

Morphometry of the *Dugong Dugon* (Muller, 1776) skeleton based on Indian Museum specimens, Kolkata, India

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Received 14 November 2017; revised 23 April 2018

The present study discussed about detailed examination of skeleton characters of four dugong specimens received from Indian Museum. The specimens were deposited and preserved in the National Zoological Collection (ZSI/27608; ZSI/27609; ZSI/27610; ZSI/27611) of The Mammal and Osteological Section, Zoological Survey of India, Kolkata.

[**Keywords:** Skeleton; *Dugong dugon*; Seacow; Lady of the sea; Indian museum]

Introduction

Dugong is the only extant representative of the family Dugongidae of order Sirenia and is the only herbivorous mammal restricted to marine¹. It is found in tropical, subtropical, coastal and island ecosystem from East Africa to Vanuatu, between about 26° north and south of the equator². The population of dugong was declining more than 50 % in the last 50 years due to human interference, including fishing-related fatalities, habitat degradation and hunting; the illegal trade on its body parts and bones also affecting its population³⁻⁵. The IUCN Red List of endangered species has classified this species as 'vulnerable'.

In India, dugong has been recorded from the Andaman & Nicobar Islands, Lakshadweep Islands, Gulf of Mannar, Palk Bay and Gulf of Kachchh⁶⁻²⁶. Nishiwaki and Marsh²⁷ reported the species from the Sunderbans, West Bengal and Jerdon²⁸ reported it from west coast of India. In Malabar Coast, dugong occurrence was reported in the imperial gazetteer²⁹. The external morphology of dugong is quite different from other marine mammals, characterised by streamlined body and massive head, truncated anteriorly with a fleshy upper lip which is pad like projecting over lower lip; the upper lip is formed with stiff bristles around muzzle. They are usually dull brownish, grey above and slightly lighter below; the skin is thick, tough, wrinkled and covered with widely scattered hairs and the fins resemble those of dolphins, but unlike dolphins, dugongs lack a dorsal fin^{2,30,25}.

Osteological study is supported to understand the structure of the animal bones, skeletal elements teeth and microbone morphology. The skull of a dugong is distinctive from other cetacean, as it is enlarged with sharply down-tipped (tusk root) premaxilla, which consists of enlarged incisors (tusks). The tusks are projections of the incisor teeth and are present in all dugongs, but they are usually only visible in mature males. The total number of vertebrae varies from 57 to 60. The number of growth layer groups in a tusk has been used for age estimation of a dugong. The dental formula of dugong $2.0.3.3/3.1.3.3 \times 2 = 36$ is also unique: Two incisors, three premolars, and three molars on each side of their upper jaw, and three incisors, one canine, three premolars, and three molars on each side of their lower jaw. The bones are solid (without bone marrow) and heavy in condition, which are among the densest in the animal kingdom^{2,30}.

Unlike other mammalian species, the morphometric study of dugong skeleton is not well-established. Understanding the morphology of the skeleton is always useful to identify the species. This study provides a description and detailed illustrations of the skeleton of the dugong as an appropriate reference for further skeleton identification.

Materials and Methods

The morphometric measurements of the skeleton of the dugong were recorded from the four identified specimens housed in the National Zoological

Collections (N.Z.C.) of Mammal and Osteological section, Zoological Survey of India, Kolkata, India. The total length of the head and body, caudal, vertebrae, cervical vertebrae, skull, premaxilla tusk root, lower maxilla, incisor and ribs of the skeleton were recorded using a ruler scale and measurement tape and the specimens were photographed. The methodology was followed by James⁷.

