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ARTICLE

SPECIES COMPOSITION OF INTERTIDAL BIVALVES IN PRENDUAN BEACH, MADURA ISLAND

[*Komposisi Spesies Bivalvia Intertidal di Pantai Prenduan, Pulau Madura*]

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ABSTRACT

Prenduan Beach on the southern coast of Sumenep Regency, Madura Island, is a habitat for various species of bivalves that may be used further. The objective of our research was to document and examine the bivalvia population in Prenduan Beach. Sampling was carried out using the 5 x 5 m quadrat plot method with a 1 x 1 m subplot at three stations with different substrates. The species diversity index (Shannon-Wiener) ranged from 1.21 to 1.36 and was classified as low. Relative abundance (RA) ranged from 0.63 to 60.63%. This study collected 159 bivalvia specimens from 7 families and 11 species. The two species with the highest relative abundance were *Anadara antiquata* (60.68%) and *Solen* sp. (15.72%). Both species have the potential to be used as a source of seafood.

Keywords: *Anadara antiquata*, coastal ecosystem, edible bivalves, *Solen* sp.

ABSTRAK

Pantai Prenduan di pesisir selatan Kabupaten Sumenep, Palau Madura, memiliki keragaman jenis kerang yang potensial untuk diteliti. Penelitian kami bertujuan untuk mendata dan menganalisis komunitas kerang di kawasan Pantai Prenduan. Pengambilan sampel dilakukan dengan metode plot kuadrat berukuran 5 x 5 m dengan subplot berukuran 1 x 1 m pada tiga stasiun dengan substrat berbeda. Indeks keragaman jenis (Shannon-Wiener) berkisar antara 1,15–1,36 dan tergolong rendah. Kelimpahan relatif (KR) berkisar antara 0,63–60,63%. Penelitian kami berhasil mengkoleksi 159 spesimen bivalvia dari 7 famili dan 11 jenis yang berbeda. Dua jenis dengan kelimpahan relatif terbesar adalah *Anadara antiquata* (60,68%) dan *Solen* sp. (15,72%). Dua jenis tersebut mempunyai potensi untuk dimanfaatkan sebagai sumber protein hewani laut.

Kata kunci: *Anadara antiquata*, ekosistem pantai, kerang konsumsi, *Solen* sp.

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INTRODUCTION

Bivalvia, the second-largest class in the phylum Mollusca are comprised of clams, cockles, mussels, and oysters. Huber (2010) mentioned that there were 9,200 species and 106 families of bivalvia throughout the world that have been discovered, while Bouchet and Rocroi (2010) reported 110 families as the recent record. Meanwhile, Myers et al. (2024) listed 92 families under the class of Bivalvia. This group has ecological and commercial significance. Bivalves can serve as a food source for birds living near the coastal areas. The presence of diverse bivalves can influence the number of bird populations that prey on bivalves as the main source of their food supply (Callier *et al*., 2018). Bivalves also have a role as biofilters or water filters for surrounding areas because they can filter enormous amounts of seawater and consequently greatly accumulate trace pollutants; bivalves are ideal bioindicators (Wijayanti, 2015). Bivalves use this filtering mechanism to filter a volume number of water that may contained plankton and their larvae, as well as various organic and inorganic particles. This helps to stabilize the substrate, reduce the effects of erosion, and also increase the complexity of habitat diversity in the waters (Paujiah *et al*., 2019).

Bivalves have significant commercial benefits, particularly as a source of food and medicine. As a food source, bivalves are highly nutritious, containing an abundance of essential nutrients including fats, lipids, and proteins, which are critical for maintaining a balanced diet (Smaal *et al*., 2019). The high concentrations of amino acids found in bivalves further enhance their protein content, making them a valuable protein source for human consumption (Supriyantini *et al*., 2007).

