# Keeping and Breeding the Red-headed Amazon River Turtle

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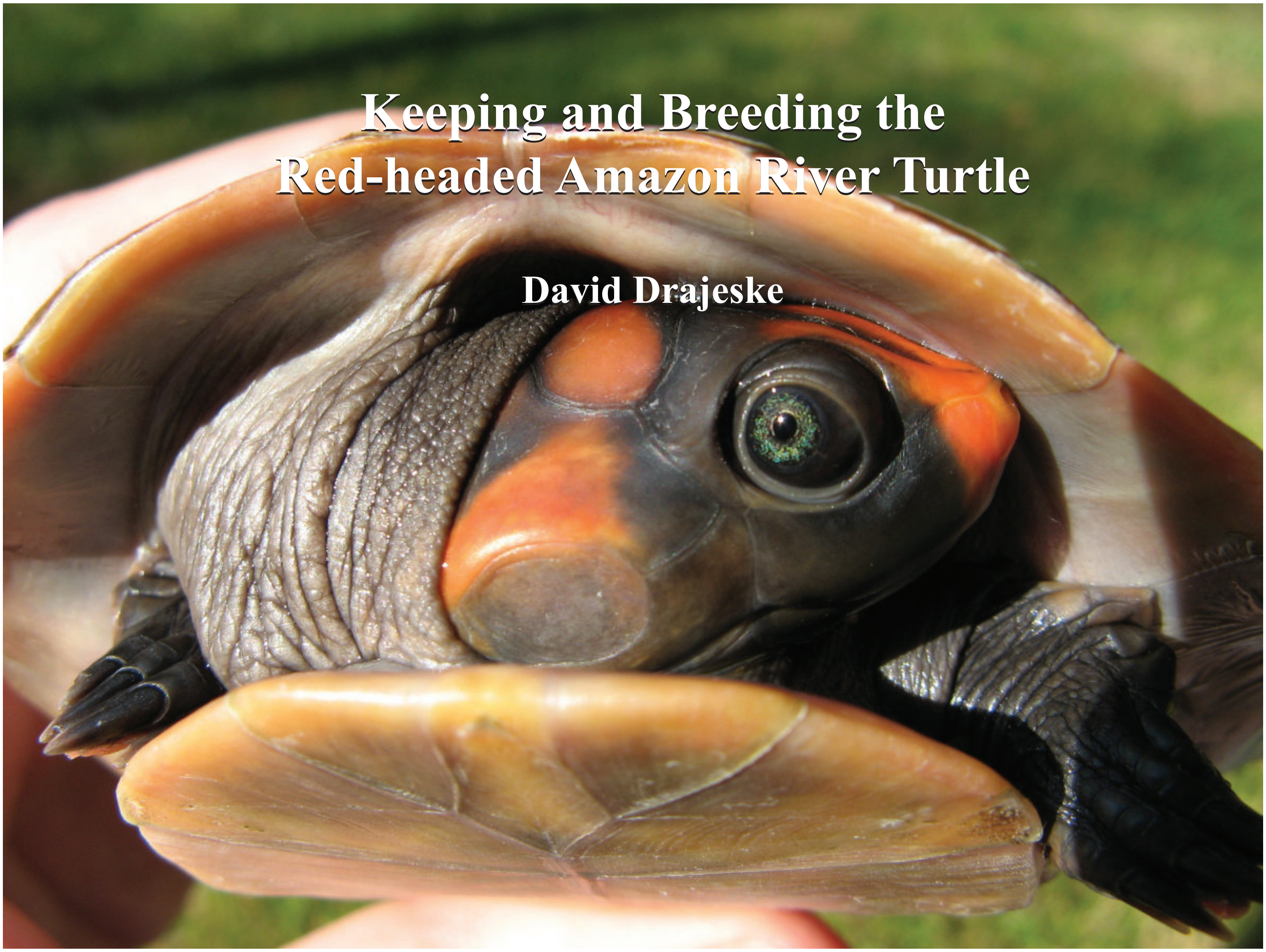

