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# Barrages, Biodiversity and the Indus River Dolphin

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**Abstract:** The Indus River Dolphin, *Platanista minor* belongs to the *Platanistoidea*, or River Dolphins which are probably the world's most endangered cetaceans. Ecological interest began in the 1970's with a largely uncoordinated monitoring programme which continue to date. In spite of problems in assessing the species' population and abundance in the turbid waters of the Indus it would seem to be stable in its main stronghold between the Sukkur and Guddu Barrages it seems to be stable if not increasing in population. The problems faced by this animal caused by the adverse effects of barrages are in common with other members of the biota. By solving problems for dolphin the rest of the ecosystem should benefit. It is suggested that the issues of biodiversity can gain a higher profile when linked to a flagship species.

**Key words:** River Dolphin, *Platanista minor*,Indus, biodiversity, barrages

## INTRODUCTION

There is debate about if there are two closely related species or possibly sub-species[1] of River Dolphin in the rivers of the Indian subcontinent, *Platanista gangetica* the Ganges River Dolphin and *Platanista minor*[2] the Indus River Dolphin. However, academic debate will not conserve either species.

Historically in Pakistan the species was distributed throughout the Indus including its main tributaries, the Jhelum, Chenab, Ravi and Sutlej from the foothills where the rivers enter the plains through to the Indus delta (Anderson, 1879). However, there are now six barrages on the Indus River, namely in downstream order, Jinnah Barrage (commissioned 1946), Chashma Barrage (commissioned 1971), Taunsa Barrage (commissioned 1959), Guddu Barrage (commissioned 1962), Sukkur Barrage (commissioned 1932) and the Kotri Barrage (commissioned 1954). There are a further nine barrages on the major Indus tributaries and three high dams used for hydroelectric power in more upland areas. These barrages have been built as low dams designed to divert water into the 58,000 km of canal system which uses Indus water to irrigate the fertile but arid lands of the Indus Plain. These dams have effectively artificially isolated the original metapopulation of the Indus Dolphin into four or five sub-populations, individuals of which might be swept downstream when the barrage gates are open during summer floods but no effective upstream movement is possible[4].

## METHOD AND MATERIAL

There are intrinsic problems involved in estimating the population size of a species living in almost totally turbid conditions which can be seen only when it surfaces for air. The counts of animal numbers have continued from 1970 to date based on visual methods. The general methodology used in most previous surveys described by Chaudhry *et al.*[5] has been used in this study. The river is generally sampled downstream by a slow boat between Sukkur and Guddu barrages.

## RESULTS

The problems of accurately assessing numbers can be seen by reference to Table 1. The dolphins were counted as they surfaced for air in the Dolphin Reserve between the Sukkur and Guddu barrages. The water current was quite slow as it was not the flood season. The general change in early counts is evident from 1970's onwards. This may indicate a continued increase in population (Table 1). Counts of the Indus dolphin are always made once a year after the breeding season i.e April / May to determine any change in population numbers. The survey takes fifteen to twenty days and depends upon the seasonal conditions in river. Financial constraint sometimes restricted the conservation efforts e.g the Sindh Wildlife Department did not count the dolphin population in 1997 and 1998. The variation observed in numbers is dependent upon a number of

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Table 1: Survey data for *Platinista minor* in the Dolphin Reserve between Sukkur and Guddu Barrages from 1974

