SOME OBSERVATIONS ON THE BIOLOGY OF THE DUGONG *(DUGONG DUGONG)* FROM THE WATERS OF SOUTH SULAWESI

Dr. John F. Allen, Curator of Animals, Jaya Ancol Oceanarium, Jalan Lodan Timur, Jakarta, Indonesia*
Dr. Marta M. Lépes, Assistant to the Curator, Jaya Ancol Oceanarium*
Tas'an, Assistant Curator, Jaya Ancol Oceanarium
Dr. Iwan T. Budiarso, Bagian Patologi Veteriner, Institut Pertanian Bogor, Taman Kencana 1, Bogor, Indonesia
Dr. Sumitro, Veterinarian, Jaya Ancol Oceanarium
Dr. D. Hammond, Ocean Park Ltd., Wong Chuk Hang Road, Aberdeen, Hong Kong

* *Present address: c/o Mr. P. Stickney, 1537 B Wilder Avenue Honolulu, Hawaii.*

Preface

The International Union for the Conservation of Nature has placed the dugong on its list of endangered species because the numbers of these amiable and relatively helpless animals are reported to be declining in most of the areas where they are found. In Indonesia the dugong is now protected by law, but this is difficult to enforce. Various Indonesian peoples have for generations killed dugongs for their palatable flesh and suposedly magical tusks. Without stringent enforcement of the law, only the long proces of education can completely halt these practices.
We hope that this report will contribute to the general knowledge of the biology and husbandry of this marine herbivore. All of the accumulated information can then be used to plan realistic programs for effective conservation and management of endangered wild populations and, hopefully, to breed and raise dugongs in captivity, better ensuring their continued survival.

Introduction

The dugong, *Dugong dugong,* is the tropical Pacific's representative of the order Sirenia. The Atlantic variety is the manatee of the family Trichechidae. The third member of the Sirenia, the Steller sea cow, *Hydrodamalis stelleri,* is presumed extinct. The family Dugongidae differs superficially from the family Trichechidae by the absence of nails on the forelimbs, a deeply notched (whalelike) tail fluke, tusks protruding from the gums and an upper lip with only a slight median cleft. Skeletal differences show seven cervical vertebrae (instead of only six in the Trichechidae), the absence of nasal bones, a more enlarged, sharply deflected premaxillae, and a more sharply deflected, mainly vertical mandibular symphasis.
The dugongs around Indonesia although decreased in numbers, appear still to be abundant (Figure 1). However, no population studies have been performed and this observation is congecture of the local fisheries departments. Contrary to this opinion, Nair et. al. report dugongs to be rare at present around Malaya, Singapore and Borneo (Kalimantan). Although dugongs are protected by law they are still caught by fishermen to be sold as food in certain local markets. One people in Sulawesi, the Orang Bajo, whose entire life is connected with the sea, (their homes are built on boats, floats, or stilts, they are married and buried in the sea, and their food comes from the

