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Diversity of Mollusca, Arthropods, and Pisces in the Estuarine Areas of Gampong Jawa and Gampong Alue Naga as Implications for the Community Economy

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Abstract: This study aims to analyze the distribution of species on three different transects to evaluate the diversity of aquatic ecosystems and its implications for the economic potential of coastal communities. Sampling methods were carried out on three transects by recording the abundance of 48 species from the mollusk, crustacean, and fish groups. Data analysis included the calculation of the Shannon-Wiener diversity index (H), evenness index (J), and dominance index (C). The results showed that Transect B had the highest total abundance (2,617 individuals) with the highest diversity index (H=2.617) and the best evenness (J=1.094). Dominant species differed on each transect, with Setipinna taty dominating Transect A (500 individuals), Petek (Secutor rocunius) dominant in Transect B (500 individuals) and Transect C (450 individuals). Species distribution showed significant habitat heterogeneity with some species showing specific habitat preferences. From an economic perspective, the presence of high-value commercial species such as kalampa anchovies, green mussels, mangrove crabs, and tiger prawns demonstrates significant potential for the development of capture fisheries, aquaculture, seafood processing, and marine ecotourism. High species diversity opens up opportunities for business diversification that can reduce economic risks and increase incomes in coastal communities. This study recommends sustainable management that integrates conservation with economic development through zoning of water use, establishing sustainable fishing quotas, and developing community capacity in seafood processing.

Keywords: Aquatic Ecosystems; Biodiversity; Coastal communities; Environmental education; Economic Value

Introduction

Estuaries are unique and complex aquatic ecosystems, where freshwater and seawater mix, creating dynamic salinity gradients. These ecosystems boast high biological productivity and serve as important habitats for various aquatic species, including molluscs, arthropods, and fish (Bi et al., 2022; Kenanga et al., 2023). Biodiversity in estuaries is strongly influenced by physical and chemical factors such as salinity, temperature, pH, and nutrient availability, which fluctuate with tidal dynamics (Akmal et al., 2025).

As an archipelagic nation, Indonesia boasts vast and diverse estuary areas, with high biodiversity potential. Aceh Province, particularly its coastal areas, boasts numerous estuary areas that serve as important habitats for various marine organisms. Gampong Jawa and Gampong Alue Naga are two estuary areas in Aceh

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with distinctive ecosystem characteristics and potential for further in-depth study of their biodiversity (Henderson et al., 2019).

Molluscs, arthropods, and Pisces are the three dominant taxa in estuarine areas and have significant economic value for coastal communities. Molluscs such as clams, oysters, and sea snails have economic value as a source of animal protein and raw materials for the craft industry (Ferreira et al., 2019). Arthropods, especially crustaceans such as shrimp and crab, are fishery commodities with high sales value in both domestic and international markets (Mujahidurrasyid, 2023; Nur, 2017). Meanwhile, Pisces, or estuarine fish, play a dual role as a primary protein source for coastal communities and an important trade commodity (Sheaves et al., 2024).

Biodiversity studies in estuaries are highly urgent given that these ecosystems face various anthropogenic pressures such as pollution, land conversion, and overexploitation. Global climate change also contributes to changes in the physical and chemical conditions of estuarine waters, which can affect species composition and distribution (Rinika et al., 2023; Duisan et al., 2021). Therefore, documentation and analysis of biodiversity in estuaries are crucial to support conservation efforts and sustainable natural resource management.

The economic aspect is inseparable from the biodiversity of estuaries (Mangkurat, 2023). Coastal communities, particularly in Gampong Jawa and Gampong Alue Naga, rely heavily on estuarine biological resources to meet their daily needs (Jubaedah et al., 2019). Fishing, shellfish cultivation, and other marine product collection are primary livelihoods that contribute significantly to the local economy (Zuraidah et al., 2020; Sujiwo et al., 2022; Utomo et al., 2025). However, scientific information on species diversity and its economic potential in these two areas remains limited.

