Sea Turtle Handling Guidebook for Fishermen

Teaching Book

United Nations Environment Programme
Mediterranean Action Plan
Regional Activity Centre For Specially Protected Areas

Sea Turtle Handling Guidebook for Fishermen Teaching Book

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Introduction

It is now evident that the strategies used in marine biology conservation, regarding sea turtles, recognise professional fishermen as the central factor. The last update of the Mediterranean Action Plan has seen all the experts agreeing to include as Priorities: «banning of exploitation and minimization of incidental catch» (UNEP, 1998: Annex III, page 2, point 8). The strategies to achieve this result can be applied a legal level, executive level or that of applied research. Limited areas or fishing periods, implementation of existing laws or common fishing tool modifications are only some of the examples recently suggested (Gerosa and Casale, 1999).

Although not explicit, these proposals agree that the role of the fishermen and their activities at sea are important to marine turtle conservation. More clear and detailed are the statements of the Mediterranean Action Plan highlighted in the chapter Implementation Measures Which Aim at Reducing Mortality at Sea and Eliminating Local Consumption and Use, which states: «to carry out campaigns among fishermen in order to urge them to release marine turtles caught incidentally …» (UNEP, 1998: Annex III, page 4, point 17) and in that concerning Information, Education and Training, which states: «a public-awareness programme, including special documentary information materials should be developed for fishermen …» (UNEP, 1998: Annex III, page 5, point 22).

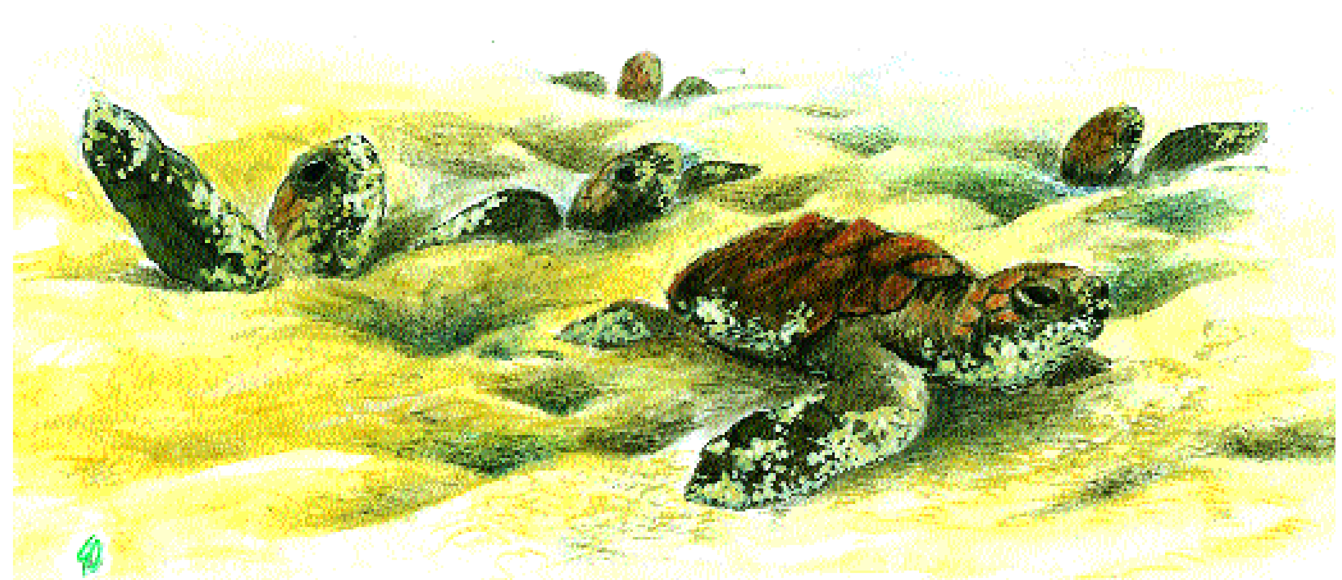
The Sea Turtle Handling Guidebook for Fishermen and the associated Teaching Book are meant to provide the tools suggested by turtle experts and people involved in conservation.

The Guidebook in particular is a direct information device which was produced for use in the field, in this case the fishing boat, through a detailed evaluation whose layout the fishermen greatly appreciated. Through the use of drawings accompanied by a simple text, some methods of handling sea turtles, from the moment they are incidentally caught to the moment they are released back into the sea, or their conservation on board until they are handed to the Authorities, are described.

The sole purpose of the Guidebook is to enable an assessment to be made of the state of health of the turtle brought on board. In order to help fishermen with difficult cases, some basic tests are provided to establish whether the animal is healthy, injured, not active, or dead, thereby increasing the possibility of saving the turtle. Each fishing method is treated on a double page (except the longline, where the delicate phase of hook removal has taken up more space) so that the user has a clearer idea of what action should be taken, and of the suggestions for each method.

The Guidebook is in the form of a directory with icons instead of letters, which allows the fisherman to find the desired page easily.

The last pages of the Guidebook contain a glossary, where some words found in the text are explai-



ned, and space is provided for notes and addresses.

The Guidebook is linked to a Teaching Book (the one that you are reading now), aimed at all those operators who will be in charge of training fishermen in aspects concerning marine turtles and in the techniques described in the Guidebook.

The Teaching Book is a more comprehensive version of the Guidebook, with additional pages concerning sea turtle biology and problems of turtles. The first pages, in particular, are about the anatomy and physiology of these reptiles, so that the reader can have a better grasp of the methodology suggested in the Guidebook. Different topics were written up in such a way as to allow the person in charge of training the fishermen to choose lessons according to their teaching needs.

The references cited in the text of the Teaching Book, which are described in detail at the end of the book, allow further reading to expand the subject treated in the book.

In order to avoid repetition of subjects that have been recently published and revised in other books, some topics have been concisely described in the Teaching Book. In particular, it is advisable to read this book in conjunction with:

- Definition and Classification of Fishing Gear Categories.

FAO Fisheries Technical Paper No. 222. Revision 1. Rome, FAO. 1990.

- Manual on marine turtle conservation in the Mediterranean.

UNEP (MAP) SPA/IUCN/CWS/Fisheries Department, MANRE, Cyprus. 1995.

- Manual on marine turtle tagging in the Mediterranean.

RAC/SPA (UNEP-MAP), Tunis, Tunisia. 1996.

- Interaction of marine turtles with fisheries in the Mediterranean.

RAC/SPA (UNEP-MAP) Tunis, Tunisia. 1999.

How to use the «Sea Turtle Handling Guidebook for Fishermen»

Since this is written for those who will have to show fishermen how to use the Guidebook, details are given on this page using practical examples to allow a good understanding of how to use the Guidebook.

The Sea Turtle Handling Guidebook for Fishermen was conceived as an easy tool to provide simple procedural guidelines on how to handle a marine turtle caught in fishing gear.

The Guidebook is composed of introduction pages, general pages on marine turtle biology and conservation and an operative section, which includes double pages for each of the three fishing methods discussed that interact with sea turtles, the Assessment of Turtle’s Condition pages, and the Recovery Techniques pages. The last few pages are a Glossary, with a space for useful addresses and notes.

By following the illustrated icons on the adjacent page you can look at the different pages.

Now that you have seen the pages, let’s get started by taking a simple example to show you the basics of using the Guidebook.

The example assumes that you are a fisherman working on a trawler and that you have incidentally caught a marine turtle in your trawl net.

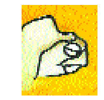
Choose the icon

which stands for trawl, and go to the specific page. The first few lines tell you to carefully bring the turtle on board. Then, by reading through the text and illustrations, you will find that you have to turn to the Assessment of Turtle’s Condition pages, which is indicated by an icon

in order to determine the status of the turtle that is on your boat.

In these pages, following the indicated text and arrows, you will find out which class (healthy, injured, not active or dead) the turtle you have caught belongs to.

Let’s say that the turtle does not move after being lifted. The arrows indicate two cases, which with the icon lead you to the page of Recovery Techniques,

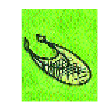


in order to be able to apply different procedures and find out the class of the turtle.

Now, let’s say that the turtle does not respond to the recovery techniques and you have classified it as not active. Read carefully the recommendation at the bottom of the

pages in order to confirm what you have found out.

Then, go back to your fishing method page, the trawl icon,



and read the 'not active turtle' paragraph. Not active classes require more attention than other classes because you are recommended to keep the turtle on board for up to 24 hours under observation; this gives the turtle enough time for a likely revival. After 24 hours, let’s suppose that the turtle revives: read the 'healthy' or 'injured turtle' paragraph of the page and release it, following the instructions.

As marine turtles are delicate animals and not easy to handle, for correct use of the Guidebook it is better to recommend carefully reading all the pages before taking any action.

The Guidebook also has a glossary at the end, which has to be used whenever a term in the text is not clear. The space for useful addresses and notes is intended for taking notes during the event and writing contact phone numbers or names of people who can assist the fishermen

The guidebook's contents provide an accurate review of published works and information from marine turtle experts' experiences and opinions.

An Outline of Marine Turtle Anatomy and Physiology

• Body shape, skeleton and internal organs

Viewed externally, a marine turtle has a large trunk with the body enclosed in a strong dorsal convex structure. From its forepart, a heavy head with a non-retractable neck stands out together with two forelimbs, whereas in the rearward part, there is the tail with the cloaca and two rear limbs (Fig. 1). The limbs are pentadactyl (Fig. 2): the pectoral ones are developed, elongated, and modified into wing-like, fore flippers whereas the hind flippers have become paddle-like (Fig.1).

The shell consists of a convex dorsal part, the carapace, and an almost flat ventral part, the plastron (Fig. 1). These two parts are joined together by elastic ligaments.

The shell, elongated along the antero-posterior axis and streamlined, consists of either the bones of the internal skeleton or other flat and wide bones (which grow under the skin) and are fused together (Fig. 2 and Fig. 3).

Carapace and plastron are covered with horny scutes or, in one species (Dermochelys coriacea), with hard skin. The external layer does not coincide, in number or in shape, with the bony plates underneath (Fig. 3).

The skull (Fig. 4), which has both primitive and specialised characteristic features, is compact with only one mobile part, the jaw. The latter can be moved thanks to powerful muscles located in the wide cavities between the upper part of the skull and the bony chamber of the brain cavity. The mouth does not have teeth, but a horny sharp beak which covers the alveolar surface of the mandibles, coinciding with the bone layer underneath (Fig. 4).

The internal organs are located inside the shell and show a characteristic disposition, according to the skeleton structure (Fig. 5).

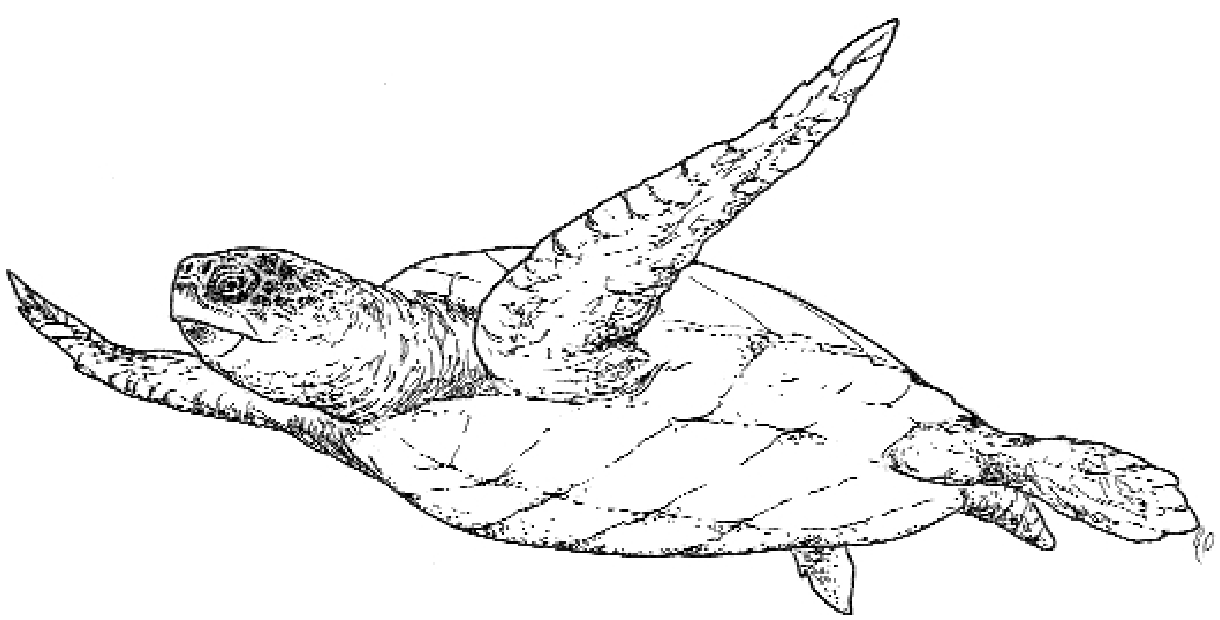
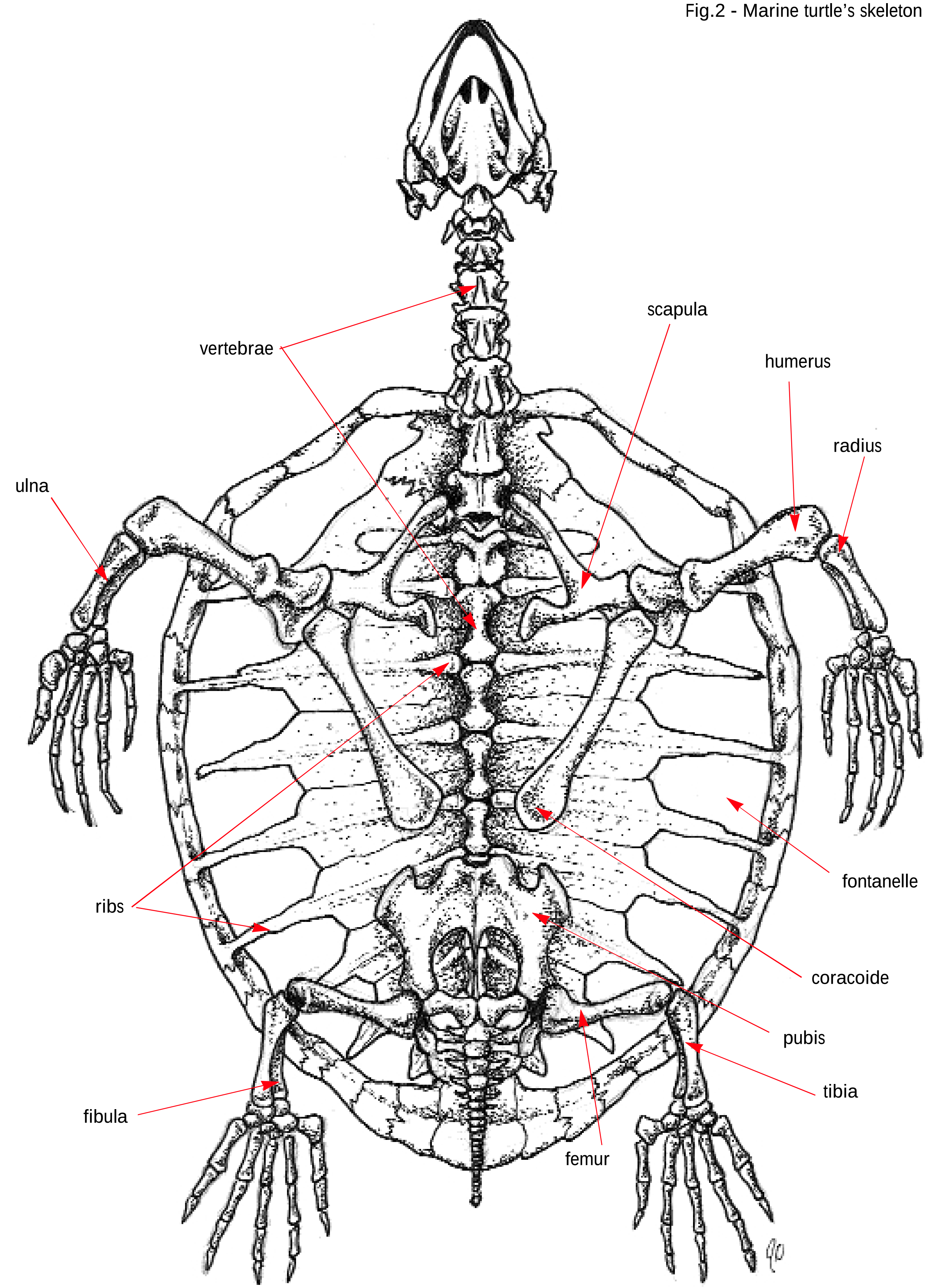


