Diet of *Dasyatis pastinaca* and *Myliobatis aquila* (Myliobatiformes) from the Azores, NE Atlantic

by

Dário PONTE[§] (1), Luís M.D. BARCELOS[§] (2), Cristina SANTOS (1),
João MEDEIROS (1, 2) & João P. BARREIROS[*] (2)

Abstract. – This paper describes and discusses the feeding ecology of two stingray species that occur in the Azores: *Dasyatis pastinaca* and *Myliobatis aquila*. Both are common coastal species associated with sandy, muddy and rocky bottoms, from surface waters to depths of over 200 m. The diet described here is based on the stomach content analysis from 33 specimens (23 *D. pastinaca*, 10 *M. aquila*) collected by spearfishing between June and October 2010 at three different locations along the coast of Terceira Island, Azores. Food habits of *D. pastinaca* consist mainly of Decapod crustaceans (with a relevance for *Pachygrapsus marmoratus*) followed by other groups with high representativeness: Polychaeta and Mysidacea. The diet of *M. aquila* consists mainly of *Calliostoma lusitanicum* and *Stramonita haemastoma*. Both species from our sample proved to be generalist predators with different feeding habits. The diet of *D. pastinaca* is characterized by Crustacea (81% IRI) and that of *M. aquila* characterized by Mollusca (82% IRI).

Received: 20 Jan. 2016
Accepted: 5 Jul. 2016
Editor: K. Rousseau

Résumé. – Régime alimentaire de *Dasyatis pastinaca* et *Myliobatis aquila* (Elasmobranchii: Myliobatiformes) des Açores, Atlantique NE.

Cet article décrit et analyse l'écologie alimentaire de deux raies des Açores : *Dasyatis pastinaca* et *Myliobatis aquila*. Ce sont deux espèces côtières communes associées à des fonds sableux, vaseux et rocheux, se trouvant depuis les petits fonds jusqu'à plus de 200 m de profondeur. Le régime décrit ici est basé sur l'analyse du contenu stomacal de 33 spécimens (23 *D. pastinaca*, 10 *M. aquila*) récoltées en chasse sous-marine entre juin et octobre 2010 à trois endroits différents le long de la côte de l'île Terceira, aux Açores. Le régime alimentaire de *D. pastinaca* se compose principalement de crustacés décapodes (avec une préférence pour *Pachygrapsus marmoratus*), suivis par d'autres groupes fortement représentés : polychètes et mysidacés. Le régime de *M. aquila* se compose principalement de *Calliostoma lusitanicum* et *Stramonita haemastoma*. Les deux espèces sont des prédateurs généralistes avec des habitudes alimentaires différentes. Le régime alimentaire de *D. pastinaca* est caractérisé par les crustacés (81% IRI) et celui de *M. aquila* par les mollusques (82% IRI).

Key words
Myliobatidae
Myliobatis aquila
Dasyatidae
Dasyatis pastinaca
Stingrays
Azores
Feeding habits

The Common stingray *Dasyatis pastinaca* (Linnaeus, 1758) (Dasyatidae) inhabits rocky sandy bottoms down to 200 m deep (Whitehead *et al*., 1984; Yeldan *et al*., 2009) but seems to be more common in shallow waters (less than 50 m) (Massutí and Moranta, 2003; Morey *et al*., 2006). This species can be found in the East Atlantic from southern Norway to South Africa, including the Azores, Canary and Madeira Islands (Barreiros and Gadig, 2011; Yigin and Ismen, 2012). It is also present in the Mediterranean, mainly in its western and southern basins. Although associated to continental platforms, it is quite common in Madeira and Azores. In the Azores, this species has no commercial interest and it is not targeted by commercial fisheries. Only occasional spearfishing catches are reported (Barreiros and Gadig, 2011).

