

Diversity and Abundance of Macroinvertebrates in Kaakkaithivu coastal waters, Jaffna estuary

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Abstract This study analyzed the diversity and abundance of aquatic macroinvertebrate community in the Kaakkaithivu coastal waters, Jaffna estuary. The sampling was carried out from July 2018 to January 2019. A total of 459 individuals of 15 macroinvertebrate families belonging to 20 taxa were identified based on their morphological characteristics by using standard keys. They are Coelenterates, Molluscs and Arthropods. According to the Shannon Weiner (H) and Simpson (D) indices, the highest species diversity value and abundance were found at the site-3 (H-2.7163, D-0.0836 and abundance-222) followed by site-2 (H-2.0511, D-0.1688 and abundance-143) and site-1 (H-1.2978, D-0.5822 and abundance-94). *Terebralia palustris* (21.35%) and *Cerithidea cingulata* (20.05%) were the most abundance species belonging to the family Potamididae whereas the least abundant species were *Cypraea* sp and *Metopograpsus* sp (0.65% each) at Kaakkaithivu coastal waters.

Keywords Abundance, Coastal waters, Diversity, Estuary, Macroinvertebrates.

I. INTRODUCTION

Studies on the diversity and abundance of estuarine macroinvertebrates have created an enormous importance for their economic and ecological values. Macroinvertebrates are aquatic animals that are quite small but can be seen with the naked eye and containing no backbone. They are diverse group of animals which includes Poriferans, Coelenterates, Platyhelminthes, Nematodes, Molluscs, Annelids, Arthropods and Echinodermites. Macro-invertebrates are most frequently used as bio indicators and play a significant ecological and economical role in Sri Lankan waters. However, these coastal ecosystems are increasingly being changed due to human activities and several impacts threat their integrity and sustainable exploitation (McLusky and Elliott, 2004).

Research reports on the diversity and abundance of macroinvertebrates in aquatic ecosystems of different countries have been extensively published by several researchers. But there is continuous need for scientific studies to evaluate the diversity and abundance of estuarine macroinvertebrates, specially the coastal water macroinvertebrates in Sri Lanka. Therefore, we envisioned to study about macroinvertebrates in Kaakkaithivu coastal waters, Jaffna estuary.

Description of the study area:

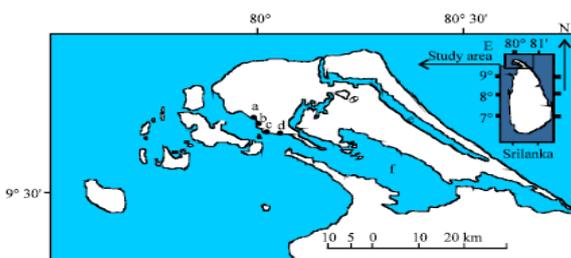


Figure 1: Location of the Jaffna Estuary

- (a) Kaakkaithivu, (b) Navanthurai, (c) Kurunagar, (d) Pasaioor (e) Thondaimannar lagoon and (f) Jaffna estuary.

Table 1: Description of the sampling sites

Sampling sites	GPS Location	Description
Site 1	Latitude 9°41'05"N longitude 79°59'05"E	Stagnant water body, which is directly connected to the canal near to recycling center Kaakkaithivu.
Site 2	Latitude 9°41'20"N longitude 79°59'05"E	Open water in front of recycling center and it is freely connected to Jaffna estuary.
Site 3	Latitude 9°40'07"N longitude 80°01'08"E	Waters near to jetty, which is directly connected to Jaffna estuary.

II. MATERIALS AND METHODOLOGY

A. Study area

Jaffna peninsula is situated in the northern part of Sri Lanka in the Indian Ocean. Jaffna estuary is a shallow coastal water body located on the Northern Province of Sri Lanka with vital economic importance. It lies between approximate 79°E 52' to 80°E 38' longitudes and 9°N 26' to 9°N 46' latitudes. It has an area about 412 km² (Chitravadivelu and Arudpragasam, 1983). Kaakkaithivu Coastal Area was selected for this study. It is a major fish landing center in Jaffna district and there is a solid waste dumping and waste recycling center in front of Kaakkaithivu Coastal waters.

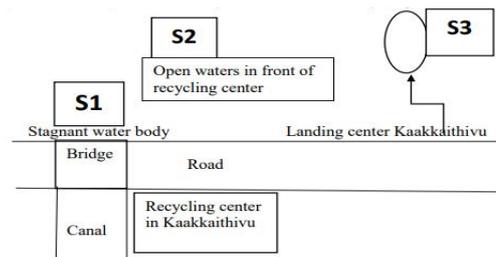


Figure 2: Sketch of sampling sites (S1, S2 and S3)

Three sites (Site-1, 2 and 3) were randomly selected for this study (Figure 2; Table 1).

