AQUATIC INSECT DIVERSITY AS A POTENTIAL INDICATOR IN THE ASSESSMENT OF ECOLOGICAL CONDITION OF TAMIRAPARANI RIVER SYSTEM, TAMILNADU

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ABSTRACT

A current study was examined in aquatic insects as a bioindicator of water quality ofperennial river Tamirabarani. Aquatic insects were sampled total of 6570 individuals belonging 26 families from 11 orders during the study period of 2016 to 2017. The study revealed most aquatic insects were recorded maximum in Gadananathi (753 individuals) and the minimum in Authur (82 individuals). The standardizedmethods were used to estimate the physico-chemical parameters of the responsible study site. The correlation coefficient analysis of Bivariate Pearson correlation and 2-tailed flag was performed Water quality parameters showed significant (positively correlated value)at the 0.01 level was found between the physic-chemical parameters values. The diversity indices discussed, that is to influence environmental variability in the diversity and distribution of aquatic insects.The biotic indices of FBI (Family biotic indices), BMWP (Biological monitoring working party) and ASPT (Average score per taxon) scores exist in Good, Fair and Poor water quality of river Tamirabarani.

KEYWORDS- **Aquatic insects, Biotic index, Biological- indicator, Water quality.**

I INTRODUCTION

Aquatic insects are major group of arthropods found in avariety aquatic ecosystem (Zborowski*et al.*, 1995). The most of their life stages spend in aquatic environments, they arise from freshwater and few in marine water(Segers and Martens, 2005).The aquatic insects of freshwater river and stream ecosystems have frequently examined the species-habitat relationship with regard to the water quality of the habitat (e.g., Compin&Céréghino, 2003; Azrina*et al*. 2005).The major role of aquatic insects used as a bioindicator of ecosystem functioning(New 1984).The anthropogenic impacts aquatic insects as bio-indicators of aquatic ecosystem have revealed thespecies diversity and richnessand aquatic insect population alsodecreases(Shafie*et al*. 2017).The distribution of aquatic insects based on Oxygen availability, Temperature, Sediment, substrate type and Presence of pollutants such as pesticides, acidic materials and heavy metals.

The diversity, abundance and distribution in relation to the physical and chemical conditions of the habitats also desecte biological indicators of aquatic insects (Wahizatul *et al*. 2011).Aquatic insect is a useful bio-indicator thatprovides a more accurate understanding of the changing water body or river system thanchemical data (Ravera *et al*.1998).Aquatic insects are most important component of aquatic ecosystem, they are used as bio indicator.Biotic indices are a tool that can manage water quality by the taxa richness and ecological sensitivity of freshwater ecosystem (Zeybek*et al*. 2014).

Water quality of tamirabarani river decrease by inflow of sewage, agricultural waste and human activities. In this study investigated the aquatic insect community, their distribution in different study site(Upstream to Downstream) and their role as bioindicator of water in the Tamirabarani river.

II MATERIALS AND METHODS

2.1Study site and sampling method

Tamirabarani is a perennial river originatesfrom Pothigaiin 1725 m altitude of Western Ghats in Tirunelveli district of Tamil Nadu. The river is the only perennial source for the potable water supply, irrigational activities, and industrial processes.The aquatic macroinvertibrates were collected by kick- net and D frame net (Balasubramanian *et al.,* 1992).All specimens from the net surface were carefully collected without any morphological damage using fine forceps or brush and preserved in 70% Ethyl alcohol immediately. The collected samples were brought to laboratory and identified Family level was carried out by done using published taxonomical literatures (Yule and Yong 2004.Sivaramakrishnan*et al.,* 2009; Selvakumar*et al.,* 2012 ;). Large aquatic insects were sorted by the naked eye whereas the sorting of the smaller ones was done under a dissecting microscope.

2.2 Physicochemical Study

The temperatures of the samples were noted at the sampling point itself. The samples were put to examination in the laboratory to determine some physical and chemical parameters. Analysis was carried out for various water quality parameters such as pH, Alkalinity, DO, BOD, Conductivity, Total Hardness,Nitrate, Sodium, Phosphorus and Manganeseusing standard method.