In addition to their nutritional value, bivalves also offer medicinal benefits. Various species of bivalves, such as *Solen* and *Corbicula*, are traditionally used in folk medicine. Local communities believe that these bivalves possess therapeutic properties that can aid in the treatment of certain ailments (Huang *et al*., 2022; Trisyani, 2022). Bivalvia are often utilized to address digestive issues, enhance immune function, and relieve symptoms of specific diseases. The medicinal use of bivalves is supported by their bioactive compounds, which have been shown to have anti-inflammatory, antimicrobial, and antioxidant effects. This content can contribute to the prevention and treatment of various health conditions, highlighting the potential of bivalves as a natural remedy in complementary and alternative medicine (Tan *et al*., 2023).

Furthermore, bivalves contribute to environmental sustainability with their filter feeder mechanism, meaning that they clean the water by filtering out plankton, bacteria, and other particulates. This natural filtration process helps maintain water quality and clarity, which is beneficial for marine ecosystems reliant on clean water sources. Bivalves can circulate the nutrients from the water column that can be used by the marine benthos in these areas. This process can modify biogeochemical cycles by filtering a quite quantity of organic matter that originated from water columns (Scatte *et al*., 2020). Therefore, bivalves play a crucial role in producing healthy aquatic and sustainable environments.

To gain an improved comprehension of the diverse habitats and commercial benefits of bivalves, extensive research has been conducted in various coastal regions. This area provides an ideal environment for studying bivalves due to its varied substrates and favorable climatic conditions, which support a rich diversity of bivalve species. Bivalves thrive in a range of environments from water columns to sand substrates mixed with mud (Hasbunallah *et al*., 2022). Their widespread distribution is influenced by natural conditions and behaviors during habitat selection, as well as interactions with their surroundings (Akhrianti *et al*., 2014). Additionally, bivalves are often found in coastal intertidal zones, which offer conducive climatic conditions for their populations (Veras et al., 2013; Sitompul, 2020).

Madura Island, Indonesia, represents diverse habitats suitable for bivalves, with its beaches hosting various bivalve families (Ambarwati *et al*., 2016; Bening and Purnomo, 2019). Haryatik *et al*. (2013) highlighted the dominance of the Solenidae family at Prenduan Beach in Sumenep Regency. These findings underscore the importance of local habitat conditions in supporting bivalve diversity and the potential for further studies in areas like Prenduan Beach to enhance our understanding of bivalve ecology and their commercial applications. Prenduan Beach, situated in

the Pragaan District of Sumenep Regency on the southern coast of Madura, is notable for its rich populations of edible bivalves, particularly *Solen* species, commonly referred to as '*lorjuk*' or razor clams (Abida *et al*., 2014). Despite the presence of numerous bivalve species, there has been a notable lack of comprehensive research on their diversity. This study seeks to address this gap by conducting a thorough analysis of the diversity and abundance of bivalves in the region.

The purpose of this study is to provide data on the bivalve population in Prenduan Beach including its composition, diversity value, and abundance. This information is crucial for maintaining ecological function and providing a framework for conservation initiatives. Additionally, such basic information will be required for bivalve utilize programs as food products intended to improve the local economy, such as harvesting practices and sustainable management.

MATERIALS AND METHODS

Description of the Study Sites

This study was conducted at Prenduan Beach, Prenduan District, Sampang Regency, Madura Indonesia (7°06'43.2"S, 113°40'39.1"E) (Figure 1) in October 2023. This sampling was carried out in the intertidal zone during the lowest tide. There were three stations and each station had a quadrant plot measuring 5 m x 5 m in the upper, middle, and lower intertidal zones. Each plot had five subplots measuring 1 m x 1 m.

Station 1 tended to have sandy substrate. Station 2 had muddy and mostly consisted of silt substrate characteristics. Both Station 1 and 2 had some number of ships docking in a few points considering that Prenduan Beach is the main stop for local fisherman to dock and anchor their ships after fishing. The substrate of Station 3 tended to have a muddy, slightly sandy character.