Fig. 1 - A sea turtle

Fig.2 - Marine turtle's skeleton



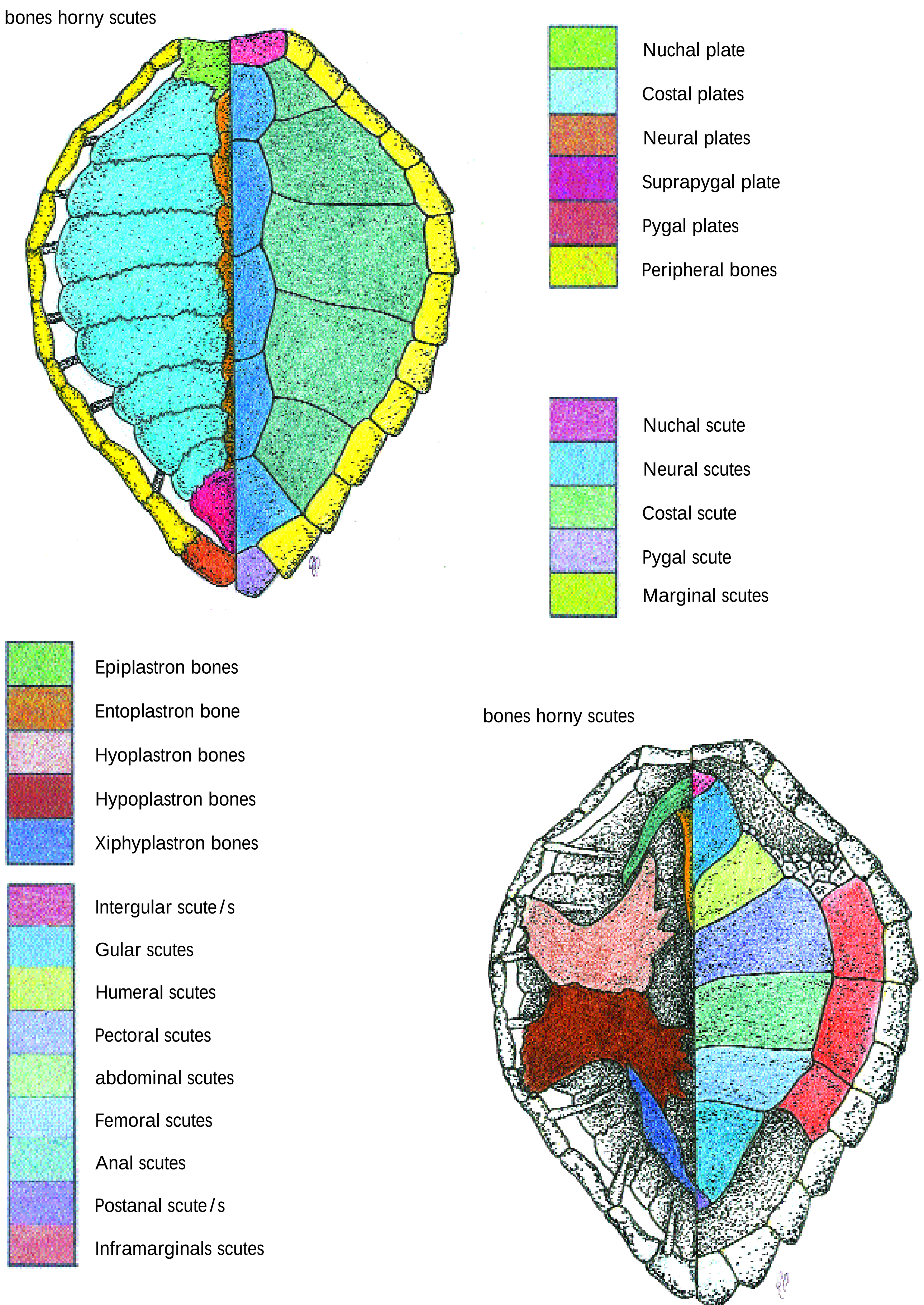
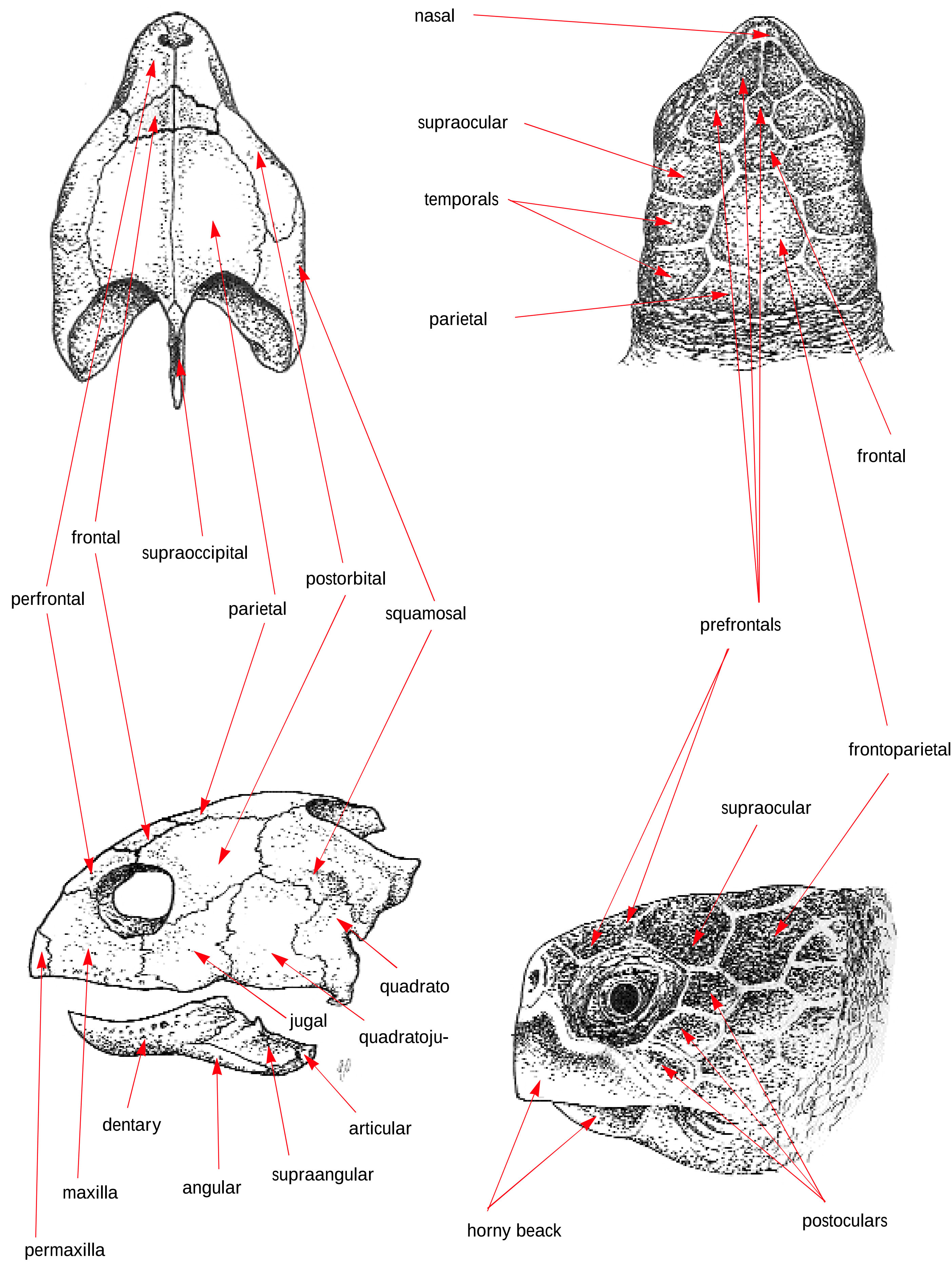


Fig. 3 - Horny scutes and bony plates of the carapace and plastron

Fig. 4 - Caretta caretta skull and head



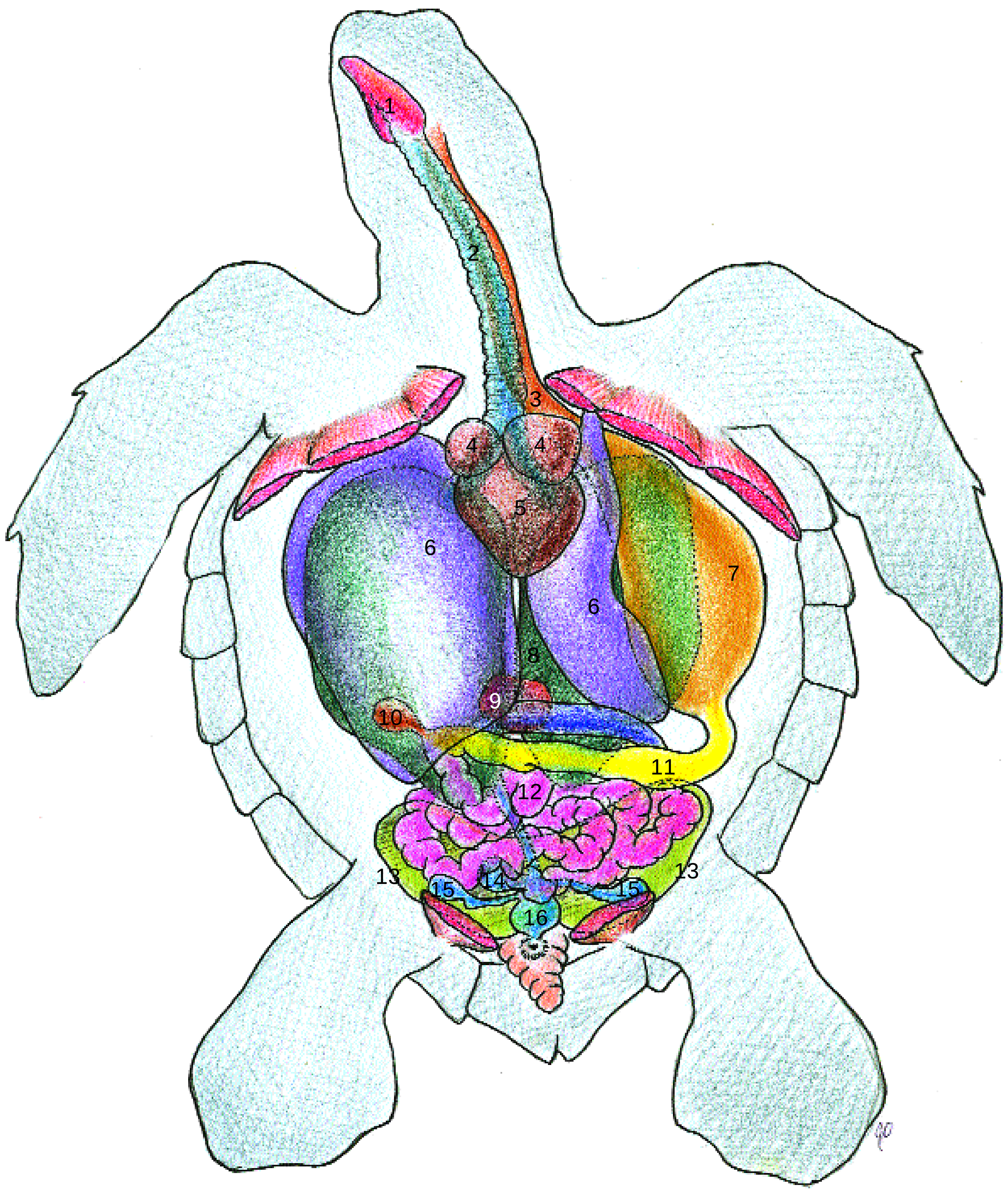


Fig. 5 - Sea turtul's internal organs : 1 tongue, 2 trachea, 3 esophagus, 4 heart (auricle), 5 heart (ventricle), 6 liver, 7 stomach, 8 lung, 9 spleen, 10 gall bladder, 11 duodenum, 12 intestines, 13 kidney, 14 urinary bladder, 15 gonad, 16 cloaca.

• Diving Physiology

Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19 to 26% of their time on the surface engaged in surface basking, feeding, orientating, and mating. For these reasons, they can be considered as diving sea animals (Lutcavage and Lutz, 1997).

In addition to the anatomical changes and the fact that they are air-breathing animals, sea turtles were forced to develop strategies in order to live in the sea. As far as respiration is concerned, an efficient oxygen transport system, the capacity of storing oxygen in the blood and tissues and an extraordinary tolerance to hypoxia, are important adaptations (Lutcavage and Lutz, 1997).

Sea turtles have wedge-shaped lungs which lie under the carapace within the pleura-peritoneal cavity and which are firmly attached to the dorsal body wall along the vertebral axis (Fig. 5). The lungs are spongy and multicameral. The ribs are fused to the shell (Fig. 2), and there is no true diaphragm separating thoracic and visceral compartments. For these reasons pelvic, gular, and pectoral muscles are recruited to ventilate the lung; in consequence, both inspiration and expiration are active, and the respiratory muscles work, improving the respiratory pumping capacity beyond that of the passive elastic properties of the lung itself (Berkson, 1966; Lutcavage and Lutz, 1997). Furthermore, sea turtles only require a few breaths lasting less than 2 to 3 seconds to empty and refill their lungs, even after being submerged for long periods (Lutcavage et al., 1989).

Taking into consideration maximum dive time, sea turtles show a wide range, between 2 and 5 hours, (Byles, 1988) and there does not seem to be a correlation between maximum dive depth and dive duration (Lutcavage and Lutz, 1997), whereas surface intervals seem to depend on whether they are located in shallow coastal areas (short surface intervals) or in deeper offshore areas (long surface intervals) (Lutcavage and Lutz, 1997).

Based on oxygen consumption measurements and estimates of total oxygen stores, aerobic limits of 33 and 70 minutes have been calculated for a 20-kg. loggerhead (Lutz and Bentley, 1985) and for an adult leatherback (Lutcavage et al., 1992) respectively. Despite these dissimilarities, the oxygen stored per kilo is surprisingly similar in the two species, with a certain difference in distribution.

In shallow dives, turtles depend upon the lung as a major oxygen store, whereas the more oceanic turtle (Dermochelys coriacea), that dives deeply, relies more upon blood and tissue stores for oxygen (Lutcavage and Lutz, 1997), as they dive to depths which would provoke complete lung collapse (Lutcavage et al., 1990; Butler and Jones, 1982).

As far as Mediterranean species are concerned, the species which reach the greatest depth is surely the Dermochelys coriacea, which can dive more than 1000 m. (Eckert et al., 1989), followed by the Caretta caretta, which has been recorded at 233 m. (Sakamoto et al., 1990), and Chelonia mydas at 110 m., even if the latter tends to remain in shallow waters (from 20 to 50 m.) (Lutcavage and Lutz, 1997). These depths should be considered as exceptional, because according to other studies complete lung collapse is believed to occur in deep-diving sea turtles at pressures equivalent to depths ranging from 80 to 160 m. (Berkson, 1967).

It is also worth mentioning that diving abilities vary considerably with age (or even more with biomass) of specimen. In fact, diving depth and breath-hold duration increase with the size of the lung oxygen store, the maturation of the oxygen transport system, and the structural development of the lung (Lutcavage and Lutz, 1997).

n case of forced diving (even if they are used to continuous diving), turtles seem to respond with physiological reactions that in many cases can threaten the specimen's survival. How to behave in such circumstances is one of the main subjects of the «Sea Turtle Handling Guidebook for Fishermen».

It is interesting to point out that during voluntary diving, despite the oxygen store having a steady decline (Lutcavage and Lutz, 1991), concomitant increases of carbon dioxide are relatively small, suggesting that an efficient ionic exchange system is operating (Lutcavage and Lutz, 1997) and that such dives are probably fully aerobic, since blood lactate values can be considered low (Lutz et al., 1989). This fact is quite different in forcibly submerged turtles, where oxygen is rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes to a lethal extent (Lutcavage and Lutz, 1997). In a 15-minute dive by a tethered adult green turtle, arterial oxygen saturation declines from 90 to 45% and a tenfold increase in blood lactate concentration occurs (Wood et al., 1984). In Caretta caretta blood oxygen was depleted to negligible levels in less than 30 minutes and blood lactate doubled between 30 and 90 minutes of forced diving (Lutz and Bentley, 1985).

The increase in blood lactate occurring during prolonged forced dives in loggerhead juveniles appears to be slightly more severe than that reported in adult green turtles (Lutcavage and Lutz, 1997). It has to be added to the above considerations, that once the turtle has started breathing, many hours are needed to re-establish the normal physiological values (Lutz and Bentley, 1985).

Finally, there are some “defence adaptations” which considerably increase the chance of survival of a specimen. A forcibly submerged individual can deplete oxygen consumption, decreasing the heart rate from 20 to 30 beat/minute to less than 1 beat/minute (Berkson, 1967), or leaving the spare oxygen and aerobic substrates for the brain and heart, while other tissues become anaerobic (Lutcavage and Lutz, 1997). Loggerhead turtles have an extraordinary ability to survive many hours of anoxia (Lutz et al., 1980) and their brain is able to maintain ATP level and ionic homeostasis by reducing its metabolic demand to a level that can be fully met by anaerobic glycolysis (Lutcavage and Lutz, 1997).

Even if few and contradictory studies exist on the subject, some marine turtles in the Gulf of California are apparently able to hibernate, and to live from 1 to 3 months without eating or breathing at a water temperature of below 15° C (Felger et al., 1976).

In addition to this, there are some modifications of the pulmonary artery which are able to reduce decompression problems (Sapsford, 1978), even if a gas embolus has been seen in the capillaries of green turtles that died after a rapid ascent from pressure chamber dives of over 14.5 atm (Berkson, 1967).

The dive duration of a sea turtle is a function not only of the total oxygen store, but also of the metabolic rate during the dive, and the latter is dependent on activity, size, body temperature, and hormonal and dietary status (Lutcavage and Lutz, 1997).

Fig. 6 - Salt gland secretion of tears in leatherbak turtle

• Water balance

Marine turtles spend most of their lives in the sea, an environment which is almost three times as concentrated as their body fluids (Table 1. adapted from Lutz, 1997) and therefore, due to osmotic pressure reasons, they must continuously face problems of water loss and salt gain.

For sea turtles the major potential routes for water loss are the respiratory tract, the integument, the gut, the kidney and the salt gland.

As far as respiration is concerned, water loss can be considered minimal for sea turtles since the relative humidity of the sea surface air that they inhale will be about 100% and the expiratory gas will have a similar water content (Benley, 1976). It is clear that a sea turtle kept in a dry environment (i.e. on the deck of a boat in the sun) would have a much higher water loss.

The second route for water loss is the integument, which, being in direct contact with sea water, has to face the transcutaneous osmotic problem. The two types of keratinous proteins of the epidermis (_-keratin covering the neck and legs, _-keratin for the shell scute) and the structure of marine turtle skin and shell indicates a high resistance to water diffusion (Benley, 1976; Lillywhite and Maderson, 1982). Excessive exposure to sun and air would also in this case considerably increase water loss.

In normal circumstances, urine loss through liquids secreted by the kidney has a similar concentration to the body fluids. However, the urine may become more concentrated than the plasma after prolonged dehydration (Prange and Greenwald, 1980) avoiding a considerable water loss. The latter from the passage of faeces is also estimated as very low (Lutz, 1997).

A different situation occurs concerning the salt glands. Those glands, which are modified lachrymal glands (Schmidt-Nielsen and F¨nge, 1958), are capable of discharging fluid with a concentration more than six times that of blood and twice that of sea water; in practice, a sea turtle that ingests 1 litre of sea water would be unburdened by the secretion of about 500 ml. of tears, leaving a net gain of 500 ml. of free water (Lutz, 1997). Thus, for a turtle able to ingest sea water, the salt gland provides a net gain of good water whereas for a turtle not able to ingest water, the discharge of salt through the specialised gland would cause considerable water loss.

Marine turtles show a significant robustness with regard to changes in internal salt water balance. Both recent and old observations concerning turtles caught by fishermen have proved that if turtles are kept in the shade and occasionally wetted with sea water, they can live on the ship deck for weeks (Caretta caretta (Gerosa, unpubl. data)) or for months (Chelonia mydas (Carr, 1954)).

