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Abundance and distribution pattern of macroinvertebrates at Watu Lumbung Beach, Gunungkidul, Yogyakarta

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ABSTRACT. Macroinvertebrates are one of the bioindicators in aquatic ecosystems. The diversity and distribution patterns of functional groups of macroinvertebrate communities are assessed to determine water quality. The objective of this research was to figure out the abundance and distribution of macroinvertebrates in Watu Lumbung Beach, Gunungkidul, Yogyakarta. This study was conducted in May 2022 with the quadrat transect method using 1×1 m quadrats along Watu Lumbung Beach, Gunungkidul, Yogyakarta. Sampling was conducted at two randomly determined stations from the lowest low tide to the middle of the sea. The first station is located near Watu Lumbung reef, which has a distance of 50 m, while the second station is 250 m from the reef, so the distance between stations is 200 m. The Shannon-Weiner diversity index (H') was calculated by analyzing the data. The data obtained in this study are the results of the inventory of macroinvertebrate species at each sampling point and the number of individuals of each species. The results showed the abundance of macroinvertebrates on Watu Lumbung beach found as many as 16 species belonging to 13 families and classified into nine classes (Polychaeta, Malacostraca, Anthozoa, Echinoidea, Ophiuridae, Gastropoda, Polyplacophora, Pilidiophora and Demospongia). The family Ophiocomidae (*Ophiocoma erinaceus* and *Ophiocoma scolopendrina*) were the most abundant species at both observation stations. The diversity index is 1.94, which shows that the diversity of macroinvertebrates on Watu Lumbung Beach is categorized as moderate.

Keywords: Distribution pattern, diversity index calculation; macroinvertebrates; species abundance; Watu Lumbung Beach

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INTRODUCTION

Indonesia is a maritime state defined as a country that maximally utilizes sea waters to conduct shipping and commerce activities (Wantimpres, 2017; Dewi, 2023). Consistent with the topography of Indonesia, characterized by waters covering 6.4 million km^2 and a coastline of 95181 km encompassing over 17504 islands, Indonesia earns recognition as one of the world's most incredible archipelagos (BIG, 2019; Maulana *et al*., 2023). One of the regions in Indonesia that is rich in water zones, especially in the form of beaches, is the province of Yogyakarta, especially in Gunungkidul Regency. Based on data from the Gunungkidul Regency Tourism Office in 2022, 62 beaches have been developed and utilized by local managers and residents as ecotourism destinations (Dinas Pariwisata Gunungkidul, 2022). One of the developed tourist destinations is the Watu Lumbung Beach in Balong Village, Girisubo District. However, very few visitors are still interested in coming to it. Apart from the steep access to the location due to the contours of the rocks, information about the richness of the biota and its usefulness for the community has yet to be optimized. Watu Lumbung Beach is flanked by Wediombo Beach and Gunung Batur Beach, which are located jutting into the sea, separated from the beach, and dominated by karst hills. The beach is fronted by a rim of fragmented coral rocks. The geological origin of this rocks is likely multifaceted, potentially stemming from erosion of Mount Batur, adjacent nature reserves, terraced agricultural landscapes, and the surrounding karstic environment inhabited by long-tailed macaques. Notably, two distinct rock formations are situated within the bay: the larger Watu Lumbung and the smaller Watu Semar.

The coral ecosystem that forms Watu Lumbung Beach can support various marine biota to survive or as a habitat for many species. Our similar studies have been conducted in the Gunungkidul area, including at Nglambor Beach, obtained Mollusca (*Monetaria* sp., *Conus* sp., *Nerita* sp.), Arthropoda (*Episesarma* sp. and *Tiarinia* sp.), Echinodermata (*Ophiochoma* sp., *Echinometra* sp., *Holothuria* sp.), Nemertea (*Baseodiscus* sp.), and Annelida (*Nereis* sp., *Perinereis* sp., *Sabella* sp.) (Aliyani, 2021; Rahmawati, 2021). In a study conducted by Wulandari and Mardiana (2022) on Krakal Beach and Kukup Beach, Gunungkidul, species from the phylum Coelenterata (*Anthopleura xanthogrammica*), Echinodermata (*Echinometra lucunter* and *Echinometra mathaei*), Arthropoda (*Brachyura* sp., *Pilumnus* sp., and *O. erinaceus*), and Mollusca (*Melanoides tuberculata* and *Conus textile*) were found. Several species from two classes of the Echinodermata phylum, including two from Ophiuroidea (*O. erinaceus* and *O. dentata*), three Echinoidea (*Echinometra oblonga*, *Echinometra Nathalie*, and *Echinothrix diadema*) species were discovered at Pok Tunggal Beach in Gunungkidul (Pakpahan *et al*., 2020). Added by Mufida *et al*. (2023) in Drini Beach, Gunungkidul, several macroinvertebrate species were found, including *O. erinaceus, O. scolopendrina, Echinometra mathaei, Tripneustes gratilla, Heterocentrotus trigonarius, Diadema setosum,* and *Holothuria notabilis*. The findings of aquatic biota from various studies show that this beach in Gunungkidul has a high abundance. Macroinvertebrates are animal that do not have a spinal structure and live in the bottom substrate of seawater naturally (indigenous residence) they can be seen directly without the help of special tools with a size <0.1 mm, while mature animals are about 3-5 cm (Nurman, 2023).

