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Article *in* Aquatic Mammals · June 2010

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Stomach Contents and Structure of a Longman's Beaked Whale (*Indopacetus pacificus*) Stranded in Kyushu, Japan

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Abstract

The stomach contents from a female Longman's beaked whale (*Indopacetus pacificus*), which stranded on the coast of Kagoshima Prefecture, Kyushu, Japan, were examined. This is the first specimen of this species from Japan and also its northern-most record. The remains collected from the stomach consisted of numerous cephalopod beaks and lenses and a large number of unidentified nematodes. Ninety-nine upper beaks and 69 lower beaks from squid species were collected from the stomach. The lower beaks were used to identify squid prey species; five species were identified: *Taonius pavo*, *Onykia loennbergi*, *Onychoteuthis borealijaponica*, *Chiroteuthis picteti*, and *Histioteuthis inermis*. *Taonius pavo* was the most common species and accounted for 84% of the total beaks. Distribution data for these squid species suggest that this whale fed in the epipelagic to mesopelagic zones in the western North Pacific off the southern part of Japan. Stomach morphology was also examined. The presence of a main stomach with three connecting chambers and one pyloric stomach compartment was confirmed. It appears that the morphology of this species' stomach is similar to that found in *Tasmacetus* and *Ziphius*. This is the first report on the food habits, stomach anatomy, and parasites of Longman's beaked whale and contributes to a better understanding of their biology.

Key Words: stomach contents, feeding habits, stomach anatomy, distribution, Japan, Longman's beaked whale, *Indopacetus pacificus, Taonius pavo*

Introduction

Longman's beaked whale (*Indopacetus pacificus*) (Longman, 1926) is one of the least known species of cetaceans. There are only ten individuals known to science collected from nine stranding events in the Indian and western Pacific Oceans. Basic information on the first six specimens was compiled by Dalebout et al. (2003). Since that report, the seventh individual stranded in Japan (Yamada et al., 2004); the eighth was documented in the Philippines (Acebes et al., 2005); and the last two individuals, probably a mother and calf pair, were found in Taiwan (Watson et al., 2008). The individual examined for this study was the seventh one mentioned that stranded in Japan (Yamada et al., 2004). All of these specimens provided important information on the osteology, external characters, molecular biology, and distribution of this beaked whale species.

There is no information on the feeding habits of Longman's beaked whale except for the two specimens investigated in the Philippines and Taiwan. Acebes et al. (2005) reported three squid upper beaks from stomach contents of a male, approximately 5.73 m in length, stranded in the Philippines. From the Taiwan individual, only pale yellow viscous fluid was documented in the first stomach of a 4.20-m juvenile male (Watson et al., 2008). Longman's beaked whale has been assumed to feed mainly on squid, similar to other beaked whales (Slip et al., 1995; Santos et al., 2001), although there was no specific identification or confirmation of squid prey hitherto published.

In the present study, the stomach contents of an individual Longman's beaked whale, which stranded dead in Kyushu, Japan, were examined in detail. This represents the first detailed information on the potential diet and stomach anatomy of Longman's beaked whale. Presence of parasites was also reported.

Materials and Methods

Sample Collection

Stomach contents were collected from a stranded Longman's beaked whale. It was an adult female, 6.48 m in total length, that stranded on the beach

in Satsumasendai-City, Kagoshima Prefecture, in western Japan (31º 54' N, 130º 13' E) on 26 July 2002 (Figures 1 & 2). Part of the main stomach contents were collected the day the animal was found, before the carcass was buried. The remaining stomach contents and the remaining stomach were secured one week after the stranding when the carcass was dug up and investigated. All stomach contents were preserved in 10% formalin at the National Museum of Nature and Science (NMNS) in Tokyo for further study.

Diet Analysis

Squid beaks were washed by a sonic wave cleaner and preserved in 70% ethanol. Lower beaks were identified to the lowest taxonomic level possible in reference to cephalopod beak identification manuals (Clarke, 1986; Kubodera, 2005) and in comparison to the beak voucher collections of the NMNS. Rostral length of the lower beak (LRL) was measured to the nearest 0.1 mm. The dorsal mantle length (DML) of the squid was estimated from the regression on LRL from Clarke (1986) and Kubodera (2005).

