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Research Article

Ostracod (CRUSTACEA) biodiversity as pollution indicators in the cauvery river Tiruchirappalli

B. Dharani CHAKRAVARTHY[1], S. BALAMURUGAN[2,*]

[1]P.G. and Research Department of Chemistry, The Gandhigram Rural Institute, Dindigul, Tamil Nadu, 624302, India
[2]P.G. and Research Department of Zoology, Arignar Anna Govt Arts College, Bharathidasan University, Tiruchirappalli, Tamil Nadu, 621211, India

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ABSTRACT

Ostracods are tiny crustaceans found in aquatic habitats and the present paper deals with the role of the water quality index on their population diversity and seasonal fluctuations at the three different sampling stations of Cauvery River, Tiruchirappalli (Tamil Nadu, South India) on a regular biweekly basis from September 2019 to August 2020. The highest level of a hydrological parameter, atmospheric temperature 33.75±0.353°C on April-20 at S-II; water temperature 32.00±0.353°C on June-20 at S-III; pH 8.5±0.106 on December-20 at S-II; DO 8.78±0.155 mg/l on December 20 at S-III; salinity 0.996±0.000 on March at S-I; phosphate 2.38±0.304 mg/l on August 20 at S-III; turbidity 3.8±0.070 NTU on February 20 at S-III; total solids 681.0±7.778 mg/l on May 20 at S-III; total hardness 246.0±4.242 mg/l in September 2029 at S-III and diversity of Ostracods population [533.5±6.71 ind/l] in S-III; [521.5±6.01 ind/l] in S-II and [510.0±2.82 ind/l] in S-I were observed in May 2020. Thus, ostracod aggregations exhibit favorable hydrological conditions and the response offers the possibility of use as pollution indicators for the Cauvery River Tiruchirappalli.

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INTRODUCTION

Clam shrimp, seed shrimp, or ostracoda are small (usually 0.15 mm long)bivalve crustaceans (Crustacea and Ostracoda) that represent one of the important groups of zooplankton and are very common in Indian River ecosystems. Ostracods have important applications in several fields, including paleobiology, biostratigraphy, paleoceanography, paleolimnology, paleoenvironmental analysis and monitoring, and paleoclimatology.As a model group, Ostracoda are very interested in various ecological and evolutionary studies.This is primarily due to the fact that non-marine ostracod valves can be frequently found calcified in lake sediments, which adds a real-time frame to the evolution of ostracod lineages and biological traits. Information about the ecology and biological diversity of aquatic ecosystems in the Cauvery River, Tiruchirappalli, Tamil Nadu, India, is still scarce or limited. The type and abundance of ostracods in any body of water are considered

***Corresponding author.**
*E-mail address: dr.s.balamurugan6@gmail.com

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indicators of productivity. The role of freshwater ostracods in an ecosystem is well-established [1]. Ostracods can be an important component in the diet of aquatic microorganisms [2], serve as ecological indicators [3,4,5], and are good food sources for other fish and other invertebrates [6]. Ostracods play an important role in transferring energy from producer to consumer and occupy an intermediate position in an aquatic food web. Their faunal composition, population density, diversity, and chemical composition of the tank are influenced by natural limits such as temperature, salinity, hydrology, substrate qualities, oxygen, and accessibility of nutritional supplements, but also by the presence of pollutants that artificially alter the water composition [7,8].

Biological indicators are helpful tools for figuring out how polluted a river system is because they respond to sporadic pollution events. Because of the variety of pollutants in our environment, more effective detection techniques have been created to safeguard human health, natural resources, and life on land and in the ocean. The importance of invertebrates in determining how environmental pollutants affect freshwater ecosystems is becoming more apparent [9]. Bioindicators are becoming more popular as a way to track water quality and reconstruct both current and historical environmental conditions. Previous research has suggested that Ostracoda is suitable for these reasons. Ostracoda is useful as an environmental bioindicator to study physical conditions in freshwater environments [4,5,9-17]. Changes in assemblage morphology, chemical makeup, and qualitative composition are used to track Ostracoda environmental changes [15,18] and perform a comparative study on the distribution, abundance, and morphological anomalies of Ostracoda. Occasional zooplankton alternation and diversity provide ideal conditions with the natural enhancement of effluent convergence and exhibit higher diversity as zooplankton thickness plays a role in reuse in the oceanic pecking order [19, 20]. The variety of abundance and seasonal variations of ostracods have a direct relationship to water quality. The diversity of occurrence and seasonal variations of ostracods are directly related to water quality. Ostracods are sensitive to changes in their aquatic environment and are useful indicators of physical and chemical conditions. Also noted is that seasonal variations in water temperature can affect the distribution, lifespan, and abundance of ostracods [21-23]. This study, therefore, has a close connection to water quality. The ostracod fauna of southern India across the Cauvery River is still poorly understood, even though there has been a consistent interest in Indian marine and non-marine ostracods for the past several decades. The objectives of this study are to (1) investigate the relationships between ostracods and selected hydrological parameters through three different water variables; (2) explore the potential utility of ostracods as indicator species; and (3) evaluate ostracod diversity by highlighting three distinct sampling locations in the Cauvery River at Tiruchirappalli, Tamil Nadu, India. This information will make it easier to use ostracodes as a proxy for biological water quality assessment, paleoecology, and paleoclimatology.