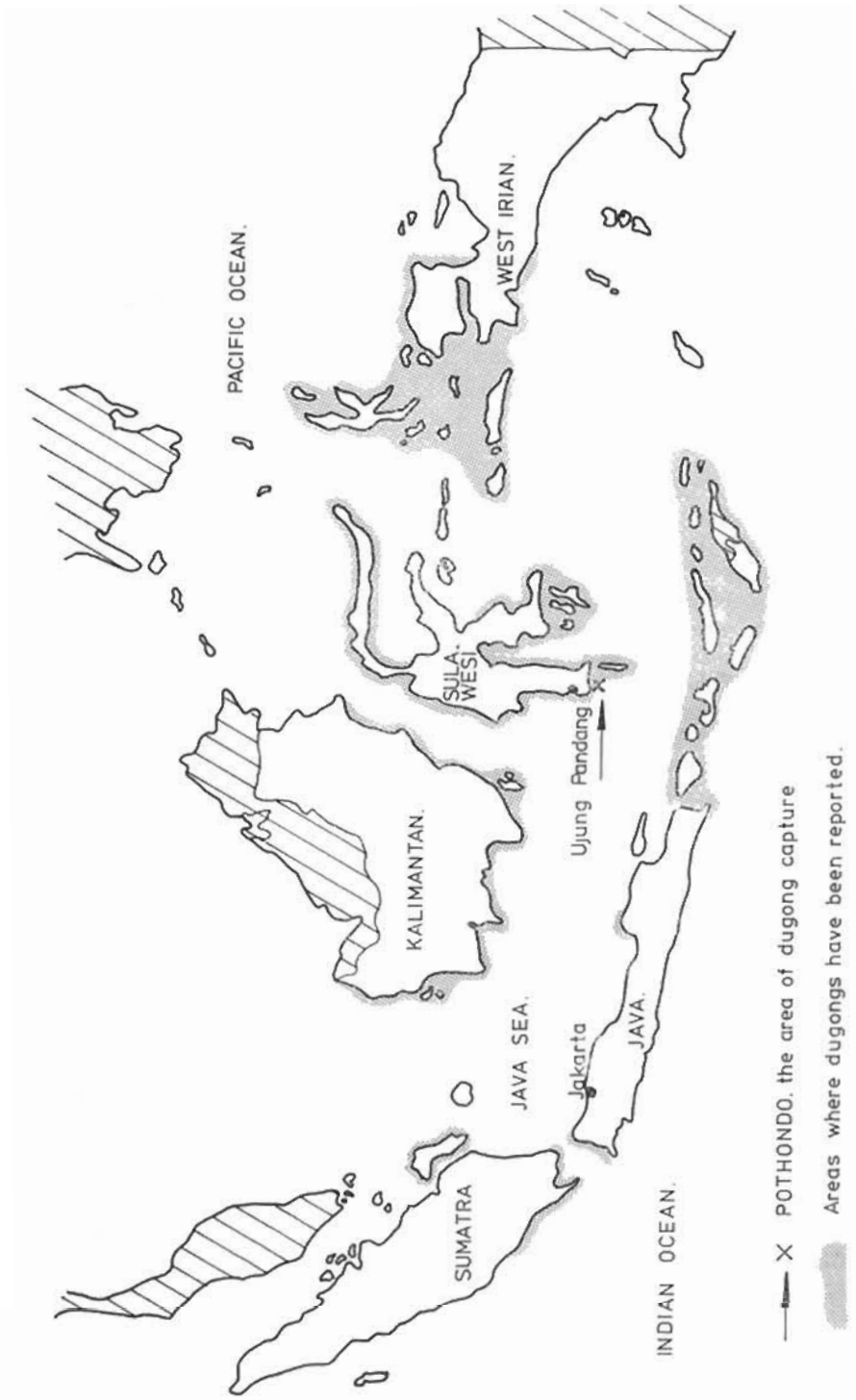


Figure 1. Distribution of the dugong in Indonesian waters.

sea), have dugongs which live in and around their water village similar to pigs around land villages. The people feed them and their children play with them by holidng onto their sides and tails while swimming. When these people need food they catch and slaughter a dugong (Tas'an). Indonesians usually dry the meat by cutting it into strips and by using various spices such as clove, pepper, coconut, sugar and salt, make 'dendeng'.

Only the meat is preserved by drying. The organs are eaten soon after slaughter as in the cow. The tusks are carved into pipes or cigarette holders. Indonesian fishermen feel these articles provide them with prowess at sea. If possible, young men like to carry in small bottles, cotton soaked with the tears of dugongs. This supposedly gives them a magical prowess with women. The name of the dugong orginates from the Malayan name for the animal, duyong. The name for this animal in the Indonesian language is ikan duyung (ikan = fish). In South Sulawesi they are called ruyung and in Sumatra babi laut (pigs of the sea).

Catching operations

In July of 1975 a survey team from the Jaya Ancol Oceanarium, Jakarta, headed by Dr. R. Singgih of the Scientific Board of Advisors and Sukiman Hendrokusumo, M. Sc., General Manager of the Oceanarium, decided that it would be possible to catch dugongs in South Sulawesi. Various bases were established around Ujung Pandang, the capital city, and on July 22 the first dugong was captured. Between July 22 and September 28 when the catching operation was terminated, a total of five dugongs were captured alive. They were caught using a large mesh net (mesh size 15 cm) made of $\frac{1}{4}$ cm nylon. It was 350 meters long and 4.5 meters deep. The animals were captured at Pothondo (Figure 1) on the southern coast of Sulawesi in shallow water at night while they were feeding on eel grass, *Zostera* sp., which is called pama in the Indonesian language.

Various observations of these animals in captivity have been made. Their subsequent deaths and the deaths of two other small dugongs acquired more recently have allowed detailed autopsies and examination of internal organs to be undertaken. Some of these examinations are not yet completed and further reports will be made as the studies are completed.

Observations in captivity :