South American river turtles of the genus *Podocnemis*, with their thoroughly webbed feet, are so well adapted to their aquatic environment they seem to swim effortlessly. I recall visiting a public aquarium as a teen, and coming upon a wall of glass at the end of a hallway. Several *Podocnemis*, along with a variety of large tropical fish, populated the crystal clear water, visible from floor to ceiling. The tranquil movement of the turtles through the water was mesmerizing. With their perfectly controlled buoyancy, they could change direction with a single foot stroke, coasting with the appearance of complete weightlessness. Recreating that scene has been a life long dream.

The red-headed amazon river turtle (*Podocnemis erythrocephala*) is the smallest and most colorful member of the genus, suitable for a home aquarium. Young specimens have dramatic red to orange coloration in a bright band on the head between the tympana, on the nose, and in a ring at the carapace margin. Adult males retain the red coloration, but in females the head color gradually fades to a brown color. Females grow to about 25-28 cm SCL, with a record size of 32 cm. Adult males are typically 19-23 cm (BERNHARD & VOGT 2012). The males also have longer and thicker tails.

This species is found almost exclusively in tropical blackwater habitats of the Rio Negro in Brazil, Venezuela, and Colombia, preferring smaller streams and lakes to the mainstem of the river (MITTERMEIER & WILSON 1974, PRITCHARD & TREBBAU 1984, HOOGMOED & DE AVILA-PIRES 1990). They also occur farther east in the basins of Rio Trombetas and Rio Tapajós, a clearwater river (BERNHARD 2010, BERNHARD & VOGT 2012, BARRIO-AMORÓS & NARBAIZA 2008). While they are occasionally found in clearwater habitats, they avoid sediment laden whitewater systems like the main course of the Amazon. Blackwater habitats are characterized by tannin stained waters that are extremely soft and acidic, with a pH of 3.5-6 and a conductivity of only 10-20 µS/cm. These waters are typically low in dissolved nutrients, which limits microbial growth. These rainforest habitats are also characterized by dramatic changes in water level between the rainy and dry seasons. Nesting occurs shortly after the waters recede to expose the nesting beaches and campinas, open sandy savannas, within the seasonally flooded forest.

This species is rare in collections. Consequently, it is bred in captivity even more rarely. They were bred by the Bronx zoo in the early 1990s. I first bred them in 1998, and the Tennessee Aquarium started breeding them more recently in 2009.

This species has been characterized as exceedingly shy. I don't think that is a fair assessment, but I would say they are cautious. Both young and old specimens come toward me seeking food. Red-headed river turtles typically swim with calm grace, but they can be startled by sudden motions near their tank, causing them to bolt. This behavior is explained by the fact that a large percentage of wild *P. erythrocephala* have portions of their shell or limbs missing due to encounters with predators including black caimans and carnivorous fish such as piranha and biara, otherwise known as the vampire barracuda (VOGT 2008, MEIER 2013). Rapid escape maneuvers from a perceived threat can result in a significant impact at the end of the aquarium. These collisions can cause damage to the leading edge of the carapace. Some shock absorbing material at the end of a long tank could prove beneficial.

The behavior of my specimens varies with lighting level. In the juvenile rearing tank I provide lower light levels at dawn and dusk. The turtles seem to forage at dusk, digging in the sand for unknown treats, although they will eat whenever food is provided. If the tank is exposed to direct sunlight or other bright light, the turtles extend their legs and expand the webbing of their feet and orient them to the light in what appears to be underwater basking. This behavior could allow the turtles to decouple thermoregulation from UVB acquisition. By basking underwater, they can obtain UVB without overheating. BERNHARD observed that he doesn't frequently see this species basking above the surface in nature and feels that they are able to adequately thermoregulate without terrestrial basking (PERSONAL COMMUNICATION).