The diversity and presence of macroinvertebrates significantly impact habitat conditions, bottom substrate, current speed, turbidity level, nutrient content, and dissolved oxygen concentration (Asmamaw *et al*., 2021; Mykrä *et al*., 2021; Duque *et al*., 2022). The presence of macroinvertebrates on a rocky beach such as Watu Lumbung Beach is strongly influenced by physicochemical factors because macroinvertebrates are sensitive to environmental changes such as tides from the upper to lower intertidal zone and changes in environmental variables that occur similarly to those on the shore, consisting of temperature, salt, pH, and oxygen. Therefore, macroinvertebrates can act as indicators of aquatic ecology, where the abundance of species in macroinvertebrates is used as a reference to determine the quality of a water body (Balderas *et al*., 2016; Mzungu *et al*., 2022).

The abundance and diversity of macroinvertebrate organisms must be measured to develop strategies for preserving aquatic biodiversity and its distribution. The purpose of this study is to identify the abundance and distribution of macroinvertebrates. Watu Lumbung Beach was selected due to its unexplored and unprecedented diversity of macroinvertebrates. As a result, it is imperative to study macroinvertebrates at Watu Lumbung Beach, Gunungkidul, Yogyakarta, to ascertain their prevalence and spatial arrangement.

MATERIALS AND METHODS

This study was conducted at Watu Lumbung Beach, Gunungkidul, Yogyakarta region, at coordinates 8°11'9 "S 110°42'1 "E (Fig. 1).

Data collection. Sampling was conducted in May 2022 at 12:00-16:00 WIB (when the beach was at low tide). Meanwhile, identification, description, and other data analysis were conducted in June 2022. Sampling was carried out at two stations, which were determined randomly. The first station is 50 m from the Watu Lumbung reef, while the second station is 250 m from the reef, so the distance between stations is 200 m. Tools and materials used in this study include shovels, tweezers, trays, cameras, stationery, and 70% alcohol. Data were collected by sweeping the two stations and utilizing a 1×1 m cylinder pipe set and the quadratic transect approach (Rahmawati, 2021). The placement of quadratics every 10 m along the transect represents the places during which macroinvertebrate samples were obtained. Preliminary data were obtained by observing and documenting the macroinvertebrate fauna encountered during the sweep. The macroinvertebrate fauna in question are invertebrates that measure more than 0.5 mm (Wührl *et al*., 2022).

Macroinvertebrates found were also taken by as many as 2-3 individuals of each type using the hand sampling method to be collected as samples. Then, from the initial data, identification, classification, and description of the species found will be carried out. Identification techniques and descriptions of macroinvertebrate fauna are based on morphological characteristics (directly), referring to http://www.wildsingapore.com, animal diversity web, and world register of marine species (WoRMS) at http://www.marinespecies.org/.

