



## NEW RECORD OF GIANT DEVIL RAY (CHONDRICHTHYES: MYLIOBATIDAE) FROM ORAN BAY (WESTERN MEDITERRANEAN SEA)

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### ABSTRACT

The present paper reports a new record of Giant devil ray *Mobula mobular* (Bonnaterra, 1788) from western Algerian waters that is encountered for the first time in that coast since its first description in 1901 and last observation in late 80's. This elasmobranch is categorized as endangered on the IUCN Red List (Endangered A2d ver 3.1) and is likely to be the rarest of the nine species of *Mobula* genus. Occasionally it is captured in Mediterranean Sea by purse seines, bottom and pelagic trawls, pelagic nets, bottom longlines, drifters and harpoons. The specimen stranded in "la Madrague Beach" in Western Algerian coasts. Its disc length was measuring 108.96 cm and disc width was 226.02 cm. This Myliobatidae is rarely seen with daily landed fish at Oran fishery. Up to date no explicit reason can be given for the strand of *M. mobular* but ghost fishing and important maritime traffic stay the most plausible cause of this incident.

**Keywords:** Myliobatidae; Morphometric measurements; Western Mediterranean; Oran Bay; Algeria

### INTRODUCTION

*Mobula mobular* is a semi-pelagic or pelagic over the continental shelf; gregarious; met often near the surface, swimming in vertical undulations from its broad pectoral fins, occasionally jumping out of the water, but also floating motionless; can also rest on the bottom (Fischer *et al.*, 1987). Satellite tag data for three *M. mobular* individuals in the Messina Strait, central Mediterranean Sea, have shown that they spent >80% of their time within the upper 50 m of the water column and dived to 700 m depth (Canese *et al.*, 2011). *Mobula mobular* is aplacental viviparous (one or two embryos). Feeds on small planktonic fish and crustaceans filtered through its gill plates (Abudaya *et al.*, 2017).

Also, this species is categorized as endangered on the IUCN Red List (Endangered A2d ver 3.1) and is likely to be the rarest of the nine species of *Mobula* genus (Notarbartolo di Sciara *et al.*, 2015). Occasionally it is captured in Mediterranean Sea by purse seines, bottom and pelagic trawls, pelagic nets, bottom longlines, drifters and harpoons (FAO, 2009).

Algeria, Greece, Italy, Spain, Tunisia, Turkey and Ukraine are together responsible for slightly more than 80 % of total landings in the Mediterranean and the

Black Sea. Between the year 2000 and 2013: 115 400 t were landed in Algerian fisheries occupying the third place after Italy 249 500t and Turkey 459 400 t (FAO, 2016). The ranking of capture fisheries production in 2014 and 2016 total catches continued to be dominated by Turkey: 321 800 t (26 % of total landings), followed by Italy: 185 300 t (16%), Algeria: 96 300 t (8%) and Greece: 65 700 t (5%) (FAO, 2018).

In the western Mediterranean, landings by weight are dominated by Algeria (37 %), Spain (29 %) and Italy (19 %), which account for 85 percent of all landings in the sub region, followed by Morocco (10 %) and France (5 %). approximately 30 % of total revenue in the region. Turkey, Egypt, Spain, Tunisia, Greece and Algeria, in addition to Italy, remain the countries producing the highest revenue from fisheries in the GFCM (General Fisheries Commission for the Mediterranean) area of application (FAO, 2018).

Incidental catches of vulnerable species as *M. mobular* taken as by-catch in many fisheries can be highly correlated to a recent report of the FAO concerning the state of Mediterranean and Black Sea Fisheries (FAO, 2016) stating that in those areas, a discard value corresponding to 20-35 % of total catch has been calculated (Sartor *et al.*, 2003; EU, 2011; Piroddi *et al.*, 2014 in FAO, 2016). The trawling discard

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rate for the French Mediterranean was estimated between 27 and 40 % (Ifremer, 2010; Bultel *et al.*, 2015 in FAO, 2016). In Morocco, trawler fisheries (mainly catching cephalopods and/or shrimp) are associated with higher rates of discards: between 12 and 46 % (Kelleher, 2005; Belhabib *et al.*, 2013 in FAO, 2016). In Algeria, high values of discards of up to 50 %, mainly related to the shrimp fishery, have also been recorded (Bouaicha, 2011; Belhabib *et al.*, 2013 in FAO, 2016) and for pelagic trawl landing values accounted for around 20% in 2010 (MPRH, 2011). In the Turkish and Bulgaria Black Sea, discard rates for pelagic trawls are estimated to be around 5.1 % of total catch (Kelleher, 2005; Keskin *et al.*, 2015 in FAO, 2016).

