NOTES ON THE INFLUENCE OF HUMAN ACTIVITIES ON SEA CHELONIANS IN SICILIAN WATERS

Russo G.*, Di Bella C.**, Loria G. R.**, Insacco G.***, Palazzo P.*, Violani C.°, Zava B.*

* Wilderness, Studi ambientali, via Cruillas 27, 90146 Palermo, Italy.
** Istituto Zooprofilattico Sperimentale della Sicilia "A. Mirri", via Rocco Dicillo 4, 90129 Palermo, Italy.
*** Fondo Siciliano per la Natura, c/o Museo Civico di Storia Naturale, Piazza delle Erbe, 97013 Comiso (Ragusa), Italy.
° Dipartimento di Biologia Animale, Università degli Studi, Piazza Botta 9, 27100 Pavia, Italy.

Abstract - In the literature there is strong evidence that human activity is seriously affecting once abundant sea turtle populations. Much of the impact is a consequence of the increased exploitation of marine and coastal waters. Sea chelonians are threatened, as a matter of fact, by the alteration of their suitable habitats (in particular, the nesting beaches), by the ingestion of nonbiodegradable debris, by entanglement in discarded fishing gear, collisions with boats, marine pollution, trawling capture and by pelagic and coastal fishing activities. Since 1994 to the present the authors have collected information about 121 individuals of Loggerhead *Caretta caretta* (Linnaeus, 1758), three individuals of Leatherback *Dermochelys coriacea* (Vandelli, 1761) and one Green turtle *Chelonia mydas* (Linnaeus, 1758), all found along the Sicilian coasts. The collected data (anamnestic and post-mortem) have revealed a conspicuous impact due to longline fishing activities. Toxicological investigations conducted on 10 specimens of *Caretta caretta* have shown contamination levels by heavy metals (Pb, Cd, Cr, As, Se) in the liver, kidneys, lungs, heart, muscle and spleen.

Riassunto - In letteratura sono ampiamente documentate le attività umane che danneggiano le popolazioni di cheloni marini, un tempo abbondanti. Gran parte dell'impatto è dovuto all'aumentato sfruttamento delle acque marine costiere. Le tartarughe marine infatti sono minacciate da diversi fattori come le alterazioni dell'habitat (in particolare le spiagge di ovodeposizione), l'ingestione di rifiuti non biodegradabili flottanti, la possibilità di impigliarsi in dispositivi da pesca abbandonati, la collisione con natanti, l'"inquinamento" marino, la cattura con reti a strascico e le attività di pesca pelagica costiera. Dal 1994 ad oggi gli autori hanno raccolto dati su 121 esemplari di *Caretta caretta*, tre individui di *Dermochelys coriacea* e una *Chelonia mydas*, tutti rinvenuti lungo le coste siciliane. I dati disponibili (anamnestici e autoptici) hanno evidenziato un cospicuo impatto dovuto alle attività di pesca con palangaresi. Gli esami tossicologici effettuati su 10 esemplari di *C. caretta* hanno rivelato livelli di contaminazione da metalli pesanti (Pb, Cd, Cr, As, Se) nel fegato, reni, polmoni, cuore, muscolo e milza.

J. Mt. Ecol., 7 (Suppl.): 37 - 41

1. Introduction

Among the species of sea turtles recorded in the Mediterranean Sea, only three, i. e. Green turtle *Chelonia mydas* (L., 1758), Loggerhead *Caretta caretta* (L., 1758) and Leatherback *Dermochelys coriacea* (Vandelli, 1761) are considered not exceptional for the whole basin (Gasc *et al.*, 1997; Bradai & El Abed, 1998; Camiñas, 1998). *C. caretta* is the most frequent chelonian in the Italian Waters, with egg-laying sites localized in Southern Italy, Sardinia, Sicily and in the smaller islands surrounding Sicily (di Palma, 1978; di Palma *et al.*, 1989; Groombridge, 1994); *C. mydas* and *D. coriacea*, on the contrary, have been recovered occasionally (Groombridge, 1994; Doria, 1998; Gianguzza *et al.*, 2000).