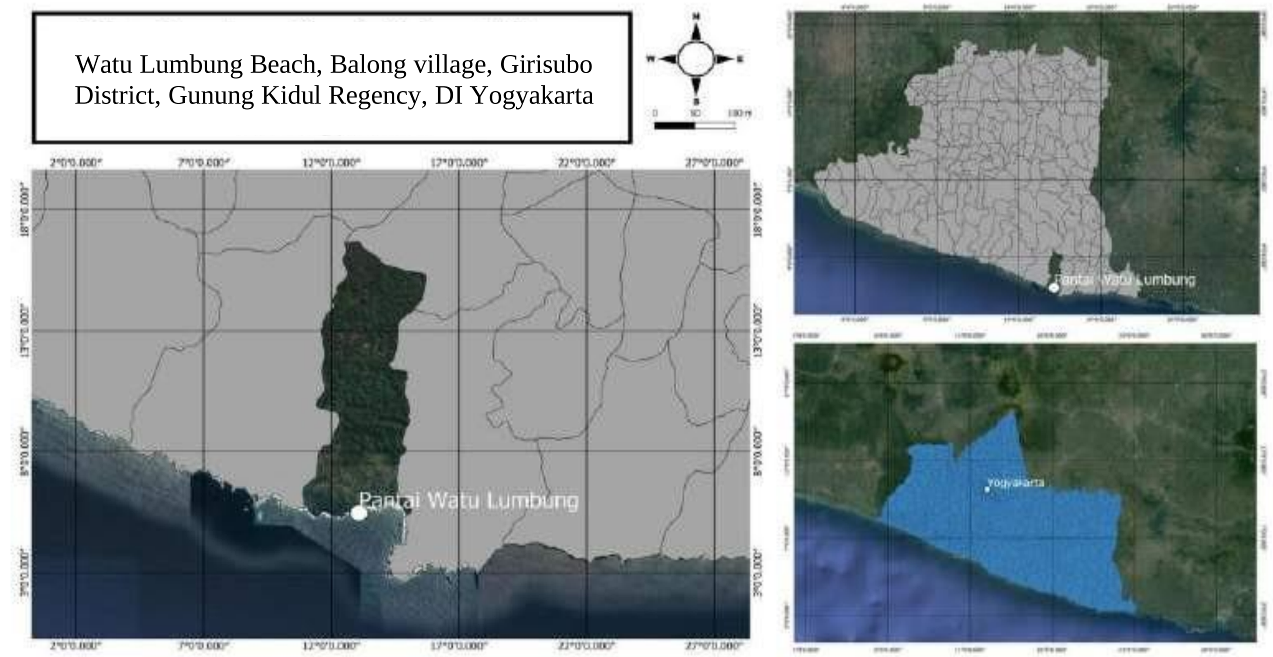

Fig. 1. Study sites in Watu Lumbung Beach, Gunungkidul

Environmental factors. pH and water temperature were measured during the sample collection technique. Two stations, stations I and II, measure the habitat parameters. We utilize a thermometer to measure the temperature and a pH meter to measure the pH. The pH meter is first calibrated using a pH buffer before inserting it into the water for ± 5-10 s.

Data analysis. Data collected using the method described below to estimate species abundance (Odum, 1971):

$Magdalef\ Index\ (D) = S\text{-}1/LogN$

$Shannon\text{ - }Wiener\ Index\ (H') = -\sum Pi \ln Pi$

$Pielou\ Index\ (e) = H'\ lnS$

Note: S= Total number of species; N= Total number of observed individuals; ni= The number of i individuals; Pi = ni/N

Determines the proportion of the total number of individuals that a given number of individuals represents. It can be calculated using the formula as follows (Odum, 1971):

$RA = ni/\mathrm{N} \times 100\%$

Note: RA= Relative abundance; N= Total number of observed Individuals; ni= The number of i individuals

The distribution pattern of macroinvertebrate species can be determined by estimating the average value and standard deviation (Odum, 1971):

$\mathrm{V} = \sqrt{2}/n - 1$

To calculate the mean value, the following formula used as follows (Odum, 1971):

m = n/N

Note: V= Variant value; n= Number of individuals; m= mean; N=Total number of individuals

There are three distribution patterns for individual organisms in nature: random, uniform, and clumped (Chabal & Heinz, 2021). These patterns provide the following outcomes: v = m; the pattern of distribution random; v > m; the pattern of distribution clumped; and v < m; the pattern of distribution uniform. Relative abundance determines the proportion of individuals to the total numbers. The following formula can calculate it.

RESULTS AND DISCUSSION

Observation results. There was a total of 118 species identified in the current study, 16 of which belonged to the 13 families and nine classes (Polychaeta, Malacostraca, Anthozoa, Echinoidea, Ophiuridae, Gastropoda, Polyplacophora, Pilidiophora and Demospongia) (Table 1). The five largest species discovered at Watu Lumbung Beach were *Ophiocoma erinaceus, Ophiocoma scolopendrina, Arbacia lixula, Conus coronatus,* and *Coenobita* sp. The least number of macroinvertebrate species were *Portunus pelagicus* (Portunidae), *Drupella margariticola* (Muricidae), *Tonicella lineata* (Tonicellidae), and *Baseodiscus hemprichii* (Valenciniidae). No previous data on the macroinvertebrates found at Watu Lumbung Beach were recorded. When grouped according to their functional groups, the functional groups of macroinvertebrates found at Watu Lumbung Beach are shown in Table 1.