**Captive Housing**

My breeding adults are housed in a large glass aquarium with a basking area mounted above that is enclosed to help keep air temperature and humidity high.

Adult *P. erythrocephala* basking under metal halide lights.

A heated nesting box is provided adjacent to the basking area filled with a mixture of peat moss and sand. Air temperatures range from 21-38ºC (70-100 ºF) and water temperatures range from 25-32 ºC (77 -90 ºF). A metal halide UVB lamp is mounted above the basking area. During the nesting season, halogen floodlights are placed above the nesting box to further warm the substrate during the day. The turtles show individual preferences in basking behavior and it is not unusual for them to rest on the basking board or in the nesting box at night. More cautious turtles can be encouraged to bask with a gradual ramp where they can sit partially submerged at the water's edge.

**Blackwater Challenges**

It is not clear what aspects of their natural water chemistry are essential for success with this species. *P. erythrocephala* are susceptible to fungal shell infections, so attention to water quality is important. Accurately mimicking the extremely soft, highly acidic water, rich in humic and fulvic acids, is technically challenging. Water chemistry requirements for blackwater inhabitants have been more thoroughly explored in the fish-keeping hobby for species like discus (*Symphysodon* sp.) that come from a similar biotope. I would consider water parameters that are used successfully with discus and more specifically the Heckel discus (*Symphysodon discus*) to also be appropriate for Red-headed river turtles. These fish also come from blackwater environments of the Rio Negro and thrive in warmer temperatures than most tropical fish. Some keepers of *P. erythrocephala*

Water is treated with a UVC light, Bubble Bead filter, and trickle filter. The sump overflow is piped to sewer.

report health problems that they attribute to excessive water hardness or alkaline pH including shell and eye problems. I have successfully kept this species with water hardness up to 8 dGH. MEIER (2013) reports good results with water hardness as high as 20 dGH as long as the animals aren't experiencing other significant stresses. I now reside in the Pacific Northwest where the tap water is extremely soft (<0.5 dGH), which is very appropriate for this species. However, this water has very little buffering capacity. The public utility adds a small amount of sodium carbonate to the water for pH control, but over time, with continued breakdown of waste by the biofilter, the pH can rapidly drop to 3.5, but I don't consider this beneficial.

Acidic water is a chemical stressor. With fish from the region, it has been shown that the humic substances help the fish to tolerate the low pH and low mineral content of the water. The humic substances also stabilize or buffer the pH at a low level. Simply decreasing pH with the addition of a mineral acid is not representative of what the animals are exposed to in the wild. As an additional complication, not all humic substances are equivalent.

I no longer routinely add humic extracts to the water but many keepers choose to, generally by adding bogwood and using peat filtration. Commercial blackwater extracts are also a safe way of providing humates. I would be careful adding fresh fallen leaves to a confined system. While some types of leaves are reported to inhibit fungi in the water, a poorly chosen variety can actually promote fungal infections. I once attempted to make my own "blackwater extract" using fresh fallen leaves from my yard. I only succeeded in making a fungus promoting nutrient broth. A *Chelus*

A plant cutting rooted in the pre-filter sump provides the start of a "plant filter" to reduce nitrate build up.

180 gallon aquarium in author's family room.

specimen exposed to this "tea" developed a *Fusarium* shell infection. In contrast, the organic substances dissolved in the Rio Negro are highly biodegraded, so readily digestible material has already been consumed. These highly degraded organic compounds can be directly anti-fungal in some, but not all, contexts. Additionally, heterotrophic microbial growth in the Rio Negro is co-limited by not only organic carbon, but nitrogen and phosphate availability (BENNER, OPSAHL, CIN-LEO, RICHEY & FORSBERG 1995).

