SOME INFORMATIONS ON THE GROWTH OF THE GANGES DOLPHIN WITH A COMMENT ON THE INDUS DOLPHIN

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ABSTRACT

Following result was obtained in the study based on the 22 Ganges dolphins obtained in East Pakistan. Though the parturition season lasts long period, there might be two peaks in early winter and in early summer. Calf is born at small size compared with that of oceanic dolphins. The female grows larger, but the weight is slightly smaller than the male of same body length, which will be related with the larger length of the female snout. The sexual and physical maturity seems to be attained at the age of about 10 or less, and more than 20 years respectively. The growth pattern of this species shows peculiarities.

From some morphological differences, it is proposed to deal the Ganges and Indus dolphins as two separate subspecies.

INTRODUCTION

When seen from the evolutional point of view, the freshwater dolphins or Platanistidae is a interesting group of toothed whales in the morphological primitiveness found together with some specialization, and the restricted habitat.

Various authers have conducted the morphological and anatomical studies on *Platanista*, especially Pilleri and his colleagues are conducting the study on *Platanista* in various field of the biological science. They will throw light on the evolution of Platanistidae.

Present study deals with the problems related with the growth and reproduction of *Platanista*, which will afford some of the fundamantal informations on the adaptation and specialization of the toothed whales.

MATERIALS

This study is based on the 22 individuals of the Ganges dolphin obtained or studied by the Cetacean Research Expedition, University of Tokyo, directed by Prof. M. Nishiwaki. These materials are shown in Table 1 together with some biological informations. As shown in Fig. 1, all the present specimens were caught in East Pakistan, present Bangladesh. Among these specimens, no. 14 is a fetus obtained at the lower Meghna and preserved at East Pakistan Fish. Res. Inst. in Chandpur, which external measurements were made by M. Nishiwaki, 5 were caught at the Kola River a tributary of the Jamuna River in the north of Tistamukhghat, 11 at the

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TABLE 1. LIST OF MATERIALS USED IN THIS REPORT

No.	Date of catch	Date of death	Sex	Body length (cm)	Body weight (kg)	Position of capture
1	12, X, 1969	12, X, 1969	♂	105.0	—	Sutiakhali, Brahmaputra
2	—, VI, 1969	—, VI, 1969	♂	100.5	—	,, ,,
3	23, VIII, 1969	23, VIII, 1969	♂	115.0	18.8	,, ,,
4	30, XI, 1969	30, XI, 1969	♂	171.5	—	Kalir Bazar, ,,
5	20, X, 1969	20, X, 1969	♀	110.0	—	Begunbari, ,,
6	20, XII, 1969	28, XII, 1969	♂	117.0	—	Kewatkhali, ,,
7	6, I, 1970	6, I, 1970	♂	113.0	14.5	Khagdahar, ,,
8	12, I, 1970	12, I, 1970	♂	121.5	—	Jamalpur, ,,
9	12, I, 1970	12, I, 1970	♂	117.5	—	,, ,,
10	19, I, 1970	19, I, 1970	♂	200.0	—	Lalpur, Maghna
11	26, I, 1970	27, I, 1970	♀	113.0	—	Kola river
12	26, I, 1970	26, I, 1970	♂	115.0	16.8	Bhairab Bazar, Meghna
13	1, II, 1970	1, II, 1970	♂	115.0	—	,, ,, ,,
14	27, VIII, 1967	27, VIII, 1967	♀	27.0	—	Chandpur ,,
15	26, I, 1970	9, IV, 1970	♀	114.0*	—	Kola river
				118.0	16.4	
16	26, I, 1970	13, IV, 1970	♀	120.0*	—	Kola river
				120.5	17.0	
17	26, I, 1970	2, VII, 1970	♀	120.0*	—	Kola river
				127.0	23.0	
18	28, IV, 1970	28, IV, 1970	♀	126.0	17.0	Dighirpur, Meghna
19	—, V, 1970	—, V, 1970	♂	122.0	22.5	Bhairab Bazar, Meghna
20	7, V, 1970	7, V, 1970	♂	199.0	84.0	E.P.A.U., Brahmaputra
21	8, VI, 1970	8, VII, 1970	♀	67.4*	?7.3*	Bhabakhali, Brahmaputra
				76.0	3.4	
22	26, I, 1970	30, VII, 1970	♂	122.0*	—	Kola river
				126.0	24.0	

* Measured at the time of capture.

Brahmaputra River, and 5 at the Meghna River near Bhairab Bazar.

One of the method used in catching these animals is the "Jagatber" usually operated in dry season (Kasuya and Haque 1972). Specimens nos. 8, 9, 11, 15, 16, 17 and 22 were obtained by this method. Some of other specimens were caught with drag net which instruments are shown in Pl. I, Fig. 2 in Kasuya and Haque (1972).

Specimens nos. 15, 16, 17, and 22 were transported to Japan and kept alive in an aquarium, The Kamogawa Sea World, for several months. No. 21 was kept alive in a pond at Mymensingh for one month, then the carcass, together with nos. 18, 19, and 20, was transported to Japan by Prof. A. K. M. Aminul Haque.

AGE DETERMINATION AND GROWTH

Age characteristics

In this species, the growth layers are observed on both tooth and scapula. On the scapula, there are observed several narrow translucent bands arranged parallel with the contour of the dorsal edge. In the younger individuals less than 2

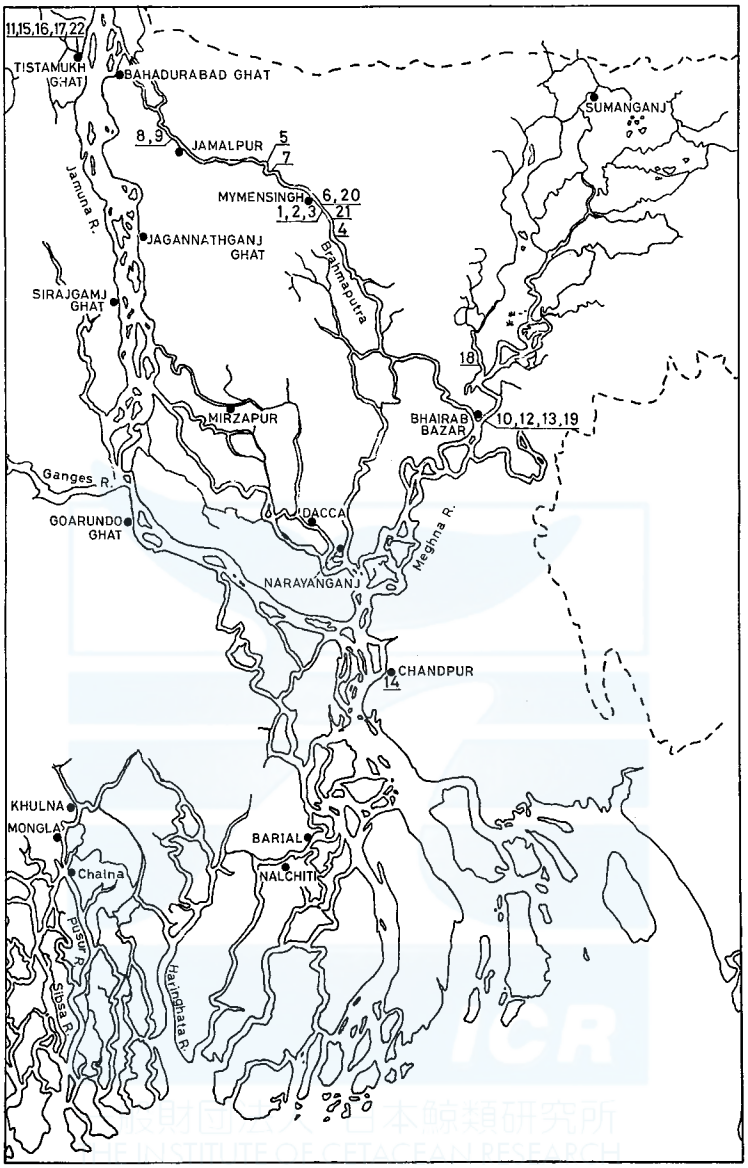

Fig. 1. Map of the Ganges and Brahmaputra River system showing the positions of the catch of present specimens. Numbers in the map indicates the specimen number in Table 1. (For Barial read Barisal.)

years old, the band is clear and the number coincides with that of growth layers in dentine and in cement. But, in the older individuals, the bands formed in the younger stage become vague or disappear, because they are covered by the bone tissue as the thickness of scapula increases.

