

## Journal of Coastal Life Medicine

journal homepage: www.jclmm.com



Document heading

doi:10.12980/JCLM.1.20133D130

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## A review of Monogenean diversity in India: Pathogens of fish diseases

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## PEER REVIEW

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## Comments

Authors studying monogenean infections of freshwater fishes in the five major water basins of India collected data from the available specific literature and illustrated them in separate tables. These data are useful for other researchers who want to work on monogeneans in India and elsewhere.

Details on Page 167

## ABSTRACT

The monogeneans parasitizing skin, fins, gills of fishes and are pathogenic to cultivated fish and a few have caused epizootic events. This paper presents a catalogue of known species of the class monogenea from the freshwater fishes of five major river systems of India. Data is gathered from all the published records of monogenean species from India and also from NCBI database for molecular studies, including the fish data gathered from Fishbase. Approximately 50 families of freshwater fishes have been reported from five Indian major river systems, having 159 nominal genera. As far as freshwater monogeneans are concerned about, 14 families having 44 genera and 208 species have been reported. In all, the present study takes a broad look at monogenean diversity in the freshwater fishes of India. The available information indicates the rich diversity of these parasites in India for that an integrated approach is necessary which should start with morphological characterization followed by molecular characterization of monogenean parasites in all river system of India. So that subsequent comparison of monogenean fauna present in different river systems of India can be made.

## KEYWORDS

Monogenea, Freshwater, Molecular biology, India

## 1. Introduction

The earth has its variety of life and biological diversity which is commonly referred as biodiversity. Generally, in recent past, interest in biodiversity has grown rapidly. Biodiversity, defined as the number and variety of organisms living within a specific geographical region and is essential for stability of ecosystems, protection of environment and understanding the intrinsic value of various species on earth<sup>[1]</sup>. Parasites, which are estimated to constitute more than half of the biodiversity<sup>[2]</sup> are the core of biodiversity surveys and ecosystem function. Parasites use to represent a

neglected component of diversity because of they are small, hidden on or within their hosts and need more careful observation to be identified with accuracy. The diversity and ecology of many groups of parasites is poorly known<sup>[3,4]</sup>. In the present study, an attempt to evaluate the state of art known about the monogenean fauna parasitic in freshwater fishes of India.

Class Monogenea is a group of parasitic worms commonly found on fishes. These parasites feed on mucus and epithelial cells of the skin and gills and sometimes on the blood. These parasites found in both captive and wild fishes and caused excessive mortalities. It is known that

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Foundation Project: Partially supported by grants from the UGC (University Grants Commission), India, under the Post Doctoral Fellowship to AC [No. F. 15-191/12(SA-II)]; under the Junior Research Fellowship (RGF) to CV [No. F. 14-2(SC)/2010(SA-III)] and by the Uttar Pradesh Government, Centre of Excellence, India, to HSS, wide project number [No.1486/70-4-2011-46(43)/2010].

## Article history:

Received 25 Jun 2013

Received in revised form 5 Jul, 2nd revised form 15 Jul, 3rd revised form 20 Jul 2013

Accepted 20 Aug 2013

Available online 28 Sep 2013

after hatching these parasites fastly try to find a host fish and this is easy for them when the fishes are in captive and crowded conditions where they have no problem in findings the host. Monogeneans have a haptor at their posterior end, it has hooks that helps them to attached to their host. These parasites have a direct life cycle, which helps them to go directly from one host to another. This attempt, has also been made to estimate the extent of our current knowledge in comparison to a total, exhaustive inventory of the monogenean fauna. Diseases borned by the parasite are the most important factor which threatened the fishery industry worldwide[5] and India is not exception to this. Monogenean parasites infect freshwater fishes are one of the major group of parasites that often cause diseases worldwide[6]. Helminth parasites beside being important for causing fish diseases but also because they are an essential and integral component of global biodiversity[3]. As parasites of fish including monogeneans, according to a rough estimate about 30000 helminth species have been documented worldwide. Monogeneans are the most ubiquitous and abundant group of parasites in the aquatic environment and predominantly ectoparasitic on gills and skin of fishes[7]. During course of their evolution, however a few species become endoparasitic by inhabiting the palleal cavity of cephalopods, urinary bladder and rectum of amphibians and reptiles, eye and nasal cavities of amphibious mammals[8]. These helminthes use to feed on blood and/or epithelial cells and mucus of fish causing direct piscine loss due to morbidity and mortality[9,10]. This becomes more severe when they invade younger fishes in intensive culture conditions[11].

Moreover, monogenean infection also lead to indirect damage, making the fishes more susceptible to secondary infections by degrade and break the epithelium and mucous layer[12]. As far as economic affects of monogenean infestation is concern, it includes decrease or rejection of edible fish products leading to subsequent loss of interest in the aquaculture practice[13]. During heavy infections of monogeneans it was found that the fish died which may significant damage and mortality. Some symptoms of heavily infected fish are: rubbing on objects in tank; erratic swimming, hanging near water surface; gills flared, mouth open, irregular opercular beat; squirting water, or coughing in order to back-flush gills; not eating, decrease in weight; lethargic, cloudy eyes; damaged or frayed fins, scaleless, skin may vary in color where the parasites have fed; patches and open wounds may appear on skin.

Some skin and gill infections illustrate that situation, such as the ichthyophthiriosis produced by the ciliate *Ichthyophthirius multifiliis*[14–16].

In India, studies related to biodiversity of helminthes (excluding monogeneans) were started from the middle of last century by workers who came to this subcontinent on medical or military deputation from foreign lands[17]. Susequently, diversity of helminthes parasites has been

documented from different parts of the country by helminthologists including: GD Bhalerao, GS Thapar, MN Datta, BS Chauhan, TD Soota, PD Gupta, HD Srivastava, CB Srivastava, SP Gupta, V Gupta, GB Shinde, G Premvati, NK Gupta, BL Kaw, SC Baugh, KC Pandey, Y Chaturvedi, M Hafeezullah, QH Baqri, RK Ghosh and MS Jayrajpuri. Most of these workers studied and described new taxa, however, a few publications also dealt with ecological aspects, life cycle, pathology and control. As far as biodiversity studies related to Indian monogeneans is concerned, it begun in fourth decade of 19th century by workers like BS Chauhan, GS Thapar, SL Jain, RV Unnithan, SP Gupta, NK Gupta, GP Agarwal, K Ramalingam, YR Tripathi, AV Gussev, KC Pandey, N Agrawal and HS Singh. Recently, compiled a comprehensive account of known nominal species of monogeneans is to be about 300 which is far from complete[18].

Here we would like to provide additional information about known monogenean parasites harboring the freshwater fishes of India. The principle objective of this paper is found out the lacunae existing in biodiversity studies of freshwater monogeneans in Indian subcontinent. Beside this, the present study brings together all monogenean parasitizing freshwater fishes from the five major river systems of India and also to provide molecular biological data available on freshwater monogeneans from this subcontinent.

## 2. Five major river system of India

There are five major river systems of India viz., Ganga, Brahmaputra, Indus, East coast and West coast. These rivers are long and are joined by many large and important tributaries. Besides this, many small seasonal and perennial rivers also use to contribute to these river systems separately (Figure 1).

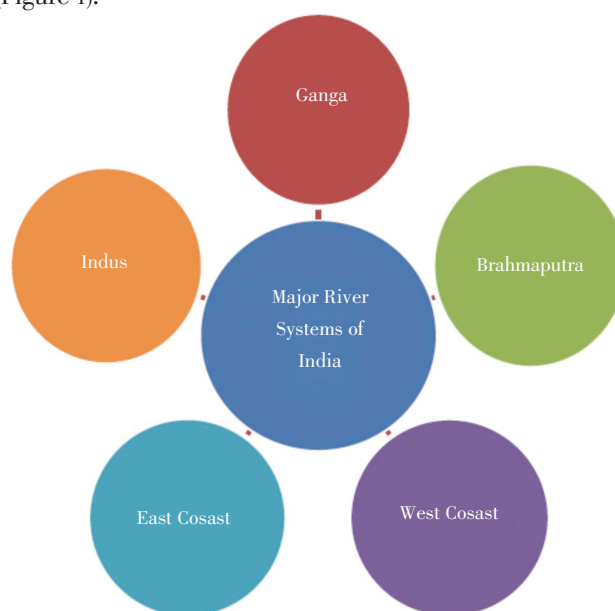


Figure 1. Five major river systems of Indian region.

### 2.1. Ganga River system

The Ganga and its major tributaries like Yamuna, Son and Gandak actually formulates the biggest cultivable plains of north and eastern India, known as the Gangetic plains. The Bhagirathi, which is considered the Ganga's true source, starts from Gomukh Gangotri glaciers in the Himalayas and flows through the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. Subsequently, it enters in Bangladesh and known as the Padma River.

### 2.2. Brahmaputra River system

Originates in China, near the sources of the Indus and the Sutlej, where it is known as the Yarlung Zangbo River or Tsangpo. It flows east, parallel to the Himalayas, reaches Namjagbarwa, turns south and enters India in Arunachal Pradesh, where it is known as Dihang. In Assam, it is called the Brahmaputra and just before entering Bangladesh it splits into two distributaries.

### 2.3. Indus River system

The Indus River originates in the northern slopes of Kailash range near Lake Mansarovar in Tibet. Although, most of the river's course runs through neighbouring Pakistan, a portion of it does run through Indian territory and has five tributaries.

### 2.4. East coast

East coast river system includes Godavari, often referred to as the Vriddh Dakshin Ganga. It arises at Tryambakeshwar, near Nasik and Mumbai in Maharashtra around 380 km distance from the Arabian Sea, and empties into the Bay of Bengal. It also includes the Krishna which originates at Mahabaleswar in Maharashtra and meets the sea in the Bay of Bengal at Hamasaladeevi in Andhra Pradesh. The Krishna River flows through the states of Maharashtra, Karnataka and Andhra Pradesh. East coast river system also has the Kaveri that headwaters are in the Western Ghats range of Karnataka state, and from Karnataka through Tamil Nadu and empties into the Bay of Bengal.

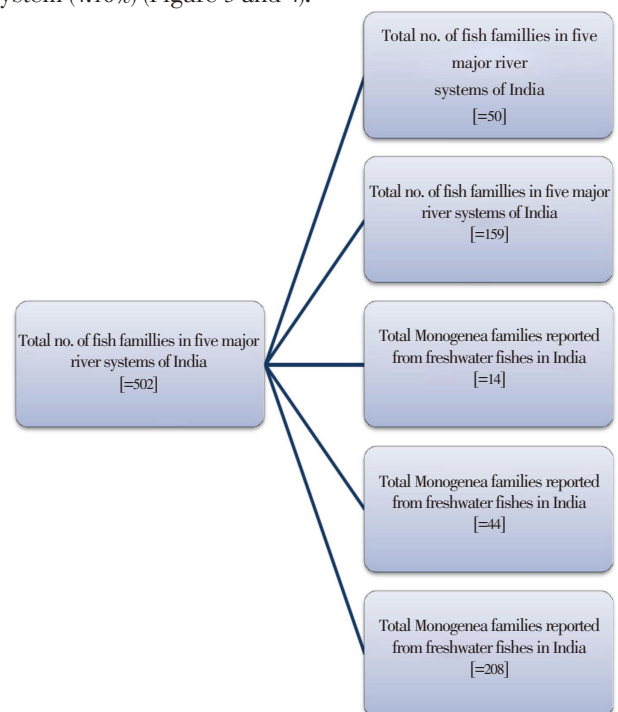
### 2.5. West Coast

The main water divide in peninsular rivers is formed by the Western Ghats, which run from north to south close to the western coast. Most of the major rivers of the peninsula such as the Narmada or Nerbudda is a river in central India and originates in Amarkantak. The Tapi is one of the major rivers of peninsular India rises in the eastern Satpura Range of southern Madhya Pradesh state, before emptying into the

Gulf of Cambay of the Arabian Sea, in the State of Gujarat.