Results

A total of four specimens of dugong skeletons received from Indian Museum, Kolkata and were identified and deposited in N.Z.C. Only one specimen was having complete structure with detail systematic as follows:

Kingdom : Animal
Phylum : Chordata
Subphylum : Vertebrata
Class : Mammalia
Order : Sirenia
Family : Dugongidae
Genus : *Dugong*

Scientific Name: *Dugong dugon* Muller, 1766

Common Name: Seacow and Lady of the sea

IUCN Red List Category & Criteria: *Vulnerable*

Material Examination: ZSI/27608 Head and Body length (HB) 255 cm, Tailfluke 105 cm, Vertebrae 85 cm, Skull 49 cm, Premaxilla 21 cm, Lower jaw 28 cm, Scapula 23 cm, Ribs 18-49 cm, Incisor 23 cm. ZSI/27609 Skull 48cm, Premaxilla 22cm, Lower jaw 26cm, Scapula 20 cm, Ribs 25-34 cm, Incisor 22 cm. ZSI/27610 Skull 51 cm, Premaxilla 25 cm, Lower jaw 30 cm, Scapula 23 cm, Ribs 20-35 cm, Incisor 26 cm. ZSI/27611 Skull 48 cm, Premaxilla 21 cm, Lower jaw 26 cm, Scapula 22 cm, Ribs 16-35 cm, Incisor 16 cm. The voucher specimens features are presented in Table 1 and three specimens pictures are presented in Figure 1.

Description: Total length of specimen (ZSI/27608) is 255 cm, tail fluke 105 cm, chest vertebrae length 85 cm, cervical vertebrae length 6 cm, and cervical

vertebrae width 8.5 cm to 10.5 cm. The skull is enlarged with sharply down-turned premaxilla, the spine has between 57 and 60 vertebrae. The tusk layers are helpful for age calculation. Upper jaw has two incisors, three premolars, and three molars and lower jaw has three incisors, one canine, three premolars, and three molars.

Distribution: Indo-Pacific; Comores, Eritrea; Federal Republic of Somalia; Kenya, Doodori, Gazi, Keya, Kiunga Marine National Reserve, Mkokoni Creeks, Msam bweni, Shimoni, Siyu Channel; Madagascar; Tanzania; Red Sea, Aqaba, Suel Canal; Gulf of Aden, Myanmar; Malay Peninsula; Gulf of Thailand; Vietnam; Gulf of Tonkin; Comoros; Mauritius; Rodriguez; Indonesia; Philippines; Guam; Palau; Micronesia; Caroline Island; Papua New Guinea; Solomon; New Caledonia; Australia; Fiji; Mozambique, Persian Gulf; Pakistan; Sri Lanka; India, Gulf of Mannar, Palk Bay, Gulf of Kachchh, Lakshadweep, Andaman and Nicobar Islands.

Discussion

As mentioned earlier, the complete measurement data was obtained only from a single specimen as other three specimens were incomplete. However, the skull, premaxilla, lower jaw, scapula length, ribs length, and incisor length of all four specimens were obtained. The natural history of the specimens could not be obtained as the specimens were not labelled and shifted from the Indian Museum to Zoological Survey of India, Kolkata for preservation.

An osteological study on two dugong skeletons from the Gulf of Mannar were described by James⁷ and the morphometric data used for comparison of dugong between the two regions, such as India and Red Sea. Lekagul and McNeely² gave the general body length of dugong (HB: 220-350 cm including tail flukes). Frazier and Mundkur²¹ and Marsh *et al.*³¹ presented the morphometric details of an immature male and Kumar *et al.*²⁵ reported the morphological features with photos of mature female dugong found dead in the Gulf of Kutchch. Nganvongpanit *et al.*³² investigated the elemental composition of the tusk

Table 1 — Morphometric measurements (cm) skeleton of Dugong

Specimen No	HB	Tail fluke	Vertebrae	Skull	Premaxilla	Lower jaw	Scapula	Ribs	Incisor
ZSI/27608	255	105	91	49	21	28	23	18-49	23
ZSI/27609				48	22	26	20	25-34	22
ZSI/27610				51	25	30	23	20-35	26
ZSI/27611				48	21	26	22	16-35	16

(HB-Head and Body length)