| Date | No. of Dolphins | Source |
|---|---|---|
| January 1974 | 138 | Pilleri and Zbinden[19] |
| December 1974 | 233 | Kasuya and Nishiwaki[15] |
| February 1977 | 171 | Pilleri and Bhatti[17] |
| April-May 1977 | 187 | Pilleri and Bhatti[17] |
| October 1977 | 168 | Pilleri and Bhatti[17] |
| Feb-March 1978 | 191 | Pilleri and Bhatti[17] |
| May 1978 | 241 | Pilleri and Bhatti[17] |
| April 1979 | 240 | Pilleri and Bhatti[18] |
| June 1979 | 292 | Pilleri and Bhatti[18] |
| September 1979 | 291 | Pilleri and Bhatti[18] |
| February 1980 | 291 | Bhatti and Pilleri[20] |
| April 1980 | 346 | Bhatti and Pilleri[20] |
| March 1986 | 429 | Khan and Niazi[16] |
| March 1987 | 437 | Reeves and Chandhry[8] |
| March 1989 | 370 | Reeves and Chandhry[8] |
| November 1992 | 439 | Reeves and Chandhry[8] |
| April-May 1996 (upstream count) | 339 | Mirza and Khurshid[6] |
| April-May 1996 (downstream count) | 458 | Mirza and Khurshid[6] |
| May 1999 | 104 | Gachal and Sindh Wildlife Dept. |
| June 1999 | 220 | Gachal and Sindh Wildlife Dept. |
| August 1999 | 367 | Gachal and Sindh Wildlife Dept. |
| August 2000 | 504 | Gachal and Sindh Wildlife Dept. |

*(in part after Mirza and Khurshid[6])*

factors including the direction of the count[6] and when the count was made (Table 1). The 1999 counts were made downstream. The 1996 data showed a 24% difference between upstream and downstream counts. The August 1999 count could therefore represent anything between 367 and 496 individuals. Clearly the numbers counted at different times using the same methodology varies such that no precise estimate of population size can be obtained (Table 1). Although the number fluctuates, overall trend seems to have been upward from 1986 to 1996 but with drops in 1977 and 1989. A regression analysis of numbers against years in Table 1 give x (year) = - 9794 + 5.08 y (n); $R^2$ 17; p = 0.07. It suggests the real increase over time in the dolphin population. In 2000 dolphins were counted 504 down stream the Guddu and Sukkur barrages. Although population counts have increased since 1970's, they have either remained stable or even declined since the early 1990's in both Sindh and Punjab[7].

## DISCUSSION

Reeves[8] showed that the isolated dolphin populations decrease in size in the upstream order of Sukkur to Guddu Barrage, Guddu to Taunsa Barrage and Taunsa to Chashma Barrage (Table 1). Possible reasons for this gradient in numbers might include:

- Natural carrying capacity of the river.
- Predation pressure – possibly by fishermen as by-catch.
- Drift – assumed one way (downstream) movement through barrages, lateral drift of animals into irrigation canals.
- Food resources – may naturally vary along the river. Pollution – from agricultural, industrial chemicals and human waste which might have physiological effects on dolphins or their prey or in extreme cases might prove fatal.

Many of these factors would equally apply to other organisms isolated by the barrages. Because of its conservation importance, the Indus River dolphin focuses international attention on its habitat and the problems it faces as exemplified by the South Asia River Dolphin Workshop, Lahore, November 1999 sponsored by WWF – Pakistan. Without the dolphin the ecology of the River Indus would receive even less attention but, because an endangered species is present, the biodiversity of the river and the effects of fragmentation by barriers get at least some attention. Table 2 collected by Mirza and Khurshid[6] and Chaudhery *et al.*[5] which suggests that aquatic and other birds migrating to or via Pakistan use the Indus valley as a flyway and often also a transit station (Table 2). Non aquatic birds such as Black and Grey Partridge use pai forest (Game Reserve) adjacent to the river. Great and Little Cormorants are not only found along the river but one also resident in the sanctuary of Haleji lake.

All the fishes shown in Table 2 are caught commercially and those identified by Reeves *et al.*[9] and Chaudhery *et al.*[5] as dolphin prey are indicated by asterisk in this table. The data for invertebrate is far from complete but taken with the other species lists gives an indication of the richness of the biodiversity of the Indus river. The contribution of dolphin studies to the understanding of biodiversity and barrages

Mirza and Khurshid[6] as part of their Sindh dolphin survey recorded the mammals, birds, fish, reptiles, amphibians and aquatic invertebrates of the survey area from the mouth of the Indus to the Guddu barrage (Table 2). This provides a non-exhaustive list of the wildlife of the lower Indus some of which, such as fish, are obligate river dependent species, whilst others, such as birds, have a looser relationship with the river. Chaudhry *et al.* [5] have produced similar lists for water birds and fish as part of their dolphin survey of the Punjab.