In the cross section of the tooth, both in dentine and cement, there are observed

wider opaque layer and narrower translucent layer accumulated alternately (Pl. I). As the number of layers in dentine and cement nearly coincides, it is considered that they are formed in a same cycle. However, as the growth layers in dentine is more regular in thickness and easily counted than the layers in cement, I concluded that the best age characteristics of *Platanista* is the dentinal growth layers, which is used in the present study.

For preparing the tooth for age determination, a larger tooth removed from the anterior part of maxilary or mandibular tooth row was ground perpendicularly from both sides to the thickness of about 50 to 70 μ (Kasuya 1972).

For determining the age, the number of the opaque layers in dentine was counted under the microscope. In the younger individuals, the age was determined into the approximate 1/4 year intervals considering the thickness of the first and last opaque or translucent layers. The dentine formed in fetal stage, an opaque layer, was not included. Several thin darker dentinal layers often observed in the layer of late fetal stage or in the first postnatal opaque layer are not discussed here. In this study, though the accumlation rate of the growth layers is not concluded, it is presumed from the consideration of the last layer (Table 2) that the translucent layer

TABLE 2. CONDITION OF THE NEWEST LAYERS IN DENTINE OF THE GANGES DOLPHIN, SHOWING THE SEASONAL ALTERNATION OF THE OPAQUE AND TRANSLUCENT LAYERS

Month	Opaque		Translucent
	Thin	Thick	
January	—	3	3
April	—	—	1
May	—	—	1
June	1	—	—
July	1	—	—
August	1	—	—
October	1	3	1
November	—	—	2
December	—	—	1

TABLE 3. AGE OF THE GANGES DOLPHIN PRESUMED FROM THE GROWTH LAYERS IN DENTINE

Age	No. of samples	Range of body length, Sex	Mean body length (cm)
0.25	1	76.0, ♀	—
0.50	1	100.5, ♂	—
0.75	2	105.0–110.0, ♀ ♂	107.5
1.00	9	113.0–117.5, ♀ ♂	116.2
1.25	1	122.0, ♂	122.7
1.50	1	120.0, ♀	
1.75	1	126.0, ♀	
10	1	171.5, ♂	—
16	1	200.0, ♂	—
28	1	199.0, ♂	—

(clear band) will be formed in winter and the opaque in summer as in the case of the oceanic dolphins (Sergeant 1959, '62, Kasuya 1972). The result of the age determination based on the growth layers in dentine is shown in Table 3.

The growth of the tooth of the Ganges dolphin has a peculiarity. Namely, the increase of the length of tooth after the formation of the root, which is considered to be finished at the 4th year after birth, is carried on by the accumulation of the thick cement layer (Pl. I). This type of growth is quite different from that observed in the tusk like tooth of the sperm whale, but can be explained as a result of specialization of the tooth of delphinidae, where the accumulation of cement layer is thinner. The accumulation of the dentinal layers continues after the formation of the root. And even in the oldest individual, in which 28 dentinal layers are counted, there is observed the space for more accumulation of dentine in the dental cavity.

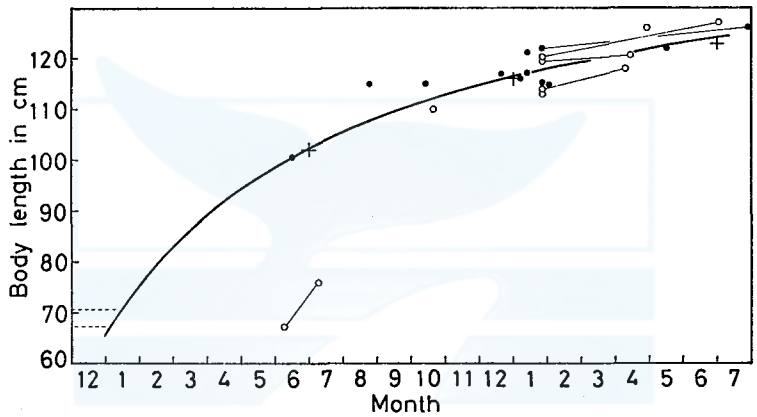

Fig. 2. Presumed mean growth curve of the Ganges dolphin. Closed circle indicates male, open circle female, and cross marks the mean body length at the age of 0.5, 1 and 1.5 year based on the growth layers in dentine. Circles connected with a straight line indicate the body length at the time of capture and that at death. The dotted lines indicate the range of known largest fetus and smallest calf.

Growth in young stage

Among the present specimens, the youngest individual was 67.4 cm (No. 21) at the time of capture. This individual is considered to be just after the birth. Anderson (1878) reported a fetus of 70.5 cm in body length. Therefore, at present, body length of the Ganges dolphin at the time of birth is presumed to be about 70 cm.

Besides the age determination data based on the dentinal layers, following informations on the growth of the Ganges dolphin were obtained. The specimen no. 21 showed the growth of 8.6 cm in body length while it was kept alive in a pond for one month. And the 3 specimens in the 4 animals kept alive in an aquarium, excluding one which had no increase of the length, showed the average growth of 1.1 cm per a month (Table 1). Furthermore, the body length of the juvenile individuals shows a slight increase with the elapse of date of catch.

The growth curve of the Ganges dolphin, shown in Fig. 2, was drawn based on the above informations. According to this curve the animal attains the body length

116 cm at one year after birth, or the increment of 65.7% of the length at the birth.

As shown in Pl. II, only the anterior teeth of upper and lower jaws had slightly erupted in the specimen no. 21. This will indicate that this animal was suckling at the time of capture. Within a month when this animal was kept alive, however, anterior 16 pairs of tooth of the both jaws erupted. And the observation of the stomach of this animal showed that it had started the feeding on fish. All the other juvenile individuals ranging from 110 cm to 120 cm in body length, caught in the river, had the food in the stomach and most of their teeth had already erupted. And these individuals were considered not to be accompanied by the mother. From these informations it is presumed that the calves born in the early winter start feeding at 1 or 2 months after birth, and weaning will be accomplished by the beginning of the dry season, or within one year after birth.

Sexual maturity

As shown in Table 4, all the individuals smaller than 130 cm in body length are sexually immature.

