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ON THE POPULATION AND BREEDING ASPECTS OF CATFISH IN FRESH WATER WETLANDS OF TAMIL NADU, PENINSULAR INDIA.

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Abstract: Population structure and breeding pattern of a few species of catfish in wetlands from two geographically contrasting regions of peninsular India were studied. Findings of the study show that there is a marked difference in the structure of populations and breeding pattern existed for some species in the two regions. The reason attributes to different climatic factors found in these regions. Apart from this, functional and structural modifications in the anatomy of fish species, its physiological adaptation to the environment also contribute to these differences.

Key words: Distribution, Breeding, Seasonality, Rainfall, Recruitment.

Introduction

Catfishes are an important part of the fish fauna in wetlands and many of them are economically important with high nutritive value. There are about 158 species of inland catfishes from 50 genera and 13 families in India. The Indian families include Bagridae, Siluridae, Schilbeidae, Pangasiidae, Amblycipitidae, Sisoridae, Clariidae, Heteropneustidae, Chacidae, Olyridae, Akysidae, Ariidae and Plotosidae (Talwar and Jhingran 1991). Diversity of catfish in India is the highest in Northeastern Hills, Gangetic River System and the Western Ghats (Barman 1994; Thomas et al. 2002). Generally, catfishes dwell in diverse habitats such as upland streams, large river channels and seasonal floodplain lagoons with broad feeding niches that include detritivores, benthic insectivores and piscivores (Winemiller and Winemiller 1996).

Study on the population structure and dynamics is important in understanding the life cycle and conservation of any fish species. Although various studies have been conducted on the taxonomy of catfishes, the ecology of catfishes in India is less known. Studies in India have focused on feeding habits of several species of catfish (Kaliyamurthy and Rao 1970; Ramakrishnaiah 1983-84; Santhanakumar and Job 1983-84; Devi et al. 1992; Yusuf and Majumdar 1993; Raj 2002). Whereas, other aspects have been less well studied except a few conducted by Kumar and Mittal (1993), Mukhopadhyay et al. (1994).

In Tamil Nadu, some studies have been conducted on the feeding ecology of catfish **(**Kaliyamurthy and Rao 1970; Santhanakumar and Job 1983-84; Raj 2002; Raghunathan et al. 2003). However, study on the population of catfishes is limited, as for the other regions of India.

We conducted this study in two regions of southern India in order to look at the size distribution of catfishes and to understand their breeding season in two geographically varying regions.

Material and Methods

Study area

Geography

The study regions such as Kancheepuram and Kanyakumari are situated in Tamil Nadu State, southern India near two of India's biodiversity hotspots such as the Eastern Ghats and the Western Ghats respectively. Among 22 wetlands studied, 9 lie in Kancheepuram and 13 are in Kanyakumari (Maps 1 & 2, Table 1). Kancheepuram district is located on North East coast of Tamil Nadu, covering about 440 km^2 (Square kilometers) area, between 79°40' to 80°20' East and 12°30' to 13°10' North. Kancheepuram contains many wetlands as being an agricultural district (< kanchi.tn.nic.in >). Kanyakumari district has an area of 167 km^2, which is located on southern most end of the Indian peninsula at about 77°15' to 77°36' E and 8°03' to 8°35' N (< kanyakumari.tn.nic.in >).

Rain

Kancheepuram receives rain mainly from North East monsoon. The rain in coastal areas is normally heavier than inland region (< kanchi.tn.nic.in >). Kanyakumari receives rainfall from both South West and North East monsoons. The mean annual rainfall is higher for Kanyakumari than in Kancheepuram (Figure 1). Hence, wetlands in Kanyakumari retain water through the year due to higher rainfall, whereas in Kancheepuram many wetlands dry up in summer prior to the monsoon.

Flora

Flora of wetlands includes phytoplanktons, micro-algae, (diatoms and other single cellular algae) and macro vegetation. The aquatic macro-vegetation of studied wetlands can be classified into three distinct layers, such as emergent, floating and submerged species. The diversity of aquatic flora especially, floating vegetation in Kanyakumari is comparatively more than in Kancheepuram.

