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THE PRESENCE OF THE GREEN SEA TURTLE, *CHELONIA MYDAS*, IN THE ADRIATIC SEA

BOJAN LAZAR[1,2], PAOLO CASALE[3], NIKOLA TVRTKOVIĆ[1], VALTER KOŽUL[4], PERO TUTMAN[4], AND NIKŠA GLAVIĆ[4]

[1]*Department of Zoology, Croatian Natural History Museum, Demetrova 1, HR-10000 Zagreb, Croatia*

[2]*Blue World Institute of Marine Research and Conservation, Kastel 24, HR-51551 Veli Lošinj, Croatia*

[3]*Via Antonio Calderara 29, IT-00125 Roma, Italy*

[4]*Laboratory of Ecology and Aquaculture, Institute of Oceanography and Fisheries, Damjana Jude 12, HR-20000 Dubrovnik, Croatia*

We collated and reviewed data on the green turtle in the Adriatic Sea from our own records, museum collections, and published literature. Results show overlap of records and cases of misidentification of large loggerheads as green turtles. Currently there have been twelve green turtles recorded in the Adriatic Sea. The majority of records refer to juveniles with a carapace length of 28-40 cm, recovered in the southern Adriatic. It is possible that this region contains pelagic habitats for the green turtle. It is therefore important to educate fishermen along the southern Adriatic coasts to identify and report recoveries of this endangered species.

Key words: by-catch, chelonian, marine habitats, Mediterranean

INTRODUCTION

The green turtle *Chelonia mydas* (Linnaeus 1758) is one of two species of sea turtle that reproduce in the Mediterranean basin (Broderick *et al.*, 2002). The regional population has been shown to be genetically distinct from that of the wider Atlantic (Bowen *et al.*, 1992; Encalada *et al.*, 1996), and not sustained by immigration of individuals from rookeries outside the Mediterranean. Over the past century this species has suffered heavy exploitation (Sella, 1995), which has led to a severe reduction of the population. At present, the Mediterranean green turtle population has been categorized as Critically Endangered (Hilton-Taylor, 2000), making it the most endangered green turtle population in the world (Seminoff, 2002).

The rookeries in Turkey and Cyprus contain approximately 99% of the Mediterranean nesting population (Kasparek *et al.*, 2001). In total, between 339 and 360 green turtle females nest annually on Mediterranean beaches (Broderick *et al.*, 2002). Although the major nesting areas of the green turtle in the region are well known (Kasparek *et al.*, 2001), there is a paucity of data on the biology and distribution of this species in marine habitats. Post-nesting satellite tracking of six adult females has shown that the waters of Cyprus, Israel, Egypt and Libya host migratory pathways and wintering areas for adults (Godley *et al.*, 2002). Juvenile green turtles have been recorded in the eastern and western Mediterranean (Margaritoulis *et al.*, 1992; Laurent *et al.*, 1997; Godley *et al.* 1998*a,b*; Gianguzza *et al.*, 2000; Meschini, 1997; Oruç, 2001), and the Black Sea (Nankinov, 1998). Margaritoulis & Teneketzis (2001) discovered a developmental habitat for green turtles at Lakonikos Bay in the Peloponnesus, Greece. However, "at sea" recoveries of individual juveniles have yielded little solid information about the life history of green turtles away from their reproductive habitats.

The green turtle is considered to be rare in the Adriatic Sea (Stossich, 1880; Pozzi, 1966; Riedl, 1983; Bruno, 1978; Lazar & Tvrtković, 1995). The first two specimens were recovered in the western Adriatic waters, near Ancona and near Venice in Italy in 1830 and 1864 respectively (Nardo, 1864; De Betta, 1870). The first records for eastern Adriatic also date from the 19th century (Damin, 1889; Depoli, 1898). Green turtles were listed in the Catalogue of Amphibians and Reptiles of the Croatian Natural History Museum (Pavletić, 1964), and included in the indexes of the fauna of the Adriatic countries (Karaman, 1939; Pozzi, 1966; Brelih & Džukić, 1974; Bruno & Maugeri, 1979). However, most data have been published in local journals or remain unpublished, making them unavailable to the wider scientific community. This paper will review such records and present new data on green turtles in the Adriatic Sea.

