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Species Composition, Density, and Distribution of Macrozoobenthos in the Estuary of the Singkil Peat Swamp Aceh Province, Indonesia

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Abstract: The Singkil peat swamp is currently experiencing severe disturbances due to deforestation, forest fires, and land conversion to oil palm plantations. These activities cause significant changes in water quality and aquatic biota, including macrozoobenthos, a crucial component within the aquatic ecosystem food chain. Therefore, this study aims to identify macrozoobenthos species and analyze their diversity, distribution, density, and dominance in the estuary of the Singkil peat swamp. Sampling was conducted from June to August 2023 at seven locations determined based on accessibility and security. Macrozoobenthos were collected using three transects (1 x 1 m), which were set up purposefully to represent each location. Samples above the substrate

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were taken directly by hand, while those in the sediment were collected using a paralon pipe with a 3 cm diameter at five points in each transect. The sediment was then sieved, and the obtained samples were placed sample bags containing 70% alcohol for preservation and then transported to the laboratory at the Faculty of Marine Affairs and Fisheries, Syiah Kuala University.

The results showed that a total of 21 species belonging to three classes, including Gastropoda, Bivalvia, and Malacostraca, were identified. The average diversity index was 1.75, falling into the medium category, with an average dominance index of 0.38 in the low category. The average species richness index was 3.17 in the medium category, while the similarity index ranged from 0 to 66.67% showing the very dissimilar to similar category. The results also showed that *Faunus ater* was the most abundant, most frequently found, and most widespread species in the Singkil peat swamp estuary. Based on these findings, the diversity of macrozoobenthos in the Singkil peat swamp estuary was in the moderate category with a low level of dominance. Furthermore, *Faunus ater* was the species with the widest distribution and highest density.

Keywords: **Singkil peat swamp, gastropods, species diversity, benthos, *Faunus ater***

1. Introduction

A peat swamp, also known as peatland, is an area with high economic value, serving as an essential habitat for both flora and fauna (Cole et al., 2015). The potential extent of peatlands in tropical regions is estimated at 44 million ha, with approximately 25 million hectares situated in Southeast Asia (Rehman et al., 2015). Furthermore, Indonesia, in particular, has the largest expanse in Southeast Asia, covering 13.5 million hectares (Baihaqi et al., 2022). This peat swamp is predominantly distributed across four large islands, including Sumatra (35%), Kalimantan (32%), Papua (30%), and Sulawesi (3%) (Graham et al., 2017; Rizka et al., 2016; Warren et al., 2017). Recent reports have shown that the degradation of these regions is accelerating, specifically in Southeast Asia, due to various factors, such as illegal logging, land conversion for plantations and settlements, and the construction of canals, causing drought and triggering forest fires in the dry season (Atkinson & Alibašić, 2023; Cole et al., 2015; Mishra et al., 2021; Nusantara et al., 2012; Suwito & Poedjirahajoe, 2022). Peat swamps play an important role in maintaining hydrological and ecological functions, exerting a significant influence on the global climate (Harrison et al., 2020; Monteverde et al., 2022). Apart from the environmental impact, peat swamps also absorb carbon, provide water storage and habitat for various species of flora and fauna, and support the economy of the surrounding community in agriculture and fisheries (Baihaqi et al., 2022). This ecosystem is characterized by a high content of mud and leaf litter that has undergone decomposition (Hidayat & Hanif, 2020; Nusantara et al., 2012).

Aceh Province has several peat swamp forest areas, including Tripa, Singkil, and Kluet (Muchlisin et al., 2015). The Tripa peat swamp is known as the largest in Aceh Province, with an estimated area of 61,803 ha, covering two districts, namely Nagan Raya and Aceh Barat Daya districts (Arief et al., 2022), while the Singkil peat swamp has an area of 102,500 hectares (Wali et al., 2020), which covers two districts, namely Aceh Selatan and Aceh Singkil districts. These two peat swamp ecosystems are situated along the south-west coast of Aceh. Several main rivers pass through the west coast, including the Tripa, Seuneam, Seumayam, Batee, Trumon, Kuala Baru, and Singkil Rivers, which discharge into the Indian Ocean. Therefore, peat swamps in this area are influenced by freshwater coming from rivers and seawater from the Indian Ocean. This unique interplay creates a unique and interesting environmental dynamic to study, including the composition of the constituent macrozoobenthos.