MATERIALS AND METHODS

Study Area

Three different stations were chosen on the Cauvery River at Tiruchirappalli (Tamil Nadu, South India) (Fig. 1). Station-I, [UA] Upper Anicut, was a stagnant water body

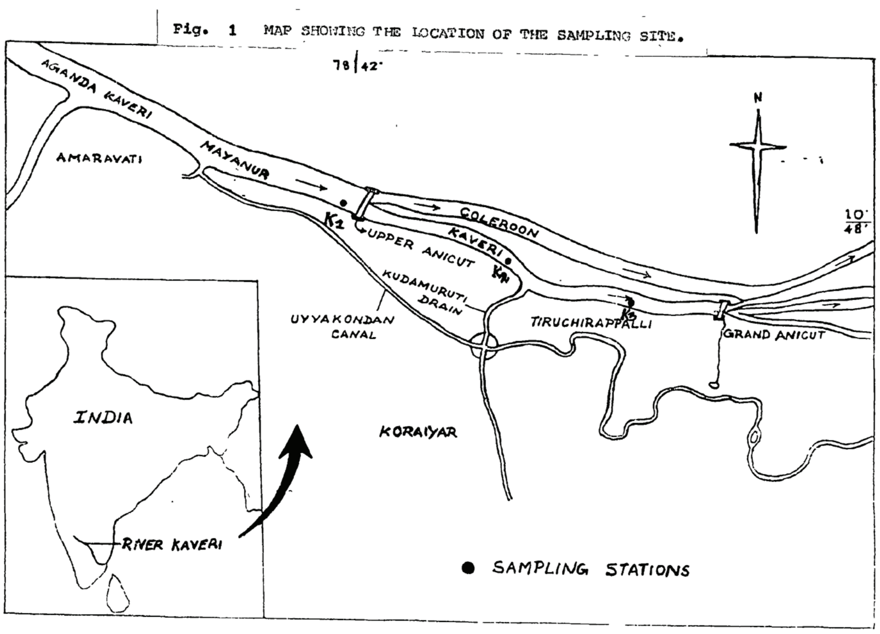

Figure 1. The location of the sampling site.

into which no pollutants were discharged. This station is located on the Trichy-Karur highway, 16 kilometers from Tiruchirappalli. The [K] Kambarasampettai Station, about 6 km downstream of Upper Anicut, contains clean water. From this station, water is pumped to drinking facilities in Tiruchirappalli city. Station-III, [C] Chintamani Road Bridge, is about 8 km downstream of Kambarasampettai. This area receives sewage from the town and other anthropogenic activities. Therefore, this zone is comparatively polluted.

Water Hydrological Parameter Analysis Samples

Atmosphere and surface water temperatures and pH are observed on the spot. The remaining variables are examined using argentometric titration methods [24] and [25], including DO (Winkler's method), salinity, turbidity, total solids, total hardness, and phosphate.

Quantitative Analysis of Ostracods

Ostracods are rarely caught in plankton nets because most of them live on or near the bottom and occasionally swim upward far enough to be netted. Therefore, the plankton nets were kept on or near the bottom of the sand. Regular, fortnightly sampling was carried out for a year (September 2019–September 2020). The samples were collected from the three stations by filtering 50 liters of water using a plankton net (60 μm mesh hand net), and the collected samples were preserved in 5 percent neutral formalin and identified by standard reference [26]. Using a Sedgewick rafter cell counter and a microscope, we conducted a quantitative analysis of the ostracod.

Statistical Analysis

Analyses of collected data were done using Microsoft Analysis Excel 2007 and Origin Pro 6.1 software.

RESULTS AND DISCUSSION

Hydrology of the Stations

Air and surface water temperature

Significant variations ($p<0.05$) in air and water temperatures in S-I, II, and III are found and plotted in Figures 2–3. The highest level of atmospheric temperature, 33.75±0.353°C, was recorded in April-20 (spring) at S-II, and the minimum air temperature, 30.91± 0.412°C, was recorded in January-20 (winter) at S-I, II, and III, respectively. A high level of water temperature of 32.00±0.353°C was recorded on June 20 (summer) at S-III, and a minimum water temperature of 27.25±0.176 °C was recorded on November 2019 (autumn) at S-I. In the present study, maximum air and water temperatures were recorded during the summer season and minimums during the monsoon season. The hydrological qualities of the water vary markedly, indicating different environmental conditions. Water temperature greatly affects all metabolic and physiological activities and life processes of aquatic organisms, such as feeding, reproduction, movement, and distribution. The annual variations in temperature and precipitation in lake environments are less pronounced than those in river environments [27]. This is because these environments are less sensitive to climate, insolation, and depth. Water temperature affects plankton production in the ecosystem [28].

pH and salinity

Significant fluctuations ($p<0.05$) in pH ranged from 7.7 to 8.0; (7.8–8.5) an7.8–8.1.1 inwards I, II, and III, respectively. The highest pH of 8.5±0.106 was found in December 2019 (winter) at S-II, and the minimum was recorded, 7.6±0.106 was found in Feb 20,7.7±0.035in March 20, in Feb 20, at S-I,II,III respectively Figure 4.

