RECENT STATUS OF THE POPULATION OF INDUS DOLPHIN

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ABSTRACT

A survey of the population of Indus dolphin *Platanista gangetica indi* (Blyth, 1859) was conducted in December 1974. The range of the significant abundance of this subspecies is restricted to the section between Sukkur and Guddu Barrages, and to the section between Guddu Barrage and Taunsa and Panjnad Barrages. The size of the population in the former section was estimated to be between 350 and 400 animals. Even if the populations in other sections are included, the total population seems to be only 450 to 600 animals. The calculated mortality rate, reproductive rate and environmental factors suggest that the population is still decreasing. For the survival of this population, the stop of the killing of this dolphin and the control of water at higher level in winter are suggested.

INTRODUCTION

The dolphin of the genus *Platanista* is found in the Indus River and in the Ganges-Brahmaputra Rivers. There is found a difference of the shape of nasal crest between the dolphins in the two separate rivers (Pilleri and Gihr, 1971). Though Kasuya (1972) reported the difference of the proportion of tail length, as he did not measure the Indus dolphin but referred the data prepared by Pilleri (1970) his conclusion is still doubtful.

It seems to be generally accepted that these two separate populations, started from a single origin, have been isolated long enough to attain some morphological differenciation. However, there are two contrary opinions on their classification. One is to consider them distinct species (Pilleri and Gihr, 1971), and the other is to classify them into two subspecies of a single species (Kasuya, 1972). At the present status of knowledge on these animals, we consider it reasonable to take the latter idea until more distinct morphological or ecological difference is found between the two, or until it is suggested that they do not freely interbreed even when the geographical barrier is not present.

The Indus dolphin was known to have been distributed in the wider range of the tributaries (Anderson, 1878). However, since the start of the construction of permanent barrages for irrigation, the dolphin population have been split up into separate smaller populations (Pilleri, 1970). And in some sections of the river, the population has been decreased or extinct (Pilleri, 1972; Roberts, 1972; Taber *et al*, 1967). The alarming situation of this dolphin was already noticed by Pilleri (1972) based on the observation made in 1969 and 1972 at the lower part of the

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section blocked by Sukkur and Guddu Barrages. The total population of this dolphin has been considered not exceeding 700–1,000 (Anon., 1973).

The present study was conducted in December 1974 to know the present range of distribution of the dolphin and to estimate the population.

RANGE OF DISTRIBUTION

The presence of the dolphin was checked at various bridges or barrages. However, as the dolphin is usually scarce near the barrage even if it is situated in the section where the presence of many dolphins is confirmed by other method (*e.g.* Sukkur or Kashmore Barrage), it was tried to collect more informations from the fishermen or people living by the river. Furthermore, if possible the length of about 1 to 3 km along the stream was observed at each spot.

Section 1, up of Jinnah Barrage

The Jinnah Barrage is situated near Kalabagh Town (71°34′N, 35°59′E). This section was observed on Dec. 15. The wide stream was present only within about 5 km above the barrage, and above the range the river enters into a gorge. Though it was reported by Anderson (1878) that the dolphin was present in the water above Kalabagh, the dolphin was not observed by us. The people in the town denied the presence of the dolphin. The dolphin seems to be absent in this part of the river in recent years.

Section 2, between Chasma and Jinnah Barrages

This part was not observed by us. But considering the small distance between two barrages and the scarcity of water below Jinnah Barrage, the dolphin will not be distributed in this section.

Section 3, between Taunsa and Chasma Barrages

This section was observed at Dera Ismail Khan and Taunsa Barrage on Dec. 14.

The water of the Indus by Dera Ismail Khan was about 500 m in width and seemed to be fairly deep suggesting the possibility of the presence of the dolphin. However we could not find it. A man living on the river bed told that he does not see the dolphin in winter season but he had once seen an animal in summer season.

At the north side of Taunsa Barrage the water was abaut 1,200 m wide. But there was found no dolphin in the area of about 2 km along the river.

From the above informations we consider that the dolphin might be absent in this section or if present the number must be almost negligible.

Section 4, from Guddu Barrage to Taunsa Barrage (R. Indus) and to Panjnad Barrage (R. Panjnad)

This section was studied at 5 spots on 7 occasions as mentioned below.

Though no animal was observed at the down stream of Taunsa Barrage (Dec.

14) and Panjnad Barrage (Dec. 13 and 17), it does not necessarily indicate the absence of the dolphin in this section because the water was scarce below the barrages and the dolphin will not migrate there.