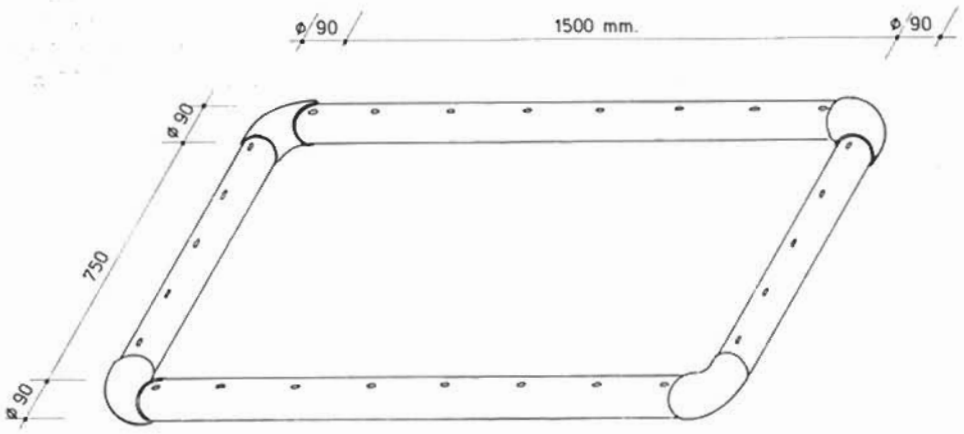
Housing

Once in Jakarta the dugongs were kept in a circular concrete pool 7.5 meters in diameter and 3 meters deep containing normal sea water with an exchange of a minimum of 10% per day fresh sea water. The water depth was maintained at 1.5 meters at night, without circulation, and at 3 meters during the day with circulation of the water through filters. When the pool was cleaned, make-up water was taken from the dolphin show tank which had sea water with chlorine levels of total 0.5 ppm and free 0.4 ppm. A conservative approach was taken and chlorine levels were kept low and were often zero in the dugong pool. As such the bacterial levels in the water were often high, as much as 3,000 colonies per ml Total Plate Count. This did not appear to have a deleterious effect on the animals. It is not kwown if maintaining bacteristatic levels of chlorine in the water would be detrimental to the dugongs feeding or general condition but is suspected that it would not. The water temperature was steady at 29° C., salinity

ranged from 30—32 ‰ and pH varried from 7.4 to 8.2. The temperature, salinity and pH values are consistant with those conditions found where the animals were captured.

Feeding

The dugongs at Jaya Ancol Oceanarium were fed eel grass *(Zostera* sp.) and mustard greens (sawi). They were offered a variety of other vegetables including chinese cabbage (bak-choy), green long beans (kacang panjang) and swamp cabbage (kankung), but only ate significant amounts of eel grass and mustard greens. The proximate analysis of each is listed in Table 1. They ate from the bottom of the pool and appeared unable to obtain food from the surface. They pulled the pama from its holder (Figure 2) and ate only the leafy parts, rejecting the roots. They ate continually both day and night unless resting or swimming. The 2.6 meter female ate 20 kg eel grass and mustard greens mixture per day until she died in a state of advanced malnutrition. Two smaller males, one 1.6 and the other 1.9 meters long, ate approximately 10 kg each eel grass and mustard greens mixture until they died also of apparent malnutrition.



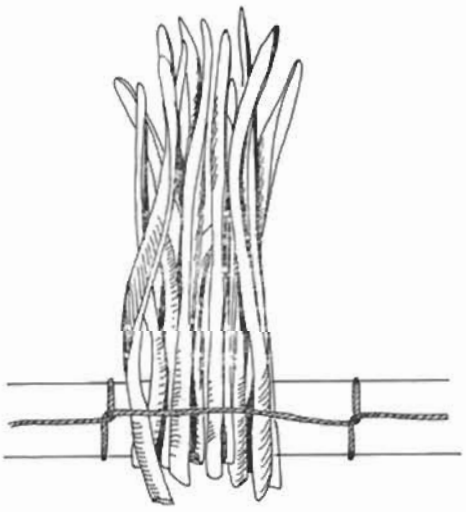


Figure 2. Feeding device for dugong. In the holder, made from PVC pipe, holes are drilled to allow water to fill the hollow tubes so that the device will sink and lay on the bottom of the pool. Nylon twine is tied with half hitches permanently around the holder with spacings of 15 - 20 cm. The food is then simply held between the twine and the PVC pipe and pulled out by the animals to be eaten.

Plate 1. Pothondo, South Sulawesi. Dahlia in the fish pond being given eelgrass.

TABLE I
PROXIMATE ANALYSIS* OF DUGONG FOOD

FOOD TYPE	WATER gm %	ASH gm%	FAT gm%	PROTEIN gm %	CARBOHYDRATE Total gm %	CARBOHYDRATE Fiber gm %	MINERAL Ca mg%	MINERAL P mg%	MINERAL Fe mg%	VITAMIN A g%	VITAMIN B_1 gm%	VITAMIN C mg	EDIBLE PART %
eel grass pama	85.8	3.0	0.3	2.0	8.9	3.2	217	36	1.6	2350	166	4.1	84
mustard greens Cai Sin or sawi	93.6	0.9	0.5	1.7	3.3	1.2	123	40	1.9	2244	36	2.6	79
Bak choy Pe-Cay	96.6	0.6	0.1	1.0	1.7	0.9	56	42	1.1	32	45	3.1	79
long beans kacang panjang	89.7	0.6	0.8	2.7	6.2	2.1	82	32	1.5	214	25	2.6	92
swamp cabbage kangkung	91.0	1.0	1.4	3.4	3.2	1.9	67	50	2.3	3542	70	17	70
water hyacinth eceng gondok	93.6	1.0	0.5	1.3	3.6	2.0	52	52	1.6	1496	92	4.2	68

* Analysis performed by Nutrition Research and Development Center, Bogor, Indonesia.