TABLE 4. SEXUAL CONDITIONS OF THE GANGES DOLPHIN

Body length (cm)	Sex	Sample size	Age	Gonads weight (g)	Maturity
110.0–126.0	♀	3	<2	0.4–1.6	immature
115.0–121.5	♂	4	<2	6.7–7.5	immature
171.5	♂	1	10	—	probably mature
199.0	♂	1	28	250	mature
200.0	♂	1	16	1110	mature

A male specimen no. 20, 199 cm in body length, was identified sexually mature by the histological observation of the testis. Though the testes were too decomposed for the histological observation, no. 20, 200 cm in body length, was considered from the weight of testes to have attained the sexual maturity. In the specimen no. 4, the testes had decomposed too bad to weigh, but the size of the original testis was presumed from the size of tunica to be a half or a third of that of no. 10. Then, the weight of the testes of this individual might have been from 40 to 140 g, which is far heavier than those of immature animals, and suggests that this individual had probably attained the sexual maturity or puberty.

This presumption lead to the conclusion that the male Ganges dolphin may attain the sexual maturity at about 10 or slightly less years as in the case of other toothed whales (Kasuya 1972, Ohsumi *et al* 1963, Sergeant 1962), and at the body length about 170 cm or less.

There are 6 records of sexually mature females known to me (Anderson 1878, Pilleri 1970), among which the smallest individual is 200 cm in body length. And the largest immature female is 150 cm (Anderson *loc. cit.*). These informations suggest that the sexual maturity will be attained between 150 cm and 200 cm. But as the female seems to attain larger size, it will be better to consider that the female attains the sexual maturity between 170 and 200 cm in body length.

Physical maturity

None of the present specimens had attained physical maturity. Table 5 shows the relation between body length and the ankylose of vertebral epiphysis to the centrum observed after cleaning the skeleton. The anterior epiphysis ankyloses earlier than the posterior one on the same vertebra. The epiphyses of the posterior thoracic vertebrae seems to be the last which ankyloses to the centrum.

TABLE 5. ANKYLOSE OF VERTEBRAL EPIPHYSES TO THE CENTRUM IN THE MALE GANGES DOLPHIN[1),2)]

No. of vertebrae			1 C1	2	3	4	5	6	7	8 D1	9	10	11	12	13	14	15	16	17	18 L1	19	20	21	22	23	24	25
Specimen no.	Body length	Age																									
10	200.0	16	+	+	+	+	+	+	+	+	+	−	±	−	±	+	+	+	−	+	+	+	+	+	+	+	+
			+	+	+	+	+	+	+	+	±	+	±	+	±	±	−	−	−	−	−	−	−	−	−	±	+	+
20	199.0	28	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	±	+
			+	+	+	+	+	+	+	±	−	−	−	−	−	−	−	−	−	−	−	±	−	−	−	+	+
4	171.5	10	+	+	+	±	±	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
			+	−	±	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
13	126.0	1.75	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
			+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−

[1)] The upper lines indicate the anterior epiphyses, and the lower the posterior.

[2)] + indicates the ankylosed epiphysis, ± that ankylosed at small parts, and − free epiphysis.

The male specimens nos. 10 and 20 are physically immature in spite of the age of 16 and 28 years old respectivily, which suggests that the growth of this species continues longer period than *Stenella caeruleoalba* (Kasuya 1972) and probably than *Globicephala melaena* (Sergeant 1962), as in the case of *Physeter catodon* (Nishiwaki *et al* 1958, Ohsumi *et al* 1965).

Anderson (1878) reported a physically mature 211 cm male, and the present specimen no. 10 is supposed to may have attained the physical maturity within a short period. These informations suggest that the body length of male at the attainment of physical maturity is between 200 and 210 cm.

In the present study, no physically mature female was obtained. The largest male known to me is 211 cm in body length (Anderson *loc. cit.*), but there are several records of female larger than this male, or 226, 238, 240 and 252 cm in body length (Anderson *loc. cit.*, Pilleri 1970). Among these records the 238 cm female is physically immature but the 252 cm female is physically mature. Then the best estimation of the body length of the female at the attainment of physical maturity may, at present, be probably about 250 cm, which is larger than that of the male.

BREEDING SEASON

In the present study sufficient number of fetus was not obtained to analize the breeding season. However, the dates of birth of the juvenile individuals were presumed from the body length and date of catch, using the mean growth curve in Fig. 2. This

TABLE 6. DATE OF BIRTH OF JUVENILE INDIVIDUALS PRESUMED FROM THE BODY LENGTH AND GROWTH CURVE, AND RECORDS OF LARGE FETUS OF GANGES DOLPHIN.

Month	IX	X	XI	XII	I	II	III	IV	V	VI
No. of birth[1)]	1	3	2	2	3	2	3	1	0	1
Large fetus[2)]	—	—	—	—	—	—	—	2	—	—

[1)] Calculated from present specimens.
[2)] Cited from Anderson (1878).

resut shows that most of the juvenile individuals were born from October to March with a center in December and January (Table 6). So, it is considered that this season is, at least, one of the parturition seasons of the Ganges dolphin, which coincides with the beginning of the dry season and with the winter season when most of the dolphins in the small rivers move to the main streams (Kasuya and Haque 1972). However, as indicated by specimen no. 21 of present study and four 25 cm fetuses in December reported by Pilleri (1970), another peak of parturition in the beginning of summer season (Anderson 1878) can not be denied. Anyway it seems to be sure that the parturition of this species can occur at any season of the year, and the presumed two peaks are not conspicuous.

If there are two peaks in the parturition season, one in the early winter and the other in the early summer, as in the case of *Stenella coeruleoalba* (Kasuya 1972), the gestation period may probably be about one year. And the 27 cm fetus in August (no. 14) might have been born in the former season and those reported by Pilleri (*loc. cit.*) in the latter. In this case, it must be presumed that the calves born in the early summer would have left, accompanied by the mother, the small streams in September when the water starts to decrease, and that some of the calves born about a year before and newly weaned had failed to leave the small streams where most of the juvenile specimens were obtained in the present expedition.

BODY WEIGHT

Fig. 3 shows the relation between body length and weight in the Ganges dolphin (circles) and the Indus dolphin (Cross marks), including 12 data cited from Pilleri (1970). As seen in Fig. 3, the body weight of the adult female is slightly smaller than that of the male of same body length, but there is no sexual difference in juvenile individuals. This will be related with the sexual dimorphism mentioned in the next chapter.

The regression line, calculated by the method of least squares for all the females of the Ganges dolphin except the smallest specimen (no. 21) is shown by the formula $W=0.0003025\ L^{2.290}$, where L means body length in cm and W body weight in kg. The formula for the Ganges dolphin of adult males and the juveniles of both sexes except no. 21 is shown by $W=0.00002456\ L^{2.826}$.

The body weight of the smallest female is smaller than the value expected from the formula, this will probably due to the unfavorable condition of the animal in the

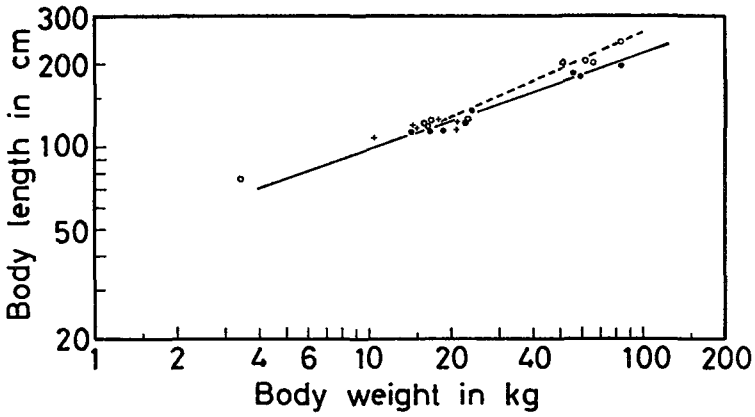

Fig. 3. Relation between body length and body weight in the Ganges dolphin. Closed circle and solid line indicate male, and open circle and dotted line female. Cross mark indicate the Indus dolphin reffered from Pilleri (1970). For explanation see text.

