

COMPOSITION, ABUNDANCE AND DISTRIBUTION OF FISH IN BANGANGA-GAMBHIR RIVER SYSTEM AND SOURCE OF FISH TO THE KEOLADEO NATIONAL PARK, BHARATPUR¹

C.R AJITH KUMAR² N.K. RAMACHANDRAN³ AND ARUN ASTHANA⁴
(With two text-figures)

Key words: Banganga-Gambhir river, *Notopterus chitala*, *Labeo dyochilus*, *Lepidocephalichthys guntea*, *Danio devario*, *Aplocheilichthys panchax*, *Labeo boggut*, geomorphology

The Keoladeo National Park, Bharatpur is situated at the confluence of two non-perennial rivers Gambhir and Banganga. A detailed survey of the ichthyofauna was carried out in the river course and in the tributaries of these rivers to know the composition, abundance and distribution of fish. Every year Keoladeo National Park gets water as well as millions of fry from these rivers and the piscivorous birds mainly depend upon this fry input. The study showed that, even though both the rivers are non-perennial, Gambhir has a number of perennial pools in the river course and also in the tributaries. Conservation of these perennial pools is very essential to get sufficient fish fry to the Park. In spite of that, several bunds are constructed and they are extensively used for reservoir fisheries. The perennial pools and the reservoirs are the main source of fry to the Park.

During the survey, samples were collected from 27 sites from Banganga-Gambhir river system and another three from Chambal. A total of 46 species were recorded, out of which 41 species were recorded from Banganga-Gambhir river system. Compared to Banganga, more species were recorded from Gambhir. It may be due to the direct connection of this river with Yamuna. Further analysis of the data from Gambhir showed that half of the species were uniformly distributed and the other half were site specific, which include the rare species also. The rarest species were *Notopterus chitala*, *Labeo dyochilus*, *Lepidocephalichthys guntea*, *Pseudeutropis atherinoides*, *Danio devario*, etc. *Aplocheilichthys panchax* and *Labeo boggut* were only recorded from Banganga. Air-breathing fishes were also recorded during the collection; however, their number was very less.

INTRODUCTION

Keoladeo National Park, Bharatpur supports more than 40 species of piscivorous birds which are recorded in thousands during the peak season. Apart from the birds, terrapins, otters and fishing cats also consume a portion of the fish. To support these high trophic level species, a large quantity of fish is required every year.

Yearly, millions of fry (as many as 65 million in 1985, Vijayan 1986) and adults of small size fish or larval fish (e.g. *Oxygaster clupeioides*, *Chanda nama* and *Puntius sophore*) enter the park along with the inflowing water. The recruitment of fry showed that all the non-airbreathers enter the Park from outside; this constitutes a major portion of the total fish population in the Park (Kumar 1991). Therefore, the outside source of fish is vital for the proper functioning of the park ecosystem. The breeding of all the fish-eating birds depends on the timely arrival of fish from outside. An examination of the source of fish was therefore undertaken.

The Park receives water from Ajan bund, a temporary reservoir situated 500 m from the Park's border. And the Ajan bund in turn

¹Accepted June 1994.

²Bombay Natural History Society, Hornbill House, Dr. Salim Ali Chowk, Shaheed Bhagat Singh Marg, Bombay 400 023.

³Salim Ali Centre for Ornithology and Natural History, Kalampalayam P.O., Coimbatore 641 010.

⁴Department of Zoology, D.A.V. College, Kanpur.

receives water mainly from the two non-perennial rivers Gambhir and Banganga. As these rivers dry up every year, the following questions arise:

1. Where does the fish stock remain when the rivers dry up? or where do fish breed to provide fry to the park during monsoon?
2. What is the nature of distribution of fishes along the river course?
3. Is there any similarity between the fish fauna of the river and that of the Park?

To tackle these questions, an exhaustive survey was carried out during May-June 1989. Both the rivers were covered from their origin to the termination point.

METHODOLOGY

Samples were collected from the water bodies in the river course as well as their tributaries including the dams and bunds. Collections were carried out using cast net of smallest mesh size (15 mm) and seine of mosquito net of 40 metre length and 1.5 metre height with floats and sinkers. Fish samples were also collected from commercial catch in the reservoirs done under the control of Fisheries Department.

A uniform catch effort was maintained to minimise bias. The various collection points are shown in Fig. 1.

