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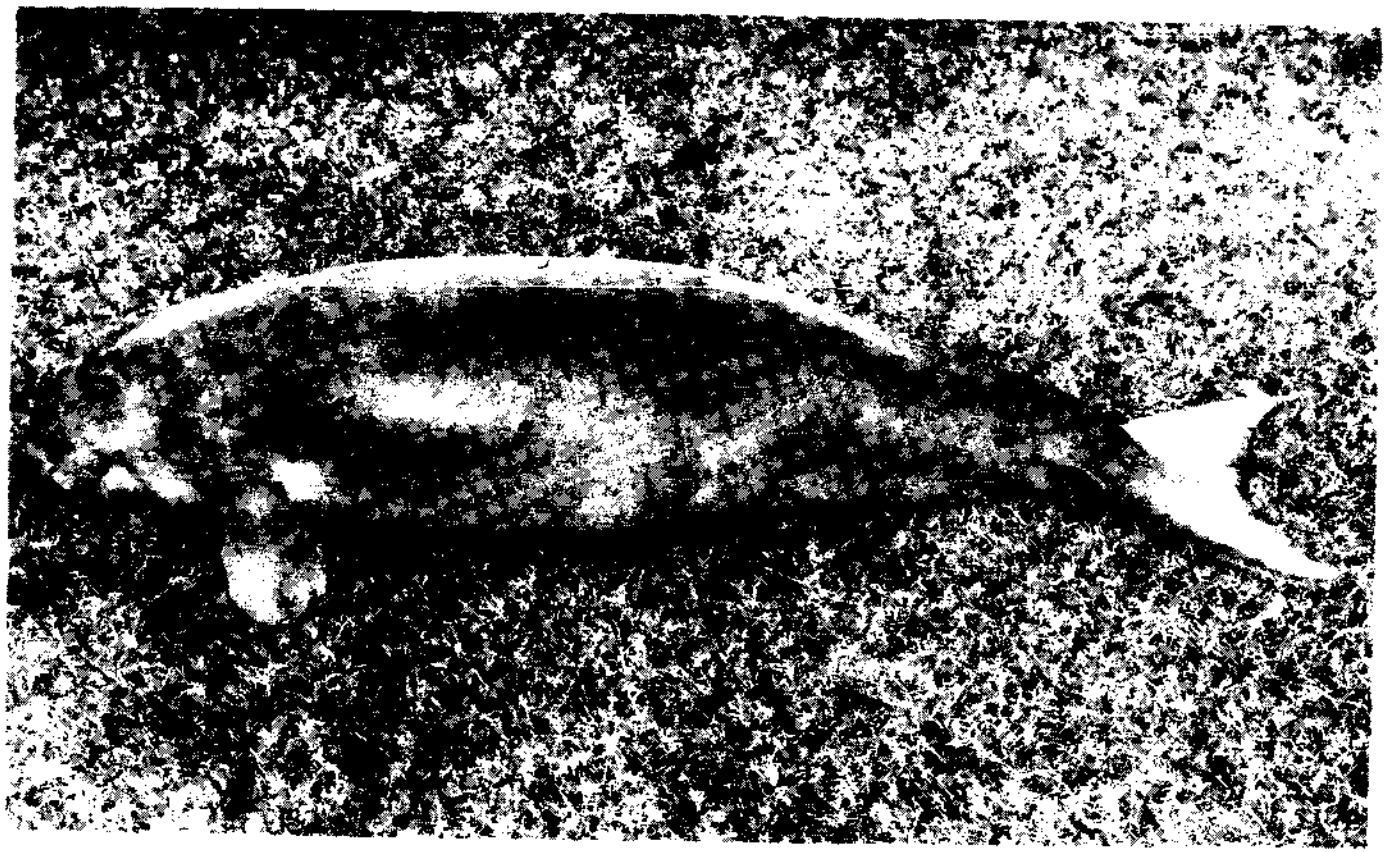
The Dugong

Dugong dugon

BULLETIN No. 26 1975



The Dugong *Dugong dugon* (Müller) of Indian waters

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THE DUGONG *DUGONG DUGON*

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PREFACE

The dugong, *Dugong dugon* (Müller), which is found in the coastal waters in several parts of the Indo-Pacific region, occurs in India in the Palk Bay, the Gulf of Mannar and in the Saurashtra waters and has been exploited for its flesh for several centuries. Apart from its economic importance, the dugong also called the sea cow, is a very interesting marine herbivore with features like muzzle, horny plates on jaws, massive bones and hair on the body. It is probable that the resemblance of dugongs to human beings when seen at a distance and the female dugong suckling the young one by holding it with a flipper might have given rise to the numerous stories of mermaids told by sailors especially in medieval times.

In recent years there has been a marked decline in the dugong population in most areas of distribution. At present dugongs are found in good numbers only in the Australian region around Queensland, Northern territory and Western Australia. The number of dugongs captured annually in Palk Bay and Gulf of Mannar in recent years has decreased considerably as compared with the early part of this century. Undoubtedly there is great need for protecting the dugong from indiscriminate exploitation since it is a rare animal.

For proper and effective conservation and management of the dugong populations adequate information on the distribution, habits, biology and the present level of exploitation is necessary. The taxonomy, morphology, distribution and natural history of dugong have been studied. Dugongs are being reared for the past fifteen years at the Regional Centre of the Central Marine Fisheries Research Institute at Mandapam Camp which is the only place in the World where they are held in captivity, and aspects like habits, growth, food and parasites have been investigated. In this Bulletin the available information on the dugong is presented comprehensively so that it will stimulate further research work on this very interesting rare marine mammal.

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Cochin
February, 1975

I INTRODUCTION

The dugong or the sea cow *Dugong dugon* (Müller) is a marine mammal which enjoys a wide distribution in the Indo-Pacific region from the east coast of Africa and Red Sea to Australia and Marshall, Solomon and New Caledonia Islands. It occurs in India in the Gulf of Mannar and Palk Bay and is captured for its flesh and oil. The dugong has been reported to occur on the Saurashtra coast also. The name dugong is derived from the Malayan name *duyong* for the animal. Countless stories of mermaids in folklore of various countries might have been inspired by the dugong due to the resemblance in external features to human beings to some extent. The number of dugongs captured in a year on the south-east coast of India in recent times is lower compared to that in earlier years. This appears to be due to reckless exploitation. Inspite of the fact that the dugong is of economic importance not much research has been done on this species till recently.

In the eighteenth century, naturalists like Müller, Lacépède and Erxleben reported the occurrence of dugong in different parts of the Indian Ocean. The anatomy of the dugong has been investigated by Owen (1838). In the early part of the present century the Indian dugong has been studied by Annandale (1905, 1907) who has given an account of the identity, external features and habits of the dugong and also its osteology. Prater (1928) published his observations on the natural history of the dugong together with notes on the economic importance of the animal. Pocock (1940) studied in detail the skeleton of dugong. Jones (1966, 1967a, 1967b) dealt with the distribution, abundance and habits of dugongs in Indian waters and pointed out the need to protect the dugong from indiscriminate exploitation. Recently Bertram and Bertram (1973) investigated the relative abundance, present level of exploitation and uses of dugong in its distributional range in the Indo-Pacific region and stressed the need for rational exploitation of this animal which has become rare in most areas of occurrence. During the past about fifteen years dugongs have been successfully reared in captivity by the Central Marine Fisheries Research Institute at Mandapam Camp and data has been collected on various aspects like morphology, habits, growth, food, parasites, exploitation and utilization.

In this bulletin information available on the biology, distribution and fishery of the Indian dugong is comprehensively presented so that studies could be undertaken in future to investigate the areas which require attention and steps could be taken to protect the species from over-exploitation.

II IDENTITY

TAXONOMY

Phylum Vertebrata
Subphylum Craniata
Superclass Gnathostomata
Class Mammalia
Order Sirenia
Family Dugongidae
Genus *Dugong*
Species *Dugong dugon* (Müller) 1776

The family Dugongidae under the order Sirenia of the class Mammalia includes a single species *Dugong dugon* (Müller) which occurs in coastal waters of the different parts of the Indo-Pacific region. The dugong was first named *Trichechus dugon* by Müller (1776). In 1799 Lacépède erected the genus *Dugong* and called the Indian Ocean dugong *Dugong indicus*. Illiger (1811) used the generic name *Halicore* for the dugong and this name was adopted by Rüppell (1834), Blanford (1888–91), Annandale (1905) and Prater (1928). A number of species of dugongs have been recognized by various workers until recently. Owen (1847) named the Australian dugong as *Halicore australis* Illiger (1811), Blanford (1888–91), Annandale (1905) and Prater (1928) referred to the Indian Ocean dugong as *Halicore dugong*. Ehrenberg (1833) established the species *Halicore hemprichii* based on a dugong skull collected from Barkan Island, Red Sea and another species *Halicore lottum* based on some teeth collected from Hanakel Island in the southern part of Red Sea. Rüppell (1834) considered that the Red Sea dugongs belong to the species *Halicore tabernaculi*. Pocock (1940) who studied the skeleton of dugongs from east coast of Africa, Red Sea, Gulf of Mannar and Australia felt that the Red Sea dugong may be racially distinct but he did not give it species or sub-species status. Pocock agreed with the view expressed by Annandale (1907) that the Indian and Australian dugongs belong to the same species.

Gohar (1957) recognized the Red Sea dugong as a distinct sub-species *Dugong dugong tabernaculi* and stated that the average size of the Red Sea dugong is smaller, the skull is heavier and broader, the zygomatic arches are stronger, the premaxillary bones are broader and stronger with less prominent angle of deflection, hair roots are not swollen into funnels and the young ones do not exceed about one metre compared to Indo-Australian dugongs. Free living young dugongs having a total length of 95 cm (compared to 110–120 cm reported in the

case of Red Sea dugong) have been recorded from Gulf of Mannar and therefore Gohar's view that the young at birth of dugongs of the Indo-Australian region and Red Sea differ markedly in size is not correct. The other differences pointed out by Gohar (1957) are not sufficient for treating the Red Sea dugong as a separate sub-species. It is now held (Ellerman and Morrison-Scott, 1951; Jones, 1967b) that the dugongs recorded from different areas of the Indo-Pacific region belong to a single species *Dugong dugon* (Müller).

Description

The body of the dugong is spindle-shaped and is divisible into head, trunk and tail. The head is relatively small and is characterized by the muzzle, a broad, flat, horse-shoe shaped extension of the upper lip, which overlaps the sides of the mouth (Fig. 1 A). On the surface of the muzzle a large number of hair, bristles and pores which appear to be sensory in function are found. At the base of the muzzle are two ridges bearing stiff bristles which are separated by a median cleft. Below the ridges is a flabby pad overhanging the mouth. In males a pair of incisors protrude through this pad while in females the incisors are not present. The eyes are small and have fleshy eye lids. The nostrils are a pair of crescent-shaped openings located dorsally behind the tip of the muzzle. The ear openings are small and located dorso-laterally on the head.

The dentition consists of incisors and molars. Canines are not present. The male dugong has a pair of incisors and five pairs of molar teeth in the upper jaw and five pairs of molar teeth in the lower jaw. The incisors and molars are separated by a wide space. The incisors are well developed in males while in the females the growth of the incisors is arrested and they remain buried in their sockets. Another pair of incisors are present in the upper jaw in the young dugong but these are shed in the early part of life. There are four pairs of incisors in the lower jaw in the young dugong but these are lost after sometime. In the female dugong five pairs of molar teeth are found in both upper and lower jaws as in males. In both sexes all the five pairs of molars in the jaws are not present at the same time. The anterior three pairs of molars are shed in the early period of life and the posterior two pairs move forward and grow. Some of even the latter molars are lost in some individuals. When teeth are shed the sockets are filled with bony matter.

At the anterior end of the trunk laterally are the paired forelimbs which are modified as flippers. Two mammae, one on each side are present in the armpits. The nipples are about 25-30 mm long in adult females (Fig. 1 B, Fig. 2 B) and about 80 mm in lactating ones. In the male the nipples are small and hardly protrude from the surface of the armpit. In the male dugong the

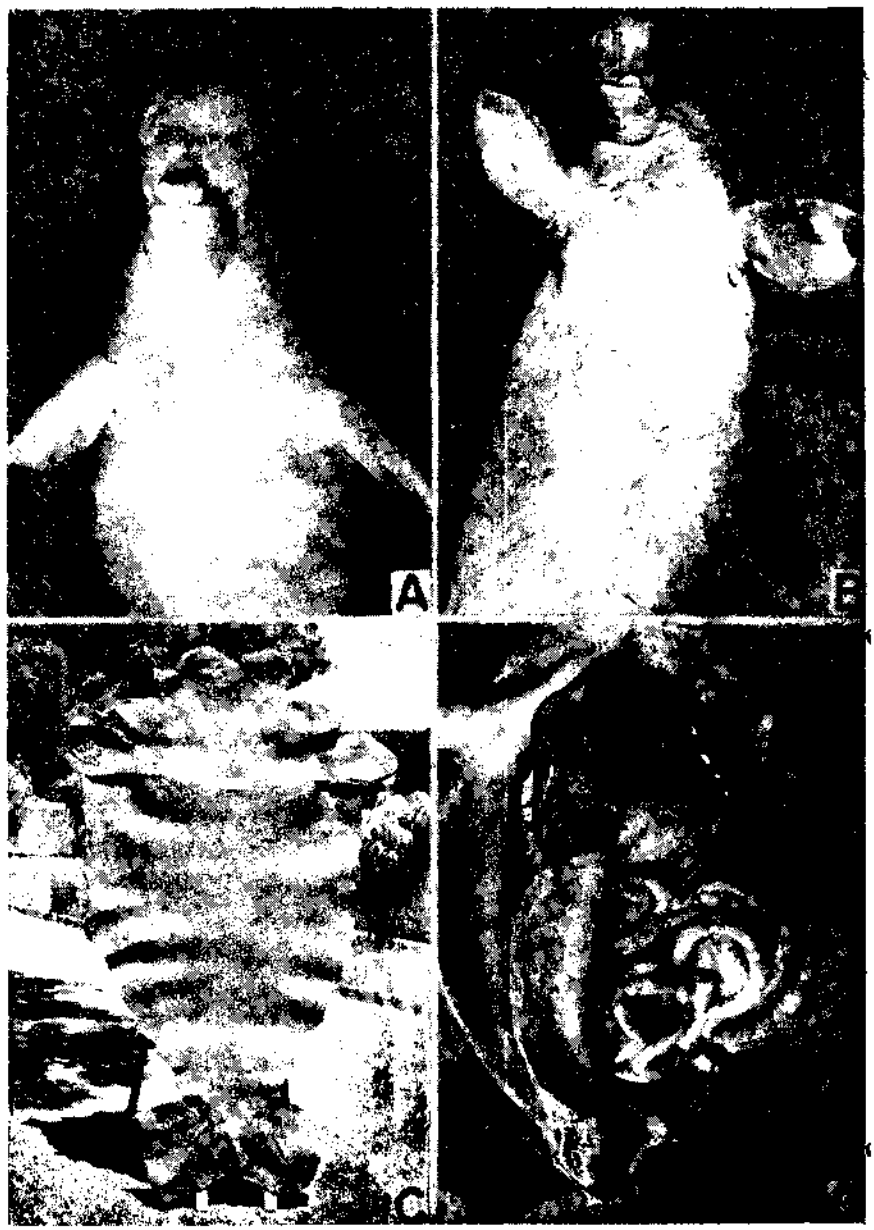

Fig. 1 A. Ventral side of the anterior part of the body of *Dugong dugon* showing muzzle having hair and bristles. B. Ventral side of the anterior part of body of female dugong showing nipples in the armpits. C. Tanned skin of dugong. D. Body wall of dugong cut open showing visceral organs.

urinogenital opening is situated at some distance anterior to the anus (Fig. 2 A). On the other hand in the female, the urinogenital opening is present in a long slit with fleshy walls, close to the anus (Fig. 2 B). The trunk is broadest in the waist region and narrows behind to form the tail. The tail is strengthened by a low dermal ridge mid-dorsally and mid-ventrally and ends by crescentic horizontal fluke.