TABLE 7. WEIGHT OF THE GANGES DOLPHIN

Specimen no.	21		19		18		20	
Body length (cm)	76.0		122.0		126.0		199.0	
Sex	♀		♂		♂		♂	
Body weight (kg)	3.42		22.5		17.0		84.0	
Weight of parts	g	%	g	%	g	%	g	%
Blubber	970	30.0	10,600	48.5	5,280	33.7	30,990	35.9
blubber	—	—	10,220	46.7	4,880	31.1	29,140	33.7
tail flukes	—	—	380	1.7	400	2.6	1,850	2.1
Skeleton	1,175	36.3	3,670	16.8	3,723	23.8	16,050	18.6
skull	558	17.3	1,210	5.5	1,640	10.5	5,630	6.5
vertebrae	365	11.3	1,430	6.5	1,150	7.3	5,170	6.0
ribs	130	4.0	560	2.6	503	3.2	2,230	2.6
scapulae	32	1.0	120	0.5	100	0.6	540	0.6
flippers[1)]	90	2.8	350	1.6	330	2.1	2,480	2.9
Skeletal muscle	418	12.9	5,881	27.3	5,255	53.6	29,790	34.5
vertebral, dorsal	192	5.9	2,720	12.4	1,800	11.5	11,440	13.2
vertebral, ventral	80	2.5	1,620	7.4	850	5.4	6,190	7.2
masseter	—	—	410	1.9	205	1.3	R. 710	0.8
others	146	4.5	1,131	5.2	2,400	15.3	11,450	13.2
Internal organs	670	20.7	1,724	7.9	1,390	8.9	9,578	11.0
Total	3,233	100.0	21,875	100.0	15,648	100.0	86,408	100.0

[1)] Including the blubber.

pond where this animal was kept alive to die.

Table 7 shows the proportional weight of organs of 4 Ganges dolphins. In this species the weight of blubber occupies high percentage of from 30 to 48% of body weight, and the internal organs do only from 8 to 20%. The ratio of skeletal muscle, which increases with the growth of the animal, is from 12 to 35% of the body weight.

In the specimens nos. 18, 19 and 21, the total weight calculated by summing up

TABLE 8. THICKNESS OF BLUBBER MEASURED ON THE LATERAL LINE, LOWER COLUMN INDICATES THE SOFT FATTY TISSUE BENEATH THE DERMIS.

Specimen	21		7		6		9		8		19		20		10	
Body length (cm)	76.0		113.0		117.0		117.5		121.5		122.0		199.0		200.0	
Sex	♀		♂		♂		♂		♂		♂		♂		♂	
	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%
Level of neck	0.5	0.7	1.2	1.1	1.0	0.9	—	—	—	—	—	—	—	—	1.5	0.8
	0.6	0.8	2.0	1.8	3.0	2.6	—	—	—	—	—	—	—	—	3.3	1.7
Level of flipper	0.5	0.7	—	—	1.1	0.9	—	—	—	—	—	—	2.0	1.0	—	—
	0.0	0.0	—	—	1.7	1.5	—	—	—	—	—	—	0.5	0.3	—	—
Level of dorsal fin	0.4	0.5	2.5	2.2	—	—	—	—	—	—	1.3	1.1	2.5	1.3	3.2	1.6
	0.2	0.3	0.0	0.0	—	—	—	—	—	—	1.1	0.9	1.5	0.8	0.0	0.0
Level of umbilicus	0.5	0.7	1.5	1.3	1.5	1.3	1.2	1.0	1.1	0.9	—	—	1.8	0.9	1.8	0.9
	0.3	0.4	1.0	0.9	2.7	2.3	0.9	0.8	1.9	1.6	—	—	0.8	0.4	2.0	1.0
Level of anus	0.3	0.4	1.0	0.9	1.5	1.3	1.6	1.4	1.9	1.6	—	—	2.2	1.1	2.5	1.3
	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—	—	0.8	0.4	0.0	0.0

the weight of each parts shows the decrease of from 2.7 to 8.2% of the original weight weighed before dissection. However, in case of no. 20 which was dissected watering to defrost, the summed weight showed the increase of 2.4%.

Table 8 shows the thickness of blubber measured on the lateral line. The blubber of this species is characterized by the thick soft fatty layer beneath the harder connective tissue which will probably correspond to the blubber observed in the oceanic cetacea.

RELATIVE GROWTH

All the measurements, except those of appendages and distances between ear, eye and angle of gape, and the length of nasal slit, were made on a tape set in parallel with the carcass. These measurements of the present specimens are tabulated in Appendix. The relative growth of the anterior region of the Ganges dolphin is shown in Figs. 4 and 5, and that of posterior region and appendages in Figs. 6–8 and Table 9. Some important measurements are summarized in Fig. 9.

The length of head region is larger in adult females than in the males of corresponding body length. This is due to the larger length of the female rostrum as suggested by Anderson (1878), and will mean that after the growth of rostrum finished in the male the growth of this region continues in the female to attain about 20 cm larger length. This sexual dimorphism is presumed to come out at about 150 cm in body length. As the position of the anterior insertion of flipper does not show the sexual difference, the length from center of eye to anterior insertion of flipper is considered to be slightly larger in adult males than in the females (Fig. 4, top). Though the rostrum and mandible of juvenile Ganges dolphin is nearly straight, those tips of older individuals of both sexes are bended obliquely upward. This feature is well shown in Pls. 39 and 40 of Anderson (1878).

The relations between body length and the dimensions of the posterior region,

and those of appendages are shown by straight lines. The regression lines in Figs. 6–8 and " mean " in Table 9 are calculated for the Ganges dolphin by the method of least squares. Among these measurements, those concerning the positions of umbilicus and genital aperture show the sexual dimorphism. In the male, umbilicus situates slightly anteriorly than it does in the females. This will be related with the extremely anterior situation of the male reproductive aperture, which situates very close to the umbilicus as in the case of *Pontoporia blainvillei* (Table 10). Though the measurement is not recorded, it is clear that the male gential aperture of *Inia* opens near to the umbilicus same as *Pontoporia* and *Platanista* (Pilleri 1969, Fig. 3). So, it is presumed that this character may be general in Platanistidae. But similar character is observed also in *Physeter* and *Kogia*.