RESULTS AND DISCUSSION

Gambhir river: This non-perennial river originates from Karauli hills of Sawai Madhopur district and after flowing 280 km in Rajasthan, ultimately joins river Yamuna in U.P. The river bed is clayey, alluvial and deep. There are deep ravines, especially upstream near Hindon and also where it joins Yamuna near Fathehabad.

The largest dam right across the river is Panchna near Karauli, where five small rivers unite to form Gambhir. A number of small and medium-sized dams have been constructed across the tributaries of Gambhir such as Urmila Sagar bund, Bund Bareta, Parvati dam, Bhandua and Jagar. These bunds are extensively used for reservoir fisheries by the State Fisheries Department. Every year the department introduces major carp seed and auctions them in summer.

On its course, Gambhir often takes zig-zag turns so that deep pools are formed where fishes can survive in summer. One of the tributaries of Gambhir, Parvati, has a very long perennial water stretch up to the river Gambhir. According to the villagers, this water stretch does not dry up even in severe drought years. During the survey, we recorded deep water bodies, both lentic and lotic, in the river.

At Sevala Bareta, an obstruction has been constructed with sluice gates to block the water and direct it to Ajan bund through Pichuna canal. During heavy flood, water overflows the dam towards Yamuna.

The first series of collections were carried out along the course of river Gambhir.

Banganga: This is also a non-perennial river originating from Manoharpur near Ramgarh of Aravalli range in Jaipur district. This river is much wider, very sandy and without any ravines. In some places it is just a sandy depression and one can hardly make out the river course. After flowing 241 km in Jaipur and Bharatpur districts, it terminates at Maghpur head and from there canals supply water to the nearby areas, and one of them, Uchain canal, joins Ajan bund.

The biggest dam across this river is Jamwa Ramgarh near Jaipur and the smaller dams on the tributaries are Kalako, Bhandari and Senthali.

Aravalli, one of the oldest mountain ranges of the subcontinent and once the highest range,

