Captive Propagation and Husbandry of the Vietnamese Leaf Turtle

(Geoemyda spengleri)

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In the past several years, among the most popular species of Southeast Asian turtles in both U.S. and European vivaria has been *Geoemyda spengleri*. This diminutive terrestrial emydid has been known variously as the Vietnamese leaf turtle, black breasted leaf turtle, Indo-Chinese serrated turtle, scalloped leaf turtle and Vietnamese wood turtle. All of these common names are suitably descriptive, but for the sake of uniformity, Vietnamese leaf turtle or *G. spengleri* will be used here.

Although first described by Gmelin in 1789, very little has subsequently come to light about the natural history or precise geographic distribution of the Vietnamese leaf turtle. Definite records exist for southernmost China and Vietnam (Fan, 1931; Bourret, 1941; Petzold, 1963 and 1965). However, literature records from Borneo, Sumatra, and the Philippines have been based on hearsay or on misidentified specimens of *Heosemys spinosa* (Mertens, 1942) and possibly on specimens of an undescribed form as well (Aoki, pers. comm.). The group of Southeast Asian turtles commonly referred to as "leaf turtles" and embracing the genera *Cyclemys*, *Geoemyda*, *Heosemys*, *Notochelys*, and *Pyxidea* remains the focus of polite disagreement among chelonian (turtle) taxonomists. For an excellent contemporary discussion of the pros and cons of various phylogenetic arrangements, see Yasukawa et al. (1992).

Since the turn of the century, leaf turtles inhabiting Okinawa and a few offshore islets were considered a subspecies known as *Geoemyda spengleri japonica*. Somewhat larger and more robust than its mainland cousins, the insular Ryuku Islands leaf turtle is further distinguished by the presence of axillary and often inguinal plates as well, distinctive relative placement of carapace annuli, weaker scalloping of the posterior marginals, more closely apposed nostrils, and the lack of sexual dichromatism. There are skeletal differences between the two forms as well as more subtle differences. Based on their exhaustive comparisons among dozens of living and preserved specimens of both mainland and insular races, Yasukawa et al. (1992) have declared *Geoemyda japonica* a full species, closely related to *G. spengleri* with which it forms an exclusive, monophyletic group.

Adult *G. spengleri* are not known to exceed 4 1/2 inches (114 mm) in straight line carapace length (CL). Their elongate, flattened, 3-keeled, posteriorly saw-toothed carapaces are distinctive. The ground color of the carapace varies considerably from orange yellow to reddish orange to drab olive, often with a complex underlying pattern of pale flecks in the underlying connective tissue. The effect can be so striking as to be described as opalescent. It is possible that a geographical correlation exists between dark and light colored forms, the latter occurring in the southern part of the species' range. The jagged posterior marginals, sometimes delicately upturned, bear out the overall similarity to a dry leaf and also recall the scalloping of the roof tiles of a pagoda.

The unhinged plastron provides other distinguishing features, chiefly the large, symmetrical black central figure. This dark blotch is edged in yellow or off-white, sometimes pressing chevron-like (V-shaped) towards the midline yielding a "Christmas tree" outline. Axillary and inguinal plates are almost always absent; the gulars are almost rectangular.

Although juveniles and adults share relatively dark soft parts attractively speckled with red or white spots, females and juveniles bear white, yellow, or reddish stripes on the head and neck. The males' heads, with a single known exception, are unpatterned but equally striking for the hooked beak, alert expression and protuberant eyes common to all specimens of *G. spengleri*. Aside from the difference in head coloration, males are smaller overall with a much longer tail and more distally located cloaca, bearing a slight plastral concavity. It is not known at what size or age the secondary sexual differences become manifest, as hatchlings exhibit the female head and neck coloration.

As far as is known, the first living specimens of *Geoemyda spengleri* to reach the western world were brought to East Berlin from what was then North Vietnam in 1961. The late Hans-Guenter Petzold (1963, 1965) imported at least eight of these turtles including a juvenile, along with specimens of several other poorly known Southeast Asian chelonians. To his credit, Petzold provided useful information about the relatively cool, very wet montane habitat of this species as well as its intolerance of excessively hot, "tropical" vivarium conditions. Captive diet was also discussed in detail. Although the longevity of these original animals is unknown, the earliest known importation of specimens into the United States was in 1980 and consisted of several juveniles allegedly captive-bred in Czechoslovakia. Whether any of these animals, offered by a Miami dealer, survives today is unknown to me. The next specimen which I saw, an adult female, was in a private collection in March 1985 and was said at the time to be the only one of its species in California. This turtle was primarily fed goldfish.