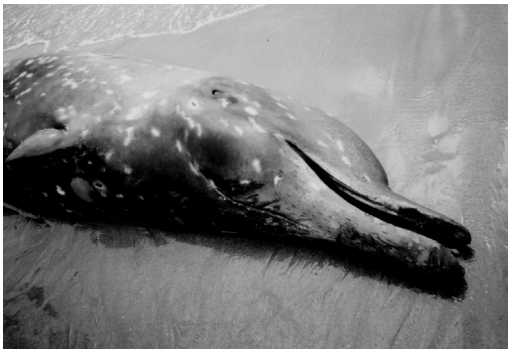

Figure 1. A Longman's beaked whale stranded in Kagoshima Prefecture, Kyushu, western Japan, on 26 July 2002 (Photograph by Kagoshima City Aquarium)

Stomach Morphology

The main stomach was cut open to collect contents during the preliminary examination prior to burial of the carcass. The morphology of the transition between the esophagus to the stomach was not recognizable when the carcass was excavated and re-examined. We collected the remaining portion of the main stomach, the rest of the stomach chambers, and a proximal portion of the duodenum. The collected stomach was fixed in a 10% formalin tank with its chambers also filled with 10% formalin. Stomach morphology was observed and recorded after the chambers were fixed.

Results

The stomach contained squid remnants, parasites, and plastics. The number of eye lenses and upper and lower beaks from squids was more than 70, 99, and 69, respectively. Forty percent of the eye lenses and beaks was found in the main stomach, 40% of eye lenses and beaks was from the third connecting chamber, and the remaining 20% of lenses and beaks

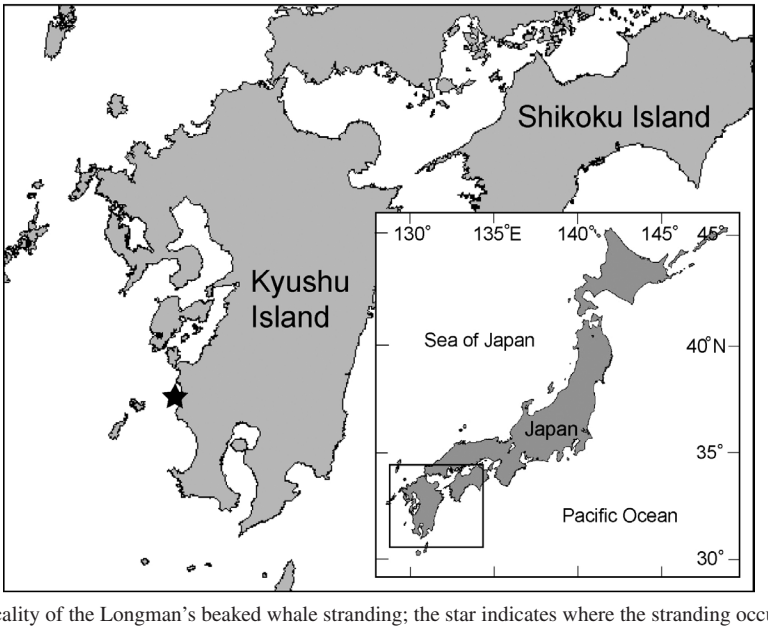

Figure 2. The locality of the Longman's beaked whale stranding; the star indicates where the stranding occurred.

came from the pyloric stomach. Because stomach contents can likely shift between compartments during fixation in formalin, the location of lenses and beaks as found might not have been their site when the animal stranded. Among the lower beaks, 57 beaks were identified as *Taonius pavo*; three beaks each as *Onykia loennbergi*; *Onychoteuthis borealijaponica*, and *Chiroteuthis picteti*; two beaks as *Histioteuthis inermis*, and one unidentified *Histioteuthis* (Table 1). The estimated lengths of ingested squid were calculated to range from 45 to 427 mm DML (Table 2). More than 639 nematodes were collected in several large masses. About 90% of nematodes were recovered from the third connecting chamber, while the remaining 10% came from the main and pyloric stomachs. The length of the nematodes ranged from 40 to 150 mm. Two plastic objects that were badly deformed were also collected; one item was 10 cm long with a shape that was suggestive of part of a plastic bottle. The other item was a 50-cm-long polypropylene strapping band.

The collected stomach material was composed of a sliver of main stomach, three connecting chambers, the pyloric stomach, and the duodenum (Figure 3). The duodenal ampulla was absent. The main stomach was cut open to collect its contents during the preliminary examination prior to burial of the carcass. The morphology of the transition between the esophagus to the stomach was not recognizable when the carcass was later excavated and re-examined.

Table 1. Stomach contents from a Longman's beaked whale stranded in Kagoshima, Japan, in July 2002

Contents	*n*
Squid	
Upper beak	99
Lower beak	69
Eye lens	70+
Parasites	639+

Table 2. Squid species and their estimated body sizes from the stomach of a Longman's beaked whale

Squid species	N	DML (mm)
Taonius pavo	57	45-427
Onychoteuthis borealijaponica	3	100-130
Onykia loennbergi	3	300
Chiroteuthis picteti	3	109-118
Histioteuthis inermis	2	70
Histioteuthis sp.	1	--
Total	69	

Discussion

Suggested Diet of Longman's Beaked Whale Considered from Stomach Contents

The stomach of the Kagoshima specimen contained a large number of oceanic squid beaks with a total absence of any fish remains. The Philippines specimen also contained three squid upper beaks without fish (Acebes et al., 2005). These two studies suggest that Longman's beaked whale feeds selectively on squid.

