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THE OCCURRENCE OF THE GREEN SEA TURTLE *CHELONIA MYDAS*, IN THE GULF OF GABES (TUNISIA)

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CHELONIA MYDAS
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ABSTRACT. – Data on the presence of the green sea turtle, *Chelonia mydas* (Linnaeus, 1758) in the Gulf of Gabes (southern Tunisia) have been reviewed on the basis of published literature and unpublished records. Fifteen green turtles were recorded, of which only four were reported before 2004, when the national stranding network was established. Green turtles occur nearly throughout the year with a peak in the spring and summer seasons (8 out of 15 records). The analysis of the content of the digestive tract supports the existence of a dietary shift, with the adults foraging almost exclusively on sea grass while juveniles adopt an omnivorous diet. Our study highlighted the importance of *Cymodocea nodosa* as a food item for the green turtle in the Gulf of Gabes. This study increases our knowledge on the occurrence, biology and interaction with human activities of *C. mydas* along the Tunisian coasts.

INTRODUCTION

The green turtle, *Chelonia mydas* (Linnaeus, 1758) is a circumglobal species distributed in tropical and sub-tropical waters. The ontogeny of this species is characterized by nutritional shifts, from omnivorous diet of early juveniles to chiefly herbivorous diet of large juveniles and adults (Cardona *et al*. 2010).

Due to the past commercial exploitation for food (Sella 1995) and the present day interaction with fisheries (Casale & Margaritoulis 2010), the Mediterranean green turtle population has been classified as endangered (IUCN 2011).

In the Mediterranean, major nesting beaches of green turtles are situated in Turkey, Cyprus and Syria, while minor nesting activity is also present in Israel and Lebanon (Kasparek *et al*. 2001, Newbury *et al*. 2002, Rees *et al*. 2008).

Using satellite telemetry, Broderick *et al*. (2007) showed that green turtle females migrate south after nesting in Cyprus to forage along the North African coast. Recently it was suggested that the Southern Adriatic hosts a pelagic developmental habitat for the small juveniles which enter the Ionian-Adriatic area drifting passively within the dominant surface currents (Lazar *et al*. 2010).

Strategically located in the center of the Mediterranean Sea, Tunisia lies in the middle of the passageway connecting the western and the eastern basins. The northern littoral zone is characterized by a rocky bottom with a steep and narrow continental shelf while the south-eastern zone presents a wide and homogeneous continental shelf with muddy and sandy bottoms such as that of the Gulf of Gabes (Fig. 1).

At the beginning of the 20th century, Blanc (1935) reported that the green turtles were sold on fish markets in Tunisia and considered the species as common along the southern coast. Laurent *et al*. (1990) mentioned its presence in the Tunisian waters, but the species was regarded

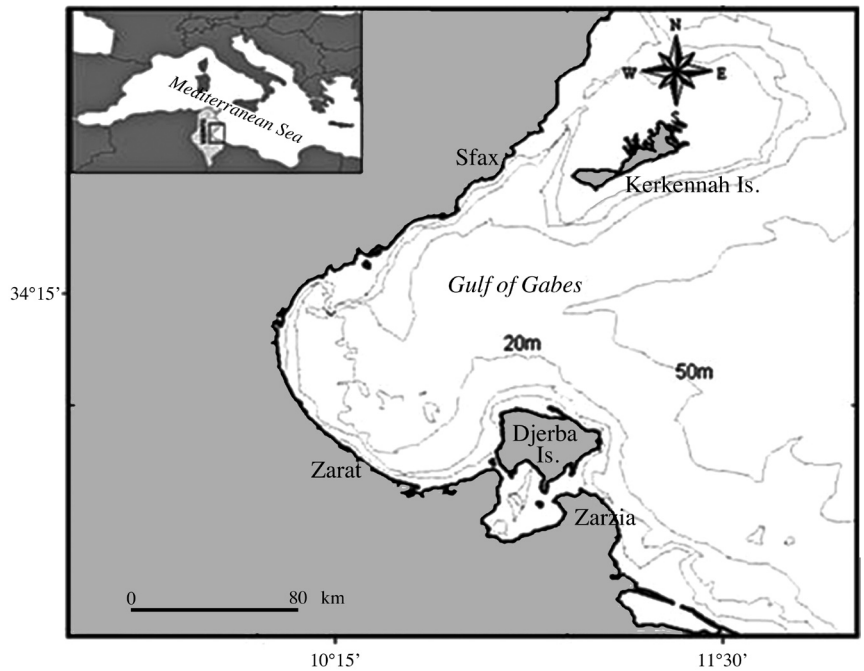

Fig. 1. – Study area of the Gulf of Gabes with 20 and 50 m isobaths (dotted lines).

as rare (Bradai *et al*. 2008).