Due to the fact that the dolphin has almost no commercial value – indeed there is an Islamic injunction against eating dolphin flesh there is little intrinsic interest in the conservation status of the dolphin exists which has undoubtedly added to the wider understanding of biodiversity in the Indus. In addition to dolphins the

Table 2: Animal Diversity in Indus River

| Scientific Name | | Common Name |
|---|---|---|
| **Mammals** | | |
| *Lutra perspicillata* | | Smooth Otter |
| *Herpestes edwardsi* | | Common mongoose |
| *Felis chaus* | | Jungle cat |
| *Rattus sp* | | Rats |
| | | Shrews |
| | | Hare |
| **Birds** | | |
| A= Mirza and Khurshid[6]; B = Chaudhry *et al.*[5] | | |
| *Pandion haliaetus* | A | Osprey |
| *Circaetus gallicus* | A | Short toed Eagle |
| *Haliaeetus gallicus* | A | Pallas's fishing Eagle |
| *Accipiter virgatus* | A | Sparrowhawk |
| *Athene brama* | A | Spotted Owlet |
| *Phalaccrocorax fuscicollis* | A | Indian Shag |
| *Nycticorax nycticorax* | A | Night Heron |
| *Ardeola grayii* | A | Pond Heron |
| *Egretta garzetta* | AB | Little Egret |
| *Ardea cinera* | AB | Grey Heron |
| *Fulica atra* | AB | Coot |
| *Hydrophasianus chirurgus* | AB | Pheasant tailed Jacana |
| *Himantopus himantopus* | AB | Black winged Stilt |
| *Anas acuta* | B | Pintail |
| *Charadrius dubius* | AB | Little ringed Plover |
| *Tringa tetanus* | A B | Red Shank |
| *Tringa nebularia* | A B | Green Shank |
| *Anas clypeata* | B | Shoverler |
| *Anas fuligula* | B | Tufted Duck |
| **Fish** | | |
| Combined lists from Chaudhry *et al.*[5] and Mirza and Khurshid[6] | | |
| *Tenualosa ilisha* | | Pall |
| **Labeo rohita* | | Pali |
| **Catla catla* | | Theli/ Thalia |
| **Notopterus notopetrus* | | Bupri |
| **Puntius sophore* | | Sophor |
| **Bagarius Bagarius* | | Fouji khaga/ Gonch |
| **Wallago attu* | | Malhi |
| (*) *Ompok sinctensis* | | Sindhi paphta |
| **Heterpheustes fossilis* | | Sanghi |
| (*) *Channa marulias* | | Soll |
| (*) *Chanda rama* | | Nama shisha |
| **Glossgobius giuris* | | Golo |
| *(*) *Maslacembelus armatus* | | Bam |
| * *Colisa lolia* | | |
| **Reptiles** | | |
| *Xenochrophis cerasogaster* | | Marsh Snake |
| *Ptyas muscosus* | | Dhaman |
| *Psammophis condanarus* | | Sand Snake |
| *Bungarus caeruleus* | | Indian Krait |
| *Naja naja* | | Cobra |
| *Viper russellii* | | Russell's Viper |
| *Varanus bengalensis* | | Monitor Lizard/ Goh |
| *Uromastix hardwicki* | | Sandha / Sando |
| *Trionyx gangeticu* | | Indian Softshell Turtle |
| *Lissemys punetata* | | Indiam flapshell Turtle |
| *Kachuga smithi* | | Brown River Turtle |
| **Amphibian** | | |
| *Rana cyanophyletic* | | Skittering Frog |
| *Rana tigerina* | | Tiger Frog |
| *Bufo andersoni* | | Indus Toad |
| *Bufo viridis* | | |
| **Crustaceans** | | |
| **Palaemon carcinus* | | Large Jhenga |
| **Palaemon malcomsoni* | | Small Jhenga |
| **Aquatic Insects** | | |
| *Laecotrephes rubi* | | Water Scorpion |
| *Laecotrephes griescis* | | Water Scorpion |
| *Ranatra elongata* | | Water Scorpion |
| *Micronecta stali* | | Water Bug |
| *Coraixa promotoria* | | Water Bug |
| *Coraixa substriata* | | Water Bug |
| **Molluscs** | | |
| *Nodularia caerulus* | | River mollusc |
| *Parrysia corrugata* | | River mollusc |
| *Parrysia flavidens* | | River mollusc |