Despite the increasing catches worldwide, dramatic declines in mobulid catches have been documented in some areas, suggesting serial depletions through over-fishing. Mobulids are caught as by-catch in purse-seine and trawl fisheries as well as netting programs (e.g. Philippines: Alava *et al.*, 2002 in Couturier *et al.*, 2012). As a result, harmonized methodologies for data collection on discards (FAO, 2018d in FAO, 2018) and incidental catches of vulnerable species (FAO, 2018e in FAO, 2018) were produced to support the implementation of the bycatch monitoring program, which was first launched in seven countries (Algeria, Lebanon, Montenegro, Morocco, Tunisia, Turkey and Ukraine) and included training of onboard observers and, as appropriate, the development of awareness material (FAO, 2018).

Although early historical accounts painted devil and manta rays as 'diabolical creatures' and 'ferocious brutes', accusing them of stealing boats and deliberately killing divers (Gill, 1908; Saenz-Arroyo *et al.*, 2006), it is now known that these rays are harmless to humans and feed mainly on zooplankton. Fisheries for mobulids are considered to be unsustainable because of large, directed catches coupled with the low fecundity and conservative life history of this group. Estimates of the world global catch of mobulids have increased from 900 t in 2000 to >3300 t in 2007 (FAO, 2009; Lack & Sant, 2009 in Couturier *et al.*, 2012).

Although mobulids have been recorded for over 400 years, critical knowledge gaps still compromise the ability to assess the status of these species. There has been a marked increase in the number of published studies on mobulids since 1990, particularly for the genus *Manta*, although the genus *Mobula* remains poorly understood (Couturier *et al.*, 2012). Literature

reports works on this Myliobatidae in Mediterranean: Notarbartolo-di-Sciara, 1987; Bustamante *et al.*, 2016 on systematics; Bradai & Capapé, 2001; Celona, 2004; Correia *et al.*, 2008; Scacco *et al.*, 2009; Bello *et al.*, 2012; Holcer *et al.*, 2012; Yagliglu *et al.*, 2013; Fortuna *et al.*, 2014; Ba<sup>o</sup>usta & Özbek, 2017; Abudaya *et al.*, 2017 on occurrence and fisheries, Canese *et al.*, 2011; Couturier *et al.*, 2012; 2013; Notarbartolo di Sciara *et al.*, 2015; Duffy & Tindale, 2018; Sakalli, 2017 on ecobiology and behaviour of *M. mobular*. For Algerian waters works are limited to old descriptions of Pellegrin, 1901; Dieuzeide *et al.*, 1953 also McEachran & Capape.1984; Fisher *et al.*, 1987 and works of Hemida *et al.*, 2002 on *Mobula mobular* and Hemida *et al.*, 2016 on *Mobula japanica* in central Algerian waters so our observation is reporting the presence of this Myliobatidae in that part of the Mediterranean not observed for more than 30 years.

## MATERIALS AND METHODS

On 5<sup>th</sup> September 2017 a specimen of *M. mobular* (Bonnaterre, 1788) stranded at "la Madrague" beach 35°46'2.54"N, 0°48'48.96"O (Figure. 1) in the western Algerian coast (Oran Bay). FAO identification sheet (Bauchot, 1987) was used to identify *M. mobular*. All measurements were made in situ to the nearest millimeter (Table 1). Unfortunately, the specimen was in advanced state of deterioration and the tail was missing, some measures were not taken as well as color of the back, so total length was measured from cephalic fins to the end of the tail spine and all measurements made on *M. mobular* specimen were reported as percentages of total length.

## RESULT AND DISCUSSION

### Result

*M. mobular* is a mobulid rarely encountered in its natural environment (Oran Bay) as in local fisheries, it is generally taken as a bycatch in trawl fisheries and the only specimen took as object of our study is suspected to be a victim of ghost fishing, a devastating practice quite common in the area (*pers.obs*). Stranded *M. mobular* (Figure 2) was characterized by a diamond-shaped disc, nearly twice as wide as long, its anterior edges almost rectilinear, its lateral angles very acute and its posterior edges clearly concave. Head wide, its front part distinct from the disc. Tail containing a long spine with prickles. Anterior part of the pectoral fins forming two long cephalic fins. Eyes and spiracles in lateral position; mouth on the ventral side of the head, devoid of fleshy taste buds; over the entire length of the jaws (Fischer *et al.*, 1987) (Figure 2).



Figure 1. Stranding zone of *Mobula mobular* ("La Madrague" Beach).  
Source: Google earth 2019<sup>®</sup>



Figure 2. The specimen *Mobula mobular* stranded at "la Madrague" Beach (05/09/2017).