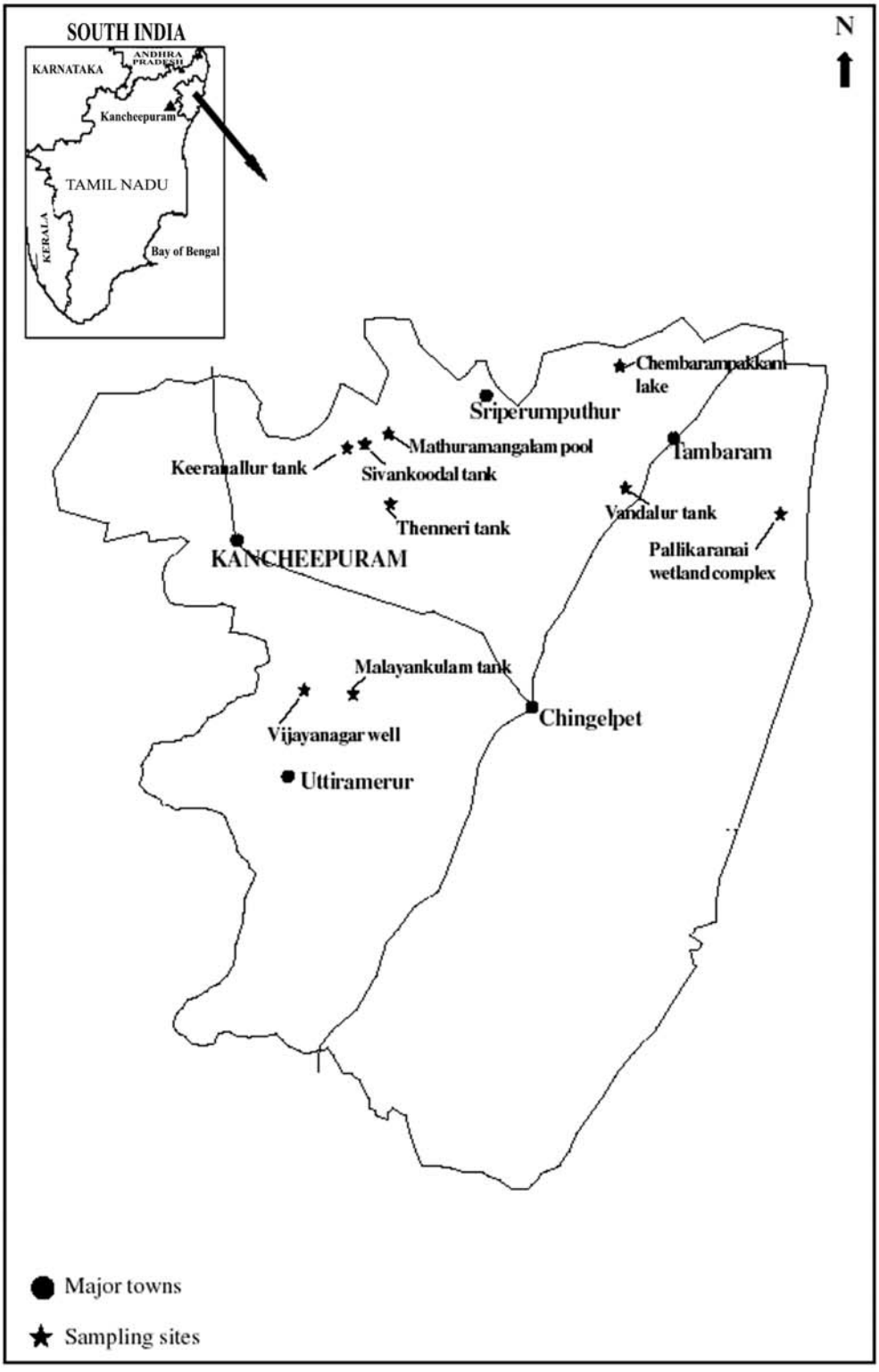
Site selection & wetland description

Sites were selected based on their differences in geography, climate, rainfall pattern and catfish species composition. Kanyakumari is located on the southern most end of the State near the Western Ghats and Kancheepuram is located on the north, near the Eastern Ghats. Although both the districts have a few catfish species in common, they do have their own unique species. Different types of wetlands such as tanks, pools, lake and open wells were selected for study based on the nature of their surface and substrate (open or closed with vegetation), seasonality (seasonal or perennial) and size, based on the findings that different cat fish species prefers diverse habitats. (Kumar and Mittal 1993).

Fish collection, identification and measurement

Fish sampling was executed in between the period of February 2003 and April 2004 in the wetlands of Kancheepuram and Kanyakumari Districts in different seasons. The wetlands were sampled at different sites so that a representative section of all habitats could be covered. Fish were collected with the help of local fishermen using cast and seine nets. Seines were used for tanks and pools with shallow waters (< 2 meters) and cast net was used for tanks and lake with deep waters (>2m). The cast net used was of 4m radius with 0.005m mesh size and two types of seines used were of 70m long 6m wide with 0.01m mesh, and the other was of 5m long 2m wide with 0.003m mesh. In addition, sampling was done during peak summer when fish are harvested by draining out the water from wetlands. Hence, all catfish species of various sizes of each wetland were sampled including juvenile. Different type of nets were used as most of the wetlands had diverse habitats such as open water, covered water with vegetation, sluice etc. Moreover, only one type of net did not seem to be effective to collect all species as some species inhabited only in selected habitats (e.g - *Ompok* was collected only from the temporary pools in Puthery tank and not from main tank even after repeated efforts).