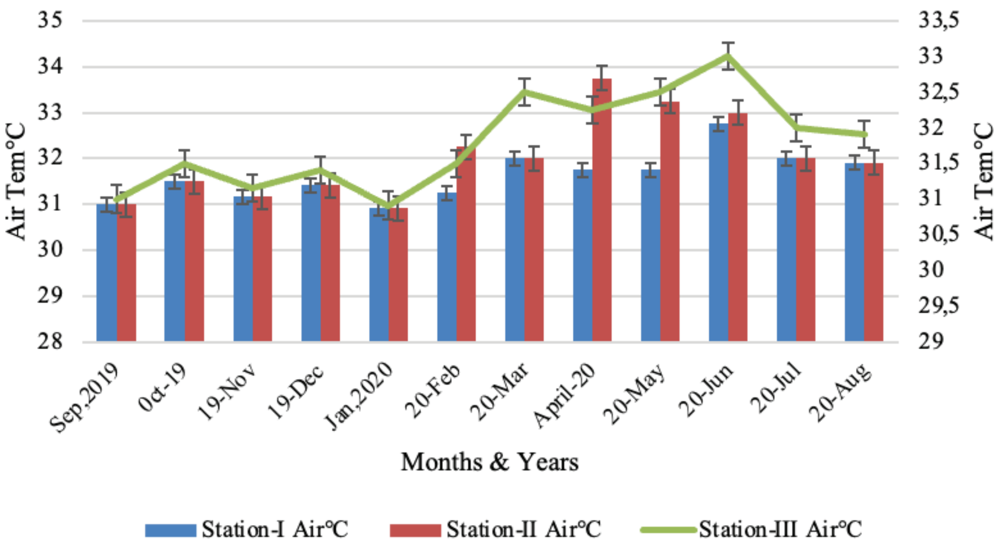

Figure 2. Air temperatures of station-I, II & III.

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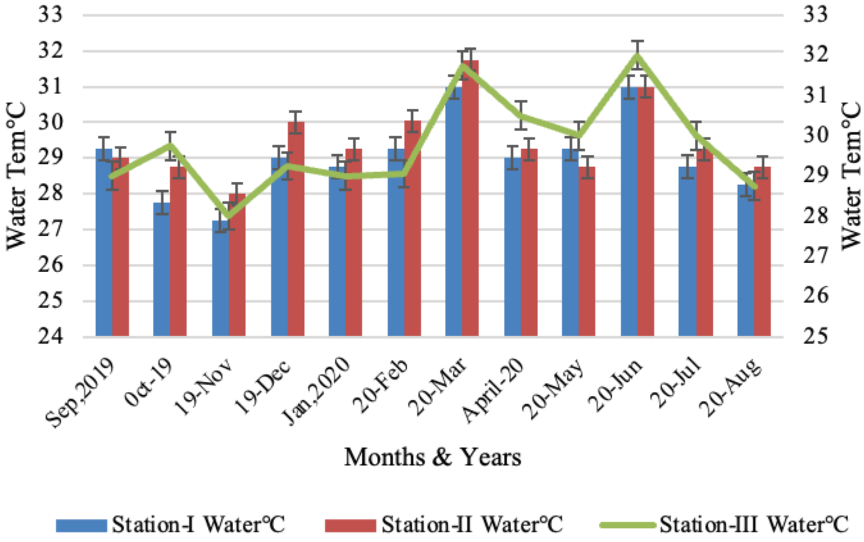

Figure 3. Water temperatures of Station-I, II & III.

Significant fluctuations ($p<0.05$) and a maximum salinity of 0.996±0.000 were found on March 20 (spring) at S-I and a minimum of 0.435±0.060 on August 20 (summer) at S-II Figure 5. A favorable pH of the water environment for the Ostracoda variety was observed in the present results. The pH of the water remained alkaline throughout the study period due to the presence of carbonates and bicarbonates from the alkaline earth metals [29, 30]. The appearance or disappearance of plankton depends on salinity. In the freshwater environment, it exerts a variety of ecological and physiological effects depending on its interaction with temperature, oxygen, and ionic compounds [31]. Variability in salinity was observed throughout the study period. The results showed that salinity is the most important environmental variable controlling the distribution of ostracods in the studied river basins. Because most of the metabolic processes that aquatic organisms engage in are pH dependent, pH has an effect on them. [3,10,17].

Dissolved oxygen (DO) and phosphate

A significant variation ($p<0.05$) and maximum oxygen content were observed in December 2019 (winter) at S-III with 8.78±0.155 mg/l and a minimum of 7.52±0.201 mg/l on April 20 (spring) at S-I Figure 6. Significant fluctuation ($p<0.05$) and maximum phosphate levels were noted 2.38±0.304 mg/l on August 20 (summer) at S-III and a

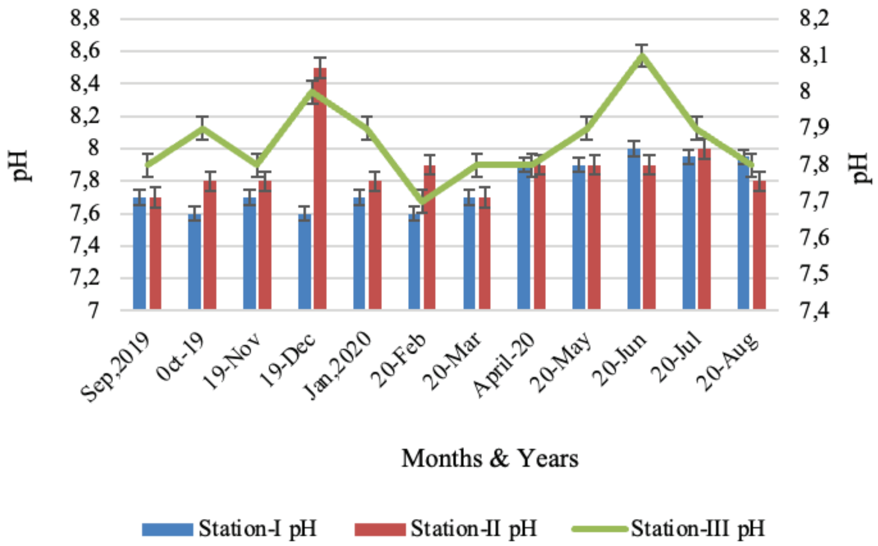

Figure 4. pH of station-I, II & III.