In this paper we analyze diet, bibliographic and new records of *C. mydas* in the Gulf of Gabes dealing with the distribution of this species in the Mediterranean. We also study the presence of some epibionts on the species studied.

MATERIALS AND METHODS

Data on the presence of the green turtle in the Gulf of Gabes were obtained by inspecting published literature and reports from stranding events and fishery bycatch. Since 2004, these information were collected in the framework of the Mediterranean Action Plan of UNEP/MAP and aimed at monitoring the reproductive and offshore biology of sea turtles in Tunisia (Ben Hassine *et al*. 2011, Bradai *et al*. 2008, Chaieb *et al*. 2010). For each turtle, date, location of the observation, size (notch-tip Curved Carapace Length, CCL; Bolten 1999), and the method of the recovery were recorded. Turtles smaller than 70 cm CCL were considered immature (Demetropoulos & Hadjichristophorou 1995), while adults were sexed on the basis of sexual dimorphic characters (i.e. the large and muscular prensile tail of males) or by direct observation of the gonads during necropsies (Wibbels 1999).

When the carcass was not too decomposed, a general necropsy, following Wolke & George (1981) was conducted to collect digestive tract (esophagus, stomach, and intestinal tract). Their organic and anthropogenic contents (debris) were separated and weighed.

The organic items from the digestive tracts were sieved through a 2 mm mesh sieves, rinsed with water, preserved in 10 % buffered formalin and placed in storage containers. Food items were then separated and weighed to the nearest 0.01 g. Taxonomic identification was preformed to the lowest possible taxon (Riedel 1963).

Epibiont samples were carefully scraped with a knife from various parts of the turtle's body and preserved in 70 % ethanol. They were later identified in the laboratory according to Hollenberg & Norris (1977), Monroe & Limpus (1979), Relini (1980) and Ruffo (1982).

The abundance of the invertebrate species was expressed as the total number of individuals (NI) found in sampled turtles, while for algal species; abundance was estimated upon the percentage cover of the given sampling surface (10 x 10 cm). The positions of each epibiotic organisms on the turtle's body were recorded.

RESULTS

Fifteen records of green turtles in the Gulf of Gabes were gathered of which only four were reported before the establishment of the stranding and monitoring network in Tunisia in 2004 (Table I and references therein). Size data were available only for eleven specimens. Five were classified as immature and six as adult females.

The green turtle presence along the Tunisian coasts occurs nearly throughout the year with a peak in spring and summer (8 cases among 15 records). Nine specimens were accidentally caught in commercial fisheries, seven of which by bottom trawlers.

Two adult females presented an external tag: the first, captured in Sfax in March 1987, was tagged in the Lara

Table I. – Records of the green turtle, *Chelonia mydas*, in the Gulf of Gabes (Tunisia). No: number of the record; CCL: notch-to-tip Curved Carapace Length; M: Male; F: Female.

No	Date	Locality	CCL (cm)	Sex	Recovery method	Remark	Reference
1	11/03/1987	Sfax	Adult	F	Catch in bottom trawl	Freshly dead; tagged in Cyprus (reference Cyprus 57)	Laurent *et al*. (1990)
2	1988	Sfax	Juvenile	?	Catch in bottom trawl	carapace	Laurent *et al.* (1990)
3	1988	Sfax	Juvenile	?	Catch in bottom trawl	carapace	Laurent *et al*. (1990)
4	1988	Sfax	Juvenile	?	Catch in bottom trawl	carapace	Laurent *et al.* (1990)
5	25/12/2004	Kerkennah	35.5	?	Stranded	carapace	Present study
6	28/02/2005	Kerkennah	36	?	Catch in gillnet	Alive, tagged and released	Present study
7	16/05/2005	Zarat	98.5	F	Stranded	Decomposed, tagged in Turkey (reference TRA O718)	Present study
8	25/06/2006	Kerkennah	65.5	?	Catch in bottom trawl	Dead	Present study
9	12/12/2006	Kerkennah	45	?	Catch in bottom trawl	Dead	Present study
10	02/07/2007	Zarzis	105	F	Stranded	Freshly dead	Present study
11	06/06/2008	Zarzis	80	F	Stranded	Decomposed	Present study
12	17/06/2008	Zarzis	83.5	F	Stranded	Decomposed	Present study
13	15/07/2010	Jerba	115	F	Catch in bottom trawl	Alive, released	Present study
14	08/11/2010	Zarzis	44	?	Stranded	Only carapace observed	Present study
15	11/04/2011	Kerkennah	110	F	Catch in gillnet	Freshly dead	Present study

Table II. – Diet composition of green turtles *Chelonia mydas* from the Gulf of Gabes. No- number of the record, correspondingly to Table I; CCL: notch-to-tip Curved Carapace Length.

