

Report

MONITORING OF FISH DIVERSITY IN RIVERS OF KERALA

SUBMITTED TO
KERALA STATE BIODIVERSITY BOARD
PALLIMUKKU, PETTAH, THIRUVANANTHAPURAM-24



RIVER RESEARCH CENTRE

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Dr. Latha Anantha

Director,

River Research Centre

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INTRODUCTION

Rivers, the icons of human civilization and culture, the natural corridors for energy, matter and species, and the immediate source of freshwater for the common man, represent very important life supporting and dynamic ecosystems. Freshwater ecosystems such as rivers play pivotal roles in water cycle, nutrient cycle, maintaining the delicate balance of aquatic food chain, purification of water, recreation, managing natural hazards like flood, drought, etc and control of infectious organisms. Freshwater biodiversity is very important, with tremendous economic, social, and environmental impacts; it provides human species with nutrient rich food, water and other resources. In the modern world many rivers no longer support socially valued native species or sustain healthy ecosystems that provide important goods and services mainly because of their close proximity to human development. Further, riverine populations are smaller and more isolated than their marine counterparts, and consequently more vulnerable. The ecological degradation of Indian rivers is due to anthropogenic interventions in the riverine habitats, particularly due to water abstraction,

construction of dams and barrages, siltation, soil erosion due to forest degradation in catchments and pollution, and these have devastating effects on the biodiversity of the ecosystem as a whole. Kerala, the land of rivers, has a cultural history, which indeed is closely intertwined with the river valley social life. It is the land of 44 rivers, 41 of them following westward, joining the Lakshadweep Sea and three others flowing eastward (Table 1; Fig. 1), most of them originating from the Western Ghats biodiversity hotspot.

The rivers of Kerala are small, whether considered in terms of length, breadth or annual stream flow. The rivers flow fast, because of the hilly nature of the terrain and as the distance between the mountains and the sea is rather short. The smallness in size of the rivers coupled with very high population density contributes towards its susceptibility towards environmental onslaughts. The rivers originating from Western Ghats and flowing through Kerala are considered as hotspots of freshwater biodiversity. Despite the small size, the riverine biodiversity in Kerala is very rich. For example, from Chalakkudy river alone 98 species of fish have been recorded. But the river Kaveri (mainly flowing through Karnataka and Tamil Nadu), though 8 times the length of Chalakkudy has only 142 species of fish. Despite its social, economic, cultural and ecological significance rivers represent a highly threatened ecosystem in Kerala State due to rampant sand mining, overexploitation of resources, encroachment, construction of dams, debilitation of watersheds, invasive alien species and pollution. Despite the importance of the rivers in terms of direct, indirect and existence values, the river systems in Kerala are not frequently monitored either for studying the ecological status or for recording fish- the major component of its

Table 1. List of rivers in Kerala and their major tributaries

No.	Name of the river	Districts in which river	Length (km)	Main tributaries
1	Manjeswaram	Kasargod	15	Pavuru
2	Uppala	Kasargod	50	Uppala
3	Shuriya	Kasargod	67	Kailanje Thodu, Kanyana Thodu, Eramathihole Kumbla
4	Mogral	Kasargod	34	Nettipadi, Muliya
5	Chandragiri	Kasargod	105	Payaswini, Chandragiri
6	Chittari	Kasargod	25	Kalnad, Bekal, Chittari
7	Nileswaram	Kasargod, Kannur	46	Aryangal, Baigotehole
8	Kariangode	Kasargod, Kannur	64	Mundore, Padimalahole, Ariakkadavuhole
9	Kavvayi	Kasargod, Kannur	31	Nil
10	Peruvamba	Kasargod, Kannur	51	Macharu Thodu, Mathamangalam, Challachal
11	Ramapuram	Kasargod, Kannur	19	Nil
12	Kuppam	Kannur	82	Cheriyathodu, Kuttikilpuzha
13	Valapattanam	Kannur	110	Valiyapuzha, Veripuzha
14	Anjarakandy	Kannur	40	Kappu Thodu, Idumba Thodu
15	Thalasseri	Kannur	28	Dharmadom puzha
16	Mahe	Kannur, Kozhikode	54	Nil
17	Kuttiyadi	Kozhikode	74	Onipuzha, Thottilapalam, Kannathil
18	Korapuzha	Kozhikode	40	Agalapuzha, Pannurpuzha
19	Kallayi	Kozhikode	40	Nil
20	Chaliyar	Kozhikode, Malappuram, Wayanad	169	Cherupuzha, Karimpuzha, Kanchirapuzha
21	Kadalundi	Malappuram, Palakkad	130	Olipuzha, Veliar
22	Tirur	Malappuram	48	Vallilapuzha
23	Bharathapuzha	Palakkad, Malappuram, Thrissur	209	Gayathri Puzha, Chittor Puzha, Kalpathi Puzha, Thoofha Puzha
24	Keecheri	Thrissur	51	Choondal Thodu
25	Puzhakkal	Thrissur	29	Para Thodu Nadu, Thodu
26	Karuvannur	Thrissur	40	Manali, Kurumali, Chimmanti

27	Chalakkudy	Thrissur, Ernakulam	130	Sholayar, Parambikulam, Karappara, Kuriarkutty,
28	Periyar	Idukki	244	Muthirapuzha, Ernakulam Idamalayar, Mangalapuzha, Perinjankutty
29	Muvattupuzha	Ernakulam, Kottayam	121	Kallar Thodupuzha, Kothamangalam
30	Meenachil	Kottayam	78	Kadapuzha, Kalathukadavu, Kurisumalai
31	Manimala	Kottayam, Pathanamthitta	90	Kokayar Blakkal Thodu
32	Pamba	Pathanamthitta, Idukki	76	Kakkiyar Kallar, Alappuzha, Arudai Pamba
33	Achenkoil	Pathanamthitta, Idukki	128	Kallar, Alappuzha,
34	Pallichal	Kollam, Pathanamthitta, Trivandrum	42	
35	Kallada	Kollam, Pathanamthitta, Trivandrum	121	Kulathupuzha, Chendruni
36	Ithikkara	Kollam, Trivandrum	56	Vattam Thodu, Vattaparambu
37	Ayroor	Kollam, Trivandrum	17	Nil
38	Vamanapuram	Kollam, Trivandrum	88	Nil
39	Mamom	Kollam, Trivandrum	27	Nil
40	Karamana	Trivandrum	68	Kaviar, Thodiyar
41	Neyyar	Trivandrum	56	Kallar, Karavaliyar
42	Kabini	Wayanad		Panamaram, Mananthavady, Bavali, Noolpuzha
43	Bhavani	Palakkad		Siruvani, Varagar
44	Pambar	Idukki		Thrithamala, Eravikulam, Myladi, Chenkaloor

Sources: (1) *Water Resource of Kerala* (1984), PWD, Govt. of Kerala

(2) *Water Atlas of Kerala* (1989), CWRDM, Kozhikkode

biodiversity. There are no published works on the fish diversity of many rivers of Kerala. The River Fish Monitoring Programme of Kerala State Biodiversity Board (KSBB) is an attempt to continuously monitor the riverine ecosystems of Kerala as well as fish habitat for ascertaining the

health of the riverine ecosystems. It also envisages testing the tissue samples of fish as an indirect measure of water quality. In the long run, this programme would facilitate collection of enormous amount of data on the status of freshwater fish resources as well as fish habitats of the state.



Figure 1. Map of the rivers of Kerala

In addition to important primary data collection on fish diversity, activities such as fish monitoring provide a hands-on opportunity for people to learn more about their local environment. Ultimately the restoration and maintenance of 'healthy' river ecosystems is important in any environmental conservation programme, particularly in Kerala, as the availability of drinking water as well as food security are intricately linked to the health of the watersheds. After all, the land mass of Kerala is nothing but the watersheds of 44 rivers and therefore maintaining the health of the rivers is more important for Kerala than any other ecosystems.

FISH MONITORING

Traditionally, the assessment and monitoring of river health has been based solely on the measurement of physical, chemical and some biological characteristics. While these parameters may be efficient in temporary decision making such as regulating effluent discharge into the system, they are not generally useful for assessing the health of the riverine ecosystem for conservation and sustainable management. The biotic integrity of an ecological system is often reflected by the health of organisms that reside in that system. Of late, measurement of riverine biota, particularly benthic macro invertebrates and fish, has been used as a widely accepted method to identify structural or functional integrity of the system. These biological creatures help to show the whole status of ecology. Therefore, the observation of their changes as a biological assessment in a water body gives direct indications of water quality. The effects on biota are usually the final point of environmental degradation and pollution of rivers. In many countries use of biota for river monitoring has been integrated into the legislative instruments and

practical methodologies. Above all, the biological survey techniques are cost-effective and could be done with the involvement of even non-specialists.

Some of the advantages of using bio-surveys for this type of monitoring are:

1. Biological communities reflect overall ecological integrity (i.e. chemical, physical, and biological integrity) and therefore biosurvey results directly assess the status of a water body.
2. Biological communities integrate the effects of different stressors and thus provide a broad measure of their aggregate impact.
3. Communities integrate the stresses over time and provide an ecological measure of fluctuating environmental conditions.
4. Routine monitoring of biological communities can be relatively inexpensive, particularly when compared to the cost of assessing toxic pollutants, either chemically or with toxicity tests.
5. The status of biological communities is of direct interest to the public as a measure of a pollution free environment.
6. Where criteria for specific ambient impacts do not exist (e.g., nonpoint source impacts that degrade habitat), biological communities may be the only practical means of evaluation.

Benthic macro invertebrates and fish are generally accepted and used in bio-monitoring surveys to study the ecological integrity of rivers. Benthic macro invertebrates are preferred by the scientific community as the best choice to monitor the ecological status of rivers. However, identification of aquatic insects requires expertise and hence it

cannot be developed as a popular programme. In this context fishes are the ideal candidates to perform river monitoring studies because they are relatively well known and easy to identify. In addition, there are traditional fishing communities as well as fishermen along almost all rivers of Kerala, who are aware of the diversity of fish in the locality. The advantages of using fish for river health monitoring can be summarized as:

- (1) In all the rivers fish represent the major 'visible' component of biodiversity.
- (2) Fish are good indicators of long-term effects and broad habitat conditions because they are relatively long-lived and mobile.
- (3) Fish assemblages generally include a range of species that represent a variety of trophic levels (omnivores, herbivores, insectivores, planktivores, piscivores). They tend to integrate effects of lower trophic levels; thus, fish assemblage structure is reflective of integrated environmental health.
- (4) Freshwater fish should be viewed as important indicators of stream health due to their total reliance on aquatic environments for all life history stages.
- (5) Fish are at the top of the aquatic food web and are consumed by humans, making them important for assessing contamination.
- (6) Fish are relatively easy to collect and identify up to the species level. Most specimens can be sorted and identified in the field by experienced fisheries professionals, and subsequently released unharmed.
- (7) Environmental requirements of most fish are comparatively well known. Life history information is extensive for many species, and information on fish distributions are commonly available.
- (8) Monitoring fish provides direct evaluation of availability of fish for fisheries and for other uses by humans.

HABITAT ASSESSMENT

In fish monitoring surveys it is also customary to assess the habitat quality based on key physical characteristics of the water body and surrounding land, particularly the catchment of the site under investigation. All of the habitat parameters evaluated are related to overall aquatic life use and are a potential source of limitation to the aquatic biota. The alteration of the physical structure of the habitat is one of major factors that degrade aquatic resources and threaten the very existence of fish. Habitat, as structured by in-stream and surrounding topographical features, is a major determinant of aquatic community potential. Both the quality and quantity of available habitat affect the structure and composition of resident biological communities. When all stations under study are not physically comparable, habitat characterization is particularly important for proper interpretation of biosurvey results. When survey is made from different sites, it is possible to correlate species richness of a particular site to habitat quality.

Data sets: The following data sets shall be collected during the fish survey and the components under each set will be explained in the subsequent section on methodology.

- i. Weather conditions
- ii. Stream characterization
- iii. Watershed features
- iv. Riparian vegetation
- v. In-stream features
- vi. Aquatic vegetation
- vii. Water quality
- viii. Bottom materials
- ix. Fish

In this fish monitoring programme focus is given on variables that could be practically measured

rapidly in the field and that would not require specialised equipment or training. This can enable the monitoring programme to be conducted not only by specialists but also by nonspecialists, conservationists, school/college teachers, biology students and interested lay persons that have received some initial training. Similarly quantifiable approach is suggested to score variables and measure ecosystem health rather than sticking on to dichotomous approaches such as “yes” or “no”, which can be subjective and difficult to repeat in the remaining years or repeated by other workers with different perceptions. Though we are assessing only the current trends regarding the health of the river, this data base generated could be used as a powerful tool for monitoring and measuring future changes in the functional status of the river. Moreover, this will act as a baseline data for piscine diversity of Kerala state. This is highly relevant in the context of deteriorating health of riverine ecosystems of Kerala.

METHODOLOGY

1. SCOPING STUDY

The major objective of scoping or pilot study is to identify the locations at each geographic zone of the river for the fish survey. It should be noted that the background information of the river and its various reaches should be obtained before undertaking scoping study. A detailed map of each of the riverine ecosystems of Kerala will be made available to the study team. The map is prepared in GIS format by the Kerala Forest Research Institute. Additional details may be obtained from the following publications:

- (i) *Water Resource s of Kerala* (1984), PWD, Govt. of Kerala

- (ii) *Water Atlas of Kerala* (1989), CWRDM, Kozhikkode, and

- (iii) *Watershed Atlas* prepared by Kerala State Land Use Board.

This field trip for the study may also be used to get in touch with local fishermen/communities, who may assist in further surveys and for collecting historical data. The possibilities of establishing Biodiversity Management Committees as per the provisions in the Biological Diversity Act may also be explored in the Panchayath where collection sites are finalised. Along with this programme KSBBS is also planning to launch a programme of forming “Bio-Clubs” for each river, which will finally serve as a hub for launching river awareness and conservation programmes. Towards the end of the survey the local communities interested in river conservation activities may be identified for forming the clubs.

2. SITE SELECTION

Kerala is divided into three physiographic zones, namely lowlands (0 -7.5 m), midlands (7.5-75 m) and highlands (> 75m). For each river one survey site should be fixed for each of these zones (three for one river). For the rivers which are not originating from the high lands, an additional site may be selected in the mid land region so that the total sites remains three. The map provided for the purpose may be utilized for fixing the survey sites. The segment of the river that is to be examined should be representative of the area of interest, and should not be based on personal choices or “good” or “bad” as this would affect the final judgement of the condition of the river. It should generally be relatively uniform in character, landform, geology and vegetation. In general the sampling stations should be selected based on (i)

being representative of the particular river reach, (ii) having reasonable access and fishability, (iii) having local fisherfolk, and (iv) having velocities sufficient to carry fish downstream to the gill net. Each survey site should be approximately 200 meter in length, although longer and shorter lengths may be used to accommodate differences in stream size and unusual channel structure or habitat.

3. WEATHER (DATA SHEET 1)

Note the present weather conditions on the day of the survey as in Data Sheet 1. The climatic conditions and time of collection should be recorded.

4. STREAM CHARACTERIZATION (DATA SHEET 1)

Stream nature: Record whether the stream under survey is perennial (flows throughout the year) or ephemeral (dries up during summer).

Stream Type: The first stream originating from the micro watershed area is regarded as the first order stream, which then joins together to form second order. The second order streams in the watershed join to form the third order (Fig. 2). The downward region of major rivers in Kerala may be third, fourth or fifth order streams. Despite the importance of the rivers in terms of direct, indirect and existence values, the river systems in Kerala are not frequently monitored either for studying the ecological status or for recording fish—the major component of its biodiversity. There are no published works on the fish diversity of many rivers of Kerala.

The River Fish Monitoring Programme of Kerala State Biodiversity Board (KSBB) is an attempt to

continuously monitor the riverine ecosystems of Kerala as well as fish habitat for ascertaining the health of the riverine ecosystems. It also envisages testing the tissue samples of fish as an indirect measure of water quality. In the long run, this programme would facilitate collection of enormous amount of data on the status of freshwater fish resources as well as fish habitats of the state.

2. RIPARIAN VEGETATION (DATA SHEET 1)

An acceptable riparian zone includes a buffer strip of a minimum of 18 m from the stream on either side. The acceptable width of the riparian zone may also be variable depending on the size and nature of the stream. Streams over 4 m in width may require larger riparian zones. The vegetation within the riparian zone is documented here as the dominant one.

Channelized: Indicate whether or not the area around the sampling reach or station is channelized (e.g. straightening of stream, bridge abutments and road crossings, diversions, etc.).

Dam Present: Indicate the presence or absence of a dam upstream in the catchment or downstream of the sampling reach. This can be known from map or local enquiry.

BOTTOM SUBSTRATES (DATA SHEET 1)

The bottom substrates of the survey area are to be identified as inorganic and organic substrate types as given in Table 2. The inorganic components should be expressed as percentage composition and should add up to 100%.

Table 2. Inorganic and organic substrate types of the stream bed

A. Inorganic materials		B. Organic materials	
Substrate type	Diameter	Substrate type	Characteristics
Bedrock	(Rock exposed at the bottom as a single unit)	Detritus	sticks, wood, coarse plant materials
Boulder	> 256 mm (10")	Muck -Mud	Black, very fine organic
Cobble	64-256 mm (2.5"-10")	Marl	Grey, shell fragments
Gravel	2-64 mm (0.1"-2.5")		
Sand	0.06-2mm		
Clay	< 0.004 mm		
Silt	0.004-0.06 mm		

1. FISH DATA COLLECTION

The fish data is gathered by primary data collection from all the three sites (for one river), market data collection and historical data (secondary data) collection.

A. PRIMARY DATA COLLECTION (DATA SHEET 2)

For primary data collection, fish catch details are recorded from each of the zone. Both cast nets (8 muzham) and gill nets (2-2.5 cm mesh size) are used for the purpose. The cast nets are operated 10 times, covering a distance of 200m in the sampling area (not repeated by on the same place). The number of fish species collected during each casting should be recorded in the data sheet appended (Data Sheet 2).

Before beginning the cast net operations, the gill net shall be set across the river/stream (preferably at a narrowest region). The gill net is to be kept for a minimum period of one hour (duration should

be noted in data sheet). As in the case above, the number of species of fish obtained during each netting should be recorded separately in the data sheet. There may be areas which are not suitable for gill netting. In this case, the cast netting should not be increased. Fish collection may also be done with other conventional gears such as hook and line, mosquito nets (necessary for collecting benthic forms such as loaches), etc. In this case also data should be recorded separately in the data sheet (other nets). Mention the method/gear used in the data sheet.

The collected fishes with known identity may be released back into the river after counting and photography, if any. The other species may be preserved in 5 per cent formalin for further taxonomic studies. The suspicious and unidentified species, if any, may be recorded as unidentified 1, 2, 3, etc. in the data sheet and need to be corrected once identification is complete. Anomalies recorded in fish (if any) may be recorded in the

data sheet as deformities (Eg. eroded fins, fungus, lesions, multiple anomalies, emaciated, etc.)

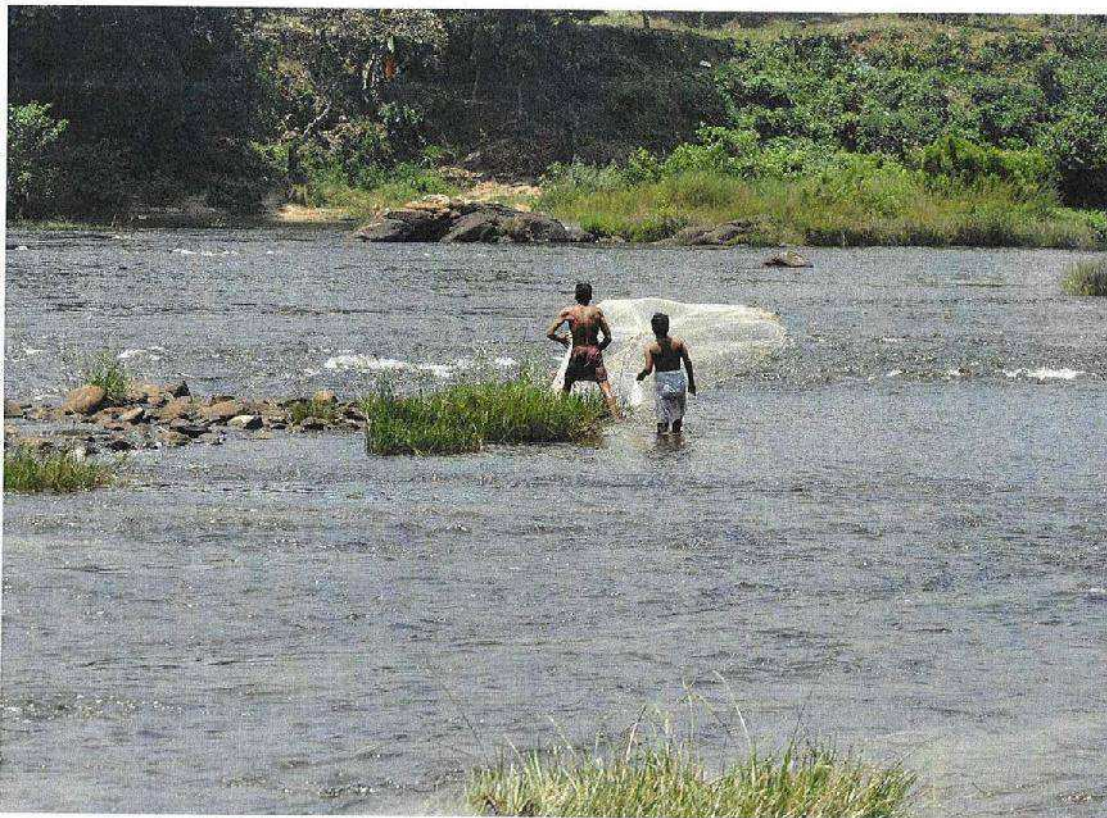
The identification guide prepared by KSBB may be used for identification purpose along with other classic publications in the field (Talwar and Jhingran, 1991; Jayaram, 1999/2009) and the website of Fish Base (www.fishbase.org). The species with doubtful identify were forwarded to Dr. C.P. Shaji (E mail: shajibarb@gmail.com) and Dr. A. Biju Kumar, Dept. of Aquatic Biology & Fisheries, University of Kerala, Thiruvananthapuram 695 581, Kerala (E mail: abiju@rediffmail.com; Telefax: 0471 2308131; 94472 16157) for identification.

Landing centers adjoining the river should be visited by the members of the study team; most

landing centers are active only in the early morning hours and in some cases during evening hours. The type (species) and number of fish collected from the landing center should be recorded in the data sheet appended. Care should be taken to record at least 20% of the actual catch. While collecting data it is to be ensured that the fish in the market is from the river in which sampling is made.

B. SECONDARY DATA COLLECTION (DATA SHEET 2)

The secondary data collection involves collection of information from the fishing communities and elderly persons who have good information on the fish fauna available in the river. The data collected were recorded in the data sheet provided.



1. MANJESHWARAM RIVER**Table 3.** Fishes of Manjeswaram river

Manjeshwaram is the smallest river in Kasaragod district. The river originates from the Balappoomanimalai, the shrub-covered hills situated at the northern border of Kerala at an elevation of 60m above msl and empties into the Uppala lake. This river has a length of 16 km and a catchment area of 90 sq. km, width of 10-50m and depth. 2-9m. Salinity usually intrudes the river during the high tide and salinity has become a critical factor influencing the faunal and floral assemblage of the river. The midland part of the river dries up during summer. Municipal garbage, house hold garbage was reported to have dumped in the river. The main ecological constraint of the river is unregulated and illegal sand mining. Several small impediments like check dams have been built across the river.

The bed of the river is sandy or muddy in most parts. The other substrates like bedrock and boulders are found in very small portion of the river. The predominant riparian vegetation and land use pattern is agricultural land of mixed crops. The canopy cover over the river is almost nil. No point source of pollution has been detected during the survey. The aquatic vegetation is dominated by rooted and submerged hydrophytes.

The water was colourless and odourless during the survey period. The pH was within the range 6.5-7.5.

The fishes of Manjeswaram river were surveyed by Biju *et al.* (1999a) which is also considered for the updating of the list. The annotated list of fishes compiling the earlier reports and the results of the present survey is given in the Table 3.

FAMILY ANGUILLIDAE

1. *Anguilla bengalensis* (Gray)

FAMILY CYPRINIDAE

2. *Puntius mahecola* (Val)
3. *Puntius parrah* (Day)
4. *Puntius filamentosus* (Val.)
5. *Puntius vittatus* Day
6. *Amblypharyngodon melettinus* (Val)
7. *Barilius gatensis* (Valenciennes)
8. *Barilius canarensis* (Jerdon)
9. *Devario aequulpinatus* (McClelland)
10. *Devario malabaricus* (Jerdon)
11. *Rasbora dandia* (Valenciennes)
12. *Garra mullya* (Sykes)

FAMILY COBITIDAE

13. *Lepidocephalus thermalis* (Val)

FAMILY BAGRIDAE

14. *Mystus gulio* (Ham.-Buch.)
15. *Mystus armatus* (Day)
16. *Mystus ocellatus* (Valenciennes)
17. *Mystus montanus* (Jerdon)

FAMILY HETEROPNEUSTIDAE

18. *Heteropneustes fossilis* (Bloch)

FAMILY CLARIIDAE

19. *Clarias dussumeiri* (Valenciennes)

FAMILY BELONIDAE

20. *Xenentodon cancila* (Ham.-Buch.)

FAMILY APLOCHEILIDAE

21. *Aplocheilichthys lineatus* (Val.)

FAMILY THERAPONIDAE

22. *Terapon jarbua* (Forsk.)

FAMILY GERREIDAE

23. *Gerres filamentosus* Cuvier

FAMILY CICHLIDAE

24. *Etroplus maculatus* (Bloch)
25. *Etroplus suratensis* (Bloch)
26. *Oreochromis mossambicus* (Peters)

FAMILY MUGILIDAE27. *Mugil cephalus* Linn.**FAMILY GOBIDAE**28. *Glossogobius giuris* (Ham.-Buch.)**FAMILY BELONTIDAE**29. *Pseudosphromenus cupanus* (Cuvier)**FAMILY SYMBRACHIDAE**30. *Ophisternon bengalense* McClelland

Table 4. Seriation Table to illustrate the fishes in different sections of Manjewaram river.

No. Fish species.	HL	ML	LL
1. <i>Bariilus gatensis</i>	1	1	0
2. <i>Lepidocephalus thermalis</i>	1	1	0
3. <i>Garra mullya</i>	1	1	0
4. <i>Mystus montanus</i>	1	1	0
5. <i>Bariilus bakeri</i>	1	1	0
6. <i>Mystus oculatus</i>	0	1	0
7. <i>Mystus gulio</i>	0	1	0
8. <i>Etrophus suratensis</i>	0	1	0
9. <i>Clarias dussumieri</i>	0	1	0
10. <i>Mugil cephalus</i>	0	1	0
11. <i>Etrophus maculatus</i>	0	1	0
12. <i>Heteropneustes fossilis</i>	0	1	0
13. <i>Amblypharyngodon meletinus</i>	0	1	0
14. <i>Xenentodon cancila</i>	1	1	1
15. <i>Puntius filamentosus</i>	1	1	1
16. <i>Puntius mahecola</i>	1	1	1
17. <i>Puntius parrah</i>	0	1	1
18. <i>Ophisternon bengalense</i>	0	1	1

HL-High land; ML-Midland; LL-Low land

The uniform sampling in all the three zones revealed that 8 species were not represented in the highland section and 13 species from low land regime. From the Table 4, it is obvious that *Xenentodon cancila*, *Puntius filamentosus* and *Puntius mahecola* were the species present in all the three zones of the river. It is also significant to note that all the 18

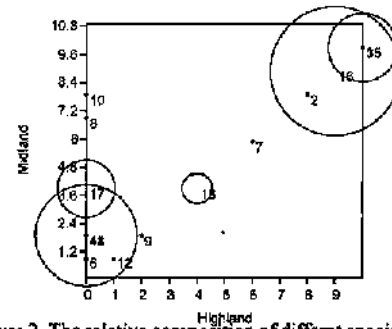


Figure 2. The relative composition of different species in the sampling (No. corresponds to Table 4.)

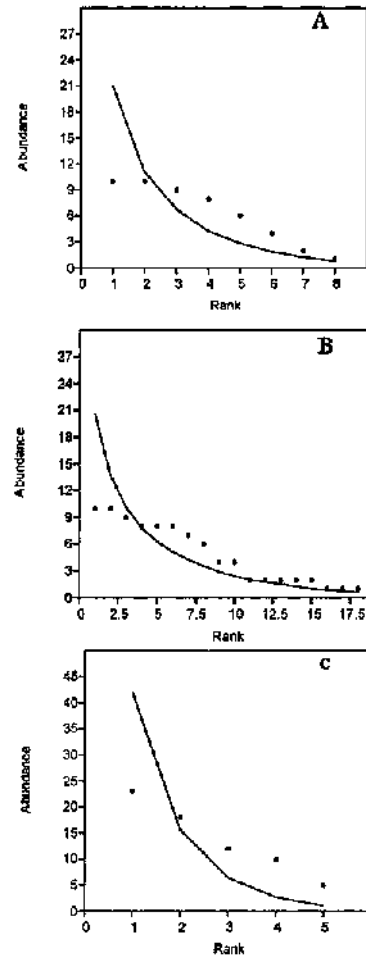


Figure 3. Abundance pattern of fishes in the three zones of Manjewaram river (A-Highland, B-midland, C-lowland)

species represented in the sampling, were abundant in different ratio in the midland stretches of the river. *Ophisternon bengalense*, inhabits freshwaters, quite adjacent to the coastal areas is represented in the middle and lowland stretches.

From the Figure 2, it is apparent that *Puntius filamentosus*, *P. mahecola* and *Barilius gatensis* (Figure 4) are the dominant species in the highland and midland where as *Ophisternon bengalense*, *Puntius filamentosus* (Figure 5), *Puntius mahecola* and *Puntius parrah* outnumbered in the lowland region. *Xenentodon cancila* and *Puntius filamentosus* equally abundant in all the three zones. More or less a uniform pattern of abundance is observed in the midland of the Manjewaram river (Fig. 3).

2. UPPALARIVER

The Uppala river originates from the Veerakamba hills in Karnataka State at an altitude of 150m above msl and it flows southwards about 7 km, then west about 13 km through Kamataka State. The river then flows 6 km through the Karnataka-Kerala border and enters Kasargod district. The river discharges into the backwaters near Uppala. Manjeswaram river joins the same backwaters at the right bank. Uppala river has a length of 50 km and a catchment area of 250 Km² of which 174 Km² belongs to Kamataka State.

The riparian vegetation and land use pattern adjacent to the Uppala river are mainly agricultural lands. No point or other source of pollution has been detected by the survey team. The mixed crops on either side of the river banks is the only polluting source. The pH ranged between 7-7.5 and water is colourless and odourless. The dominant substrate



Figure 4. *Barilius gatensis* (Val)



Figure 5. *Puntius filamentosus* (Val)

of the river bed is sand (95%) and in few places pebbles (5%) also forms the river bed. The rooted hydrophytes and submerged hydrophytes are the dominant aquatic plants.

The fishes of Uppala river has been documented by Biju *et.al.* (1999b; Biju, 2003). The present monitoring programme documented some more species and the updated list is given in Table 5.

Table 5. Fishes of Uppala river

FAMILY -MEGALOPIDAE

1. *Megalops cyprinoids* (Broussonet)

FAMILY - ANGUILLIDAE

2. *Anguilla bengalensis* (Gray)

FAMILY - CYPRINIDAE

3. *Puntius mahecola* (Val.)
4. *Puntius fasciatus* (Jerdon)
5. *Puntius filamentosus* (Val.)
6. *Puntius vittatus* Day
7. *Amblypharyngodon melettinus* (Val.)

8. *Barilius gatensis* (Val.)
 9. *Barilius canarensis* (Jerdon)
 10. *Devario malabaricus* (Jerdon)
 11. *Rasbora dandia* (Hamilton)
 12. *Garra mullya* (Sykes)
FAMILY: COBITIDAE
 13. *Lepidocephalus thermalis* (Val.)
FAMILY - BAGRIDAE
 14. *Mystus gulio* (Ham.-Buch.)
 15. *Mystus armatus* (Day)
 16. *Mystus montanus* (Jerdon)
 17. *Mystus oculatus* (Val.)
FAMILY: HETEROPNEUSTIDAE
 18. *Heteropneustes fossilis* (Bloch)
FAMILY - BELONIDAE
 19. *Xenentodon cancila* (Ham.-Buch.)
 20. *Hyphramphus limbatus* (Valenciennes)
FAMILY - APLOCHEIIDAE
 21. *Aplocheilichthys imbecilis* (Val.)
FAMILY - SYNGNATHIDAE
 22. *Microphis cuncalus* (Hamilton, 1822)
FAMILY - AMBASSIDAE
 23. *Ambassis miops* Günther
 24. *Parambassis thomassi* (Day, 1870)
FAMILY: TERAPONIDAE
 25. *Terapon jarbua* (Forsk.)
FAMILY: GERREIDAE
 26. *Gerres filamentosus* Cuvier
FAMILY: CICHLIDAE
 27. *Etilapia maculatus* (Bloch)
 28. *Etilapia suratensis* (Bloch)
 29. *Oreochromis mossambicus* (Peters)
FAMILY: MUGILIDAE
 30. *Mugil cephalus* Linn.
FAMILY: GOBIDAE
 31. *Awous gutum* (Hamilton)
 32. *Glossogobius giuris* (Ham.-Buch.)
FAMILY: BELONTIDAE
 33. *Pseudosphromenus cupanus* (Cuvier)

Since the river originates at low elevation, delineation of highland was impossible. Hence the

Table 6. Seriation Table to illustrate the fishes in ML and LL of Uppala river.

No. Fish species.	ML	LL
1 Heteropneustes fossilis	1	0
2 Garra mullya	1	0
3 Amblypharyngodon melettinus	1	0
4 Barilius bakeri	1	0
5 Lepidocephalus thermalis	1	0
6 Mystus gulio	1	1
7 Puntius filamentosus	1	1
8 Puntius mahecola	1	1
9 Puntius parrah	1	1
10 Clarias dussumieri	1	1
11 Puntius vittatus	1	1
12 Barilius gatensis	1	1
13 Etroplus suratensis	0	1
14 Mugil cephalus	0	1
15 Mystus montanus	0	1
16 Etroplus maculatus	0	1
17 Megalops cyprinoides	0	1

ML-Midland; LL-Low land 1- present; 0-absent

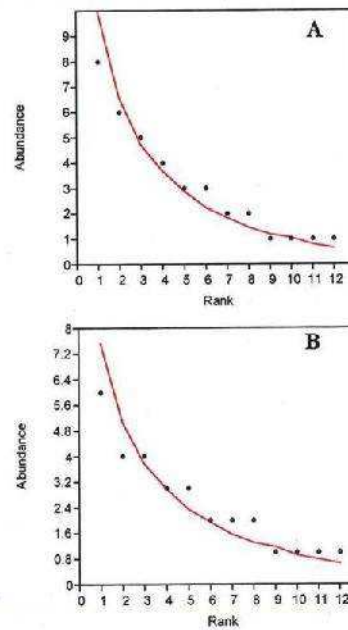


Figure 6. Abundance pattern of fishes in the two zones of Uppala river (A--midland, B-lowland)

entire river stretch is divided into two sections, the lowland and midland. From the Table 6, it is discernible that 12 species are present in both the midland and low land region. *Mystus gulio*, *Puntius filamentosus*, *Puntius mahecola* (Figure 7), *Puntius parrah* (Figure 8), *Clarias dusumeiri*, *Puntius vittatus* and *Barilius gatensis* were common throughout the river.

