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Experiences with the Raising, Keeping and Breeding of the Diamondback Terrapin (*Malaclemys terrapin macrospilota*)

The diamondback terrapin (*Malaclemys terrapin*) is the only North American emydid turtle that lives almost exclusively in brackish waters. It is distributed along the east coast of the USA to the Gulf of Mexico, ranging from Massachusetts in the north to Texas in the south. In earlier times it used to be farm-bred in large numbers for human consumption. It is rather rarely found in terraria despite its having been imported on a regular basis until the mid-1980'. Today, the export of these terrapins has been banned through national protection laws by several federal states (e.g., Florida) in which it occurs naturally. It therefore appears important to use the specimens existing in private collections to build up successfully reproducing groups.

Aside from a report on the breeding of *M. t. centrata* (Sassene 1984) and a contribution on *M. t. iniquata* (Gisaco 1992), the available literature contains little information on the successful propagation of diamondback terrapins in captivity.

Systematics

Following Iverson (1992), altogether seven subspecies are recognized: *Malaclemys t. terrapin* (northeastern USA from Massachusetts to North Carolina), *M. t. centrata* (from North Carolina to the northeastern coast of Florida), *M. t. littoralis* (Texas), *M. t. macrospilota* (west coast of Florida), *M. t. pilosa* (northwest coast of Florida to Louisiana), *M. t. tequesta* (east coast of Florida), *M. t. rhizophorarum* (Florida Keys Archipelago). Very good illustrations of all subspecies can be found in Verrea (2004).

Identifying the subspecific affiliation of a diamondback terrapin that lacks data on its exact origin is not always possible beyond doubt since these animals may display a high degree of variability as to their colour patterns. The southern subspecies are easily distinguished from their northern counterparts by their button-like protrusions on the rear margins of their vertebral scutes, though. Specimens that managed to escape from breeding farms or were released in the wild may well have caused a genetic pollution of subspecies or local varieties.

Description

Diamondback terrapins (*M. t. macrospilota*) usually grow to a maximum carapace length of 22.9 cm in the female, and about 14 cm in the male sex (Masa 1996). The latter sport a much longer and stouter tail. The arched carapace is blackish brown to black in colour. Conspicuously pale yellow to bright orange coloured centres of the individual carapace scutes are the most distinct identification traits of this particular subspecies (Fig. 1). The second through fourth vertebral scutes show distinct, button-like tubercles that are most pronounced in juveniles, but become less conspicuous as the terrapins grow older. The soft parts are light grey in colour, with a faint blue hue, and show numerous dark, irregularly scattered speckles that differ with the individual. A constant trait appears to be that all adult females have an unpatterned head that appears white. Female specimens furthermore develop very large heads with well-pronounced jaws as they grow older (Fig. 2). In contrast to the

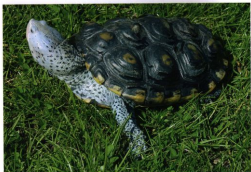


Fig. 1. An adult *Malaclemys terrapin macroscelota* female with intensely orange-coloured scale centres.



front legs, the hind legs are furnished with clearly recognizable webbings.

Distribution and natural habitat

Populations of *M. t. macroscelota* are restricted to the west coast of Florida where the terrapins reside in the brackish zones of rivers and in mangrove swamps on the coast. Tree trunks emerging from the water and floating debris form favourite basking sites, but sections of the banks that fall dry during low tide are also used for this purpose (RIMSSEN



Fig. 2 (center). The powerful muscles of mastication are clearly visible in female # 3 (F3).

Fig. 3 (below). Portray of the more delicate head of male # 1 (M1).



Fig. 4. Two male diamondback terrapins basking.

pers. comm.). Hatchlings avoid open water, and bury themselves or hide amongst washed-up tang and seaweed at the level of the flood line (Lovich et al. 1991, Emsw et al. 1994).

Sand dunes on the margins of mangrove forests make for oviposition sites. To reach these, the terrapins sometimes have to wander far. Gravid females often become victims of the traffic during this period of time, as they have to cross roads in their quest to find a suitable site for their eggs. This situation is aggravated by the fact that this point of time also marks the beginning of the tourist season, which brings about increased traffic densities (Moriz 2004). An even larger threat to the eggs, but also to the terrapins themselves, exists in the form of raccoons. They manage to find and destroy between 92.2 and nearly 100 percent of the clutches (Furman 2004). Crab traps are another hazard to adult diamondback terrapins, with *Russison* et

al. (2004) stating that terrapins are found in those traps at a rate of 0.0 to 0.49 per trap per day.