Table 1. Functional groups of macroinvertebrates found at Watu Lumbung Beach

Phylum	Class	Family	Species	Σ Individual
Annelida	Polychaeta	Nereidae	*Nereis virens*	3
Arthropods	Malacostraca	Coenobitidae	*Coenobita* sp.	5
Arthropods	Malacostraca	Portunidae	*Portunus pelagicus*	1
Cnidaria	Anthozoa	Poritidae	*Porites murrayensis*	2
Echinodermata	Echinoidea	Arbaciidae	*Arbacia lixula*	6
Echinodermata	Echinoidea	Arbaciidae	*Arbacia punctulata*	2
Echinodermata	Ophiuridae	Ophiocomidae	*Ophiocoma erinaceus*	42
Echinodermata	Ophiuridae	Ophiocomidae	*Ophiocoma scolopendrina*	35
Mollusca	Gastropods	Columbellidae	*Pardanilops testudinaria*	2
Mollusca	Gastropods	Conidae	*Conus coronatus*	6
Mollusca	Gastropods	Cypraeidae	*Monetaria annulus*	3
Mollusca	Gastropods	Muricidae	*Drupella margariticola*	1
Mollusca	Gastropods	Muricidae	*Semiricinula turbinoides*	3
Mollusca	Polyplacophora	Tonicellidae	*Tonicella lineata*	1
Nemertea	Pilidiophora	Valenciniidae	*Baseodiscus hemprichii*	1
Porifera	Demospongiae	Chalinidae	*Haliclona caerulea*	5

Based on the observations, the type of bottom substrate in each plot of the research location is rocky, and some have seagrass bottom substrate. According to Rahmadhani and Martuti (2023), the type of bare substrate is one of the factors that can influence and indicate the existence of variations in macroinvertebrates; a stiff bare substrate will be different from a soft primary substrate. Mikuś *et al*., (2021) stated that rigid bottom or rough substrates can form suitable living spaces compared to soft substrates and are more conducive to distributing food sources for macroinvertebrates. The rocky bottom substrate type allows aquatic macroinvertebrate species to bury themselves by burrowing into the substrate (sedentary) (Mason & Sanders, 2021). This can be seen from the results of the identification of macroinvertebrate functional groups at Watu Lumbung Beach, including many macroinvertebrates from the phyla Arthropoda, Mollusca, and Annelida that can dig holes in the bottom substrate of waters, one of which is a craggy bottom substrate. This is reinforced by the opinion of Korbel *et al*. (2019) and Atapaththu (2023) that macroinvertebrates are generally able to dig holes in the bottom substrate of waters that cannot swim freely, which includes species from the phylum of annelids, mollusks, platyhelminths, nematodes, and arthropods.

O. erinaceus was the most abundant species obtained at this study site at collection stations 1 and 2. *O. erinaceus* is frequently observed in coral crowns in deeper waters (Andilala *et al*., 2020). *O.*

erinaceus inhabits coral heads, while other species inhabit fragments of coral and colonies of the green alga Halimeda. This species can change its color (Lesti *et al*., 2021). *O. erinaceus* is generally uniformly black throughout the body and elongated, with thick and short spines on the arms and cream-colored tube feet (Amini *et al*., 2014; Boissin *et al*., 2016). *O. erinaceus* is the holotype animal with a diameter of approximately 17 mm and an arm's length of up to 12 cm, a disc diameter of 20 mm, and is pentagonal with a slight interradial on each side. The dorsal disc is covered with granules 0.15 mm in diameter and is a nocturnal and benthic animal. Habitats are found on coral reef flats, sand-substrate seagrass areas, coral fragments in shallow water, and coral sublittoral areas such as reefs, coral shoals, coral crevices, coral pits, and dead corals (Risjani *et al*., 2021; Selamat *et al*., 2021).