In light of the above, I feel that the most important aspects to replicate are the low nutrient content of the water along with a mildly acidic pH: a clearwater environment. I also use a UVC lamp to further reduce the microbial density in the water. My tanks are provided with ample biofiltration and in the adult tank, warm fresh water is added automatically daily replacing about 5% of the water.

In addition, tropical plant cuttings have been placed in the pre-filter sump, where they have rooted and remove additional nutrients from the water. Excess water overflows from a sump to the sewer. With this system, water parameters are very stable and the nitrate concentration remains at about 5 mg/L. The pH runs between 5.5 and 6.0. In areas with extremely hard alkaline water, I would consider using a reverse osmosis system to reduce the mineral content of the water, but some mineral content is advisable. I use a small bag of crushed coral in the filter sump to stabilize the pH of my soft water.

**Shell Health**

*Podocnemis* in my care don't routinely shed whole scutes like many North American turtles do. While this might be related to me keeping them indoors, it really seems like shedding in this genus is facultative. They can shed in response to mechanical, chemical, or biological challenges to the shell. Juveniles that I have raised indoors have grown to adulthood without shedding at all, and don't seem to have any ill effects from retaining their scutes. If they do begin to shed, or the edges of scutes start to lift at the edges, it often indicates a problem with microbes or some other aspect of husbandry. Fungal shell infections have been successfully treated with topical gentian violet and oral terbinifine. Older specimens may develop a general light flakiness of the shell that doesn't necessarily indicate disease. Small flakes can be removed by gentle scrubbing with a toothbrush. Any larger peeling sections should not be removed prematurely or underlying tissue can be damaged. This species can probably benefit from gentle sources of abrasion. Outer layers of the shell do gradually wear away. The turtles will seek out hard objects in their tank and rub against them as if their shell itches. I keep a sand substrate in the larger tanks, which provides some abrasion. Small tanks are kept bare-bottomed. Natural or artificial wood and rocks provide both hiding places and opportunities to scratch.

In my early experience with this species, I allowed algae to grow on their shells.

While algae doesn't seem to cause problems in many species, in this case, the algae seemed to modify the growth pattern of a rapidly growing female. This initially appeared as small gaps or gullies between the scutes where growth was occurring. With further growth, bulges developed at the scute margins. Once the algae were eliminated, normal smooth growth resumed, but a ridge remained at the former scute margin.

**Feeding**

Red-headed river turtles are primarily herbivores, but they will eagerly accept higher protein foods. Live fish housed with these turtles generally survive indefinitely, since the turtles do not actively hunt them, but slower fish that aren't alert or those that taunt the turtles with long flowing tails and fins may be consumed. My specimens are fed a variety of greens, fruits, vegetables, and seeds along with commercial turtle and tortoise pellets. Foods they have accepted include dandelions, turnip greens, kale, collards, mustard greens, romaine, endive, escarole, mulberry leaves, broccoli, green beans, peas, apples, pears, strawberries, plums, shelled sunflower seeds, and cooked steel cut oats.

They rapidly consume pellets and sweet foods, but are not in a hurry to eat their greens and often wait until the lights go out and eat the greens at night. They are also cautious with new foods and may only taste a new food for a couple days before deciding it is good to eat. The only supplements I provide other than the vitamins and minerals contained in the commercial pellets are algae powders rich in carotenoids including astaxanthin and beta-carotene. Diet appears to be more important than natural sunlight in maintaining vibrant coloration. Captive specimens in South America fed cat food fade in color (BERNHARD, PERSONAL COMMUNICATION).

**Breeding**

*Podocnemis erythrocephala* lay clutches of 4-16 elliptical eggs, typically 42 X 27 mm. Wild hatchlings initially weigh 7.9-15.3 g. The eggs can have either hard or pliable shells. The female can retain shelled eggs for an extended time period without a loss of viability. In their native habitat, females carrying eggs have been captured weeks before the nesting areas are exposed by the receding water (BATISTELLA

& VOGT 2008, CARVALHO JR, PEZZUTI & MARANHÃO 2011, CASTAÑO-MORA, GALVIS-PEÑUELA & MOLANO 2003). I occasionally see pliable shelled eggs, but the majority of clutches are hard shelled.

