

Literature Cited

- DE SOLA, C.R. 1931. The turtles of the northeastern states. Bull. N.Y. Zool. Soc. 34:131-160.
- EHRHART, L.M. 1983. Marine turtles of the Indian River lagoon system. Florida Sci. 46:337-346.
- LATHAM, R. 1969. Sea turtles recorded in the Southold Township region of Long Island. *Engelhardtia* 2(1):7.
- MEYLAN, A.B. 1986. Riddle of the ridleys. Nat. Hist. 95(11):90-96.
- MEYLAN, A., AND SADOVE, S. 1986. Cold-stunning in Long Island Sound, New York. *Marine Turtle Newsletter* 37:7-8.
- MORREALE, S.J., MEYLAN, A., AND BAUMANN, B. 1989. Sea turtles in Long Island Sound, New York: an historical perspective. In: Eckert, S.A., Eckert, K.L., and Richardson, T.H. (compilers). Proc. 9th Ann. Workshop Sea Turt. Conserv. Biol. NOAA Tech. Mem. NMFS-SEFC 232:107-110.
- MURPHY, R.C. 1916. Long Island turtles. *Copeia* 1916:56-60.
- WITHERINGTON, B.E., AND EHRHART, L.M. 1985. Hypothermic stunning of marine turtles in Florida east-coast lagoons in January 1985: a comparison with two previous cold-stunning episodes. Abstracts SSAR/Herp. League Meeting, 4-9 August 1985, Tampa, FL.
- WITHERINGTON, B.E., AND EHRHART, L.M. 1989. Hypothermic stunning and mortality of marine turtles in the Indian River Lagoon System, Florida. *Copeia* 1989:696-703.

Received: 3 April 1997

Reviewed: 1 March 1998

Revised and Accepted: 22 May 1998

Chelonian Conservation and Biology, 1998, 3(1):87-90
© 1998 by Chelonian Research Foundation

Ecological Notes on Feral Populations of *Trachemys scripta elegans* in Northern Taiwan

TIEN-HSI CHEN¹ AND KUANG-YANG LUE¹

¹Department of Biology, National Taiwan Normal University, Taipei 117, Taiwan, Republic of China
[Fax: 886-2-29312904; E-mail: d0120@ntou66.ntou.edu.tw]

The natural distribution of the red-eared slider, *Trachemys scripta elegans*, is confined to the southeastern United States and northeastern Mexico (Ernst, 1990; Iverson, 1992). However, this turtle has been exported to various countries and areas, including Taiwan, by pet dealers. The introduction of this sub-species has occurred in many countries in Asia, Europe, and Africa (Newbery, 1984; Uchida, 1989; Iverson, 1992; Platt and Fontenot, 1992; da Silva and Blasco, 1995; Ota, 1995; Luiselli et al., 1997), as well as in North America outside its natural range (Hutchison, 1992; Iverson, 1992). Until recently, the introduction of foreign commercial and pet animal species has been a common practice in Taiwan (Shao and Tzeng, 1993). Although the status of *T. s. elegans* in Taiwan has never been documented, it is believed to be widely distributed on this island. Individuals who have bought juveniles of this species as pets may

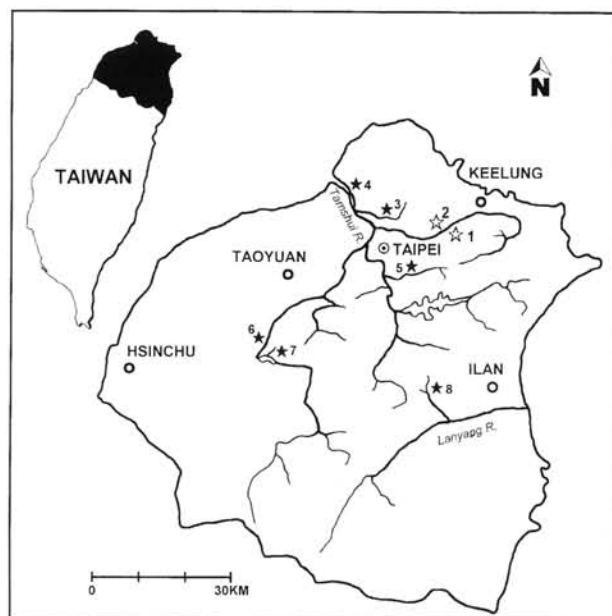


Figure 1. Localities of collecting sites of *Trachemys scripta elegans* from northern Taiwan. Stars represent the collecting sites, open stars (1 and 2) are the major study sites. 1 = Wutu, 2 = Hsichih, 3 = Waishuanhsi, 4 = Chouwei, 5 = Mucha, 6 = Yuansulin, 7 = Dashi, 8 = Shuanlanpi.

occasionally release the turtles into ponds and rivers when they become inconveniently large. Some individuals are also released through Buddhist "mercy" ceremonies.