The main species of prey squid from the Kagoshima specimen was *T. pavo*, with the estimated range of DML from 45 to 427 mm. Young (1978) reported that the paralarvae of *T. pavo* probably live in the upper 400 m of ocean depths; juveniles of this species can be found primarily between 600 and 650 m depths, with adults observed at greater depths from 725

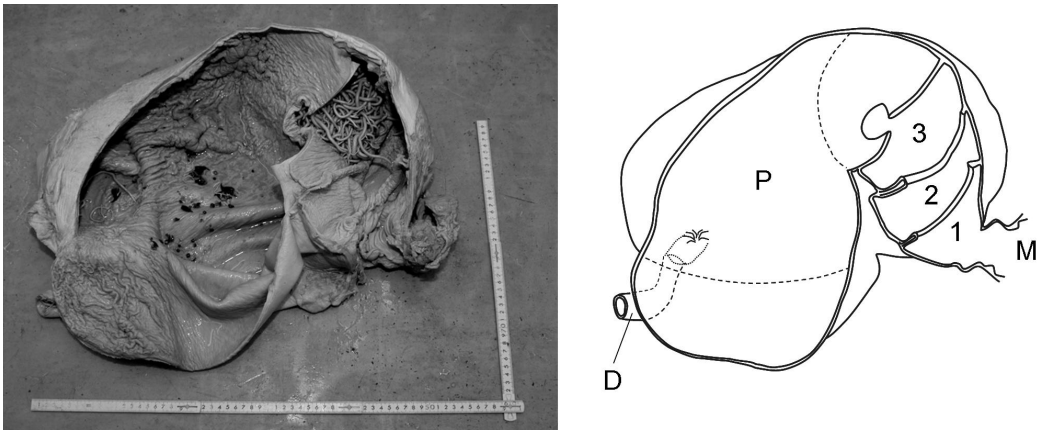

Figure 3. Photo (left) and diagrammatic illustration (right) are both of the stomach of Longman's beaked whale opened; note the duodenal ampulla is lacking. M: main stomach; 1, 2 & 3: connecting chambers 1, 2 & 3; P: pyloric stomach; and D: duodenum.

to 970 m. Watanabe et al. (2006) reported that *O. borealijaponica* stay at depths of 500 to 600 m during the day and migrate to the 100 m layer at night, while *H. inermis* stay deeper than 400 m throughout the day. Young (1978) and Kubota et al. (1981) gave the depth range of *C. picteti* to greater than 950 m during the day with a migration to the 100 m layer at night. *T. pavo* is known to make no significant vertical migration (Young, 1978). Judging from the vertical distributions of prey squid, Longman's beaked whales seem to prefer to forage in epipelagic to mesopelagic waters, which is similar to other beaked whale species (MacLeod et al., 2003; Ohizumi & Kishiro, 2003).

Kubota et al. (1981), Okutani (2005), and Watanabe et al. (2006) discuss the geographical distribution ranges of squid found in the Kagoshima specimen. The ranges of these squid overlap with each other in the Pacific Ocean off southern Japan where the Kagoshima specimen stranded.

Nematode parasites from the stomach of the stranded specimen described in this paper are here reported for the first time from this species. Further details on these parasites are in the final stages of analysis and will be published elsewhere.

The Stomach Morphology of Longman's Beaked Whale

Mead (1993) suggested that all beaked whale genera lack the forestomach except *Indopacetus*, of which no specimen was available in his study. Since a fresh and intact main stomach was not collected in the present study, the following three points could not be confirmed: (1) presence or absence of a forestomach, (2) the shape of the main stomach, and (3) the shape of the transition from the esophagus. Still, from the material collected, a small sliver of main stomach was observed, and it seems that the main stomach is followed by three connecting chambers and one pyloric stomach compartment. Mead (1993, 2007) classified the stomachs of Ziphiidae according to the number of compartments of main and pyloric chambers. Except for the fore- and main stomach morphology, the stomach of Longman's beaked whale can be categorized as the "generalized ziphiid stomach" as described by Mead (2007), including those of *Ziphius* and *Tasmacetus*. This result is in accordance with Dalebout et al. (2003) who suggested that *Ziphius*, *Hyperoodon*, and *Tasmacetus* share similar tooth morphology with Longman's beaked whale. All these species

