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Comprehensive Inventory and Medicinal Potential of Macroalgae in Cibuaya Beach Coastal Ecosystem, Ujung Genteng, Sukabumi

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Abstract

The potential for macroalgae diversity along the coast of Cibuaya Beach, Pangumbahan Village, Ujung Genteng, Sukabumi Regency, West Java, is illustrated in this study. Macroalgae, recognized as integral components of marine ecosystems, have garnered attention due to their substantial economic value and ecological benefits. This study aims to conduct an inventory and identification of macroalgae in this specific locale. The quadratic transect method was employed to provide a comprehensive overview of macroalgae types in the area. The identification results revealed the presence of 25 macroalgae types from 19 tribes and 3 divisions. The diversity assessment yielded a moderate value (2.4) at station 1, while station 2 exhibited a lower diversity level with a value of 1.06, indicating higher species diversity at station 1. Analysis of dominance, as measured by the dominance index, indicated a low level (0.13) at station 1 and a medium level (0.59) at station 2, with *Boergesenia forbesii* emerging as the dominant type at both stations. These findings contribute to a deeper understanding of macroalgae diversity potential along the Cibuaya Coast, providing crucial insights to support marine conservation efforts in the region and serving as a cornerstone for further ecological investigations. Furthermore, considering the proven medicinal potential of macroalgae in prior studies, these findings underscore the significance of this research in the realm of potential drug development and nature-based therapies.

Keyword: Biodiversity, Conservation, Ecology, Diversity, Potential

INTRODUCTION

The maritime areas of Indonesia encompass a vast expanse exceeding its landmass. These marine territories remain incompletely understood by the populace, both in terms of their biodiversity and potential resources, including coral reefs, fish, and macroalgae (Effendi et al., 2021; Setia et al., 2020, 2021, 2023). Among these regions is the area of Ujung Genteng, located in West Java.

Ujung Genteng, situated in Ciracap sub-district, Sukabumi, West Java, has emerged as a focal point of investigation within the realm of coastal biology. Positioned along the periphery of the Indian Ocean, the shores of Pangumbahan Village span a distance of 16 km, featuring a coastline that molds into a gently sloping bay. Notably, among the coastal features garnering attention is Cibuaya Beach, extending approximately 1.25 km in length. Distinguished by the contours of its somewhat recessed coastline and the profusion of macroalgae, Cibuaya Beach boasts a habitat teeming with biodiversity. Additionally, substantial coral clusters serve as geographical attributes shielding the beach from the direct impact of formidable waves (Arifah & Supriatna, 2021; Triacha et al., 2021). This environmental milieu renders Ujung Genteng a fertile habitat for diverse organisms, with its abundant macroalgae captivating scholarly interest in the realm of coastal ecology.

Macroalgae, organisms devoid of true roots, stems, and leaves, constitute a pivotal component of coastal ecosystems, inhabiting substrates in tidal regions of the ocean at depths ranging from 1 to 5 meters (Duffy et al., 2019; Hall et al., 2022). Taxonomically, macroalgae are categorized into three primary divisions, namely Chlorophyta, Phaeophyta, and Rhodophyta. This classification hinges upon their pigment composition, specifically Chlorophyceae (green algae), Phaeophyceae (brown algae), and Rhodophyceae (red algae). In Indonesia, Rhodophyceae encompasses 34 species, Chlorophyta 51 species, and Phaeophyceae 16 species (Kirana et al., 2021; Simatupang et al., 2018).Besides their economic utility as foodstuffs, cosmetics, and pharmaceuticals, macroalgae play a pivotal ecological role. As primary producers in marine ecosystems, they contribute significantly to oxygen production and serve as a vital food source for myriad marine organisms. The proliferation of macroalgae is contingent upon a myriad of environmental factors encompassing temperature, salinity, pH, and dissolved oxygen (DO) levels. Macroalgae also contribute to carbon sequestration, with some species having an annual productivity of approximately 2 kg C /m 2/yr, which is higher than that of temperate tree plantations or grasslands (T. Handayani et al., 2022; Rose, 2021).