2.3 Data analysis

The impact of disturbances and pollutions on the stream water to measure by biological indices.Diversity indices like Simpson diversity index (D) and and Shannon-Weiner index (H') analysed by using the computerised software package PAST verson 2.14(Hammer *et al*., 2001). The correlation coefficient analysis (Bivariate Pearson correlation and 2-tailed flag) done by SPSS software packages.The indices used to study waterquality is followed by Family Biotic Index (FBI) (Armitage *et al*., 1983), Biological Monitoring Work Party (BMWP) (Armitage *et al*., 1983), Average Score Per Taxon (ASPT) (Metcalfe, 1989). These metrics were based on the idea that unstressed streams and rivers have richer invertebrate taxa that were dominated by intolerant species. On the other hand, polluted streams have less numbers of invertebrate taxa and were dominated by tolerant species.

III RESULT

3.1 Aquatic insects Distribution and abundance

A total of 6570individuals belonging 26familiesfrom 11orders ofmacroinveribrates were collected from tamirabarani river sites.The study revealed most aquatic insects were recorded in Gadananathi (753 individuals) and the minimum at Authur (82 individuals) (Table-1).With regard to the total number of individuals recorded in eighteen sites, Ephemeropotera was most dominant (2243 individuals; 34.25%) followed byTrichoptera,(1677 individuals; 25.61%), Hemiptera (757 individuals; 11.56%),Diptera (537 individuals; 8.20%),Coleoptera (315 individuals; 4.81%),Plecoptera(310 individuals; 4.73%),Odonata (232individuals; 3.54%),Oligochetae (193individuals; 2.95%), Lepidoptera(125individuals; 1.91%), Megaloptera(105 individuals; 1.60%).Hiudinidae(96 individuals; 1.47%).Family level to descripes individual abundance in18 sampling station wereHydropsychidae presentin high numbers (1080 individuals)and Mesovelidae were found least numbers(58 individuals).Followed byLeptophlebiidae(831),Chironomidae was present at all sampling stations, but the abundance was higher in the downstream.

3.2 Physiochemical parameters

The variation ofphysico-chemical characteristics to estimate eighteen studysite(Table-2).Water temperature of study station ranged from 18 ^{o}C to 30^{o}C.The water pH ranged from a minimum of 6.81and maximum study sites. Conductivity of water parameter was higher 87µs/cm and lower 23µs/cmsampling station respectively.Total hardness of water ranged from maximum of 58 mg/litand minimum of 6 mg/lit study area of river. The water alkalinity ranged from 7 mg/l and 72 mg/l sites respectively. The values of nitrite (0.01 mg/lit to of 0.43), nitrate (0.02 mg/lit to 1.17 mg/lit), phosphate (0.03 mg/lit -0.42 mg/lit) and magnesium (0.3 mg/lit to 3.1 mg/litmg/lit)ranged in eighteen study sites. The DO of water ranged from 5.8 mg/lit to 8.8 mg/lit sampling station. The BOD of water ranged from 1.21mg/lit to 5.7 of mg/lit in all sampling station respectively.

The correlation coefficient analysis (Bivariate Pearson correlation and 2-tailed flag significant at the 0.01) was performed (Table 3). Water quality parameters showed the positively correlated value of the significant at the 0.01 level was found between the physic-chemical parameters values. Subsequently, the negatively correlated value was between dissolved oxygen (-.952) and all the parameters, also the negatively correlated value was between BOD and dissolved oxygen (-9.22) was significantly at the 0.01 level respectively as Table-3.

3.3 Diversity Indices

The highest value of Simpsondiversity index (1/D)0.92 and Shannon-Weiner index (H')2.67 noted inMukkudalS11(Table- 4 and Figure-1).The Lowest value of Simpsonindex (1/D) 0.80 and Shannon-Weiner index (H')1.80was observed in AthurS18 (Table- 4).