B. Sampling

Sampling was done from July 2018 to January 2019, twice a month in early morning from three sampling sites (S1, S2 and S3) (Figure 2; Table 1). Water samples were collected from water column by placing the 5L bottles in each sampling sites (S1, S2 and S3) and the mud samples were collected from each sampling sites by using steel and plastic scoop. These samples were brought to the laboratory and preserved in 70% of alcohol for further analysis.

C. Analysis of the samples

Coastal surface water (5L) and bottom mud samples collected from field were brought to the laboratory of Department of Zoology for the identification of macro-invertebrates. Mud samples were collected and dissolved by water samples of respective sampling sites. The dissolved mud samples were sieved by using series of mesh size sieve set. The mesh size were top to down denote as follows 4000 microns, 2000 microns, 500 microns, 250 micron, 125 microns, and 63 microns respectively (Plate 1.).

The macroinvertebrates were collected either in dead or alive states. The dead shells were washed properly by the respective water samples collected from Kaakkaithivu sampling locations; then placed them in 70% ethanol and kept them for 20 minutes to clean the macroinvertebrates. The alive macroinvertebrates were allowed to die and the dead bodies were removed from the organisms (shells) using forceps and cleaned them by using water samples from sampling sites and then placed them in 70% ethanol. Then all the cleaned organisms were dried fully under the sun light for 24 hours.

D. Identification of Macroinvertebrates

The macroinvertebrates were identified by using standard keys and literatures based on the morphological features (Carpenter and Niem, 1998; Chitravadivelu, 1993; De Bruin *et al.*, 1995; Fernando, 1977; Malik Fernando, 2009 and Sivasanthini *et al.*, 2014).



Plate 1: Mud sample analysis by using sieve set

E. Data Analysis

After identification and enumeration of macro invertebrates, diversity indices were calculated by the following equations: Shannon Weiner Diversity index (H');

$$H' = - \sum (n_i/N) \ln (n_i/N),$$

Where n_i is number of individuals of i^{th} species, N is total number of individuals, \ln is the natural log, and \sum is the sum of the calculations.

Shannon evenness (E_H);

$$E_H = H'/\ln(S)$$

Where H' is Shannon's Weiner diversity index and $\ln S$ is natural log of the total number of species recorded.

Simpson's dominance index (D);

$$D = \sum (n_i/N)^2$$

Simpson's evenness (E_D);

$$E_D = D/S$$

III. RESULTS AND DISCUSSION

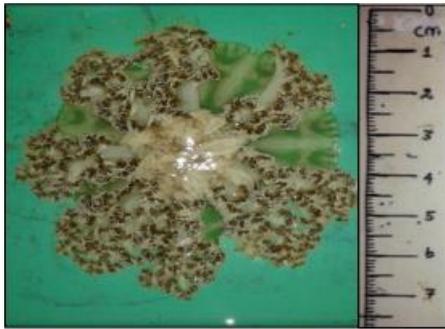
In this study, 459 specimens belonging to 20 macroinvertebrate taxa and 15 families were collected (Table 2). They were,

Terebralia palustris, *Cerithidea cingulata*, *Murex virgineus*, *Volegalea* sp, *Littoraria undulata*, *Morula margariticola*, *Cypraea* sp, *Clypeomorus* sp, *Cardita bicolor*, *Donax* sp, *Dosinia lincta*, *Portunus pelagicus*, *Thalamita crenata*, *Metopograpsus* sp, *Gammarus locusta*, *Penaeus monodon*, *Penaeus latisulcatus*, *Penaeus semisulcatus*, *Cassiopea picta*, and *Acromitus* sp (Plate 2).

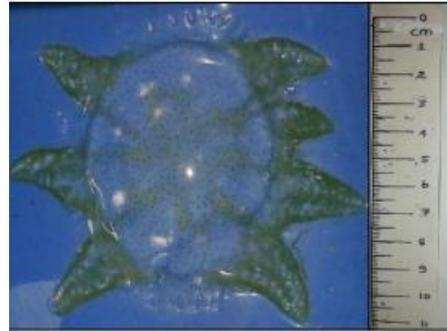
In this present study, twenty species of macro-invertebrates were recorded. 13 species were first time documented in the Kaakkaithivu coastal waters namely. *Cerithidea cingulata*, *Murex virgineus*, *Volegalea* sp, *Littoraria undulata*, *Morula margariticola*, *Cypraea* sp, *Clypeomorus* sp, *Cardita bicolor*, *Dosinia lincta*, *Metopograpsus* sp, *Gammarus* sp, *Cassiopea picta* and *Acromitus* sp, where among the rest of seven species, three species of shrimps were reported by Chitravadivelu and Arudpragasam (1983) and Piratheepa *et al.*, (2012) and those were *Penaeus monodon*, *Penaeus latisulcatus*, and *Penaeus semisulcatus*.

