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Diet breadth of fish communities in Vamanapuram river, Kerala, South India

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ABSTRACT

An understanding of the feeding habits of fish species in natural environment gives clues for selecting the species for aquaculture. It helps in formulating artificial feeds for culturing species under artificial conditions for small scale or large scale aquaculture. The main objective of the present study was to find the food preferences of fish species in different ecological niches such as low land streams, riverine and estuary. Stomachs were cut, food items removed and stored in 4% formalin. Diet breadth was calculated as per the standard methods widely recommended. The diet breadth calculated for the fish assemblages in Vamanapuram River showed that *Puntius amphibius* has the highest breadth of 6.64. The surface feeding fishes had low diet breadth which ranged from 1.13-1.83. Their main food has been observed to be terrestrial insects. The generalists like *Rasbora daniconius* and *Puntius filamentosus* have diet breadth of 3.27 and 4.15, respectively. Whereas fish species found in estuarine habitats showed diet breadth range from 1.00 to 2.82. The fishes present in the upper regions of the river habitat were observed to have low diet breadth than lowland streams. In general, high diet breadth values were observed during February to May. The breadth of *Barilius bakeri* showed minor variations among the three seasons (1.00 to 1.20). Based on the diet breadth, the majority of the fishes in Vamanapuram River generalists..

INTRODUCTION

The diet breadth of fish species in a community explains the spectrum or range of food items consumed by the fishes. The variations in diet breadth can be used to classify the fishes as specialist and generalist (Saswata Maitr et al., 2019). High breadth shows a generalistic mode of feeding and low values indicate more specialistic nature. In riverine ecosystems, because of the dynamic nature, and with varied habitats the fishes have adaptations to feed on variety of food items. Several studies pertaining to the diet breadth of fish species of different Indian rivers and streams have been carried out (Arunachalam et al., 1988; Arun, 1992; David kingston, 1992; David Kingston et al., 2011). The diet breadth of Srilankan streams, studied

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by Moyle and Senanayake (1984) showed that most of the species had narrow diet breadths. Julio Cesar Sa- Oliveira et al. (2014) studied diet and niche breadth and overlap in fish communities within the area affected by an Amazonian Reservoir in Brazil. Heng et al. (2018) reported the diet breadth and dietary overlap between three commercially important food fishes of Cambodia. In the present study, the diet breadths of different fish species from the riverine stretches of Vamanapuram River, South Kerala, India have been studied in detail.

MATERIALS AND METHOD

Vamanapuram River is one of the major rivers in Kerala with a catchment area of 787 square kilometre located in Thiruvananthapuram and Kollam districts of Kerala state, India. It is found at latitude of 8˚35' 24'' N and 8˚49' 13'' N and longitude of 76˚44' 24'' E and 77˚12' 45'' E. The area is characterized by lateritic uplands with intermittent valleys. The altitude ranged from 40m to 300m. It originates from Ponmudi Hills (1074 m above sea level) flows onwards through Vamanpuram Town, and joins the Kadinamkulam backwater and then enters to the Arabian Sea at Mudalapallipozhi near Perumathura, 25 km north of Thiruvananthapuram city. The climate is typically sub-equatorial with three main seasons, the premonsoon (February- May), monsoon (June - September) and postmonsoon (October - January). The premonsoon and later part of the post-monsoon periods are usually dry (Pisharody, 1987).

Twelve sites were chosen for sampling throughout the Vamanapuram River from the lowlands to mouth of the river. The study sites were selected in different habitats like lowland streams (Habitat I), riverine (Habitat II) and estuary (Habitat III). Among the 12 study sites, seven were lowland streams three riverine and two estuarine stations. For trophic estimates, fishes were collected using monofilament gill nets. Depending on the habitats, depth of water column and availability of fishes, gill nets of varying mesh sizes were used. A uniform effort of 20 minutes was set for all the nets at all habitats during 10 am in the morning. Soon after the net is hauled, fishes were removed and anaesthetized in 50ppm Benzococaine to prevent the regurgitation of food particles. Then the fishes were transferred to 4% formalin for preservation. Large sized fishes were injected with formalin using a hypodermic syringe and then preserved in 4% formalin.

