STOMACH CONTENTS OF BOTTLENOSE DOLPHIN *TURSIOPS TRUNCATUS* (MONTAGU, 1821): FIRST RESULTS FROM SPECIMENS STRANDED IN THE TUSCAN ARCHIPELAGO IN THE PERIOD 1990–2021

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Abstract – Bottlenose dolphin is one of the most frequently observed cetaceans in the Mediterranean. The diet of *Tursiops truncatus* (Cetacea: Odontoceti) consists on a variety of prey, including fishes, cephalopods, and occasionally crustaceans. The first data of stomachs contents of thirty-five *T. truncatus* stranded in Tuscany coasts, north-western Mediterranean, between 1990 and August 2021, are presented. The results show an abundant and frequent presence of Osteichthyes, compared to cephalopods. European hake, conger eel, Sparidae and Octopodidae results to be important prey not only for bottlenose dolphins but also species of commercial interest.

Introduction

Bottlenose dolphin *Tursiops truncatus* (Montagu, 1821) is a cosmopolitan species; it is found in all tropical and temperate coastal waters of the world [7]. The bottlenose dolphins in the Mediterranean Sea mainly shows coastal habits [6,9], which often lead it to interact with fishing activities, such as opportunistic feeding from set nets. The diet of *T. truncatus* consists on a variety of prey, including fishes, cephalopods, and occasionally crustaceans [1]. The trophic spectrum of bottlenose dolphin in the Mediterranean Sea is mainly composed on a great variety of demersal and pelagic preys [3,8,10,13,16] including species of commercial value, such as *Merluccius merluccius* (Linnaeus, 1758) and octopus species. The most widely used technique for evaluating cetacean diet is the stomach content analysis [11] of stranded animals.

In this study, first data on the diet of specimens of *T. truncatus* stranded in Tuscany, north-western Mediterranean, are provided.

Stranding of bottlenose is a rather common event along Tuscany coasts: a total of 207 bottlenose dolphins were found stranded in Tuscany between February 1990 and August 2021, showing and increasing trend with a peak mortality in summer months (ARPAT, unpublished data). This temporal trend is not referred probably to a real increase in mortality for this species but to the increasing monitoring, thanks to the efforts and coordination by

Referee List (DOI 10.36253/fup_referee_list)
FUP Best Practice in Scholarly Publishing (DOI 10.36253/fup_best_practice)
Alessandra Neri; Cecilia Mancusi; Letizia Marsili; Paolo Sartor; Alessandro Voliani, *Stomach contents of bottlenose dolphin* Tursiops truncatus *(Montagu, 1821): first results from specimens stranded in the Tuscan Archipelago in the period 1990–2021,* pp. 738-746 © 2022 Author(s), CC BY-NC-SA 4.0, 10.36253/979-12-215-0030-1.70

Regional Agency for Environmental Protection (ARPAT) as stated by Regional Regulation LR 30/2015[1] and the consequent establishment of the Observatory for Biodiversity in Tuscany.

Therefore, the stranded individuals are a unique opportunity to collect data aimed at increasing the biology and ecology of this species, including is dietary habits and trophic spectrum.

Materials and Methods

The bottlenose dolphins examined come from a stomachs collection of forty-seven individuals (20 males and 27 females) stranded along the Tuscany coasts between 1990 and August 2021 and collected by the Regional Agency for Environmental Protection of Tuscany (ARPAT, Livorno, Italy).

After dissection, the collected stomachs were frozen at -20 °C. They were successively de-frozen and their content, after being washed in a sieve with 0.3 mm of mesh, was preserved in a solution of 75 % ethanol. The stomach content analysis was performed under stereoscope. The identification of preys was carried out using specific guides [4,15] and comparing the undigested remains, e.g. otoliths for bony fishes and beaks for mollusk cephalopods, with collections of original samples; the preys were identified at the lowest possible taxonomic level.