This study aimed to assess the diversity of mollusks, arthropods, and fish in the Gampong Jawa and Gampong Alue Naga estuaries and analyze its implications for the local economy (Sirih et al., 2024). The results are expected to provide comprehensive baseline information on the potential of estuarine biological resources and their contribution to the well-being of coastal communities, thereby supporting the development of sustainable and scientifically based management strategies (Irwansyah et al., 2022; Hartati & Rahman, 2016; Siregar et al., 2023; Zamdial et al., 2019; Rozirwan et al., 2024; Ginting, 2023; Wilopo et al., 2023).

Method

This study was conducted in the Gampong Jawa estuary area, Kuta Raja District, and Gampong Alue Naga, Syiah Kuala District, Banda Aceh City, Indonesia, from June to July 2025. Sampling locations were selected using purposive sampling based on different ecological types and environmental conditions. Sampling was conducted by fishermen using gillnets (mesh size 2.5 cm), Angkoi (traps), traps, hand nets, cast nets, and 10 medium-sized hooks, which were placed at each station. Sampling was conducted twice daily, from morning to evening. Specimens collected at each station were counted and photographed in the field. After collection, specimens were preserved in 7% formalin solution (Hasan et al., 2019; Insani et al., 2022), labeled according to the local name, station, and date of collection, and transported to the laboratory for identification. Molluscs, arthropods, and fish were identified using manuals from Allen (1999), White et al. (2013), and Froese et al. (2022).

Data Analysis

The number of specimens (N), species composition, diversity, uniformity, and dominance were compared between sampling stations and analyzed descriptively. The Shannon diversity index (H') is used to estimate species diversity: Shannon-Wiener Diversity Index (H') Used to measure the level of species diversity, calculated using the formula:
Shannon-Wiener Diversity Index (H') used to measure the level of species diversity, calculated using the formula:

$$H' = -\sum(p_i ln\ p_i) \quad (1)$$

Where:
H' = diversity index
$p_i = \frac{ni}{N}$ (proportion of individuals of species i)
i = Number of individuals of species ke-i
N = the total number of individuals of all species.
Evenness Index (E) describes how evenly individuals are distributed across species:

$$E = \frac{H'}{\ln S} \quad (2)$$

Where:
E = Equity index
H' = Shannon-Wiener diversity index
S = Total species
Indeks Simpson's Dominance Index (D) indicates the dominance of a particular species in a community:

$$D = \sum \left(\frac{n_i}{N}\right)^2 \quad (3)$$

Where:
D= Dominance index

n_i= Number of individuals of a species i
N = Total individuals of all species

Result and Discussion

Mollusks, Arthropods, and Fish Found in the Estuarine Area of Gampong Jawa and Gampong Alue Naga. A total of 33 species of mollusks, arthropods, and fish were collected. The abundance of species in this area is influenced by the abundance of available food and the strong ocean waves.

The shallow waters allow all species in the estuary ecosystem to survive. Most of the specimens collected were subadults or adults, which may be related to the size of the nets used in this study. All species of mollusks, arthropods, and fish captured were native to the estuary area, and no foreign species were found during sampling, such as tri and other exotic fish (Hasan et al. 2020a; Hasan et al., 2020; Insani et al., 2020; Serdiati et al., 2020; O'Mara et al., 2024; Fitriadi et al., 2022; Canonico et al., 2005). This indicates that the estuary ecosystems of Gampong Jawa and Gampong Alue Naga are still well-maintained (Hasan et al., 2020; Mangitung et al., 2021; Serdiati et al., 2021; Maddern et al., 2007; Salim et al., 2024).