Plate 2. Ventral side of head region of a male dugong.

Reports from the Central Marine Fisheries Research Institute, India (Nair et. al.) indicate that their two dugongs which were also fed sea grass, here *Cymodocea* sp., ate between 50-75 kg each per day when they died in 1970. When captured in 1959 they were similar lengths to the males in Jakarta. By 1966 those in India were eating 25-30 kg sea grass each daily. However, when they died in 1970, postmortem showed them also to be in an emaciated condition.

Respiration

The longest breath hold we have recorded was 6.5 minutes. Expiration and inhalation proceed with very little noise and this only on inhalation. The normal respiratory rate was 1 breath per 2-3 minutes with breath-holds of up to 6 minutes.

Body temperature

Body temperature was recorded using a thermister probe passed at least 25 cm up the rectum. Two individuals were between 34.0 and 35.0 degrees Centigrade. These animals were quiet when measurements were taken. As both of these individuals soon died these results may not reflect a normal parameter. Dr. Elsner reports body temperatures a little above 36° C. but the method of recording and activity of the animals were not reported.

Plate 3. Side view of the head of a male dugong. Note tusk.

Sound production

Contrary to Jones' report that dugongs have never been known to make any sound audible to the human ear, the dugongs at Ancol have made sounds. These have ranged from a low chirp, similar to a newly hatched chick, to a squeal like that made by a young pig when caught. In this latter case the young dugong was also being caught. Vocalizations have also been reported from Africa, Australia and India. (Nair et.al.) Dugong vocalizations have been recorded by Nair et. al. and found to make chirping sounds of frequency 3-8 KHz.

Reproduction

One dugong delivered a stillborn calf on August 1, 1975. This animal had been in captivity for 9 days and was eating from a keepers hand the day before the delivery. This male calf weighed 20 kg and was 128 cm long. Hammond reports (pers. comm.) a stillborn calf of a recently captured animal off Australia which weighed 20.5 kg and was 112 cm long. (See morphometrics in Appendix 1)

Behaviour

A pair of dugongs, both young males, put together for the first time in the Oceanarium dugong pool, became immediate friends and were inseparable until the death of one.

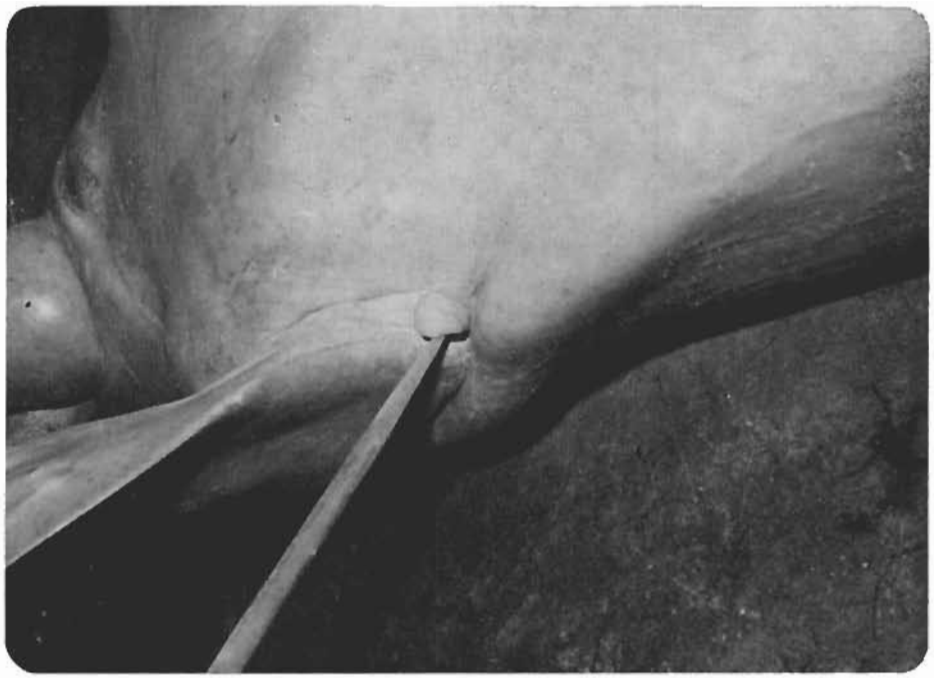


Plate 4. Female dugong. The mammary teat is indicated.

They did everything in unison, often maintaining contact by touching each other with the edge of their pectoral appendages or by touching sides when resting on the bottom of the pool. Though normally sluggish in movements they could swim quite fast and would perform acrobatics underwater, consisting mainly of swimming on their backs and doing sommersaults. They would push each other and swim away. These times appeared like play. Upon the death of one, the other was off feed for the day and regained appetite only slowly. These animals appeared to be quite sensitive to noise in their pool and would spook excitably whenever someone would enter the water or if one of the weights used to anchor the sea grass was accidentally dropped in the water, hitting the bottom of the pool.