MAP - 1
Map showing the study sites in Kancheepuram District



MAP - 2
Map Showing the study sites in Kanyakumari District

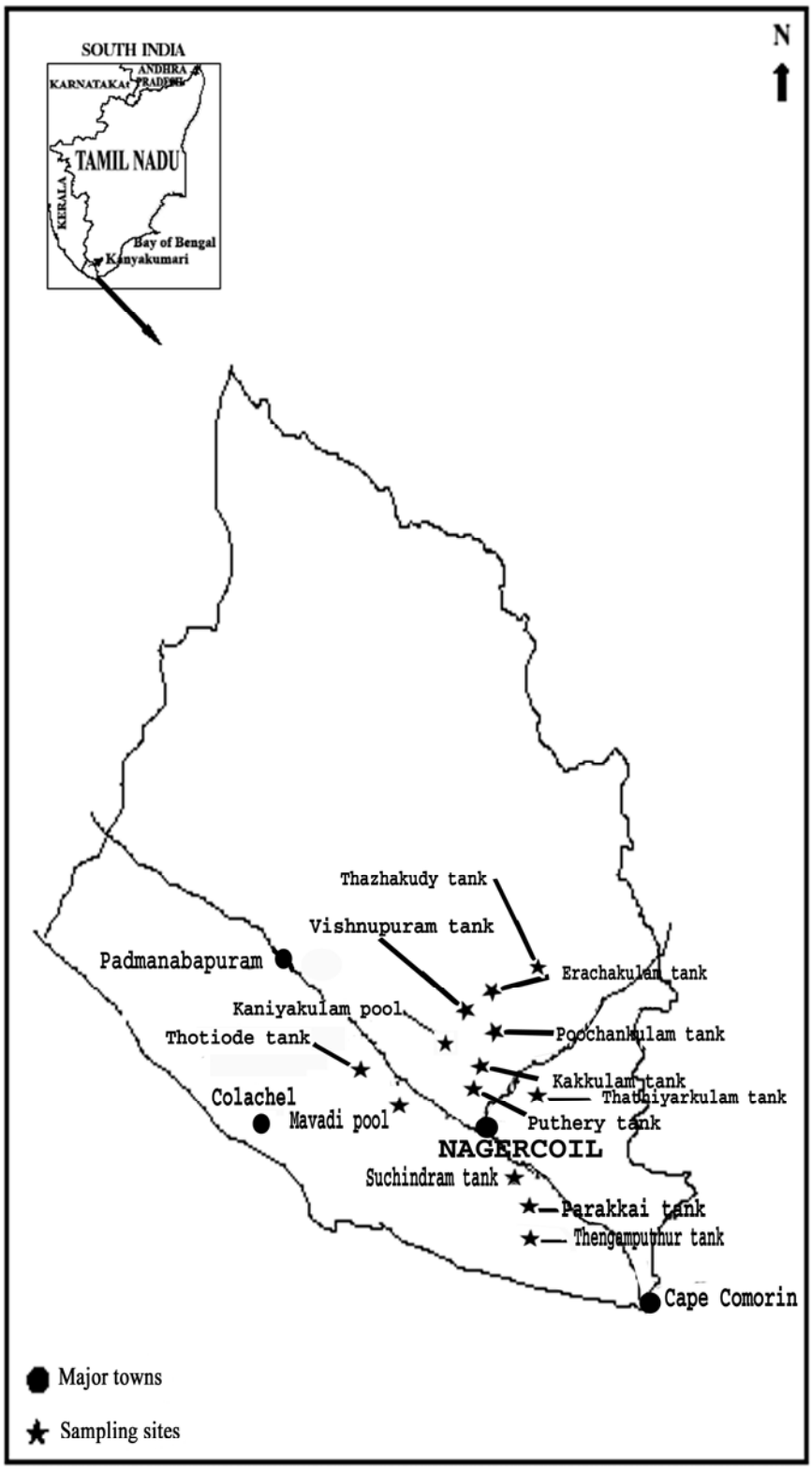
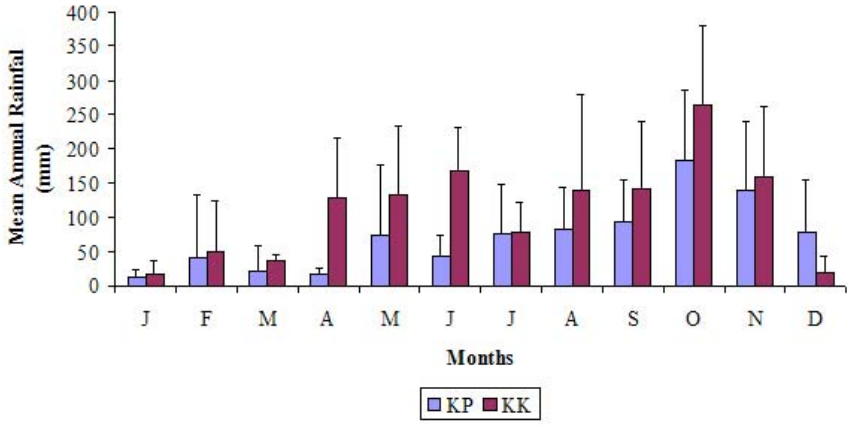


Table 1. List of wetlands and their geographical location with area.

