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First Record of the Nile Soft-Shelled Turtle, *Trionyx triunguis*, from Kos Island, Greece, with Comments on its Occurrence in the Eastern Mediterranean

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The distribution of *Trionyx triunguis*, the Nile soft-shelled turtle, includes the major streams and rivers of the eastern Mediterranean coastal area (Lortet, 1887; Strauch, 1890; Siebenrock, 1913; Gruvel, 1931; Haas, 1951; Serruya, 1978; Sella, 1982; Ilani, 1983; Ilani and Shalmon, 1984; Werner, 1988; Yom-Tov and Mendelssohn, 1988), the Nile system including the lakes in the Natrun Valley (west of the delta), the White Nile and Blue Nile of Sudan, south to Lake Turkana (Rudolf) in Kenya and Lake Albert in Uganda, the Eritrea zone of Ethiopia, Juba and Scebeli rivers in Somalia and south along the Tanzania coast (Gray, 1855; Deraniyagala, 1948; Lanza and Sassi, 1966; Iverson, 1986). In central and western Africa, the species ranges from the Cunene River along the Angola – Namibia border to the major river systems of former Zaire, Cabinda, Congo, Gabon, Cameroon, Chad, Niger, Nigeria, Benin, Togo, Ghana, Ivory Coast, Liberia, Sierra Leone, Guinea, Gambia, Senegal, as far north as Mauritania (Gray, 1855; Siebenrock, 1913; Gadow, 1923; Flower, 1933; Lanza and Sassi, 1966; Penrith, 1971; Iverson, 1986; Branch, 1988).

The data on the presence of this species in Asiatic Turkey are quite recent (Haas, 1951, Hathaway, 1972; Basoglu, 1973; Atatür, 1979; Kinzelbach, 1986; Gramentz, 1990; Kasparek and Kinzelbach, 1992). It is known in the southwest from the Dalaman River and nearby lakes system, Esen Creek, the Antalya-Belek-Manavgat region, and the Göksu River to the coastal zones of the Cukurova region, including the estuaries of the Seyhan and Ceyhan Rivers, to the former Amik Lake basin and Asi (Orontes) River in the extreme southeast (Haas, 1951; Eiselt, 1976; Atatür, 1979; Sella, 1982; Van Den Berk et al., 1988; Baran and Kasparek, 1989; Kasparek and Kinzelbach, 1992). To date, *T. triunguis* has not been recorded from any of the islands of the Dodecanese group nor from west of the Dalaman River.

Figure 1. An adult *Trionyx triunguis* specimen on the beach of Mastagari, Kos Island, Greece, off the coast of Turkey.

In 1992, Ritso Polder (son of WNP) visited the Greek island of Kos on the southwest coast of Turkey. On about 20 July on the beach of Mastagari, he observed a turtle swimming about 10 m off shore. He succeeded in bringing the animal ashore (Fig. 1), and found that it had become entangled in a fishing line, which was strung tightly around its neck and one foreleg. After removing the line, the turtle was taken to Kos City and placed in a small basin, said to serve as temporary housing for marine turtles, but it escaped during the night. The carapace length was estimated to be between 60 and 70 cm. The stress of entanglement may have influenced the animal's behavior and it could have been in the water a long time, possibly drifting far from its original habitat.

With regard to the occurrence of *T. triunguis* in the northeastern Mediterranean, Atatür (1979) listed 10 localities along the Mediterranean coasts of Turkey (Fig. 2). The previously known northwestern limit of *T. triunguis* along Turkey's Mediterranean coast was the Köycegiz Lake – Dalyan system, Mugla (Atatür, 1979; Gramentz, 1990; Kasparek and Kinzelbach, 1992). The Greek island of Kos, which is located about 18 km from Bodrum and 22 km from Resadiye, lies about 200 km west of the previously known northwestern limit (see Atatür, 1979; Gramentz, 1990; Kasparek and Kinzelbach, 1992). Except for a few small creeks and brooks, almost no fresh water systems empty into the Mediterranean along the Turkish coast between Kos Island and Dalyan. Thus, the animal found near Kos is in accordance with observations that the species may enter salt water (Hathaway, 1972; Atatür, 1979; Geldiay et al., 1982; Carr and Carr, 1985), at least for a limited time, and can travel considerable distances.

Flower (1933) gave the first indication that *T. triunguis* may be salt-water tolerant. He suggested that serious and continuous floods of the Nile River could have accounted for the species' appearance in the extreme eastern Mediterranean along the coasts of Palestine and elsewhere. Other authors have also stated that it is occasionally found in the sea, including Hathaway (1972), Atatür (1979), and Geldiay et al. (1982) for the Turkish coasts, and Carr and Carr (1985) for the African coasts.