Table 1.

Salt concentration (mm l^{-1}) of sea turtle Plasma and seawater, and the ratios of average plasma concentrations to those of seawater

	Na	K	Ca	Mg	Br	Cl	Osmotic pressure	References
Seawater	470	10	10.2	54	0.8	548	949	Kennish, 1994
Plasma								
Chelonia mydas	158	1.5					370	Holmes and Mc Bean, 1964
Caretta caretta	145	3.8	1.5	2.1		107	321	Lutz and Dunbar-Cooper, 1987
Caretta caretta	140	3.2	1.3	1.2	0.3	110	320	Lutz et al., 1986
Plasma/seawater ratios	3.2	3.5	7.3	32.7	2.7	5.1	2.8	

Marine turtle life cycle

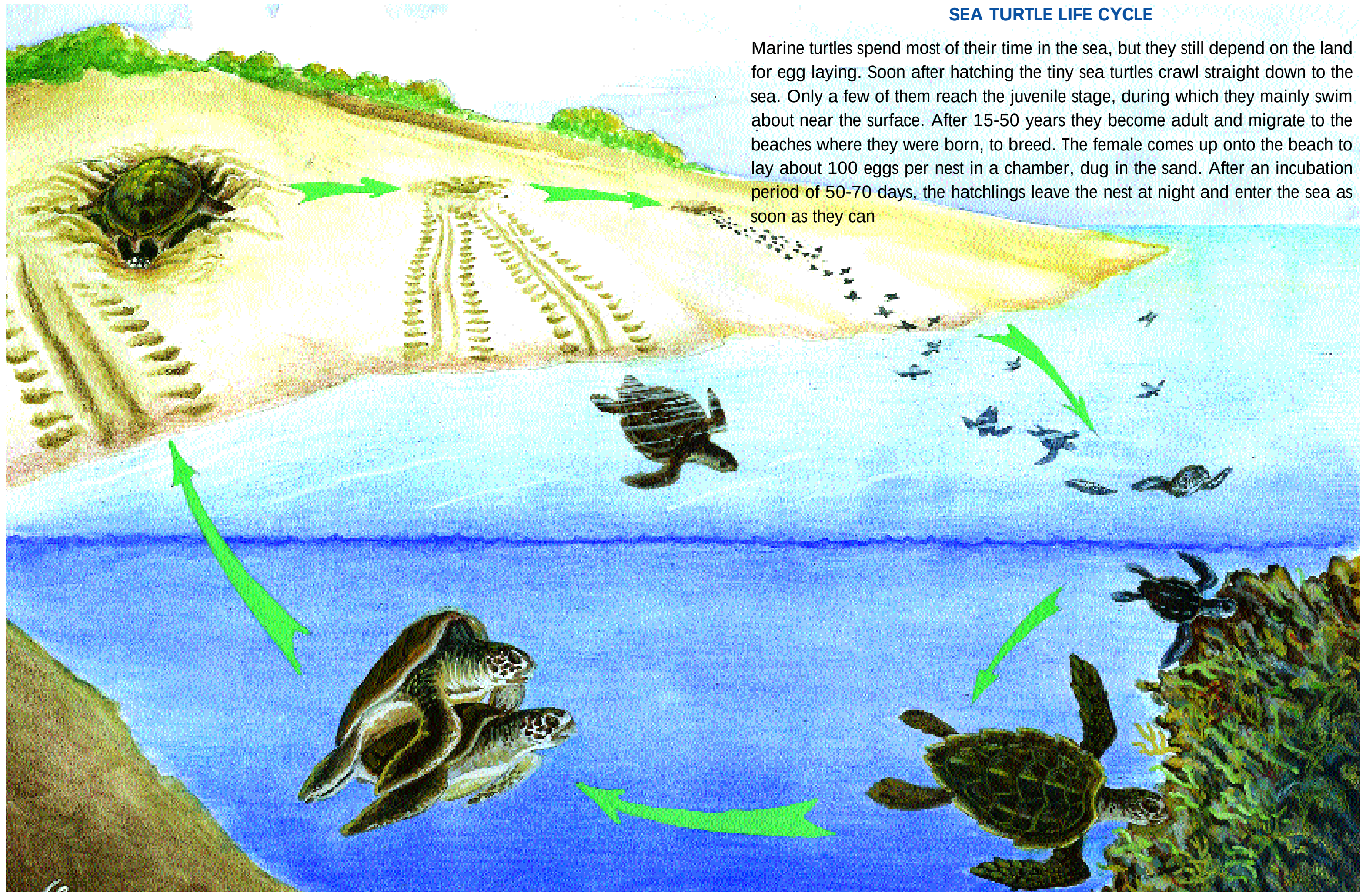
Marine turtles spend most of their lives in the water, but their existence starts from the land as hatchlings and later on, as adults, the females return to land to lay their eggs. The life cycle, the sequence of events from the origin (birth) of an individual to its death, for marine turtles, is set mostly in the water and only part takes place on land.

The seven species of marine turtle living in the world share a common life cycle with only minor differences. Hatchlings enter the sea and will only be seen again as juveniles in the open ocean in the foraging zone. The elapse of time between the hatchling stage and the juvenile one (found in the open ocean) is unknown, as is the ocean area where they spend this part of their life. As juveniles they will then be found again in a developmental habitat. Moving to the foraging habitat, they will share the same zone with adults. For the reproductive period, they migrate from the foraging habitat to the mating area. Females and males encounter each other in the nesting habitat for a while; then the males return to the foraging habitat and the females spend the season in the nesting habitat. At the end of the reproductive period the females will return to the foraging area. Once the eggs are laid on the beach, hatchlings emerge after about two months and then crawl into the sea.

• A FEW MORE DETAILS (Fig.6)

After emerging from the nest, sea turtles go into the sea, beginning a pelagic phase that is believed to last at least several years. The early pelagic stage, that occurs in most sea turtle species, is the poorest known life-stage and has become known as the "lost year" (Carr, 1982; Bolten and Balazs, 1995).

Hatchlings sequentially use three different sets of cues to maintain orientation during their initial migration offshore. While on the beach, they find the ocean by crawling toward the brighter seaward horizon, orientating away from the elevated silhouettes of vegetation and dunes (Witherington and Martin, 1996). Upon entering the sea, they initially orientate seawards by swimming into the waves; by setting a magnetic course on the basis



of near shore cues they continue their offshore migration (Lohman and Lohman, 1996).

As soon as they enter the sea they undergo a period of hyperactive continuous swimming activity (frenzy period) which lasts for an average of 24 hours. By the second/third day (postfrenzy period), hatchlings start to swim only during the day; variation in frenzy and postfrenzy behaviour may be found from species to species (Wyneken and Salmon, 1992).

They undertake denatant migration offshore to the open ocean (Jones, 1968), often taking refuge in circular current systems (gyres) that serve as moving, where they grow for a period of years to juveniles (Musick and Limpus, 1997).

The juvenile nursery habitat (pelagic and oceanic) is often found in the sea in association with weed lines or drift lines that exist near the frontal boundaries near major currents (Witham, 1991). Evidence given by frequent capture of juveniles has shown them to be present in the whole of the Mediterranean (Margaritoulis et al, in press).The duration of this period varies from species to species and also among populations. Green turtles apparently spend a shorter time in the oceanic nursery than loggerheads. The latter stay in the pelagic area to a much larger size than the green (Musick and Limpus,1997).

The end of this part of the life cycle is determined when the juveniles reappear in the juvenile developmental habitat (neritic and demersal). From a physiological point of view, the shift from the pelagic to the demersal stage could be explained by the greater capacity of older specimens to dive deeper and for longer periods than juveniles (see page xx). The leatherbacks represent an exception, because they are pelagic even as adults (Musick and Limpus,1997). During this phase, juveniles may make seasonal foraging migrations into temperate latitudes. According to several authors, seasonal juvenile migrations have been recorded within the Mediterranean (Camiñas and De La Serna, 1995).

Once the juveniles reach adult size (i.e. they are larger than the minimum breeding size), they are found in the adult foraging habitat, which is an area usually separated from the nesting habitat. Adult-size turtles within foraging habitats include sexually immature and mature individuals (Musick and Limpus, 1997). Although foraging areas occur over a wide range around the world, the primary marine turtle foraging areas are located within the north and the south 20°C isotherm of the average sea surface temperature and on the relatively shallow continental shelf areas (Musick and Limpus, 1997).

In some populations, adult foraging habitats geographically coincide with juvenile developmental ones. In the Mediterranean, the Gulf of Gabes and the Adriatic Sea appear to be two such cases, as both adults and juveniles have been found there (Margaritoulis, 1988; Argano et al., 1992; Bradai, 1992; Laurent and Leuscure, 1994; Lazar, 1995; Lazar et al., 2000; Vallini et al., in press).

At the beginning of the breeding season, both female and male adults travel from the foraging habitats to the breeding habitats (breeding migration), which are generally located near the nesting habitats. Female sea turtles generally do not reproduce every year whereas males may breed every year or every two years (Wibbels et al., 1990; Limpus, 1993). The mean interval between reproductive seasons of the same female varies among species, the range being from 1 to 9 years (Miller, 1997; Demetropoulus and Hadjichristophorou, 1995).

Very little is known about courtship behaviour, most observations having been made in captivity. Mating often occurs near the nesting beach but it could also take place along migratory corridors. It generally occurs in the month or two preceding the egg-laying cycle of the season (Limpus and Miller, 1993). Copulation lasts several hours and mating pairs can be seen on the surface of the sea, and multiple matings of females during a nesting season have been reported (Hirth, 1997). In the green turtle, the carapace of the older females is often deeply and permanent scarred in the marginal, where the claws of the male clasp the female (Miller, 1997).

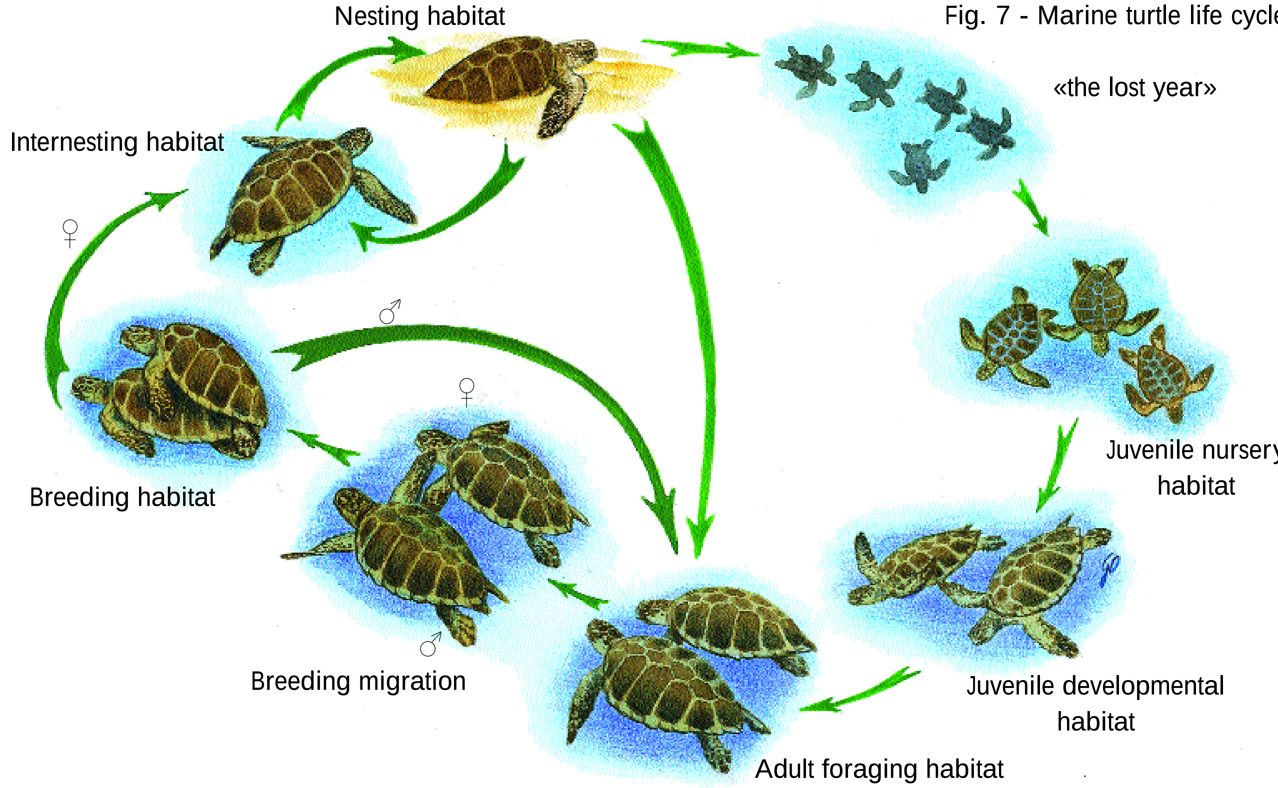
At the end of the mating period, males return to the adult foraging habitat, whereas females swim between the breeding and nesting habitats (the internesting habitat). The adult female emerges on the nesting beach to lay several clutches of eggs at approximately 2-week intervals, variable depending on the species (Miller, 1997). The nesting sites usually correspond to the region of the turtle's birth; it is still not clear what range of km. defines it, because it varies from 0 to 290 km. (Bjorndal et al., 1983; Limpus et al., 1992).

A nesting beach is usually a beach that is accessible from the sea, high enough to prevent inundation of the eggs by tides, with a suitable substratum for gas exchange in the egg chamber and able to provide the right level of heat and moisture for the eggs (Mortimer, 1982). The nesting process is very similar for the different species of marine turtle and has been fully described by many authors (Hendrikson, 1958; Carr and Ogren, 1960; Miller, 1997).

The eggs, white, spherical and with a diameter of 4-6 cm. (depending on the species), buried in the sand about 50 cm. deep, are naturally incubated for a period of about 50-70 days, depending on the species and on the temperature. The number of eggs per clutch and the number of clutches per season is also variable depending on the species. An average of 100 eggs per clutch is generally found (Hirth 1980). The nest environment has to be compatible with the need for certain conditions that allow embryo development, such as gas exchange, moisture and temperature (Mortimer, 1990). Temperature is certainly one of the main elements affecting marine turtles, determining also the sex of the hatchlings. Although the incubation temperature varies among species, cooler temperatures generally produce males and warmer temperatures produce females. Hatching success is typically high (80% or more) unless external factors interfere (Magnuson et al., 1990).

Hatchlings mostly emerge during the night (Bustard, 1967; Witherington et al., 1990); this event is controlled by a gradient of sand temperature on the surface (Gyuris, 1993). Hatchlings in a nest are not independent individuals, they meet the challenge of emerging from the nest with group action. The first young turtle that hatches does not start digging at once, but lies still until some other nest mates are free from their eggs. Turtles in the top layer scratch down the ceiling, those at the bottom trample and compact the sand that filters down from above. They help each other by climbing up the flask-shaped egg chamber and often hatch out in groups (Carr and Hirth, 1961).

Fig. 7 - Marine turtle life cycle



Sexual maturity and longevity

Due to their complex life cycle, with different life stages inhabiting dissimilar habitats, data gathered in the wild is not enough to give an exact estimation of the ages of marine turtles (Bjorndal and Zug, 1995). An evaluation of the age at which turtles attain sexual maturity is given by three methods: skeletochronology, which is based on the concept that periodic marks or growth checks on hard parts such as scales or bones give an estimation of age (Zug et al., 1986); mark-recapture data (Bjorndal and Bolten, 1995), and growth statistical models (Frazer and Ehrhart, 1985). For loggerheads the mean age of sexual maturity is estimated to be within a range of 25-35 years of age in wild stock (Chaloupka and Musik, 1997); for leatherbacks 9 years of age (Zug and Parham, 1996) and for green turtles within a range of 40–60 years of age (Bjornadal and Zug, 1995).

Taking into account the above-mentioned evaluation and considering that a reproductive period has been recorded of at least 23 years for the green turtle (Hirth, 1997), it could be estimated that this species could live up to 80 years. For the loggerhead, the lifespan estimation is of more than 60 years (Dodd, 1988).

Marine turtles and epibionts

The marine turtle can be considered as a small moving ecosystem. It is likely, in fact, that many different species of animal and plant are found on the carapace and skin of caught turtles.

In addition to the common seaweed (Green, 1998; Senties et al. 1999), it is possible to find specimens of different classes of animal such as: sponges (Demospongiae), hydroids and corals (Hydrozoa, Anthozoa), molluscs (Gastreropoda, Bivalvia), segmented worms (Polychaeta), leeches (Clitellata), barnacles (Cirripedia), sandhoppers and crabs (Malacostraca), moss animals (Gymnolaemata), sea squirts (Ascidiacea) and fish (Osteichthyes) (Dodd, 1988; Frazier et al. 1985; Frazier et al. 1991; Frazier et al., 1992; Hirth, 1997; Frick et al. 1998; Frick et. al., 2000).

The presence of the varieties of species mentioned above seems to be related to geographical distribution. Some species belonging to the barnacle class Cirripedia (Chelonibia testudinaria, Chelonibia caretta, Conchoderma virgatum, Lepas hillii) have been the most commonly found (even in the Mediterranean). This is probably because they are easy to identify and also because of their size (Gramentz, 1988a; Basso, 1992). On the other hand, other species such as the shark sucker fish belonging to the Class Osteichthyes (Echeneis remora), seem to be very rare both in the Mediterranean and in other seas (Green, 1998; Frazier, 1971; Gerosa and Aureggi, unpubl. data).

Epibionts can be found on all parts of the turtle's body, even on injuries (Oliverio et al., 1992), but many species prefer the carapace (Gramentz, 1988a; Frick, et al., 1998).

Apart from their negative action on the hydrodynamics of the specimen, the fouling of the epibionts does not cause any particular erosion of the part on which they are growing even if some species like the barnacle Stephanolepas muricata seem to cause injuries to the animal (Hendrickson, 1958).

The worst problems are caused when there is an excessive presence of encrusting species. When the surface covered by epibionts extends to the whole body and their weight is 33% of the turtle's weight, they cause motor complications and an increase in mass, which in juveniles can lead to a progressive debilitating illness and in some cases death (Basso, 1992).

Sight and feeding complications can occur when the epibionts cover the zones surrounding the head, in particular the eyes or inside parts of the mouth (Hendrickson, 1958; Basso, 1992). The area surrounding the eyes seems to be particularly affected by a leech which is common on turtles caught incidentally in the Mediterranean: Ozobranchus branchiatus (Gramentz, 1988a; Basso, 1992).