MATERIALS AND METHODS

The data presented are based upon inspection of (1) museum collections, (2) literature, and (3) our personal records. We examined collections from the Croatian Natural History Museum in Zagreb, the Natural History Museum in Rijeka, the Natural History Museum in Split, the Natural History Museum in Dubrovnik, the Natural History Department of the City Museum in Zadar, the Slovenian Museum of Natural History in Ljubljana, and the Natural History Museum in Vienna. External morphological identification was carried out according to Pritchard & Mortimer (1999), whilst

Correspondence: B. Lazar, Department of Zoology, Croatian Natural History Museum, Demetrova 1, HR-10000 Zagreb, Croatia. *E-mail*: Bojan.Lazar@hpm.hr

skulls identification was preformed after Wyneken (2001). We compared records from literature and carefully avoided any possible duplication.

Data on the size (length) or weight of individuals are presented as given in the literature or reported by fishermen. The data set is, unfortunately, highly heterogeneous. It includes estimates of the total length or mass of the turtle, as well as estimates or measurements of carapace length. In the latter case, it is often unknown what precisely was measured (e.g. the curved or the straight carapace length). Therefore, these data should be considered just as an indication of the size class.

RESULTS AND DISCUSSION

From all museum collections examined, green turtles from the Adriatic were only listed in the catalogues of the Croatian Natural History Museum (CNHM). We inspected and re-identified all the sea turtles from the Herpetological Collection and the Osteological Collection of CNHM. All of the specimens listed as green turtles (CNHM 215: 589; CNHM 600: 752, 753, 2061; CNHM 216: 413) were actually large loggerheads, with a curved carapace length notch to tip (CCL_{n-t}) (Bolten, 1999) ranging from 63.0-81.4 cm.

The green turtle has been recorded on several occasions in the western Adriatic (Table 1 and references therein). However, it seems that in some cases the same specimen gave rise to several "records" in the literature. For instance, both Nardo (1864) and De Betta (1870) described the same records of two green turtles recovered in Italy, one in Ancona in 1830 and another in Malamocco in 1864 (Table 1). Stossich (1880) and Faber (1883) also mentioned that "two green turtles have been found in the Adriatic until that time", but without providing any additional information. It seems that all these records are originally based upon findings of just two specimens in Italy (Nardo, 1864). This is also the case with two turtles from Apulian Adriatic coast reported by Basso (1992), Pastorelli *et al.* (1999), and Centro Studi Cetacei (2000) (Table 1).

All literature records of green turtles in the eastern Adriatic Sea come from Croatian waters (Damin, 1889; Depoli, 1898; Hirtz, 1927; Mršić, 1987). The report of a "big turtle *Chelone midas*" as recorded by Hirtz (1927) and accompanied by a black and white photo of the specimen, reveals that this turtle was a loggerhead. As all of the original identifications of species turned out to be incorrect wherever we could perform re-identification, we question the identification of green turtles in the other cases where the record is not supported by some material evidence. The reason for the misidentification of sea turtles in Croatia most likely lies in the old Croatian name for *C. mydas*: "the huge (big) turtle". As most of loggerheads that frequent Adriatic Sea are juveniles (Affronte & Scaravelli, 2001; Lazar & Tvrtković, 1995), it seems that any "big" loggerheads were automatically and erroneously identified as *C. mydas*. Therefore, the record of a "big turtle" identified as *C. mydas* by Damin (1889), or the one identified by a local priest in 1945 and reported by Mršić (1987) are doubtful. The exception could be the record of a juvenile turtle weighting 18 kg captured in the Bay of Rijeka, Croatia (Depoli, 1898), but again, this record is not supported by any physical evidence.