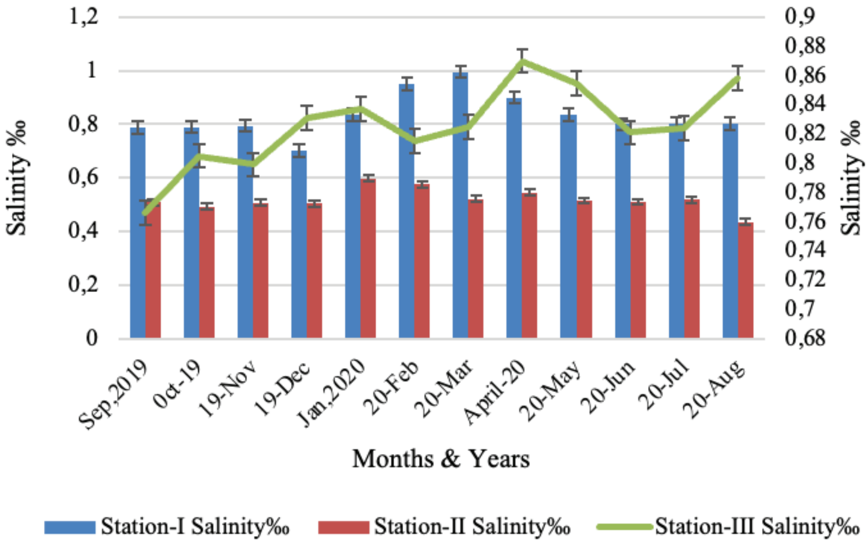

Figure 5. Salinity of station-I, II & III.

minimum of 1.41±0.007 mg/l on January 20 (winter) at S-II Figure 7. DO content is the most critical parameter when assessing water quality and reflects the prevailing physical and biological processes [5,9,15,17,32]. The oxygen content of natural water varies with temperature, turbulence, salinity, the photosynthetic activity of algae and higher plants, and atmospheric pressure. A low content of DO in the present findings indicates that the decomposition of organic matter due to the photosynthetic and respiratory processes of aquatic plants that are more or less busy has accumulated. The oxygen content of natural water varies with temperature, turbulence, salinity, the photosynthetic activity of algae and higher plants, and atmospheric pressure. The maximum phosphate levels observed during the monsoon season may be due to land runoff of nutrients from agricultural fields. The phosphate conditions of the water played an important role in phytoplankton production. Nutrients were found to have an impact on zooplankton density. Those present agreed with [5,9,10,15,17,23,29] who documented that this nutrient is important for the productivity of many aquatic environments.

Turbidity, Total Solid and Total Hardness

Significant fluctuations ($p<0.05$) and maximum turbidity of 3.8±0.070 NTU were observed on February 20 (winter) at S-III and a minimum of 1.55±0.035 NTU was observed

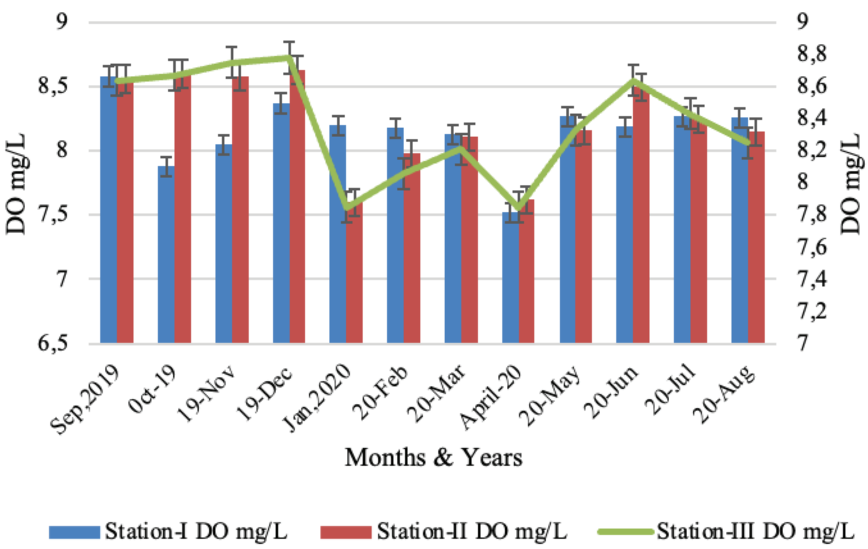

Figure 6. DO of Station-I, II & III.

