

## Prey of offshore bottlenose dolphins from the South China Sea

Nélio B. Barros<sup>1,4</sup>, E. C. M. Parsons<sup>2,5</sup> and Thomas A. Jefferson<sup>3,6</sup>

<sup>1</sup>Hubbs-Sea World Research Institute, 6295 Sea Harbor Drive, Orlando, FL 32821-8043, USA

<sup>2</sup>The Swire Institute of Marine Science, The University of Hong Kong, Cape d'Aguilar, Shek O, Hong Kong

<sup>3</sup>Ocean Park Conservation Foundation, Ocean Park, Aberdeen, Hong Kong

### Abstract

The diet of bottlenose dolphins in southeast Asia is poorly known. Two forms of bottlenose dolphins occur off Hong Kong; an inshore form (*aduncus*-type) and an offshore form (*truncatus*-type), which differ in total length and other morphological features. We examined the stomach contents of four offshore bottlenose dolphins stranded between 1994 and 1997. Nine species of fish (of nine families) and three species of cephalopods (of three families) were identified as prey. These species are found in neritic and pelagic habitats, and represent both surface-dwellers as well as demersal inhabitants. Whereas some prey species may be found close to shore, others extend their distribution into deeper waters, suggesting that the dolphins may have also fed in inshore waters in the process of stranding. Although sample sizes are small, little competition with other cetacean species found around Hong Kong (Indo-Pacific humpback dolphins and finless porpoises) is suspected, as few prey species were shared by these dolphins.

**Key words:** diet, food habits, stomach contents, offshore bottlenose dolphin, *Tursiops truncatus*, Hong Kong, South China Sea.

### Introduction

Bottlenose dolphins (*Tursiops truncatus*) are found all along the coast of China and along both east and west coasts of the island of Taiwan (Wang, 1984;

Zhou & Qian, 1985; Zhou *et al.*, 1985; Miyashita *et al.*, 1985; Huang, 1996). Research on the morphometrics of animals in Chinese waters indicated that there are two forms, referred to as the *truncatus*- and *aduncus*-types (Zhou, 1987; Gao *et al.*, 1995; Wang, 1999). The *truncatus* form is similar to offshore forms from other areas, reaching 2.65–3.30 m in total length (Zhou, 1987). The *aduncus* form is much smaller (generally less than 2.5 m), has more and smaller teeth, a longer beak, larger flippers and dorsal fin, and adults have spots on their ventrum (Zhou & Qian, 1985; Zhou, 1987; Gao *et al.*, 1995). The *aduncus*-type is thought to be a more coastal form, whereas the *truncatus*-type tends to occur in deeper offshore waters. The ranges of the two forms do overlap in at least the East and South China Seas, and mixed schools have been reported from around the Penghu Islands, Taiwan (Zhou & Qian, 1985). More recently, the two sympatric forms of bottlenose dolphins in Chinese waters have been shown to differ in their molecular (Wang *et al.*, 1999) and morphological (Wang *et al.*, in press a,b) characteristics. Genetic work conducted elsewhere indicated that the *truncatus* form is allied with offshore bottlenose dolphins from other ocean basins, and the *aduncus* form may be a distinct species more closely related to other species of dolphins outside of the genus *Tursiops* (Curry, 1997).

In the territorial waters of Hong Kong, Indo-Pacific humpback dolphins (*Sousa chinensis*) and finless porpoises (*Neophocaena phocaenoides*) are the most commonly observed cetaceans (Parsons *et al.*, 1995; Jefferson & Leatherwood, 1997; Jefferson & Braulik, 1999), however, bottlenose dolphins are rarely observed. In the period 1973–1997, 10 bottlenose dolphins stranded in this area (Parsons *et al.*, 1995; Parsons, 1997, 1998); two of these were live strandings (Parsons, 1998). The stomachs of four of these were examined during necropsy and their contents collected for further analyses. From observations during necropsy (Parsons *et al.*, 1995), the animals analysed in this

<sup>4</sup>Current address: Center for Marine Mammal and Sea Turtle Research, Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, USA.

<sup>5</sup>Current address: The Hebridean Whale and Dolphin Trust, 28 Main Street, Tobermory, Isle of Mull, Argyll PA75 6NU, United Kingdom.

<sup>6</sup>Current address: Southwest Fisheries Science Center, NOAA, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038, USA.