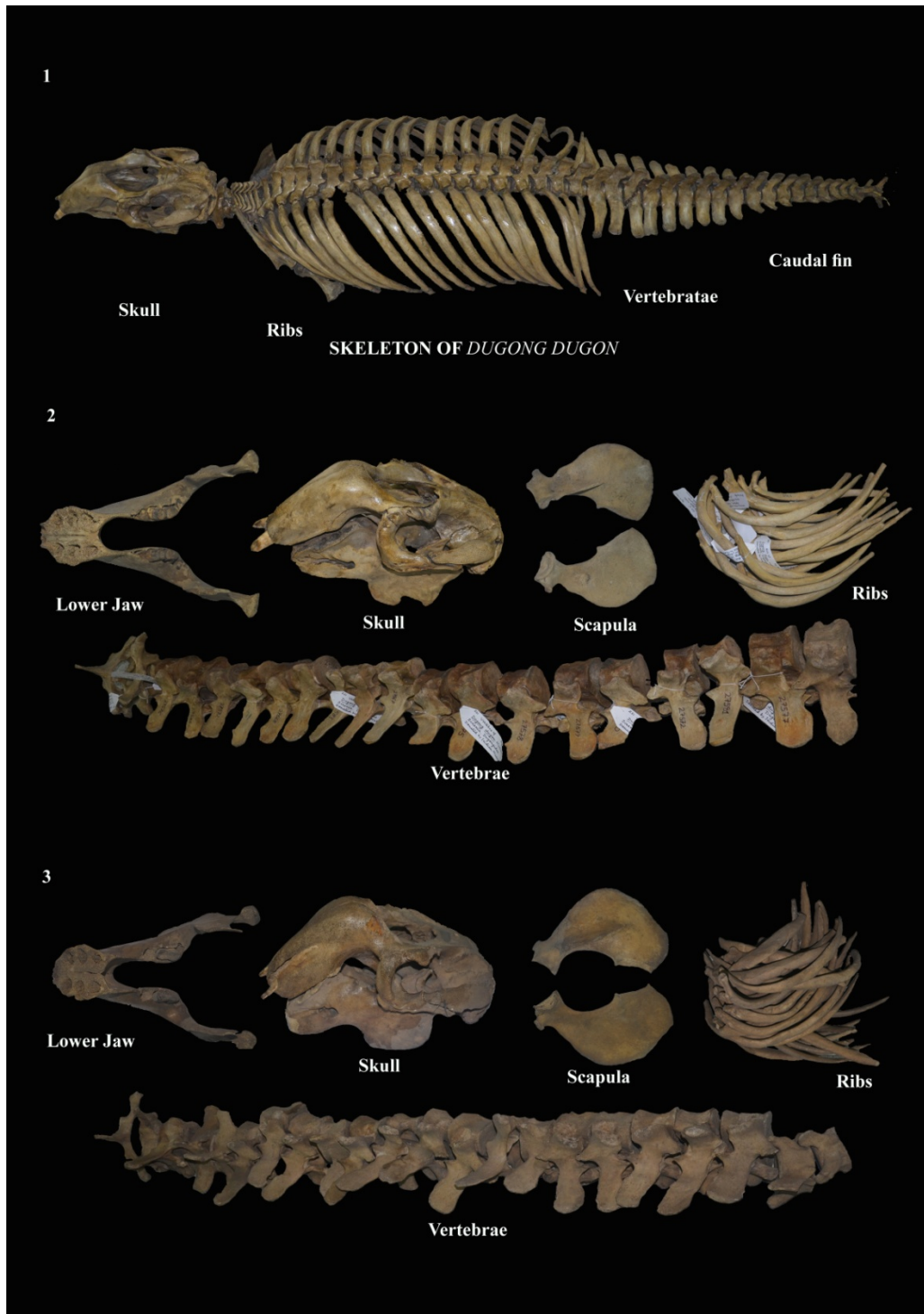


Fig. 1 — Morphometric features of museum specimens of *Dugong dugon* (ZSI/27608; ZSI/27609; ZSI/27610) from Zoological Survey of India, Kolkata.

of dugong for identifying the sex and habitat. However, these studies have not provided any details about the features and morphometric measurements of the skeleton of dugong. In the

present study, the complete morphometric data along with the photograph of dugong skeleton was presented, which is useful for the preliminary determination of species.