Sampling of Bivalvia

Bivalves were collected by digging in the intertidal zone of the beach. The hole was dug until 15 cm deep. This digging process was done using a shovel. Bivalves collected in each plot were then stored in separate plastics according to each station. After that, the bivalve samples were cleaned under running water to remove sand and other particles. The clean specimens were then stored in a bottle and preserved in 70% alcohol.

Identification Process

Identification of bivalves was carried out based on shell morphology, by observing characteristics of the shell including shell shape, umbo, shell sculpture, shell colour, and periostracum. Shell morphometry was conducted using a caliper by measuring shell length, shell height, and shell width. Identification was carried out based on Huber (2010, 2015), and the World Register of Marine Species (https://www.marinespecies.org/) as references.

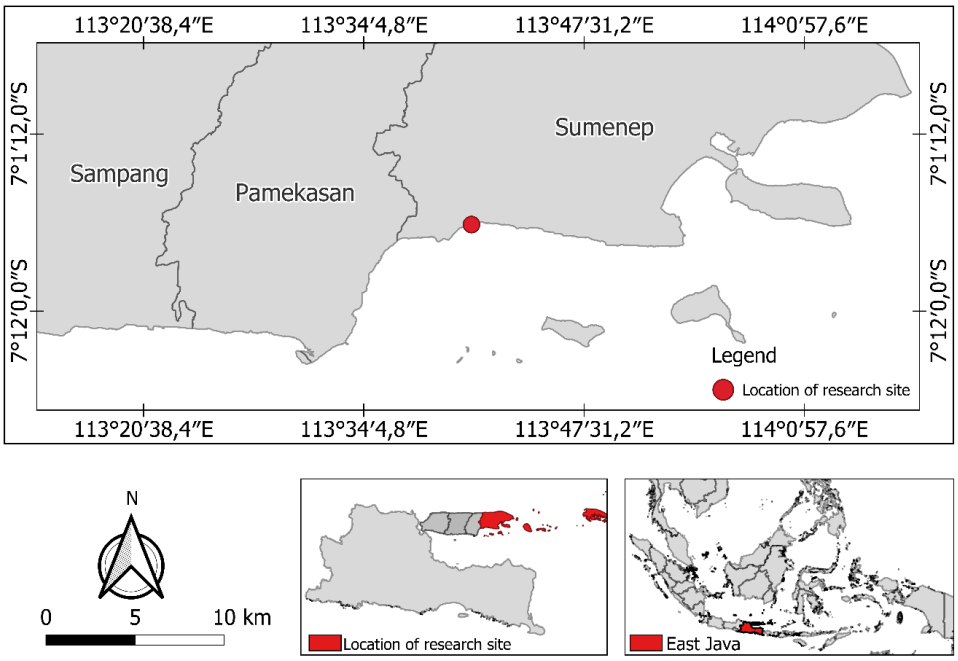

Figure 1. The location of Prenduan Beach, Sumenep Regency (*Lokasi Pantai Prenduan, Sumenep*).

Data Analysis

The Diversity Index analyzed based on Shannon-Wienner (Krebs, 1989) is formulated as follows:

$$H' = -\sum_{i=s}^{s} pi \ln pi$$

Notes:
H' = Shannon-Wiener Diversity Index
Pi = $\frac{ni}{N}$
ni = Number of individuals of a species i
s = Total number of individuals of all species

The abundance of bivalves found was calculated using the relative abundance formula according to Odum (1993) as follows:

$$RA = \frac{ni}{N} \times 100\%$$

Notes:
RA = Relative Abundance
Ni = Number of individuals of the i^{-th} species
N = Number of individuals in all species

RESULTS

A total of 159 individuals were collected from the study site. They consisted of 11 species that belong to 7 families. The species are described as follows.