N°	CCL (cm)	Diet component; Wet Mass g/ Mass (%); Total Mass (%)										
		Algae/ Seagrasses					Animal matter				Inorganic matter	
		Cymnodocea nodosa	*Posidonia oceanica*	*Cystoseira barbata*	Unidentified material	Total	*Pyura dura*	*Tethya* sp.	Unidentified material	Total	Plastic bag	Total
9	45	7.6 (8)	2.4 (2.5)			10.5	34.5 (36.6)	44.6 (47.3)	5.3 (5.6)	89.5		0
8	65.5	125 (83.3)	8.6 (5.7)			89				0	16.4 (11)	11
11	80	1523 (100)				100				0		0
12	83.5	285 (100)				100				0		0
7	98.5	750 (100)				100				0		0
10	105	2100 (79.6)			530 (20.1)	99.7				0	7 (0.3)	0.3
15	110	1734.6 (44.4)	23.2 (0.6)	19 (0.5)	2133.2 (54.5)	100				0		0

Table III. – Epibiotic organisms collected from the green turtles from the Gulf of Gabes. No: number of the record, correspondingly to Table I; NI: number of the epibiont species. For all macroalgal species the percentage surface coverage is given according to the following scale: +, rare few thalli; ++, any number of thalli with percentage coverage less than 5%; +++, any number of thalli with percentage coverage between 5-10 %.

Epibiont species	NI	No	Localisation
Chelonibia testidunaria	21	9	Carapace
	1	10	Carapace
	1	11	Carapace
	8	15	Hind flipper
Stephanolepas sp.	8	6	Front flipper
Platylepas hexastylos	1	10	Hind flipper
Ampithoe riedli	4	9	Carapace
Jania rubens	++	9	Carapace
Polysiphonia sp.	+++	9	Carapace

area in Cyprus while the second, stranded dead in Zarat on May 2005, was tagged in Kazanli beach in Turkey (Table I, Fig. 1).

Dietary analyses were based upon a subsample of seven dissected turtles with CCL range of 45-110 cm. Larger specimens (CCL > 60 cm, N = 6) had been dominantly feeding on sea grass (89-100 % wet mass), while the diet of the single analyzed juvenile, with a 45 cm CCL, had been based mainly on animal prey (89.5 % w.m.), consisting of tunicate *Pyura dura* and the sponge *Tethya* sp. (83.8 % of stomach contents) (Table II).

Two out of seven dissected turtles (29 %) had ingested anthropogenic debris (2 plastic bags in each stomach weighted respectively seven and 16.4 g (Table II)); however no clear evidence of blockage in the digestive tract was observed during the necropsy.

Epibiont sampling was performed on five turtles. Six different epibiont species were recorded: one amphipod *Ampithoe riedli*, two species of algae (*Jania rubens* and *Polysiphonia* sp.) and three barnacles: *Chelonibia testidunaria*, *Platylepas hexastylos* and *Stephanolepas* sp. (Table III). *Chelonibia testidunaria* adhere to their hosts superficially, while those within the family Platylepadidae were partially (*Platylepas hexastylos*) or fully encapsulated (*Stephanolepas* sp.) within the host's tissue.

DISCUSSION

The Gulf of Gabes is a very shallow basin and one of the most productive marine habitats in Tunisian waters. This area is an important foraging ground for loggerhead turtles from Greece, Turkey and Cyprus. Recently it was suggested that it was also by the green turtle, but data on its presence in the Gulf of Gabes are scarce. This study demonstrates that the species, whose presence in the Tunisian water was previously considered exceptional (Laurent *et al*. 1990), frequent the Gulf of Gabes all the year round and was composed by both juveniles and mainly adult females.

The presence of small juveniles in the Gulf of Gabes might be an incidental event as the nesting areas in the Mediterranean are far from the Tunisian waters. It is possible that some juveniles are passively drifting with the dominant surface current in the Mediterranean Sea into the South-East Tunisian coast and particularly around the Kerkennah and Jerba islands where an important loop to the mainstream occurs (Hattour *et al*. 2010). This hypothesis is consistent with the proposal of many studies, which suggest that current can influence the dispersion of immature individuals and their choice of development site (Bass *et al*. 2006).