## 3. Host and parasites

From India, total 50 families of freshwater fishes from five major river systems are found having 159 nominal genera. From these genera, only 14 families which belong to 44 genera of freshwater monogeneans were reported (Table 1 and Figure 2). The present study takes a broad look at monogenean diversity in the fishes of five major river systems of India in order to determine the status of monogenean diversity. The study reveals that approximately 35.45% fishes have so far been investigated for monogenean infection in general and still 74% are remaining that are not screened. As far as investigations related to five different major river systems are concerned, the data is presented in the form of table and figure (Table 2). The data shows that in India, not a significant number of host species have been studied for monogeneans. The maximum screening has been made in Ganges river system *i.e.* 62.25% followed by East coast river system (34.37%), Indus river system (17.18%), Brahmaputra river system (16.50%) and West coast river system (4.16%) (Figure 3 and 4).



**Figure 2.** Flow chart showed the total number of fish and parasites in five freshwater systems of India.

**Table 2**

Status of screened fishes in five major river systems of India.

| Major river system | Total fish fauna | Screened fish | % Screened |
|--------------------|------------------|---------------|------------|
| Ganga              | 151              | 94            | 62.25      |
| Brahmaputra        | 103              | 17            | 16.50      |
| Indus              | 64               | 11            | 17.18      |
| East coast         | 160              | 55            | 34.37      |
| West Coast         | 24               | 1             | 4.16       |

**Table 1**

List of monogeneans, their host from five major river systems of India.