The skin of dugong is thick and hair is present on its surface (Fig. 1 C). The colouration of the dugong varies in different individuals. It is grey or brownish grey dorsally and laterally and pale white ventrally. Annandale (1905) stated that a specimen examined by him was brownish grey dorsally fading to pure grey laterally and to dirty flesh colour ventrally.

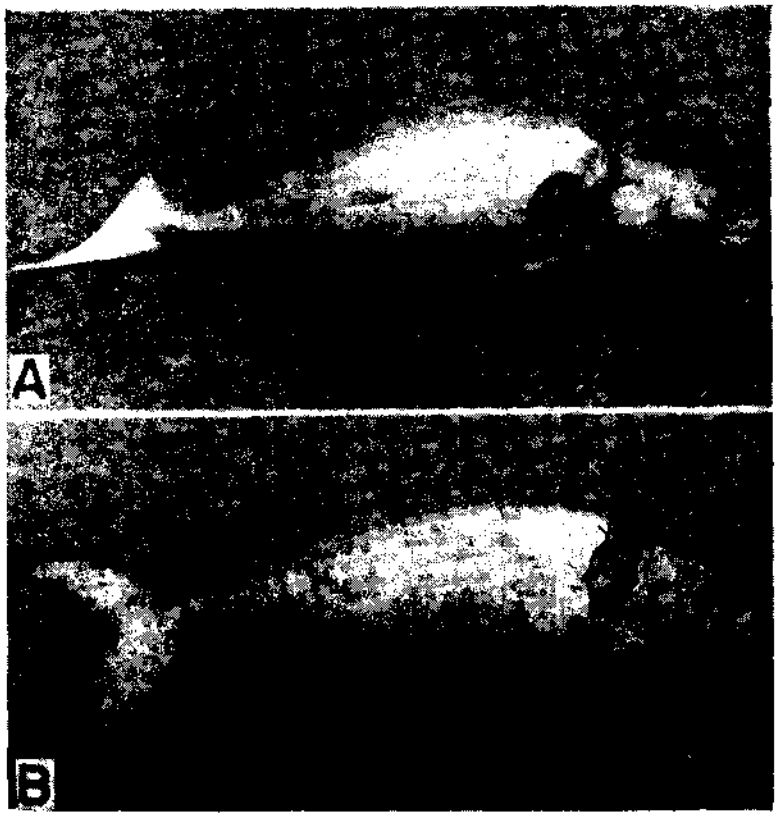

Fig. 2 A. Male *Dugong dugon*. B. Female *Dugong dugon*.

Dugong dugon (Müller) 1776

SYNONYMS

Trichecus (sic) *dugon* Müller, *Linne's Vollstandingen Natursyst. Suppl.*, 1776, 21.

Trichechus dugung Erxleben, *Syst. Regn. Anim.*, 1777, 599.

Dugong indicus Lacépède, *Tabl. Mamm.*, 1799, 17.

Halicore dugong Illiger, *Prodr. Syst. Mamm. et Avium*, 1811, 141; Blanford, *Fauna of British India, Burma and Ceylon, Mammalia*, 1888–91, 594; Annandale, *J. Proc. Asiat. Soc. Bengal*, 1, 1905, 238; Prater, *J. Bombay nat. Hist. Soc.* 33, 1928, 84.

Halicore hemprichii Ehrenberg, in Hemprich and Ehrenberg, *Symb. Phys. Mamm.*, 2 : folio K, 1833.

Halicore lottum Ehrenberg, in Hemprich and Ehrenberg, *Ibid.*, 1833.

Halicore tabernaculi Rüppell, *Mus. Senckenbergianum*, **1**, 1834, 113.

Halicore australis Owen, *Juke's Voyage of 'Fly'*, **2**, Appendix, 1847, 323.

Halicore cetacea Heuglin, *Reise in Nordost. Afr.*, **2**, 1877, 135.

Halicore halicore Hilmy, *Proc. Egpt Acad. Sci.*, **4**, 1949.

Dugong dugong (Sub-sp.) *tabernaculi* Gohar, *Publ. Mar. Biol. Stn. Al. Ghardaqa*, 9, 1957, 40.

Dugong dugong Jones, *J. Mar. biol. Ass. India*, **1**, 1959, 198.

Dugong dugon Ellerman and Morrison-Scott, *Checklist of Palaearctic and Indian Mammals*, 1758–1946, 1951, 337; Jones, *Internat. Zoo. Yearbk.*, 7, 1967, 215.

COMMON NAMES

Country	Language	Name
India	English	*Dugong, Sea cow*
	Tamil	*Avolia, Kadal panni*
Malayan Federation	Malay	*Duyong*
Egypt	Local language	*Gueld, Naqat al-bahr.*

GENERAL VARIABILITY

Fifteen morphometric characters of Red Sea and Indian dugongs (Table I) were compared using *t*-test (Table II). The results show that the length of flippers and small intestine is only significant at 5% level. These differences may be due to local variation. The test for variance also supports the view that the Red Sea and Indian dugongs belong to same species. Ellerman and Morrison-Scott (1951) and Mohr (1957) also do not recognize the Red Sea dugong as a separate sub-species. The differences between the Indian and Red Sea dugongs in certain structural features which have been mentioned by Gohar (1957) have been stated earlier.

TABLE I

Morphometric measurements in centimetres of dugongs of Red Sea and Gulf of Mannar

	Red Sea dugongs																Indian dugongs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1	2	3
	Male	Female	Female	Male	Female	Male	Male	Female	Male	Female	Female	Male	Female	Female	Female	Female	Male	Female	Female
1. Total length	198	277	225	207	288	208	282	215	192	220	170	195	254	220	220	215	240	242	226
2. Length of muzzle	—	—	—	13 (6.2)	18 (6.2)	13 (6.2)	—	14 (6.5)	13 (6.7)	13 (5.9)	12 (7.0)	12 (6.1)	20 (7.8)	14 (6.4)	—	11 (5.1)	14.8 (6.1)	14.5 (6.0)	24.8 (10.9)
3. Breadth of muzzle	—	—	—	18 (8.7)	27 (9.3)	15 (7.2)	17 (6.0)	19 (8.8)	17 (8.8)	20 (9.1)	17 (10.0)	16 (8.2)	25 (9.8)	18.5 (8.4)	—	19 (8.8)	21.0 (8.7)	24.5 (10.1)	22 0 (9.7)
4. Length of chin	9.0 (4.5)	—	—	—	14 (4.8)	10 (4.8)	—	10.5 (4.8)	10 (5.2)	13 (5.9)	11 (6.5)	11 (5.6)	13 (5.1)	11 (5.0)	—	12.5 (5.8)	11 (4.5)	14.0 (5.8)	14.3 (6.3)
5. Breadth of chin	8 (4.0)	—	—	—	18 (6.3)	9 (4.3)	—	13 (6.0)	13 (6.8)	20 (9.1)	18 (10.5)	15 (7.7)	23 (9.1)	18 (8.2)	—	20 (9.3)	12.5 (5.2)	17.5 (7.2)	14.5 (6.4)
6. Length of flipper	31 (15.6)	—	—	28 (13.5)	45 (15.6)	26 (12.5)	39 (13.8)	28 (13.0)	27 (14.0)	28 (12.7)	22 (12.9)	29 (14.8)	32 (12.5)	29 (13.1)	32 (14.5)	27 (12.5)	41 (17.0)	43.5 (17.9)	34.5 (15.2)
7. Breadth of flipper	13 (6.6)	—	—	14 (6.8)	20 (6.9)	—	—	15 (7.0)	14 (7.3)	15 (6.8)	13 (7.6)	14 (7.2)	18 (7.1)	15 (6.8)	15 (6.8)	15 (7.0)	—	—	11.5 (5.1)
8. Circumference of belly	162 (81.8)	—	—	160 (77.2)	217 (75.3)	162 (77.8)	200 (70.9)	167 (77.6)	150 (78.1)	165 (75.0)	140 (82.3)	146 (74.8)	175 (68.8)	180 (81.8)	—	170 (79.0)	174 (72.5)	156.5 (64.6)	150.2 (66.4)
9. Distance between submental sulcus and genital orifice	90 (45.4)	—	—	—	—	—	—	135 (62.7)	120 (62.5)	152 (69.0)	116 (68.2)	115 (58.9)	—	150 (68.2)	—	148 (68.8)	99.5 (41.4)	124.5 (51.4)	115 (50.8)
10. Length of genital orifice	5 (2.5)	—	—	—	—	—	—	7 (3.2)	—	—	4.5 (2.6)	5 (2.6)	—	5 (2.3)	—	5 (2.3)	—	—	8.8 (3.8)
11. Distance between genital orifice and anus	28 (14.1)	—	—	30 (14.5)	—	31.5 (15.1)	38.0 (13.4)	4.00 (1.8)	32 (16.6)	4.5 (2.0)	4 (2.3)	3 (1.5)	—	5 (2.3)	5 (2.3)	3.5 (1.6)	31.7 (13.2)	—	10 (4.4)
12. Breadth of tail fluke	70 (35.3)	83 (29.9)	—	65 (31.4)	90 (31.2)	74 (35.5)	80 (28.3)	59 (27.4)	56 (29.1)	73 (33.2)	51 (30.0)	63 (32.3)	69 (27.1)	71 (32.2)	—	61 (28.3)	70 (29.1)	80.5 (33.2)	62.6 (27.6)
13. Length of small intestine	1050 (530)	1550 (559)	1100 (488)	1100 (531)	1850 (642)	1300 (625)	1170 (414)	1350 (627)	1270 (661)	—	—	—	—	—	—	1360 (632)	1100 (458)	1090 (450)	—
14. Length of large intestine	1750 (883)	2800 (1010)	1900 (844)	1700 (821)	3350 (1163)	1880 (903)	2700 (957)	2000 (930)	2050 (1067)	—	—	—	—	—	—	2130 (990)	2150 (895)	—	2080 (920)
15. Length of caecum	—	—	—	30 (14.4)	—	36 (17.3)	—	37 (17.2)	40 (20.8)	—	—	—	—	—	—	30.5 (14.2)	25.0 (10.4)	—	32.5 (14.3)

The data on Red Sea dugongs has been taken from Gohar (1957).

The values in parentheses are percentages in total length.

Analysis of variance of different morphometric characters of dugongs of Red Sea and Gulf of Mannar

(measurements in centimetres)

	Red Sea		Gulf of Mannar		S. D.				
	Mean	Variance	Mean	Variance	Red Sea	Gulf of Mannar	t	D. F.	Remarks
Total length	224.13	1086.35	236.00	50.66	32.03	7.11	0.59	17	Not significant
Length of muzzle	13.91 (6.4)	6.62 (0.4)	18.03 (7.7)	22.91 (5.2)	2.57 (0.6)	4.78 (2.3)	1.84	12	Not significant
Breadth of muzzle	19.04 (8.6)	11.60 (1.1)	22.50 (9.5)	2.16 (0.3)	3.41 (1.0)	1.46 (0.1)	1.60	13	Not significant
Length of chin	11.36 (5.3)	3.17 (0.3)	13.10 (5.5)	2.22 (0.6)	1.78 (0.1)	1.48 (0.2)	1.19	12	Not significant
Breadth of chin	15.91 (7.4)	20.44 (4.0)	14.83 (6.3)	4.22 (0.7)	4.52 (2.0)	2.05 (0.2)	0.37	12	Highly insignificant
Length of flipper	30.21 (13.6)	30.44 (1.1)	39.67 (16.7)	14.38 (1.3)	5.51 (0.3)	3.79 (0.3)	2.66	15	Significant at 5% level
Breadth of flipper	15.10 (7.0)	3.74 (0.08)	—	—	1.93 (0.2)	—	—	—	
Circumference of belly	168.77 (76.9)	411.71 (15.1)	160.23 (67.8)	101.37 (11.43)	20.28 (3.8)	10.06 (3.3)	2.10	14	Not significant
Distance between submental sulcus and genital orifice	128.25 (63.0)	416.18 (56.3)	113.00 (47.9)	106.16 (21.0)	20.40 (7.6)	10.30 (4.3)	1.11	9	Not significant
Length of genital orifice	5.25 (2.6)	0.40 (0.09)	—	—	0.63 (0.3)	—	—	—	
Distance between genital orifice and anus	15.70 (7.3)	192.23 (40.2)	20.85 (8.8)	117.72 (19.4)	13.86 (6.3)	10.85 (4.4)	0.46	12	Highly insignificant
Breadth of tail fluke	68.93 (30.8)	108.06 (6.8)	71.06 (30.0)	53.93 (5.6)	10.38 (2.6)	7.34 (2.3)	0.32	15	Highly insignificant
Length of small intestine	1310 (571)	53040 (5783.3)	1095 (454)	25.00 (16.0)	230.30 (76.0)	5.00 (4.0)	1.21	10	Not significant
Length of large intestine	2226 (957)	263804 (9882)	2115 (908)	1225 (156.5)	513.61 (99.4)	35.00 (12.5)	0.26	10	Highly insignificant
Length of caecum	34.70 (16.8)	14.96 (5.8)	28.75 (12.4)	14.06 (3.9)	3.86 (2.4)	3.74 (1.9)	1.57	5	Not significant

S. D. : Standard deviation. D. F. : Degrees of freedom.

The values in parentheses are percentages.