Today all the sea turtle species are considered globally endangered. Undoubtedly human interference is the cause of this collapse (Lutcavage *et al.*, 1997). Sea chelonians are threatened, as matter of fact, by the alteration of their suitable habitats (in particular, the nesting beaches), by the ingestion of nonbiodegradable debris, by the entanglement in discarded fishing gear, collisions with boats, marine pollution, trawling capture and by pelagic and coastal fishing activities.

Here we report on the influence exerted by several human activities directly or indirectly correlated with the survival of turtle populations; in particular, we report damages due to some fishing equipment, such as longline (drift and bottom longlines), driftnets, trammel nets and trawl net fishing, the finding of nonbiodegradable debris inside the turtles' digestive tract, and the frequency of injuries due to abandoned fishing gear or to collision with boats.

2. Materials and Methods

From June 1994 to May 1998 we have collected biometric, anamnestic and post-mortem

data from 125 sea turtles (121 *C. caretta*, three *D. coriacea* and one *C. mydas*), within the monitoring and research activities by the Centro Recupero Fauna Selvatica (Catania) of the Fondo Siciliano per la Natura, Wilderness Studi Ambientali of Palermo and the Istituto Zooprofilattico Sperimentale della Sicilia. Most animals came from fortuitous captures in the open sea, by means of different fishing tools and from findings of stranded individuals along the coasts of Sicily. Other turtles, wounded or in any case unable to dive, were recovered by yachtsmen or fishermen in the open sea. As regards biometrics, the carapace length was recorded following the Curve Line Method as reported by Márquez (1990) (CLCL, Curve Line Carapace Length); the weight was recorded using dynamometers. We must stress, however, that the finding of specimens has been totally fortuitous and makes our sample non homogeneous; as a matter of fact, it is correlated with professional fishing and yachting activities, which are performed in various ways and in different sites and periods of the year.
Furthermore, ten stranded specimens of *C. caretta* found dead have been examined for the detection of heavy metals in liver, kidneys, lungs, heart, muscle and spleen.
Concentrations of Pb, Cd, Cr, As and Se have been established by means of atomic absorption spectroscopy (Zeeman/ 3030) in graphite furnace, after incineration and calcination in muffle furnace. Mercury was detected by the cold vapours technique after reduction with SnCl2. In particular, arsenic was determined using the standard addition method. Methods used have the following detectability limits (expressed in µg/kg of dry material): Pb = 20; Cd = 2; Cr = 10; Hg = 30; As = 50; Se = 50. Age determination of the specimens tested for toxicological examinations was performed by means of histological sections of the humerus, according to the scheletochronological method proposed by Zug (1991).

3. Results and Considerations

The frequency of findings of the three turtle species (121 *C. caretta*, three *D. coriacea* and one *C. mydas*) as reported by us is indicative of their real presence in Italian waters.

