Chapter 10

FISHES OF RAIN FOREST STREAMS/RIVERS OF INDIA A RESEARCH OVERVIEW

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Introduction

Fishes are important as they indicate the ecological processes and the producer-consumer interactions. Fish can be used for ecological assessments at all levels of biological organization; assessment procedures are available at the levels of ecosystems, populations, individuals, organs and at the cellular and molecular levels (Harris, 1995). Fish can also be used as indicators over a temporal ranges varying from minutes to decades and spatially from a local scale measured in metres to entire river catchments (Karr, 1991) over thousand kilometers because fish species exhibit diverse morphological, ecological and behavioural adaptations to their natural habitats. Fishes are the intagral components of stream/river systems andn represent a visible measure of stream ecosystem structure and function. Fish assembledge structure and function are also associated with geographic variation and the understanding the pattern is crucial for effective assessment and monitoring of streams/ rivers.

Review of Research

Terrestrial environment has a major impact on drainage basins and stream channels. Patterns of habitat heterogeneity may change due to temporal and spatial changes. Anthropogenic landscape disturbances such as deforestation, row crop agriculture and grazing, shift the structural and functional relationships between the landscape elements and the stability of the physical environment. For small streams, agriculture, deforestation and grazing alter structural relationships among physical components of the streams by either reducing the amount of woody debris entering into the stream and hence the depth, substrates and velocity associated with development (Bisson, *et al.*, 1982; Marzelf, 1978) or by directly removing spatial habitat complexity by channelization. In either case land use activities reduce the (terrestrial to aquatic) allochthonous energy transfers while increasing the instream (autohthonous) energy production (Gregary *et al.*, 1991). This shift from allochthonous to authochthonous energy sources is particularly important to fish in headwater streams as most of the tropical stream fishes rely on allochthonous food sources.

In large rivers, the impact of land-use activities on the structural heterogeneity relies mostly on its floodplains. Construction of flood control structure, removal of large woody debris, closing off of side streams and cleansing of riparian forests disconnects the floodplains from the main channel and decreases the length of lateral boundary between the terrestrial and aquatic environment (Sedell and Forgatt, 1984). As various life stages and species of stream fish require different kinds of physical habitats, spatial heterogeneity and the maintenance of connectivity between habitat patches is critical for the reproduction and survival of fish in lotic ecosystems (Schlosser, 1991). The terrestrial aquatic interface in upstream areas or at the stream margin and flood plain in downstreams allow habitat which are the key factors influencing the population and community dynamics of stream fish.

In the light of the above patterns stream fish ecologists started to focus on establishing relationship between habitat heterogeneity and critical biological processes of population and community dynamics of lotic fishes.

Environmental variability in streams, especially habitat features, has been recognized as determining factors of distribution and abundance pattern for fishes. This aspect has been documented extensively during 1980s throughout the world (Angermeier, 1987; Mahon and Port, 1985; Schlosser, 1982, 1987; Lobb and Orth, 1991; Pringle *et al.,* 1988; Baker and Ross, 1981, Matthews and Hill, 1980; Angermeier and Karr, 1984; Hugueny, 1989; Eadie *et al.,* 1986; Rohm *et al.,* 1987; Matthews and Robinson, 1988; Hughes *et al.,* 1986; Pflieger *et al.,* 1981; Larsen *et al.,* 1986; Whittier *et al.,* 1988; Baecher *et al.,* 1988; Mahon, 1984; Jackson and Harvey, 1989; Coon, 1987; Meffe, 1984; Pusey *et al.,* 1993).