In addition, we report three new recoveries of green turtles in the Adriatic Sea (Table 1, Fig 1), all incidentally captured in fishing nets. The first, with a carapace length of about 30 cm, was found in the Po River Delta in Italy in August 1985 (identification by P. Casale). Another juvenile green turtle, weighting 4 kg, was recovered in Margherita di Savoia in Italy in July 1996

TABLE 1. Records of the green turtle in the Adriatic Sea (remarks are given as presented in the papers or reported by the finders; CL - carapace length). Doubtful records are marked with an asterisk.

No.	Date	Locality	Country	Reference	Remarks
1	1830	Ancona	Italy	Nardo (1864), De Betta (1870)	Length: 45.7 cm
2	July 1864	Malamocco, Venice	Italy	Nardo(1864), De Betta (1870)	CL: 28 cm
3*	22 June 1889	Bakar Bay	Croatia	Damin (1889)	CL: 83 cm
4	9 Sept 1885	Rijeka (Fiume) Bay	Croatia	Depoli (1898)	Mass: 18 kg
5*	1945	Baška Voda, Makarska	Croatia	Mršić (1987)	"large specimen"
6	1980-1989	Unknown (south Adriatic)	Italy	Pastorelli *et al.* (1999), L. Rositani, pers. comm.	.CL: 28-31 cm
7	August 1985	Po River Delta	Italy	This paper	CL: about 30 cm
8	July 1986	Bari	Italy	Basso (1992) Pastorelli *et al.* (1999)	CL: 28-31 cm
9	1 Feb 1991	Lido S. Anna, Brindisi	Italy	Pastorelli *et al.* (1999) Unpubl. data	CL: 31.5 cm
10	July 1996	Margherita di Savoia	Italy	This paper	Mass: 4 kg
11	3 April 1998	Torre a Mare, Bari	Italy	Pastorelli *et al.* (1999) Cento Studi Cetacei (2000)	CL: 31 cm
12	14 Dec 2001	Trpanj, Pelješac Peninsula	Croatia	This paper	CL: 40 cm

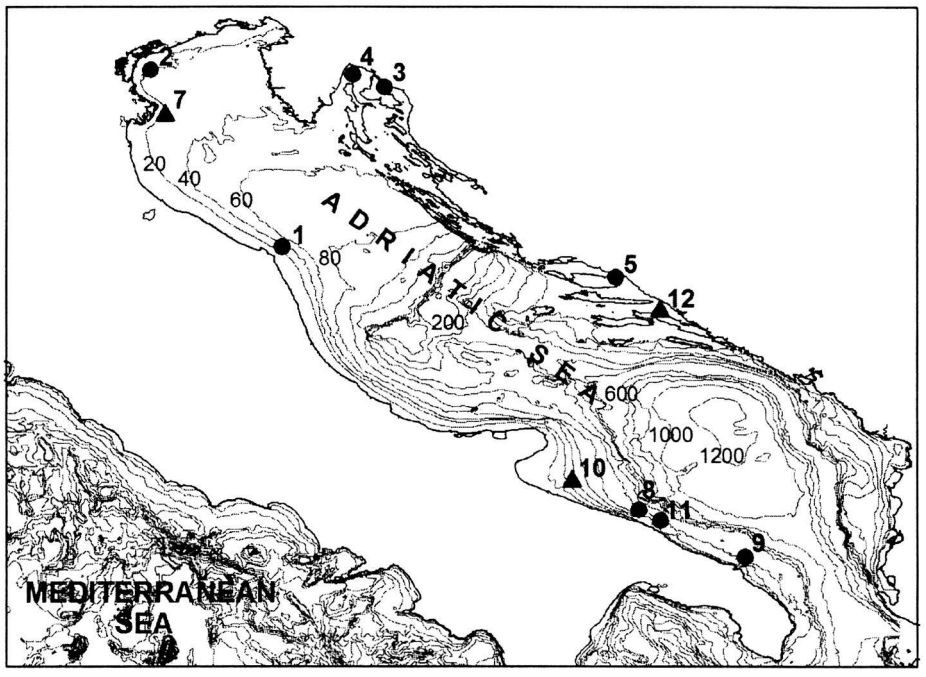

FIG. I. Distribution of recoveries of green turtle in the Adriatic Sea. (Number of the record refers to No. in Table 1. The record No. 6 with unknown locality is not shown; circles, data from literature; triangles, new data).