Shao and Tzeng (1993) noted that many red-eared sliders had been observed in various water bodies, including rivers, ponds, lakes, and artificial reservoirs in Taiwan. However, whether this exotic turtle has established a breeding colony remains uncertain. Considering its broad ecological tolerances, omnivorous diet, and dispersal ability (Gibbons, 1990), *T. s. elegans* is likely to be capable of reproducing in natural environments of Taiwan. If feral populations of *T. s. elegans* become established, it is possible that they may impact the indigenous fauna on this island.

The purpose of this study is to investigate the status of feral *T. s. elegans* in northern Taiwan. We have also obtained some ecological data on this turtle to assess its potential impact on other native organisms.

Materials and Methods. — Fieldwork was conducted from February 1995 to May 1996 at seven sites in the Tamshui River basin and one in the Lanyang River (Fig. 1). Five sites were located in the urban area near Taipei, whereas three sites were in the montane area. Most studies on the population structure, food habits, and reproductive characteristics were carried out at the urban sites of Wutu and Hsichih on the Keelung River. Turtles were collected either with funnel traps baited with canned cat food, long-handled dipnet, or by hand. Traps were set in shallow water near the bank. Location, time, and date of each capture was recorded.

The maximum straight carapace length (CL) was measured to the nearest 0.1 mm with vernier calipers. Animals were sexed as males based on secondary sexual characteristics by examining the position of the cloacal opening beyond the rear carapacial margins and elongation of the foreclaws;

females do not show these characteristics (Cagle, 1948, 1950). We designated individuals < 100 mm CL and without male secondary sexual characteristics as juveniles. Each turtle was marked by notching the scutes with a hand saw for future individual identification (Cagle, 1939). Clutch sizes were obtained by counting eggs in nests and in gravid females through X-ray examination (Gibbons and Greene, 1979). One gravid female was injected with oxytocin to induce oviposition (Ewert and Legler, 1978). The length, width, and mass of each egg was measured. Eggs were incubated in vermiculite at 28.5°C. The CL of hatchlings was not measured. Stomach contents were gently flushed (Legler, 1977) and preserved in 70% ethanol for later identification. The frequency of occurrence of each food item was recorded.

Because Buddhists generally carve their names or Buddhist symbols on the carapace of turtles prior to releasing them, the occurrence of such inscriptions was also examined.

Results. — A total of 134 red-eared sliders (*Trachemys scripta elegans*) was captured from the eight sites during the study period. Turtles were found in various habitats, including estuaries, rivers, reservoirs, and montane streams and ponds. *Trachemys s. elegans* coexisted with three native species (*Ocadia sinensis*, *Mauremys mutica*, and *Pelodiscus sinensis*) at one site, two of these species at three sites, and one of them at four sites (Table 1). The capture rates of *T. s. elegans* were equal or higher than those of native species at four sites. The ratio of inscribed turtles was high at the remote montane sites (Yuansulin, Dashi, and Shuanlanpi), and low at urban sites. The most frequently inscribed species was *M. mutica*.

Among the 119 captured *T. s. elegans* from Wutu and Hsichih on the Keelung River, 7 were juveniles (37.2–99.4 mm CL, mean = 51.5 mm), 46 males (102.7–208.6 mm CL, mean = 154.7 mm), and 66 females (100.1–256.0 mm CL, mean = 172.3 mm). The population in the major study area was dominated by large individuals (Fig. 2). About 70% of the captured turtles had reached minimum mature size. Juveniles were relatively rare.

Three females were found to contain shelled eggs upon radiographic examination in May 1996. Three nests with eggs were found on an open bank of the river in late May 1996. The nest depths were 14.5, 19.1, and 16.4 cm. Clutch

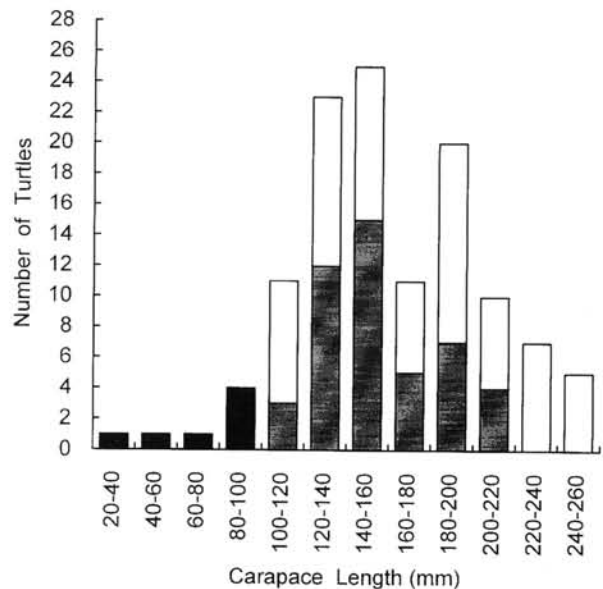


Figure 2. Distribution of carapace lengths of *Trachemys scripta elegans* captured from the Keelung River, Taiwan. Black bars represent juveniles, gray bars males, and unshaded bars females.