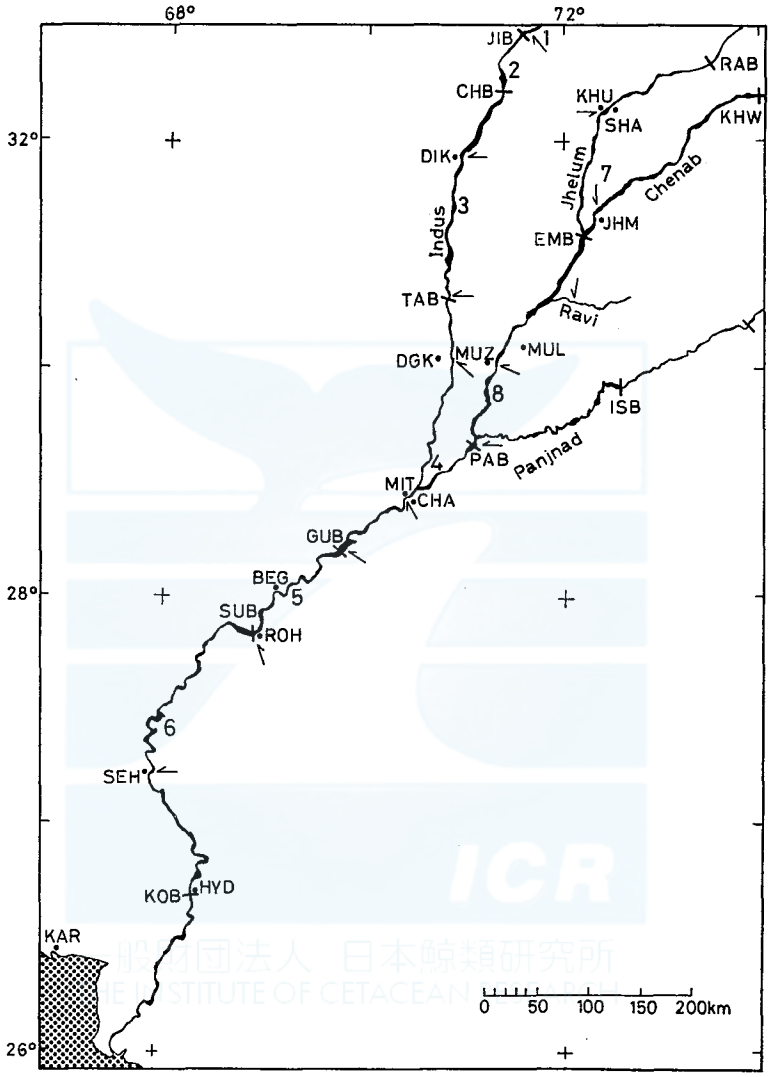

Fig. 1. Map of the Indus. Black bar indicates the barrage, numeral the number of the section in text, and the arrow the check point of *Platanista*. BEG, Begari. CHA, Chachran. CHB, Chasma Barrage. DGK, Dera Ghazi Khan. DIK, Dera Ismail Khan. EMB, Emerson Barrage. GUB, Guddu Barrage. HYD, Hyderabad. ISB, Islam Barrage. JHM, Jhang Maghiana. JIB, Jinnah Barrage. KAR, Karachi. KHU, Khushab. KHW, Khanki Weir. KOB, Kotri Barrage. MIT, Mithankot. MUL, Multan. MUZ, Muzaffargarh. PAB, Panjnad Barrage. RAB, Rasul Barrage. ROH, Rohri. SEH, Sehwan. SHA, Shahpur. SUB, Sukkur Barrage. TAB, Taunsa Barrage.

By Dera Ghazi Khan, the observation was made on Dec. 14 at the boat bridge connecting Dera Ghazi Khan and Muzaffargarh. The water there was only about 100 m wide and probably less than few meters in depth. No dolphin was found in the ranges of about 1 km at the both sides of the bridge.

Other observations were made along the stream of the length of about 3 km at the boat bridge between Mithankot and Chachran on Dec. 13 and 17. On this spot the water was more plenty than that at Dera Ghazi Khan situating about 150 km north. The width was about 500 m and the current was fast (2 to 3 km/hr). At the first visit one small dolphin (about 120 cm in body length) was observed swimming leisurely at about 100 m north of the bridge, and another slightly larger animal was seen at about 500 m south of the bridge. In case of the second visit, two small individuals were sighted near the latter spot.

At the water just above the Guddu Barrage, there was found no dolphin (Dec. 12).

From the above informations it is safe to conclude that some individuals of the Indus dolphin are distributed in this section of the Indus River. The range of the distribution in winter season will be from Guddu Barrage to the confluence of the Indus and the Panjnad. The length of this part is about 100 km. As this part of the section receives the water from the two rivers, the water level will not be too low to support *Platanista* in winter season.

Section 5, between Sukkur and Guddu Barrages

The presence of the dolphin in this section was confirmed from boats, and the estimation of the population is made in the next section of this report.