VOGT (2001) concluded that this species is able to produce up to four clutches of eggs per season based on inspection of the ovaries of females that had been

caught as food by the local people. In over twenty years of breeding this species, my captive specimens lay a maximum of one clutch per season even though I have increased their feeding over time to see if multiple clutches would result.

The shortest inter-nesting interval I've observed is nine months.

My adult females and male are housed together year-round. The male seems able to detect when a female is carrying ripe ova. Otherwise, he does not harass them. During breeding season, he will follow a female very closely, sniffing near her cloaca. The proper smell will maintain his interest. Then, following successful mating, it seems that the olfactory cue changes within a few days and he then directs his attention to other females.

When courting a female, he will approach her head, positioning himself at a precise distance, and make gentle biting motions near her face. While doing this, his carapace is angled toward her, as if he is peering around the edge of a shield for protection. The female will also make biting motions near the male's face, but he hovers just out of reach. At times she also bobs her head. If the female is receptive, she will extend her tail, which is otherwise tucked tightly to the side.

Once the male notices the extended tail, copulation is completed quickly. Similar observations have been made by FERRARA, SCHNEIDER, VOGT & BURGER (2009). In the wild, several males may pursue a female and FANTIN, FARIAS, MONJELÓ & HRBEK (2010) have shown that multiple paternity is relatively common.

I provide both daily and seasonal oscillation of water temperatures encourage breeding. The daily swings are 1.6 to 3.3ºC (3-6ºF). Years ago, I used an aquarium heater with a bimetallic thermostat that wasn't very good at maintaining constant temperatures, and the turtles bred. I replaced the erratic heater with a precise digitally controlled model, and all breeding activity ceased, even though I was providing seasonal temperature cues. I now use a controller that provides separate day and night temperature setpoints to provide this variability. I make no effort to simulate seasonal variation in water level.

A nesting box is thermostatically heated from below and has halogen floodlights above to warm the substrate.

Recovering eggs from the nesting box.

While the older male in my founding group only courts the females during breeding season, my young adults seem less constrained by the seasons and can produce eggs at any time of year. FERRARA has observed that courtship may occur at any time of year with wild specimens (PERSONAL COMMUNICATION).

Following mating, shelled eggs can be detected by palpation about 6 weeks later.

My least anxious female nests about 7 weeks after mating. While she may initially be unsatisfied with the acceptability of the nesting box, simply adding more water to the substrate can encourage her to nest. The other two females will repeatedly explore the nesting box, evaluating the substrate by digging with their front feet and sniffing or nuzzling the soil. Unimpressed, they return to the water without nesting. The nesting box is heated from below but I have also added halogen

Rinsed and disinfected eggs prior to covering completely with incubation media.

floodlights over the nesting area, which are on during the daytime, providing surface temperatures as high as 60ºC (140ºF) directly below the bulb. My females nest in the early evening when soil temperatures are at their maximum. When the more discriminating females do nest, it is centered directly below a floodlight.

While monitoring the many trips to the nesting area by a gravid female, I have tried putting a thin layer of white sand on top of a darker peat mixture, thinking that this would make it obvious when a nest had been completed. However, when the female finished hiding the nest, it was completely covered by white sand with no evidence of the darker material below.

### Incubation

Fertile eggs begin to chalk within 24 hours, with a white circle appearing on the upper surface, signifying that development has commenced. Eggs of this species benefit from incubation in very moist acidic media. Incubation conditions described as moist or wet by other authors were too dry for this species. I once incubated in vermiculite that was hydrated with 1.5:1 water to vermiculite by weight, but the eggs desiccated and none survived, even though they were fertile. Incubation was successful when the water content was increased to 2.5 or 3.0:1. The eggs also tolerate direct misting with distilled water. It is a common practice to incubate turtle eggs of many species partially buried in the substrate with the top exposed. However, increased contact between the egg and the moist substrate increases the moisture available to the egg. I now bury the eggs completely about 2-3 cm below the surface to provide ample water.