Postmortem observations

The deaths of dugongs at Ancol Oceanarium have been primarily related to problems of the gastro-intestinal system. A female which died after more than 2 months in captivity had a gastric impaction caused by a piece of plastic with pama fibers entangled ground it. This presumably led to a nutritional insufficiency, a hydropericardium and a terminal pseudomembraneous colitis with tympany. One young male that died exhibited emaciation and a patchy colangitis. The third death was another young male who, although eating, continued to loose weight. No gross pathology was observed on postmortem examination and it is thought the animal most likely died of malnutrition. In all cases more than sufficient food was available to the animals and although they appeared to eat continually, either the psycological stresses of captivity

or some nutritional lack in the food itself kept the animals from eating sufficient quantity such that loss of weight and starvation ensued. (Morphometrics of these three animals in Appendix 1)

Numerous parasites, an as yet unidentified trematode, were found in the nasal passages of all three animals examined. In two they caused extensive erosion of the mucus membranes of the nose and around the larynx. Other trematodes, *Opisthotrema dujonis,* were found in the dilatation of the eustachion tube (the glutteral pouch). In only one animal were intestinal parasites found. These were again trematodes, *Indosolenorchis hirudinaceus,* in the caecum and an as yet unidentified nodular parasite in the duodenum. Hammond reports that the stomachs of those dugongs he posted in Australia were heavily parasitized with nematodes identified as *Paradujardinia halicoris.*

Remarks on anatomy :

General

Literature on the anatomy of the dugong is scarce but good accounts are found in Owen and Hill. The following remarks on anatomy agree for the most part with the above accounts. However, an attempt is made here to clarify certain anatomical arrangements.

The arrangement of the internal organs was novel to these investigators. The first 4 ribs, 18 pair in number in one animal, a female, and 19 pair in two others, both males, are attached to the sternum. From this point on the ribs terminate at the lateral extremity of the body leaving the ventral area, for a greater extent than in most mammals, free of bony support. There is little if any neck with the contents of the thorax beginning directly from the pharynx.

Respiratory

The Australian aborigines supposedly kill dugongs by putting plugs in their external nares (Goodwin) and it is said that dugongs cannot breathe through their mouths. This is true but only because they do not lift their head sufficiently out of the water to clear the airway to their larynx. There is a common pharynx into which the nasopharynx continues. The oral cavity enters the pharynx via a sphincter like opening 1.5 cm in diameter. Thus there should be anatomically possible a patent airway from the mouth to the larynx.

The bifurcation of the trachea into bronchi occurred 8 cm posterior to the larynx in the 165 cm long male, 5 cm in the 263 cm female and 4.5 cm in the 158 cm male. The tracheal and broncheal rings are a continuous spiral. The shape of the trachea is round, 3.5 cm in diameter outside and 2.7 cm in diameter inside.

The diaphragm attaches ventrally from the 1st to 18th ribs and dorsally at the vertebral column from the 1st to the 15th ribs and is set almost horizontally. The lungs are quite long, extending beyond the upper part of the kidneys and overlie the major part of the abdominal organs.

Cardiovascular

The heart has 2 apices, one each for the left and right ventricles. Antemortem blood samples have successfully been taken from the flukes and pectoral fins. The arrangement of the vessels in the flukes is different from cetaceans in that when a cross section of the flukes is made, there are several vessels running parallel to each other approximately every 1 cm at mid thickness. These are similar in gross anatomy to the arterial-venule complexes in the cetacean flukes with a central artery surrounded by veins. In the cetacean these are assigned the role of a counter-current heat exchange mechanism.

Urogenitall

The kidneys are single lobed and similar externally to those of the pig. Their internal structure is complex and reported to suggest a retained segmental structure (Hill). The uterus is bicornuate and the ovaries flat. In the male the testicles lie in a subperitoneal position at the caudal end of the kidneys. The testicles were found between ribs 16 - 19 in one and between 15-17 in the other. The kidneys lie between ribs 9 and 17. The end of the penis is 3 pronged and consists, according to Harrison of 2 semulinar lateral lobes and a median conical eminence. There is no os penis. Mammae in both sexes are present but much reduced in the male. They are axillary in position.
For more detailed information on the reproductive organs of the dugongs see Harrison.

Endocrine

In the first two autopsies only one adrenal, the left, could be located. It was thought possible that during the first two autopsies the right adrenal was inadvertently lost so great care was taken during the third autopsy to find both adrenals. In the third autopsy only the right adrenal could be found and it was 12.5 x 5 cm irregular in shape. It was thought that perhaps it had two lobes and was the right and left adrenals combined into one. However, it was found entirely to the right of the midline at the cranial pole of the kidney at the origin of the 9th rib. Hill also reports the right adrenal gland to have a varying and somewhat diffuse structure.
The thyroid is located ventral to the trachea and is bilobed. The pineal is absent.