The Common eagle ray, *Myliobatis aquila* (Linnaeus, 1758) (Myliobatidae) has been considered as relatively rare (Afonso and Vasco-Rodrigues, 2015) albeit common in the Azores, especially in the first 100 m or so. In this region, *M. aquila* is not targeted by commercial fisheries and, as for *D. pastinaca*, only occasional spearfishing catches have been reported. This species is actively searched by recreational divers and underwater photographers (Barreiros and Gadig, 2011).

It occurs in the NE Atlantic, from the British islands to Morocco and South Africa, while also in the Mediterranean (Capapé *et al*., 2007; Luna, 2009; Barreiros and Gadig, 2011) and the Macaronesian Archipelagos of Madeira and Azores (Whitehead *et al*., 1984; Patzner *et al*., 1992; Debelius, 1997; Santos *et al*., 1997; Harmelin-Vivien *et al*., 2001; Saldanha, 2003; Barreiros and Gadig, 2011). It can be found in shallow waters, bays and estuaries (Compagno, 1986) and offshore waters, with records down to 537 m (Whitehead *et al*., 1984). It's also known to form spawning aggregations (Barreiros and Gadig, 2011; Afonso and Vasco-Rodrigues, 2015).

§ Both authors contributed equally to this study.
(1) João Medeiros Unipessoal Lda, Parque Industrial de Angra do Heroísmo, Lote 1, 9700-135 Angra do Heroísmo, Portugal. [dario_ponte@hotmail.com] [cristina83santos@gmail.com]
(2) CE3C /ABG – Centre for Ecology, Evolution and Environmental Changes / Azorean Biodiversity Group. University of the Azores, 9700-042 Angra do Heroísmo, Portugal. [ldbarcelos@gmail.com] [joaomedeiros@joaomedeiros.pt]
* Corresponding autor [joao.ps.barreiros@uac.pt]

According to Barreiros and Gadig (2011), *Myliobatis aquila* is apparently more diurnal than *Dayatis pastinaca*, a species less mobile than the former and usually found motionless over sandy bottoms during daylight periods.

This study describes the food habits of both species based on a sample from Terceira Island (Azores).

The study of fish diets by analyzing stomach contents is a well-established standard practice (Hyslop, 1980) and may be used to understand variations in growth, reproduction, migration and basic functioning of fish assemblages (Kulbicki *et al*., 2005; Viana and Vianna, 2014). The only studies on the feeding habits of these species where made in the Mediterranean (Capapé, 1976; Ismen, 2003; Jardas *et al*., 2004; Yeldan *et al*., 2009; Valls *et al*., 2011; Wetherbee *et al*., 2012; Jacobsen and Bennett, 2013).

The present study is the first for the Azores archipelago and the NE Atlantic.

MATERIAL AND METHODS

Study area

The Azores are a remote archipelago, located in the central north Atlantic, running WNW-ESE between 37º and 40º N latitude, 25º and 32º W longitude (Santos *et al*., 1995), surrounded by steep bottoms and deep waters (Silva *et al*., 2011). These characteristics make bottom dwelling species more vulnerable because of reduced habitats.

The study was conducted on three sites in Terceira Island: Vila Maria Bay and Cinco Ribeiras on the South shore, and Biscoitos in the North (Fig. 1), except for *Myliobatis Aquila,* for which no specimen was found in BI.

All specimens were caught between June and October 2010 by daylight (no night dives were undertaken) using spearfishing techniques. This method prevents regurgitation of stomach contents (Bowen, 1983) and makes the selection of individuals easier (Derbal and Kara, 1996; Frisch *et al*., 2012). Since none of the species is targeted by commercial fisheries, it was the only possible way to obtain specimens. A total of 10 specimens of *Dasyatis pastinaca* and 23 of *Myliobatis aquila* were collected. Sizes ranged between 240 and 503 mm (avg. 334.8 mm) for *D. pastinaca,* and 283 to 532 mm (avg. 406 mm) for *M. aquila*.

