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LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN ITALY AND IN THE MEDITERRANEAN BASIN

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A total of 411 records of leatherback turtles (*Dermochelys coriacea*) are reviewed for the whole of the Mediterranean, of which 57 are new records reported from Italy. Data on anthropogenic factors, spatio-temporal distribution, size and maturity are discussed. Leatherback turtles are most frequently captured incidentally by fishing nets. Specimens seem to concentrated in specific areas rather than being evenly distributed along a linear gradient from the Atlantic. Moreover, they frequent the Mediterranean all the year round without clear seasonal patterns of immigration or emigration. However, seasonal movements may occur between northern and southern coasts. Specimens entering the Mediterranean are likely to be large juveniles and adults of both sexes.

Key words: body size, by-catch, conservation, distribution, marine turtle, threats

INTRODUCTION

The leatherback sea turtle, *Dermochelys coriacea* (Vandelli, 1761) is in danger of extinction because of human impacts affecting its populations worldwide (Spotila *et al.*, 1996) and is listed as Critically Endangered in the IUCN Red List of Threatened Species (Hilton-Taylor, 2000). It has the widest range among sea turtles (and even among reptiles), occurring at high latitudes (Marquez, 1990) thanks to its thermoregulatory capability (Paladino *et al.*, 1990). It is the most pelagic turtle and seems to feed mainly upon jellyfish and other pelagic invertebrates (Bjorndal, 1997). Specimens frequent the Mediterranean, but they are likely to originate in the Atlantic, since reproduction in the Mediterranean, if it occurs, is certainly exceptional (Lescure *et al.*, 1989).

Unfortunately, the presence of this species in the Mediterranean is often known only from anecdotal information, and just a few individual records exist. Moreover, reliable data are usually dispersed between different journals, and only a few authors have reviewed data from a Mediterranean perspective (Capra, 1949; Capocaccia, 1968; Delaugerre, 1987; 31, 55, and 109 records respectively.

The aim of this study is to report data obtained from a large sample of individual records, in order to provide information on the distribution and threats to this species in the Mediterranean. Some of the Italian records have appeared in congress presentations (Nicolosi *et al.*, 2001; Casale *et al.*, in press).

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MATERIALS AND METHODS

Information about leatherback turtles found in Italy was collected from individual reports to authorities, scientists or newspapers, mainly in the framework of a tagging and awareness programme carried out between 1981 and 2000 (Argano, 1992). Some of these records eventually appeared in articles by participants in the program, and are reported here as reviewed records. Moreover, a form was distributed to Italian museums in order to gather information about leatherback turtles held in their collections, and any other records as well. Finally, published Italian and Mediterranean records dispersed through different kinds of international and national journals were collected by means of a bibliographic search (which, though accurate, certainly cannot be considered complete), and by using previous reviews and the bibliographic synthesis by Laurent (1998). As several articles made partial reviews, each record was compared with others in order to avoid duplication.

Specimens were classified as follows: captured incidentally during fishing operations, taken from the sea surface by hand, stranded, and sighted. Captures during fishing operations were classified as follows: longline, set and drifting nets, unspecified nets (most are likely to be set or drift nets, because different names are usually used for trawl nets), trawl, other and unknown fishing equipment. When available, lengths of specimens where classified as follows: unspecified length, total length (TL), unspecified carapace length (CL), curved carapace length (CCL), and straight carapace length (SCL). It should be taken into account that unspecified carapace lengths are likely to be curved measures, as this is the easiest to obtain, and that total lengths may not be com-