The lowland is dominated by estuarine dweller, *Mugil cephalus*. The abundance of the fishes in the highland and lowland in the Uppala river is illustrated in Figure 6. All the 17 species represented in the collection maintains a uniform pattern of abundance with slight variation. *Barilius gatensis* is the most dominating species in the Uppala river which is followed by *Puntius filamentosus*. *Amblypharyngodon melettinus*, *Puntius mahecola*, *Puntius parrah* and *Puntius vittatus* (Figure 9) are more or less equally abundant.

3. SHIRIYA RIVER

Shiriya river originates from Anekundi Reserve Forest in Karnataka at an elevation of about 230m, above msl. This is an inter State river, flowing through the villages Puttige, Mugu, Angadimogaru, Badoor, Maire, Kudlamerkala, Arikadi, Ujar, Ulvar and Bombrana. The river then flows in a westerly direction for 10 km, through the villages Kayyar, Ichlanged, Shiriya and Bombrana, before joining the sea through the Kumbala Backwaters. The Kumbala, a small stream, originating in Ednad, also empties into the same backwaters. The Pallatadka Hole, a tributary of the Shiriya river originates from Karnataka Reserve Forest and joins the main river from the left in Angadimogaru village. The other important tributaries are the Kallajethodu, the Kanyanathodu and the Erramatti Hole. The upper

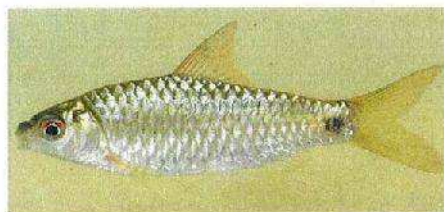


Figure 7. *Puntius mahecola* (Val)



Figure 8. *Puntius parrah* (Day)



Figure 9. *Puntius vittatus* (Day)

reaches of the main river are variously known as Adkastala Hole, Badantodka Hole, Mudnuru Hole, etc at different reaches. The length of the river is 67 Km. The total drainage area of the river is 587Km², out of which 297Km², lies in Karnataka.

The river is ephemeral and approximate width is 50m. The river banks are occupied by cashew plantations maintained by the Plantation Corporation Kerala Ltd (PCKL) and hence the canopy cover in most of the places is almost nil. In between the cashew plantations, some private occupied land is also there where the areca nut and other cash crops are raised. The aquatic vegetation is sparse and is dominated by rooted and submerged hydrophytes. Bed rock forms the dominant substrate.

The fishes of Shiriya river has been documented by Biju (2003). Some more species were also recoded during this survey. An updated list is given in Table 7.

Table 7. Fishes of Shiriya river

FAMILY CLUPEIDAE

1. *Dayella malabarica* (Day)

FAMILY -MEGALOPIDAE

2. *Megalops cyprinoids* (Broussonet)

FAMILY: CYPRINIDAE

3. *Devario malabaricus* (Jerdon)

4. *Amblypharyngodon melettinus* (Vale)

5. *Rasbora dandia* (Valenciennes)

6. *Barilius bakeri* (Jerdon)

7. *Barilius gatensis* (Valenciennes)

8. *Osteochilichthys nashii* (Day)

9. *Barbodes subnasutus* (Valenciennes)

10. *Puntius chola* (Hamilton)

11. *Puntius fasciatus* (Jerdon)

12. *Puntius filamentosus* (Valenciennes)

13. *Puntius mahecola* (Valenciennes)

14. *Puntius punctatus* (Day)

15. *Puntius vittatus* (Day)

16. *Garra mullya* (Sykes)

FAMILY: BALITORIDAE

17. *Mesonemacheilus triangularis* (Day)

FAMILY :COBITIDAE

18. *Lepidocephalus thermalis* (Val.)

FAMILY - BAGRIDAE

19. *Mystus gulio* (Ham.-Buch.)

20. *Mystus armatus* (Day)

21. *Mystus montanus* (Jerdon)

22. *Mystus oculatus* (Val.)

FAMILY: SILURIDAE

23. *Ompok bimaculatus* (Bloch)

FAMILY: CLARIIDAE

24. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

25. *Heteropneustes fossilis* (Bloch)

FAMILY: GOBIDAE

26. *Awous gutum* (Hamilton)

27. *Glossogobius giuris* (Ham.-Buch.)

FAMILY - AMBASSIDAE

28. *Parambassis thomassi* (Day)

FAMILY: CICHLIDAE

29. *Etilopius maculatus* (Bloch)

30. *Etilopius suratensis* (Bloch)

31. *Oreochromis mossambicus* (Peters)

FAMILY: NANDIDAE

32. *Nandus nandus* (Ham-Buch)

FAMILY: ANABANTIDAE

33. *Anabas testudineus* (Bloch)

FAMILY: MUGILIDAE

34. *Mugil cephalus* Linn.

FAMILY - BELONIDAE

35. *Xenentodon cancila* (Ham.-Buch.)

36. *Hyporhamphus limbatus* (Val.)

FAMILY - APLOCHEIIDAE

37. *Aplocheilus lineatus* (Val.)

FAMILY: BELONTIDAE

38. *Pseudosphromenus cupanus* (Cuvier)

FAMILY - SYNGNATHIDAE

39. *Microphis cuncalus* (Ham.-Buch.)

Table 8. Seriation Table to illustrate the fishes in different sections of the Shiriya river

No	Fish species	ML	LL
1.	<i>Amblypharyngodon melettinus</i>	1	0
2.	<i>Awous gutum</i>	1	0
3.	<i>Barilius bakeri</i>	1	0
4.	<i>Barilius gatensis</i>	1	1
5.	<i>Clarias dussumieri</i>	1	0
6.	<i>Etilopius maculatus</i>	1	1
7.	<i>Etilopius suratensis</i>	1	1
8.	<i>Garra mullya</i>	1	0
9.	<i>Heteropneustes fossilis</i>	1	0
10.	<i>Hyporhamphus limbatus</i>	1	1
11.	<i>Lepidocephalus thermalis</i>	1	0
12.	<i>Megalops cyprinoides</i>	0	1
13.	<i>Mugil cephalus</i>	0	1
14.	<i>Osteochilichthys nashii</i>	1	1
15.	<i>Puntius filamentosus</i>	1	1
16.	<i>Puntius mahecola</i>	1	0
17.	<i>Puntius parrah</i>	1	0
18.	<i>Xenentodon cancila</i>	1	1

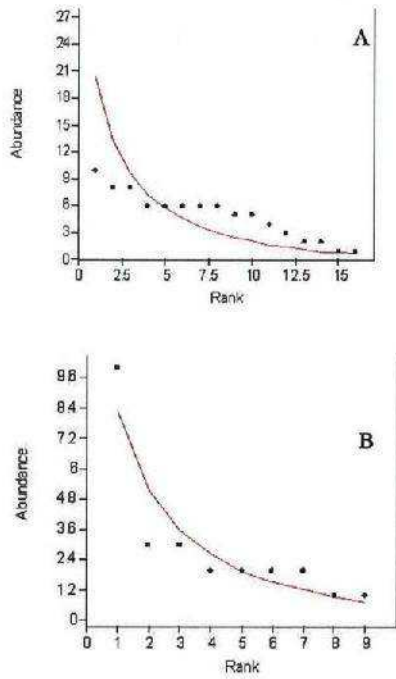


Figure 10. Abundance pattern of fishes in the two zones of Shiriya river (A--midland, B-lowland)

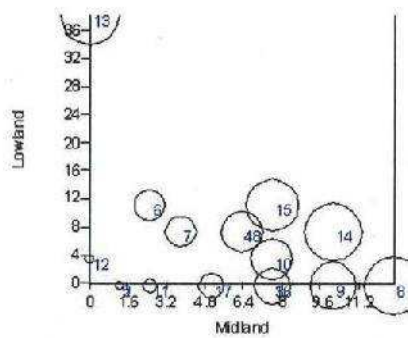


Figure 11. Bubble plot to show the relative composition of different species in the sampling. Disc represents the overall abundance (Table 8 for sp.no).

A total of 39 species were recorded from the Shiriya river. The present uniform sampling yielded 18 species with varying abundance. The estuarine

dwellers like *Microphis cuncalus* (Ham-Buch), *Mugil cephalus* were reported from the lowland reaches of the river. Total 67 individual were recorded from the midland and 40 individuals were recorded from the lowland. A uniform abundance was observed in the midland whereas in low land certain species dominated (Figure 10 a&b). Out of the 18 species recorded, 16 species represented the midland and two species viz. *Megalops cyprinoids* and *Mugil cephalus* were absent in the sampling. In the low land, nine species were recorded during the sampling. *Garra mullya*, *Lepidocephalus thermalis*, *Puntius parrah*, *P. filamentosus*, *Heteropneustes fossilis*, *Clarias dussumieri*, *Barilius bakeri* and *Barilius gatensis* were not recorded from the lowland.

Megalops cyprinoids (Figure 12 a) and *Mugil cephalus* are primarily estuarine species and the latter was the most abundant species in the midland. *Puntius filamentosus* and *P. parrah* has maintained an equal dominance in the midland. The abundance of each the species in the midland, lowland and overall composition is plotted in the Figure 11.



Figure 12 a. *Megalops cyprinoids* (Broussonet)



Figure 12 b. *Mugil cephalus* (Linn)

4. MOGRAL RIVER

This river originates from Kanathur in Karadka Reserve Forests in Kasargod taluk. It flows in a north-westerly direction through Bettipadi and Muliya where it is joined by another stream originating from the northern part of Karadka Reserve Forest. From Yedhir, the river takes a meandering course and flows through fairly flat regions of Madhur and Patla. Muliya and Nellipady are the main tributaries of Mogral River. Before emptying into the Arabian Sea it forms a long stretch of backwaters about 5Km. in length. The river does not have permanent estuary. During rainy season the river mouth will be opened temporarily. The river has a length of 34 km. of which a distance of 20km. from the sea mouth is tidal. It has a drainage area of 132 Km²

The quantum of water in this river is very less compared to other rivers. The main ecological problem of the river is sand mining. The banks at the lower reaches of river are vegetated by mangroves species. During high tide, major part of the river gets mixed with salt water.

Predominant land use type is the cashew plantations maintained by the PCKL and agricultural lands. The average width of the stream is 50m. Water is colourless and odourless at the time of sampling.

The fishes of the Mogral river have been documented by Biju (2003). Including the results of the present survey, an annotated list is given in the Table 9. Altogether 34 fishes are currently known from the Mogral river. *Dayella malabarica* (Day), *Megalops cyprinoides* (Broussonet), *Macrornathus guentheri* (Day), *Mastacembelus armatus* (Lacepede), *Parambassis thomassi* (Day), *Mesonoemacheilus triangularis* (Day)

and *Nandus nandus* (Ham-Buch) which were recorded through the earlier surveys could not be located during the present survey (Table 9). The rarity of the species could be one of the reason for their absence in the present sampling.

Table 9. Annotated list of fishes of Mogral river

FAMILY CLUPEIDAE

1. *Dayella malabarica* (Day)

FAMILY -MEGALOPIDAE

2. *Megalops cyprinoides* (Broussonet)

FAMILY: CYPRINIDAE

3. *Devario malabariucus* (Jerdon)

4. *Amblypharyngodon melettinus* (Val)

5. *Rasbora dandia* (Valenciennes)

6. *Barilius canarensis* (Jerdon)

7. *Barilius gatensis* (Valenciennes)

8. *Osteochilichthys nashii* (Day)

9. *Barbodes subnasutus* (Valenciennes)

10. *Puntius filamentosus* (Valenciennes)

11. *Puntius mahecola* (Valenciennes)

12. *Puntius punctatus* (Day)

13. *Puntius vittatus* (Day)

14. *Garra mullya* (Sykes)

FAMILY: BALITORIDAE

15. *Mesonoemacheilus triangularis* (Day)

FAMILY :COBITIDAE

16. *Lepidocephalus thermalis* (Val.)

FAMILY - BAGRIDAE

17. *Mystus oculatus* (Val.)

FAMILY: CLARIIDAE

18. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

19. *Heteropneustes fossilis* (Bloch)

FAMILY: GOBIDAE

20. *Awous gutum* (Hamilton)

21. *Glossogobius giuris* (Ham.-Buch.)

FAMILY : MASTACEMBELIDAE22. *Macrornathus guentheri* (Day)23. *Mastacembelus armatus* (Lacepede)**FAMILY - AMBASSIDAE**24. *Parambassis thomassi* (Day)**FAMILY: CICHLIDAE**25. *Etilopius maculatus* (Bloch)26. *Etilopius suratensis* (Bloch)27. *Oreochromis mossambicus* (Peters)**FAMILY: NANDIDAE**28. *Nandus nandus* (Ham-Buch)**FAMILY: ANABANTIDAE**29. *Anabas testudineus* (Bloch)**FAMILY: BELONTIDAE**30. *Pseudosphromenus cupamus* (Cuvier)**FAMILY: MUGILIDAE**31. *Mugil cephalus* Linn.**FAMILY - BELONIDAE**32. *Xenentodon cancila* (Ham.-Buch.)33. *Hyporhamphus limbatus* (Valenciennes)**FAMILY - APLOCHEILIDAE**34. *Aplocheilichthys lmeatus* (Val.)

Of the 34 species known from the Mogral river, 18 species were represented in the sampling (Table 10). Except *Mugil cephalus* all the species were recorded from the midland. The lower reaches of the river characterised by saline intrusion harboured only 7 species. It is obvious from the Table 10 that the cyprinids, cobitids and bagrids which are the primary freshwater fishes were absent in the low land.

Analyses for the abundance of the fishes in the sampling revealed that the midland maintained a uniform abundance of most of the species. However, the lower reaches were dominated by certain specialists such as *Mugil cephalus* and *Megalops cyprinoids* (Figure 13; Table

Table 10. Abundance pattern of fishes in the two zones of Mogral river (A--midland, B-lowland; C-Lowland)

No Fish species	ML	LL
1. <i>Amblypharyngodon meletinus</i>	6.00	0
2. <i>Awous gutum</i>	1.00	0
3. <i>Barilius bakeri</i>	6.00	0
4. <i>Barilius gatensis</i>	14.00	0
5. <i>Clarias dussumieri</i>	1.00	0
6. <i>Etilopius maculatus</i>	5.00	2.33
7. <i>Etilopius suratensis</i>	5.00	3.49
8. <i>Garra mullya</i>	10.00	0
9. <i>Heteropneustes fossilis</i>	8.00	0
10. <i>Hyporhamphus limbatus</i>	7.00	6.98
11. <i>Lepidocephalus thermalis</i>	2.00	0
12. <i>Megalops cyprinoids</i>	0.00	1.00
13. <i>Mugil cephalus</i>	00.00	10.00
14. <i>Puntius filamentosus</i>	9.00	6.98
15. <i>Puntius mahecola</i>	6.00	0.00
16. <i>Puntius parrah</i>	4.00	0.00
17. <i>Xenentodon cancila</i>	7.00	5.81

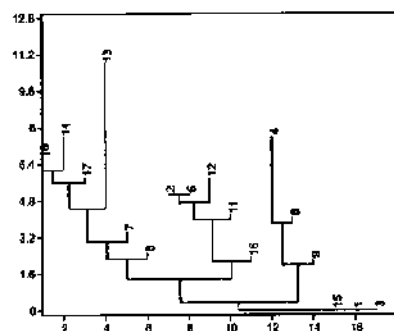


Figure 13. Neighbourhood clustering based on abundance of fishes in the two zones of Mogral river. (number corresponds to Table 11)

10). *Amblypharyngodon meletinus*, *Barilius bakeri* and *Puntius mahecola* were equally abundant in midland of mogral river (6.00) and found to be absent in the lower regime of the river. *Barilius gatensis* is the most abundant species (14.00) in the middle zone and this was followed by *Garra mullya* (10.00)

5. CHANDRAGIRI RIVER

Chandragiri River flows through Karnataka and Kerala states and it originates from the highlands of Coorg Ranges of the Western Ghats. The length of this river is 105 Km. Chandragiri is the longest river in the Kasaragod district. Highland, midland and lowland shows the diversity in the flora and fauna. The proposed Moonaamkadavu dam is across this river. Moonaam kadavu, Kottodi puzha, Adhoor river, Parappachal, Karicheri Puzha, Painikkara thodu and Payaswini are the main tributaries of Chandragiri. The main source of fresh water for the people in Kasaragod is Chandragiri. The other name of Chandragiri is 'Payaswini' which means "elixir". There is no sign of industrial effluents to this river. But Municipal and house hold garbage are reported to be dumped in the river. The main ecological problem of the river is sand mining. The river ultimately reaches the Arabian sea at Kasaragod estuary.

Forty two species of fishes were reported to occur in the Chandragiri river. Of these, 26 species were represented in the sampling with varying frequencies (Table 11).

Table 11. Annotated list of fishes of Chandragiri river.

FAMILY CLUPEIDAE

1. *Dayella malabarica* (Day)

FAMILY -MEGALOPIDAE

2. *Megalops cyprinoids* (Broussonet)

FAMILY -ANGUILLIDAE

3. *Anguilla bengalensis* (Gray)

FAMILY: CYPRINIDAE

4. *Devario malabaricus* (Jerdon)
5. *Amblypharyngodon melettinus* (Val)
6. *Rasbora dandia* (Valenciennes)

7. *Barilius bakeri* Day
8. *Barilius gatensis* (Valenciennes)
9. *Salmophasia acinaces* (Valenciennes)
10. *Salmophasia boopis* (Day)
11. *Horadandia atukorali* Deraniyagala
12. *Osteochilichthys nashii* (Day)
13. *Hypselobarbus jerdoni* (Day)
14. *Barbodes subnasutus* (Val)
15. *Puntius demisonii* (Day)
16. *Puntius fasciatus* (Jerdon)
17. *Puntius filamentosus* (Valenciennes)
18. *Puntius mahecola* (Valenciennes)
19. *Puntius punctatus* (Day)
20. *Puntius vittatus* (Day)
21. *Garra mullya* (Sykes)

FAMILY: BALITORIDAE

22. *Mesonemacheilus triangularis* (Day)

FAMILY: COBITIDAE

23. *Lepidocephalus thermalis* (Val.)

FAMILY: BAGRIDAE

24. *Mystus armatus* (Day)
25. *Mystus malabaricus* (Jerdon)
26. *Mystus oculatus* (Val.)
27. *Mystus gulio* (Hamilton)

FAMILY: SILURIDAE

28. *Wallago attu* (Bloch and Schneider)
29. *Ompok bimaculatus* (Bloch)

FAMILY: CLARIIDAE

30. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

31. *Heteropneustes fossilis* (Bloch)

FAMILY: GOBIDAE

32. *Awous gutum* (Hamilton)
33. *Glossogobius giurii* (Ham.-Buch.)

FAMILY: MASTACEMBELIDAE

34. *Macrogathus guentheri* (Day)
35. *Mastacembelus armatus* (Lacepede)

FAMILY - AMBASSIDAE

36. *Parambassis thomassi* (Day)

FAMILY: CICHLIDAE

37. *Etoplus maculatus* (Bloch)
 38. *Etoplus suratensis* (Bloch)
 39. *Oreochromis mossambicus* (Peters)

FAMILY: NANDIDAE

40. *Nandus nandus* (Ham-Buch)
 41. *Pristolepis malabaricus* (Jerdon)

FAMILY: ANABANTIDAE

42. *Anabas testudineus* (Bloch)

FAMILY: BELONTIDAE

43. *Pseudosphromenus cupanus* (Cuvier)

FAMILY: MUGILIDAE

44. *Mugil cephalus* Linn.

FAMILY - BELONIDAE

45. *Xenentodon cancila* (Ham.-Buch.)
 46. *Hyprhamphus limbatus* (Val.)

FAMILY - APLOCHEIIDAE

47. *Aplocheilus lmeatus* (Val.)

FAMILY: CHANNIDAE

48. *Channa marulius* (Hamilton)
 49. *Channa straita* (Bloch)
 50. *Channa gachua* (Bloch)

FAMILY SYNGANTHIDAE

51. *Microphis cunocalus* (Hamilton)

FAMILY: SYNBRANCHIDAE

52. *Ophisternon bengalense* McClelland

The results of the surveys conducted by Biju et al (1999b), Fasa and Shaji (2002) and Biju (2003) were also referred for the compilation of this updated list. Altogether 52 species were recorded from the Chandragiri River. *Dayella malabarica* (Figure 14), *Megalops cyprinoids*, *Microphis cunocalus*, *Mugil cephalus* are primarily estuarine species. However, the present uniform sampling to estimate the abundance of the fish species yielded only 30 species (Table 12). *Puntius mahecola*, *Puntius parrah* and *Puntius vittatus* were the fishes present throughout the river.

Table 12. Seriation Table to illustrate the fishes in different sections of the Chandragiri river

No Fish species	HL	ML	LL
1. <i>A. melettinus</i>	0	1	0
2. <i>Anguilla bengalensis</i>	0	1	0
3. <i>Avouis gutum</i>	0	1	0
4. <i>Barilius gatensis</i>	1	1	0
5. <i>Channa striata</i>	0	1	0
6. <i>Clarias dussumieri</i>	1	1	1
7. <i>Garra mullya</i>	1	1	0
8. <i>Heteropneustes fossilis</i>	1	0	0
9. <i>Horadandia atukorali</i>	1	1	0
10. <i>Hyprhamphus limbatus</i>	1	1	0
11. <i>Hypselobarbus jerdoni</i>	1	1	0
12. <i>Hypselobarbus thomassi</i>	1	0	0
13. <i>Lepidocephalus thermalis</i>	1	1	0
14. <i>Monopterus fossorius</i>	1	0	0
15. <i>Mystus gulio</i>	0	1	1
16. <i>Mystus montanus</i>	0	1	0
17. <i>Mystus oculatus</i>	0	1	0
18. <i>Ompok bimaculatus</i>	1	0	0
19. <i>Ophisternon bengalense</i>	1	1	0
20. <i>O. mossambicus</i>	0	1	0
21. <i>Parambassis thomassi</i>	1	0	0
22. <i>Puntius conchoniis</i>	1	1	0
23. <i>Puntius denisonii</i>	1	1	0
24. <i>Puntius fasciatus</i>	0	1	0
25. <i>Puntius filamentosus</i>	1	1	1
26. <i>Puntius mahecola</i>	1	1	1
27. <i>Puntius parrah</i>	1	1	1
28. <i>Puntius vittatus</i>	1	1	1
29. <i>Salmophasia acinaces</i>	1	1	0
30. <i>Xenentodon cancila</i>	1	0	0

HL-High land; ML-Midland; LL-Low land



Figure 14. *Dayella malabarica* (Day)

The abundance pattern shows that all the three zones of the river have an unequal abundance of fish species. Certain species (*Garra mulya* and *Puntius conchonus*) abounded in the upper reaches of the river (Figure 15 A). *Anguilla bengalensis*, *Mystus montanus*, *Channa striata*, *Oreochromis mossambicus*, *Amblypharyngodon melettinus*, *Puntius fasciatus*, *Mystus oculatus*, *Awous gutum* and *Mystus gulio* were not recorded from the highland stretches of the river. A total of 22 species were collected from the high land area.

The midland was packed by 26 species and the middle zone was noted for the absence of 6 species viz. *Xenentodon cancila*, *Heteropneustes fossilis*, *Hypselobarbus thomassi*, *Monopterus fossorius*, *Ompok bimaculatus* and *Parambassis thomassi*. The middle zone also had an uneven abundance of fishes (Figure 15 A-C). *Garra mulya* and *Puntius fasciatus* were the most abundant species in this zone. These species were followed by *Barilius gatensis*, *Puntius mahecola*, *Puntius filamentosus*, *Puntius vittatus*, *Amblypharyngodon melettinus* and *Puntius parrah* (Table 13; Figure 15). The remaining fishes maintained a uniform pattern of abundance.

Table 13. Abundance of fish species in the sampling of Chandragiri river

No	Fish species	HL	ML	LL
1	<i>A. melettinus</i>	0.00	4.26	0.00
2	<i>Anguilla bengalensis</i>	0.00	0.67	0.00
3	<i>Awous gutum</i>	0.00	1.79	0.00
4	<i>Barilius gatensis</i>	0.67	5.61	0.00
5	<i>Channa striata</i>	0.00	0.67	0.00
6	<i>Clarius dusumieri</i>	0.22	1.12	1.12
7	<i>Garra mulya</i>	7.85	10.76	0.00
8	<i>Heteropneustes fossilis</i>	0.22	0.00	0.00
9	<i>Horadandia attukorali</i>	0.22	0.22	0.00
10	<i>Hyporhamphus limbatus</i>	0.67	1.35	0.00
11	<i>Hypselobarbus jerdoni</i>	0.90	0.45	0.00
12	<i>Hypselobarbus thomassi</i>	0.90	0.00	0.00
13	<i>Lepidocephalus thermalis</i>	0.45	0.45	0.00
14	<i>Monopterus fossorius</i>	0.22	0.00	0.00
15	<i>Mystus gulio</i>	0.00	0.90	0.45
16	<i>Mystus montanus</i>	0.00	0.22	0.00
17	<i>Mystus oculatus</i>	0.00	0.67	0.00
18	<i>Ompok bimaculatus</i>	0.45	0.00	0.00
19	<i>Ophisternon bengalense</i>	0.22	0.90	0.00
20	<i>Oreochromis mosambica</i>	0.00	0.45	0.00
21	<i>Parambassis thomassi</i>	0.90	0.00	0.00
22	<i>Puntius conchonus</i>	5.61	1.79	0.00
23	<i>Puntius denisonii</i>	0.45	2.02	0.00
24	<i>Puntius fasciatus</i>	0.00	6.73	0.00
25	<i>Puntius filamentosus</i>	2.47	4.93	2.47
26	<i>Puntius mahecola</i>	1.12	5.61	0.22
27	<i>Puntius parrah</i>	2.24	4.04	0.67
28	<i>Puntius vittatus</i>	1.35	4.93	0.45
29	<i>Salmophasia acinaces</i>	1.57	0.90	0.00
30	<i>Xenentodon cancila</i>	4.48	0.00	0.00

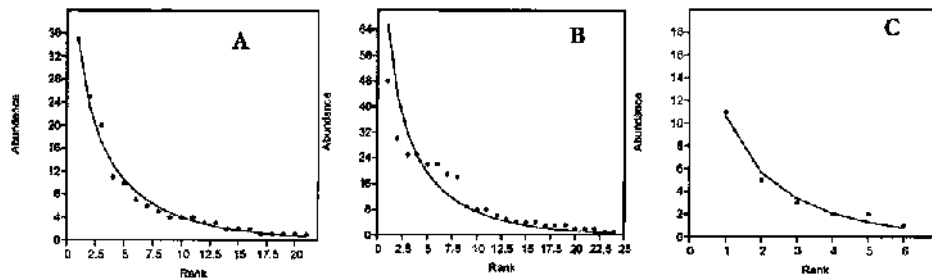


Figure 15. Abundance pattern of fish distribution in the two zones of Chandragiri river (A-midland, B-Midland C-lowland)

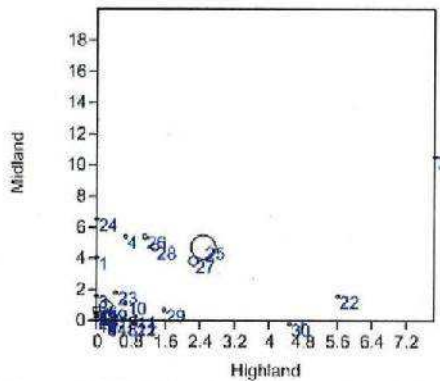


Figure 16. Bubble plot to show the relative composition of different species in the Chandragiri river (The species number as in Table 13)

The lower zone of the river characterized by saline intrusion and harboured few freshwater species as evidenced from the sampling records. *Puntius filamentosus*, *Clarias dusumieri*, *Puntius parrah*, *Puntius vittatus*, *Puntius mahecola* and *Mystus gulio* were the species that could be recorded from the lowland. The abundance is also in uneven pattern and the common species was the *Puntius filamentosus* (Figure 16).

6. CHITTARI RIVER

Chittari river is passing through Ajanur, Pullur-Periya Panchayaths of Kasaragod Districts. It is one of the smallest river in the district having 25 kilometers length. The main tributaries of this river are Kalnad, Bekal, Chittari, Adot, Kodttu, Charlikadavu. Most of the tributaries are seasonal. The river finds its origin from the midland and joins Arabian Sea at Chittari estuary. During high tide the major part of the river becomes saline.

The Chittari river originates from the lateritic hills. The river has got a width of 50m. The land use pattern on either side of the river is agricultural lands. The aquatic vegetation is minimal with rooted and submerged hydrophytes.

The fishes of Chittari river has been enlisted by Biju (2003) as a part of the doctoral thesis preparation. Apart from these, there had not been any concerted effort to document or study the fishes of Chittari river. The annotated list of fishes of Chittari river is given in Table 14.

Table 14. Annotated list of fishes of Chithari river

FAMILY CLUPEIDAE

1. *Dayella malabarica* (Day)

FAMILY -MEGALOPIDAE

2. *Megalops cyprinoids* (Broussonet)

FAMILY CYPRINIDAE

3. *Devario malabaricus* (Jerdon)
4. *Amblypharyngodon melettinus* (Valenciennes)
5. *Rasbora dandia* (Valenciennes)
6. *Barilius gatensis* (Valenciennes)
7. *Salmophasia acinaces* (Valenciennes)
8. *Barbodes subnasutus* (Valenciennes)
9. *Puntius parrah* (Day)
10. *Puntius filamentosus* (Valenciennes)
11. *Puntius mahecola* (Valenciennes)
12. *Puntius chola* (Hamilton)
13. *Puntius fasciatus* (Jerdon)
14. *Puntius punctatus* (Day)
15. *Puntius vittatus* (Day)
16. *Garra mullya* (Sykes)

FAMILY :COBITIDAE

17. *Lepidocephalus thermalis* (Val.)

FAMILY - BAGRIDAE

18. *Mystus armatus* (Day)
19. *Mystus oculatus* (Val.)

FAMILY: CLARIIDAE

20. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

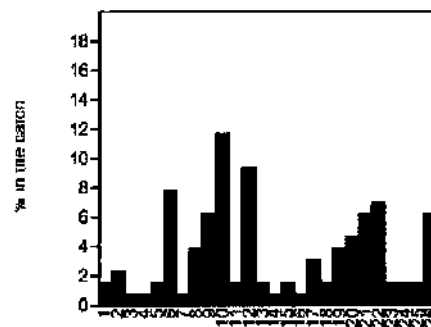
21. *Heteropneustes fossilis* (Bloch)

FAMILY: SILURIDAE22. *Wallago attu* (Bloch and Schneider)23. *Ompok bimaculatus* (Bloch)**FAMILY - BELONIDAE**24. *Xenentodon cancila* (Ham.-Buch.)25. *Hyprhamphus limbatus* (Val.)**FAMILY - APLOCHEIIDAE**26. *Aplocheilus lineatus* (Valenciennes)**FAMILY: NANDIDAE**27. *Nandus nandus* (Ham-Buch)**FAMILY: CICHLIDAE**28. *Etrophus maculatus* (Bloch)29. *Etrophus suratensis* (Bloch)30. *Oreochromis mossambicus* (Peters)**FAMILY: SCATOPHAGIDAE**31. *Scatophagus argus* (Linnaeus, 1766)**FAMILY: ANABANTIDAE**32. *Anabas testudineus* (Bloch)**FAMILY: BELONTIDAE**33. *Pseudosphromenus cupanus* (Cuvier)**FAMILY: GOBIDAE**34. *Awous gutun* (Hamilton)**FAMILY: CHANNIDAE**35. *Channa gachua* (Bloch)36. *Channa striatus* (Bloch)**FAMILY: SYMBRACHIDAE**37. *Ophisternon bengalense* McClelland**FAMILY: MASTACEMBELIDAE**38. *Macrognathus guentheri* (Day)

From the literature survey, it is found that very few concerted efforts have been made to document the fishes of Chittari river. The present list is an updated list based on the works of Biju (2003) and the results of the present survey. Chittari is one of the smallest rivers in Kerala and many of its tributaries are seasonal too. Though small and seasonal, the river harbors 38 species (Table 15).

Table 15. Percentage contribution of fish species in the sampling of Chittari river

No. Fish species	% in the total catch
1 Amblypharyngodon melettinus	1.56
2 Anguilla bengalensis	2.34
3 Awous gutun	0.78
4 Barilius gatensis	0.78
5 Channa marulius	1.56
6 Channa striatus	7.81
7 Clarias dussumieri	0.78
8 Etrophus maculatus	3.91
9 Etrophus suratensis	6.25
10 Garra mullya	11.72
11 Heteropneustes fossilis	1.56
12 Hyporhamphus limbatus	9.38
13 Lepidocephalus thermalis	1.56
14 Macrognathus guentheri	0.78
15 Megalops cyprinoides	1.56
16 Mystus gulio	0.78
17 Mystus oculatus	3.13
18 Ophisternon bengalense	1.56
19 Puntius conchoniis	3.91
20 Puntius filamentosus	4.69
21 Puntius mahecola	6.25
22 Puntius parrah	7.03
23 Puntius vittatus	1.56
24 Salmostoma acinaces	1.56
25 Scatophagus argus	1.56
26 Xenentodon cancila	6.25

**Figure 17.** Fish species abundance in Chittari river (The species number as in Table 16.)

The present survey yielded 26 with various level of abundance (Table 15; Figure 17). Since the river originates from the low elevation laterite hills, it was impossible to delineate into high, mid and lowland regimes. The present data is the abundance and diversity of the whole of Chittari river. *Garra mullya* (Figure 18) was the most dominant species which was followed by the *Hyporhamphus limbatus* and *Channa striata*. *Etrophus suratensis*, *Puntius mahecola* and *Xenentodon cancila* were recorded in the same frequency. *Awous gutum* (Figure 19), *Barilius gatensis*, *Clarias dussumieri* (Figure 20) and *Macrognaathus guentheri* (Figure 21) were the species found to have very low abundance in the sampling



Figure 18. *Garra mullya* (Sykes)



Figure 19. *Awous gutum* (Hamilton)



Figure 20. *Clarias dussumieri* (Valenciennes)



Figure 21. *Macrognaathus guentheri* (Day)

7. NILESHWARAM RIVER

Nileshwaram river is running through Kannhangad and Nileshwaram municipalities of Kasaragod. It is flowing very close to the coastal area and finds its origin in the interior hills of Kinaanoor-Karindalam and from the hills of Guruvanam of Madikkai Panchayath. The main feeders of this river are small rivulets which are active during the rainy season. The main source of this river is water flow from the *surangam* like structures from the Guruvanam hills. Arayi river, Theerthankara river, Kottachaal stream, Padnekad river, etc. are other tributaries of Nileshwaram river. During high tide, the river becomes salty and it is controlled by Nambiarkkal dam at Padnekad up to some extent. Nileshwaram river joins to Kavvayi backwater at Kottappuram and finally empties in to the Arabian sea of Thaikadappuram estuary.