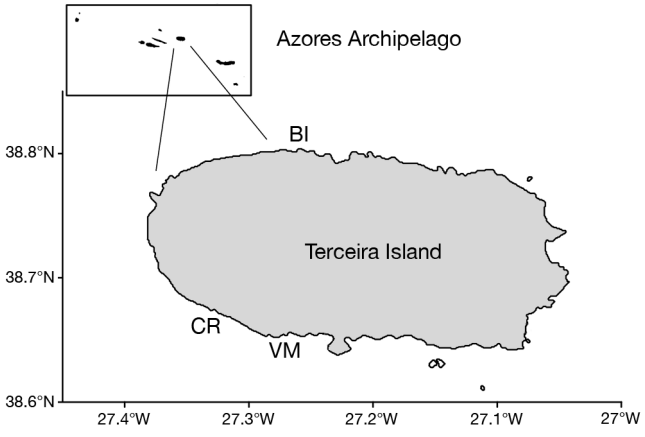

Figure 1. - Sampling sites of *Dasyatis pastinaca* and *Myliobatis aquila* in Terceira Island, Azores, NE Atlantic. BI: Biscoitos; CR: Cinco Ribeiras ; VM: Vila Maria Bay.

Sampling

All stomachs were individually weighed to the nearest g, and the vacuity state determined. Prey items where identified, weighed (dry weight), measured (when possible) and preserved in a 70% alcohol solution. Later, they were identified to the lowest possible taxonomic level, with the help of adequate bibliography (Cailliet *et al*., 1986; Hayward and Ryland, 1990; Wirtz, 1995; Debelius, 1997; Saldanha, 2003).

Additionally, and for the purpose of ongoing work on these species, gonads and livers were preserved frozen while spines and jaws were dried and measured for a biometric study (work in progress).

Data analysis

To get an adequate description of the diet, it is necessary to sample a minimum number of stomachs (Cailliet, 1976; Mauchline and Gordon, 1985; Magurran, 2004). The most used method is the one proposed by Hurtubia (1973), that relates the trophic diversity H' (Spellerberg and Fedor, 2003) with a randomly sampled stomach (Mauchline and Gordon, 1985), expressed by the equation:

$$H' = -\sum_{i=1}^{s} (pi)\,(\ln pi),$$

where H'= trophic diversity; S = species number; *pi* = proportion of a prey item on the total amount of prey. When the accumulation curve becomes stabilized, it means that an adequate number of stomachs has been sampled (Hurtubia, 1973). This method is also useful for its broader use and its viability when comparing data from diverse sources.

Trophic evaluation of the diet

Two types of evaluations were used: quantitative and qualitative. The first one gives information about the feeding activity of the predator and is expressed by two indexes: vacuity index (VI) – the total number of empty stomachs expressed in percentage of the total number of stomachs (Berg, 1979); and repletion index (IR) – the weight of the preys in percentage of the total weight of the predator thus determining feeding intensity (Hyslop, 1980).

Since a single index is not enough for a qualitative evaluation of the diet (Hyslop, 1980), it is necessary to use different indexes that emphasize diverse aspects of a predator diet (Pinkas *et al*., 1971; Berg, 1979; Hyslop, 1980; Bowen, 1983).

The most used, due to their simplicity and easy calculation are numerical importance (expressed as a percent by number, %Cn) and frequency of occurrence (proportion of stomachs containing a specific prey item**,** %FO) (see Cailliet, 1976; Bowen, 1983). These ones reflect how many preys and how often a certain prey was selected, but do not give any information about the nutritional intake by the predator. For that purpose, the calculation of percentage by weight %Cw (see Cailliet, 1976) is necessary.

Pinkas *et al*. (1971) combine the three indexes above to measure the importance of a prey guild. The Index of Relative Importance (IRI) is calculated as follows:

$$IRI = (\%Cn + \%Cw)\ \%FO$$

This index gives more emphasis to %FO, allowing the highest present preys (> %Cn) to get a major role in the diet and putting the less representative (< %Cn) in a second role, albeit eventually more heavy (> %Cw). To overcome that issue, Zander (1982) proposed the utilization of the Main Food Index (MFI):

$$MFI = \sqrt{[(\%Cn + \%F)/2]} \times \%Cw$$

This gives a major role to the weight of prey items.