**Table 1.** Biological details of stomach content from 4 offshore bottlenose dolphins stranded near Hong Kong.

| Field no   | Stranding date | Sex | Size (cm) | Wet weight (g) | Prey type | Prey taxa | Prey items |
|------------|----------------|-----|-----------|----------------|-----------|-----------|------------|
| TT94-11/25 | 25 November 94 | M   | 293       | —              | F         | 6         | 17         |
| TT94-04/12 | 12 April 94    | F   | 244       | 1              | C         | 2         | 2          |
| TT95-07/13 | 13 July 94     | —   | 234       | 102            | F,C       | 2         | 3          |
| TT97-02/05 | 5 February 95  | M   | 294       | 348            | F,C       | 5         | 10         |

F=fish; C=cephalopod.

study (Table 1) all belong to the larger, offshore form. There is scant information in the published literature about the food habits of bottlenose dolphins in this area of the world. Although based on a small sample, this study provides preliminary data on feeding of these dolphins in waters of the South China Sea, off Hong Kong.

#### Materials and Methods

Stomach contents were weighed and the hard structures of prey, such as fish otoliths and squid beaks, were used for species identification (Table 1). These structures were identified with the aid of local reference collections and published pictorial guides (Zeng, 1981; Shen, 1984; Clarke, 1986; Smale *et al.*, 1995). Undigested fishes were identified using field guides (Myers, 1989; Nakabo, 1993), following the ichthyological methods outlined in Straus & Bond (1990). Whenever possible, they were measured to the nearest millimetre. Fish otoliths were sorted into left and right, and squid beaks into upper and lower. The highest number of these structures was assumed to represent the total number of specimens consumed of each particular prey. Back-calculation of original prey size was not possible due to the unavailability of corresponding regression equations (Parsons, 1997). Nonetheless, otolith and beak sizes are provided for future comparative studies (Table 2).

#### Results

The average number of prey taxa and number of prey items per stomach were 3.75 and 8, respectively. The larger animals had more prey in their stomachs and presented a more diverse diet (Table 1). An undigested fish measuring 17.4 cm in standard length was retrieved from the stomach of TT-94-11/25, and was identified as a blacktip grouper (*Epinephelus fasciatus*), based on morphological characters (dorsal fin: X1, 15; anal fin: III, 8; pectoral fin: 18; body depth in standard length: 3; rows of teeth in mid-size of lower jaw: 3; approxi-

mate total length: 21 cm; number of pre-opercular spines: 3; maxilla completely exposed and not hidden by the gape) (Randall *et al.*, 1990; Nakabo, 1993). A 73-cm long cutlassfish (*Trichiurus lepturus*) was preyed upon by another dolphin (TT-95-07/13), in addition to two semi-digested swordtip squid (*Loligo edulis*), one measuring 8.7 cm in mantle length. An inshore lizardfish (*Saurida* sp.), approximately 35 cm long, was retrieved from the stomach of dolphin TT-97-02/05. Altogether, nine species of fish (of nine families) and three species of cephalopods (of three families) were identified as prey of the dolphins analysed in this study (Table 2).

#### Discussion

From the data available in this study, offshore bottlenose dolphins stranded in Hong Kong appear to forage in a variety of habitats. Their diet included species of neritic and pelagic habits, with both surface-dwellers as well as demersal inhabitants (Table 2). Some species have wide distribution ranges, and are found close to shore or extending into deeper waters. The blacktip grouper (*Epinephelus fasciatus*), for instance, is generally found in shallow waters around coral and rocky reefs, but may also occur to depths of 100–160 m (van der Elst, 1981; Smith & Heemstra, 1986). In this geographical area, *E. fasciatus* represents the most common groupers of outer reef slopes in waters deeper than 15 m (Myers, 1989).

The cutlassfish (*Trichiurus lepturus*) is a cosmopolitan demersal-pelagic species of tropical and temperate distribution, often entering estuaries and harbours, but also found in waters 300–350 m deep (van der Elst, 1981; Smith & Heemstra, 1986; Whitehead *et al.*, 1986). Off southern Brazil, where they are also consumed by bottlenose dolphins (Pinedo, 1982), cutlassfish were collected mainly from the outer continental shelf, where particularly large, adult (length >70 cm) specimens were found (Haimovici *et al.*, 1994). Offshore bottlenose dolphins from the northeastern and southeastern coasts of the United States (Mercer, 1973; Barros &