Conclusion

The future for dugongs in India is uncertain and appears bleak. Dugong populations and distribution reports are very less and are no quantitative data on the status of dugongs as well as seagrass beds from this place. Pressures from gill netting and fishing practices and habitat destruction may lead to the extinction of dugongs from the Indian coast. The present study reported morphometry features of dugong as support for morphological identification as well as create awareness among the fisher folk community.

Acknowledgement

The authors wish to thank Dr. Kailash Chandra, Director, Zoological Survey of India, Kolkata for providing necessary facilities for this work and also thanks to the Ministry of Environment, Forests and Climate Change, Government of India.

References

- Wilson, D. E. and Reeder, D. M., *Mammal Species of the World: A Taxonomic and Geographic Reference- Third Edition* Johns Hopkins University Press, Baltimore, MD. 2005, pp. 1-2141.
- Lekagul, B. and McNeely, J. A., *Mammals of Thailand*. Kurusapha Ladprao Press. 1977, pp.1-757.
- Perrin, W. F., Dolan, M. L. L. and Alava, M. N. R., *Report of the workshop on the biology and conservation of small cetaceans and dugongs of Southeast Asia*, Dumaguete, 27-30 June 1995. United Nations Environment Programme, Bangkok. (1996), pp. 1-161.
- Trippel, E. A., Strong, M. B., Terhune, J. M. and Conway, J. D., Mitigation of harbour porpoise (*Phocoena phocoena*) by-catch in the gill net fishery in the lower Bay of Fundy. *Canadian Journal of Fisheries and Aquatic Science* 56 (1999) pp.113-123.
- Marsh, H. and Soltzick, S., *Dugong dugon*. The IUCN Red List of Threatened Species 2015, pp.
- Annandale, N., Notes on the species, external characteristics and the habits of the Dugong. *Journal of the Asiatic Society of Bengal* 1 (1905) pp. 238-243.
- James, P. S. B. R., An osteological study of the dugong *Dugong dugon* (Sirenia) from India. *Marine Biology* 27 (1974) pp. 173-184.
- Jones, S., On a pair of Captive Dugongs. Loris (*Journal of Ceylon Wildlife Protection Society*) December: (1959) pp. 83-87.
- Jones, S., The dugong or the so-called mermaid, *Dugong dugon* (Muller) of the Indo-sri Lanka waters - Problems of research and conservation. *Spolia Zeylanica*, 35 (1980) pp. 22-260
- Jonklass, R., Some observations on dugongs (*Dugong dugon* Erxleben). *Loris* 9 (1961) pp.1-8.
- Lal Mohan, R. S., On the occurrence of *Dugong dugon* (muller) in the Gulf of Clutch. *J. Mar. Biol. Ass. India* 5 (1963) pp. 152.
- Lal Mohan, R. S., Some observations on the Sea cow, *Dugong dugon* in the Gulf of Kutch. *Journal of Marine Biological Association of India* 18 (1976) pp. 391-397.
- Lal Mohan, R. S., Some observations on the sea cow, *Dugong dugon* from the Gulf of Mannar and Palk Bay during 1971-1975. *Journal of the Marine Biological Association of India* 18: (1980) pp. 391-396.
- Mani, S. B., Occurrence of the sea cow, Halicore dugong (Exrl.) off the Saurashtra coast. *Journal Bombay Natural Historical Society* (1960) pp.57.
- Nair, R., Lal Mohan, R. S. and Satyenarayana Rao, K., The *Dugong dugon*. ICAR Bulletin of the Central Marine Fisheries Research Institute. *Central Marine Fisheries Research Institute*, Cochin, India. (1975), pp.45