Family Arcidae

***Anadara antiquata* (Linnaeus, 1758)**

Description: shell length to 45.50 mm; shell height to 42 mm; average width of 21.70 mm, shell width to 31.70 mm; shell inflated; cardinal area wide, moderately shallow. Sculpture of about 34 strong, low, nodulose ribs; interstices narrow, shallow, crossed by small concentric striae. Color white. Periostracum black, dense, hair-like.
Habitat: middle and lower intertidal

Family Tellinidae

***Psammacoma gubernaculum* (Hanley, 1844)**

Description: shell length to 54 mm; shell height to 45.60 mm; shell width to 30.10 mm; average width of 15.97 mm; shell inflated, suborbicular; umbones low; small. Sculpture feeble-like, chiefly concentric. Color white.
Habitat: upper and middle intertidal

Family Placunidae

***Placuna placenta* (Linnaeus, 1758)**

Description: shell length to 58.50 mm; shell height to 81.10 mm; shell width to 5.70 mm; average width of 4.80 mm; shell thin, brittle, nearly equilateral; cardinal area narrow. Umbones crossed by V-shape structure, attached by ridge-like nymphs. Color brown. Periostracum brown, inconspicuous.
Habitat: middle and lower intertidal

Family Pectinidae

***Amusium pleuronectes* (Linnaeus, 1758)**

Description: shell length to 49.60 mm; shell height to 52.35 mm; shell width to 9 mm; shell equivalve, ovate, dorsal margin forming wing-like ears at both ends; Umbones small trigonal pit point; cardinal area small. Colour brown to pinkish outer, interior white. Periostracum absent.
Habitat: lower intertidal

Family Psammobiidae

***Gari elongata* (Lamarck, 1818)**

Description: shell length to 51.50 mm; shell height to 28.45 mm; shell width to 17.80 mm; average width of 14.70 mm; shell elongated, ovate, compressed laterally; umbones not prominent. Colour brown, interior purple. Periostracum conspicuous, horny, dehiscent.
Habitat: middle and lower intertidal

Family Solenidae

***Solen* sp.**

Description: shell length to 54.30 mm; shell height to 30.23 mm; shell width to 28.50 mm; average width of 19.25 mm; shell narrowly elongate, equivalve, razor-like shape; umbones not prominent. Colour brown. Periostracum prominent, frequently glossy.
Habitat: middle and lower intertidal

Family Veneridae

***Anomalodiscus squamosus* (Linnaeus, 1758)**

Description: shell length to 18.20 mm; shell height to 14.40 mm; shell width to 11.50 mm; shell ovate to subtrigonal outline; cardinal area radially disposed, hinge in each valve. Sculpture radially

ribbed, intricated. Colour brown, vague dark brown features. Periostracum vertical lenticular ribbed.
Habitat: lower intertidal

***Dosinia* sp.**

Description: shell length to 32.50 mm; shell height to 35.10 mm; shell width to 13.40 mm; shell lenticular, compressed laterally, equivalve, obliquely rounded, umbones sub medians, flattened; cardinal area heterodont, radially disposed, hinged in each valve. Colour white. Periostracum inconspicuous with small rounded carving pattern features.
Habitat: upper intertidal

***Marcia hiantina* (Lamarck, 1818)**

Description: shell length to 45 mm; shell height to 36.10 mm; shell width to 30.60 mm; shell solid, equivalve, obliquely rounded; cardinal area radially disposed, umbones prosogyrate. Colour brown, vague stripes like black line. Periostracum inconspicuous.
Habitat: lower intertidal

***Marcia recens* (Holten, 1802)**

Description: shell length to 40.30 mm; shell height to 30.70 mm; shell width to 29.80 mm; shell solid, equivalve, obliquely rounded; cardinal area heterodont, umbones prosogyrate. Colour light to dark brown. Periostracum inconspicuous.
Habitat: upper intertidal