| Fish                           | Fish family     | Monogenea  | Monogenea family  |
|--------------------------------|-----------------|--|---|
| <b>I. Ganga River System</b>   |                 |  |   |
| <i>Acanthocobitis botia</i>    | Balitoridae     | –  | –   |
| <i>Ailia coila</i>             | Schilbeidae     | –  | –   |
| <i>Ailia punctata</i>          | Schilbeidae     | –  | –   |
| <i>Anabas testudineus</i>      | Anabantidae     | <i>Trianchoratus agrawali</i><br><i>Trianchoratus karni</i>  | Dactylogyridae<br>Dactylogyridae  |
| <i>Anchoviella bataviensis</i> | Engraulidae     | <i>Engraulicola forcepopenis</i>   | Gastrocotylidae   |
| <i>Anguilla bengalensis</i>    | Anguillidae     | –  | –   |
| <i>Anodontostoma chacunda</i>  | Clupeidae       | <i>Neomazocraes anadontostomae</i>   | Mazocraeidae  |
| <i>Arius gagorides</i>         | Ariidae         | –  | –   |
| <i>Arius thunbergi</i>         | Ariidae         | <i>Chauhanellus alatus</i>   | Dactylogyridae  |
| <i>Aspidoparia morar</i>       | Cyprinidae      | <i>Labotrema aspidopariaii</i>   | Diplectanidae   |
| <i>Badis badis</i>             | Nandidae        | –  | –   |
| <i>Bagarius bagarius</i>       | Sisoridae       | <i>Bifurcophaptor giganticus</i><br><i>Bychowskyella bagariusi</i>   | Dactylogyridae<br>Dactylogyridae  |
| <i>Bagarius docmak</i>         | Sisoridae       | <i>Quadricanthus bagrae</i>  | Dactylogyridae  |
| <i>Bagarius dorsalis</i>       | Sisoridae       | <i>Dactylogyrides dorsali</i>  | Dactylogyridae  |
| <i>Bagarius yarrelli</i>       | Sisoridae       | –  | –   |
| <i>Barbus stigmatsemion</i>    | Cyprinidae      | <i>Dactylogyryus gussevi</i>   | Dactylogyridae  |
| <i>Barilius barna</i>          | Cyprinidae      | –  | –   |
| <i>Barilius shacra</i>         | Cyprinidae      | –  | –   |
| <i>Barilius tileo</i>          | Cyprinidae      | –  | –   |
| <i>Botia Dario</i>             | Cobitidae       | –  | –   |
| <i>Botia lohachata</i>         | Cobitidae       | –  | –   |
| <i>Callichrous malabaricus</i> | Siluridae       | <i>Thaparocleidus devraji</i>  | Dactylogyridae  |
| <i>Carassius auratus</i>       | Cyprinidae      | <i>Dactylogyryus inexpectatus</i>  | Dactylogyridae  |
| <i>Carassius species</i>       | Cyprinidae      | <i>Pellucidhaptor kritskyia</i>  | Dactylogyridae  |
| <i>Catla catla</i>             | Cyprinidae      | <i>Dactylogyryus kalyanensis</i><br><i>Diplozoon indicum</i><br><i>Dogielius catalius</i><br><i>Gyrodactylus elegans indicus</i><br><i>Paradactylogyryus catalius</i><br><i>Singhiogyryus exotica</i>                                  | Dactylogyridae<br>Diplozoidae<br>Dactylogyridae<br>Gyrodactylidae<br>Dactylogyridae<br>Dactylogyridae   |
| <i>Chacha chacha</i>           | Chacidae        | –  | –   |
| <i>Chanda baculis</i>          | Ambassidae      | <i>Chandacleidus lucknowensis</i><br><i>Chandacleidus saiensis</i>   | Dactylogyridae<br>Dactylogyridae  |
| <i>Chanda nama</i>             | Ambassidae      | <i>Chandacleidus saiensis</i><br><i>Chandacleidus lucknowensis</i><br><i>Chandacleidus recurvatus</i><br><i>Spicocleidus namae</i>   | Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae                                    |
| <i>Chanda ranga</i>            | Ambassidae      | <i>Chandacleidus recurvatus</i>  | Dactylogyridae  |
| <i>Channa gachua</i>           | Ophiocephalidae | <i>Gyrodactylus raipurensis</i>  | Gyrodactylidae  |
| <i>Channa marulius</i>         | Ophiocephalidae | –  | –   |
| <i>Channa orientalis</i>       | Ophiocephalidae | <i>Gyrodactylus raipurensis</i>  | Gyrodactylidae  |
| <i>Channa punctata</i>         | Ophiocephalidae | <i>Gyrodactylus hyderabadensis</i>   | Gyrodactylidae  |
| <i>Channa striatus</i>         | Ophiocephalidae | –  | –   |
| <i>Chagunius chagunio</i>      | Cyprinidae      | <i>Dactylogyryus chagunionis</i><br><i>Neodiplozoon barbi</i>  | Dactylogyridae<br>Diplozoidae   |
| <i>Chitala chitala</i>         | Notopteridae    | <i>Notopterodiscoides chitalai</i><br><i>Notopterodiscoides cirri</i><br><i>Notopterodiscoides indicus</i><br><i>Notopterodiscoides curviamulus</i><br><i>Notopterodiscoides lucknowensis</i><br><i>Pseudodiplectanum lucknowensis</i> | Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae<br>Diplectanidae |
| <i>Cirrhinus ariza</i>         | Cyprinidae      | <i>Dactylogyryus anchoracanthus</i><br><i>Dactylogyryus cirrhini</i><br><i>Dactylogyryus crucitrabus</i><br><i>Gyrodactylus elegans indicus</i>  | Dactylogyridae<br>Dactylogyridae<br>Dactylogyridae<br>Gyrodactylidae                                    |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                           | Fish family    | Monogenea                              | Monogenea family |
|--------------------------------|----------------|--|------------------|
| <i>Cirrhinus cirrhosus</i>     | Cyprinidae     | <i>Dactylogyrus chauhanus</i>          | Dactylogyridae   |
|                                |                | <i>Dactylogyrus mrigali</i>            | Dactylogyridae   |
|                                |                | <i>Dactylogyrus yogendrai</i>          | Dactylogyridae   |
|                                |                | <i>Gyrodactylus elegans indicus</i>    | Gyrodactylidae   |
|                                |                | <i>Mazocraes singhi</i>                | Mazocraeidae     |
| <i>Clarias batrachus</i>       | Clariidae      | <i>Hamatopeduncularia batrachi</i>     | Dactylogyridae   |
|                                |                | <i>Quadricanthus kobiensis</i>         | Dactylogyridae   |
| <i>Clarias fuscus</i>          | Clariidae      | <i>Quadricanthus kobiensis</i>         | Dactylogyridae   |
| <i>Clarias gariepinus</i>      | Clariidae      | <i>Quadricanthus bagrae</i>            | Dactylogyridae   |
|                                |                | <i>Quadricanthus clariadis</i>         | Dactylogyridae   |
| <i>Clupisoma garua</i>         | Schilbeidae    | <i>Bychowkyella gharui</i>             | Dactylogyridae   |
|                                |                | <i>Bychowkyella gussevi</i>            | Dactylogyridae   |
|                                |                | <i>Bychowkyella jaini</i>              | Dactylogyridae   |
|                                |                | <i>Bychowkyella pricei</i>             | Dactylogyridae   |
|                                |                | <i>Thaparocleidus indicus</i>          | Dactylogyridae   |
|                                |                | <i>Thaparocleidus seenghali</i>        | Dactylogyridae   |
|                                |                | <i>Thaparocleidus vaginalis</i>        | Dactylogyridae   |
| <i>Coius quadrifasciatus</i>   | Coiidae        | –                                      | –                |
| <i>Colisa fasciatus</i>        | Belontiidae    | <i>Gyrodactylus chauhani</i>           | Gyrodactylidae   |
|                                |                | <i>Gyrodactylus colisai</i>            | Gyrodactylidae   |
|                                |                | <i>Heteronchocleidus buschkieli</i>    | Dactylogyridae   |
|                                |                | <i>Heteronchocleidus colisai</i>       | Dactylogyridae   |
|                                |                | <i>Heteronchocleidus gracilis</i>      | Dactylogyridae   |
| <i>Colisa lalia</i>            | Belontiidae    | <i>Heteronchocleidus lucknowensis</i>  | Dactylogyridae   |
|                                |                | –                                      | –                |
|                                |                | –                                      | –                |
|                                |                | –                                      | –                |
|                                |                | –                                      | –                |
| <i>Crossocheilus latius</i>    | Cyprinidae     | –                                      | –                |
| <i>Ctenopharyngodon idella</i> | Cyprinidae     | <i>Dactylogyrus ctenopharyngodonis</i> | Dactylogyridae   |
| <i>Culaea inconstans</i>       | Gasterosteidae | <i>Dactylogyrus eucalius</i>           | Dactylogyridae   |
| <i>Cyprinus carpio</i>         | Cyprinidae     | <i>Dactylogyrus anchoratus</i>         | Dactylogyridae   |
| <i>Danio sp.</i>               | Cyprinidae     | <i>Dactylogyrus aequipinnati</i>       | Dactylogyridae   |
| <i>Erethistes pusillus</i>     | Erethistidae   | –                                      | –                |
| <i>Esomus danricus</i>         | Cyprinidae     | <i>Ancyrocephalus chakrabartii</i>     | Dactylogyridae   |
| <i>Eutropiichthys murius</i>   | Schilbeidae    | –                                      | –                |
| <i>Eutropiichthys vacha</i>    | Schilbeidae    | <i>Bychowkyella gharui</i>             | Dactylogyridae   |
|                                |                | <i>Bychowkyella gomia</i>              | Dactylogyridae   |
|                                |                | <i>Bychowkyella indica</i>             | Dactylogyridae   |
|                                |                | <i>Bychowkyella lucknowensis</i>       | Dactylogyridae   |
|                                |                | <i>Bychowkyella vacha</i>              | Dactylogyridae   |
|                                |                | <i>Thaparocleidus indicus</i>          | Dactylogyridae   |
|                                |                | <i>Thaparocleidus pangasi</i>          | Dactylogyridae   |
| <i>Thaparocleidus vachius</i>  | Dactylogyridae |  |                  |
| <i>Gagata cenia</i>            | Sisoridae      | –                                      | –                |
| <i>Gagata gagata</i>           | Sisoridae      | –                                      | –                |
| <i>Gagata sexualis</i>         | Sisoridae      | –                                      | –                |
| <i>Gagata youssoufi</i>        | Sisoridae      | –                                      | –                |
| <i>Gangra viridescens</i>      | Sisoridae      | –                                      | –                |
| <i>Garra gotyla</i>            | Cyprinidae     | <i>Labotrema rajendrai</i>             | Diplectanidae    |
| <i>Glossogobius giuris</i>     | Sisoridae      | <i>Dactylogyrus gobi</i>               | Dactylogyridae   |
|                                |                | <i>Dactylogyrus glossogobii</i>        | Dactylogyridae   |
|                                |                | <i>Dactylogyrus lali</i>               | Dactylogyridae   |
| <i>Gonialosa manmina</i>       | Clupeidae      | <i>Mazocraes gonialosae</i>            | Mazocraeidae     |
|                                |                | <i>Mazocraeoides gonialosae</i>        | Mazocraeidae     |
| <i>Glyptothorax lonah</i>      | Sisoridae      | –                                      | –                |
| <i>Glyptothorax stoliczkae</i> | Sisoridae      | –                                      | –                |
| <i>Gudusia chapra</i>          | Clupeidae      | –                                      | –                |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                           | Fish family      | Monogenea                                  | Monogenea family   |
|--------------------------------|------------------|--|--------------------|
| <i>Heteropneustes fossilis</i> | Heteropneustidae | <i>Bychowkyella fossilisi</i>              | Dactylogyridae     |
|                                |                  | <i>Gyrodactylus gussevi</i>                | Gyrodactylidae     |
|                                |                  | <i>Gyrodactylus neonephrotus malmbergi</i> | Gyrodactylidae     |
| <i>Ilisha megaloptera</i>      | Clupeidae        | –  | –                  |
| <i>Johnius coitor</i>          | Sciaenidae       | <i>Paramazocraes guptai</i>                | Mazocraeidae       |
| <i>Johnius gangeticus</i>      | Sciaenida        | –  | –                  |
| <i>Johnius ruber</i>           | Sciaenidae       | <i>Bilaterocotyle mamaevi</i>              | Allodiscocotylidae |
| <i>Labeo ariza</i>             | Cyprinidae       | –  | –                  |
| <i>Labeo bata</i>              | Cyprinidae       | <i>Dactylogyrus batae</i>                  | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus fotedari</i>               | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus lohanii</i>                | Dactylogyridae     |
|                                |                  | <i>Dogielius catalius</i>                  | Dactylogyridae     |
|                                |                  | <i>Gyrodactylus elegans indicus</i>        | Gyrodactylidae     |
|                                |                  | <i>Paradactylogyrus catalius</i>           | Dactylogyridae     |
|                                |                  | <i>Thaparogyrus lucknowius</i>             | Dactylogyridae     |
|                                |                  | –  | –                  |
| <i>Labeo boga</i>              | Cyprinidae       | –  | –                  |
| <i>Labeo calbasu</i>           | Cyprinidae       | <i>Dactylogyrus labei</i>                  | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus vicinus</i>                | Dactylogyridae     |
|                                |                  | <i>Paradactylogyrus catalius</i>           | Dactylogyridae     |
| <i>Labeo dero</i>              | Cyprinidae       | –  | –                  |
| <i>Labeo gonius</i>            | Cyprinidae       | <i>Dactylogyrus brevitubus</i>             | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus labei</i>                  | Dactylogyridae     |
|                                |                  | <i>Dogielius catalius</i>                  | Dactylogyridae     |
|                                |                  | <i>Paradactylogyrus catalius</i>           | Dactylogyridae     |
| <i>Labeo pangusia</i>          | Cyprinidae       | –  | –                  |
| <i>Labeo rohita</i>            | Cyprinidae       | <i>Dactylogyrus batae</i>                  | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus glossogobii</i>            | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus labei</i>                  | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus lohanii</i>                | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus speciosus</i>              | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus yogendrai</i>              | Dactylogyridae     |
|                                |                  | <i>Gyrodactylus elegans indicus</i>        | Dactylogyridae     |
|                                |                  | <i>Haploleidus vachi</i>                   | Dactylogyridae     |
|                                |                  | <i>Mazocraes mamaevi</i>                   | Mazocraeidae       |
|                                |                  | <i>Paradactylogyrus catalius</i>           | Dactylogyridae     |
|                                |                  | <i>Paramazocraes gorakhanati</i>           | Mazocraeidae       |
| <i>Lates calcarifer</i>        | Latidae          | <i>Laticola latesi</i>                     | Diplectanidae      |
| <i>Leognathus edentulus</i>    | Leiognathidae    | <i>Actinocleidus leiognathi</i>            | Dactylogyridae     |
| <i>Lepidocephalus guntea</i>   | Cobitidae        | –  | –                  |
| <i>Lutjanus johni</i>          | Lutjanidae       | <i>Ancyrocephalus johni</i>                | Dactylogyridae     |
| <i>Macrogathus aculeatus</i>   | Mastacembalidae  | <i>Mastacembelocleidus bam</i>             | Dactylogyridae     |
|                                |                  | <i>Mastacembelocleidus indicus</i>         | Dactylogyridae     |
|                                |                  | <i>Mastacembelocleidus bam</i>             | Dactylogyridae     |
| <i>Macrogathus pancalus</i>    | Mastacembalidae  | <i>Mastacembelocleidus bam</i>             | Dactylogyridae     |
| <i>Mastacembalus armatus</i>   | Mastacembalidae  | <i>Mastacembelocleidus heteranchorus</i>   | Dactylogyridae     |
|                                |                  | <i>Mastacembelocleidus bam</i>             | Dactylogyridae     |
|                                |                  | <i>Mastacembelocleidus bam</i>             | Dactylogyridae     |
| <i>Morulius calbasu</i>        | Cyprinidae       | <i>Dactylogyrus calbasi</i>                | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus fotedari</i>               | Dactylogyridae     |
|                                |                  | <i>Dactylogyrus vicinus</i>                | Dactylogyridae     |
| <i>Mystus bleekeri</i>         | Bagridae         | <i>Cornudiscoides bleekerae</i>            | Dactylogyridae     |
|                                |                  | <i>Cornudiscoides geminus</i>              | Dactylogyridae     |
|                                |                  | <i>Cornudiscoides gussevi</i>              | Dactylogyridae     |
|                                |                  | <i>Cornudiscoides susanae</i>              | Dactylogyridae     |
|                                |                  | <i>Cornudiscoides tukarami</i>             | Dactylogyridae     |
|                                |                  | <i>Thaparocleidus pusillus</i>             | Dactylogyridae     |
| <i>Mystus gulio</i>            | Bagridae         | –  | –                  |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                             | Fish family     | Monogenea                              | Monogenea family |
|----------------------------------|-----------------|--|------------------|
| <i>Mystus keletius</i>           | Bagridae        | <i>Bifurcohaptor indicus</i>           | Dactylogyridae   |
| <i>Mystus nemurus</i>            | Bagridae        | <i>Bifurcohaptor indicus</i>           | Dactylogyridae   |
| <i>Mystus seenghala</i>          | Bagridae        | <i>Chauhanellus indicus</i>            | Dactylogyridae   |
| <i>Mystus tengara</i>            | Bagridae        | <i>Bifurcohaptor indicus</i>           | Dactylogyridae   |
|                                  |                 | <i>Chauhanellus indicus</i>            | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides megalorchis</i>     | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides proximus</i>        | Dactylogyridae   |
|                                  |                 | <i>Hematopeduncularia orientalis</i>   | Dactylogyridae   |
|                                  |                 | <i>Hematopeduncularia ritai</i>        | Dactylogyridae   |
|                                  |                 | <i>Neocalceostoma srivastavai</i>      | Calceostomatidae |
| <i>Mystus vittatus</i>           | Bagridae        | <i>Bifurcohaptor indicus</i>           | Dactylogyridae   |
|                                  |                 | <i>Bifurcohaptor indicus</i>           | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides agarwali</i>        | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides gontiai</i>         | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides kulkarnii</i>       | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides proximus</i>        | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides proximus</i>        | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides susanii</i>         | Dactylogyridae   |
|                                  |                 | <i>Cornudiscooides vittai</i>          | Dactylogyridae   |
|                                  |                 | <i>Gyrodactylus mizellei</i>           | Gyrodactylidae   |
|                                  |                 | <i>Thaparocleidus parvulus</i>         | Dactylogyridae   |
|                                  |                 | <i>Thaparocleidus pusillus</i>         | Dactylogyridae   |
| <i>Nandus nandus</i>             | Nandidae        | <i>Sundanonchus behuri</i>             | Dactylogyridae   |
| <i>Nangra carcharhinoides</i>    | Sisoridae       | <i>Cornudiscooides geminus</i>         | Dactylogyridae   |
| <i>Nangra nangra</i>             | Sisoridae       | –                                      | –                |
| <i>Naziritor chelynooides</i>    | Cyprinidae      | –                                      | –                |
| <i>Neolissochilus spinulosus</i> | Cyprinidae      | –                                      | –                |
| <i>Notopterus chitala</i>        | Notopteridae    | <i>Malyanodiscooides indicus</i>       | Dactylogyridae   |
|                                  |                 | <i>Notopterodiscooides curviamulus</i> | Dactylogyridae   |
|                                  |                 | <i>Notopterodiscooides notopterus</i>  | Dactylogyridae   |
| <i>Notopterus notopterus</i>     | Notopteridae    | <i>Malyanodiscooides indicus</i>       | Dactylogyridae   |
| <i>Ompok bimaculatus</i>         | Siluridae       | <i>Bychowskyella asiatica</i>          | Dactylogyridae   |
|                                  |                 | <i>Bychowskyella kanpurensis</i>       | Dactylogyridae   |
|                                  |                 | <i>Thaparocleidus malabaricus</i>      | Dactylogyridae   |
| <i>Ompok malabaricus</i>         | Siluridae       | <i>Thaparocleidus malabaricus</i>      | Dactylogyridae   |
| <i>Ompok pabda</i>               | Siluridae       | <i>Bychowskyella asiatica</i>          | Dactylogyridae   |
|                                  |                 | <i>Thaparocleidus octotylus</i>        | Dactylogyridae   |
| <i>Osteobrama cotio cotio</i>    | Cyprinidae      | <i>Dactylogyroides osteobramii</i>     | Dactylogyridae   |
| <i>Osteobrama cotio cunmo</i>    | Cyprinidae      | <i>Dactylogyrus cotius</i>             | Dactylogyridae   |
| <i>Otolithes argenteus</i>       | Sciaenidae      | <i>Diplectanidae tripathii</i>         | Diplectanidae    |
| <i>Otolithoides pama</i>         | Sciaenidae      | –                                      | –                |
| <i>Oxygaster bacaila</i>         | Cyprinidae      | <i>Dogielius indicus</i>               | Dactylogyridae   |
| <i>Pampus cinereus</i>           | Stromateidae    | <i>Bicotyle stromatea</i>              | Axinidae         |
| <i>Pangasius pangasius</i>       | Panagasiidae    | <i>Thaparocleidus pangasi</i>          | Dactylogyridae   |
| <i>Parambassis lal</i>           | Ambassidae      | –                                      | –                |
| <i>Pinniwallago kanpurensis</i>  | Siluridae       | –                                      | –                |
| <i>Platycephalus indicus</i>     | Platycephalidae | <i>Haliotrema indicum</i>              | Dactylogyridae   |
| <i>Poropuntius clavatus</i>      | Cyprinidae      | –                                      | –                |
| <i>Pristis microdon</i>          | Pristidae       | –                                      | –                |
| <i>Pseudechensis sulcata</i>     | Sisoridae       | –                                      | –                |
| <i>Psilorhynchus sucatio</i>     | Psilorhynchidae | –                                      | –                |
| <i>Pterocryptis gangetica</i>    | Siluridae       | –                                      | –                |
| <i>Puntius chola</i>             | Cyprinidae      | <i>Dactylogyroides mahecoli</i>        | Dactylogyridae   |
| <i>Puntius conchoniui</i>        | Cyprinidae      | –                                      | –                |
| <i>Puntius dorsalis</i>          | Cyprinidae      | <i>Dactylogyrus moorthyi</i>           | Dactylogyridae   |
|                                  |                 | <i>Dactylogyroides dorsali</i>         | Dactylogyridae   |
| <i>Puntius filamentous</i>       | Cyprinidae      | <i>Dactylogyroides mahecoli</i>        | Dactylogyridae   |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                                | Fish family | Monogenea                           | Monogenea family   |
|-------------------------------------|-------------|-------------------------------------|--------------------|
| <i>Puntius guganio</i>              | Cyprinidae  | –                                   | –                  |
| <i>Puntius sarana</i>               | Cyprinidae  | <i>Diplozoon indicum</i>            | Diplozoidae        |
| <i>Puntius sophore</i>              | Cyprinidae  | <i>Dactylogyroides longicirrus</i>  | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus angularis</i>       | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus brevitignus</i>     | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus indicus</i>         | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus longiacus</i>       | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus orientalis</i>      | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus subtilis</i>        | Dactylogyridae     |
|                                     |             | <i>Gyrodactylus punti</i>           | Gyrodactylidae     |
|                                     |             | <i>Gyrodactylus vivekanensis</i>    | Gyrodactylidae     |
| <i>Pseudotropius garua</i>          | Cichlidae   | <i>Thaparocleidus multispiralis</i> | Dactylogyridae     |
| <i>Puntius ticto</i>                | Cyprinidae  | <i>Dactylogyroides longicirrus</i>  | Dactylogyridae     |
|                                     |             | <i>Dactylogyroides tripathii</i>    | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus cauveryi</i>        | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus subtilis</i>        | Dactylogyridae     |
|                                     |             | <i>Gyrodactylus baughi</i>          | Gyrodactylidae     |
|                                     |             | <i>Gyrodactylus punti</i>           | Gyrodactylidae     |
| <i>Raiamas bola</i>                 | Cyprinidae  | <i>Dactylogyrus boli</i>            | Dactylogyridae     |
|                                     |             | <i>Diplozoon indicum</i>            | Diplozoidae        |
| <i>Rastrelliger kanagurata</i>      | Scombridae  | <i>Pricea fotedari</i>              | Gotocotylidae      |
| <i>Rhabdosargus sarba</i>           | Sparidae    | –                                   | –                  |
| <i>Rhinomugil corsula</i>           | Mugilidae   | <i>Yogendrotrema rajghatai</i>      | Microcotylidae     |
| <i>Rita gagra</i>                   | Bagridae    | <i>Diplectanum guptai</i>           | Diplectanidae      |
| <i>Rita rita</i>                    | Bagridae    | <i>Bychowskyella raipurensis</i>    | Dactylogyridae     |
|                                     |             | <i>Hematopeduncularia ritai</i>     | Dactylogyridae     |
|                                     |             | <i>Metahaliotrema srivastavai</i>   | Dactylogyridae     |
|                                     |             | <i>Thaparocleidus seenghali</i>     | Dactylogyridae     |
| <i>Salmostoma bacaila</i>           | Cyprinidae  | <i>Ancyrocephalus baughi</i>        | Dactylogyridae     |
|                                     |             | <i>Ancyrocephalus ghoshi</i>        | Dactylogyridae     |
|                                     |             | <i>Ancyrocephalus spiculus</i>      | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus anchoracanthus</i>  | Dactylogyridae     |
|                                     |             | <i>Dactylogyrus parvianchoris</i>   | Dactylogyridae     |
|                                     |             | <i>Diplozoon indicum</i>            | Diplozoidae        |
|                                     |             | <i>Dogielius lucknowensis</i>       | Dactylogyridae     |
| <i>Salmostoma phulo</i>             | Cyprinidae  | –                                   | –                  |
| <i>Salmostoma sardinella</i>        | Cyprinidae  | –                                   | –                  |
| <i>Schizothoraichthys progastus</i> | Cyprinidae  | –                                   | –                  |
| <i>Sciaena coiter</i>               | Sciaenidae  | <i>Bilaterocotyle lucknowensis</i>  | Allodiscocotylidae |
|                                     |             | <i>Bilaterocotyle mamaevi</i>       | Allodiscocotylidae |
|                                     |             | <i>Lobotrema kumari</i>             | Diplectanidae      |
|                                     |             | <i>Paramazocraes guptai</i>         | Dactylogyridae     |
|                                     |             | <i>Paramazocraes yogenderai</i>     | Dactylogyridae     |
| <i>Securicula gora</i>              | Cyprinidae  | <i>Heteromazocraes mamaevi</i>      | Mazocraeidae       |
| <i>Setipinna brevifilis</i>         | Engraulidae | –                                   | –                  |
| <i>Setipinna phasa</i>              | Engraulidae | <i>Heteromazocraes phasae</i>       | Mazocraeidae       |
| <i>Sicamugil cascasia</i>           | Mugilidae   | –                                   | –                  |
| <i>Silonia silondia</i>             | Schilbeidae | <i>Bychowskyella cauveryi</i>       | Dactylogyridae     |
|                                     |             | <i>Neocalceostoma microformis</i>   | Calceostomatidae   |
|                                     |             | <i>Thaparocleidus multispiralis</i> | Dactylogyridae     |
|                                     |             | <i>Thaparocleidus siloniansis</i>   | Dactylogyridae     |
| <i>Sisor rhabdophorus</i>           | Sisoridae   | –                                   | –                  |
| <i>Sperata aor</i>                  | Bagridae    | <i>Thaparocleidus speratai</i>      | Dactylogyridae     |
|                                     |             | <i>Thaparocleidus speratai</i>      | Dactylogyridae     |
| <i>Sperata seenghala</i>            | Bagridae    | <i>Bifurcohaptor giganticus</i>     | Dactylogyridae     |
|                                     |             | <i>Hamatopeduncularia sohani</i>    | Dactylogyridae     |
|                                     |             | <i>Thaparocleidus seenghali</i>     | Dactylogyridae     |



Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                               | Fish family   | Monogenea                              | Monogenea family |
|------------------------------------|---------------|--|------------------|
|                                    |               | <i>Thaparocleidus wallagonius</i>      | Dactylogyridae   |
| <i>Tor tor</i>                     | Cyprinidae    | <i>Diplozoon indicum</i>               | Diplozoidae      |
| <i>Tenuulosa ilisha</i>            | Clupeidae     | <i>Cribomazocraes ilewellyni</i>       | Mazocraeidae     |
|                                    |               | <i>Leptomazocraes indica</i>           | Mazocraeidae     |
|                                    |               | <i>Leptomazocraes lucknowensis</i>     | Mazocraeidae     |
|                                    |               | <i>Mazocraes gussevi</i>               | Mazocraeidae     |
|                                    |               | <i>Mazocraes multispiralis</i>         | Mazocraeidae     |
|                                    |               | <i>Pseudomazocreoides indicus</i>      | Mazocraeidae     |
| <i>Tetradon oblongus</i>           | Tetradontidae | <i>Diclidophora indica</i>             | Diclidophoridae  |
| <i>Wallago attu</i>                | Siluridae     | <i>Bychowkyella tripathii</i>          | Dactylogyridae   |
|                                    |               | <i>Thaparocleidus gontius</i>          | Dactylogyridae   |
|                                    |               | <i>Bychowkyella wallagonia</i>         | Dactylogyridae   |
|                                    |               | <i>Chauhanellus indicus</i>            | Dactylogyridae   |
|                                    |               | <i>Cosmetocleithrum orientalis</i>     | Dactylogyridae   |
|                                    |               | <i>Dactylogyrus kontii</i>             | Dactylogyridae   |
|                                    |               | <i>Hamatopeduncularia lucknowensis</i> | Dactylogyridae   |
|                                    |               | <i>Hamatopeduncularia sohani</i>       | Dactylogyridae   |
|                                    |               | <i>Hamatopeduncularia wallagonius</i>  | Dactylogyridae   |
|                                    |               | <i>Hamatopeduncularia yogendrai</i>    | Dactylogyridae   |
|                                    |               | <i>Mizelleus indicus</i>               | Dactylogyridae   |
|                                    |               | <i>Mizellus indicus</i>                | Dactylogyridae   |
|                                    |               | <i>Mizellus longicirrus</i>            | Dactylogyridae   |
|                                    |               | <i>Neocalceostoma chauhani</i>         | Calceostomatidae |
|                                    |               | <i>Neocalceostoma microformis</i>      | Calceostomatidae |
|                                    |               | <i>Rhamnoscercus srivastavai</i>       | Diplectanidae    |
|                                    |               | <i>Thaparocleidus indicus</i>          | Dactylogyridae   |
|                                    |               | <i>Thaparocleidus longiphallus</i>     | Dactylogyridae   |
|                                    |               | <i>Thaparocleidus wallagonius</i>      | Dactylogyridae   |
| <i>Xenentodon cancila</i>          | Belonidae     | <i>Xenentocleidus xenentodoni</i>      | Dactylogyridae   |
| II. Brahmaputra River System       |               |  |                  |
| <i>Acanthocobitis botia</i>        | Balitoridae   | –                                      | –                |
| <i>Acanthocobitis zonalternans</i> | Balitoridae   | –                                      | –                |
| <i>Ailia coila</i>                 | Schilbeidae   | –                                      | –                |
| <i>Anabas testudineus</i>          | Anabantidae   | <i>Trianchoratus kearnii</i>           | Dactylogyridae   |
| <i>Badis badis</i>                 | Nandidae      | –                                      | –                |
| <i>Badis blosyrus</i>              | Nandidae      | –                                      | –                |
| <i>Badis kanabos</i>               | Nandidae      | –                                      | –                |
| <i>Bagarius bagarius</i>           | Sisoridae     | –                                      | –                |
| <i>Barbodes hexagonolepis</i>      | Cyprinidae    | –                                      | –                |
| <i>Barilius barna</i>              | Cyprinidae    | –                                      | –                |
| <i>Barilius shacra</i>             | Cyprinidae    | –                                      | –                |
| <i>Barilius tileo</i>              | Cyprinidae    | –                                      | –                |
| <i>Batasio tengana</i>             | Bagridae      | –                                      | –                |
| <i>Botia dario</i>                 | Cobitidae     | –                                      | –                |
| <i>Botia dayi</i>                  | Cobitidae     | –                                      | –                |
| <i>Catla catla</i>                 | Cyprinidae    | <i>Dactylogyrus laabei</i>             | Dactylogyridae   |
| <i>Chaca chaca</i>                 | Chacidae      | –                                      | –                |
| <i>Chagunius chagunio</i>          | Cyprinidae    | –                                      | –                |
| <i>Channa barca</i>                | Channidae     | –                                      | –                |
| <i>Channa stewartii</i>            | Channidae     | –                                      | –                |
| <i>Chitala chitala</i>             | Notopteridae  | –                                      | –                |
| <i>Cirrhinus cirrhosus</i>         | Cyprinidae    | <i>Dactylogyrus chauhanus</i>          | Dactylogyridae   |
| <i>Clarias batrachus</i>           | Clariidae     | –                                      | –                |
| <i>Crossocheilus latius</i>        | Cyprinidae    | –                                      | –                |
| <i>Ctenopharyngodon idella</i>     | Cyprinidae    | <i>Dactylogyrus lamellatus</i>         | Dactylogyridae   |
| <i>Cyprinus carpio</i>             | Cyprinidae    | <i>Dactylogyrus extensus</i>           | Dactylogyridae   |
| <i>Devario acuticephala</i>        | Cyprinidae    | –                                      | –                |
| <i>Erethistes pusillus</i>         | Erethistidae  | –                                      | –                |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                                 | Fish family     | Monogenea                            | Monogenea family |
|--------------------------------------|-----------------|--------------------------------------|------------------|
| <i>Exostoma labiatum</i>             | Sisoridae       | –                                    | –                |
| <i>Gagata gagata</i>                 | Sisoridae       | –                                    | –                |
| <i>Gagata youssoufi</i>              | Sisoridae       | –                                    | –                |
| <i>Gangra viridescens</i>            | Sisoridae       | –                                    | –                |
| <i>Garra kempfi</i>                  | Cyprinidae      | –                                    | –                |
| <i>Garra lissorhynchus</i>           | Cyprinidae      | –                                    | –                |
| <i>Glyptosternon maculatum</i>       | Sisoridae       | –                                    | –                |
| <i>Glyptothorax annandalei</i>       | Sisoridae       | –                                    | –                |
| <i>Gonialosa manmina</i>             | Clupeidae       | –                                    | –                |
| <i>Gudusia chapra</i>                | Clupeidae       | –                                    | –                |
| <i>Labeo ariza</i>                   | Cyprinidae      | –                                    | –                |
| <i>Labeo boga</i>                    | Cyprinidae      | <i>Diplozoon cauveri</i>             | Diplozoidae      |
| <i>Labeo gonius</i>                  | Cyprinidae      | <i>Dactylogyrus subtilis</i>         | Dactylogyridae   |
| <i>Labeo pangusia</i>                | Cyprinidae      | <i>Diplozoon cauveri</i>             | Diplozoidae      |
| <i>Lepidocephalus guntea</i>         | Cobitidae       | –                                    | –                |
| <i>Lepidocephalus menoni</i>         | Cobitidae       | –                                    | –                |
| <i>Mesonoemacheilus pulchellus</i>   | Belontiidae     | –                                    | –                |
| <i>Mystus aor</i>                    | Bagridae        | –                                    | –                |
| <i>Mystus bleekeri</i>               | Bagridae        | –                                    | –                |
| <i>Mystus cavasius</i>               | Bagridae        | –                                    | –                |
| <i>Mystus menoda</i>                 | Bagridae        | –                                    | –                |
| <i>Mystus seenghala</i>              | Bagridae        | –                                    | –                |
| <i>Mystus tengara</i>                | Bagridae        | <i>Bifurcohaptor indicus</i>         | Dactylogyridae   |
| <i>Mystus vittatus</i>               | Bagridae        | <i>Bifurcohaptor indicus</i>         | Dactylogyridae   |
|                                      |                 | <i>Cornudiscoides proximus</i>       | Dactylogyridae   |
| <i>Macroglyphus aculeatus</i>        | Mastacembelidae | <i>Mastacembelocleidus bam</i>       | Dactylogyridae   |
| <i>Nandus nandus</i>                 | Nandidae        | <i>Sundanonchus behuri</i>           | Dactylogyridae   |
| <i>Nemacheilus elongatus</i>         | Balitoridae     | –                                    | –                |
| <i>Nemacheilus labeosus</i>          | Balitoridae     | –                                    | –                |
| <i>Nemacheilus nagaensis</i>         | Balitoridae     | –                                    | –                |
| <i>Nemacheilus pavonaceus</i>        | Balitoridae     | –                                    | –                |
| <i>Nemacheilus reticulofasciatus</i> | Balitoridae     | –                                    | –                |
| <i>Nemacheilus subfuscus</i>         | Balitoridae     | –                                    | –                |
| <i>Neoeucirrhichthys maydelli</i>    | Cobitidae       | –                                    | –                |
| <i>Notopterus notopterus</i>         | Notopteridae    | <i>Notopterodiscoides notopterus</i> | Dactylogyridae   |
| <i>Ompok bimaculatus</i>             | Siluridae       | –                                    | –                |
| <i>Osteobrama cotio cotio</i>        | Cyprinidae      | –                                    | –                |
| <i>Otolithoides pama</i>             | Sciaenidae      | –                                    | –                |
| <i>Oxygymnocypris stewartii</i>      | Cyprinidae      | –                                    | –                |
| <i>Pangasius pangasius</i>           | Pangasiidae     | –                                    | –                |
| <i>Parachiloglanis hodgarti</i>      | Sisoridae       | –                                    | –                |
| <i>Pareuchiloglanis kamengensis</i>  | Sisoridae       | –                                    | –                |
| <i>Polynemus sexfilis</i>            | Polynemidae     | <i>Pseudolamellodiscus polynemus</i> | Diplectanidae    |
| <i>Prambassis lala</i>               | Ambassidae      | –                                    | –                |
| <i>Pristis microdon</i>              | Pristidae       | –                                    | –                |
| <i>Pseudecheneis sulcata</i>         | Sisoridae       | –                                    | –                |
| <i>Psilorhynchus homaloptera</i>     | Psilorhynchidae | –                                    | –                |
| <i>Ptychobarbus dipogon</i>          | Cyprinidae      | –                                    | –                |
| <i>Puntius conchoniensis</i>         | Cyprinidae      | –                                    | –                |
| <i>Puntius guganio</i>               | Cyprinidae      | –                                    | –                |
| <i>Puntius sophore</i>               | Cyprinidae      | <i>Dactylogyroides longicirrus</i>   | Dactylogyridae   |
| <i>Puntius ticto</i>                 | Cyprinidae      | <i>Dactylogyroides tripathii</i>     | Dactylogyridae   |
| <i>Salmo trutta fario</i>            | Salmonidae      | –                                    | –                |
| <i>Salmotoma bacaila</i>             | Cyprinidae      | –                                    | –                |
| <i>Salmotoma phulo</i>               | Cyprinidae      | –                                    | –                |
| <i>Salmotoma sardinella</i>          | Cyprinidae      | –                                    | –                |
| <i>Schistura beavani</i>             | Balitoridae     | –                                    | –                |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                                | Fish family      | Monogenea                         | Monogenea family |
|-------------------------------------|------------------|-----------------------------------|------------------|
| <i>Schistura manipurensis</i>       | Balitoridae      | –                                 | –                |
| <i>Schistura prashadi</i>           | Balitoridae      | –                                 | –                |
| <i>Schizopygopsis younghusbandi</i> | Cyprinidae       | –                                 | –                |
| <i>Schizothoraichthys progastus</i> | Cyprinidae       | –                                 | –                |
| <i>Schizothorax macropogon</i>      | Cyprinidae       | –                                 | –                |
| <i>Schizothorax molesworthi</i>     | Cyprinidae       | –                                 | –                |
| <i>Schizothorax oconnori</i>        | Cyprinidae       | –                                 | –                |
| <i>Schizothorax waltoni</i>         | Cyprinidae       | –                                 | –                |
| <i>Sicamugil cascasia</i>           | Mugilidae        | –                                 | –                |
| <i>Sinilabeo dero</i>               | Cyprinidae       | –                                 | –                |
| <i>Sisor rabdophorus</i>            | Sisoridae        | –                                 | –                |
| <i>Sperata aor</i>                  | Bagridae         | –                                 | –                |
| <i>Sperata seenghala</i>            | Bagridae         | –                                 | –                |
| <i>Tor progeneius</i>               | Cyprinidae       | –                                 | –                |
| <i>Triplophysa microps</i>          | Balitoridae      | –                                 | –                |
| <i>Triplophysa stenura</i>          | Balitoridae      | –                                 | –                |
| <i>Triplophysa stewarti</i>         | Balitoridae      | –                                 | –                |
| <i>Triplophysa tibetana</i>         | Balitoridae      | –                                 | –                |
| <i>Wallago attu</i>                 | Siluridae        | –                                 | –                |
| <i>Xenentodon cancila</i>           | Belonidae        | <i>Xenentocleidus xenentodoni</i> | Dactylogyridae   |
| III. Indus River System             |                  |                                   |                  |
| <i>Acanthocobitis botia</i>         | Balitoridae      | –                                 | –                |
| <i>Aspidoparia morar</i>            | Cyprinidae       | –                                 | –                |
| <i>Bagarius yarrelli</i>            | Sisoridae        | –                                 | –                |
| <i>Barbus chagunio</i>              | Cyprinidae       | <i>Neodiplozoon barbi</i>         | Diplozoidae      |
| <i>Barilius pakistanicus</i>        | Cyprinidae       | –                                 | –                |
| <i>Barilius vagra</i>               | Cyprinidae       | –                                 | –                |
| <i>Carassius vulgaris</i>           | Cyprinidae       | <i>Diplozoon nipponicum</i>       | Diplozoidae      |