Behaviour

These terrapins are largely diurnal and quite often seen basking in the sun. They have fairly large escape distances and tend to respond to the slightest disturbance with slipping into the water and diving to safety immediately. Diamondback terrapins are carnivorous, making use of a wide spectrum of suitable foods: shrimp, mussels, snails, fish, and a multitude of aquatic insects and their larvae. Adult females feed mainly on mussels. Their large heads, strong muscles of mastication and distinct horn beaks enable them to crack even thick mussel shells.

The terrapins are active throughout the year and insert periods of rest only during phases of bad weather. They do not really hibernate (all data from *Russison* pers. comm.).

First husbandry experiences

I acquired two male and one female diamondback terrapins from a pet shop in summer 1990. At the time, the animals measured about 8 cm in carapace lengths. They appeared healthy and showed themselves very lively. They were housed together in an aquarium of 100 × 60 × 50 cm (length × width × height). The tank was decorated with a piece of cork bark that formed a bridge for the terrapins to bask on, and a piece of root and several rocks that created underwater hiding places. An about 5 cm-deep layer of sand was used as substrate. The water level was 30 cm, and the water temperature kept at about 28 °C during the day and ca. 25 °C at night. An internal filter kept the water clean and also created a substantial current. The aquarium was illuminated with a 36-W fluorescent tube and a 75-W mixed-spectrum lamp that was mounted right above the cork bridge. Here, the latter created a hot spot where temperatures reached a maximum of 45 °C. The photoperiod ranged from twelve to fourteen hours of light per day, with the hot spot being switched on for six to eight hours. Initially, the animals were fed small amounts daily, but this was changed to a two- to three-day routine after about half a year. Provided with this environment the terrapins showed themselves very lively and soon became tame. Unfortunately, the two males mentioned above fell victim to a technical accident (a broken heater) and died in 1999. Table 1 shows sizes and weights of the diamondback terrapins kept by myself.

Husbandry conditions of the adult specimens

Starting in 1993, two male and two female *M. t. macropolina* were housed together in

an aquaterrarium measuring 130 × 75 × 45 cm in which a 40 × 30 × 25 cm-large section formed a terrestrial part. The tank was set up in my turtle room in a cellar. It was illuminated with two fluorescent tubes of 36 W each, and two spotlights of 100 W each created a hotspot. Water temperatures fluctuated between 23 and 30 °C. The water was mechanically purified with an external filter and completely replaced every two to three weeks. During every water exchange sea salt was added at a ratio of less than one gram per litre of water.

In 2004, the terrapins moved to an aquarium of 145 × 135 cm (length × width) with a 45 cm-level of water. They furthermore have available a tank of 160 × 70 cm with a water level of 55–60 cm. The water is purified here with an integrated multichamber interior filter, and partial water exchanges are effected every three to four weeks. Pollution levels of the water are monitored by means of regular tests of nitrate concentrations.

Attached to the larger tank is a terrestrial section of 70 × 55 cm in dimensions that is furnished with sand/peat mix. The terrapins can access it via a ramp. A bridge made of cork bark serves as an additional basking site. The terrestrial section and the bridge are exposed to the warmth generated by spotlights of 100 and 150 W, respectively. The aquatic partition is furnished with several rocks and a large branch, which creates the necessary structure. Depending on the season, the water temperatures vary from 23 to 29 °C with corresponding photoperiods between ten and fourteen hours of light. The terrapins are kept at a water temperature of 15–17 °C and a shortened photoperiod during the months of December and January.

	Carapace length [mm]	Weight [g]	kept since	Notes
F1	183.0	920	1993	† 2001
F2	172.0	850	1990	
F3	165.8	825	2002	
F4	162.2	795	2000	offsp. from F1
M1	117.5	320	1998	offsp. from F1
M2	129.0	335	1998	offsp. from F1

Table 1. Sizes and weights of the diamondback terrapins kept by me (as of September 2004).



Fig. 5. The breeding female # 2 (F2) busy excavating an oviposition pit.

They are fed at two- to three-day intervals, but on an almost daily basis during their period of greatest activity between May and August.

Diet

The terrapins are fed with turtle jelly (Acrans 1998, slightly modified), smelt, various species of freshly killed freshwater fish (roach, rudd, and young sunfish), frozen freshwater shrimp, frozen krill, beef heart (fortified with calcium lactate, Supravit™ and Korvirin ZVT), earthworms, calamari, mosquito larvae, trout pellets, Lundt™ (a special food for sea birds), freeze-dried *Gammarus*, snails, and, at high water temperatures, also with endives, duckweed and dandelion leaves.

