred with eight clutches of eggs produced. These clutches were measured and recorded, with three clutches set up for incubation and maintained until hatching; the remaining clutches were discarded. The hatchlings were maintained indoors in an aquatic enclosure with five different growth measurements—weight, carapace length, width, height, and plastron length—taken over a 2-year period. Analysis of this data have shown increased growth in all measurements. Discriminant analysis was also undertaken in order to classify the sexes, using the recorded measurements. Other relevant growth and development information was recorded opportunistically.

Review of Literature

The pink-eared turtle (*Emydura victoriae*) is a common species [IUCN, 2005] of short-necked turtle found in the fresh waters of the Victoria and Daly Rivers, and possibly the Ord River drainage systems, in Northern Territory and Western Australia [Cann, 1998]. At present, the Ord River specimens are of unknown taxonomy, but thought to be *E. victoriae* [Cann, 1998; Kutchling, personal communication].

It was first described by Gray [1842] as *Chelymys victoriae* from a specimen collected from an unknown origin in northern Australia [Goode,1967]; although Kutchling (personal communication) has visited the British Museum which indicates the Victoria River as the collection site. The species is very similar to *E. australis* [Cann, 1978; Cogger, 2000], and for many years they had been confused as the same species. Only recently was *E. victoriae* separated as its own taxa within the *Emydura* group, based on the drainage system found [Cann, 1998]. This species is a larger member of the red-faced turtle complex, with female carapace lengths of 200+ mm long. With a salmon-colored temporal stripe that runs from the eye to the neck and a second one that runs along the lower jaw [Cogger, 2000], this species is difficult to identify from others in the complex. Red or pink markings are also located with stripes and/or spots on the legs and a light chocolate brown shell. The plastron is a white-cream color. Aged specimens may have macrocephaly, which is the gross enlargement of the muscular tissue between the jaw and eye [Cogger, 2000].

The wild diet of this species is poorly documented, but they are considered omnivorous and have been reported to feed on freshwater mussels, snails, insects, crustaceans, and vegetable matter, as found in scat analysis [Cann, 1998].

There is very little information on the reproductive biology of *E. victoriae* in situ. One nest, on the Mary–McKinlay River junction in the Northern Territory, was observed on October 21 and was estimated to have laid eggs in August [Smith and Wood, 1985]. The nest contained an estimated 16–17 eggs, with about 5 already hatched. One egg contained a dead embryo with the remaining eggs viable. Owing to egg degradation, reliable measurements could not be taken. Ten hatchlings were measured: weight 5.73 g (mean), carapace length 3.16 cm (mean), width 2.87 cm, and height 1.58 cm (mean). Legler [1985] reports that in the Northern Territory *Emydura* species laid eggs from late August to early November. It is thought that nesting occurs around this period to correspond eggs

hatching with the start of the wet season, which ensures hatchlings have a good head start owing to an abundance of water [Doody and Welsh, 2005].

In late September and early October 1996 tracks were observed from female *E. victoriae* with a disturbed clutch observed in mid-October [Doody and Welsh, 2005].

Materials and methods

Animals

Four females were captured from Lake Kununurra in 1997, weighing 136, 358, 582, and 928 g. At the time of mating, these animals weighed 1,100, >615, 886, and 1,090 g. Males ranged in size at the time of capture from 246 to 198 g. Of the fertile clutches produced, these animals weighed 391 and 460 g. Age was difficult to determine in most of the animals, but the 100–200 g animals at the time of capture would most probably have been 1–2-year-old animals. Turtles were identified by Trovan PIT tags (Trovan Ltd, United Kingdom) inserted subcutaneously into the hind limb. However, the females could be visually identified by their larger size and shell markings.

Growth measurements were undertaken on five male and five female pink-eared turtles and identified by marking the carapace (see section “Diet” for details). Juveniles were maintained in small groups of similar size and feeding stage. Turtles were positively sexed at 2 years of age by shell morphology. Males showed a distinct concave plastron while the females' is convex in shape.

Enclosures

The breeding enclosure on display was approximately 18 m^2, with a 3–4 m^2 pond on one side. The pond was 60 cm deep at one end and 35 cm at the other. A small gravel land area allowed the turtles to exit the water. There were rocks and driftwood in the water which were used as hiding areas and basking points. The turtles shared the enclosure with Mitchell's water monitors (*Varanus mitchelli*), primitive archerfish (*Toxotes lorentzi*), and blue catfish (*Arius graeffei*).