III DISTRIBUTION

AREAS OF DISTRIBUTION

Dugong dugon has a wide distribution in the tropical Indo-Pacific region, approximately between longitudes 32° E and 170° W and latitudes 35° S and 40° N. Ellerman and Morrison-Scott (1951) and Macmillan (1955) have stated that the dugong has been recorded from East Africa, Madagascar, Mafia Island, Kenya, Red Sea, India, Ceylon, Andaman Islands, Arakan Sea (Burma), Mergui archipelago, Ryukyu Islands, Formosa, Malaysian Seas, Philippine Islands, Northern Australia, Torres Strait, Queensland, Western Australia, New Guinea, Caroline Islands, Solomon Islands, Marshall Islands, and New Caledonia. The dugong is also reported to occur east of Kyushu, Japan and off Gunsan, near Chosen, Korea but these records have to be confirmed (Hirasaka, 1934). The distribution of the dugong is presented in Fig. 3.

At the present time dugongs are found in good numbers in some coasts of Australia and have become rare in most other areas of distribution. They were formerly very common around Madagascar (Petit, 1923a; 1923b) but the populations have dwindled considerably. Only restricted numbers of dugongs are found around Madagascar now. Dugongs have been recorded around Mauritius in seventeenth century but there are no modern records. In East Africa dugongs are moderately common on the coasts of Somalialand, Kenya (Lamu region) and Pemba Channel of Tanzania and in restricted numbers in Zanzibar channel and Mozambique (Bertram and Bertram, 1973). According to Sanderson (1955) dugongs have been reported from some large land-locked freshwater lakes of East Africa. But this report has to be confirmed. Most probably it is not true.

In Red Sea dugongs are found in Gulf of Aquaba, Gulf of Suez, Sudan coasts, Dahalak archipelago, Massawa and Jeddah. Dugongs have been formerly stated to be abundant in the Arabian (Persian) Gulf but now they are very rare there (Gohar, 1957; Bertram and Bertram, 1973).

Dugongs are rare at present around Malaya and Singapore, Borneo and Sabah while they are found in good numbers along southern Papua. Only a few or small numbers are seen in Solomon Islands, Bougainville Island, Palau Islands, Arakan Sea, Philippine Islands, Taiwan, Ryukyu Islands, Hong Kong, Noumea and New Caledonia, New Hebrides and Kia Island in Lau group in Fiji.

In Australia dugongs are plentiful in Torres Strait, Cape York, Rockingham Bay, Cairns, Yarraba, Princess Charlotte and Ninion Bays, Lockhart Mission and

Mornington Island. Good numbers of dugongs are present in Shoalwater Bay, Broadsound, Cardwell, Arukun Mission, Goulburn Island, Shark Bay and Peron peninsula and small numbers in Sydney, Moreton Bay, Gladstone, Mackay, Bowen, Townsville, Magnetic Island, Hinchingbrooke Channel, Hopevale Mission, Melville Island, northern Arnhem Land, Bathurst Island and Darwin (Bertram and Bertram, 1973).

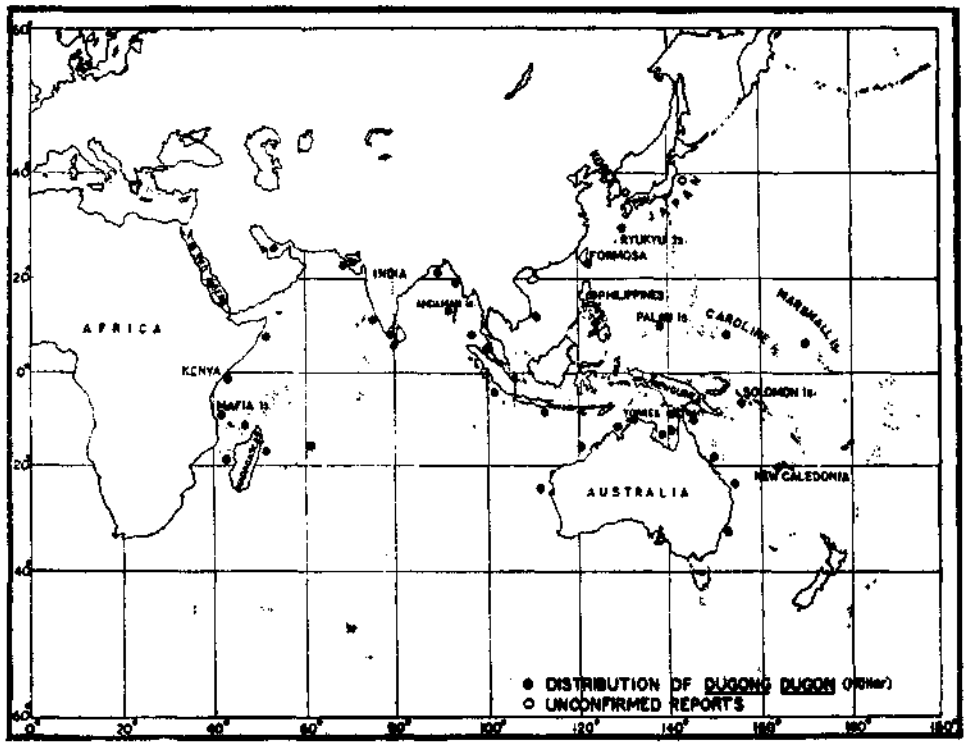

Fig. 3. Geographical distribution of *Dugong dugon*

DISTRIBUTION ON INDIAN COASTS

There is a population of the dugong in the Gulf of Mannar and Palk Bay. Around a number of islands which exist in the Gulf of Mannar between Rameswaram and Tuticorin and in shallow parts of the area where sea gresses are abundant and offer shelter and food dugongs are presnt. Dugongs are chiefly caught around Musal Island off Mandapam, Appa Island and Balayamuni Island off Kilakarai. The statement of Thomas (1966) that dugongs in herds of 400-500 in number have been seen in the area cannot be true. In Palk Bay dugongs are recorded off Adirampattinam, Devipattinam and Tondi. Stray numbers of dugongs are caught in the Gulf of Kutch (Moses, 1942; Mani, 1960; Mohan,1963).

The dugong has been reported from Malabar coast (Prater, 1928; Morrison-Scott, 1951). The reports may be based on individuals which would have strayed into the area from Gulf of Mannar as mentioned by Jones (1967b). Prater (1928) has stated that the dugong is found around Andaman Islands.

In the Gulf of Mannar the number of dugongs caught has considerably decreased compared to earlier times. It is likely that this is due to depletion of the stock as a consequence of indiscriminate capture.

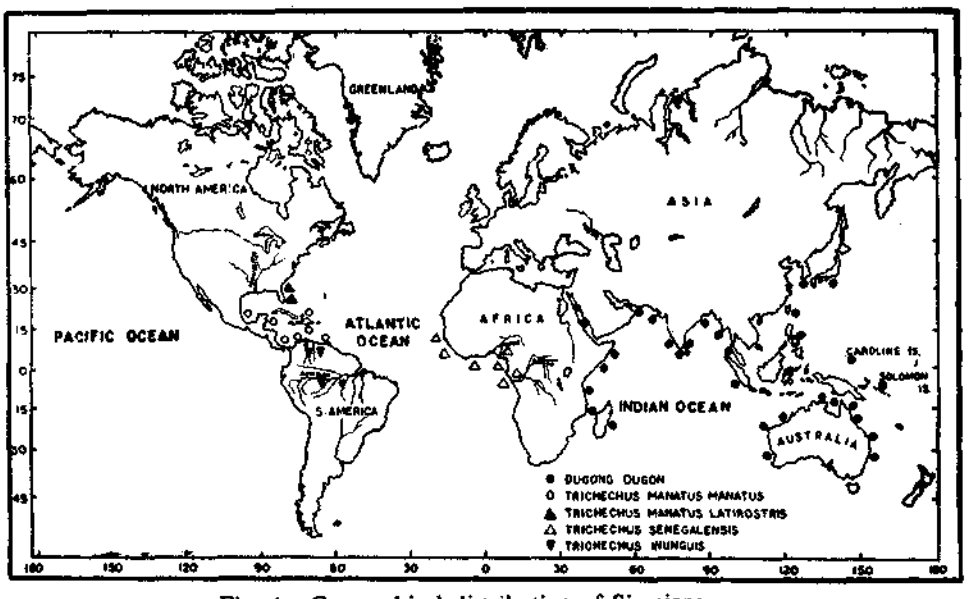

Fig. 4. Geographical distribution of Sirenians.

The dugong has a wide range of distribution. On the other hand the other sirenians, the manatees *Trichechus senegalensis* Link, *T. manatus manatus* (Linnaeus), *T. manatus latirostris* (Harlan) and *Trichechus inunguis* (Natterer) have restricted distribution. *T. senegalensis* occurs along the west coast of Africa and in the rivers of Senegal and Angola. *Trichechus manatus latirostris* is found around Florida peninsula as far north as Georgia, whereas *Trichechus manatus manatus* occurs around West Indies, on the coast of Yucatan, southern Mexico and from Central America to Guyana. *T. inunguis* is a freshwater species found in the Amazon and Orinoco river systems (Fig. 4).

The sea cow *Rhytina stelleri* discovered in 1741 by the naturalist Steller in the Behring Sea became extinct in the later part of the eighteenth century within about thirty years as a consequence of intensive hunting for its flesh. The dugong should not meet a similar end due to thoughtless exploitation. It is evident that

dugongs have become rare in many areas where they were abundant previously. Though they have an extensive range of distribution each population may be localised as there cannot be intermixing of distant populations for example of dugongs of Indian and Australian regions. The sluggish habits, huge body and weak organs of locomotion of dugongs preclude any possibility of intermixing of populations of distant areas even of the same country. So if the population gets depleted or exterminated, it will not be replenished by stocks of other distant localities. Moreover, migration has not been reported in these animals. This may be one of the reasons for the dugongs being not found around isolated islands of the Indian Ocean though they are present around islands near mainland. The dispersion of dugong would have taken place along coasts.

IV INTERNAL ORGANS

The anatomy of the dugong of the Indo-Australian region has been studied by Owen (1838), Petit (1925; 1955), Hill (1945) and Harrison (1969) and that of the Red Sea dugong by Gohar (1957) and Batrawi (1957).

In the buccal cavity of the dugong the horny plates, an upper horny plate in the upper jaw and a lower horny plate in the lower jaw which are characteristic of sirenians are present. During development the plates are derived from the mucous membrane of the two jaws. The horny plate in the lower jaw is much better developed than that in the upper jaw and has a furrow-like depression along the median line which does not reach the anterior tip of the plate. The entire surface of the lower horny plate is covered by minute bristles and the plate covers the abortive teeth of the lower jaw. The upper horny plate lies on the palatine processes of the premaxillaries and maxillaries and its surface is covered by stiff bristles. There are knob-like prominences of irregular shape scattered on the surface of the plate and these are also covered by stiff bristles. These structures of the horny plates facilitate crushing of sea grasses on which the dugong feeds.

The tongue is situated behind the lower horny plate with its anterior tip extending over the posterior edge of the plate. The tongue is short, being about 14 cm in length in the adult dugong. A major part of it is attached to the floor of the mouth and only the anterior portion and lateral borders are free. The tongue has different types of papillae, viz., digitiform papillae, fungiform papillae, microscopic papillae and calicipenicilliform papillae. The calicipenicilliform papillae lie in a small depression and do not have the characteristic ridge; these papillae are compound papillae, a bunch of about twelve long papillae sometimes arising out of a common stem being found in a depression. A few long digitiform papillae are also found in the depressions. The calicipenicilliform papillae are abundant in the middle third of the dorsum of the tongue and very few of them are seen in other parts of the tongue. On the sides of the tongue near the upper surface small pits are present. Below the stratified surface epithelium of the tongue, the corium a thin layer of loose texture is present and below this is the thick glandular layer comprising of mucilaginous glands and striated muscle fibres. The anterior end of the tongue is cornified, dark in colour and provided with bristles.

The salivary glands are well developed. The epiglottis is short and thick and covers the glottis. The trachea is short and the lungs are flattened

dorsoventrally and extend up to the kidneys. The oesophagus is narrow and leads into the stomach. The stomach consists of the cardiac stomach and pyloric stomach. The latter has two caecae. The liver is massive and the pancreas is lobulated and moderately developed. The small intestine is very long and it is about 4–5 times the total length of the animal. The large intestine (Fig. 1 D) is longer than the small intestine, being about 9 times the length of the animal and has a caecum. The anus is located midventrally at the posterior end of the trunk. The anal opening leads into a shallow sinus into which the outer end of rectum opens.

An important feature of the skeleton of the dugong is the massiveness and dense nature of the bones which enable the animal to remain under water with ease while browsing. The intermaxillaries, maxillaries and mandible are deflexed and carry on their surface the horny plates. The mandible occupies more than half of the skull and has a deep arch in the lower middle portion. Nasal bones are absent and the anterior narial apertures are located far back and pointed upwards. The parietals meet in the roof and the tympanic bone is annular and ankylosed with the periotic. The cranial cavity is small and slightly elongated. The orbits are small. The coronoid process is large and the zygomatic is stout. Lachrymal bone is well developed.

