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The structures of eye and surrounding tissues of Longman's beaked whale, *Indopacetus pacificus*^{*}

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Abstract Observations were made on one eye from a Longman's beaked whale *Indopacetus pacificus*, which was probably one of the least known extant cetaceans. The whale died shortly after swimming aground on the coast in the Nishikata Beach, Sendai-shi, Kagoshima-ken Prefecture, Japan, on July 26, 2002. It was a mature female with body length 6.45 m. This paper documented the basic structural characteristics of her visual organ of the whale in order to better understand this animal.

Keyword: Longman's beaked whale; *Indopacetus pacificus*; eye structure; anatomy; morphology

1 INTRODUCTION

The Longman's beaked whale *Indopacetus pacificus* (Longman, 1926) is probably one of the least known extant cetaceans. The existence of this species comes only from two skulls found in the Indian and South Pacific Oceans, five other remains were collected in Australia, Somalia and South Africa, which were mostly skeletal or young ones (McCann, 1962; Azzaroli, 1968; Mead, 1989; Paterson and Dyck 1990; Pitman et al., 1999; Pitman, 2002). A Longman's beaked whale died shortly after swimming aground on the coast in the Nishikata Beach, Sendai-shi, Kagoshima-ken Prefecture, Japan on July 26, 2002, it was a mature female with body length 6.45 m. One eyeball was removed from the specimen buried at the beach, although it decomposed badly when it was collected. This paper attempts to document the basic structural characteristics of the visual organ of the rare Longman's beaked whale in order to better understand this animal.

2 MATERIAL AND METHOD

The eyeball was obtained from stranded Longman's beaked whale in Kagoshima-ken Prefecture, Japan on July 26, 2002, and preserved in 10% formalin at the Section of Birds and Mammals, Department of Zoology, the National Science Museum, Tokyo 169-0073, Japan. This whale was a

mature female with body length 6.45 m. Dissections were documented photographically on December 1–5, 2003. Morphometric data was measured according to Zhu et al. (2000, 2001).

3 RESULT

3.1 Extraocular muscle

As seen in other mammals, the eyeball of the Longman's beaked whale possesses seven extraocular muscles. These muscles consist of the Musculus rectus dorsalis (Fig.1), M. rectus ventralis (Fig.2), M. rectus medialis (Fig.1), M. rectus lateralis (Fig.1), M. obliquus dorsalis (Fig.1), M. obliquus ventralis (Fig.2), and the M. retractor bulbi (Fig.3). Unfortunately we were unable to give a detailed description of these extraocular muscles since the specimen decomposed badly when it was collected. However, by careful dissection, it is found that the four recti and the two oblique muscles are inserted at different points on the eyeball (Fig.1). The distal portion of each of these six muscles consists of a tendon which inserts onto the sclera. Widths of the extraocular muscle tendons (except the retractor bulbi) at points of insertion on the sclera are presented in Table 1.

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Table 1 Width of the extraocular muscle tendon (except the retractor bulbi) at points of insertion on the sclera in Longman's beaked whale

Extraocular muscle	Width of tendon (cm)
Dorsal rectus muscle	3.09
Ventral rectus muscle	4.68
Medial rectus muscle	0.92
Lateral rectus muscle	1.35
Dorsal oblique muscle	1.75
Ventral oblique muscle	1.91

3.2 Eye anatomy

Many ducts open from the orbital glands onto the surface of the palpebral conjunctiva (Fig.4). The

openings of the ducts are visible with naked eye.

The eyeball is seen to be nonspherical. It is shorter in the lateral-medial (EL) direction than either dorsal-ventral (EH) or rostral-caudal (EW) directions. EW is slightly wider than EH (Table 2). The cornea is an oval structure (Fig.1 and Fig.5), and it is longer in the rostral-caudal (CW) direction than in the dorsal-ventral (CH) direction (Table 2). Corneal thickness is greatest at the periphery and least near the center (Table 2). The sclera (Fig.5) is composed of an extremely dense connective tissue, and it is thinnest near the limbus and thickest medially. The lens (Fig.5) is almost spherical (Table 2) that is suspended just behind the iris by zonular fibers and ciliary processes.

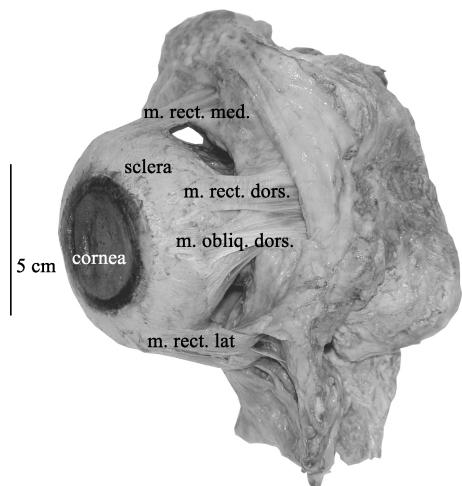


Fig.1 Extraocular muscles of the left eye of Longman's beaked whale, showing the Musculus rectus dorsalis (m. rect. dors.), M. rectus medialis (m. rect. med.), M. rectus lateralis (m. rect. lat.), and M. obliquus dorsalis (m. obliq. dors.)