The following species found during this study was *O. scolopendrina*. The ventral disc has a lighter and varied coloration. Colors are lighter below, patchy, or occasionally even dark above (Fatemi & Stöhr, 2019). The arm length reaches 13 cm, and the disc diameter reaches 20 mm. *O. scolopendrina* comprises five arms that capture food particles on the water's surface during tides (Goharimanesh *et al*., 2023). Habitats are found on the bottom (benthic), in littoral areas, and crevices of large rocks. *O. scolopendrina* refers to the genus *Ophiocoma*. It is in intertidal rock pools and under boulders (Lesti *et al*., 2021). This species appears well-adapted to extreme environments/conditions, tolerating temperatures up to 40°C and extensive variations in water salinity (Andilala *et al*., 2020). Due to this capacity, these two species are widespread on Gunung Kidul's beaches, including Watu Lumbung Beach. The high abundance of these species is possible because of the availability of the primary food source for *O. erinaceus* and *O. scolopendrina*, which is suspended particles and material in the water, as well as bacteria attached to sediments. Thus, these two species are essential in coral reef trophodynamics, an association between decomposing organisms, the primary producers, and upper-level consumers (Andilala *et al*., 2020).

Diversity, evenness, and abundance. The results of calculations and analyses are presented in Table 2. Based on the diversity index calculation, it is known that the macroinvertebrates found on Watu Lumbung Beach show a diversity index value (H') of 1.94, which is classified into the medium category. Diversity is a systematic description of the community's structure and can aid in interpreting data related to the number of types of organisms (Rahmawati, 2021). The number of species in the community impacts the biota's diversity and uniformity in the community. The value of diversity depends on the number of individuals in each species (Roswell *et al*., 2021). Consequently, the greater the number of species, the greater the diversity. The aquatic macroinvertebrate species diversity index can be a benchmark for indicating the condition of aquatic ecosystems because they have a tolerance threshold for changes and the quality of their habitat aquatic ecosystems to maintain their body metabolism (Sumudumali & Jayawardana, 2021).

Table 2. Diversity, evenness, and abundance index in the Watu Lumbung Beach.

Parameters	Value
Total number of individuals	118
Total number of species	16
Diversity index (H')	1.94
Evenness index (e)	0.70
Richness index (D)	0.21

The ecosystem of Watu Lumbung Beach is relatively stable, which can be attributed to the presence of sufficient food source factors, suitable substrate conditions, and other factors, such as the moderate diversity of macroinvertebrates in Watu Lumbung Beach, which indicate a moderate amount of produce in Watu Lumbung Beach. The beach's evenness (e) is 0.70; according to Ezenwa *et al*., (2023), this value indicates that the community is even. In general, this research site has no species dominance because several species are obtained with only one individual, so the dominance value is low.

The relative abundance. *O. erinaceus*, through a relative abundance of 35.59 %, was the species most frequently observed. The appropriateness of the organism in the ecosystem affects the large number of *O. erinaceus*. *O. erinaceus* utilizes algae as its primary food source while frequently anchored in rough or rocky terrain (McClanahan & Muthiga, 2020). This is consistent with the condition of the research area, which consists solely of stony substrates and is overrun with algae. This is also reinforced by the statement of Gao *et al*. (2024) that rough substrate conditions affect food distribution, where rough substrates can facilitate the growth of algae and accumulate organic material, which is essential for the survival of macroinvertebrates. The pattern of clumped distribution is the most prevalent. It is more likely that a population will form clusters of varying sizes to facilitate interaction between individuals. Local habitat factors also affect the clumped distribution pattern, which causes organisms to form clumps in response. This was implemented as a method of survival for the individual if sustenance source, climate, habitat, and reproduction type all change in the future (Dewi, 2018). The distribution pattern of four species, *Baseodiscus hemprichii*, *Drupella margariticola*, *Portunus pelagicus,* and *Tonicella lineata*, couldnot be evaluated due to the discovery of only one specimen during sampling. When it was attempted to be analyzed, it returned a variant with the value of 0, rendering its determination impossible.

An approach for quantifying the proportion of individuals belonging to a particular species within a community is termed relative species abundance (Chao & Chiu, 2016). This metric, along with species richness, serves as a fundamental component of biodiversity indices. Relative abundance plays a crucial role in the collection of marine biota diversity data. It offers an estimate of species population size while minimizing sampling effort, particularly advantageous for species that are challenging to monitor or capture directly. Additionally, several indicators may exhibit varying sensitivity to the same ecological parameters.