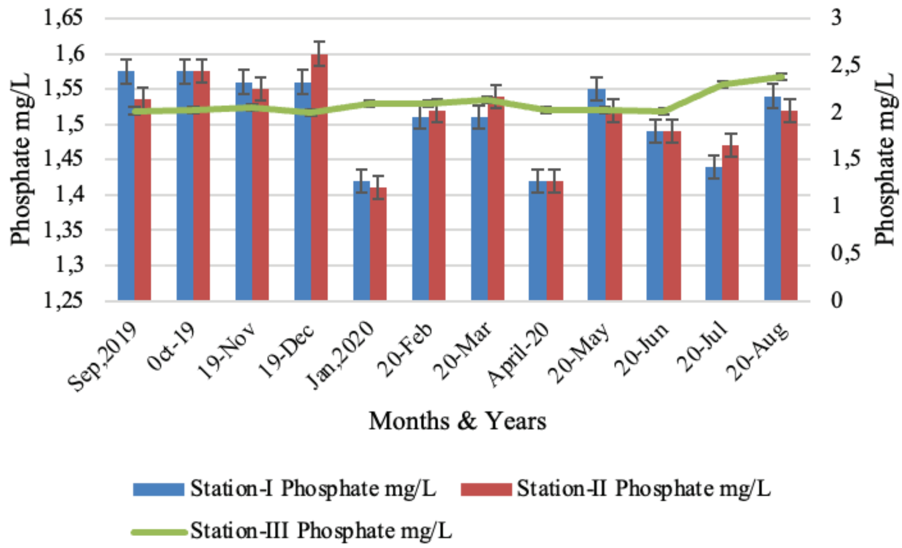

Figure 7. Phosphate of Station-I, II & III.

on January 20 (winter) at S-I Figure 8. Significant fluctuations ($p<0.05$) and maximum total solids were recorded at 681.0±7.778 mg/L on May 20 (Spring) at S-III and a minimum of 325.5±7.474 mg/L on November 2019 (Fall) at S-II Figure 9. A maximum total hardness of 246.0±4.242 mg/L was found in September 2019 (autumn) at S-III and a minimum of 94.50±1.060 mg/L was found in February-2020 (winter) at S-I Significantly ($p<0.05$) Figure 10. The increasing and decreasing degrees of turbidity, total solids, and total hardness correspond to [5,11,15,17,19,33,34] the fluctuations are mainly caused by the addition of solutes and their use by organisms and other aquatic plants and animals during the monsoon and followed by the months after the monsoon. Higher total solids levels during the monsoon season were brought on by incoming surface runoff and drainage, which contained significant amounts of silt, clay, and other material, increasing turbidity and obstructing light from entering the water column. Lower values might result from nutrients being lost in sediments and being used by planktonic organisms and aquatic plants.

Quantitative analysis of Ostracods

The maximum Ostracoda density was observed at 533.5±6.71 ind./L, 521.5±6.01 Ind./L, and 510.0±2.82 ind./L in stations III, II, I, and $p<0.05$ significant respectively in the month of May 2020 (spring) Figure 11 and

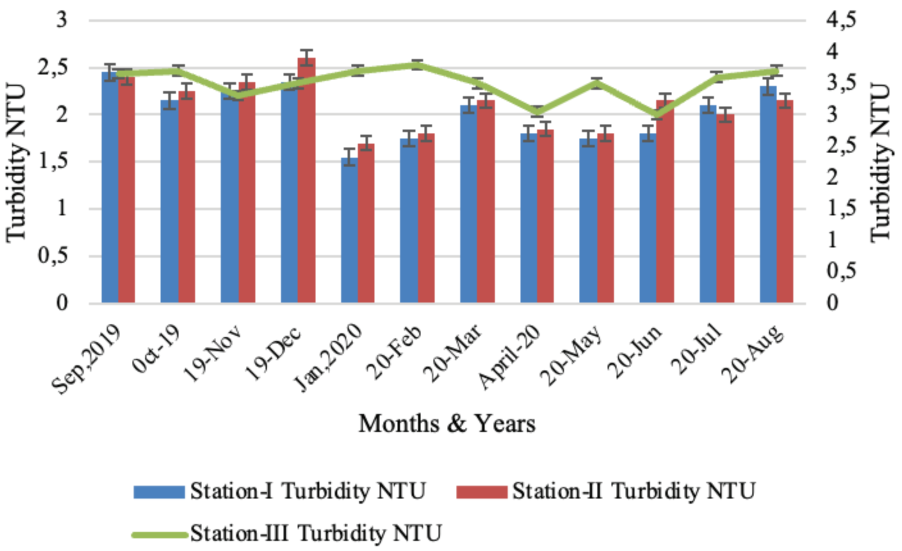

Figure 8. Turbidity of Station-I, II & III.

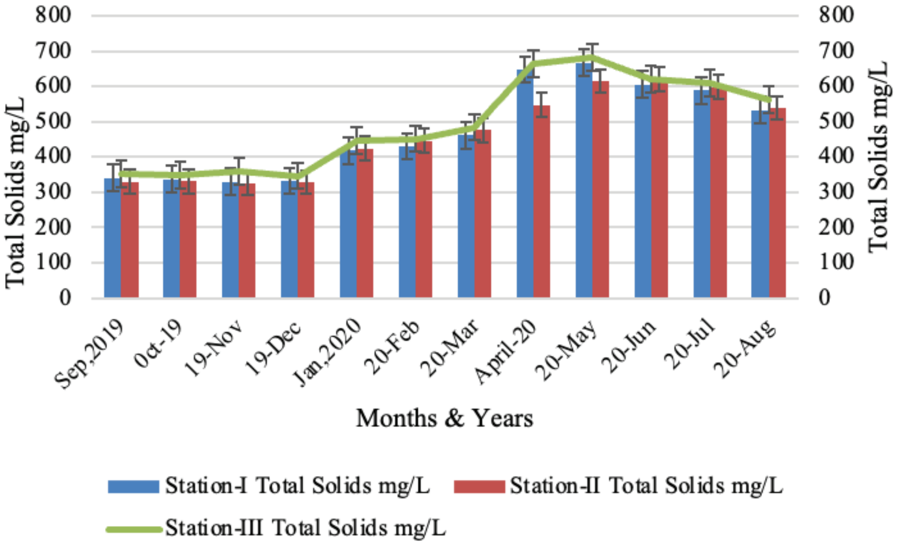

Figure 9. Total solids of station-I, II & III.