**Table 2.** Prey in stomach contents of 4 offshore bottlenose dolphins stranded near Hong Kong.

| Field no   | Prey species                              | Prey family  | No prey | Otolith/beak size <sup>1</sup> | Habitat <sup>2</sup> |
|------------|---|--------------|---------|--------------------------------|----------------------|
| TT94-11/25 | Teleosts                                  |              |         |                                |                      |
|            | <i>Epinephelus fasciatus</i> <sup>3</sup> | Serranidae   | 1       | —                              | N-P; R               |
|            | <i>Trichiurus lepturus</i>                | Trichiuridae | 4       | 5.1 (4.8–5.3)                  | P; D                 |
|            | <i>Uroconger lepturus</i>                 | Congridae    | 2       | 5.7 (4.2–7.2)                  | N-P; D               |
|            | <i>Apogon</i> sp.                         | Apogonidae   | 3       | 8.5 (7.6–9.3)                  | N                    |
|            | <i>Caranx</i> sp.                         | Carangidae   | 1       | 3.1                            | P; S                 |
| TT94-04/12 | Sparid                                    | Sparidae     | 6       | 8.4 (7.6–9.1)                  | N                    |
|            | Cephalopods                               |              |         |                                |                      |
|            | <i>Sepia</i> sp.                          | Sepiidae     | 1       | —                              | N; D                 |
| TT95-0713  | <i>Loligo</i> sp.                         | Loliginidae  | 1       | —                              | N                    |
|            | Teleosts                                  |              |         |                                |                      |
| TT95-0713  | <i>Trichiurus lepturus</i> <sup>3</sup>   | Trichiuridae | 1       | —                              | P; D                 |
|            | Cephalopods                               |              |         |                                |                      |
| TT97-02/05 | <i>Loligo edulis</i> <sup>3</sup>         | Loliginidae  | 2       | 0.9                            | N                    |
|            | Teleosts                                  |              |         |                                |                      |
|            | <i>Pomadasys argenteus</i>                | Haemulidae   | 1       | 6.7                            | N                    |
|            | Sparid                                    | Sparidae     | 1       | 7.5                            | N                    |
|            | Scarid                                    | Scaridae     | 3       | —                              | N; R                 |
|            | <i>Saurida</i> sp.                        | Synodontidae | 3       | 12.0                           | N; D                 |
| TT97-02/05 | Cephalopods                               |              |         |                                |                      |
|            | <i>Octopus</i> sp.                        | Octopodidae  | 2       | 4.6 (4.4–4.7)                  | N; D                 |

<sup>1</sup>Mean values in mm (range); lower rostral length for *Loligo*, hood length for *Octopus*.

<sup>2</sup>N=neritic; P=pelagic; R=common around reefs; D=demersal; S=surface.

<sup>3</sup>See text for actual prey size.

Odell, 1990) prey upon *Octopus* spp. and the epipelagic squid *Illex* spp. Both cephalopod groups seem abundant on the continental shelf break where these animals are thought to occur (Kenney, 1990).

Two other inshore cetaceans (Indo-Pacific humpback dolphins and finless porpoises) are the only species commonly seen in Hong Kong (Jefferson & Leatherwood, 1997; Jefferson & Braulik, 1999), and together account for over 77% of all cetacean strandings in this area (Parsons, 1998). Humpback dolphins feed almost exclusively on fish (chiefly from the croaker family Sciaenidae), and other prey associated with estuarine waters, whereas finless porpoises seem to prefer squid and other pelagic fish prey (Parsons, 1997; Barros *et al.*, unpublished data). There are a few species shared by the bottlenose dolphins analysed in the present study and the two 'resident' species (e.g., *Apogon* spp., *Trichiurus lepturus*, *Loligo* spp.), but since they seem to have different distributions, they are not likely to compete significantly for similar food resources.

It is possible that the prey of offshore bottlenose dolphins identified in this study may not be a true representation of their diet in deeper waters of the South China Sea. The prey items could have been consumed as the dolphins approached inshore waters in the process of stranding. Off Peru, off-

shore bottlenose dolphins feed on mullet, a common prey of inshore dolphins from the same area (Van Waerebeek *et al.*, 1990). Off east Florida, offshore bottlenose dolphins occasionally prey on Atlantic croakers (*Micropogonias undulatus*) (Barros, unpublished data), one of the main species in the diet of inshore bottlenose dolphins (Barros & Odell, 1990). Other species of pelagic cetaceans, such as the pygmy killer whale (*Feresa attenuata*) (Zerbini & Santos, 1997) and beaked whales (family Ziphiidae) (Ross, 1984) prey also on neritic species prior to stranding. The deep-water diet of offshore bottlenose dolphins from other areas of the world includes the fish families Bathylagidae, Congridae, Diretmidae, Gadidae, Labridae, Melamphaeidae, Merluccidae, Myctophidae, Sternophychidae, Stromateidae, and others, as well as mesopelagic cephalopod families (Enoploteuthidae, Ommastrephidae, Thysanoteuthidae, Histiototeuthidae, Chiroteuthidae, Octopoteuthidae, Cranchiidae) (Walker, 1981; Mead & Potter, 1990; Van Waerebeek *et al.*, 1990).

This study provides only a partial picture of the food habits of bottlenose dolphins from the South China Sea, off Hong Kong. We recommend that additional samples be collected from stranded offshore and inshore dolphins. Future studies should

also address the trophic relationships among the cetacean species sharing the habitats available throughout the waters of Hong Kong and surrounding areas.

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