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Feeding behaviour of the bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821) in the Sado estuary, Portugal, and a review of its prey species

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Abstract. The purpose of this article is to present the information available on the feeding behaviour and diet of bottlenose dolphins resident in the Sado estuary, Portugal. Bottlenose dolphins are opportunistic feeders, with a diversified diet that includes crustaceans, cephalopods, pelagic and benthonic fish, according to availability and abundance. The direct observation of feeding behaviours, supported by photographic and video records, allowed the identification of some of the dolphin prey species in this area, namely the European eel, the mullets, the common cuttlefish and the octopus. A list of the most frequent bottlenose dolphin prey species around the world was compared to the fish and cephalopod species occurring in the Sado estuary. This comparison enabled to list species that are probably preyed upon by the local dolphins. Observed foraging behaviour was more frequent in the shallower parts of the study area, where it may be easier to find and capture prey.

Key words: *Tursiops truncatus*, bottlenose dolphin, feeding, prey, fish, cephalopods.

Resumo: Comportamento alimentar do golfinho-bico-de-garrafa, *Tursiops truncatus* (Montagu, 1821) no estuário de Sado, Portugal, e uma revisão de suas espécies de presas. O objetivo deste artigo é apresentar a informação disponível acerca do comportamento alimentar e da dieta dos golfinhos-bico-de-garrafa residentes no estuário do Sado, em Portugal. Os golfinhos-bico-de-garrafa são predadores oportunistas, com uma dieta diversificada que inclui crustáceos, cefalópodes e peixes pelágicos e bentônicos, de acordo com a disponibilidade e a abundância. A observação direta dos comportamentos alimentares, apoiada por registros fotográficos e videográficos, permitiu a identificação de algumas das espécies de presas dos golfinhos nesta região, nomeadamente a enguia-europeia, taínhas, o choco-comum e o polvo. Uma lista das espécies de presas mais comuns dos golfinhos-bico-de-garrafa em diversas regiões foi comparada com as espécies de peixes e cefalópodes que ocorrem no estuário do Sado. Esta comparação levou à elaboração de uma lista adicional de espécies que provavelmente também são presas dos golfinhos na região. A observação de comportamentos alimentares foi mais freqüente nas partes mais rasas da área de estudo, onde deverá ser mais fácil encontrar e capturar presas.

Palavras-chave: *Tursiops truncatus*, golfinho-bico-de-garrafa, alimentação, presa, peixes, cefalópodes.

INTRODUCTION

The bottlenose dolphin (named "roaz" or "golfinho-roaz" in Portugal, and "golfinho bico-de-garrafa" or "golfinho-flipper" in Brazil) is a generalist predator (LEATHERWOOD, 1975), with a diet that may include cephalopods, crustaceans and a great variety of pelagic and benthonic fish, according to the availability and abundance of local resources. However, as CORKERON *et al.* (1990) have noted, when choice is possible, even wild bottlenose dolphins show food preferences. For instance, the analysis of stomach contents of bottlenose dolphins resident in Sarasota Bay, Florida – a community that has been studied since 1970 - has shown that these dolphins feed on fish only, even though cephalopods and shrimp are also available (BARROS & WELLS, 1998). Mullets (Family Mugilidae) have always been considered dolphin favourite prey, but some studies (e.g., BARROS & ODELL, 1990; BARROS & WELLS, 1998; have found that these species are not necessarily the most frequent prey. The relative importance of mugilids in the diet of bottlenose dolphins may have been overrated due to the fact that mullets are often captured at the surface, even when they leap (Barros & Odell, 1990). A review of several studies of bottlenose dolphin diets or preferences in various regions resulted in the compilation presented on Table 1, listing the main prey-species (fish and cephalopods) that have been identified on the stomach contents of animals found stranded or accidentally netted (by-caught), and also through direct observation of predation events. It was decided not to include in this list species that were mentioned by some authors as only “rare”. Some food items that were identified only to the genus or family level are listed, however.