Thirty two (32) fish species representing 17 genera were collected during the study period. Dietary analysis was done on each individual fish. The fish were cut open and guts removed. The contents of the stomach or intestine up to the first bend and if no stomach was present the gut was pressed in a gridded glass slide and examined using dissection microscope. The minute and microscopic items were observed in high power microscopes. The diet breadth was calculated using the formula of Levins (1968):

$$B = 1 / P_{ij},$$

where P_{ij} is the proportion of the food in each category.

RESULTS AND DISCUSSION

Thirty two (32) fish species representing 17 genera were collected during the study period (Table 1). Among the 32 species available in the Vamanapuram river, *Puntius amphibious* (PA)

showed the highest diet breadth of 6.64 (Table 1). This species was observed to be a bottom feeder and it had affinity for a wide range of food items. Another bottom feeder, *Garra mullya* (GM) had a diet breadth of 2.21, whose main food items were small algae and filamentous algae. The morphological adaptation of this species especially mouth structure was more suited for the bottom feeding nature. Other bottom feeding fishes like *Etroplus maculatus* (EM), *Mystus montanus* (MM), *Puntius melanampyx* (PM), *Mystus armatus* (MA), *Puntius ticto* (PT) and *Puntius vittatus* (PV) had diet breadths ranged from 2.78 - 5.31. Of all the bottom feeding fishes *Garra mullya* (GM), *Puntius ticto* (PT) and *Puntius vittatus* (PV) came under category one in which their diet breadths was more or less in the same vicinity. The surface feeding fishes like *Danio aequipinnatus* (DA), *Barilius bakeri* (BB) and *Aplocheilus lineatus* (AL) had diet breadths of 1.83, 1.18 and 1.13 respectively, and they relied more on terrestrial insects as their main food. The generalists fish groups such as *Rasbora daniconius* (RD) and *Puntius filamentosus* (PF) had diet breadths of 3.27 and 4.15 respectively. The estuarine fishes had diet breadth values ranged from 1.00 - 2.82. Out of these, 42.5% had low diet breadth values (< 2.00).

In general, the riverine habitat had low diet breadths than lowland stream habitats. PA showed highest breadth in Habitat-I (6.68) followed by *Mystus montanus* (MM) (5.31) and *Puntius melanampyx* (PM) (5.14). The surface feeders *Danio aequipinnatus* (DA), *Barilius bakeri* (BB) and *Aplocheilus lineatus* (AL) had diet breadths of 2.08, 1.20 and 1.13 respectively. While comparing the breadth values of Habitat-I and Habitat- II, with the exception of *Puntius ticto* (PT) (3.59) and *Labeo dero* (LD) (1.58), all other species in the riverine habitat had low breadth values than lowland stream habitat. In the estuarine habitat, diet breadth values were very low (1.00 - 2.42) indicating the dominance of specialists.

The fish assemblages of Vamanapuram River had wide temporal variations in diet breadth (Figure 1). In general, high breadth values were observed during premonsoon season. The breadth of *Puntius amphibious* (PA) during premonsoon was 6.28, whereas 4.17 during postmonsoon. The increased number of diet breadth was due to the concentration of food materials in place due to reduced water flow during premonsoon months. In species like DA, BB, PS and AL, the breadth values had an increase during monsoon and there was further a reduction during postmonsoon due to increased water flow during monsoon months and reduction of water flow during post monsoon months.

Table -1. Diet breadth of fish species in Vamanapuram River (mean count)

Species	Habitat I	Habitat II	Habitat III	Overall Diet breadth
Puntius amphibious (PA)	6.68	5.80		6.64
Puntius filamentosus (PF)	4.14	3.87		4.15
Danio aequipinnatus (DA)	2.08	1.28		1.83
Rasbora daniconius (RD)	3.33	2.06		3.27
Puntius ticto (PT)	3.52	3.59		3.41
Puntius vittatus (PV)	2.78			2.78
Puntius melanampyx (PM)	5.14			5.14
Garra mullya (GM)	2.44	2.00		2.21
Puntius sarana (PS)	2.54			2.54
Barilius bakeri (BB)	1.20	1.02		1.18
Etroplus maculatus (EM)	4.36	2.44	1.00	4.29
Mystus armatus (MA)	4.83			4.83
Mystus montanus (MM)	5.31			5.31
Amblypharyngodon microlepis (AP)	4.16			4.16
Labeo dero (LD)	1.45	1.58		1.53
Aplocheilus lineatus (AL)	1.13			1.13
Ambassis gymnocephalus (AG)	2.77		1.22	1.62
Gerres oblongus (GO)			1.51	1.51
Stolephorus commersoni (SC)			1.13	1.13
Carangoides malabaricus (CM)			2.42	2.42
Therapon jarbua (TJ)			1.00	1.00
Etroplus suratensis (ES)		2.82		2.82
Hemiramphus xanthopterus (HX)		1.00		1.00
Sillago sihama (SS)			1.00	1.00
Upeneus vittatus (UV)			1.00	1.00
Leiognathus equulus (LE)			1.34	1.34
Johnius aneus (JA)			1.00	1.00
Sphyraeno jello (SJ)			1.00	1.00
Liza tade (LT)			1.22	1.22
Xenentodon cancila (XC)			1.22	1.22
Glossogobius giurus (GG)			1.00	1.00
Channa gachua (CG)			1.00	1.00