Three species of crab were recorded, in which *Metopograpsus* sp was first time documented in the Kaakkaithivu coastal waters in this present study and two species such as *Portunus pelagicus* and *Thalamita crenata* were reported by Sivasanthini *et al.*, (2014). Eight species of gastropods and three bivalves were identified. Identified mollusc shells were belonged to nine families such as Potamididae, Cerithiidae, Muricidae, Melongenidae, Littorinidae, Cypraeidae, Carditidae, Donacidae, and Veneridae .

Phylum: Coelenterata



Cassiopea picta



Acromitus sp

Phylum: Mollusca



Cardita bicolor



Donax sp



Dosinia lineta



Terebralia palustris



Cerithidea cingulata



Murex virgineus



Volegalea sp



Littoraria undulata



Morula margariticola



Cypraea sp



Clypeomorus sp

Phylum: Athropoda



Portunus pelagicus



Thalamita crenata



Metopograpsus sp



Penaeus monodon



Penaeus latisulcatus



Penaeus semisulcatus



Gammarus locusta

Plate 2: Identified macro-invertebrates in Kaakkaithivu coastal waters

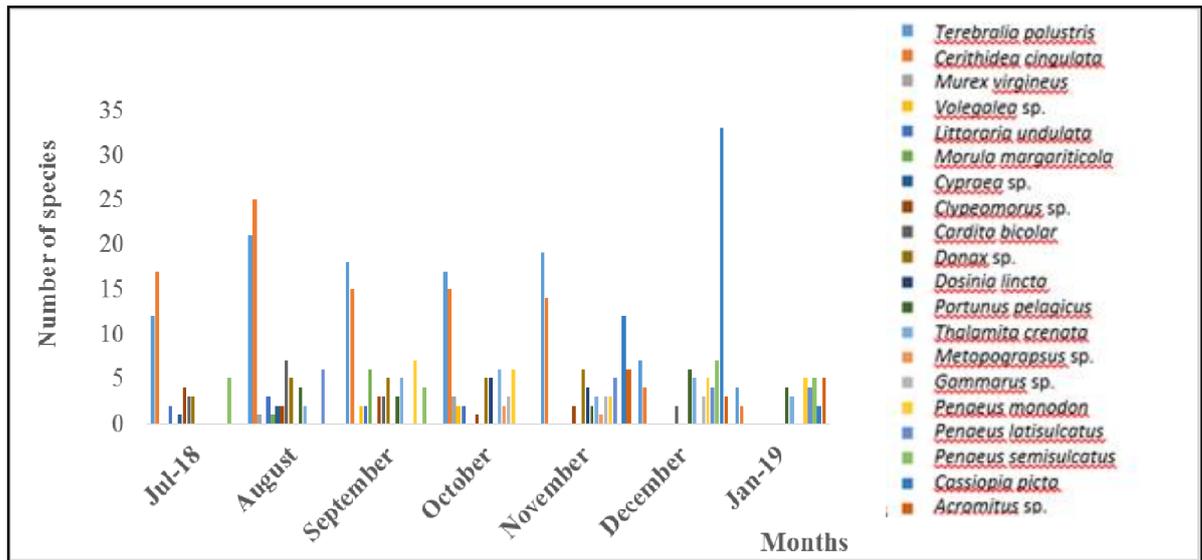


Figure 3: Abundance of macro-invertebrates in Kaakkaithivu coastal waters.

Table 2: Macro-invertebrate composition

Taxonomic order	Family	Species
Sorbeoconcha	Potamididae	<i>Terebralia palustris</i>
	Cerithiidae	<i>Cerithidea cingulata</i>
Neogastropoda	Muricidae	<i>Murex virgineus, Morula margariticola</i>
	Melongenidae	<i>Volegalea sp</i>
Littorinimorpha	Littorinidae	<i>Littoraria undulata</i>
	Cypraeidae	<i>Cypraea sp</i>
Carditida	Carditidae	<i>Cardita bicolor</i>
Cardiida	Donacidae	<i>Donax sp</i>
Venerida	Veneridae	<i>Dosinia lincta</i>
Decapoda	Portunoidae	<i>Portunus pelagicus, Thalamita crenata</i>
	Grapsidae	<i>Metopograpsus sp</i>
	Penaidae	<i>Penaeus monodon, Penaeus latisulcatus, Penaeus semisulcatus</i>
Amphipoda	Gammaridae	<i>Gammarus locusta</i>
Rhizostomeae	Cassiopeidae	<i>Cassiopea picta</i>
	Catostylidae	<i>Acromitus sp</i>