The crucial role played by algae in maintaining environmental equilibrium and providing resources for marine life cannot be overstated. Energy derived from sunlight, carbon dioxide, and water through photosynthesis is harnessed by algae, thereby establishing the foundation of the aquatic food chain as primary producers. Additionally, the survival prospects of fish and other marine organisms are bolstered by algae through the generation of oxygen via photosynthesis. Furthermore, the sustainability of natural ecosystems and human needs is supported by algae through primary production processes, carbon sequestration, and nutrient cycling, thus reinforcing marine food webs. Marine algae function as essential providers and regulators of habitats for a diverse range of organisms, including economically significant fish and shellfish species. Consequently, algae exert a significant influence in preserving the balance of marine life and serving as a vital source of sustenance within marine food chains (Dolliver & O'Connor, 2022; Rose, 2021). Furthermore, in terms of medicinal potential, macroalgae such as *Galaxaura rugosa* and *Gelidiella acerosa* from Ujung Genteng exhibit promising properties as functional ingredients for the food supplement industry (Rasyid & Handayani, 2019). Nevertheless, there remains a limited understanding of the diversity of macroalgae and the potential bioactive compounds they harbor for medicinal purposes in the Cibuaya Beach area.

In light of the pivotal role played by macroalgae and the existing knowledge gap regarding their diversity and medicinal potential in Cibuaya Beach, undertaking a comprehensive inventory utilizing the quadratic transect method emerges as an imperative step. Such an endeavor is deemed necessary given the dearth of information concerning macroalgae and their medicinal properties in the vicinity of Cibuaya Beach. The research hypothesis posits that Chlorophyta division will likely exhibit dominance at two stations along the Cibuaya Coast, as compared to Phaeophyta and Rhodophyta divisions. Consequently, the primary objective of this study is to bridge this knowledge lacuna by identifying macroalgae species in Cibuaya Beach and scrutinizing the medicinal potential inherent in the macroalgae species identified.

METHOD

The research was conducted at Cibuaya Beach, Pangumbahan Village, Ujung Genteng, Sukabumi, West Java, from August 18 to 23, 2017. Data collection was undertaken at two stations, selected based on distinct substrate types (Aprilia et al., 2023). Station 1, positioned at coordinates S 07°20'48.0" and E 106°24'00.4", featured a substrate comprising sand, coral fragments, and live coral. Conversely, Station 2, situated at coordinates S 07°20'55.5" and E 106°24'08.9", presented substrates consisting of sand, coral fragments, and rocks (**Figure 1**). The data garnered from both stations served as the primary foundation for identifying and inventorying the utilization of macroalgae as a reservoir of bioactive compounds along the Cibuaya Coast. This endeavor facilitated a profound exploration into the medicinal attributes inherent in marine ecosystems within this locale.

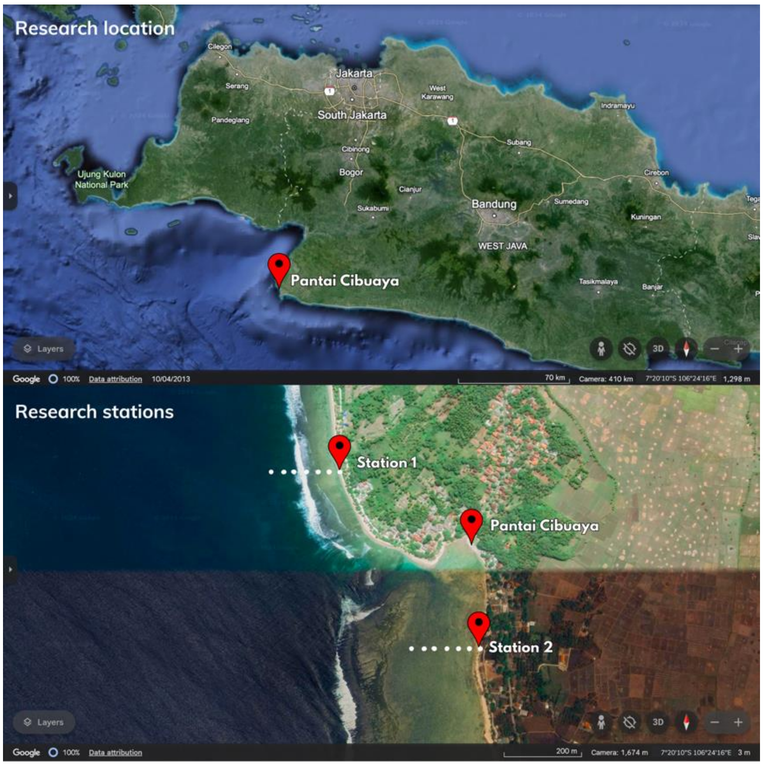


Figure 1. Illustrates the geographical location of the research site situated along the coastline of Cibuaya Beach, Pangumbahan Village, Ujung Genteng, Sukabumi, West Java

Data Acquisition

Data acquisition was conducted at two designated stations based on predetermined substrate criteria. Each station was segmented into one transect with three repetitions, culminating in three transects encompassing 30 observation points. The methodology employed in this study adheres to the quadratic transect approach, which has demonstrated efficacy in elucidating the distribution patterns of macroalgae within coastal ecosystems. Commencing from installation at the seaward edge of the beach (inshore end), the transect positions were determined until the initial macroalgae sighting. Notably, a spatial separation of 20 meters between Transect 1 and Transect 2 was established, with two transect lines drawn perpendicular to the shoreline spanning 100 meters. This deliberate design facilitated the assessment of community disparities across distinct transects and afforded insight into the diversity profile at each station (S. Handayani, 2022; S. Handayani et al., 2020, 2023).