Measurements were made on biometric characteristics of *M. mobular* stranded on "la Madrague beach", and description are resumed in table 1. It appears that measurements reported as percentage of total length (TL) were as follows: Disc Length (82.56%), Disc width (171.27%), Tail spine length (136.42%), Eye diameter (4.73%), Mouth width

(5.24%), Clasper (10.71%), Pre-oral length (7.56%), Pre-orbital length (19.28%), Pectoral fin (convex length) (132.14%), Pectoral fin (concave length) (78.44%), Cephalic fin length (16.51%), Cephalic fin width (5.36%), Distance between cephalic fins (16.50%), Cranial width (21.86%), Preoral length (8.42%).

Table 1. Morphometric measurements of *Mobula mobular* specimen

Morphometrical characteristic	Measurement (mm)	%TL
Total length*	131.97*	100.00
Disc Length	108.96	82.56
Disc width	226.02	171.27
Tail spine length	180.03	136.42
Eye diameter	6.24	4.73
Mouth width	6.92	5.24
Clasper	14.14	10.71
Pre-oral length	9.98	7.56
Pre-orbital length	25.45	19.28
Pectoral fin (convex length)	174.38	132.14
Pectoral fin (concave length)	103.52	78.44
Cephalic fin length	21.79	16.51
Cephalic fin width	7.07	5.36
Distance between cephalic fins	21.78	16.50
Cranial width	28.85	21.86
Preoral length	11.11	8.42

\*Total length measured from the cephalic fins to the end of the tail spine

**Discussion**

The length of Algerian coastline is about 1622 km (PAP RAC/PAM, 2015-Ministry of the Environment) and as stated previously, *M. mobular* haven't been encountered in Western Algerian coast (Oran Bay) for more than 30 years since Pellegrin, 1901; Dieuzeide *et al.*, 1953 also McEachran & Capape, 1984; and Fisher *et al.*, 1987 descriptions. There were only observations and works of Hemida *et al.*, 2002 in

Central and Eastern Algerian waters but no information exists on its occurrence in the Western Algerian waters. Population trends and behavior of this mobulid are difficult to obtain given that the majority of studies available in the literature were mainly based on visual observations (Holcer *et al.*, 2012; Fortuna *et al.*, 2014) of population of that giant aquatic animals or limited to only 1 or two specimens as is the case of our study (table 2).

Table 2. Main studies exhibiting the number of *Mobula mobular* specimens observed and/or caught and/or described and their respective length given by several authors.

Reference	Observed	Caught	Described	Length (m)	Area	
Capapé <i>et al.</i> , 1990	-	-	1	2.2	France, Aigues-Morte Gulf	
Duffy & Tindale, 2018	-	-	5	1.8-2.8	Northern New Zealand	
Fortuna <i>et al.</i> , 2014	3255	-	3	≈3	Otranto strait	
Celona, 2004	50	45	5	-	Messina Strait	
Canese <i>et al.</i> , 2011	-	-	3	2.5-3	Italy	
Holcer <i>et al.</i> , 2012 (3 years)	-	-	20	1.3-3		Adriatic Sea
Scacco <i>et al.</i> , 2009	-	-	1	3		Tyrrhenian Sea
Storai <i>et al.</i> , 2011 (1990-2009)	15	-	3-12	1.8-3.5	South Adriatic	
Jardas, 1996	-	-	1	-	Cres Island, North Adriatic	
Marano <i>et al.</i> , 1988	-	-	2	-		
Dulčić & Lipej, 2002	-	-	2	3.5-5	Mediterranean	
Yaglioglu <i>et al.</i> , 2013	-	-	1	1.40		
Başusta and Özbek, 2017	-	30	2	2.70-2.72	Turkey	
Bradai & Capapé., 2001	-	-	2	2.09 and 2.9	Tunisia	
Capapé & Zerouali, 1976	-	-	1	3		Gulf of Gabes
Hemida <i>et al.</i> , 2002 (1999-2001)	-	14 East 7 Center 0 West	21	1.30-3.34	Central and Eastern Algerian coasts	
Present study	-	-	1	2.26	Western Algerian coasts	

According to UNEP/CMS, 2014, Notarbartolo di Sciarra *et al.*, 2015, Arnoud, 2018, giant devil ray (*Mobula mobular*) is the largest species of the genus *Mobula* and has a very low reproductive capacity. Its geographic range is limited to the Mediterranean Sea and possibly adjoining North Atlantic waters. This species is taken as bycatch in many different fisheries (most notably in pelagic driftnets) in several locations within its range. There are no overall regional population estimates for this species. A report of the first stranding of this mobulid species in Oran Bay can help us to trace a precise trajectory of this migratory species beginning in Alboran Sea and fill gaps concerning its population ecobiology.