This practice has not caused any problems with egg anoxia.

To test the idea that acidic incubation media may be helpful, I compared incubation in long fiber sphagnum moss to incubation in vermiculite, which is often neutral to alkaline depending on its source. The eggshells were noticeably softer at the end of incubation in the sphagnum, and the hatchlings incubated in sphagnum were larger and more robust than those incubated in vermiculite. Both substrates seemed to provide sufficient moisture. I now include peat moss in my incubation mixtures. I've used 20-50% peat by volume, mixed in HatchRite™, vermiculite, or sand. My current preferred mix is sand with peat. I hydrate the sand to about 5-6 wt% water. I hydrate the peat separately to about 50 wt % water, then microwave the moist peat for a couple of minutes to reduce any microbial population. Then I mix about 20% peat by volume into the sand. I add additional water weekly to maintain constant weight.

Incubation duration varies from 60 to greater than 100 days depending on temperature. With temperature averaging 29.2ºC, incubation lasts 79 days.

An incubator that can provide two different temperature setpoints per day gives added flexibility.

Incubation in acidic media such as sphagnum moss or peat moss helps release calcium from the eggshell to promote growth.

My early incubation efforts with this species resulted in high hatch rates.

However, over time, I started to have problems with late term embryo mortality.

In some cases, the hatchling would pip the egg, and then die. At the time, I was also experimenting with different incubation temperatures in an effort to produce hatchlings of known sex. The problem seemed more severe with cooler incubation temperatures. On necropsy, some of these dead-in-shell embryos showed signs of sepsis. I started rinsing fresh eggs in a disinfectant solution prior to incubation. The veterinary disinfectant, F10SC, is diluted 500:1 in distilled water. I first rinse the eggs in distilled water to remove most of the mucus, then the eggs are submerged in the disinfectant solution for 30 seconds prior to being placed in the incubator. Since using the disinfectant dip, late term embryo deaths are very rare. That being said, higher incubation temperatures appear to have a beneficial effect on the neonate's immune function, so when testing lower incubation temperatures for their TSD effect, I gradually ramp up temperatures during the final third of incubation, after sex determination is likely complete.

**Temperature Dependent Sex Determination (TSD)**

The sex of the offspring is determined by temperature with females being produced from warmer nests (TSD Ia). Constant temperature incubation at 30.7ºC results in both sexes in approximately equal numbers. VOGT suggested that very cool temperatures, approximately 21 to 23ºC may also be feminizing in this species, which would mean they are actually TSDII, although the feminizing temperatures may be too low for successful incubation at constant temperature (PERSONAL COMMUNICATION).

I feel that constant high temperature incubation above the sex determination threshold is not natural and may cause a variety of problems including increased frequency of scute deformities. I built custom incubators that allow me to mimic the temperature trend of a typical day in a natural nest with rapid heating in the morning and more gradual cooling in the evening. NOVELLE (2006) found that in wild nests, incubation success increased with longer incubation duration (range 65-87 days). I choose incubation conditions that result in durations in the upper end of that range. In an example profile that I have used to produce females, temperatures were varied between 35 and 23ºC with an average of 28.2ºC. To produce males, I incubated at a constant temperature incubation of 28.4ºC, although a small percentage of females occur at this temperature. The incubation duration is 85-88 days to pipping for both of these temperature profiles. Hatchlings seem to benefit from these longer incubation periods, efficiently

Once the yolk is mostly absorbed, hatchlings are removed from the incubator, rinsed, and moved to an aquarium.

Hatchling *P. erythrocephala* exploring a 10-gallon aquarium.