The initial squared plot was situated at the juncture of the first macroalgae encounter, subsequently advancing at intervals of 10 meters along the transect line until reaching a distance of 100 meters, thus culminating in ten plots. Macroalgae species identification was conducted post-sampling through direct observation and comprehensive literature review. Additional samples were procured for species yet to be conclusively identified, with a concurrent evaluation of their medicinal potential as sourced from pertinent literature. Macroalgae observations were confined to the quadratic transects, undertaken via surface snorkeling along the designated transect paths, particularly during low tide intervals (S. Handayani, 2022; S. Handayani et al., 2020, 2023). Environmental parameters encompassing temperature, salinity, water pH, and current velocity were measured to complementarily elucidate the ecological milieu of Cibuaya Beach, thereby fortifying the interpretative framework of the observational data.

Data Analysis

Diversity Index

The species diversity index serves as a pertinent parameter for delineating the composition of biological communities. The degree of diversity within a community can be gauged by assessing the number and prevalence of species within said community. High species diversity is observed when a community comprises a myriad of species with relatively equitable abundance, whereas low diversity is denoted by the prevalence of specific species within the community (Morris et al., 2014; Setia et al., 2021). The diversity index delineates the abundance and richness of taxa within a given community, quantified through the Shannon-Wiener index computed using the following equation:

$$H' = -\sum Pi \ln pi \ atau \ H' = -\sum Nni. ln$$

where *Pi* represents the proportion of the i-th type relative to the total sample, *Ni* denotes the number of individuals of the i-th type, and *N* signifies the total number of individuals across all types. The value of the diversity index (*H′*) provides insight into the level of diversity within a community. As posited by Morris et al. (2014), *H′* values ≤ 1.5 indicate low diversity, those falling between 1.5 and 3.5 signify moderate diversity, and H′*H′* values exceeding 3.5 denote high levels of diversity.

Dominance Index

The Dominance Index serves as a pivotal tool in discerning the prevalence of a specific type within a biological community. Its application seeks to ascertain the degree to which a particular type exerts dominance within said community, rendering this information crucial within an ecological framework for monitoring shifts and population dynamics within ecosystems as posited by Handayani et al, (2023). The Simpson Dominance Index, utilized in this study, is computed through the equation:

$$\mathbf{C} = \sum_{\mathrm{i}=l}^{n} (pi)^2$$

Where C represents the Dominance Index, and Pi denotes the ratio of individuals belonging to the i-th type to the total population (ni/N). The value of the dominance index furnishes insights into the level of dominance present within a community (S. Handayani et al., 2023; Morris et al., 2014). In accordance with Hanyani et al. (2023) and Setia et al. (2020), the delineation of high and low dominance is expounded as follows:

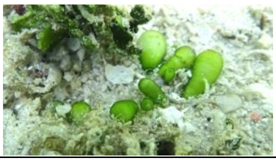
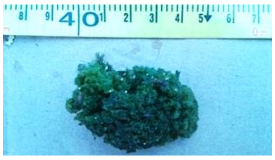
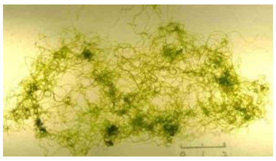
$0.0 < D \leq 0.5$: Low dominance,
$0.5 < D \leq 0.75$: Medium dominance,
$0.75 < D \leq 1.0$: High dominance.

RESULT

Diversity of Macroalgae Identified along the Cibuaya Coastline

The presence and diversity of macroalgae along the coast of Cibuaya Beach, situated in Pangumbahan Village, Ujung Genteng, Sukabumi, were investigated in this study. Twenty-three types of macroalgae, distributed among 19 genera and 3 distinct divisions, were observed. Of these, 78.3% were distributed across three designated observation stations, while the remaining 21.7% were encountered sporadically across a limited number of stations. Detailed descriptions of each macroalgae type have been meticulously documented and are available in **Table 1**.