Dermochelys coriacea

In an individual (CLCL: 132 cm; estimated weight approximately: 200 kg) caught with a surface longline on 2 August.1996, 4 miles south of Porto Palo (Trapani), a hook was found embedded in the left front limb. Another individual (CLCL: 131 cm; estimated weight approximately: 180 kg), captured on 23 July 1996, 18 miles south east of Siracusa, was set free from some packing bands in which the animal got tangled up. For the third specimen (CLCL: 145 cm; weight: 260 kg), found dead and stranded at Marinella di Selinunte (Trapani) on 19 April 1996, the autopsy has ascertained that it died by drowning. This turtle was found ten days earlier entangled in a trammel net; the fishermen brought it ashore while it was agonising and released it pushing it forcibly into the water.
We believe it useful to add some data referring to the finding of this species in Sicilian waters during the past years:
- a male individual stranded dead at Mazara del Vallo (Trapani) on 5 April 1988. The post-mortem examination revealed the digestive system completely clogged up by non-biodegradable debris (Jereb and Ragonese, 1990). The specimen was prepared and it is now in the collection of I.R.M.A.- C.N.R., Mazara del Vallo;
- a specimen captured by a driftnet from a fishing motorboat off Ustica island on 11 May 1989 (estimated weight: approximately 300 kg) and drowned by the negligence of the crew, during its transfer to the little harbour of Arenella, Palermo. The specimen was prepared and deposited at the Ripartizione Faunistica Venatoria, Palermo;
- a specimen (CLCL: 137; weight: 230 kg) captured off Lampedusa Island on 10 July1992. The autopsy performed at the Istituto Zooprofilattico of Palermo revealed the presence of approximately 2 kg of nonbiodegradable debris (newspapers and plastics) in the stomach, as well as necrotic areas in the intestinal ansae. Its carapace is preserved at the Museo Civico di Storia Naturale, Comiso, Ragusa;
- an individual caught alive by a gillnet near Termini Imerese (Palermo) on 24 June 1996 (length: 185; weight: 250-300 kg; see Camiñas, 1998).

Chelonia mydas

An individual of this species (CLCL: 37.8 cm; weight: 5.4 kg) was captured by a scuba diver off the locality Aspra (Palermo) on 11 May1998; it showed clear abrasion markings along its neck and the edge of the front flippers, probably caused by a fishing net. About a month after its release, the same turtle was captured again off la Bandita (Palermo), a few miles from the Aspra coast. After the second

capture, a careful checking of the reptile showed the presence of a small fish hook, approximately one centimetre long, within the intestine. During a month's keeping in aquarium, the turtle evacuated the hook and a mass of entangled nylon line (Gianguzza *et al.*, 2000). The ingestion of fishing hooks by *C. mydas* (a mainly herbivorous species) is certainly an occasional event; as a matter of fact, the foreign body found was similar to those used for angling from a fixed position on the coast, and it could have been ingested by accident during the turtle's foraging activity.

Caretta caretta

Most of the specimens observed were juveniles or subadults, having a CLCL of less than 70 cm (sensu Dodd, 1988); the frequency of the recorded size classes is shown in Fig. 1. Out of 121 specimens the 61.1 % (n = 74) were collected alive in the open sea, in difficulty or in altered health conditions; the remaining 38.9 % (n = 47) were formed by individuals found stranded along the coast (all deceased except three which were subsequently rehabilitated in the regional recovery centres of Messina and Catania. Our observations show that a conspicuous fraction of the sample is formed by individuals which had been caught by a trawl line (36.4 %; n = 44). The recovered hooks belonged mainly to the device called "conzo", used for the capture of swordfishes (*Xiphias gladius* L.), more rarely to the bottom longline type. We agree with Argano *et al.* (1992), whose data, concerning the whole Italian coastlines from 1981 to 1990, show that the trawl line is one of fishing gears with the greatest impact on the population of sea turtles.

The 7.4 % (n = 9) are represented by Loggerheads captured with bottom and surface nets, while the lowest percentage concerns captures by means of trawl nets (1.6 %, n = 2). The latter data, however, are certainly not representative of the real influence exerted by drag fishing on the populations of C. caretta, and in general on the other species of sea turtles (Bradai & El Abed, 1998); as a matter of fact, data reported by Laurent and Lescure (1991), concerning the Tunisian coasts, reveal a high impact at captures of 883, 2122 and 2913 Loggerheads (for the period January-April) respectively in the years 1986, 1987 and 1988; all these animals were destined for human consumption! Additional information collected by us at Mazara del Vallo (Trapani), suggest not negligible frequencies of captures regularly carried out by fishing boats, although we do not possess reliable estimates. The impact caused by driftnets used for the capture of swordfishes ("spadara") seem to be less relevant (Di Natale, 1996). As regards the impact exerted by the different fishing gear, we must stress the collaboration offered by fishermen from several Sicilian marines (in particular, small marines) who actively volunteered to take part in the rescue of turtles in difficulty, contacting the competent authorities for the transfer of turtles to the nearest recovery centres. As a matter of fact, we noticed a certain involvement concerning the problems of sea turtles conservation, which would be useful to encourage both with effective education activity and with specific study campaigns directly involving workers in the fishing sector.