Underwater basking.

Hatchlings like to rest near the surface on floating plastic plants.

Juvenile *P. erythrocephala* exploring a 120-gallon aquarium.

converting yolk to bodyweight. With these incubation conditions, both male and female hatchlings leaving the egg may weigh as much as 80% of the initial egg weight. One hatchling was 4.3 cm SCL and 16.3g, the largest on record!

I have tried running a series of incubators with similarly shaped high variance daily temperature profiles, with successively lower temperatures (see Figure 1).

The highest temperatures resulted in females. The next lower temperature profile resulted in mixed sex broods. The lowest temperatures resulted in all females! This is consistent with VOGT'S suggestion that low temperatures may be feminizing.

### Hatchling Care

In addition to a basking area, hatchlings are provided with floating plastic plants where they frequently rest near the surface. Hatchlings start feeding within a week of internalizing the yolk sack. Providing hiding areas on the bottom of the tank will make them feel more secure. A calm environment free of distractions is especially important during the first few weeks to encourage feeding. They will accept bloodworms, greens, and pelleted foods. One way to provide a distraction free area for initial feeding is to place the hatchling in a small tray of water in the incubator until it has accepted a few meals. Live worms or insect larvae can be used if necessary to stimulate feeding. I feed sinking pellets, since the hatchlings seem to first look for food on the bottom. They will also accept floating pellets, but slower individuals may not find any pellets before their siblings eat them all.