Table 1. Description of macroalgae species on the coast of Cibuaya Beach

No	Species	Description
	Chlorophyta	
1	*Boergesenia forbesii* 	The thallus forms cylindrical pouches containing fluid and clusters with solitary branching. Its surface is smooth with shades ranging from light green to dark green. Its habitat includes substrates such as rocks, dead coral, coral fragments, and other marine plants
2	*Boodlea composita* 	It has a light green sponge-shaped thallus. Its habitat is attached to dead coral.
3	*Chaetomorph crassa*  By www.horta.uac.pt	It has cylindrical thallus resembling rambutan, forming tangled clumps resembling tangled threads and green in color. This macroalgae is often found in intertidal zones, tends to cover water bodies, and adheres to solid objects in shallow waters.
4	*Caulerpa serrulate*  By Agardh, J.G. 1837	Its thallus has stolons, erect, sometimes prostrate, and green in color. Near the base, it is cylindrical, tapering upwards, often twisted or spiraled with serrated or wavy edges. This macroalgae grows in intertidal zones to subtidal zones, both on sandy substrates and attached to crevices in coral reefs.
5	*Caulerpa sertularioides* 	The thallus has creeping stolons with rhizoids (roots) anchoring to the substrate, and ramuli emerge on the stolons between the roots, forming densely arranged, thin, and regularly serrated shapes.
6	*Enteromorpha intestinalis*  By www.pinsdaddy.com	It has a cylindrical, hollow thallus like a flat pipe; grows from the thallus at the base with branching at its base, upper branches swell, change in the middle, and lower branches are pipe-shaped; adheres to substrates with small disc-shaped adhesive organs. Its color ranges from bright green to yellowish-green. This type is commonly found in intertidal zones. On gravel, rocks, coral fragments, it forms thick colonies in shallow waters and often covers water bodies.

7	*Halimeda opuntia* 	It has a thallus composed of segments. Relatively small segments are oval-oblong, kidney-shaped, and wavy. This macroalgae is often found in crevices of both live and dead coral, coral rocks, coral fragments, and coarse sand.
8	*Utricularia reticulata* 	The sheet-like thallus resembles a broad woven ribbon, green in color. It grows forming thick colonies, its adhesive organs are difficult to observe, and colonies are usually attached to a solid substrate. This type thrives in the upper intertidal zone (supratidal).
	Rhodophyta	
9	*Amphiroa fragilissima*  By Lamouroux, J.V.F. 1816	The thallus forms dense tufts, cylindrical branches, segments or books, with regular dichotomous or trichotomous branching. The thallus contains lime, easily breaks at branching points. Cream, yellowish-brown to pinkish-red in color. This type grows on rocks or coral fragments.
10	*Acanthophora spicifera*  By Børgesen, F. 1910	It has a cylindrical thallus, free branching, erect, with short spines around the thallus which are characteristic of this species. Cartilaginous substance. Dark brown or yellowish-brown in color. Dense tufts with branching in all directions. This macroalgae grows on rocky substrates.
11	*Eucheuma alvarezii* 	The thallus grows erect, densely forming dense clusters, and with irregular branching. This type's habitat is in the intertidal zone ranging from coral substrates to subtidal zones.
12	*Eucheuma spinosum*  By www.alamy.com	The thallus is either cylindrical or flattened with branching. The clusters have simple and complex branching. The thallus ends in a sharp point. Its skin surface is smooth with thorns, colors ranging from dark brown, brownish-green, yellow-green, to purple-red. This macroalgae is scattered in Indonesian waters in places with rocky substrates, clear water, currents, or water movement, with a salinity level between 28-36 per mil and sufficient sunlight.
13	*Galaxaura arborea*  (Littler et al., 2006)	The thallus is straight, up to 10 cm tall, arranged like tweezers. The thallus ends bluntly with regular and dichotomous branching. Adheres to the substrate by small adhesive organs. Reddish-brown in color. This type of macroalgae grows on rocks and dead coral.
14	*Galaxaura rugosa* 	The cylindrical thallus has short segments. Irregular dichotomous branching forms dense clusters at the top. The thallus ends bluntly and somewhat hollow. The height of the cluster can reach about 5-7 cm. The thallus is pale yellow at the tip and red towards the base. Grows attached to rocks on the upper and outer parts of the reef.