RESULTS

Dasyatis pastinaca

A total of 23 individuals of *D. pastinaca* were sampled, with a VI of 56.5% (Fig. 2). Sixty-five prey items, belonging to seven taxa, were found. Indexes were calculated (Tab. I).

The most common taxa were decapod crustaceans (57.2 %IRI), followed by polychaetes (18.2 %IRI). Teleost fish appear with only 0.5 %IRI. Within the decapod prey group, *Pachygrapsus marmoratus* (Fabricius, 1787) accounted for 53% by weight, Scyllaridae for 13% and unidentified species for 34%.

Myliobatis aquila

A total of 10 individuals were sampled, with a VI of 10%. Plotting the accumulated trophic diversity with the sampled number of stomachs, we get a significant number of stomachs sampled (Fig. 3).

A total of 371 prey items were found, belonging to two major groups (Mollusca and Crustacea), from which six were identified to species level (Tab. II). The species with higher %IRI and %MFI is *Calliostoma lusitanicum* Nordsieck & García-Talavera, 1979 with 53.9 and 62.7, respectively, followed by *Stramonita haemastoma* (Linnaeus, 1767) with 26.7 and 23.8, respectively.

DISCUSSION

The two species examined in this study are the most common stingrays in Azorean waters (Barreiros and Gadig, 2011). Nevertheless, and according to Porteiro *et al*. (2010), the following species of stingrays also occur in the Azores: *Dasyatis centroura* (Mitchill, 1815), *Pteroplatytrygon violacea* (Bonaparte, 1832) and *Taeniura grabata* (Geoffroy Saint-Hilaire, 1817). None is actively sought by local fisheries or have any commercial value as food. Their economic importance, however, is increasing with recreational diving and underwater photography. These could prove to be a valuable asset to increase our overall knowledge on stingrays in this region, although additional efforts in collection of

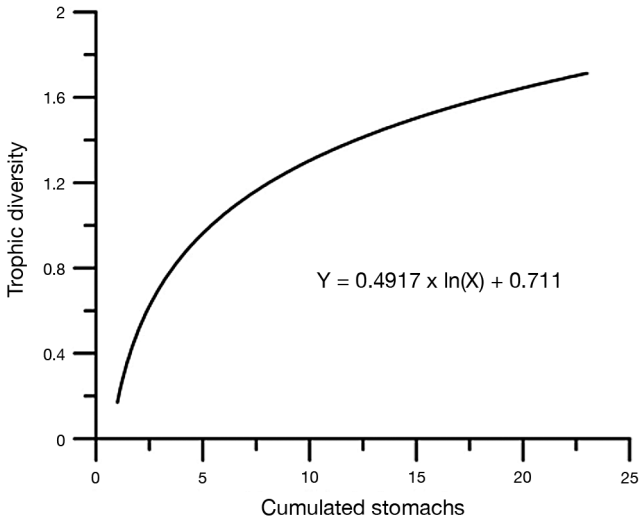

Figure 2. - Cumulated trophic diversity and number of sampled stomachs from *Dasyatis pastinaca* from Terceira Island, Azores, NE Atlantic.

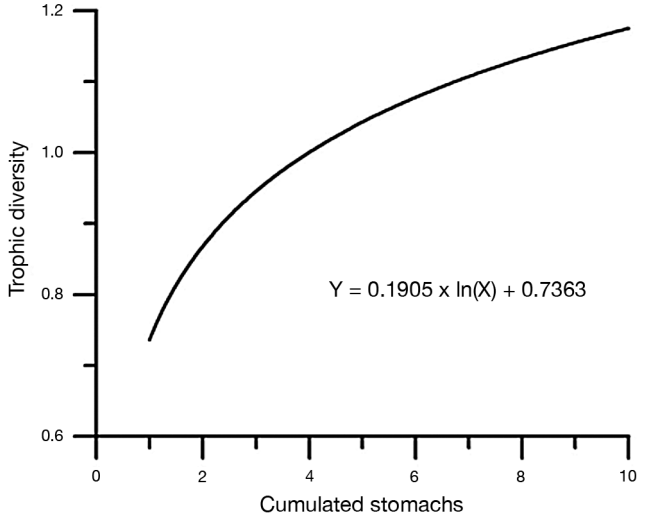

Figure 3. - Cumulated trophic diversity and number of sampled stomachs from *Myliobatis aquila* from Terceira Island, Azores, NE Atlantic.