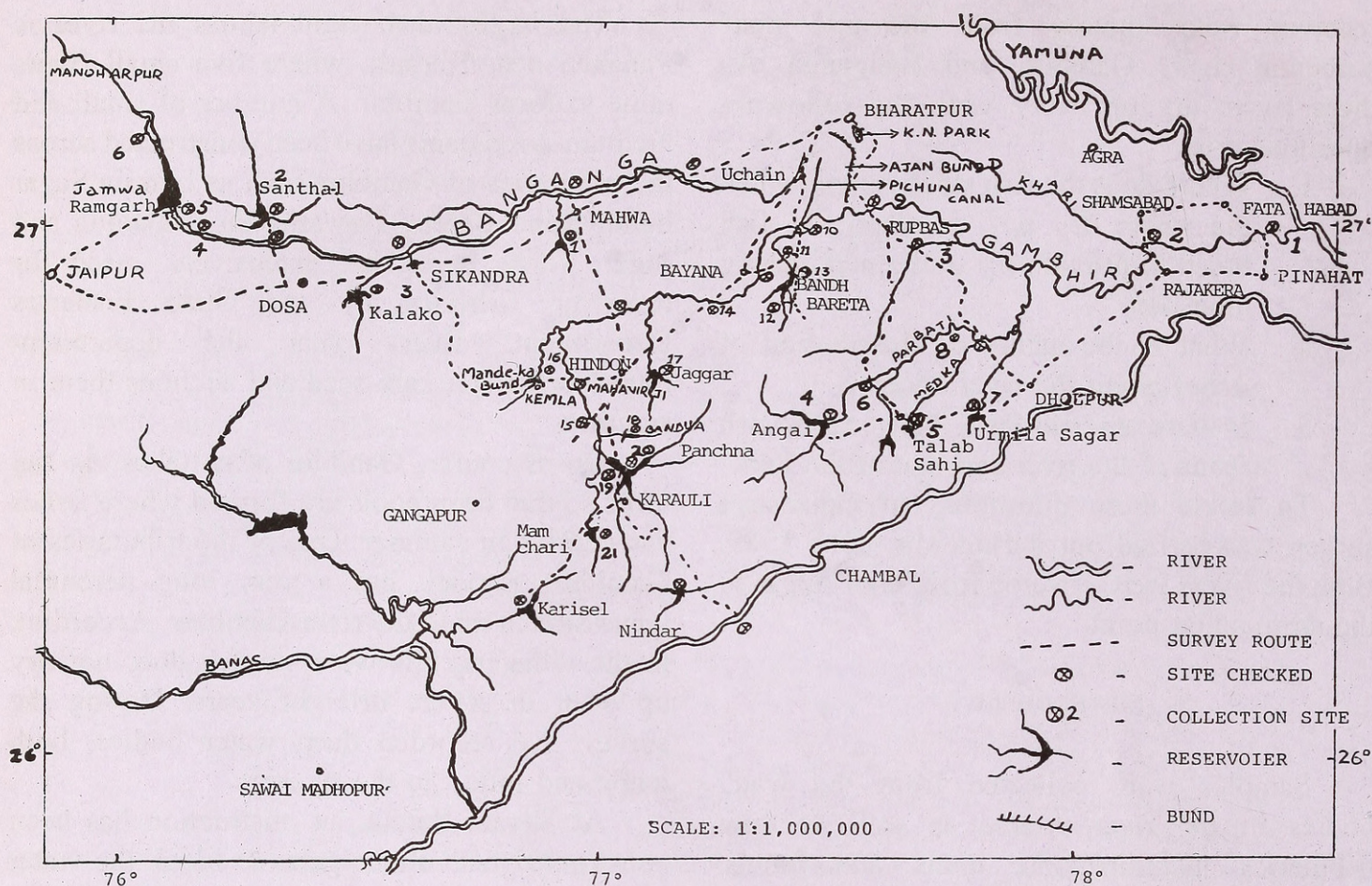


Fig. 1. Map showing the various sampling stations in the Banganga and Gambhir river system.

at earlier times would have blocked the monsoon clouds much more effectively than it does today to make the Banganga, a mighty river and it might have been connected either with Yamuna or Gambhir in geological time. The Gangetic plain rivers often change their courses and due to this, the river might have passed through the depression of the Keoladeo National Park.

Geomorphological study with the help of landsat imagery and aerial photographs of Gambhir river basin reveals the fluvial changes that have occurred during the quaternary period. The river Gambhir was once a major right bank tributary of the river Banganga which in turn was a major right bank tributary of Yamuna (Sharma 1986). Further detailed investigations

by Sharma (1986) along the middle and lower course of river Banganga and Gambhir show that in the recent past Banganga was a continuous stream flowing up to the Yamuna. But because of neotectonic activity around Bharatpur, the flow of Banganga river has been obstructed and now it is neither directly connected with Yamuna nor with Gambhir. Banganga is a mountain torrent with a bed of sand mixed with gravel in a semi-arid climatic condition. It, therefore, brings tremendous quantity of sediments from headwaters to the plains. In due course it got choked and became braided with a number of distributaries in this part of the land area. The neotectonic activity was re-activated on one hand and tremendous quantity of

sediments was deposited on the other hand, causing a saucer-shaped depression in Bharatpur region (Sharma 1986), and, this depression in Bharatpur is inadequate to allow a free flow of the river Banganga to join the river Yamuna. So during the period of high rainfall the area gets flooded. To control the flood and also to make use of water for agriculture, a skillful network of bunds was constructed several decades ago. The water thus contained by the dykes is gradually drained off and the land is used for raising the kharif crop. This system of irrigation is known as inundation irrigation (Anon. 1979). Ajan bund is considered to be the oldest such bund constructed somewhere between 1726-1763 (Gasquin 1927, Panday 1970). In early times, the water management was under the control of local rulers. Nowadays the Irrigation Department governs the distribution of water and supplies it to the park from Ajan bund.

The flat sandy nature of the river bed, the anthropogenic interferences as well as degradation of Aravalli might have contributed in many ways to erase the actual river course.

SURVEY DISCUSSION

During the survey, a total of 46 species of fish were recorded of which four species were from Chambal and one from a dam connected with the Chambal. They are *Barilius bola*, *Chagunius chagunius*, *Labeo boga* and *Puntius dorsalis* from Chambal and *Garra gotyla* from Needad dam. *Puntius dorsalis*, collected during the survey from Chambal was the first recorded by Datta Gupta *et al.* (1961) from Khetry, Jaipur or Udaipur. The exact place of the catch was not mentioned. It is included in the list of Datta and Majumdar (1970) and the subsequent faunal studies in Rajasthan (Dhawan 1969, Mathur and Yazdani 1970, 1973; Mahajan 1980, Sharma and Kulshreshtha 1981, Johal and Dhillon 1981, Sharma and Johal 1982, Johal and sharma 1986,

Gupta *et al.* 1988) did not mention this species. According to Jayaram (1981), it is a peninsular species.

