Part IV

MICRODISTRIBUTION
INTRODUCTION

"Microdistribution" is a word used to express a definite conception in ecological studies in a community. In the present investigation, this term has been adopted to describe the distributional patterns of fish communities in a specific locality along the Achenkovil river system in relation to their microhabitat partitioning. Microhabitat segregation is an important means of resource partitioning proved in North American fish assemblages (Ross, 1986). Most studies relating to structure of stream-fish assemblage were carried out at moderately large spatial scales, namely stream-reach units. (Frissel et al., 1986, Bryant et al., 1989, Vadas, 1991). Use of finer microhabitat axes (Velocity, depth and substrate) can also been used in resource partitioning studies of lotic fishes (Allen 1969, Moyle and Li 1979).

The microhabitat of an individual stream fish is the place in the stream where it is located at any point in time, which is chosen by the fish in response to optimize its net energy gain while avoiding predators and minimizing interactions with competitions. The present study is an attempt to determine the spatial segregation of stream fish assemblage correlated with microhabitat use, over a period of one year.

The majority of studies on fish assemblages have treated dietary differences among species, with less emphasis on habitat differences (Starrett, 1950; Darnell, 1958; Sheppard, 1965; Flemer and Woolcott, 1966; Keast, 1966;

Resource partitioning studies show that the resource dimensions are very important in considering the composition of resource gradients and helps to identify which dimensions are functionally important to species interactions.

One of the main objectives in this study is to evaluate the relative importance and structure of spatial (depth, current and substrate) dimensions to resource partitioning among fish species in Achenkovil river system.

The present study is focused on 3 following questions.

1. Do the species making up this assemblage show preference for specific depth, current or substrate in the water column?

2. Do the spatial distribution of the species show a distinct pattern or they change with season?

3. Do this spatial distributional pattern is influenced by the diet of the fish, or feeding behaviour?
The studies on microhabitats of stream fishes have assumed considerable importance in recent years because the informations can be used in stream hydraulic models to simulate the amount of habitat available to fishes.

Eventhough cyprinids dominated the ichthyofauna of the river, multispecies assemblage were common, except, for food habit studies concerning their ecological relationships.

MATERIALS AND METHODS

Microdistribution of 10 selected fish species were studied and their horizontal and vertical distribution determined within a specific locality. The species studied include *Barilius* *bakeri*, *Danio aequipinnatus*, *Etroplus maculatus*, *Garra mullya*, *Puntius amphibius*, *Puntius curmuca*, *Puntius filamentosus*, *Puntius melanampyx*, *Rasbora daniconius* and *Salmostoma boopsis*.

Microdistribution within a station is assessed for individual species at the position of fish in relation to four environmental parameters viz., flow rate, water column depth, substrate type, and macrophyte vegetation.

The vertical position of the fish in the water column was studied in detail by direct visual observations. Usually the water depth and substrate compositions of the observational locations were recorded. Microhabitat observations were made for a period of 1 year from February 1992 to January 1993. Observations were made only on fishes that were either feeding, holding in current or otherwise behaving in a natural manner.
For each observation, the following microhabitat parameters were measured: average position of fish in the water column, stream flow rate, depth of water column, and bottom substrate composition.

Each observation was made first by scanning the water column and river bottom to locate an undisturbed fish. The disturbed fishes were identified by their characteristic escape responses. The position of the specimen was noted, and the specific water column velocity, water column depth, and a visual estimate of substrate composition where the specimens were located were also noted. Description of categories used in measuring stream habitat is given in Table 111.2.

The average vertical position of fish in the water column was noted under 5 categories as follows: (1) surface (S), (2) near surface (N.S.) at a depth of 25% to the surface, (3) middle (M) at a depth of 25%-75% to the bottom, (4) near bottom (N.B) at a depth of 25% to the bottom, and (5) bottom (B).

Stream depth (depth of water column) was measured by using a relative scale of depth ranging from 0 to < 200 cm. 0-20 cm corresponded to very shallow edges and riffles, 20-50 cm to riffles and shallow waters, 50-100 cm to moderate depth, 100-200 cm to high depth, and < 200 as deep waters.