A large bacterial filtration system (approximately 120 l) helped clean the water and fed a waterfall into the pond. It was heated via 4 300 W aquarium heaters and maintained a water temperature range of 24–26°C in summer and 22–24°C in winter. The heaters were cased within a protective PVC tube. The tube had many holes drilled into it to allow water flow which prevented the turtles being burnt if they lay on it.

Basking lights were provided to give heat and adequate UV radiation exposure for the animals. The bulbs were situated approximately 40 cm above basking points on land or logs. These consisted of 300 W infrared bulbs and 300 W Osram Ultravitalux bulbs (Osram Sylvania, Danvers, MA) that were on a 12 hr timing system.

Holding ponds consisted of plastic tubs of various sizes that were maintained both indoors and outdoors. These facilities had heating supplied via the 200 W aquarium heaters and filtered by either canister filters or the keeper syphoning on a regular basis. Hiding areas were supplied in the form of bark, wood, rocks, and vegetation. Substrates consisted of white sand or nothing. Coarse river gravel was initially provided, but the turtles incurred nail injuries from digging in this substrate. Basking lights were supplied; these consisted of 100 W spotlights fixed onto a rock, wood, or vegetation. UV

was supplied via the 20 W Silvania Reptistar fluorescent tubes (Osram Sylvania), maintained on a 12 hr light cycle.

Husbandry

The daily husbandry regimen consisted of enclosure cleaning, water maintenance, light, temperature, and health monitoring, and feeding.

Water temperatures were adjusted according to seasons (22–24°C in winter and 24–26°C in summer). Air temperature and humidity were maintained at normal daily levels. Water quality was maintained by regularly cleaning uneaten foods and fecal matter as well as frequent water changes. Ph, nitrates, nitrites, and ammonia were monitored through commercial water-testing kits. External filters were cleaned weekly or as required. Shell scutes were regularly removed from the water with a fish net in order to prevent blocking the filter intake valves. It is important to note that filter material was washed in old exhibit water so as to not kill the bacteria load in the filter.

Very few health issues arose in the species. Nail injuries were treated with Silverzine topical cream (Smith and Nephew Healthcare, Mount Waverley, Victoria, Australia) application and left to dry for 1 hr before being placed back in the pond. A shell and skin fungus affected several animals and was treated by drying the animals out and treating with Silverzine topical cream. It was suspected that inadequate filtration caused the fungal problem; as a result, the filtration system was modified.

In group situations, it was found that smaller turtles were shy and had a diminished feeding response, possibly as a result of being housed with larger, more dominant cage mates.

Diet

Feeding was undertaken three times a week for adults. Juvenile turtles were fed daily, which decreased to every second day as animals got older and started eating solid foods.

Adult turtles were fed a varied diet consisting of crickets, mealworms, roaches, prawns, white-and bluebait fish, herring, squid, chopped mice, rats, and turtle pudding (see Appendix A for turtle pudding diet breakdown). Each turtle was fed ad lib, but would probably consume about 10 g three times a week.

The turtles were also fed on vegetation, including *Hibiscus*, *Caprosma*, and *Ficus* species. A small branch of one of these fodder species was put into the pond over the summer period and was opportunistically grazed upon.

Juvenile turtles were harder to feed requiring live foods to stimulate a feeding response. The most common and easy foods to obtain were mosquito larvae, blood worms, and brine shrimp. Once feeding started, the young turtles were weaned onto other food items. Insects, such as live crickets and mealworms, also assisted in the weaning process. Some turtles accepted the feeding changes earlier than others and grew considerably faster, as a result. Larger animals were separated from smaller animals to reduce competition. Larger food items were chopped to smaller pieces to suit the young turtles' size.

Measurements

Five growth measurements were taken over a 2-year period: weight, carapace length, width, height, and plastron length. Data were collected weekly for 38 weeks to monitor the juveniles' initial feeding and growth. Measurements were taken fortnightly until 51 weeks and monthly until 100 weeks.

Animals were identified by marking the carapace scutes with red nail polish. Different clutches were allocated different scute types. Clutch one was marked on the marginal scutes with one starting at the first marginal to the right of the nuchal and numerically running clockwise around the shell. Clutch two was marked on the costal scutes starting at the top of the shell behind the nuchal and running clockwise around the shell. Clutch three was marked on the median (or vertebral) scutes that run down the center of the shell. Median scutes were divided by the vertebral ridge, and numbering started at the top right (one) and ran clockwise finishing at the top left (six).