The contribution of each prey item (e.g. species of higher Taxa) to the food spectrum was assessed as percentage of abundance (%N, e.g. its contribution to the total number of preys) and percentage of frequency (%F), that is the percentage of stomachs in which at least one individual of a given prey item was found.

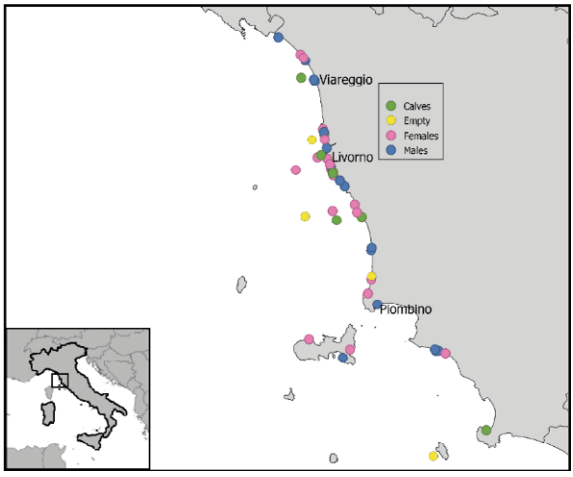

Figure 1 – Locations of the sites of *T. truncatus* strandings.

[1] *Legge regionale 19 marzo 2015, n. 30. Norme per la conservazione e la valorizzazione del patrimonio naturalistico-ambientale regionale. Modifiche alla l.r. 24/1994, alla l.r. 65/1997, alla l.r. 24/2000 ed alla l.r. 10/2010.*

Results

After the analysis of stomach contents of 47 collected samples, thirty-five *T. truncatus* stomachs (17 males and 18 females) showed some food remain, while the other stomachs were empty or belonged to calves nursed by the mother (Figure 1).

Table 1 shows the list of preys found in the stomachs analysed, with the relative data of abundance and frequency. Overall, a total of 2792 prey items (belonging to 76 taxa) were identified as 2358 fishes (58 taxa) and 434 cephalopods (18 taxa). Osteichthyes resulted the most abundant and frequent preys with a numerical abundance percentage (%N) of 84.5 % and a percentage frequency (%F) of 97.1 %. Cephalopods were less abundant than fishes (%N=15.5), while their frequency was high (%F=74.3). The results obtained show that European hake, *M. merluccius* (%N=21.9), and the conger eel, *C. conger* (12.4 %), were the most abundant species, while the snake blenny, *O. barbatum* (6.8 %), the annular sea bream. *D. annularis* (5.1 %), and the common Pandora, *P. erythrinus* (3.9 %), were fishes of secondary importance, in terms of numerical abundance (Table 1). The most abundant cephalopods were the broadtail shortfin squid, *I. coindetii* (4.7 %), followed by the horned octopus, *E. cirrhosa* (3.2 %), and the common octopus, *O. vulgaris* (2.3 %). As shown in Table 1, *C. conger* was the most frequent prey (80.0 %), while *M. merluccius* was present in half of the dolphins examined (48.6 %); other species, e.g. *D. annularis, P. erythrinus* and *I. coindetii* have a frequency of occurrence of 45.7 % each one. At level of Families, Congridae (%N=13.1; %F=82.9), Merlucciidae (%N=21.9; %F=48.6) and Sparidae (%N=11.0; %F=65.7) were the most important for bony fishes, while Octopodidae (%N=7.0; %F=42.9) and Ommastrephidae (%N=4.7; %F=45.7) were the most important for cephalopods (Figure 2).

Table 1 – List of preys found in *T. truncatus* from the Tuscany area (western Mediterranean Sea). For each prey item: N, number of preys; %N, percentage in number (* = < 0.1); F, number of occurrence; %F, frequency of occurrence in percentage.