Section 6, between Kotri and Sukkur Barrages

The river of this section is devided into two by Ghulam Mohammed Barrage situated about 12 km north of Kotri Barrage. During our trip we only confirmed that the water is very scarce at just below Sukkur Barrage and at Sehwan Town, which is situated slightly south of the midpoint between Sukkur and Kotri Barrages. This indicates the probable absence of the dolphin in the upper part of the section. However, as reported by Pilleri (1972), Mr. Roberts sighted one animal near the north of Ghulam Mohammed Barrage and suggested that the population of the dolphin in the section will be quite small. He also states that *Platanista* is not expected down stream of Kotri Barrage. These informations are considered to be correct.

Section 7, from Emerson Barrage to Rasul Barrage (R. Jhelum) and to Khanki Weir (R. Chenab)

The section was studied on Dec. 16 at the bridge on the Jhelum River connecting Khushab and Shahpur. This bridge is situated nearly at the midpoint between the two barrages. At this point the stream was only from 100 to 150 m in width and shallow. No dolphin was observed.

The other observation was made by the bridge crossing the Chenab River at

the north of Jhang Maghiana This bridge is situated about 32 km upper stream of Emerson Barrage. In spite of the close distance from the lower barrage, the water was only bout 70 m wide and was very shallow.

It is reasonable to expect no dolphin in this section, as already suggested by Taber *et al* (1967) through the observation of the Ravi and Chenab Rivers.

Section 8, between Panjnad and Emerson Barrages

The Ravi River, a tributary of the Chenab River, was almost dry in this season (Dec. 16) leaving small ponds on the bed.

At the bridge connecting Multan and Muzaffargarh the stream was about 150 m in width and shallow, and no dolphin was observed on two occasions (Dec. 13 and 16). At Panjnad Barrage an information was collected on Dec. 17 from a fishermen telling that the dolphin is absent in this section.

No dolphin seems to be distributed in this section.

POPULATION IN THE SECTION BETWEEN SUKKUR AND GUDDU BARRAGES

The field observation of the Indus River of this section was conducted in the period from Dec. 7 to Dec. 12, using one (from Guddu Barrage to Begari) or two (from Begari to Rohri) local boats. The size of the boats was about 2.8 m wide and 6.5 m long. The boats cruised only in daytime with a stop for lunch, and usually 2 or 3 biologists watched the front direction of the boat while it was slowly rowed down the stream.

On Dec. 7 1974 our boats left the camp on the east bank of the Indus situating about 1 km south of Begari and arrived at Begari after 10 minutes. Then we took a jeep at Begari for Guddu Barrage. At Guddu Barrage a boat was arranged and we left that place at 1526 of the same day. After spending 2 nights on the boat, we arrived at the camp near Begari at 1900 of Dec. 9. On Dec. 9, as the observation was stopped at sunset (1735), we could not observe the river of about 3 km. On the next day (Dec. 10), we changed the boat and left the camp for Rohri, and arrived there at 0920 of Dec. 12 after spending 2 nights on the boats.

Though it was dry season, the width of the water was more than 200 m (estimated by eye) at any part of the section. However the width was small enough and the weather was calm to keep all the width in the range of observation, except when the water was split into two streams by sand bank or by island. On such cases the observation was always made on the larger stream. The speeds of the current was 2.7 km/hr (Dec. 8), 1.5 km/hr (Dec. 9), or 5.0 km/hr (Dec. 11) at the shore on the faster side of the stream.

The stream probably corresponds to the arm of the Indus running the east side of Tappu Island reported by Pilleri (1970, 1972) was narrow and formed a sort of canal, but was distinguished by fairly wide dry river bed. When Pilleri visited Tappu Island in 1969 the east arm was much larger than the west, but it reduced the size by 1972 to be as wide as the west arm (Pilleri, 1972). Possibly the

east arm attained the present condition by continuing the reduction of the size after Pilleri visited there in 1972.

When the dolphin was found, the number of surfacings was counted for each individuals untill the animal passes the level of the boat. The distinction of the individual was made considering the position and interval of surfacings, the size of the animal, and sometimes the swimming direction. Though most of the animals