The Singkil peat swamp is an essential habitat for several endemic animals, including the endangered orangutans *Pongo abelii*, long-tailed macaques *Macaca fascicularis*, Sumatran tigers *Panthera tigris sumatrensis*, honey bears *Helarctos malayanus*, estuarine crocodiles *Crocodylus porosus*, Sumatran elephants *Elephas maximus sumatrensis*, and hornbills *Buceros* sp. The area is also home to several flora, including orchids *Papilionanthe*, pitcher plants *Nepenthes* spp, ferns *Pteridophyta,* and mangrove forests (Onrizal, 2019). Several studies

have shown that more than 169,000 hectares of the Singkil peat swamp area have experienced damage due to illegal logging, forest fires, land clearing, and deforestation (Aswandi et al., 2016). The degradation of peatlands causes the release of carbon into the atmosphere, which contributes to the greenhouse effect (Sugianto et al., 2021), exacerbating global warming and climate change. At the local level, damage to these areas has an impact on changes in the quality of the aquatic environment, specifically on aquatic biota, such as macrozoobenthos, which can damage food chains or food webs in waters, leading to reduced productivity.

Research in the Singkil peat swamp area, Aceh Province, has reported morphometric variations and length-weight relationships of *Faunus ater* in the estuary of the southwest coast of Aceh (Khalidin et al., 2024). Studies have successfully identified 39 fish species belonging to 26 families and 31 genera and the phylogeography of *Anabas testudines* (Razi et al., 2023; Razi et al., 2024). Savira et al. (2024) also identified 32 phytoplankton species divided into eight classes, namely Bacillariophyceae, Cyanophyceae, Chlorophyceae, Cryptophyceae, Euglenoidea, Trebouxiophyceae, Ulvophyceae, and Zygnematophyceae.

Macrozoobenthos are animals living in the benthic zone or on the bottom sediments of waters. This biota is one of the most important groups in aquatic ecosystems due to its role as a key organism in the food web (Purba et al., 2015). These organisms are also bioindicators for monitoring and assessing changes in waters, acting as decomposers of organic matter in waters (Saputra et al., 2017), showing their lack of adaptability (Mushthofa et al., 2014; Ridwan et al., 2016). There have been limited studies reported so far on the abundance and diversity of macrozoobenthos in swamp areas in Indonesia, specifically in Aceh Province. Rizka et al. (2016), reported 34 species of macrozoobenthos, consisting of four classes, including gastropods, bivalves, crustacea, and insects, with *Faunus ater* (gastropods) being the most dominant species. Previous reports have shown that there is no information regarding the diversity and distribution of macrozoobenthos in the Singkil peat swamp area and threats to this ecosystem continue to occur. This condition is feared to threaten the existence of these organisms and change the stability of the aquatic environment. Therefore, this study aims to analyze the species composition and distribution of macrozoobenthos in the Singkil peat swamp. The study outcome is expected to serve as baseline data for preparing fisheries resource management plans.

2. Materials and Methods

2.1 Site and Time

Sampling was carried out from June to August 2023 at seven locations in the Singkil peat swamp area. The sampling location was the estuary area or river mouths in the region. The locations were determined purposefully based on the information collected from local fishermen, comprising river estuaries that were accessible and safe. A map of the study location is presented in Figure 1. Benthos identification was carried out at the Laboratory of the Faculty of Marine Affairs and Fisheries, Syiah Kuala University.