Another important species recorded during the survey was *N. chitala* from Gambhir, just before its confluence with Yamuna in Uttar Pradesh. The only earlier record of this species was from Ajan bund near Bharatpur by Moona (1963). It is considered to be an endangered species (Menon 1987).

New addition to the fish fauna of Rajasthan: *Aplocheilus panchax* recorded from Banganga during the survey was a new addition to the fish fauna of Rajasthan. Even though this fish has a wide distribution in South Asia (Jayaram 1981), there was no record of this species from Rajasthan (Kumar and Asthana 1993). During this survey it was very frequently seen in Ramgarh area, upstream as well as downstream. *A. blochii* was recorded from Jodhpur by Mathur and Yazdani (1969).

Species richness and distribution of fishes in the rivers: Out of the total 46 species collected during the survey, 38 were recorded from Gambhir and 28 from Banganga (Tables 1 and 2). Connection of Gambhir with Yamuna may be one of the reasons for the higher richness of species in Gambhir than in Banganga. However, three species, namely *Aplocheilus panchax*, *Labeo boggut*, and *Channa striatus* were not observed in Gambhir.

Gambhir: Further analysis of the catch from the river Gambhir was carried out using SYSTAT software and a dendrogram was prepared (Fig. 2). An arbitrary line was drawn in the middle. The result shows that half of the species were distributed uniformly and these species were recorded in large numbers (Table 1 - e.g. *Cirrhinus reba*, *Labeo rohita*, *Puntius sophore*, *Osteobrama cotio*, *Salmostoma bacaila*, etc.). The other half were comparatively rare and site specific. Some of them were recorded mostly upstream, such as *Danio devario*, *Labeo*

TABLE 1
COLLECTION SITES AND SPECIES RECORDED IN GAMBHIR RIVER AND ITS TRIBUTARIES

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sampling sites																					
<i>Gudusia chapra</i>	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-
<i>Notopterus chitala</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Notopterus notopterus</i>	1	1	3	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-
<i>Chela cachius</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
<i>Salmostoma bacaila</i>	-	2	-	2	-	-	-	3	-	2	-	-	-	3	2	2	-	-	3	-	2
<i>Salmostoma phulo</i>	-	2	-	-	-	-	-	2	-	-	-	-	-	2	2	2	-	-	3	-	2
<i>Esomus danricus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
<i>Danio devario</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>Amblypharyngodon mola</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
<i>Puntius sarana</i>	-	-	-	1	-	-	-	-	-	-	-	1	2	1	1	-	-	1	-	-	1
<i>Puntius sophore</i>	2	2	3	2	-	-	3	3	-	2	2	2	-	2	2	3	2	1	-	2	2
<i>Puntius ticto</i>	1	1	-	-	-	-	-	2	-	1	-	-	-	-	1	-	-	-	-	-	2
<i>Osteobrama cotio</i>	3	3	3	3	-	3	-	-	3	2	-	3	-	-	2	-	-	-	-	2	-
<i>Labeo bata</i>	-	-	-	-	-	-	1	-	-	-	2	-	-	-	2	-	-	3	1	-	2
<i>Labeo calbasu</i>	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1
<i>Labeo dyocheilus</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
<i>Labeo gonius</i>	-	-	-	1	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1
<i>Labeo pangusia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
<i>Labeo rohita</i>	2	2	-	3	-	-	-	2	2	1	-	2	2	-	1	-	2	2	2	2	3
<i>Cirrhinus mrigala</i>	2	2	-	3	-	2	2	-	2	-	-	-	-	1	2	-	2	3	2	2	2

Table 1 (continued)

Species	Sampling sites																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
<i>Cirrhinus reba</i>	3	3	3	3	-	-	-	2	3	2	2	3	3	2	3	-	3	-	-	2	2
<i>Catla catla</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	2
<i>Noemacheilus botia</i>	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lepidocephalichthys guntea</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Mystus cavasius</i>	-	-	1	-	-	2	-	-	1	2	1	-	-	-	1	-	-	-	-	1	-
<i>Mystus vittatus</i>	1	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Mystus seenghala</i>	-	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-	2	-	2
<i>Ompok bimaculatus</i>	-	1	1	-	-	1	1	-	-	-	-	3	2	3	-	-	-	-	-	-	1
<i>Wallogo attu</i>	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
<i>Pseudotropius antherinoides</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
<i>Heteropneustes fossilis</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
<i>Xenentodon cancila</i>	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Channa marulius</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Channa punctatus</i>	1	-	-	1	2	-	1	1	-	-	-	-	-	-	-	3	-	-	-	-	-
<i>Chanda nama</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-
<i>Chanda ranga</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<i>Glossogobius giuris</i>	2	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Mastacembelus armatus</i>	-	1	-	2	-	-	1	-	-	1	-	2	-	-	1	-	1	-	1	-	1
Total species	12	13	7	16	4	6	8	10	6	10	7	9	6	11	13	6	7	7	12	9	18