Origins of Mediterranean turtle species

Three of the seven living species of marine turtle are regularly found in the Mediterranean: the loggerhead turtle (Caretta caretta, Linnaeus, 1758), the green turtle (Chelonia mydas, Linnaeus, 1758) and even more rarely the leatherback turtle (Dermochelys coriacea, Vandelli, 1761).

The female loggerhead nesting population of the Mediterranean originated about 12,000 years ago from the western Atlantic stock, diverging genetically from them (Bowen et al., 1993). Besides the apparent morphological and biological differences, sub-structuring of breeding stocks within the Mediterranean has been recently confirmed by genetic studies (Laurent et al., 1998).

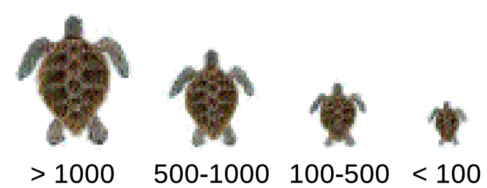
Investigations of green turtles suggest that a colonisation event from the Atlantic colonies to the Mediterranean took place within the last 10,000 years; this theory is based on the genetic relationship of green turtles observed between Cyprus and the Atlantic stock (Bowen et al., 1992; Encalada et al.,1996). It is most likely that by being mainly localised in the eastern part of the Mediterranean, these turtles have been isolated for a long time from the Atlantic population (Demetropoulos and Hadjichristophorou, 1995).

Nesting ground distribution within the Mediterranean

Loggerheads and green turtles both regularly nest in the Mediterranean, whereas there are no records of leatherback turtle nests in the basin. The latter has been found swimming mostly in the western Mediterranean (Capocaccia, 1968; Delaugerre, 1987) and occasionally found entangled in fishing gear or stranded along the coast (Margaritoulis, 1986; Basso, 1992; Castells and Mayo, 1992; Taskavak and Farkas, 1998; Miraglia et al., in press).

Considering that the Mediterranean is divided into two different basins, the western and eastern, connected by the Channel of Sicily, the nesting ground distribution of both species is restricted to the eastern part.

The loggerhead turtle, which is widespread in all of the Mediterranean, is the most common species. Its main nesting grounds are found in Greece,



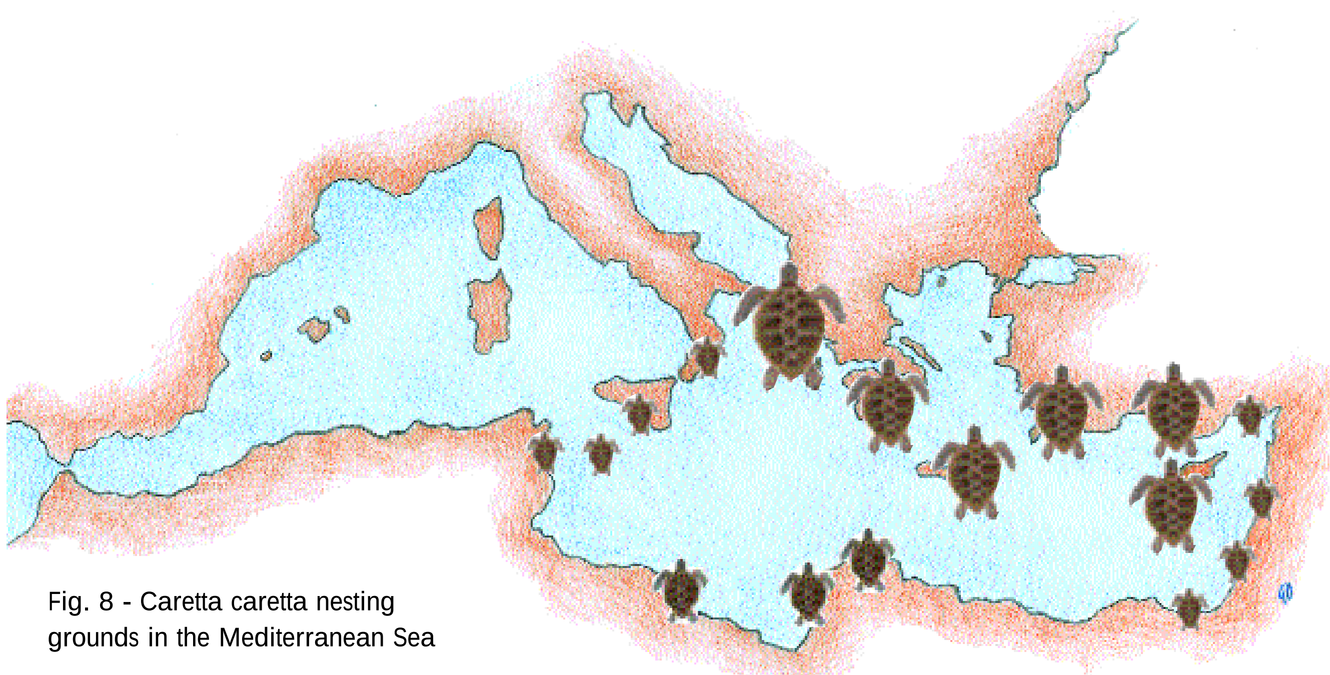
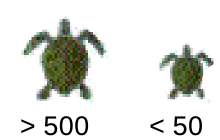


Fig. 8 - Caretta caretta nesting grounds in the Mediterranean Sea

Cyprus, Turkey and Libya; other minor nesting grounds are found in Egypt, Israel, Italy, Lebanon and Tunisia (Fig. 8). Based on the recorded annual numbers and without considering Libya (which needs further investigation (Laurent et al., 1999)), the total loggerhead nesting effort in the Mediterranean has been estimated in the range of 3375 to 7085 nests per season (Margaritoulis et al., in press).

The green turtle is believed to be restricted to the Eastern Mediterranean because of the water temperature gradient along the coast (Groombridge, 1990) though a few juveniles have been found in the western basin (Rafa and Salinas, 1990; Laurent 1996; Meschini et al., in press)

The green turtles' main nesting grounds have been reduced to a few beaches located in the eastern part of the basin along the south east Turkish coasts (Yerli and Cambolat, 1998; Aureggi et al., 2000) and in Cyprus (Hadjichristophorou and Demetropoulos, 1998; Godley et al., 1998a) (Fig. 9). Although data has only been regularly collected on green turtle nesting effort in the Mediterranean in the last few years, the yearly average of nests laid along Mediterranean beaches is at least 1000 nests.



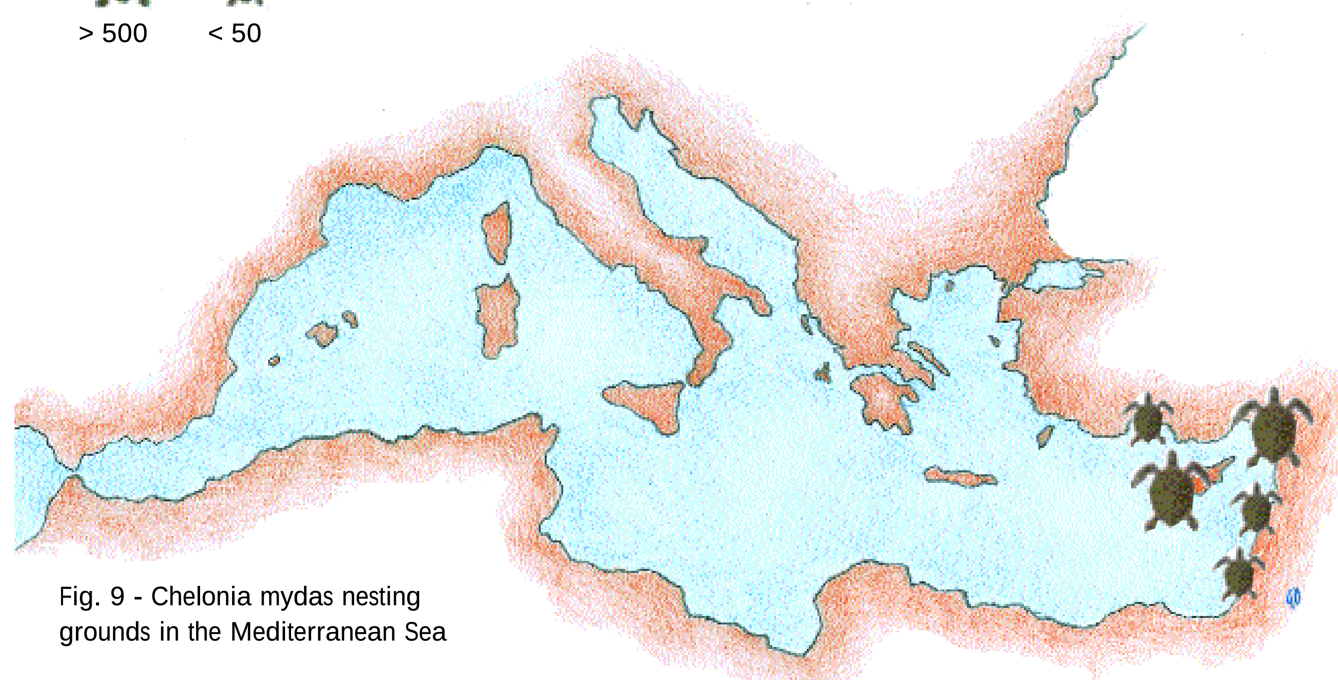


Fig. 9 - Chelonia mydas nesting grounds in the Mediterranean Sea

Food habits

The foraging ecology of marine turtles is poorly known. Following the habitat model based on ontogenetic stages described in the life cycle (see page 16), sea turtles will come across different habitats and therefore different sources of food.

- Loggerhead turtle

The loggerhead is carnivorous and has jaws adapted for the functions of crushing and grinding (Pritchard, 1979).

Loggerhead hatchlings have been seen in close association with drifting Sargassum (Bolten and Balazs, 1995).

Coelenterate and cephalopod molluscs are especially favoured by loggerhead juveniles but their diet also includes other molluscs, crustaceans and gelatinous makroplankton (Bjorndal, 1997), showing they are opportunistic feeders. Juvenile loggerheads stay in the juvenile nursery habitat for a variable period of 3 to 10 years, or longer, depending on the individual and ocean basin (Musick and Limpus, 1997).

When in the juvenile developmental habitat, the loggerhead feeds throughout the water column, capturing jellyfish and salps on the surface and middle depths, but apparently concentrating its foraging efforts on the bottom (Bjorndal, 1997).

In the adult foraging habitat, the loggerhead eats a variety of benthic invertebrates, including molluscs, crustaceans and sponges, which it crushes before swallowing (Mortimer, 1995). Dietary analysis of some specimens caught in Tunisia and in the eastern Adriatic Sea has indicated that loggerheads feed on benthic invertebrates, gastropods, hermit crabs, holothurians, lamellibranches (Laurent and Lescure, 1994) echinoids and crustaceans respectively (Lazar et al., in press).

Green turtle

The vegetarian green turtle has finely-serrated jaw surfaces, which in some populations form quite long pseudo-teeth (Pritchard, 1979).

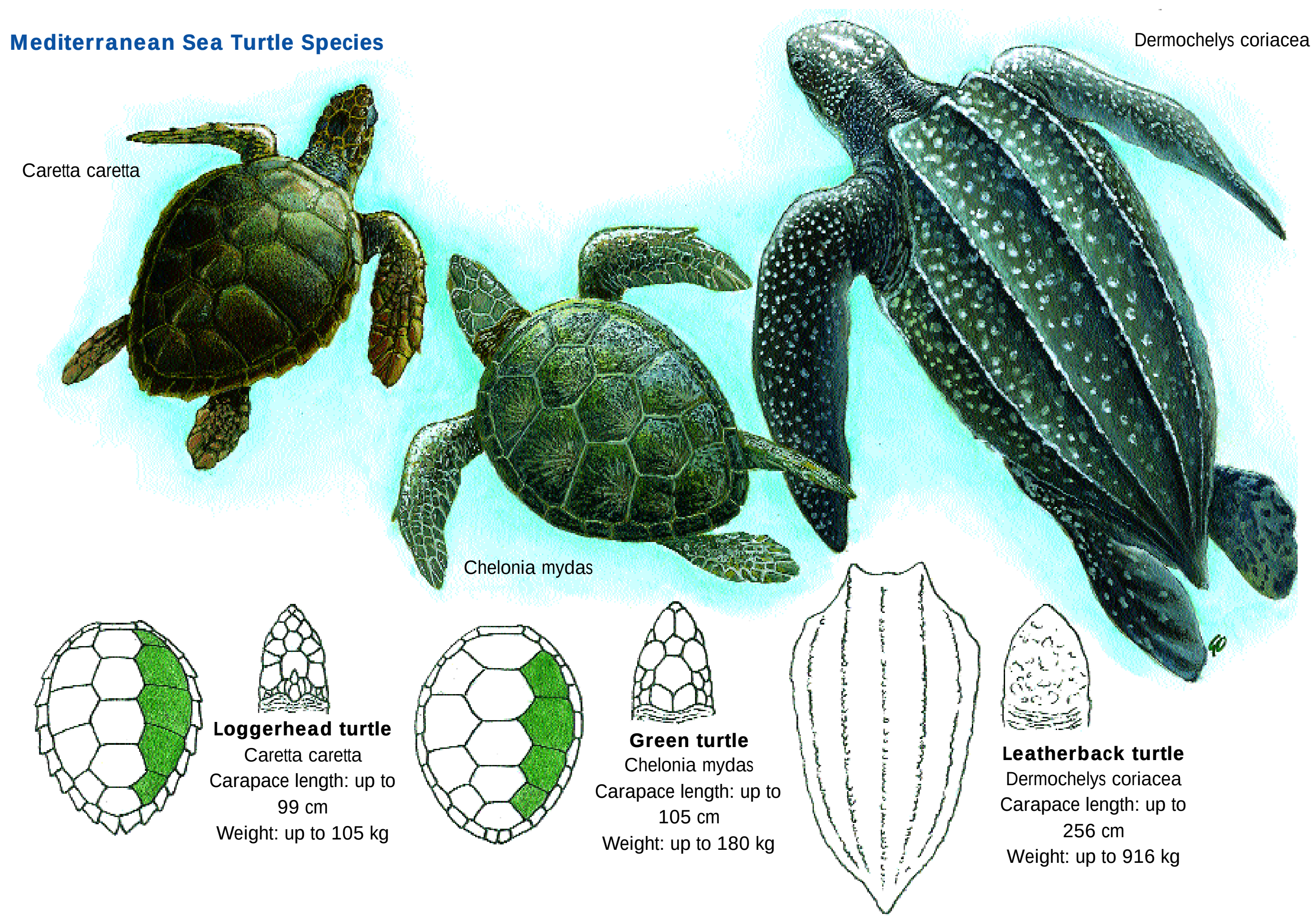
Green turtle hatchlings have been seen in close association with drifting Sargassum (Carr and Meylan, 1980). Their diet is similar to that of loggerheads until they become herbivorous at a later stage (Demetropoulos and Hadjichristophorou, 1995).

When they are in the juvenile developmental habitat, green turtles shift to a herbivorous diet and as herbivores, occupy a feeding niche unique among sea turtles; they feed primarily on sea grasses and algae, although they also consume animal matter, particularly jellyfish, salps and sponges (Bjorndal, 1997). In the Mediterranean they feed mainly on sea grasses and algae (Demetropoulos and Hadjichristophorou, 1995).

- Leatherback turtle

The leatherback has delicate scissor-like jaws which would suffer severe damage if subjected to anything much harder than their usual food of jellyfish (Pritchard, 1979).

The leatherback is mostly pelagic, spending most of its time in the open sea. The distribution of the foraging leatherback appears to be largely dependent upon the distribution of the jellyfish, salps and other gelatinous organisms upon which it feeds, and which often accumulate near convergent zones or water mass boundaries. It feeds throughout the water column from the surface to great depths (Eckert et al., 1989). Because the ability to capture and consume the gelatinous prey species is not size-dependent, there would seem to be no reason for a diet shift between size classes, as is apparently the case in other sea turtle species (Bjorndal, 1997).



Ingestion of plastic and other debris

There is ample evidence that sea turtles ingest plastic and other indigestible materials of human origin. Taking into consideration the plastic packaging only, every year more than 24,000 tons of these materials are thrown into the sea (Welch, 1988).

As evidence of the critical situation of debris pollution in the Mediterranean, many Mediterranean beaches, even if not much frequented by tourists or being part of a reserve or national park, are covered by a lot of debris coming from the sea current (Gerosa et al., 1995; Broderick and Godley, 1996; Clarke et al., 2000).

Some long-term studies show that in some areas 80% of the turtles have these items in their stomach (Stanley et al., 1988) but a more realistic percentage seems to be 50% (Cottingham, 1988; Plotkin and Amos, 1988; Bjorndal et al. 1994; Shaver and Plotkin, 1998).

As far as Mediterranean sea turtle species are concerned, the most exposed to this phenomenon is Chelonia mydas (32%), followed by Caretta caretta (26%), and Dermochelys coriacea (24%) (Balazs, 1985). For all species, except the leatherback turtle, immature turtles are involved more frequently than adults (Magnuson et al., 1990).

In addition, hatchlings are particularly attracted to floating bits of tar, which, once bitten, can block both the beak and the oesophagus, causing death (Carr, 1987; Lutcavage et al. 1997).

These worryingly high percentages are probably due to the turtles' habit of allowing themselves to be passively transported by sea currents for long periods of time, increasing the likelihood of an encounter with debris which is concentrated in temporary gear and down welling zones (Magnuson et al., 1990).

Concerning objects ingested by turtles, most commonly found are plastic bags and sheets (32.1%), followed by tar balls (20.8%) and plastic particles (18.9%) (Magnuson et al., 1990). Turtles also ingest a wide variety of synthetic drift items, including balloons, styrofoam and polyethylene beads, monofilament fishing line, aluminium foil, tar, glass, rubber, and heat-sealed tabs from beverage cans, although less than what was mentioned above (Plotkin and Amos, 1988; Magnuson et al., 1990).

Plastic bags and other kinds of white or transparent debris (e.g. styrofoam, PVC), are mistaken for jellyfish or other kinds of prey (Gramentz, 1988b). In addition, plastic covered with fish eggs or encrusting organisms, such as algae and bryozoans, may even "smell" or "taste" like authentic food items (O'Hara, 1988). It has been suggested, in fact, that hungry animals are less likely to discriminate between natural food and look-alike debris (Balazs, 1985).