Bottlenose dolphins use a variety of foraging techniques, adapted to prey types and to the physiography of the feeding areas, showing remarkable behavioural plasticity (Leatherwood, 1975; Reynolds *et. al.,* 2000).

The small population of bottlenose dolphins in the Sado estuary is the only case of resident delphinids in the continental waters of Portugal, and one of the smallest known populations. This population has been the focus of a number of studies throughout the years, namely about its demography, home range, habitat use, movement patterns and also production of acoustic signals (e.g., Harzen, 1995; Cândido, 2003; Gaspar, 2003; Silva, 2003; Dos Santos *et al*., 2005). Some individual dolphins in this population have been sighted and photographed all year long in the area since 1981.

This article intends to gather information concerning feeding preferences and behaviours of the resident bottlenose dolphins, identifying as far as possible the fish and cephalopod species that have been recorded on film or video as confirmed prey, and listing also the probable prey-species. These were defined by looking at fish and cephalopods confirmed as prey in other bottlenose dolphin populations, and that are known to occur also in the Sado estuary. A number of studies, in fact, provide valuable information concerning the fauna of the Sado estuary (e.g., Sobral, 1981; Amorim, 1982; Bruxelas *et al*., 1992; Gonçalves, 1994; Lopes da Cunha, 1994; Cabral, 1999). Finally, the relation between dolphin feeding behaviour and local water depth was analyzed.

Material and Methods

Study area

The study was conducted in a coastal area of about 200 km^2 in continental Portugal, centered in the estuary of the Sado river and including adjacent waters (Fig. 1). The river mouth (which is located at 38° 30’ N, 08° 55’ W) is relatively narrow, with strong currents, but the estuary widens more upstream, reaching over 5 km from north to south shore. The city of Setúbal is located on the north shore, opposed to the sandy Tróia Peninsula. The estuary is divided in two channels, separated by a series of mud banks. The North Channel is heavily influenced by the city, its harbour and industrial areas and has a maximum depth of 15 m. The South Channel is wider and shows stronger water flows, reaching a depth of 30m. More upstream, the estuary is shallower and spreads into several ramifications bordered by mudflats. With a variety of habitats and high biological richness, the Sado Estuary Nature Reserve was created in 1980, covering the upper estuary.

Data collection

Between May 2005 and April 2006, observations were carried out in 10 different days, in a total of 69 hours following dolphin groups. Data from 41 days of previous sampling, collected between 2000 and 2004, were also analyzed, and the original notes of published descriptions of behaviour related to feeding in this population were also studied.

Field trips were conducted in an 8.4-m boat, with at least three observers sharing data collection duties. On leaving harbour, a predetermined transect was followed, until the sighting of a dolphin group was achieved, and then such groups were followed for as long as possible. All sampling was carried out in a non-intrusive manner, keeping a distance of about 50 to 100 m to the focal group, considered to include all animals involved in the same general activity in a 200-m radius.

Behaviour was sampled *ad libitum* (Altmann, 1974; Mann, 2000), and other data were recorded simultaneously, such as position and depth. The dorsal fins of all animals in each focal group were

Table 1. A list of bottlenose dolphin identified prey species, by family, with references (families according to NELSON, 2006, original authors according to FROESE & PAULY, 2006).