Nervous

The brain was removed from the dugongs and examined. It is primitive in appearance. Each cerebral hemisphere has only one sulcus. The eyes were removed and have been sent to Mr. Dral of the Netherlands Institute for Sea Research, for examination.

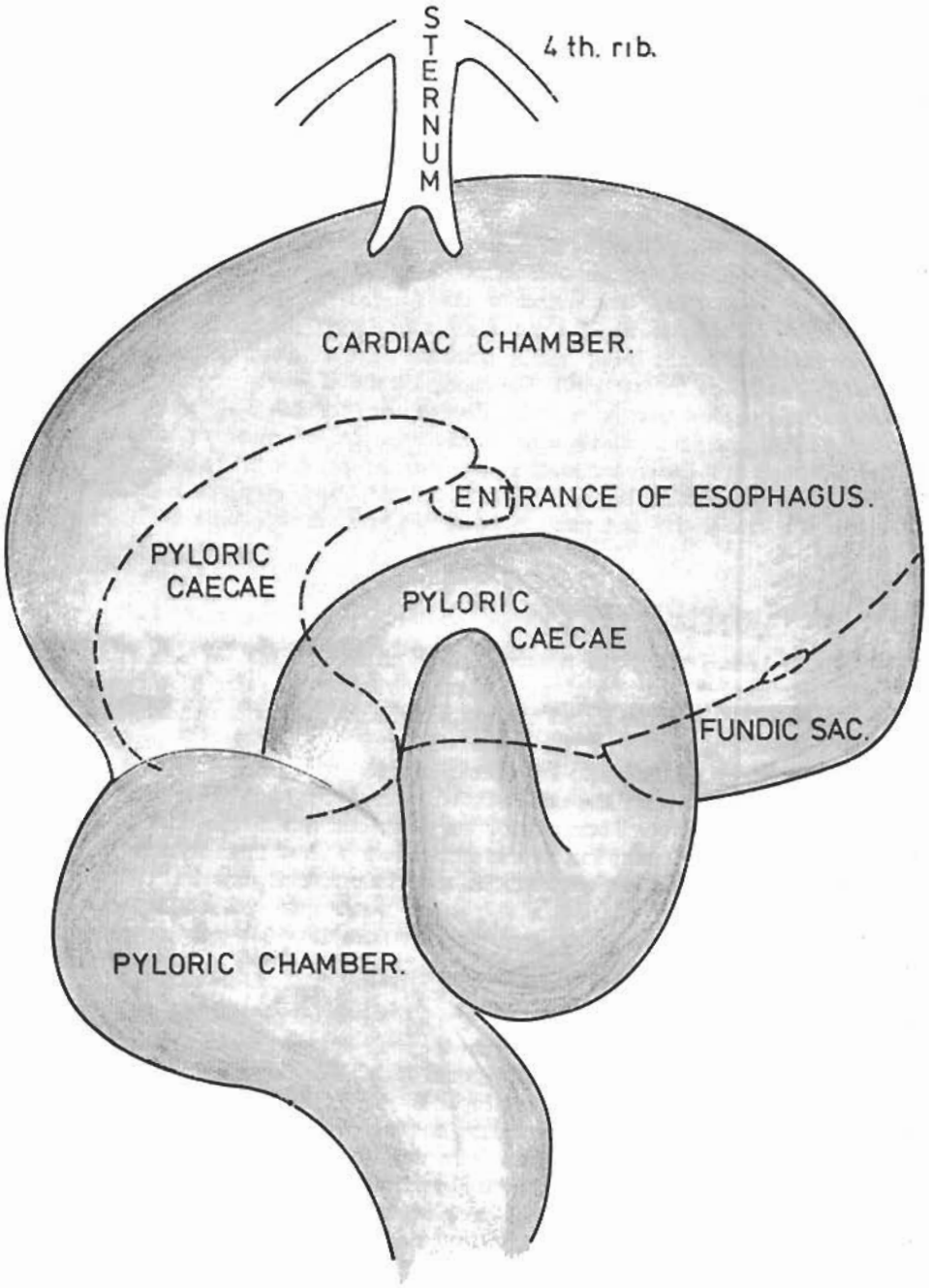


Figure 3. The dugong stomach.

Gastro-intestinal

There are two tusks which are not used in feeding and are reported to only extend past the gums in the males. However, the 2.6 meter female had tusks which extended 2 cm past the gums. The dental formula was $\frac{3}{4}$ + tusk, $\frac{3}{4}$ + tusk in the female. It was 4, 4 in the two young males and no evidence of tusks could be found. Upon disection of the gum from the mandible posterior to the last visible tooth, one immature tooth was found.