***Placamen isabellina* (R. A. Philippi, 1849)**

Description: shell length to 28.95 mm; shell height to 24.67 mm; shell width to 15.45 mm; shell oval-subquarade in-outline; cardinal area heterodont, radially disposes, hinge in each valve, umbones prosogyrate. Sculpture of 14 fine concentric ribs with prominent regular spaced recurved lamellae, nodulose ribs. Colour white with vague navy features. Periostracum conspicuous, with curved-like shape.
Habitat: middle intertidal

Table 1. Composition of Bivalves found at Station 1 (S1), Station 2 (S2) and Station 3 (S3) at Prenduan Beach, Sumenep. (*Komposisi Bivalvia pada Stasiun 1 (S1), Stasiun 2 (S2), dan Stasiun 3 (S3) di Pantai Prenduan, Sumenep*).

Family (*Suku*)	**Species (*Jenis*)**	**S1**	**S2**	**S3**	**(Ni)**	**RA (%)**
Arcidae	*Anadara antiquata*	53	11	32	96	60.38
Tellinidae	*Psammacoma gubernaculum*	6	3	11	20	12.58
Placunidae	*Placuna placenta*	2	2	0	4	2.52
Pectinidae	*Amusium pleuronectes*	1	0	0	1	0.63
Psammobiidae	*Gari elongata*	2	0	3	5	3.14
Solenidae	*Solen* sp.	11	4	10	25	15.72
Veneridae	*Anamalodiscus squamosus*	0	0	1	1	0.63
	Dosinia sp.	1	0	0	1	0.63
	Marcia hiantina	0	0	1	1	0.63
	Marcia recens	1	0	0	1	0.63
	Placamen isabellina	1	2	1	4	2.52
Number of specimens		78	22	59	159	
Number of species		9	5	7		
Diversity Index		1.15	1.36	1.30		

Anadara antiquata was the most common species (96 individuals) and provided the highest relative abundance of 60.68% followed by *Solen* sp. and *Psammacoma gubernaculum* with the relative abundance of 15.72% and 12.58%, respectively. Meanwhile, *Amusium pleuronectes*, *Marcia hiantina*, *Marcia recens*, *Anamalodiscus squamosus*, and *Dosinia* sp. were only found in one individual each, giving an abundance index value only 0.63%.

Figure 2. The Bivalves from Prenduan Beach, Sumenep Regency (*Bivalvia dari Pantai Prenduan, Kabupaten Sumenep*). A. *Amusium pleuronectes*; B. *Anadara antiquata*; C. *Psammacoma gubernaculum*; D. *Dosinia sp*.; E. *Gari elongata*; F. *Marcia hiantina*; G. *Marcia recens*; H. *Placemen isabellina*; I. *Placuna placenta*; J. *Solen* sp.; K. *Anamalodiscus squamosus*. Scale bar: 10 mm (*Skala ukuran: 10 mm*).

Table 2. Size variation of Bivalves from Prenduan Beach, Sumenep Regency, Madura (*Variasi ukuran pada Bivalvia dari Pantai Prenduan, Kabupaten Sumenep*).

Family (*Suku*)	**Species (*Jenis*)**	**Shell length (mm) (*Panjang cangkang*) (mm)**		**Shell height (mm) (*Tinggi cangkang*) (mm)**		**Shell width (mm) (*Lebar cangkang*) (mm)**	
		Range (*Kisaran*)	**Mean (*Rerata*)**	**Range (*Kisaran*)**	**Mean (*Rerata*)**	**Range (*Kisaran*)**	**Mean (*Rerata*)**
Arcidae	*Anadara antiquata*	14.90–45.5	32.30	15.30–42	26.57	10.00–31.70	21.70
Tellinidae	*Psammacoma gubernaculum*	21.6–54	39.60	18.2–45.6	29.4	7.4–30.1	15.97
Placunidae	*Placuna placenta*	58.5–82.45	73.34	56.6–81.1	71.9	3.6–5.7	4.8
Pectinidae	*Amusium pleuronectes*	49.6	49.6	52.35	52.35	9	9
Psammobiidae	*Gari elongata*	31.6–51.5	45.36	17.4–28.45	25	12.7–17.8	14.7
Solenidae	*Solen* sp.	21.4–54.3	31.82	19.6–56.8	30.23	11.4–28.5	19.25
Veneridae	*Anamalodiscus squamosus*	18.2	18.2	14.4	14.4	11.5	11.5
	Dosinia sp.	32.5	32.5	35.1	35.1	13.4	13.4
	Marcia hiantina	45	45	36.1	36.1	30.6	30.6