Name of Wetland	**Coordinates**		**Area (ha)**
Kancheepuram District	**Latitude**	**Longitude**	
Chembarampakkam Lake	12°55'- 13°5' N	80° 0'- 80 ° 5' E	35,700
Keeranallur tank	12°55'- 13°0' N	79° 45'- 79°50' E	75
Malayankulam tank	12°40'- 12°45' N	79° 50'- 79°55' E	250
Mathuramangalam pool	12°55'- 13°0' N	79° 45'- 79°50' E	0.1
Pallikaranai Wetland complex	12°55'- 13°0' N	80 °10'- 80 °15' E	594
Sivankoodal tank	12°55'- 13°0' N	79° 45'- 79° 50' E	100
Thenneri tank	12°50'- 12°55' N	79° 50'- 79° 55' E	800
Vandalur tank	12°50'-12 °55' N	80° 0'- 80° 5' E	75
Vijayanagar well	12°40'- 12°45' N	79°45'- 79°50' E	0.025
Kanyakumari District			
Erachakulam tank	8°10'- 8°15' N	77°25'- 77°30' E	100
Kakkulam tank	8°10'- 8°15' N	77°25'- 77°30' E	0.84
Kaniyakulam pool	8°10 - 8°15' N	77°20 - 77° 25' E	0.06
Mavadi pool	8°10 - 8°15' N	77°20 - 77° 25' E	0.5
Parakkai tank	8° 5' - 8°10' N	77 ° 25'- 77 ° 30' E	200
Poochankulam tank	8°10'- 8°15' N	77°25'- 77 °30' E	0.6
Puthery tank	8°10'- 8°15' N	77°25'- 77 °30' E	300
Suchindram tank	8°5'- 8°10' N	77°25'-77° 30' E	50
Thathiyarkulam tank	8°10 - 8°15' N	77° 25'- 77° 30' E	38
Thazhakudy tank	8°10'- 8°15' N	77°25'- 77°30' E	100
Thengamputhur tank	8° 5'- 8°10' N	77° 25'- 77°30' E	250
Thotiode tank	8°10 - 8°15' N	77°20'- 77°25' E	4
Vishnupuram tank	8°10'- 8°15' N	77°25'- 77 °30' E	25

Figure 1. Mean annual rainfall in Kancheepuram and Kanyakumari Districts from 2000 - 2004.



Therefore, use of different nets was mandatory in collecting fish specimen in an effective manner, as there is a possibility of missing of some juveniles and species if large sized mesh nets or one type of net alone would have been used.

Fish sampling effort for cast net depended upon size (small / medium / large) of the wetland studied. As, sampling area covered in this net was comparatively smaller, three / five / ten samples were done according to the size of respective wetland. The duration of sampling effort for large seine was on an average of 5 hours/seine/day and for small seine it was 30 minutes /seine/day.

Various fish species collected from different wetlands were labeled and preserved in 10% formaldehyde solution. Standard taxonomic keys of Day (1989), Talwar and Jhingran (1991), Jayaram (1999), Menon (1999) were used to identify the fish species. Measurements of various body parts of a few individuals of each species were recorded up to the nearest millimeter followed by Biswas (1993), Ng (2004) to confirm the identification. Finally, the specimens identified in lab were also confirmed with Ichthyologists from ZSI (Zoological Survey of India, Southern Circle, Chennai). Morphometric measurements such as the standard length, total length and weight of all individuals were measured using dial calipers, measuring scales and electronic balance.

Morphometric analysis

Individuals of catfish belonging to different species were divided into various size classes based on their total length, from 10-50 mm (Millimeters) to 300-350 mm and plotted in histograms. Comparisons were made for different size classes of fish collected during the same season between two regions and for the same region in two seasons using '$\chi 2$ test'.

Recruitment analysis

Relationship between juvenile recruitment and rainfall were correlated. The rainfall data for study areas were obtained from office of the Department of Statistics of Government of Tamil Nadu in Kancheepuram and Kanyakumari districts respectively.

Results

Population Structure

Size (Length) distribution of catfishes in the study areas

Among the catfish species of Kanyakumari district, *Heteropneustes fossilis* (Bloch 1794) has a broad size distribution (50-350 mm) and *Ompok malabaricus* (Valenciennes 1840) (200-300 mm) has a narrow size distribution. In Kancheepuram, *H. fossilis* has the broad size distribution (50 – 250 mm) as that in Kanyakumari and *Pseudeutropius atherinoides* (Bloch 1794) has a narrow size distribution (50 - 100 mm).