- absent 1 = rare 2 = common 3 = dominant

Site 1: Gambhir just before joining with Yamuna; Site 2: Gambhir river (next to the point where the tributary Khari joins Gambhir); Site 3: River Kagwar; Site 4: Parvati or Angai dam; Site 5: Talab Sahi; Site 6: 15 km away from Sepu in Parvati river; Site 7: Urmila Sagar; Site 8: Second site in river Parvati; Site 9: 5 km before Rubas; Site 10: Sevala Baretta; Site 11: Near Supa bridge (Kakund nadi 10 km from Baretta dam); Site 12: Dar (upstream of Baretta); Site 13: Bund Baretta; Site 14: Samovar bridge (between Bayana and Hindon); Site 15: Katkar; Site 16: Mandai-ka-Bund; Site 17: Jagar Bund; Site 18: Bandua Bund (Jagar to Karouli) 17 km to Karouli; Site 19: Panchna dam; Site 20: Near Panchna bridge; Site 21: Mamchhari Bund (13 km south-west of Karouli).

Single Linkage Method (Nearest Neighbour) Tree Diagram
Distances Metric is Euclidean distance.

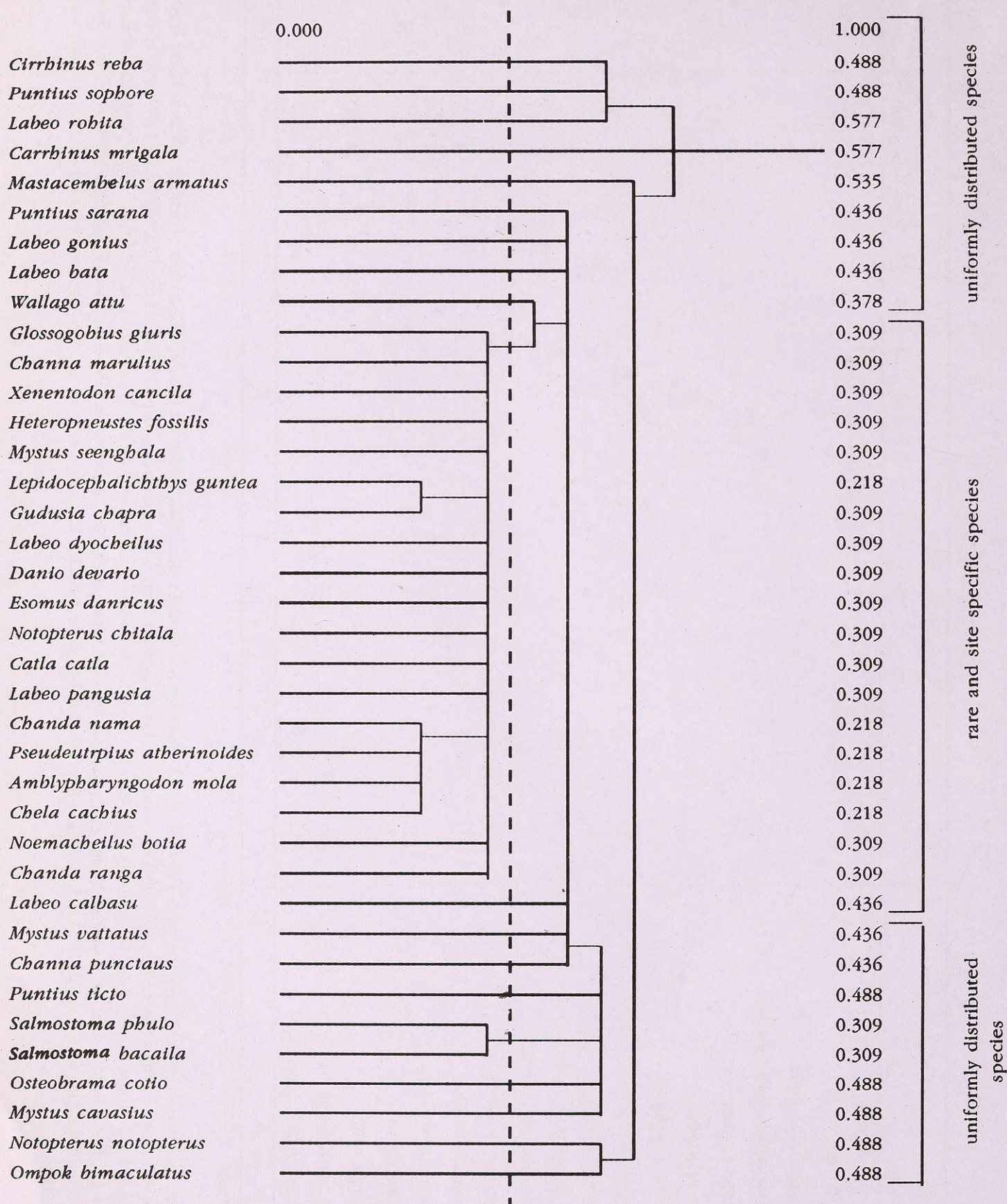


Fig. 2. Dendrogram showing the two main groups of species in Gambhir river.

TABLE 2
COLLECTION SITES AND SPECIES RECORDED IN BANGANGA RIVER AND ITS TRIBUTARIES

Species	Sampling sites					
	1	2	3	4	5	6
<i>Notopterus notopterus</i>	-	1	1	-	-	-
<i>Salmostoma bacaila</i>	2	-	3	-	-	-
<i>Salmostoma phulo</i>	2	-	3	-	-	-
<i>Esomus danricus</i>	-	-	-	3	-	-
<i>Danio devario</i>	-	-	-	-	2	-
<i>Amblypharyngodon mola</i>	-	3	3	-	-	2
<i>Puntius sarana</i>	1	1	-	-	-	-
<i>Puntius sophore</i>	-	-	-	2	2	3
<i>Puntius ticto</i>	-	-	-	2	-	2
<i>Osteobrama cotio</i>	3	3	2	-	-	-
<i>Labeo bata</i>	-	-	-	2	2	-
<i>Labeo calbasu</i>	1	1	1	-	1	-
<i>Labeo rohita</i>	2	-	-	-	-	-
<i>Cirrhinus mrigala</i>	2	2	-	-	2	-
<i>Cirrhinus reba</i>	2	2	2	3	2	-
<i>Catla catla</i>	-	2	-	-	-	-
<i>Mystus cavasius</i>	-	1	-	-	-	-
<i>Mystus vittatus</i>	-	-	-	1	1	-