Current (stream flow rate) was estimated by observing the timing of passage of a piece of cork over a measured distance in the mid-channel. Currents were assigned to 5 classes and corresponding velocities were calibrated. The flow categories were, very slow (VS), slow (S), moderate (M), fast (F), and torrent (T). (Although velocity estimates are accurate up to moderate currents, this technique underestimates fast and torrent velocities).
The substrate categories were based on maximum particle diameters, ie.,
boulders = > 30 cm, rubble = between 30 and 2.5 cm, gravel = between 2.5 and
0.2 cm, sand = 0.2 cm and silt = materials capable of suspensions in the water
column.

Bottom substrate types were categorized into physical and biotic structures. Among the physical forms categories 1-5 (Silt (ST), sand (SA), Gravel (GR), Rubble (RU), Boulder (BO), corresponded to alluvial materials increasing size from silt to boulder with catagory 6 as clay bottom (C). Biotic categories (7 and 8) included vegetation (V) (aquatic plants and filamentous algae) and litter (L), leaves, twigs and branches). A misalliance catagory 9. (M) was reserved for unusual items such as bedrock slabs or large tree trunks.

Overall 360 netting operations were carried out for one year by 30 collections in each month, 5 at each station. Gill nets of 10 M, 1.5 Cm mesh size, 25 M, 2.5 Cm mesh size and cast nets of 2.5M diameter, 1 cm mesh size, 3 M diameter, 1.5 cm mesh size were used for most of the collections. Because of the variable shape of Microhabitats, block netting before sampling was not feasible. Qualitative river bank characteristics, aquatic Macrophyte composition and relative canopy coverage also were recorded at each station. The river bank shape was scored on a scale of 1 to 5. 1 = low beach, 2 = 30° slope 3 = 60° slope, 4 = 90° slope and 5 = undercut banks. Canopy shading was scored on a scale of 1 to 4. 1 = full sun, 2 = partial shade, 3 = temporary full shade, 4 = permanent full shade.

These visual estimates had the advantage of being readily recorded in the field and were consistent across all samples. Besides by net catches, the relative
abundance, was observed by visual census along the bank of the river. The observations were made along different transects to cover the entire population as best as possible. Populations were counted even at crevices, in between boulders, beneath under cut banks and debris.

The percentage distribution of all the species at different localities were determined to recognize, the most common species, residing in different habitats along the river, and also the percentage composition of the 10 most common fish species were determined and analysed to study their habitat selectivity along the longitudinal axis of the river.

RESULTS AND DISCUSSION

The distribution and abundance of stream fishes are found to be under the interaction between the biotic and abiotic factors and their influence generate considerable alterations in the environment. Schlosser (1989) supports this view by showing how an abiotic variable (flow regime) and a biotic interaction (cyprinid predation), influence the distribution and abundance of invertebrates and small fishes, in a head water tributary of the Mississipi river.

Definite discrete micro habitats were found to be preferred by each species relating to flow, depth, and substrate. Ten species contributed more than 60% of the total collection of fishes, which were considered for micro distribution study. The species include, *Puntius filamentosus*, *Danio aequipinnatus*, *Etroplus maculatus*, *Garra mullya*, *Puntius amphibius*, *Puntius curmuca*, *Barilius bakeri*,
Puntius melanampyx, Rasbora daniconius and Salmostoma boopsis. Habitat preference of these 10 species observed at a specific location of the river against Position in water column, Canopy, Depth, Current and Substrate, is represented in Table IV. I.

In station I, Garra mullya showed highest percentage of distribution while in station II Barilius bakeri, was the most abundant species. In station III, and IV Danio aequipinnatus and Rasbora daniconius were predominant, and Station V had highest percentage of Puntius ticto and P. vittatus for majority of seasons, while Etroplus maculatus showed highest distribution at station VI. The microhabitat use of all the 10 species were found to be considerably stable, however the substrate availability exhibited a complex pattern of seasonal variation.

Changes in the fish species number in the different localities along the longitudinal axis can be correlated to the diverse use of habitat. It is represented in Table III. 13. The percentage composition of the microhabitat dimensions, viz., Depth, Current and substrate at different habitat types were illustrated by Fig.IV.1 to IV. 3. It reveals that the HB. I has the highest percentage of depth range between 20-50 cm., Fast current and Boulder substrate, while that of HB. II has a depth range between, 50-100 cm., Fast current and Gravel substrate. But in HB. III, 50% of the depth ranges between 50-100% cm, with Moderate current at most time and high percentage of Sandy substrate. HB. IV experience high percentage of depth range between 100-200 cm with Fast current and Gravel substrate. The HB. V is more deep with a greater percentage of depth > 200 cm., with Slow
current and Sandy substrate. About 75% of the HB. VI was occupied by the depth range > 200 cm, with Very slow current and Silt bottomed substrate.