Figure 1. Diversity of mollusks, arthropods and fish in estuarine areas, *Nerita columbella, Anadara granosa, Plicatula plicatula, Verna viridis, Melania testudinaria, Lottia limunata, Anodonta woodiana, Curbicula. Sp, Uca demani, Charybdis cruciate, Pagurus, Thalamita crenata, Ocypode cordimanus, Scylla serrata, Acrobraciun rosenbergii, Sepiida suborder, Loligo. Sp Clupanodon thrissa,, Sardinella jussieui, Setipinna taty, Secutor rocunius, Upeneus sulphureus, Grammoplites scaber, Ilisha elongate, Trichiurus lepturus, Scomber lysan, Equulites elongatus, Tylosurus crocodilus, Gerres erytrhrourus, Cynoglossus puncticeps, Siganus canaliculatus, Crenimugil seheli, Scatophagus argus*

Table 1. Diversity of Mollusca, Arthropod and Fish Species

Spesies/ scientific name	Local name
Nerita columbella	Kieong Batik
Anadara granosa	Kreung Darah
Plicatula plicatula	Tiroum Bangka
Verna viridis	Krueng ijou
Melania testudinaria	Sumpil
Lottia limunata	Kieong lipeih
Anodonta woodiana	Kiejing
Curbicula. Sp	Remaah
Uca demani	Bieng bina-tu
Charybdis cruciata	Rajung Krang
Pagurus	Kelomang
Thalamita crenata	Rajung ijou
Ocypode cordimanus	Bieng Lehopp
Scylla serrata	Bieng Bangka
Acrobraciun rosenbergii	Udeung Galah
Sepiida suborder	Noh/Sotong
Loligo. Sp	Cumie
Clupanodon thrissa	Senagin
Sardinella jussieui	Tambant
Setipinna taty	Billeh ue
Secutor rocunius	Peuteuk
Upeneus sulphureus	Eungkot pisang
Grammoplites scaber	Baji/pasaak
Ilisha elongate	Baleek Mata
Trichiurus lepturus	Layuran
Scomber lysan	Tlang-Tlang
Equulites elongatus	Cirik Buju
Tylosurus crocodilus	Caroang buju
Gerres erytrhrourus	Kipah-Kipah
Cynoglossus puncticeps	Liedah
Siganus canaliculatus	Barounang
Crenimugil seheli	Belaneuk
Scatophagus argus	Cabeh/jabeh

Population and Ecological Aspects of Fish in Estuarine Areas

Total number of individuals (N) The total number of individuals (N) of each species of mollusk, arthropod, and fish varied (Figure 3). In addition, 4,080 samples of mollusk, arthropod, and fish were collected from the estuarine areas of Gampong Jawa and Gampong ALue Naga. The highest number of individuals was obtained from station 1 (1,546 individuals), followed by station 2 (1,370 individuals) and station 3 (1,164 individuals). At all stations spesies Mollusk, Arthropod, and fish species consisting of Billis Ue (*Setipinna taty)* and Tamban (*Sardinella jussieui*) were recorded as the most dominant, with 955 and 410 individuals, respectively. The *Engraulidae* family is a group of pelagic fish that use mangrove environments as spawning and feeding grounds, often found in lower rivers, estuaries, and tidal areas. The family with the most species found at all stations (Ibrahim at al., 2018; Halim, 2015; Maurya & Mahajan, 2025; Khanjani et al., 2025).

Based on species distribution data across three different transects, this study analyzed 33 species from various taxonomic groups including mollusks, crustaceans, and fish. The results showed significant variations in species composition and abundance across each observation site, with Transect A having the highest total abundance of 1,546 individuals, followed by Transect B with 1,370 individuals, and Transect C with 1,164 individuals. These differences in abundance indicate differences in habitat conditions or environmental factors influencing species distribution across the three sites.

Table 2. Distribution of Diversity of Mollusk, Arthropod and Fish Species in Estuarine Areas