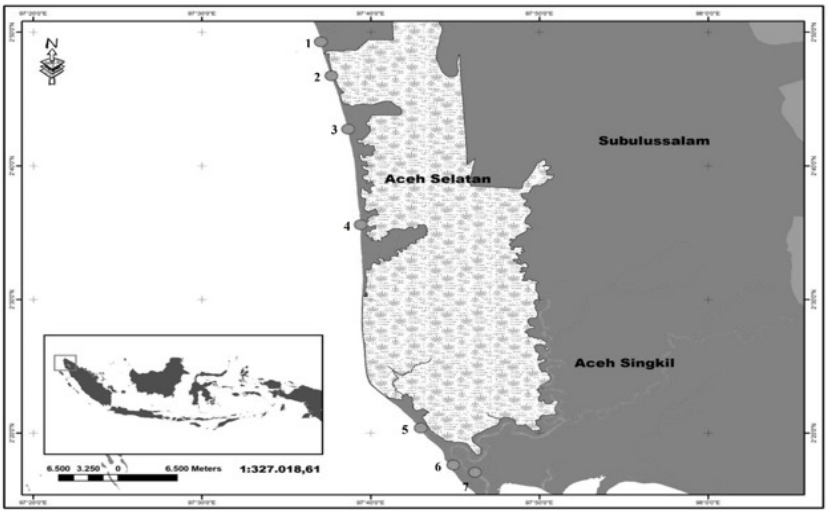

Figure 1. The map of Singkil peat swamp areas shows the seven sampling sites covering two districts of Aceh Selatan and Aceh Singkil, Indonesia.

2.2 Macrozoobenthic Collection

A macrozoobenthos sample was taken using three diagonal transects (1 m x 1 m), which were determined purposefully at each location. Macrozoobenthos on the surface of the transect were collected directly by hand, while those in the sediment were taken using a paralon pipe (15 cm in diameter) to a depth of 20–30 cm. The sediment samples at the four corners and the middle of the transect were taken using the pipe. Subsequently, the substrate was filtered using a sieve with a size of 1 mm, and the filtered sample was separated by hand. The collected macrozoobenthos were placed into a labeled sample bottle, and 70% alcohol was added as a preservative. The samples were photographed using a digital camera (Nikon D5300, Japan) for documentation, and then transported to the laboratory of the Faculty of Marine and Fisheries, Universitas Syiah Kuala for further identification and analysis. Macrozoobenthos were identified morphologically based on the method proposed by Dharma (1988), and Abbott & Dance (2000). Water temperature, salinity, pH, and dissolved oxygen were measured once at each sampling location during high tide using water quality checker equipment.

2.3 Parameters: Species Composition

The species composition was calculated based on Brower et al. (1998) as follows:

$$P(\%) = \frac{ni}{N} \times 100$$

where, P= species composition, ni= total individuals of species-i, N= total individual of all species.

Density

The density was calculated based on Brower et al. (1998) as follows:

$$D = \frac{Ni}{A} \quad (1)$$

where, D= density (ind/m^2), Ni= total individual (ind), A= sampling plot area (m^2)

Species distribution

The Morisita index of species distribution was calculated based on Magurran (1988) as follows:

$$I_d = n \times \frac{\sum X^2 - N}{N(N-1)} \quad (2)$$

where, $I_{d\ =:}$ Morisita index (individual/m^2), n= total plot, N= total individual, X^2= total species in each plot, and frequency of occurrence in each plot. According to Krebs [30], the species distribution is classified as follows: I_d > 1: grouped, I_d < 1= uniform, I_d = 1 is random distribution pattern.

Species richness index

The species richness index was calculated based on Magurran (1988) as follows:

$$D = \frac{(S-1)}{\log N} \quad (3)$$

where D = species richness index, S = total species, and N = total individual of all species. This index was categorized into three categories: D < 3.5 is low species richness; D = 3.5–5 is moderate species richness; and D > 5 is higher species richness.

Diversity index

The Shannon-Wienner diversity index was calculated based on Krebs (1989) as follows:

$$H' = -\sum_{i=1}^{s} PiLog2Pi \quad (4)$$

where H = Shannon-Wienner diversity index, Log_2 = 3.3219 x log Pi, where Pi = ni/N. N is the total number of individuals in all species. This index was classified into three categories, namely: H'< 2 is lower diversity and unstable community; 2<H'≤4 is moderate diversity and community stability; H'>4 is higher diversity and stable community (Odum, 1993).

Dominance index

The dominance index was calculated based on Odum (1993) using the formula as follows:

$$C = \sum \left(\frac{ni}{N}\right) 2 \quad (5)$$

where C is the dominance index, ni is the total number of individuals in species i, and N is the total number of individuals in all species. The dominance index ranges between 0 and 1. When the index tends to 0, no dominant species occur, and when the index tends to 1, it shows the presence of dominant species. According to Krebs (1989), this index is classified into three categories as follows: 0 < C ≤ 0.5 is low dominance, 0.5 <C ≤ 0.75 is moderate dominance, and 0.75 <C 1.00 is higher dominance.

Similarity index

The similarity index shows how much the community structures are similar to one another.