	N	%N	F	%F
OSTEICHTHYES				
Argentinidae	2	0.1	1	2.9
Argentina sphyraena Linnaeus, 1758	2	0.1	1	2.9
Atherinidae	2	0.1	1	2.9
Atherina boyeri Risso, 1810	2	0.1	1	2.9
Bothidae	5	0.2	3	8.6
Arnoglossus sp. Bleeker, 1862	4	0.1	2	5.7
Bothus podas (Delaroche, 1809)	1	*	1	2.9
Callionymidae	4	0.1	2	5.7
Callionymus risso Lesueur, 1814	1	*	1	2.9
Callionymus sp. Linnaeus, 1758	3	0.1	1	2.9
Carangidae	119	4.3	11	31.4
Trachurus mediterraneus (Steindachner, 1868)	64	2.3	8	22.9
Trachurus sp. Rafinesque, 1810	55	2.0	4	11.4
Carapidae	4	0.1	1	2.9
Carapidae unidentified	4	0.1	1	2.9

	N	%N	F	%F
Centracanthidae	44	1.6	11	31.4
Spicara flexuosa Rafinesque, 1810	26	0.9	8	22.9
Spicara maena (Linnaeus, 1758)	2	0.1	1	2.9
Spicara smaris (Linnaeus, 1758)	16	0.6	4	11.4
Cepolidae	1	*	1	2.9
Cepola macrophthalma (Linnaeus, 1758)	1	*	1	2.9
Citharidae	6	0.2	3	8.6
Citharus linguatula (Linnaeus, 1758)	6	0.2	3	8.6
Clupeidae	102	3.7	11	31.4
Sardina pilchardus (Walbaum, 1792)	87	3.1	4	11.4
Sardinella aurita Valenciennes, 1847	3	0.1	2	5.7
Clupeidae unidentified	12	0.4	6	17.1
Congridae	366	13.1	29	82.9
Ariosoma balearicum (Delaroche, 1809)	11	0.4	6	17.1
Conger conger (Linnaeus, 1758)	345	12.4	28	80.0
Gnathophis mystax (Delaroche, 1809)	10	0.4	3	8.6
Engraulidae	47	1.7	10	28.6
Engraulis encrasicolus (Linnaeus, 1758)	47	1.7	10	28.6
Gadidae	87	3.1	10	28.6
Micromesistius poutassou (Risso, 1827)	1	*	1	2.9
Trisopterus capelanus (Lacepède, 1800)	86	3.1	10	28.6
Gobiidae	164	5.9	20	57.1
Lesueurigobius sp. Whitley, 1950	32	1.1	11	31.4
Gobius niger Linnaeus, 1758	92	3.3	11	31.4
Gobius spp. Linnaeus, 1758	8	0.3	3	8.6
Gobiidae unidentified	32	1.1	1	2.9
Haemulidae	1	*	1	2.9
Pomadasys incisus (Bowdich, 1825)	1	*	1	2.9
Merlucciidae	612	21.9	17	48.6
Merluccius merluccius (Linnaeus, 1758)	612	21.9	17	48.6
Moronidae	1	*	1	2.9
Dicentrarchus labrax (Linnaeus, 1758)	1	*	1	2.9
Mugilidae	36	1.3	11	31.4
Chelon ramada (Risso, 1827)	15	0.5	4	11.4
Mugilidae unidentified	21	0.8	7	20.0
Mullidae	66	2.4	8	22.9
Mullus barbatus Linnaeus, 1758	1	*	1	2.9
Mullus sp. Linnaeus, 1758	65	2.3	7	20.0
Ophidiidae	191	6.8	13	37.1
Ophidion barbatum Linnaeus, 1758	191	6.8	13	37.1
Phycidae	12	0.4	1	2.9
Phycis sp. Walbaum, 1792	12	0.4	1	2.9
Sciaenidae	12	0.4	2	5.7
Umbrina cirrosa (Linnaeus, 1758)	12	0.4	2	5.7