Spesies/ scientific name	Transect A	Transect B	Transect C
Kieong batik *(Nerita columbella)*	40	80	20
Kreung darah (*Anadara granosa*)	12	25	5
Tiroum Bangka (*Plicatula plicatula*)	30	62	20
Kerang hijau (*Verna viridis)*	120	35	20
Sumpie (*Melania testudinaria)*	50	100	50
Kiong lipeh (*lottia limunata)*	10	28	21
Kijing (*Anodonta woodiana)*	10	32	12
Remaahs (*Curbicula.Sp*)	100	5	35
Bieng bangka *(uca demani)*	45	45	35
Udeung plang *(parapenaeopsis sculptilis)*	15	4	8
Rajungan bintang *(Portunus sanguinolentus)*	10	5	3
Kepiting batu *(Grapsus tenuicristatus)*	10	3	10
Bieg lauhopo *(Ocypode cordimanus)*	7	8	5
Noh/ (*Sepiida suborder)*	2	3	2
Cumi-cumi (*Loligo. Sp*)	10	5	2
Udeung galah *(Macrobraciun rosenbergii)*	12	4	2
Udang pueteh *(Metapenaeus ensis)*	10	43	5
Senagin (*Clupanodon thrissa)*	30	25	20
Tambant *(Sardinella jussieui)*	120	200	90
Billih ue (*Setipinna taty)*	500	5	450
Pueteuk *(Secutor rocunius)*	50	350	50

Spesies/ scientific name	Transect A	Transect B	Transect C
Eungkot Pisang *(Upeneus sulphureus)*	10	47	70
Baji/pasaak *(Grammoplites scaber)*	10	5	2
Baleak Mata *(Ilisha elongate)*	60	10	15
Layurann *(Trichiurus lepturus)*	45	13	21
Tlang-tlang *(Scomber lysan)*	15	20	8
Ciriek Buju *(Equulites elongatus)*	80	5	90
Caroang buju *(Tylosurus crocodilus)*	10	5	7
Kipah/kipah *(Gerres erytrhrourus)*	4	2	10
layouh-layuh *(Pterophyllum imei)*	4	5	7
Baronang/*Siganus canaliculatus*	10	67	10
Beulanuek/ *Crenimugil seheli*	25	54	16
Cabeeh/jabeh *Scatophagus argus*	80	70	43
Jumlah	1546	1370	1164