Longitudinal changes in streams between headwater to lower reaches or stream order in relation to fish distribution and assemblages pattern (Matthews, 1986; Osborne and Wiley, 1992; Paller, 1994) have led to the development of lotic paradigms that increase in fish species richness with increasing drainage area. This pattern has been followed across a wide range of latitudes (Lake, 1982; Welcomme, 1985 ; Angermeier and Schlosser, 1989 ; Osborne and Wiley, 1992 ; Beacher *et al.* 1988). Resource use in terms of habitat (Smart and Gee, 1979 ; Hem 1987. Greenberg 1991 ; Barn *et al.* 1988 ; Jowette and Duncan, 1990 ; Fausch and Bramblatt, 1991; Poff and Allan, 1995; Kinzie 1988 ; Pusey *et al.*, 1993), food (Wynes and Wissing, 1982 ; Poff and Allan, 1993 and 1995; Miller, 1983), habitat segregation for depth (Fisher and Pearson, 1987), current (Matthews *et al.* 1982; Gido *et al.,* 2000) and substrate particle size (Mathesan and Brooks, 1983) have been studied in details. Increased siltation in streams and its impact on fish communities have been studied in Central United States (Judy *et al.* 1984; Derkman and Rabeni, 1987). Fish assemblages have been used in detecting anthropogenic impacts (Loeb, 1994 ; Davis and Simon, 1995) and the use of fish communities in surface water assessment was proposed by Karr (1981) in what he termed as Index of Biotic Integrity (IBI). This has been widely used in mid western streams of United States (Karr *et al.* 1986 ; Miller *et al.* 1988 ; Fausch *et al.* 1990 ; Karr, 1991; Hall *et al.,* 1996). Legislative mandate has been specified to protect biological integrity in U.S. Clean Water Act and Canada's National Park Act (Angermeier and Karr, 1994), though there is no mandate in United States to protect biological diversity. But such protection has already been endorsed by many nations as it forms a central goal of 1992 Earth summit.

Tropical diversity of African freshwater species has been dealt in detail (Levaque, 1997) on the diversity and variability, species diversity and evolution, growth and feeding behaviour, reproductive strategies and life history studies, response to environmental constraints, dynamics of fish assemblages and conservation of fish diversity. Studies on tropical Asian rivers are scanty and the only data that are fairly good (and that is only true for some rivers) are fisheries statistics; however they are at

best only a crude estimate of the totality of conditions in a large water body (Hynes, 1989). Extensive studies on freshwater fishes in India are available, but most of them are either concerned with taxonomy (Datta Munshi and Srivastava, 1988 ; Talwar and Jhingran 1991, Menon 1999. Jeyaram, 1999) or with capture fisheries or aquaculture. Much of the published information has been summarized by Jhingran (1992) with extensive bibliography. Studies on fish assemblage structure and their food and habitat requirements in Indian streams are lacking though few initiatives started in the 1980's in Western Ghat streams (Arunachalam *et al.* 1988, 1997 a,b and c; Arunachalam, 2000). Himalayan streams (Edds, 1993) and Sri Lankan streams and reservoirs (Moyle and Senanayake, 1984 ; Wickramanayake and Moyle, 1989 ; Wickramanayake, 1990 ; Piet, 1998; Piet et al. 1999).

In order to manage populations of lakes and streams, geographic framework has been settled for biological criteria (Hughes *et al.* 1994) and this has been widely used for fish assemblage data (Pflieger *et al.* 1981). This eco-region concept has been evolved for evaluating the fish assemblages in catchments, drainage basins and physiographic regions to form icthyogeographic regions. This has been developed widely in United States recentlyfor fish assemblages (Mc Cormick *et al.* 2000; Larsen *et al.* 1986 ; Oswood *et al.*, 2000 VanSickle and Hughes 2000; Schrank *et al.* 2001).