Furthermore, the fraction of specimens captured by hand in the open sea is particularly significant. These turtles showed a type of behaviour described by observers as "inability to dive" (18.2 %; n = 22). These individuals did not show any symptom which could reveal a pathological condition, even after an in-depth diagnostic examination. After several days of keeping in aquarium, however, they evacuated nonbiodegradable materials together with faeces.

Such a behaviour, previously observed by Bjorndal (1997), is certainly due to the accumulation of digestion gases in the intestinal tract, not adequately canalized because of obstructions by nonbiodegradable debris. This hypothesis was confirmed by the results of post-mortem examination on 44 specimens of *C. caretta*; the 15.9 % (n = 7) of these Loggerheads showed intestinal occlusions, caused by the ingestion of foreign bodies of various nature, such as pumice

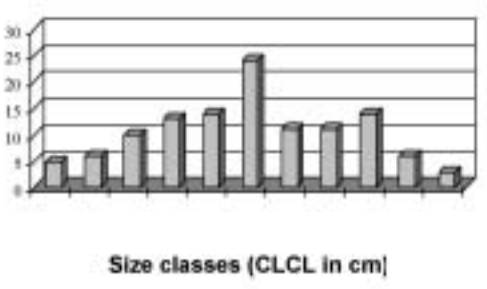

Fig. 1 – Frequency for different size classes of *Caretta caretta* turtles recovered during the period considered (CLCL expressed in cm).

Tab. 1 - Average concentrations of some heavy metals found in organs and tissues of *Caretta caretta*, expressed in ppm (mg/kg of dry material) and relative standard deviation, minimum and maximum values (n. r. = not revealed).

		Heart	Kidneys	Liver	Muscle	Lungs	Spleen
Lead	Mean	1.28667	4.625714	2.983	1.568	2.70375	0.84
Pb	St. dev.	0.45495	4.519111	2.206143	0.493171	2.766369	0.155563
	Min	0.75	1.71	1.18	1.05	0.93	0.73
	Max	1.95	14.38	8.34	2.43	9.27	0.95
Cadmium	Mean	0.96	6.751429	2.495	1.226	1.03375	0.67
Cd	St. dev.	0.21679	2.310183	1.526734	0.517906	0.57654	0
	Min	0.72	3.56	1.22	0.47	0.24	0.67
	Max	1.31	9.34	5.68	2.21	1.96	0.67
Chromium	Mean	0.25778	0.528571	0.495	0.344	0.41125	0.23
Cr	St. dev.	0.05540	0.10854	0.146837	0.065184	0.233815	0.113137
	Min	0.18	0.37	0.28	0.24	0.24	0.15
	Max	0.35	0.65	0.69	0.43	0.89	0.31
Mercury	Mean	0.52778	1.108571	1.091	1.682	1.515	0.455
Hg	St. dev.	0.30817	0.333788	0.32566	1.066342	0.570363	0.162635
	Min	0.29	0.86	0.67	0.21	0.86	0.34
	Max	1.31	1.84	1.76	4.28	2.55	0.57
Arsenic	Mean	0.01744	0.017714	0.0065	n. r.	0.010625	n. r.
As	St. dev.	0.00371	0.005707	0.006964		0.006781	
	Min	0.013	0.01	0		0	
	Max	0.024	0.026	0.015		0.016	

stones, pieces of wood and plastics, fragments of electrical wires, candy wrappings, newspaper bits, tar, cellophane, etc. This material, though not directly correlated with the animals' mortality, could nonetheless contribute to alter their health state, exposing them to the danger of collision with boats and increasing predation risk, as well as the chance of incidental capture in some commercial fisheries. It has also been suggested that ingested plastics could result in PBC accumulation (Bjorndal, 1997).