Juveniles were weighed on electronic scales (precision balances). For more accurate data, scales to the decimal gram were used particularly when the animals were small. They were placed on a small plastic lid that sat underneath the plastron raising their legs off the ground which prevented them from moving off the scales.

The carapace length, width, height and plastron length were measured with callipers to 0.5 mm.

Carapace length was measured from the top of the nuchal scute on top of the neck to the end of the supracaudal scutes, straight length. The marginal scutes at the end of the shell are serrated and the longest point on the scutes was measured and not the indent (maximal carapace length, not midline carapace length).

Carapace width was measured from the furthest marginal points along the carapace (maximal carapace width); this was about marginal six or seven from the nuchal.

Carapace height was measured from the highest point along the vertebral line of the median scoots on the carapace to under the plastron, which was usually around the intergular shield.

Plastron length was measured from the end of the gular shields under the neck (these are serrated from the further most point) to the tip of the anal shields. The anal shields are divided, so the measurement is taken at the further most point (maximal plastron length, not midline plastron length).

Statistical Analysis

Measurements of carapace length, width, height, and animal weight, respectively, were taken at regular intervals for each of the five males and five female turtles. Naturally, these measurements tend to increase in time. At any one time, the observations may be thought of as measurements on correlated data, as it is reasonable to expect the variables weight, carapace length, width, and height to be related in some way.

One objective is to see whether the two groups of turtles—males and females—can be distinguished based only on the measurements, bearing in mind that the turtles are of the same age. That is, is there any evidence of sexual dimorphism and at what age is this apparent? Statistically speaking, assuming the different turtles yield independent measurements, one, in essence, wishes to discriminate between the sexes based on the variables weight, carapace length, width, and height. This is the objective of the statistical procedure known as discriminant analysis.

Discriminant analysis is cited in well-known text books on multivariate statistics, including Morrison [1990] and Johnson and Wichern [1998], which typically relies on an assumption of multivariate normality of the data. The first mentioned text refers to Jolicoeur and Mosimann [1960] who analyzed size and shape variation in the painted turtle, whereas Jolicoeur [1963] suggests taking logarithms of the shape measurements before doing a multivariate statistical analysis. Based on this observation at each of 10, 20, 30, 40, and 50 weeks, respectively, the training sample of 10 multivariate observations of four-dimensional data (Ln (le), Ln (Wi), Ln (Ht), Ln (Wt)), where Ln represents natural logarithms (for the five males and five females) was used to classify the observations into the two groups, males and females.

Discriminant analysis for the two groups essentially seeks to find that one linear combination of the four variables can be used as a measure to classify turtles into male and female. The analysis was carried out using Minitab 15.0.

Results

Reproductive Behavior

Pink-eared turtles at Perth Zoo were found to be seasonal breeders, with reproductive behaviors observed from September to November with oviposition starting in late November and ending in April. Adult males in the captive group were observed displaying to the females throughout the breeding season. This entailed the male swimming head first toward the female, waving and vibrating its forelimbs in the female's face. This was also observed when the male swam beside and over the top of the female. Nipping on the legs and shell has also been observed, but no injuries were recorded from these actions. More than one male has been observed courting a female at the same time. Possibly in response to harassment by the male, females have been observed displaying aggression toward the males as well as the other females. This consists of biting feet, shell, head, and tail.

Excessive aggression from males and females can cause some animals to become secretive and defensive, often hiding away.

Feeding has been observed to increase during the breeding season by the female turtles and decreases in the males. It is thought that the females are consuming more to assist in egg development and males are reduced owing to the continual interest in mating behavior. Females have been observed feeding on vegetation more in the breeding season. They have also been observed harvesting algae from submerged logs in the enclosure. It was found that the female would drag her top jaw over the log surface eating the accumulated material. On more than several seasons, the logs reduced in size and became rounded from this behavior.

Egg Oviposition

In eight clutches of eggs, oviposition was recorded from November to February, and April. Females became very restless around the time of oviposition, as they were unable to dig in the enclosure and paced the edge looking for laying sites. Female pacing was usually observed in late afternoon, and then removed from the exhibit and put into sand-filled outdoor enclosure to lay their eggs. The laying enclosure had a small pond for the female to retreat to once oviposition had finished. In most clutches, oviposition occurred immediately and the female was then returned to the exhibit. Before release into the exhibit, the inguinal cavities were palpated; this was a reliable way of determining if oviposition had occurred. Eggs were deposited in the soil about 15–200 mm deep. The soil around the eggs was loose with varied air pockets. Above the eggs, the chamber seemed thinner and soil more compacted. On the surface, there was very little evidence of a nest site.