Generally, it occurs in low densities (with group sizes of one to four individuals) throughout its range, although a recent episode in which these rays were mass captured off Gaza indicates that the species may occasionally occur in large aggregations. This species occurs both in neritic (Notarbartolo di Sciarra & Serena 1988, Bradaï & Capapé 2001, Scacco *et al.*, 2009, Holcer *et al.*, 2012 in Notarbartolo di Sciarra *et al.*, 2015) and offshore (Canese *et al.*, 2011 in Notarbartolo di Sciarra *et al.*, 2015) waters ranging in depth from a few tens of meters to several thousand meters.

The main threat to the Mediterranean giant devil ray is fishing, although the species is rarely targeted and is usually caught accidentally. Unfortunately, this elasmobranch is sometimes targeted as was the case in Gaza strip on 26<sup>th</sup> February 2013 where nearly 500 individuals were captured by purse seine vessels before being consumed or devoid of their precious fins (Couturier *et al.*, 2013). In reality, according to the NGO IFAW (International Fund for Animal Welfare) (Elsayed, 2016), gills are also used in traditional Chinese medicine to treat ailments such as asthma, rashes, chicken pox or even cancer. Where approximately, a single ray can give up to 3.5 kilograms of dried gills, which can be sold up to 502 € per kilo in China. Water pollution mainly hydrocarbons, solid wastes as plastic can contribute a lot to harm these creatures may be swallowing hundreds of plastic particles a day. Debris has been recognized as a global environmental problem including within deep habitats and recent studies showed that microplastic pollution can impact filter-feeding marine megafauna, namely mobulid rays, filter-feeding sharks, and baleen whales (Anastasopoulou *et al.*, 2013; Germanov *et al.*, 2018)

Related to conservation strategy Lawson *et al.*, (2017) resumed the international, national, and territorial protections currently in place for devil and

manta rays. The most important of them are:

International protections that restricts fishing and/or trade of multiple species of the genus (*Mobula* spp.).

- CMS Appendix I & II (2014) conservation of migratory species of wild animals,
- European Union (2015) The fishing opportunities for certain fish stocks and groups of fish stocks,
- IATTC (2015) Resolution on the conservation of mobulid rays,
- CITES (2016) Inclusion of the genus *Mobula* spp. in appendix II of the Convention on International Trade in Endangered Species

*M. mobular* is also listed in:

- Annex II to the Barcelona Convention SPA/BD Protocol, Barcelona Convention SPA/Bio Protocol Annex II (1976). (Algeria, Ratification: 16.02.81/ AC Acceptance of Amendments: 09.06-04)
- Bern Convention Appendix II (1979)

Furthermore, Basusta & Özbek, 2017 reported that the parties to the Barcelona Convention agreed that this species cannot be retained on board, trans-shipped, landed, transferred, stored, sold, displayed or offered for sale, and must be released unharmed and alive, to the extent possible, pursuant to Recommendation GFCM/36/2012/3 (FAO, 2012) *M. mobular* is also protected by National and territorial initiatives (Ba<sup>o</sup>usta & Özbek, 2017; Lawson *et al.*, 2017):

- EU (72/2016/EU),
- Australia (2015),
- Maldives (2014),
- Brazil (2013),
- Croatian (Law of the Wild Taxa 2006),
- Maltese (Sch. VI),
- Israeli (since 2005),
- Greek (PD 67/1981),
- Turkish (Environmental Law No. 2 872) legislation,
- Guam, USA Territory (2011),
- Raja Ampat, Indonesia Regency (2012),

Added to this since 90's European legislation authorized driftnet no longer to 2.5 km to limit capture of marine mammals, turtles and migratory species. Many attempts were tried to banish completely the use of driftnets [amending Regulations (EC) No 894/97, (EC) No 812/2004 and (EC) No 2187/2005 as concerns drift nets in Council Regulation (EC) No 809/2007 and (Davies & Laura, 2015). To our vision, it seems insufficient to protect such epipelagic marine organisms that are encountered from tens to hundreds of meters. According to local fisherman (seiner owner) witnesses, it is very rare to meet or capture *M. mobular* in Oran Bay, since 2015 this elasmobranch

was met only two times in different places, 1<sup>st</sup> at "Pointe de l'aiguille" and the 2<sup>nd</sup> at Cape Falcon where they were swimming slowly very close to the surface confirming that the species frequents the western Algerian coasts and probably a small population exists.