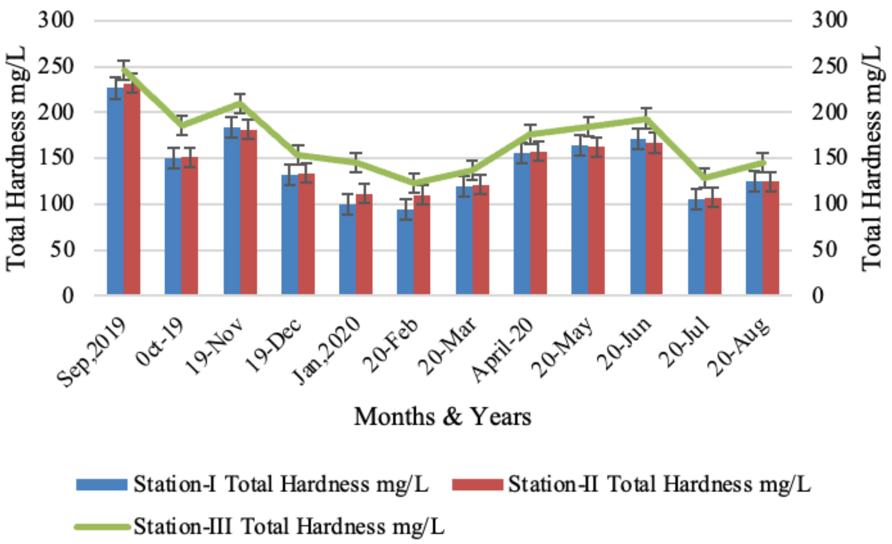

Figure 10. Total hardness of Station-I, II & III.

a minimum density of ostracoda 123.5±1.76 ind/L; 127.0±1.41 ind/L; and 157.0±1.41 ind/L was found significant in October-20 (autumn) at S-I, II, III and $p<0.05$, respectively Figure 11. Ostracod-related zooplankton was recorded in greater abundance in the summer and less in the winter, reaching a peak percentage at all stations in May 2020 Figure 11. The present study demonstrates that environmental factors such as temperature, salinity, dissolved oxygen, turbidity, total solids, and phosphates appear to affect the cumulative dispersal of ostracods. This observation is consistent with those [6,14,19,35-38] that findings such as zooplankton (ostracods) fluctuation are mainly due to environmental changes and emphasizes that temperature and salinity are factors of primary importance, while factors such as the nature of the substrate, depth, shelter, food supply, and predation are secondary. However, these factors are known to control the presence or absence of ostracod species and their abundance at specific stations. The abundance of these organisms provides a portion of very good food for fish, amphibians, and other invertebrates. Due to their benthic nature, it is believed that these ostracods can accumulate toxins to a large extent, while at the same time being primary consumers. They are believed to be important organisms that carry toxins to higher tropical levels [39]. Ostracoda inhabit a variety of environments and are found almost everywhere in all types of freshwater, in lakes,

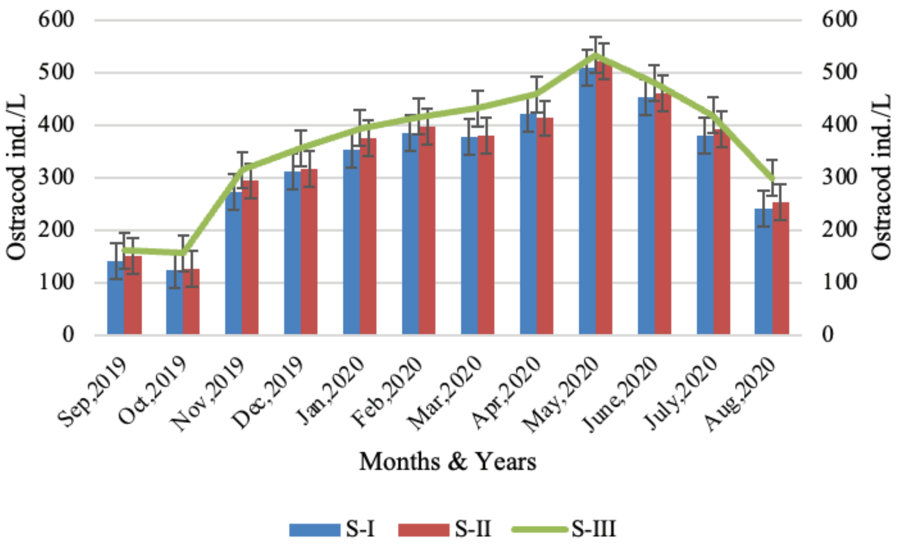

Figure 11. Quantitative analysis of station-I, II & III.

ponds, swamps, streams, and heavily polluted areas [14] etc. They have been reported from the intestinal tracts of fish and amphibians [40].