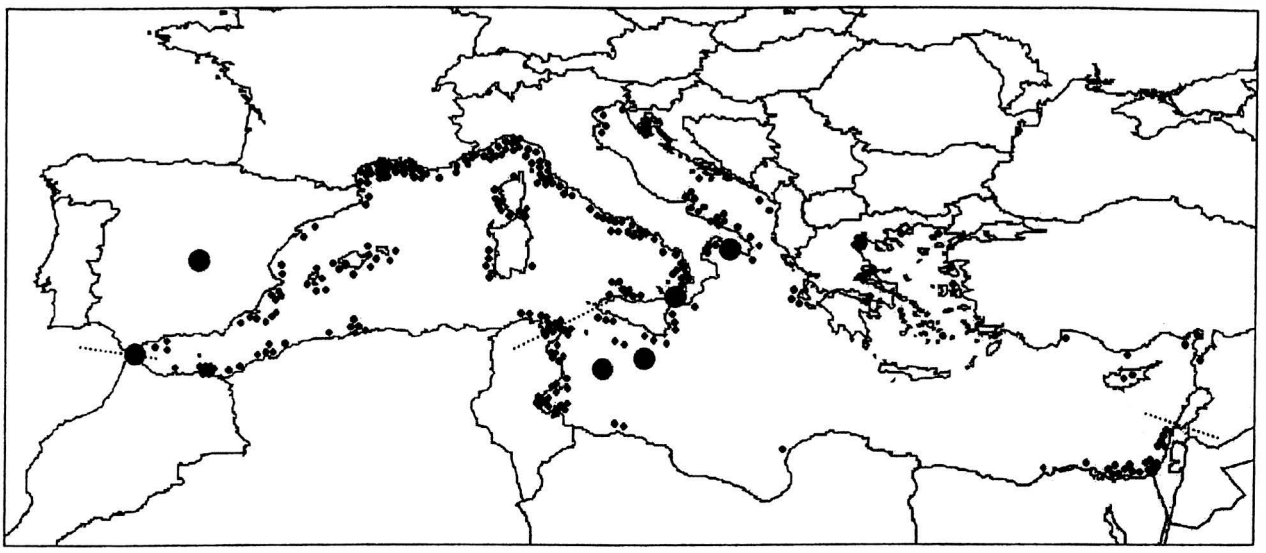

FIG. 1. Geographical distribution of Mediterranean records (n=411). Small circles: single records; large circles: 13 (Straits of Gibraltar), 25 (Spain), 19 (Pelagian Islands, Italy), 13 (Malta), 14 (Straits of Messina), 14 (Gulf of Taranto) records. Dotted lines: arbitrary divisions between western and eastern basins, and between northern and southern Mediterranean coasts.

parable, as they can be obtained in different ways: straight, ventral side, or dorsal side.

RESULTS AND DISCUSSION

We collected a total of 411 individual records for the whole of the Mediterranean (Fig. 1) with 152 of these from Italy, of which 57 are reported in the present work for the first time. Records concerned turtles stranded (n=52), taken (n=9), captured (n=170), sighted (n=53), or found in unknown circumstances (n=127). A listing of all records is available as an electronic supplement on the *Herpetological Journal* website: http://biology.bangor.ac.uk/~bss166/HJ/

ANTHROPOGENIC IMPACTS

Specimens reported by fishermen (n=170) were caught by set or drift nets (29.4%), longlines (20.6%), unspecified nets (12.9%), trawl (4.7%), other fishing equipment (9.4%), and unknown fishing equipment (22.9%). Proportions of specimens caught by different fishing equipment are particularly interesting, because finding a leatherback turtle is an exceptional event that is usually reported, and so this should theoretically give a realistic picture of the interaction between turtles and fishing activities. Moreover, the turtle project operating in Italy since 1981 focused particularly on longline fishing and so, if a bias exists, it should be towards this method. Thus, on the basis of present results it is likely that set/drift nets and unspecified nets (which are likely to be set or drift nets too) are responsible of most of the incidental catch of this species, as the majority (55%) of specimens caught by known equipment were caught by these methods.

Out of the 17 specimens caught in Italy by longline, three were dead, and four alive, while the final condition of the other 10 was unknown. The deaths of two specimens could be due to causes other than the fishing equipment, while one specimen died as a result of the damage caused by internal hooks. This is an uncommon event: the great majority of leatherback turtles caught by longline are found entangled in the branch-line or hooked externally (e.g. Witzell & Cramer, 1995).

Of the specimens caught in Italy by set/drift nets (n=13) and unspecified nets (n=19), 23.1% and at least 52.6% (the status of two specimens is unknown) died respectively. Proportions for the whole of the Mediterranean are at least 36.0% (n=50; the status of 11 specimens is unknown) and at least 54.5% (n=22; the status of two specimens is unknown), respectively. Hence, present data suggest that incidental capture of turtles as part of fishing activities causes high mortality and represents a significant threat.

Among the 20 specimens stranded in Italy (most died: only one was released alive), five had injuries on the head and/or carapace, presumably due to impacts with boats or their propellers; at least three had been caught by set/drift nets, and at least one had plastic bags in the digestive tract.