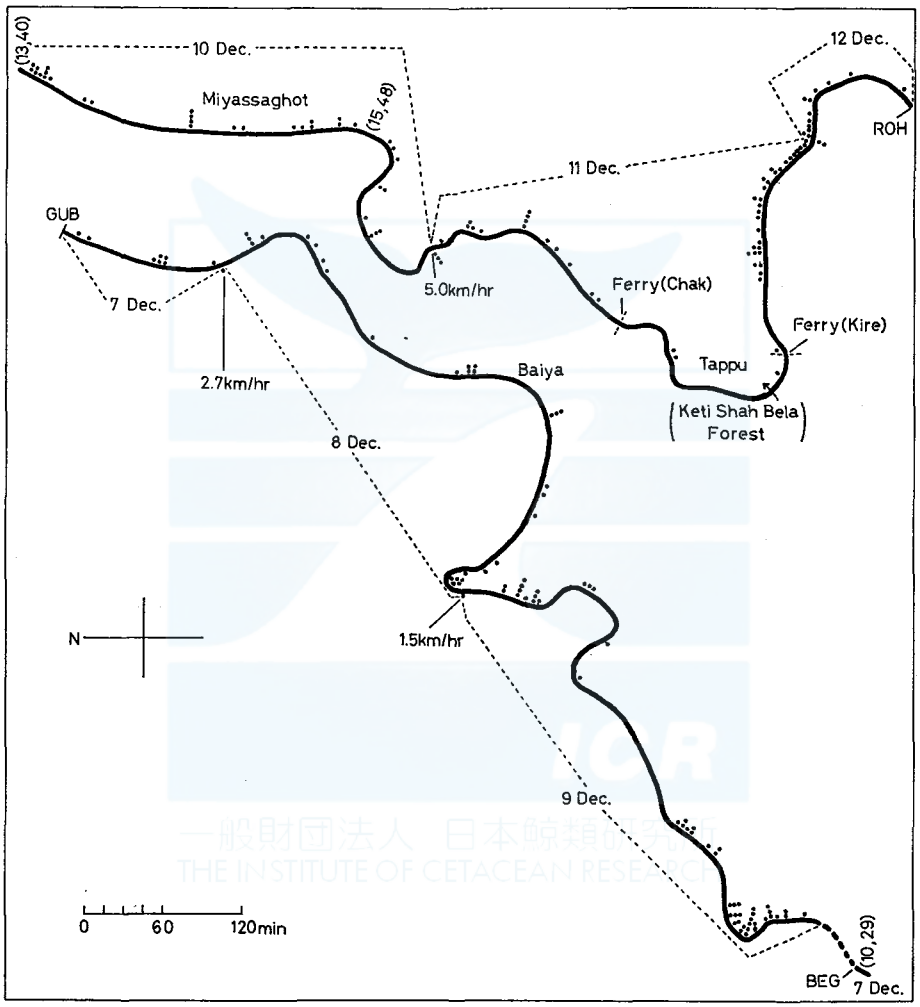

Fig. 2. Schematic figure of the Indus between Guddu Barrage and Begari (bottom) and between Begari and Rohri (top). Direction of the stream and cruising hours are indicated instead of direction and goegraphical distance. Circle at the left side of the river indicate the dolphin observed in cruising hours, and that at the right the animals observed while anchored. Numbers in parenthesis indicate the roughly estimated number of dolphins and number of surfacings in high density area. BEG, Entrance of Begari Canal. GUB, Guddu Barrage. ROH, Rohri.

seemed to be solitally, the area with high density was usually restricted to some deep places, and the dolphin was scarce in the shallow and rapid stream. In some cases many dolphins were found in a small area (e.g. 100 to 500 m in diameter), and the distinction of the individuals was difficult. Even in these cases it was not sure if the animals were forming a school or only assembling randomly at one spot. These cases are shown with parenthesis in Table 1. In this table the lines are arranged in the order of from the upper stream to the lower stream.

Interval of respiration

One juvenile dolphin (about 120 cm in body length), which was released after

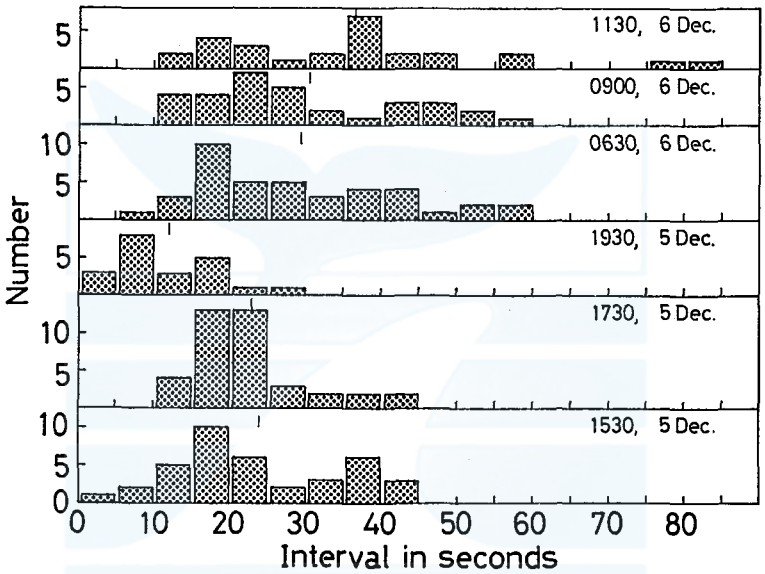

Fig. 3. Frequency of respiration interval of a juvenile *P. g. indi*.

the observation, was driven into a small inlet. And the interval of surfacing for respiration was measured for 5 to 20 minutes at various hours of a day in order to get some clue on distinguishing the individual dolphins in the river. This result is shown in Figs. 3 and 4.