Due to the slow gut passage time, which can last up to 6 months (Schulman and Lutz, 1995), ingestion of all these kinds of item can: cause intestinal blockage; release toxic chemicals; reduce nutrient absorption; cause gas accumulation in the large intestine; reduce hunger sensation; inhibit feeding and mating activity; diminish reproductive performance, cause suffocation, ulceration, intestinal injury, physical deterioration, malnutrition, and starvation (Mrosovsky, 1981; Wehle and Coleman, 1983; Wallace, 1985; O'Hara et al. 1986; Bryant, 1987; Farrell, 1988; Gramentz, 1988b; Welch, 1988; McGavern, 1989; Schulman and Lutz, 1995). Some plasticizers can concentrate in tissues, and toxic ingredients can cause eggshell thinning, tissue damage, and aberrant behaviour (Wehle and Coleman, 1983; O'Hara et al., 1986). Finally, there is strong evidence that in some turtles, ingestion of synthetic materials caused their death (Shaver and Plotkin, 1998; Bjorndal et al., 1994).

Main threats

Main threats

As a result of human activities, marine turtle populations have declined throughout the world in the past few decades.

In the Mediterranean they are affected by many different threats, which are grouped in this section according to the two environments where they spend their life: on land and at sea.

ON LAND

• Tourist development

The loss of nesting beaches due to the development of tourism is one of the main threats in the Mediterranean, where most of the coasts have been developed in the past few decades (Margaritoulis et al., in press). Buildings such as hotels, nightclubs, etc. near nesting beaches have a negative impact due to the consequential use of light, increase of human presence, vehicles, garbage, roads, and so on.

• Increased human presence

The use of developed nesting beaches by tourists or residents can have a negative impact on marine turtle nesting, incubation of eggs and hatchlings. The most common and serious case is the disturbance of nesting females (Margaritoulis, 1985; Demetropoulus and Hadjichristophorou, 1995), in fact nocturnal human activities on the beach can cause females to abort nesting, in particular during the initial phase (emergence from the sea through to egg-cavity excavation) (Carr and Giovannoli, 1957; Carr and Ogren, 1960; Hirth and Samson, 1987). Turtle-watch ecotourism groups affect the normal post-oviposition behaviour: females spend less time covering the eggs and camouflaging the nest site (Johnson et al., 1996). Pedestrian traffic on the beach can result in a lowered hatchling emergence success rate due to the compaction of sand above the nests (Mann, 1978). In addition, pedestrian tracks can disorient hatchlings crawling to the sea (Hosier et al., 1981; Witherington, 1999).

• Artificial lighting

According to extensive studies, artificial beachfront lighting has a negative impact on both female nesting and on hatchlings.

Adult green turtles avoid brightly-lit areas on nesting beaches (Witherington, 1986; Gerosa et al., 1995); in fact, a decrease in the number of nests was observed in brightly-lit areas compared to darker ones (Margaritoulis, 1985). In addition to lights emanating from buildings, there are other sources of light that might cause a negative impact affecting nesting behaviour, such as light from vehicles driven next to or on nesting beaches (Arianoutson, 1988; Witherington and Martin, 1996), torch lights, campfires, (Margaritoulis, 1985; Arianoutson, 1988), and camera flashes (Campbell, 1994).

Since visual response to brightness is the principal component of the sea-finding behaviour of emerging hatchlings (Witherington, 1995), artificial lighting can result in fatal disorientation. Hatchlings that have their sea-finding instinct disrupted by unnatural stimuli often die from exhaustion, dehydration, predation and other causes (Witherington and Martin, 1996). Some of the

Marine turtles appeared on the Planet 110 million years ago. But in the last 50 years human disturbances has brought this marine reptiles to the brink of extinction.

most notable cases reported are when hatchlings have been run over on roads (Irwin et al., 1998; Witherington, 1999; Gerosa et al., in press), entrapped in vegetation or debris (Yerly and Demirayak, 1996), and burned to death in the flames of an abandoned fire (Mortimer, 1979).

• Beach vehicle driving

Driving vehicles on nesting beaches during the night can deter female nesting and disorient hatchlings emerging from the nest (Magnuson et al., 1990). Driving directly above incubating eggs can cause sand compaction which might decrease the hatching success rate of the nest (Mann, 1978;). Furthermore, vehicle tracks on the beach can interfere with the ability of hatchlings to reach the sea (Witherington, 1999; Hosier et al., 1981). Additionally, vehicle traffic on nesting beaches contributes to erosion, in particular during high tides or on narrow beaches where driving is concentrated on the high beach and fore dune (Magnuson et al., 1990).

• Sand mining

Sand mining on nesting beaches can have an impact by changing the natural aspect of the beach and decreasing the possibility for a turtle to find a suitable place to lay eggs (Sella, 1982). Due to sand mining activities, mud areas can be found in some places, deterring turtle nesting (Yerli and Demirayak, 1996).

• Beach erosion

Erosion of nesting beaches can result in partial or total loss of suitable nesting habitats (National Maine Fisheries Service and U.S. Fish and Wildlife Service, 1991). Man's interference with the natural process through coastal development can accelerate erosion rates.

• Garbage on the beach

A considerable amount of debris such as plastic and glass objects, rubbish from hospitals and tar balls, found on nesting beaches, comes from the sea (Gerosa et al., 1996). Layers of debris have been found in the sand at different depths (Gerosa et al., 1995; Kasparek, 1995; Broderik and Godley, 1996); these can reduce space suitable for egg-laying on the beach (Gerosa et al., 1996) and deter hatchlings from emergence (Yerli and Demirayak, 1996). In addition to debris coming from the sea, there is also a great amount left on the beach by tourists frequenting the area (Gerosa and Casale, 1994).

• Recreational beach equipment

Recreational beach equipment such as lounge chairs, cabanas, umbrellas, canoes, small boats, etc. can be a physical obstacle which deters nesting attempts, interferes with incubation of eggs and hinders hatchlings crawling to the sea (Magnuson et al., 1990; Arianoutson, 1988; Witherington, 1999). Documentation on aborted nesting attempts near such obstacles is increasingly common as more recreational equipment is left in place all night on nesting beaches (Magnuson et al., 1990).

• Predation

Marine turtle nests can be attacked by different predators such as red foxes, jackals, dogs, feral hogs, etc. As these animals are able to find eggs buried in the sand and destroy many of the nests laid, (Demetropoulus and Hadjchristophorou, 1989; Brown and Macdonald, 1995; Margaritoulis et al.,1996a; Yerli and Demirayak, 1996; Broderik and Godley, 1996) they are becoming one of the principal threats to the nesting area (Aureggi et al., 1999). In addition, once a nest has been attacked, ghost crabs and birds may arrive to eat what is left (Aureggi and Gerosa, unpub. data).

Hatchlings just prior to or during emergence, or while crawling to the sea, are often attacked by predators (Broderik and Godley, 1996; Aureggi et al., 1999). Even adults coming ashore to lay eggs can be attacked by jackals (Peters et al., 1994; Macdonald and Brown, 1992) but only rarely has an attack by a domestic dog been recorded (Caldwell, 1959).

- Inundation

Marine turtle nests near the high tide line are at risk from inundation which can affect the hatching success rate of the nest. Sea storms can also reach turtle nests, flooding them (Magnuson et al., 1990; van Piggelen and Strijboch, 1993; Gerosa et al., 1995; Yerli and Demirayak, 1996;) and altering their hatching success.

AT SEA

- Incidental catch

The number of turtles incidentally caught in fishing gear has become one of the main threats in the world and in the Mediterranean. A review on the subject is in the book by Gerosa and Casale, 1999.

- Ghost gear

Equipment lost from and discarded from commercial fishing gear in the sea can have a negative impact on marine turtles. Such gear continue to catch and entangle marine life indiscriminately, causing injury, strangulation, starvation and drowning (see page xxx).

- Turtle exploitation

Turtle exploitation has a negative impact on the sea turtle population. It was common in the past in the Mediterranean (Sella, 1982; Argano et al., 1990), whereas now it is limited to a few countries of the Mediterranean (Mayol and Castello Mas, 1983; Grametz, 1989; Laurent, 1990; Laurent et al., 1996). Sometimes turtles are killed and eaten on board, especially when some of the crew regard the turtle as a delicacy (Panou et al., 1992; Gerosa and Casale, 1999).

- Boat collision

Collision with sea-going vessels can injure or kill turtles. The regions of greatest concern are those with a high concentration of boat traffic and turtles (Magnuson et al., 1990; Bentivegna and Paglialonga, 1998: Margaritoulis et al., in press).

- Pollution and marine debris

Ingestion of marine debris can have diverse negative effects on marine turtles (see page xxx). The effect of pollutants resulting from industrial, agricultural or residential sources is still difficult to evaluate. Since they need to swim near the surface to breathe, turtles can come across chemicals which provoke skin carcinogenesis (Lutz et al., 1986) and loss of function of the sense organs and of the salt gland, causing death (Lutcavage et al., 1995; George, 1997). The sea turtle's method of respiration, rapid inspiration of surface layer air before diving, would introduce petroleum vapour into the lungs, thereby reducing the growth of the animal (Lutcavage et al., 1997). Eating contaminated food or tar balls induces a decrease in the animal's breeding capacity and causes physiological problems (Lutcavage et al., 1997). In addition, tar sticks so well onto the turtle's body that it can induce immobility of the flippers and therefore prevent swimming (Gramentz, 1986; Basso, 1992). Pesticides, heavy metals and PCBs have been detected in sea turtles and eggs (Storelli et al., 1998a; 1998b; George, 1997; Godley et al., 1999; Storelli and Marcotrigiano, 2000). Recent studies also hypothesized that pollutants can affect the reproductive success of turtles (Aguirre et al., 1994).

- Underwater explosion

The use of underwater explosives can injure or kill turtles and may degrade or destroy their habitats (Margaritoulis, 1985; Arianoutsou, 1988).

- Predation

Predation of hatchlings and of young turtles is assumed to be significant in the sea whereas predation of adults is less common. Hatchlings entering the sea may be preyed upon by a wide variety of fishes and to a lesser extent by marine birds (Stancyk, 1982). Tiger sharks appear to be the main predator of adults and of juveniles (Stancyk, 1982). In the Mediterranean, the monk seal was also recorded as an adult predator (Margaritoulis et al., 1996b).

- Disease and parasites

There is little information available to assess the effects of disease and/or parasites on the marine turtle population. Only in the last few years have vets paid more attention to these species. Most reported diseases of sea turtles have been recorded in captive animals (Kinne, 1985). The only disease studied in detail is the fibropapilloma which has infected many specimens of different populations belonging to different species of sea turtle, with particular concentration among green turtles (Balazs, 1991; Herbst, 1994). In the Mediterranean no record of any cases of fibropapilloma has been recorded. Severe infestation by spirorchids (blood flukes) have been recorded in the loggerhead (Wolke et al., 1982).

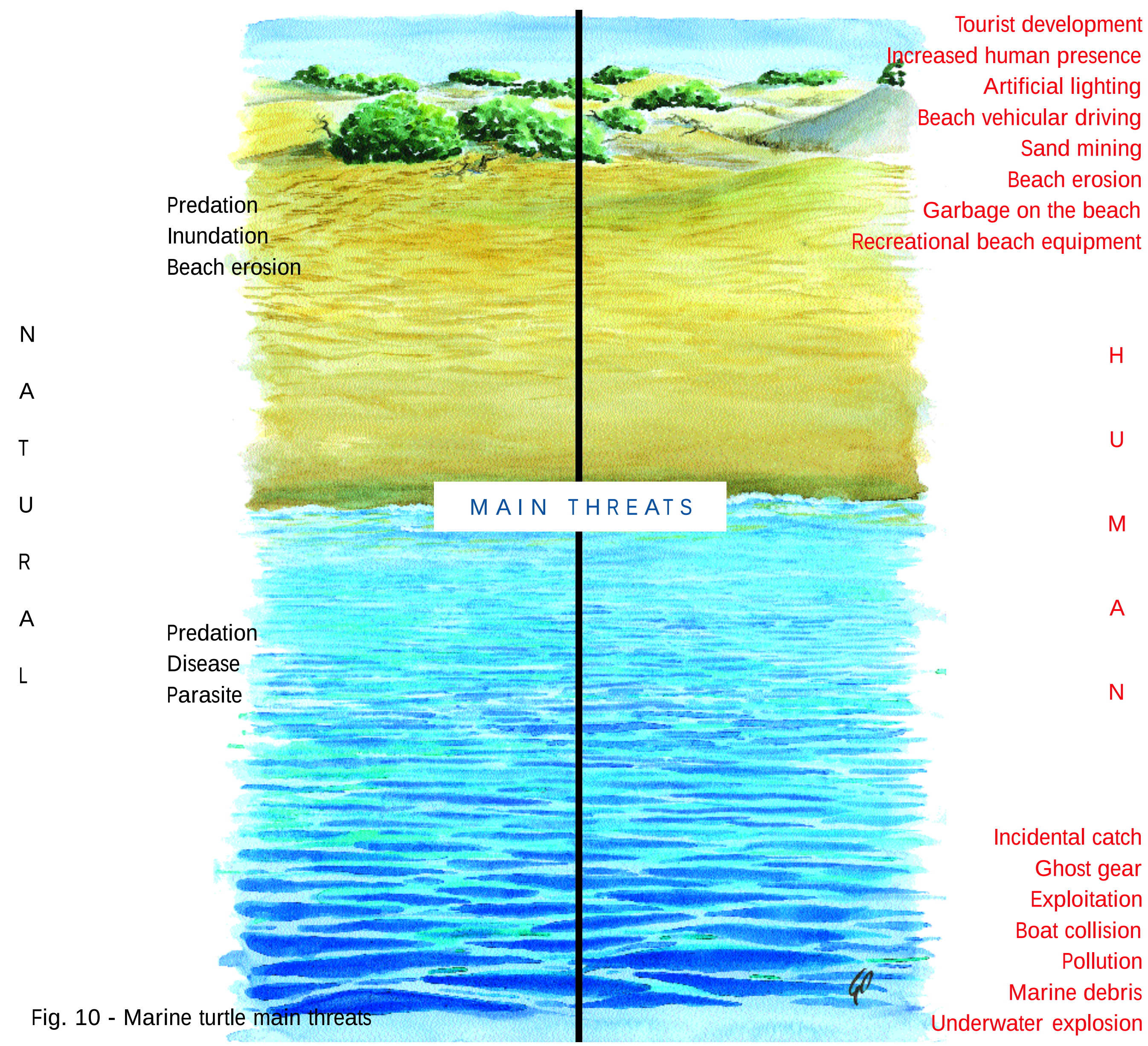


Fig. 10 - Marine turtle main threats

Fishing methods

In the Mediterranean Sea many different fishing methods are used. Comparing the updated fishing method lists proposed by FAO (Nédelec and Prado, 1990) with the bibliography concerning marine turtles, it can be concluded that the most common fishing methods that interact with these marine reptiles are placed in three categories: longlines, trawls, and gillnets.

At the moment it is not possible to assess the exact number of marine turtles incidentally caught every year in the Mediterranean, but some extrapolations exclusively concerning the longline show an alarming figure of 35,000 or more loggerhead turtles caught annually in the western and central Mediterranean (Panou et al., 1992), of which between 15,000 and 20,000 specimens, or more, were annually caught solely by Spanish fishing vessels off the Balearic islands (Mayol, 1986; Camiñas, 1988; Aguilar et al., 1995; Camiñas, 1997).

If estimations concerning other common fishing methods (in particular the gillnet, about which there is still no data available) are added to these numbers, it is evident that the interaction between sea turtles and fisheries is one of the most urgent problems that must be solved to ensure the survival of sea turtles in the Mediterranean (Tab. xxxx). A description of the main fishing gear and a review of the interaction of marine turtles with fisheries in the Mediterranean is found in Gerosa and Casale (1999).

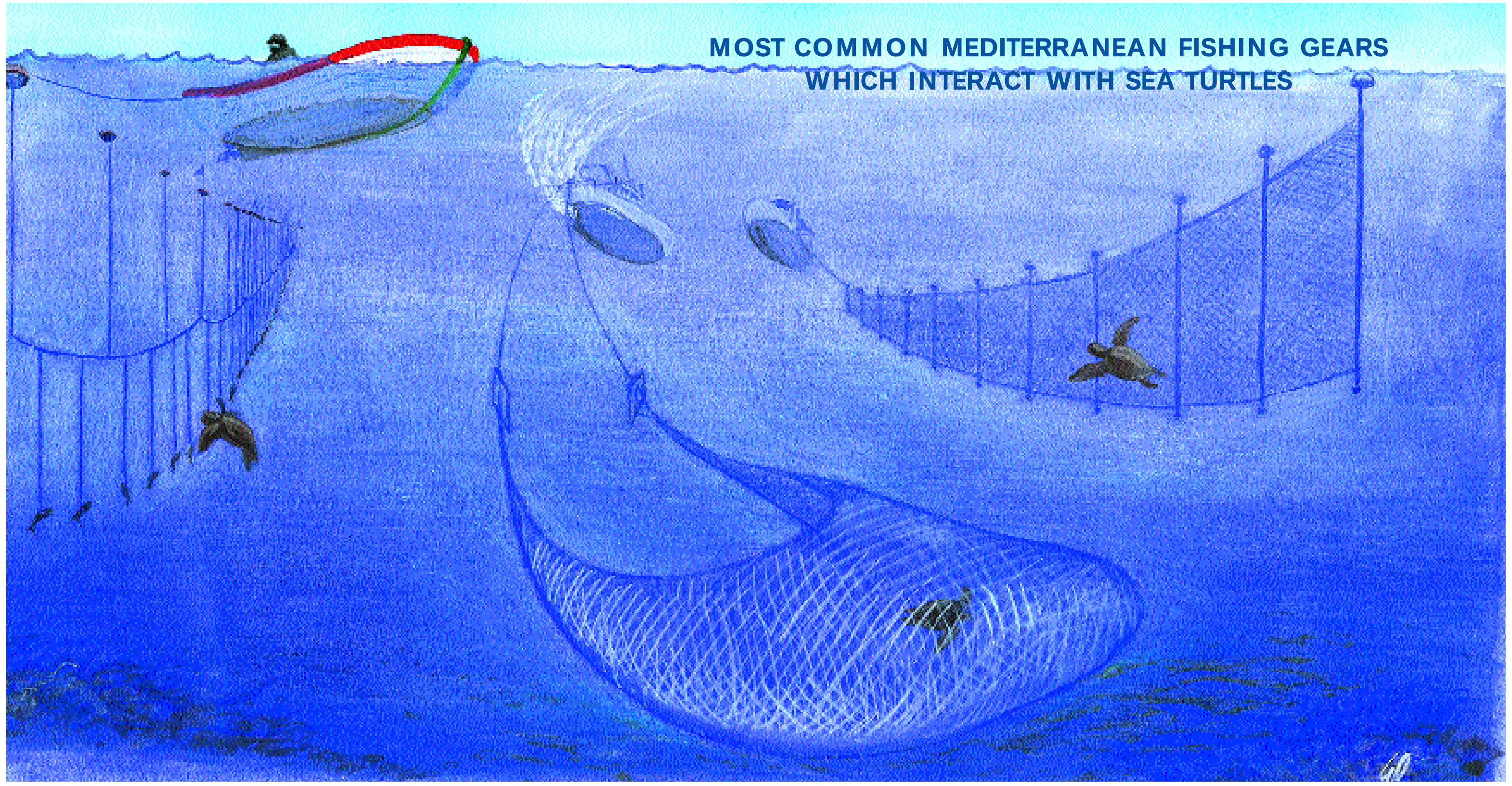
Although it is not possible at the moment to prevent with the mortality caused by the fishing gear (about 10% for longlines; low for trawls; more than 50% for gillnets (Gerosa and Casale, 1999)), the probability of marine turtles surviving from the moment of their capture to that of their release (time during which fishermen are in contact with the animals) can be increased.