To overcome the difficulty of locating the eggs in the sand pit, a layer of white sand was put over the enclosure's predominant soil type, which was red river sand. This made locating the eggs easier from

the observation of disturbed soil. Once the eggs were located, they were carefully dug up and transferred into a container with some moistened vermiculite. The top of the eggs were numbered to identify them, which also assisted in maintaining their correct orientation.

Clutch Information

Eight clutches were laid and collected for measuring. The largest clutch sizes were 16 and 18 eggs and the smallest 6 and 7, with an average clutch size of 10. The smallest clutch sizes were from the smallest females and conversely for the largest. Egg sizes varied between clutches. The average weight was 8.7 g with a length of 34.5 mm and 20.7 mm wide. (See Table 1 for more information on clutches.) Eggs are oval-shaped and white in color. Double clutching had occurred on three occasions, with clutch intervals of 54, 85, and 88 days.

Hatching Information

Three of these clutches (32 eggs in total) were artificially incubated. The eggs were prepared in a one-to-one water/vermiculite mix by weight. Perlite was also used in one of the vermiculite mixes and hatched healthy young. Within 1–2 weeks, fertile eggs had developed a dark band across the center. This band developed larger in size throughout incubation until filling the egg before hatching. The outer shell of the egg often became very brittle and at hatching fell away from the inner membrane. This occurred in about half the eggs incubated. Incubation periods varied between 60 and 68 days at 26–29°C (Table 2).

Juvenile turtles at hatching weight ranged from 4.06 to 6.44 g, with an average of 5.5 g. The carapace length ranged from 27.85 to 35.15 mm, with an average of 31.9 mm. Carapace width ranged from 26.80 to 34.10 mm, with an average of 31.0 mm. Carapace height ranged from 13.05 to 15.25 mm,

with an average of 14.3 mm. Plastron length ranged from 22.80 to 28.10 mm, with an average of 25.9 mm (Table 2).

Hatchlings had characteristically soft shells and high ridges along the middle of the carapace. The marginal scutes at the base of the carapace were heavily serrated and seemed to grow out as the juveniles got older. At 2 years of age, the serrated scutes were just present. The coloration of the shell was fawn brown, with a white plastron, and light grey skin. As they aged, the shell coloration became darker. They had pinkish-red facial stripes, one running from behind the eye to behind the tympanum and the other from the base of the lower jaw along the underside of the upper neck. Red flecking was present around the dorsal part of the neck and in stripes running along their leg flanks. In captivity, it was found that the pinkish-red color faded to yellow and did not change even into the breeding season.

Growth of young

Weight

The pink-eared turtles' weight increases with time (Fig. 1). Growth in both sexes began slowly and then increased rapidly from 20 weeks until about 85 weeks, after which the weights began to plateau. A statistical difference in weight between the males and females was noted after 20 weeks. At 100 weeks of age, females' average weight was more than 400 g with males weighing just over 250 g.

Carapace length

The carapace length showed increased growth in males and females with time (Fig. 2). They showed a very similar curve that had a steady incline until around 60 weeks, and then growth slowed and

plateaued. A statistical difference in carapace length between them was observed after 20 weeks. At 100 weeks of age, females had a carapace length of 154 mm and males 136 mm.

Carapace width

Carapace width showed a steady increase in growth over time (Fig. 3). Growth increased until about 55 weeks before it started to plateau in both males and females. A statistical difference in carapace width was calculated at 20 weeks. Females and males at 100 weeks were 140 and 121 mm, respectively.

Carapace height

The pink-eared turtles' carapace height increased with time (Fig. 4). Growth in both sexes began slowly and then increased rapidly from 70 weeks, after which the height began to plateau. A statistical difference in carapace height between them was observed after 20 weeks. Carapace height varied between females and males at 100 weeks with females measuring 58 vs. 49 mm for males.

Plastron length

The pink-eared turtles' plastron length increased with time (Fig. 5). Growth in both sexes began slowly and then increased rapidly from 85 weeks and then began to plateau. At 100 weeks, females had a larger plastron size of 138 mm compared with the males at 117 mm.