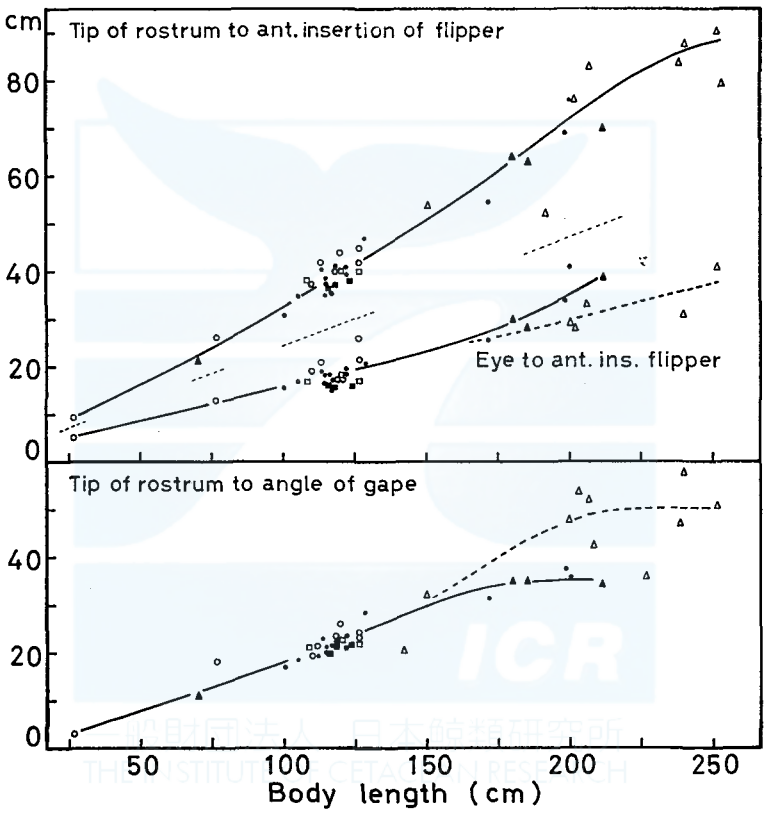

Fig. 4. Relative growth of the anterior region in *Platanista*. Circle indicates present specimen of the Ganges dolphin, triangle the Ganges dolphin reffered from Anderson (1878) and Pilleri (1970), square the Indus dolphin reffered from Pilleri (1970). The closed marks and solid line indicate male, and open marks and dotted line female. Lines are drown by eye for the Ganges dolphin.

DISCUSSION ON THE GROWTH

Though, in the present study, no definite conclusion on the parturition season was

obtained, the possibility was suggested to consider that *Platanista* has two parturition seasons one in early winter and the other probably in early summer. Then, the breeding season of this species seems to retain the same pattern as that of *Stenella caeruleoalba* which is different from that of *Physeter*, *Phocoena*, or *Delphinapterus* (Kasuya 1972).

Ohsumi (1966) showed an allometric relationship, $B=0.532\ M^{0.916}$, between mean body length at birth (B in m) and that of female at the attainment of sexual maturity (M in m) for *Physeter*, *Beradius* and several species of Delphinidae. If this formula is applied for *Platanista* assuming B=0.70 (m), 135 cm is obtained as the

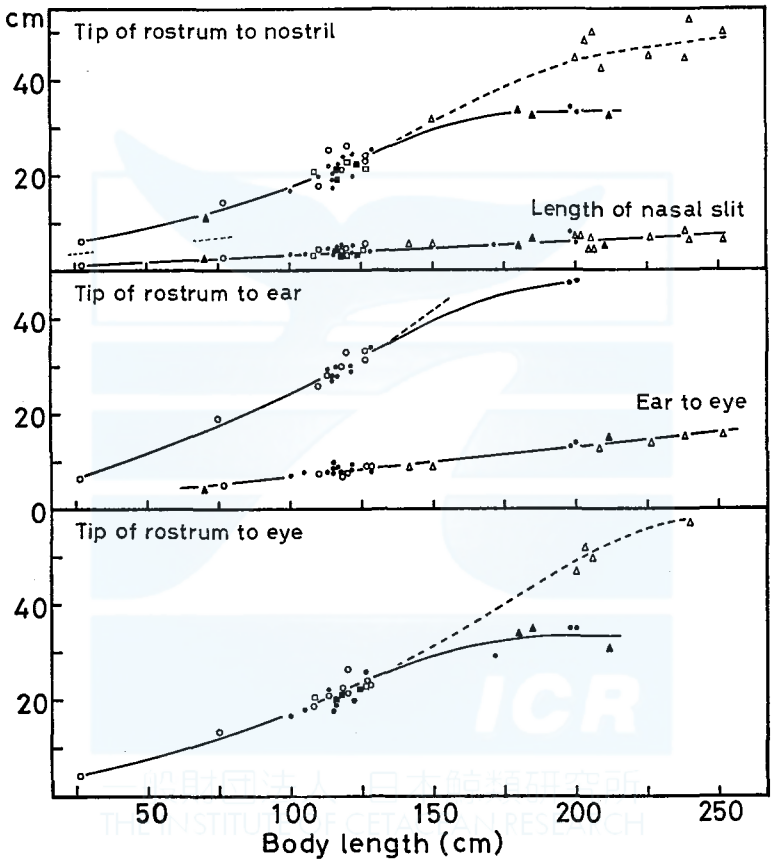

Fig. 5. Relative growth of the anterior region in *Platanista*. For marks see Fig. 4.

female body length at the attainment of sexual maturity. However, this figure is too smaller than the length obtanied in this study, even if it is compared with the smaller sex or the male.

The increment of body length of *Platanista* in the first one year after the birth is 65.7% of the body length at birth. This is nearly same with the value seen in some Delphinidae species (Kasuya 1972), and it is considered that the growth pattern of *Platanista* in the early stage of life retains presumable primitiveness as in the case of

some Delphinidae species. Then it is considered that the augmentation of body size may have happened in the later part of the growth as one of the specialization of *Platanista*.

Accompanied with the augmentation of body length, the elongation of the growth period may have brought on as in the case of *Physeter*. But these specialization of growth is considered to have been accomplished as a result of evolution occured independently of that of oceanic odontoceti. Though in the oceanic species the secondary sexual characters as the tooth, or size or proportion of body develops usually in the male with an exception of body length of some Ziphiids, in *Platanista*

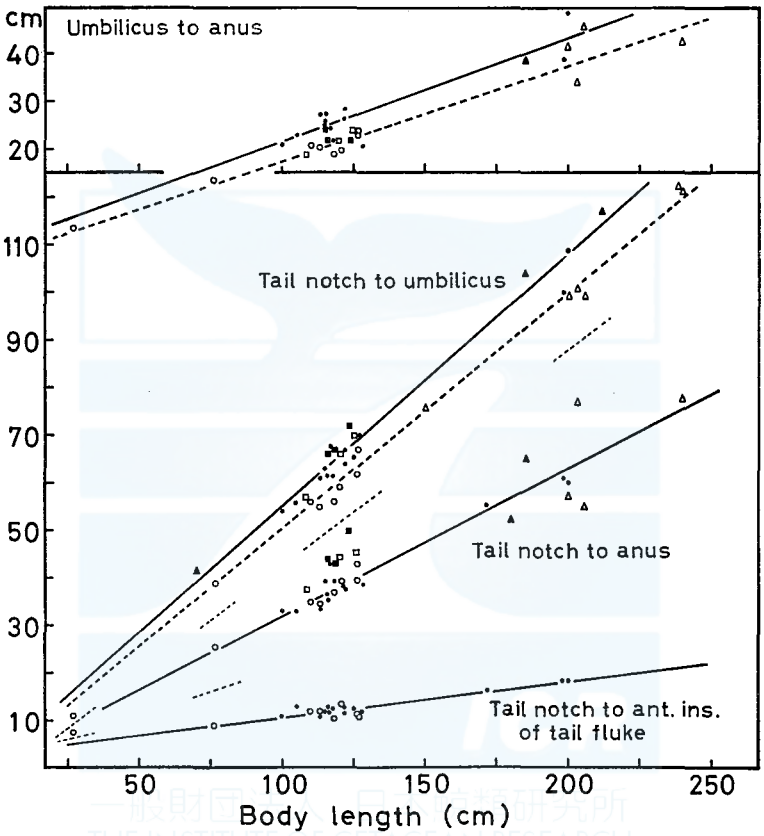

Fig. 6. Relative growth of the posterior region in *Platanista*. Lines are calculated for the Ganges dolphin by the method of least squares. For other marks see Fig. 4.

the body length and the length of rostrum which are the prominent secondary sexual characters develop in the female. In Ziphiidae, at least in *Berardius bairdi* and *Ziphius cavirostris*, the male is smaller than the female (Omura *et al* 1955).