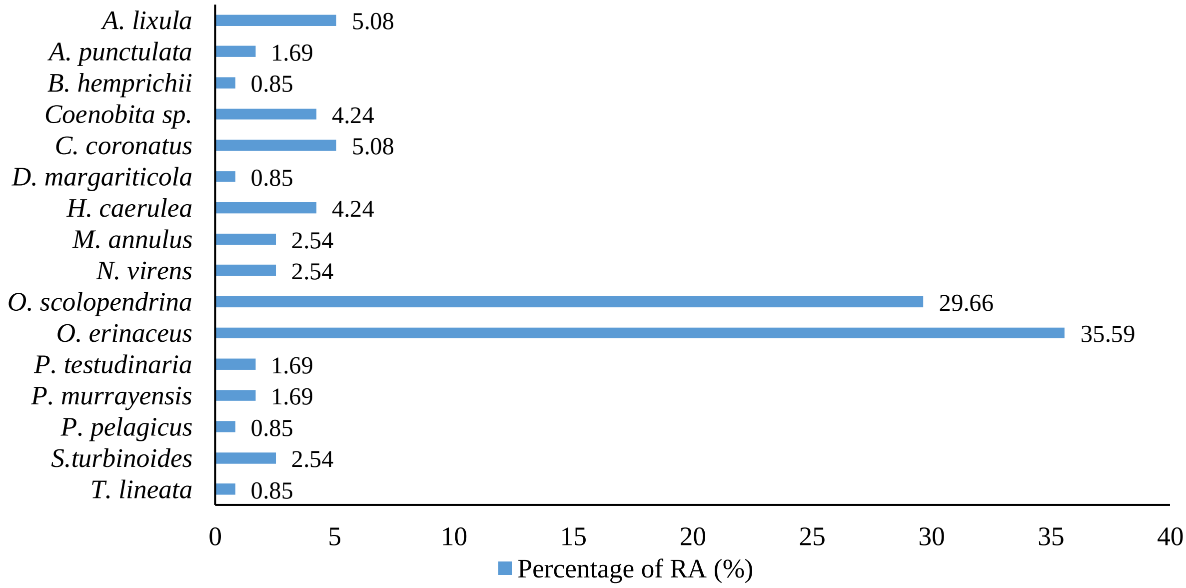

Fig. 2. Relative abundance of macroinvertebrates species from the Watu Lumbung Beach

Based on the calculation of the relative abundance of the species found in the Watu Lumbung Gunungkidul Beach research location, the highest percentage (35.59%) and the lowest percentage (0.85%) were obtained (Fig. 2). The high and low percentage of relative abundance of each species is influenced by several factors, including temperature, food availability, biotic interactions, and environmental conditions (Casas *et al*., 2019). Martin-Garcia *et al*. (2022) stated that the percentage of relative abundance is strongly related to habitat. Habitats with rough, rocky, and hollow characteristics are reported to have higher species richness and can increase the biodiversity within them. Also, habitats with hollow substrates can provide protection and safe attachment for macroinvertebrates to avoid predators and prevent being swept away by water currents (Gao *et al*., 2024). In addition, relative abundance extensively depends on the sampling technique during the study and the relative abundance index used because each model's effectiveness and performance differ. Low relative abundance is also likely influenced by substrate type. Dirty and muddy substrates will affect the number of macroinvertebrate individuals. The level of diversity and abundance of an animal population is influenced by environmental factors where the animal lives (Liu *et al*., 2013; Romiguier *et al*., 2014).

Distribution patterns. Macroinvertebrates in the Watu Lumbung Beach research area is known to exhibit clumped patterns determined by an analysis of distribution patterns, specifically *Arbacia lixula*, *Arbacia punctulata*, *Coenobita* sp., *Conus coronatus*, *Haliclona caerulea*, *Monetaria annulus*, *Nereis virens*, *Pardanilops testudinaria,* and *Porites murrayensis*. However, there is also a uniform distribution pattern, such as Ophiocoma scolopendrina and Ophiocoma erinaceus. The most typical pattern in nature is the clumped or clustered distribution pattern. This is so that it will impact the pattern of its expansion since macroinvertebrates in their lives prefer to locate a more favorable area to maintain their existence (Machuca-Sepúlveda *et al*., 2024). The following Table 3 presents the findings of the distribution pattern.