	Fish	
Fam. Anguillidae	Fam. Mugilidae	Fam. Sciaenidae
Anguilla sp. [11]	*Mugil* sp. [2,17]	*Leiostomus xanthurus* Lacepède, 1802 [1,2,3,11,12]
Fam. Congridae	*Mugil cephalus* Linnaeus, 1758 [1,3,7,12,16]	*Seriphus politus* Ayres, 1860 [8]
Conger sp. [7]	*Liza* sp. [14]	*Genyonemus lineatus* (Ayres, 1855) [8]
Conger conger (Linnaeus, 1758) [4,14]	*Liza argentea* (Quoy & Gaimard, 1825) [16]	*Menticirrhus undulatus* (Girard, 1854) [8,17]
Conger cinereus Rüppell, 1830 [5]	Fam. Hemiramphidae	*Menticirrhus americanus* (Linnaeus, 1758) [1]
Fam. Engraulidae	*Hemiramphus brasiliensis* (Linnaeus, 1758) [10]	*Bairdiella chrysoura* (Lacepède, 1802) [1,2,11,12]
Engraulis encrasicolus (Linnaeus, 1758) [4]	Fam. Belonidae	*Cynoscion nothus* (Holbrook, 1848) [2]
Engraulis ringens Jenyns, 1842 [17]	*Tylosurus gavialoides* (Castelnau, 1873) [16]	*Cynoscion arenarius* Ginsburg, 1930 [2,12]
Engraulis anchoita Hubbs & Marini, 1935 [18]	*Strongylura marina* (Walbaum, 1792) [12]	*Cynoscion analis* (Jenyns, 1842) [17]
Anchoa sp. [1,11,17]	Fam. Melamphaidae [13]	*Cynoscion regalis* (Bloch & Schneider, 1801) [1,11]
Fam. Clupeidae	Fam. Diretmidae	*Cynoscion nebulosus* (Cuvier, 1830) [1,12]
Sardina pilchardus (Walbaum, 1792) [4]	*Diretmus argenteus* Johnson, 1864 [13]	*Sciaena deliciosa* (Tschudi, 1846) [17]
Sardinops sagax (Jenyns, 1842) [17]	Fam. Zeidae	*Stellifer minor* (Tschudi, 1846) [17]
Dorosoma cepedianum (Lesueur, 1818) [12]	*Zeus faber* Linnaeus, 1758 [6]	*Micropogonias undulatus* (Linnaeus, 1766) [1,11,12]
Fam. Cyprinidae	Fam. Scorpaenidae	*Pogonias cromis* (Linnaeus, 1766) [12]
Abramis sp. [3]	*Scorpaena* sp. [12]	*Umbrina* sp. [12]
Fam. Ariidae	*Setarches guentheri* Johnson, 1862 [13]	Fam. Mullidae
Ariopsis felis (Linnaeus, 1766) [12]	Fam. Triglidae	*Mullus* sp. [12]
Fam. Alepocephalidae	*Prionotus carolinus* (Linnaeus, 1771) [12]	Fam. Cepolidae
Xenodermichthys copei (Gill, 1884) [13]	Fam. Cottidae	*Cepola rubescens* Linnaeus, 1766 [4]
Fam. Stomiidae	*Taurulus bubalis* (Euphrasen, 1786) [15]	Fam. Embiotocidae
Odontostomias micropogon Norman, 1930 [13]	Fam. Percidae	*Hyperprosopon argenteum* Gibbons, 1854 [8]
Fam. Synodontidae	*Sander* sp. [12]	*Amphistichus argenteus* Agassiz, 1854 [8]
Synodus foetens (Linnaeus, 1766) [12]	Fam. Pomatomidae	*Phanerodon furcatus* Girard, 1854 [8]
Fam. Merlucciidae	*Pomatomus saltatrix* (Linnaeus, 1766) [11]	Fam. Pinguipedidae
Merluccius merluccius (Linnaeus, 1758) [4,7,9,14]	Fam. Carangidae	*Pinguipes brasilianus* Cuvier, 1829 [18]
Merluccius gayi gayi (Guichenot, 1848) [17]	*Trachurus* sp. [4,7,14]	Fam. Ammodytidae
Fam. Phycidae	*Trachurus trachurus* (Linnaeus, 1758) [6,15]	*Ammodytes* spp [15]
Urophycis sp. [11]	*Trachurus delagoa* Nekrasov, 1970 [5]	Fam. Uranoscopidae
Fam. Gadidae [4,7]	Fam. Haemulidae	*Astroscopus y-graecum* (Cuvier, 1829) [12]
Micromesistius poutassou (Risso, 1827) [6,7,14]	*Orthopristis chrysoptera* (Linnaeus, 1766) [1,3]	Fam. Gobiidae [6]
Gadiculus argenteus thori Schmidt, 1914 [7]	*Pomadasys olivaceum* (Day, 1875) [5]	Fam. Trichiuridae
Trisopterus sp. [15]	Fam. Sparidae [7,9]	*Trichiurus lepturus* Linnaeus, 1758 [2,12]
Trisopterus luscus (Linnaeus, 1758) [6]	*Pagellus erythrinus* (Linnaeus, 1758) [4]	*Lepidopus caudatus* (Euphrasen, 1788) [13,14]
Gadus morhua Linnaeus, 1758 [15]	*Pagellus bellottii* Steindachner, 1882 [5]	Fam. Scombridae
Pollachius virens (Linnaeus, 1758) [15]	*Lagodon rhomboides* (Linnaeus, 1766) [1,3,12]	*Scomber japonicus* Houttuyn, 1782 [5]
Merlangius merlangus (Linnaeus, 1758) [15]	*Archosargus probatocephalus* (Walbaum, 1792) [3;12]	*Scomberomorus cavalla* (Cuvier, 1829) [12]
Melanogrammus aeglefinus (Linnaeus, 1758) [15]	*Boops boops* (Linnaeus, 1758) [14]	*Sarda* sp. [12]
Fam. Ophidiidae	*Diplodus puntazzo* (Cetti, 1777) 14	Fam. Paralichthyidae
Ophidion sp. [4]	*Diplodus sargus* (Linnaeus, 1758) [5]	*Paralichthys lethostigma* Jordan & Gilbert, 1884 [12]
Fam. Batrachoididae	*Sarpa salpa* (Linnaeus, 1758) [5]	Fam. Bothidae
Opsanus beta (Goode & Bean, 1880) [3]	*Dentex dentex* (Linnaeus, 1758) [14]	*Bothus* sp. [12]
Opsanus tau (Linnaeus, 1766) [1]	Fam. Centracanthidae	Fam. Tetraodontidae
Porichthys notatus Girard, 1854 [8]	*Spicara* sp. [14]	*Sphoeroides marmoratus* (Lowe, 1838) [12]
Porichthys myriaster Hubbs & Schultz, 1939 [8]		*Lagocephalus laevigatus* (Linnaeus, 1766) [12]
Aphos porosus (Valenciennes, 1837) [17]		