(identification by G. Marzano). The third specimen (CCL_{n-t}: 40.0 cm) was found dead entangled in the gill net, 1 km east from the City of Trpanj, along the north-eastern coast of the Pelješac Peninsula in Croatia, on the 14th December 2001 (identification by B. Lazar). The last turtle has been preserved and is kept in the herpetological collection of the CNHM in Zagreb. It is worthy of note that green turtles have not yet been recorded in Slovenia (Kryštufek & Janžeković, 1999), neither in Montenegro (Lazar & Tvrtković, 1995) nor Albania (Haxhiu, 1995). Hence, the juvenile caught in Trpanj in Croatia is the first certain record of the green turtle in the eastern Adriatic Sea.

At present, only 12 green turtles have been recorded in the Adriatic Sea (Table 1 and references therein). This is less than the number of leatherback turtles (*Dermochelys coriacea*) recorded in these waters (18 specimens, Casale *et al.*, 2003). Margaritoulis & Teneketzis (2001) showed that 40.1% of turtles captured in the Lakonikos Bay in the Ionian Sea, Greece, were juvenile *C. mydas,* and suggested that the bay may present a developmental habitat for the species. In contrast to this, the proportion of green turtles to loggerhead turtles seems to be far lower in the Adriatic Sea. For instance, Pastorelli *et al.* (1999) presented recoveries of only four green turtles and at least 181 loggerheads along the southern Adriatic coast (Italy) during 1978-1998 (see Fig. 1 in Pastorelli *et al.*, 1999). This is also reflected in the data from the eastern Adriatic, where only one out of more than 100 turtles handled was a green turtle (Lazar, personal data). However, it is possible that some of 1220 reported recoveries of unidentified turtles of the family Cheloniidae in the eastern Adriatic (Lazar & Tvrtković, 1995) belong to green turtle.

The number of green turtles in the Adriatic is low. Nevertheless, two facts should be stressed: first, the majority of turtles were small, pelagic juveniles with a carapace length ranging from 28-40 cm (Table 1), and second, most of the records come from southern Adriatic waters (Fig.1). Although these records could be incidental, individual events, it is possible that some juvenile green turtles are passively drifting into the Adriatic on the dominant surface current in the Ionian-Adriatic area. It is known that currents may affect the distribution of hatchlings and pelagic juveniles (Bolten & Balazs, 1995; Musick & Limpus, 1997; Lohmann *et al.*, 1999). The prevailing surface current enters the Adriatic from Ionian Sea along the eastern coast moving to the north (Orlić *et al.*, 1992). The presence of green turtles in the southern Adriatic, Italian waters in particular, could be explained by the anticlockwise gyre that branches from the main current in the southern Adriatic hence influencing the distribution of recoveries. Therefore, it is possible that southern Adriatic, with surface sea temperatures of 24-25 °C in the summer and >13 °C in the winter (Cushman-Roisin *et al.*, 2001) contains pelagic habitats for green turtle.

The Adriatic Sea is one of the most intensively fished areas of the Mediterranean. This results in a high level of interactions between sea turtles and fisheries. It is estimated that about 2500 turtles are incidentally caught each year by the eastern Adriatic trawl fisheries (Lazar & Tvrtković, 1995) with an additional 3600 turtles caught by the western fleet (Casale *et al.*, 2001). Although we should not over-interpret the low number of records, the Adriatic fisheries seems to interact also with the critically endangered green turtle population; the extent of by-catch is, however, beyond our knowl-

edge at the moment. Identification of critical habitats and migratory pathways are among research priorities for sea turtles (Bjorndal, 1999). In order to create an effective conservation strategy it is of the utmost importance to understand turtle movements and the relationship between habitats they utilize, particularly in the case of the critically endangered Mediterranean green turtle population. Taking this into consideration, attention should focus on the education of fishermen and local inhabitants along the southern Adriatic coasts to identify and report recoveries of this species.

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