In the present study, species with maximum size were of *H. fossilis* (Total length - 320 mm) and *O. malabaricus* (TL - 265 mm). Species with smaller size were of *Mystus vittatus* (Bloch 1794) (TL - 39 mm), *Mystus armatus* (Day 1865) (TL - 57 mm), *Mystus montanus* (Jerdon 1849) (TL - 72 mm) and *P. atherinoides* (TL - 50 mm).

Size distribution of individuals of regional species in the wetlands of two districts has been illustrated (Figure 2). Among common species of both districts, *H. fossilis* was larger in Kanyakumari than in Kancheepuram. *M. vittatus* was almost in same size in both districts (Figure 3). Regional comparison shows that generally there is a statistically significant difference in the population structure of *H. fossilis* ($\chi 2 = 10.4$, $p < 0.01$) and *M. vittatus* ($\chi 2 = 4.7$, $p < 0.05$).

Comparisons of size distribution of catfish species between dry and wet seasons

Seasonal comparisons between two districts showed that *M. vittatus* from both districts were almost similar in size and small sized individuals were recorded in Kancheepuram during the dry season. *H. fossilis* had many small individuals and wide size ranges especially during the dry season. *P. atherinoides* had similar size ranges during both dry and wet seasons (Figure 4).

In Kanyakumari, *H. fossilis* and *M. armatus* had many small individuals with wide size range particularly during dry season. *M. vittatus* had wide size ranges during the wet season with many smaller individuals (Figure 5).

Comparison on same species in different regions indicated that the size structure is significantly different for *H. fossilis* ($\chi 2 = 16.2$, $p < 0.001$) and *M. vittatus* ($\chi 2 = 6.1$, $p < 0.05$).

Seasonal comparison (between the dry and wet seasons) within region also showed that there is a significant difference in the population structure of *H. fossilis* ($\chi 2 = 38$, $p < 0.0001$) and *M. vittatus* ($\chi 2 = 23.8$, $p < 0.0001$) in Kanyakumari and for *M. vittatus* ($\chi 2 = 79.9$, $P < 0.0001$) in Kancheepuram.

For three species (*H. fossilis*, *M. armatus* and *P. atherinoides*), the smallest size class was recorded during dry season. Although, *M. vittatus* had smallest individuals in the same dry season in Kancheepuram, it was during the wet season in which smallest individuals were recorded for this species in Kanyakumari (Figures 4 & 5).

Juvenile Recruitment and the Rainfall

Simple correlation and test of significance on its values shows that the influence of rainfall over juvenile recruitment is significant for a few species in Kanyakumari during wet season {*H. fossilis* ($r = 0.83$, $p < 0.005$); *M. armatus* ($r = 0.83$, $p < 0.005$) and *M. vittatus* ($r = 0.64$, $p < 0.005$)}.

Discussion

Population Structure

Among species of Kanyakumari district, *H. fossilis* has a broad size distribution and *O. malabaricus* has narrow size distribution, although both grow normally to the same size. In Kancheepuram, *H. fossilis* has broad size distribution as that in Kanyakumari and *P. atherinoides* has narrow size distribution. The reason for narrow range of size distribution of *O. malabaricus* in Kanyakumari attributes to its distinct seasonal breeding behavior that occurs in suitable habitats with favourable environmental parameters. Moreover, the laboratory experiments showed that *Ompok* perished the following day upon

Figure 2. Size distribution of regional Catfish species of Kanyakumari and Kancheepuram Districts.

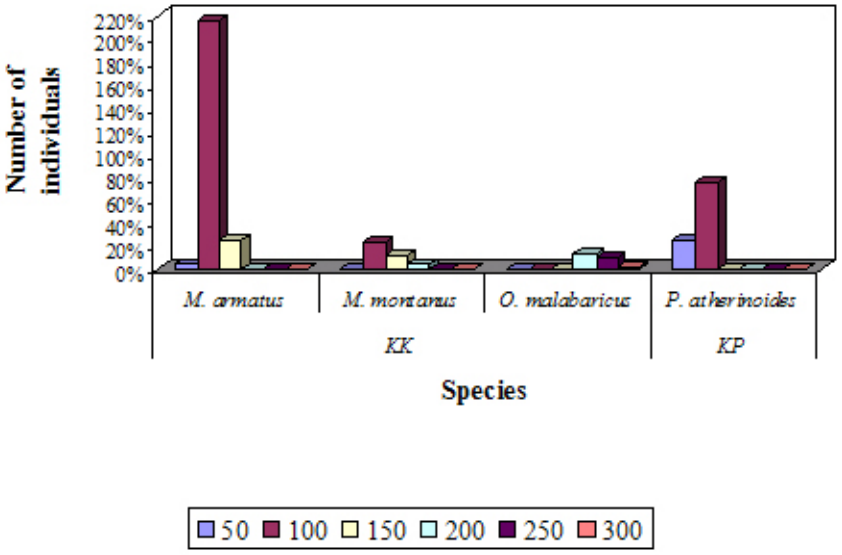


Figure 3. Size distribution of common species found in both districts during dry and wet seasons.