Table 3. Macroinvertebrate distribution patterns in the intertidal transitional Zone of Watu Lumbung Beach

Species	V	M	Distribution pattern
Arbacia lixula	0.63	0.050	Clumped
Arbacia punctulata	1.41	0.016	Clumped
Baseodiscus hemprichii	0.00	0.008	-
Coenobita sp.	0.70	0.042	Clumped
Conus coronatus	0.63	0.050	Clumped
Drupella margariticola	0.00	0.008	-
Haliclona caerulea	0.70	0.042	Clumped
Monetaria annulus	1.00	0.025	Clumped
Nereis virens	1.00	0.025	Clumped
Ophiocoma scolopendrina	0.24	0.296	Uniform
Ophiocoma erinaceus	0.22	0.355	Uniform
Pardanilops testudinaria	1.41	0.016	Clumped
Porites murrayensis	1.41	0.016	Clumped
Portunus pelagicus	0.00	0.008	-
Semiricinula turbinoides	1.00	0.025	Clumped
Tonicella lineata	0.00	0.008	-

The distribution pattern of distances between people within a population region is designed to avoid the pressures of competition for natural resources. Environmental and social variables have an impact on the distribution pattern. Clumps are the most typical distribution pattern seen in nature. Resource availability, dispersal, disturbance, and population dynamics influence species distribution patterns. In the clumped distribution pattern, this sampling shows the condition of the sea at high tide. The seawater discharge becomes more extensive, and the sea surface becomes more expansive, thus the sampling point in a particular plot becomes broader and higher (Babu *et al*., 2021). The resulting distribution pattern shows different patterns, namely clustering and uniformity. According to Ford & Roberts (2020), individual traits are clustered due to the uniformity of habitat, so there isa grouping in a place with much food. In general, animals live in groups; this is done because they tend to defend themselves from predators and other unfavorable factors. The substrate of the bottom of the water determines the distribution in a body of water because there are food sources in the substrate.

The environmental factors. The environment plays a significant role in any biological review because it is essential for the growth of macroinvertebrates. pH and water temperature were measured during sample collection (Table 4).

Table 4. Habitat parameters of Watu Lumbung Beach

Parameters	Range	Optimum
Water temperature (° C)	31.3-36.4	28-32 (Alfatihah *et al.*, 2022)
pH	7.7-8.4	6.5-8.5 (EPA, 2024; DWR, 2024)

Water temperature at Watu Lumbung beach ranged from 31-36°C during the study, which was poor to preserve the existence of macroinvertebrates, thus this factor affects the low abundance of species at the study site. Most invertebrates' water temperature tolerance ranges from 26-32°C (Alfatihah *et al*., 2022). Temperature variations extending beyond the optimal range impact an organism's ability to develop and reproduce (Buckley & Huey, 2016). The pH of the water was measured as being alkaline (> 7), indicating acceptable water quality. The key aquatic elements that influence water acidity include biological processes such as photosynthesis, temperatures, and oxygen levels. The carbon dioxide, bicarbonate, and carbonate levels within the water become unbalanced due to pH changes. Waters with pH values between 6.5 and 8.5 are most productive and excellent for marine life (EPA, 2024; DWR, 2024). These processes can involve the generation of acidic or alkaline compounds within the system itself. Additionally, external factors such as the influx of acidic waste from terrestrial sources can contribute to pH variations. The measured pH at Watu Lumbung Beach was classified as suitable for the survival of marine invertebrates.

Physicochemical elements such as temperature, pH, and salinity greatly influence macroinvertebrates distribution patterns and abundance. The correlation between stress and fertility outcomes suggests that these chemical and physical elements will impact the organism's development percentage, metabolic activity, and immune response (Llacuna *et al*., 2016; Soltani *et al*., 2024). Watu Lumbung's macroinvertebrates, particularly their biodiversity, require additional investigation and study. The need for in-depth studies of macroinvertebrate biodiversity at this site is primarily due to the difficulty of beach access. Further studies on other invertebrate species and their populations at the molecular genetic level would benefit conservation and biodiversity at this location.

CONCLUSION

In the present research, the abundance of macroinvertebrates in Watu Lumbung beach was determined to consist of 16 species belonging to 13 families and nine classes (Polychaeta, Malacostraca, Anthozoa, Echinoidea, Ophiuridae, Gastropoda, Polyplacophora, Pilidiophora and Demospongia) and the diversity is categorized as moderate. The family Ophiocomidae (*Ophiocoma erinaceus* and *Ophiocoma scolopendrina*) were the most abundant species at both observation stations.

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