Table I. – Diet composition of *Dasyatis pastinaca* from a sample collected in Terceira Island, Azores, NE Atlantic, where NP represents the number of captured prey, NS the number of stomachs where a given prey appears, %F frequency of occurrence for a given prey item, %Cw weight percentage, %Cn numerical percentage, IRI is the Index of relative Importance for each prey item and MFI the index of preferential prey in percentage. Items in brackets correspond to the prey item group Decapoda.

Prey item	NP	NS	Weight (g)	%F	%Cw	%Cn	IRI	%IRI	%MFI
Polychaeta	31	2	17.5	20.0	21.6	47.7	1387	18.2	42.0
Amphipoda	4	2	20.9	20.0	25.9	6.2	640	8.4	6.0
Mysidacea	16	3	12.4	30.0	15.3	24.6	1199	15.7	23.0
Decapoda	13	8	28.0	80.0	34.7	20.0	4372	57.2	28.0
Pachygrapsus marmoratus	6	5	14.8	50.0	18.3	9.2	1375	18.0	14.1
Scyllaridae	3	1	3.6	10.0	4.5	4.6	91	1.2	1.7
Decapoda unid.	4	2	9.6	20.0	11.9	6.2	362	4.7	6.1
Teleostei	1	1	2.0	10.0	2.5	1.5	40	0.5	1.0
Total	65	16	80.8	–	100.0	100.0	7638	100.0	100.0

Table II. - Diet composition of *Myliobatis aquila* from a sample collected in Terceira Island, Azores, NE Atlantic. See abbreviation significance in table I.

Prey item	NP	NS	Weight (g)	%F	%Cw	%Cn	IRI	%IRI	%MFI
Decapoda	53	9	70.0	14.3	66.9	14.3	1160.3	10.2	45.2
Pachygrapsus marmoratus	10	1	35.1	11.1	33.6	2.7	402.9	3.6	1.9
Calcinus tubularis	22	2	26.6	22.2	25.4	5.9	697.1	6.3	4.4
Dardanus calidus	21	6	8.3	66.7	7.9	5.7	906.6	8.2	5.3
Gastropoda	318	17	34.6	85.7	33.1	85.7	10182.3	89.8	54.8
Stramonita haemastoma	85	7	15.8	77.8	15.1	22.9	2957.3	26.7	23.8
Calliostoma lusitanicum	222	7	17.7	77.8	16.9	59.8	5970.7	53.9	62.7
Littorina neritoides	11	3	1.1	33.3	1.0	3.0	132.6	1.2	1.9
Total	371	26	104.6	–	100.0	100.0	11342.6	100.0	100.0

specimens for strengthening the present work is absolutely needed.

Dasyatis pastinaca

Despite a low number of sampled stomachs, not representative for an accurate evaluation, this study still allows an overview of the diet of this species. In fact, it is the first one made for the NE Atlantic, and one of the few for this species in the world (see Ismen, 2003; Yeldan *et al*., 2009).

Our results agree with those from other studies (Ismen, 2003; Yeldan *et al*., 2009), that also found crustaceans being the dominant group in the diet of *D. pastinaca*. In the above author studies, fish came in second, but in our study this group came lastly.

When comparing the mean size (TL) of our reduced sample to the figures obtained by Ismen (2003) and Yeldan *et al*. (2009), the mean size of our sample, 334.8 mm, is considerably smaller than that reported by these authors (522.5 and 602.5 mm, respectively). This difference is certainly due to the small size of our sampled specimens, probably because they were collected in shallow water, when compared with the ones from those studies. In the above author works, respectively 256 and 346 specimens were available when compared to our small number (23). As said before, stingrays are not actively fished in the Azores and the only specimens available are those that are possible to collect by spearfishing.