Behaviour

As has already been mentioned above, diamondback terrapins are largely diurnal in their habits. They spend the night at the bottom of their aquarium, usually right next to a rock or a root. Some specimens dig for themselves a shallow depression or cover their carapaces with some substrate. After the lights have come on in the morning, the animals slowly become active and start swimming around. They are excellent swimmers

and divers, but also enjoy just drifting at the water surface. The hotspots above the cork bridge come on two hours after the general illumination, and all the animals move there immediately for an extensive basking session. Some specimens prefer to bask on land and were seen throwing sand at each other after some time of communal basking. Once they have warmed up sufficiently, the terra-



Fig. 6. A fertile clutch of *Malaclemys terrapin macrospilota*.

pins move off in search of food or a mating partner.

Amongst themselves, the animals behave peacefully, and biting fights were never observed, not even amongst the males. Females were seen, however, threatening each other briefly with open mouths. This apparently serves to establish a loose ranking order that corresponds with their body sizes. No aggressive behaviour was noted towards smaller conspecifics or map turtles of the genus *Graptemys*.

Mating

Courtship activities are not limited to a certain season, but males are more active in their pursuit between April and June and again in October. In order to enable the females to enjoy some respite in between, they are separated from the males for intermittent periods of time. This does not serve to stimulate the males for mating, as they are, as was mentioned above, ready to mate all the time anyway.

Courtship begins with a male, or several of them, approaching a female from the side and trying to olfactorily test her extensively with the neck extended. Thereafter the male advances from below and above and tries to position himself in front of the female. If he manages to do so, he will gently fan the water in front of the female's head and try to touch

it carefully. This behaviour may go on for hours. If the female is not interested in mating, she will simply ignore the male's efforts and continue to search for food. No female was ever seen biting after a male. If the female is ready to mate, however, she will retract her head and front legs and prop herself up on her hind legs. The male will now position himself above the female and mate. Copulation may take up to five minutes and is eventually terminated by the female as abruptly as it started. She will then try to swipe the male off using her hind legs while she swims around the aquarium with him attached.

Oviposition

A female conspicuously scouring the terrestrial section indicates that the laying of eggs is imminent. This partition is filled with a sand/peat mix that keeps moisture very nicely. The substrate mix is covered with a 4-5 cm deep layer of light-coloured sand, which enables me to spot immediately that digging activities have taken place. Furthermore, the pure sand does not cause major pollution if it is carried into the water.

Creating a terrestrial part that is readily accepted by the terrapins may sometimes be a problem. According to my observations it is of great advantage to mount the terrestrial section some 10 to 20 cm above the water level. Furthermore, the temperature at the



Fig. 7. A distinct scute anomaly in the first captive-bred male M2.

Fig. 8 (above left). A diamondback terrapin (*M. t. macropilosa*) hatching.

Fig. 9 (above right). Carapace colourations of four hatchlings aged 20 days.

Fig. 10 (center left). The plastra of hatchlings are also fairly individual as to their colour patterns.

Fig. 11 (center right). Juveniles begin to change their colouration at an age of about two to three months.

Fig. 12 (below). *Malaclemys terrapin macropilosa* is a terrapin with a contrasting colour pattern.



substrate surface should be rather high, i.e., 40 to 45 °C, which is easily achieved by installing an additional spotlight. The terrapins seem to prefer a terrestrial spot that is not sheltered on all sides.

Provided with an environment like this, there is actually nothing that could hinder the successful laying of eggs. A female will usually dig some "test holes" before she eventually deposits her eggs (Fig. 5). A typical oviposition pit is 8 to 10 cm deep and pear-shaped. The substrate is substantially condensed to form the walls of the pit, but fairly loose where it separates the individual eggs (they are laid so that they do not touch each other). The covering layer of substrate is once more condensed. Oviposition does not take longer than 30 minutes and takes place

during the day, preferably during the late afternoon hours.

Immediately after the eggs have been laid, the female appears quite exhausted. However, she recovers within a day and is then particularly hungry. A clutch normally consists of five to seven eggs, and two or three clutches may be produced during one season. The sizes of the eggs depend very much on the body size of the female that laid them and may vary from 35.50 to 39.21 mm in length and 20.85 to 23.01 mm in diameter.