Only very few species showed temporal consistency in diet breadth. In BB, the breadth was almost consistent with minor variations (1.00 - 1.31) among the three seasons. The diet breadth of *Gerres oblongus* (GO) varied between 1.00 during premonsoon and 1.47 during post monsoon. During the postmonsoon, when more number of estuarine fishes was caught and the

breadth of most of them was 1.00. Based on the diet breadth, the fishes in Vamanapuram can be classified as specialists (B < 3.00) and generalists (B > 3.00) and out of the 16 species occupying the freshwater region, 7 were specialists and 9, generalists. Out of the 7 specialists, 3 species were specialised to feed on the surface and 4 on bottom. Among the surface feeding specialists, DA was an important member of the community since it contributed to 13.55% of the total fish collected. According to Arunachalam et al. (1988), this species was a typical specialist feeding on the terrestrial insects. *Barilius bakeri* (BB), another specialist had a diet breadth of 1.18 and AL, 1.13.

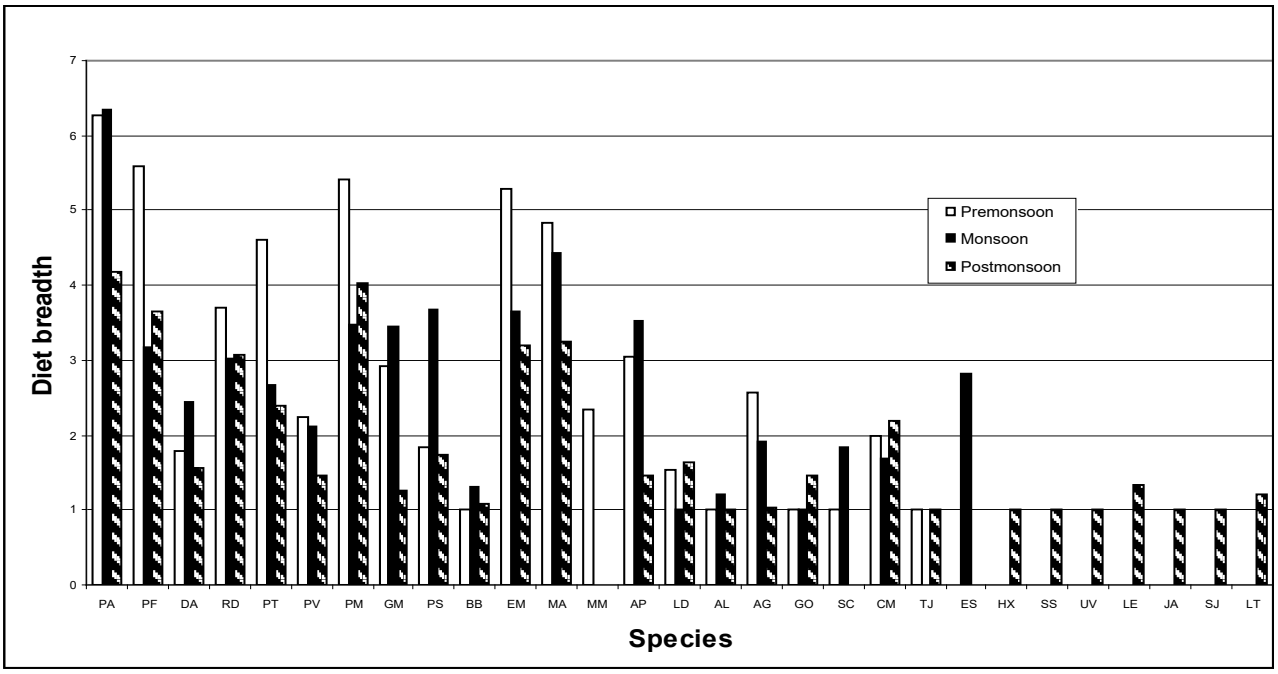

Fig. 1: Seasonal variations in diet breadth of fish species in Vamanapuram River

The bottom specialists were PV (2.78), GM (2.21), *Puntius sarana* (PS) (2.54) and LD (1.53). Among these, PV, GM and PS were herbivores feeding mainly on plant matter whereas LD was a carnivore feeding mainly on chironomid larvae. The important generalists were PA (6.64), PF (4.15), PM (5.14), PT (3.41) and *Amblypharyngodon microlepis* (AP) (4.16). Among these, PT and AP were herbivores. Most of the estuarine fishes were specialists feeding on fish. Temporal variations in diet breadth were noticed in almost all species and in general it was rather high during premonsoon season. According to Welcome (1979), differential prey availabilities, optimal foraging or interspecific competition could explain changes in diet breadth of a fish. The seasonal variations observed in the present study may be due to the differential food availabilities. Arunachalam et al. (1990) reported relatively low densities of invertebrates during the monsoon (wet) season in the stream pools of Kallar River. Various studies show that food availability was low during the dry season i.e. premonsoon in the present study (Zaret and Rand, 1971 and Power, 1983 in Panama; Matthes, 1964 in Zaire). The high diet breadth values observed during premonsoon may be due to the low food