- Prater, S. H., The dugong or sea cow (Halicore dugong). *Journal of the Bombay Natural History Society*, 1999, 33 (1928) pp. 84-99.
- Silas, E. G., Occurrence of the sea cow, Halicore dugong (Exrl.) off the Saurashtra coast. *Journal of the Bombay Natural History Society*. Bombay 58 (1961) pp. 263-266.
- Silas, E. G., and Fernando, B., *The Dugong in India - is it going the way of the Dodo?* Commission on Endangered Marine Animals and Marine Parks, Cochin, India. *Central Marine Fisheries Research Institute*, (1985) pp. 18.
- Husar, S. L., *Dugong dugon*. *Mammalian Species* 88 (1978) pp. 1-7.
- James, P. S. B. R., and Mohan, R. S. L., The marine mammals of India. Marine Fisheries Information Service. *Technical and Extension Series*. 71 (1987) pp.1-13.
- Frazier, J. G. and Mundkur, T., Dugong, *Dugong dugon* (Müller) in the Gulf of Kutch, Gujarat. *Journal of the Bombay Natural Historical Society* 87 (1990) pp. 368-379.
- Das, H. S. and Dey, S. C., Observation on the dugong, *Dugong dugon* (Müller) in the Andaman and Nicobar Islands, India. *Journal of the Bombay Natural Historical Society* 96(2) (1999) pp. 195-198.
- Sing, H. S., Sea mammals in marine protected area in the Gulf of Kachchh. *Indian Journal of Marine Science* 32 (3) (2003) pp. 258-262.
- Sivakumar, K. and Nair, A., Dugong distribution habitat and risks due to fisheries and other anthropogenic activities in India. *Wildlife Institute of India -Technical Report*, (2013) pp.74.
- Kumar, J. S. Y., Naseef V. T., Thiyagarajan D., Soni Gunjan M., Belim Imtiyaz, Govindharajan P., Satyanarayan Ch. and Venkataraman K., Observation of endanger marine mammal (*Dugong dugon*) along the west coast of India. *International Journal of Integrative Sciences, Innovation and Technology*. 2 (1) (2013) pp. 55- 58.
- Anand, Y., Tatu, Ketan and Pandey, C. N., Status of Dugong (*Dugong dugon*) in Gulf of Mannar and Palk Bay, Tamil Nadu, India. *Indian Journal of Geo-Marine Science*, 44 (9) (2015) pp.1442-1448.
- Nishiwaki, M., and Marsh, H. D., (1985). *The Dugong dugon* (Muller, 1776). S. H. Ridgeway, and R. J. Harrison, editors. *Handbook of Marine Mammals*. Academic Press, London, (1985) pp. 1-31.

- 28 Jerdon, T. C., *The mammals of India; a natural history of all animals known to inhabit continental India*. J. Wheldon, London, (1874) pp. 1-335.
- 29 Anon, *The Imperial Gazetteer of India*. The Indian Empire Vol 1. Descriptive. Clarendon, Oxford, 1909, pp. xxxi + 568.
- 30 Phil, M., "ADW: Sirenia: Information". *Animal Diversity Web*. University of Michigan Museum of Zoology. Retrieved 13 May 2007 (2000), pp. 1.
- 31 Marsh, H., Penrose, H., Eros, C. and Hugues, J., *Dugong: Status Report and Action Plans for Countries and Territories*. UNEP, (2002), pp. 1-172.
- 32 Nganvongpanit, K., Buddhachat, K., Piboon, P., Euppayo, T., Kaewmong, P., Cherdsookjai, P., Kittiwatanawong, K. and Thitaram, C., Elemental classification of the tusks of dugong (*Dugong dugon*) by HH-XRF analysis and comparison with other species. *Scientific Reports* 7 (2017), pp. 1-12.