	N	%N	F	%F
Scombridae	2	0.1	1	2.9
Scomber sp. Linnaeus, 1758	2	0.1	1	2.9
Serranidae	13	0.5	5	14.3
Serranus cabrilla (Linnaeus, 1758)	1	*	1	2.9
Serranus sp. Cuvier, 1816	12	0.4	4	11.4
Soleidae	3	0.1	3	8.6
Solea solea (Linnaeus, 1758)	1	*	1	2.9
Solea sp. Quensel, 1806	1	*	1	2.9
Soleidae unidentified	1	*	1	2.9
Sparidae	308	11.0	23	65.7
Boops boops (Linnaeus, 1758)	23	0.8	6	17.1
Dentex dentex (Linnaeus, 1758)	1	*	1	2.9
Diplodus annularis (Linnaeus, 1758)	143	5.1	16	45.7
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	5	0.2	2	5.7
Lithognathus mormyrus (Linnaeus, 1758)	16	0.6	1	2.9
Pagellus acarne (Risso, 1827)	1	*	1	2.9
Pagellus erythrinus (Linnaeus, 1758)	110	3.9	16	45.7
Sparus aurata Linnaeus, 1758	8	0.3	2	5.7
Spondyliosoma cantharus (Linnaeus, 1758)	1	*	1	2.9
Sphyraenidae	9	0.3	3	8.6
Sphyraena sphyraena (Linnaeus, 1758)	9	0.3	3	8.6
Synodontidae	1	*	1	2.9
Synodus saurus (Linnaeus, 1758)	1	*	1	2.9
Triglidae	32	1.1	13	37.1
Chelidonichthys cuculus (Linnaeus, 1758)	8	0.3	3	8.6
Chelidonichthys lucerna (Linnaeus, 1758)	2	0.1	2	5.7
Triglidae unidentified	22	0.8	9	25.7
Osteichthyes unidentified	106	3.8	21	60.0
Total Osteichthyes	2358	84.5	34	97.1
CEPHALOPODA				
Argonautidae	1	*	1	2.9
Argonauta argo Linnaeus, 1758	1	*	1	2.9
Enoploteuthidae	1	*	1	2.9
Abralia veranyi (Rüppell, 1844)	1	*	1	2.9
Histioteuthidae	7	0.3	1	2.9
Histioteuthis reversa (Verrill, 1880)	7	0.3	1	2.9
Loliginidae	65	2.3	12	34.3
Alloteuthis spp. Wülker, 1920	12	0.4	5	14.3
Loligo vulgaris Lamarck, 1798	51	1.8	9	25.7
Loligo sp. Lamarck, 1798	2	0.1	1	2.9
Octopodidae	195	7.0	15	42.9
Eledone cirrhosa (Lamarck, 1798)	90	3.2	9	25.7
Eledone moschata (Lamarck, 1798)	40	1.4	7	20.0
Octopus vulgaris Cuvier, 1797	64	2.3	9	25.7
Octopodidae unidentified	1	*	1	2.9

	N	%N	F	%F
Ommastrephidae	130	4.7	16	45.7
Illex coindetii (Vérany, 1839)	130	4.7	16	45.7
Onychoteuthidae	11	0.4	2	5.7
Ancistroteuthis lichtensteinii (Férussac [in Férussac & d'Orbigny], 1835)	7	0.3	2	5.7
Onychoteuthis banksii (Leach, 1817)	4	0.1	1	2.9
Sepiidae	13	0.5	1	2.9
Sepia officinalis Linnaeus, 1758	1	*	1	2.9
Sepia spp. Linnaeus, 1758	12	0.4	1	2.9
Sepiolidae	9	0.3	6	17.1
Heteroteuthis dispar (Rüppell, 1844)	2	0.1	2	5.7
Sepiolidae unidentified	7	0.3	4	11.4
Cephalopoda unidentified	2	0.1	2	5.7
Total Cephalopoda	434	15.5	26	74.3
Total preys	2792			