size varied from 8 to 25 eggs, with an average of 17.4 ($n = 6$, $sd = 6.5$). All the nests found were destroyed by unknown predators. Based on eggs obtained by hormonal induction of one gravid female, egg length ranged from 35.3–38.3 mm ($n = 11$, mean = 36.8 ± 0.9), width from 21.8–24.9 mm ($n = 11$, mean = 23.4 ± 0.8), and mass from 10.9–12.3 g ($n = 11$, mean = 11.8 ± 0.5). Seven hatchlings emerged after 75 days of incubation. Two juveniles of 37.2 and 40.2 mm CL were collected in early May 1996.

The food items listed in Table 2 were identified from 17 stomach samples (2 juveniles, 6 males, and 9 females). Animal materials appeared in all stomachs, while plant materials occurred in 76.5% of the samples. Snails (*Physa acuta*) were the most frequently ingested item and occurred in 82.4% of the samples. Fishes (29.4%), dipteran larvae and pupae (23.5%), and terrestrial insects (23.5%) were also ingested frequently. The only plant items were filamentous algae (29.4%), *Murdannia keisak* leaves (29.4%), and some leaves and shoots of unknown species (35.3%).

Discussion. — Many *T. s. elegans* could be found in various aquatic habitats in northern Taiwan. From the results

Table 1. Trapping results of freshwater turtles from eight sites in northern Taiwan. Major sampling areas were sites 1 and 2, Wutu and Hsichih. Numbers in parentheses indicate the number of turtles with carved inscriptions.

No.	Site	Environment	Habitat	<i>Ocadia sinensis</i>	<i>Mauremys mutica</i>	<i>Pelodiscus sinensis</i>	<i>Trachemys scripta</i>
1	Wutu	Urban	River	661 (0)	1 (0)	3 (0)	68 (2)
2	Hsichih	Urban	River	51 (0)	0	0	51 (0)
3	Waishuanhsi	Urban	River	1 (0)	0	0	2 (0)
4	Chouwei	Urban	Estuary	2 (0)	0	0	3 (0)
5	Mucha	Urban	River	2 (0)	0	0	3 (0)
6	Yuansulin	Montane	Reservoir	17 (3)	4 (4)	0	3 (3)
7	Dashi	Montane	Stream	4 (1)	2 (1)	0	2 (2)
8	Shuanlanpi	Montane	Pond	12 (5)	21 (11)	0	2 (2)
Totals:				750 (9)	28 (16)	3 (0)	134 (9)

- LEGLER, J.M. 1977. Stomach flushing: a technique for chelonian dietary studies. *Herpetologica* 33:281-284.
- LU, D.-J., CHEN, T.-H., AND WU, S.-H. 1996. The trade collection of freshwater turtles and tortoises in domestic market. [In Chinese]. Taipei: Council of Agriculture, 26 pp.
- LUE, K.-Y., AND CHEN, T.-H. 1996. The study on the management of freshwater turtles in Taiwan (I). [In Chinese]. Taipei: Council of Agriculture, 16 pp.
- LUISELLI, L., CAPULA, M., CAPIZZI, D., PHILIPPI, E., TRUJILLO JESUS, V., AND ANIBALDI, C. 1997. Problems for conservation of pond turtles (*Emys orbicularis*) in central Italy: is the introduced red-eared turtle (*Trachemys scripta*) a serious threat? *Chelon. Conserv. Biol.* 2:417-419.
- MITCHELL, J.C., AND PAGUE, C.A. 1990. Body size, reproductive variation, and growth in the slider turtle at the northeastern edge of its range. In: Gibbons, J.W. (Ed.). *Life History and Ecology of the Slider Turtle*. Washington, DC: Smithsonian Institution Press, pp. 146-151.
- NEWBERY, R. 1984. The American red-eared terrapin in South Africa. *African Wildl.* 38:186-189.
- OTA, H. 1995. A review of introduced reptiles and amphibians of the Ryukyu Archipelago, Japan. [In Japanese]. *Island Studies in Okinawa* 13:63-78.
- PARMENTER, R.R., AND AVERY, H.W. 1990. The feeding ecology of the slider turtle. In: Gibbons, J.W. (Ed.). *Life History and Ecology of the Slider Turtle*. Washington, DC: Smithsonian Institution Press, pp. 257-266.
- PLATT, S.G., AND FONTENOT, L.W. 1992. The red-eared slider, *Trachemys scripta* (Wied) in South Korea. *Bull. Chicago Herp. Soc.* 27:113-114.
- SHAO, K.T., AND TZENG, C.S. 1993. Revision on the checklist of admitting import of aquarium fishes of Taiwan (II). [In Chinese]. Taipei: Council of Agriculture, 79 pp.
- UCHIDA, I. 1989. The current status of feral turtles of Japan. [In Japanese]. *Anima* 205:80-85.