Continua

Continuação Tabela 1

Cephalopods
Fam. Sepiidae
Sepia officinalis Linnaeus, 1758 [5]
Fam. Loliginidae
Loligo sp. [5, 6, 11, 12, 15]
Loligo vulgaris Lamarck, 1798 [4, 14]
Loligo gahi Orbigny, 1835 [17]
Lolliguncula brevis (Blainville, 1823) [1, 2]
Alloteuthis subulata (Lamarck, 1798) [15]
Fam. Enoploteuthidae
Abralia veranyi (Rüppell, 1844) [13]
Fam. Ommastrephidae [1]
Todarodes sagittatus (Lamarck, 1799) [4, 14, 15]
Ornithoteuthis antillarum Adam, 1957 [13]
Fam. Onychoteuthidae
Ancistroteuthis lichtensteini (Férussac, 1835) [14]
Fam. Octopodidae
Octopus vulgaris Cuvier, 1797 [4]
Eledone moschata (Lamarck, 1799) [4]
Eledone cirrhosa (Lamarck, 1798) [15]

[1]Barros, 1993; [2]Barros & Odell, 1990; [3]Barros & Wells, 1998; [4]Blanco *et al*., 2001; [5]Cockcroft & Ross, 1990; [6]De Pierrepont *et. al.*, 2005; [7]Fernandez *et al*., 2006; [8]Hanson & Defran, 1993; [9]Kovacic & Bogdanovic, 2006; [10]Lewis & Schroeder, 2003; [11]Mead & Potter, 1990; [12] reviewed by Mead & Potter, 1990; [13]Rancurel, 1964; [14]Relini *et al*., 1994; [15]Santos *et al*., 2001; [16]Sargeant *et al*., 2005; [17]Van Waerebeek *et al*., 1990; [18]Würsig & Würsig, 1979.