Sex Dimorphism

Sexual dimorphism was clearly apparent in the growth of the juveniles (Figs. 1–5). By using the statistical procedure known as discriminant analysis in the special case of separating two

populations—males and females—while using a training sample of 10 observations (5 females and 5 males) on the 4 variables logarithm of carapace length, width, height, and weight, we were able to see clear sexual dimorphism even at the age of 20 weeks. We assumed equal classification costs and equal prior probabilities for the sexes and equal covariance matrices (for the logged variables). In fact, in this case of equal numbers for the sexes in the training sample, our analysis corresponds to using Fisher's linear discrimination rule. To quote Johnson and Wichern [1998; p 664] “In sum, for two populations, the maximum relative separation that can be obtained by considering the linear combinations of the multivariate observations is equal to the distance D^2. This is convenient because D^2 can be used, in certain situations to test whether the population means μF and μM differ significantly.” Here

$$D^2 = (\bar{x}_F - \bar{x}_M)' \; S_{\text{pooled}}^{-1} (\bar{x}_F - \bar{x}_M)$$

In fact, the corresponding Fishers *F*-statistic (related to Hotelling's T^2 statistic, for testing the equality of the two multivariate population means assuming two independent samples with equal covariance matrices) takes the value 3.7777. The degrees of freedom for the numerator are two and for the denominator is seven, whence the *P*-value for the test statistic is 0.077 which is significant at the 10% level of significance. This suggests the assumption of sexual dimorphism is reasonable at 20 weeks. The data on which the calculations of the *F*-statistic are based are presented below (see Table 3). It must be noted that because some turtles come from the same parents while the method of discriminent analysis can still successfully be employed as it has been here, it can be argued that by quoting *P*-value is potentially misleading because of pseudoreplication.

The results of the proportion of correct classification and the turtles incorrectly classified were as follows (Table 4).

Sexual dimorphism can also be seen in Figures 1–4 for the individual variables, though clearly the statistical examination of student *t*-statistics from the individual variables does not give as clear a picture of when sexual dimorphism occurs. It is only when using the combined and transformed information as suggested above, and by using multivariate statistics, that one can see a ready analysis of the turtle data.

Males show a concave plastron from about 50 weeks of age, but it was not marked until they were at least 2 years old. Females showed a distinct convex plastron with a very short stocky tail over the same time frame. In young turtles, tail length was not reliable for sexing until the animals gained considerable size at about 75 weeks of age. At this time, the males' tail became much longer than the females'. Males at 80 weeks old had tail lengths of 56 mm while females of the same age had total tail length of less than 48 mm. Sexually mature males have a total length tail size greater than 82 mm while the females' tail were less than 50 mm in length.

Maturity

One male from the study group had matured after 2 years. He had a greatly enlarged tail and penis in comparison to the other males in the group. Our wild-caught females laid clutches at an approximate age of 6 and 7 years old. Their ages were estimated based on the captive growth rates of the offspring. It is suspected that this species of turtle is capable of breeding at a younger age based on the apparent maturity of a younger captive bred male at 2 years of age. Egg shells have also been found earlier in the pond of a 4 year old female. More study is required in this area to get a better understanding of the maturing of this species.

Discussion

Our knowledge of pink-eared turtle behavior is limited; however, this article has discussed observed reproductive behaviors in courtship and aggression between males and females. These behaviors are not uncommon in turtles of different species from around the world. Female oviposition has been observed on several occasions and is well described

In total 8 clutches of eggs were laid from three females over a 2-year period. Clutch sizes did vary greatly from 6 to 18 eggs. The smaller clutches were from a female of a less robust size compared with the others and was suspected to be a younger animal. The larger older females had much larger clutch sizes. There was no correlation between clutch sizes and time of year. Egg metrics varied between clutches, but eggs laid early in the season from November to February tended to be of greater size in all measurements compared with those laid in the April. This is possibly owing to the natural cooling of the environment reducing the development of larger eggs. It may also be owing to the reduced light cycle at this time of year influencing reproductive output. The clutch sizes are smaller than other species in the complex, although there was a small number of female turtles to sample from. The general measurements of the eggs were of similar size to other *Emydura* sp., particularly to that of *E. krefftii*.

Three clutches were incubated full term and hatched after 60 days at 26–29°C. This incubation is consistent with other members of the*Emydura* group to produce healthy offspring, but incubation times of around 40 days have been recorded in *E. macquarii*. From the limited data in the hatchlings, it could be suggested that the faster incubated young were of a larger size in weight, carapace length and width, and plastron length to those that had slightly longer incubation periods. This would make sense if the young turtles stayed in the egg for longer periods during incubation, as it would use more

energy reducing fat reserves and possibly utilizing energies that may have been required for growth. This would need to be verified through further study of a much larger sample size.