Currently, extensive fish list with few details on abundance but with no habitat feature are available for streams and rivers in Western Ghats (Rao, 1977; Jayaram, 1981; Indra and Remadevi, 1981; Rema Devi and Indra, 1981; Rema Devi and Indra, 1984; Menon, 1984; Rema Devi and Indra, 1986; Ramakrishniah, 1986; Manimekalan, 1998; Kadar, 1989; Kurup and Kuriakose, 1991; Jayaram, 199la and b; Rema Devi and Menon, 1992; Kurup, 1992; Menon and Rema Devi, 1993; Pethiyagoda and Kottelat, 1994; Kurup, 1994; Rema Devi and Menon, 1994; Rema Devi and Menon, 1995; Menon and Rema Devi, 1995; Shaji and Easa, 1995a, b and c; Shaji *et al.*, 1995; Menon and Jacob, 1996; Jeyaram, 1997; Arun *et al.*, 1996; Arun, 1997; Vairavel *et al.*, 1998; Gopi and Radhakrishnan, 1998; Shaji *et al.* 1998; Anmachalam and Sankaranarayanan, 1999; Biju *et al.*, 1999; Raju Thomas *et al.*, 1999; Ajithkumar *et al.* 1999; Jeyaraj *et al.*, 1999; Zacharias and Minimol, 1999; Jayaram and Dhas, 2000; Chhapgar and Manakadam, 2000; Shaji and Easa, 2001; Gopi, 2001) and Eastern Himalayas (Dey, 1975; Dutta and Sen, 1977; Choudary and Sen, 1977; Sen and Choudary, 1977; Sen, 1997; Yazdani, 1977; Yazdani and Rao, 1978; Chadhury, 1978; Ghosh, 1979; Ghosh and Lipton, 1982; Khuda Buksh, 1980; Khuda Buksh and Barat, 1987; Chadhury, 1981; Dutta and Barman, 1984; Viswanath and Sarojnalini 1988; Dutta and Barman, 1985; Sen, 1985; Edds, 1986; Viswanath *et al.*, 1987; Chanda, 1989; Sinha, 1991; Viswanath, 1993; Agarwala, 1994; Yadava and Chandra, 1994; Sen, 1995; Sen and Biswas, 1994; Sen, 1995; Paalab and Chowdhary, 1997; Bhattachariya *et al.*, 1998; Selim and Viswanath, 1998; Viswanath *et al.*, 1998a and b; Sen, 1998a and b; Viswanath and Kosygin 1999 and 2000; Bhowmik and Ayyappan, 2000; Arunkumar and Thombi Singh, 2000; Singht, 2000). Also unpublished reports are available on fish list (Menon, 1992), fish habitat features (Haniffa and

Arunachalam.1999, Arunachalam, 1999, 2000) and food and habitat requirements in the form of Ph.D., thesis (Sankaranarayanan, 1999 ; Antony Johnson, 1999 ; Manimekalan, 2000; Soranam, 2000). Ecology of mahseer (Shrestha, 1997) especially on the habitats, migration, life history, rehabilitation, conservation management and ranching has been studied in detail in the rivers of Nepal. Currently the National Bureau of Fish Genetic Resources, Lucknow has initiated a major research programme on the habitat inventory and germplasm conservation in Western Ghats and Eastern Himalayas with 13 co-operating centres of which the senior author (M.A.) is a major collaborator for Western Ghats.

Conservation Status

Freshwater fishes are the most diverse group of India's vertebrates with a minimum of 600 species (Talwar and Jhingran, 1991). Conservation Assessment and Management Plan (CAMP) workshop (Molur and Walker, 1998) assessed the conservation status of 327 species and nearly 100 more species have not been assessed to date. Since then 10 numbers are recently discovered from Western Ghat and Eastern Himalayas streams/rivers. Based on the recent conservation assessment, 88 species in Western Ghat streams and 82 species in Eastern Himalayas are in threatened category. Of the threatened species nearly 25-30% are highly endemic to their geographic realms. Habitat alterations and degradation, hydrological alterations, introduction of alien/ exotics into reservoirs and over exploitation are the major threats to the rain forest streams of India.

Conservation Approaches

Conservation of all ecological elements at gene, species and ecosystem levels are necessary and current conservation policy is not adequate for protecting ecological elements in a large spatial scale like landscapes. Conservation of fish assemblages are necessary and need a framework for classifying fish assemblages because most aquatic assemblages are probably organized by complex combinations through stochastic and deterministic processes.