Myliobatis aquila

In their study, Jardas *et al*. (2004) found that the most frequent prey group of *M. aquila* was molluscs followed by sipunculids. Among molluscs, bivalves made an important contribution to the diet, followed by gastropods. They also found similarities between their study and previous ones (see Jardas *et al*., 2004 for details).

We have similar results: molluscs play a major role in the feeding of the species, but we found gastropods in the stomach contents while bivalves were completely absent. In the secondary group of prey, instead of sipunculids as found by Jardas *et al*. (2004), we found crustaceans, mostly from the hermit-crab family Diogenidae. This led us to think that the eagle ray, a mollusc feeder, searches for the shells, something that could help explain the occurrence of hermit crabs in the stomachs. This particular aspect surely deserves additional studies, including visual monitoring of *M. aquila* while feeding.

Jardas *et al*. (2004) refer to other prey groups (Polychaetae, Nemertinae and teleost fish) with a small importance in the diet. We did not find any of these groups in our sample. The extensive work by Jacobsen and Bennett (2013) also reports decapod crustaceans and teleost fish as major prey items of stingrays. However, it would be speculative to compare our small sample from two species with the vast guild studied by these authors.

Low weights of *Pachygrapsus marmoratus* are most certainly due to the fact that only small specimens, or even just parts of these crabs, were found in the stomachs. A fact that explains the apparent contrast with the comparative high weight of large amphipods.

This study is a first evaluation of the feeding ecology for these two species for the NE Atlantic and in fact outside the Mediterranean basin. Although the number of sampled stomachs was not high enough for a more conclusive evaluation of the diet of *Dasyatis pastinaca* together with a high VI value, our results are in agreement with the other few studies made for this species. Concerning *Myliobatis aquila,* despite the most important group of prey being the same (with the exception given by the absence of polychaetes and the above discussed presence of hermit-crabs), there are differences in the feeding ecology of this species between Mediterranean and Atlantic populations. The different niches occupied by our target species reflect their different diets clearly, showing *D. pastinaca* as a crustacean predator and *M. aquila* with an apparent preference for molluscs and worms.

Acknowledgments. – We which to thank François Chauvin for collecting all specimens and for his work in the laboratory while on a post-graduation program in the Azores University.

REFERENCES

AFONSO P. & VASCO-RODRIGUES N., 2015. - Summer aggregations of the common eagle ray, *Myliobatis aquila*. *Arquipélago*. *Life Mar. Sci*., 32: 79-82.

BARREIROS J.P. & GADIG O.B.F., 2011. - Sharks and Rays from the Azores, an illustrated Catalogue. 1st edit., 189 p. Portugal: IAC - Instituto Açoriano de Cultura, Angra do Heroísmo.

BERG J., 1979. - Discussion of methods of investigating the food of fishes, with reference to a preliminary study of the prey of *Gobiusculus flavescens* (Gobiidae). *Mar. Biol*., 50: 263-273.

BOWEN S.H., 1983. - Quantitative description of the diet. *In:* Fisheries Techniques (Nielsen L.A. & Johnson D.L., eds), pp. 325-336. Maryland: American Fisheries Society.

CAILLIET G.M., 1976. - Several approaches to the feeding ecology of fishes. Proc. of the First Pacific Northwest Technical Workshop, Fish Food Habits Studies, Sea Grant Publ. WSG-WO-77-2: 1-13.

CAILLIET G.M., LOVE M.S. & EBELING A.W., 1986. - Fishes: A Field and Laboratory Manual on their Structure, Identification and Natural History. 194 p. Belmont, CA, USA: Wadsworth Publishing Company.

CAPAPÉ C., 1976. - Étude du régime alimentaire de l'aigle de mer, *Myliobatis aquila* (L., 1758) des côtes tunisiennes. *J. Cons. Int. Explor. Mer*, 37: 29-35.