Additional recorded data are represented by the frequency of specimens found with an amputated flipper (7.4 %; n = 9). Though we are aware that some species of sharks can amputate the limbs of sea turtles (Dodd, 1988), we must remark that the loss can also be caused by necrotic processes, triggered by lesions due to the entanglement in discarded gear (such as nets or nylon lines). Moreover, these lesions have been observed in ten specimens of C. caretta collected during our investigations (8.3 % of the 121 Loggerheads considered).

Studies on the contamination levels by heavy metals and pesticides in adult Loggerheads are almost lacking. Chronic pollution from industrial or agricultural sources has been linked with immune suppression, raising a concern for sea turtles. In particular, marine turtle fibropapilloma disease is currently associated with a viral infection; however, the expression of the disease may be mediated by a compromised immune system (Herbst, 1994; Lutcavage *et al.*, 1997). C. *caretta* is primarily carnivorous, feeding on a wide variety of food items, especially molluscs (Dodd, 1988; Russo *et al.*, 1994). In addition, it can achieve a life span of more than 50 years, and has a potential to bioaccumulate heavy metals and pesticides.

Scheletochronological analysis carried out on humerus sections has established that the age reached by the turtles was included between 4

and 9 years. Results by chemical analyses are shown in Table 1. Selenium content was always below the limit of detectability of the method. Contamination levels obtained show altogether lower values than those reported by Storelli *et al.* (1996), except for the selenium content, the concentration of which reached 15.88 mg/kg of dry material in the liver (Di Bella *et al.*, 1998).

4. Acknowledgements
We are grateful to all those who have collaborated with us and, in particular, to Santo Caracappa and Antonino Corrao (Istituto Zooprofilattico Sperimentale della Sicilia), Maria Gabriella di Palma (Soprintendenza Beni Culturali e Ambientali of Palermo), Antonio Di Natale (Centro Studi Cetacei), Paolo Palazzo e Vanessa Marino (Wilderness - Studi ambientali), Luigi Lino, Salvo Rubbino, Antonello Mancuso, Giuseppe Coci and Valeria Reitano (Centro Recupero Fauna Selvatica of the Fondo Siciliano per la Natura), Capitanerie di Porto of Palermo, Mazara del Vallo, Porticello, Termini Imerese, Terrasini and Catania, Uffici della Ripartizione Faunistica Venatoria of Palermo and of Catania and Ufficio CITES della Regione Siciliana.

References

ARGANO R. N., BASSO R., COCCO M. & GEROSA G. (1992) - Nuovi dati sugli spostamenti di tartaruga marina comune (*Caretta caretta*) in Mediterraneo. *Boll. Mus. Ist. biol. Univ. Genova*, 56-57 (1990-91): 137-163.

BRADAI M. N. & EL ABED A. (1998) - Presence de la Tortue Luth *Dermochelys coriacea* dans les eaux tunisiennes. *Rapp. Comm. int. Mer Médit.*, 35: 382-383.

BJORNDAL K.A., 1997 - *Foraging Ecology and Nutrition of Sea Turtles*, pp. 199-231. In: Lutz P. L. & J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, pp. 432.

DI BELLA C., CORRAO A., CARACAPPA S., DI PALMA M. G., RUSSO G. & ZAVA B. (1998)- Indagini sulla presenza di metalli pesanti in *Caretta caretta* (Linnaeus, 1758). *Biol. Mar. Medit.*, 5 (1): 794-796.

DI PALMA M. G. (1978) - Notizie sulle tartarughe marine in Sicilia (Reptilia, Testudines). *Naturalista sicil.*, (4) 2 (1-2): 1-6.

DI PALMA M. G., LO VALVO F. & ZAVA B. (1989) - Indagini sulla ovodeposizione di *Caretta caretta* (L., 1758) in Sicilia (Reptilia, Chelonia). *Naturalista sicil.*, (4) 13 (1-2): 53-59.