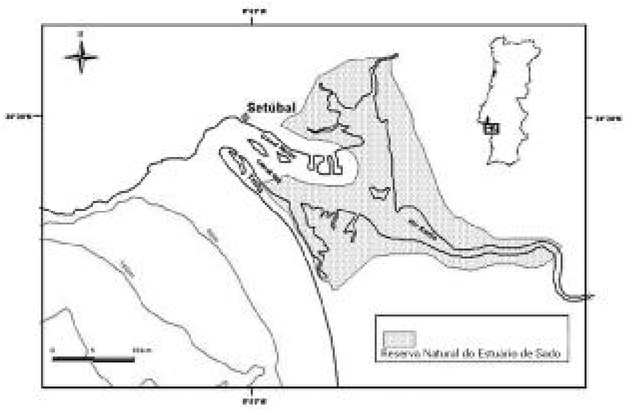

Figure 1. Map of the study area, with dotted section indicating the Sado Estuary Nature Reserve. (After Cândido, 2003)

carefully photographed, using a Nikon D70S camera with a 300-mm lens, for later confirmation of identities, and behaviours at the surface were recorded on digital videotape, using a Sony Mini-DV camera.

Data analysis

All reports and data sheets from field trips conducted between 2000 and 2006 were searched for any mention of activities possibly related to feeding behaviour or sightings of potential prey species. Also, approximately 5000 photographic prints and slides, both recent and archived, were studied for evidence of feeding behaviour.

In order to test the independence of foraging activities and local water depth, a table with depth classes at sampling points was created and the χ^2 statistic was calculated, using ACTUS (Estabrook & Estabrook, 1989). This application performs the analysis of bidimensional contingency tables through simulation statistics, which can also pin-point the specific table cells that allow the rejection of the null hypothesis, in case of non-independence between lines and columns (Almada & Oliveira, 1997).

Results

Confirmed prey

Anguilla anguilla (Linnaeus, 1758)

On 30 September 2005 we were following a focal group of four identified dolphins that had earlier split from a larger group to move into a secondary estuary arm. Following one of the long dives, one of the four individuals, an adult coded as THO, surfaced with an anguilliform prey in the mouth (Fig. 2), which was manipulated for a few seconds in the air, in what appeared to be playful behaviour, before ingestion.

Two other such events were observed, one five minutes later, in the same general area, by the same individual and with the same behaviour (Fig. 3) and another about one hour later. The photo and video records were studied by an ictiologist and eel expert who had no doubt in identifying both prey items as European eels, with one of them clearly being a female.

Figure 2. Bottlenose dolphin manipulating an European eel (*Anguilla anguilla*) before ingestion.

Figure 3. A similar episode, minutes later, same dolphin.

Sepia officinalis

The common cuttlefish is considered by local fishermen as one of the most important food resources of the bottlenose dolphins in the Sado region. The photographic record of a cuttlefish capture was finally obtained on 8 September 2000 in the lower estuary, during the observation of a behavioural sequence already described by Dos Santos & Lacerda (1987), named "*cuttlefish breaking*". The dolphin surfaces with a cuttlefish in the mouth, and hits the water surface with the head until the prey breaks in two pieces: the posterior, shelled mantle is discarded, while the anterior half is swallowed.

Octopus vulgaris

The consequence of an attack by a bottlenose dolphin on a common octopus has been described by Dos Santos & Lacerda (1987). The dolphin surfaced with the intended prey in the mouth, but the octopus was able to move the tentacles and then the rest of its body towards the top of the dolphin's head, apparently obstructing the blowhole. The outcome of this predation attempt wasn't clear, nor is there any knowledge about the frequency or efficiency of these "octopus defence reactions", which may depend on the octopus' size and the position in which it is grabbed by the dolphin. However, this cephalopod may be included in the list of prey species for this population. It was already included in the diet of other bottlenose dolphins, such as those studied by Blanco *et al.* (2001) in the Western Mediteranean Sea.