Though *Platanista* resembles with *Physeter* and *Kogia* in the anterior situation of genital aperture, *Platanista* may have developed this character independently of the other two species.

It is concluded, from the above discussions, that the pattern of the growth ob-

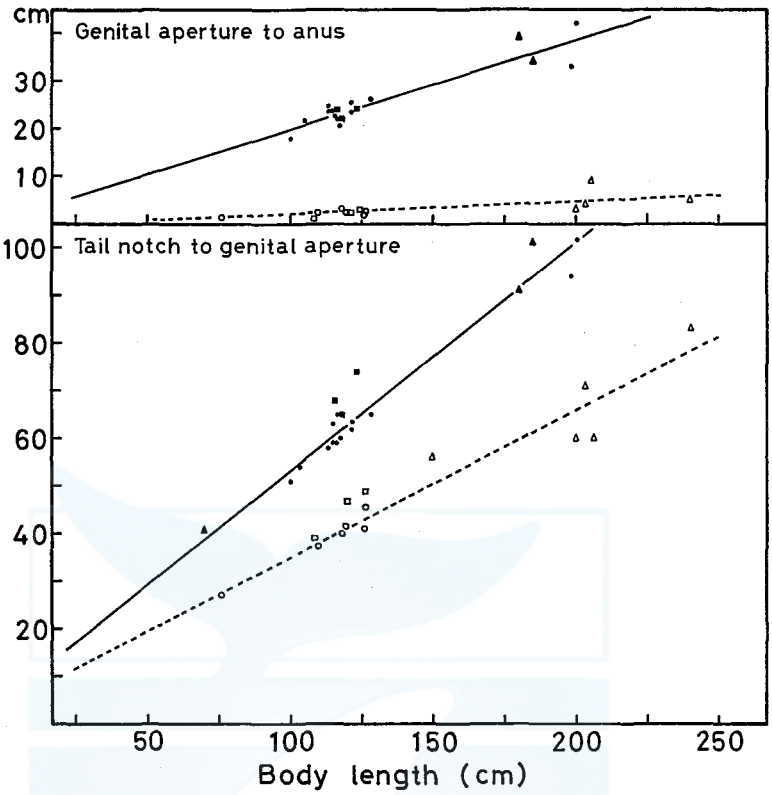

Fig. 7. Relative growth of the posterior region in *Platanista*. For marks see Fig. 6.

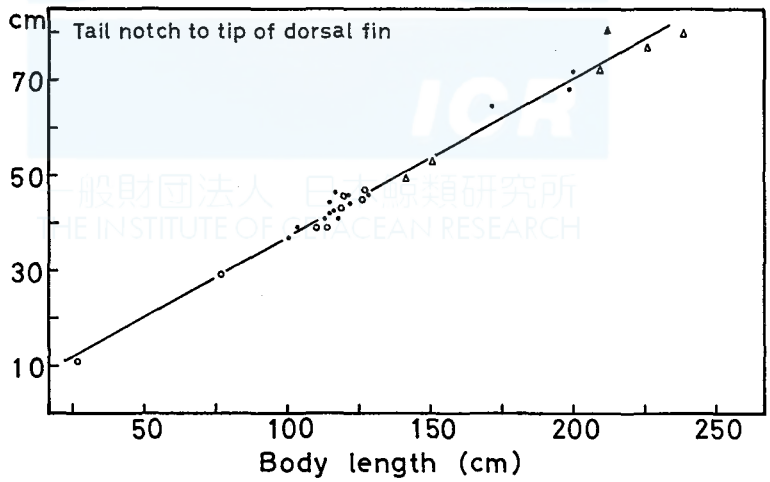

Fig. 8. Relation between body length and length from tail notch to tip of dolsal fin. For marks see Fig. 6.

TABLE 9. COEFFICIENT OF THE REGRESSION LINES[3] OF THE PROPORTIONAL LENGTH OF THE GANGES DOLPHIN

Measurements	Sex	Upper limit a	Upper limit b	Mean a	Mean b	Lower limit a	Lower limit b
Length from tail notch to tip of dorsal fin[2]	♀, ♂	0.357	4.5	0.335	3.68	0.328	1.9
,, to anus[1]	♀, ♂	0.395	−0.3	0.310	1.06	0.266	−0.3
,, to genital aperture[1),2)]	♀	0.391	−2.7	0.309	4.10	0.254	7.7
,, ,,	♂	0.527	3.5	0.479	5.05	0.437	7.1
,, to umbilicus[1),2)]	♀	0.561	−4.2	0.508	−1.49	0.492	−2.4
,, ,,	♂	0.563	1.6	0.530	1.93	0.472	6.0
,, to anterior insertion of tail fluke	♀, ♂	—	—	0.075	3.22	—	—
Length from anus to genital aperture[1]	♀	0.058	2.9	0.028	0.74	0.014	−0.3
,, ,,	♂	0.216	−0.1	0.187	1.31	0.152	2.7
,, to umbilicus[1]	♀	0.227	−2.7	0.202	−2.59	0.177	−1.8
,, ,,	♂	0.247	−0.4	0.217	0.23	0.254	−11.4
Distance from anterior insertion of flipper to anterior distal tip[2]	♀, ♂	0.179	−0.1	0.166	0.83	0.145	−0.7
Distance from axilla to posterior distal tip of flipper	♀, ♂	0.155	−2.2	0.121	−0.85	0.122	−3.4
Width of flipper[1),2)]	♀, ♂	0.134	−1.6	0.107	−1.51	0.098	−2.5
Total spread of tail flukes[1),2)]	♀, ♂	0.309	−4.6	0.235	−1.47	0.181	−1.1
Distance from tip of to tail flike to tail notch[2]	♀, ♂	0.170	−2.8	0.155	−3.77	0.121	−2.3
,, to anterior insertion	♀, ♂	0.222	−2.6	0.215	−3.50	0.160	−0.8

[1] Include Pilleri (1970), [2] Include Anderson (1878), [3] $Y=aX+b$, where Y and X indicate proportional and body length shown in cm respectively.

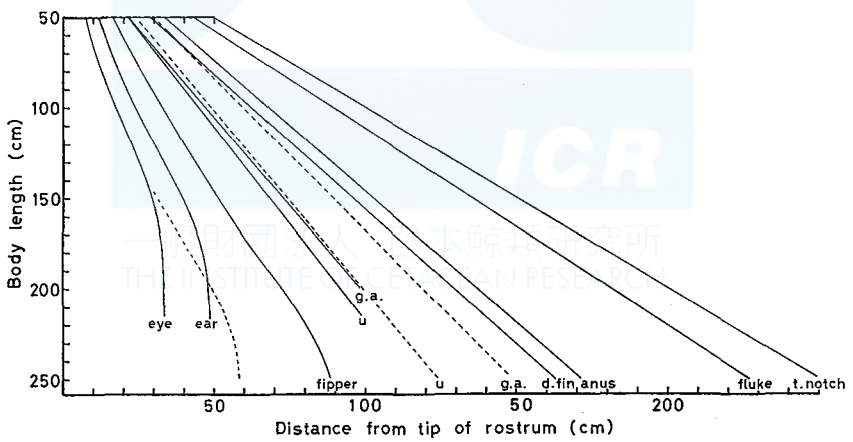

Fig. 9. Summary of Figs. 4–8, showing change of the relative positions of the external organs in the Ganges dolphin. Eye indicates center of eye, ear opening of ear, flipper anterior insertion of flipper, u umbilicus, g.a. genital aperture, d. fin dorsal fin, anus center of anus, fluke anterior insertion of tail fluke, and t. notch tail notch (left to right). Dotted line is for female and solid line for male.