Family (*Suku*)	Species (*Jenis*)	Shell length (mm) (*Panjang cangkang*) (mm)		Shell height (mm) (*Tinggi cangkang*) (mm)		Shell width (mm) (*Lebar cangkang*) (mm)	
	Marcia recens	40.3	40.3	30.7	30.7	29.8	29.8
	Placamen isabellina	17.7–28.95	23.36	21.5–26.65	24.67	12.2–15.45	14.16

DISCUSSION

Each species of Bivalvia on Prenduan Beach had a varied distribution. The highest number of species obtained was *A. antiquata*, which had 96 individuals. This species was found in every part of the plots in the middle and lower intertidal. This can be confirmed by their large numbers, indicating an even distribution of the *A. antiquata* throughout the coastal area. The *A. antiquata* became the most commonly found species, probably because they are recognized as poor buriers (Brotohadikusumo, 1994), making them vulnerable to be found along the intertidal areas. The substrate where *A. antiquata* was found tended to be sandy and a little muddy. According to Prasadi *et al*. (2016), the Arcidae family can be found in sandy mud substrates down to 20 meters in the intertidal area. The study undertaken by Barrientos-Luján *et al*. (2021) showed that the diversity of bivalves in a particular habitat can be influenced by the condition of the substrate that they populate.

The second largest abundant species was *Solen* sp. (15.72%). This value was higher than the relative abundance of *Solen* sp. from Talang Siring Beach, Sumenep, which was 12.73% (Kurniawan *et al*., 2024). *Solen* sp. belongs to the Solenidae family. Members of the Solenidae family are mostly found in sandy tides as the tides help them to develop during the larval stages; the animals are rarely found in silty tides (Saeedi, 2016). According to the research by Ambarwati and Irawan (2020), the Solenidae family is mostly found on beaches that have muddy and sandy substrates. This has been shown that the number of *Solen* sp. individuals at Station 2 was the least of that of the other stations in Prenduan Beach. The majority of Solenidae were found burrowed in substrates in a vertical position in the middle and lower intertidal. When the beach is receding, these Solenidae can appear on the surface. With a flat, elongated shape and resembling the shape of bamboo, *Solen* sp. is also known as razor clams to local communities (Ramadhan *et al*., 2017). Razor clams have many benefits, especially in the health sector. The animals possess mineral elements such as calcium, phosphorus and magnesium, which can help the process of maintaining the immune system so that it can promote a healthy body (Trisyani, 2022). The potential contained in this razor clam is widely utilized by local communities. The razor clam itself is a type of shellfish that has a high level of diversity, especially in tropical regions (Anggarani and Purnama, 2019). In this study, the results of diversity values were obtained for bivalves of the *Solen* sp. and were found to be quite abundant. This level of abundant diversity can be used as an indicator between the interactions of one species with other species in a community (Ehrlén and Morris, 2015).