| <i>Chela cachius</i>                | Cyprinidae       | –                                 | –                |
| <i>Chitala chitala</i>              | Notopteridae     | –                                 | –                |
| <i>Crossocheilus diplochilus</i>    | Cyprinidae       | –                                 | –                |
| <i>Cyprinus carpio</i>              | Cyprinidae       | –                                 | –                |
| <i>Cyprinus carpio specularis</i>   | Cyprinidae       | <i>Diplozoon nipponicum</i>       | Diplozoidae      |
| <i>Dipyuchus maculatus</i>          | Cyprinidae       | –                                 | –                |
| <i>Gagata cenia</i>                 | Sisoridae        | –                                 | –                |
| <i>Glyptosternon maculatum</i>      | Sisoridae        | –                                 | –                |
| <i>Glyptosternon reticulatum</i>    | Sisoridae        | –                                 | –                |
| <i>Glyptothorax kashmirensis</i>    | Sisoridae        | –                                 | –                |
| <i>Glyptothorax pectinopterus</i>   | Sisoridae        | –                                 | –                |
| <i>Glyptothorax telchitta</i>       | Sisoridae        | –                                 | –                |
| <i>Heteropneustes fossilis</i>      | Heteropneustidae | –                                 | –                |
| <i>Labeo ariza</i>                  | Cyprinidae       | –                                 | –                |
| <i>Labeo dero</i>                   | Cyprinidae       | –                                 | –                |
| <i>Lepidocephalus guntea</i>        | Cobitidae        | –                                 | –                |
| <i>Mystus cavasius</i>              | Bagridae         | –                                 | –                |
| <i>Nangra nangra</i>                | Sisoridae        | –                                 | –                |
| <i>Nangra robusta</i>               | Sisoridae        | –                                 | –                |
| <i>Nemacheilus gracilis</i>         | Balitoridae      | –                                 | –                |
| <i>Notopterus notopterus</i>        | Notopteridae     | –                                 | –                |
| <i>Ptychobarbus conorostris</i>     | Cyprinidae       | –                                 | –                |
| <i>Puntius conchoniuis</i>          | Cyprinidae       | –                                 | –                |
| <i>Racoma labiata</i>               | Cyprinidae       | –                                 | –                |
| <i>Raimas bola</i>                  | Cyprinidae       | <i>Dactylogyrus boli</i>          | Dactylogyridae   |
| <i>Salmotrutta ferio</i>            | Salmonidae       | –                                 | –                |
| <i>Schistura afasciata</i>          | Balitoridae      | –                                 | –                |
| <i>Schistura alepidota</i>          | Balitoridae      | –                                 | –                |
| <i>Schistura corica</i>             | Balitoridae      | –                                 | –                |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                                    | Fish family   | Monogenea                             | Monogenea family     |
|---|---------------|---------------------------------------|----------------------|
| <i>Schistura curtistigma</i>            | Balitoridae   | –                                     | –                    |
| <i>Schistura microlabra</i>             | Balitoridae   | –                                     | –                    |
| <i>Schistura prashari</i>               | Balitoridae   | –                                     | –                    |
| <i>Schizopygopsis stoliczkae</i>        | Cyprinidae    | –                                     | –                    |
| <i>Schizothoracichthys curvifrons</i>   | Cyprinidae    | <i>Diplozoon nipponicum</i>           | Diplozoidae          |
| <i>Schizothorax esocinus</i>            | Cyprinidae    | <i>Diplozoon nipponicum</i>           | Diplozoidae          |
| <i>Schizothorax longipinnis</i>         | Cyprinidae    | –                                     | –                    |
| <i>Schizothorax macropogon</i>          | Cyprinidae    | –                                     | –                    |
| <i>Schizothorax nasus</i>               | Cyprinidae    | –                                     | –                    |
| <i>Schizothorax plagiostomum</i>        | Cyprinidae    | <i>Diplozoon nipponicum</i>           | Diplozoidae          |
| <i>Schizothorax richardsonii</i>        | Cyprinidae    | –                                     | –                    |
| <i>Sicamugil cascasia</i>               | Mugilidae     | –                                     | –                    |
| <i>Silonia silondia</i>                 | Schilbeidae   | –                                     | –                    |
| <i>Sisor rabdophorus</i>                | Sisoridae     | –                                     | –                    |
| <i>Sperata aor</i>                      | Bagridae      | –                                     | –                    |
| <i>Sperata seenghala</i>                | Bagridae      | <i>Cornudiscooides geminus</i>        | Dactylogyridae       |
| <i>Terapon theraps</i>                  | Terapontidae  | –                                     | –                    |
| <i>Tetradon oblongus</i>                | Tetradontidae | <i>Neodictidophora simhai</i>         | Diclidophoridae      |
| <i>Tor putitora</i>                     | Cyprinidae    | <i>Dactylogyroides gussevia</i>       | Dactylogyridae       |
|   |               | <i>Paradactylogyrus himalayensis</i>  | Dactylogyridae       |
|   |               | <i>Parancyrocephaloides putitorai</i> | Dactylogyridae       |
| <i>Triacanthus biaculeatus</i>          | Triacanthidae | <i>Ancyrocephalus triacanthi</i>      | Dactylogyridae       |
|   |               | <i>Ancyrocephaloides chilkae</i>      | Dactylogyridae       |
| <i>Triplophysa aliensis</i>             | Balitoridae   | –                                     | –                    |
| <i>Triplophysa gracilis</i>             | Balitoridae   | –                                     | –                    |
| <i>Triplophysa griffithi</i>            | Balitoridae   | –                                     | –                    |
| <i>Triplophysa marmorata</i>            | Balitoridae   | –                                     | –                    |
| <i>Triplophysa microps</i>              | Balitoridae   | –                                     | –                    |
| <i>Triplophysa stenura</i>              | Balitoridae   | –                                     | –                    |
| <i>Triplophysa stoliczkae</i>           | Balitoridae   | –                                     | –                    |
| <i>Triplophysa yasinensis</i>           | Balitoridae   | –                                     | –                    |
| IV. East Coast River System             |               |                                       |                      |
| <i>Amblypharyngodon mola</i>            | Cyprinidae    | –                                     | –                    |
| <i>Anguilla bengalensis bengalensis</i> | Anguillidae   | –                                     | –                    |
| <i>Anodontostoma chacunda</i>           | Clupeidae     | <i>Neomazocraes anadontostomae</i>    | Mazocraeidae         |
| <i>Aristichthys nobilis</i>             | Cyprinidae    | –                                     | –                    |
| <i>Bagarius bagarius</i>                | Sisoridae     | –                                     | –                    |
| <i>Balitora mysorensis</i>              | Balitoridae   | –                                     | –                    |
| <i>Barbodes bovanicus</i>               | Cyprinidae    | –                                     | –                    |
| <i>Barbodes carnaticus</i>              | Cyprinidae    | –                                     | –                    |
| <i>Barbodes sarana</i>                  | Cyprinidae    | <i>Diplozoon indicum</i>              | Diplozoidae          |
| <i>Barbodes wynaadensis</i>             | Cyprinidae    | –                                     | –                    |
| <i>Barilius gatensis</i>                | Cyprinidae    | –                                     | –                    |
| <i>Callichrous malabaricus</i>          | Siluridae     | <i>Thaparocleidus devraji</i>         | Dactylogyridae       |
| <i>Caranx kalla</i>                     | Carangidae    | <i>Bilaterocotyle spindalis</i>       | Allodiscocotylidae   |
| <i>Caranx rotterli</i>                  | Carangidae    | <i>Chauhanocotyle rotterli</i>        | Allodiscocotylidae   |
| <i>Caranx sp.</i>                       | Carangidae    | <i>Heteromicrocotyla multispina</i>   | Heteromicrocotylidae |
| <i>Catla catla</i>                      | Cyprinidae    | <i>Dactylogyrus spinitubus</i>        | Dactylogyridae       |
| <i>Chanda nama</i>                      | Ambassidae    | –                                     | –                    |
| <i>Channa marulius</i>                  | Cyprinidae    | –                                     | –                    |
| <i>Channa orientalis</i>                | Cyprinidae    | <i>Metagyrodactylus minutus</i>       | Dactylogyridae       |
| <i>Channa striata</i>                   | Cyprinidae    | –                                     | –                    |
| <i>Chanos chanos</i>                    | Chanidae      | –                                     | –                    |
| <i>Chorinemus tala</i>                  | Carangidae    | <i>Tripathia chorinemi</i>            | Microcotylidae       |
| <i>Cirrhinus ariza</i>                  | Cyprinidae    | <i>Dactylogyrus anchoracanthus</i>    | Dactylogyridae       |
| <i>Cirrhinus cirrhosus</i>              | Cyprinidae    | <i>Dactylogyrus chauhanus</i>         | Dactylogyridae       |
|   |               | <i>Dactylogyrus mrigali</i>           | Dactylogyridae       |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                               | Fish family      | Monogenea                            | Monogenea family |
|------------------------------------|------------------|--------------------------------------|------------------|
|                                    |                  | <i>Diplozoon indicum</i>             | Diplozoidae      |
| <i>Cirrhinus fulungee</i>          | Cyprinidae       | –                                    | –                |
| <i>Cirrhinus macrops</i>           | Cyprinidae       | –                                    | –                |
| <i>Clarias batrachus</i>           | Clariidae        | <i>Dactylogyrus macrogaster</i>      | Dactylogyridae   |
|                                    |                  | <i>Quadriacanthus kobiensis</i>      | Dactylogyridae   |
|                                    |                  | <i>Quadriacanthus postbifidus</i>    | Dactylogyridae   |
| <i>Clarias dussumieri</i>          | Clariidae        | –                                    | –                |
| <i>Clupea harengus</i>             | Clupeidae        | <i>Dactylogyrus tetaradiatus</i>     | Dactylogyridae   |
| <i>Clupisoma garua</i>             | Schilbeidae      | <i>Bychowskyella caballeroi</i>      | Dactylogyridae   |
| <i>Ctenopharyngodon idellus</i>    | Cyprinidae       | –                                    | –                |
| <i>Cyprinus carpio carpio</i>      | Cyprinidae       | –                                    | –                |
| <i>Danio aequipinnatus</i>         | Cyprinidae       | –                                    | –                |
| <i>Danio rerio</i>                 | Cyprinidae       | –                                    | –                |
| <i>Devario devario</i>             | Cyprinidae       | –                                    | –                |
| <i>Devario fraseri</i>             | Cyprinidae       | –                                    | –                |
| <i>Engraulis purava</i>            | Engraulidae      | <i>Diclidophora caudospina</i>       | Diclidophoridae  |
| <i>Esomus danricus</i>             | Cyprinidae       | –                                    | –                |
| <i>Esomus thermoicos</i>           | Cyprinidae       | –                                    | –                |
| <i>Eteutheronema tetradactylum</i> | Polynemidae      | <i>Diplectanidae</i>                 | Diplectanidae    |
| <i>Etroplus suratensis</i>         | Cichlidae        | <i>Scleroleidoides etropi</i>        | Dactylogyridae   |
| <i>Etroplus suratensis</i>         | Cichlidae        | –                                    | –                |
| <i>Gagata itchkeea</i>             | Sisoridae        | –                                    | –                |
| <i>Garra gotyla stenorrhynchus</i> | Cyprinidae       | –                                    | –                |
| <i>Garra mccllellandi</i>          | Cyprinidae       | –                                    | –                |
| <i>Garra mullya</i>                | Cyprinidae       | –                                    | –                |
| <i>Glossogobius giuris</i>         | Gobiidae         | <i>Dactylogyrus pharyngocephalus</i> | Dactylogyridae   |
| <i>Glyptothorax annandalei</i>     | Sisoridae        | –                                    | –                |
| <i>Glyptothorax lonah</i>          | Sisoridae        | –                                    | –                |
| <i>Glyptothorax madraspatanum</i>  | Sisoridae        | –                                    | –                |
| <i>Gudusia chapra</i>              | Clupeidae        | –                                    | –                |
| <i>Hemibagrus punctatus</i>        | Bagridae         | –                                    | –                |
| <i>Heteropneustes fossilis</i>     | Heteropneustidae | –                                    | –                |
| <i>Hilsa sp.</i>                   | Clupeidae        | –                                    | –                |
| <i>Hypophthalmichthys molitrix</i> | Cyprinidae       | <i>Singhiogyrus singhi</i>           | Dactylogyridae   |
| <i>Hypostomus species</i>          | Loricariidae     | <i>Hetrotylus heterotylus</i>        | Dactylogyridae   |
| <i>Hypselobarbus curmuca</i>       | Cyprinidae       | –                                    | –                |
| <i>Hypselobarbus dobsoni</i>       | Cyprinidae       | –                                    | –                |
| <i>Hypselobarbus dubius</i>        | Cyprinidae       | <i>Dactylogyrus brevicardus</i>      | Dactylogyridae   |
|                                    |                  | <i>Dactylogyrus cauveryi</i>         | Dactylogyridae   |
|                                    |                  | <i>Dactylogyrus dubii</i>            | Dactylogyridae   |
|                                    |                  | <i>Dactylogyrus magnicordus</i>      | Dactylogyridae   |
| <i>Hypselobarbus kolus</i>         | Cyprinidae       | –                                    | –                |
| <i>Hypselobarbus micropogon</i>    | Cyprinidae       | –                                    | –                |
| <i>Indoreonectes evezardi</i>      | Balitoridae      | –                                    | –                |
| <i>Labeo ariza</i>                 | Cyprinidae       | –                                    | –                |
| <i>Labeo bata</i>                  | Cyprinidae       | –                                    | –                |
| <i>Labeo boga</i>                  | Cyprinidae       | –                                    | –                |
| <i>Labeo boggut</i>                | Cyprinidae       | –                                    | –                |
| <i>Labeo calbasu</i>               | Cyprinidae       | –                                    | –                |
| <i>Labeo fimbriatus</i>            | Cyprinidae       | <i>Dactylogyrus chitravanshii</i>    | Dactylogyridae   |
| <i>Labeo kontius</i>               | Cyprinidae       | <i>Dactylogyrus kontii</i>           | Dactylogyridae   |
| <i>Labeo pangusia</i>              | Cyprinidae       | –                                    | –                |
| <i>Labeo porcellus</i>             | Cyprinidae       | –                                    | –                |
| <i>Labeo potail</i>                | Cyprinidae       | –                                    | –                |
| <i>Labeo rohita</i>                | Cyprinidae       | <i>Dactylogyrus yogendrai</i>        | Dactylogyridae   |
| <i>Lates calcarifer</i>            | Latidae          | <i>Diplectanum latesi</i>            | Diplectanidae    |
|                                    |                  | <i>Laticola latesi</i>               | Diplectanidae    |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