SPATIO-TEMPORAL DISTRIBUTION

Arbitrarily dividing the Mediterranean into two subareas at Cape Bon (Tunisia) - Sicily (Italy) (Fig. 1), Italian records were equally distributed between the eastern (74: 56 in the Ionian/Sicily Channel and 18 in the Adriatic Sea) and the western (75: Tyrrhenian Sea) Mediterranean side, but some possible methodological biases due to different efforts in collecting information should be taken into account. In order to reduce such possible biases two considerations may help. First, the number of specimens reported by fishermen is likely to depend on research effort rather than the number of those stranded, gathered, or sighted. Second, the geographical distribution of specimens caught by nets are likely to be relatively unbiased, because these fishing

TABLE 1. Number of *Dermochelys coriacea* specimens caught by drifting longlines intended for swordfish during studies carried out in different Mediterranean areas, with fishing effort in number of hooks and days, and the corresponding catch rates.

Area	Turtles	Hooks	Days	Turtles/ 1000 hooks	Turtles/ day	Source
Spain	2	1 572 965	792	0.0013	0.0025	Camiñas & Valeiras, 2001
Italy, Tyrrhenian	1	19 610	24	0.0510	0.0417	Guglielmi *et al.*, 2000
Italy, Sicilian Channel	2	109 375	114	0.0183	0.0175	Guglielmi *et al.*, 2000
Italy, Western Ionian	0	13 974	37	0.0000	0.0000	Guglielmi *et al.*, 2000
Italy, Northern Ionian	4	1 513 481	1935	0.0026	0.0021	De Metrio *et al.*, 1983
Italy, Western and Northern Ionian	0	437 500	318	0.0000	0.0000	De Metrio & Deflorio, 2001
Greece, Eastern Ionian	0	–	785	–	0.0000	Panou *et al.*, 1999
Greece, East Ionian and Aegean	1	320 209	255	0.0031	0.0039	Kapantagakis, 2001

activities were not associated with awareness campaigns as others were. So, taking into account only specimens caught by nets, most (84.4%; n=32) were caught on the western side (Tyrrhenian). Although it cannot be excluded that this difference is due to different fishing efforts, this pattern conforms to a strong west-east gradient with most records in the western basin explained by the Atlantic origin of the specimens (e.g. Capocaccia, 1968; Oliver, 1986; Duron-Dufrenne, 1986; Delaugerre, 1987). However, it is possible that the observed Mediterranean distribution is partially biased by differences in research effort in different areas. Indeed, in the present review the apparently skewed distribution of Mediterranean records (239 and 169 records in the western and eastern basin respectively) is due to records from Spain and France. These are countries where research interest in this species and the amount of reporting might have been higher than in countries in the eastern basin. No skewed distribution is evident if only the southern Mediterranean coast (Gibraltar Strait to Israel, including the Spanish territories in north Africa) is considered: even including the 11 records from "Gibraltar Strait" as southern, 52 and 50 records were from the western and eastern basin respectively. Recent investigations from the eastern Mediterranean (Margaritoulis, 1986; Camiñas, 1998; Taskavak & Farkas, 1998) seem to suggest that with a greater research effort many more records could come from areas under-represented at the moment. It is interesting that western Mediterranean records decreased from the 69.8% of Capocaccia's (1968) review to 58.6% of the present one (n=408: the exact position of three records in Italy was unknown).

Certainly, caution is needed when comparison is made of countries where research effort may vary. A rigorous comparison could only be made by using a standardized approach. Catch rates by different fishing activities could be useful, but such data are unfortunately limited. Even though based on a limited sample size, catch rates of longline fishing targeted at swordfish (Table 1) represent the best standardization available at present. Assuming that the catch effort is proportional to the number of hooks/branch-lines (leatherback turtles are usually entangled in branch-lines or hooked; e.g. Witzell & Cramer, 1995) such a comparison does not suggest any west-east gradient; actually, both catch rates from Italy/Tyrrhenian and Italy/Sicily Channel are higher than the one from Spain (Fisher exact test, P<0.05, n=1 592 575 and n=1 682 340 respectively). Margaritoulis (1986) reported that most Greek records were from the Aegean Sea (it is interesting that the only specimen reported from Greece in Table 1 was also from the Aegean) and that while leatherback turtles were well known by fishermen of this area, it was not so for fishermen from other areas, suggesting a gradient opposite to that (west-east) in Greek waters. In conclusion, even though at present most records are from the western basin and leatherbacks seem to occur more on the western

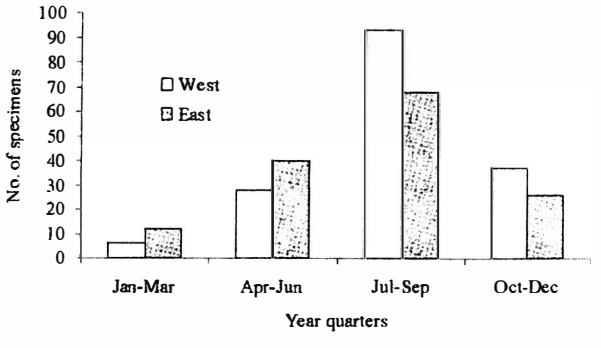

FIG. 2. Temporal distribution in the western and eastern basins (n=310).