The aim of this manual, in fact, is to provide fishermen with simple methodologies in order to reduce direct and indirect mortality of sea turtles, in particular mortality due to incorrect handling of turtles caught at sea. In this way, fishermen, aware of their primary role, will be able to contribute to marine turtle conservation, thereby reducing the rate of indirect mortality. It is hoped that a better knowledge of sea turtles could reduce the consumption of turtle flesh, the illegal sale of sea turtle shells and the unjustified killing of sea turtles, which are often causes of death based on scant knowledge, prejudice and some old traditions that are still present in some Mediterranean localities (Argano et al., 1990; Laurent et al., 1996; Godley et al,. 1998b; Kopsida et al, in press).

Table 2.

Estimation of incidental capture of marine turtles and direct mortality in Mediterranean fisheries (sources: Laurent, 1998; Gerosa and Casale, 1999)

Fishing method	Country with available data	Annual number of capture	Direct mortality (%)
Longlines	Algeria, Greece, Italy, Malta, Marocco, Spain	300 - 35,637	0.4 - 16.7 24.4 (delayed)
Trawls	Croatia, Egypt, France, Greece, Italy, Spain, Tunisia, Turkey	low - 4000	0.0 - 10
Gillnets	Croatia, Cyprus, France, Italy, Turkey	low - 625	10.0 - 100



LONGLINES

Longlines consist of a main line, sometimes of considerable length, to which snoods with baited or unbaited hooks are fixed at regular intervals. The main line is set either near the seabed or in mid-water or near the surface. The longline bases its capture capability on the likelihood of a hook meeting a specimen of the target species.

TRAWLS

Trawls use a net consisting of a cone-shaped body, closed by a bag and extended at the opening by wings. The net is trawled by one ship or more, and is an «active» fishing gear in that it catches all the animals in its path, collecting them in the terminal bag. According to type of trawls are used either on the seabed or in mid-water.

GILLNETS

Gillnets are nets placed vertically so that they fence in or block off areas of water and catch every marine organism bigger than the mesh which tries to pass through it. Although they are considered «passive» fishing gear, as far as turtles are concerned gillnets could be judged «active» because their catch may be attractive to turtles.

Ghost gear

The worldwide estimation of the losses and / or discard of commercial fishing gear or of parts of this gear indicate values between 1,350 and 135,000 metric tons of materials left in the oceans of the world (Merrell, 1980; Welch, 1988). The wide gap (nearly two degrees of magnitude) of this published data underlines the difficulty of this kind of survey and the scarcity of data available about this matter. Also, it is difficult to distinguish whether the death was caused by “ghost gear” or by operative fishing gear.

Even though there are different types of “ghost gear”, they all continue to catch and entangle marine beings indiscriminately (Magnuson et al., 1990). In addition to this, the plastic debris (ghost gear included) generally tends to be concentrated along coastlines (O’Hara, 1988) where there is a high probability of catching sea turtles.

The worst “ghost gear” seem to be those from gillnets. Remaining in the water for an unlimited time and subject to no control, they continue to be attractive to carnivorous marine turtles (such as Caretta caretta), which find caught fish an easy source of food (Ehrhart et al., 1990; Gerosa and Casale, 1999). The monofilament fishing lines (belonging to pelagic longlines) lost by vessels are the most common type of debris to entangle turtles (O’Hara, 1988). It is common, in fact, to find entangled sea turtles belonging to different species (Balazs, 1985) even if the entanglement may result from random encounters with this gear. Less dangerous seems to be the entanglement caused by trawls’ “ghost gear”. In fact, this method does not have a mesh size that allows sea turtle entanglement and it is generally weighted by leads that hold the net at the bottom of the sea. In addition to this, the high cost of this gear does not encourage the abandoning of it and its loss is generally due to its being broken on natural or artificial obstacles met at the bottom of the sea during fishing. According to some authors, 68% of all cases of sea turtles entangled are due to “ghost gear” catches (O’Hara and Iudicello, 1987).

The consequences caused by this fishing debris are very serious. In some cases sea turtles are only injured but in most cases the effect is fatal, causing strangulation, starvation or drowning (Carr, 1987; Laist, 1987; McGavern, 1989; Gregg, 1988)

LONGLINE

• Caught species and size

Use of longlines is a fishing method which may lead to the incidental capture of different species of marine turtle (Gerrior, 1996). The most frequently captured species of Mediterranean marine turtle is the Caretta caretta, either because of its food habits (see page xx) or because there are more specimens in the basin. The common bait, almost exclusively animal, attracts specimens of Caretta caretta and then catches them with the hidden big hooks that areup to 11 cm. long (De Metrio et al., 1983).

As far as turtle size is concerned, this method is apparently selective, due to the different size of hooks used. In particular, longlines seem to catch a high proportion of specimens with over 50 cm. Carapace Curve Length (CCL) (Gerosa and Casale, 1999).

• The hooks

The hook is a simple but efficient tool for catching fish and during the past has undergone very few changes regarding its shape and the materials from which it is made.

The size of hooks used by professional fishermen ranges from 8 to 11 cm. (De Metrio et al., 1983) and they are generally made of iron. Despite the high cost, as observed on Japanese longlines operating in international Mediterranean waters (Gerosa and Casale, 1999), steel hooks are being more frequently used instead of iron hooks.

The number of hooks used by each ship is variable: from longlines 20 km. long with 800-1000 hooks (De Metrio et al., 1983) to ones 60 km. long with 2400 hooks (Aguilar et al., 1995).

• Cutting the line

One of the most common and easiest methods used by a longliner is to cut the line holding the turtle and to immediately release the turtle back into the sea. This method, which is suggested in this manual, requires further details which can increase the chance of the turtle's survival.

The line has to be cut when hook removal is believed to be dangerous (both for the turtle and for the person who has to handle it) or impossible (see page xxx) and it is appropriate for all different kinds of hook and for any hooked position on the turtle's body.

If the turtle is, for example, big and heavy and it cannot be brought on board, the best method is to cut the line as close to the animal as possible, leaning from the boat if necessary. If the turtle can be brought on board, after having put it on the deck and having established that the hook cannot be removed (see page xx), the best method is to cut the line as close to the beak or eye of the hook (if visible) as possible.

Before cutting the line, keep a gentle, consistent tension of the line in order to avoid over-pulling, which could cause internal damage to the turtle. In this way, the hook will be inside the turtle's body and the part of the line left will be ingested. According to some reported experiences, iron hooks can gradually dissolve in salted water; furthermore, these same experiences report that a turtle is even able to bear many hooks (Argano et. al., 1992).

On the other hand, other studies have stated that 28.9% of turtles with hooks inside die immediately after being released (Mas and Garsia, 1990; Aguilar et al., 1995).

Therefore, it is recommended that fishermen continue using iron hooks rather than steel ones, as the action of salty water swallowed dissolves the iron hooks more easily, whereas the steel hooks remain unaffected for a long time.

As far as the ingested part of the line is concerned, there are several reported cases of death due to the action of the line on the gut function (Bjorndal et. al., 1994). If the line is cut short, it could increase the chance of the turtle's survival. In fact, there are several cases in which turtles have been able to expel the hook and attached line (Mas and Garsia, 1990).

• The importance of line retrieval by hand

The use of longlines can still be considered an artisan fishing method. Most of the longline ships are generally small or of medium size and they are managed at domestic level. New technologies were introduced a few years ago in order to provide help in this hard, repetitive method. One example is the introduction of line reels on board which help fishermen in the main line retrieval process. The consequent saving of time and energy has meant the introduction of longer lines with more hooks, which increases the productivity of this method.

As far as turtles are concerned, the increased speed of retrieval of the lines and the loss of the much more sensitive retrieval by hand, have increased damage to the incidentally-caught turtles.

As it is not possible to modify the turtles' attempts to get free from the hooks and the consequent damage, the only way to intervene is to keep fishermen always on the alert once the turtle is hooked. In fact, once the turtle is seen, the main line reel must be stopped, the vessel slowly steered towards the turtle keeping an eye on the branch line at all times, and then retrieval of the turtle on

LONGLINES

Scan the main line as far ahead as possible in order to sight turtles in advance.

Immediately upon sighting the turtle:
* reduce both vessel and main line reel speed
* steer the vessel towards the turtle
* minimise tension on both the main line and the branch line with the turtle

Once the branch line containing the turtle is in your hands, put the engine in neutral and pull in the turtle manually until it is brought alongside the vessel.

If the turtle is DEAD
- The best thing to do is to bring the turtle into the harbour, store it in a freezer, and then give it to the competent Authority. Leave any entangled hooks or line in place
- If it is not possible to keep the dead turtle on board, return it to the sea, after removing any entangled line and visible hooks

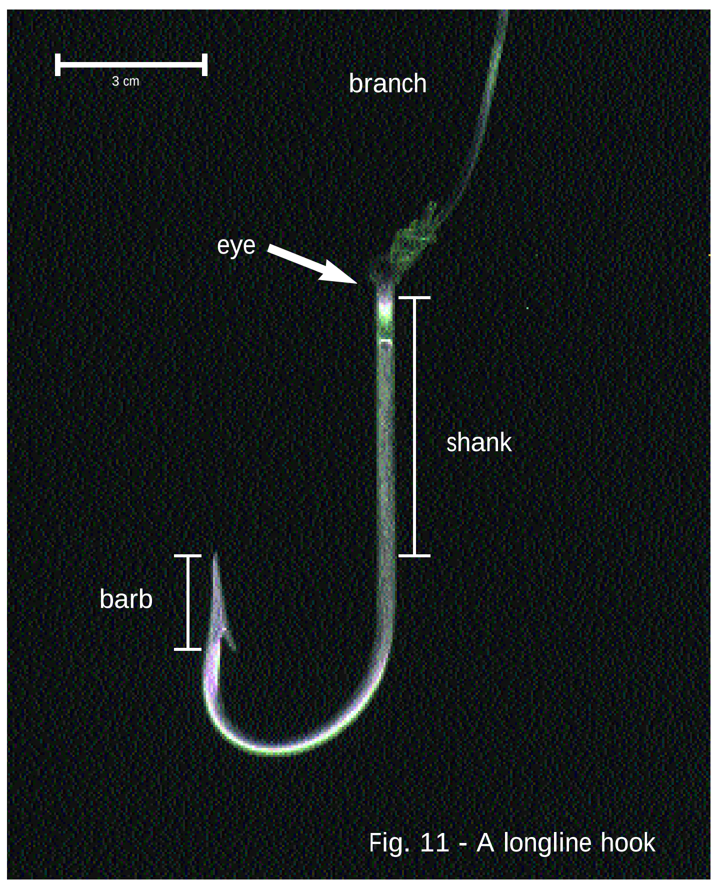
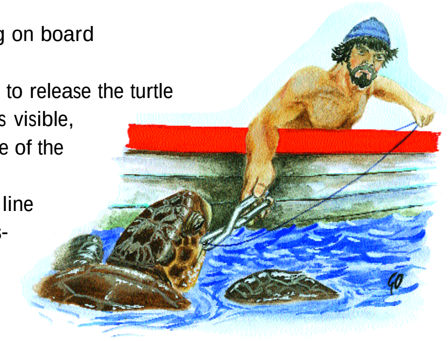


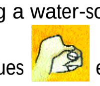
Fig. 11 - A longline hook

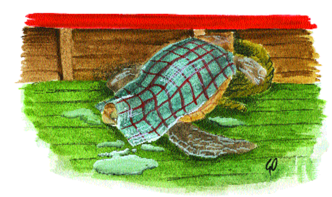
If the turtle is too large to bring on board
- Stop the vessel
- If entangled, remove the line to release the turtle
- If hooked, and if the hook is visible, cut the line as close to the eye of the hook as possible
- If hooked internally, cut the line as close to the beak as possible
- Check that the turtle has swam safely away before starting up the vessel



If the turtle can be taken on board
Use a dip net or hold the turtle by the side of the carapace or by the flippers. Do not use the line to which the turtle is hooked, any sharp objects or gaffs to take the animal on board

After assessing the turtle's condition  follow the instructions below:

If the turtle is NOT ACTIVE
Keep the turtle on board and:
- look for a shady and out-of-the-way place
- raise the hindquarters of the turtle about 20 cm off the deck
- keep it damp using a water-soaked towel. Do not place the turtle in a container holding water
- repeat the techniques  every two hours until the turtle responds to at least one of them, for up to 24 hours
- if the turtle reacts to one of them, it can be considered INJURED. Leave it on board for a few hours, then follow the suggestions on the next page
- if there is no response or if the response is undetectable, after 24 hours the turtle can be considered DEAD



board by hand can begin. It is necessary to highlight the fact that this latter phase of turtle retrieval is very delicate. Turtles have a strong reaction to artificial light (in case of night fishing) and this might cause further damage to the animal while it is trying to escape.

• Hook removal

Fishing hooks generally cause damage to the turtles which cannot be immediately assessed (Aguilar, 1995).

If the turtle is hooked externally, on its body or in the mouth, the case can be considered the least harmful to turtles. As a matter of fact, in these cases it is possible to remove the hook without causing serious damage to the turtle.

However, it is more common that the hook is completely ingested by the turtle, ending up hooked in the upper intestinal track, especially in the oesophagus. In this case, hook removal becomes much more complex, as is the handling of the hook itself.

Hook removal from a turtle (including from the mouth) has to be considered a delicate procedure that requires veterinary tools and skills (Walsh, 1999). Anyway, there are cases where it is better to remove the hook even if work conditions are not ideal (such as on board) and the people involved are not specialized, but it is advisable to think carefully before attempting to remove the hook. All the removal phases have to be carefully carried out and the procedure immediately interrupted if difficulties crop up.

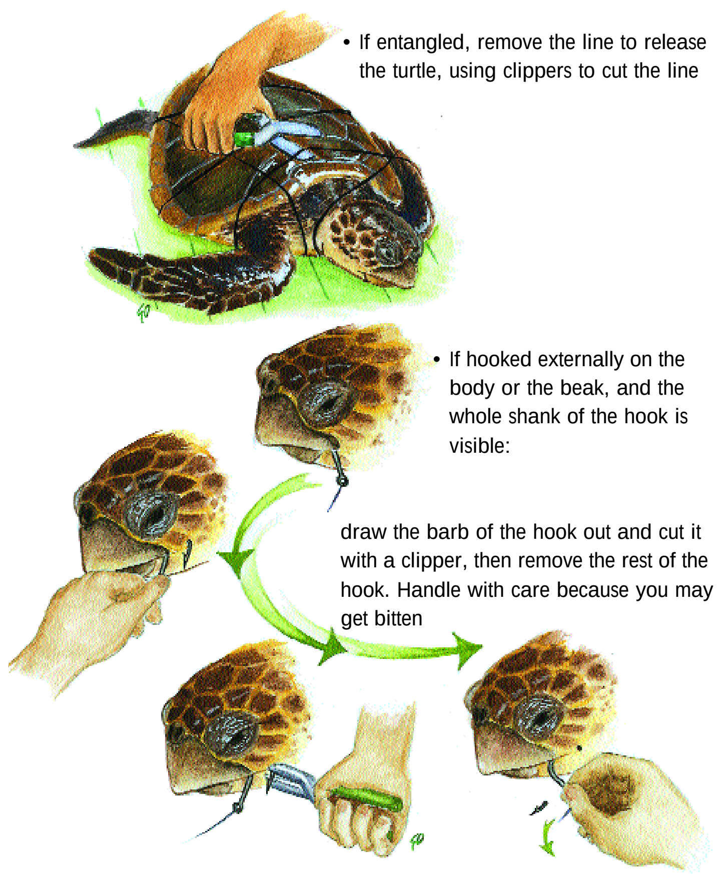
The advantage of early hook removal is the prevention of further injuries and infection induced by the presence of the hook inside the body (Balazs et. al. 1995).

If the turtle is hooked externally (flippers, neck, tail) it is suggested that the hook be removed in any case, unless it is near vital parts such as eyes, nose or cloaca.

If only part of the hook is visible from the mouth, it is not always advisable to operate. In fact, not all partially visible hooks can be considered safely removable. Apart from all the different eventualities, it is worth highlighting that only the hooks with the whole shank visible are considered removable

LONGLINES

If the turtle is HEALTHY or INJURED



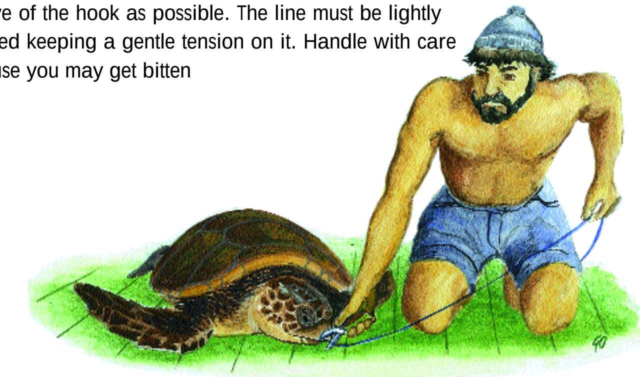
and that in all other cases the line should be cut as described in the paragraph "cutting the line" (see page xx).