My experience with *Geoemyda spengleri* really began with the acquisition of an adult pair in November, 1985. Still going strong, these unusually large specimens (4. 4 inches (113 mm) CL, M 4.1 inches (103 mm) CL) were shipped from Hong Kong, but had probably been collected in Vietnam. Initial prophylaxis with Metronidazole administered orally (Buskirk, 1988) was done empirically as a safeguard against protozoan infection. The only health problem experienced by either specimen subsequently, was a rapidly developing case of necrotizing stomatitis (mouth rot) in the female. This was treated successfully with injections of Amikacin, a gram-negative antibacterial medication, and local debridement (necessary removal of infected tissue). The female still has difficulty consuming earthworms, owing to the partial loss of her mandible. Several turtle keepers have reported the sudden death of apparently healthy Vietnamese leaf turtles (Nicol, 1991). A large juvenile I was given in 1986 survived only 15 months, growing disproportionately such that the plastron's growth outpaced that of the carapace: later the animal's hindquarters became markedly swollen. The turtle's demise was preceded by it few days of inactivity. Although no microbiological exam was done, the colon of the turtle upon necropsy was blocked with copious mucus. Nicol (1991) discusses problems with shell rot, glossitis, and ocular inflammation.

My remaining experiences with and observations of *Geoemyda spengleri* have been singularly positive and upbeat. It is fortunate that I have had access to European literature and to reptile staff in zoological institutions skilled in keeping this species as well. Practices

credited to published works that do not differ significantly from my own are clearly thus indicated. If any reader's favorable experiences digress markedly from the pointers given below, please share your observations with others.

First, as mentioned in the introductory paragraph relating to Petzold, Vietnamese leaf turtles **do not** like it hot! Although Rudloff (1986) is actually the second person known to have bred this species in captivity, his excellent paper on reproduction-oriented husbandry remains the "gold standard." Temperature-wise, Rudloff advocates reliance upon indoor ambient temperature without supplementary heat from late spring through summer. In the winter months, the room temperature is maintained from 59-70°F (15 -21°C) by central heating. Petzold (1965) advocates keeping this species outdoors (in northern Europe) during the summer as long as overnight temperatures do not fall below 50°F (10°C). Attempts at housing my chelonians outdoors during the cool (60-70°F) (16 - 21°C) San Francisco Bay Area summer did not work well, as they ceased feeding and nearly stopped moving about until brought back indoors. Although direct sunlight does not reach Rudloff's vivarium, my *G. spengleri* often bask in early morning or late afternoon sunshine, which reaches their indoor enclosure only in the summer months. Trying to maintain this species outdoors year round in central Florida where it gets quite warm, may have contributed to the high mortality reported by Nicol (1991). Rudloff advocates a 9-hour photophase in January and a 14-hour photophase in July via a timed 25-watt incandescent bulb in a corner of the tank. He also uses a 20-watt fluorescent lamp. I provide only a Vitalite® for about seven hours in summer; nine or so in winter. The true photoperiod closely matches that of seasonal day length at 37°N latitude as the *G. spengleri* have always been housed near a large window.

I will now describe the suggested enclosure. As one would expect from a humidity-loving, but terrestrial, small turtle, a soft substrate such as sphagnum moss or cypress mulch is best. I provide the latter to a maximum depth of 3 1/ 2 inches (9 cm). Rudloff advocates non-manured peat mixed with sand and leaves. As he suggests, the substrate should be misted daily - sometimes I spray it twice daily. One or more shallow water dishes should be provided. The turtles will sometimes copulate in these and generally defecate in them. Reportedly, the Fort Worth Zoo has kept *G. spengleri* in shallow water on which dry "islands" are readily available for oviposition or other activities. Rudloff suggests that juveniles are more water-loving than adults, echoing Felix (1965). For cover sites, thin pieces of wood or sections of board serve well, as do broken flower pots (a personal favorite). It is important, however, not to crowd the interior and thereby block the running about which is involved in courtship. Even more crucial to breeding success, is to allow plenty of room - at least 39 inches (1 m) on one side, according to Rudloff. The adoption of his space criteria has, in my opinion, been one of the factors responsible for the successful breeding of my pair of *G. spengleri*.

Petzold (1965) declares this species' fondness for snails, with which I strongly agree. Garden snails compose roughly 80% of my specimens' diets, the remaining consisting of slugs, earthworms, waxworms, crickets, pinkie (newborn) mice, and bits of fruit. Petzold lists other dietary items of captives as follows: "weevils and earthworms, ground meat, bananas, carrots, and less often, lettuce and cabbage." Rudloff maintains that his Vietnamese leaf turtles consume only living, moving prey - mostly pinkie mice. He advocates feeding these turtles sparingly, probably good advice for all adult carnivorous turtles. While in nearly eight years my original two (1.1) *G. spengleri* have not increased in length, the male's weight has

increased by only .7 ounce's (20 g) and the female's has fluctuated seasonally by about 1.8 ounces (50 g).