*Reported Dolphin prey
(*) Related species reported as dolphin prey[9]

barrages have affected other species: *Hilsa*, for example, in spite of fish ladders, which are perversely used in places as convenient fishing sites, has declined possibly due to the increased human predation the impediment of ascending a fish ladder leading to a reduced breeding area and the physical change of the river and its breeding sites by the barrage impoundments.

The dolphin is not the only top mammalian predator on the river which could be affected by man's activity and the general uncontrolled use of agricultural and industrial chemicals. The Smooth Otter *(Lutra perspicillata)* occurs sparsely throughout the area. Faecal markings (spraints) have been found by the author in the Sukkur to Guddu area and are reportedly more frequent around Taunsa. Foster-Turley *et al.*[10] regard it as restricted to "water reservoirs at dams and barrages". Other factors also threaten this, the most widely distributed otter in Pakistan (the Eurasian Otter *Lutra lutra* only occurs in the extreme north), including the fact that, on Indus tributaries such as the Jhelum, Chenab, Ravi and Sutlaj, major parts of these rivers remain effectively dry for much of the year leaving only water around the dams, little food and little continuity of suitable otter habitat. Increasing human population (3% per year) in Pakistan, together with persecution by fishermen and hunters, also reduces numbers[11].

Although the river in inter-barrage areas may appear, incorrectly, largely structurally unchanged, the flow regime has been both regulated by high dams in upper tributaries and by flow reduction, diverting up to three quarters of the river's flow into irrigation canals. Future changes in structure, however, could well happen due to the elimination of the "freshet effect" (=flood effect) which, in many wild rivers, renews the flood plain and contributes to meandering[12].

These water management measures have the following effects upon aquatic organisms:

- Increased sedimentation due to slower flows can adversely affect some aspects of biodiversity by lotic to lentic change.
- The presence of irrigation canals adds thousands of kilometers to the availability of water channels, some albeit seasonal, which adds habitat to natural fish and invertebrate distribution and adds a resource exploitable by local fishermen away from and possibly reducing fishing pressure on the main river.
- At the Taunsa Barrage commercial fish landings increased from 75,000 kg in 1980 to 170,000 kg in 1989[5]. Although fishing methods have changed little in recent years, the reasons for this increase might be due to increased fishing effort, increased fish production or better reportage[13]. If it is due to increased fishing activity, the increased use of nets increases the chance of dolphin entanglement. Consequently fish abundance and dolphin safety may come into conflict. Conversely pollution on the River Ravi – into which Lahore discharges its untreated waste water – has caused a drop in fish production of 5,000 tones per year, a consequence of pollution which will be reflected throughout the food chain[5].
- Reptiles and amphibians probably benefit from the increased habitat created by the irrigation canals and the land they serve.

However, water regulation alters but does not prevent river floods and for birds, the Indus valley is a major migratory flyway. It is probable, therefore, that the barrages themselves have little direct effect on bird biodiversity. Lateral seepage from canals does result in extensive areas of waterlogged land of little agricultural use but well used by birds such as Little Grebe, Pond Heron, Little Egret, Coot, Black-winged Stilt, Red-wattled Lapwing and reptiles such as soft shelled turtles[14]. This is certainly a way in which biodiversity is increased by the indirect effects of irrigation canals.

The natural biodiversity of the Indus basin has been altered by the construction of barrages. As a subject for study it has received scant attention and if it were not for the presence of the River Dolphin it would possibly have been totally neglected. Concerns relating to the dolphin in terms of human pressures, pollution and isolation also apply to other biota and there would seem to be value in addressing the generalities of biodiversity by reference to a specific high profile species. The inadequacies of the biodiversity data emphasise the need for more information perhaps, almost literally, on the back of dolphin research.

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