The respiration interval showed wide variation from 4″ to 81″. Judging from the inconspicuous peaks of the frequency, there seems to be three modes of respiration interval. The one is at 20″ or less, the second at about 40″, and the third at 80″. The frequency of the shorter interval had decreased in the second day. This may be related to the decrease of excitement caused by the driving.

The observations of freely swimming animals give slightly different feature. The mean interval of 9 respirations of a median size animal was 64″. The 4 intervals of another median size animal ranged from 10″ to 80″ with a mean of 54″. On the other hand the mean interval of 12 respirations of one small animal, which was swimming slowly at one spot, was 87″. These informations suggest that the ratio

of the longer interval may increase in the freely swimming animals, but that there is no significant difference of the mean length of the interval between small and larger animals. These features are also confirmed by the data reported by Pilleri (1970), in which the highest frequency was at 60″, the next peak at 10″, and the average was 42″.

The respiration in night time was checked by the respiration sound. This shows that the respiration in the night is strongly biased to the shorter side.

Estimation of the population

The numbers of dolphins and of surfacings observed in the Indus between

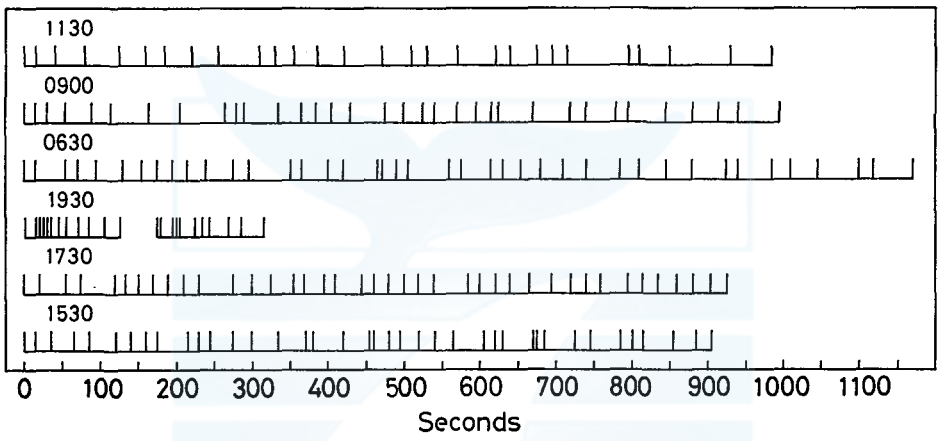

Fig. 4. Respiration pattern of *P. g. indi* based on same data in Fig. 3.

Guddu Barrage and Rohri are shown in Table 1. The rough estimation of number of dolphins we sighted is made, as shown bellow, from the total number of surfacings and number of surfacings with the distinction of each individuals.

$$(420+117)\frac{182}{420}=256$$

However this does not give the total number of dolphins in the observed water, because the overlooked animals are neglected. Accordingly the following method was used in this study.

Excluding the count of the dolphins made at the places where the dolphins were too concentrated to get reliable distinction of each individual, if the number of dolphins are plotted against the number of surfacings of each individual, there is found a tendency decreasing toward the left (Fig. 5). The frequency of animals sighted twice is higher than that expected from the linear decrease. This may be because, if the first surfacing is sighted, a larger attention is apt to be paid for the second surfacing. If the least square is used for the points between 1 to 5 surfacings, the relationship $y=-15.90x+82.1$, where y is the number of dolphins and x is

the number of surfacings, is obtained. However the frequency of the animals with 6 or 7 surfacings does not come on the extended straight line. Possibly these points will include the cases where two or more animals were erroneously considered as a single animal. If each case with 6 (7 cases) or 7 (3 cases) surfacings is considered to be represented by 2 animals with 5 or less surfacings, the real number of animals discussed here should be 192, and above formula should be parallelly slided up for $(7+3)\times 2\div 5=4.0$ and can be shown as follows.