DI NATALE A. (1996) - L'uso delle reti derivanti di tipo "spadara": analisi della situazione. *Biol. Mar. Medit.*, 3 (1): 360-364.

DODD G. J., Jr. (1988) - Synopsis of the biological data on the Loggerhead Sea Turtle *Caretta caretta* (Linnaeus, 1758). U. S. Fish Wildl. Serv., *Biol. Rep.*, 88 (14), 110 pp.

DORIA G. (1998) - Primo reperto di *Chelonia mydas* (Linnaeus, 1758) per il Mar Ligure (Reptilia, Testudines, Cheloniidae). *Doriana*, 7 (303): 1-4.

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.

GASC J. P., CABELA A., CRNOBRNJA-ISAILOVIC J., DOLMEN D., GROSSENBACHER K., HAFFNER P., LESCURE J., MARTENS H., MARTINEZ RICA J. P., MAURIN H., OLIVEIRA M. E., SOFIANIDOU T. S., VEITH M. & ZUIDERWIJK A. (eds.) (1997) - *Atlas of Amphibians and Reptiles in Europe*. Societas Europaea Herpetologica & Muséum National d'Histoire Naturelle (IEGB/SPN), Paris, 496 pp.

GIANGUZZA P., RUSSO G., VIOLANI C. & ZAVA B. (2000) - Ascertained record of the Green Turtle Chelonia mydas (L., 1758) in the Tyrrhenian Sea. *Atti Soc. ital. Sci. nat. Museo civ. Stor. nat Milano*, 141: 19-22.

GROOMBRIDGE B. (1994) - Marine turtles in the Mediterranean: distribution, population status, conservation. *Nature and Environment*, No. 48, Council of Europe Press, 100 pp.

HERBST L. H., 1994 - Fibropapillomatosis of marine turtles. *Annu. Rev. Fish Dis.*, 4: 389.

JEREB P., RAGONESE S. (1990) - On a specimen of the Leatherback Turtle, *Dermochelys coriacea* (Linnaeus, 1766), stranded at Mazara del Vallo (South-West Sicily). *Rapp. Comm. int. Mer Médit.*, 32 (1): 239.

LUTCAVAGE M. E., PLOTKIN P., WITHERINGTON B. & LUTZ P. L. (1997) - *Human Impacts on Sea Turtle Survival*, pp. 387-409. In: Lutz P. L. & J. A: Musick (eds.), The Biology of Sea Turtle. CRC Press.

LAURENT L. & LESCURE J. (1994) - L'hivernage des Tortues Caouannes *Caretta caretta* (L.) dans le Sud *Tunisien. Rev. Ecol. (Terre Vie)*, 49: 63-86.

MÁRQUEZ R. M. (1990) - *FAO Species Catalogue, Vol. 11: Sea turtles of the world. An Annotated and Illustrated Catalogue of Sea Turtle Species known to Date*. FAO Fisheries Synopsis. No. 125, Vol. 11. Rome, FAO. 81 pp.

PRITCHARD P. C. H. (1997) - *Evolution, Phylogeny, and Current Status*, pp. 1-28. In: Lutz P. L. & J. A: Musick (eds.), The Biology of Sea Turtles, CRC Press.

RUSSO G., GIANGUZZA P. & ZAVA B. (1999) - Osservazioni sulla dieta di *Caretta caretta* (Linnaeus, 1758) in Mediterraneo. *Biol. Mar. Medit.*, 6 (1): 602-604.

STORELLI M. M. , CECI E. & MARCOTRIGIANO G. O. (1996) - Distribution of heavy metals and organic residues in some tissues of *Caretta caretta* (Linnaeus, 1758) specimen beached along Adriatic Sea. *Abstract of 31st European Marine Biology Symposium, Saint Petersburg* 1996, p. 24.

ZUG, G.R. (1991) - Age determination in turtles. Society for the Study of Amphibians and Reptiles, *Herpetological Circular No.* 20, 28 pp.