Mugilids

As in other parts of the world, mullets seem to be an important part of the bottlenose dolphins' diet in the Sado region. These fish often leap above the surface (sometimes spontaneously but also as apparent anti-predatory attempts), and dolphins have been observed and photographed many times leaping or engaging in other aerial behaviours to capture them in mid-air.

Mullets are represented in the Sado estuary by five abundant species (Salgado, 1984): *Mugil cephalus*, *Liza ramada* (Risso, 1826), *L. aurata* (Risso, 1810), *L. saliens* (Risso, 1810) e *Chelon labrosus* (Risso, 1827). All have been included in the list of prey species since their discrimination at the surface is impossible, from a distance, and there is no reason to think that any may be avoided.

Probable prey

The literature available on the invertebrates and vertebrates identified in the Sado estuary (reviewed by Dos Santos, 1998) lists a number of species not yet confirmed as prey of the resident dolphins but well known from diet studies of other bottlenose dolphin populations. Therefore, we consider the species listed on Table 2 as probable prey species of these dolphins, awaiting an occasion to be confirmed.

Foraging behaviour and depth

Depth measurements made at behavioural sampling sites were arbitrarily divided in three classes:

Table 2. A list of probable prey species of the bottlenose dolphins in the Sado estuary (see text).

Fish	Fam. Sparidae
Fam. Congridae	*Boops boops* (Linnaeus, 1758)
Conger conger ([Artedi, 1738] Linnaeus, 1758)	*Diplodus annularis* (Linnaeus, 1758)
Fam. Engraulidae	*D. sargus* (Linnaeus, 1758)
Engraulis encrasicolus (Linnaeus, 1758)	*D. vulgaris* (E. Geoffrey Saint-Hilaire, 1817)
Fam. Clupeidae	*D. puntazzo* (Cetti, 1777)
Alosa fallax (Lacepède, 1803)	*D. cervinus cervinus* (Lowe, 1838)
Sardina pilchardus (Walbaum, 1792)	*Pagellus bogaraveo* (Brünnich, 1768)
Sardinella aurita Valenciennes, 1847	*P. acarne* (Risso, 1810)
Fam. Merlucciidae	*Pagrus pagrus* (Linnaeus, 1758)
Merluccius merluccius (Linnaeus, 1758)	*P. auriga* (Valenciennes, 1843)
Fam. Gadidae	*Sarpa salpa* (Linnaeus, 1758)
Trisopterus luscus (Linnaeus, 1758)	*Sparus aurata* Linnaeus, 1758
Pollachius pollachius (Linnaeus, 1758)	*Spondyliosoma cantharus* (Linnaeus, 1758)
Fam. Batrachoididae	*Oblada melanura* (Linnaeus, 1758)
Halobatrachus didactylus (Schneider, 1801)	Fam. Gobiidae
Fam. Triglidae	*Gobius niger* Linnaeus, 1758
Trigla lucerna Linnaeus, 1758	*Pomatoschistus microps* (Krøyer, 1838)
Fam. Carangidae	*P. minutus* (Pallas, 1770)
Trachurus trachurus (Linnaeus, 1758)	Cephalopods
Fam. Mullidae	Fam. Loliginidae
Mullus surmuletus Linnaeus, 1758	*Loligo vulgaris* Lamarck, 1798

low depth (less than 5 m), medium depth (between 5 and 15 m) and high depth (over 15 m).

After analysing the contingency table created with ACTUS, it may be concluded that the frequency of feeding behaviour is not independent of depth rank: $\chi^2_{(2,\, n = 260)} = 30.486$, $p < 0.001$.

Feeding is more frequent than what would be expected at random when depth is low ($p < 0.01$), and less frequent at higher depths ($p < 0.001$) (Tab.3). On the contrary, non-feeding activities in the estuary are less frequent at lower depths ($p < 0.01$) and more frequent at higher depths ($p < 0.001$).

Table 3. Frequencies of Foraging and Non-foraging behaviour categories, in the three water depth classes, with results of ACTUS simulation statistics (see text). Up arrows indicate cells with values significantly higher than what would be expected if distribution was independent, and vice-versa.