3.4 Biotic Indices

Biotic indices were determined by scores of Family biotic index(FBI), Biological monitoring working party (BMWP) and Average score per taxon (ASPT). These indicesindicate 'Good', 'Fair' and 'Poor' according to the water quality.The sampling sites of FBI score ranged between3.18 to7.86.The study site of BMWP score ranged between28to127. The ASPT score ranged from6.00 to 3.77 (Table-5 Figure-2)

Table.1: Aquatic Insect diversity in selected sites of Tamirabarani River system

Order/Family	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Ephemeroptera Leptophlebiidae	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-
Heptageniidae	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Caenidae	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
PLCHOTERA Perlidae	+	+	+	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-
TRICHOPTERA Hydropsychidae	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	-	-
Stenopsychidae	+	+	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-
Lepidostomatidae	+	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Glossosomatidae	-	+	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-

Rhyacophilidae	+	+	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-
Hemiptera Mesovelidae	-	+	+	+	+	-	-	-	+	-	-	+	-	-	+	-	-	-
Naucoridae	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Belostomatidae	+	-	-	-	-	+	-	+	+	+	+	+	+	-	+	-	-	-
Gerridae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+
Nepidae	+	+	+	+	+	-	+	+	+	+	+	-	-	+	+	-	-	-
Coleoptera Hydrophilidae	+	+	-	+	+	+	+	+	-	+	+	+	+	+	-	+	+	-
Gyrinidae	+	+	+	+	+	+	+	+	-	-	+	-	-	-	+	+	+	-
Odonata Libellulidae	+	+	+	+	+	+	-	+	+	+	-	-	-	-	-	+	+	+
Calopterygidae	+	+	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera Pyralidae	+	+	+	+	+	-	+	-	+	-	+	+	-	+	+	+	+	+
Megaloptera Sialidae	+	+	+	+	+	+	+	+	-	-	+	-	-	-	-	-	-	-
Hirudinidae Hirudidae	+	+	+	+	-	+		+	+	+	+	-	+	-	+	-	-	-
Oligochaetae Oligochaetae	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+
Diptera Culicidae	-	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+
Tipulidae	-	+	-	+	+	-	+	-	-	+	+	+	+	+	+	+	+	+
Chironomidae	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Notes: Ramanathi (S1),Gadananathi (S2), Illupayaru (S3), Karaiyar (S4), Servalar (S5), Papanasam (S6), Manimuthar (S7), Chittar–kutralam (S8),Vikkramasingapuram (S9), Kallidaikurichi (S10), Mukkudal (S11), Cheranmahadevi (S12), Kurukuthurai (S13), Manappadaiveedu (S14), Seevalaperi (S15),Valanadu (S16), Srivaikundam (S17) and Athur(S18).

Table.2 Physiochemical parameters studied in the selected study sites of the river Tamiraparani.

Physico-chemical parameters	Study Sites																	
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**
Water temperature	18	20	24	18	18	20	20	18	25	25	24	27	28	21	22	24	27	30
pH	6.85	6.91	7.11	6.85	6.81	7.06	6.87	6.85	7.42	7.43	7.47	7.63	7.72	7.8	7.22	7.47	7.8	7.88
Conductivity	24	35	58	24	23	43	34	24	55	58	62	81	83	41	43	56	87	88
Total Hardness	6	8	22	6	6	18	8	6	25	24	26	45	43	20	23	31	47	58
Total Alkalinity	7	11	22	7	8	17	10	7	22	27	20	41	46	24	25	34	56	72
Silica	0.28	0.41	1.54	0.28	0.25	0.53	0.31	0.28	2.34	2.42	2.31	3.24	4.11	2.68	2.75	3.37	4.23	5.43
Nitrite	0.01	0.03	0.21	0.01	0.01	0.12	0.03	0.01	0.22	0.28	0.25	0.33	0.41	0.12	0.15	0.27	0.41	0.43
Nitrate	0.02	0.03	0.33	0.02	0.03	0.24	0.04	0.02	0.35	0.43	0.38	0.56	0.57	0.22	0.27	0.41	0.76	1.17
Phosphate	0.03	0.03	0.15	0.03	0.04	0.12	0.04	0.03	0.23	0.29	0.27	0.35	0.42	0.16	0.18	0.22	0.36	0.41
Magnesium	0.4	0.7	1.5	0.4	0.3	1.34	0.8	0.4	1.42	1.65	1.38	2.1	2.6	1.32	1.3	2.1	2.3	3.1
DO	8.6	8.5	6.7	8.6	8.8	7.8	8.4	8.6	7.4	7.2	7.2	6.3	5.8	7.3	7.1	6.8	6.4	5.5
BOD	1.2	1.3	2.2	1.2	1.2	1.8	1.3	1.2	2.3	2.7	2.5	5.1	5.4	2.5	2.7	4.7	5.3	5.7