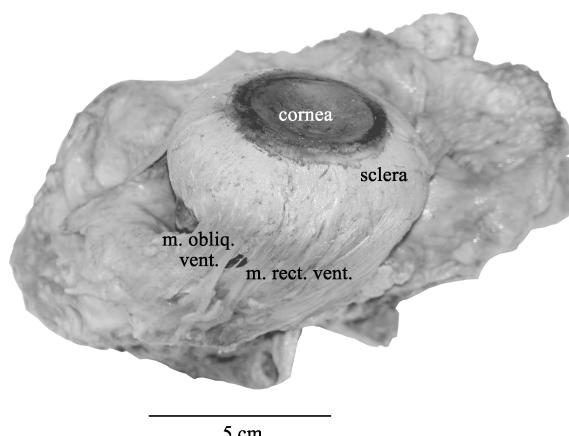


Fig.2 Extraocular muscles of the left eye of Longman's beaked whale, showing the M. rectus ventralis (m. rect. vent.) and M. obliquus ventralis (m. obliq. vent.)

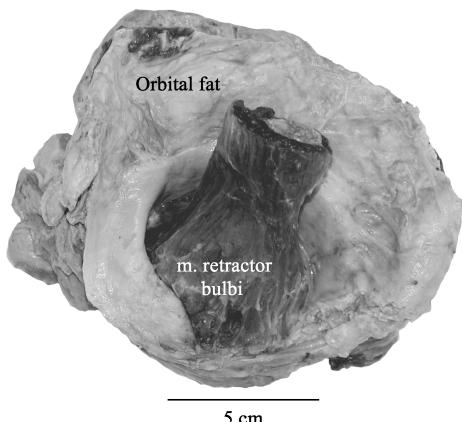


Fig.3 M. retractor bulbi of the Longman's beaked whale

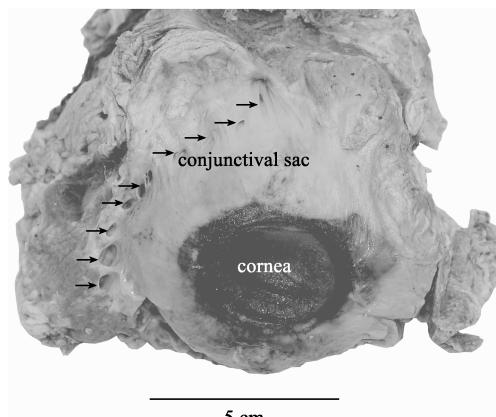


Fig.4 Several ducts (see the arrowheads) open from the orbital glands onto the surface of the palpebral conjunctiva

Table 2 Morphometric data from Longman's beaked whale eye

SD	BL	EL	EH	EW	CW	CH	GCT	CT	SC	LW	LH	LL	ON
L	6.45	3.8	5.9	6.6	3.1	2.5	0.28	0.06	1.5	1.43	1.27	1.41	0.51

SD indicates whether the eye came from the left (L) or right (R) side, BL = body length in meters.

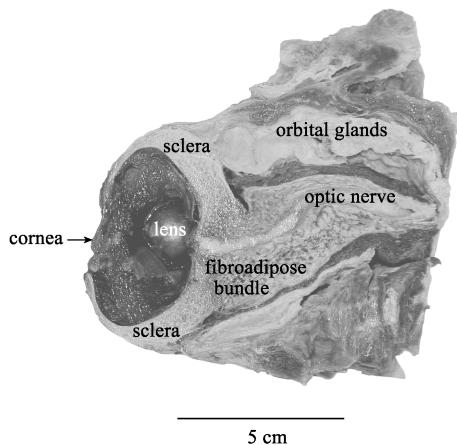


Fig.5 Transected left eye of the Longman's beaked whale, the thick sclera, fibroadipose bundle, and optic nerve are evident

All other measurements are in millimeters. Eyeball length (EL) is measured in lateral-medial direction, eyeball height (EH) is measured in dorsal-ventral direction, eyeball width (EW) is measured in rostral-caudal direction, CW=width of cornea measured rostral to caudal, CH=height of cornea measured dorsal to ventral, GCT=greatest corneal thickness usually 1mm from the limbus, CT=corneal thickness at the center, SC=greatest thickness of sclera, LW=width of lens measured rostral to caudal, LH=height of lens measured dorsal to ventral, LL=length of lens measured lateral to medial, ON=diameter of the optic nerve measured 4 cm form the optic disc.

The distance from the cornea to the optic disc is 2.44 cm. The other structures, such as retina, choroids, iris, ciliary processes, etc. are unable to be described because of decomposition.

4 ACKNOWLEDGMENTS

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