A total of fifty species of fishes were known to occur in Nileshwaram river (Table 16).

Table 16. Annotated list of fishes of Nileshwaram river

FAMILY CLUPEIDAE

1. *Dayella malabarica* (Day)

FAMILY: ANGUILLIDAE

2. *Anguilla bengalensis* (Gray)

FAMILY: CYPRINIDAE

3. *Devario malabaricus* (Jerdon)
4. *Amblypharyngodon melettinus* (Val)
5. *Rasbora dandia* (Valenciennes)
6. *Barilius gatensis* (Valenciennes)
7. *Salmophasia boopis* (Day)
8. *Puntius fasciatus* (Jerdon)
9. *Barbodes subnasutus* (Val)
10. *Puntius parrah* (Day)

11. *Puntius filamentosus* (Valenciennes)

12. *Puntius mahecola* (Valenciennes)

13. *Puntius chola* (Hamilton)

14. *Puntius punctatus* (Day)

15. *Puntius vittatus* (Day)

16. *Tor khudree* (Sykes)

17. *Garra mullya* (Sykes)

FAMILY: BALITORIDAE

18. *Mesonemacheilus triangularis* (Day)

19. *Mesonemacheilus guentheri* (Day)

FAMILY: COBITIDAE

20. *Lepidocephalus thermalis* (Val.)

FAMILY - BAGRIDAE

21. *Horabagrus brachysoma* (Guenther)

22. *Mystus armatus* (Day)

23. *Mystus oculatus* (Val.)

24. *Mystus montanus* (Jerdon)

25. *Mystus gulio* Hamilton

FAMILY: CLARIIDAE

26. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

27. *Heteropneustes fossilis* (Bloch)

FAMILY: SILURIDAE

28. *Wallago attu* (Bloch and Schneider)

29. *Ompok bimaculatus* (Bloch)

FAMILY - BELONIDAE

30. *Xenentodon cancila* (Ham.-Buch.)

31. *Hyprhamphus limbatus* (Val.)

FAMILY - APLOCHEILIDAE

32. *Aplocheilus lineatus* (Val.)

FAMILY: NANDIDAE

33. *Pristolepis marginata* (Jerdon)

34. *Nandus nandus* (Ham.-Buch)

FAMILY: CICHLIDAE

35. *Etrophus maculatus* (Bloch)

36. *Etrophus suratensis* (Bloch)

37. *Oreochromis mossambicus* (Peters)

FAMILY: SCATOPHAGIDAE

38. *Scatophagus argus* (Linnaeus)

FAMILY - AMBASSIDAE

39. *Parambassis thomassi* (Day)

FAMILY: ANABANTIDAE

40. *Anabas testudineus* (Bloch)

FAMILY: BELONTIDAE

41. *Pseudosphromenus cupanus* (Cuvier)

FAMILY: GOBIDAE

42. *Avons gutem* (Hamilton)

43. *Glossogobius giuris* (Hamilton)

FAMILY: CHANNIDAE

44. *Channa gachua* (Bloch)

45. *Channa striata* (Bloch)

46. *Channa marulius* (Bloch)

FAMILY: SYMBRACHIDAE

47. *Ophisternon bengalense* McClelland

FAMILY: MASTACEMBELIDAE

48. *Mastacembelus armatus* (Lacepede)

49. *Macrognathus guentheri* (Day)

FAMILY: TETRAODONTIDAE

50. *Carinotetraodon travancoricus* (Hora & Niar)

The present sampling yielded 25 species. Since the river is flowing through areas without much altitudinal variations, the classification such as high land, midland and lowland was practically impossible. Hence only single data set on the fishes of Nileshwaram river is given.

The fishes collected from the Nileshwaram river and percentage composition is given in Table 17. *Channa striata* (Figure 22), *Etrophus maculatus* (Figure 23) and *Puntius filamentosus* were outnumbered all other species in the sampling. This was followed by the *Xenentodon cancila* (7.69%) and *Puntius parrah* (05.13%). *Anguilla bengalensis* (Figure 24), *Channa marulius*, *Clarias dussumieri*, *Heteropneustes fossilis*, *Lepidocephalus thermalis*, *Mystus gulio*, *Mystus montanus*, *Mystus oculatus*, *Oreochromis mossambicus*, *Pristolepis marginata*,

Table 17. Percentage contribution of fish species in the sampling of Nileshwaram river

NoFish species	% in the catch
1 Amblypharyngodon meletinus	2.56
2 Anguilla bengalensis	1.28
3 Awous gutum	2.56
4 Barilius gatensis	2.56
5 Channa marulius	1.28
6 Channa striata	12.82
7 Clarias dussumeiri	1.28
8 Etroplus maculatus	12.82
9 Etroplus suratensis	3.85
10 Heteropneustes fossilis	1.28
11 Hyporhamphus limbatus	2.56
12 Lepidocephalus thermalis	1.28
13 Macrognathus guentheri	2.56
14 Megalops cyprinoides	2.56
15 Mystus gulio	1.28
16 Mystus montanus	1.28
17 Mystus oculatus	1.28
18 Ophisternon bengalensis	2.56
19 Oreochromis mosambicus	1.28
20 Pristolepis marginata	1.28
21 Puntius chola	2.56
22 Puntius conchoniis	1.28
23 Puntius filamentosus	12.82
24 Puntius mahecola	3.85
25 Puntius parrah	5.13

Salmophasia boopis, *Scatophagus argus* were evenly represented in the samples.

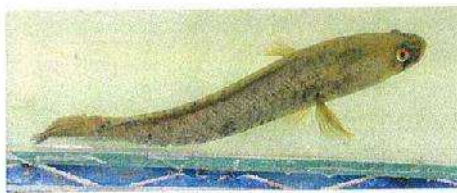


Figure 22. Channa striata (Bloch)

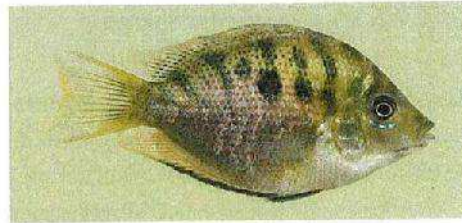


Figure 23. Etroplus maculatus (Bloch)



Figure 24. Anguilla bengalensis(Gray)

When the data has been subjected to the neighborhood clustering, it clearly indicated different clusters according to their abundance in the sampling (Figure 25).

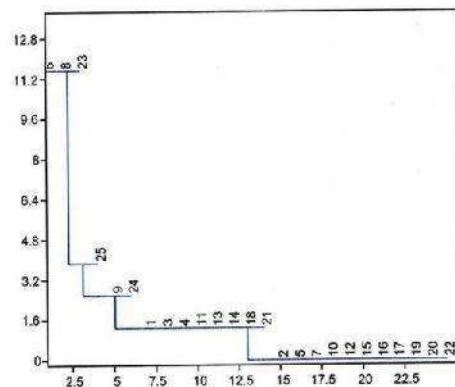


Figure 25. Neighborhood joining cluster based on abundance (The species number corresponds to the number in Table 17)

Four distinct classes could be identified based on the abundance. Thirteen species falls in the lower category of abundance and 8 species in the medium category. Three species viz, *Channa striata*, *P. filamentosus* and *Etroplus maculatus* were highly abundant (Figure 25).

8. KARYANGODE RIVER

Karyangode river is flowing through the southern part of the Kasaragod district. It originates from the hills of Coorg ranges. After 60 Kms of traverse, the river joins with Arabian Sea at Thaikadappuram estuary. Karyangode is the main tributary to the third largest backwater in Kerala, the Kavvayi. Karyangode river flows through the midlands of Kasaragod and Kannur districts and reaches Thaikadappuram estuary. It is the least polluted river in the district. Historically this river has great importance too. Erinhikkal puzha, Kuruncheri chaal, Moothupara, Cheruvappadi, Mangod stream and Thejaswini are the main tributaries of Karyangode. Many other small streams which are originating from the nearby sacred grooves are also contributing water. The famous Kakkadavu dam is built in this river. The main ecological problems of the river is sand mining.

The information on the fishes of Karyangode river rather scanty. Table 18 provides an annotated list of fishes prepared from the literature and through the present survey.

Table 18. List of fishes of Karyangode River

FAMILY - ANGUILLIDAE

1. *Anguilla bengalensis* (Gray)

FAMILY - CYPRINIDAE

2. *Amblypharyngodon meletinus* (Val)
3. *Rasbora dandia* (Valenciennes)
4. *Horadandia attukorali* (Deraniyagale)
5. *Barilius galensis* (Valenciennes)
6. *Salmophasia acinaces* (Val)
7. *Puntius fasciatus* (Jerdon)
8. *Puntius parrah* (Day)
9. *Puntius conchoniis* (Ham-Buch)
10. *Puntius denisonii* (Day)

11. *Puntius filamentosus* (Valenciennes)

12. *Puntius mahecola* (Valenciennes)

13. *Puntius vittatus* (Day)

14. *Catla catla* (Hamilton-Buchanan)

15. *Garra mullya* (Sykes)

FAMILY : COBITIDAE

16. *Lepidocephalus thermalis* (Val.)

FAMILY - BAGRIDAE

17. *Mystus oculatus* (Val.)

18. *Mystus montanus* (Jerdon)

19. *Mystus gulio* Hamilton

FAMILY: CLARIIDAE

20. *Clarias dussumieri* (Valenciennes)

FAMILY: HETEROPNEUSTIDAE

21. *Heteropneustes fossilis* (Bloch)

FAMILY: SILURIDAE

22. *Wallago attu* (Bloch and Schneider)

23. *Ompok bimaculatus* (Bloch)

FAMILY - BELONIDAE

24. *Xenentodon cancila* (Ham.-Buch.)

25. *Hyphramphus limbatus* (Val.)

FAMILY - APLOCHEILIDAE

27. *Aplocheilichthys* (Val.)

FAMILY: NANDIDAE

28. *Pristolepis marginata* (Jerdon)

FAMILY: CICHLIDAE

29. *Etilapia maculatus* (Bloch)

30. *Etilapia suratensis* (Bloch)

31. *Oreochromis mossambica* (Peters)

FAMILY : SCATOPHAGIDAE

32. *Scatophagus argus* (Linnaeus)

FAMILY: GOBIDAE

33. *Awous gutum* (Hamilton)

FAMILY: CHANNIDAE

34. *Channa gachua* (Bloch)

35. *Channa straita* (Bloch)

36. *Channa marulius* (Bloch)

FAMILY: SYMBRACHIDAE

37. *Ophisternon bengalensis* McClelland

FAMILY : MASTACEMBELIDAE

38. *Mastacembelus armatus* (Lacepede)

Table 19. Seriation Table to illustrate the fishes in different sections of the stream

No	Fish species	HL	ML	LL
1.	<i>Anguilla bengalensis</i>	0	0	1
2.	<i>Barilius gatensis</i>	1	1	1
3.	<i>Channa striata</i>	0	0	1
4.	<i>Clarias dussumieri</i>	1	0	0
5.	<i>Etrophus maculatus</i>	0	0	1
6.	<i>Garra mullya</i>	1	0	0
7.	<i>Heteropneustes fossilis</i>	1	0	0
8.	<i>Horadandia attukorali</i>	0	1	0
9.	<i>Horadandia attukorali</i>	1	0	0
10.	<i>Hyporhamphus limbatus</i>	0	1	0
11.	<i>Lepidocephalus thermalis</i>	1	0	0
12.	<i>Macrogathus guentheri</i>	1	0	0
13.	<i>Monopterus fossilis</i>	1	0	0
14.	<i>Mystus gulio</i>	0	1	1
15.	<i>Mystus montanus</i>	0	1	1
16.	<i>Mystus ocellatus</i>	0	1	0
17.	<i>Ompok bimaculatus</i>	1	0	0
18.	<i>Ophisternon bengalensis</i>	1	0	0
19.	<i>Oreochromis mossambicus</i>	0	1	0
20.	<i>Puntius conchonius</i>	1	0	0
21.	<i>Puntius denisonii</i>	1	0	0
22.	<i>Puntius fasciatus</i>	1	1	0
23.	<i>Puntius filamentosus</i>	1	1	1
24.	<i>Puntius mahecola</i>	1	1	1
25.	<i>Puntius parrah</i>	1	1	1
26.	<i>Puntius vittatus</i>	1	1	0
27.	<i>Salmophasia acinaces</i>	0	1	0
28.	<i>Xenentodon cancila</i>	1	0	0

When the abundance is plotted against the rank it was revealed that the species abundance is unequal and certain species dominated in the highland and midland. Altogether 18 species were collected from the different sampling sites in highland (Table 19). From the midland 13 species were recorded and abundance of fishes showed an uneven pattern (Figure 26 A-B). In the low land, only 9 species could be observed with skewed abundance pattern (Figure 26 C).

The clustering analyses indicates that *Barilius gatensis* is the most abundant species in all the

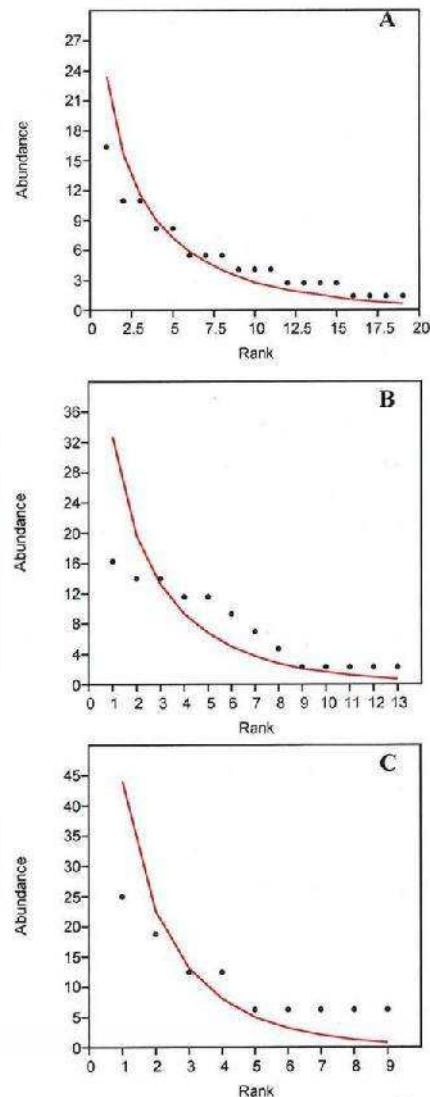


Figure 26. Abundance pattern of fishes in 3 zones of Karyangode river (A--HL, B-ML; C-LL)

three zone which was followed by *Puntius filamentosus*. *Heteropneustes fossilis*, *Horadandia attukorali*, *Macrogathus guentheri* and *Monopterus fossilis* clustered due to their medium abundance in the highland and entire absence in the midland and lowland.

Clarius dusumieri, *Ompok bimaculatus*, *Puntius conchonius* and *Puntius denisonii*, clustered in to a group due to entire absence in the mid and low and poor representation (1 individual) in the highland. *Leptdocephalus thermalis*, *Ophisternon bengalense* and *Xenentodon concila* formed another cluster due to slightly higher abundance (3 individuals) than the species mentioned above. *Salmophasia acinaces*, *Mystus oculatus* and *Horadandia attukorali* were represented by single individual in the middle zone and were not recorded from lowland and high land. Significantly, *Oreochromis mossambica*, an exotic perch was absent in the low and high land but inhabited the midland with a moderate abundance.

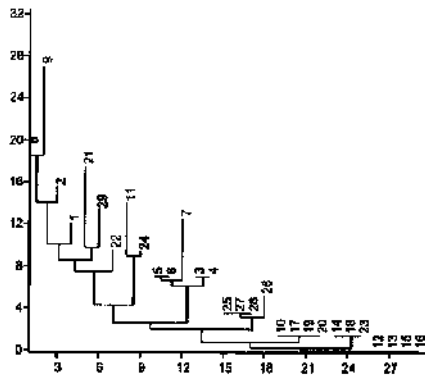


Figure 27. Neighbor joining cluster (Number corresponds to the Table 18)

Mystus gulis and *Mystus montanus* were represented by single individual each in the midland and low land whereas *Anguilla bengalensis* *Channa striatus* were present in the low land only and represented by single individual. *Etroplus maculatus* though reported only from the low land outnumbered others in the same cluster (Figure 27).

9. KAVAYYI RIVER

This is a small river which originates in Cheemeni village at an altitude of 385m and flows past Alpadampa and Vadasseri, before emptying in to the Kavvayi backwaters. Three streams coming from the north join the main stream. The river enters the backwaters at Udamanthai. It has a length of 31 Km and a catchment area of 143Km².

The fishes of Kavayyi river is given in Table 19.

Table 20. Fishes of Kavayyi river

1. *Aplochilus lineatus* (Val)
2. *Channa striata* (Bloch)
3. *Devario malabaricus* (Jerdon)
4. *Etroplus maculatus* (Bloch)
5. *Gurra mullya* (Sykes)
6. *Heteropneustes fossilis* (Bloch)
7. *Hyporhamphus limbatus* (Val)
8. *Macragnathus malabaricus* (Jerdon)
9. *Puntius filamentosus* (Val)
10. *Puntius mahecola* (Val)
11. *Puntius parrah* (Day)
12. *Rasbora dandia* (Val)

Table 21. Seriation Table to illustrate the fishes in different sections of the Kavayyi river

No.	Fish species	HL	ML	LL
1.	<i>Aplochilus lineatus</i>	1	0	0
2.	<i>Channa striata</i>	0	1	0
3.	<i>Devario malabaricus</i>	1	1	1
4.	<i>Etroplus maculatus</i>	0	0	1
5.	<i>Garra mullya</i>	0	1	0
6.	<i>Heteropneustes fossilis</i>	1	0	0
7.	<i>Hyprhamphus limbatus</i>	0	1	0
8.	<i>Macragnathus guentheri</i>	1	0	0
9.	<i>Puntius filamentosus</i>	0	1	1
10.	<i>Puntius mahecola</i>	1	0	0
11.	<i>Puntius parrah</i>	0	1	1
12.	<i>Rasbora dandia</i>	1	1	1

The fishes of Kavayi river has not been documented well. Biju (2003) who studied the fishes of northern Kerala excluded the Kavayi river from their exploration. Altogether 12 species were recorded from Kavayi river during the present survey (Table 20 and 21). The sampling in the highland yielded six species viz., *Devario malabaricus*, *Puntius mahecola*, *Rasbora dandia*, *Macrogathus malabaricus*, *Heteropneustes fossilis* and *Aplochilus lineatus*. Among all these six species, *Devario malabaricus* is most abundant species which was followed by *Puntius mahecola*. The abundance of these six species was more or less even. In the midland, seven species were recorded and *Puntius parrah* outnumbered all the remaining species. The midland dwellers showed a skewed pattern of abundance obviously due to the over abundance of *P. parrah* and *Rasbora dandia* (Figure 28).

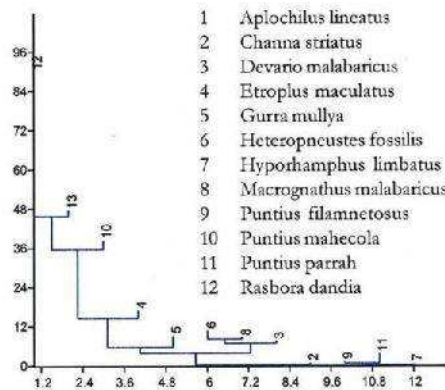


Figure 28. Neighborhood cluster of fishes based on abundance-Kavayi river

From the lowland, only five species were recorded. Significantly, the *Puntius parrah* was the most dominating species which was followed by *Rasbora dandia* (Figure 28).

The neighborhood clustering to elucidate the species groups based on their abundance is depicted in Figure 28. *Puntius parrah* (Figure 29) is distant from all other groups because of its high abundance in midland and lowland and its absence in the highland. The species next to the above is *Rasbora dandia* (Figure 30) which abounded in the midland and lowland and survived in the highland and over abounded there. *Puntius filamentosus* though absent in the highland was frequent in the sampling with a moderate number of individuals. *Macrogathus guentheri*, *Puntius mahecola* and *Heteropneustes fossilis* (Figure 31) were recorded only in the highland and absent in the other two zones.



Figure 29. *Puntius parrah* (Day)



Figure 30. *Rasbora dandia* (Valenciennes)



Figure 31. *Heteropneustes fossilis* (Bloch)

10. PERUVAMABARIVER

Peruvamba river basin in the northern part of Kannur district is situated in between North Karingote basin and south Kuppam and Ramapuram river basin. The river lies between 12°03' N to 12° 15' N and 75° 12' E to 75° 24' E. The length of the river is 16 Km and basin area is 269 Km². The main tributaries are the Macharuthodu, Mathamangalam, Challachal, Mukkutenkarachal, Nitaringapuzha and Panappuzha. The pre monsoon occurs from June till the end of September contributing about 82 percent rainfall which is followed by post monsoon until November. Although there is maximum rainfall in this area because of sloppy terrain and impervious nature of the soil, most of the precipitation is lost as run off in to the sea. The winter season from December to February is characterized by general dryness (Kumar and Sukumar, 2010).

The freshwater fishes of the Peruvamba river have not been documented well. The present survey is not an exhaustive one and collection was limited to few days. Altogether seven species were recorded during the present sampling (Table 22.).

Table 22. Seriation and abundance of the fishes in different sections of the Peruvamba river

No. Fish species	HL	ML	LL
1. <i>Xenentodon cancila</i>	18.8	20.2	05.2
2. <i>Garra mullya</i>	13.8	00.0	0.00
3. <i>Mystus montanus</i>	03.1	01.1	05.2
4. <i>Puntius filamentosus</i>	25.0	30.9	59.4
5. <i>Puntius fasciatus</i>	32.8	29.8	00.0
6. <i>Devario malabaricus</i>	06.3	00.0	00.0
7. <i>Rasbora dandia</i>	00.0	04.3	00.0

All the seven species were present in the midland zone and six species were recorded from the highland (*Puntius fasciatus* was not recorded from lowland). From the lowland, only three species, viz. *Xenentodon cancila*, *Mystus montanus* and *Puntius filamentosus* and *Rasbora dandia* were recorded.

The bubble plot graph (Figure 32), clearly shows the relative abundance of the seven species in three distinct regimes. *Puntius filamentosus* outnumbered all other species in all the zones which was followed by the *Puntius fasciatus* and *Xenentodon cancila* (Figure 33). *Garra mullya* were represented well in the highland and was absent in the midland and lowland. The analyses for the dominance reveal that was dominance of individual species was in the order of highland (0.4492), midland (0.2458) and lowland (0.23).

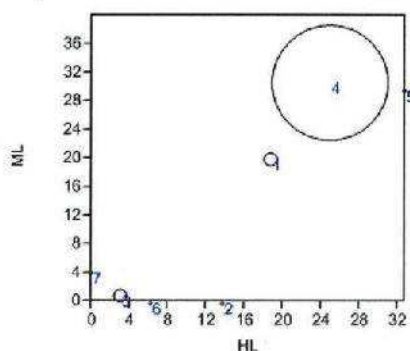


Figure 32. Bubble plot to show the relative composition of different species-Peruvamba river (The species number as in Table 21)



Figure 33. *Xenentodon cancila* (Hamilton)

11. RAMAPURAM RIVER

Ramapuram is a small river 19 Km. long and originates from the hills coming within the village limits of Iringal at an altitude of 57 m above asl. The river flows through the villages of Pariyaram Kolapartvayal, Cherthazham and Madayi. The drainage area of the basin is 52 Km². The river joins with the southward branch of the Peruvamaba river and empties into the sea to the south of Ezhimala. Both the sides of the Ramapuram river are covered with mangrove islands at Chempallikundu and Cheruthazham.

The fishes of Ramapuram river has not been documented so far. The present survey could record 13 fishes from the Ramapuram river and its tributaries. The fishes and the percentage composition in the sampling is given in Table 23.

Table 23. Fishes of Ramapuram river with their percentage composition in the sampling

No.	Fish species	%
1	<i>Channa striata</i>	14.57
2	<i>Devario malabaricus</i>	02.02
3	<i>Etroplus maculatus</i>	03.24
4	<i>Etroplus suratensis</i>	01.62
5	<i>Glossogobius giuris</i>	00.40
6	<i>Heteropneustes fossilis</i>	01.62
7	<i>Hyporhamphus itimbatus</i>	02.83
8	<i>Mugil cephalus</i>	02.43
9	<i>Mystus</i> sp	09.31
10	<i>Puntius filamentosus</i>	30.36
11	<i>Rasbora dandia</i>	30.36
12	<i>Thryssa</i> sp	00.81
13	<i>Xenentodon cancella</i>	00.40

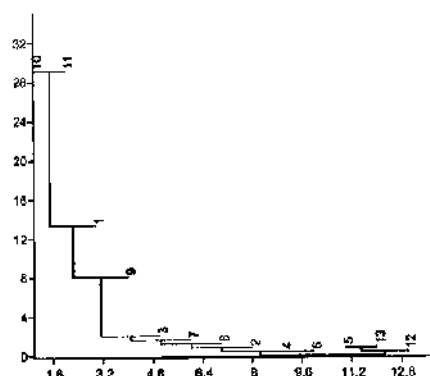


Figure 34. Neighbor joining cluster based on the abundance-Ramapuram river (The species number corresponds to the number in Table 22.)

Ramapuram is a small river and saline ingress is high in most of its length. The sampling results further corroborates this observation. *Mugil cephalus* and *Thryssa* sp., though in low abundance are reported from here. The upper reaches of the river had a high abundance of *Puntius filamentosus* and *Rasbora dandia* (Figure 34). The *Channa striata* and *Mystus* sp. followed the above mentioned species.

12. KUPPAM RIVER

Kuppam river is otherwise known as Payangadi river. Kuppam river finds its origin in Padinalkad ghat reserve forests in Coorg district, Karnataka. The river flows through Taliparamba and Kannur taluks. The river has a length of 82 Km and an area of 539 Km² of which 70 Km is in Karnataka. The main tributaries are the Pakkattupuzha, Alakutta thodu, Kuttikolpuzha, Mukkutta thodu and the Cheriya thodu. The river has a steep course in its initial reaches but on entering Kerala after a run of 12 Km, the bed level falls to 115m. Kuppam river flows almost parallel to the Valapattanam river but at Payangadi, it takes a sudden twist to the south

and flows parallel to the coast. Kuppam river joins with the Valapattanam estuary before it empties in to the sea. Karuvanchal thodu, Alakkode thodu and Perimpuzha are the other streams joins with the Kuppam river.

The fishes of Kuppam river has been enlisted by Biju (2003). The present sampling yielded 12 species (Table 24), The zonation based on the altitude was impossible because there is not much altitudinal gradient along the river course. Hence the entire river system has been considered as a single unit.

Table 24. List of fishes collected from Kuppam river and their abundance

No	Fish species	Abundance
1	<i>Barilius bakeri</i>	14.75
2	<i>Devario malabaricus</i>	12.29
3	<i>Garra mullya</i>	02.45
4	<i>Lepidocephalus thermalis</i>	01.63
5	<i>Pristolepis marginata</i>	03.27
6	<i>Puntius denisonii</i>	04.91
7	<i>Puntius fasciatus</i>	01.63
8	<i>Puntius filamentosus</i>	28.68
9	<i>Rasbora dandia</i>	19.67
10	<i>C. travancoricus</i>	00.81
11	<i>Tor Khudree</i>	04.91
12	<i>Xenentodon cancila</i>	04.91

The neighborhood clustering to group the fishes revealed that two distinct groups were obvious. *Puntius denisonii* (Figure 35), *Tor khudree* (Figure 36) and *Xenentodon cancila* equally observed in the samples while, *Puntius filamentosus* and *Rasbora dandia* were outnumbered all the fishes in the collection. *Barilius bakeri* (Figure 37) and *Devario malabaricus* followed the above mentioned species (Figure 37).

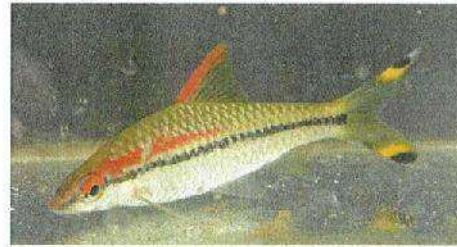


Figure 35. *Puntius denisonii* (Day)



Figure 36. *Tor khudree* (Sykes)



Figure 37. *Barilius bakeri* (Day)

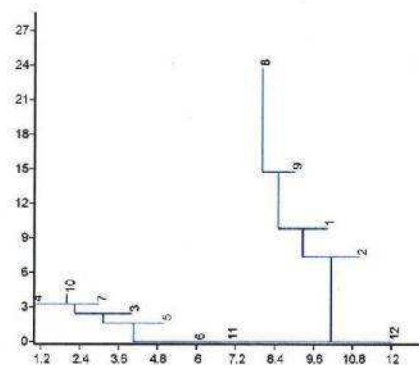


Figure 38. Neighbor joining cluster (The species number corresponds to the number in Table 24)

13. VALAPATTANAM RIVER

Valapattanam River is in Kannur district and is the largest river in Kannur. The river originates from the Western Ghats and empties into Arabian Sea. This river is a major source of irrigation in Kannur. On the bank of this river is the Valapattanam town and the famous pilgrim center Parassinikadavu Muthappan Temple.

The Valapattanam River was the main trade route and was always bustling with activities. Thus it got the name 'valya pattanam' meaning 'Big Town'. The solid waste and sewage were discharged by the human settlements along the entire length of the river. Valapattanam is also a famous fishing harbour as well as the main source of the irrigation in the district.

Table 25. Seriation Table to illustrate the fishes in different sections of Valapattanam river.

No	Fishes	HL	ML	LL
1	<i>Etropius suratensis</i>	1	0	0
2	<i>Mystus malabariucus</i>	1	0	0
3	<i>Pristolepis marginata</i>	1	0	0
4	<i>Puntius fasciatus</i>	1	0	0
5	<i>Xenentodon cancila</i>	1	0	0
6	<i>Barilius bakeri</i>	1	1	0
7	<i>Devario malabaricus</i>	1	1	0
8	<i>Garra mullya</i>	1	1	0
9	<i>Puntius filamentosus</i>	1	1	1
10	<i>Rasbora dandia</i>	1	1	1
11	<i>Hypselobarbus jerdoni</i>	0	0	1
12	<i>Puntius mahecola</i>	1	1	0

From seriation Table 25, it is understood that 10 species were recorded from the highland, five

species in the midland and three species in the lowland. The abundance graph depicted indicates that out of the ten species in the highland, four species maintains an even abundance and the remaining species show an uneven abundance (Figure 39A). The midland represented by five species showed a skewed abundance (Figure 39B). The clustering for the neighbouring species in terms of their abundance indicated that *Rasbora dandia*

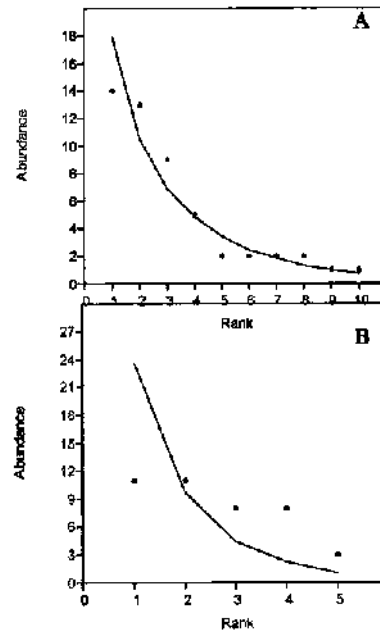


Figure 39. Abundance pattern of fishes in the two zones of Valapattanam river (A-HL, B-ML)

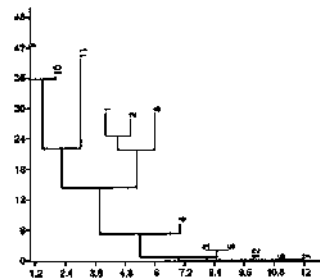


Figure 40. Neighbor joining cluster (The species number corresponds to the number in Table 25.)

was more or less equally abundant in all three zones while *Hypselobarbus jerdoni* was restricted to the lowland zone with high abundance. *Barilius bakeri*, *Devario malabaricus* and *Puntius filamentosus* dominated the highland and midlands with more or less equal abundance. *Etrophus suratensis*, *Mystus malabaricus*, *Xenentodon cancila*, *Pristolepis marginata* and *Puntius fasciatus* were represented in the collection by one or two individuals (Figure 40). The dominance indices clearly shows that a high value (0.338) in the lowland inferring the high dominance of taxa (*Puntius filamentosus*) which was followed by midland (D=0.225) dominated by *Barilius bakeri* and *Devario malabaricus*.

14. ANJARAKANDY RIVER

Anjarakandy river originates from Kannothe Reserve Forest at an altitude of +600m above MSL and traverse for about 16 km. through dense forest and hilly terrain. The river falls rapidly and at Kannavam, the bed level is only +90m MSL. Two small tributaries, the Kapputhodu and the Idumbathodu join the main river near Kunderipoyil. Hereafter the river takes a meandering course till Orikkara, where it branches into two. One branch turns south to join the Arabian Sea 3 Km north of Tellicherry town. The river is known as the Dharmadam river here. The other branch falls into the Arabian Sea 5 km north of Tellicherry town. The basin has an area of 412Km² lying entirely in Kerala. The length of the river is 48 Km.