This index was calculated based on Brower et al. (1998), as follows:

$$SI(\%) = \frac{2C}{A+b} x100 \quad (6)$$

where, SI= similarity index (%), A = total species at location-a, A= total species in location-b, C= total species shared between locations a and b. According to Odum (1993), this index is classified into four categories: 75% – 100% is very similar, 50% – 75% is similar, 25% – 50% is not similar, < 25% is very dissimilar.

Frequency of incidence

The frequency of incidence or local distribution was calculated based on Muchlisin and Azizah (2009), as follows:

$$FOI\ (\%) = Ni/N \times 100 \quad (7)$$

where, FOI is the frequency of incidence (%), Ni is the total number of sampling locations where species-i were found, Nt= total sampling location.

2.4 Data Analysis

Data were presented in the form of tables and figures and then analyzed descriptively by comparing the research with theories and other relevant reports, followed by drawing conclusions. The data were analyzed using statistical analysis in Microsoft Excel.

3. Results and Discussion

3.1 Species Composition, Density, and Distribution

A total of 21 species belonging to three classes of macrozoobenthos, including Gastropoda, Bivalvia, and Malacostraca, were successfully recorded during the study. The photographs of the macrozoobenthos are presented in Figure 2. Gastropoda was observed to be more abundant compared to the other two. Furthermore, this class comprised a total of 12 species, while Bivalvia and Malacostraca had six and three, respectively, as shown in Figure 3. Based on the number of species in each location, Kuala Trumon (St. I) had the highest number of species (nine species), while a lower number of two species was recorded at Pelabuhan Desa Kilangan (St. VII) (Table 1). Based on the total number of individuals, the Impadang site (St. IV) had the highest number (82 individuals), while the lowest was recorded at the Teupin Tinggi site (St. III), namely a total of nine individuals. *Faunus ater* had the highest number of individuals compared to other species, as shown in Table 1.

Figure 2. Macrozoobenthos in the Singkil Peat Swamp collected during the study.

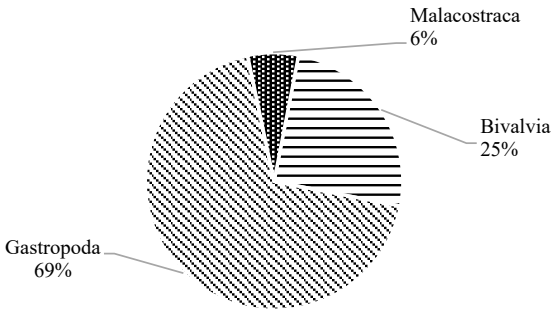

Figure 3. Class composition of macrozoobenthos in the estuary of Singkil peat swamp, Aceh Province, Indonesia.

Table 1. Species composition and total individuals of macrozoobenthos according to sampling location in the estuary of Singkil peat swamp, Aceh Province, Indonesia.

Class	Species	St I	St II	St III	St IV	St V	St VI	St VII	Total Ind.	FOI (%)
Bivalvia	*Acanthocardia tuberculata*	-	5	-	-	-	-	-	5	28.6
	Corbicula fluminea	8		-	8	-	2	-	18	42.9
	Gari crassula	-	2	-	-	-	-	-	2	28.6
	Geloina expansa	2	-	-	16	5	-	-	23	42.9
	Iacra seychellarum	-	-	4	-	-	-	-	4	28.6
	Plebidonax deltoides	-	4	3	-	-	-	-	7	42.9
Gastropoda	*Ancylus sp.*	-	-	-	-	2	-	-	2	28.6
	Brotia herculea	-	-	-	2	-	-	-	2	28.6
	Cerithideopsis scalariformis	3	-	-	-	-	-	-	3	28.6
	Cerithium caeruleum	-	-	-	-	-	-	8	8	28.6
	Clithon sp.	6	-	-	-	-	-	-	6	28.6
	Conus lugubris	-	-	2	-	-	-	-	2	28.6
	Faunus ater	30	2	-	50	20	14	4	120	85.7
	Mauritia arabica	2	-	-	-	-	-	-	2	14.3
	Vittina natalensis	-	-	-	1	2	3	-	6	42.9
	Vittina semiconica	-	-	-	3	-	4	-	7	28.6
	Vittina turrita	-	-	-	2	-	-	-	2	14.3
	Terebralia palustris	-	-	-	-	-	3	-	3	14.3
Malacostraca	*Clibanarius vittatus*	4	-	-	-	2	-	-	6	28.6
	Coenobita sp.	2	-	-	-	-	-	-	2	14.3
	Ocypode pallidula	3	4	-	-	-	-	-	7	28.6
Total Individual		**60**	**17**	**9**	**82**	**31**	**26**	**12**	**237**	
Total Species		**9**	**5**	**3**	**7**	**5**	**5**	**2**	**21**	