The position of the hook is also important. For example, if the rotating action required for hook removal may damage any vital organ (eye or nose), it is better not to remove the hook.

If the turtle is hooked inside the mouth, in order to find out the hook's position; stimulation of the turtle is suggested to let the animal open the fauces and reveal the hook. Being careful of the turtle's reaction, it is possible to induce the animal to open its mouth with mechanical stimulus on the cheek (near the beak) or by carefully tapping the anterior part of the beak with a soft object.

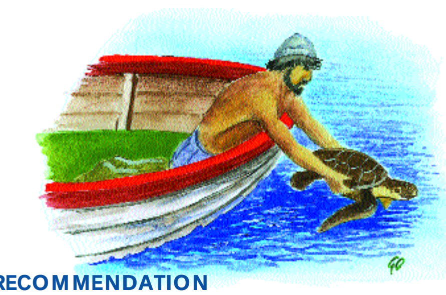
Being careful not to get bitten by the turtle, hook removal can be started by handling the shank of the hook. If there are more than one pair of pliers on board, it may possible to retrieve the shank of the hook with one of them. Firmly holding it bet-

• If the shank of the hook is partly visible or not visible, cut the line as close to the eye of the hook as possible. The line must be lightly handled keeping a gentle tension on it. Handle with care because you may get bitten



Return the turtle gently to the sea, head first, vertically, over the stern of the boat:

• with vessel in neutral gear
• without dropping the turtle on the deck



RECOMMENDATION

• If you have a Log Book remember to record any information about the turtle caught
• Remember to respect the provisions of the law concerning this fishing method

ween the thumb and index finger (or between the jaws of the pliers), rotate it towards the fluke of the hook, pushing it outside. As soon as the hook barb is out, keep on rotating strongly until the barb of the hook is completely out. Then cut the barb of the hook using pliers. In this way the hook has no more obstacles and it can be easily removed, rotating in the opposite direction, back to the beginning.

During the removal procedure, sanitary regulations must be considered as absolutely essential. Besides rigorously respecting the smoking prohibition while handling an animal or being close to it, the best thing to do is to use a disinfectant or an antiseptic solution both for hands and tools. As an alternative, a thorough cleansing with soap is essential.

It is important when dealing with fishermen to stress the fact that turtles are animals that bite as their unique defence in order to avoid bad experiences with the sharp beak of the turtle. Anyway, the limited mobility of the neck of the turtle is a safety guarantee for those who handle the turtle at an adequate distance from the mouth. Last but not least, it is always necessary to be careful with the hands when removing the hook, bearing in mind that the animal could feel pain during this procedure.

• Entangled specimen

Even if it can be considered a rare event, the longlines may entangle a turtle.

Entangled animals have been found in both the mainline and the branches of it (Ogren, 1994; Gerrior, 1996; Witzell, 1996). Although an entangled turtle generally does not show signs of external serious injuries, the fact that it has been captured means that it has been unable to dive because it has not breathed. This can weaken and, ultimately, kill the turtle. In the worst case, an entangled live turtle can be externally or internally hooked and therefore the first action should be to release the turtle from the line. The use of clippers is advised because the line is usually made of strong material.

TRAWL

• Caught species and size

The most common type of trawl used in the Mediterranean is the bottom trawl. As this method fishes exclusively at the bottom of the sea, turtles are caught (except for the leatherback, which is pelagic) more because of their size rather than their species.

The carapace length of the specimen caught with the trawl is typically over 40 cm. approximately (Kontos and Webster, 1985; Laurent et al. 1996; Laurent, 1996; Margaritoulis et al., in press) and it is probable that the low number of small specimens found represents the ones in transit from the pelagic to the demersal stage (Gerosa and Casale, 1999).

Bringing a turtle on board

• Longline

A turtle caught by either trawl or gillnet is generally entangled externally, whereas with longline the turtle is generally hooked and may have ingested the hook and part of the mainline. Fishermen are used to bringing on board the catch, pulling the branch line by hand, and if the catch is too big they may use sharp objects or gaffs. This habit should be avoided in all cases. If the turtle is lifted by pulling the branch line to which it is hooked, the weight of the animal can cause further damage to the internal organs so that its chance of survival would sharply decrease. In addition, the use of sharp objects or gaffs would cause new injuries, which could kill the turtle.

The best way of retrieving a turtle on board would be to use a dip net of adequate size. Remember that it is better to handle the turtle gently while placing it on the floor of the boat and then setting it free from the meshes of the dip net. In cases where a dip net is not available, it is advisable to take the turtle by hand. In decreasing order of safety, the best place to hold the animal is as follows: by the carapace; by the front flippers (as close to the axilla as possible) and by the rear limbs (as close to the carapace as possible).

TRAWLS

- Once the net is on board, try to spot the turtle in the terminal bag
- Always put the trawl down on the deck before opening and emptying it
- Separate the turtle from the rest of the catch and by-catch

After assessing the turtle's condition ? follow the instructions below:

If the turtle is HEALTHY or INJURED

Return the turtle gently to the sea, head first vertically, over the stern of the boat:

- with vessel in neutral gear
- with the net not trawling
- without dropping the turtle on the deck

• Trawl

Turtles are usually brought on board together with the net and the crew generally do not realise that turtles are present until the net is on the deck. Even if the fishermen cannot see the turtle until that moment, it is advisable to follow some precautions.

The most important safety measure is clearly the method of emptying the net. On many trawl ships the net is usually opened from a considerable height from the floor of the deck. In this way, the turtle could be damaged, because it will drop on the deck and it may get injured (landing on its head in the worst cases). It is therefore advisable to open the terminal bag once it is over the deck, so as to avoid dropping the turtle.

As happens with every kind of net-fishing, in the trawl, the turtle could be found entangled in the net and therefore it is advisable to proceed with care in order to release the animal back into the sea.

If the turtle is NOT ACTIVE

Keep the turtle on board and:

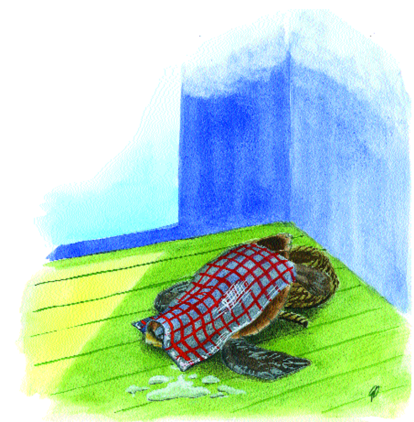
- look for a shady out-of-the-way place
- raise the hindquarters of the turtle about 20 cm off the deck
- keep it damp using a water-soaked towel. Do not place the turtle in a container holding water
- repeat the techniques every two hours until the turtle responds to at least one of them, for up to 24 hours
- if the turtle reacts to one of them, it can be considered INJURED

Leave it on board for a few hours, before releasing it

- if there is no response, or if the response is undetectable after 24 hours the turtle can be considered DEAD

If the turtle is DEAD

- The best thing to do is to bring the turtle into harbour, store it in a freezer, and then give it to the competent Authority
- If it is not possible to keep the dead turtle on board, return it to the sea



RECOMMENDATION

- If you have a Log Book remember to record any information about the turtle caught.
- Remember to respect the provisions of the law concerning this fishing method
- Refrain from trawling near turtle nesting beaches during turtle nesting season
- Limit trawl shots to less then ninety minutes in areas of high turtle density

• Gillnet

The efficiency of gillnet captures is based on the capacity to entangle a specimen and on the ability to hold it until the net is retrieved by fishermen.

For these reasons, when a turtle is entangled in the net, it is generally found with skin injuries due to its attempts to break free. Before taking the turtle on board, as is described in the 'Longline' paragraph, it is absolutely necessary to set the turtle free from the net that has entrapped all or part of its body.

The use of clippers is recommended in order to facilitate turtle release .

Release of the turtle into the sea

Release of a turtle, both healthy and injured, has to be done carefully.

Before proceeding with its release it is necessary to put the engine of the vessel into neutral gear and ensure that the fishing gear is not being used. Once released, since the turtle swims away in any direction, following these two simple precautions will ensure that the turtle will not get injured by the vessel's propeller or by the fishing gear. It is also recommended that before release, a check is made that there are no fishing vessels working nearby so that the animal is not recaptured by other nets.

The best way to release the turtle is to gently return the animal with the plastron over the surface of the sea with the head first (Balazs et al., 1995).

The best place to return the turtle into the sea would be from the stern, or if possible from the cut-out door, so that the turtle is directed in the opposite direction of the vessel's route, thereby avoiding a collision with the vessel. The majority of professional vessels do not have a cut-out door and the deck is generally a few meters from the surface of the sea. In this case the turtle has to be released with the head vertically facing the sea, avoiding a strong impact of the plastron with the sea water.

The releasing phase ends with observation of the turtle's behaviour in the water. It is necessary to be sure that the turtle has gone safely away before starting the engine.

Cold-stunning

Cold-stunning is a particular condition of a not active turtle. It is the commencement of freezing which affects the extremities, eyes, or neck, which may be partially frozen and the limbs may become stiff (Sadove et al., 1998). This case is quite rare in the Mediterranean.

Cold-stunning occurs when the water temperature is approximately 10° C, while a further decrease in temperature to 5 – 6°C could cause death of the animal (George, 1997).

Specimens in this particular physiological condition are not easily caught by traditional fishing methods because they reach the surface of the sea and they float without moving (looking dead). Juveniles can reach the cold-stunning stage faster than adults (George, 1997).

GILLNET

• Caught species and their dimensions

As far as marine turtles are concerned, this fishing method is selective neither for species nor for size of caught specimens.

The gillnet is a fishing net which is placed vertically so that it fences in or blocks off areas of water and catches every marine organism bigger than the mesh size which tries to pass through (UNI, 1981). Gillnets could be considered to be passive fishing gear: turtles are caught by chance, as they move from place to place. However, according to fishermen (Panou et al., 1992), turtles actively try to feed on fish entangled in the trammel net, damaging even the gear, suggesting that this kind of net could constitute active fishing gear because it can attract turtles, increasing the probability of their being caught (Gerosa and Casale, 1999).

If placed near marine turtle nesting sites, it could even catch hatchlings which have just emerged (Margaritoulis, 1995; Haddoud and El Gomati, 1997;Baran and Kasparek, 1989; Aureggi and Gerosa, unpub. data).

Turtle on the deck

• Healthy or injured turtles

Healthy or injured turtles brought on board generally start crawling on the deck as soon as they are free to do so. It is advisable both for the safety of the animal and the fishermen to always keep the turtle under control. Once the procedures suggested in this guidebook are completed, it is essential to release the animal into the sea as soon as possible.

• 'Not active' turtles

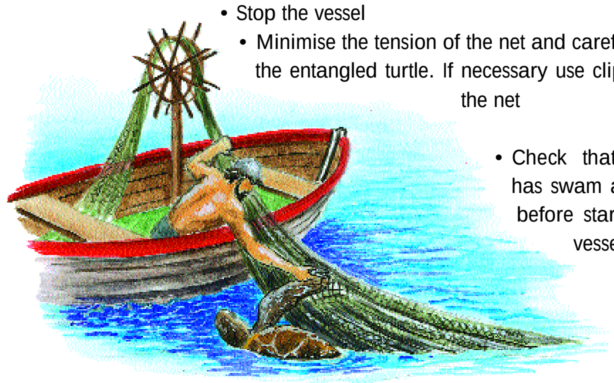
The state of 'not active' turtle clearly shows that the health condition of the animal is critical. These specimens must be carefully handled in order not to cause further damage to them. However, this operation is not dangerous for the fishermen.

Once it is assessed that the turtle is in the not active condition, further procedures have to be followed in order to allow to the animal to revive.

GILLNETS

• Scan the net as far ahead as possible to spot turtles as early as possible
• Immediately upon sighting the turtle reduce the speed of the net reel and carefully pull in the net

If the turtle is too large to bring on board



• Stop the vessel
• Minimise the tension of the net and carefully remove the entangled turtle. If necessary use clippers to cut the net
• Check that the turtle has swam away safely before starting up the vessel

If the turtle can be taken on board

• Carefully set the turtle free from the net.If necessary use clippers to cut the net
• Hold the turtle by the side of the carapace or by the flippers. Do not use any sharp objects or gaffs to retrieve it

1. Choose a place

The most important phase concerns the choice of the place where the not active turtle will be kept for such a time (up to 24 hours) as suggested by experts. It would be better to advise fishermen to decide in advance so that all the crew will agree and will be aware of the place chosen on board.

The selected place has to be out of the area generally used during fishing. It must be shaded and it must give a solid support to the turtle, so that the animal will not fall down due to the rolling and the pitching of the boat.

2. Sloping position

One of the most common injuries that occur to caught turtles is the ingestion of sea water into the lungs which may lead the animal to start drowning. In order to allow the sea water to drain out of the lungs, it is necessary to put the animal with its hindquarters lifted higher than the forepart of its body.

After assessing the turtle's condition  follow the instructions below:

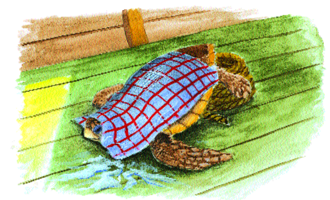
If the turtle is HEALTHY or INJURED

Return the turtle gently to the sea, head first, vertically, over the stern of the boat:

• with vessel in neutral gear
• with the net not in the water
• without dropping the turtle on the deck

If the turtle is NOT ACTIVE

Keep the turtle on board and:
• look for a shady and out-of-the-way place
• raise the hindquarters of the turtle about 20 cm off the deck
• keep it damp using a water-soaked towel. Do not place the turtle into a container holding water
• repeat the techniques  every two hours until the turtle responds to at least one of them for up to 24 hours
• if the turtle reacts to one of them, it can be considered **INJURED**. Leave it on board for a few hours before releasing it.
• if there is no response, or if the response is undetectable after 24 hours, the turtle can be considered **DEAD**



If the turtle is DEAD
• The best thing is to bring the turtle into harbour, store it in a freezer, and then give it to the competent Authority
• If it is not possible to keep the dead turtle on board, return it to the sea

RECOMMENDATION

• If you have a Log Book remember to record any information about the turtle caught.
• Remember to respect the provisions of the law concerning this fishing method
• Refrain from fishing near turtle nesting beaches during turtle nesting season

The slope depends on the size of the turtle, so that the bigger the turtle's dimensions the higher its position should be. As a general rule: a turtle of mid size (50 cm. carapace length) should be put with the hindquarters about 30 cm. from the ground. On the other hand, a sharply sloping position could prevent the turtle from correct breathing, which is not ideal for a turtle that is attempting to revive.

Embolia seems generally not to be a problem for marine turtles thanks to their particular physiological adaptations (see page xx). The methodology described earlier is a further guarantee for the turtle to release possible air bubbles present in the hindquarters of the turtle, thus saving the brain from possible damage.

3. The importance of shade

As mentioned before, it is essential to keep the turtle in a shaded place.

The direct irradiation of the sun would increase the body temperature of the animal, causing further damage. The ideal temperature to help the turtle revive should be between 25°C and 30°C. Temperatures below 25°C notably increase recovery time and temperatures above 30° C may approach the critical maximum (Stabenau et al., 1993).

At the same time, excessive skin transpiration, which would not be compensated by hydric recovery, could dehydrate, the turtle adding further physiological stress to the existing problems. The use of a dampened towel to cover the body, head included, will reduce the loss of water, creating a dampened micro-habitat.

It is worth reminding the people in charge of keeping the turtle under observation to regularly add sea water to the towel until the towel is saturated.

The water must be put on the upper part of the carapace so that the head and eyes are always damp. In fact, due to their form and to the presence of the salt gland, the eyes are the part of the body most sensitive to dehydration.

4. 24 hours on board

As is noted in different parts of the Guidebook, the ideal time to keep a turtle on board, with its hindquarters lifted higher than the forepart of the body, is recommended by many experts to be up to 24 hours (Balazs et al., 1995). If, during these hours, the turtle does not respond to at least one of the recovery techniques (see page xx), it can be considered dead.

In order to assess any possible sign of the animal's revival, regular checks are essential, during which sea water has to be added to the towel and the recovery techniques applied at least every two hours.

When the turtle cannot be kept on board for up to 24 hours, there is not enough time to judge if the animal is dead or not. In these cases, if it is possible, bring the turtle to the closest harbour and give it to the competent Authority, indicating the time that the turtle has already spent on board. If this is not possible, apply the recovery techniques for the last time and then release the turtle into the sea.

From 'not active' to injured

As a consequence of the assistance given to the turtle, it might show slow activity (movement of the pectoral and pelvic muscles, a slight moderate head lift, hyperventilation, significant increase in heart rate, movement of the flippers) (Balazs, 1986; Stabenau et al., 1993) or it might react to at least one of the recovery techniques (see page xx), showing the first signs of revival.

If the animal does not move from its position or does not show discomfort, it is best to leave the turtle until it is able to move its flippers and change its position. Although an animal that revives after this treatment can be considered injured, its release into the sea is advisable only after a few hours have elapsed in order to give the turtle the opportunity to recover and to recuperate its physiological functions for its life in the sea.

ASSESSMENT OF TURTLE'S CONDITION

The methodology that has to be carefully followed to operate on a marine turtle depends on the health conditions of the animal. Applying simple techniques, this Guidebook aims to provide fishermen with skills that allow them to decide if the animal is healthy, injured, not active or dead.

The latter category is herein described in a separate paragraph, whereas all the others are included in this section.

Once the turtle is on board and it is on the deck with its plastron on the floor, it is necessary to start observing its behaviour.

The first clues that allow evaluation of the turtle's condition concern its capacity of making crawling movements and strong head lifting when breathing but it is not uncommon to find an animal that lies without moving or breathing for some minutes; therefore, it is necessary to follow the instructions below, in order to assess its condition.