| Fish                                     | Fish family     | Monogenea                                | Monogenea family |
|--|-----------------|--|------------------|
| <i>Lepidocephalus thermalis</i>          | Cobitidae       | –  | –                |
| <i>Longischistura bhimachari</i>         | Balitoridae     | –  | –                |
| <i>Macroglyphus aculeatum</i>            | Mastacembalidae | <i>Dactylogyrus manairensis</i>          | Dactylogyridae   |
| <i>Mastacembalus armatus</i>             | Mastacembalidae | <i>Mastacembelocleidus heteranchorus</i> | Dactylogyridae   |
| <i>Megalaspis cordyla</i>                | Carangidae      | <i>Tripathiana minuta</i>                | Microcotylidae   |
| <i>Megalops cyprinoides</i>              | Megalopidae     | –  | –                |
| <i>Mesonoemacheilus guentheri</i>        | Balitoridae     | –  | –                |
| <i>Mesonoemacheilus pulchellus</i>       | Balitoridae     | –  | –                |
| <i>Mystus cavasius</i>                   | Bagridae        | –  | –                |
| <i>Mystus malabaricus</i>                | Bagridae        | –  | –                |
| <i>Mystus seenghala</i>                  | Bagridae        | –  | –                |
| <i>Mystus tengara</i>                    | Bagridae        | <i>Cornudiscoides heterotylus</i>        | Dactylogyridae   |
|  |                 | <i>Cornudiscoides megalorchis</i>        | Dactylogyridae   |
|  |                 | <i>Cornudiscoides microtylus</i>         | Dactylogyridae   |
|  |                 | <i>Hamatopeduncularia orientalis</i>     | Dactylogyridae   |
| <i>Mystus vittatus</i>                   | Bagridae        | –  | –                |
| <i>Nemacheilus kodaguensis</i>           | Balitoridae     | –  | –                |
| <i>Nematolosa nasus</i>                  | Clupeidae       | <i>Mazocraeoides nematolosa</i>          | Mazocraeidae     |
| <i>Notopterus notopterus</i>             | Notopteridae    | –  | –                |
| <i>Ompok bimaculatus</i>                 | Siluridae       | –  | –                |
| <i>Ompok pabda</i>                       | Siluridae       | <i>Thaparocleidus octotylus</i>          | Dactylogyridae   |
| <i>Oreochromis mossambicus</i>           | Cichlidae       | –  | –                |
| <i>Osteobrama belangeri</i>              | Cyprinidae      | –  | –                |
| <i>Osteobrama cotio cunna</i>            | Cyprinidae      | –  | –                |
| <i>Osteobrama cotio peninsularis</i>     | Cyprinidae      | –  | –                |
| <i>Osteobrama dayi</i>                   | Cyprinidae      | –  | –                |
| <i>Osteobrama vigorsii</i>               | Cyprinidae      | –  | –                |
| <i>Osteochilichthys brevidorsalis</i>    | Cyprinidae      | –  | –                |
| <i>Osteochilus godavariensis</i>         | Cyprinidae      | –  | –                |
| <i>Osteochilus nashii</i>                | Cyprinidae      | –  | –                |
| <i>Osteochilus thomassi</i>              | Cyprinidae      | –  | –                |
| <i>Oxygaster bacaila</i>                 | Cyprinidae      | <i>Dogielius indicus</i>                 | Dactylogyridae   |
| <i>Pama pama</i>                         | Sciaenidae      | <i>Microcotyle pamae</i>                 | Microcotylidae   |
| <i>Pangasius pangasius</i>               | Pangasiidae     | –  | –                |
| <i>Parambassis ranga</i>                 | Ambassidae      | –  | –                |
| <i>Parapsilorhynchus prateri</i>         | Cyprinidae      | –  | –                |
| <i>Parluciosoma labiosa</i>              | Cyprinidae      | <i>Dactylogyrus pedunculatus</i>         | Dactylogyridae   |
| <i>Platycephalus indicus</i>             | Platycephalidae | <i>Haliotrema indicum</i>                | Dactylogyridae   |
| <i>Polydactylus indicus</i>              | Polynemidae     | <i>Diplectanum polynemus</i>             | Diplectanidae    |
| <i>Polynemous indicus</i>                | Polynemidae     | <i>Microcotyle polynemi</i>              | Microcotylidae   |
| <i>Proeutropiichthys taakree taakree</i> | Schilbeidae     | –  | –                |
| <i>Pseudogobius javanicus</i>            | Gobiidae        | –  | –                |
| <i>Pterocryptis wynaadensis</i>          | Siluridae       | –  | –                |
| <i>Puntius arulius</i>                   | Cyprinidae      | –  | –                |
| <i>Puntius cauveriensis</i>              | Cyprinidae      | –  | –                |
| <i>Puntius chola</i>                     | Cyprinidae      | <i>Dactylogyrus bucinus</i>              | Dactylogyridae   |
| <i>Puntius conchoniis</i>                | Cyprinidae      | –  | –                |
| <i>Puntius dorsalis</i>                  | Cyprinidae      | <i>Dactylogyrus moorthyi</i>             | Dactylogyridae   |
| <i>Puntius fasciatus</i>                 | Cyprinidae      | –  | –                |
| <i>Puntius filamentosus</i>              |                 | <i>Dactylogyroides mahecoli</i>          | Dactylogyridae   |
| <i>Puntius melanostigma</i>              | Cyprinidae      | –  | –                |
| <i>Puntius narayani</i>                  | Cyprinidae      | –  | –                |
| <i>Puntius parrah</i>                    | Cyprinidae      | –  | –                |
| <i>Puntius sarana</i>                    | Cyprinidae      | <i>Dactylogyrus barbi</i>                | Dactylogyridae   |
|  |                 | <i>Dactylogyrus hyderabadensis</i>       | Dactylogyridae   |
|  |                 | <i>Dactylogyrus sarani</i>               | Dactylogyridae   |
|  |                 | <i>Dactylogyrus sphyrnoides</i>          | Dactylogyridae   |