## CONCLUSION

Water pollution (mainly hydrocarbons, solid waste as plastic) and important maritime traffic can contribute a lot to harm these inoffensive animals that haven't been observed for more than 30 years in that part of the Mediterranean, but up to date no explicit reason can be given for the real strand of *Mobula mobular* in "la Madrague" beach but ghost fishing and important maritime traffic (commercial, tourism) stay the most plausible cause of this incident. Research on *M. mobular* is very scarce and more studies should focus on its occurrence by visual observation and/or GPS tagging, ecobiology, distribution, reproduction and nursery areas should be identified and fishing should strictly been prohibited along Algerian coasts and in the Mediterranean Sea.

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## REFERENCES

- Abudaya, M., Ulman, A., Salah, J., Fernando, D., Wor, C., & Notarbartolo di Sciara, G. (2017). Speak of the devil ray (*Mobula mobular*) fishery in Gaza. *Rev. Fish. Biol. Fisheries*, 1-11. doi: <http://dx.doi.org/10.1007/s11160-017-9491-0>.
- Alava, M. N. R., Dolumbalo, E. R. Z., Yaptinchay, A. A., & Trono, R. B. (2002). Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. In *Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, July 1997* (Fowler, S. L., Reed, T. M. & Dipper, F. A., eds), pp. 132–148. Occasional Paper of the IUCN Species Survival Commission No. 25.
- Anastasopoulou, A., Mytilineou, C., Smith, C. J., & Papadopoulou, K. N. (2013). Plastic debris ingested by deep-water fish of the Ionian Sea (Eastern Mediterranean). *Deep. Sea. Res. Part 1 Oceanogr. Res. Pap.*, 74, 11-13.

Arnoud, C. (2018). *Le diable de mer de Méditerranée*. Breuillet. France. [Especies-menacees.fr](https://www.especies-menacees.fr). *Le portail sur les especes menacees et les animaux en voie de disparition*. Retrieved 26/08/2018 (Published 26.07.2018 at 16h06 / Modified 30.07.2018 at 11h15/). Available at <https://www.especies-menacees.fr/diable-de-mer-mediterranee/>. [In French].

Barcelona Convention. (1976). Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Annex II Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean. United Nations Environment Programme. Barcelona, 16 February 1976.

Baousta, N., & Özbek, E. Ö. (2017). New record of giant devil ray, *Mobula mobular* (Bonnaterre, 1788) from the Gulf of Antalya (Eastern Mediterranean Sea). *J. Black Sea/Mediterranean. Environ*, 23(2), 162-169.

Bauchot, M.-L. (1987). Raies et autres batoides. In W. Fischer, M. L. Bauchot & M. Schneider (Eds.) *Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et Mer Noire. Zone de pêche 37* (pp. 761- 1530). Italy, Rome. FAO. [In French]

Belhabib, D., Harper, S., Zeller, D., & Pauly, D. (2013). Reconstruction of marine fisheries catches for Morocco (north, central and south), 1950–2010. Fisheries Centre Working Paper 2015–48. University of British Columbia, Vancouver, Canada. 18 pp.

Bello, G., Lipej, L., & Dulèiæ, J. (2012). Comments on a finding of *Mobula mobular* (Mobulidae) in the Adriatic Sea. *Cybium*, 36(4), 575-577.

Bern Convention. (1979). Convention on the conservation of European wildlife and natural habitats. Appendix II Strictly protected fauna species. Council of Europe. Bern, 19 September 1979.

Bouaicha, M. (2011). Étude de suivi des rejets de la pêche crevette dans la baie de Bou-Ismaïl. Centre national d'étude de la pêche et de l'aquaculture, Bou-Ismaïl. 37 pp.

Bradai, M.N., Capapè, C. (2001). Capture du diable de mer *Mobula mobular* dans le Golfe de Gabes (Tunisie Meridionale Méditerranée Centrale) (Capture of the giant devil ray *Mobula mobular* in