Table 3. Correlation of Physiochemical parameters on the selected sites of river Tamiraparani (Pearson Correlation and Flag significant correlation were analyzed)

Physico-chemical Parameters	Water Temp.	pH	C	TH	TA	SI	NI	NA	P	MA	DO	BOD
Water Temp.	1	.866**	.976**	.956**	.915**	.922**	.977**	.932**	.964**	.955**	-.952**	.900**
pH	.866**	1	.867**	.896**	.870**	.941**	.887**	.849**	.910**	.887**	-.888**	.867**
C	.976**	.867**	1	.969**	.920**	.901**	.982**	.926**	.963**	.950**	-.946**	.921**
TH	.956**	.896**	.969**	1	.975**	.955**	.966**	.968**	.957**	.970**	-.957**	.964**
TA	.915**	.870**	.920**	.975**	1	.952**	.926**	.976**	.905**	.955**	-.920**	.949**
SI	.922**	.941**	.901**	.955**	.952**	1	.934**	.927**	.936**	.944**	-.943**	.942**
NI	.977**	.887**	.982**	.966**	.926**	.934**	1	.934**	.983**	.964**	-.956**	.933**
NA	.932**	.849**	.926**	.968**	.976**	.927**	.934**	1	.913**	.945**	-.914**	.897**
P	.964**	.910**	.963**	.957**	.905**	.936**	.983**	.913**	1	.940**	-.940**	.918**
MA	.955**	.887**	.950**	.970**	.955**	.944**	.964**	.945**	.940**	1	-.971**	.946**
DO	-.952**	-.888**	-.946**	-.957**	-.920**	-.943**	-.956**	-.914**	-.940**	-.971**	1	-.922**
BOD	.900**	.867**	.921**	.964**	.949**	.942**	.933**	.897**	.918**	.946**	-.922**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4. Diversity index for the sites of riverTamirabarani.

Diversity index	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18

Simpson_1-D	0.88	0.89	0.88	0.89	0.881	0.908	0.851	0.91	0.91	0.92	0.93	0.91	0.84	0.8	0.9	0.9	0.867	0.8
Shannon_H	2.5	2.58	2.468	2.5	2.468	2.635	2.314	2.64	2.58	2.63	2.67	2.46	1.98	2	2.3	2.3	2.098	1.8

Table 5.Biotic index for the sites of River Tamirabarani.

Biotic index	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
FBI	3.86	3.40	3.44	3.24	3.18	4.29	3.55	4.38	5.42	4.21	5.20	6.04	7.86	6.89	6.46	6.81	6.81	6.92
BMWP	125	127	114	117	125	102	123	90	78	71	75	57	32	34	42	46	38	28
ASPT	5.68	6.00	5.42	5.32	5.71	4.64	5.86	5.00	4.88	4.73	4.69	4.38	3.77	3.78	3.82	4.18	4.22	4.00

FBI score: 0-4=Good water quality: 4.01-6=Fair water quality: 6.01-10=Poor water quality
BMWP score: 0-60=Poor water quality; 61-110=Fair water quality; 111=Good water quality
ASPT score: 0-4.40= poor water quality, 4.41-5.30= Fair water quality, 5.31-10 = Good water quality