CAPAPÉ C., GUÉLORGET O., VERGNE Y. & QUIGNARD J.P., 2007. - Reproductive biology of the common eagle ray, *Myliobatis aquila* (Chondrichthyes: Myliobatidae) from the coast cf Languedoc (Southern France, northern Mediterranean). *Vie Milieu*, 53: 25-30.

COMPAGNO L.J.V., 1986. - Myliobatidae. *In* Smiths' Sea Fishes (Smith M.M. & Heemstra P.C., eds), pp. 132-134. Berlin: Springer-Verlag.

DEBELIUS H., 1997. - Mediterranean and Atlantic Fish Guide. 159 p. Stuttgart: IKAN - Unterwasserarchiv.

DERBAL F. & KARA M.H., 1996. - Alimentation estivale du mérou, *Epinephelus marginatus* (Serranidae), des côtes est algériennes. *Cybium*, 20: 295-301.

FRISCH A.J., COLE A.J., HOBBS J.P.A., RIZZARI J.R. & MUNKRES K.P., 2012. - Effects of spearfishing on reef fish populations in a multi-use conservation area. *PLoS ONE*, 7: e51938.

HARMELIN-VIVIEN M.L., HARMELIN J.G. & ALMEIDA A.J., 2001. - Structure of fish assemblages on coastal rocky shores of the Azores. *Bol. Mus. Munic. Funchal*, 6: 127-138.

HAYWARD P.J. & RYLAND J.S., 1990. - The Marine Fauna of the British Isles and North-West Europe: 2. Molluscs to Chordates. 627 p. Oxford: Clarendon Press.

HURTUBIA J., 1973. - Trophic diversity measurement in sympatric predatory species. *Ecology*, 54: 885-890.

HYSLOP E.J., 1980. - Stomach contents analysis – A review of methods and their application. *J. Fish Biol*., 17: 411-429.

ISMEN A., 2003. - Age, growth, reproduction and food of common stingray (*Dasyatis pastinaca* L., 1758) in İskenderun Bay, the eastern Mediterranean. *Fish Res*., 60: 169-176.

JACOBSEN I.P. & BENNETT M.B., 2013. - A comparative analysis of feeding and trophic level ecology in stingrays (Rajiformes; Myliobatoidei) and electric rays (Rajiformes: Torpedinoidei). *PLoS ONE*, 8: e71348.

JARDAS I., SANTIC M. & PALLAORO A., 2004. - Diet composition of the eagle ray, *Myliobatis aquila* (Chondrichthyes: Myliobatidae), in the Eastern Adriatic Sea. *Cybium,* 28: 372-374.

KULBICKI M., BOZEC Y.-M., LABROSSE P., LETOURNEUR Y., MOU-THAM G. & WANTIEZ L., 2005. - Diet composition of carnivorous fishes from coral reef lagoons of New Caledonia. *Aquat. Living Resour*., 18: 231-250.

LUNA S.M., 2009. - *Myliobatis aquila*: Common eagle ray. Fishbase. http://www.fishbase.org/summary/4330.

MAGURRAN A.E., 2004. - Measuring Biological Diversity. 215 p. Oxford: Blackwell Science.

MASSUTÍ E. & MORANTA J., 2003. - Demersal assemblages and depth distribution of elasmobranchs from the continental shelf and slope off the Balearic Islands (western Mediterranean). *ICES J. Mar. Sci*., 60: 753-766.

MAUCHLINE J. & GORDON J.D.M., 1985. - Trophic diversity in deep-sea fish. *J. Fish Biol*., 26 : 527-535.

MOREY G., MORANTA J., RIERA F., GRAU A.M. & MORALES-NIN B., 2006. - Elasmobranchs in trammel net fishery associated to marine reserves in the Balearic Islands (NW Mediterranean). *Cybium*, 30: 125-132.

PATZNER R.A., SANTOS R.S., RÉ P. & NASH R.D.M., 1992. - Littoral fishes of the Azores. An annotated checklist of fishes observed during the "Expedition Azores 1989." *Arquipélago - Life Earth Sci*., 10: 101-111.