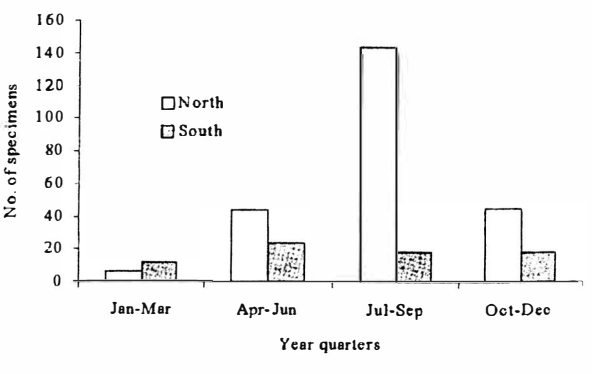

FIG. 3. Temporal distribution in the northern and southern coasts (n=310).

side of Italy, there is no strong evidence of a west-east gradient at Mediterranean level; it is certainly possible that the distance from the Atlantic is only one of the factors determining the distribution of this highly vagile species in the Mediterranean, and that specimens might concentrate in particular areas (for instance, in the Tyrrhenian and Aegean Seas), probably for feeding reasons.

Seasonally, records are concentrated in the warm period of the year (Fig. 2), but it is possible that such a distribution reflects that of the human activities responsible for the findings, rather than the actual temporal distribution of the species. Seasonal differences between western and eastern basins do not seem to occur (Fig. 2; χ^2=8.91, df=3, P>0.05, n=310), suggesting the lack of strong seasonal movements between them. Since it is assumed that specimens originate in the Atlantic, this also suggests that the species is present in the Mediterranean all the year round, without an evident seasonal immigration/emigration pattern. Conversely, turtles seem to move northwards in summer (Fig. 3; χ^2=38.02, df=3, P <0.0001, n=310), although biases due to seasonal differences in research and fishing effort or reporting rate cannot be completely excluded.

SIZE AND SEX

Known carapace lengths (curved and unspecified, excluding one specimen of 6.6 cm; Lescure *et al.*, 1989) ranged between 112 and 190 cm (mean=145.0, SD= 17.2, n=83; Fig. 4). Curved-line carapace lengths ranged between 115 and 190 cm (mean=145.5, SD=16.4, n=44; Fig. 4). In two important Atlantic nesting grounds, French Guyana and the Virgin Islands, the mean CCLs of observed nesting females were 157.4 cm (n=192) and 153.6 cm (n=39) (van Buskirk & Crowder, 1994); in the latter place, about 90% of specimens were larger than 144 cm CCL (n=358; Boulon *et al.*, 1996). NMFS (2001) and Eckert (2002) considered as juvenile those specimens less than 145 cm CCL.

Twenty-eight specimens were reported to be female (14 through direct observation of ovaries or specifically of large follicles/eggs, another also through necropsy, but without specific indications, and 13 through an unknown method) and 16 were reported to be male (an immature determined through direct observation of penis, and 15 through unknown methods – but probably at least some of them assigned using presence of the elongated tail typical of mature males). Those females with known carapace length for which the authors reported the presence of ovaries were 115 CCL, 130 CL, 145 CCL cm long and those for which the authors specifically reported only the presence of large follicles/eggs were 130 CL, 132 CCL, 150 CL, 155 CCL, 158 CCL, 190 CL cm. The immature male had a CCL of 136 cm (Turkey). All these data on size and internal anatomy suggest that the Mediterranean is frequented by both adults (certainly females and probably also males) and large juveniles (both sexes). It is interesting that – except for one very small specimen – small juveniles have never been reported, suggesting that neither the Mediterranean nor the north-east Atlantic are areas where the Atlantic populations of this species spend time as small juveniles. This is consistent with size data from the north-west Atlantic (NMFS, 2001), and suggests that small juveniles are limited to lower latitudes in the north Atlantic. Accordingly, a recent analysis based on the distribution of 98 small (<145 cm CCL) specimens around the world suggests that leatherbacks do not leave tropical waters before reaching a size of about 100 cm, probably because of thermal constraints (Eckert, 2002).