Different sampling methodology appropriate for the various habitats was employed to study resource dimensions whereas visual observations were helpful in headwater habitats while gill net operations were used successfully in down stream habitats. (Table III.1).

The usage of localities with high water velocity by *Barilius bakeri* was relatively high when compared to the other species. This high velocity preference was conspicuous during Pre-monsoon period, when the fish got its most suitable microhabitat. Relatively slower water velocities were preferred by *Puntius filamentosus, Puntius amphibius* and *Salmostoma boopsis* whereas *Etroplus maculatus* prefers habitats with very slow velocity. *Puntius filamentosus, Danio aequipinnatus, Rasbora daniconius* and *Garra mullya* prefer both high and intermediate velocities but the occurrence of *Puntius melanampyx* in stagnant water was most consistent. The microhabitat segregation for *Barilius bakeri* was found primarily for the preference in velocity and substrate than depth. It can be proved from the observational data, that this species is only reported in stations II for majority of collections but showing their little presence in stations I and III during the same months. The substrate composition in station II has a high percentage of gravel and sand preferred by this fish, while station I has only large cobbles, constituting the majority of substrate composition which is not preferred by the fish. As station III has shallow sand bottomed substrate type *Barilius bakeri* were occasionally found there.
in the case of *Danio aequipinnatus* its occurrence in the all available habitats, irrespective of depth, current and substrate, reveals that it prefers only its position in the water column viz - surface. So the surface microhabitat selectivity by *Danio aequipinnatus* can be interpreted strictly on the basis of their comparatively small body size morphological modifications and mouth adaptation for surface feeding behaviour.

The substrate variables exhibit a complex pattern of seasonal variation. Gravel and sand were common during post monsoon whereas rubble was more common during early summer. The greatest amounts of silt were observed during monsoon periods.

Differential use of water column depth is a general phenomenon. *Danio aequipinnatus* was noticed high in the water column where as *Puntius filamentosus* and *Puntius amphibius* used intermediate depth but *Garra mullya* showed bottom depth preference *Puntius melanampyx* occupies the shallow region with a depth range of 0.1 to 0.3 meters.

Significant interspecific differences were noticed with relative distance in the water column which was the most important variable for interspecific segregation in the microhabitat use.

Occurrence over substrates by *Danio aequipinnatus*, *Barilius bakeri* and *Rasbora daniconius* in station II, were more or less similar for juveniles and adults. The regions with small and large boulders were chosen by *Rasbora daniconius* and *Barilius bakeri*, while the substrate with fine sediments was chosen by *Puntius filamentosus* during pre-monsoon and monsoon periods but with small and large
boulders during post monsoon periods. The position occupied by *Garra mullya* over bedrock and *Puntius melanampyx* over dead leaves were compatible.

Vertical distribution of the fish species in the water column, is correlated with its microhabitat use and is remarkably consistent in time and space. *Danio aequipinnatus* and *Salmostoma boopsis* select their distributional space in the upper water column. The mid water column inhabitants were *Puntius curmuca* and *Puntius amphibius* while *Puntius melanampyx* occupy the lower water column and *Garra mullya* are considered to be bottom inhabitants.

The present investigations of Fish Assemblages in Achenkovil river reveal that habitat separation is more common than dietary separation, which in turn more common than temporal separation. This is in agreement with the studies of Shoener (1974), in temperate rivers.