<i>Mystus seenghala</i>	-	1	-	-	-	-
<i>Ompok bimaculatus</i>	-	1	-	-	1	-
<i>Wallago attu</i>	-	1	-	-	-	-
<i>Channa marulius</i>	-	1	-	-	-	-
<i>Channa punctatus</i>	1	1	-	1	1	-
<i>Channa striatus</i>	1	-	-	-	-	-
<i>Glossogobius giuris</i>	1	-	-	-	-	-
<i>Mastacembelus armatus</i>	1	3	-	-	-	-
<i>Aplocheilichthys panchax</i>	-	-	-	-	2	2
<i>Labeo boggut</i>	-	-	-	-	1	-
Total species	12	15	7	7	11	4
	*	*	*		*	

- = absent 1 = rare 2 = common 3 = dominant * = dam

Site 1: Bhandari bund; Site 2 : Senthai bund; Site 3: Kalako bund; Site 4: Downstream of Banganga; Site 5: Jamva Ramgarh; Site 6: Upstream of Ramgarh

pangusia, *Chela cachius*, *Catla catla* and *Esomus danricus*. Some other species such as *N. chitala*, *Guducia chapra*, *Xenentodon cancilla*, *Channa marulius*, etc. were downstream specific.

The most dominant recruiting species to the Park, such as *Puntius sophore*, *Cirrhinus reba*, *Salmostoma bacaila* (*Oxygaster bacaila*) and

Osteobrama cotio recorded during the survey had a wide distribution in the river course. Major carps such as *Cirrhinus mrigala* and *Labeo rohita* also had a wide distribution because of their introduction to reservoirs for commercial purpose. These widely distributed species enter the Park in large numbers when

water is drawn from these sources. *Chanda*, one of the major species that enters the Park, was confined to Panchna and Angai dams. It can, therefore, be concluded that the origin of most of the non-airbreathing species inside the Park is these dams and the pools in the river course. Because of large quantity of water present in reservoirs, more species were recorded in them particularly in Angai, Panchna and Mamchari, but in some reservoirs water depth was very low and so was the number of species.