Like many chelonians, Vietnamese leaf turtles often do not move unless there is a specific reason for them to so. As Rudloff is keen to point out, they will sit motionless for hours, heads held high and eyes wide open. This bittern-like stance may be interrupted by the presence of prey. However, they are easily distracted by motion, and will forsake the prey in their jaws to pursue another turtle which is trying to feed simultaneously. Therefore, visual separation at feeding time is often advisable.

The other major interaction between these turtles occurs during mating. In my experience, there is little they would rather do, particularly early in the morning. Only on the hottest of days, unusual in coastal northern California, and also during the shortest winter days, do they eschew procreation. There is little formal courtship other than first facing one another with necks outstretched (Rudloff). However, my male sometimes quietly mounts the female from behind without having bothered to reintroduce himself. Only occasionally, I have observed the chasing about the enclosure described by Rudloff. The female remains motionless during copulation, her head partially withdrawn, while the male's head is fully extended.

Rudloff advocates seasonal separation of male and female once the latter becomes gravid, coinciding with her sudden hostile behavior towards the male. He observed mating most frequently in autumn after the central heating in his apartment was turned on, following a drop in ambient temperature in late summer. Conditions in private U.S. homes are somewhat different from those in apartments of what was formerly East Germany, but I am less likely to turn up the thermostat than many of my fellow citizens. The rise in room temperature preceded by a cooling down, akin to Rudloff’s early autumn change, more typically occurs in my home in Oakland, California in February. By early December, my leaf turtles become nearly quiescent, only occasionally stirring to bask and even less often to feed, and remain this way for six to eight weeks.

Even after countless episodes of copulation, my female show's none of the aggressiveness which typifies Rudloff's gravid female's by January or so. Indeed, my 1.1 *G. spengleri* seem to exhibit true ''pair bonding.'' The male has seldom so much as nipped at the female, let alone forced himself upon her. Two other seasoned captive females, at different times, have been introduced to the enclosure in hopes they would also become gravid, and each has charged at the male or gaped menacingly at his most timid approach. One of these females has bitten the limbs of the other three Vietnamese leaf turtles, and neither ever permitted being mounted, insofar as was observed. Although Rudloff considers this species too delicate to be kept with other turtle species, the female exhibiting consistent intraspecific aggression has since managed to live in peace with four larger Asian terrestrial emydids.

Data on oviposition and incubation is presented in Table 1 and summarizes the published accomplishments of Rudloff(*) and Hudson & Mehaffey (**) at the Fort Worth Zoo in Texas as well. The second, smaller egg laid by the author's female presumably on 5/22/93 (***) was not discovered until 6/21, deeper in the substrate exactly where the female had been observed nesting. The egg had banded and increased from an initial weight of only 4.1 g to 8.8 g on 7/24.

TABLE 1

Date Laid	# Eggs Laid	Dimensions	Incubation Temperature	Incubation (Days)	Comments
2/25/85	1*	42 x 18mm (8.2 g.)	87 F (30 C)		dead, complete embryo (5/85)
4/4/85	1*	47mm long	83 F (28 C)	66	
5/12/85	1*		77 F (25 C)	73	
5/1/88	2**		87F (30 C)	67	
7/20/88	1				
8/4/89	2		84-92 F (29-33 C)		embryos killed by overheating (9/27/89)
6/21/90	2	46mm long	83 F (28 C)	65	no development of second egg
7/6/90	1		83 F (28 C)		contained 1 cm embryo; eggshell cracked, moldy
10/3/91	1	45 x 21mm (12.7 g.)			infertile
5/22/93	1***	45.4 x 21mm (12.3 g.)	81 F (27 C)		

The larger egg was opened a week following the hatching of the smaller one and found to contain a dead but well developed embryo lacking a tail and a portion of the right posterior carapace. An additional three *G. spengleri* eggs (#), from two clutches, were incubated in a Hovabator ® and developed normally between May and July 1993 in another private California collection. However, only one hatchling has survived, which alone had emerged without assistance on 7/4/93. The hobbyist who oversaw the incubation of this trio strongly advises against interfering with the hatching of *G. spengleri* eggs.

Thus, seven hatchlings have been produced from 17 eggs of which three showed no signs of embryonic development. The incubation period in all cases is remarkably constant. Note the similarity in size and mass of the July and August 1993 hatchlings from different parents. Since 1988, the Fort Worth Zoo has produced several more hatchling *G. spengleri*. Rudloff was fortunate to observe the first nesting by one of his female turtles on 25 February 1985. He describes the process as rapid, taking only about an hour and comments that considerable material was used to cover the nest. He believes the substrate depth was insufficient and was as stunned by the large size of the elongated egg as I have been each time I have found a *G. spengleri* egg in the enclosure. Only once have I witnessed nesting. Before further describing that activity I would comment that it took place beneath a fragment of flower pot, effectively concealing the female. Indeed, all egg's found to date in my enclosure had been deposited under cave-like shelters. Possible explanations for such a practice include:

a) the female wishes to remain as hidden as possible during oviposition.

b) such relatively dark and cool sites are deemed more conducive to ensuring hatching success, and/or concealing the egg(s) from predation;

c) sheltered areas are less humid.