There are seven cervical vertebrae, nineteen thoracic, four lumbar, one sacral and twenty–five to twenty–seven caudal vertebrae. The centra of vertebrae do not have epiphysis. The cervical vertebrae are compressed antero-posteriorly. All the vertebrae have articulating processes. The articulating processes of the caudal vertebrae are imperfectly developed and this gives considerable mobility to the caudal region. Sacrum is absent. The sternum is small in size. There are nineteen pairs of ribs. Clavicles are absent. The scapula is convex on the dorsal side and concave ventrally and has a short acromion process and well-developed coracoid. The humerus is short and stout and radius and ulna are apposed to each other at the distal end. Carpals and metacarpals are reduced in number. The first digit is less developed than other digits. In some individuals it has one bone while in others it has two bones. Nails are absent. Only traces of pelvic girdle are present. Pubic bones are absent and ischium and ilium are rod–like.

The heart is located in the sternal region. The apex of the ventricle has a cleft and two superior vena cava are present. Retia mirabilia are present in the brain and other parts of the body. The diaphragm is oblique.

The brain is small. Cerebrum has a few shallow sulci on frontal, parietal and temporal lobes and corpus callosum is well developed. The third ventricle is large and wide. The olfactory lobes are elongated and cylindrical. Pineal gland is absent.

The kidneys are elongated. The medullary portion of the kidneys is divided into anterior and posterior halves by a transverse septum. The ureters are dipelvic, the two dilatations of each ureter opening into the anterior and posterior parts of the kidney. The dilatations of the ureter are in close contact with each other and by the partial fusion of their adjacent walls the transverse septum dividing the kidney into anterior and posterior halves is formed.

In the males the testes are present posterior to the kidneys. The penis lies, at rest, telescoped in a preputial chamber situated at a distance from the anus. The penis is broader at the base and narrow towards the tip, the region just below the glans penis having smallest diameter. The glans penis at the tip of the penis is formed of erectile tissue and ends by a short process at the tip of which is the urino-genital opening. At the base of the glans penis there are a pair of two semi-lunar lobes forming a collar-like structure. There is a wide preputial fold, frenulum preputiae at the base of the penis which extends on the ventral surface up to the semi-lunar lobes below the glans penis. When erected the penis of an adult male measures 20—25 cm in length.

In the females the ovaries are present in a peritoneal pouch connected to the dorsal abdominal wall by a mesovarium. The uterus is bicornuate and placenta non-deciduous and diffuse. The urino-genital opening of the female is located at a short distance in front of the anus in a long slit with thick fleshy walls. The urino-genital opening is close to the anus in the female while in the male it is at some distance anterior to the anus. The genital or vulval cleft of the female is about 8–12 cm long and lies at a distance of 25 to 35 mm from the anus. The genital cleft leads into a spacious chamber in the anterior part of which is the clitoris. The clitoris consists of proximal corpus clitoris and distal glans clitoris. The urethral caruncle is elongated and lies posterior to the clitoris and above the opening of the urinary meatus. The vagina opens posterior to the urethral caruncle by an oval opening.

Underneath the skin of the dugong is the thick blubber constituted by adipose tissue. The blubber of dugong is not as thick as that of whales. This is due to the fact that the dugongs occur in warm tropical seas and they do not require protection against loss of heat to the same extent as whales need. Good quantities of fat are found in the connective tissue of omentum and below peritoneal lining of the coelom of the dugong.

V BIOLOGY

REPRODUCTION

The female dugong gives birth to one young one at a time. However, there are reports by fishermen, of dugongs giving birth to twins. Foetus of the Indian dugong has not been collected so far. Turner (1894) described from Australia the foetus of a dugong, measuring 162.7 cm but the identity of the foetus is doubtful as a free-living young dugong with a total length of 95 cm has been recorded by Jones (1959) from Mandapam area and the foetus described by Turner is too large for the species which grows only up to a length of about 3 metres. Dugongs are monogamous. This is evident from many captures of a family of dugongs consisting of a male, a female and a young one. In the case of Indian dugong information is not available about age at first pregnancy, number of offspring born during the lifetime of a female and age at which cessation of breeding takes place in the female. Bertram and Bertram (1973) found that among one hundred and forty three individuals examined from Northern Australia, the size of smallest pregnant female was 2.3 metres.

Jones (1967 b) reported observations made by Dr. P. S. B. R. James on courtship of a pair of dugongs reared in the aquarium at Mandapam Camp in April, 1966. At that time it was believed that the pair dugongs consisted of a male and a female. Later on examining the dugongs when they died in 1970, it was found that both of them were males. Obviously what was observed as courtship by Dr. James is only playful activity of the dugongs in captivity.

GROWTH

Some observations have been made on two dugongs reared in captivity, in the aquarium at the Central Marine Fisheries Research Institute, Mandapam Camp. A male dugong 160 cm in length caught in October, 1959 and reared in the aquarium reached a size of 207 cm when it died in July, 1970. Another male dugong measuring 196 cm captured in December, 1959 and reared in the aquarium attained a length of 226 cm in August, 1970 at the time of its death.

In about eleven years the first individual showed a growth of 47 cm with an average growth rate of 4.3 cm per year while the second one exhibited a growth of 30 cm during the same period with an average rate of growth of 2.8 cm per year. It may be seen that the growth of the first dugong was faster than the second one due to the fact that the former was younger.

Heinsohn (1972) plotted the total length of 76 dugongs captured in northern Queensland and distinguished them into four arbitrary age classes: birth to one year (1.09 to 1.8 m); one to two years (1.81 to 2.4 m); two to three years (2.41 to 2.7 m); and over three years of age (over 2.7 m). With the help of the age classes he drew a hypothetical growth curve which indicated a progressive reduction in growth rate with age. Husar (unpublished) disagrees with the hypothesis of Heinsohn in regard to age and growth of dugong. The observations made on dugongs in captivity at Mandapam Camp also do not corroborate Heinsohn's view as the two dugongs reared for eleven years measured only 207 cm and 226 cm.

The captive dugongs were not weighed when alive. So there is no information on their rate of increase in weight. The animals were kept in a tank measuring 6.6 m in length, 3.5 m in breadth and 1.2 m in depth. The slow growth, and emaciated condition of the captive dugongs observed in post-mortem examination revealed that the amount of blubber and flesh in the body was much less than that of dugongs caught from natural habitat. A dugong measuring 226 cm in length kept in captivity weighed only 191 kg while one 225 cm in length caught from natural habitat weighed 237 kg.

LENGTH–WEIGHT RELATIONSHIP

For determining length–weight relationship measurements of 7 males and 10 females were analysed.

The general equation $W = a\ L^n$ can be expressed in the logarithmic form as $\log W = \log a + n \log L$, i. e., $Y = A + BX$, where $A = \log a$, $B = n$, $Y = \log W$ and $X = \log L$ which is a linear relationship between Y and X. The linear relationship is fitted separately for male and female dugongs. The estimation of the parameters A and B for each case was obtained by the method of least squares. The details are given in Table III. The length–weight relationship of males and females is represented in Fig. 5 A and B.

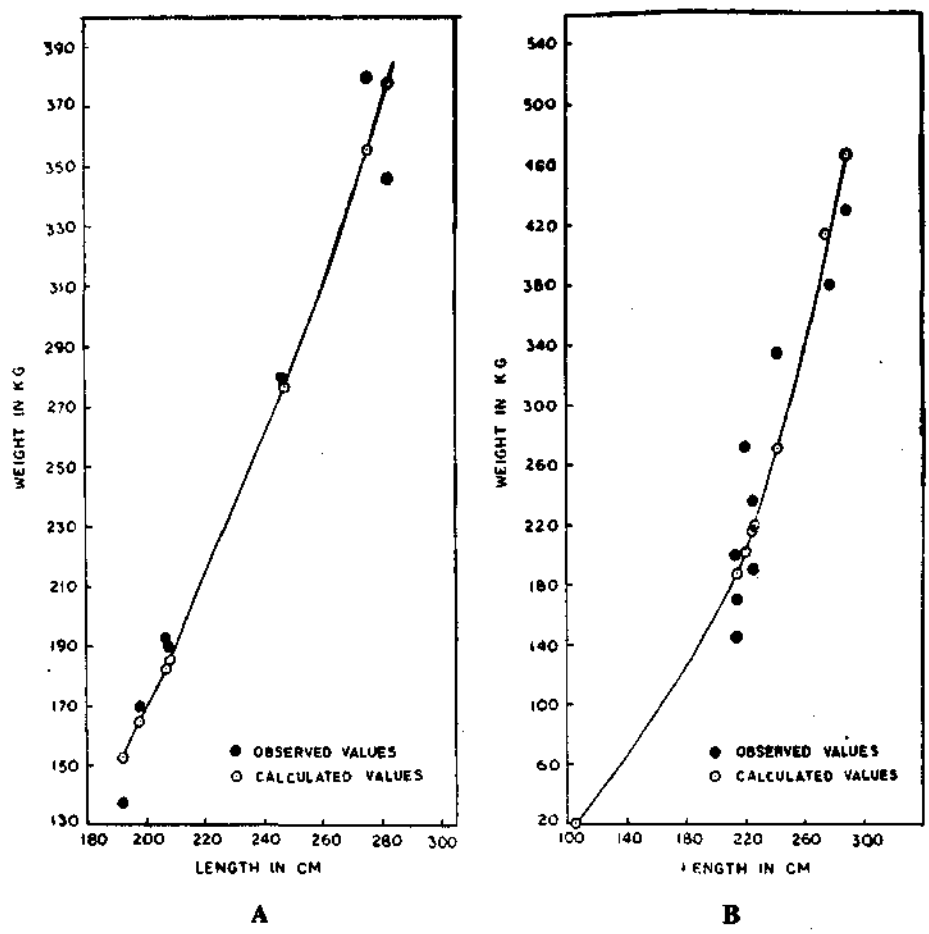

Fig. 5 Length-weight relationship of *Dugong dugon*.

A. Males. B. Females.

TABLE III

Sum of squares and products of Length and Weight data of male and female dugongs.

Sex	Number	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY
Male	7	16.4963	16.5008	38.9040	39.0615	38.9539
Female	10	23.3569	22.8240	54.6800	53.3767	53.7038

$W = a L^n$

$W = \cdot 000651\ L^{2.3524}$ for males

$W = \cdot 000009344\ L^{3.1305}$ for females

$\log W = -3 \cdot 1864 + 2.3524 \log L$ (Males)

$\log W = -5 \cdot 0295 + 3.1305 \log L$ (Females)

As seen in the length-weight charts (Tables IV and V) male and female dugongs increase in weight up to 220 cm in more or less the same pattern but after 220 cm the female dugong increases in weight by 10–15 kg more than males per 10 cm increase in length.

TABLE IV

Length-Weight chart of male dugongs (Calculated values).

Length (cm)	Weight (kg)	Increment in length (cm)	Increment in weight (kg)
192	153	—	—
200	169	8	16
210	190	10	21
220	214	10	24
230	237	10	23
240	260	10	23
250	285	10	25
260	312	10	27
270	340	10	28

TABLE V

Length-Weight chart of female dugongs (Calculated values).

Length (cm)	Weight (kg)	Increment in length (cm)	Increment in weight (kg)
106	20	—	—
110	24	4	4
120	38	10	14
130	52	10	14
140	68	10	16
150	82	10	16
160	100	10	18
170	115	10	15
180	130	10	15
190	146	10	16
200	162	10	16
210	178	10	16
220	200	10	22
230	232	10	32
240	266	10	34
250	300	10	34
260	340	10	40
270	382	10	42
280	425	10	43
288	468	8	43

LONGEVITY

No information is available on the longevity of dugong. The inferences deduced here are based on data available on the dugongs reared in captivity at Mandapam Camp. It is presumed that at birth the dugong is less than 95 cm in length as the smallest free living dugong captured in Mandapam area was 95 cm in length. During the period 1959 to 1970 a male dugong grew in captivity from a size of 160 cm to 207 cm and a bigger one from 195 cm to 226 cm. In the natural habitat the growth of dugong will be much faster than in captivity, especially that of the juveniles. If we consider that 90 cm is the length of dugong at birth and assuming that the rate of growth in the natural habitat is double that in captivity, about 10 cm per year, the dugong measuring 160 cm which was captured in 1959 would have taken about seven years to attain that size. This dugong lived in captivity for about 11 years. Therefore, it is presumed that the longevity of dugong may be about twenty years.

SIZE RANGE

The length of most of the dugongs captured in Gulf of Mannar and Palk Bay ranges between 170 cm and 280 cm. The smallest size recorded is 95 cm

from Gulf of Mannar and the largest individual 406 cm from off Saurashtra coast. The accuracy of the measurement of the dugong reported off Saurashtra coast is doubted (Silas, 1961).

Food

The dugong is a herbivorous animal and feeds on sea-grasses which are found in abundance in shallow regions of the coastal waters. Some early authors (Rüppell, 1833; Annandale, 1905) have reported presence of *algae* in stomachs of dugongs and the people of Palau Islands believe that the dugong feeds on holothurians and clams (Harry, 1956). But observations made by several workers in recent times show that the dugong feeds exclusively on sea-grasses. In Madagascar the sea-grass on which dugongs feed is called *dugong grass* by the local people.

Sea-grasses constituting food

Dugongs captured in the Gulf of Mannar and Palk Bay in the neighbourhood of Mandapam were found to have in their stomachs the sea-grasses *Cymodocea serrulata* (*C. ciliata* of some of the earlier authors), *Cymodocea isoetifolia*, *Halodule uninervis*, *Halophila ovalis* and *Enhalus acoroides* (Table VI). The

Table VI

Food of *Dugong dugon* as recorded in different localities by various authors.