15	*Gracilaria coronopifolia*  By Agardh, J.G. 1852	The cylindrical thallus is smooth, brownish-green or yellowish-brown in color, adheres to the substrate with small discs, with repeated dichotomous branching. Generally dense in the upper portion of the cluster. Grows on rocks in coral reef areas.
16	*Gracilaria salicornia*  By Dawson, E.Y. 1954	The thallus is round, smooth, segmented or segmented. Forms dense clusters that expand horizontally up to 25 cm. Thallus size is ±1-1.5 mm, height ±15 cm. Cartilaginous substance, easily breaks. Grows on gravel rocks in sandy reef areas in tidal zones.
17	*Hypnea asperi*  By http://ritsz-scientist.blogspot.co.id	Cylindrical thallus, alternate branching, with short branch thorns resembling spikes or horns. The clusters are dense and expand in various directions. Generally grows attached to rocks or as epiphytes on various substrates.
18	*Gelidiella acerosa*  By Feldmann, J. & Hamel, G. 1934	Cylindrical thallus with irregular branching coming out of stolons (creeping roots). The thallus has short branches that grow side by side on the branches. The characteristic of this type of macroalgae usually includes serially growing ramuli arranged in a row on one side.
19	*Laurencia nidifica*  By Agardh, J.G. 1852	The thallus of *L. nidifica* exhibits a cylindrical form with dichotomous branching, resulting in a dense foliage. Thallus size ranges from 5 to 7 cm in length and 0.5 to 1 mm in diameter. This species thrives epiphytically, adhering to rocks or other substrates in marine environments.
	Phaeophyta	
20	*Padina australis*  By Hauck, F. 1887	The thallus of *P. australis* resembles a fan, forming segments of thin leaf-like lobes with radial hairy lines and calcification on the leaf surface. Its holdfast appears as a small fibrous disc. The upper part of the lobes tends to widen with a flat margin. This species adheres to rocks in reef flat areas, both in locations directly exposed to wave action and sheltered regions.
21	*Sargassum duplicatum* 	*Thallus* circular on the main stem and somewhat flattened on the branches, with a smooth or sleek surface. Dichotomous branching with oval-shaped leaves, serrated edges, thick and duplicated. Clump height can reach up to 60 cm. It typically grows attached to rocks in reef areas, particularly on the outer edges of the reef flat frequently subjected to wave impact.
22	*Turbinaria conoides* 	The cylindrical main stem of *T. conoides* stands upright, rough, with traces of branching. Its holdfast appears as a small disc with radial expanding roots. Branching revolves around the main stem. The leaf consists of a stem and generally small leaflets, approximately 1 cm in diameter. It forms semi-circular kidney-shaped structures with serrated leaf margins. Typically found in reef flat areas, adhering to rocks.

23	*Dictyopteris* sp. 	The thallus takes on a cylindrical stem form with elongated flattened leaves and a distinct midrib. Leaf edges are undulated or serrated, with some leaf tips pointed while others are blunt or flat. It forms dense clusters, growing attached to rock substrates in the outer edges of reef flats.

Macroalgae Inventory

The coastal region of Cibuaya Beach underwent comprehensive assessment to discern the presence of macroalgae. This endeavor yielded the identification of a total of 23 macroalgae species, spanning 19 genus and 3 divisions. Station 1 exhibited 21 species, encompassing representations from 17 genus, whereas station 2 boasted 22 species, comprising 18 genus (**Table 2**). This study not only provides a more in-depth picture of macroalgae diversity, but also looks at the medicinal potential associated with the bioactive compounds contained therein, which may have valuable medical and pharmaceutical applications.

Table 2. Inventory and Medicinal Potential of Macroalgae along the Cibuaya Coastline, Pangumbahan Village, Ujung Genteng, Sukabumi