A total of thirty species have been recorded during the present survey. The spectrum consists of several estuarine species. From the seriation Table 26, it is obvious that only seven species are reported from the high land, 13 species from the midland

Table 26. Abundance pattern of fishes in the 3 zones of Anjarakandy river (A-Highland, B-Midland; C-Lowland)

No	Fish species.	HL	ML	LL
1	<i>Aplocheilichthys lineatus</i>	18.52	3.23	0.00
2	<i>Barilius bakeri</i>	14.81	0.00	0.00
3	<i>Bhavana australis</i>	11.11	0.00	0.00
4	<i>Brachirus orientalis</i>	0.00	0.00	1.82
5	<i>Caranx</i> sp	0.00	0.00	1.82
6	<i>Channa gachua</i>	7.41	3.23	0.00
7	<i>Channa striata</i>	0.00	1.61	0.00
8	<i>Etrophus suratensis</i>	0.00	0.00	18.18
9	<i>Garra mullia</i>	0.00	3.23	0.00
10	<i>Gerres erythrous</i>	0.00	0.00	3.64
11	<i>Gerres filamentosus</i>	0.00	0.00	3.64
12	<i>Horabagrus brachysoma</i>	0.00	0.00	1.82
13	<i>Hypselobarbus curmuca</i>	0.00	1.61	0.00
14	<i>Lates calcarifer</i>	0.00	0.00	7.27
15	<i>Lutjanus argentimaculatus</i>	0.00	0.00	3.64
16	<i>M. frangularis</i>	7.41	0.00	0.00
17	<i>Mugil cephalus</i>	0.00	0.00	10.91
18	<i>Mystus gulio</i>	0.00	0.00	3.64
19	<i>Mystus montanus</i>	0.00	0.00	1.82
20	<i>Notopterus notopterus</i>	0.00	3.23	0.00
21	<i>Parambassis thomassi</i>	0.00	0.00	7.27
22	<i>Pristolepis marginata</i>	0.00	19.35	0.00
23	<i>Puntius fasciatus</i>	25.93	4.84	0.00
24	<i>Puntius filamentosus</i>	0.00	24.19	0.00
25	<i>Puntius parrah</i>	0.00	24.19	0.00
26	<i>Rasbora dandia</i>	14.81	4.84	0.00
27	<i>Salmophasia acinaces</i>	0.00	3.23	0.00
28	<i>Silago sihama</i>	0.00	0.00	1.82
29	<i>Therapon arbua</i>	0.00	0.00	1.82

and 19 species were present in the lowland. The abundance pattern is provided in the Figure 41 A-C. In the highland all the recorded species maintained an unequal abundance while in the midland, except one species, all of them have more or less an equal abundance. In the lowland, eight species having four groups are visible.

The neighbourhood clustering clearly indicates *Aplocheilichthys lineatus* and *Puntius fasciatus* closer

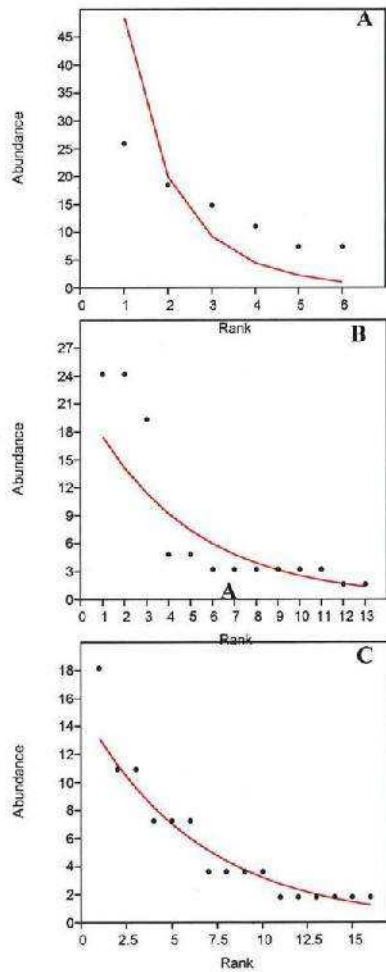


Figure 41. Abundance pattern of fishes in the three zones of Anjarakandy river (A--midland, B-lowland; C-Lowland)

together because they were outnumbered in the highland and maintained moderate abundance in the midland (Figure 41). These two species were entirely absent in the lowland. *Pristolepis marginata*, *Puntius filamentosus* and *Puntius parrah* were closer similar due to their distribution in and high abundance in the midland and entire absence in the high and lowland. *Mugil cephalus*,

Thryssa sp. and *Etroplus suratensis* were scored high in the low land and conspicuous for their absence in the high and midland (Figure 42). Except *Etroplus suratensis*, the former two are pure estuarine species. And among these three, *Etroplus* is the most abundant species. The other estuarine species which were grouped among the above with restricted distribution in the lowland are *Gerres erythrous*, *Gerres filamentosus* (Figure 43), *Lutjanus argentimaculatus* and *Mystus gulio*.

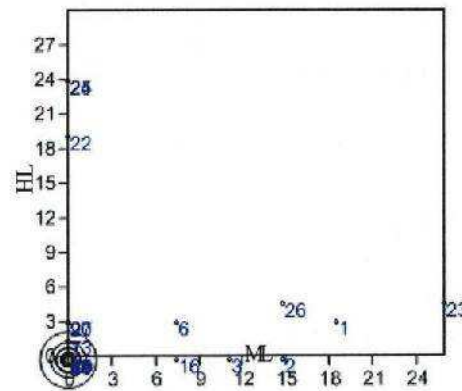


Figure 42. Abundance of fishes in the sampling of Anjarakandy river (The species number corresponds to the number in Table 25)



Figure 43. *Gerres filamentosus*

15. THALASSERY RIVER

The Tellicherry river is also known as the Ponnayam river. Its source is at an elevation of +550 m. above msl. in the Kannothe Reserve Forest on the Western slope of the Western Ghats. Its only tributary is on the right bank which originates from the hills at Muriya about 3km. east of Kuthuparambu and joins the main river about 14 km above its mouth. The main river, after flowing for about 28 Km in a westerly direction empties itself into the Arabian Sea at Mannoyed about 3 km. north of Tellicherry Town.

This is one of the smallest rivers in Kerala having a length of 28 km and a drainage area of 132Km². The river flows through the villages of Cheruvancheri, Mudiyanaga, Pattayam, Mokeri and Pandakkal.

The fishes of Thalassery river had been listed by Biju (2003) while dealing with the freshwater fishes of the northern Kerala.

From the Table 27, it is obvious that four species were recorded from the highland, six species from midland and seven species from the lowland. *Aplocheilus lineatus*, *Puntius fasciatus* and *Notopterus notopterus* are the three dominant species in the highland region. *Notopterus notopterus* is new record and so far it has been known only from Kabini river. Midland was dominated by species like *Pristolepis marginata*, *Puntius filamentosus* and *Rasbora dandia*. In the lowland, the niches were occupied by the estuarine species (Figure 44). *Eetroplus suratensis*, *Lutjanus argentimaculatus* (Figure 45) and *Leiognathus* sp. were more or less in equal abundance.

Table 27. Abundance pattern of fishes in the three zones of Thalassery river

No. Fish species	HL	ML	LL
1. <i>Aplocheilus lineatus</i>	38.46	13.33	0.00
2. <i>Brachirus orientalis</i>	0.00	0.00	3.33
3. <i>Channa gachua</i>	7.69	6.67	0.00
4. <i>Eetroplus suratensis</i>	0.00	0.00	20.00
5. <i>Glossogobius giuris</i>	0.00	0.00	3.33
6. <i>Leiognathus</i> sp.	0.00	0.00	16.67
7. <i>Lutjanus argentimaculatus</i>	0.00	0.00	20.00
8. <i>Mugil cephalus</i>	0.00	0.00	13.33
9. <i>Notopterus notopterus</i>	15.38	0.00	0.00
10. <i>Pristolepis marginata</i>	0.00	26.67	0.00
11. <i>Puntius fasciatus</i>	38.46	13.33	0.00
12. <i>Puntius filamentosus</i>	0.00	23.33	0.00
13. <i>Rasbora dandia</i>	0.00	16.67	0.00
14. <i>Thryssa</i> sp.	0.00	0.00	23.33

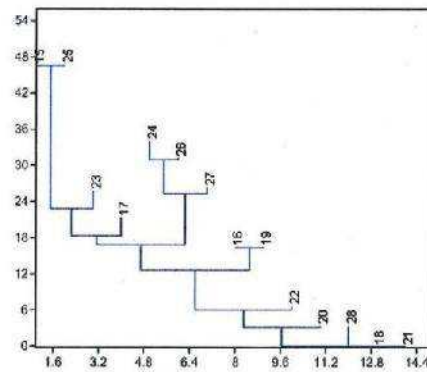


Figure 44. Neighbor joining cluster (The species number corresponds to the number in Table 26)



Figure 45. *Lutjanus argentimaculatus*

16. MAHE RIVER

Mahe River is also known as Mayyazhipuzha. Mahe was a former French settlement which lies in Kannur district but is officially part of Pondicherry. During the rule of the British, Mahe river was popularly called as the English Channel. It was named so as this river separated British ruled Thalassery and French ruled Mahe. The river originates from the forests of Wayanad and has a length of 54 Km. Some of the villages through which the river passes are Vanimel, Iringanoor Peringalam, Edachery, Eramala, Kariyad, Mahe etc. After traversing through all these villages, it empties into the Arabian Sea.

Mahe river has no major tributaries but is fed by numerous rivulets from both sides. Long ago, this river was used for transporting both men and material.

A total of 20 species were recorded from the Mahe river. Twelve species were observed in the highland region, nine species from the midland and lowland (Table 28). The ranking based on the abundance revealed an uneven distribution in all the three zones of the river (Table 28; Figure 46).

Devario malabaricus, *Rasbora dandia* and *Puntius filamentosus* were present in all the three zones and all three species outnumbered rest of the species. *Liza* sp was most abundant species in the lowland region *Puntius fasciatus* *Rasbora dandia* dominated in the highland and lowland regions respectively. *Aplochilus lineatus*, *Lepidocephalus thermalis* and *Mesonemcheilus triangularis* were the least abundant species in the highland region. *Puntius denisonii*, *Puntius fasciatus* and *Xenentodon cancella* least abundant

Table 28. Abundance pattern of fishes in the three zones of Mahe river.

No. Species	HL	ML	LL
1. <i>Aplochilus lineatus</i>	1.56	0.00	0.00
2. <i>Barilius bakeri</i>	10.94	0.00	0.00
3. <i>Brachirus orientalis</i>	0.00	0.00	1.9
4. <i>Devario malabaricus</i>	12.50	21.95	21.57
5. <i>Etroplus maculatus</i>	0.00	12.20	0.00
6. <i>Etroplus suratensis</i>	0.00	0.00	1.96
7. <i>Garra mulliya</i>	6.25	0.00	0.00
8. <i>Gerres</i> sp.	0.00	0.00	1.96
9. <i>Glossogobius giuris</i>	0.00	4.88	1.96
10. <i>Lepidocephalus thermalis</i>	1.56	0.00	0.00
11. <i>Liza</i> sp.	0.00	0.00	41.18
12. <i>Mastacembelus armatus</i>	1.56	0.00	0.00
13. <i>Mesonemacheilus triangularis</i>	1.56	0.00	0.00
14. <i>Mugil</i> sp.	0.00	0.00	3.92
15. <i>Puntius denisonii</i>	3.13	4.88	0.00
16. <i>Puntius fasciatus</i>	18.75	4.88	0.00
17. <i>Puntius filamentosus</i>	12.50	9.76	3.92
18. <i>Puntius punctatus</i>	7.81	7.32	0.00
19. <i>Rasbora dandia</i>	21.88	29.27	21.57
20. <i>Xenentodon cancella</i>	0.00	4.88	0.00

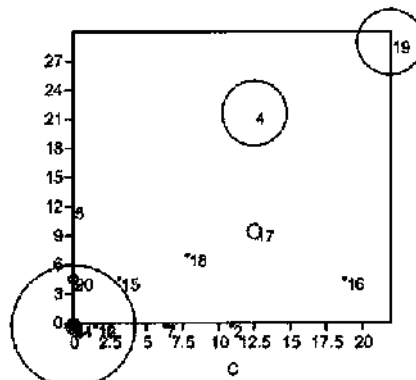


Figure 46. Bubble plot to show the relative abundance of different species in Mahe river (The species number as in Table 28.)

in the midland region. *Brachirus orientalis*, *Gerres* sp. and *Glossogobius giuris* all are partly estuarine were poorly represented in the samples of lowland zone.

17. KUTTIADI RIVER

Rising from the Narikota Ranges on the western slopes of the Wynad Hills, part of Western Ghats at an elevation of 1220 m asl, the Kuttiyadi River flows through Badagara, Quilandy and Kozhikode Taluks. The river is also known as the Murat River. This river has a length of 74km. It drains into the Arabian Sea at Kottakal 7 km and along with its tributaries it drains in area of 583Km².

The major tributaries of the river are the Onipuzha, the Thottilpalampuzha the Kadiyangad puzha Thevannathilpuzha and the Madappallipuzha. The river passes through Oorakuzhi, Kuttiadi, Traveler, Muyipot, Maniyur and Karuvacheri. The historical Kottakkal Forest is situated at the mouth of the river.

The fishes of Kuttiyadi river is not known well enough and the present survey yielded only 10 species (Table 29).

Table 29. Seriation Table to illustrate the presence-absence of species in three zones Kuttiyadi river.

No	Fishes	HL	ML	LL
1.	<i>Barilius bakeri</i>	1	0	0
2.	<i>Devario malabaricus</i>	1	1	0
3.	<i>Etroplus maculatus</i>	0	1	0
4.	<i>Etroplus suratensis</i>	0	0	1
5.	<i>Gerres filamentosus</i>	0	0	1
6.	<i>Mugil cephalus</i>	0	0	1
7.	<i>Mystus sp.</i>	0	0	1
8.	<i>Puntius denisonii</i>	1	1	0
9.	<i>Puntius filamentosus</i>	1	1	0
10.	<i>Rasbora dandia</i>	1	1	0

Barilius bakeri is the most abundant species in the highland which was followed by *Puntius*

filamentosus and *Rasbora dandia* (Figure 47).

The middle zone is abounded by *Rasbora dandia* and *Devario malabaricus* (Figure 48) and *Puntius denisonii*. The lowland is dominated by *Gerres filamentosus*.

Table 30. Comparative abundance of fishes in the 3 zones of the Kuttiyadi river

No	Fishes	HL	ML	LL
1.	<i>Barilius bakeri</i>	7.14	0.00	0.00
2.	<i>Devario malabaricus</i>	21.4	15.79	0.00
3.	<i>Etroplus maculatus</i>	0.00	5.26	0.00
4.	<i>Etroplus suratensis</i>	0.00	0.00	9.37
5.	<i>Gerres filamentosus</i>	0.00	0.00	28.13
6.	<i>Mugil cephalus</i>	0.00	0.00	50.00
7.	<i>Mystus sp.</i>	0.00	0.00	12.5
8.	<i>Puntius denisonii</i>	25.00	21.05	0.00
9.	<i>Puntius filamentosus</i>	25.00	15.79	0.00
10.	<i>Rasbora dandia</i>	21.43	42.11	0.00

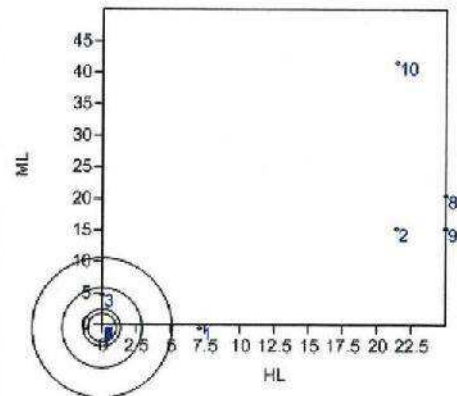


Figure 47. Bubble plot to show the relative abundance of fishes -Kuttiyadi river (The species number as in Table 30.)



Figure 48. *Devario malabaricus* (Jerdon)

18. KORAPUZHA RIVER

Korapuzha also known as Elathur river is a short river of 40 Km length, with a drainage area of 624 km², flowing through the Kozhikode district. It is formed by the confluence of two streams, Agalapuzha and Punnoorpuzha which originate in the mountains of Wayanad district. The Korapuzha empties into the Arabian Sea at Elathur. The river and its main tributaries become tidal as they near the Arabian Sea. There is heavy boat traffic over the last 25 km of its course. It forms part of the West Coast Inland Navigation System.

The Korapuzha is generally considered as the *cordon sanitaire* between the North Malabar and South Malabar in the erstwhile Malabar District. Until the 20th century the Nair women of North Malabar crossing the Korapuzha and going south or marrying a person from South Malabar was considered a taboo and those who violated faced Bhrasht (Ostracism) and forfeiture of caste.

The fishes of Korapuzha has not been documented so far. The present list consists of eight species from three zones of the river (Table 31). The list could not be considered as an exhaustive and the chances for many more species can not be over ruled.

Table 31. Seriation Table to illustrate the presence-absence of species in three zones of the river

No. Fish species	HL	ML	LL
1. <i>Etroplus maculatus</i>	0	1	0
2. <i>Garra mullya</i>	1	0	0
3. <i>Gerres filamentosus</i>	0	0	1
4. <i>Mugil cephalus</i>	0	1	1
5. <i>Mystus sp.</i>	0	0	1

6. <i>Puntius filamentosus</i>	1	1	0
7. <i>Rashora dandia</i>	0	1	0
8. <i>Xenentodon cancila</i>	1	0	0

Table 32. Comparative abundance of fishes in the 3 zones of the Korapuzha river

No. Fish species	HL	ML	LL
1 <i>Etroplus maculatus</i>	00.00	09.09	00.00
2. <i>Garra mullya</i>	08.33	00.00	00.00
3 <i>Gerres filamentosus</i>	00.00	00.00	37.50
4 <i>Mugil cephalus</i>	00.00	63.64	37.50
5 <i>Mystus sp.</i>	00.00	00.00	25.00
6 <i>Puntius filamentosus</i>	90.91	09.09	00.00
7 <i>Rashora dandia</i>	00.00	18.18	00.00
8 <i>Xenentodon cancila</i>	09.09	00.00	00.00

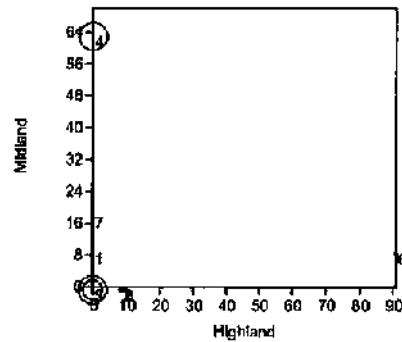


Figure 49. Bubble plot to show the relative abundance of different species (The species number as in Table 31)

The survey in Korapuzha could yield only 8 species. Three species viz., *Garra mullya*, *Xenentodon cancila* and *Puntius filamentosus* were recorded from the highland. *Rashora dandia* was the most commonest species in the midland. Lowland is dominated by the estuarine species like the *Mugil cephalus* and *Gerres filamentosus* (Table 32 and Figure 49).

19. KALLAYI RIVER

Kallayi river originates from Kunnamangalam as a small stream and flows down 30 km through Kunnathupalam, Mankavu and Kallayi towns and ends in the Arabian Sea. Perennial in nature, it is connected to Beypore river by a channel at Mankavu. Considerable amount of coconut husks are deposited in this river by the coir cottage-industry units for retting (John, 1976). These husks settle onto the bottom and due to the decay of these, a black silt is formed on the substratum mixed with sand. Further, a large number of logs are kept in the river for conditioning all through the year which also foul the water. During the rainy season the water level rises 2 to 4 metres. In fact, the torrential flow of rainwater from uplands cleanses the river seasonally.

Table 33. Comparative abundance of the fish species distribution in the three zones of Kallai river

No. Species	HL	ML	LL
1. <i>Devario malabaricus</i>	20.00	0.0	00.00
2. <i>Etroplus suratensis</i>	00.00	0.0	09.09
3. <i>Gerres filamentosus</i>	00.00	0.0	36.36
4. <i>Glossogobius giuris</i>	00.00	00.00	09.09
5. <i>L. argentimaculatus</i>	00.00	00.00	09.09
6. <i>Mugil cephalus</i>	00.00	77.78	27.27
7. <i>Mystus</i> sp.	00.00	00.00	09.90
8. <i>Puntius filamentosus</i>	40.00	00.00	00.00
9. <i>Rasbora dandia</i>	40.00	22.20	00.00

Kallayi is a small stream which harbour very few fish species. Nine species were recorded during the present sampling (Table 33). *Puntius filamentosus* and *Rasbora dandia* were the commonest species in the highland. From the

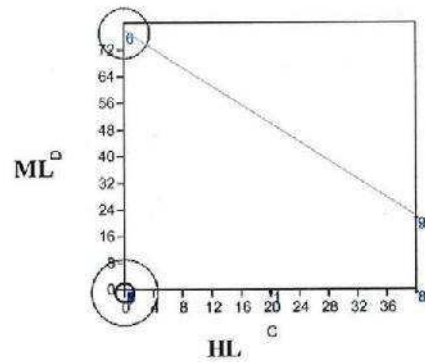


Figure 50. Bubble plot to show the relative abundance of different species-Kallayi river (The species number as in Table 32)

midland only two species were recorded viz. *Mugil cephalus* and *Rasbora dandia* (Figure 50). The lowland was inhabited by six species. The *Gerres filamentosus* was the most dominant species which was followed by *Mugil cephalus*. *Etroplus suratensis* (Figure 51), *Glossogobius giuris*, *Lutjanus argentimaculatus* and *Mystus* sp. were equally abundant in the lowland region of the Kallayi river.



Figure 51. *Etroplus maculatus* (Bloch)



Figure 52. *Lutjanus argentimaculatus* (Forsskal)

20. CHALIYAR RIVER

Chaliyar, one of the major rivers of Kerala, originates from the Iambalari (Elembalai) Hills in Gudalur of Nilgiris District (Tamil Nadu). Chaliyar River is the fourth longest river in Kerala with a length of 169 Kms. Chaliyar river has a total drainage area of 2,923 Km², of which 2,535 Km² is in Kerala and the rest in Tamil Nadu. The Chaliyar river flows through Wayanad, Malappuram and Kozhikode districts. Chaliyar River is known in the lower reaches, which form part of the West Coast Inland Navigation system, as the Beypore River. Nilambur, Mampad, Edavanna, Arikkod, Vazhakkad and Feroke are situated along this river. The Chaliyar joins the Arabian Sea near Beypore. The Kavanakallu Regulator cum bridge is constructed over the Chaliyar River, 13 Km away from Kondotty Hill. About 27 Km from Nilambur, beyond the Chaliyar is Valamthode. The river has two names- Chaliyar and Beyporepuzha, of which the former is more popular. The river meets the Arabian Sea at an 'azhi' (estuary), the southern part of which is known as Chaliyam and northern part as Beypore.

Chalipuzha, the Punnapuzha, the Pandiyar, the Karimpuzha, the Vadapurampuzha, the Iringipuzha and the Iruthilpuzha are its important tributaries.

Fishes of the Chaliyar river has been documented by Easa and Basha (1995), Easa and Shaji (1997), Baby *et al* (2011). The annotated list is given in the Table 34.

Table 34. List of fishes known from the Chaliyar

FAMILY: ANGUILLIDAE

1. *Anguilla bengalensis* (Gray)

2. *Anguilla bicolor* McClelland

FAMILY: CYPRINIDAE

3. *Barilius bakeri* Day
4. *Barilius gaterensis* (Valenciennes)
5. *Salmophasia acinaces* (Valenciennes)
6. *Salmophasia boopis* (Day)
7. *Amblypharyngodon melettinus* (Valenciennes)
8. *Devario malabaricus* Jerdon
9. *Esomus danricus* Hamilton
10. *Rasbora dandia* (Valenciennes)
11. *Tor khudree* (Sykes)
12. *Osteobrama bakeri* (Day)
13. *Barbodes subnasutus* (Valenciennes)
14. *Hypseobarbus curmuca* (Hamilton)
15. *Puntius denisonii* (Day)
16. *Puntius fasciatus* (Jerdon)
17. *Puntius filamentosus* (Valenciennes)
18. *Puntius mahecola* (Valenciennes)
19. *Puntius punctatus* (Day)
20. *Puntius vittatus* (Day)
21. *Osteochilichthys nashii* (Day)
22. *Labeo rohita* (Hamilton)
23. *Garra stenorhynchus* (Jerdon)
24. *Garra mullya* (Sykes)

Family: Balitoridae

25. *Balitora mysorensis* Hora
26. *Bhavana australis* (Jerdon)
27. *Schistura denisoni* (Day)
28. *Mesonemacheilus guentheri* Day
29. *Mesonemacheilus triangularis* Day

Family: Cobitidae

30. *Pangio goaensis* (Tilak)
31. *Lepidocephalus thermalis* (Valenciennes)

Family: Bagridae

32. *Mystus montanus* (Jerdon)
33. *Mystus ocutatus* (Valenciennes)
34. *Batasio travancoria* Hora and Law

Family: Siluridae

35. *Ompok bimaculatus* (Bloch)

36. *Ompok malabaricus* (Valenciennes)
 37. *Wallago attu* (Bloch & Schneider)
Family: Sisoridae
 38. *Glyptothorax anamalaiensis* Silas
 39. *Glyptothorax annandalei* Hora
 40. *Glyptothorax davissinghi* Manimekalan & Das
 41. *Glyptothorax madraspatanus* (Day)
Family: Clariidae
 42. *Clarias dussumieri* Valenciennes
Family: Heteropneustidae
 43. *Heteropneustes fossilis* (Bloch)
Family: Belonidae
 44. *Xenentodon cancila* (Hamilton)
Family: Aplocheilidae
 45. *Aplocheilus lineatus* (Valenciennes)
Family: Mastacembelidae
 46. *Mastacembelus armatus* (Lacepede)
Family: Ambassidae
 47. *Parambassis dayi* (Bleeker)
 48. *Parambassis ranga* (Hamilton)
 49. *Parambassis thomassi* (Day)
Family: Cichlidae
 50. *Pristolepis marginata* Jerdon
 51. *Etilopius maculatus* (Bloch)
 52. *Etilopius suratensis* (Bloch)
 53. *Oreochromis mossambicus* Peters
Family: Gobiidae
 54. *Glossogobius giuris* (Hamilton)
 55. *Schismatogobius deraniyagalai* Peth & Kott
 56. *Sicyopterus griseus* (Day)
Family: Belontiidae
 57. *Pseudosphromenus cupanus* (Cuvier)
Family: Channidae
 58. *Channa gachua* Hamilton
 59. *Channa marulius* (Hamilton)
 60. *Channa striata* (Bloch)
Family: Tetraodontidae
 61. *Carinotetraodon travancoricus* (Hora & Nair)

Family: Soleidae

- 62.
- Brachirus orientalis*
- (Bloch)

Family: Syngnathidae

- 63.
- Microphis cuncalus*
- (Hamilton)

A total of 63 species of fishes were reported from the Chaliyar river (Table 34). However, during the present survey 35 fishes were reported with varying frequencies (Table 35). The seriation Table reveals that 27 species were recorded from the highland and 26 species were from the midland. In the lowland 17 species were recorded. The abundance of the fishes in the three zones showed an uneven pattern of distribution. However, in the midland, several species maintained a uniform abundance (Figure 53).

Table 35. Seriation Table to illustrate zone wise distribution of fishes

No.	Fish species	HL	ML	LL
1.	<i>A. melettinus</i>	0	1	0
2.	<i>Anguilla bengalensis</i>	0	1	1
3.	<i>Awous gutum</i>	1	1	1
4.	<i>Barilius bakeri</i>	1	1	1
5.	<i>Barilius gatensis</i>	1	0	0
6.	<i>Channa gachua</i>	1	1	1
7.	<i>Channa striata</i>	0	0	1
8.	<i>Clarias dussumieri</i>	1	0	0
9.	<i>Devario malabaricus</i>	1	1	1
10.	<i>Etilopius maculatus</i>	0	1	1
11.	<i>Etilopius suratensis</i>	0	0	1
12.	<i>Garra mullya</i>	1	0	0
13.	<i>Garra stenorhynchus</i>	1	1	0
14.	<i>Heteropneustes fossilis</i>	1	0	0
15.	<i>Hyprhamphus limbatus</i>	0	1	1
16.	<i>Lepidocephalus thermalis</i>	1	0	0
17.	<i>M. triangularis</i>	1	1	0
18.	<i>Mastacembelus armatus</i>	1	1	0
19.	<i>M. guentheri</i>	1	1	0

20. <i>Mystus gulio</i>	0	0	1
21. <i>Mystus montanus</i>	1	1	0
22. <i>Mystus ocutatus</i>	0	0	1
23. <i>Ompok bimaculatus</i>	1	1	0
24. <i>O. mossambicus</i>	1	1	1
25. <i>Osteochilichthys nashii</i>	1	1	0
26. <i>Puntius denisonii</i>	1	1	0
27. <i>Puntius fasciatus</i>	1	1	1
28. <i>Puntius filamentosus</i>	1	1	1
29. <i>Puntius mahecola</i>	1	1	1
30. <i>Puntius parrah</i>	1	1	0
31. <i>Puntius vittatus</i>	0	1	1
32. <i>Salmophasia acinaces</i>	1	1	0
33. <i>Sicyopterus griseus</i>	1	1	0
34. <i>Tor mussullah</i>	1	1	0
35. <i>Xenentodon cancila</i>	1	1	1

26. <i>Puntius denisonii</i>	1.19	1.59	0.00
27. <i>Puntius fasciatus</i>	3.57	1.85	0.40
28. <i>Puntius filamentosus</i>	5.15	3.70	1.59
29. <i>Puntius mahecola</i>	5.81	2.77	1.45
30. <i>Puntius parrah</i>	0.53	1.06	1.59
31. <i>Puntius vittatus</i>	0.00	1.45	3.43
32. <i>Salmophasia acinaces</i>	2.38	1.45	0.00
33. <i>Sicyopterus griseus</i>	2.51	1.06	0.00
34. <i>Tor mussullah</i>	3.43	1.19	0.00
35. <i>Xenentodon cancila</i>	1.19	1.06	1.45

Table 36. Abundance pattern of fishes in the three zones of Chaliyar river

No Fish species	HL	ML	LL
1. <i>Amblypharyngodon melettinus</i>	0.00	0.79	0.00
2. <i>Anguilla bengalensis</i>	0.00	0.13	0.13
3. <i>Awous gutam</i>	0.40	1.19	0.53
4. <i>Barilius bakeri</i>	2.38	0.79	0.53
5. <i>Barilius gatensis</i>	0.79	0.00	0.00
6. <i>Channa gachua</i>	0.13	0.40	0.26
7. <i>Channa striata</i>	0.00	0.00	0.13
8. <i>Clarias dussumieri</i>	0.40	0.00	0.00
9. <i>Devario malabaricus</i>	6.74	5.55	2.38
10. <i>Etrophus maculatus</i>	0.00	0.53	1.59
11. <i>Etrophus suratensis</i>	0.00	0.00	0.40
12. <i>Garra mullya</i>	1.59	0.00	0.00
13. <i>Garra stenorrhynchus</i>	4.10	2.11	0.00
14. <i>Heteropneustes fossilis</i>	0.26	0.00	0.00
15. <i>Hyphramphus limbatus</i>	0.00	0.40	1.19
16. <i>Lepidocephalus thermalis</i>	0.40	0.00	0.00
17. <i>Mesonemacheilus triangulatis</i>	1.72	1.06	0.00
18. <i>Mastacembelus armatus</i>	0.92	0.26	0.00
19. <i>Mesonemacheilus guentheri</i>	1.19	0.40	0.00
20. <i>Mystus gulio</i>	0.00	0.00	0.26
21. <i>Mystus montanus</i>	0.40	0.26	0.00
22. <i>Mystus oculatus</i>	0.00	0.00	0.13
23. <i>Ompok bimaculatus</i>	0.40	0.40	0.00
24. <i>Oreochromis mosambicus</i>	0.40	1.45	0.53
25. <i>Osteochilichthys nashii</i>	0.92	0.26	0.00

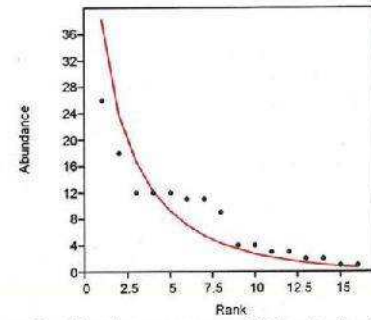
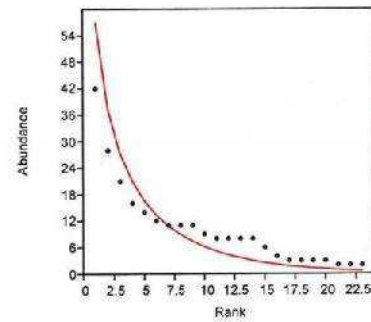
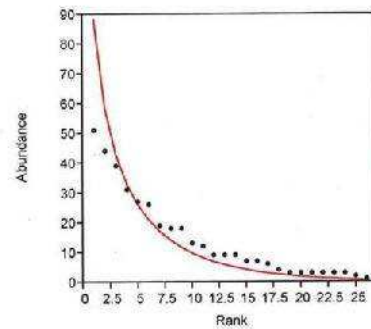


Figure 53. Abundance pattern of fishes in the three zones of Chaliyar river (A-HL, B-ML; C-LL)

21. KADALUNDI RIVER

The Kadalundi river is formed by the confluence of its two main tributaries, the Olipuzha and the Veliyar. Olipuzha takes its origin from the Cherakkombhanmala and the Veliyar from the forests of Erattakombanmala. The total length of this river is 130 Km, with a drainage area of 1099 Sq. Km. The river flows towards the Chaliyar and joins the Arabian Sea at about 5 Km south of the Chaliyar river mouth. The Pooraparamba river, a small stream, is also included in this basin, as its length is only 8 km. with a drainage area of 23 Sq. Km. The total drainage area of the basin is thus 1122 Sq.Km. The Kadalundi river, also known by the names, Karimpuzha and Oravanpurampuzha, is important from the navigation point of view.

Thirty one species of fishes were reported from the Kadalundi river. Except two species, all are primarily freshwater fishes (Table 37). However, the uniform sampling yielded only 14 species (Table 38).

Table 37. Fishes of Kadalundi river

Family : Notopteridae

1. *Notopterus notopterus* (Pallas)

Family : Cyprinidae

2. *Barilius bendelisis* (Hamilton)

3. *Barilius bakeri* (Day)

4. *Barilius gatensis* (Valenciennes)

5. *Salmophasia hoopis* (Day)

6. *Amblypharyngodon melettinus* (Val.)

7. *Devario malabaricus* (Jerdon)

8. *Rashora dandia* (Valenciennes)

9. *Barbodes subnasutus* (Valenciennes)

10. *Puntius denisonii* (Day)

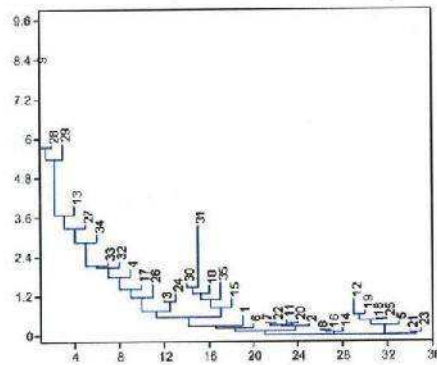


Figure 54. Neighbor joining cluster (The species number corresponds to the number in Table 35)

Devario malabaricus is the most abundant species in all the three zones which was followed by the *Puntius filamentosus* and *P. mahecola* (Table 36; Figure 54). *Garra stenorhynchus* was outnumbered in highland and midland but conspicuously absent in lowland zone. *Heteropneustes fossils*, *Lepidocephalus thermalis* and *Clarias dussumieri* were least abundant and restricted to the lowland region. *Salmophasia acinaces* (Figure 55) and *Sicyopterus griseus* were high in highland and rare in lowland. *Puntius fasciatus* and *Tor mussullah* were numerically abundant in the highland and represented by few individuals in the midland. The former was conspicuously absent in the lowland and the latter was represented by three individuals.