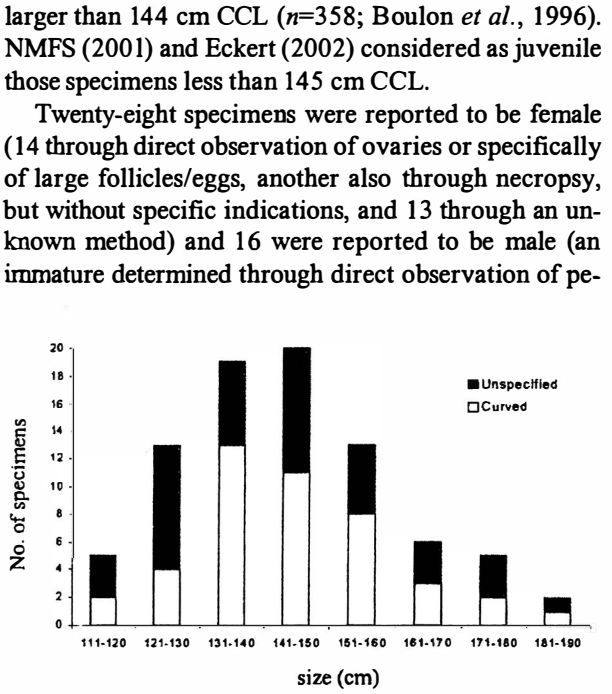

FIG. 4. Frequency distribution of curved (n=44) and unspecified carapace lengths (n=39).

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REFERENCES

Argano, R. (1992). Sea turtles and monk seal in Italian seas: conservation and perspectives. *Boll. Mus. Ist. biol. Univ. Genova* **56-57**,113-135.

Bjorndal, K. A. (1997). Foraging ecology and nutrition of sea turtles. In *The Biology of Sea Turtles*, 199-232. Lutz, P. L. and Musick, J. A. (Eds). Boca Raton: CRC Press, Inc.

Boulon, R. H. Jr., Dutton, P. H. & McDonald, D. L. (1996). Leatherback turtles (*Dermochelys coriacea*) on St. Croix, U.S. Virgin Islands: fifteen years of conservation. *Chelonian Conservation and Biology* **2**, 141-147.

Camiñas, J. A. (1998). Is the leatherback (*Dermochelys coriacea* Vandelli, 1761) a permanent species in the Mediterranean Sea? *Rapp. Comm. int. Mer Médit.* **35**, 388-389.

Camiñas, J. A. & Valeiras, J. (2001). Spanish drifting longline monitoring program. In *Assessing marine turtle bycatch in European drifting longline and trawl fisheries for identifying fishing regulations*, 73-136. Laurent, L., Camiñas J. A., Casale, P., Deflorio, M., De Metrio, G., Kapantagakis, A., Margaritoulis, D.,

Politou, C. Y. and Valeiras, J. Project-EC-DGXIV 98-008. Joint project of BIOINSIGHT, CUM, IEO, IMBC, STPS. Final report. Villeurbanne, France.

Capocaccia, L. (1968). La *Dermochelys coriacea* (L.) nel Mediterraneo (Reptilia, Testudinata). *Atti Accad. Ligure Sc. Lett.* **24**, 318-327.

Capra, F. (1949). La *Dermochelys coriacea* (L.) nel Golfo di Genova e nel Mediterraneo. *Ann. Mus. Civ. St. Nat. Genova* **63**, 270-282.

Casale, P., Argano, R., Basso, R., Freggi, D. & Gerosa, G. Leatherback sea turtles (*Dermochelys coriacea*) in Italian waters. *Proceedings of the First Mediterranean Conference on Marine Turtles, Rome 24-27 October 2001*. In press.

De Metrio, G. & Deflorio, M. (2001). In *Assessing marine turtle bycatch in European drifting longline and trawl fisheries for identifying fishing regulations,* 33-72. Laurent, L., Camiñas J. A., Casale, P., Deflorio, M., De Metrio, G., Kapantagakis, A., Margaritoulis, D., Politou, C. Y. and Valeiras, J. Project-EC-DGXIV 98-008. Joint project of BIOINSIGHT, CUM, IEO, IMBC, STPS. Final report. Villeurbanne, France.