Figure 1 Diversity index of river Tamirabarani

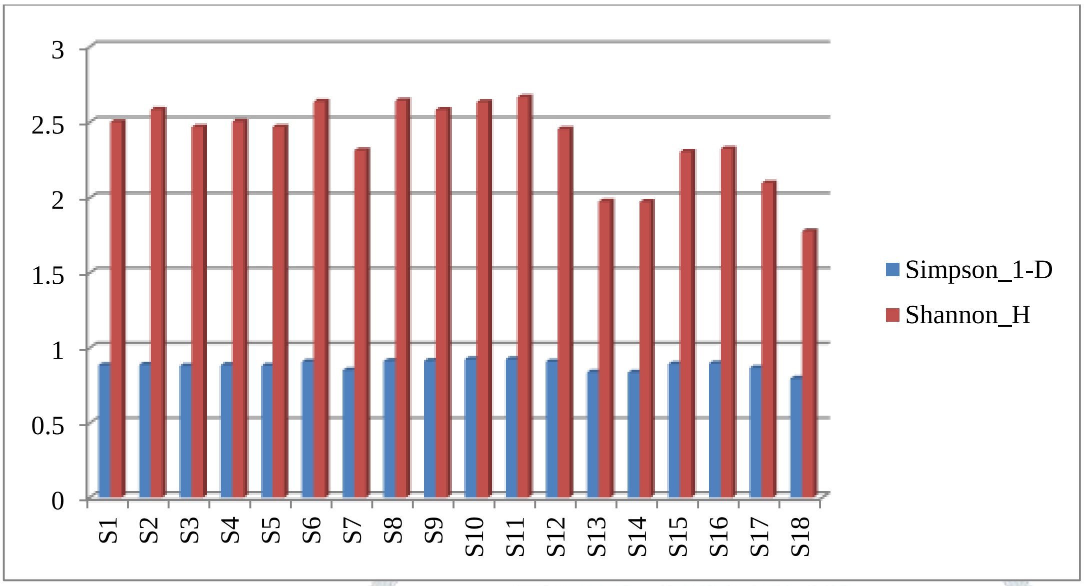
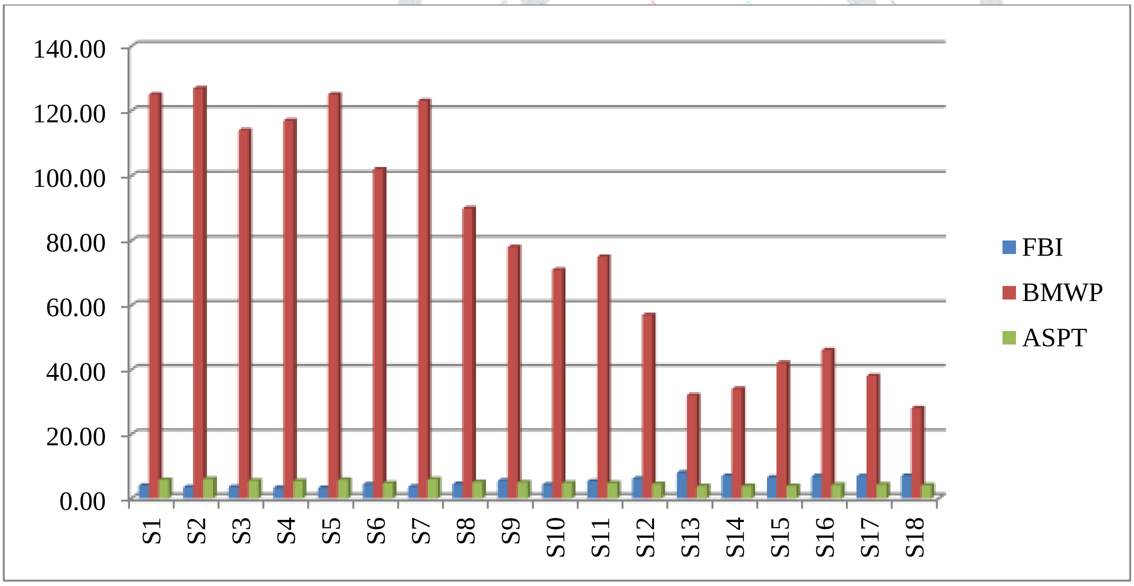