More recently, *T. triunguis* seems to have become one of the most common turtle species captured unintentionally in nets by commercial shrimp trawlers along the southeastern Mediterranean coast of Turkey. In comparison with the marine turtles, *Chelonia mydas* and *Caretta caretta*, the bycatch ratio of *T. triunguis* is quite high. Oruc et al. (1996), for instance, reported that the number of *T. triunguis* specimens caught incidentally by trawl nets in the eastern Medi-

Figure 2. Distribution of *Trionyx triunguis* along the Mediterranean coast of Turkey (modified from Atatür, 1979). ■ = present record, ● = records by Oruc et al., 1996, ▲ = records by Atatür, 1979.

terranean (190) was higher than *C. mydas* (160) or *C. caretta* (26) during a 6-month observation period between 16 October 1995 and 15 March 1996 (5 Turkish trawl boats monitored; 3 from Karatas and 2 from Cevlik). Of the 190 *T. triunguis* specimens, 174 were caught in the area between Karatas and Ceyhan counties where the Ceyhan River empties into the Mediterranean, the other specimens were from the coasts of Mersin, Tuzla, Yumurtalik, and Iskenderun. Of the specimens caught by the trawlers 75% had a carapace length of more than 50 cm. Capture depths for about 68% of the specimes was 10–20 m, with about 2% of specimens caught at depths less than 10 m, and about 30% from depths of 20 to 40 m, where the brackish character of the water has almost disappeared.

There are only two known breeding populations in southwestern Turkey: one from the Lake Köycegiz – Dalyan complex and the other from the vicinity of Dalaman River, Kükürt Lake – Kargin Lake system (Atatür, 1979). In Israel, there have been reports of its presence in many of the small westward-flowing rivers, and also of nesting sites (Haas, 1951; Sella, 1982; Yom-Tov and Mendelssohn, 1988). It seems to have disappeared from most of these sites, and now only Nahal Alexander supports a dense population (Werner, 1988). Kasparek and Kinzelbach (1992) claim reproduction takes place, but almost no healthy hatchlings have been seen recently. This may be due to the heavily polluted state of the river. Thus, the present breeding potential of this Israeli population may have been compromised (Y. Werner, *pers. comm.*). The population at Nahal Alexander may have little chance for survival without human intervention.

A review of the literature did not reveal any previous reports of the Nile soft-shelled turtle for Greece. Though a preserved specimen of *T. triunguis* is to be found in the Museum of the Hydrobiological Station of the Greek Island of Rhodes (D. Margaritoulis, *pers. comm.*), it is of unknown provenance. Thus, this may be the first report of *T. triunguis* for the territory and herpetofauna of Greece, and an extension of 200 km for the known range of the species.

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Cutaneous Surface Area in Freshwater Turtles

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Cutaneous surface area has a profound influence on the biology of organisms. Body size and shape determine the amount of cutaneous surface area in most organisms. However, turtles have a relatively inert bony shell (Dunson, 1986) that also affects cutaneous surface area variation (Stone et al., 1992). Because different turtle species often have different shell morphologies, turtles are unusual among vertebrates in that two species of similar size and shape can have significant differences in the amount of cutaneous surface area.

In freshwater turtles, two important physiological processes are linked to cutaneous surface area: aquatic respiration and desiccation. Turtles with high cutaneous surface area have increased potential for exchange of respiratory gases with water (Stone et al., 1992), but probably have increased susceptibility to desiccation (e.g., Costanzo et al., in press). These physiological processes may greatly influence an organism's behavior and ecology. For example, capacity for aquatic respiration may influence submergence times, vulnerability to surface predation, foraging efficiency, habitat requirements, and choice of hibernacula, whereas susceptibility to desiccation may influence dispersal, nesting ecology, ability to survive drought or extreme temperatures, and choice of hibernacula.

Given that cutaneous surface area may explain variation in so many important physiological and ecological aspects of the biology of freshwater turtles, it is surprising that only scattered measurements of cutaneous surface area have been made. This paper presents new data on cutaneous surface area in freshwater turtles, compares two methods for collecting such data, reviews previous data, and attempts to synthesize these data in a relevant ecological and physiological framework.

Methods. — We measured surface area using two methods. First, we skinned 56 common musk turtles, *Sternotherus odoratus*, that had been collected for other research (Iverson, 1984, and unpublished; Seidel et al., 1986). These turtles came from three sources: Kosciosko Co., Indiana (13 males and 22 females); Mayes Co., Oklahoma (1 male and 2 females); and Garland Co., Arkansas (13 males, 5 females). In addition to these turtles, we also skinned two eastern mud turtles (*Kinosternon s. subrubrum*) from the Arkansas site. Turtles were sacrificed immediately before skinning, and all of the skin of each turtle was