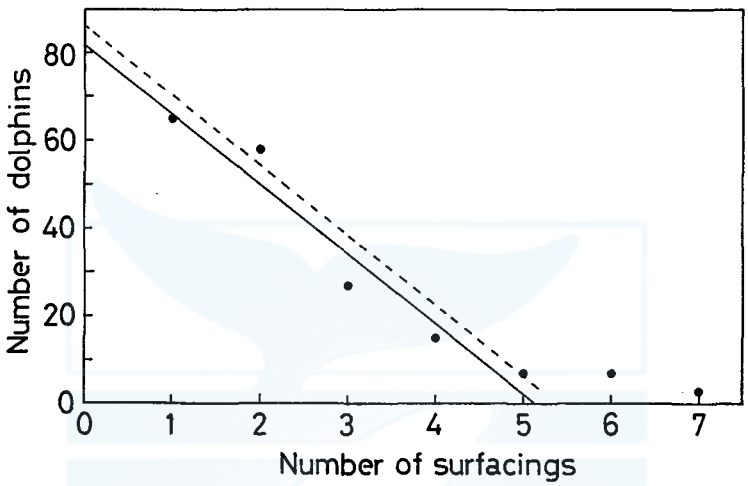

Fig. 5. Frequency of the number of observed surfacings of each individual of *Platanista* in the section between Guddu and Sukkur Barrages. Solid line indicates $y=-15.90x+82.1$, and dotted line $y=-15.90x+86.1$.

TABLE 1. NUMBER OF DOLPHINS AND OF SURFACINGS OBSERVED BETWEEN GUDDU BARRAGE AND ROHRI IN DEC. 1974

Date	Hours of observation	While cruising		While at stop	
		surfacings	dolphins	surfacings	dolphins
7	2°01′	20	10	—	—
7	8′30″	—	—	8	1
8	8°24′	61	28	—	—
9	20′	—	—	1	1
9	9°04′	124	53	—	—
7	10′	(29)	(10)	—	—
10	15′	(40)	(13)	—	—
10	4°24′	66	24	—	—
10	19′	(48)	(15)	—	—
10	2°34′	29	9	—	—
11	13′	—	—	6	3
11	9°00′	90	48	—	—
12	6′	—	—	3	2
12	1°42′	30	12	—	—
Total		420 (117)	182 (38)		

$$y=-15.90x+86.1 \quad \text{.....(1)}$$

The estimation of the number of overlooked dolphins is obtained from formula (1) as the value of y=86.1 corresponding to x=o. The real number of dolphins represented by one surfacing is obtained as follows.

$$\frac{182+7+3+86.1}{420}=0.661 \quad \text{.....(2)}$$

From this figure and total number of surfacings counted, the total number of dolphins should have been present in the observed area is obtained as follows.

$$(420+117)\times 0.661=355.0 \quad \text{.....(3)}$$

This is the minimum estimate of dolphins in the Indus River between Guddu Barrage and Rohri. In order to estimate the total number of dolphins in the section, the number of dolphins in the unobserved area must be added.

There are three occasions where the smaller branch of the stream was not observed in spite of the possible presence of the dolphin. The length of time of those cases were 20′ (Dec. 8), 19′ (Dec. 9), and 8′ (Dec. 9). And the number of spoutings counted in the corresponding main streams were 0, 16, and 0 respectively. Assuming that the same number of dolphins are distributed both in the smaller branch and larger main stream, the following number is calculated as the number of dolphins might have been present in the smaller stream.

$$(0+16+0)\times 0.661=10.6 \quad \text{.....(4)}$$

However this can be a overestimate, because it is more reasonable to expect the smaller number of dolphins in the smaller branch.

While the cruise of about 1 hour at the upper part of Begari, the observation was not made because of the night time. The number of dolphins in this area can be estimated from the number of surfacings counted in each one hour period at both sides of this area. In the upper area there were observed 47 surfacings in one hour, and in the lower area 64 surfacings. The mean is 50.9 surfacings. This shall represent

$$50.9\times 0.661=33.6 \quad \text{.....(5)}$$

However this estimation is also considered to be higher, because the water of the unobserved area was so shallow to have difficulty in cruising at night and the water at both sides of this area was deeper.

Another estimation must be made for the area between Rohri and Sukkur Barrage (about 2 km), where we could not cruise. As the number of surfacings counted during the cruise of the same distance just above Rohri was 14, the number of the dolphins in the areas between Rohri and Sukkur Barrage is obtained as follows.

$$14\times 0.661=9.3 \quad \text{.....(6)}$$

By totalling the figures (3), (4), (5), and (6), 409 is obtained as the number of dolphins between Guddu and Sukkur Barrages. As this figure is a maximum estimation, more reasonable estimation can be between this figure and that of (3), or about 380 animals.[1)]

Size composition

Table 2 shows the number of dolphins and of the surfacings classified by the size of the dolphin in the section between Guddu and Sukkur Barrages. The juvenile animals smaller than about 140 cm in body length are classified into " Small ", the large individuals presumably exceeding 180 cm and having the elongated rostrum were classified into " Large ", and the remaining dolphins into " Intermediate ". Though the frequency of the three sizes are calculated by two methods, one by the number of observed surfacings and the other by the number of identified individuals, there is observed no significant difference between the ratios obtained by two methods. And the approximate ratio of small, intermediate, and large animals is 70%, 20%, and 10% respectively. According to Kasuya (1972)