Table 3: Diversity indices of Macro-invertebrates at three sampling sites

Indices		Sites		
		S1	S2	S3
Simpson's dominance index	Diversity value	0.5822	0.1688	0.0836
	Evenness	0.0832	0.0130	0.0005
Shannon index	Diversity value	1.2978	2.0511	2.7163
	Evenness	0.669	0.7947	0.9797
Species richness (S)		7	13	16
Abundance		94	143	222

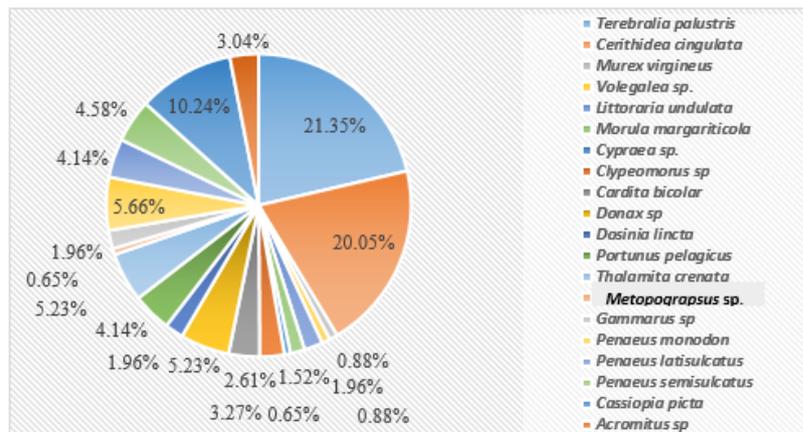


Figure 4: Percentage of occurrence of each species collected from Kaakkaithivu coastal water

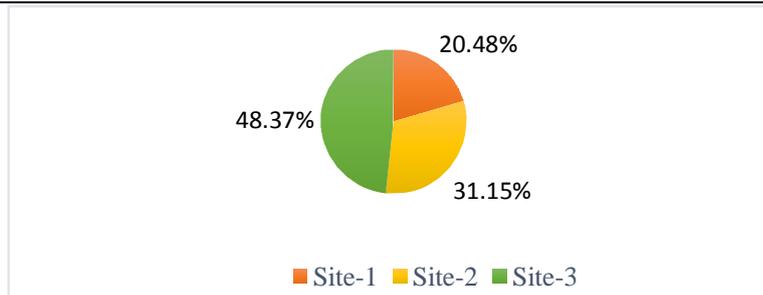


Figure 5: Percentage of occurrence of total species from each sampling sites

Shannon Weiner and Simpson diversity indices were calculated to find out the species diversity per site. The highest species diversity was found at the site 3 while the lowest was found at the site 1. The species richness was also reflected the same pattern i.e., the site 3 showed the highest species richness (16 species) while site 1 associated with 7 species with varied evenness values (Table 3). The low evenness value indicated that there was no balance for distribution of their numbers of species and community was dominated by a taxon or some taxa (Magurran, 2004).

As a result of the study, 459 individuals and 20 taxa belonging to four classes were identified. Those were Gastropoda (8 taxon), Bivalvia (3 taxon), Malacostraca (7 taxon) and Scyphozoa (2 taxon). Out of these, Class Gastropoda was the most dominant group among the identified taxa. During this present study the maximum abundance (48.37% - 222 individuals) was observed at the site 3 while the lowest documented (20.48% - 94 individuals) at the site 1 (Figure 5). The *Cerithidea cingulata* was the most dominant species in site 1 (8.93%) and site 2 (9.59%) whereas in site 3, *Cassiopea picta* (8.06%) (Figure 4).

IV. CONCLUSION

The conducted study revealed that at least twenty species of macroinvertebrates belonging to 15 families are existing in Kaakkaithivu coastal waters, Jaffna estuary. They are *Terebralia palustris*, *Cerithidea cingulata*, *Murex virgineus*, *Volegalea* sp, *Littoraria undulata*, *Morula margariticola*, *Cypraea* sp, *Clypeomorus* sp, *Cardita bicolor*, *Donax* sp, *Dosinia lincta*, *Portunus pelagicus*, *Thalamita crenata*, *Metopograpsus* sp, *Gammarus locusta*, *Penaeus monodon*, *Penaeus latisulcatus*, *Penaeus semisulcatus*, *Cassiopea picta*, and *Acromitus* sp.

The species *Terebralia palustris* was the most abundance species during the study period, it was recorded from all selected sampling sites of the Kaakkaithivu coastal waters (21.35%). The species richness and abundance were high at site 3 (48.37%), followed by site 2 (31.15%) and site 1 (20.48%).

Three site wise comparisons clearly indicate that the abundance and diversity of macro-invertebrates significantly vary with sites. This may be due to the water quality status and the ecology of the locations. Further detailed studies are needed in this area for the better management of the estuary.

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