- the Gulf of Gabes (southern Tunisia, central Mediterranean). *Cybium*, 25, 389–391.
- Bultel, E., Le Manach, F., Ulman, A., & Zeller, D. (2015). Catch reconstruction for the French Mediterranean Sea, 1950-2010. Fisheries Centre Working Paper 2015–38, University of British Columbia, Vancouver, Canada. 20 pp.
- Bustamante, C., Barriá, C., Vargas-Caro, C., Ovenden, J. R. & Bennett, M. B. (2016). The phylogenetic position of the giant devil ray *Mobula mobular* (Bonnaterre, 1788) (Myliobatiformes, Myliobatidae) inferred from the mitochondrial genome. *Mitochondrial DNA Part. A*, 27(5), 3540-3541. Doi: [10.3109/19401736.2015.1074208](https://doi.org/10.3109/19401736.2015.1074208).
- Canese, S., Cardinali, A., Romeo, T., Giusti, M., Salvati, E., Angiolillo, M., & Greco, S. (2011). Diving behavior of the giant devil ray in the Mediterranean Sea. *Endanger. Species. Res*, 14(2), 171-176. Doi: [10.3354/esr00349](https://doi.org/10.3354/esr00349)
- Capapé C., & J. Zaouali. (1976). Note sur la présence de la mante de mer *Mobula mobular* (Bonnaterre, 1788) (Sélaciens, Rajiformes) dans les eaux tunisiennes. *Doriana*, 5(223): 1- 8. [In French]
- Capapé, C., Bouchereau, J.L., & J.A. Tomasini. (1990). Présence du diable de mer, *Mobula mobular* (Bonnaterre, 1788) (Pisces, Rajiformes, Mobulidae) dans le golfe d'Aigues-Mortes. Anatomie de la ceinture pelvienne et des ptérygopodes. *Mésogée*, 50: 9-14. [In French]
- Celona, A. (2004). Catture ed avvistamenti di mòbula, *Mobula mobular* (Bonnaterre, 1788) nelle acque dello Stretto di Messina. *Ann. Ser. Hist. Nat.* 14, 11-18. [In Italian].
- CITES. (2016). Consideration of proposals for amendment of appendix I and II. CoP17 Prop. 44. Inclusion of the genus *Mobula* spp. in appendix II. Available at <https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-44.pdf>.
- CMS. (2015). Notification to the parties No. 2015/007. Amendment to appendices I and II of the convention on the conservation of migratory species of wild animals (CMS). Available at [http://www.cms.int/sites/default/files/document/Appendices\\_COP11\\_E.pdf](http://www.cms.int/sites/default/files/document/Appendices_COP11_E.pdf).
- Correia, J. P., Graça, J. T., & Hirofumi, M. (2008). Long term transportation, by road and air, of Devil ray (*Mobula mobular*), Meagre (*Argyrosomus regius*), and Ocean Sunfish (*Mola mola*). *Zoo Biol.* Published in affiliation with the American Zoo and Aquarium Association, 27(3), 234-250. Doi: [10.1002/zoo.20178](https://doi.org/10.1002/zoo.20178).
- Council Regulation (EC) No 809/2007 of 28 June 2007 amending Regulations (EC) No 894/97, (EC) No 812/2004 and (EC) No 2187/2005 as concerns drift nets. OJ L 182, 12.7.2007, p. 1–2 (BG, ES, CS, DA, DE, ET, EL, EN, FR, IT, LV, LT, HU, MT, NL, PL, PT, RO, SK, SL, FI, SV) Special edition in Croatian: Chapter 04 Volume 004 P. 184 – 185. Retrieved 08/02/2019. Available at: <http://data.europa.eu/eli/reg/2007/809/oj>
- Council Regulation (EU). 2015. The fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union vessels, in certain non-Union waters, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014. Available at <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R0104&from=EN>.
- Couturier, L. I. E., Marshall, A. D., Jaine, F. R. A., Kashiwagi, T., Pierce, S. J., Townsend, K. A., Weeks, S. J., Bennett M. B., & Richardson, A. J. (2012). Biology, ecology and conservation of the Mobulidae. *Journal of fish biology*, 80(5), 1075-1119.
- Couturier, L. I. E., Bennett, M. B., & Richardson, A. J. (2013). Mystery of giant rays off the Gaza strip solved. *Oryx*, 47(4), 480. Doi: [10.1017/S0030605313000793](https://doi.org/10.1017/S0030605313000793).
- Davies, A., & Zandersone, L. (2015). Initial Appraisal of a European Commission Impact Assessment. Prohibition on driftnet fisheries. EPRS. European Parliamentary Research Service. 1-7.
- Dieuzeide R., Novella, M., & Roland J. (1953). Catalogue des Poissons des côtes algériennes. *Bull. Trav. Stn. Aquic. Pêche Castiglione*. 4, 1–135. [In French]
- Duffy, C. A., & Tindale, S. C. (2018). First observation of the courtship behaviour of the giant devil ray *Mobula mobular* (Myliobatiformes: Mobulidae). *N. Z. J. Zool.*, 1-8. Doi: [10.1080/03014223.2017.1410850](https://doi.org/10.1080/03014223.2017.1410850).
- Dulèiæ, J., & Lipej, L. (2002). Rare and little-known fishes in the Eastern Adriatic during last two decades (1980-2001). *Period. Biol.*, 104(2), 185-194.