TABLE 2. RELATIVE ABUNDANCE OF THE THREE SIZES OF *PLATANISTA* IN THE SECTION BETWEEN GUDDU AND SUKKUR BARRAGES

	No. of surfacings		No. of dolphins	
	no.	%	no.	%
Small	299	69.9	97	66.4
Intermediate	89	20.8	32	21.9
Large	40	9.3	17	11.7
Total	428	100.0	146	100.0

the female *Platanista* in the Brahmaputra River attains the sexual maturity at the length between 170 and 200 cm and grows about 50 cm larger than the male, and the rostrum is especially long in mature females. So it is considered that the individuals classified into large animal in Table 2 represent the mature females, and the intermediate premature animals of both sexes and mature males. This means that the number of mature females is only 10% of the total population. Even under the unreasonable assumption that all the intermediate animals are sexually mature, the percentage of the mature femals could be 15% of the total population (an even sex ratio is assumed). In other words, the number of mature females is considered to be surely less than 30% and probably about 20% of all the females in the section between Guddu and Sukkur Barrages.

DISCUSSION

It is indicated that the dolphin is distributed also in the lower part of the section at the north of Guddu Barrage. Though its length is almost same with that of the

1) The fitness of Poisson distribution to the points in Fig. 5 is worse. It gives overlooked animal 28 instead of 86 and the population between 269 and 309.

entire section between Guddu and Sukkur Barrages, the water in the former area is more scarce than in the latter. So the total number of the dolphin in that part must be smaller than that in the section between Guddu and Sukkur Barrages. Possibly it will not exceed the half of the population in the latter section or about 200 animals. If the density of 2 animals in 3 km is applied for the area, the population can be about 100 animals. As the number of dolphins in the section between Kotri and Sukkur Barrages and that between Taunsa and Chasma Barrages is almost negligible, the total number of *Platanista* in the Indus River is estimated to be between 450 and 600. This is the lowest estimation has ever been made on this population.

The ratio of sexually mature females to the total females was obtained in the former section. The corresponding figures of delphinids are 69.1 % (calculated from the data in Sergeant, 1962) in *Globicephala melaena*, 68.3 % (Kasuya *et al*, 1974) in *Stenella attenuata*, and 58.5 % (Kasuya, 1972) in *S. coeruleoalba*. However these may sometimes have a bias derived from the segregation of the animals by different growth stage (Kasuya *et al*, 1974). The real maturity ratio of female *S. attenuata* calculated from the life table in Kasuya *et al* (1974, Table 24) is 59.0 %. These values are extremely high compared with that of *Platanista* in the Indus. A possible explanation of this phenomenon is the high mortality rate. If the mean age at sexual maturity is known, the mortality is roughly estimated. Kasuya (1972) suggested on *Platanista* in the Brahmaputra River that the age at the attainment of sexusal maturity in famales might be 10 years of slightly less as in the case of other toothed whales. If 9 years is applied for the age of the female *Platanista* in the Indus River at the attainment of sexual maturity, there can be the following equations.

$$\frac{\int_9^\infty e^{-\mu x}\,dx}{\int_0^9 e^{-\mu x}\,dx} = \frac{\text{No. of mature females}}{\text{No. of immature females}}$$

$$M = 1 - e^{-\mu}$$

Where μ is the annual mortality coefficient, M the annual mortality rate, x the age of the animal in years. As the number of mature females is 20 % of the total females, the annual mortality rate of 0.164 is obtained from the above equations. Even for the assumption of improbably high ratio of mature females 30 %, the annual mortality rate is 0.125 Though the mortality can change by the age of the animal, the above calculation will give some idea on the mean mortality rate of *Platanista* in the past. There is another problem in this estimation. The mean mortality thus calculated is largely influenced by the change of the annual recruit, and in the strict sence this value can indicate the real mean mortality only when the population is stable. In a decreasing population the mortality will be underestimated, and in a increasing population overestimated. However, as the environment of the dolphin has been changing worse as mensioned below, it is unreasonable to suspect the increasing population. Accordingly the mortality estimated here seems to be correct or an underestimation.

The next problem in analysing the population of the dolphin is the recruitment rate of *Platanista*. Kasuya (1972) showed that the parturition and mating

seasons of *Platanista* in the Brahmaputra River are in winter season and that the calves born in the early winter are weaned by the beginning of the next dry (winter) season. If this reproductive cycle is correct for *Platanista* in the Indus River, the mean calving interval will be at least 2 years. Then the gross annual reproductive rate is calculated as follows, assuming the even sex ratio and the ratio of mature females 20% obtained above.

$$0.20\times\frac{1}{2}\times\frac{1}{2}=0.050$$

Even in case of the unreasonably high ratio of mature females 30%, the gross annual reproductive rate is only 0.075.