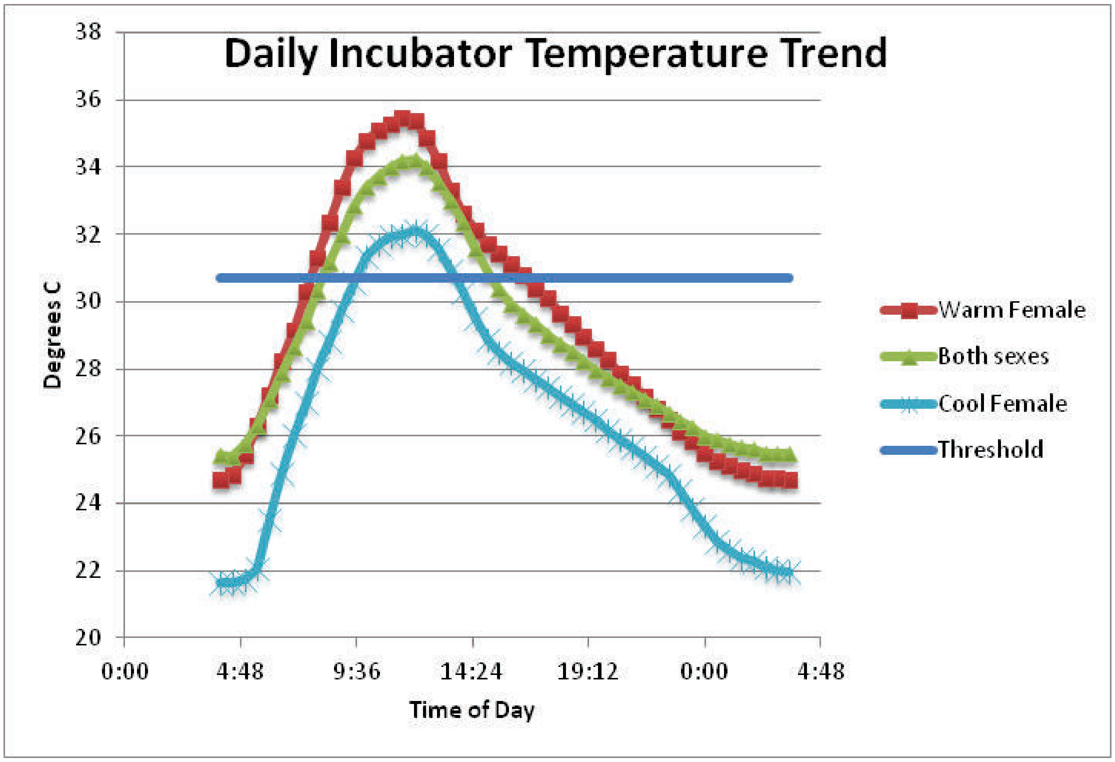


Figure 1 - Warm female incubation: mean 29.4ºC, non-linear constant temperature equivalent (CTE) 30.7ºC (GEORGES, DOODY, BEGGS, YOUNG 2004). Temperature profile producing both sexes: mean 29.0ºC, CTE 29.5ºC. Cool temperature female profile: mean 26.6ºC, CTE 28.0ºC. Approximate threshold at constant temperature is 30.7ºC.

Hatchlings are fed twice per day for the first several weeks, then once per day for the first year. While food availability varies seasonally in the wild, I provide food consistently throughout the year. Wild juveniles will show growth annuli on their shells, most noticeable on the plastron, but these aren't present on my captive raised individuals. With a captive diet, juveniles can grow more rapidly than in the wild. A captive bred female hatched in 1998 reached 26 cm in 6 years. I now target more natural growth rates by varying the fraction of rich pelleted foods in the diet. If they are growing too quickly, I reduce the pellets. I now target an average size of approximately 8 cm SCL and 60 g at one year of age and 11 cm and 135 g at two years of age.

**Time to Mature**

It appears that in *Podocnemis*, maturity in females may not occur before a certain age, even if growth is accelerated in captive conditions. Even though the female described above was sufficiently large, she did not appear to reach sexual maturity until she was almost 10 years old, similar to the time required in the wild. Prior to that point, the male paid no attention to her. Also, prior to sexual maturity, she frequently showed male-typical courtship behavior and courted the largest female. I have speculated that this male-typical behavior by a presumed adult female was an artifact of constant temperature incubation near the sex determination threshold temperature (DRAJESKE 2010). However, the extreme level of male-typical courtship may have been largely pre-pubescent behavior.

The other adult females have only rarely displayed male courtship behavior. This captive bred female first laid a clutch of 12 eggs the season she turned 10 years old. Even though mating was witnessed, this first clutch was infertile, and the eggs were 30% smaller than those of the older females. She laid 11 fertile eggs in 2010, the season she turned 12 years old, resulting in my first second generation captive offspring for this species. Egg size has gradually increased in successive clutches while clutch size has ranged from 10-12 eggs. In my group, it appears clutch mass is proportional to the female's bodyweight, typically 9-10%, but over

A hatchling, yearling, and two year old.

12% in one instance, and egg size increases with the age and breeding experience of the female. Two F1 females that were fed to target more natural growth rates recently produced their first fertile clutches at 8 and 10 years of age. Both females produced initial infertile clutches the year before.

**Warm Temperatures are Essential**

The equatorial region this species resides in is uniformly warm. As a consequence, they have not evolved the capability to deal with cold temperatures. Exposure to low temperatures can be fatal either during shipping, or when outdoor specimens experience unexpected cold weather. One keeper lost a pair of erythrocephala when an unexpected cold front dropped water temperature to 13.9ºC (57ºF). Another keeper lost 1 of 2 animals when a heater failed and the temperature decreased to 16.7ºC (62ºF). I am careful to avoid temperature excursions when performing water changes. While cleaning the tanks of hatchlings in the winter, I place them in an incubator as a precaution.

**Availability**

*Podocnemis erythrocephala* are listed under Appendix II of CITES, but are not listed under the US Endangered Species Act. They are not routinely exported from their natural range, but captive bred specimens can be sold across state lines in the US and internationally with proper CITES documentation. Hopefully, as we continue to unravel their secrets, and breeding success continues to improve, more people will be able to enjoy this enigmatic species outside of South America.

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