Banganga: The river Banganga is not directly connected with Yamuna which may be one of the reasons for the fewer number of species in this river (Table 1). Yet another reason may be its possible sandy nature. During the flood period, indirect connection is possible through the flood water and also through the Ajan bund which is connected with both the rivers- Banganga and Gambhir. There was no perennial water body in the river course except a small stretch near Ramgarh and a pool upstream of Ramgarh. So the recruitment of fry from this river is only from the reservoirs.

Aplocheilus panchax, which was a new addition to the fish fauna of Rajasthan was restricted only to Ramgarh area. Among *Labeo* species *Labeo boggut* was recorded only from Ramgarh area and not from Gambhir. The species such as *Gudusia chapra*, *Notopterus* sp., *Chela cachius*, *Labeo dyocheilus*, *Labeo gonius*, *Labeo pungusia*, *Noemacheilus botia*, *Lepidocephalichthys guntea*, *Pseudeutropius atherinoides*, *Heteropneustes fossilis*, *Xenentodon cancila*, and *Chanda* spp. were not recorded from river Banganga.

Fish stock: A large number of small and large dams have been constructed across the tributaries of both Banganga and Gambhir for irrigation as well as for drinking water. Almost all these dams are used for reservoir fisheries by the State Fisheries Department. Major carps are

being introduced in these reservoirs every year by the Department.

In addition to the perennial reservoirs, a number of deep pools and small stretches of water are present on the course of river Gambhir and the river bed is more alluvial. Important among them (upstream to Bharatpur) are near Sevla Bareta, Supa bridge, Samover bridge and at Katkar. Downstream to Bharatpur are collection site 6 and 8 in Parvati and 9, 2 and 1 in the river course of Gambhir. These pools provide habitat for the fish stock to survive the summer and breed during the monsoon. Almost all fishes, mainly the small ones, captured in these pools were in breeding stage. Conservation of these perennial pools is very essential to get sufficient fish fry to the Park.

In the reservoirs, small as well as large commercial species were abundant. In some reservoirs autostocking is also reported. When water is released from these reservoirs the fishes get into the river and disperse. Hence these pools and reservoirs are the main source of fish to the Ajan bund and thereby to the Park. Another possible source is that when Gambhir joins Yamuna during high discharge, there is a chance of upstream movement of fishes to Gambhir because of the tendency of fish to move against the current.

Several species which were not reported from the Park were collected during the survey such as *Labeo pungucia*, *L. dyocheilus*, *L. boggut*, *Notopterus notopterus* and *Aplocheilus panchax* (Kumar and Vijayan 1988), although their number was very low. Such rarity may be one of the reasons for the non-availability of these fishes and their fry in the Park.

Even though there are air-breathing fishes in some of the reservoirs such as Angai dam, Talab sahi, Urmila sagar, and Manda-ka-bund, they are very rare in the river course. Air breathers are not riverine species.

ACKNOWLEDGEMENTS

This study was an offshoot of the Keoladeo National Park Ecology Project taken up by Bombay Natural History Society, sponsored by US Fish & Wildlife Service through the Ministry of Environment and Forests, Government of India. We are grateful to Dr. V.S. Vijayan, Project Scientist, for his guidance and suggestions during the study, to Dr. A.G.K. Menon, Zoological Survey of India for

confirmation of species, and to Rajasthan State Fisheries Department officials for giving permission and assistance to make collections. Discussions with Dr. Neil Armentrout, US Fish & Wildlife Service, Dr. U.K. Gopalan, National Institute of Oceanography, Cochin are acknowledged. We express our gratitude to Dr. P.A. Azeez, Mr. N.R. Nadarajan and K.N. Mohanan for their help in various ways and are also thankful to Mr. Rajpal and the other local assistants for their help during the survey.