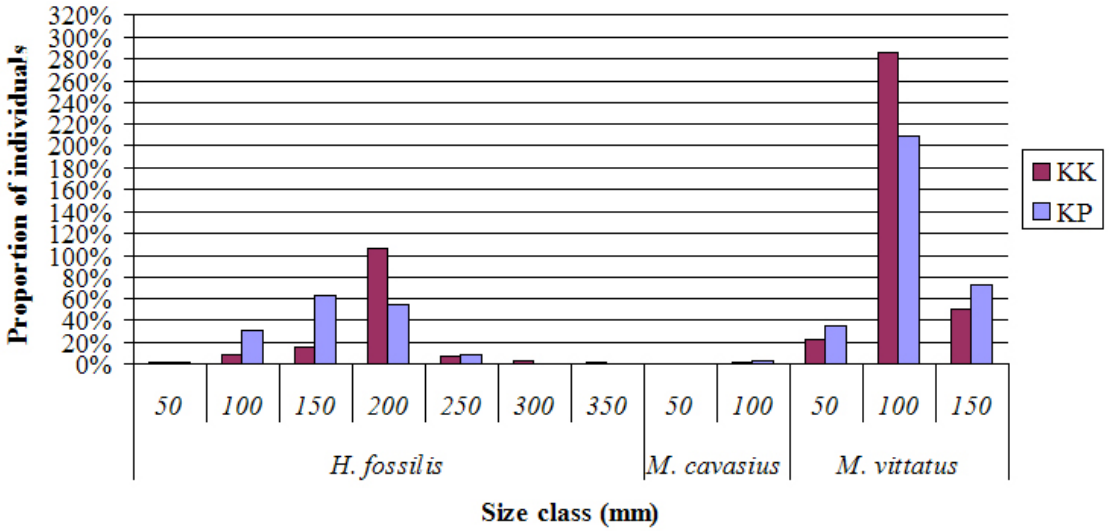


Figure 4. Size distribution of Catfish in Kancheepuram between dry and wet seasons.

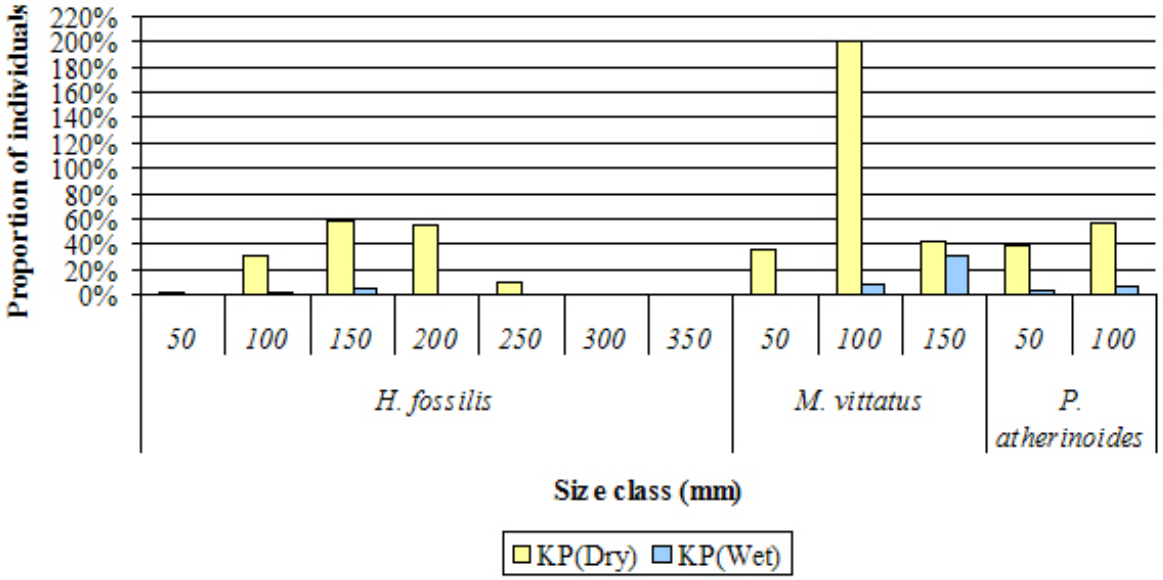
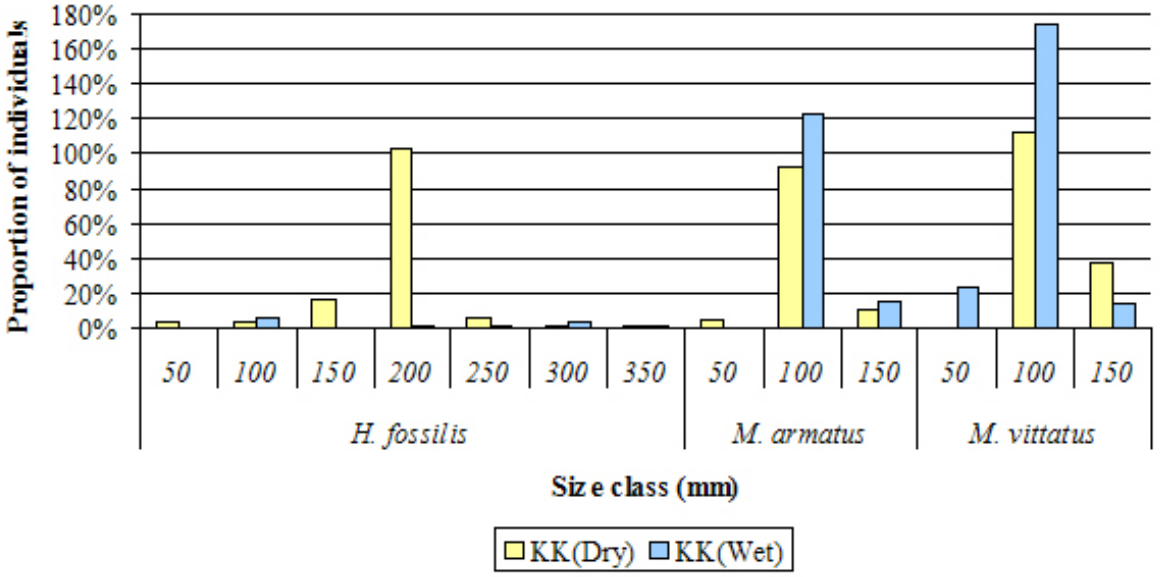