Received: 15 May 1997

Reviewed: 20 March 1998

Revised and Accepted: 20 April 1998

Chelonian Conservation and Biology, 1998, 3(1):90-93
© 1998 by Chelonian Research Foundation

Testosterone Titers of Immature Loggerhead Sea Turtles (*Caretta caretta*) Incidentally Caught in the Central Mediterranean: A Preliminary Sex Ratio Study

PAOLO CASALE¹, GUIDO GEROSA¹,
ROBERTO ARGANO², SALVATORE BARBARO³,
AND GAETANO FONTANA¹

¹Chelon - Marine Turtle Conservation and Research Program, Tethys Research Institute, viale Val Padana 134/B, 00141 Roma, Italy [Fax: 39-6-8125301; E-mail: pa.casale@agora.stm.it]; ²Dipartimento di Biologia Animale e dell'Uomo, Università degli Studi "La Sapienza", viale dell'Università 32, 00185 Roma, Italy; ³Analysis s.r.l. (Artemisia), via A. Losurdo 42, 00146 Roma, Italy

As do many other reptiles, at least six of the seven living marine turtle species demonstrate temperature-dependent

sex determination (see Janzen and Paukstis, 1991, for a review). Apart from being a complex theoretical topic (e.g., see Ewert and Nelson, 1991), temperature-dependent sex determination is also of great relevance to conservation practice, and failure to appreciate the phenomenon may represent a factor increasing the vulnerability of these threatened species, since various human activities (including conservation programs) may unintentionally alter the normal hatchling sex ratio (Mrosovsky and Yntema, 1980). Moreover, since each nesting site may be different from others as regards to thermal (and hence sex-determining) characteristics, a decrease in site availability due to human activity may lead to less thermal variability and this may result in a different overall sex ratio. A knowledge of sex ratio values and their possible temporal changes is of fundamental interest for marine turtle conservation.

In the Mediterranean Sea the serious threats to the populations of *Caretta caretta* and their subsequent decline (see Groombridge, 1990, for a review), make it particularly urgent to include sex ratio dynamics, as well as the other demographic factors influencing population structure, in the planning of conservation strategies. The obvious first step is to investigate the natural sex ratio of loggerheads in the Mediterranean, as no data have been available up to now.

The greatest difficulty in such a study is to have adequate study material. Direct capture of turtles from the wild is difficult in areas where their populations are low and involves major financial commitment. A possible alternative is to collect turtles caught in fisheries as non-target species.

This work undertakes both to provide sex ratio estimates for *Caretta caretta* in the Mediterranean for the first time, and to investigate the possibility of taking advantage of the catch effort normally conducted by professional fishermen.

Materials and Methods. — Adult turtles are not the ideal target for this kind of investigation, in that males and females may have different reproductive behaviors and perhaps also different reproductive cycles (Wibbels et al., 1990). This, together with different migration patterns between feeding, wintering, and breeding sites, may result in the adult sex ratio within a limited zone being unrepresentative of the population as a whole. Utilizing immature and subadult turtles avoids sampling errors of this kind. Furthermore, juveniles, representing a condensation of many cohorts, are a valuable source of insight into demographic structure and, hence, about the productivity of the future adult population.

Immature loggerheads do not show external sexual dimorphism, and the most non-invasive and simple sexing method available at present is based on the evaluation of the levels of testosterone in the blood (Wibbels et al., 1987b).

The 70 specimens of *Caretta caretta* examined in this study were captured within a range of 180 km off Lampedusa Island, Italy (12°35' E; 35°31' N) between 30 June and 20 September in 1991, 1992, and 1993.

This study area, in particular the Gulf of Gabès, is thought to be an important wintering area (Margaritoulis, 1988a; Laurent et al., 1990) and foraging zone (Argano et al.,