Locality	Food	Author and year
Gulf of Mannar	Algae	Annandale (1905)
	Sea grasses	Prater (1928)
	Cymodocea ciliata, C. isoetifolia, Enhalus koenigi, Halophila ovalis, H. stipulacea, C. rotundata and *C. australis* (in captivity)	Jones (1959; 1967a)
	Halophila ovalis, Halodule uninervis, Cymodocea serrulata	Nair and Mohan (Manuscript)
	C. serrulata, C. rotundata, C. isoetifolia, E. koenigi	Thomas (1966)
Gulf of Kutch	'Filamentous algae'	Mani (1960)
Red Sea	'Algae'	Rüppell (1833)
	Diplanthera uninervis	Gohar (1957)
Madagascar	*Cymodocea (Diplanthera) australis*	Petit (1924)
	Cymodocea ciliata	Petit (1955)
Australia	*Halophila ovalis, Zostera capricorni*	Dexler and Freund (1906)
	H. ovalis, Z. capricorni	Petit (1955)
Solomon Islands, Marshall Islands & New Caledonia	*Cymodocea* sp., *Halophila* sp.	Macmillan (1955)
Locality not mentioned	*Zostera, Posidonia*	Pocock (1940)

dugong feeds also on the sea-grass *Halophila stipulacea* when it is available. *H. stipulacea* is rarely found in this area.

Cymodocea serrulata is considered to be the chief constituent of the diet of the dugong in Mandapam area. But in one dugong which we examined recently *Halophila* formed 80% of the stomach contents, *Halodule uninervis* 10% and *Cymodocea serrulata* 10%. This suggests that the food preference of dugongs is not very strict. It is noteworthy that marine algae have not been found in the stomachs of dugongs. The stomach contents are remarkably free from sand and mud. The dugongs reared by the Central Marine Fisheries Research Institute are fed with the sea-grasses *Cymodocea serrulata* and *Halodule uninervis*.

Food of dugong in other parts of the Indo-Pacific

The dugongs of Madagascar area have been reported to feed on *Cymodocea australis* (Petit, 1924; 1955), and those of Australia on *Halophila ovalis* and *Zostera capricorni* (Dexler and Freund, 1906; Petit, 1955). Gohar (1957) stated that the Red Sea dugong feeds exclusively on the sea-grass *Diplanthera uninervis*. Macmillan (1955) has recorded that the dugongs of Solomon Islands, Marshall Islands and New Caledonia feed on *Cymodocea* sp. and *Halophila* sp. (Table VI). Manatees also feed on sea-grasses.

Descriptions of sea-grasses

As there is some confusion about the identity of sea-grasses which form the food of the dugong, short descriptions of the sea-grasses belonging to the family Potomegetonaceae under the order Helobieae are given below.

Tribe : Cymodoceae

Cymodocea serrulata (R. Br) Aschers and Magnus (Fig. 6 A)

Plants with rhizomes, leaves erect, flat, 10–20 cm in height, 0.5 - 1.0 cm broad, with ligulate sheaths. The species grows in sandy and muddy areas and forms extensive meadows. It is a dominant member of the sea-grasses occurring in the Gulf of Mannar and Palk Bay and is invariably found in the stomachs of dugongs.

Cymodocea isoetifolia Aschers (Fig. 6 B)

Plants with rhizomes, leaves erect, about 15-25 cm in height, essentially cylindrical, about 2 mm in diameter. This species of sea-grass occurs in the sublittoral areas in Gulf of Mannar and Palk Bay but it is not as common as *C. serrulata*. It also forms one of the chief items of food of the dugong.

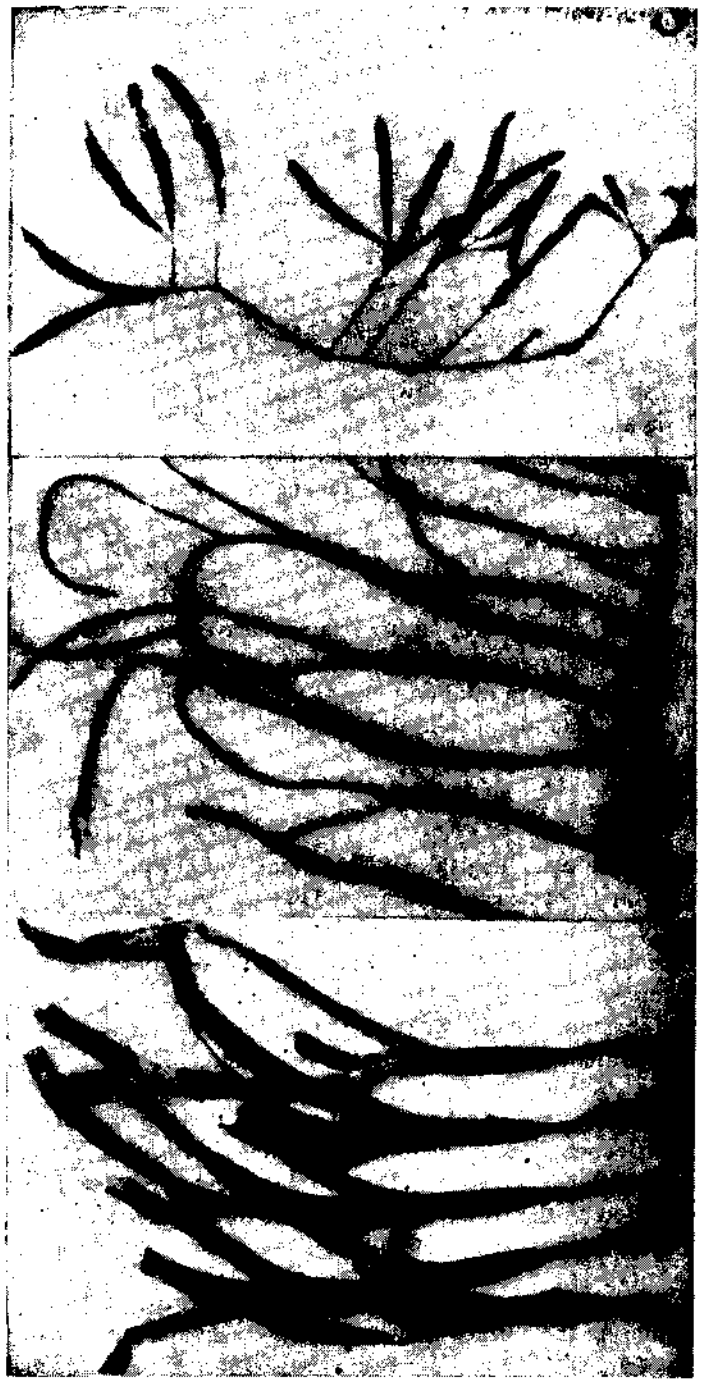

Fig. 6. Sea-grasses which form food of *Dugong dugon* of Mandapam area.
A. *Cymodocea serrulata*. B. *Cymodocea isoetifolia*. C. *Halophila ovalis*.

Halodule uninervis (Forsk.) Aschers

Plants with horizontal or prostrate stems with erect leaves. Leaves 10–15 cm in length, 1.5–2 mm in width, with ligulate sheath, leaf tips with 2 or 3 points, lacunae present near the median nerve. This species grows in the littoral regions with muddy bottom and is not very abundant in Gulf of Mannar and Palk Bay. It is usually found in association with other sea-grasses. It is also one of the important items of food of dugong.

Tribe: Zostereae

Halophila ovalis (R.Br) Hook (Fig. 6 C)

Plants with slender rhizomes, two leaves arise from each node; leaves ovoid, 3-4 cm long and 1–1.5 cm in width, stipulate and with long petioles, rooted at nodes. This species is common on sandy substrata in the sublittoral region. It often forms a major part of the stomach contents of the dugong.

Enhalus acoroides (L. f.) Royle

Rhizomatous plants, rhizome stout, covered with black thread-like structures. They are tall plants with strap shaped leaves 75–100 cm long and 1-2 cm in width. This species of sea-grass has been reported as *E. koenigi* by earlier workers. It grows in muddy areas of the sublittoral region. It is not abundant and is found mainly around the islands of Gulf of Mannar. Dugongs feed on it occasionally.

HABITS

Dugongs are harmless, sluggish marine animals inhabiting coastal waters. They are not found far from coastal waters. They are found in calm areas and sheltered bays where the bottom consists of silt and sand conducive to rich growth of sea-grasses. Some areas of Gulf of Mannar and Palk Bay offer ideal living conditions for dugongs. They do not live in close proximity to actively growing coral reefs and surf-beaten coastal waters. It has been reported that dugongs sometimes enter Australian rivers (Bertram and Bertram, 1973).

The dugong is not capable of swimming swiftly as it does not have well developed organs of locomotion. The animal can steady itself or move forward or back over a short distance with the help of the flippers. Forward movement of the animal is effected by the trunk and tail. The dugong does not relax on exposed rocks or coral reefs as mentioned in many early accounts of voyages.

The dugong comes up to the surface of water for breathing once every few minutes. For coming to the surface it swims at an angle and the posterior part of the head emerges first. Then the head is raised bringing the nostrils above

the water level but leaving the mouth submerged. The nostrils open simultaneously. Each time the dugong comes to the surface it takes only a single breath and the time taken for opening and closing of nasal flaps is 2 — 3 seconds. The Indian dugong has been found to come up to the surface of water for breathing at intervals of 1½ — 4 minutes. It has been reported that in the Australian dugong the interval varies between 33 seconds and 8 minutes and 26 seconds (Kenny, 1967). However, the average time the Australian dugong remains under water is 3 minutes.

The dugongs are herbivorous feeding exclusively on sea-grasses. The mouth of the dugong is located ventrally and therefore the animal makes sideward thrusts and lifts its head to grab sea-grass. When the head is thus lifted up the fleshy outer border of the muzzle curves back giving a forward position to the mouth (Jones, 1959). Gohar (1957) considers that the stiff bristle-like hair present on the antero-lateral aspects of the mouth of the Red Sea dugong help in rasping sea-grasses from the substratum. He is of the opinion that the bristles present on the postero-lateral angles of the mouth probably filter the sea water and mud taken along with sea-grasses in the course of feeding. He has expressed the view that the hard and sharp edge of the flippers of the Red Sea dugong helps in digging out sea-grasses from the substratum and gathering them. The flippers of the Indian dugong do not appear to be useful to the animal for dislodging sea-grasses from the habitat or for collecting them. Gohar (1957) states that the Red Sea dugong does not seem to ingest sea-grass directly after uprooting it but gathers it in heaps and when a number of heaps have been made it feeds on one heap after another. He states that this mode of feeding is beneficial to the animal as the sea-grass kept in heaps becomes free of sand, mud and unwanted items like fishes, starfishes, holothurians and polychaetes. The dugong can remain under water with ease while browsing due to its massive body and dense bones.

Dugongs are voracious feeders and feed at all times of the day. The wet weight of stomach contents (sea-grasses) of dugongs varies between 10 kg and 24 kg. The stomach, intestine and caecum have been observed to be full in all individuals examined. Rhizomes of sea-grasses have also been encountered in the stomachs indicating the active browsing habits of the animals. In captivity two dugongs reared in the aquarium of Central Marine Fisheries Research Institute at Mandapam Camp feed on sea-grass kept in bundles tied to a heavy stone. They are also hand fed sometimes. The dugong experiences difficulty in feeding on floating sea-grasses as the mouth is situated ventrally. In captivity dugongs have been observed to feed on floating sea-grasses by lifting the head above the surface of water and making snapping movements of jaws. While feeding at the bottom, the flippers of dugongs are helpful in holding the body in position.

Jones (1967b) has stated that dugongs have not been known to make any sound audible to human ear. But vocalization in dugongs has been reported from Australia and Africa. Calves of dugongs have been stated to make bleating lamb–like cry (Troughton, 1947). Kingdon (1971) has mentioned that dugongs in distress make whistling sounds. The sounds do not have a high frequency component. Recently vocalization has been recorded (Nair and Mohan, unpublished) in Indian dugong kept in captivity. The dugong has been found to make chirping sounds of frequency 3 to 8 K Hz.

Dugongs have an acute sense of hearing. The sound caused by movement of oars of boats is heard by the animals. They are scared away from their habitat by mechanized vessels.

There are conflicting views about the dugong's power of vision. While some consider that the eyesight of dugong is poor, according to others, it has excellent vision both during daytime and night.

When the dugong is kept exposed to air, there is flow of a viscous fluid from the eyes. The dugong does not have lachrymal duct. The excess of secretion of lachrymal gland comes out when the animal is removed from water and made to lie on land.

Male and female dugongs show great attachment to each other and, if one is captured, its partner follows it so that it can also be caught without much effort. If offspring is caught, the parents follow and they also become victims. The female dugong lies horizontally in water and suckles its young from its pectoral nipples. Sometimes the dugong holds the young one with a flipper while suckling. There are some reports of suckling while remaining in a vertical position. The figure of a dugong suckling its young one, given by Finn (1929) which was probably copied from Tennant (1861) does not appear to be natural. There is great parental care. The mother dugong pushes the young one to the surface of water and takes it for rides on her back.

Newly captured dugongs swim wildly and refuse to take food for two or three days when left in aquarium. They get agitated when visitors go near the tank. Dark coloured clothes and shadows of visitors disturb them. But dugongs which have been held in captivity for a few months allow themselves to be cleaned by hand or brush.

The dugongs are fairly hardy animals and can be transported on land with a 0.3 m layer of sea-grasses and water below. One has thus been transported from Mandapam to Madras over a distance of about 600 km in twenty hours (Thomas, 1966).

PARASITES

One species of nematode and some species of trematode parasites have been recorded in dugongs. External parasites have not been reported so far in dugong.

A. NEMATODE PARASITE

Order : Ascaroidea Raillet and Henry
Family : Ascaridae Cobbel
Sub-Family : Ascarinae Travassos
Genus : *Paradujardinia* Travassos

Paradujardinia halicoris (Owen, 1833, Fig. 7 A) Syn. *Ascaris halicoris* Owen, 1833; *Dujardinia halicoris* Baylis, 1920; 1936; *Paradujardinia halicoris* Yamaguti, 1961.

A well-marked constriction separates the head from the neck. The dorsal lip octogonal and has two moderately large simple papillae. The palps of ventro-lateral lips asymmetrical, ventral lobe short and has two large papillae, lateral lobes long with small papillae at their extremity, bluntly conical at their free ends which converge between base of lips. The oesophagus occupies about 1/8 of total length; its posterior bulb measures 0·55 mm in length and 6 mm from anterior end. Intestinal caecum present. Nerve ring and excretory pore situated at about 1·5 mm and 1·2 mm from anterior end.