De Metrio, G., Petrosino, G., Matarese, A., Tursi, A. & Montanaro, C. (1983). Importance of the fishery activities with drift lines on the populations of *Caretta caretta* (L.) and *Dermochelys coriacea* (L.) (Reptilia, Testudines), in the Gulf of Taranto. *Oebalia* **IX**, 43-53.

Delaugerre, M. (1987). Statut des tortues marines de la Corse (et de la Mediterranee). *Vie Milieu* **37**, 243-264.

Duron-Dufrenne, M. (1986). Fréquentation de la tortue luth *Dermochelys coriacea* L. en Méditerranée occidentale de juin 1985 à juillet 1986. *Mésogée*, **46**, 63-65.

Eckert, S.A. (2002). Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. *Marine Ecology Progress Series* **230**, 289-293.

Guglielmi, P., Di Natale, A. & Pelusi, P. (2000). *Effetti della pesca col palangaro derivante sui grandi pelagici e sulle specie accessorie nel Mediterraneo centrale*. Rapporto al Ministero per le Politiche Agricole e Forestali. DGPA Roma.

Hilton-Taylor, C. (Compiler) 2000. *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland and Cambridge, UK.

Kapantagakis, A. (2001). Greek drifting longline monitoring program. In *Assessing marine turtle bycatch in European drifting longline and trawl fisheries for identifying fishing regulations,* 20-32. Laurent, L., Camiñas J. A., Casale, P., Deflorio, M., De Metrio, G., Kapantagakis, A., Margaritoulis, D., Politou, C. Y. and Valeiras, J. Project-EC-DGXIV 98-008. Joint project of BIOINSIGHT, CUM, IEO, IMBC, STPS. Final report. Villeurbanne, France.

Laurent, L. (1998). *Descriptive bibliography on Marine Turtles for the Mediterranean and Black Seas*. Tunis: RAC/SPA.

Lescure, J., Delaugerre, M. & Laurent, L. (1989). La nidification de la tortue luth, *Dermochelys coriacea* (Vandelli, 1761) en Mediterranée. *Bulletin Societé Herpetologie de France* **50**, 9-18.

Margaritoulis, D. (1986). Captures and strandings of the leatherback sea turtle, *Dermochelys coriacea*, in Greece (1982-1984). *Journal of Herpetology* **20**, 471-474.

Marquez M., R. (1990). *Sea turtles of the world*. FAO Fish. Synopsis No. 125, Vol. 11.

Nicolosi, P., Zuin, S. & Turchetto, M. (2001). Tartarughe liuto, *Dermochelys coriacea* (Vandelli, 1761), conservate nei Musei Italiani di Storia Naturale. *Atti 5° Convegno Nazionale sui Cetacei e sulle Tartarughe Marine, Monte Argentario 6-9/12/2001*. Centro Studi Cetacei, **79**, 47.

NMFS, (2001). *Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic*. U.S. Department of Commerce NOAA Technical Memorandum NMFS-SEFSC-**455**.

Oliver, G. (1986). Captures et observations de tortues luth, *Dermochelys coriacea* (Linnaeus, 1766), sur les côtes françaises de Méditerranée. *Vie Milieu* **36**, 145-149.

Paladino, F.V., O'connor, M.P. & Spotila, J. (1990). Metabolism of leatherback turtles, gigantothermy, and thermoregulation of dinosaurs. *Nature* **344**, 858-860.

Panou, A., Tselentis, L., Voutsinas, N., Mourelatos, V., Kaloupi, S., Voutsinas, V. & Moschonas, S. (1999). Incidental catches of marine turtles in surface long line fishery in the Ionian Sea, Greece. *Contributions to the Zoogeography and Ecology of the eastern Mediterranean Region* **1**, 435-445.

Spotila, J. R., Dunham, A. E., Leslie, A. J., Steyermark, A. C., Plotkin, P. T. & Paladino, F. V. (1996). Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? *Chelonian Conservation and Biology* **2**, 209-222.

Taskavak, E. & Farkas, B. (1998). On the occurrence of the leatherback turtle, *Dermochelys coriacea*, in Turkey (Testudines: Dermochelyidae). *Zoology in the Middle East* **16**, 71-75.

van Buskirk, J. & Crowder, L. B. (1994). Life-history variation in marine turtles. *Copeia* **1994**, 66-81.

Witzell, W. N. & Cramer, J. (1995). *Estimates of sea turtle bycatch by the U.S. pelagic longline fleet in the western north Atlantic ocean*. NOAA Tech. Memo. NMFS-SEFSC-**359**.

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