Table 1, continued

List of monogeneans, their host from five major river systems of India.

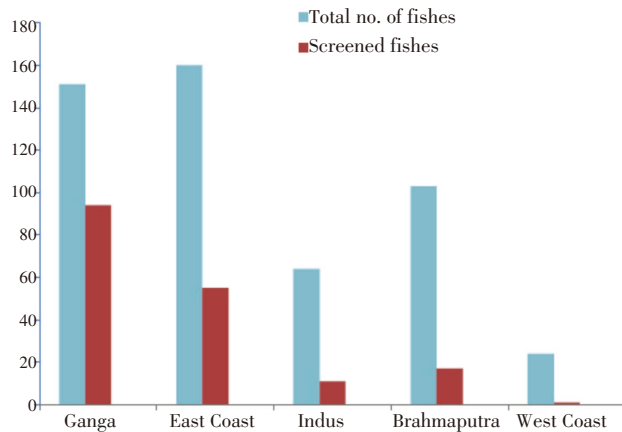
| Fish                           | Fish family     | Monogenea                            | Monogenea family   |
|--------------------------------|-----------------|--------------------------------------|--------------------|
|                                |                 | <i>Dactylogyrus varicorhinoides</i>  | Dactylogyridae     |
|                                |                 | <i>Diplozoon indicum</i>             | Diplozoidae        |
| <i>Puntius sophore</i>         | Cyprinidae      | –                                    | –                  |
| <i>Puntius ticto</i>           | Cyprinidae      | <i>Dactylogyrus moorthyi</i>         | Dactylogyridae     |
| <i>Puntius vittatus</i>        | Cyprinidae      | –                                    | –                  |
| <i>Rasbora caverii</i>         | Cyprinidae      | –                                    | –                  |
| <i>Rastrelliger kanagurata</i> | Scombridae      | <i>Pricea fotedari</i>               | Gotocotylidae      |
| <i>Rita kukurnee</i>           | Bagridae        | –                                    | –                  |
| <i>Rita pavimenta</i>          | Bagridae        | <i>Diplectanum guptai</i>            | Diplectanidae      |
|                                |                 | <i>Neofridericianella ritai</i>      | Fridericianellidae |
| <i>Rita rita</i>               | Bagridae        | <i>Bychowskyella raipurensis</i>     | Dactylogyridae     |
| <i>Rohtee ogilbii</i>          | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma acinaces</i>     | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma bacaila</i>      | Cyprinidae      | <i>Dactylogyrus circumphallus</i>    | Dactylogyridae     |
| <i>Salmostoma balookee</i>     | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma belachi</i>      | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma horai</i>        | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma navacula</i>     | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma phulo</i>        | Cyprinidae      | –                                    | –                  |
| <i>Salmostoma untrahi</i>      | Cyprinidae      | –                                    | –                  |
| <i>Saurida tumbil</i>          | Synodontidae    | –                                    | –                  |
| <i>Schistura semiarmata</i>    | Balitoridae     | –                                    | –                  |
| <i>Sciaena belengeri</i>       | Sciaenidae      | <i>Diplectanum umbrinum</i>          | Diplectanidae      |
| <i>Sciaena glauca</i>          | Sciaenidae      | <i>Diplectanum minutum</i>           | Diplectanidae      |
| <i>Sciaena maculata</i>        | Sciaenidae      | <i>Diplectanum minutum</i>           | Diplectanidae      |
| <i>Sciaena vogleri</i>         | Sciaenidae      | <i>Diplectanum orrissai</i>          | Diplectanidae      |
| <i>Sillago sihama</i>          | Sillaginidae    | <i>Diplectanum sillagonum</i>        | Diplectanidae      |
| <i>Silonia childreni</i>       | Schilbeidae     | –                                    | –                  |
| <i>Silonia silondia</i>        | Schilbeidae     | <i>Bychowskyella cauveryi</i>        | Dactylogyridae     |
| <i>Sinilabeo dero</i>          | Cyprinidae      | –                                    | –                  |
| <i>Sperata aor</i>             | Bagridae        | <i>Ancylo-discoides micracanthus</i> | Dactylogyridae     |
| <i>Sperata seenghala</i>       | Bagridae        | –                                    | –                  |
| <i>Tenualosa ilisha</i>        | Clupeidae       | –                                    | –                  |
| <i>Thynnichthys sandkhoh</i>   | Cyprinidae      | –                                    | –                  |
| <i>Tor khudree</i>             | Cyprinidae      | –                                    | –                  |
| <i>Tor mussullah</i>           | Cyprinidae      | –                                    | –                  |
| <i>Tor tor</i>                 | Cyprinidae      | <i>Dactylogyrus tori</i>             | Dactylogyridae     |
| <i>Wallago attu</i>            | Siluridae       | <i>Bychowskyella chauhani</i>        | Dactylogyridae     |
|                                |                 | <i>Bychowskyella singhi</i>          | Dactylogyridae     |
|                                |                 | <i>Mizellus indicus</i>              | Dactylogyridae     |
|                                |                 | <i>Mizellus longicirrus</i>          | Dactylogyridae     |
|                                |                 | <i>Thaparocleidus indicus</i>        | Dactylogyridae     |
|                                |                 | <i>Thaparocleidus sudhakari</i>      | Dactylogyridae     |
|                                |                 | <i>Thaparocleidus wallagonius</i>    | Dactylogyridae     |
| V. West Coast River System     |                 |                                      |                    |
| <i>Catla catla</i>             | Cyprinidae      | –                                    | –                  |
| <i>Channa species</i>          | Channidae       | –                                    | –                  |
| <i>Cirrhinus mrigala</i>       | Cyprinidae      | –                                    | –                  |
| <i>Cirrhinus mrigala</i>       | Cyprinidae      | –                                    | –                  |
| <i>Cirrhinus reba</i>          | Cyprinidae      | –                                    | –                  |
| <i>Clupisoma garua</i>         | Schleidae       | –                                    | –                  |
| <i>Labeo bata</i>              | Cyprinidae      | –                                    | –                  |
| <i>Labeo boggut</i>            | Cyprinidae      | –                                    | –                  |
| <i>Labeo calbasu</i>           | Cyprinidae      | –                                    | –                  |
| <i>Labeo fimbriatus</i>        | Cyprinidae      | –                                    | –                  |
| <i>Labeo goniis</i>            | Cyprinidae      | –                                    | –                  |
| <i>Mastacembalus species</i>   | Mastacembalidae | –                                    | –                  |
| <i>Minnous</i>                 | Cyprinidae      | –                                    | –                  |
| <i>Mystus aor</i>              | Bagridae        | –                                    | –                  |