Figure 55. *Salmophasia acinaces* (Valenciennes)

11. *Puntius fasciatus* (Jerdon)
12. *Puntius filamentosus* (Valenciennes)
13. *Puntius mahecola* (Valenciennes)
14. *Puntius parrah* Day
15. *Puntius punctatus* (Day)
16. *Puntius sophore* (Hamilton)
17. *Puntius vittatus* (Day)
18. *Garra mullya* (Sykes)
- Family: Balitoridae**
19. *Masonemacheilus guentheri* Day
- Family: Aplocheilidae**
20. *Aplocheilus lineatus* (Valenciennes)
- Family: Nandidae**
21. *Pristolepis marginata* Jerdon
- Family: Cichlidae**
22. *Etroplus canarensis* Day
23. *Etroplus maculatus* (Bloh)
- Family: Gobiidae**
24. *Glossogobius giuris* (Hamilton)
- Family: Mugilidae**
25. *Mugil cephalus* Linn
- Family Gerreidae**
26. *Gerres filamentosus* (Cuvier)
- Family: Mastacembelidae**
27. *Macrognathus guentheri* (Day)
28. *Mastacembelus armatus* (Lacépède)
- Family: Belontiidae**
29. *Pseudosphromenus cupanus* (Cuvier)
- Family: Channidae**
30. *Channa gachua* Hamilton
- Family: Tetraodontidae**
31. *Carinotetraodon travancoricus* (Hora & Nair)

Devario malabaricus and *Puntius filamentosus* were the dominant species in the mid land region. *Rasbora dandia* followed the above species. *Gerres filamentosus* and *Mugil cephalus* was the dominating fishes in the lowland regime of the river.

Channa gachua, *Puntius denisonii* and *Salmophasia boopis* were recorded in equal frequency from the midland (Table 37 and 38).

Table 38. Seriation Table -Kadalundi river

No	Fish species	HL	ML	LL
1.	<i>A. melettinus</i>	0	1	0
2.	<i>Channa gachua</i>	0	1	0
3.	<i>Devario malabaricus</i>	1	1	0
4.	<i>Etroplus maculatus</i>	0	1	0
5.	<i>Etroplus suratensis</i>	0	0	1
6.	<i>Garra mullya</i>	0	1	0
7.	<i>Gerres filamentosus</i>	0	0	1
8.	<i>Glossogobius giuris</i>	0	0	1
9.	<i>Mugil cephalus</i>	0	0	1
10.	<i>Pristolepis marginata</i>	1	0	0
11.	<i>Puntius denisonii</i>	0	1	0
12.	<i>Puntius filamentosus</i>	1	1	0
13.	<i>Rasbora dandia</i>	1	0	0
14.	<i>Salmophasia boopis</i>	0	1	0

Table 39. Abundance pattern of fishes in the 3 zones of Kadalundi river.

No	Fish species	HL	ML	LL
1.	<i>A. melettinus</i>	0.00	3.64	0.00
2.	<i>Channa gachua</i>	0.00	1.82	0.00
3.	<i>Devario malabaricus</i>	14.55	7.27	0.00
4.	<i>Etroplus maculatus</i>	0.00	3.64	0.00
5.	<i>Etroplus suratensis</i>	0.00	0.00	1.82
6.	<i>Garra mullya</i>	0.00	3.64	0.00
7.	<i>Gerres filamentosus</i>	0.00	0.00	16.36
8.	<i>Glossogobius giuris</i>	0.00	0.00	3.64
9.	<i>Mugil cephalus</i>	0.00	0.00	9.09
10.	<i>Pristolepis marginata</i>	1.82	0.00	0.00
11.	<i>Puntius denisonii</i>	0.00	1.82	0.00
12.	<i>Puntius filamentosus</i>	12.73	9.09	0.00
13.	<i>Rasbora dandia</i>	7.27	0.00	0.00
14.	<i>Salmophasia boopis</i>	0.00	1.82	0.00

22. TIRUR RIVER

Tirur River originates from the Athvanad in the Malappuram district and flow south-west to Thiruvnavaya and then north-west to Elamkulam where it turns south-west joining the Bharathapuzha River which flows into the Arabian Sea near the coastal town of Ponnani. It is known for its mangroves and its diverse fishes and birds..

This river is navigable and forms part of west coast water transport system. Its length is 48 km. Thunchath Ramanujan Ezhuthachan - the father of Malayalam literature was born and brought up on the banks of this river and his birth place Thunjan Parambu is situated very near to the river and the place is called Annara desam and Trikkandiyooramson in Vettattnad. Vallathol Narayana Menon, poet and the founder of Kerala Kalamandalam, was also born on the banks of this river.

The fishes of Thirur River were reported by Biju (2003) and reported 15 species from the Thirur river. The annotated list is given in Table 40. The present survey could record 11 species (Table 41). The seriation Table reveals that four species were recorded from the highland, two species from the midland and five species from the lowland.

Table 40. Fishes of Thirur river

- Family: Clupeidae**
 1. *Dayella malabarica* (Day)
Family : Cyprinidae
 2. *Salmophasia boopis* (Day)
 3. *Amblypharyngodon melettinus* (Val)
 4. *Devario malabaricus* (Jerdon)
 5. *Rashora dandia* (Hamilton)
 6. *Puntius filamentosus* (Valenciennes)
 7. *Puntius punctatus* (Day)

8. *Puntius vittatus* (Day)
Family: Siluridae
 9. *Wallago attu* (Bloch)
Family: Bagridae
 10. *Mystus* sp.
Family: Aplocheilidae
 11. *Aplocheilus lineatus* (Valenciennes)
Family: Cichlidae
 12. *Oreochromis mossambicus* (Peters)
 13. *Eetroplus maculatus* (Bloch)
Family: Anabantidae
 14. *Anabas testudineus* (Bloch)
Family: Mugilidae
 15. *Mugil cephalus* Linn
Family Gerreidae
 16. *Gerrus filamentosus* (Cuvier)
Family: Scatophagidae
 17. *Scatophagus argus* (Linnaeus)
Family : Mastacembelidae
 18. *Macrogathus guentheri* (Day)
 19. *Mastacembelus armatus* (Lacepede)
Family: Belontiidae
 20. *Pseudosphromenus cupanus* (Cuvier)
Family: Channidae
 21. *Channa gachua* Hamilton
 22. *Channa striata* (Bloch)

Table 41. Seriation Table to illustrate the fishes in different sections of Tirur river

No.Fish species	HL	ML	LL
1. <i>Channa striata</i>	1	0	0
2. <i>Eetroplus maculatus</i>	0	0	0
3. <i>Eetroplus suratensis</i>	0	0	1
4. <i>Gerres filamentosus</i>	0	0	1
5. <i>Mastacembelus armatus</i>	0	0	0
6. <i>Mugil cephalus</i>	0	1	1
7. <i>Mystus</i> sp	0	1	1
8. <i>Puntius filamentosus</i>	1	0	0
9. <i>Puntius punctatus</i>	1	0	0
10. <i>Scatophagus argus</i>	0	0	1
11. <i>Wallago attu</i>	1	0	0

The distribution of the fishes at the time of sampling in the Tirur river is available from the Table 40.

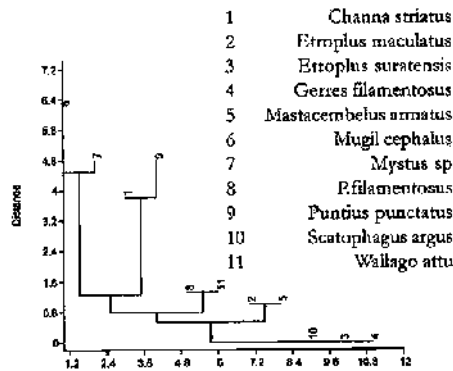


Figure 56. Neighbor joining cluster (see the list in the Figure for the species number.)

The clustering based on the abundance is available from the Figure 56. *Channa striata* and *Puntius punctatus* were the two species abounded in the highland and they were not reported from the other two zones. *Mugil cephalus* and *Mystus sp.* were outnumbered in the lowland and midland. *Wallago attu*, *Etroplus suratensis* and *Gerres filamentosus* were collected from low land in low proportion.

23. BHARATHAPPUZHA

The headwaters of main tributary of Bharathappuzha originates in the Anaimalai Hills in the Western Ghats, and flows westward through Palakkad Gap, across Palakkad, Thrissur and Malappuram districts of Kerala, with many tributaries joining it, including the Tirur River. For the first 40 km or so, the Bharathappuzha follows an almost northerly course till Pollachi. At Parli both Kannadippuzha and Kalpathippuzha merge and flow as Bharathappuzha and follow a westerly

course until it empties into the Arabian Sea at Ponnani. Thoothapuzha joins with Nila at Pallippuram.

The watershed areas of Bharathapuzha basin is about 6,186 km², the largest among the river basins in Kerala. A little more than two-thirds of this area (4400 km²) is within Kerala and the remaining area (1786 km²) is in Tamil Nadu. Though Bharathapuzha has a large basin, the water flow is relatively less compared to other lengthy rivers in Kerala. The construction of a number of dams has reduced the river flow in the Bharathapuzha.

A total of 70 fishes have been reported from the Bharathapuzha (Table 42).

Table 42. List of fishes known from Bharathapuzha.

Family : Notopteridae

1. *Notopterus notopterus* (Pallas)

Family Anguillidae

2. *Anguilla bengalensis* (Gray)
3. *Anguilla bicolor* McClelland

Family : Cyprinidae

4. *Salmophasia acinaces* (Valenciennes)
5. *Salmophasia boopis* (Day)
6. *Laubuca fasciatus* Silas
7. *Amblypharyngodon melettinus* (Val)
8. *Barilius bendelisis* (Hamilton)
9. *Barilius bakeri* (Day)
10. *Barilius gatensis* (Valenciennes)
11. *Devario malabaricus* Jerdon
12. *Rasbora dandia* (Valenciennes)
13. *Horadandia atukorali* Deraniyagala
14. *Esomus thermoicos* (Valenciennes)
15. *Tor malabaricus* (Jerdon)
16. *Osteobrama bakeri* (Day)

17. *Hypselobarbus curmuca* (Hamilton)
 18. *Hypselobarbus jerdoni* (Day)
 19. *Hypselobarbus kurali* Menon & Devi
 20. *Barbodes carnaticus* (Jerdon)
 21. *Barbodes subnasutus* (Valenciennes)
 22. *Puntius conchoniatus* (Hamilton)
 23. *Puntius denisonii* (Day)
 24. *Puntius dorsalis* (Jerdon)
 25. *Puntius fasciatus* (Jerdon)
 26. *Puntius filamentosus* (Valenciennes)
 27. *Puntius mahecola* (Valenciennes)
 28. *Puntius parrah* Day
 29. *Puntius punctatus* (Day)
 30. *Puntius vittatus* (Day)
 31. *Kantaka brevidorsalis* (Day)
 32. *Osteochilichthys nashii* (Day)
 33. *Garra mcClellandi* (Jerdon)
 34. *Garra menoni* Devi and Indra
 35. *Garra mulya* (Sykes)
Family: Balitoridae
 36. *Bhavana australis* (Jerdon)
 37. *Nemacheilus anguilla* Annandale
 38. *Schistura denisoni* (Day)
 39. *Schistura semiarmatus* Day
 40. *Mesonemacheilus guentheri* Day
 41. *Mesonemacheilus triangularis* (Day)
 42. *Oreonectes keralensis* Rita and Nalbarr
Family: Cobitidae
 43. *Lepidocephalus thermalis* (Valenciennes)
Family: Bagridae
 44. *Mystus seengtee* (Sykes)
 45. *Mystus montanus* (Jerdon)
 46. *Mystus ocutatus* (Valenciennes)
 47. *Balasio travancoria* Hora and Law
Family: Siluridae
 48. *Ompok bimaculatus* (Bloch)
 49. *Ompok malabaricus* (Valenciennes)
 50. *Wallago attu* (Bloch & Schneider)
Family: Sisoridae
 51. *Glyptothorax madraspatanus* (Day)
Family: Clariidae
 52. *Clarias dussumieri* Valenciennes
Family: Heteropneustidae
 53. *Heteropneustes fossilis* (Bloch)
Family: Belonidae
 54. *Xenentodon cancila* (Hamilton)
Family: Aplocheilidae
 55. *Aplocheilus lineatus* (Valenciennes)
Family: Mastacembelidae
 56. *Mastacembelus armatus* (Lacepede)
Family : Ambassidae
 57. *Chanda nama* (Hamilton)
 58. *Parambassis dayi* (Bleeker)
 59. *Parambassis ranga* (Hamilton)
 60. *Parambassis thomassi* (Day)
Family: Nandidae
 61. *Pristolepis marginatus* Jerdon
Family: Cichlidae
 62. *Etroplus maculatus* (Bloch)
 63. *Etroplus suratensis* (Bloch)
Family: Gobiidae
 64. *Glossogobius giuris* (Hamilton)
Family: Mastacembelidae
 65. *Mastacembelus armatus* (Lacepede)
Family: Belontiidae
 66. *Pseudosphromenus cupanus* (Cuvier)
Family: Channidae
 67. *Channa gachua* Hamilton
 68. *Channa marulius* (Hamilton)
 69. *Channa striata* (Bloch)
Family: Tetraodontidae
 70. *Carinotetraodon travancoricus* (Hora & Nair)

The present uniform sampling yielded only 23 species. The index for Evenness is very high in lowland indicates the less variation among the species in lowland and high variation in the

highland. The dominance index is very high in the midland clearly indicates the high abundance of certain species (Table 43 and 44).

Table 43. Dominance and evenness indices in three zones of Bharathapuzha

Indices	HL	ML	LL
Dominance	0.1804	0.2293	0.2193
Evenness	0.3882	0.5581	0.9478

Table 44. Fish species and their abundance in three zones of Bharathapuzha.

No. Fish species	HL	ML	LL
1. <i>A. meletinus</i>	27.48	0.000	0.000
2. <i>Anguilla bicolor</i>	0.000	0.157	0.000
3. <i>Barilius gatensis</i>	6.872	0.000	0.000
4. <i>Bhavana australis</i>	2.712	0.000	0.000
5. <i>Channa gachua</i>	27.12	0.000	0.000
6. <i>Channa striata</i>	0.542	0.000	0.000
7. <i>Cirrhinus mrigala</i>	0.000	2.194	0.000
8. <i>Clarias dussumieri</i>	0.362	0.000	0.000
9. <i>Etroplus suratensis</i>	3.255	9.404	0.000
10. <i>Garra mullya</i>	1.808	10.52	0.000
11. <i>Heteropneustes fossilis</i>	0.000	41.22	0.000
12. <i>Hyphramphus limbatus</i>	0.362	0.627	0.000
13. <i>Labeo rohita</i>	0.181	5.172	0.000
14. <i>L. thermalis</i>	0.362	2.351	0.000
15. <i>Mastacembelus armatus</i>	0.542	0.000	0.000
16. <i>M. triangularis</i>	0.723	7.367	0.000
17. <i>Mystus seengtee</i>	1.447	16.92	0.000
18. <i>O. mossambicus</i>	2.893	0.000	9.462
19. <i>Parambassis thomassi</i>	0.362	0.000	25.16
20. <i>Puntius fasciatus</i>	5.425	4.075	0.000
21. <i>Puntius filamentosus</i>	13.92	40.000	22.37
22. <i>Rasbora dandia</i>	2.893	0.000	26.23
23. <i>Wallago attu</i>	0.181	0.000	16.77

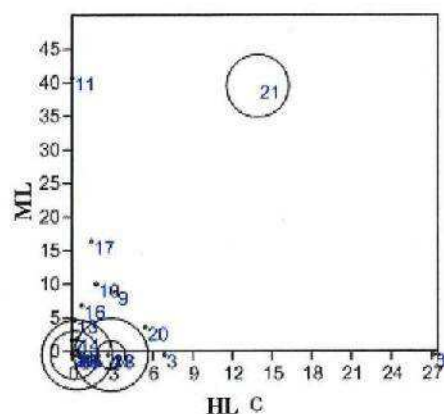


Figure 57/ Abundance pattern of fishes in the three zones of Bharathapuzha.

The diversity profile of the Bharathapuzh shows that the high land harbours 20 species, midland 11 species and lowland harbours 5 species. *Puntius filamentosus*, *Parambassis thomassi*, *Rasbora dandia*, *Oreochromis mossambicus* and *Wallago attu* were absent in midland had a high abundance in lowland. Except the *Puntius filamentosus*, all three above species had very low abundance in highland (Table 44 and Figure 57).

24. KECHERI RIVER

Kecheri river is one of the small rivers in the State and is practically dry during summer. It originates from Machad Malai at an elevation of 365 m above mean sea level. Choondal thodu is the only important tributary of this river. Linked with backwaters at Enamakal, river empties into Arabian Sea at Chettuva. The total length of river is 51 Km. and has a drainage area 401 Sq Km. The river basin is located in Thrissur district. The Vazhani part of Pecchi- Vazhani wildlife sanctuary is drained by Kecheri river.

Table 45. Fishes of Kecheri river**Family : Cyprinidae**

1. *Amblypharyngodon melettinus* (Val)
2. *Devario malabaricus* Jerdon
3. *Rasbora dandia* (Valenciennes)
4. *Barbodes subnasutus* (Valenciennes)
5. *Puntius dorsalis* (Jerdon)
6. *Puntius filamentosus* (Valenciennes)
7. *Puntius mahecola* (Valenciennes)
8. *Puntius parrah* Day
9. *Puntius punctatus* (Day)
10. *Puntius vittatus* (Day)
11. *Garra mullya* (Sykes)

Family: Cobitidae

12. *Lepidocephalus thermalis* (Valenciennes)

Family: Bagridae

13. *Mystus montanus* (Jerdon)
14. *Mystus ocutatus* (Valenciennes)

Family: Siluridae

15. *Ompok bimaculatus* (Bloch)

Family: Heteropneustidae

16. *Heteropneustes fossilis* (Bloch)

Family: Belontiidae

17. *Xenentodon cancila* (Hamilton)

Family: Aplocheilidae

18. *Aplocheilus lineatus* (Valenciennes)

Family : Chandidae

19. *Parambassis ranga* (Hamilton)

Family: Cichlidae

20. *Etilopius maculatus* (Bloch)

Family: Mastacembelidae

21. *Mastacembelus armatus* (Lacepede)

Family: Channidae

22. *Channa gachua* Hamilton

Family: Tetraodontidae

23. *Carinotetraodon travancoricus* (Hora & Nair)

Kecheri is a small river and only 23 fish species were recorded from this river (Table 45). However, only 11 species were represented in the present sampling (Table 46 and 47). Six species were

Table 46. Seriation Table to illustrate the fishes in different sections of the stream

No.Fishes.	HL	ML	LL
1. <i>A. melettinus</i>	1	0	0
2. <i>Aplocheilus lineatus</i>	1	1	0
3. <i>Devario malabaricus</i>	1	1	1
4. <i>Etilopius maculatus</i>	0	1	0
5. <i>Mastacembelus armatus</i>	0	1	0
6. <i>Mystus oculatus</i>	0	1	0
7. <i>Puntius fasciatus</i>	0	1	0
8. <i>Puntius filamentosus</i>	0	1	0
9. <i>Puntius mahecola</i>	1	1	0
10. <i>Puntius punctatus</i>	1	1	0
11. <i>Rasbora dandia</i>	1	1	1

Table 47. Abundance of fish species in three zones of the Kecheri river.

No Fish species	HL	ML	LL
1. <i>A.melettinus</i>	39.62	0.00	0.00
2. <i>Aplocheilus lineatus</i>	1.89	1.47	0.00
3. <i>Devario malabaricus</i>	24.53	32.35	3.85
4. <i>Etilopius maculatus</i>	0.00	16.18	0.00
5. <i>Mastacembelus armatus</i>	0.00	1.47	0.00
6. <i>Mystus oculatus</i>	0.00	7.35	0.00
7. <i>Puntius fasciatus</i>	0.00	1.47	0.00
8. <i>Puntius filamentosus</i>	0.00	8.82	0.00
9. <i>Puntius mahecola</i>	5.66	10.29	0.00
10. <i>Puntius punctatus</i>	5.66	1.47	0.00
11. <i>Rasbora dandia</i>	22.64	19.12	6.15

recorded from the highland, ten species from the midland and two species from the lowland.

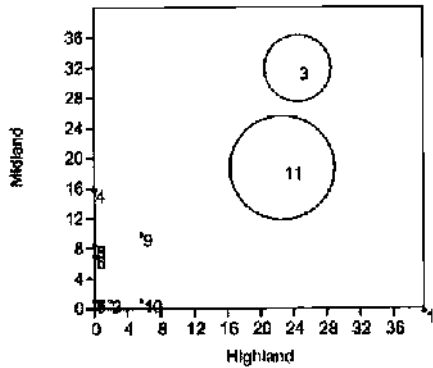


Figure 58. Bubble plot to show the relative abundance of fish species (The species number as in Table 47)

The abundance value indicates that the *Rasbora dandia* and *Devario malabaricus* are the two species dominating in the Kecheri river. The *Amblypharyngodon melettinus* is restricted to the highland and it outnumbered all the remaining species.

25. PUZHAKKAL RIVER

Puzhakkal river originate in the hills of Killannoor at an elevation of >150 m above msl. The river has a length of 29 km and a total of 234 sq.km drainage area. Puvathodu, Poomalathodu, Nadathodu and Kattachirathodu are the main tributaries.

A total of 25 species were enlisted from the Puzhakkal river (Table 53). Most of the them are common species and cyprinids are the most common species found in the Puzhakkal river.

Table 48. Fishes of the Puzhakkal river

Family : Cyprinidae

1. *Amblypharyngodon melettinus* (Val)
2. *Devario malabaricus* (Jerdon)
3. *Esomus danricus* Hamilton
4. *Rasbora dandia* (Valenciennes)
5. *Laubuca labuca* (Hamilton)
6. *Barbodes subnasutus* (Valenciennes)
7. *Puntius dorsalis* (Jerdon)
8. *Puntius filamentosus* (Valenciennes)
9. *Puntius mahecola* (Valenciennes)
10. *Puntius parrah* Day
11. *Puntius punctatus* (Day)
12. *Puntius vittatus* (Day)
13. *Garra mullya* (Sykes)

Family: Cobitidae

14. *Leptdocephalus thermalis* (Valenciennes)

Family: Siluridae

15. *Ompok bimaculatus* (Bloch)

Family: Bagridae

16. *Mystus oculatus* (Valenciennes)

Family: Heteropneustidae

17. *Heteropneustes fossilis* (Bloch)

Family: Aplocheilidae

18. *Aplocheilus lineatus* (Valenciennes)

Family: Belonidae

19. *Xenentodon cancila* (Hamilton)

Family: Ambassidae

20. *Parambassis ranga* (Hamilton)

Family: Cichlidae

21. *Etoplus maculatus* (Bloch)

Family: Mastacembelidae

22. *Mastacembelus armatus* (Lacepede)

Family: Channidae

23. *Channa gachua* Hamilton

24. *Channa striata* (Bloch)

Family: Tetraodontidae

25. *Carinotetraodon travancoricus* (Hora & Noir)

Table 49. Abundance of fishes in three zones of Puzhakkal river.

No.	Fish species	HL	ML	LL
1.	<i>A. melettinus</i>	0.00	5.28	0.00
2.	<i>Aplocheilus lineatus</i>	0.00	0.34	0.0
3.	<i>C. travancoricus</i>	0.00	0.17	0.00
4.	<i>Barbodes subnasutus</i>	0.00	0.17	0.00
5.	<i>Devario malabaricus</i>	6.64	9.71	1.13
6.	<i>Esomus danricus</i>	0.00	2.04	0.00
7.	<i>Eetroplus maculatus</i>	0.68	0.85	0.12
8.	<i>Garra mullya</i>	0.00	0.51	0.00
9.	<i>Laubuca laubuca</i>	0.00	25.55	0.00
10.	<i>Lepidocephalus thermalis</i>	0.85	0.00	0.15
11.	<i>Mastacembelus armatus</i>	0.51	0.00	0.09
12.	<i>Mystus oculatus</i>	0.34	0.34	0.06
13.	<i>Puntius dorsalis</i>	0.17	3.07	0.03
14.	<i>Puntius filamentosus</i>	4.09	0.00	0.70
15.	<i>Puntius mahecola</i>	0.85	2.04	0.15
16.	<i>Puntius parrah</i>	0.00	0.17	0.00
17.	<i>Puntius punctatus</i>	2.21	1.7	0.38
18.	<i>Rasbora dandia</i>	2.90	17.04	0.49

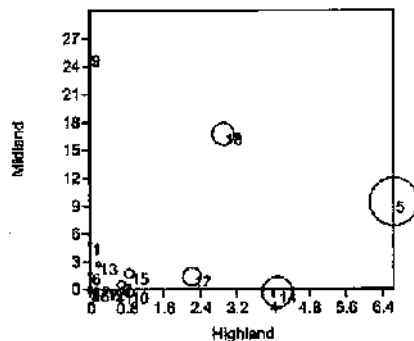


Figure 59. Bubble plot to show the abundance of different species in Puzhakkal river (The species number as in Table 49)

The most dominant species was the *Laubuca laubuca* which was restricted to the middle zone of the river (Figure 59). *Rasbora dandia* and *Devario malabaricus* were showed high abundance in the middle zone and their number

was less in the either side (Table 49). *Puntius dorsalis* showed very low value of abundance in all the three zones of the river (Figure 59).

26 KARUVANNUR RIVER

Karuvannur river basin lies between 100 15' to 10° 40' North latitude and 76° 00' to 76° 35' East longitude within Thrissur and Palakkad districts of Kerala. It is bounded by Thrissur and Chavakkad Taluks of Thrissur district in the North, Mukundapuram and Kodungallur Taluks of Thrissur district in the South, Alathur and Chittor Taluks of Palakkad district in the East and the Arabian Sea in the West. Karuvannur River basin, constituting an area of 1054 km², lies in Southern Western Ghats and covers 32 panchayats, 9 blocks and 2 districts. The river originates from the Western Ghats and is fed by its two main tributaries, viz., Manali and Kurumali. Manali river originates from Ponnudi in the boundary of Thrissur and Palakkad districts at an elevation of +928m. Chimony and Muply, the two sub-tributaries of Kurumali originate from Pundimudi at an elevation of +1116 m.. Karuvannur river has a drainage area of 1054 km², stream length 48 km, average monsoon flow of 1275 Mm³, average lean flow 55 Mm³ and thus the total flow 1330 Mm³. (Rajagopalan, 2005). The average rainfall in low land of river basin was estimated to be 2858mm, midland 3011mm and highland 2851 mm. About 60 per cent of rainfall is received during south west monsoon period, 30 per cent from north east monsoon and 10 per cent in the pre-monsoon period.

Fifty six species have been reported from the Karuvannur river (Table 50).

Table 50. List of fishes of Karuvannur river**Family Anguillidae**

1. *Anguilla bengalensis* (Gray)
2. *Anguilla bicolor* McClelland

Family : Notopteridae

3. *Notopterus notopterus* (Pallas)

Family : Cyprinidae

4. *Barilius gatensis* (Valenciennes)
5. *Salmophasia boopis* (Day)
6. *Amblypharyngodon melettinus* (Val.)
7. *Devario malabaricus* Jerdon
8. *Esomus danricus* Hamilton
9. *Rasbora dandia* (Valenciennes)
10. *Osteobrama bakeri* (Day)
11. *Barbodes subnasutus* (Valenciennes)
12. *Puntius dorsalis* (Jerdon)
13. *Puntius fasciatus* (Day)
14. *Puntius filamentosus* (Valenciennes)
15. *Puntius mahecola* (Valenciennes)
16. *Puntius parrah* Day
17. *Puntius punctatus* (Day)
18. *Puntius vittatus* (Day)
19. *Catla catla* (Hamilton)
20. *Labeo rohita* (Hamilton)
21. *Garra mullya* (Sykes)

Family: Balitoridae

22. *Bhavana australis* (Jerdon)
23. *Mesonemacheilus guentheri* Day
24. *Mesonemacheilus triangularis* (Day)

Family : Cobitidae

25. *Lepidocephalus thermalis* (Val)

Family: Bagridae

26. *Mystus gulio* (Hamilton)
27. *Mystus malabaricus* (Jerdon)
28. *Mystus montanus* (Jerdon)
29. *Mystus ocutatus* (Valenciennes)
30. *Batasio travancoria* Hora and Law
31. *Horabagrus brachysoma* (Guenther)

32. *Ompok bimaculatus* (Bloch)

33. *Wallago attu* (Bloch & Schneider)

Family : Sisoroidae

34. *Glyptothorax madraspatanus* (Day)

Family: Clariidae

35. *Clarias dussumieri* Valenciennes

Family: Heteropneustidae

36. *Heteropneustes fossilis* (Bloch)

Family: Belonidae

37. *Xenentodon cancila* (Hamilton)

Family: Aplocheilidae

38. *Aplocheilus lineatus* (Valenciennes)

Family: Mastacembelidae

39. *Macrogathus guentheri* (Day)
40. *Mastacembelus armatus* (Lacepede)

Family: Chandidae

41. *Chanda nama* (Hamilton)
42. *Parambassis dayi* (Bleeker)
43. *Parambassis thomassi* (Day)

Family: Nandidae

44. *Nandus nandus* (Hamilton)
45. *Pristolepis marginata* Jerdon

Family: Cichlidae

46. *Etroplus maculatus* (Bloch)
47. *Etroplus suratensis* (Bloch)

Family: Gobiidae

48. *Glossogobius giuris* (Hamilton)
49. *Sicyopterus griseus* (Day)

Family: Anabantidae

50. *Anabas testudineus* (Bloch)

Family: Belontiidae

51. *Pseudosphromenus cupanus* (Cuvier)

Family: Channidae

52. *Channa diplogramme* (Day)
53. *Channa gachua* Hamilton
54. *Channa marulius* (Hamilton)
55. *Channa striata* (Bloch)

Family: Tetraodontidae

56. *Carinotetraodon travancoricus* (Hora & Nair)

The present survey yielded 28 species with varying abundance. Twenty one species were reported from highland region, 25 species from midland and nine species from the lowland region. In the highland the abundance of the species was uneven whereas in midland, some species maintained an even abundance (Table 51; Figure 60).

Table 51. Abundance of fishes in Karivannur river

No Fish species	HL	ML	LL
1. <i>A. melettinus</i>	0.0	11.1	0.0
2. <i>Aplocheilus lineatus</i>	0.2	0.1	0.0
3. <i>Awaous gutum</i>	0.0	0.1	0.0
4. <i>Barilius gatensis</i>	1.1	0.0	0.0
5. <i>C. travancoricus</i>	0.0	0.2	3.4
6. <i>Channa gachua</i>	0.4	0.5	0.2
7. <i>Channa marulius</i>	0.4	0.1	0.1
8. <i>Channa striata</i>	0.5	0.2	0.2
9. <i>Devario malabaricus</i>	6.8	4.3	0.0
10. <i>Etroplus maculatus</i>	0.0	2.1	0.0
11. <i>Etroplus suratensis</i>	0.0	0.4	0.0
12. <i>Garra mullya</i>	2.2	0.4	0.0
13. <i>Glossogobius giuris</i>	0.0	0.6	0.0
14. <i>H. brachysoma</i>	0.0	1.1	1.6
15. <i>L. thermalis</i>	0.1	0.1	0.0
16. <i>Mastacembelus armatus</i>	0.2	0.6	0.0
17. <i>M. triangularis</i>	0.1	0.0	0.0
18. <i>Mystus montanus</i>	0.4	0.0	0.0
19. <i>Mystus oculatus</i>	0.0	0.4	0.0
20. <i>Parambassis dayi</i>	1.1	0.6	0.0
21. <i>Pristolepis marginata</i>	1.6	0.5	0.0
22. <i>Puntius fasciatus</i>	1.6	0.7	0.0
23. <i>Puntius filamentosus</i>	6.0	6.1	0.0
24. <i>Puntius mahecola</i>	2.3	4.9	0.0
25. <i>Puntius punctatus</i>	1.2	1.9	0.9
26. <i>Rasbora dandia</i>	4.0	6.0	6.2
27. <i>Tilapia mossambicus</i>	1.6	1.3	5.6
28. <i>Xenentodon cancila</i>	0.0	0.5	5.2

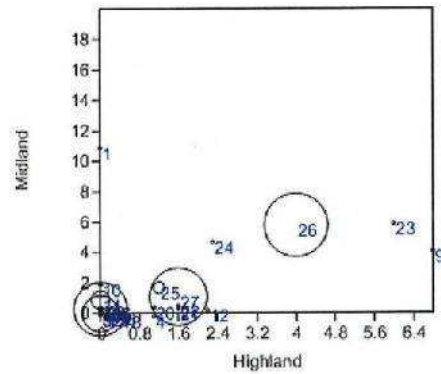


Figure 60. Fish species abundance in Karivannur river (The species number corresponds to the number in Table 51)

Amblypharyngodon melettinus was the most abundant species in the Karivannur river. *Puntius mahecola*, *Devario malabaricus* and *Puntius filamentosus* were in one cluster because of their high abundance in highland and midland. *Rasbora dandia* outnumbered in all three zones (Figure 60).

27. CHALAKUDY RIVER

Chalakydy river basin, fifth longest river has six artificial reservoirs in the basin. Dominant rock types are charnockite and biotite gneiss, with recent sediments in the western part and along the river. Geomorphologically, this stretch is characterized by floodplain, transitional plain, low rolling terrain, moderately undulating terrain, highly undulating terrain and hilly area. Average annual rainfall in this area is around 3300 mm, varying from a little over 3000 mm in Chalakydy town to 3700 mm in Poringalkuthu. Seasonal variation of temperature is within 5°C. Total average annual drainage discharge (1980–2000) is 1421.81 million m³ near Chalakydy town, as reported by Irrigation Department, Government of Kerala.

The 144 km long Chalakudy River, is an Inter state river that drains the runoff from a 1,704 sq.km catchment. Out of the four main tributaries, its northern tributaries originate from Neeliampathy hills and its southeastern tributaries originate from Anamalai Hills of Western Ghats. Total utilizable yield of river basin is estimated at 2,033 M³ out of which 494 M³ is expected from Tamil Nadu.

The very high variation in rainfall pattern and distribution across different locations within river basin ranging from Parambikulam a low rainfall area to Valparai a very heavy rainfall area has allowed niches for different vegetation patterns to evolve in valleys over time. Hence Chalakkudy river basin is known for its rich floral and faunal diversity, riparian species diversity and fish diversity. The sustenance of this richness is in turn dependent on the wellbeing of river.

One of the most unique features of this inter state river basin that distinguishes it from other river basins in Kerala and even perhaps India is the fact that more than two third catchment of river basin; 1200 sq.km is still within the jurisdiction of Forest Department. Presently, river basin has three Forest Divisions and a Wild Life Sanctuary (Parambikulam Wild Life Division) within Kerala. Chalakkudy River basin has more than 150-year-old history of human induced deforestation for cash crop plantations of tea, coffee, forest plantations of teak by the British, clear felling and selection felling by the Forest Department, leasing out prime forest areas to dams, reservoirs and other related infrastructures, human settlements, public limited corporation etc.