The average sizes of the hatchlings in comparison with *E krefftii* are similar, although it would seem that *E victoriae* young have a slightly broader shell (carapace width).

No comparison has been made with the growth data of *E. victoriae*, because there is little information on other tropical *Emydura* species growth rates to compare with. The pig-nose turtle (*Carettochelys insculpta*) is a tropical freshwater species that had considerable research undertaken and reaches maturity after 15 years, much longer than the *Emydura* complex including *E. victoriae*.

The growth rate of juvenile turtles was rapid with females reaching sub adult sizes in 2 years.

Sexual maturity of freshwater turtles in Australia varies between genera [Cann, 1998]. This study observed one male matured at 2 years of age. One of the wild-caught females was collected at 136 grams in April 1997 and estimated to be 1-year-old. Her first recorded clutch was in November 2003, estimating her age to be 7 years old at breeding. Captive bred animals may breed at a younger age, because at 12 months the captive bred females were more than 200 g. From these data, females may mature at 3–4 years of age. Females produced multiple clutches, with one animal double clutching once and the other twice for two successive seasons. On these 3 occasions, the oviposition intervals were 54, 85, and 88 days. The 85- and 88-day intervals could in fact be the third clutch produced by the females and the second clutches missed by staff. If this was the case, then these animals may have tri-clutched in the one season; this has earlier been observed in *E. kreffti* [Cann, 1998].

The accuracy of the carapace height measurement was found to be dubious and varied greatly between staff. This was because of staff measuring at different points and the varying morphology of the plastrons shape. Limiting the number of staff taking the measurements and standardizing the points to be measured reduced to variability between samples.

The carapace height was left out of the discriminant analysis because it was highly correlated with the other four variables and did not add to the correct classification based on the aforementioned variables.

Conclusion

1. The pink-eared turtle is a species that had very little information documented in the wild or in captivity up until this study. In the literature, it is still unclear as to the taxonomic position of *E. victoriae*, *E. australis*, and the species of turtle located in the Ord River drainage. Therefore, taxonomic clarification for the turtles in this region is required.
2. Through this study we have found pink-eared turtles to be relatively easy to maintain and breed in captivity. Critical features of the captive husbandry were found to be water quality, temperature, lighting, and diet. The same requirements were critical to breeding the species with alterations in temperatures, lighting, and feeding required to simulate the seasonal changes that would occur in the wild.
3. Eggs incubated well under artificial conditions at 26–29°C. Hatching occurred after 60 days and juveniles grew rapidly once converted from live food items to standard captive foods. Weight, carapace length, width, and height, and plastron length all showed increased growth over time, and sexual dimorphism was found to be apparent in 4 of the measurements at 20 weeks of age.

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Appendix A

Turtle pudding diet of pink-eared turtles

Ingredients (the ingredients should be as fresh as possible)

1 kg	Beef heart
1 kg	Rats (skinned, no head, feet or tail)
1 kg	White bait fish or small fresh sardines
300 g	Prawns
4	Egg yolks
1.4 L	Boiled water
500 g	Gelatine
20 g	Herptivite
30 g	Calcium carbonate

METHOD

1. Trim fat from heart and remove skin, feet, head, and tail from the rats.
2. Mince prawns, rats, hearts, and fish through a fine mincer.
3. Add four egg yolks and mix thoroughly.
4. Boil water and immediately add gelatin. Stir until dissolved. If gelatin is added slowly, mixing is easier and more thorough.

5. Add liquid to meat mix and stir until evenly spread throughout.
6. Add vitamins and minerals, if the temperature of the mix is lower than 40°C, and mix ingredients thoroughly.
7. Place mixture into trays and allow cooling in the refrigerator until it sets. Once set, cut into strips and put into the freezer. Once frozen, remove from trays and store in date recorded containers. Food older than 6 months in freeze should be discarded.

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Table 1. Clutch information for *E. victotiae*