Div.	Genus	Species	Stations			Phytochemical compound	Potensi medicine	References
			1	2	Total			
Chlorophyta	*Boergesenia*	*B. forbesii*	290	2149	2439	Steroids, flavonoids, phenolics, and saponins	Antioxidant	(Gazali et al., 2023)
	Boodlea	*B. composita*	33	1	34	Tannins, steroids, flavonoids, flavonoids, phenol, and saponin	Antioxidants and anti-inflammatories	(Praveen et al., 2017)
	Chaetomorpha	*C. crassa*	61	69	130	Flavonoids, phenolics, tannins, and steroids	Antioxidant	(Gazali et al., 2019)
	Enteromorpha	*E. intestinalis*	120	28	148	Flavonoid, phenoid, and tannins	Antioxidant	(Akkoz et al., 2011)
	Caulerpa	*C. sertularoides*	3	16	19	Alkaloids, flavonoids, phenolics, and terpenoids	Anticancer, antiviral, antimalarial and antioxidant	(Agena et al., 2023; Garcia-Bedoya et al., 2021)
		C. Sertulata	7	0	7	Alkaloid, flavonoid, phenolic, and terpenoids	Anticancer, antiviral, antimalarial and antioxidant	(Syakilla et al., 2022)
	Ulva	*U. reticulata*	5	9	14	Flavonoids and Tanins	Antioxidant	(Gomathi & Anna Sheba, 2018)
	Halimeda	*H. oppuntia*	60	0	60	Phenols and steroids	Antioxidant	(Ahsan et al., 2020)
Rhodophyta	*Amphiroa*	*A. fragilissima*	9	19	28	Tannins, flavonoids, phenols, and steroids	Antioxidants and antimicrobials	(Viswanathan et al., 2014)
	Achantopora	*A. spicifera*	1	5	6	Phenol, alkaloid, saponin, flavonoid dan steroid	Antioxidants and antibacterials	(Mestry et al., 2015)
	Euchema	*E. alvarezii*	12	65	77	Polyphenol	Antioxidant, antibacterial, and antiviral	(Shah et al., 2022)
		E. spinosum	9	72	81	Flavonoids, triterpenoids, alkaloids, steroids, and ascorbic acid	Antioxidants and antibacterials	(Damongilala et al., 2021; Yusvantika et al., 2022)
	Galaxaura	*G. arborea*	4	0	4	Flavonoids, steroids, and saponins	Antimicrobial, antioxidant, and anticancer activities	(Al-Enazi et al., 2018)
		G. rugosa	7	1	8	Flavonoids, steroids, and saponins	Antimicrobial, antioxidant, and anticancer activities	(Al-Enazi et al., 2018)

	Gracillaria	*G. coronopifolia*	58	4	62	Flavonoids, steroids, phenols, terpenoids, saponins and alkaloids	Antiviral, antifungal, and antibacterial	(Li et al., 2019)
		G. salicornia	35	51	86	Flavonoids, steroids, and saponins	Antioxidant, antimicrobial, and antifungal activities	(Arulkumar et al., 2018)
	Hypnea	*H. asperi*	121	3	124	Flavonoids, steroids and saponins	Antioxidant	(Rachmawati et al., 2021a)
	Gelidiella	*G. acerosa*	0	20	20	Flavonoids, steroids, and saponins	Antioksidan, antimicrobial, antifungi, anticoagulant, anticholinesterase, anticancer, and post-coital contraceptive activities	(Begum & Hemalatha, 2022)
	Laurentia	*L. nidifica*	0	13	13	Alkaloids, flavonoids, saponins, tannins, steroids, and phenols	Antioxidant, antimicrobial, and antifungal activities	(Samar et al., 2022)
Phaeophyta	*Padina*	*P. australis*	92	259	351	Alkaloids, flavonoids, saponins, tannins, and antioxidants	Antioxidant, antimicrobial, and antifungal activities	(Rachmawati et al., 2021b)
	Sargassum	*S. duplicatum*	15	17	32	Flavonoids, steroids, and saponins	Antioxidant, antimicrobial, and antifungal activities	(Herawati & Pudjiastuti, 2021)
	Turbinaria	*T. conoides*	28	16	44	Flavonoids, steroids, and saponins	Antimicrobial and antioxidant activities	(Pérez et al., 2016)
	Dictyopteris	*Dyctyopteris sp.*	85	5	90	Flavonoids, steroids, and saponins	Antioxidant, antimicrobial, and antifungal activities	(Silva et al., 2020)
TOTAL	**19 Genus**	**23 Species**	**1055**	**2827**	**3884**			

Environmental Factor Analysis

The marine ecological characteristics of Cibuaya Beach, situated in Pangumbahan Village, Ujung Genteng, Sukabumi, exhibit resemblances to the coastal regions in the southern part of Java Island, featuring substantial waves emanating from the Indian Ocean. However, the distinction in substrate composition serves as the determining criterion for observation stations. Station 1, characterized by a substrate predominantly composed of coral and sand, differs from station 2, where white sand lines the beach and rock formations alongside coral fragments exist in tidal zones to tubir (**Figure 2**).

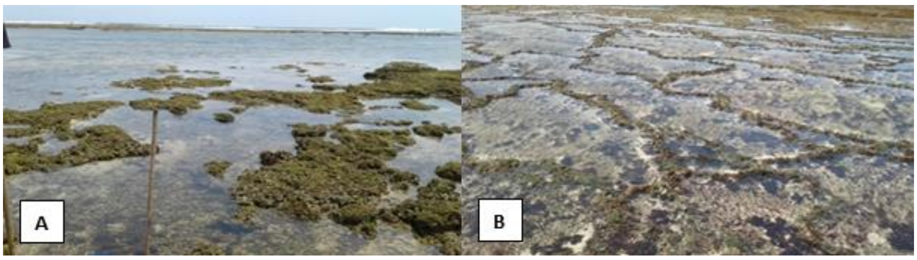


Figure 2. Depicts the locations of observation stations, with station 1 denoted as (A) and station 2 as (B).