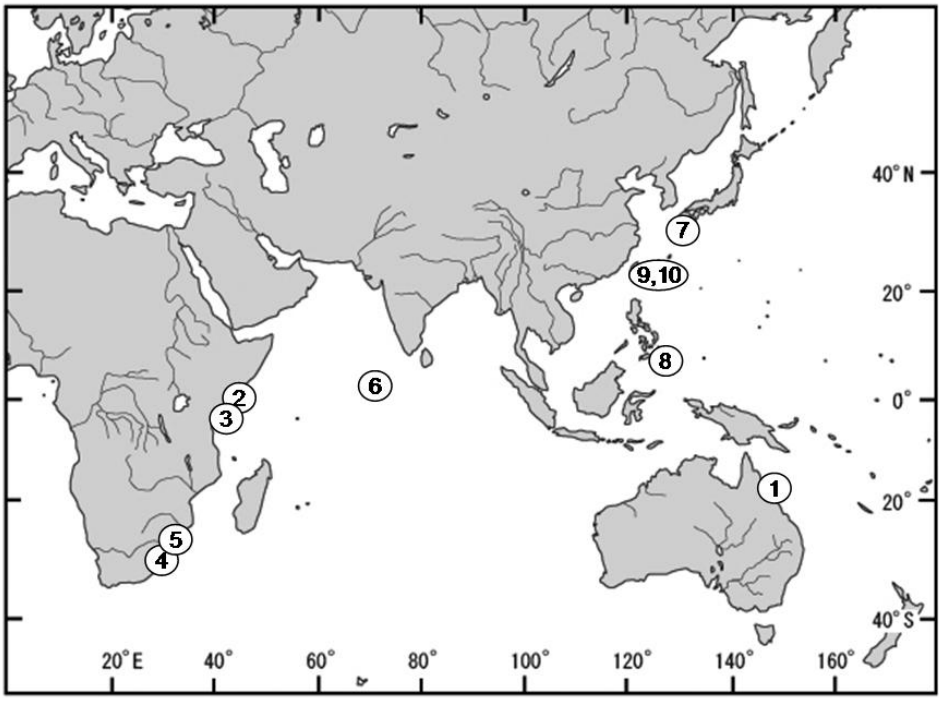

Figure 4. Map of the Indian and the western Pacific Oceans showing localities of all known stranding records of Longman's beaked whale—1: 1888, Australia (Longman, 1926); 2: 1955, Somalia (Azzaroli, 1968); 3: *ca*. 1968, Kenya (Dalebout et al., 2003); 4: 1976, South Africa (Dalebout et al., 2003); 5: 1992, South Africa (Dalebout et al., 2003); 6: 2000, Republic of Maldives (Dalebout et al., 2003); 7: 2002, Japan (Yamada et al., 2004); 8: 2004, Philippines (Acebes et al., 2005); 9 and 10: 2005, Taiwan (Watson et al., 2008).

possess comparative conical teeth. These corresponding findings might indicate the phylogenetic position of Longman's beaked whale within the family Ziphiidae. The existence of the duodenal ampulla is variable among Ziphiidae (Mead, 2007); no duodenal ampulla was found in this Kagoshima specimen.

This study is the northern-most record for this beaked whale species and provides the first information on the feeding habits of Longman's beaked whale. Details on the stomach anatomy, although not complete, might serve to elucidate systematic relationships among the ziphiid taxa. Additional data are needed to understand the biology of this species and the systematics of the family Ziphiidae.

Brief Comments on the Distribution of Longman's Beaked Whale

As was mentioned above, this beaked whale species is known from ten stranded individuals (Longman, 1926; Azzaroli, 1968; Dalebout et al., 2003; Yamada et al., 2004; Acebes et al., 2005; Watson et al., 2008; Figure 4). Dayaratne & Joseph (1993) reported at least three southern bottlenose whales (*Hyperoodon planifrons*) were by-caught in Sri Lanka. These three individuals were reidentified as Longman's beaked whales by Anderson et al. (2006). We agree with Anderson et al. as related to their reidentification of those specimans; however, these examples are not included in Figure 4 because the actual species identification were not made on them. Very likely, possible sighting records of Longman's beaked whales were also published by Mörzer Bruyns (1971), Gallo-Reynoso & Figueroa-Carranza (1995), Pitman et al. (1999), Anderson et al. (2006), and Barlow (2006), all of which suggest the fairly extensive distribution of Longman's beaked whales throughout the Indo-Pacific Ocean. Further investigations are necessary to clarify and determine the distribution of this species.

Acknowledgments

We appreciate the efforts of the Department of Health and Welfare of Sendai City and Kagoshima City Aquarium for the help provided during the necropsy. We acknowledge the professional efforts from H. Ishikawa, K. Arai, A. Umetani, T. Kakuda, Y. Tajima, K. Maeda, and S. Ito, who dissected the whale together and collected stomach samples under the scorching sun. T. Okutani advised on the distribution of squid. Robert Brownell, Jr. provided helpful comments on earlier drafts of this paper. S. Yamamoto helped with laboratory work. We are also grateful to Professor H. Kohno for his generosity in providing this opportunity to examine the stomach of this individual.

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