Figure 2.Family Biotic Index of river Tamirabarani



IV DISCUSSION

The physicochemical parameters of aquatic insects are more important of riverine habitates. In this study the physical parameters of pH, Water temperature, Conductivity, Total alkalinity, Total hardness, Nitrite, Nitrate,Phosphate, Magnesium, and BOD which increase in downstream and DO decrease in downstream then the upstream, because of higher interference of raw sewage, agricultural waste and human settlement directly flood the river.The aquatic insects richness moderately influence of physicochemical variables, they are increased at the downstream areas and decreases upstream areas (Mophinkani et al., 2014). Study sites Kurukuturai, Manappadaiveedu, Srivaikundam and Aathurwere impacted by higher intrusion of raw sewage and agricultural waste and also hadmany other human disturbances along the banks of Tamirabarani river.

Diversity indices represents a numberof existing species, distribution of individualsand total number of existing individuals in a population. (Wilhmet al., 1968and Allan et al., 1975). Shannon- Wiener diversity index (H′) values to be less than 1 they indicat pollutednature of the stream water(Turkmen et al., 2010).The highest Shannon H′ (2.67) and Simpson index (0.92) value record fromMukkudal,pretty good with more taxaencounter on this station. The same results were recorded by the earlier studies (Barman et al., 2015).
The biological assessment of freshwater ecosystems due to thediverse taxa of aquatic insects that exhibit a range of responses to river pollution levels (Sinco*et al.*,2014).The Europe was first developed biotic indices for biomonitoring in stream water, followed by United States (Richardson, 1928; Woodiwiss, 1964).In our study, the Ephemeroptera was most abundance in river tamirabarani.Meanswere, the most diverse and relatively abundants in order of Hemiptera was found the Bakuamari stream, Assam (Barman et al., 2015).The Pollution sensitivity group (EPT) was presence in Pabanasam and absenceof Kurukkuthurai, Tirunelveli - Kokkirakulam and Aathur (Mophin-Kani et al., 2014). In present study to collect samples on upstream levels to downstream, when the EPT richness in Gadananathi and absence of Srivaikundam and Authur. The aquatic insectdiversity decrease in the downstream level due to the higher inflow of sewage,agricultural wastes and human settlement to directly reach the main stream flow.
The Family Biotic Index used to assess the organic pollution (Stefano et al., 2002). The current investication Family Biotic Index score indicate Kurukkuthurai, Manappadaiveedu, Seevalaperi, Vallanadu, Srivaikundam and Aathur poor water quality. In this study result declare the previous study(Mophin-Kani et al., 2014). The BMWP scores higher in Pollution intolerant family's and pollutiontolerant families contain low scores (Dinakaranet al., 2007). Present study the highest BMWP score 127(Gadananathi) indicate good water quality and score 28(Authur) indicate poor water quality. The Average Score Per Taxon (ASPT) scores higher in station they indicate good water quality. They ranged from good, fair and poor.

V CONCLUTION

The result from the present studybased on the composition of aquatic insects conclude that the water quality of Tamirabarani river is clean at upstream level and moderate to fair towards the downstream as they become polluted by various sources.Biological monitoring study indices (FBI, BMWP and ASPT) indicate the water quality as good, fair and poor water quality in river Tamirabarani. The EPT is a pollutant sensitivitive taxa theydeficient in human settlement area. The upstream region of river containshigh abundance of pollution sensitive species whereas the abundance oftolerent species levels increase towardsthe downstream sites. Macroinvertebrates are efficient in predicting the quality of water and hence are good biological indicators of pollution.

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