The relationship between the presence of macroalgae and environmental factors at each station is closely scrutinized. Measurements of crucial factors including temperature, pH, current velocity, and salinity are conducted to elucidate this relationship. Comprehensive details regarding the environmental parameters at both observation stations are provided in **Table 3**.

Table 3. Environmental Factors at Each Observation Station

Parameters	Station 1	Station 2
Temperatur	30.8°C	30°C
pH	7	6
Current (cm/s)	15.63	10.10
Salinity	34 ‰	35 ‰
Substrate	Sand, coral fragments, and live coral	Sand, coral fragments, and rocks

Diversity and Dominance Analysis

The analysis of diversity and dominance holds paramount significance in elucidating community structures. High diversity within communities is characterized by the presence of numerous species with relatively uniform abundance, whereas low diversity is marked by the dominance of a select few species, leading to the prevalence of a limited number of types within the population. In this study, the Simpson diversity index and dominance index were employed to delineate the observed structure of macroalgae communities (**Figure 3**).

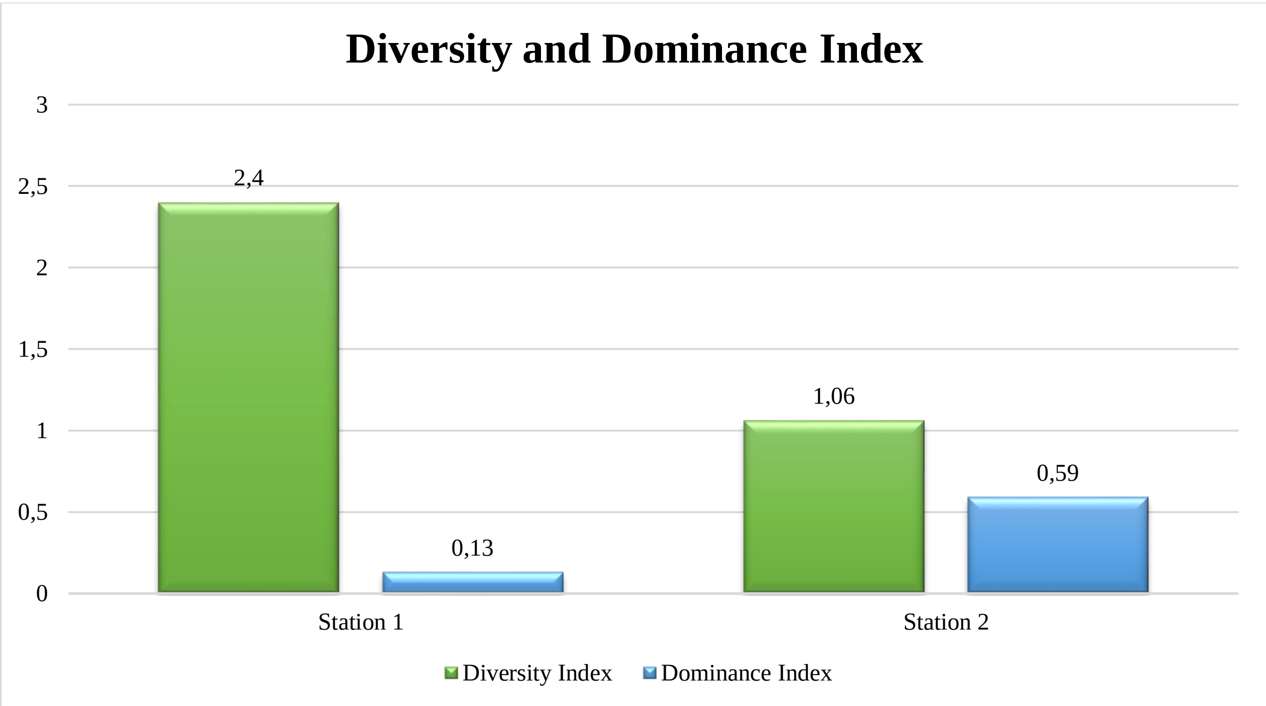


Figure 3. Macroalga Species Diversity and Dominance Index on the Coastal Shore of Cibuaya Beach, Pangumbahan Village, Ujung Genteng, Sukabumi