Figure 5. Size distribution of Catfish in Kanyakumari between dry and wet seasons.



its introduction into the aquarium, whereas other species (*Mystus and Heteropneustes*) thrived well for many days. This shows that the turbidity and oxygen content of water are likely to influence the survival and breeding of *O. malabaricus* and hence they have a seasonal pattern of breeding, limited size in population.

The broad size distribution of *H. fossilis* might be due to multi seasonal and aseasonal breeding nature. Hence, all size classes were represented in the sample for this species. Moreover, *H. fossilis* can withstand a wide range of environments, as they are air-breather and a hardy species. Therefore, this has succeeded in multiseasonal breeding. Although, *M. vittatus* could tolerate anoxic conditions to a certain extent in aquaria, its tolerance was comparatively lower than that of *H. fossilis*.

Comparing to size distributions of species shared between the study regions, Kanyakumari has larger individuals than that of Kancheepuram. The reason might be due to favourable environmental factors such as uniform supply of water due to high rainfall, diverse vegetation in wetlands. These factors ultimately support the food abundance for fish in wetlands of former district than latter.

Statistically significant difference obtained in population size structure of a few species (*H. fossilis* and *M. vittatus*) during a particular season (dry) in two regions and different seasons within region might relate to the difference in their breeding seasons.

According to Bhatt (1971), males below 8 cm and females below 8.5 cm of *Mystus vittatus* were immature and males above 8cm and females above 8.5 cm were reproductively mature. In the present study, both mature and immature individuals were seen (0-50, 50-100, 100-150 mm), indicating populations of *M. vittatus*. Accordingly, they are comprised of different generations.

Breeding

Distribution of juveniles of certain species in two different seasons has been used in this study to speculate upon their breeding season. Karamchandani and Motwani (1955), Saxena (1972), Winemiller (1991) have also studied over this hypothesis.

Karamchandani and Motwani (1955), Saxena (1972) have stated that collection of larvae and juveniles of *Rita rita* (Hamilton 1822) from River Ganga during July and August months shows that the breeding season for this species might be from March to August. Comparisons on population size structure and gonad condition of seven common *Serranochromis* species during two different seasons (falling water – May to August and low water – September to December) in the Upper Zambezi River floodplain indicate that these species initiates spawning near the end of low water period (Winemiller, 1991).

Seasonal comparison in the present study on size class distribution shows that *H. fossilis* has smaller individuals (50, 100 mm) during both dry and wet seasons in Kanyakumari, and in Kancheepuram it was during dry season. The pattern of distribution of juveniles of *H. fossilis* in Kanyakumari confirm that breeding season of this species is aseasonal and multiseasonal in this region. Generally, breeding season could be a few months before dry or wet season in Kanyakumari and mostly before dry season in Kancheepuram. The basis for aseasonal reproduction of *H. fossilis* is due to different monsoonal rains such as Southwest and Northeast in Kanyakumari. Rainy season is predominant during April - June (Southwest), August – November (Northeast) in Kanyakumari and September – November (Northeast monsoon) in Kancheepuram.