Tail of male about 1/146 and that of female 1/89 in total length. Four pairs of large pre-anal papillae, an unpaired median papilla in front of cloaca and a pair of double post-anal papillae present. Spicules short with tubular shaft. Gubernaculum absent. In female vulva pre-equatorial, at about anterior third of body, uteri parallel, common trunk short, vagina directed backwards. Eggs large, measure 0·13 mm in diameter, shell with reticular marking on the surface.

This parasite was reported by von Linstow (1904) from the intestine of the dugong from Gulf of Mannar. It has also been reported from dugongs of Palao, Red Sea and Madagascar.

A Red Sea dugong was found to be infected by about 540 nematodes of this species (Gohar, 1957) and the nematodes caused severe damage to the stomach by piercing the mucosal, glandular and muscular layers of the stomach. The infestation caused swelling of the gastric wall and ulceration. No such condition has been reported in Indian dugongs though forty to fifty nematodes are not uncommon in an individual.

B. TREMATODE PARASITES

Order : Digenea Van Beneden, 1858
Family : Paramphistomidae Fischoeder, 1901
Sub-family : Solenorchiinae Hilmy, 1948
Genus : *Indosolenorchis* Crusz, 1951

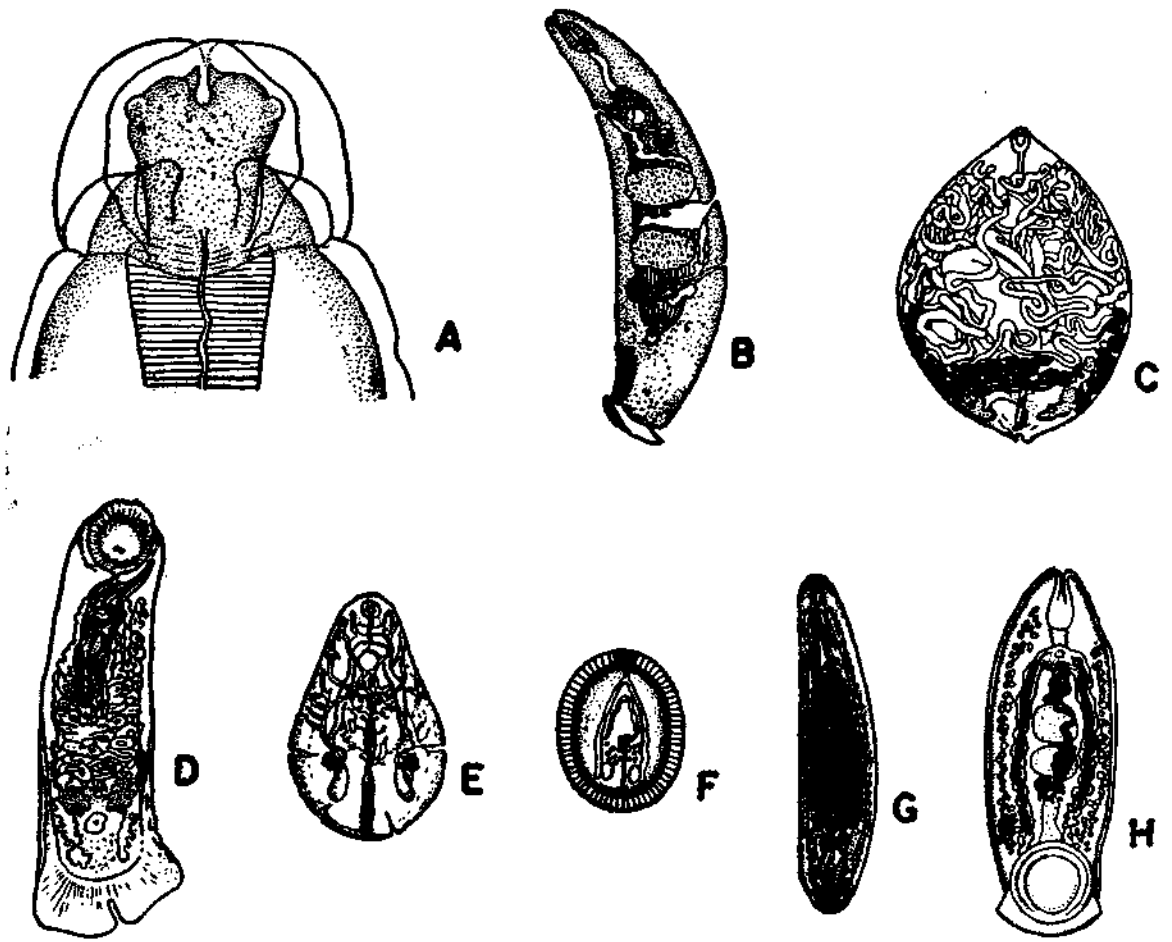

Fig. 7. Parasites of dugong. A. Dorsal view of head of male *Paradujardinia halicoris*. B. *Indosolenorchis hirudinaceus*. C. *Lankatrema mannarense*. D. *Taprobanella bicaudata*. E. *Opisthotrema dujonis*. F. *Pulmonicola pulmonalis*. G. *Rhabdiopoeus taylori*. H. *Solenorchis travassosi*.

Indosolenorchis hirudinaceus Crusz 1951 (Fig. 7 B). Syn. *Indosolenorchis hirudinaceus* Crusz, 1951; Yamaguti, 1958.

Body fusiform, convex dorsally and flattened ventrally, with post-acetabular muscular lip. Acetabulum subterminal, deeply hollowed with semilunar muscular cushion antero-dorsally. Oral sucker preceded by vestibule, with two dorso-lateral pouches. Oesophagus with posterior bulb. Caeca ribbon-shaped, flattened from side to side, terminating divergently in front of acetabulum. Testes median, separated from each other by excretory vesicles. Seminal vesicle coiled, cirrus pouch well developed having coiled internal seminal vesicle and straight cirrus which opens in front of uterus. Genital atrium opens at level of intestinal bifurcation. Ovary median, present just behind testes. Opening of Laurer's canal at level of posterior testes middorsally. Vitellaria extend on each side from oral sucker to a little beyond caecal ends. Uterine coils anterior to testes; eggs large. Excretory vesicle inter-testicular with posterior diverticle ending in a coil between ovary and acetabulum. The diverticulum gives off two lateral arms just after the ovary ventrally and then merges into two main longitudinal excretory ducts. Lymph system consists of two pairs of longitudinal stems.

The species has been recorded by Crusz (1951) in dugongs caught off Colombo. The parasites are found only in the caecum. In one dugong 226 cm in length 43 individuals of *I. hirudinaceus* were noticed. Locomotion in these parasites is like that of leeches.

Family : Opisthotrematidae Poche, 1926
Sub-family : Lankatrematinae Yamaguti, 1958
Genus : *Lankatrema* Crusz and Fernand, 1954

Lankatrema mannarense Crusz and Fernand, 1954 (Fig. 7 C) Syn. *Lankatrema mannarense* Crusz and Fernand, 1954; Yamaguti, 1958.

Body ovoid, flattened, concave ventrally and convex dorsally. Spines absent. Oral sucker small, terminal. Oesophagus slender, caeca simple. Testes lobed, symmetrical, present along posterolateral margins of body, cirrus pouch small having pars prostatica and minute coiled cirrus. Genital pore median. Ovary large, branched transversely, elongated and extends as far as vitellaria. Laurer's canal absent. Vitelline follicles large extending on the lateral sides anterior to testes. Uterus occupies most of anterior 2/3 of body forming a large elongated egg reservoir in front of ovary; metraterm thick-walled, eggs very small with a very long filament at each pole. Excretory pore at posterior end, vesicle bifurcated near its pore and V-shaped.

This parasite is found in the stomach of dugong.

Family : Rhabdiopoeidae Poche, 1926
Subfamily : Taprobanellinae Yamaguti, 1958
Genus : *Taprobanella* Crusz and Fernand, 1958

Taprobanella bicaudata Crusz and Fernand (Fig. 7 D) Syn. *Taprobanella bicaudata* Crusz and Fernand, 1954; Dollfus, 1955; Yamaguti, 1958.

Body boat-shaped, prolonged backward into two short, broad, flat, muscular lobes without spines; dorsal side smooth, curved spines on ventral side. Oral sucker large with ventral aperture. Oesophagus narrow, caeca with short diverticles, extending to posterior end of body. Testes lobed, symmetrical, directly medial to caeca near posterior extremity. Cirrus pouch large, containing distal portion of seminal vesicle, prostatic complex and long muscular ductus ejaculatorius. External seminal vesicle winding at posterior end of cirrus pouch. Genital pore near left margin of oral sucker. Ovary median, immediately post-testicular. Laurer's canal absent. Vitelline follicles in two short pre-testicular extracaecal lateral fields. Uterus extending in transverse coils between testes and cirrus pouch. Eggs operculate, small with 1-3 filaments at opercular pole and 2-3 at the other end. Excretory pore median, dorsal, at level of ovary.

T. bicaudata is found in the pyloric caeca and stomach of dugong.

While only three species of trematodes have been reported from dugongs of Gulf of Mannar a few other species have been recorded in dugongs of Australia and Red Sea (Table VII). From Australia *Opisthotrema dujonis* was recorded in the eustachian tube and oesophagus, *Pulmonicola pulmonalis* in lungs and *Rhabdiopoeus taylori* in intestine of dugong. *Solenorchis travassosi, S. baeri, S gohari* and *S. naguibmahfouzi* have been recorded in the Red Sea dugong (Hilmy, 1949). To give a comprehensive idea about the parasites of the dugong, a short account of the parasites recorded in other parts of the Indo-Pacific region are given in Table VIII.

TABLE VII

Parasites of *Dugong dugon* indicating site of infestation and pathological manifestation.

Order	Parasites	Site of infestation	Pathological manifestation	Distribution
Ascaroidea (Nematoda)	*Paradujardinia halicoris* (Owen, 1833)	intestine stomach (glandular organ)	damage to stomach, ulceration, piercing the stomach wall and entering peritonial cavity	Madagascar, Red Sea, Gulf of Mannar, Australia
Digenea (Trematoda)	*Indosolenorchis hirudinaceus* (Crusz, 1951)	caecum	no great harm is done to the host, though certain histopathological changes are observed	Gulf of Mannar
	Lankatrema mannarense Crusz and Fernand, 1954	caecum	—	Gulf of Mannar
	Taprobanella bicaudata Crusz and Fernand, 1954	caecum	—	Gulf of Mannar
	Opisthotrema dujoins (Leuckart, 1874)	Inner nares, eustachian tube, oesophagus	—	Philippines Australia
	Pulmonicola pulmonalis (von Linstow, 1904)	lungs	—	Torres Strait, Australia
	Rhabdiopoeus taylori Johnston, 1913	intestine caecum	—	Queensland, Australia
	Solenorchis travassosi Hilmy, 1948	caecum	—	Red Sea
	S. baeri Hilmy, 1948	caecum	—	Red Sea
	S. gohari Hilmy, 1948	caecum	—	Red Sea
	S. naguibmahfouzi Hilmy, 1948	caecum	—	Red Sea

Family : Opisthotrematidae Poche, 1926
Subfamily : Opisthotrematinae Harwood, 1939
Genus : *Opisthotrema* Fischer, 1883

Opisthotrema dujonis (Leuckart, 1874) (Fig. 7 E)

Body oval to pyriform, flattened, ventral surface spiny, oral sucker subterminal, followed by a slender moderately long oesophagus; caeca sinuous; testes indented. Cirrus pouch long, median containing slender convoluted seminal vesicle and long protrusible cirrus. Genital pore terminal. Ovary lobed, in front of testes. Laurer's canal present. Vitellaria consisting of rounded follicles. Uterus long, slender, convoluted, occupying major part of central portion of body; metraterm with strong muscular wall; eggs oval, with filaments at each pole. Excretory pore dorsoterminal. Excretory vesicle tubular, with branches.

This parasite is found in the eustachian tube of dugongs of Australia and Philippines. *O. cochleare* Fischer, 1883 is a junior synonym of this species.

Genus : *Pulmonicola* Poche, 1926

Pulmonicola pulmonalis (von Linstow, 1904) Poche, 1926 (Fig. 7 F)

Body with muscular rim except for the region occupied by the oral sucker. Cuticle smooth, oral sucker subterminal; caeca straight, uniform in diameter. Testes entire, medial to caecal ends. Cirrus pouch slender, spirally coiled distally, containing strong convoluted seminal vesicle. Genital pore terminal. Ovary median, lobed, pre-testicular. Receptaculum seminis and Laurer's canal present. Vitellaria consisting of small number of follicles situated in intercaecal field between testes and ovary. Uterus convoluted; metraterm dorsal to cirrus pouch; eggs very small with long filaments at each pole.

This parasite infests lungs of dugong of Australia. *Opisthotrema pulmonale* von Linstow is a synonym of this species.

Family : Rhabdiopoeidae Poche, 1926
Subfamily : Rhabdiopoeinae Yamaguti, 1958
Genus : *Rhaibdiopoeus* Johnston, 1913

Rhabdiopoeus taylori Johnston, 1913 (Fig. 7 G)

Body tongue-shaped, tapering anteriorly, with curved papillae on concave ventral surface. Oral sucker muscular, followed by simple oesophagus; caeca convergent and join at their posterior end by transverse commissure behind excretory pit. Testes lobed, symmetrical, outside the caeca in posterior third of body. Seminal vesicle long, tubular, winding in median field. Cirrus pouch

long and slender. Genital pore close to oral sucker. Ovary rounded, inter-testicular., shell gland compact. Seminal vesicle and Laurer's canal absent. Vitellaria massed behind testes. Uterine coils transverse, very numerous; eggs with filaments. Excretory stems with numerous simple lateral branches, united dorsal to oesophagus.

This species is an intestinal parasite of Australian and Red Sea dugongs.