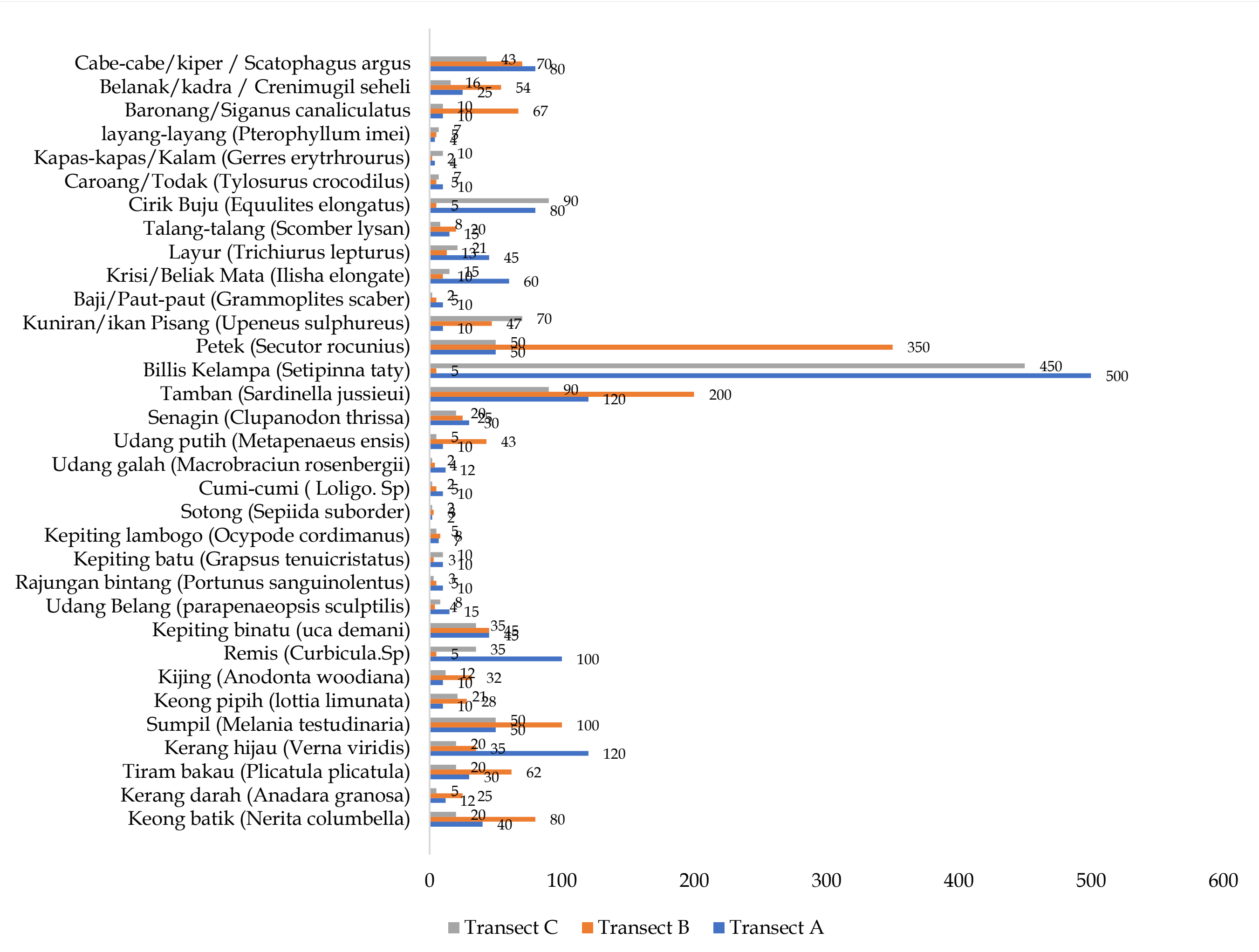

Figure 2. Number of specimens (N) of the Mollusca, Arthropod and fish assemblages in the estuary area during sampling in the estuary area

Analysis of dominant species showed interesting patterns across each transect. In Transect A, Setipinna taty dominated with 500 individuals, followed by Sardinella jussieui and Verna viridis with 120 individuals each, and Curbicula sp with 100 individuals. In Transect B, Stolephorus indicus was the most dominant species with 900 individuals, the highest abundance in the entire study, followed by Secutor rocunius with 350 individuals and Sardinella jussieui with 200 individuals. Meanwhile, in Transect C, Setipinna taty again showed dominance with 450 individuals, Sardinella jussieui and Equulites elongatus with 90 individuals each, and Upeneus sulphureus with 70 individuals (Sheaves et al., 2024).

Species distribution patterns indicate diverse habitat preferences. Several species, such as Melania testudinaria, Uca demani, and Sardinella jussieui, exhibited relatively stable distributions across all three transects, indicating good adaptation to a variety of habitat conditions. Conversely, many species exhibited clear habitat preferences, such as Stolephorus indicus, which was very high in Transect B but low in Transect A, Verna viridis, which was high in Transect A but low in other transects, and Curbicula sp., which showed extreme variation between transects.

Ecological indices provide a more in-depth look at community structure. The highest diversity index (H) was found in Transect B (2.617), followed by Transect A (2.556) and Transect C (2.396), indicating that Transect B has the habitat conditions most conducive to species diversity. The evenness index (J) was also highest in Transect B (1.094), indicating the most even distribution of individuals among species. Interestingly, the dominance index (C) was also highest in Transect B (0.165), indicating the presence of a few species dominating despite high diversity.

The taxonomic composition shows that the fish group with 21 species exhibits the most varied distribution patterns, with Stolephorus indicus and Setipinna taty being the dominant species indicating specific habitat preferences. The crustacean group with 14 species

Showed significant variation in distribution, while the 11 mollusk species generally showed good adaptation to a variety of habitat conditions. These differences in distribution are likely influenced by environmental factors such as substrate conditions, depth, salinity, water quality, food availability, interspecific competition, and predation pressure.