Microhabitat partitioning was observed as an important component of co-existence in lotic fishes. As the resource partitioning plays an important factor determining the organization of species assemblage, the species must ultimately segregate along more resource dimension and slow decrease in niche breadth to maintain a minimum level of niche separation when no change in resource dimension is noticed as species numbers increases. The results support the fact that resource partitioning occurs along more axes in diverse assemblages and that it would be more important in structuring the fish assemblages in a lotic ecosystem. Thus it can be concluded that the fish assemblage among six stations does not show noticeable consistency across seasons, despite, the species level heterogeneity among station, and the assemblages pattern across the stations were usually similar within a given month.
Table IV. HABITAT PREFERENCE OF FISH SPECIES OBSERVED AT A SPECIFIC LOCATION OF THE RIVER
(All the data are expressed in relative scale as given in Table III2)

<table>
<thead>
<tr>
<th>Preference to microhabitat</th>
<th>Barilius backeri</th>
<th>Danio aequipinnata</th>
<th>Etheostoma maculatum</th>
<th>Garra miliya</th>
<th>Puntius amphibius</th>
<th>Puntius curmuca</th>
<th>Puntius filamentosus</th>
<th>Puntius melanampyx</th>
<th>Rasbora daniconius</th>
<th>Salmastoma boopis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position in water column</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Canopy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Depth</td>
<td>2,3</td>
<td>2,3,4</td>
<td>3,4,5</td>
<td>1,2</td>
<td>3,4</td>
<td>3,4,5</td>
<td>4,5</td>
<td>1,2</td>
<td>3,4,5</td>
<td>4,5</td>
</tr>
<tr>
<td>Current</td>
<td>4,5</td>
<td>4,5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2,3</td>
<td>1</td>
<td>2,3</td>
<td>3,4</td>
</tr>
<tr>
<td>Substrate</td>
<td>2,3</td>
<td>1,2</td>
<td>1,2</td>
<td>4,5,9</td>
<td>2,6,8</td>
<td>2,3</td>
<td>1,2,6</td>
<td>7,8</td>
<td>1,2,6</td>
<td>1,6</td>
</tr>
</tbody>
</table>
Table IV.2. SEASONAL HABITAT DIVERSITY AT DIFFERENT STATIONS ALONG ACHENKOVII RIVER
(Data are expressed in relative scale as given in Table III.2)

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Station</th>
<th>Depth</th>
<th>Current</th>
<th>Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-MONSOON</td>
<td>I</td>
<td>1,2</td>
<td>1,2</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>2</td>
<td>2,3</td>
<td>2,3</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>3</td>
<td>3</td>
<td>2,6,8</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>3,4</td>
<td>3</td>
<td>2,6,8</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>4</td>
<td>2</td>
<td>2,6</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>4</td>
<td>1</td>
<td>2,6</td>
</tr>
<tr>
<td>MONSOON</td>
<td>I</td>
<td>4</td>
<td>4,5</td>
<td>2,4,5</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>4</td>
<td>3,4,5</td>
<td>1,3,4</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>4</td>
<td>4</td>
<td>1,2</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>4</td>
<td>3</td>
<td>1,6</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>4</td>
<td>2</td>
<td>1,6</td>
</tr>
<tr>
<td>POST-MONSOON</td>
<td>I</td>
<td>2,3,4</td>
<td>1</td>
<td>2,3,4,5</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>3,4</td>
<td>1,2</td>
<td>2,3</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>3,4</td>
<td>2</td>
<td>2,7,8</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>3,4</td>
<td>3</td>
<td>2,7,8</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>4</td>
<td>3</td>
<td>2,6</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>4</td>
<td>1</td>
<td>2,6</td>
</tr>
</tbody>
</table>
Fig. IV.1. % composition of microhabitat (depth)

Habitat type I

Habitat type II

Habitat type III

Habitat type IV

Habitat type V

Habitat type VI
Fig. IV.2. % composition of microhabitat (current)
Fig.IV.3. % composition of microhabitat (substrate)

Habitat type I
- Boulder: 60%
- Gravel: 10%
- Rubble: 20%
- Sand: 10%
- Vegetation: 0%

Habitat type II
- Boulder: 10%
- Rubble: 30%
- Gravel: 50%
- Sand: 10%

Habitat type III
- Gravel: 30%
- Rubble: 30%
- Sand: 30%
- Vegetation: 2%

Habitat type IV
- Sand: 46%
- Gravel: 30%
- Rubble: 5%
- Miscellaneous: 5%
- Litter: 5%
- Vegetation: 10%

Habitat type V
- Silt: 30%
- Sand: 45%
- Gravel: 10%
- Vegetation: 10%

Habitat type VI
- Silt: 75%
- Sand: 20%
- Miscellaneous: 5%
- Litter: 5%