Chang and Navas (1984) have also found that presence of juveniles in dry season indicated that the spawning season was not so distinct for *Dormitator latifrons* (Richardson 1844) and its reproduction occurred through the year, which resembles the multiseasonal breeding pattern of *H. fossilis* in the present study.

Similarly, breeding season for *M. vittatus* is before the wet period in Kanyakumari, which is from December – March. Whereas,

the breeding season in Kancheepuram, is prior to the dry period, which is during August to December (Northeast monsoon). These results show that *M. vittatus* however found in both regions, its breeding season in these regions is very different. The reason is due to different rainfall patterns found in these districts as already mentioned for *H. fossilis*.

Interestingly, Bhatt (1971) has also found that *M. vittatus* breeds during August – September in Aligarh, as the result of present study obtained for this species in Kancheepuram. The maturity and fecundity of *Rita rita* of Ganga River system was studied by Saxena (1972). He has concluded that the peak period of spawning of *Rita rita* takes place during July to August. Thakur (1978) experimented with the maturity and spawning of *Clarias batrachus* (Linnaeus 1758) collected from wild and found that the species has a very short spawning period during July- August. Study on the breeding behaviour of *Pseudeutropius taakree* (Sykes 1839) in Nagarjunasagar reservoir, Andhra Pradesh shows that the species breeds during June-September (Ramakrishnaiah 1983-84). These findings suggest that the said catfish species including *M. vittatus* breed during northeast monsoon (August – October) in many states of India whichever obtain better rainfall only during this season.

However, scientists from other countries have also reported the dry seasonal reproduction for a few catfish species, as that of the results obtained for *M. vittatus* in Kanyakumari, which is during December – March. Trajano (2003) has found that seasonal reproduction is most common for the subterranean catfish, *Vegitglanis zammaranoi* (Gianferrari, 1923) in Brazil region, which is during dry and hot season (January to March).

Findings of said literature together with results of the present study suggest that a few catfish species seen in regions, which obtain moderately a heavy rainfall in multiple seasons, wait for the rain to get over and start breeding immediately, in other words during the dry period. The reason for such a pattern of breeding season of some species from Brazil region could be due to its proximity to the Amazon forest, which obtains better rainfall in different seasons. Whereas, other species found in regions with particular seasonal and low rainfall has a wet seasonal breeding pattern.

Influence of environmental factors on recruitment

Although, *H. fossilis* and *M. armatus* had juveniles during both wet and dry seasons in Kanyakumari, correlation results suggest that however, they breed during wet period, predominant breeding occurs only during the dry season.

Correlation between rainfall and juvenile recruitment is apparent for a few species (*H. fossilis*, *M. armatus* and *M. vittatus* with 5% significance) during the wet season in Kanyakumari. This result also supports said idea on the breeding season of these species in the region, approximately a few months before North East monsoon (August – December) that is during March – July, in other words during dry season.

Karamchandani and Motwani (1955) have also collected larvae and juveniles of *Rita rita*, a catfish from River Ganga during July and August months which is generally a rainy season in the region. They also concluded that breeding season for this species might be in between March and August. This finding looks similar to the results of present study.

Although, aseasonal reproduction has been observed for *H. fossilis* in Kanyakumari, *M. vittatus* has a seasonal breeding in this region suggesting that rainfall alone does not have an influence over the breeding. Additionally, a few other environmental and / or physiological factors are also involved in determining this.

Kumar and Mittal (1993) have confirmed that being an air breather, *H. fossilis* can withstand widely differing habitats including the low oxygen condition. This adaptation supports the survival and reproduction of this species in different habitats and seasons apart from the rainfall. Singh and Agarwal

(1986) have quoted that rains and floods will change the water quality, and this change may stimulate fish for maturation.

The distribution of juveniles and significant results obtained from correlation analysis strongly support the argument that breeding season of *H. fossilis* and *M. vittatus* in Kanyakumari is during December – March, which is a dry weather period. However, juveniles are recorded for these species during the dry season in Kancheepuram; where correlation results are not significant, indicating that the breeding season of these species in kancheepuram is not so clear.

Conclusion

Results of this study show that patterns of rainfall and breeding apparently influence the population dynamics of some catfish species in these regions. Species with different breeding seasons have a wide range of size distributions and those have a particular breeding season has only a narrow and uniform size distribution. Although, rainfall influences the breeding season of fish, there are several other factors including the physiological adaptations such as air-breathing nature play a vital role together with the rainfall in determining the breeding of fish.

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