Family : Paramphistomidae Fischoeder, 1901
Subfamily : Solenorchiinae Hilmy, 1948
Genus : *Solenorchis* Hilmy, 1948

Solenorchis travassosi Hilmy, 1948, (Fig. 7 H)

Body elongate, flattened, with transverse terminal pad. Cuticle smooth. No ventral pouch. Acetabulum subterminal with semilunar muscular cushion antero-dorsally. Oral sucker with anterior and posterior sphincter muscles. Oesophageal bulb not present. Caeca with sinuous wall, reaching to anterior end of acetabulum. Testes indented, nearer to posterior end. Seminal vesicle convoluted, hidden by uterine coils. Cirrus pouch absent. Male duct opening separately into the genital atrium anterior to female pore. Ovary post-testicular, submedian. Uterus winding anterior to testes. Genital atrium bifurcated. Vitelline follicles extending in lateral fields. Excretory vesicles inter-testicular, equatorial pore dorsal to anterior testes.

The parasite infests the caecum of Red Sea dugong. Other parasites belonging to the same genus reported from Red Sea dugong are *Solenorchis baeri* Hilmy, 1948, *S. gohari* Hilmy, 1948, and *S. naguibmahfouzi* Hilmy, 1948.

Though these species are considered to be distinct by Yamaguti (1958) and others, Dollfus (1955) stated that they are synonymous and may belong to the genus *Lygocotyle* Stunkard, 1917 but he hesitated to attribute them to *Z. lunata* (Diesing, 1836). On considering their characters they seem to belong to *Solenorchis* Hilmy and the species appear to be valid.

The barnacles *Balanus* sp. and *Chelonobia* sp. are found attached on the dorsal surface of the body and near the axilla of flippers of the dugong.

ENEMIES

Man is the chief enemy of the dugong as he captures it for its flesh and oil. Sharks and rays attack dugongs and are a source of danger to them. Jones (1967b) reported that a spine of a ray, about 7 cm long was found attached to

the peritoneum of a captured dugong. A callous area filled with lymph-like fluid was seen around the spine and it was considered that the dugong would have been stung by a ray when it came into contact with the ray.

EVOLUTION

Earlier remains of sirenians have been reported from the Tertiary deposits of Europe. It is considered that the original home of sirenians was the Mediterranean. The sirenians appear to have come into existence during the middle of Eocene period and were abundant along the coast of Europe until Pliocene. From the Mediterranean the ancestors of dugongs are considered to have migrated eastwards and those of manatees westwards. (Abel, 1908).

The most primitive sea-cow known to us is *Porastomus* of Eocene. The distinctive character of these primitive sea-cows is the teeth are more or less like the standard teeth of mammals. *Porastomus* had a fully differentiated dentition consisting of incisor, canine and molar teeth though the downward deflection of upper and lower jaws which is so distinct in modern sea-cows was absent. These primitive sea-cows possessed functional hind limbs. Another primitive sea-cow of Eocene, *Eotherium* had well developed acetabulum for the articulation of femur indicating that the primitive sirenian had functional hind limbs. In the sea-cows of upper middle Eocene, the hind limbs became non-functional with a degenerated pelvis and fused ilium, ischium and pubis. It is possible to trace the progression of the degeneration of hind limbs in the later primitive sea-cows. In *Metaxytherium* a primitive sea-cow of Miocene period of Austria, the pubis has entirely disappeared; in *Halitherium* of Oligocene period the acetabular cavity has obliterated and became rudimentary. In Steller's sea-cow *Hydrodamalis* (= *Rhytina*) which became extinct recently the skull is like that of living sirenians with downturned deflection of jaws. *Hydrodamalis* has centra with epiphysis, seven cervical vertebrae, nineteen pairs of ribs and rudimentary femur. The skull is small and teeth are absent. The epiphysis is absent in living sirenians. In the dugong the vestigial pelvis consists of three bones of which the first is long and the other two are small. The pectoral girdle is well developed with all the complementary bones of a mammalian pectoral girdle.

Among the living representatives of mammals, the proboscidians bear close resemblance to sirenians. The primitive forms of proboscidians and sirenians have many similarities especially in the structure of pelvic bones, brain and dentition. The living members of the two groups resemble each other in the position of teats and structure of heart. The molar teeth of sea-cows resemble those of early proboscidians. The mode of succession of molar teeth is also similar in the two groups. The resemblance which sirenians show to cetaceans is only superficial and it is mainly due the same aquatic habitat which they occupy.

VI EXPLOITATION

Along the southeast coast of India dugongs are caught throughout the year by using gill nets and shore seines. About 25–30 dugongs are caught in a year. Majority of the dugongs are caught during the period October–April when they come to inshore waters of Gulf of Mannar for feeding. At this time the sea is calm and pastures of sea-grasses available near the islands offer good browsing grounds.

Fishing grounds

In Gulf of Mannar the dugongs are found around the chain of islands from Rameswaram to Pandyan Island off Tuticorin and they are more common around Manali Island, in the shallow bays of Musal Island (off Mandapam) and around Appa Island and Balayamuni Island (off Kilakarai). These areas are characterized by extensive growth of sea-grasses. In Palk Bay dugongs are caught in Rameswaram Bay, Olaikuda, Devipattinam, Thondi, Soundarapandia-pattinam and Adirampattinam. They are usually captured at a distance of 1–3 km from the shore and depth of 5–9 metres.

Fishing gear

In Gulf of Mannar the dugongs are caught with turtle nets, dugong nets and shore seines. Turtle nets are wide meshed gill nets made of twisted cotton twine of about 2.5 mm thickness or twisted *Acacia* bark fibre; the mesh size (stretched) is 10–15 cm. Dugong nets are bottom set gill nets made of cotton or nylon twine about 2.5 mm in thickness, which have a mesh size of 15–18 cm. Occasionally dugongs get entangled in ray nets which are another type of gill nets with large meshes. In Rameswaram Bay, Devipattinam and around Musal Island dugongs are occasionally caught in shore seines. In Gulf of Kutch they are caught in gill nets.

In Australia dugongs are captured by harpooning from boats. Hunting is carried out on still nights when the coastal waters are calm. Moonlight is desirable but not essential. Floating, broken sea-grasses are considered as a sign of presence of dugongs in the vicinity. Silence is maintained at the time of hunting as otherwise the dugongs move away. The oars of the boats are muffled with cloth. The fisherman who harpoons stands at the bow of the boat and when he sees a dugong he immediately thrusts the harpoon with maximum possible force, bending over the side of the boat along with the harpoon to push it through the thick skin of the animal. In Torres Strait harpooning is done from platforms. In this method a platform with thin supports is set up a

few feet above water in areas rich in sea-grasses where a dugong has fed sometime earlier and the hunter waits with a harpoon on the platform for the animal. It is believed that as the tide falls the dugong stops feeding and goes to deeper water and it again comes back to the same place always to resume feeding (Bertram and Bertram, 1973).

In Madagascar and neighbouring islands dugongs are caught with nets and harpoons. The nets are set vertically in the opening of a sand bank. One end of the net is fixed and the other end is free. The dugong's muzzle or flipper is caught in the meshes of the net and trying to free itself, the animal soon becomes hopelessly entangled and dies either by drowning or is killed with a harpoon. While spearing the dugong, the boat may capsize. To avoid this, the fishermen rope several boats together at the time of harpooning.

Mode of killing

On capturing, the dugong is brought ashore and kept alive by tying the tail to some firm, immovable object. Usually dugongs are killed either by keeping two wooden plugs in the nostrils and hammering them with a long, heavy wooden piece or by hitting the head with a heavy piece of wood. In the nineteenth century in Madras State some government officials had to be present at the time of cutting the dugong as it was believed that it might contain treasures. In Madagascar and some other places a peculiar oath forswearing any unnatural relationship between the person who captured it and the victim is taken before cutting the animal.

VII ECONOMIC IMPORTANCE

Dugongs are fished in India mostly for their flesh which is soft and tastier than mutton or beef. People who have tasted dugong meat are unanimous that it is a delicacy. It is no wonder that a Malay king called it 'royal fish' and made it his monopoly. The dugong fetches a good price and augments the income of fishermen. A dugong about 250 cm in total length is sold for Rs. 400—500 at Kilakarai. In India dugong meat is very much relished by Muslims. Now people of other communities are also eating it. The price of dugong meat fluctuates between Rs. 4 and Rs. 6 per kg depending on the demand. If a dugong is captured after a long interval the price shoots up to Rs. 8 per kg. In places like Kilakarai where Muslims predominate the price of dugong meat is high while in other places like Pamban and Rameswaram where there is small Muslim population the price is low. In former years dugongs caught at Pamban were exported in live condition to Ceylon.

Many medicinal qualities are attributed to the flesh and bones of dugong. Eating dugong meat is considered to cure piles. Dugong meat is believed to have rejuvenating qualities. The bones especially those of the skull are powdered and used by the natives of Comorra Island for treating ulcers (Prater, 1928).

Oil

The dugong oil is useful in several ways. When the blubber lying below the skin is treated a clear oil is obtained which could be used in cooking, as a fuel for lighting, and as a preservative for canoes (Bertam and Bertram, 1968) The blubber of a dugong weighing 4–6 cwt. (201–302 kg) on boiling yields 6-14 gallons (27-63 litres) of oil (Watts, 1890). It was suggested as a substitute for cod-liver oil (Prater, 1928; Gohar, 1957). The fisherfolk of Ceylon administer the fat of dugong in the form of a sweetmeat for treating dysentery (Watts, 1890). The Moharrais of Madagascar use the fat from the head of dugong for headache and earache and the fat of the body of the dugong, mixed with rice is taken as a laxative and it is also considered to cure skin diseases (Petit, 1923a).

Skin

Formerly sandals were made with the hide of dugong. Due to its thickness the hide is useful only for making soles of sandals. Experimental tanning of dugong skin has shown that the process is very slow as the skin is very thick (Bertram and Bertram, 1973). It is believed that the Ark of Covenant was kept in a hide of dugong during its wanderings along the shores of the Red Sea and Sinai desert.

TUSKS

Prater (1928) reported that cigarette holders and rosaries made from tusks of dugongs were sold in Egypt. The rosaries were believed to facilitate child birth and avert evil fate. In Australia dugong tusks are polished and beautiful carved handles made (Troughton, 1924; Allen, 1942)

CHEMICAL ANALYSIS OF DIFFERENT PARTS OF THE BODY OF DUGONG

According to Gohar (1951) the results of chemical analysis of fat of Red Sea dugong are as follows.

Refractive index at 4° C	1·457
Acid Value	0·15
Saponification Value	194·8
Iodine Value	58·0
Reichert Meissle Value	0·88
Polenski Value	0·6
Unsaponifiable matter	0·82

In many respects the dugong fat resembles that of pig.

The chemical composition of liver of the Indian dugong in percent dry weight is given below.

Protein	47·04%
Fat	12·26%
Ash	32·71%

VIII CONSERVATION

It is accepted by all biologists studying dugongs that the populations of these mammals are much smaller throughout the range of their distribution at the present day compared to those several decades earlier. The decline in the populations is due to indiscriminate exploitation by man. After extensive observations and enquiries made of local people Bertram and Bertram (1966, 1968) have concluded that in spite of excessive fishing there are good numbers of dugongs in the Australian region around Queensland, Northern Territory and Western Australia and stated that if the dugongs in the region are protected it will result in the building up of large stocks from which steady supplies of meat could be got.

As early as at the beginning of the present century Annandale (1905) reported that while it was then not possible to capture more than one dugong at a time in Gulf of Mannar it was said many hundreds occurred in the area in earlier times. Jones (1967b) has stated that there have been reports of considerable fall in the dugong population in Palk Bay after the cyclone in December, 1954. The heavy rains during the cyclone flooded the region and lowered the salinity very much. According to Jones (1967b) fishermen reported that large numbers of dugongs were found dead and after that time they have become rare. The fishermen attributed the mortality of dugongs to scarcity of sea-grasses which perished as a consequence of flooding by fresh water. However, mortality of dugongs has not been recorded in the Palk Bay or Gulf of Mannar when the cyclone accompanied by tidal wave hit Mandapam area in December, 1964.

The fishermen admit that in recent years there has been a fall in the number of dugongs captured but they continue to retain it whenever a dugong gets entangled in nets set in shallow littoral waters for fish or turtles as they get additional income. With its slow rate of reproduction and prolonged gestation period the dugong cannot withstand unscrupulous depredation. One encouraging feature of the catches is that pregnant females and young ones are not usually caught. The dugong resources should be conserved by enforcing the law regulating capture. The dugong is a protected marine animal in India under the Wild Life Protection Act, 1972. There is great need for giving effect to the provisions of the Act and taking adequate measures to prevent indiscriminate capture as dugongs are in a very vulnerable position with the operation of increasing numbers of nylon nets in recent years. Enforcement of legislation should not pose much difficulty as dugongs are confined to shallow coastal waters and illegal capture could be easily detected. As the fishermen are mostly illiterate

and ignorant of the decrease in abundance of dugongs as a consequence of thoughtless exploitation, extensive propaganda has to be carried out by Government fisheries organizations and other bodies interested in conservation of the dugong. Areas where dugongs occur in good numbers should be declared as sanctuaries as the salt water lagoons of Everglades National Park, Florida have been declared for the manatee.

Along Australian coasts dugongs are found in good numbers in some areas in spite of active exploitation. This is due to the fact that the number of fishermen and boats operating in the region is not high. Even in Australian coasts large gill nets are set at some places to control sharks which are a hazard to swimmers and dugongs get entangled in these nets but as the number of nets used is low there is no significant harm at present to dugong populations in the region.

In other areas of distribution in the Indo-Pacific region like Indian coasts, Ceylon, Madagascar, Malaya and New Caledonia there has been considerable fall in the number of dugongs captured annually and in some places the animal has become rare. The International Union for the Conservation of Nature (I. U. C. N., 1973) rightly considers dugong as an animal in the danger of extermination. In the African Conservation Convention which is in force from September, 1968 the dugong is included in Class A species "which should be totally protected throughout the entire territory of the contracting States" (Curry-Lindahl, 1969). Protective legislation exists in Australia and Ceylon also.

Our present knowledge on the magnitude of resources, population dynamics, age and growth, reproductive biology and ecological aspects of the dugong is very meagre. Detailed investigations should be carried out on these aspects as the information gathered will be helpful in proper management of the resources.