Clutch ♯	Date of oviposition	Clutch size	Egg mass (g)a	Egg length (mm)a	Egg width (mm)a
1	19/01/2003	10	9.53–10.69 (10.0)	33.40–36.60 (35.3)	21.10–23.10 (21.9)
2	14/02/2003	8	10.01–11.35 (10.6)	37.00–39.55 (38.6)	21.00–22.00 (21.3)
3	30/11/2003	16	6.87–8.61 (8.0)	30.4–33.95 (32.4)	19.90–21.10 (20.6)
4	30/12/2003	9	7.80–10.15 (9.5)	31.60–35.50 (34.0)	20.40–22.10 (21.7)
5	4/02/2004	7	10.21–11.04 (10.6)	34.50–37.50 (36.4)	21.90–22.40 (22.1)
6	16/04/2004	6	4.63–7.76 (6.2)	31.60–36.65 (33.9)	17.85–19.55 (18.9)
7	21/04/2004	18	6.46–9.12 (7.4)	29.70–34.20 (31.4)	18.90–21.50 (20.0)
8	26/04/2004	7	6.98–7.64 (7.3)	32.90–34.75 (33.7)	18.70–19.45 (19.1)
Average		10	8.7	34.5	20.7

[a] Each measurement shows range and the mean

Table 2. Incubation and hatching data for E.victoriae

Clutch ♯	Ovi position	Eggs incubated	Dates of hatching	Numbers hatched	Incubation and temperature (°C)	Mass g[a]	C pace L (mm)[a]	C pace W (mm)[a]	C pace H[a]	Plastron L (mm)[a]
1	30/11/2003	N=16	31/01/04–	(N=11)	62–68 days @	4.06–	27.85–	26.80–	13.05–	22.80–
			6/02/2004		28–29°C	5.17	31.3	29.5	14.6	25
						-4.7	-30.1	-28.3	-13.9	-24.2
2	30/12/2003	N=9	29/02/04–	(N=8)	61–62 days @	5.59–	29.80–	30.60–	14.00–	24.45–
			1/03/2004		28–29°C	6.13	32.25	34.1	15.25	26.9
						-5.8	-31.6	-32.2	-14.6	-25.7
3	4/02/2004	N=7	4/04/2004	(N=6)	60 days @ 26°C	5.84–	33.70–	31.15–	14.25–	27.40–
						6.44	35.15	32.9	14.8	28.1
						-6.1	-34.1	-32.5	-14.5	-27.7
Average						5.5	31.9	31	14.3	25.9

[a] Each measurement shows range and mean

Table 3. The data on which the calculations of the *F*-statistic found for 20 weeks

SEX (Female or male)	Carapace length at 20 weeks	Carapace width at 20 weeks	Carapace height at 20 weeks	Carapace weight at 20 weeks
F	60.3	60.3	24.05	28.05
F	65.2	64.85	27.35	38.67
F	60.65	61.45	25.15	31.31
F	73.55	72.8	29	49.29
F	54.7	56.35	22.65	21.97
M	57.95	55.2	22.3	23.32
M	54.95	54.95	22.2	22.29
M	59.95	61.9	24.55	27.94
M	58.35	59.45	24.3	26.02
M	52.65	51.9	21.05	19.00

20=20 weeks

Table 4. The results of the proportion of correct and incorrectly classified turtles

Weeks	Proportion correctly classified	Obs. turtles not correctly classified
10	0.7	F3, F5, M8
20	0.9	F5
30	0.9	F5
40	0.9	F1
50	1	–

Figure 1. The weight of young *E.victoriae* according to age (mean±sd).

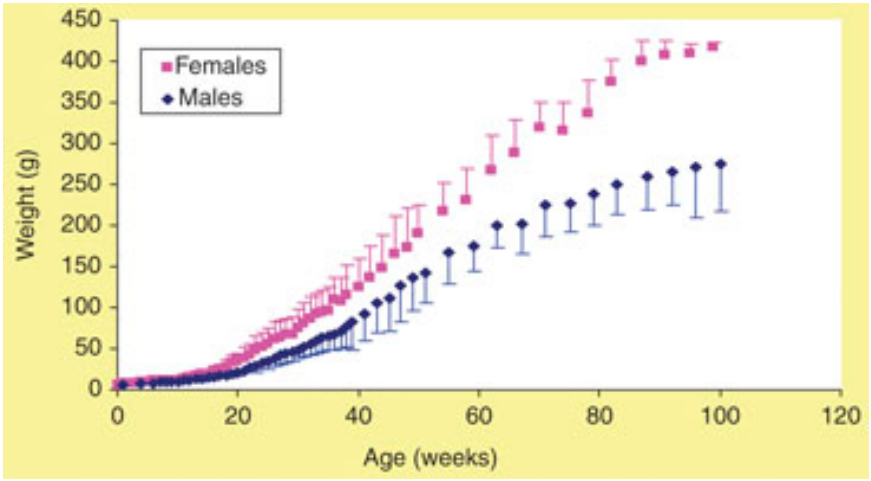

Figure 2. The carapace length of young *E. victoriae* according to age (mean±sd).