DISCUSSION

The coastal inventory of macroalgae has unveiled intriguing insights into the diversity and distribution of these organisms in the ecosystem of Cibuaya Beach. The findings reveal the presence of various genera and species across different divisions of macroalgae. Specifically, the Chlorophyta division exhibits seven genera encompassing eight species, including notable ones such as *Boergesenia forbesii*, *Boodlea composita*, *Chaetomorpha crassa*, *Enteromorpha intestinalis*, and *Halimeda oppuntia*. In contrast, the Rhodophyta division comprises eight genera with a total of eleven species, such as *Amphiroa fragilissima*, *Euchema alvarezii*, *Euchema spinosum*, *Gracillaria coronopifolia*, and *Hypnea asperi*. The Phaeophyta division records four genera with four species, including *Padina australis*, *Sargassum duplicatum*, *Turbinaria conoides*, and *Dyctyopteris* sp. This inventory significantly enhances our comprehension of macroalgae diversity in the coastal ecosystem of Cibuaya Beach.

The presence of macroalgae at various observation stations is indeed closely related to the characteristics of their respective substrates. Macroalgae can attach to a variety of substrates, including rocks, corals, sand, and mud, which influences the species produced at both stations. The attachment of macroalgae to substrates plays a crucial role in their growth and survival. Environmental factors such as temperature, pH, and salinity also play significant roles in macroalgae growth. The optimal temperature range for macroalgae growth is between 20°C to 30°C, and both stations fall within this range. The pH levels at stations 1 and 2 are both recorded at 7, aligning with the optimum conditions for macroalgae growth. Salinity, another environmental factor, plays a significant role in macroalgae life. Increased salinity correlates with decreased photosynthesis rates, but the salinity at both stations (34‰ and 35‰) remains within the range supportive of macroalgae growth. Limiting factors in spore dispersal, attachment, and algal growth, such as currents, also play crucial roles in nutrient distribution (Dewinta et al., 2021; Eggertsen et al., 2021; Wang et al., 2021). Although the currents at stations 1 and 2 are slow-moving (15.63 cm/second and 10.10 cm/second, respectively), this research aligns with the categorization of current speeds. The slow current conditions at Cibuaya Beach are interpreted as conducive to macroalgae growth.

This study utilized the Shannon-Wiener diversity index to assess the diversity of macroalgae species at Cibuaya Beach, classifying it as high (exceeding 3.5), moderate (between 1.5 and 3.5), or low (less than 1.5) (**Figure *3***). The diversity index values recorded at station 1 were deemed moderate (2.4), whereas those at station 2 were categorized as low (1.06) (**Figure *3***). Despite station 2 harboring a greater number of macroalgae species compared to station 1, its diversity was lower due to the predominance of the *Boergesenia forbesii* species. Dominance values at station 1 were classified as low (0.13), contrasting with station 2, where they were moderate (0.59). The low dominance observed at station 1 suggests the absence of any singularly dominant species in the study area. Conversely, the prevalence of Boergesenia forbesii at station 2 can be attributed to the supportive substrate, namely rocks and coral fragments. The theory of plant competition may further elucidate species dominance, with competition for minerals and temperature favoring the prevalence of *Boergesenia forbesii* at station 2 (Auliadani et al., 2022; Kokabi et al., 2016; Miao et al., 2020). Although these findings diverge from the initial hypothesis anticipating dominance from the Chlorophyta, Phaeophyta, and Rhodophyta divisions, this study underscores the intricate interplay between environmental factors and the composition of macroalgae species within the Cibuaya Beach ecosystem.

CONCLUSION

The diversity of macroalgae within the coastal ecosystem of Cibuaya, Ujung Genteng, Sukabumi, has been investigated and delineated in this study. A total of 23 macroalgae species have been identified, encompassing 19 genera and spanning across 3 distinct divisions. Observational data indicate that the majority, constituting 78.3% of the species, are widely distributed across the three designated observation stations, while the remaining 21.7% are confined to specific stations. The pronounced diversity of macroalgae in this locale underscores its significant potential within the realm of bioactive research. Through a comprehensive review of existing literature, it has been established that each macroalgae species harbors medicinal potential, particularly as antioxidants. This underscores the considerable promise of the Cibuaya coastal ecosystem as a reservoir for natural-based pharmaceutical research and development. Thus, an in-depth understanding of the diversity and bioactive potential of macroalgae in this locality serves as a pivotal foundation for further exploration in the realms of biology and pharmaceutical science.

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