PINKAS L., OLIPHANT M.S. & IVERSON I.L.K., 1971. - Food habits of Albacora, Bluefin tuna, and Bonito in California waters. *Calif. Fish. Bull.*, 152: 1-105.

PORTEIRO F.M., MENEZES G.M., AFONSO P., MONTEIRO J.G. & SANTOS R.S., 2010. - Marine fish (Chondrichthyes, Actinopterygii). *In:* A List of the Terrestrial and Marine Biota from the Azores (Borges P.A.V., Costa A., Cunha R. *et al.*, eds), pp. 331-344. Cascais, Portugal: Principia Editora.

SALDANHA L., 2003. - Fauna Submarina Atlântica: Portugal continental, Açores e Madeira. 4ª edit., 364 p. Lisboa: Europa-América.

SANTOS R.S., HAWKINS S., MONTEIRO L.R., ALVES M. & ISIDRO E.J., 1995. - Marine research, resources and conservation in the Azores. *Aquat. Conserv. Mar. Fresh Water Ecosyst.*, 5: 311-354.

SANTOS R.S., PORTEIRO F.M. & BARREIROS J.P., 1997. - Marine fishes of the Azores: An annotated checklist and bibliography. *Arquipélago. Life Mar. Sci.*, Suppl. 1: 1-231.

SILVA M.A., MACHETE M., REIS D., SANTOS M., PRIETO R., DÂMASO C., PEREIRA J.G. & SANTOS R.S., 2011. - A review of interactions between cetaceans and fisheries in the Azores. *Aquat. Conserv. Mar. Fresh Water Ecosyst.*, 21: 17-27.

SPELLERBERG I.F. & FEDOR P.J., 2003. - A tribute to Claude Shannon (1916-2001) and a plea for more rigorous use of species richness, species diversity and "Shannon-Wiener" Index. *Glob. Ecol. Biogeogr.*, 12: 177-179.

VALLS M., QUETGLAS A., ORDINES F. & MORANTA J., 2011. - Feeding ecology of demersal elasmobranchs from the shelf and slope off the Balearic Sea (western Mediterranean). *Sci. Mar.*, 75: 633-639.

VIANA A. da F. & VIANNA M., 2014. - The feeding habits of the eyespot skate *Atlantoraja cyclophora* (Elasmobranchii: Rajiformes) in southeastern Brazil. *Zool.* 31:.119-125.

WETHERBEE B.M., CORTÉS E. & BIZZARRO J.F., 2012. - Food Consumption and Feeding Habits. *In* Biology of Sharks and Their Relatives, 2nd edit. (Carrier J.C., Musick J.A. & Heithaus M.R., eds), pp. 239-264. Boca Raton: Taylor & Francis Group.

WHITEHEAD P.J.P., BAUCHOT M.-L., HUREAU J.-C., NIELSEN J. & TORTONESE E. (eds), 1984. - Fishes of the North-eastern Atlantic and the Mediterranean. Vol. 1-III, 1473 p. Paris: Unesco.

WIRTZ P., 1995. - Unterwasserführer Madeira, Kanaren und Azoren, Niedere Tiere. 193 p. Stuttgart: Delius Klasing.

YELDAN H., AVSAR D. & MANAŞIRLI M., 2009. - Age, growth and feeding of the common stingray (*Dasyatis pastinaca* L., 1758) in the Cilician coastal basin, northeastern Mediterranean Sea. *J. Appl. Ichthyol.*, 25: 98-102.

YIGIN C.C. & ISMEN A., 2012. - Age, growth and reproduction of the common stingray, *Dasyatis pastinaca* from the North Aegean Sea. *Mar. Biol. Res.*, 8: 644-653.

ZANDER C.D., 1982. - Feeding ecology of littoral Gobiid and Blennioid fish of the Banyuls area (Mediterranean Sea). I. Main food and trophic dimension of niche and ecotope. *Vie Milieu*, 32 :1-10.