The fishes of Chalakudy river has been documented by several researchers (Shaji and Easa, 1999; Ajithkumar et.al, 1999; Biju et.al., 2000; Sekaran

et.al., 2002; Kurup et.al., 2004; Raghavan et.al., 2008). Raghavan et.al., (2008) reported 71 fishes belonging to 27 families and 50 genera from the Chalakudy river. They discussed various threats to species. The present exhaustive list is based on the earlier reports (Table 52). Some species were omitted from this list by virtue of systematic ambiguity and requires further examination.

Table 52. Fishes of Chalakudy river

Family: Clupeidae

1. *Dayella malabarica* (Day)

Family: Megalopidae

2. *Megalops cyprinoides* (Broussonet)

Family: Anguillidae

3. *Anguilla bengalensis* (Gray)
4. *Anguilla bicolor* McClelland

Family : Cyprinidae

4. *Barilius bendelisis* (Hamilton)
5. *Barilius bakeri* Day
6. *Barilius gatensis* (Valenciennes)
7. *Salmophasia acinaces* (Valenciennes)
8. *Salmophasia boopis* (Day)
9. *Amblypharyngodon melettinus* (Val.)
10. *Laubuca dadiburjori* (Menon)
11. *Laubuca fasciatus* Silas
12. *Devario malabaricus* (Jerdon)
13. *Rasbora dandia* (Valenciennes)
14. *Tor khudree* (Sykes)
15. *Osteobrama bakeri* (Day)
16. *Barbodes carnaticus* (Jerdon)
17. *Barbodes subnasutus* (Valenciennes)
18. *Hypselobarbus curmuca* (Hamilton)
19. *Hypselobarbus jerdoni* (Day)
20. *Hypselobarbus kurali* Menon & Devi
21. *Hypselobarbus pulchellus* (Day)
22. *Hypselobarbus thomassi* (Day)
23. *Puntius fasciatus* (Jerdon)

24. *Puntius assimilis* (Jerdon)
 25. *Puntius bimaculatus* (Bleeker)
 26. *Puntius chalakkudiensis* Menon *et al*
 27. *Puntius denisonii* (Day)
 28. *Puntius dorsalis* (Jerdon)
 29. *Puntius filamentosus* (Valenciennes)
 30. *Puntius mahecola* (Valenciennes)
 31. *Puntius parrah* Day
 32. *Puntius punctatus* (Day)
 33. *Puntius vittatus* (Day)
 34. *Osteochilichthys longidorsalis*
 35. *Catla catla* (Hamilton)
 36. *Labeo nigrescens* Day
 37. *Labeo rohita* (Hamilton)
 38. *Garra mullya* (Sykes)
 39. *Garra surendranathanii* Shaji *et al*
Family : Balitoridae
 40. *Homaloptera montana* Herre
 41. *Bhavana australis* (Jerdon)
 42. *Travancoria elongata* Peth & Kottelat
 43. *Schistura denisoni* (Day)
 44. *Mesonemacheilus guentheri* Day
 45. *Mesonemacheilus herrei* Naibant & Ban
 46. *Mesonemacheilus triangularis* (Day)
Superfamily : Cobitidae
 47. *Lepidocephalus thermalis* (Val.)
Family: Bagridae
 48. *Mystus gulio* (Hamilton)
 49. *Mystus malabaricus* (Jerdon)
 51. *Mystus montanus* (Jerdon)
 52. *Mystus ocutatus* (Valenciennes)
 53. *Batasio travancoria* Hora and Law
 54. *Horabagrus brachysoma* (Guenther)
 55. *Horabagrus nigricollaris* Peth & Kott
Family: Siluridae
 56. *Ompok bimaculatus* (Bloch)
 57. *Ompok malabaricus* (Valenciennes)
 58. *Wallago attu* (Bloch & Schneider)
Family : SCHILBEIDAE
 58.. *Neotropius mitchelli* (Gunther)
Family: Sisoridae
 59. *Glyptothorax anamalaiensis* Silas
 60. *Glyptothorax annandalei* Hora
 61. *Glyptothorax madraspatanus* (Day)
Family: Clariidae
 62. *Clarias dussumieri* (Val)
Family : Heteropneustidae
 63. *Heteropneustes fossilis* (Bloch)
Family: Belontiidae
 64. *Xenentodon cancila* (Hamilton)
Family : Aplocheilidae
 65. *Aplocheilus lineatus* (Valenciennes)
Family: Mastacembelidae
 66. *Mastacembelus armatus* (Lacepede)
Family : Chandidae
 67. *Chanda nama* (Hamilton)
 68. *Parambassis dayi* (Bleeker)
 69. *Parambassis ranga* (Hamilton)
 70. *Parambassis thomassi* (Day)
Family : Nandidae
 71. *Nandus nandus* (Hamilton)
 72. *Pristolepis marginata* (Jerdon)
Family : Cichlidae
 73. *Etilia maculatus* (Bloch)
 74. *Etilia suratensis* (Bloch)
Family : Gobiidae
 75. *Glossogobius giuris* (Hamilton)
 76. *Sicyopterus griseus* (Day)
 77. *Awaous gutum* (Hamilton)
Family: Eleotridae
 78. *Eleotris fusca* (Forster)
Family : Anabantidae
 79. *Anabas testudineus* (Bloch)
Family: Belontiidae
 80. *Pseudosphromenus cupanus* (Cuvier)
Family: Poeciliidae
 81. *Poecilia reticulata* Peters
 82. *Gambusia affinis* (Baird & Girard)

Family: Channidae

83. *Channa gachua* Hamilton
 84. *Channa marulius* (Hamilton)
 85. *Channa striata* (Bloch)

Family: Tetraodontidae

86. *Carinotetraodon travancoricus* (Hora & Nair)

Though 86 species were reported from the Chalakudy river by various researchers, only 38 species were represented in present sampling. The Table 53 reveals that 31 species could be collected from the highland and midland. Seventeen species were recorded from the lowland.

23. <i>Ompok bimaculatus</i>	0.0	0.1	0.8
24. <i>Osteochilichthys nashii</i>	1.6	0.2	0.0
25. <i>Parambassis thomassi</i>	0.0	0.0	0.6
26. <i>Pristolepis marginata</i>	1.4	0.8	0.0
27. <i>Puntius fasciatus</i>	1.0	0.3	0.0
28. <i>Puntius assimilis</i>	0.5	0.2	0.0
29. <i>Puntius denisonii</i>	1.1	0.7	0.0
30. <i>Puntius filamentosus</i>	3.5	5.3	4.9
31. <i>Puntius mahecola</i>	1.9	1.4	1.6
32. <i>Puntius punctatus</i>	0.9	0.9	1.2
33. <i>Rasbora dandia</i>	2.7	5.1	6.5
34. <i>Salmophasia acinaces</i>	0.8	0.3	0.0
35. <i>Salmophasia boopis</i>	1.5	0.3	0.0
36. <i>Sicyopterus griseus</i>	1.0	0.3	0.0
37. <i>C. travancoricus</i>	0.0	0.0	1.0
38. <i>Xenentodon cancila</i>	0.8	0.6	0.0

Table 53. Abundance of fish species in three zones of Chalakudy river.

No	Fish species	HL	ML	LL
1.	<i>Anabas testudineus</i>	0.0	0.0	0.8
2.	<i>Aplocheilichthys lineatus</i>	0.2	0.2	0.2
3.	<i>Awaous guttum</i>	0.8	0.3	0.0
4.	<i>Barbodes carnaticus</i>	0.5	0.0	0.0
5.	<i>Barbodes subnasutus</i>	0.0	0.3	2.2
6.	<i>Bariilus bakeri</i>	2.7	2.5	0.0
7.	<i>Bariilus gatensis</i>	2.7	2.2	0.0
8.	<i>Batasio travancoria</i>	0.3	0.0	0.0
9.	<i>Bhavana australis</i>	0.3	0.0	0.0
10.	<i>Devario malabaricus</i>	3.7	2.8	3.1
11.	<i>Etroplus maculatus</i>	0.0	0.7	3.6
12.	<i>Etroplus suratensis</i>	0.0	0.3	0.8
13.	<i>Garra mullya</i>	5.3	3.2	0.0
14.	<i>Garra surendranathini</i>	1.6	0.5	0.0
15.	<i>Horabagrus nigricollaris</i>	0.5	0.3	0.0
16.	<i>Hypselobarbus curmuca</i>	1.4	0.2	0.0
17.	<i>Hypselobarbus jerdoni</i>	0.1	0.0	0.0
18.	<i>Lepidocephalus thermalis</i>	0.3	0.2	0.3
19.	<i>P. cupanus</i>	0.2	0.1	0.3
20.	<i>Mastacembelus armatus</i>	0.4	0.3	0.2
21.	<i>M. triangularis</i>	0.8	0.3	0.0
22.	<i>Mystus montanus</i>	0.3	0.2	0.0

The abundance pattern of fishes in three zones were depicted in the Figure 61. In the highland, one species showed high abundance (Figures 61A-C). Eleven species were in low rank of abundance.

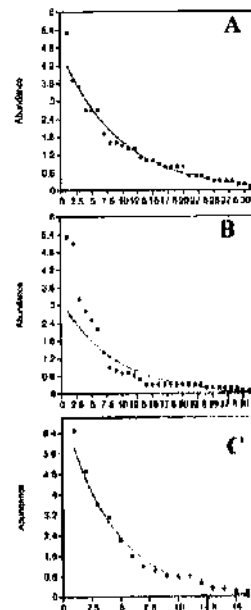


Figure 61. Abundance pattern of fishes in the three zones of Chalakyar river (A--HL, B-ML, C-LL)

In midland, two species were outnumbered all the remaining and twenty five species were in the guild of low abundance. In lowland, exceptional abundance of certain species was observed. The high dominance index for lowland (0.124) compared to highland (0.059) further corroborated this observation (Table 54).

Table 54. Dominance and evenness indices of the samples collected from 3 zones of Chalakudy river

Indices	HL	ML	LL
No. species	31	31	17
Individuals	479	362	335
Dominance	0.059	0.093	0.12
Evenness	0.694	0.50	0.62

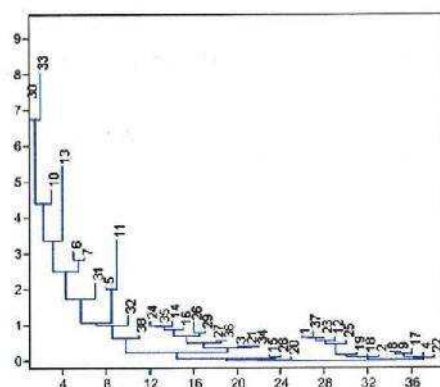


Figure 62. Neighbourhood clustering based on the abundance of fishes of Chalakudy river (see Table 59 for species number)

From the Figure 62 and Table 54, it is apparent that *Rashbora dandia* and *Puntius filamentosus* were the two outnumbering species in the samples. *Devario malabaricus* was very next to it in terms of its abundance. All these three species were more

or less equally abounded in all three zones. *Barilius bakeri* and *B. gatensis* were equally abounded and restricted in the highland and midland sections of the river.

28. PERIYAR RIVER

Periyar originates from Sivagiri peaks (1800m MSL) of Sundaramala. The total length of the river is 244 Kms with a catchment area of 5284 Sq. Km in Kerala. It flows northwards for 48 kms and at Thekkady and joins Mullayar, which is another tributary of the Periyar. The Mullaperiyar dam is constructed at the confluence of both the rivers Periyar and Mullayar to create the Periyar lake and reservoir and the Periyar Tiger Reserve.

From Periyar lake and reservoir, water is diverted eastwards to Tamil Nadu via a tunnel enabling the water to join the Vaigai River. From Periyar Reservoir, the Periyar river flows northwestward for 35 km through Vandiperiyar, Elappara and Aiyappankoil to join the Idukki reservoir formed by the Idukki, Cheruthoni and Kulamavu dams. From Idukki reservoir, Periyar river flows northwestwards and then westward to join the Arabian sea at Munambam near Kodungallur and the Vembanad lake at Kochi.

The inventory of the freshwater fishes of Periyar goes back to 1941 with the description of two new cyprinid from Periyar Tiger Reserve (Raj, 1941a&b). Chacko (1948) commented on the fisheries in Periyar lake. Several workers enlisted the fishes of Periyar Tiger Reserve and outside the Protected Area (John, 1936; Menon and Jacob, 1996; Zacharias, et.al, 1996; Arun et.al, 1996; Arun, 1997; Kurup and Radhakrishnan, 2005, 2010).

A total of 84 species were known to occur in the entire course of Periyar river. The present sampling yielded 36 species (Table 56).

Table 55. List of fishes known from Periyar river

Family Anguillidae

1. *Anguilla bengalensis* (Gray)
2. *Anguilla bicolor* McClelland

Family : Cyprinidae

3. *Barilius bakeri* Day
5. *Barilius gatensis* (Valenciennes)
6. *Salmophasia acinaces* (Valenciennes)
7. *Salmophasia boopis* (Day)
8. *Amblypharyngodon melettinus* (Val)
9. *Devario malabaricus* (Jerdon)
10. *Horadandia atukorali* Deraniyagala
11. *Rasbora dandia* (Valenciennes)
12. *Tor khudree* (Sykes)
13. *Osteobrama bakeri* (Day)
14. *Barhodes subnasutus* (Valenciennes)
15. *Hypselobarbus curmuca* (Hamilton)
16. *Hypselobarbus kurali* Menon & Devi
17. *Hypselobarbus periyarensis* (Raj)
18. *Eechathalakenda ophitcephala* (Raj)
19. *Puntius bimaculatus* (Bleeker)
20. *Puntius denisonii* (Day)
21. *Puntius dorsalis* (Jerdon)
22. *Puntius fasciatus* (Jerdon)
23. *Puntius filamentosus* (Valenciennes)
24. *Puntius mahecola* (Valenciennes)
25. *Puntius murvattupuzhaensis* Jameela Beevi & Ramachandran
26. *Puntius parrah* Day
27. *Puntius punctatus* (Day)
28. *Puntius vittatus* (Day)
29. *Lepidopygopsis typus* Raj
30. *Catla catla* (Hamilton)
31. *Crossocheilus periyarensis* Menon & Jacob

32. *Garra McClellandi* (Jerdon)
33. *Garra mullya* (Sykes)
34. *Garra periyarensis* Gopi
35. *Garra emarginata* Kurup & Radhakri.
36. *Garra mlapparaensis* Kurup & Radhakri.
37. *Garra surendranathanii* Shaji *et al*

Family : Balitoridae

38. *Homaloptera santhamparaensis* Arunachalam *et al*
39. *Homaloptera sllasi* Kurup and Radhakrishnan
40. *Bhavanaia australis* (Jerdon)
41. *Travancoria jonesi* Hora
42. *Schistura denisoni* (Day)
43. *Schistura menoni* Zacharias & Minimoi
44. *Schistura periyarensis* (Kurup & Radhak)
45. *Mesonemacheilus guentheri* Day
46. *Mesonemacheilus pulchellus* Day
47. *Mesoemacheilus triangularis* Day
48. *Oreonectes keralensis* Rita and Nalbant

Family: Cobitidae

49. *Lepidocephalus thermalis* (Valenciennes)

Family : Bagridae

50. *Mystus gulio* (Hamilton)
51. *Mystus malabaricus* (Jerdon)
52. *Mystus montanus* (Jerdon)
53. *Mystus ocutatus* (Valenciennes)
54. *Mystus vittatus* (Bloch)
55. *Batasio travancorta* Hora and Law
57. *Horabagrus brachysoma* (Guenther)

Family: Schilbeidae

55. *Neotropius mitchelli* (Guntler)

Family: Siluridae

56. *Ompok bimaculatus* (Bloch)
57. *Ompok malabaricus* (Valenciennes)
58. *Wallago attu* (Bloch)

Family : Sisoridae

59. *Glyptothorax annandalei* Horn
60. *Glyptothorax madraspatanus* (Day)

61. *Glyptothorax anamalaiensis* Silas
Family: Clariidae
62. *Clarias dussumieri* (Valenciennes)
Family: Heteropneustidae
63. *Heteropneustes fossilis* (Bloch)
Family : Mugilidae
64. *Rhinomugil corsula* (Hamilton)
Family: Belontiidae
65. *Xenentodon cancila* (Hamilton)
Family: Aplocheilidae
66. *Aplocheilus lineatus* (Valenciennes)
Family: Mastacembelidae
67. *Mastacembelus armatus* (Lacepede)
68. *Macragnathus guentheri* (Day)
Family: Chandidae
69. *Chanda nama* (Hamilton)
70. *Parambassis dayi* (Bleeker)
71. *Parambassis ranga* (Hamilton)
72. *Parambassis thomassi* (Day)
Family: Nandidae
72. *Pristolepis marginata* Jerdon
Family: Cichlidae
73. *Etroplus maculatus* (Bloch)
74. *Etroplus suratensis* (Bloch)
Family : Gobiidae
75. *Glossogobius giuris* (Hamilton)
76. *Sicyopterus griseous* (Day)
Family: Belontiidae
77. *Pseudosphromenus cupanus* (Cuvier)
Family: Channidae
78. *Channa gachua* Hamilton
79. *Channa marulius* (Hamilton)
80. *Channa striata* (Bloch)
Family: Tetraodontidae
81. *Carinotetraodon travancoricus* (Hora and Nair)

A total of 36 species of fishes were encountered during the present sampling. The abundance of fish

species in the Periyar river during the present sampling is given in Table 56 and Figure 63.

Table 56. Abundance of fishes in different zones of the periyar

No. Fish species	HL	ML	LL
1. Aplocheilus lineatus	6.89	0.43	0.00
2. Barbodes subnasutus	0.00	0.14	0.14
3. Barilius bakeri	0.00	0.43	0.00
4. Barilius gatensis	0.86	0.43	0.00
5. Batasio travancoria	0.00	0.29	0.00
6. Bhavania australis	5.16	0.57	0.00
7. Devario malabaricus	4.30	1.00	0.00
8. Garra mullya	6.31	3.16	0.00
9. Garra surendranathanii	0.00	0.72	0.00
10. Glossogobius giuris	0.00	0.14	0.00
11. Glyptothorax anamalaiensis	1.43	0.43	0.00
12. Glyptothorax annandalei	0.00	0.29	0.00
13. Horabagrus nigricollaris	0.00	0.14	0.00
14. Hypselobarbus curmuca	0.00	0.29	0.00
15. Hypselobarbus kurali	0.14	0.43	0.00
16. Indoreonectes keralensis	0.29	0.00	0.00
17. Lepidocephalus thermalis	1.29	0.43	0.00
18. Macragnathus guentheri	0.00	0.14	0.00
19. Mastacembelus armatus	0.00	0.14	0.00
20. M. triangularis	9.76	0.29	0.00
21. Mystus malabaricus	0.00	0.14	0.00
22. Mystus montanus	0.86	0.00	0.00
23. Nemacheilus guentheri	0.00	3.16	0.00
24. Osteobrama bakeri	0.00	0.00	0.29
25. O.longidorsalis	0.00	0.29	0.00
26. P.cupanus	1.00	0.29	0.00
27. Puntius chalakkudiensis	0.00	0.14	0.00
28. Puntius denisonii	0.00	0.14	0.00
29. Puntius fasciatus	10.33	4.30	0.29
30. Puntius filamentosus	6.03	1.29	1.72
31. Puntius mahecola	0.00	0.14	0.29
32. Puntius punctatus	8.75	0.43	0.43
33. Puntius vittatus	0.00	0.00	0.29
34. Rasbora dandia	10.90	1.15	0.29
35. Schistura denisonii	0.00	0.14	0.00
36. Tor khudree	0.00	0.43	0.00

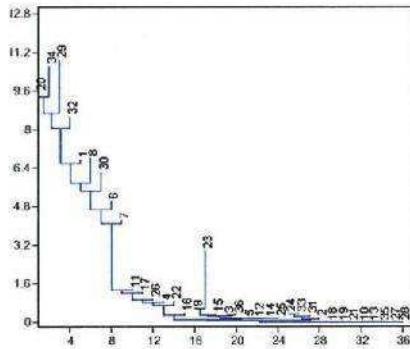


Figure 63. Neighbourhood clustering based on the abundance of fishes of Periyar (see Table 62 for species number)



Figure 66. *Puntius punctatus* (Day)

Puntius fasciatus (Figure 64) showed a uniqueness due to its high abundance in the highland and midland. *Mesonemacheilus triangularis* (Figure 65) restricted to the highland abounded there where as *Puntius punctatus* (Figure 66) and *Rasbora dandia* were exceptionally outnumbered in the highland, moderate in the midland and low in lowland. *Aplocheilus lineatus*, *Garra mullya* and *Puntius filamentosus* moderately represented in the samples of highland (Table 56 Figure 63)



Figure 64. *Puntius fasciatus* (Jerdon)



Figure 65. *Mesonemachilus triangularis* (Day)

29. MUVATTUPUZHA RIVER

Muvattupuzha River is one of the important rivers in Ernakulam District of Kerala. Muvattupuzha river is a union of three streams, Thodupuzha river, Kaliyar river and Kothamangalam river. These three small rivers conglomerate at Muvattupuzha to Muvattupuzha river and from there flows to drain into the Vaikom backwaters embracing the various interior areas of Ernakulam and Kottayam districts.

The fishes of Muvattupuzha river were listed by Thomas (2002). Beevi and Ramachandran (2005) described a new small barb, *Puntius muvattupuzhaensis* Beevi and Ramachandran, 2005 from the river. The present sampling resulted in 22 species (Table 57) and their abundance in the sampling is given in Table 58.

Table 57. Seriation Table to illustrate the distribution of fishes in Muvattupuzha river

No.Fish species	HL	ML	LL
1. Aplocheilus lineatus	1	0	0
2. Barbodes subnasutus	0	1	1
3. Barilius bakeri	1	0	0
4. Garra mullya	1	1	0
5. Glossogobius giuris	0	1	0
6. Glyptothorax annandalei	1	0	0
7. Hypselobarbus curmuca	1	0	0
8. Hypselobarbus kurali	1	0	0
9. Lepidocephalus thermalis	1	1	0
10. Mastacembelus armatus	1	1	0
11. Megalops cyprinoids	0	1	0
12. Mesonemacheilus triangularis	1	0	0
13. Parambassis dayi	0	1	0
14. Parambassis thomassi	0	1	0

15. Puntius fasciatus	1	1	0
16. Puntius filamentosus	1	1	0
17. Puntius mahecola	0	1	0
18. Puntius muvattupuzhaensis	0	1	1
19. Puntius parrah	0	1	1
20. Puntius punctatus	0	1	1
21. Rasbora dandia	1	1	1
22. Schistura denisoni	1	0	1

Table 58. Abundance of different species of fishes in Muvattupuzha river

No Fish species	HL	ML	LL
1. Aplocheilus lineatus	1.74	0	0
2. Barbodes subnasutus	0	5.24	7.42
3. Barilius bakeri	1.31	0	0
4. Garra mullya	1.31	0.87	0
5. Glossogobius giuris	0	0.87	0
6. Glyptothorax annandalei	0.43	0	0
7. Hypselobarbus curmuca	0.43	0	0
8. Hypselobarbus kurali	0.43	0	0
9. Lepidocephalus thermalis	2.18	1.74	0
10. Mastacembelus armatus	0.43	0.87	0
11. Megalops cyprinoids	0	0.43	0
12. M.triangularis	1.74	0	0
13. Parambassis dayi	0	1.31	0
14. Parambassis thomassi	0	1.31	0
15. Puntius fasciatus	3.49	1.74	0
16. Puntius filamentosus	7.86	3.93	0
17. Puntius mahecola	0	0.87	0
18. P muvattupuzhaensis	0	3.05	3.05
19. Puntius parrah	0	2.18	3.49
20. Puntius punctatus	0	5.67	14.8
21. Rasbora dandia	5.24	2.62	9.17
22. Schistura denisoni	1.31	0.00	1.31

Thirteen species were recorded from the highland, 15 species from midland and six species from the lowland. The abundance of the fish species in the three zones are given in Table 58 and Figure 68.

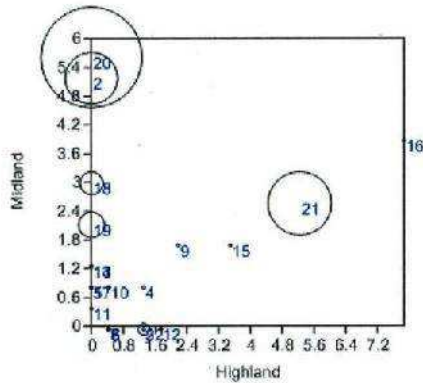


Figure 67. Bubble plot to show the relative composition of different species in the sampling (The species number as in Table 57.)

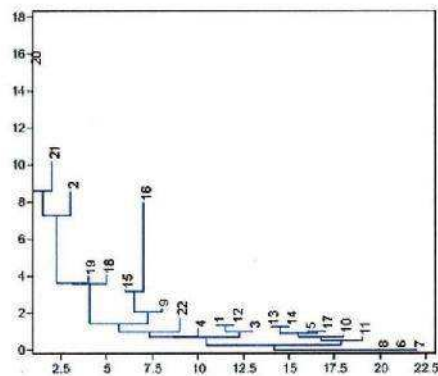


Figure 68. Neighbor joining cluster based on abundance of fishes in Muvattupuzha river (The species number corresponds to the number in Table 57)

The most abundant species in the low lands were *Puntius punctatus*, *Rasbora dandia* and *Barbodes subnasutus*. The *Barbodes subnasutus*, *Puntius filamentosus* and *Puntius punctatus* were also abundant in the midland. *Puntius muvattupuzhaensis* has abounded equally in the highland midland (Figure 69).



Figure 69. *Puntius muvattupuzhaensis*

30. MEENACHIL RIVER

The Meenachil river flows through the heart of Kottayam district of Kerala state, India. The river, 78 km long, flows through Poonjar, Teekoy, Erattupetta, Palai, Ettumanoor and Kottayam before emptying itself into the Vembanad Lake at Kumarakom, the famous tourist place of Kerala.

The Meenachil river is formed by several streams originating from the Western Ghats. The general elevation ranges from 77 m to 1156 m in the high lands and less than 2 m in the lowlands and 8 to 68 m in the midlands. The Meenachil has a watershed area of 1208.11 km². The river has a total annual yield of 2,349 million cubic meter and an annual utilizable yield of 1110 million cubic metre. The river has 38 tributaries including major and minor ones. The river has 47 sub watersheds and 114 micro watersheds.

The results of the present sampling is given in the Table 59. Altogether 20 species were recorded during the present survey. Most of them are common species and reported from other river systems of Kerala. The abundance of the species in the sampling is given in Table 60.

Table 59. Seriation table to illustrate the distribution of fishes in three zones of Meenachil river.

No. Fish species	HL	ML	LL
1. Aplocheilus lineatus	1	1	0
2. Barbodes subnasutus	1	1	0
3. Barilius bakeri	1	0	0
4. Garra mullya	1	0	0
5. Glossogobius giuris	1	1	0
6. Horabagrus brachysoma	0	0	1
7. Hypselobarbus curmuca	1	0	0
8. Hypselobarbus kurali	1	0	0
9. Labeo dussumieri	0	0	1
10. Lepidocephalus thermalis	1	0	0
11. Macrognaathus guentheri	1	0	0
12. Mastacembelus armatus	1	0	0
13. M. triangularis	1	0	0
14. Puntius denisonii	1	0	0
15. Puntius fasciatus	0	0	0
16. Puntius filamentosus	1	1	0
17. Puntius punctatus	1	1	1
18. Rasbora dandia	1	1	1
19. Schistura denisoni	1	0	1
20. Wallago attu	0	0	1

The seriation Table (Table 59) revealed that 16 species were recorded from the highland, six species from the midland and lowland.

Table 60. Abundance of fishes in the three zones of Meenachil river.

No. Fish species	HL	ML	LL
1. Aplocheilus lineatus	0.98	0.49	0.00
2. Barbodes subnasutus	2.45	2.45	0.00
3. Barilius bakeri	2.45	0.00	0.00

4. Garra mullya	2.94	0.00	0.00
5. Glossogobius giuris	0.49	0.49	0.00
6. Horabagrus brachysoma	0.00	0.00	8.82
7. Hypselobarbus curmuca	0.98	0.00	0.00
8. Hypselobarbus kurali	2.45	0.00	0.00
9. Labeo dussumieri	0.00	0.00	14.71
10. Lepidocephalus thermalis	7.35	0.00	0.00
11. Macrognaathus guentheri	0.98	0.00	0.00
12. Mastacembelus armatus	0.49	0.00	0.00
13. M. triangularis	0.98	0.00	0.00
14. Puntius denisonii	0.98	0.00	0.00
15. Puntius fasciatus	0.00	0.00	0.00
16. Puntius filamentosus	6.86	6.37	0.00
17. Puntius punctatus	0.49	1.96	9.80
18. Rasbora dandia	7.84	1.96	8.82
19. Schistura denisoni	0.98	0.00	3.92
20. Wallago attu	0.00	0.00	0.49

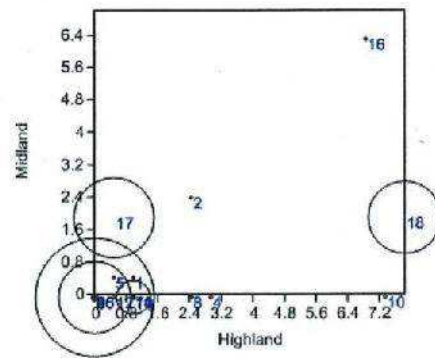


Figure 70. Bubble plot to show the abundance of fish in the Meenachil (The species number as in Table 59)

Labeo dussumieri was the dominant species in the lowland which was followed by the *Puntius punctatus*. *Horabagrus brachysoma* is conspicuously absent in the midland and highland but abounds highly in the lowland. The fishery in Meenachil is unto some extent supported by *Labeo dussumieri* and *Horabagrus brachysoma*.

31. MANIMALA RIVER

Manimala River finds its origin in the Muthavara Hills (2500 feet above main sea level) in the Western Ghats, in Idukki district of Kerala. The river passes through the districts of Kottayam, Pathanamthitta and finally joins with the Pamba River at Muttar near Tiruvalla in Alappuzha district. Yendayaar, Koottikkal, Mundakayam, Erumeli, Manimala, Vaipur, Mallappally, Thuruthicad, Vennikkulam, Kaviyoor, Kallooppara, Niranam, Muttar, Thalavadi, Kozhimukku and Champakkulam lies on the banks of Manimala River. Its running length is estimated at 92 km.

The uniform sampling during the present survey yielded 20 species with varying frequencies in the highland, midland and lowland (Table 61).

Table 61. Abundance of fishes in three zones of Manimala river

No Fish species	HL	ML	LL
1. Aplocheilus lineatus	2.17	0.00	0.00
2. Barilius bakeri	2.17	0.00	0.00
3. Garra mullya	1.30	2.17	0.00
4. Glossogobius giuris	0.00	0.87	0.00
5. Hypselobarbus curmuca	0.87	0.00	0.00
6. Hypselobarbus kurali	1.30	0.00	0.00
7. Lepidocephalus thermalis	0.43	2.17	0.00
8. Mastacembelus armatus	3.04	0.87	0.00
9. Megalops cyprinoids	0.00	0.43	0.00
10. Osteobrama bakeri	0.00	3.48	0.00
11. Parambassis dayi	0.00	1.74	0.00
12. Parambassis thomassi	0.00	1.30	0.00
13. Puntius fasciatus	5.22	1.74	0.00
14. Puntius filamentosus	4.35	9.13	0.00

15. Puntius mahecola	0.00	2.17	0.00
16. Barbodes subnasutus	0.00	6.96	0.00
17. Puntius punctatus	9.57	6.52	2.17
18. Rasbora dandia	4.78	3.04	6.09
19. Schistura denisonii	2.17	0.00	1.74
20. Wallago attu	0.00	0.00	10.00

Puntius punctatus was the most dominant species in the samples collected from all the three zones of the Manimala river (Figure 71). *Wallago attu* (Figure 72) was available only in the lowland and it was abundant there. *Puntius filamentosus* was dominating in the midland and was entirely absent in the lowland. *Barbodes subnasutus* was recorded only from the midland and showed high abundance value (71 and Table 61).

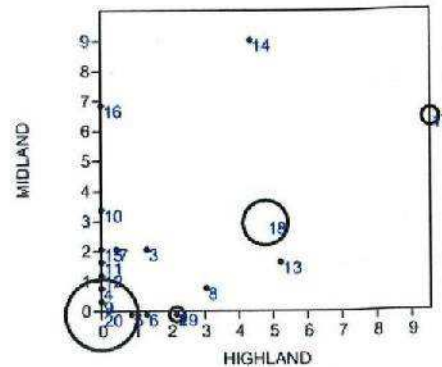


Figure 71. Bubble plot to show the relative composition of different species in the Manimala river (The species number as in Table 61)



Figure 72. Wallago attu

32. PAMBA RIVER

Pampa river is the third longest river in the state of Kerala with a length of 176 km. Pampa river originates in Periyar tiger reserve. Kakkiyar, Kallar, Azhuthai and Pampa are the main tributaries for the river. The headwaters of Pampa is regarded as most diverse and pristine in the upper reaches.

Fish fauna of Pampa river is affected by many factors like exotic fishes, unethical fishing practices, damming and pollution. The life of people in the downstream of the river is deeply affected by the pollution in the lake especially since many communities depend on this lake for drinking water needs.

The fishes of Pampa river has been documented by Raju *et al* (1999), Kurup (2001), Thomas *et al*, (2002) and Fasa and Shaji (2003). The updated list is given in the Table 62.