Note: St I=Kuala Trumon, St II=Ie Meudama, St III=Teupin Tinggi, St IV=Impadang, St V=Kuala Baru Laut, St VI=Jembatan Kembar, St VII=Pelabuhan Desa Kilangan. FOI= frequency of occurence

Table 2. Distribution patterns of macrozoobenthos in the estuary of Singkil peat swamp, Aceh Province, Indonesia

No.	Species	Morisita index	Category
1	*Acanthocardia tuberculata*	-1.5	Uniform
2	*Ancylus sp.*	-42.0	Uniform
3	*Brotia herculea*	-42.0	Uniform
4	*Cerithideopsis scalariformis*	-12.0	Uniform
5	*Cerithium caeruleum*	3.0	Grouping
6	*Clibanarius vittatus*	1.4	Grouping
7	*Clithon sp.*	3.0	Grouping
8	*Coenobita sp.*	3.0	Grouping
9	*Conus lugubris*	3.0	Grouping
10	*Corbicula fluminea*	1.1	Grouping
11	*Faunus ater*	0.8	Uniform
12	*Gari crassula*	3.0	Grouping
13	*Geloina expansa*	1.6	Grouping
14	*Iacra seychellarum*	3.0	Grouping
15	*Mauritia arabica*	3.0	Grouping
16	*Vittina natalensis*	0.8	Uniform
17	*Vittina semiconica*	1.3	Grouping
18	*Vittina turrita*	3.0	Grouping
19	*Ocypode pallidula*	1.3	Grouping
20	*Plebidonax deltoides*	1.3	Grouping
21	*Terebralia palustris*	3.0	Grouping

The results showed that *Faunus ater* was widely distributed in the Singkil peat swamp, and this species occurred in six of the seven locations studied (FO 85.7%), followed by *Corbicula fluminea, Geloina expansa, Plebidonax deltoides,* and *Vittina natalensis.* Meanwhile, a narrow distribution was observed in *Mauritia arabica*, *Vittina turrita*, *Terebralia palustris*, and *Coenobita* sp., where these species were only found at one site, as shown in Table 1. A total of six species, including Acanthocardia tuberculata, *Ancylus* sp., *Brotia herculea, Cerithideopsis scalariformis, Faunus ater, and V. natalensis,* had a uniform distribution pattern, while the other 15 had a grouping distribution pattern (Table 2). Based on the sampling location, the average density of macrozoobenthos in the Singkil peat swamp ranged from 2.9 ind./m^2, in Teupin Tinggi (St. III), to 27 ind./m^2, in Impadang (St. IV), with an average value of 11.1 ind./m^2. Based on species, the highest density was found in *Faunus ater* (6.6 ind./m^2), while the lowest was recorded in *Gari crassula, Ancylus* sp., *Brotia herculean, Conus lugubris, Mauritia arabica, Vittina natalensis*, *Vittina turrita,* and *Coenobita* sp., as shown in Table 3.

3.2 Ecological Indices

The macrozoobenthic diversity index in the Rawa Singkil area ranged from 0.92 to 2.40, with an average diversity of 1.75, belonging to the low category. Furthermore, the dominance index ranged from 0.22 to 0.56, with an average value of 0.38 in the low dominance category. The species richness index ranged from 2.10 to 4.50, with an average value of 3.17, which was in the medium category. The highest species richness index was found in Kuala Trumon (St. I) at 4.50, as shown in Table 4. The similarity index of macrozoobenthos in the Tripa peat swamp was between 0 to 66.67%, where Impadang (St. IV) and Jembatan Kembar (St. VI) had a higher similarity compared to other locations, as shown in Figure 4.

3.3 Main Water Quality Parameters

The water temperature ranged from 28.6 °C to 33.7 °C, with an average of 30.17 °C, while salinity was between 0 to 22 ppt, with an average value of 5.43 ppt. The dissolved oxygen (DO) in this study ranged from 3.9 mg/L to 6.8 mg/L, with an average of 5.29 mg/L, while the pH was between 4.6 to 8.7, with an average of 7.2, which was the highest (Table 5).