The net reproductive rate is obtained as the difference of gross reproductive rate and the mortality rate. It is 0.05–0.164=−0.114 and surely less than 0.075–0.125=−0.050. Though this calculation is rough, it will be correct to conclude that the population of *Platanista* in the Indus River has been decreasing at the rate of about 10% per annum. As the environment does not seem changing better, the decrease of the population will be continuing.

One possible reason of the high mortality of this dolphin population can be the unknown amount of the catch by local fishermen. Another and more important factor seems to be the change of the environment caused by the development of the irrigation system as indicated by various authors (Anon., 1973; Pilleri, 1972; Roberts, 1972; Taber *et al*, 1967). The cause of the disappearance of the dolphin in most of the part of the Indus seems to be related directly to the construction of the barrages for irrigation system. The dolphin population, before the construction of the barrages, will have expanded the range of distribution in summer season and retreated to main stream in winter season as in the case of *Platanista* in the Ganges-Brahmaputra Rivers (Kasuya and Haque, 1972). However the construction of barrages blocked the seasonal movement and devided the population into smaller units. Then, as most of the water is used for irrigation in each section, only the subpopulations in few sections where the water level is not too low in winter season have survived at the lower population level. It is told that the water decreases even at Begari so low in February not to allow the use of the local fishing boat. Begari situates at the middle of the section between Guddu and Sukkur Barrages where most of the *Platanista* population is left. This condition will be bad for the survival of the dolphin. Furthermore, if the utilization of water for irrigation increases in future, the survival of this dolphin population will be impossible.

As the conclusion following two acts are suggested for the survival of *Platanista gangetica indi* (Blyth, 1859). One is to stop the poaching of this dolphin. For this purpose the educational propaganda will be needed to deny the erroneous conception on the medical efficiency of the dolphin oil. The other is to keep the water of some section above the certain level even in the winter season. This seems to be possible only through the accomplishment of the economical utilization of the water resources.

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REFERENCES

ANDERSON, J., 1878. *Anatomical and zoological researches comprising an account of the zoological results of the two expeditions to western Yunnan in 1868 and 1875 and a monograph of the two cetacean genera,* Platanista *and* Orcella, vol. 1. Bernard Quaritch, London, 550 pp.

ANONYMOUS, 1973. Indus dolphin or susu, *Platanista indi* (Blyth, 1859). in *Red Data Book* vol. 1 (Mammalia): 2. Inst. Union Conserv. Nat., Morges.

BLYTH, E., 1859. On the great rorqual of the Indian Ocean with notice of other cetals, and of the sirenia or marine pachyderms. *J. Asiat. Soc. Bengal*, 28: 481–498.

KASUYA, T., 1972. Growth and reproduction of *Stenella caeruleoalba* based on the age determination by means of dentinal growth layers. *Sci. Rep. Whales Res. Inst.*, 24: 57–79.

KASUYA, T., 1972. Some informations on the growth of the Ganges dolphin with a comment on the Indus dolphin. *Ibid.*, 87–108.

KASUYA, T., and A.K.M. AMINUL HAQUE, 1972. Some informations on distribution and seasonal movement of the Ganges dolphin. *Ibid.*, 24: 109–115.

KASUYA, T., N. MIYAZAKI, and W. H. DAWBIN, 1974. Growth and reproduction of *Stenella attenuata* in the Pacific coast of Japan. *Ibid.*, 26: 157–226.

PILLERI, G., 1970. Observations on the behaviour of *Platanista gangetica* in the Indus and Brahmaputra Rivers. *Investigations on Cetacea*, ed. G. Pilleri, 2: 27–69, Berne.

PILLERI, G., 1972. Field observations carried out on the Indus Dolphin *Platanista indi* in the winter of 1972. *Ibid.*, 4: 23–29, Berne.

PILLERI, G., and M. GIHR, 1971. Differences observed in the skull of *Platanista gangetica* (Roxburgh, 1801) and *indi* (Blyth, 1859). *Ibid.*, 3(1): 13–21, Berne.

ROBERTS, T. J., 1972. A brief examination of ecological changes in the province of Sind and their consequences on the wildlife resources of the region. *Pakistan J. Forestry*, 22: 89–96.

SERGEANT, D. E., 1962. The biology of the pilot or pothead whale *Globicephala melaena* (Traill) in Newfoundland waters. *Bull. Fish. Res. Board Canada*, 132: 1–84.

TABER, R. D., A. N. SHERI, and M. S. AHMAD, 1967. Mammals of the Lyallpur region, West Pakistan. *J. Mamm.*, 48(3): 393–407.