TABLE 10. DISTANCE BETWEEN THE CENTERS OF GENITAL APERTURE AND UMBILICUS, MEASURED ALONG THE BODY AXIS AND SHOWN IN % OF BODY LENGTH

Sex	Male			Female		
Species	N	Range	Mean	N	Range	Mean
Platanista g. gangetica	12	0.8– 4.1	2.5	6	14.4–22.0	17.1
Pontoporia blainvillei (Pilleri 1971)	3	5.1– 7.7	6.0	4	13.0–14.8	13.8
Stenella attenuata (Nishiwaki *et al* 1965)	3	17.7–19.2	18.3	4	20.6–25.2	23.4
Feresa attenuata (Nishiwaki *et al* 1965)	6	10.5–14.3	12.4	7	12.9–19.4	16.4
Berardius bairdi (Omura *et al* 1955)	20	—	21.3	5	—	24.8
Physeter catodon (Matthews 1938)	60	—	7.6	8	—	20.8
Kogia simus (Kasuya *et al* unpbl.)	1	—	7.0	—	—	—

served in *Platanista gangetica* might have originated from that which had scarcely showed sexual dimorphism or augmentation of body size. From this hypothetical primitive growth pattern, that of recent delphinids and other oceanic toothed whales may have derived. But, among recent toothed whales, the delphinids seems to have attained the least modification in the growth pattern. This presumption is compatible with the morphological information on the growth of tooth (see *Age determination*).

TAXONOMICAL CONSIDERATION OF *PLATANISTA*

In Figs. 4–8, the proportional measurements of the Indus dolphin cited from Pilleri (1970) are also plotted. Though most of measurements are within the range of individual variation of the Ganges dolphin, the measurements concerning the length of tail show a significant difference between the dolphins from two river systems (Fig. 10, Table 11). Namely, when compared between the dolphins of nearly same body length, 118 cm, obtained from the two river systems, the length of tail is 6.7 cm shorter in the Ganges dolphin than the Indus dolphin. This difference is too large to concider as individual variation or personal deviation of the measurement. There is also observed a slight difference of the position of the anterior insertion of flipper between the dolphins from two river systems, which seems to come from the difference of the length from center of eye to anterior insertion of flipper (Fig. 4). But it can not be concluded, at present, if the difference is significont or not.

Pilleri (1971) reported the osteological difference observed on the height of nasal crest as a character to distinguish *Platanista gangetica* (Lebeck, 1801) and *P. indi* Blyth, 1859.

According to Yamashita (1971), the strong Himalayan orogenic movement started in the middle of Pleistocene, and is still continuing. He also indicated the

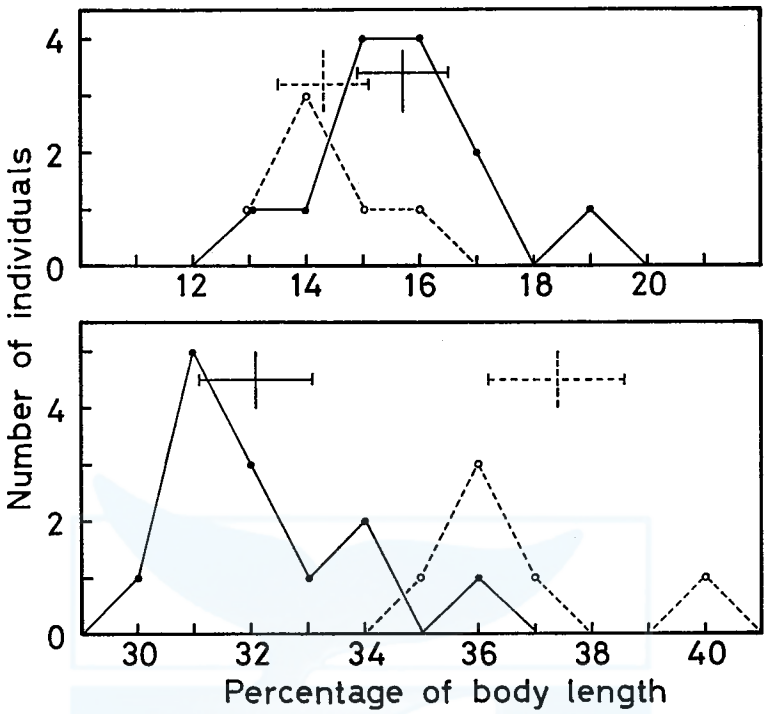

Fig. 10. Frequency distributions of relative length from eye to anterior insertion of flipper (top), and that from tail notch to anus (bottom) in *Platanista*, showing the morphological differences between *Platanista gangetica gangetica* (closed circle and solid line) and *Platanista g. indi* (open circle and dotted line). Vertical and horizontal lines indicate the mean and the ranges of two standard errors in both sides of the mean.

TABLE 11. SOME MEASUREMENTS SHOWING THE MORPHOLOGICAL DIFFERENCE BETWEEN THE GANGES AND INDUS DOLPHINS

Species	Ganges dolphin		Indus dolphin[1)]	
No. of samples compared	13		6	
Range and mean of body length (cm)	110.0–126.0	117.2	108.0–126.0	118.3
Length from anus to tail notch				
range and mean in cm	33.5– 43.0	37.6	38.0– 46.0	44.3
range and mean in percentage	29.6– 36.8	32.1	35.2– 40.7	37.4
Length from eye to flipper				
range and mean in cm	15.0– 21.0	18.3	16.0– 18.5	16.9
range and mean in percentage	12.8– 18.6	15.7	13.0– 15.7	14.3

[1)] Pilleri, 1970

possibility that the upper streams of some river had shifted, during this period, to have a connection with another river. This kind of exchange of the drainage area may have occurred between the Indus and the Ganges-Brahmaputra, which will have offered the chance for the *Platanista* to expand its habitat to another river, or to ex-

change the animal between connected two rivers. Anyway there will be no doubt that *Platanista* in the two river systems had originated from the same origin, and gained some morphological differences as the result of the separate evolution.

In some species of Mysticeti (Nishiwaki and Kasuya 1970, Omura 1957, Omura *et al* 1970), the characters of nasal or tail region seems to be the character where the differentiation occurs rapidly. Probably same presumption will be possible on *Platanista*. And, in my opinion, the evidence is still insufficient to consider *Platanista gangetica* and *P. indi* as two distinct species. The best way, at present, will be to deal them as two subspecies, or *Platanista gangetica gangetica* and *Platanista gangetica indi*.

SUMMARY

By the consideration of the growth of the Ganges dolphin based on the 22 individuals obtained in East Pakistan, the following results were obtained.

1. As the age characteristics, the growth layers in dentine is the best among the three characteristics compared in this study.
2. The opaque layers in dentine is suggested to be formed in summer, and the translucent in winter.
3. One of the peak of parturition season is in December and January, and the other, probably in early summer.
4. The calf seems to be born at about 70 cm in body length, and attain the body length of 116 cm in one year, and 123 cm in 1.5 years.
5. The calf probably start feeding at 1 or 2 month after birth, and weaning is accomplished within one year.
6. The sexual maturity is supposed to be attained at the age of 10 or slightly less, and the physical maturity, in the males, at the age more than 20 years.
7. The body weight of the adult female is slightly smaller than that of the male of the same body length.
8. Sexual dimorphism is observed in the body length, length of rostrum, positions of genital aperture and umbilicus, and perhaps in the position of flipper.
9. The growth pattern of *Platanista* seems to have originated from that probably had observed in primitive delphinids.
10. There is a clear difference of the length of tail between the Ganges dolphin and the Indus dolphin. And it is proposed to deal them as separate subspecies.