Incubation

The soft-shelled eggs should be recovered as soon as possible because the above mentioned high substrate temperature poses an increased risk for their drying up. After tak-

	F1	F2	F3
1997	First clutch, several eggs found in the water; all infertile		
1998	Clutch of 7 eggs (2 in the water and chewed-up); 2 hatched, 3 infertile		
1999	no eggs laid		
2000	1st clutch on 18. May (5 eggs; 3 hatchlings, 2 perished), 2nd clutch on 08. June (4 eggs, infertile)	1st clutch, several eggs found in the water; infertile	
2001	deceased in April	1st clutch on 25. May (4 eggs, 2 hatchlings, 2 infertile), 2nd clutch on 30. June (4 eggs, infertile)	
2002		1st clutch on 10. June (7 eggs, infertile), 2nd clutch on 10. July (7 eggs; 4 hatchlings, 1 perished, 2 infertile)	
2003		1st clutch on 05. June (6 eggs; infertile), 2nd clutch on 04. July (5 eggs, infertile)	1st clutch on 28. May (5 eggs; infertile), 2nd clutch on 03. July (5 eggs, infertile)
2004		no clutches (a possible reason being the alterations made to the aquarium)	no clutches (a possible reason being the alterations made to the aquarium)

Table 2. Overview of the clutches obtained and their hatching success.

ing their measurements and weighing them. I place them on a bed of a sand/peat mix in a feeder cricket box, cover them loosely with some substrate, close the box and transfer it into an incubator after Buzon (1980). Here, the level of relative humidity ranges at 90 %. The lid prevents condensation from dripping onto the eggs. Unfertilized eggs usually collapse within one to two weeks. Developing eggs, on the other hand, begin to produce a white spot and eventually turn snow white (Fig. 6). During their subsequent development some may change their colour again, assuming a grey marbled pattern and showing small reddish speckles. These eggs continue to mature normally, though. When they begin to "sweat", you can be sure that the hatchlings are due to emerge within the next few days. Table 2 shows details on oviposition events and fertilization rates of the clutches produced by my terrapins.

The first two clutches were incubated at 28 °C without nightly decreases. All subsequent hatchlings were of the male sex. Except for one, all hatchling males sported some scutellation anomalies (Fig. 7). I cannot offer any explanation for this phenomenon, especially as it did not occur in eggs incubated at higher values. Clutches No. 3 and 4 were incubated at 30-32 °C with a slight decrease at night and produced for 75 % females. Under these circumstances the babies emerged after 54 to 59 days, measuring between 29.60 and 34.23 mm. Right after their hatching the baby terrapins bury themselves in the substrate and stay there for one to three days. Thereafter they reappear on the surface or are found swimming in the water of the incubator. On hatching, they display a pale grey colouration (Fig. 8). The black buttons on their vertebral scutes are most conspicuous now as they cover almost the entire expansion of the scute (Fig. 10). Their soft parts are of the same colour, with a highly contrasting pattern of black dots.

Raising of the juveniles

The baby diamondback terrapins are raised in an aquarium of 60 x 30 cm with a water level of 13 cm. This tank is furnished with a

root, a bridge of cork bark, and some hornwort. Water temperatures are kept between 26 and 30 °C, decreasing by 2-3 °C at night. So far, all hatchlings were raised in pure freshwater, with salt being added only after their first period of winter rest. I noted that this helps prevent a dulling of the skin.

The aquarium is illuminated with a 75 w spotlight. Newly hatched diamondback terrapins are initially somewhat clumsy in the water and will not leave it. Their diet consists for the first few weeks mainly of various types of live foods (red and black mosquito larvae, daphnias and small earthworms). Thereafter they receive the same foods as the adults. During the early stages the juveniles receive food once to twice every day, later this is changed to a daily regime with one day of fast per week.

Raising diamondback terrapins is easy, and on reaching 5 cm in carapace length, the animals are moved to a larger tank. By this time their behaviour has also changed. They have become expert swimmers and take lengthy basking sessions. They also begin to change colours at this point of time. New growth rings are black, and the centres of the scutes assume the colour of honey (Fig. 11). These centres grow with time and turn yellowish to orange with increasing age. The honey scutes are not replaced before an age of two to three years; thereafter they are replaced regularly every year in early summer.

Sexing of juvenile diamondback terrapins is a simple task once they have grown to about 6 cm in carapace length. Males are sexually mature on reaching 8 cm (two to three years old) and easily recognized by their longer and stouter tails. Females become sexually mature when they are about 14 cm long (five to seven years old).

Discussion

The past years of keeping were marked by a substantial fluctuation in the fertilization rates between the individual clutches. The terrapins obviously respond to changes in their environment. Relocating them repeatedly during the course of 2003 could well provide an explanation for the fact that all

eggs obtained were infertile. Building alterations during this time also necessitated various changes in the illumination of their tank.

Stability returned in the spring of 2004. Now, the sexes were experimentally kept separated and joined only to facilitate their mating. The many changes effected during the course of 2004 probably thwarted any chances of success, but I am hopeful for 2005 that fertilization rates can be improved and larger numbers of babies will hatch.

Although rarely seen in Europe, I can only recommend the keeping of this terrapin. It is a peaceful species that is easily kept under the described circumstances. Its lively behaviour is exciting to watch not only for every visitor – even I keep on enjoying my diamondback terrapins.

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