In order to prioritize the assemblage level conservation, utilitarian and non-utilitarian goods can be developed. Utilitarian values may come from economic goods and non-utilitarian from less tangible benefits but it warrants conservation because it may consist of rare or endemic species. While selecting assemblages many species-poor assemblages may be valuable because of their unusual organization or assemblages of several regionally rare or endemic species may be more valuable than assemblages of many common forms. Habitat restoration and management goal must be directed at the conservation of assemblages. Even when habitat restoration is contemplated, stock transfer could be an important interim measure. Fish conservation attitude has been changed internationally' and several initiatives have come (Williams and Miller, 1990 ; Maitland and Lyie, 1996) with captive breeding and rearing of rare fish. Conservation status of India's freshwater fishes, especially in

rainforest streams in Western Ghats and Eastern Himalayas is poor. Despite the discovery of several new species to date, the rate of increase of pressure on this fauna is high that extinction may be expected even before discovery.

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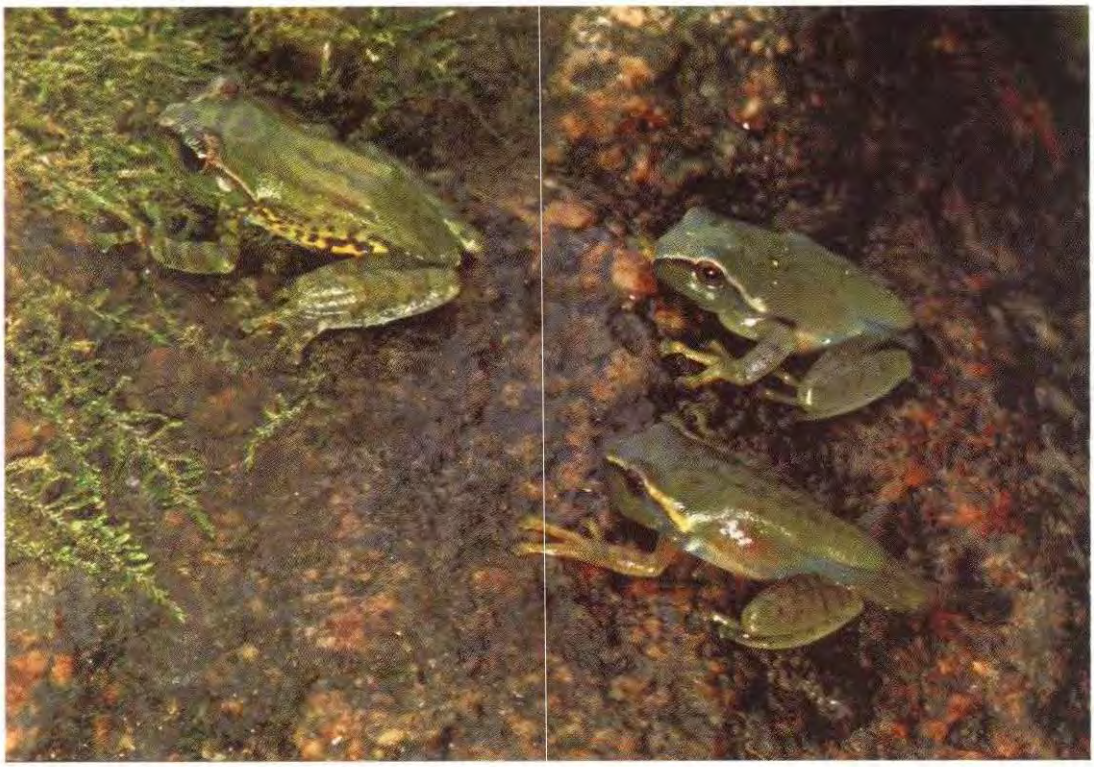
Plate 4



Polypedates pleurostictus (in different developmental stages) : S.U. Saravana Kumar

Hemidactylus anamallensis *: S.U. Saravana Kumar*