**Table 1, continued**

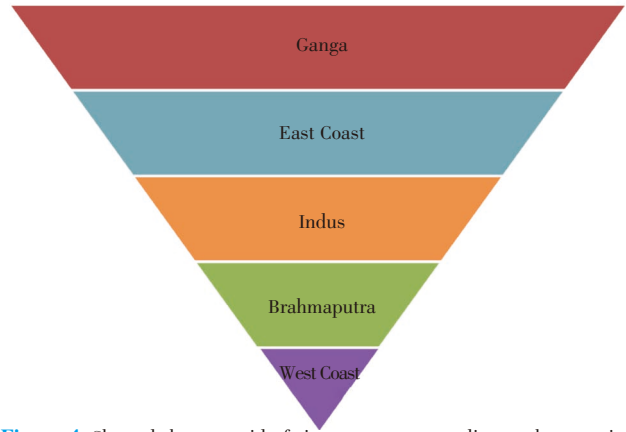
List of monogeneans, their host from five major river systems of India.

| Fish                         | Fish family  | Monogenea                        | Monogenea family |
|------------------------------|--------------|----------------------------------|------------------|
| <i>Mystus cavasius</i>       | Bagridae     | –                                | –                |
| <i>Mystus seenghala</i>      | Bagridae     | –                                | –                |
| <i>Nematalosa nasus</i>      | Clupeidae    | <i>Mazocraeoides nematalosae</i> | Mazocraeidae     |
| <i>Notopterus notopterus</i> | Notopteridae | –                                | –                |
| <i>Ompok bimaculatus</i>     | Siluridae    | –                                | –                |
| <i>Puntius sarana</i>        | Cyprinidae   | –                                | –                |
| <i>Rita pavementata</i>      | Bagridae     | –                                | –                |
| <i>Tor tor</i>               | Cyprinidae   | –                                | –                |
| <i>Tor tor</i>               | Cyprinidae   | –                                | –                |
| <i>Wallago attu</i>          | Siluridae    | –                                | –                |

References for these reports are not cited in the text, however, it can be checked from the comprehensive work of Pandey and Agrawal, 2008.



**Figure 3.** Status of screened fishes in river systems of India.



**Figure 4.** Shown the pyramid of river systems according to the parasites infection.

**Table 3**

List of molecular data of freshwater Indian monogeneans (References are not cited but the data can be checked on the [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)).

| Monogenea species                       | Host                           | Locality (River system) | Accession number   |
|---|--------------------------------|-------------------------|--------------------|
| <i>Bifurcophaptor indicus</i>           | <i>Mystus vittatus</i>         | Ganga                   | GU830881           |
| <i>Bifurcophaptor indicus</i>           | <i>Mystus vittatus</i>         | Brahmaputra             | JX852710           |
| <i>Cornudiscoides proximus</i>          | <i>Mystus vittatus</i>         | Ganga                   | GQ925913           |
| <i>Dactylogyroides longicirrus</i>      | <i>Puntius sophore</i>         | Ganga                   | GU903482           |
| <i>Dactylogyroides longicirrus</i>      | <i>Puntius sophore</i>         | Brahmaputra             | KC685371           |
| <i>Dactylogyroides tripathii</i>        | <i>Puntius ticto</i>           | Brahmaputra             | JX993982           |
| <i>Dactylogyryus labei</i>              | <i>Catla catla</i>             | Brahmaputra             | JX566720           |
| <i>Dactylogyryus ctenopharyngodonis</i> | <i>Ctenopharyngodon idella</i> | Ganga                   | EU643633           |
| <i>Dactylogyryus ctenopharyngodonis</i> | <i>Ctenopharyngodon idella</i> | Ganga                   | EU643635           |
| <i>Dactylogyryus lamellatus</i>         | <i>Ctenopharyngodon idella</i> | Brahmaputra             | JQ926199, JQ926200 |
| <i>Dactylogyryus eucalius</i>           | <i>Culaea inconstans</i>       | Ganga                   | EU643634           |
| <i>Dactylogyryus inexpectatus</i>       | <i>Carassius auratus</i>       | Ganga                   | EU643632           |
| <i>Dactylogyryus anchoratus</i>         | <i>Cyprinus carpio</i>         | Ganga                   | AJ564111           |
| <i>Dactylogyryus extensus</i>           | <i>Cyprinus carpio</i>         | Brahmaputra             | JQ926197, JQ926198 |
| <i>Gyrodactylus colisai</i>             | <i>Colisa fasciata</i>         | Ganga                   | GQ925912           |
| <i>Malayanodiscoides bihamuli</i>       | <i>Notopterus chitala</i>      | Ganga                   | GU830882           |
| <i>Mastacembelocleidus indicus</i>      | <i>Macrogathus aculeatus</i>   | Ganga                   | GU830884           |
| <i>Mastacembelocleidus bam</i>          | <i>Macrogathus aculeatus</i>   | Brahmaputra             | JX987076           |
| <i>Notopterodiscoides notopterus</i>    | <i>Notopterus notopterus</i>   | Brahmaputra             | JX444912           |
| <i>Sundanonchus behuri</i>              | <i>Nandus nandus</i>           | Ganga                   | GU830883           |
| <i>Sundanonchus behuri</i>              | <i>Nandus nandus</i>           | Brahmaputra             | JX444913           |
| <i>Thaparocleidus longiphallus</i>      | <i>Wallago attu</i>            | Ganga                   | GU980972           |
| <i>Thaparocleidus parvulus</i>          | <i>Mystus vittatus</i>         | Ganga                   | GU014844           |
| <i>Thaparocleidus silontansis</i>       | <i>Silonia silondia</i>        | Ganga                   | GU980973           |
| <i>Thaparocleidus wallagonius</i>       | <i>Wallago attu</i>            | Ganga                   | JN020351           |
| <i>Trianchoratus agrawali</i>           | <i>Anaba testudineus</i>       | Ganga                   | GU830880           |
| <i>Trianchoratus kearni</i>             | <i>Anaba testudineus</i>       | Brahmaputra             | JX987077           |
| <i>Xenentocleidus xenentodoni</i>       | <i>Xenentodon cancila</i>      | Ganga                   | JX535617           |
| <i>Xenentocleidus xenentodoni</i>       | <i>Xenentodon cancila</i>      | Brahmaputra             | JX987075           |



Although, monogeneans are a diverse group, with several species currently described in India, in which only a few species has been molecularly sequenced (Table 3). Of course, molecular analysis of these tiny worms is necessary to investigate for species distinctions. This finding represents a known diversity of these fish pathogens and in this respect, additional molecular characterization can also fruitfully assist in inferring the phylogeny.

#### 4. Discussion

Monogenea is one of the largest class that include more than 5000 known species; all of them are reported as parasitic<sup>[19,20]</sup>. Among the known species, 95% of the genera have been reported from fishes and remaining 5% have been reported from amphibious vertebrates. Approximately including freshwater and marine 112 genera belonging to 28 families on monogenoidea have been abstracted from India<sup>[18]</sup>. The demand for fish as a valuable protein source has increased all over the world, whereas, the catch of capture fishery came to a stand still<sup>[21,22]</sup>. However, metazoan parasites in general and monogeneans in particular cause greater losses on account of having direct life cycle, which can be completed easily in a closed system<sup>[11]</sup>. The danger of new forms of monogenoidosis appearing with the introduction of new members into fish culture which threatens not only freshwater but marine fishes as well<sup>[23]</sup>. If we stick to one host one parasite rule, a very big gap exists in the state of our knowledge as far as biodiversity of freshwater monogeneans are concerned and only few work have been done in India<sup>[24]</sup>.

However, the data clearly shows that only one fourth freshwater fish fauna has so far been screened. If we look at individual river system of India, a very big scope of investigation exists in West coast followed by Brahmaputra and Indus river system which warrants serious attention of helminths taxonomists to concentrate upon. Only little bit work has been done on the parasites of Brahmaputra river system by workers in India<sup>[25,26]</sup>. Previous studies indicate that no information was provided on the total diversity of monogeneans at the species level in Indian region. For this, the best way is to use molecular data which can constitute the only practical means of obtaining species-level resolution in a survey of monogeneans. Additional molecular sampling might uncover the diversity of these species rich group of parasites but this trend has not much popular in case of monogeneans. In India, only a few species of freshwater monogeneans has been sequenced through studies of some workers<sup>[27–36]</sup>. But with this data, it is difficult to establish the phylogeny and discuss the validity of freshwater monogenean having very minute differences in their body parts. Therefore, molecular analysis of the fauna is strongly urged to be investigated. This study also suggests that molecular data will reveal unexpectedly high diversity with varying ecological and phylogenetic affinity. These findings represent a known diversity of these widely occurring fish pathogens. Monogeneans diversity from India is still in infancy and the total possible number of these parasites showed that Indian region indicates only low percentage of these parasites that are presently known. Besides this, the available information also indicates that an integrated approach is necessary which should start with morphological characterization followed by molecular characterization of monogenean parasites in all river system of India.

In conclusion, this study suggests that subsequent comparison of monogenean fauna present in different river systems of India can be made. This information might prove to be a meaningful observation that can be used in designing the control measures of these serious pathogens of fishes. It is clear that much remains to be learned about this group within India and the biodiversity tools including molecular studies provides a practical means of moving forward.

#### Conflict of interest statement

The authors declare that there are no conflicts of interest.

#### Acknowledgements

Support for this project was supplied partially by grants from the UGC (University Grants Commission), India, under the Post Doctoral Fellowship to AC [No. F. 15–191/12(SA–II)]; under the Junior Research Fellowship (RGF) to CV [No. F. 14–2(SC)/2010(SA–III)] and by the Uttar Pradesh Government, Centre of Excellence, India, to HSS, wide project number [No.1486/70–4–2011–46(43)/2010]. The authors also would like to thank Head, Department of Zoology, Chaudhary Charan Singh University, Meerut (U.P.), India for providing laboratory facilities.

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#### Comments

##### Background

Monogeneans are common and specific parasites of fishes. Most of them cause infection in the gills. A great number of monogenean species has been described from India, and the occurrence of several unknown species can be expected. Due to their pathogenic effect on cultured and wild fishes, studies on their occurrence, development, pathomechanism, *etc.* is reasonable.

##### Research frontiers

Authors collected data on monogeneans of freshwater fishes from the five major river systems of India. In tables they included both fishes infected with monogeneans and those having no data on monogenean infection. They also presented data on species studied by molecular methods.

##### Related reports

Monogenean fauna of fishes in the Palaearctic Fauna region is well studied and several species of monogeneans have been described from different fishes. Fish fauna of the Indian Fauna Region is rich in species, but only about one forth of them has been studied for monogenean infection. Authors of this manuscript study their biodiversity in the five river systems.

##### Innovations and breakthroughs

Authors present a catalogue of described monogeneans by the major river systems of India and analyze the stage of research accordingly.

##### Applications

The work which the authors have done has a character of a synopsis and it is a useful analysis of the present situation. It could be utilized by all researchers who intend to study monogeneans of Indian fishes or compare them with

monogeneans of other regions.

### Peer review

Authors studied monogenean infections of freshwater fishes in the five major water basins of India and collected data from the available specific literature and illustrated them in separate tables. These data are useful for other researchers who want to work on monogeneans in India and elsewhere.

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