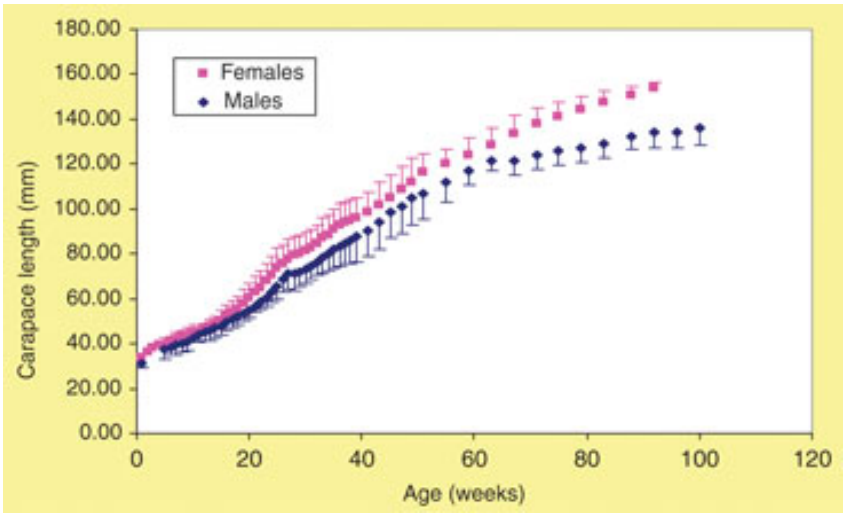

Figure 3. The carapace width of young *E. victoriae* according to age (mean±sd).

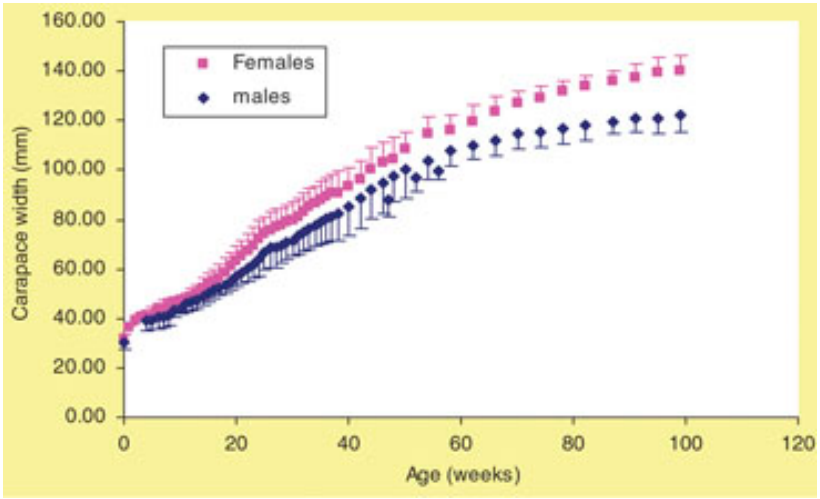

Figure 4. The carapace height of young *E. victoriae* according to age (mean±sd).

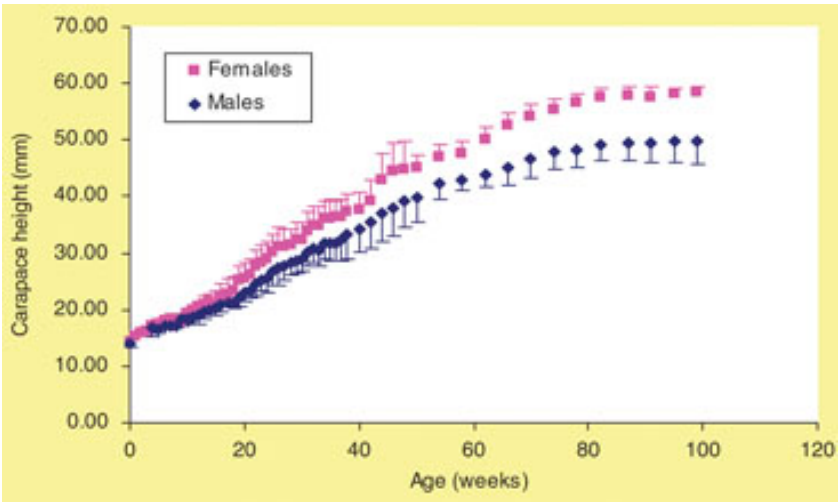

Figure 5. The plastron length of young *E. victoriae* according to age (mean±sd).