availability of their choice and fishes switched over to other items of food. On the other hand, Moyle and Senanayake (1984) hypothesised that the relative consistency of the environment during dry season enabled the development of autochthonous food. This fact may also be true in the present study for the high diet breadth values noticed during dry season. The breadth of PA during premonsoon and monsoon were found to be 6.28 and 6.35, respectively. The breadth was 4.17 during post monsoon. During post monsoon the fish consumed a major percentage of small algae whereas in other seasons it consumed more of chironomid larvae. Similarly, PF had a diet breadth of 5.59 during premonsoon whereas during monsoon and postmonsoon, it was 3.18 and 3.65 respectively. Similarly, PT, PM and EM also showed relatively high values during premonsoon season.

Comparing the diet breadth values of fish species in different habitats, Habitat -I showed high values. The exceptions were PT and LD. The high segregation of bottom feeding fishes in riverine habitat observed in food overlap studies supports the high specialisations (low breadth values) noticed in this habitat. The interspecific competition may also be responsible for the high diet breadths observed in Habitat- I, since species richness is high in streams and more competition for the available food. *E. maculatus* (EM) had the maximum difference in diet breadth between the habitats (Habitat I - 4.36, Habitat- II - 2.44 and Habitat III – 1.00). It consumed more filamentous algae and littoral vegetation (58% and 23%, respectively) in riverine habitat. In the stream habitat, its food was mainly chironomid larvae (41%). Another fish which displayed much spatial difference in its food spectrum was RD (3.33 and 2.06 in Habitat I and Habitat II, respectively). The difference lies in the fact that the fish consumed a high percentage of terrestrial insects (67%) in the riverine habitat whereas it consumed a lower percentage (45%) of the same in the stream habitat. The streams which have comparatively more canopy cover are supposed to harbour more of terrestrial insects than the river habitat. Moreover, the trend is reverse with this fish in the present study. A similar reverse trend is observed in DA also. Thus the quantity of terrestrial insects available per fish is higher in rivers than in streams which in turn may be a factor for the high consumption of terrestrial insects in rivers.

Conclusion

Vamanapuram River, one of the major rivers of Kerala, is rich in fish species. The diet breadth study undertaken for different fish species of the river showed that the food preference greatly relied on habitat preference and feeding habits of the fish**.** Both specialists and generalists are found in the habitats. In general, the riverine habitat showed low diet breadths than lowland stream habitats. Estuarine fishes showed very low diet breadth indicating the dominance of specialists. *Puntius amphibious* showed the highest diet breadth followed by *Mystus montanus* and *Puntius melanampyx.*

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