Table 62 . Freshwater fishes of Pamba river

I Family: Megalopidae	12 <i>Osteobrama bakeri</i> (Day)
1 <i>Megalops cyprinoides</i> (Broussonet)	13 <i>Barbodes subnasutus</i> (Valenciennes)
II Family Anguillidae	14 <i>Hypselobarbus curmuca</i> (Hamilton)
2 <i>Anguilla bengalensis</i> (Gray)	15 <i>Puntius dorsalis</i> (Day)
3 <i>Anguilla bicolor</i> McClelland	16 <i>Puntius fasciatus</i> (Jerdon)
III Family : Cyprinidae	17 <i>Puntius filamentosus</i> (Valenciennes)
4 <i>Barilius bakeri</i> (Day)	18 <i>Puntius mahecola</i> (Valenciennes)
5 <i>Barilius gatensis</i> (Valenciennes)	19 <i>Puntius punctatus</i> (Day)
6 <i>Salmophasia acinaces</i> (Valenciennes)	20 <i>Puntius vittatus</i> (Day)
7 <i>Amblypharyngodon melettinus</i> (Val)	21 <i>Labeo dussumieri</i> (Valenciennes)
8 <i>Devario malabaricus</i> (Jerdon)	22 <i>Labeo rohita</i> (Hamilton)
9 <i>Horadandia atukorali</i> Deraniyagala	23 <i>Garra mullya</i> (Sykes)
10 <i>Rasbora dandia</i> (Valenciennes)	IV Family: Balitoridae
11 <i>Tor khudree</i> (Sykes)	24 <i>Bhavana australis</i> (Jerdon)
	25 <i>Travancoria jonesi</i> Hora
	26 <i>Schistura denisoni</i> (Menon)
	27 <i>Mesonemacheilus guentheri</i> (Day)
	28 <i>Mesonemacheilus triangularis</i> (Day)
	V Family: Cobitidae
	29 <i>Pangio goaensis</i> (Tilak)
	30 <i>Lepidocephalus thermalis</i> (Valenciennes)
	VI Family: Bagridae
	31 <i>Mystus gulio</i> (Hamilton)
	32 <i>Mystus montanus</i> (Jerdon)
	33 <i>Mystus ocutatus</i> (Valenciennes)
	34 <i>Mystus vittatus</i> (Bloch)
	35 <i>Horabagrus brachysoma</i> (Guenther)
	36 <i>Batasio travancoria</i> Hora and Law
	VII Family: Sisoridae
	37 <i>Ompok bimaculatus</i> (Bloch)
	38 <i>Wallago attu</i> (Bloch)
	VIII Family : Clariidae
	39 <i>Clarias dussumieri</i> (Valenciennes)
	IX Family : Heteropneustidae
	40 <i>Heteropneustes fossilis</i> (Bloch)
	X Family: Belonidae
	41 <i>Xenentodon cancila</i> (Hamilton)
	XI Family: Aplocheilidae
	42 <i>Aplocheilus lineatus</i> (Valenciennes)

- XII Family: Synbranchidae**
 43 *Ophisternon bengalense* McClelland
- XIII Family: Mastacembelidae**
 44 *Mastacembelus armatus* (Lacepede)
- XIV Family: Chandidae**
 45 *Chanda nama* (Hamilton)
 46 *Parambassis dayi* (Bleeker)
 47 *Parambassis ranga* (Hamilton)
 48 *Parambassis thomassi* (Day)
- XV Family: Nandidae**
 49 *Nandus nandus* (Hamilton)
 50 *Pristolepis marginata* (Jerdon)
 51 *Etroplus maculatus* (Bloch)
 52 *Etroplus suratensis* (Bloch)
- XVI Family: Gobiidae**
 53 *Glossogobius giuris* (Hamilton)
- XVII Family: Anabantidae**
 54 *Anabas testudineus* (Bloch)
- XVIII Family: Belontiidae**
 55 *Pseudosphromenus cupanus* (Cuvier)
- XIX Family: Channidae**
 56 *Channa diplogramme* (Day)
 57 *Channa gachua* Hamilton
 58 *Channa marulius* (Hamilton)
 59 *Channa striata* (Bloch)
- XX Family: Tetraodontidae**
 60 *Carinotetraodon travancoricus* (Hora and Nair)

Table 63. Abundance of fishes in the three zones of Pamba river

No	Fish species	HL	ML	LL
1	<i>Barilius bakeri</i>	4.39	0.00	0.00
2	<i>Catla catla</i>	0.00	0.88	0.00
3	<i>Danio malabaricus</i>	4.39	0.00	0.00
4	<i>Garra mullia</i>	0.88	0.88	0.00
5	<i>Glossogobius giuris</i>	0.00	1.75	0.00
6	<i>Hypseobarbus curmuca</i>	1.75	2.63	0.00

7	<i>Labeo dussumieri</i>	1.75	2.63	0.00
8	<i>Labeo rohita</i>	0.00	1.75	0.00
9	<i>L. thermalis</i>	2.63	0.88	0.00
10	<i>P. cupanus</i>	0.00	0.88	0.00
11	<i>Mastacembelus armatus</i>	0.00	1.75	0.00
12	<i>Mystus malabaricus</i>	1.75	0.88	0.00
13	<i>Nemacheilus guentheri</i>	0.88	0.00	0.00
14	<i>M. triangularis</i>	0.88	0.00	0.00
15	<i>Puntius mahecola</i>	0.00	1.75	0.00
16	<i>Puntius denisonii</i>	0.88	0.00	0.00
17	<i>Puntius fasciatus</i>	4.39	2.63	3.51
18	<i>Puntius filamentosus</i>	7.89	6.14	7.02
19	<i>Barbodes subnasutus</i>	0.00	5.26	6.14
20	<i>Puntius punctatus</i>	0.00	2.63	8.77
21	<i>Rasbora dandla</i>	0.00	1.75	10.53
22	<i>Schistura denisonii</i>	0.88	0.00	5.26

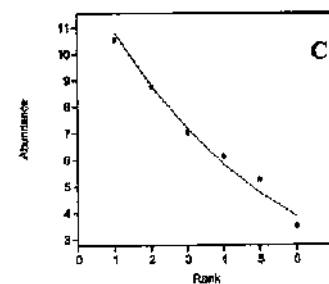
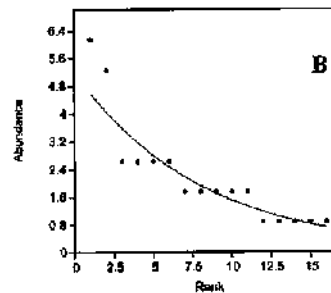
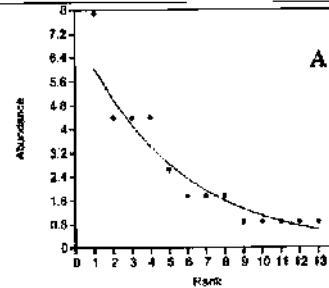


Figure 73. Abundance pattern of fishes in the three zones of Pamba river (A-HL, B-ML; C-LL.)

The abundance pattern of the fishes in the three zones of the Pamba river is given in the Table 63 and Figure 73A-C.

From the Figure 74, it is apparent that *Puntius punctatus*, *Puntius filamentosus* and *Rasbora dandia* highly abundant in the lowland. The P.

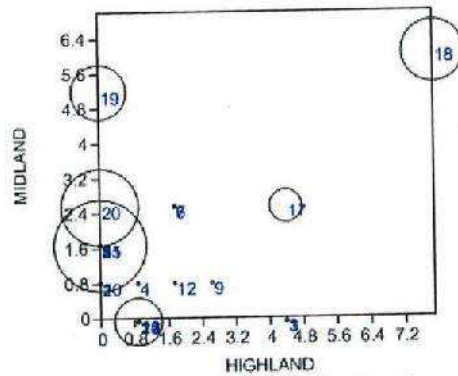


Figure 74. Bubble plot to show the abundance of fishes different species in Pamba river (The species number as in Table 63)

filamentosus and *B.subnasutus* were outnumbered midland and the latter could not be recorded from the highland. *Puntius filamentosus* has outnumbered in all the three zones of the river. *Glossogobius giuris* (Figure 75), *Labeo rohita* (an exotic culture species), *Mastacembelus armatus* and *Puntius mahecola* were exclusive to the midland of Pamba River and occupied the lower guild of abundance.

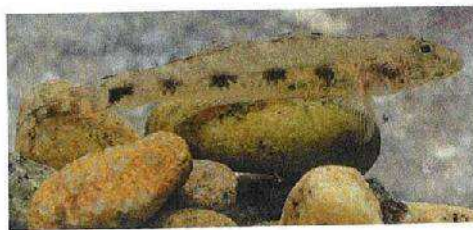


Figure 75. *Glossogobius giuris* (Hamilton)

33. ACHANKOVIL RIVER

Achankovil River, locally referred as Achankovilaru, is a significant water body in Kerala. The river rises south of Devarmala in the Western Ghats in the Pathanamthitta District of Kerala at an elevation of 700m. The Achankovil River is formed from the streams Rishimala, Pasukidamettu and the Ramakkaltheri of the Southern Western Ghats. The river follows a north westerly course till Kumbazha and in this portion it is joined by Kal Ar about 1km upstream of Turai forests. The river follows a generally western direction till Idappamon. Here it turns northwest up to Thazakkara and there after flows westwards. At Tharaimukku, the Kuttenperoor canal branches from the main river and joins Pamba. The river then splits up in several branches and flows in a north westerly direction to join Pamba river near Veeyapuram.

The basin extends over an area of 1484 km² and lies entirely in Kerala State. The total length of the river is 130 km.

The fishes of Achenkovil river has been documented by Varghese (1994). Kurup *et al.*, (2004), Swapna (2009), Kalesh *et al* (2010) and Baby *et al* (2011). The annotated list of fishes known to occur in the Achenkovil river system is given in the Table 64.

Table 64. Fishes of Achenkovil river

Family Anguillidae

1. *Anguilla bengalensis* (Gray)
2. *Anguilla bicolor* McClelland

Family : Cyprinidae

3. *Barilius bakeri* Day

4. *Barilius gatensis* (Valenciennes)
5. *Salmophasia boopis* (Day)
6. *Amblypharyngodon melettinus* (Val)
7. *Laubuca fasciata* (Silas)
8. *Devario malabaricus* (Jerdon)
9. *Rasbora dandia* (Valenciennes)
10. *Tor khudree* (Sykes)
11. *Osteobrama bakeri* (Day)
12. *Barbodes subnasutus* (Valenciennes)
13. *Hypseobarbus curmuca* (Hamilton)
14. *Hypseobarbus kurali* Menon & Devi
15. *Puntius bimaculatus* (Bleeker)
16. *Puntius chalakkudiensis* Menon et al
17. *Puntius denisonii* (Day)
18. *Puntius fasciatus* (Jerdon)
19. *Puntius filamentosus* (Valenciennes)
20. *Puntius mahecola* (Valenciennes)
21. *Puntius punctatus* (Day)
22. *Puntius vittatus* (Day)
23. *Garra mullya* (Sykes)
24. *Garra surendranathanii* Shaji, Arun & Easa

Family : Balitoridae

25. *Bhavana australis* (Jerdon)
26. *Mesonemacheilus guentheri* (Day)
27. *Mesonemacheilus triangularis* (Day)

Family : Cobitidae

28. *Lepidocephalus thermalis* (Valenciennes)

Family : Hagriidae

29. *Mystus seengtee* (Sykes)
30. *Mystus armatus* (Day)
31. *Mystus montanus* (Jerdon)
32. *Mystus malabaricus* (Jerdon)
33. *Batasio travancoria* Hora and Law
34. *Horabagrus brachysoma* (Guenther)

Family: Siluridae

35. *Ompok bimaculatus* (Bloch)
36. *Wallago attu* (Bloch)

Family : Sisoridae

37. *Glyptothorax annandalei* (Day)
38. *Glyptothorax anamalaiensis* Silas

Family: Heteropneustidae

39. *Heteropneustes fossilis* (Bloch)

Family : Belontiidae

40. *Xenentodon cancila* (Hamilton)

Family : Aplocheilidae

41. *Aplocheilus lineatus* (Valenciennes)

Family: Mastacembelidae

42. *Mastacembelus annatus* (Lacépède)

Family: Chandidae

43. *Parambassis dayi* (Bleeker)
44. *Parambassis thomasi* (Day)

Family : Nandidae

45. *Pristolepis marginatus* (Jerdon)

Family : Cichlidae

46. *Etilopius maculatus* (Bloch)
47. *Etilopius suratensis* (Bloch)
48. *Oreochromis mossambicus* (Peters)

Family : Gobiidae

49. *Glossogobius giuris* (Hamilton)

Family: Belontiidae

50. *Pseudosphromenus cupanus* (Cuvier)

Family : Channidae

51. *Channa gachua* Hamilton
52. *Channa striata* (Bloch)

Family : Tetraodontidae

53. *Carnotetraodon travancoricus* (Hora & Nair)

The fish monitoring programme could record 46 species. The dominance index is high in the highland illustrating the dominance of certain species (0.138). The low value of evenness index also supports this observation (Table 65).

Table 65. Dominance and evenness indices of the fish distribution in three zones of Achenkovilar.

Indices	HL	ML	LL
Dominance	0.13	0.073	0.075
Evenness	0.60	0.715	0.695

Table 66. Abundance of fishes in the three zones of Achenkovilar.

No. Fish species	HL	ML	LL
1. <i>A. melettinus</i>	0.0	1.3	0.7
2. <i>Anabas testudineus</i>	0.0	2.0	0.5
3. <i>Anguilla bengalensis</i>	0.0	0.3	0.3
4. <i>Aplocheilichthys lineatus</i>	0.0	0.0	3.1
5. <i>Barbodes subnasutus</i>	0.0	4.0	2.5
6. <i>Barilius bakeri</i>	0.4	0.0	0.0
7. <i>Barilius gatensis</i>	0.7	0.0	0.0
8. <i>Batasio travancoria</i>	0.1	0.0	0.0
9. <i>C. travancoricus</i>	0.0	3.1	0.7
10. <i>Channa marulius</i>	0.0	0.4	2.2
11. <i>Channa striata</i>	0.0	0.3	2.9
12. <i>Clarias dussumieri</i>	0.0	0.7	1.4
13. <i>Devario malabaricus</i>	3.1	0.7	0.0
14. <i>Etroplus maculatus</i>	0.1	1.2	6.4
15. <i>Etroplus suratensis</i>	0.0	0.0	2.6
16. <i>Garra mullya</i>	1.2	0.9	0.3
17. <i>Heteropneustes fossilis</i>	0.0	0.3	0.7
18. <i>Horabagrus brachysoma</i>	0.0	0.5	0.0
19. <i>Hyprhamphus limbatus</i>	0.0	0.0	2.7
20. <i>Hypselobarbus curmuca</i>	0.3	0.0	0.0
21. <i>Labeo dussumieri</i>	0.1	0.1	0.0
22. <i>Lepidocephalus thermalis</i>	0.4	0.0	0.0
23. <i>Macrognathus guentheri</i>	0.0	0.0	0.7
24. <i>Mastacembelus armatus</i>	0.4	0.3	0.4
25. <i>M. triangularis</i>	0.4	0.0	0.0
26. <i>Mystus gulio</i>	0.0	0.0	0.3
27. <i>Mystus montanus</i>	0.3	0.0	0.0
28. <i>Mystus oculatus</i>	0.0	0.1	0.7
29. <i>Nandus nandus</i>	0.0	0.0	0.3
30. <i>Ompok bimaculatus</i>	0.0	0.0	2.3
31. <i>Oreochromis mossambicus</i>	0.0	1.0	6.5
32. <i>Osteobrama bakeri</i>	0.0	1.3	0.0
33. <i>Parambassis ranga</i>	0.0	0.0	0.7
34. <i>Parambassis thomassi</i>	0.0	0.8	2.6
35. <i>Pristolepis marginata</i>	0.0	0.7	1.3
36. <i>P. cupanus</i>	0.0	0.7	0.1
37. <i>Puntius denisonii</i>	1.0	0.0	0.0
38. <i>Puntius fasciatus</i>	2.0	0.0	0.0
39. <i>Puntius filamentosus</i>	1.3	2.2	2.0
40. <i>Puntius mahecola</i>	0.7	2.3	0.0

41. <i>Puntius vittatus</i>	0.7	1.3	2.9
42. <i>Rasbora dandia</i>	0.8	1.3	0.0
43. <i>Salmophasia boopis</i>	5.2	1.0	0.0
44. <i>Tor khudree</i>	0.5	0.0	0.0
45. <i>Wallago attu</i>	0.0	0.1	1.0
46. <i>Xenentodon cancila</i>	0.0	0.8	2.5

Etroplus maculatus and *Oreochromis mossambicus* were dominated in lowland and the latter was conspicuously absent in highland. *Puntius vittatus* was next to the above species in terms of abundance in the lowland. *Etroplus suratensis* and *Hyprhamphus limbatus* were absent in the highland and the latter was present in the midland. However, they were moderately represented in the lowland. *Channa striata* also followed the same pattern (Figure 76 and 77).

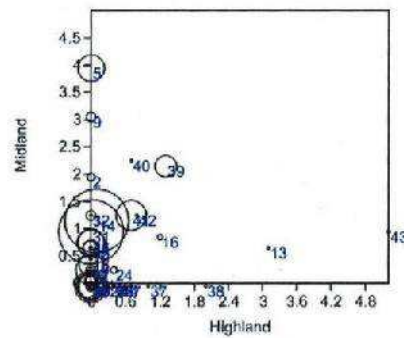


Figure 76. Bubble plot to show the abundance of fishes in the Achenkovilar (The species number as in Table 75)

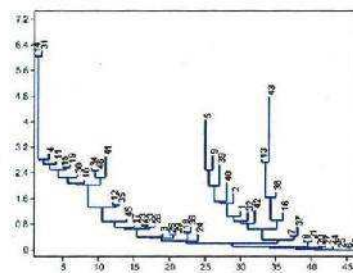


Figure 77. Neighborhood joining cluster based on abundance of fishes in Achenkovilar (The species number corresponds to the number in Table 75)

34. KALLADA RIVER

Kallada is one of the major river systems of southern Kerala. Kallada River flows through Kollam district. The river originates from the Kulathupuzha hills near Ponmudi. This river which has a length of 121 kms flows through the places Pathanapuram, Kunnathur, Kottarakkara and Kollam. The end point of this river is the Ashtamudi Kayal. The river bed is usually rocky and it is difficult to swim and play in such a river. There are huge rocks, deep pits and other obstructions in the river. The main tributaries of Kallada River are Kulathupuzha, Chenturnipuzha and Kalthuruthipuzha. There is a famous Hanging Bridge built across the river and the famous tourist destination Palaruvi waterfall is also in this river.

Very little information is available on the fish diversity of the Kallada River. Thomas et al. (2002) and Thomas (2004) published general information on the fish diversity of the river. Pethiyagoda and Kottelat (2005) reported on the occurrence of *Puntius exclamatio* in the Thenmala region of the river. Of late, Abraham et al. (2011) reported on the fish fauna associated with Kallada River, Kerala and recorded the presence of 45 species of fish based on available works on the fish diversity of Kallada river.

The present uniform sampling in the Kallada river yielded 32 species with varying abundance (Table 67). The diversity profile of the Kallada river in highland, midland and low land are depicted in the Figure 78. The diversity profile indicates that eight species from highland, 18 species from midland and 17 species from the lowland.

Table 67. Fishes and their abundance in Kalladayar,

No	Fish species	HL	ML	LL
1.	<i>A. macrolepis</i>	0.00	0.00	2.48
2.	<i>Anabas testudineus</i>	0.00	0.83	0.00
3.	<i>Anguilla bicolor</i>	0.00	0.00	1.65
4.	<i>Aplocheilichthys lineatus</i>	0.00	0.83	0.00
5.	<i>Barilius bakeri</i>	2.48	0.00	0.00
6.	<i>C. travancoricus</i>	0.00	0.83	0.00
7.	<i>Channa diplogrammae</i>	0.83	0.00	0.00
8.	<i>Channa marulius</i>	0.00	0.00	0.83
9.	<i>Channa striata</i>	0.00	0.83	0.83
10.	<i>Clarias dussumieri</i>	0.00	0.83	0.00
11.	<i>Dayella malabarica</i>	0.00	0.00	1.65
12.	<i>Eetroplus maculatus</i>	0.00	5.79	1.65
13.	<i>Eetroplus suratensis</i>	0.00	0.00	4.13
14.	<i>Eetroplus suratensis</i>	0.00	0.83	0.00
15.	<i>Garra hughi</i>	2.48	0.00	0.00
16.	<i>Garra mullya</i>	0.83	0.00	0.00
17.	<i>Glossogobius giuris</i>	0.00	2.48	2.48
18.	<i>Hyprhamphus limbatus</i>	0.00	0.00	1.65
19.	<i>L. thermalis</i>	0.00	3.31	0.00
20.	<i>Mastacembelus armatus</i>	0.00	2.48	1.65
21.	<i>Megalops cyprinoids</i>	0.00	0.00	0.83
22.	<i>M. triangularis</i>	0.83	0.00	0.00
23.	<i>Mystus montanus</i>	0.83	0.00	0.00
24.	<i>Mystus oculatus</i>	0.00	0.83	0.00
25.	<i>Ompok bimaculatus</i>	0.00	0.83	0.83
26.	<i>Parambassis dayi</i>	0.00	1.65	0.83
27.	<i>Parambassis thomassi</i>	0.00	8.26	1.65
28.	<i>Pristolepis marginata</i>	0.00	2.48	0.00
29.	<i>P. cupanus</i>	3.31	1.65	0.83
30.	<i>Puntius fasciatus</i>	6.61	2.48	0.00
31.	<i>Puntius filamentosus</i>	0.00	0.00	9.09
32.	<i>Xenentodon cancila</i>	0.00	7.44	4.13

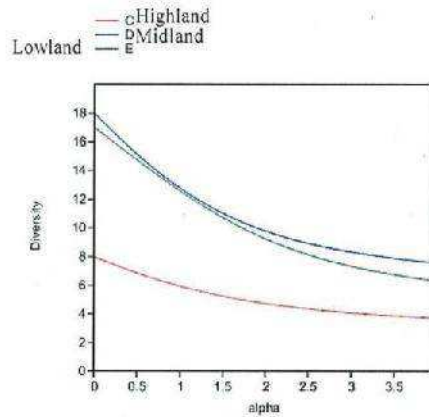


Figure 78. Diversity profile of Fishes in Kallada river C-HL; D-ML; E-LL

Puntius filamentosu, *Xenentodon cancila*, *Etroplus suratensis* and *Glossogobius giuris* are the fish species outnumbered in the Lowland (Figure 78). *Parambassis thomassi*, *Xenentodon*

cancila, *Etroplus maculatus* were dominated in the sampling at the midland.

35. PALLICHAL RIVER

The Pallichal River, a perennial originates from Western Ghats. This river begins at the southern cliffs of Kalaritharakunnu in Adoor and passes through Nellimukal, Anayadi and Vattakkayal before merging with the Kozhikode canal, near Karunagapally, in Kollam district.

The present uniform sampling in the Pallichal river yielded 24 fish species. The abundance of the species in the highland, midland and lowland are provided in the Table 68.

Table 68 . Fishes of Pallichal river and their abundance

No	Fish species	HL	ML	LL
1.	Anabas testudineus	0.87	3.03	7.36
2.	Anguilla bengalensis	1.30	1.73	1.30
3.	Barbodes subnasutus	0.87	0.87	2.16
4.	Barilius bakeri	0.43	0.87	0.87
5.	Barilius gatensis	0.43	0.87	0.43
6.	Batasio travancoria	0.43	0.43	0.87
7.	Channa striata	1.73	3.03	4.76
8.	Devario malabaricus	0.43	1.73	1.73
9.	Etroplus maculatus	2.16	3.90	7.36
10.	Garra mullya	0.43	0.87	1.73
11.	Glossogobius giuris	0.43	0.87	0.43
12.	Heteropneustes fossilis	0.43	0.43	0.43
13.	Hyprhamphus limbatus	1.30	0.87	0.87
14.	Hypselobarbus curmuca	0.43	0.43	0.87
15.	Mastacembelus armatus	0.43	0.43	0.43
16.	Mystus montanus	0.00	0.00	0.43

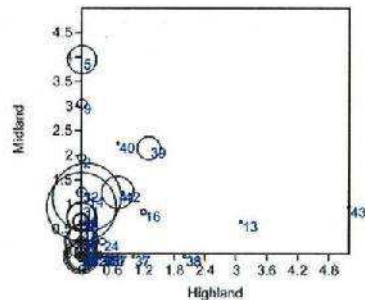


Figure 79. Bubble plot of abundance-Kallada river (The species number as in Table 67)

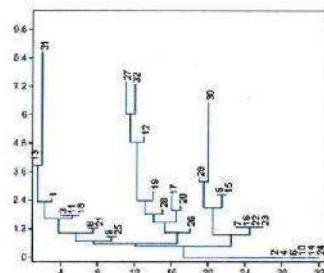


Figure 80. Neighborhood joining cluster based on abundance-Kallada river (The species number corresponds to the number in Table 67.)

17. <i>Mystus oculatus</i>	0.00	0.00	0.43
18. <i>Nandus nandus</i>	0.43	0.43	0.87
19. <i>O. mossambicus</i>	1.30	2.60	3.90
20. <i>Osteobrama bakeri</i>	0.00	0.87	0.43
21. <i>P. cupanus</i>	0.43	0.00	0.43
22. <i>Puntius filamentosus</i>	1.73	3.46	3.46
23. <i>Puntius vittatus</i>	0.43	4.76	1.73
24. <i>Rasbora dandia</i>	1.73	2.16	3.90

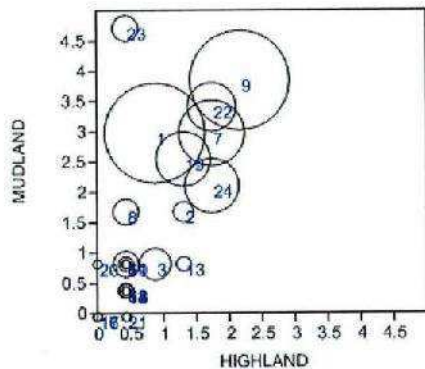


Figure 81. Bubble plot of abundance of fishes in the Pallichal river (The species number as in Table 68)

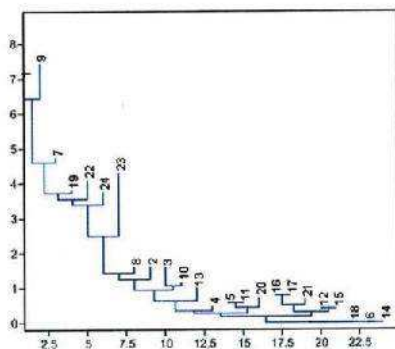


Figure 82. Neighborhood joining cluster based on abundance in Pallichal river (The species number corresponds to the number in Table 68)

The fishes of Pallichal river has not been documented well so far. The present sampling yielded 24 species (Table 68 and Figure 81).

Anabas testudineus and *Etroplus maculatus* are the most dominated species in the lowland. *Channa striata*, *Oreochromis mossambicus* and *Rasbora dandia* were followed the above species. *Puntius vittatus*, *Etroplus maculatus* and *Puntius filamentosus* were abounded in the midland. *Nandus nandus*, *Batasio travancoria* and *Hypselobarbus curmuca* though they were recorded from all zones, they occupied in the lower guild of abundance (Figure 81).

36. ITHIKKARA RIVER

Ithikkara river originates from Madathurikunnu which lies at an altitude of 240 meters above MSL. The main tributaries of the river are Vattamparambu thodu, Kundumonthodu, Vatamthodu, Kulangethodu and Pallimon Ar. The Ithikkara river transverse through the southern region of Kollam and finally empties into the Paravur Lake. It is a comparatively unpolluted river of the state without any major industry on its bank. In its course, it receives a variety of domestic wastes and domestic waste water and agricultural effluents.

The monitoring resulted in 18 fish species and their abundance is provided in the Table 69.

Table 69. Abundance of fishes in the sampling at Ittikara river

No.	Fish species	Abundance (%)
1.	<i>Ambassis</i> sp.	0.52
2.	<i>Aplocheilus lineatus</i>	1.55
3.	<i>Awous gutum</i>	0.00
4.	<i>Barbodes subnasutus</i>	10.82
5.	<i>Barilius bakeri</i>	1.03

6. <i>Devario malabaricus</i>	12.89
7. <i>Garra mullya</i>	1.03
8. <i>Garra surendranathinii</i>	0.52
9. <i>Hyprhamphus limbatus</i>	0.52
10. <i>Hypselobarbus curmuca</i>	5.15
11. <i>Lepidocephalus thermalis</i>	1.03
12. <i>Mastacembelus armatus</i>	1.03
13. <i>Puntius exclamatio</i>	10.82
14. <i>Puntius filamentosus</i>	33.51
15. <i>Puntius mahecola</i>	2.06
16. <i>Rasbora dandia</i>	14.95
17. <i>Xenentodon cancila</i>	2.58

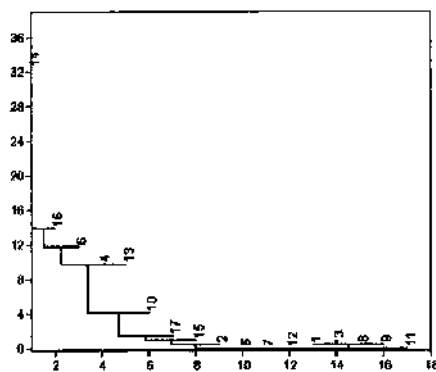


Figure 83. Neighborhood joining cluster based on abundance-Ittikara river (The species number corresponds to the number in Table 69)

The classification such as highland, midland and lowland has not been made in the case of Ittikara river due to the origin of the river from the low elevation. The *Puntius filamentosus* is the most dominating species river which was followed by the *Rasbora dandia*. *Barbodes subnasutus* and *Puntius exclamatio* were of equal abundance *Ambassis sp.*, *Garra surendranathinii* and *L. thermalis* were in the low profile of the abundance (Table 69 and Figure 83).

37. AYROOR RIVER

Information on the fish fauna of Ayur river is rather scanty. The present monitoring programme yielded 16 species. The composition of the species in the catch is given in Table 70.

Table 70. Abundance of fishes of Ayur river

No Fish species	Abundance (%)
1 <i>Amblypharyngodon microlepis</i>	6.08
2 <i>Anabas testudineus</i>	7.02
3 <i>Channa striata</i>	0.23
4 <i>Devario malabaricus</i>	9.83
5 <i>Etroplus maculatus</i>	12.4
6 <i>Etroplus suratensis</i>	7.02
7 <i>Hyprhamphus limbatus</i>	2.81
8 <i>Lepidocephalus thermalis</i>	0.46
9 <i>Parambassis thomassi</i>	9.60
10 <i>Pisodonophis horo</i>	3.74
11 <i>Pristolepis marginata</i>	4.45
12 <i>Puntius fasciatus</i>	3.04
13 <i>Puntius filamentosus</i>	14.98
14 <i>Puntius fasciatus</i>	10.07
15 <i>Puntius mahecola</i>	6.32
16 <i>Xenentodon cancila</i>	1.87

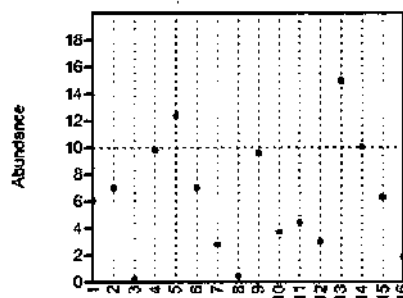


Figure 84. Graph plotted against the abundance of fishes-Ayur river (The species number corresponds to the number in Table 70.)

Puntius filamentosus is the most dominant species in the sampling and this was followed by *Etrophus maculatus* and *Puntius fasciatus*. *Channa striata* is poorly represented in the sampling (Figure 84).

38. MAMMOM RIVER

The Mamom watershed area lies between 8°30' to 8°40' North latitude and 76°45' to 76°55' East longitude and is entirely lies within the Thiruvananthapuram district. The watershed is bounded by Chirayinkil taluk in north, Thiruvananthapuram taluk in south, Nedumangad taluk in east and Arabian Sea in west. The watershed has a total area of 57.11 km² covering seven villages spread over six panchayaths, two blocks and one district. The Mamom river emerges from Pandalakottu malai (Plavamukku) near Mudavaram about 60 m above sea level and flows to Kadinankulam Kayal. The northeastern portion of the watershed flows westerly. The lower region is with very gently sloping beaches and the middle region is flat lands with valleys and isolated lateritic mounds.

The Mamom river watershed has a rectangular shape with length width ratio of 3:1. The Mamom river has a drainage area of 114 Sq.km and total length of 27 Km. Parvathyputhenaar is a major tributary that joins the Mamom river which has a dendritic drainage pattern. Another branch from Koonthallar joins the Vamanapuram river. Geological formation of Mamom watershed is Caimozoic formation with several types of rocks, which include sandstone and clay with lignite intercalation of the Warkalli (Varkala) formation. Lower region is coastal sand and alluvium.

The abundance of the fishes in Mamom river is provided in the Table 71 and Figure 85. Altogether 18 species were recorded from Mamom river during the present uniform sampling. Most of the species are common and found in most of the freshwater habitats of the state.

Table 71. Fishes recorded during the present survey and their abundance in Mamom river

No	Fish species	Abundance (%)
1.	<i>A. microlepis</i>	0.70
2.	<i>Anabus testudineus</i>	1.28
3.	<i>Aplocheilichthys lineatus</i>	2.21
4.	<i>Barbodes subnasutus</i>	15.37
5.	<i>Dayella malabarica</i>	1.51
6.	<i>Devario malabaricus</i>	19.09
7.	<i>Etrophus maculatus</i>	7.33
8.	<i>Etrophus suratensis</i>	1.75
9.	<i>Hypselobarbus curmuca</i>	0.58
10.	<i>Lepidocephalus thermalis</i>	0.58
11.	<i>Mystus gulio</i>	3.38
12.	<i>Pseudosphromenus cupanus</i>	0.70
13.	<i>Puntius fasciatus</i>	1.98
14.	<i>Puntius filamentosus</i>	10.59
15.	<i>Puntius punctatus</i>	9.78
16.	<i>Puntius vittatus</i>	5.36
17.	<i>Rasbora dandla</i>	15.72
18.	<i>Xenentodon canella</i>	2.10

Devario malabaricus was the most dominant species in the fishes recorded from the Mamom river and this was followed by the *Rasbora dandla* and *Barbodes subnasutus*. The second guild of abundance was occupied by the *Puntius filamentosus*, *Etrophus maculatus*, *Puntius punctatus* and *Mystus gulio*. The lower strata of abundance has been filled by the *Lepidocephalus*

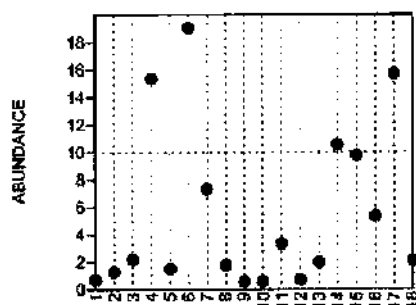


Figure 85. Graph plotted against the abundance of fishes-Mammom river (The species number corresponds to the number in Table 71.)

thermalis, *Hypselobarbus curmuca*, *Amblypharyngodon microlepis*, *Pseudosphromenus cupanus cupanus*, *Anabas testudineus*, *Puntius fasciatus* and *Xenentodon cancila*.

39. VAMANAPURAM RIVER

Vamanapuram River is an 88-km long river in southern Kerala. The river originates in the Chemunjimotta hills (alt. 1860m) hills on the southern side of the Western Ghats and flows through Thiruvananthapuram and Kollam districts of Kerala. It ends in Anjengo Lake (Anchuthengu Lake) near Varkala. The two tributaries of this river are the Upper Chittar and Manjaprayar streams. The fishes of Vamanapuram river has been documented by Abraham et al (2011). The fishes known from the Vamanapuram river has been given in the Table 72.