	Low Depth	Medium Depth	High Depth
Foraging	Ç 62	56	È 13
Non-foraging	È 28	56	Ç 45

DISCUSSION

The first purpose of this work was the compilation and update of existing records concerning species preyed upon by the bottlenose dolphin, with a special focus on the resident population of the Sado estuary, where stomach content studies have not been carried out.

Although a single prey item identified as *Anguilla* sp. had already been reported (Mead & Potter, 1990), the direct observation of captures of European eels (*Anguilla anguilla*) is a relevant addition to the literature. The species was already considered a likely prey in the Sado estuary, following fishermen's observations (Dos Santos & Lacerda, 1987). It is especially abundant in the upper Sado estuary (Lopes

DA CUNHA, 1994). The identification of the four dolphins involved in this isolated foraging episode is an interesting record that may be used in future studies of food preferences. Anyway, while dolphins are well known to play with fish before swallowing them (see the ethogram of MÜLLER *et al*., 1997), this pattern has not been recorded in the Sado frequently.

The common cuttlefish, although a known prey of bottlenose dolphins in many populations, had not been confirmed in the Sado, despite many observations of "cuttlefish breaking", which is sometimes commensally used by local people who collect the dorsal parts left by the dolphins. It should be noted that, while cephalopods are sometimes preferred by dolphins, their caloric value is considerably lower than that of most fish (as reviewed by EVANS, 1987).

The listing of probable prey species (Tab.2) may be useful in the sense of drawing attention to locally-existing species that are known prey to this generalist delphinid elsewhere. A special case deserving further discussion is *Halobatrachus didactylus*. Like other batrachoidids, the Lusitanian toadfish is a benthonic species of highly soniferous habits (DOS SANTOS *et al*., 2000). High levels of acoustic production by toadfish have been recorded in areas where dolphins were foraging. On the other hand, large quantities of remains of other soniferous toadfish (e.g. *Opsanus beta* and *Porichthys* sp.) have been found in the stomachs of dolphins living in the coastal waters of Florida (BARROS & ODELL, 1990) and of California (HANSON & DEFRAN, 1993). These facts encouraged us to consider the Lusitanian toadfish as a probable prey species for the Sado population. However, it should be noted that this is a widely distributed species in the Eastern Atlantic and the Mediterranean Sea and it has not, to our knowledge, been confirmed as bottlenose dolphin prey anywhere.

Future research in this subject should expand from the limited possibilities of direct observation of predation. Chances to analyze stomach contents should be maximized, in connection to the national stranding network and with local fisheries authorities, and the means to use other techniques, such as stable isotopes, should be considered (as discussed by BARROS & CLARKE, 2002).

The study of possible prey preferences within the population, which may occur on an individual level or at some group level (of age or sex classes, for instance) can only be pursued if larger amounts of feeding behaviour data are collected, together with rigorous and persistent photo-ID work.

The dolphins' foraging behaviour was shown to occur predominantly in very shallow waters. This effect of depth on feeding is probably related to the longer times the animals may spend actually exploring the substrate when searching for bottom prey. It might be easier to get a larger meal during a series of foraging dives if vertical travel times are shortened. It is also possible that foraging hotspots are low depth waters that happen to be richer in prey – the relationship between depth and resource availability is simply not known. This is perhaps the most important gap of knowledge detected during the development of this project: the distribution of potential food resources for the dolphins. Data on fish and cephalopod occurrence in this region, and its spatial and seasonal variation, are insufficient, fragmentary and outdated, both for benthic and especially for pelagic species. Several studies have highlighted the dependence that habitat use by bottlenose dolphins has on prey distribution (e.g., HANSON & DEFRAN, 1993). Monitoring of the estuarine and coastal fauna, and imaging studies of dolphin foraging hotspots are therefore necessary steps to improve knowledge about the ways these animals make their living in this habitat.

This information will also be important to the efforts for the conservation of this dolphin population, since it could help to define critical areas where protection measures are particularly relevant.

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