Psammacoma gubernaculum was the species with the third-highest relative density, at 12.58%. This value was higher than the density of *P. gubernaculum* from Talang Siring Beach, Sumenep, which was 1.12% (Kurniawan et al., 2024). This species prefers to live in the nearshore and offshore regions, where the substrate composition is more dominated by clay/mud than sand (Liu *et al*., 2023). The substrate type of Station 3, where *P. gubernaculum* was most prevalent, aligns with this condition. As a seafood, *P. gubernaculum* is still less common than other well-known clam species such as *Anadara* (*kerang darah*/*kerang bulu*) and Solenidae (*kerang bambu*) (Silaban *et al*., 2021; Ambarwati and Irawan, 2020)

Each station is differentiated by the characteristics of substrates. Station 3 had a muddy, slightly sandy character for this station's substrate characteristics. Station 2 had muddy and mostly consisted of silty substrate characteristics. Station 1 which had the position at the outer boundary of the open ocean tended to have sandy substrate. Most of bivalves in Prenduan Beach were found at Station 1. According to Nans *et al*. (2019) coarser sands have high permeability and can have a

larger angle of repose than those sands that have a finer texture. Station 1 consisted of a lot of sandy substrates which can support most sea faunas to adapt to these conditions.

Compared to the number of bivalve species recorded from other beaches on Madura Island, the number of bivalve species found on Prenduan Beach was relatively fewer. Ambarwati *et al*. (2016) identified 38 bivalve species from 15 families from Modung Beach, Bangkalan Madura. Meanwhile, at Barung Toraja Beach, Sumenep, Madura, 8 bivalve species from 6 families were reported. Although the number of species from Barung Toraja Beach was less than the species number of bivalves from Prenduan Beach, the number of individuals found was quite high, reaching a total of 785 individuals of bivalvia (Bening and Purnomo, 2019). A recent study conducted by Kurniawan *et al*. (2024) revealed that in Talang Siring Beach, Pamekasan was a habitat for 21 species of Bivalvia from 8 families with a diversity index of 1.6 to 2.2. Prenduan Beach is a center for local fishermen to dock boats and set up fishing spots beneath the intertidal zones, which is assumed to be the reason for the limited amount of species and population of bivalves compared to bivalvia from the other three beaches in Madura. Anchoring activities can also affect the abundance of bivalvia as well as their diversity (Williams *et al*., 2013).

Table 2 shows that each species of bivalvia has a wide variety of shell lengths, shell width, and also shell height. The size or dimension of the shell is mostly influenced by the hydrological and sedimentological characteristics of the various habitats (Gaspar *et al*., 2002). Filter feeders prefer higher-velocity water because certain species may easily access their food under these conditions (Szałkiewicz *et al*., 2022). Most bivalvia choose to take food that is abundant in their environment, such as consuming phytoplankton during blooming. Bivalves' shell size varies with the season and the availability of food due to both diet and habitat factors (Jung *et al*., 2019).

CONCLUSION

The present study identified 11 species of bivalves from Prenduan Beach which belong to 7 families, i.e. Arcidae, Tellinidae, Placunidae, Pectinidae, Psammobiidae, Solenidae, and Veneridae. The species diversity index (H') at the three research stations were 1.15, 1.36, and 1.30 respectively. The relative abundance (RA) ranged from 0.63 to 60.38. The three species with the highest relative abundance (RA) were *Anadara antiquata* (60.38%), *Solen* sp. (15.72%) and *Psammacoma gubernaculum* (12.72%). Bivalves on Prenduan Beach were distributed mainly in the middle and the lower intertidal zone of the beach. The substrate conditions in the area may affect the dimension of the bivalves found as they play a crucial role in the animals' growth.

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AUTHOR CONTRIBUTIONS

All authors have contributed to this paper. FQN: sampling, data analysis, writing; RA: conceptualization, sampling, identification, writing; and NRI: identification, writing.