The study showed that gastropods were the most abundant macrozoobenthos found at the study location. This was because gastropods tolerate various types of waters, including marine, brackish, or freshwater, and these organisms could also live on sandy or muddy substrates (Biessy et al., 2019; Kalay & Lewerissa, 2022). Furthermore, the highest number of species was found in Kuala Trumon (St. I), and this location had a sandy clay substrate. This caused the area to be rich in organic material, which was a food source for this biota (Barus et al., 2019). According to Choirudin et al. (2014), the ability of clay to store organic material was greater compared to sand because the substrate had denser pores, leading to better entrapment. Similar research was also obtained by Simanjuntak et al. (2018), where organic material had a strong relationship with sediment texture. Several studies have shown that sediment texture with smaller grain sizes contains higher levels of organic matter, and vice versa. These situations were also supported by the water conditions with pH being neutral, while temperature and dissolved oxygen were within the optimum range (Minggawati, 2013; Sinambela & Sipayung, 2015), leading to the ability of several macrozoobenthic species to live and reproduce in the location.

Table 3. Species density of macrozoobenthos in the estuary of Singkil peat swamp, Aceh Province, Indonesia based on sampling location

Class	Species	Location							Average (ind/m^2)
		St I	St II	St III	St IV	St V	St VI	St VII	
Bivalvia	*Acanthocardia tuberculata*	-	1.6	-	-	-	-	-	1.6
	Corbicula fluminea	2.6	-	-	2.6	-	0.6	-	2.0
	Gari crassula	-	0.6	-	-	-	-	-	0.6
	Geloina expansa	0.6	-	-	5.3	1.6	-	-	2.5
	Iacra seychellarum	-	-	1.3	-	-	-	-	1.3
	Plebidonax deltoides	-	1.3	1.0	-	-	-	-	1.1
Gastropoda	*Ancylus* sp.	-	-	-	-	0.6	-	-	0.6
	Brotia herculea	-	-	-	0.6	-	-	-	0.6
	Cerithideopsis scalariformis	1.0	-	-	-	-	-	-	1.0
	Cerithium caeruleum	-	-	-	-	-	-	2.6	2.6
	Clithon sp.	2.0	-	-	-	-	-	-	2.0
	Conus lugubris	-	-	0.6	-	-	-	-	0.6
	Faunus ater	10.0	0.6	-	16.6	6.6	4.6	1.3	6.6
	Mauritia arabica	0.6	-	-	-	-	-	-	0.6
	Vittina natalensis	-	-	-	0.3	0.6	1.0	-	0.6
	Vittina semiconica	-	-	-	1.0	-	1.3	-	1.1
	Vittina turrita	-	-	-	0.6	-	-	-	0.6
	Terebralia palustris	-	-	-	-	-	1.0	-	1.0
Malacostraca	*Clibanarius vittatus*	1.3	-	-	-	0.6	-	-	1.0
	Coenobita sp.	0.6	-	-	-	-	-	-	0.6
	Ocypode pallidula	1.0	1.3	-	-	-	-	-	1.1
	Total (ind/m^2)	**19.7**	**5.4**	**2.9**	**27**	**10**	**8.5**	**3.9**	

Table 4. Ecological indices of macrozoobenthos in the estuary of Singkil peat swamp, Aceh Province, Indonesia

Location	Diversity index (H')	H' index category	Dominance index (C)	C index category	Species richness index (d)	d index category
Kuala Trumon	2.40	Moderate	0.29	Low	4.50	Moderate
Ie Meudama	2.23	Moderate	0.22	Low	3.25	Low
Teupin Tinggi	1.53	Moderate	0.36	Low	2.10	Low
Impadang	1.74	Moderate	0.42	Low	3.14	Low
Kuala Baru Laut	1.51	Moderate	0.48	Low	2.71	Low
Jembatan Kembar	1.90	Moderate	0.35	Low	2.83	Low
Pelabuhan Desa Kilangan	0.92	Low	0.56	Moderate	3.71	Moderate
Average	1.75	Moderate	0.38	Low	3.17	Moderate

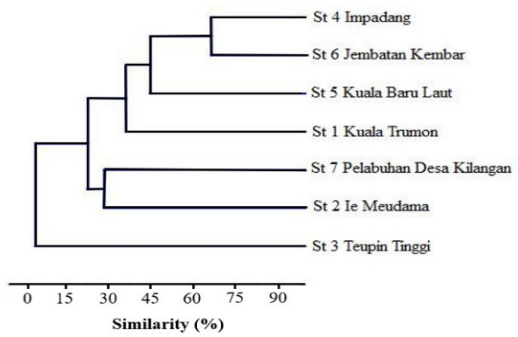

Figure 4. The similarity index of macrozoobenthos in the estuary of Singkil peat swamp, Aceh Province, Indonesia.