- Elsayed A.M. (2016). Pour le transfert des raies mobulas dans l'annexe II de la CITES pour une meilleure protection. Document IFAW. Retrieved 12/02/2019. Available at <https://www.ifaw.org/france/actualites/pour-le-transfert-des-raies-mobulas-dans-lannexe-ii-de-la-cites-pour-une-meilleure-protec>.
- EU. (2011). Impact assessment of discard reducing policies. EU Discard Annex. Studies in the field of the Common Fisheries Policy and Maritime Affairs. Impact Assessment Studies related to the CFP. European Commission. Project: ZF0926\_S10, Brussels, Belgium.
- FAO. (2009). Sharks and Rays of the Mediterranean and Black Sea. FAO Species Identification Cards. Rome, FAO. 2009. 113 p
- FAO. (2012). FAO General Fisheries Commission for the Mediterranean: Report of the thirty-sixth session. Marrakech, Morocco, 14–19 May 2012. GFCM Report No. 36. Food and Agricultural Organization of the United Nations (FAO), Rome.
- FAO. (2016). The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome, Italy. 152 pp.
- FAO. (2018). The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome. 172 pp.
- Fischer, W., Schneider, M., & Bauchot, M. L. (1987). Fiches FAO d'identification des espèces pour les besoins de la pêche: Méditerranée et Mer Noire, Zone de pêche 37. (v. 2: Vertébrés), [In French].
- Fortuna, C. M., Kell, L., Holcer, D., Canese, S., Filidei Jr, E., Mackelworth, P., & Donovan, G. (2014). Summer distribution and abundance of the giant devil ray (*Mobula mobular*) in the Adriatic Sea: Baseline data for an iterative management framework. *Sci. Mar.*, 78(2), 227-237. Doi: [10.3989/scimar.03920.30D](https://doi.org/10.3989/scimar.03920.30D).
- Germanov, E. S., Marshall, A. D., Bejder, L., Fossi, M. C., & Loneragan, N. R. (2018). Microplastics: No small problem for filter-feeding megafauna. *Trends. Ecol. Evol*, 33(4), 227-232.
- Hemida, F., Mehezem, S., & Capapé, C. (2002). Captures of the giant devil ray, *Mobula mobular* Bonnaterre, 1788 (Chondrichthyes: Mobulidae) off the Algerian coast (southern Mediterranean). *Acta. Adriat*, 43(2), 69-76.
- Hemida, F., Kassar, A., & Capape, C. (2016). Mediterranean occurrence of *Mobula japonica* (Chondrichthyes: Mobulidae) with first record from the Algerian coast. *Rapp. Comm. int. Mer Médit.*, 326. (2016, September). [http://ciesm.org/online/archives/abstracts/pdf/41/CIESM\\_Congress\\_2016\\_Kiel\\_article\\_0326.pdf](http://ciesm.org/online/archives/abstracts/pdf/41/CIESM_Congress_2016_Kiel_article_0326.pdf).
- Holcer, D., Lazar, B., Mackelworth, P., & Fortuna, C. M. (2012). Rare or just unknown? The occurrence of the giant devil ray (*Mobula mobular*) in the Adriatic Sea. *J. Appl. Ichthyol.*, 29(1), 139-144. Doi: [10.1111/jai.12034](https://doi.org/10.1111/jai.12034)
- IATTC. (2015). Resolution on the conservation of mobulid rays caught in association with fisheries in the IATTC convention area. Available at <https://www.iatcc.org/PDFFiles2/Resolutions/C-15-04-Conservation-of-Mobulid-Rays.pdf>.
- Ifremer. (2010). Panorama des rejets dans les pêcheries françaises. Edited by Guérine, L., Rochet, M.J., Peronnet. 49 pp. [In French].
- Jardas, I. (1996). Adriatic Ichthyofauna. Zagreb: Školska knjiga. 552 p. [In Croatian].
- Kelleher, K. (2005). Discards in the world's marine fisheries. An update. FAO. Rome. No. 470, 131 pp.
- Keskin, Ç., Ulman, A., Raykov, V., Daskalov, G. M., Zyllich, K., Pauly, D., & Zeller, D. (2015). Reconstruction of fisheries catches for Bulgaria: 1950–2010. Fisheries Centre Working Paper 2015–20. University of British Columbia, Vancouver, Canada, 18 pp.
- Lack, M., & Sant, G. (2009). Trends in Global Shark Catch and Recent Developments in Management. Cambridge: TRAFFIC International, 33.
- Lawson, J.M., Fordham, S.V., O'Malley, M.P., Davidson, L.N.K., Walls, R.H.L., Heupel, M.R., Stevens, G., Fernando, D., Budziak, A., Simpfendorfer, C.A., Ender, I., Francis, M.P., Notarbartolo di Sciara, G., Dulvy, N.K. (2017). Sympathy for the devil: a conservation strategy for devil and manta rays. *PeerJ* 5:e3027.
- Marano, G., Rositani, L., Ungaro N., & De Zio, V. (1988). Catches by surface longlines in the southern Adriatic Sea (Italian coasts), triennium 1984-86. *FAO Fish. Rep.*, 394: 112-120.