REFERENCES

- ANON. (1979): Master plan for flood control works in Bharatpur District. First draft. Report No. 1. Irrigation Dept., Bharatpur.
- DATTA, A.K. & N. MAJUMDAR (1970): Fauna of Rajasthan, India. Part 7. Fishes. *Rec. Zool. Surv. India*. 62 (1-2): 63-100.
- DATTA GUPTA, A.K., P.K.B. MENON, C.K.G. NAIR & C.R. DAS (1961): An annotated list of fishes of Rajasthan. *Proc. Rajasthan Acad. Sci. Pilani*. 8(1 & 2): 129-134.
- DHAWAN, S. (1969): Fish Fauna of Udaipur Lake. *J. Bombay nat. Hist. Soc.* 66: 190-194.
- GASQUIN, H.S. (1927): Record of Irrigation by bunds and canals in the Bharatpur State - during the year 1896-97 to 1925-26. Irrigation Dept., Bharatpur.
- GUPTA, S.N., V.S. DURVE, S.D. KULSHRESHTHA & N.K. SHARMA (1988): Limnology, fisheries and conservation needs of tank Khandia, Jhalawar. *Pro. Nat. Sym. Present and Future of Bhopal Lake*. 91-96.
- JAYARAM, K.C. (1981): The fresh water fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. Zoological Survey of India, Calcutta.
- JOHAL, M.S. & K.S. DHILLON (1981): Ichthyofauna of Ganganagar district (Rajasthan), India. *Res. Bull. Punjab Uni.* 32: 105-107.
- JOHAL, M.S. & K.P. SHARMA (1986): Fish fauna of Sawai Madhopur district, Rajasthan State, India. *Vest. cs. spolec. zool.* 50: 112-119.
- KUMAR, C.R.A. (1991): Habitat segregation of fishes in Keoladeo National Park, Bharatpur, Rajasthan. Ph D. Thesis. Kanpur University, Kanpur.
- KUMAR, C.R.A. & A. ASTHANA (1993): The fish fauna of Rajasthan. *Indian Rev. Life Sci.* 13: 133-148.
- KUMAR, C.R.A. & V.S. VIJAYAN (1988): On the fish fauna of Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc.* 85(1): 44-49.
- MAHAJAN, C.L. (1980): Effect of human activities on the structure and functioning of fresh water ecosystem of Ghana Bird Sanctuary, Bharatpur and Ramgarh Lake, Jaipur, Rajasthan. A preliminary report on the Man and Biosphere Project (1976-77). Department of Science and Technology. Govt. of India.
- MATHUR, D.S. & G.M. YAZDANI (1969): Occurrence of *Aplocheilichthys blochii* (Arnold) in Rajasthan. *Lab. dev. J. Sci. and Tech. B*, 7(1): 77.
- MATHUR, D.S. & G.M. YAZDANI (1970): *Noemacheilus rajasthanensis*, a new species of roach from Rajasthan (India). *J. Zool. Soc. India* 22: 79-100.
- MATHUR, D.S. & G.M. YAZDANI (1973): Additional records of fishes from Jodhpur with a list of species occur in the district. *Sci. & Cul.* 39(2): 87-89.
- MENON, A.G.K. (1987): Rare and endangered Indian freshwater fishes. In abstract: Symposium on the impact of current land use pattern and water resources development on riverine fisheries. C.I.C.F.R.I. Barrackpore.
- MOONA, J.C. (1963): Notes on fishes from Bharatpur district, Rajasthan. *Rec. Indian Mus. Delhi* 58(2): 56-66.
- PANDAY, R. (1970): Bharatpur up to 1826 (A special and political history of Jat). Rama Publishing House, Jaipur.
- SHARMA, K.P. & M.S. JOHAL (1982): On the fish and fisheries of Jaisamand Lake. Rajasthan, India. *Vest. cs. spolec. zool.* 64: 56-69.
- SHARMA, K.P. & S.D. KULSHRESHTHA (1981): Fishes and fisheries of Kota district, Rajasthan. *J. Zool. Soc. India* 33(1 & 3): 63-70.
- SHARMA, M.L. (1986): Geomorphology of a semi-arid region - A case study of Gambhir river basin, Rajasthan - India. Scientific Publishers, Jodhpur.
- VIJAYAN, V.S. (1986): Keoladeo National Park ecology study. Summary report 1980-1985. Bombay Natural History Society, Bombay.



Ajith Kumar, C. R., Ramachandran, N K, and Asthana, Arun. 1995.
"Composition, abundance and distribution of fish in Banganga-Gambhir river system and source of fish to the Keoladeo National Park, Bharatpur." *The journal of the Bombay Natural History Society* 92, 30–39.

View This Item Online: <https://www.biodiversitylibrary.org/item/189744>

Permalink: <https://www.biodiversitylibrary.org/partpdf/156120>

Holding Institution

Smithsonian Libraries and Archives

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: In Copyright. Digitized with the permission of the rights holder

License: <http://creativecommons.org/licenses/by-nc/3.0/>

Rights: <https://www.biodiversitylibrary.org/permissions/>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.