Faunus ater was widely distributed in the estuary of the Singkil peat swamp and was found in almost all sampling locations except at Teupin Tinggi (St. III). This was because the species was very adaptable to various types of habitats, including estuaries, lagoons, mangroves, seagrass beds, and tidal areas (Das et al., 2018; Ramadhaniaty et al., 2023). Apart from having the widest distribution in the Singkil gambut swamp estuarine waters, *Faunus ater* also had the highest density compared to other species at every sampling location. According to Indra et al. (2019), *Faunus ater* preferred sandy substrates and this was in line with the conditions of the study location, where the substrate generally contained varying amounts of sand. Desmarina et al. (2022) stated that it had a long lifespan and the ability to regenerate quickly. The study showed that *Faunus ater* had a uniform distribution pattern, showing that it shared a food niche and habitat between individuals (Angraini et al., 2018; Daulima et al., 2021; Momo et al., 2022). Apart from food availability, distribution patterns were also influenced by the ability to adapt to environmental conditions (Suminar et al., 2020). Dewiyanti et al. (2021) stated that *Faunus ater* had a high ability to adapt to environmental conditions and could compete with other macrozoobenthic species for food and space.

There were three species of bioindicators of aquatic environmental health found in this study, namely, *C. fluminea, Geloina expansa*, and *Faunus ater.* These species were well adapted to uncomfortable environmental conditions. *F. fluminea*, for example, was found in two locations, namely Kuala Trumon and Impadang, with a density of 2.6 ind./m^2. In addition, *Geloina expansa* and *Faunus ater* were also found in these locations with high levels of density. Therefore, of the seven research locations, two of them, namely Kuala Trumon and Impadang, have begun to be disturbed, as indicated by the presence of the three bioindicator species.

The distribution pattern of macrozoobenthos in the Rawa Singkil area was mostly in groups, but there were six species with a uniform distribution pattern, including *Faunus ater.* Distribution patterns were influenced by habitat types, such as the physicochemical factors of water and food, as well as the adaptability of biota (Nababan et al., 2017), and uniform distribution patterns were rarely found in wild populations. In this study, the clustered distribution pattern showed that the species were not always found at every sampling station or had fairly large fluctuations in density. *Faunus ater* was the most abundant, frequently found, and widely distributed species in the Singkil peat swamp estuary. However, the dominance index showed a low category except at Pelabuhan Desa Kilangan (St. VI), indicating that there were no dominant species.

Table 5. The main water quality parameter in the estuary of Singkil peat swamp, Aceh Province, Indonesia

Location	Temperature (°C)	Dissolved oxygen(mg/L)	pH	Salinity (ppt)	Sediment type
Kuala Trumon	29.0	5.6	7.5	9	Sandy clay
Ie Meudama	28.9	4.1	7.5	2	Sandy
Teupin Tinggi	28.6	3.9	4.6	0	Sandy
Impadang	28.6	5.1	6.7	3	Sandy
Kuala Baru Laut	28.9	5.9	6.8	2	Sandy
Jembatan Kembar	33.5	6.8	8.7	22	Sandy clay
Pelabuhan Desa Kilangan	33.7	5.6	8.6	0	Dusty clay
Min	28.6	3.9	4.6	0	
Max	33.7	6.8	8.7	22	
Average	30.17	5.29	7.20	5.43	

Conclusions

A total of 21 species belonging to three classes, including Gastropoda, Bivalvia, and Malacostraca of macrozoobenthos, were recorded during the study period. Furthermore, gastropods had a higher number of members compared to the other two classes. *Faunus ater* was the most abundant, frequently found, and widely distributed compared to other species. The macrozoobenthos diversity index in the Singkil peat swamp estuary was classified in the moderate category with a low dominance index.

Conflict of interest

The authors have no conflicts of interest to declare.

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