Station-III maintained higher nutrient levels (phosphate, turbidity, and total solids), and this may be due to the mixing of hospital wastewater and runoff from Tiruchirappalli City. A relatively higher number of ostracods was found at S-III than at S-I and S-II. It is interesting to note that both the water and sediments at Station-III contain higher levels of organic matter, suggesting that ostracods abundance also depends on food availability, as suggested by [5,9,13,15,16,41,42]. Station III offers ideal conditions for organic enrichment due to the inflow of effluent and exhibits higher diversity as the density of the mussel and shrimp population plays a crucial role in the recycling of materials in the aquatic food chain. Therefore, continuous monitoring is essential for the conservation of this river ecosystem. Overall, the results of this study clearly show that we still have very limited ecological knowledge about the habitat preferences of species. We are also aware that our sampling was conducted in the spring, which may limit our ability to draw general conclusions about ostracod habitat preferences. However, our results strongly suggest that ostracods would likely provide better explanations for habitat requirements. Therefore, detailed and extensive field and laboratory studies on the ecology of these species can answer various questions about habitat preferences.

CONCLUSION

According to hydrological parameters and the diversity of Ostracode populations in the Cauvery River at Tiruchirappalli, the river is suitable for aquaculture (fish, shrimp, and crab farming). There are a number of environmental pressures that affect ostracod distribution, either natural or anthropogenic. In stations I and II, the ostracod population was found to be higher in the summer and lower during the monsoon months. Due to the hydrological conditions and the high diversity of the ostracod population in the Cauvery River, ostracods can be used as pollution indicators. Among the three stations, Station I and II are unpolluted, and Station III has the least polluted area. In order to protect the environment, the public is advised to avoid or minimize pollutants such as pesticides, oils, and detergents.

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AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

REFERENCES

[1] Hartmenn G. Asiatiche Ostracoden Systamatische Zoogeographische Untersuchungen. Int Rev Gesamten Hydrobiol Syst Beich 1975;3:1−55.

[2] King CE, Kornicker LS. Ostracoda in Texas Bays and Lagoons: An ecological study. Smithson Contrib Zool 1970;24:1−92. [CrossRef]

[3] Dezfuli BS. Cypria reptans (Crustacea: Ostracoda) as an intermediate host of Neoechinorhynchus rutili (Acanthocephala: Eoacanthocephala) in Italy. J Parasitol 1996;42:503−505. [CrossRef]

[4] Külköylüoğlu O, Vinyard GL. A new bisexual form of Cavernocypris subterranea (Wolf, 1920) (Crustacea, Ostracoda) from Idaho. Great Basin Nat 1998;58:380−385.

[5] Parameswari E, Davamani V, Kalaiarasi R, Ilakiya T, Arulmani S. Utilization of ostracods (Crustacea) as bioindicator for environmental pollutants. Int Res J Pure Appl Chem 2020;21:73−93. [CrossRef]

[6] Balamurugan S, Vishakan R, Subramanian P. Seasonal variation in non-marine ostracod population in Cauvery River, Tiruchirappalli, Tamilnadu, India. J Exp Zool India 2002;5:181−187.

[7] Boomer I, Attwood F. Ostracods as freshwater pollution indicators: a case study from the Ouseburn, a polluted urban catchment (Tyneside, NE England). J Micropalaeontol 2007;26:117−125. [CrossRef]

[8] Boomer I, Eisenhauer G. Ostracod faunas as palaeoenvironmental indicators in marginal marine environments. In: Holmes J, Chivas A, editors. The Ostracoda: Applications in quaternary research. Washington, DC: American Geophysical Union; 2002. p. 135−149. [CrossRef]

[9] Chakrabarti S. A comparative study on the occurrence, density and seasonal variations of Phytoplankton and Zooplankton in a Perennial Pond Ecosystem of Tripura, India. Appl Ecol Environ Sci 2021;9:761−768. [CrossRef]

[10] Külköylüoğlu O. Diversity, distribution and ecology of non-marine Ostracoda (Crustacea) in Turkey: application of pseudorichness and cosmoecious species concepts. Recent Res Dev Ecol 2013;4:1−18.

[11] Manickam N, Saravana Bhavan P, Santhanam P, Muralisankar T, Srinivasan V. Seasonal variations of zooplankton diversity in a perennial reservoir at Thoppaiyar, Dharmapuri District, South India. Austin J Aquac Mar Biol 2014;1:7.

[12] Odum EP. Fundamentals of Ecology. 3rd ed. Philadelphia: WB Saunders Co.; 1971. p. 1−29.

[13] Ramesh K, Rajashekhar AV. Seasonal variation and abundance of zooplankton in Upper Manair Reservoir at Rajanna Sircilla, Telangana State, India. Indian J Ecol 2021;48:558−562.

[14] Strickland JP, Parsons TR. A practical hand book of seawater analysis. Bull Fish Res 1972.