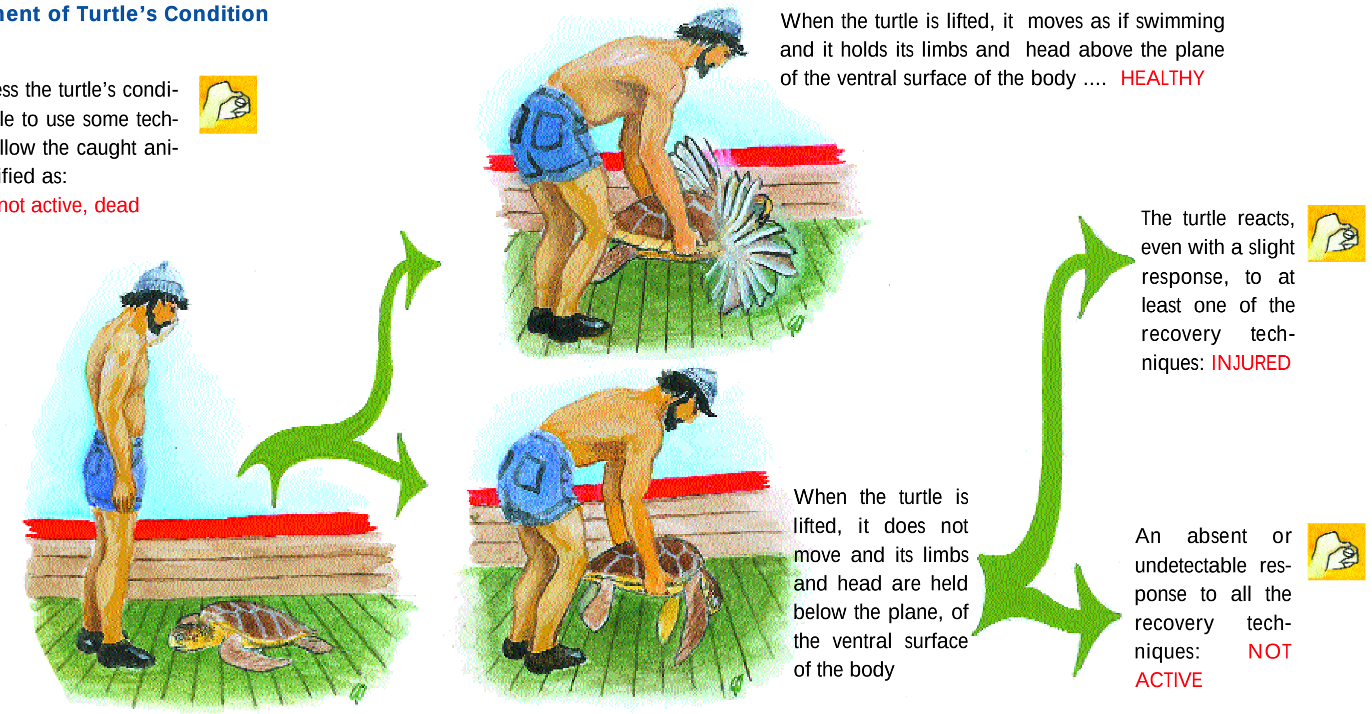
Firstly it is necessary to determine whether it is possible to lift the animal. If so, assuming a crouched position behind the animal, hold both sides of the carapace in the central part (firmly with your hands), then lift the animal horizontally to about 30 cm. from the floor. Approaching and lifting the animal from behind avoids your getting bitten by the turtle. While lifting the animal, remember to keep your back straight and to lift the weight of the animal whilst bending your legs. If the turtle is lifted to more than about 30 cm., its safety could be at risk because if the animal were dropped on the floor it could get injured.

When a healthy turtle is lifted, it reacts with strong swimming movements. The flippers' movements could hit your hand, but they are usually not strong enough to cause injury or pain. On the other hand, a turtle not in good condition (injured or not active), does not move when lifted, and its limbs and head are mostly held below the plane of the ventral surface of the body (plastron). Once this test is concluded, place the turtle carefully on the ground.

In order to distinguish the injured condition from the not active one, it is necessary to apply the recovery techniques (see page 40).

Assessment of Turtle's Condition

* In order to assess the turtle's condition it is possible to use some techniques which allow the caught animal to be classified as: healthy, injured, not active, dead



HEALTHY
* The turtle lifts its head strongly when breathing.
* When a flipper is pulled there is a strong withdrawal reaction.
* When placed on solid ground such as a floor the turtle attempts to make crawling movements.

INJURED
* The head and limbs are mostly held below the plane of the ventral surface of the body. The movements are very erratic or spasmodic and non-directional, appearing uncontrolled.
* The recovery techniques produce only a weak localised flinch response.
* When a flipper is pulled or pressure is applied on the neck, there is only a weak or absent withdrawal reaction.

NOT ACTIVE
* Recovery techniques do not produce any response.
* When a flipper is pulled or pressure is applied on the neck, there is no withdrawal reaction.
* No attempt is made by the turtle to move on solid ground such as a floor.

ATTENTION: if you find a turtle with flesh that has begun to rot and that stinks, it means that it is surely DEAD

DEAD TURTLES

One of the main known causes of many deaths of sea turtles concerns the inability to distinguish between a turtle that apparently does not react (comatose turtle, see page xxx) and a turtle that is actually dead.

Returning a comatose turtle into the sea, as fishermen in many cases do, means causing its death (Demetropoulos and Hadjichristophorou, 1995).

In order to prevent this important "involuntary" cause of death, which can be easily avoided, many aspects must be considered.

Recalling what has already been described in this manual, we prefer to follow an outline that considers both the safety of the turtles and the needs of fishermen working on board.

In order to define a priori whether a turtle is dead or not, it is necessary to find the animal inactive with stiff muscles (rigor mortis) and/or with flesh that has begun to rot. Other clues such as evidence of the beginning of decomposition (in particular around the head and/or flippers) together with a bad smell, sloughing of scutes (in particular over the head and/or on the carapace), could also help. The other case in which the turtle can be considered dead concerns the absence of reactions to at least one of the recovery techniques (see page 40) after regular and careful application of them for 24 consecutive hours (Balazs et al., 1995).

According to recent studies a temporal limit to the possibility of the turtle recovering should not be given and the hypothesis that a turtle be assessed as dead because it does not react to at least one of the recovery techniques should be rejected (Conant, T. in litt., May 31, 2000).

For practical reasons, in order to encourage a person to handle a marine turtle that they have incidentally caught (fishermen could become exasperated if they thought that they might have to keep the turtle on board without a temporal limitation) and considering the likelihood of incorrectly assessing the turtle's condition after observing it for up to 24 hours, it is reasonable to assume that this temporal limitation is the best methodology to apply.

• How to behave with a dead turtle

The amount of information that can be collected from a dead turtle is so great that it is worth persuading fishermen to bring the specimen to the nearest harbour and give it to the competent Authorities instead of returning it to the sea.

The best way to transport a dead turtle is in a cool box hold (even better is to freeze it) so that decomposition will not start. Therefore, it is advisable to treat the turtle like the rest of the catch.

In order not to lose any data, the specimen should be kept entire and any kind of fishing gear attached to it should not be removed (in particular hooks and associated line). Once in the harbour (or before, if the vessel has a phone, radio or CB on board) the local Authority should be informed.

If it is not possible to bring the dead turtle back to the harbour, the animal should be returned to the sea after having removed any fishing gear (such as hook, monofilament, line etc.) entangled in its body (Balazs et al, 1995). If the turtle is internally hooked and the hook is not visible, the line must be cut as close as possible to the beak so that the line is no longer visible. These final pieces of advice would avoid the entanglement of other marine beings attracted by the "ghost gear" (see page xxx).

RECOVERY TECHNIQUES

• Resuscitation

Turtles caught by any kind of fishing gear may be brought up in a comatose condition. If they are put back into the sea in this state, they are unlikely to survive (Demetropoulos and Hadjichristophorou, 1995).

Several techniques have been described for the resuscitation of comatose sea turtles, but a standard methodology approved by all experts has not yet been found. Most of the recovery techniques require further analysis and are too complicated to be applied in the cases described in this manual (Shoop, 1982; Stabenau et al., 1993).

The first advised technique, the sloping position (see page xxx), has been recommended and only a few modifications have been made during the past few years (Balazs, 1986; Balazs et al., 1995; Demetropoulus and Hadjichristophorou, 1995).

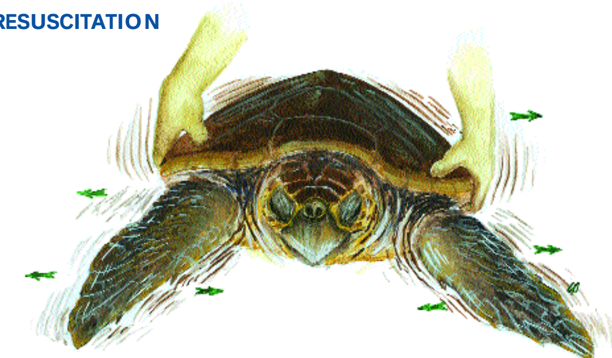
On the other hand, the second advised technique, besides being recent, has the advantage of easy application and does not require any tools. It consists of rocking the turtle gently from left to right and from right to left by holding the outer edge of the carapace and lifting up one side about 10 cm., then alternating to the other side (Conant,T. in litt., May 31, 2000). Unlike the previous technique, which were almost all empirical, this method has been chosen considering the physiological aspects and they were compared with other alternative procedures (Stabenau and Vietti, 1999)

By using empirical observations, it is also possible to determine whether the turtle is reviving. In some experiences with comatose turtles, immediate post-revival characteristics include (in chronological order): movement of the pectoral and pelvic muscles, moderate head lifting, hyperventilation (6 to 10 breaths per minute), significant increases in heart rate and in the end, movement of the flippers (Balazs, 1986; Stabenau et al., 1993).

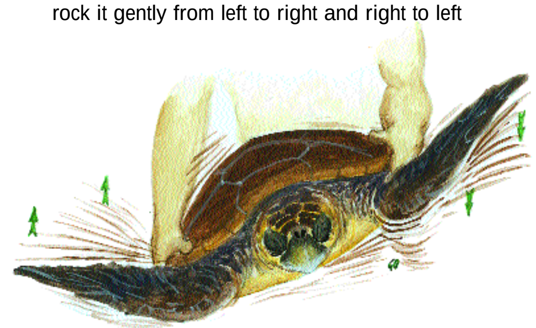
In order to give a better view of the recovery techniques mentioned in the bibliography, a description of some procedures which are well known and which should no longer be applied is herein illustrated.

Recovery Techniques

RESUSCITATION



Holding the turtle by the side of the carapace, lift one side about 10 cm then lift the other side and rock it gently from left to right and right to left



RECOMMENDATION WHEN USING TECHNIQUES

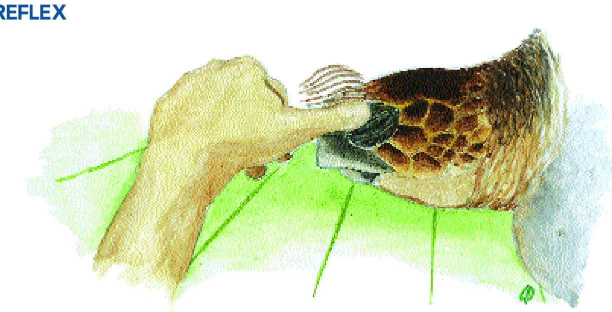
* While applying the techniques, observe the turtle closely and carefully and handle it firmly and gently without injuring or damaging it.
* Techniques can be used quickly but only twice in succession. In case of uncertainty of response, a second attempt can be made ten minutes after the first one.

The supine position, for example, should be absolutely avoided because since the lungs are located dorsally, under the carapace, the heavy food-laden digestive tract and other organs pushing down on the lungs could prevent lung ventilation (Balazs, 1986).

The practice of stepping on the plastron to revive the turtle (Hopkins and Richardson, 1984; Oravetz, 1999) may actually do more harm then good. Plastral pumping may cause the airway to block, thus prohibiting air from entering the lungs. Pumping the plastron while a turtle is on its back also causes the viscera to compress the lungs, thereby hindering lung ventilation (Conant,T. in litt., May 31, 2000).

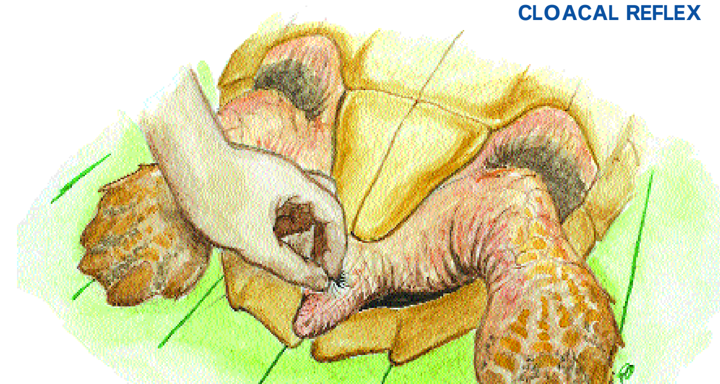
Sea turtles being resuscitated must be kept in the shade and kept damp or moist (see page xxx) but under no circumstances should they be placed into a container holding water (Conant,T. in litt., May 31, 2000).

EYE REFLEX



When you lightly touch the eye or the upper eyelid with your finger, the animal exhibits a flinch response closing its eyes

CLOACAL REFLEX



When you pinch the cloaca, the animal contracts the cloaca and/or moves the tail sideways

• Reflex tests

In the case of a turtle that is not active, its condition has to be assessed in order to determine whether it is dead or still alive. In order to assess its condition it is possible to apply some reflex tests on board, even without having scientific knowledge or specific tools.

The depression phenomenon, depending on the gravity, is graded from a light depression of the sensory neuron to a deep coma.

Light states of depression are called “obtundation of the sensory neuron” and are characterised by loss of liveliness and mitigation of all the body and sensory neuron symptoms and thus of the response to the usual stimulus. The animal often lies in a decubitus, apathetic and indifferent state.

Even more serious is sopor, where the animal is completely indifferent to what is happening around it and looks as though it was sleeping. Stimulus, such as energetic action (i.e. hitting the animal’s shoulders with the hand), bathing the eyes and nose with cold water, electric stimulus, etc. give a light, imprecise and short response demonstrating that the animal is still alive.

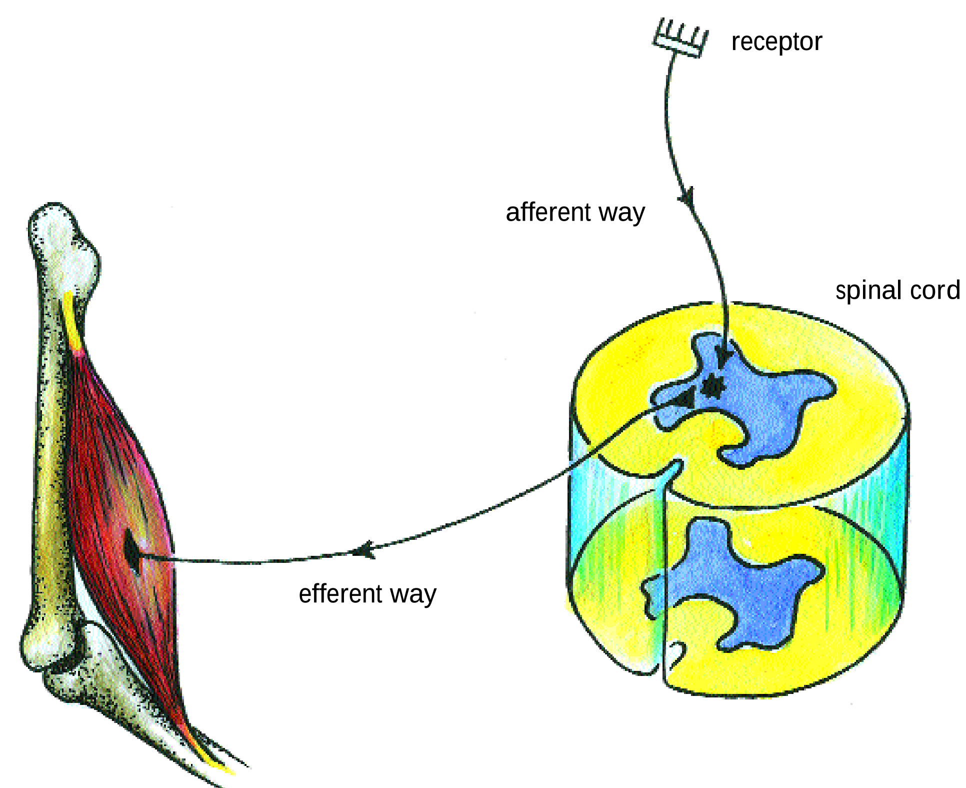


Fig. 12 - Reflex arch

The most serious state of depression, the coma, is characterised by a deep somnolence and drowsy state with loss of any capacity to react. In this state the animal retains only the essential vegetative functions (respiration and cardiocirculatory activity). Marine turtles, having a particular physiology suitable for the sea environment, are able to slow down their vegetative functions (Felger et al., 1976), making these imperceptible on a brief observation of the turtle.

Therefore, in this case, it is necessary to conduct further observations, provoking reactions to other stimuli, which reflexes allow the observer to understand if the animal is actually not active or not alive.

The reflex can be defined in general as passive motor, vassel or secretory reaction, caused in response to a stimulus which acts on a sensitive apparatus and is transmitted through an elementarily defined nervous circuit (reflex arc Fig. 12).

For example, if we consider a reflex arc that does not involve the brain, but involves the spinal cord exclusively, we have to consider that the stimulus, from wherever it originates (tactile receptor present in: skin, anus mucous, bones, eye) goes through the spinal cord depending only on the nervous cell that has recorded the stimulus (afferent way) and it is unconsciously transmitted to the cell that transforms the stimulus into a motor impulse which is then transmitted (efferent way) to the organ that reacts (muscles, blood-vessels, glands).

The diagnostic value of the reflex allows the observer to evaluate the state of the nervous system and understand if the animal is actually not active or not alive.

Reflexes such as touching a limb (which produces withdrawal), cutaneous and mucous, are generally weakened and are absent in the coma state.

The last reflexes to disappear are the cloacal and the eye reflexes (named in the Guidebook) and the pupil reflex (not treated in the Guidebook).

1) Cloacal reflex: consists of contraction of the anus's external sphincter due to mechanical stimulation of the perianal region; when the reflex is absent the cloaca is sucking and the turtle is incontinent. The cloacal reflex protects the turtle from involuntary defecation.

2) Eye reflex: consists of closure of the eyelid due to mechanical stimulation of the cornea or of the area surrounding the eye. This reflex can be considered a defence and it is used by the animal to protect the eye surface, which could be damaged by contact with any foreign body.

3) Even if it is not treated in the Guidebook, it is worth citing the pupil reflex, which consists of contraction of the iris constrictor muscle with consequent restriction due to a sudden, intense light being shone on the eye. If there is no suitable light source (i.e. a small torch) the pupil reflex could be observed in the passive closing and opening of one or both eyes.

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