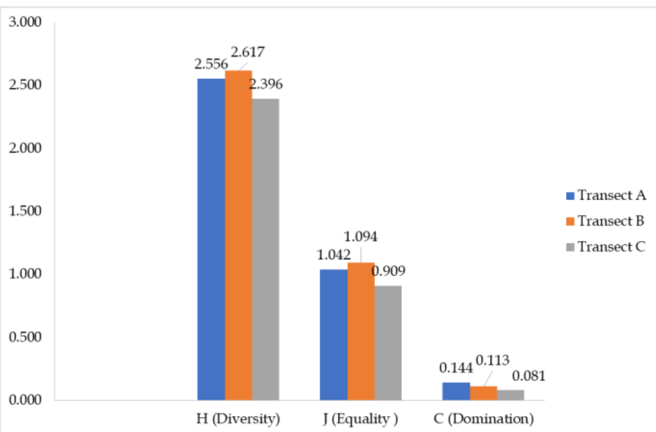

Figure 3. Distribution of diversity of mollusk, arthropod and fish species in estuarine areas

The habitat characteristics of each transect were unique. Transect A appeared to be a habitat that strongly supported certain species such as Setipinna taty and Verna viridis. Transect B was the most diverse habitat with the highest diversity and strongly supported Stolephorus indicus. Transect C was a habitat with low dominance but moderate diversity. These data indicate that species distributions varied significantly across transects, reflecting significant habitat heterogeneity and species adaptation to specific environmental conditions and complex ecological interactions within aquatic ecosystems.

Diversity of Mollusks, Arthropods and Fish for Community Economic Development

The implications for improving the community's economy from this species distribution data are significant. The high abundance of economically valuable species such as *Stolephorus indicus*, *Setipinna taty,* and Sardinella jussieui in all three transects indicates the potential for developing a capture fisheries industry that can increase the income of local fishermen. The presence of crustacean species such as *Scylla serrata* (mud crab), striped shrimp (*parapenaeopsis sculptilis*), and Uca demani can support the development of cultivation and fishing that provide added economic value. Mollusk species such as *Anadara granosa* (blood cockle) and various types of gastropods can be developed as processed food products or souvenirs that enhance the creative economy of coastal communities.

The high species diversity, particularly in Transect B, opens up opportunities for fisheries business diversification, reducing the risk of dependence on a single commodity. Communities can develop seafood processing businesses, such as fish crackers, shrimp paste, fish floss, and other processed products with higher sales value. The presence of endemic and unique species can also support the development of marine ecotourism, providing alternative income sources for local communities through tour guide services, boat rentals, and the sale of handicrafts.

To optimize this economic potential, a sustainable management strategy that takes environmental carrying capacity into account is needed. Developing environmentally friendly fishing technologies, establishing organized fishing groups, and increasing community capacity in seafood processing can increase economic added value. Furthermore, further studies are needed on optimal fishing seasons, establishing sustainable fishing quotas, and developing effective marketing systems to maximize economic returns while preserving aquatic resources.

Conclusion

Species distribution studies across three transects revealed significant habitat heterogeneity. Transect B had the highest species diversity (H=2,617) and the highest total abundance (1,546 individuals), making it the location with the greatest economic potential, *primarily* due to the dominance of *Stolephorus* indicus, a high-value export commodity. Transects A and C each had unique characteristics, with the dominance of *Setipinna taty*, which also has significant economic value as a raw material for the seafood processing industry. The varied distribution of species across transects reflects complex ecological adaptations and opens up opportunities for economic diversification in coastal communities. The presence of 46 species from various taxonomic groups, including high-value species such as anchovies, anchovies, green mussels, mangrove crabs, and tiger prawns, demonstrates significant potential for the development of capture fisheries, aquaculture, seafood processing, and marine ecotourism. Ecological indices showing high diversity but with certain dominant features indicate the need for management. The presence of 33 species from various taxonomic groups, including species, seafood processing, and an integrated management approach that combines conservation and community economic development, are important. This species distribution data can provide a scientific basis for planning water use zones, establishing sustainable fishing quotas, and developing business diversification strategies that support the well-being of coastal communities.

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Conceptualization, methodology, formal analysis, investigation, resources, data curation, and original draftwriting: I.; validation, review and editing, and visualization: A.R., J., A., D.A and N.A All authors have read and approved the published version of the manuscript.

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All author declares that there is no conflict of interest.

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