[15] Patra SB. Diversity of Zooplanktonic Community of two wetlands of Kolkata. Int J Adv Life Sci Res 2022;5:18−28. [CrossRef]

[16] Tan CWJ, Gouramanis C, Pham TD, Hoang DQ, Switzer AD. Ostracods as pollution indicators in Lap An Lagoon, central Vietnam. Environ Pollut 2021;278:116762. [CrossRef]

[17] Thilak J, Sakthivel R. Studies on the fresh water Ostracoda from Villupuram, Trichy, Thiruvannamalai, Nilgiri and Chennai Districts of Tamil Nadu, India. Int J Geosci Res 2020;7:1353−1375. [CrossRef]

[18] Carbonel P. Ostracods and the transition between fresh and saline waters. In: De Deckker P, Colin JP, Peypouquet JP, editors. Ostracoda in the Earth sciences. Amsterdam: Elsevier; 1988. p. 157−173.

[19] Balamurugan S, Gulam Mohideen BM, Subramanian P. Biodiversity of zooplankton in Cauvery River at Tiruchirappalli, Tamilnadu. J Aqua Biol 1999;14:21−25.

[20] Balamurugan S, Arivazhagan R, Subramanian P. Seasonal variation of zooplankton population in Ayyampalayam temple tank, Tiruchirappalli, Tamilnadu, India. J Adv Zool 2001;22:52−55.

[21] Kornicker LS, Shon IG. Viability of ostracod eggs digested by fish and effect of digestive fluids on ostracod shell, ecology and paleoecological implications. Bull Centre Rech Pan 1971;5:125−135.

[22] Külköylüoğlu O, Vinyard GL. Distribution and ecology of freshwater Ostracoda (Crustacea) collected from springs of Nevada, Idaho, and Oregon: a preliminary study. West N Am Nat 2000;60:6.

[23] Külköylüoğlu O, Yavuzatmaca M, Akdemir D, Sarı N. Ostracod diversity in Kahramanmaraş (Turkey). Int Rev Hydrobiol 2012;97:247−261. [CrossRef]

[24] APHA. Standard methods for the examination of water and wastewater. 21st ed. Washington, DC: American Public Health Association; 2005.

[25] Sheeba S, Ramanujan N. Qualitative and quantitative study of zooplankton in Ithikkara river, Kerala. Pollut Res 2005;24:119−122

[26] Alfred JRB, Bricice S, Issac MCR, Michaele G, Rajendran M, Royan JP, et al. A guide to the study of freshwater organisms. Supplement-I. Madurai: Madurai University; 1973.

[27] Fakruzzaman M, Zaman M. Preliminary investigation on the physico-chemical characteristics of some ponds in Central Barind regions, Bangladesh. Lima 1996;3:18−22.

[28] Gupta SK, Gupta RC. General and Applied Ichthyology (Fish and Fisheries). New Delhi: S. Chand & Co. Ltd.; 2006. p. 1130.

[29] Lewis WM. Basis for the protection and management of tropical lakes. Lake Reser Res Manag 2000;5:35–48. [CrossRef]

[30] Mahobe H, Mishra P. Study of physico chemical characteristics of water ponds of Rajnandgaon Town, Chhattisgarh. Int J Sci Eng Res 2013;4:738–748.

[31] Mohammed MA, Keyser D, Al-Wosabi MA, Al-Khirbas B, Al-Qadassi WM. Taxonomy and distribution of fresh water Ostracoda from Socotra Island, Yemen. Revue Micropaléontologie. 2014;57:23–33. [CrossRef]

[32] Engel PL, Swain FM. Environmental relationships of Recent ostracodes in Mesquite, Aransas and Copano Bays, Texas Gulf coast. Trans Gulf Coast Assoc Geol Soc 1967;17:408–427.

[33] Manickam N, Saravana Bhavan P, Santhanam P, Chitrarasu P, Jawahar Ali A. Zooplankton diversity in a perennial freshwater lake. In: Desai PV, Roy R, editors. Diversity and Physiological Processes. Goa: Goa University; 2012. p. 25–37.

[34] Oso JA, Fagbuaro O. An assessment of the physico-chemical properties of a tropical reservoir, Southwestern, Nigeria. J Fish Int 2008;3:42–45.

[35] Puri HS, Bonaduce G, Malloy J. Ecology of the Gulf of Naples. Publ Staz Zool Napoli. 1964;33(Suppl):87–199.

[36] Banerjee G, Narasimha Ramulu K, Srikanth K, Ravindar B, Gowri P. Seasonal changes in the ostracod population in relation to the physico-chemical changes of a perennial tank in Warangal District, A.P. Int J Adv Biotechnol Res. 2011;2:286–290.

[37] Mahor RK. Diversity and seasonal fluctuation of zooplankton in fresh water reservoir Tighra Gwalior (M.P). Inter Res J 2011;2:24–25.

[38] Puri HS. Ecological distribution of recent Ostracoda. In: Symposium on Crustacean: Mar Biol Assoc India Sci 1966;2:457–495.

[39] Triantaphyllou MV, Tsourou T, Koukousioura O, Dermitzakis MD. Foraminiferal and ostracod ecological patterns in coastal environments of SE Andros Island (Middle Aegean Sea, Greece). Revue Micropaléontologie 2005;48:279–302. [CrossRef]

[40] Elofson O. Zur Kenntnis der mariner ostracoden Schwedens, MIT besonderer Beriicksichtigung des skagerracks. Uppsala Univ Zool Bidr 1941;19:215–234.

[41] Trivedy MK, Goel PG. Chemical and biological methods for pollution studies. Karad: Envi Pub.; 1984. p. 2-47.

[42] Hoff CC. Ostracod of Illinois, their biology and taxonomy. Ill Biol Monogr. 1942;19:1–196. [CrossRef]