For several days in mid-May of this year, the female was unusually restless, pacing back and forth across the least obstructed side of the glass enclosure, the front. She had continued to accept food less frequently than usual and rejected the male's sporadic advances. On the morning of 22 May, she backed into the tightest fitting shelter, beneath half a small terra cotta pot split lengthwise. She seldom has used this site for sleeping or daytime rest. Only her eyes and snout protruded, and when I noticed that the pot shard was jiggling slightly, I suspected she was nesting. I gently removed the pot above her at 10:45 A.M. and saw a partially covered large egg. Over the next two hours, the female continued to cover the nest by raking damp cypress mulch with her hind feet until her posterior was noticeably raised up. She did not move her firmly anchored forelimbs for several hours. Had the pot not been removed, it is unclear how much longer her nest covering would have continued. She extended her hindlimbs horizontally and laterally and piled up such a mound of mulch beneath her that two small trenches lay to either side. For several hours afterwards, she did not move. A smaller egg was discovered in the same location on 21 June and removed to the incubator. This egg showed a broad white band consistent with fertility and hatched 8/2/93 in much the same fashion as the larger 1990 egg. Other fertile Vietnamese leaf turtle eggs have banded within 24 hours of being laid. Two eggs of unknown vintage have been discovered on different occasions in the enclosure, buried in the seldom disturbed substrate beneath the largest "cave."

Rudloff incubates most, if not all, of his chelonian and ophidian eggs on foam rubber in an incubator not otherwise described in detail. I have used a 10-gallon aquarium filled to a depth of about 2 3/4 inches (7 cm) in which a submersible aquarium heater has been placed on a slant. Panes of glass, easily removed to ventilate the chamber and which allow the inspection of the eggs daily, cover the top. The eggs themselves rest atop moist vermiculite in a plastic tray resting on pieces of brick. This very humid environment seems to work, but many people who have hatched far more turtle eggs employ other methods. The low-tech method I use was taught to me by the late Tim Hurley and has successfully yielded hatchling

Pyxidea mouhoti as well as *Rhinoclemmys pulcherrima incisa*.

On the morning of 26 August 1990, one end of the egg laid on 21 June was broken off. Bending closer, I was eye to beady eye with a miniature replica of an adult female *G. spengleri*. Sometime after dark that evening, the neonate walked out of the hole it had made more than 12 hours earlier. This hatchling measured 1 1/4 inches (32.2 mm) CL and weighed .3 ounces (8.0 g). A small egg tooth and yolk sac were present, but were resorbed (or sloughed) within a few days. My hatchling first accepted food (a tiny slug and portion of an earthworm) on its seventh day of life. This year's considerably smaller hatchling retained a larger yolk sac which was sloughed on the fourth day life. This hatchling began to accept food--slivers of garden snail and bits of earthworm--on the tenth day and continues to feed daily in its solitary enclosure. Rudloff's hatchlings consumed earthworms, small garden snails, grubs, and by the age of 11 weeks, small pinkies.

TABLE 2

I.D.	Date	CL (mm)	Weight (g.)
R	6/10/85*	30	4.3
R	9/-/85	41	11.0
B	8/26/90*	32.2	8.0
B	11/1/90	36.8	9.8
B	1/27/90	38.8	11.9
B	2/24/93	41.0	15.3
B	8/8/91	60.6	42.4
B	9/12/93	73.0	65.0
B	6/21/93	79.3	92.5
C	7/11/93	30.0	5.5
D	8/2/93	29.5	5.5

Table 2 summarizes growth of Rudloff's first hatchling (R) in the first three months of life, of my own (B) over nearly three years, and the neonatal dimensions of the July 1993 hatchling (C) as well as of my August 1993 hatchling (D). Rudloff does not provide the dimensions of his second neonate.

The nearly three year-old juvenile has exhibited normal, well-proportioned growth and retains the bright neck stripes typified by females of this species. A year ago, this youngster was moved from its small, solitary enclosure to that of the parents, with whom it has since lived amicably. At times, it has attempted to wrest food from either of the adults, but there is no consistent aggression between members of this trio. I cannot explain, however, the

inevitable (and non-reciprocal) hostile behavior of other Vietnamese leaf turtles placed with this congenial threesome.

This unusual terrestrial turtle species has been most interesting to work with. I hope his account will benefit others who wish to manage and breed the Vietnamese leaf turtle.

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