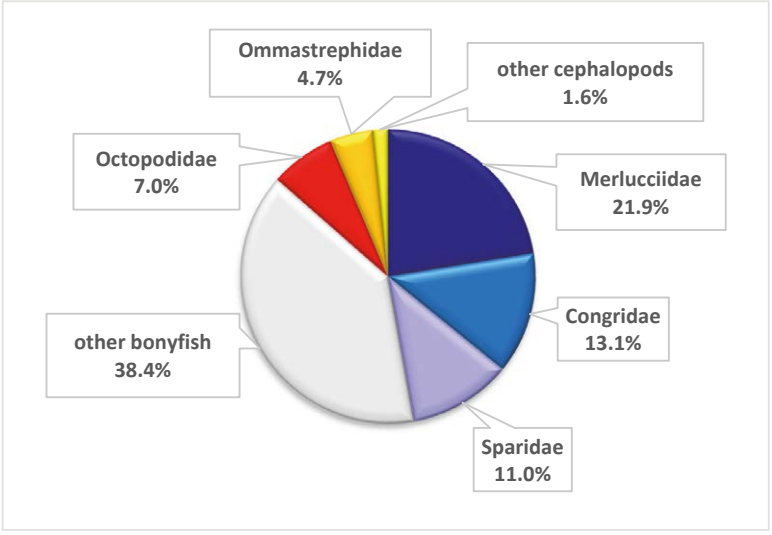

Figure 2 – Stomachs contents of *T. truncatus*. Numerical abundance (percentage) at level of Families.

Discussion

The results of this dietary study showed that in the investigated area, the Tuscan Archipelago, north-western Mediterranean Sea, the trophic spectrum of the bottlenose dolphin was highly diversified; in spite of the rather low number of stomachs analysed (35), 76 different taxa, belonging mainly to bony fishes and also to cephalopods. Nevertheless, the

bulk of the predation is based on a restricted group of species, in particular the European hake and the conger eel. Sparidae (fishes) and Octopodidae (mollusk cephalopods) can be considered as prey of secondary importance. The importance of these preys in the diet of *T. truncatus* was previously reported in the Gulf of Cadiz [5], except for Octopodidae which were relevant in the diet of female bottlenose dolphins in the western Mediterranean Sea [3].

The presence of European hake as main prey for the bottlenose dolphin agrees with previous data from European Atlantic coasts [5,12,14] and in the western Mediterranean Sea [3]. Most of the prey identified from the stomach contents of *T. truncatus* are species with benthic and necto benthic habit, as reported by [13], for this same study area, and by [3], for the wester Mediterranean Sea, but also some pelagic fishes [12,14]. This aspect could be related to the generalist habits of this predator, as shown by the presence of the conger eel that may change according to the different location investigated [3,12,14].

Moreover, it is worthy to mention the remains of set nets (e.g. trammel nets, gill nets) found in the stomachs of two specimens of bottlenose dolphin analysed, which showed evident signs of bycatch, such as net wrapped on the head and severed caudal fin. This aspect confirms the opportunistic interaction of *T. truncatus* with fishing activities and can be an indication that those dolphins died trapped in the nets in attempt to feed [2].

Conclusions

The results obtained confirm that the feeding behaviour of *T. truncatus* predator is mainly coastal. In addition, most of the diet if based on species of commercial relevance, as *M. merluccius*, *I. coindetii* and some species of Sparidae and Octopodidae.

Therefore, further investigations are needed to investigate the role of this cetacean in the natural mortality of commercially exploited species, subjected to regular stock assessment, as well as to deepen the knowledge of food and feeding of *T. truncatus*, and important species in the marine coastal ecosystems. Supplementary investigation will be possible only continuing to supervise stranding, to collect and analyse stomachs content of this top predator.

Acknowledgements

We kindly acknowledge Claudia Musumeci, CIBM Livorno, for her assistance in drawing the map of Figure 1.

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