- McEachran, J.D., & Capapé, C. (1984). *Mobulidae, Dasyatidae*, In: Whitehead, P.J.P., Bauchot, M.-L., Hureau, J. C., Nielsen, J., & Tortonese, E. (eds.): *Fishes of the North-Eastern Atlantic and the Mediterranean*. Vol. 1. Unesco, Paris: 197–202, 210–211.
- MPRH. 2011. Canevas des statistiques locales mensuelles. Ministère des pêches et des ressources halieutiques, 34 pp. [In French]
- Notarbartolo di Sciara, G. (1987). A revisionary study of the genus *Mobula* Rafinesque, 1810 (Chondrichthyes: Mobulidae) with the description of a new species. *Zool. J. Linnean Soc*, 91(1), 1-91. Doi: [10.1111/j.1096-3642.1987.tb01723.x](https://doi.org/10.1111/j.1096-3642.1987.tb01723.x).
- Notarbartolo di Sciara, G., & Serena, F. (1988). Term embryo of *Mobula* (Bonnaterre, 1788) from the Northern Tyrrhenian Sea (Chondrichthyes, Mobulidae). *Atti Soc. ital. Sci. Nat. Museo Civ. Stor. Nat. Milano*, 129(4), 396–400.
- Notarbartolo di Sciara, G., Serena, F., & Mancusi, C. (2015). *Mobula mobular*. *The IUCN Red List of Threatened Species 2015* Retrieved on 23 August, 2018 available at <http://dx.doi.org/10.2305/IUCN.UK.2015-1.RLTS.T39418A48942228.en>
- PAP RAC/PAM. (2015). Ministry of the Environment. National Strategy for Integrated Coastal Zone Management in Algeria. (Support PAM-Med Partnership, UNESCO). 94 p.
- Pellegrin, J. (1901). Sur une Raie cornue gigantesque pêchée à Oran. *Bull. Mus. Natl. Hist. Nat. Paris*, 7, 327–328, [In French].
- Piroddi, C., Gristina M., Zyllich, K., Ulman, A., Zeller, D., & Pauly, D. 2014. Reconstruction of Italy's marine fisheries catches (1950–2010). *Fisheries Research*, Volume 172, pp. 137–147.
- Sakalli, A. (2017). Relationship between Climate Change Driven Sea Surface Temperature, Chl-a Density and Distribution of Giant Devil Ray (*Mobula Mobular* Bonnaterre, 1788) In Eastern Mediterranean: A First Schooling By-Catch Record off Turkish Coasts. *Aquac. Stud.*, 17(1), 005-016. Doi: <http://10.17693/yunusae.v17i26557.280070>.
- Sartor, P., Sbrana, M., Reale, B., & Belcari, P. (2003). Impact of the deep sea trawl fishery on demersal communities of the northern Tyrrhenian Sea (Western Mediterranean). *J. Northwest Atl. Fish. Sci.*, 31, 275-284.
- Scacco, U., Consalvo, I., & Mostarda, E. (2009). First documented catch of the giant devil ray *Mobula mobular* (Chondrichthyes: Mobulidae) in the Adriatic Sea. *Mar. Biodivers. Rec.*, 2. E93. Doi: [10.1017/S1755267209001110](https://doi.org/10.1017/S1755267209001110)
- Storai, T., Zinzula, L., Repetto, S., Zuffa, M., Morgan, A., & Mandelman, J. (2011). Bycatch of large elasmobranchs in the traditional tuna traps (tonnare) of Sardinia from 1990 to 2009. *Fisheries Research*, 109(1), 74-79.
- UNEP/CMS. (2014). Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS) 2014: PROPOSAL FOR THE INCLUSION OF ALL SPECIES OF MOBULA RAYS (GENUS *Mobula*) In CMS APPENDIX I AND II. (Submitted by Fiji), Retrieved 26/08/2018. Available at [https://www.cms.int/sites/default/files/document/Doc 7 2 10 Prop I 10 %26 II 11 Mobula spp FJI.pdf](https://www.cms.int/sites/default/files/document/Doc%207%20Prop%20I%20%26%20II%20Mobula%20spp%20FJI.pdf).
- Yaglioglu, D., Turan, C., & Gurlek, M. (2013). On the occurrence of the giant devil ray *Mobula mobular* (Bonnaterre, 1788) from the Mediterranean coast of Turkey-a bycatch documentation. *J. Appl. Ichthyol*, 29(4), 935-936.