REFERENCES

ABEL, O. 1908. The genealogical history of marine mammals. *Ann. Rep. Smithn Inst., Washington.*

ALLEN, G. M. 1942. *Extinct and vanishing Mammals of the Western Hemisphere with the marine species of all the Oceans.* American Committee for International Wildlife Protection. Special Publication No. 11. New York.

ANNANDALE, N. 1905. Notes on the species, external characters and habits of the dugong. *J. Proc. Asiat. Soc. Bengal* (N. S.), **1** : 238-243.

————1907. The appendicular skeleton of the dugong. *Rec. Indian Mus.*, **1** : 79.

BATRAWI, A. 1957. The structure of dugong kidney. *Publ. Mar. Biol. Stn Al. Ghardaqa*, **9** : 51-68.

BAYLIS, H. A. 1920. On the classification of Ascaridae i. Systematic value of certain characters of the alimentary canal. *Parasitology*, **12** (3) : 253-264.

————1936. *Fauna of British India including Ceylon and Burma, Nematoda* **1**. 408 pp. London.

BERTRAM, G. C. L. AND C. K. R. BERTRAM. 1966. The dugong. *Nature*, London, **209** (5026) : 938-939.

————1968. Bionomics of dugongs and manatees. *Ibid.*, **218** (5140) : 423-426.

————1973. The modern sirenia : their distribution and status. *Biol. J. Linn. Soc.*, **5** (4) : 297-338.

BLANFORD, W. T. 1888-91. *The Fauna of British India including Ceylon and Burma. Mammalia.* London, 592-594.

BUDKER, P. 1945. Pinnipedes et sireniens d' Afrique. *Note Afr.*, **27** : 4-6.

CRUSZ, H. 1951. A new amphistome fluke *Indosolenorchis hirudinaceus* gen. et. sp. nov., from the caecum of the dugong from Indian Ocean. *Ceylon J. Sci.*, Sect. *B*. Biol., **24** (3) : 135-141.

———— AND V. S. V. FERNAND. 1954. The trematode parasites of the dugong with descriptions of the two monostomes and histopathological changes in the host. *J. Parasit.*, **40** (5) Sect. 1 : 499-507.

CURRY-LINDAHL, K. 1969. The new African conservation convention. *Oryx*, **10** (2) : 116-126.

DERANIYAGALA, P. E. P. 1965. A sanctuary for turtles, dugongs, whales and dolphins in the Indian Ocean and southern Oceans. *Loris*, **10** (4) : 246-250.

DEXLER, H. AND L. FREUND. 1906. Zur biologie und morphol von *Halicore dugong*. *Archiv. Naturgesch.*, **1** (2) : 77-106.

DOLLFUS, R. PH. 1955. Parasites. In: *Traite de Zoologie*, Grasse, P. P. Premier Fascicule, Paris. **17** : 891-893.

EHRENBERG, C. G. 1830. *Symb. Phys. Mammal.*

ELLERMAN, J. R. AND T. C. S. MORRISON-SCOTT. 1951. *Checklist of Palaearctic and Indian Mammals, 1758-1946*. British Museum, London. 337.

ETHERIDGE, R. 1905. Further discovery of dugong bones on the coast of New South Wales. *Rec. Aust. Mus.*, **6** : 17-19.

FERNAND, V. S. V. 1953. The teeth of dugong. *Ceylon J. Sci.* (Zool), **25** : 139-147.

FINN, F. 1929. *Sterndale's Mammalia of India*. 133-134.

FISCHER, P. M. 1884. Uber den Bau von *Opisthotrema cochleare* nov. genus, nov. sp. ein beitrag zur Kenntnis der trematoden. *Zeitschr. Wiss. Zool.*, **40** (1) : 1-41.

FISCHOEDER, R. 1904. Die paramphistomiden der saugetiere. *Zool. Anz.*, **24** : 367-375.

GIBSON-HILL, C. A. 1950. The dugong. *Malay nat. J.*, **5** : 25-29.

GOHAR, H. A. F. 1944. Marine Biological Stn Annual Report, 1942-1943. Fac. Sc., Fonad I Univ. Cairo : 34-36.

————1957. The Red Sea dugong. *Publ. Mar. Biol. Stn Al. Ghardaqa*, **9** : 3-50.

GRUVEL, A. 1921. Exposed d'un voeu pour la creature de reserves de tortues marines et dugongs sur te cotes de Madagascar. *Commn. Soc. Nat. Acclim. Paris.*

————1922. Uoeu pour la protection des tortues marins et dugons de Madagascar. Sur les longoustes et les langoustes et les hiutres perlvies de Madagascar. *Bull. Soc. Nat. Acclim.*, **4** : 74-76.

HARRISON, R. J. 1969. Reproduction and reproductive organs. In: *The Biology of Marine Mammals* (H. T. Anderson, Ed), pp. 253-348. Academic Press, New York.

HARRY, R. R. 1956. 'Eugenie' the dugong mermaid. *Pacif. Discov.*, **9** : (1) : 21-27.

HEINSOHN, G. E. 1972. A study of dugongs *(Dugong dugong)* in northern Queensland, Australia. *Biol. Conserv.*, **4** (3) : 205-213.

HILL, O. W. C. 1945. Notes on the dissection of two dugongs. *J. Mamm.*, **26** : 153-175.

HILMY, I. S. 1949. New paramphistomes from the Red Sea dugong *Halicore halicore* with description of *Solenorchis* gen. n. and Solenorchinae sub. f. n. *Proc. Egypt Acad. Sci.*, **4** : 1-14.

HIRASAKA, K. 1934. On the distribution of sirenians in the Pacific. *Proc. 5th Pacific Sci. Congr., Victoria & Vancouer BC, Canada*, 1933 : 4221-4222.

HUSAR, L. SANDRA. Survey of the Order Sirenia. Part I The Dugong *(Dugong dugon)*. Mimeograph. 40 pp. National Museum of Natural History, Washington D. C.

I. U. C. N. 1973. Main list of the world's rare and endangered mammals. *Spec. Suppl. to Bull.*, 4 (4).

JOHNSTON, S. J. 1913. On some trematode parasites of marsupials and of a monotreme. *Proc. Linn. Soc. N. S. Wales*, **37** (4) : 727-740.

JONES, S. 1959. On a pair of captive dugongs *Dugong dugong* (Erxleben). *J. mar. biol. Ass. India*, **1** (2) : 198-202.

————1966. Problems of research and conservation of the dugong, *Dugong dugon* (Müller) in the Indo-Pacific. *Proc. Pacif. Sci. Congr.*, **11** : 16.

————1967a. On a pair of captive dugongs, *Dugong dugon* (Erxleben). *Loris*, **11** (2) : 83-86.

————1967b. The dugong, *Dugong dugon* (Müller) its present status in the seas around India with observations on its behaviour in captivity. *Internat. Zoo Ybk*, **7** : 215-220.

KENNY, R. 1967. Breathing pattern of the dugong. *Aust. J. Sci.*, **29** (10) : 372-373.

KINGDON, J. 1971. *East African mammals, an atlas of evolution in Africa.* **Vol. 1.** Academic Press, London. 446 pp.

MACMILLAN, L. 1955. The dugong. *Aust. Geogr. Walkabout Mag*, **21** (2) : 17-20.

MANI, S. B. 1960. Occurrence of the sea-cow *Halicore dugong* (Erxl.) off Saurashtra coast. *J. Bombay nat. Hist. Soc.*, **57** : 216-217.

MOHAN, R. S. LAL. 1963. On the occurrence of *Dugong dugon* (Müller) off the Gulf of Kutch. *J. mar. biol. Ass. India.*, **5** (1) : 152.

MOHR, E. 1957. Sirenen oder see kuhe. Wittenberg. A. Zimsem Verlag.

MONAD, T. 1925. Notes sur le dugong de Madagascar. *Revue gen. Sci.*, **6** : 163.

MORICEAU. 1902. Peche de dugongs d' Ambauja. *Revue Madagas. Paris*, 538-539.

MOSES, S. T. 1942. The fisheries of Gujarat Coast. *J. Gujarat Soc.*, **4** (2) : 75.

MURIE, J. 1884. Sirenia. In : *Cassel's Natural History*, Ed. Duncan Cassell & Co. Ltd., London.

OWEN, R. 1838. On the anatomy of the dugong. *Proc. Zool. Soc. Lond.*, 28-45.

————1847. *Juke's Voyage of the Fly* 2, Appendix : 323.

PETIT, G. 1923 a. Sur le dugong de Madagascar : Notes Ethnographiques, *Bull. Mem. Soc. Anthrop. Paris*, **4** (7) : 75-83.

————1923b. La repartition geographique et l' extinction des sireniens actuals, *Revue Hist. nat appl.*, **4** (6) : 161-173.

————1924. Notes sur les dugongs des cotes de Madagascar. *Bull. Mus. Hist. nat. Paris*, **2** : 124-127.

——————1925. Recherches anatomiques sur l' appareil genito-urinaire male des sireniens. *Arch. Morph. Gen. et. Exp* , Paris: 1-326.

——————1955. Ordre des Sireniens. In: *Traite de Zoologie.*, Grasse, P. P. Premier Fascicule, Paris. **17** (1): 918-981.

PHILLIPS, W. W. A. 1927. Guide to the Mammals of Ceylon. Pt. 7 Sirenia. *Ceylon J. Sci.*, **15** : 51.

POCHE, F. 1926. Das system der platodaria. *Arch. Naturg., A.* **91** (2-3): 458 pp.

POCOCK, R. T. 1940. Some notes on the dugong. *Ann. Mag. nat. Hist.*, **11** : 329-345.

PRATER, S. H. 1928. The dugong or sea-cow (*Halicore dugong*). *J. Bombay nat. Hist. Soc.*, **33** : (1): 84-99.

RAJ, B. Sundara. 1927. Littoral Fauna of Krusadai Island.

RIHA, A. 1911. Das mannlichen urogenital system von *Halicore dugong* Erxl. *Zeitsch. Morph. Anthrop.*, B: 395-422.

RÜPPELL, E. 1833. Beschreibung des im rothen meere vorkommenden dugong (*Halicore*). *Mus. Senckenbergianum*, **1**: 95-113.

SANDERSON, I T. 1962. *Living Mammals of the World.* Hamish Hamilton, London.

SILAS, E. G. 1961. Occurrence of the sea cow *Halicore dugong* (Erxl.) off Saurashtra coast. *J. Bombay nat. Hist. Soc.*, **58**: 263-266.

SMITH, F. G. W. 1959. Science and the mermaid. *Sea Front* , **5** (2): 74-82.

TENNENT, J. E. 1861. *The Natural History of Ceylon*, London.

THOMAS, D. 1966. Natural History of dugong in Rameswaram waters. *Madras J. Fish.*, **2**: 80-82.

THURSTON. 1894. *Madras Govt. Mus. Bull* , **3**.

TURNER, W. 1894. The foetus of *Halicore dugong* and *Manatus senegalensis. J. Anat. Phys.*, **28**: 315-332.

VON LINSTOW, O. F. B. 1904. Neue helminthen. *Ctbl. Bakt.*, **37** (5): 678-683.

WATTS. 1890. *Dictionary of Economic Products.* **III**, 197.

YAMAGUTI, S. 1958. *Systema Helminthum* **I.** The *Digenetic Trematodes of Vertebrates.* Pt. I. Interscience Publishers, New York.

——————1961. *Systema Helminthum* **III.** *The Nematodes of Vertebrates* Pt. I. Interscience Publishers, New York.

APPENDIX I

DATA TO BE COLLECTED WHEN DUGONGS ARE CAPTURED

Data :
Locality ; depth, distance from shore :
Method of capture (what type of net) :
Condition : Live/Dead/Injured :
Number of dugongs caught :
Sex :
Details of foetus if any :
Number and length; if the foetus is observed it should be preserved :
Total weight :
Total length :
(Tip of muzzle to tip of tail)
Tip of muzzle to vent :
Tip of muzzle to genital orifice :
Distance between genital orifice and anus :
Anus to end of tail fluke (median) :
Width of muzzle :
Length of muzzle :
Breadth of chin :
Length of flippers :
Width of flippers :
Length of nipple :
Circumference in neck region :
(in front of the origin of flippers)
Circumference in belly region :
(at genital orifice)
Circumference in tail region :
(at origin of tail fluke)
Breadth of tail fluke :
Length of small intestine :
Length of large intestine :
Length of caecum :
Number of teeth :
Parasites if any :
Food items:
(to pe preserved)
Price :

APPENDIX II

THE MERMAID LEGEND

It is generally agreed that dugongs and manatees seen by sailors during voyages inspired them to spin legends of mermaids and mermen (Prater, 1928; Smith, 1959). The rough resemblance of the sirenians to human beings when seen at a distance should be responsible for the innumerable tales of mermaids. Further, dugongs rise up from water now and then and appear like human beings and the females suckle the young ones and look after them with great affection. These would have given credulence to the stories of mermaids.

Magasthenes recorded a creature with the appearance of a woman in the sea off Taprobane, Ceylon. The Portuguese and Spaniards gave the dugong a name meaning woman-fish. The Comorra fishermen attribute human origin to dugong. Before selling the meat of dugong the Mohorrai fishermen of Madagascar take an oath swearing that there is no unnatural relationship between them and their captive ! (Petit, 1927). Columbus reported to have seen three mermaids off the Coast of Hispaniola or Haiti in January, 1493. He recorded "they were not as beautiful as had been painted although they were like a man in the face." Columbus had stated that he had seen similar creatures off the west coast of Africa also. What Colombus had seen should have been manatees which occur around West Indies and also off West Coast of Africa (Smith, 1959). From a distance the manatee appears like a human being though it has an ugly face. The manatee has paddle-shaped flippers and does not have hind limbs.

The Chaldeans believed that a creature known as *Oannes* half-man and half-fish which arose from Erythraean Sea bordering Babylonia taught men building cities and other arts. The Philistines called this creature *Dagon*. The Mexicans and Peruvians also believed in the existence of a fish-god. Fantastic tales about mermaids and mermen were propagated in Europe until the end of the nineteenth century (Smith, 1959).

With the great increase in the knowledge of marine animals and availability of authentic information the stories about mermaids and mermen are now known to be fiction and are not believed by people.

Errata

Page	*Line*	*For*	*Read as*
5	7	is present	are present
6	34	and small intestine to be omitted	—
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