ACKNOWLEDGEMENT

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APPENDIX I. EXTERNAL MEASUREMENTS

Specimen no.	14	21	5	11	15	16	18
Sex	♀	♀	♀	♀	♀	♀	♀
From tip of upper jaw to:							
1. tail notch (total length)	27.0	76.0	110.0	113.0	118.0	120.5	126.0
2. anterior end of nasal slit	6.0	14.5	18.0	25.0	21.0	26.2	23.0
3. angle of gape	3.5	13.5	19.5	21.0	23.5	26.2	24.0
4. center of eye	4.2	13.5	18.5	21.0	22.5	26.6	23.0
5. ear	6.5	19.0	26.0	28.2	30.0	33.0	31.5
6. anterior insertion of flipper	9.5	26.5	37.5	42.0	40.0	44.0	42.0
From tail notch to:							
7. tip of dorsal fin	11.0	29.0	39.0	39.0	43.0	45.9	45.0
8. anterior insertion of tail fluke	—	9.0	12.0	12.0	10.5	13.6	11.5
9. center of anus	7.5	25.5	35.0	34.5	37.0	39.2	39.0
10. center of genital aperture	—	27.0	37.5	—	40.0	41.7	41.0
11. center of umbilicus	10.9	39.0	56.0	55.0	56.0	59.0	62.0
From angle of gape to:							
12. center of eye	—	2.3	3.2	—	—	—	3.0
13. ear	—	6.5	8.3	—	—	—	9.5
From ear to:							
14. eye	—	5.5	7.8	—	7.5	8.0	9.0
Flipper:							
15. anterior insertion to anterior distal tip, straight	3.2	13.5	18.5	18.0	18.0	19.1	18.0
16. anterior insertion to anterior distal tip, along curvature	—	14.5	20.5	20.0	20.0	21.0	19.5
17. axilla to posterior distal tip	2.0	9.5	13.0	12.5	13.0	13.5	13.5
18. greatest width	2.0	6.5	11.0	11.5	11.0	12.6	11.0
19. width at base	—	2.5	4.0	—	—	—	4.0
Dorsal fin:							
20. length of base	3.3	9.0	12.0	7.0	—	25.5	10.0
21. height	0.4	1.5	2.0	2.0	2.5	3.1	1.3
Tail fluke:							
22. tip to tip (total spread)	3.8	15.0	24.0	27.0	26.5	24.3	25.0
23. tip to notch	1.8	8.0	12.5	15.0	14.0	12.4	15.0
24. tip to anterior insertion	3.5	14.0	18.5	—	19.0	19.0	22.5
Nasal slit:							
25. length	1.1	2.5	4.5	4.0	4.0	4.5	5.8

In nos. 1 to 11, length was measured in parallel with body axis.

OF THE GANGES POLPHIN (cm).

17 ♀	2 ♂	1 ♂	7 ♂	3 ♂	13 ♂	12 ♂	6 ♂	9 ♂	8 ♂	19 ♂	22 ♂	4 ♂	20 ♂	10 ♂
127.0	100.5	105.0	113.0	115.0	115.0	115.5	117.0	117.5	121.5	122.0	128.0	171.5	199.0	200.0
24.0	(16.3)	19.5	21.5	(17.0)	19.0	20.0	22.0	23.5	24.0	19.5	25.0	34.0	33.0	—
24.5	17.0	18.5	23.0	20.0	21.3	19.5	21.5	23.0	23.5	21.0	28.5	31.6	37.5	36.0
23.5	16.5	18.2	21.5	18.0	20.0	19.0	21.0	22.5	22.0	20.0	26.0	29.2	35.0	35.0
33.5	—	—	29.0	—	27.8	27.0	28.0	30.0	30.0	29.0	34.0	—	47.5	48.0
45.0	31.0	35.0	40.5	35.0	38.5	37.5	36.0	40.5	41.0	39.5	47.0	54.6	69.0	76.0
47.0	37.0	39.0	41.0	44.5	42.0	42.5	46.5	41.0	44.0	46.0	47.0	64.8	68.0	72.0
11.0	11.0	13.0	11.0	12.8	12.0	12.0	12.5	12.0	13.0	11.5	11.5	16.5	18.5	18.5
43.0	33.0	33.0	33.5	39.5	35.5	36.5	43.0	39.5	38.0	38.5	39.0	55.3	61.0	60.0
45.5	51.0	54.5	58.0	63.0	59.0	59.0	65.0	60.0	63.5	62.0	65.0	—	94.0	102.0
67.0	54.0	56.0	61.0	65.5	63.0	61.5	67.5	61.5	64.5	67.0	70.0	—	100.0	109.0
—	—	—	4.2	—	3.4	3.5	2.7	3.0	3.5	3.0	3.5	—	4.5	6.0
—	—	—	9.0	—	9.4	9.5	9.5	9.3	9.5	9.5	9.0	—	14.0	16.0
9.0	7.5	8.0	8.0	8.0	8.8	8.7	9.0	8.0	8.8	9.5	8.0	—	13.5	14.0
20.5	15.5	17.5	19.0	17.0	19.0	19.0	19.0	18.5	18.0	17.0	21.0	—	35.5	29.0
23.0	17.5	19.0	21.0	19.5	21.3	21.0	21.5	20.5	20.0	19.5	22.5	—	39.5	33.0
14.0	11.5	12.0	13.0	13.0	13.2	13.5	14.0	12.5	13.0	11.5	15.5	24.4	23.0	21.0
15.0	8.0	10.0	9.5	8.5	11.5	11.5	9.0	11.5	12.5	11.0	14.0	17.8	25.0	22.5
—	3.5	4.0	3.5	3.0	—	4.0	3.0	4.0	4.0	4.5	5.0	5.7	7.0	7.0
16.0	—	—	21.0	—	8.0	—	19.0	17.0	18.0	11.0	12.5	—	36.0	—
2.5	—	—	4.5	—	2.8	1.5	2.0	3.0	3.0	1.5	3.1	—	5.5	—
28.0	23.0	22.5	26.5	26.5	26.5	25.0	28.5	27.0	28.5	29.0	29.0	38.7	57.0	42.5
16.0	13.0	11.0	15.5	14.5	15.3	13.5	15.0	15.0	—	16.0	15.5	—	30.0	23.0
23.0	—	—	22.5	—	22.5	20.5	22.0	21.5	22.5	21.0	24.0	—	38.5	33.0
4.5	4.3	4.3	4.3	3.3	2.8	3.5	4.8	4.8	3.5	5.0	4.0	5.6	8.0	6.0

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EXPLANATION OF PLATES

PLATE I

Ground thin section of the teeth of Ganges dolphin, translucent layers are shown black and opaque layers white.

Fig. 1. Specimen no. 20, male, body length 199 cm, number of growth layers 28.
Fig. 2. Specimen no. 4, male, body length 171.5 cm, number of growth layers 10.
Fig. 3. Specimen no. 18, female, body length 126.0 cm, number of growth layers 1 3/4.

PLATE II

Ganges dolphin, no. 21, female, body length 67.4 cm. Photographed at the time of capture. Anterior most one or two pairs of teeth started to erupt, and hairs are observed on the both jaws.

PLATE III

Ganges dolphin, no. 7, male, body length 113 cm. In fresh condition the colouration is pale brown with a tinge of gray. The colour of throat and chest region is paler.