Table 72. List of fishes reported from the Vamanapuram river

Ambassidae

1. *Parambassis thomassi* (Day)

Anguillidae

2. *Anguilla bengalensis* (Gray)

Aplocheilidae

3. *Aplocheilichthys lineatus* (Valenciennes)

Bagridae

4. *Horabagrus brachysoma* (Gunther)
5. *Mystus malabaricus* (Jerdon)
6. *Travancoria jonesi* Hora
7. *Mesonemacheilus triangularis* (Day)

Cobitidae

8. *Lepidocephalus thermalis* (Valenciennes)

Belontiidae

9. *Xenentodon cancila* Hamilton-Buchanan

Channidae

10. *Channa gachua* (Bloch & Schneider)
11. *Channa marulius* (Hamilton-Buchanan)
12. *Channa striata* (Bloch)

Cichlidae

13. *Etilapia maculatus* (Bloch)
14. *Etilapia suratensis* (Bloch)

Cyprinidae

15. *Devario malabaricus* (Jerdon)
16. *Rasbora dandia* (Hamilton)
17. *Amblypharyngodon microlepis* (Bleeker)
18. *Barilius bakeri* Day
19. *Tor khudree* (Sykes)
20. *Garra mullya* (Sykes)
21. *Hypselobarbus curmuca* (Hamilton)
22. *Puntius dorsalis* (Jerdon)
23. *Puntius fasciatus* (Jerdon)
24. *Puntius filamentosus* (Valenciennes)
25. *Puntius mahecola* (Valenciennes)

Gobiidae

26. *Glossogobius giuris* (Hamilton-Buchanan)

Tetraodontidae

27. *Carinotetraodon travancoricus* (Hora & Nair)

Twenty seven species of fishes are known from the Vamanapuram river. The present survey could

record 25 species. Their abundance in the catch is given in Table 73.

Table 73. Abundance of the fishes in the Vamanapuram river

No	Fish species	HL	ML	LL
1	Anabas testudineus	0.00	0.00	11.15
2	Aplocheilus lineatus	0.66	2.95	0.98
3	Barilius bakeri	1.31	1.97	0.00
4	Catla catla	0.00	0.00	1.64
5	Etioplos suratensis	0.00	0.00	5.90
6	Garra mullya	0.33	2.62	0.00
7	Glossogobius giuris	0.00	0.00	0.98
8	H. fossilis	0.00	0.00	4.59
9	L. thermalis	0.00	0.66	0.00
10	Mastacembelus armatus	0.00	0.33	0.00
11	Mystus montanus	0.66	0.33	0.00
12	Mystus ocellatus	0.00	0.00	0.98
13	Ompok bimaculatus	0.00	0.66	0.66
14	O. mossambicus	0.00	0.00	0.66
15	Parambassis thomassi	0.00	2.30	2.30
16	Pristolepis marginata	0.00	0.98	0.00
17	Puntius dorsalis	0.00	0.33	0.00
18	Puntius fasciatus	0.98	0.00	2.30
19	Puntius filamentosus	0.00	5.25	11.48
20	Puntius mahecola	0.00	1.97	2.30
21	Puntius punctatus	0.00	6.23	0.00
22	Puntius vittatus	0.00	6.89	0.00
23	Rasbora dandia	3.61	5.25	0.00
24	Salmophasia boopis	0.00	4.26	1.31
25	Xenentodon cancila	0.00	1.31	0.98

From the Table 73, it is explicit that six species were recorded from the highland, 17 species from the midland and 15 species from the lowland. High dominance value for high land ($D=0.292$) indicates the dominance of certain species in this stretch. The evenness value is also high for this region (Table 74).

Table 74. Dominance and evenness indices of the three zones of Vamanapuram river

Indices	HL	ML	LL
No. species	6	17	15
Dominance	0.292	0.097	0.145
Evenness	0.735	0.715	0.628

The results of the cluster analysis to elucidate the pattern of abundance of fish species is given the Figure 86. *Anabas testudineus* (Figure 87) and *Puntius filamentosus* out grouped from the rest due to their high dominance in the samples from the lowland. The former is restricted to the lowland alone. *Etioplos suratensis* and *Heteropneustes fossilis* were in the second hierarchical level and they were restricted to the lowlands.

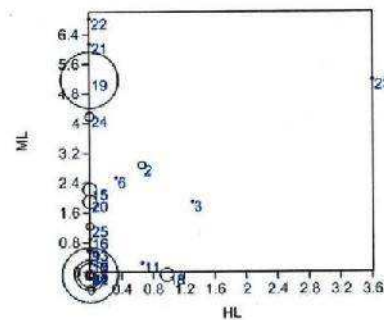


Figure 86. Bubble plot based on abundance - Vamanapuram river (The species number corresponds to the number in Table 73)



Figure 87. *Anabas testudineus* (Bloch)

40. KARAMANA RIVER

Karamana river originates from Chemmunji Mottai, a peak in the Sahyadri hills, at altitude of 1717m amsl. Another prominent mountain peak known as Adirumalaia, with an altitude of 1591 m amsl, forms the source of Attaiar, a major tributary of Karamana River. Along the course of the Karamana river, the master stream of the system, here is a 71m waterfall at Pachani Thuval, 2km downstream of Chemmunji Mottai. The Vazhapazhattiar and the Attaiar tributaries of the Karamana river, originate from Panditheri Malai (1560m) and Adrumalai (1594m) which join at an altitude of 249m and join with Karamana river at an altitude of 149 m at about 2km downstream of the Panchani-Thuval waterfall. Further down 5 other tributaries also join Karamana River.

There are Two Dams across the Karamana river, Peppara Dam and the Aruvikkara Dam.. There are fourteen tributaries drains into the Karamana river before Peppara Dam, of which, Kavi ar, Thodai ar, Attampuram thodu are the important ones. Again, there are several tributaries joining Karamana river system between the two dams. Atfinagal thodu, Kottur thodu and Chittar are few among them. Lower reaches of the Karamana river system after Aruvikkara dam is considered as Karamana river proper. Although numerous smaller tributaries are found to feed the Karamana river, downstream from Aruvikkara dam, the Killi ar is the only significant tributary with in this stretch. This tributary originates from Vettampalli hill (217 asl) in Nedumangad Taluk and agglomerate with Karamana ar at Nadakara.

The Karamana river forms an estuary, Poonthura estuary before debauching into the Lakshadweep

Sea. Karamana river system flows through the villages of Aryanad, Uzhamalakkal, Vellanad, Karakulam, Vattiyookavu, Vilappil, Iranimuttam, Nemorn, and Thiruvallam of Nedumangad and Neyyattinkara Taluks. The main stream of the Karamana river system has a total channel length of 68 km. The Karamana river ranks seventeenth in terms of its channel length and occupies 20th position among all the rivers of Kerala state (Abraham, 2002).

The fishes of Karamana river have been listed by Abraham et al (2011) and the thirty seven species are known from the river at present (Table 75).

Table 75. List of fishes reported from Karamana river

Ambassidae

1. *Parambassis thomassi* (Day)
2. *Parambassis ranga* (Hamilton-Buchanan)
3. *Anguilla bengalensis* Gray

Aplocheilidae

4. *Aplocheilichthys lineatus* (Valenciennes)

Bagridae

5. *Ilorabagrus brachysoma* (Guenther)
6. *Mystus malabaricus* (Jerdon)
7. *Mystus gulio* (Hamilton-Buchanan)

Balitoridae

8. *Mesonemacheilus triangularis* (Day)

Cobitidae

9. *Lepidocephalus thermalis* (Valenciennes)

Belonidae

10. *Xenentodon cancila* (Hamilton-Buchanan)

Channidae

11. *Channa marulius* (Hamilton-Buchanan)
12. *Channa striata* (Bloch)

Cichlidae

13. *Etropius maculatus* (Bloch)
14. *Etropius suratensis* (Bloch)
15. *Oreochromis mossambicus* (Peters)

Clariidae

16. *Clarias dussumieri* (Valenciennes)

Cyprinidae

17. *Devario malabaricus* (Jerdon)
18. *Rasbora dandia* (Valenciennes)
19. *Barilius bakeri* (Jerdon)
20. *Tor khudree* (Sykes)
21. *Garra mullyu* (Sykes)
22. *Hypselobarbus curmuca* (Hamilton)
23. *Puntius dorsalis* (Jerdon)
24. *Puntius fasciatus* (Jerdon)
25. *Puntius filamentosus* (Valenciennes)
26. *Puntius mahecola* (Valenciennes)
27. *Puntius parrah* (Day)
28. *Puntius punctatus* (Day)
29. *Barbodes subnasutus* (Valenciennes)
30. *Puntius vittatus* (Day)

Gobiidae

31. *Sicyopterus griseus* (Day)
32. *Awous gutum* (Hamilton-Buchanan)
33. *Glossogobius giuris* (Hamilton-Buchanan)

Heteropneustidae

34. *Heteropneustes fossilis* (Bloch)

Mastacembelidae

35. *Mastacembelus armatus* (Lacepede)

Nandidae

36. *Nandus nandus* (Hamilton-Buchanan)
37. *Pristolepis marginata* (Jerdon)

Siluridae

38. *Wallago attu* (Bloch and Schneider).

The abundance of the fishes observed during the sampling is given in the Table 76 and Figure 88.

Table 76. Abundance of the fishes in the Karamana river.

No	Fish species	HL	ML	LL
1	<i>Aplocheilichthys lineatus</i>	0.00	1.02	0.00
2	<i>Barilius bakeri</i>	2.80	5.00	0.00
3	<i>Channa marulius</i>	0.00	1.10	1.02
4	<i>Channa striata</i>	0.00	1.27	0.42
5	<i>Clarias dussumieri</i>	0.00	1.78	2.21
6	<i>Devario malabaricus</i>	1.78	2.29	0.00
7	<i>Etropius suratensis</i>	0.00	2.12	1.87
8	<i>Etropius maculatus</i>	0.00	3.14	0.00
9	<i>Garra mullya</i>	1.10	0.51	0.00
10	<i>Glossogobius giuris</i>	0.00	1.27	0.00
11	<i>Heteropneustes fossilis</i>	0.00	1.78	1.53
12	<i>Lepidocephalus thermalis</i>	0.00	0.51	0.00
13	<i>Mastacembelus armatus</i>	0.00	1.19	0.42
14	<i>Mystus gulio</i>	0.00	2.04	1.19
15	<i>Mystus montanus</i>	0.00	0.34	0.00
16	<i>Nandus nandus</i>	0.00	1.19	1.19
17	<i>M. triangularis</i>	0.93	0.00	0.00
18	<i>Ompok bimaculatus</i>	0.00	0.68	0.00
19	<i>O. mossambicus</i>	0.00	4.24	1.10
20	<i>Parambassis thomassi</i>	0.00	5.68	0.85
21	<i>Pristolepis marginata</i>	0.00	0.76	0.00
22	<i>Puntius fasciatus</i>	2.88	0.00	0.00
23	<i>Puntius filamentosus</i>	0.00	3.56	0.85
24	<i>Barbodes subnasutus</i>	0.00	2.37	1.10
25	<i>Puntius vittatus</i>	0.00	10.60	4.24
26	<i>Rasbora dandia</i>	7.38	6.11	2.63
27	<i>Wallago attu</i>	0.00	0.34	0.85

From the Table 76 and Figure 88, it is apparent that *Puntius vittatus* is most dominant species in the midland and lowland. However, it was absent in the highland. *Rasbora dandia* outnumbered in all the three zones. *Barilius bakeri* is the species

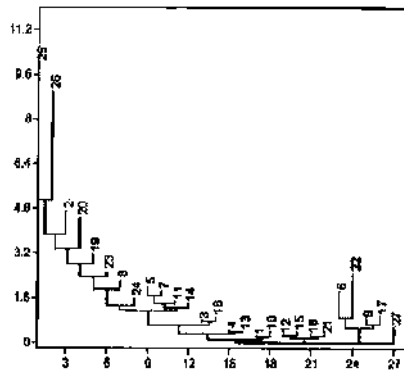


Figure 88. Neighborhood joining cluster based on abundance-Karamana river (The species number corresponds to the number in Table 76)

very next to the above species which is confined to the highland and midland.

41. NEYYAR RIVER

The Neyyar originates from the Agastya Mala (Agasthyakoodam), flows through Neyyattinkara taluk in Thiruvananthapuram District of Kerala and joins Lakshadweep Sea near Poovar. It has a total length of 56 km. Tributaries include the Kallar River, Mullayar River, and the Karavaliyar River. Streams like Vandichirathode, Kulathoorvaliyathode, Maruthoorthode, Athiyamurthode, Thaliyalthode, Kottukalthode and Venganoorthode joins the main stream.

The total area of Neyyar river basin is 128 sq. km. and it lies between 8°17'2" to 8° 53'2" N, and 76°40'2" to 76° 17'2" E. The area of river basin is spread over six blocks, one Municipality and 41 Panchayats. Neyyar is an irrigation reservoir created on the Neyyar river at lat. 8° 32' N and long. 77° 08' E, about 30 km south-east of Thiruvananthapuram. Commissioned in 1959, the reservoir has a water spread of 1,500 ha and

receives catchment from 140 km². Neyyar reservoir, apart from meeting the irrigation needs of Thiruvananthapuram district, recharges the Aruvikkara reservoir to maintain uninterrupted water supply to the city of Thiruvananthapuram and its suburbs. Neyyar wild life sanctuary is located in the river basin.

The exotic fishes (Indian Major Carps) such as catla, rohu and mrigal were introduced into the reservoir during 1971-72 for augmenting fish production (Nair, 1973). Harikrishnan and Azis (1989) studied the ecology of the Neyyar reservoir and reported it to be ideal for fisheries development. The fish fauna of the river is not extensively surveyed. Thomas *et al.* (2000) studied the fish fauna of Neyyar wildlife sanctuary. The fishes of Neyyar river and their abundance is given in Table 77 and Figure 89.

Table 77. Fishes of Neyyar river and their abundance

No. Fish species	HL	ML	LL
1 <i>Anguilla bengalensis</i>	0.00	0.40	0.00
2 <i>Anguilla bicolor</i>	0.00	0.00	0.40
3 <i>Aplocheilichthys lineatus</i>	0.00	3.61	1.20
4 <i>Barilius bakeri</i>	1.61	2.41	0.00
5 <i>Channa marulius</i>	0.00	0.40	0.00
6 <i>Channa striata</i>	0.00	0.40	0.00
7 <i>Clarias dussumieri</i>	0.00	0.40	0.00
8 <i>Eleotris fusca</i>	0.00	0.00	0.40
9 <i>Garra mullya</i>	0.80	3.21	0.00
10 <i>H. fossilis</i>	0.00	0.40	0.00
11 <i>Hypselobarbus kawali</i>	0.00	2.01	0.00
12 <i>L. thermalis</i>	0.00	0.80	0.00
13 <i>Mastacembelus armatus</i>	0.00	0.40	1.20
14 <i>Mystus montanus</i>	0.80	0.40	0.00

15	<i>Ompok bimaculatus</i>	0.00	0.80	0.80
16	<i>Ompok malabaricus</i>	0.00	0.40	0.00
17	<i>O. mossambicus</i>	0.00	0.00	0.80
18	<i>Parambassis dayi</i>	0.00	0.40	0.00
19	<i>Parambassis thomassi</i>	0.00	2.81	2.81
20	<i>Prestolepis marginata</i>	0.00	1.20	0.00
21	<i>P. cupanus</i>	0.00	0.80	0.00
22	<i>Puntius dorsalis</i>	0.00	0.40	0.00
23	<i>Puntius fasciatus</i>	1.20	0.00	0.00
24	<i>Puntius filamentosus</i>	0.00	6.43	2.41
25	<i>Puntius mahecola</i>	0.00	2.41	0.00
26	<i>Barbodes subnasutus</i>	0.00	0.80	0.00
27	<i>Puntius punctatus</i>	0.00	7.63	0.00
28	<i>Puntius vittatus</i>	0.00	8.43	0.00
29	<i>Rasbora dandia</i>	0.00	6.43	0.00
30	<i>Salmophasia boopis</i>	0.00	5.22	1.20
31	<i>Tor khudree</i>	0.40	0.00	0.00
32	<i>Wallago attu</i>	0.00	0.40	0.00
33	<i>Xenentodon cancila</i>	0.00	1.61	1.20

abundant species in the midland and were not recorded from the high and low zones of the river (Table 77; Figure 89).

42. PAMBAR RIVER

The Pambar River is an east flowing river which originates in the Anaimudi Hills in Idukki District. It traverses Turner's Valley in Eravikulam National Park and flows into the Chinnar Wildlife Sanctuary through the Taliar Valley between Kanthalloor and Marayoor Villages and eastwards through the sanctuary. It is joined by seasonal rivulets and a few perennial streams originating from sholas in the upper reaches. Fish fauna of Pambar is poorly studied except a few studies by Easa and Shaji (1996) and Thomas and Biju (1998). The present survey recorded 12 species and their abundance is given in the Table 78.

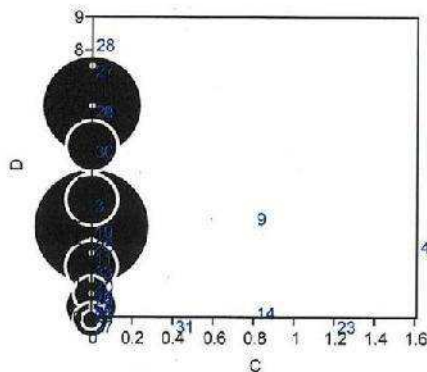


Figure 89. Bubble plot to show the relative composition of different species in the Neyyar river (The species number as in Table 77)

Altogether 33 species of fishes were recorded from the Neyyar river. Five species were recorded from the highland, 28 species from the midland and 10 species from the lowland. *Puntius punctatus*, *P. vittatus* and *Rasbora dandia* were the most

Table 78. Abundance of fishes in the Pambar river

No Fish species	Abundance (%)	
1	<i>Barilius bendeleis</i>	10.00
2	<i>Barilus gatensis</i>	10.00
3	<i>Barbodes carnaticus</i>	04.00
4	<i>Garra stenorhynchus</i>	12.00
5	<i>Lepidocephalus thermalis</i>	04.00
6	<i>Mesonemacheilus pambarensis</i>	10.00
7	<i>Puntius filamentosus</i>	30.00
8	<i>Puntius punctatus</i>	04.00
9	<i>Rasbora dandia</i>	02.00
10	<i>Salmophasia acinaces</i>	02.00
11	<i>Schistura denisonii</i>	04.00
12	<i>Tor khudree</i>	08.00

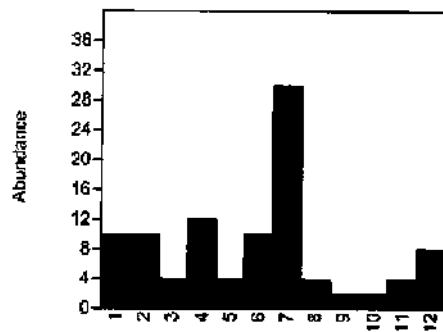


Figure 90 Abundance pattern of fishes in the Chinnar river (species no as in Table 78)

Puntius filamentosus was the most dominant species in the Pambar river. This was followed by the *Garra stenorhynchus*, *Barilius bendelisis* and *Barilius gatensis*.

43. KABINI

The Kabini is one of the three east flowing rivers of Kerala. It is a perennial tributary of Cauvery river and constitutes a powerful system in the landscape of Wayanad. Kabini river is formed by the confluence of Panamaram rivulet originating from Lakkidi and Mananthavady rivulet originating from Thondiarmudi peak 6 km north of Panamaram town. Almost the entire Wayanad is drained by Kabini and its major and minor tributaries namely, Panamaram, Mananthavady and Thirunelly. Kabini joins the river Cauvery at Thirumakudal Narsipur in Karnataka and there after transverse through Tamil Nadu and finally empties in to the Bay of Bengal.

The fishes of Wayanad and Kabini has been documented by Easa and Basha (1995), Easa and Shaji (2003), Manimekalan (2001) and

Arunachalam *et al* (2005). The list of fishes known from Kabini river system is given in the Table 79.

Table 79. List of fishes reported from Kabini river

Family : Notopteridae

1. *Notopterus notopterus* (Pallas)

Family : Cyprinidae

2. *Barilius gatensis* (Valenciennes)
3. *Salmophasia acinaces* (Valenciennes)
4. *Salmophasia boopis* (Day)
5. *Salmophasia balookee* (Sykes)
6. *Amblypharyngodon melettinus* (Valenciennes)
7. *Laubuca laubuca* (Hamilton)
8. *Danio rerio* Hamilton
9. *Devario malabaricus* Jerdon
10. *Devario neilgherriensis* (Day)
11. *Esomus barbatus* (Jerdon)
12. *Esomus darnicus* (Hamilton)
13. *Rasbora dandia* (Hamilton)
14. *Tor khudree* (Sykes)
15. *Tor neilli* (Day)
15. *Neolissochilus wynaadensis* (Day)
17. *Barbodes bovanicus* (Day)
18. *Barbodes carnaticus* (Jerdon)
19. *Barbodes subnasutus* (Valenciennes)
20. *Hypselobarbus dubius* (Day)
21. *Hypselobarbus lithopidos* (Day)
22. *Hypselobarbus micropogon* (Val)
23. *Hypselobarbus thomassi* (Day)
24. *Puntius arullus* (Jerdon)
25. *Puntius chola* (Hamilton)
26. *Puntius conchomius* (Hamilton)
27. *Puntius fasciatus* (Day)
28. *Puntius mahecola* (Valenciennes)
29. *Puntius punctatus* (Day)
30. *Puntius sophore* (Hamilton)

31. *Puntius vittatus* (Day)
 32. *Puntius rubrotinctus* (Jerdon)
 33. *Osteochilichthys nashii* (Day)
 34. *Osteochilichthys thomassi* (Day)
 35. *Kantaka brevidorsalis* (Day)
 36. *Catla catla* (Hamilton)
 37. *Cirrhinus mrigala* (Hamilton)
 38. *Cirrhinus reba* (Hamilton)
 39. *Labeo ariza* (Hamilton)
 40. *Labeo kontius* (Jerdon)
 41. *Labeo potail* (Sykes)
 42. *Labeo rohita* (Hamilton)
 43. *Garra stenorhynchus* (Jerdon)
 44. *Garra mcClellandi* (Jerdon)
 45. *Garru mullya* (Sykes)
Family: Balitoridae
 46. *Balitora mysorensis* Hora
 47. *Bhavana australis* (Jerdon)
 48. *Acanthocobitis mooreh* (Sykes)
 49. *Schistura denisoni* (Day)
 50. *Schistura nilgiriensis* Menon
 51. *Schistura semiarmatus* (Day)
 52. *Longischistura striatus* (Day)
 53. *Mesonemacheilus guentheri* Day
 54. *Mesonemacheilus petrubanarescui* Menon
Family : Cobitidae
 55. *Lepidocephalus thermalis* (Valenciennes)
Family: Bagridae
 56. *Mystus armatus* (Day)
 57. *Mystus seengtee* (Sykes)
 58. *Mystus malabaricus* (Jerdon)
 59. *Mystus montanus* (Jerdon)
 60. *Hemibagrus punctatus* (Jerdon)
Family : Siluridae
 61. *Pterocryptis wynaadensis* (Day)
 62. *Ompok bimaculatus* (Bloch)
 63. *Ompok malabaricus* (Valenciennes)
 64. *Wallago attu* (Bloch)
Family: Sisoridae

65. *Glyptothorax annandalei* Hora
 66. *Glyptothorax madraspatanus* (Day)
Family: Clariidae
 67. *Clarias dussumieri* Valenciennes
Family : Heteropneustidae
 68. *Heteropneustes fossilis* (Bloch)
Family : Aplocheilidae
 69. *Aplocheilus lineatus* (Valenciennes)
Family : Poeciliidae
 70. *Poecilia reticulata* (Peters)
Family : Mastacembelidae
 71. *Mastacembelus armatus* (Lacepede)
Family : Chandidae
 72. *Parambassis ranga* (Hamilton)
 73. *Parambassis thomassi* (Day)
Family: Nandidae
 74. *Pristolepis marginatus* Jerdon
Family: Cichlidae
 75. *Oreochromis mossambicus* (Peters)
Family: Gobiidae
 76. *Glossogobius giuris* (Hamilton)
Family: Channidae
 77. *Channa gachua* (Hamilton)
 78. *Channa marulius* (Hamilton)
 79. *Channa striata* (Bloch)

The fish monitoring programme recorded 31 fish species from Kabini river system. The abundance of the fishes is provided in the Table 80.

Table 80. Fishes and their abundance in Kabini.

No	Fishes	Abundance
1	Aplocheilus lineatus	3.120
2	Barbodes carnaticus	1.478
3	Barilius gatensis	2.135
4	Channa gachua	0.985

5	<i>Cirrhinus reba</i>	3.777
6	<i>Devario malabaricus</i>	6.732
7	<i>Esomus danricus</i>	2.956
8	<i>Garra mullya</i>	3.612
9	<i>Hemibagrus punctatus</i>	0.493
10	<i>Hypselobarbus micropogon</i>	1.806
11	<i>Laubuca laubuca</i>	4.598
12	<i>Mastacembelus armatus</i>	0.985
13	<i>Mesonemacheilus guentheri</i>	2.135
14	<i>Mystus malabaricus</i>	2.791
15	<i>Mystus montanus</i>	1.478
16	<i>Mystus seengtee</i>	4.433
17	<i>Notopterus notopterus</i>	1.314
18	<i>Ompok malabaricus</i>	2.135
19	<i>Oreochromis mossambicus</i>	2.791
20	<i>Osteochilichthys nashii</i>	1.480
21	<i>Parambassi ranga</i>	21.02
22	<i>Parambassis thomassi</i>	1.314
23	<i>Pristolepis marginata</i>	1.478
24	<i>Puntius conchoniis</i>	0.612
25	<i>Puntius mahecola</i>	5.255
26	<i>Puntius punctatus</i>	2.135
27	<i>Puntius vittatus</i>	3.120
28	<i>Rasbora dandia</i>	4.762
29	<i>Salmophasia balookee</i>	1.970
30	<i>Salmophasia boopis</i>	2.791

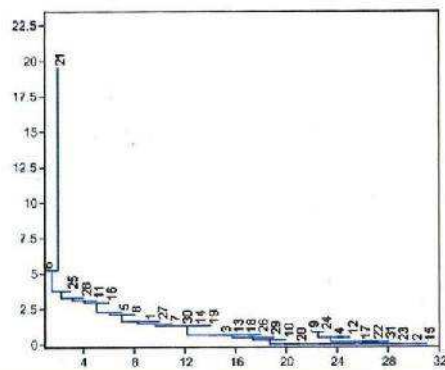


Figure 91. Neighborhood joining cluster based on abundance of fishes from Kabini river (The species number corresponds to the number in Table 80)

31 *Schistura semiarmatus* 1.314

The analyses indicate that *Parambassis ranga* is the most dominant species in the Kabini river system. This was followed by the *Devario malabaricus*. The *Puntius mahecola*, *Rasbora dandia* and *Laubuca laubuca* were almost equally abundant in the Kabini river system (Figure 91).

44. BHAVANI RIVER

The Bhavani river is a 217 km. long perennial river fed mostly by the southwest monsoon and supplemented by the northeast monsoon. Its 6,200 km² watershed area spread over Tamil Nadu (87%), Kerala (9%) and Karnataka (4%).

The fishes of Bhavani river enlisted by Rajan (1955), Easa and Basha (1995), Easa and Shaji (2003). The annotated list is given in Table 81.

Table 81. List of fishes known from the Bhavani.

Family: Cyprinidae

1. *Barilius gatensis* (Valenciennes)
2. *Salmophasia acinaces* (Valenciennes)
3. *Devario malabaricus* Jerdon
4. *Devario neilgherriensis* (Day)
5. *Rasbora dandia* (Hamilton)
6. *Tor khudree* (Sykes)
7. *Barbodes carnaticus* (Jerdon)
8. *Hypselobarbus lithopidos* (Day)
9. *Hypselobarbus micropogon* (Val)
10. *Puntius fasciatus* (Jerdon)
11. *Puntius dorsalis* (Jerdon)
12. *Garra stenorrhynchus* (Jerdon)
13. *Garra mullya* (Sykes)

Family: Balitoridae

14. *Balitora mysorensis* Hora
 15. *Homaloptera pillai* Indra and Remadevi
 16. *Bhavana australis* (Jerdon)
 17. *Schistura semiarmatus* (Day)
 18. *Mesonemacheilus guentheri* (Day)
 19. *Nemacheilus monilis* Hora

Family: Cobitidae

20. *Lepidocephalus thermalis* (Valenciennes)

Family Bagridae

21. *Mystus balookee* (Sykes)

Family: Aplocheilidae

22. *Aplocheilus lineatus* (Valenciennes)

Family: Nandidae

23. *Pristolepis marginatua* Jerdon

Family: Cichlidae

24. *Oreochromis mossambicus* (Peters)

Family: Gobiidae

25. *Glossogobius giuris* (Hamilton)

A total of 25 species have been recorded from the Bhavani river. The fish monitoring investigators could record 18 species (Table 82).

Table 82. Fishes of Bhavani river (Kerala part) with their abundance

No.Fish species	HL	ML	LL
1 Barilius gatensis	5.18	5.98	7.17
2 Devario malabaricus	0.00	0.40	0.80
3 Garra mullya	1.59	1.59	1.59
4 Garra stenorhynchus	4.78	3.59	2.39
5 Homaloptera pillai	1.20	1.59	1.20
6 Lepidocephalus thermalis	0.00	1.59	0.00
8 Puntius fasciatus	4.38	5.58	7.57
9 Rasbora dandia	5.18	6.37	5.98
10 Puntius dorsalis	3.59	0.80	0.40
11 Salmophasia acinaces	1.20	1.20	0.00
12 Schistura semiarmatus	0.40	0.40	0.40
13 Mesonemacheilus guentheri	0.80	0.40	0.40

14	<i>Glossogobius giuris</i>	0.00	0.00	0.80
15	<i>Aplocheilus lineatus</i>	1.20	1.20	1.20
16	<i>Nemacheilus monilis</i>	0.00	0.80	0.80
17	<i>Mastacembelus armatus</i>	0.00	0.40	0.40
18	<i>Oreochromis mossambicus</i>	0.00	0.00	2.39

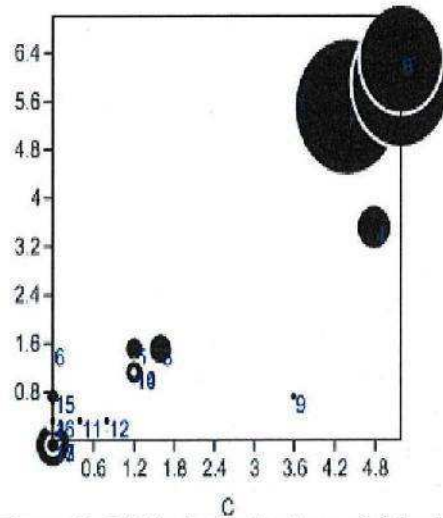


Figure 92. Bubble plot to abundance of fishes in the Bhavani river (The species number as in Table 82).

From the Table 82 and Figure 92, it is clear that *Barilius gatensis* abounds in all the three zones of the river. The species which are very next to the above are *Rasbora dandia*, *Garra stenorhynchus* and *Puntius fasciatus*. *Devario malabaricus* and *Nemacheilus monilis* were in the lower guild. *Oreochromis mossambicus* though absent in the high and midland but abounds in the lowland (Figure 92).

RECOMMENDATIONS

THE MOST IMPORTANT RECOMMENDATIONS EMERGING FROM THE FISH SURVEY ALONE ARE NOTED HERE. THESE NEED TO BE GIVEN THE DUE IMPORTANCE THEY DESERVE BY CONCERNED AUTHORITIES FOR THE POSTERITY OF THE RIVERS OF KERALA

DESTRUCTION AND ALTERATION OF HABITATS TO BE ASSESSED

The most important problem observed is the alteration of natural flows in the rivers due to dams and other modification of habitats like sand mining, reclamation of the flood plains and wetlands, river banks and riparian habitats etc. These are obstructing the lateral and horizontal connectivity in river related ecosystems affecting the breeding and feeding movement of fishes. Assessment of these impacts should be taken up urgently by the government through appropriate institutions. Measures for restoring connectivity of rivers and associated ecosystems should be taken up.

PREVENT THE USE OF UNREGULATED SMALL MESHED NETS

The use of small meshed fishing gears which capture even the fishlings is common throughout Kerala which needs regulation

FISHING USING CHEMICAL AND HERBAL POISONS TO BE BANNED

Diverse types of fish poisons both of plant chemical origin are widely used in upstream, middle and downstream parts of most rivers. This results in the depletion of the new

recruits and it become unable to restore the viable population.

USE OF ICHTHYOTOXINS AS POISONS TO BE BANNED

Ichthyotoxins ranging from chemical and plant derivatives are still in use in different parts of the state. Some are potent toxins to kill even the large sized non-fish species and kill wide array of species in the system. The biodiversity loss is very heavy due to the frequent application of the ichthyotoxins. There is no efficient system to monitor and regulate these mode of fishing.

INSECTICIDES AND PESTICIDES LEACHING INTO RIVERS NEED TO BE REGULATED

The heavy and indiscriminate use of insecticides and pesticides in the agricultural fields starting from plantations upstream have resulted in the loss of fish resource base from the river systems.

DYNAMITING TO BE BANNED

Dynamiting is quite common in the rivers of Kerala. This method of fishing is one among the serious threats to the freshwater fish bases.

ELECTRO-FISHING SHOULD BE BANNED

Electro-fishing is common in the down streams of the rivers of Kerala.

INTRODUCTION OF EXOTIC SPECIES TO BE LEGALLY REGULATED

The stocking of exotic and alien species into the natural waters of Kerala has resulted in

in the decline of indigenous species. More than 20 freshwater fish species are established well in the freshwaters of Kerala. The high proliferation rate resulted in the decline of the native species. The advertent and inadvertent introductions for aquaculture and aquarium trade are high during these years. Stringent measures must be adopted to regulated the introduction of exotic fauna and flora.

The fish habitats are being changed to less conducive for the native fishes due to the regular and excessive stocking of the culture species like Catla, Rohu, Mrigala, Tilapia, Gold carp, etc. Introduce policies and legal measures to regulate the regular stocking.

WATER QUALITY

Pollution due the industrial wastes, sewage, organic wastes are increasing at an alarming rate. Efforts may be made to create awareness among the public to combat pollution and curb pollution at the source.

ILLEGAL ORNAMENTAL FISH TRADE

Fishes are the icon of pet trade. Several freshwater species, especially loaches are active in the international aquarium trade and most of them especially the loaches of the family Balitoridae are endemic to the Southern Western Ghats too. The breeding protocols for even the species that fetch an exorbitant prize in the international market have not been standerdised. Most of the traders rely on the wildstock for the constant supply of the fishes. The illegal trade of the endemic species has to be banned. Simultaneously, the efforts may be made for the artificial propagation of the highly valued freshwater species.

MONSOON FISHING

The heavy fishing during the onset of monsoon is quite common in Kerala and there is no information on the fishery during this breeding period of fishes. An awarness must be created among the public to abandon fishing during the breeding seasons of fishes.

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