Food passes down the esophagus to a 4 chambered stomach (Figure 3). The cardiac leads to a pyloric chamber with two caecal sacs. Off the cardiac chamber is a small fundic sac. A histological description of the various chambers of the stomach was reported by Hammond et. al. The sac-like fundic fegion showed essentially a typical glandular stomach in the adult and a newborn showed small gastric glands not as well differentiated as in the adult. The body of the stomach or cardiac region appeared to have typical gastric mucosa. The pyloric stomach and pyloric caecae had similar mucosa glandular constituents which were characteristic of pyloric mucosa. A common bile and pancreatic duct opens into the pylorus at its distal end. A gall bladder is present. Actual lengths of the small and large intestines are found in the appendix. (Organ weights and measurements are listed in Appendix II).

Recommendations for future studies

Very little is known about the natural history of the dugong in Indonesian waters. A population survey is essential to determine relative numbers of dugongs in the various areas where they are found to determine if indeed they are endangered in any of these areas. Studies on dugongs in the wild, especially in regards to diet, are necessary before future attempts to keep them in captivity are made. Once sufficient information is obtained from the wild, further attempts to capture and hold dugongs in captivity can be made. Then regular weighing and examinations of health statis, including routine blood sampling, should be made to follow these animals' adjustment period in captivity to determine what the specific problems may be.

Acknowledgements

Many people have assisted in the collection of the data which have been presented in this paper. We will not attempt to name them all but would like to especially thank Mr. Ciputra, president of P. T. Pembangunan Jaya ; The Board of Scientific Advisors of Jaya Ancol Oceanarium with Dr. Singiih as head ; and Mr. Sukiman Hendrokusumo, general manager of the Oceanarium, for bringing us (Dr. Allen and Dr. Lepes) to Indonesia such that observations such as these could take place.

Mr. Purnomo, parasitologist at Namru-2 Detachment, Pos Box 226/B.P.P.K., J1. Percetakan Negara 1, Jakarta, provided identification of the parasites.

Mrs. Anny and the staff of the Laboratorium, Gelanggang Samudra, provided the information on water treatment and quality.

Finally to the entire staff of Jaya Ancol Oceanarium (Gelanggang Samudra) for their hard work during the time that the dugongs were alive in captivity in Djakarta.

APPENDIX I
MORPHOMETRICS*

	Dahlia ♀	Sangrobeni ♂	Pothondo ♂	Fetus (Dahlia) ♂	Fetus ***
1. Length, total (most anterior part of head to deepest part of notch between flukes)	263.5	165.5	158.0	128.0	112.0
2. Length, most anterior part of head to center of eye	26.1		16.0	12.0	
3. Length, most anterior part of head to angle of gape			9.0	4.5	
4. Length, most anterior part of head to external auditory meatus			25.0	19.0	
5. Center of eye to external auditory meatus		10.0	10.0	8.0	
6. Center of eye to angle of gape	11.8	8.2	10.0	7.5	
7. Center of eye to midpoint between nostrils		15.5	15.5	10.5	9.5
8. Width, eye to eye	24.3	15.0	16.2	13.7	
9. Length, most anterior part of head to anterior insertion of flipper	61.0		34.5	17.0	
10. Length, most anterior part of head to midpoint umbilicus	121.5	68.0	68.0	32.5	
11. Length, most anterior part of head to midpoint genital aperture	172.0	88.6	81.0	38.5	
12. Length, most anterior part of head to center of anus	175.5	110.7	103.0	48.5	
13. Thickness of 'blubber', mid-dorsal			2.0		
14. Thickness of 'blubber', mid-lateral at midlength			2.0		
15. Thickness of 'blubber', mid-ventral at midlength,		1.2	1.1		
16. Girth, axilla	129.0	86.3	91.0	62.0	57.0
17. Girth, maximum	141.0		110.0	73.0	
18. Location of maximum girth as distance from most anterior part of head	105.0		63.0		
19. Girth, anus	102.0	63.0	74.0	42.0	
20. Eye aperture, Height; Length	0.5;1.0	0.5;1.0	0.5;1.0	0.7;1.0	
21. Mammary teats, length; diameter	3.0;1.5		0.5;0.7		
22. Genital slit, length	11.6	10.0	13.5		
23. Diameter of external auditory meatus	0.5	0.4		0.1	
24. Length, flipper (anterior insertion to tip)	56.0	27.5	27.5	18.0	
25. Length, flipper (axilla to tip)	41.5	22.7	26.5	17.0	19.0
26. Width, flipper (maximum)	18.3	12.6	12.0	8.0	
27. Width, flukes (tip to tip)	81.1	40.0**	58.5	16.5	37.0
28. Distance from nearest point on anterior border of flukes to notch	33.7	19.5	20.2	12.5	
29. Distance between end of genital aperture to anus		19.0	14.5		
30. Distance from anus to deepest part of notch between flukes			54.5		
31. Girth at tail stalk			35.0		23.0