The occurrence of the adults could be explained by the coastal migration of some individuals from nesting areas in the eastern side of the Mediterranean Sea to the

feeding grounds along the North African coastal (Broderick *et al*. 2007, Godley *et al*. 2002, Rees *et al*. 2008) as suggested also by the finding of two adult females previously tagged in Kazanli beach in Turkey and in Lara area Cyprus (Table I).

The analysis of the diet of green turtles found in the Gulf of Gabes suggested two types of diet: omnivorous in juveniles and the herbivorous in subadult and adult green turtles. The latter mainly feeding on the sea grass *Cymodocea nodosa*. The shallow and warm waters of the Gulf of Gabes allow a local large coverage of *C. nodosa* and the most extensive and continuous *Posidonia oceanica* meadows of the Mediterranean (Bradai *et al*. 2004, Hamza & Bradai 1994). The fact that these species are preferred by the green turtles (because of their higher nutritional value (Cardona *et al*. 2010, Margaritoulis & Teneketzis 2003), makes the Gulf of Gabes a favorable benthic habitat for the species as it is for herbivore fish such as the salema *Sarpa salpa* (Linnaeus, 1758), the parrot fish *Sparisoma cretense* (Linnaeus, 1758), and the two rabbit fishes *Siganus luridus* and *S. rivulatus* (Bellassoued *et al*. 2011, Bradai *et al*. 2004). The vertical distribution of *C. nodosa* suggests that the green turtles in the Gulf of Gabes spend most of their time at depths less than 10 m where it prevails (Hays *et al*. 2002, Lipkin *et al*. 2003).

In different Mediterranean regions, green turtles were shown to feed upon different prey: Demetropoulos & Hadjichristophorou (1995) reported the sea grass *C. nodosa* as the only component in the diet of three juvenile green turtles (CCL = 30-50 cm) from Cyprus. Conversely, Lazar *et al*. (2010) reported the gut content of a juvenile green turtle (CCL = 40 cm) stranded in the Adriatic Sea which has dominantly feed upon benthic polychaetes *Chaetopterus variopedatus* (69.8 %), while sea grass *C. nodosa* and marine algae accounted for only 11.1 % of the total wet mass. Cardona *et al*. (2010) suggested that in the Mediterranean Sea, turtles shorter than 40 cm CCL min feed on a negligible amount of sea grass and that the contribution of sea grass matter to the nutrients assimilated by green turtles increased steadily in relation to turtle's size.

The existence of such differences in the prey composition supports the ability of the juvenile green turtles to adopt different feeding strategies, possibly in response to local abundance and type of available benthic resources (Carrión-Cortez *et al*. 2010).

The most frequent group of epibionts was the barnacles. Despite the fact that all three barnacle species found in this study (*C. testidunaria*, *P. hexastylos* and *Stephanolepas* sp.) were previously documented to be associated with green turtles (Hirth 1997, National Marine Fisheries Service and United States Fish and Wildlife Service 1998), only *C. testidunaria* (Chelonibiidae) was observed in the majority of the turtles sampled. It is a cosmopolitan barnacle isolated from many hosts but primarily on sea turtles (Relini 1980, Monroe & Limpus 1979). *Chelonibia testidunaria* was also known as the most characteristic epibiont of the loggerhead turtle (e.g. Frick *et al*., 1998, Kitsos *et al*. 2005) as well as the most common barnacle observed on green turtles in Australia (Limpus *et al*. 1994), Galapagos Islands (Green 1996) and Brazil where it was found in 100 % of the sampled green turtles (Pereira *et al*. 2006). To our knowledge this is the first record of the epibiont associated with *C. mydas* in the southern Mediterranean Sea.

Green turtles spend most of their time in fairly shallow coastal waters (Musick & Limpus 1997); this makes them vulnerable to incidental capture in fisheries and to the ingestion of marine debris. Our data indicated that the most serious threat was fisheries. Specimens reported by fishermen were caught by gillnet and bottom trawl.

Plastic bags were found in 2 turtles (Table II) suggesting that plastic debris consumption is not uncommon in green turtles visiting the Gulf of Gabes. These turtles can mistake plastic bags for the green algae *Ulva rigida*, an abundant alga in the Gulf of Gabes (Hamza *et al*. 1995).

Our analysis suggests a possible importance of the Gulf of Gabes as a foraging habitat for the green turtle in the Mediterranean Sea. To confirm this finding and provide a more detailed picture of the presence of the green turtle in the Tunisian water, systematic data collection and awareness programs among professional fishermen and local coastal inhabitants are essential. Moreover, to protect green turtles and their most important foraging habitat, the phanerogam meadows, it is recommended for the Gulf of Gabes the reduction of fishing effort especially for trawler, with a prohibition of incursion into the depth below 50 m. Plastic pollution should be also reduced.

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