* All measurements are straight-line and reported in centimeters.
** Flukes malformed
*** Recorded by Dr. Hammond in Australia

APPENDIX II
ORGAN WEIGHTS

ORGAN OR TISSUE	Dahlia ♀	Sangrobeni ♂	Pothondo ♂	(Hammond) ♀
Total weight	250 kg	65.0 kg	78.0 kg	250 kg
Heart	830 gm	227 gm	139 gm	462 gm
Lung	5500 gm		1277 gm	2500 gm
Liver	3180 gm	1300 gm	751 gm	3000 gm
Pancreas		48 gm	1 gm	
Spleen	50 gm	17 gm	68 gm	111 gm
Kidney : Right	560 gm	243 gm	157 gm	549 gm
Left	620 gm	215 gm	161 gm	550 gm
Stomach			1213 gm	
Adrenal			56 gm	
Gonads : Right		11.5 gm		
Left		10.0 gm	33 gm	
Thyroid		18.5 gm	3 gm	
Intestine			2990 gm	
Skin and Blubber		19.5 kg	18.0 kg	
Muscle		15.0 kg	24.5 kg	
Bone*		14.0 kg	16.5 kg	
Viscera			7.2 kg	
Brain		206 gm	208 gm	

ORGAN MEASUREMENTS

Intestine :				
Small	6.93 m	6.6 m	6.38 m	12.5 m
Large	14.00 m	10.4 m	9.56 m	18.6 m
Caecum		22.0 cm	29.0 cm	
Gonads : Right		5.0 x 2.4 cm	3.5 x 2.5 cm	
Left		5.0 x 2.2 cm	4.5 x 2.0 cm	

Hammond's report shows heart and lung weights only half of those in Dahlia (both animals have approximately the same total body weight). Also his lengths of intestines are considerably more than that found in Dahlia. We will have to await the report of more such organ weights and measurements in the dugong before we can say what these differences mean.

Liver showed patchy cholangitis

* This is wet weight. The dry weight of the skeleton of an approximately 250 kg male dugong was 20 kg with the head itself weighing 5 kg of this weight.

APPENDIX III
HEMATOLOGY

TEST	RESULTS
1. Hematocrit	40-41 %
2. Hemaglobin	12.8-13.0 gm%
3. Total Red Blood Cell Count	3.2-3.3 x 10^6/ mm^3
4. Total White Blood Cell Count	3.2-4.8 x 10^2/ mm^3
5. Differential	
segmented nutriphiles	0-3%
immature nutriphiles or band cells	3%
lymphocytes	21-23%
monocytes	3-10%
eosinophilic granulocytes	61- 73%
6. Sedimentation rate	7/35 - 68/75 mm/1 hr

Note : These results are from only 2 samples from an inappetent male which died soon afterwards showing malnutrition, nasal parasitism, and patchy cholangitis. The results are presented because they are the only ones known to these authors from any dugong, sick or well.

CHEMISTRY

1. Sugar	93.3 mg%
2. Ureum	98.5 mg%
3. Uric Acid	2.4 mg%
4. Creatinine	2.6 mg%
5. Total Bilirubin	0.21 mg%
Direct	0.14 mg%
Indirect	0.07 mg%
6. Cholesterol	180 mg%
7. SGPT	16 RF Units
8. SGOT	15 RF Units
9. Alkaline Phosphatase	10 SKA Units
10. Total Protein	8.1 gm%
Albumen	4.8 gm%
Globulin	3.3 gm%
11. Amylase	410 units

Note : These results are from one sample only two days before the above animal died.

References

Elsner, R. Preliminary report on dugong studies, August-September 1966. Unpublished.

Goodwin, G. G., Mammals of the air, land, and waters of the world. In F. Drummer, ed., *The Animal Kingdom*. Doubleday & Co. New York 1954.

Hammond, D., I. G. Schmidt, and R. Elsner, The histological description of the four-chambered stomach of the dugong. Unpublished manuscript.

Harrison, R. J. Reproduction and Reproductive Organs. In Harald T. Andersen, ed., *The Biology of Marine Mammals*. Academic Press 1969.

Hill, W. C. Notes on the dissection of two dugongs. J. Mamml. 26 : 153-75 1945.

Jones, S. The dugong *Dugong dugong* (Muller) its present status in the seas round India with observations on its behaviour in captivity. International Zoo Yearbook 7 : 215-220 1967.

Nair, R. V., R. S. Lal Mohan and K. Satyanarayana Rao, The Dugong, *Dugong dugong*. ICAR Bulletin of the Central Marine Fisheries Research Institute No. 26 Cochin, India. Feb. 1975.

Owen, R. Some notes descriptive of the principle viscera of a dugong. *Proc. Zool. Soc. London* 6 : 28-45 1838.