REFERENCES

Abida I. W., Wahyuni E. A., Efendy, M., 2014. Hubungan Panjang Berat Lorjuk (*Solen* spp) di Perairan Pesisir Pantai Selatan Pulau Madura. *Jurnal Kelautan: Indonesian Journal of Marine Science and Technology, 7*(1), pp. 26–32. https://doi.org/10.21107/jk.v7i1.794

Akhrianti I., Bengen D. G., Setyobudiandi, I., 2014. Spatial Distribution and Habitat Preference of Bivalvia in the Coastal Waters of Simpang Pesak Sub District, East Belitung District. *Jurnal ilmu dan teknologi kelautan tropis*, *6*(1), pp. 171–172 https://doi.org/10.29244/jitkt.v6i1.8639

Ambarwati R., Faizah, U., Trimulyono, G., 2016. Keanekaragaman dan Distribusi Bivalvia di Pantai Modung, Kabupaten Bangkalan Madura. *Sains dan Matematika*, *5*(1), pp. 25–26

Ambarwati R., Irawan, B., 2020. The population of *Solen* sp.(Bivalvia: Solenidae) from Pamekasan, Indonesia. *Ecology, Environment and Conservation*, *26*, S199–S204.

Anggarani, M. A., & Purnama, E. R., 2019. Morphometric and Nutrient Content of Endemic *Solen* sp. (Lorjuk) of Pamekasan Madura. In National Seminar on Chemistry 2019 (SNK-19), pp. 73–76. Atlantis Press. https://doi.org/10.2991/snk-19.2019.6

Barrientos-Luján N. A., Rodríguez-Zaragoza F. A., López-Pérez, A., 2021, Richness, Abundance and Spatial Heterogeneity of Gastropods and Bivalves in Coral Ecosystems Across The Mexican Tropical Pacific. *Journal of Molluscan Studies*, *87*(2), pp. 9–10 https://doi.org/10.1093/mollus/eyab004

Bening C. A., Purnomo T., 2019. Keanekaragaman dan Kelimpahan Bivalvia di Pantai Barung Toraja Sumenep, Madura. *LenteraBio*, *8*(3), pp. 151–155.

Bouchet, P., Rocroi J., Bieler R., Carter J.G., & Coan E.V., 2010. Nomenclator of bivalve families with a classification of bivalve families. *Malacologia*, 52(2):1–184.

Brotohadikusomo N. A., 1994. The Ecology of Two Species of Blood Clams, *Anadara granosa* (L.) and *Anadara antiquata* (L.) in Central Java, Indonesia. (Philosophiae Doctoral Thesis, Bangor University).

Callier M. D., Byron C. J., Bengtson D. A., Cranford P. J., Cross S. F., Focken U., ... & McKindsey C. W., 2018. Attraction and Repulsion of Mobile Wild Organisms to Finfish and Shellfish Aquaculture: A Review. *Reviews in aquaculture*, *10*(4), pp. 924–949. https://doi.org/10.1111/raq.12208

Ehrlén J., Morris W. F., 2015. Predicting Changes in The Distribution and Abundance of Species Under Environmental Change. *Ecology letters*, *18*(3), pp. 303–314. https://doi.org/10.1111/ele.12410

Gaspar M. B., Santos M. N., Vasconcelos P., Monteiro C. C., 2002. Shell morphometric relationships of the most common bivalve species (Mollusca: Bivalvia) of the Algarve coast (Southern Portugal). *Hydrobiologia*, *477*, pp. 73–80.

Haryatik, D., Hafiluddin, H., & Farid, A., 2013. Hubungan Panjang Berat dan Morfometrik Kerang Pisau (Solen Grandis) di Perairan Prenduan Kabupaten Sumenep Madura. Rekayasa, 6(1), 28–36. https://doi.org/10.21107/rekayasa.v6i1.2102

Hasbunallah M. D., Pratama U. A., Firmanysah T. A., Fajar E., Saputra, A., 2022. Analisis Jenis Kerang Bivalvia di Pulau Setan Kawasan Mandeh Sumatera Barat. In *Prosiding Seminar Nasional Biologi* (Vol. 2, No. 2, pp. 126–136. https://doi.org/10.29303/jbt.v23i2.6193

Huang T.H., Ke C.H., Chen C.C., Chuang C.H., Liao K.W., Shiao Y.H., Lin C.S., 2022. The Effects of Freshwater Clam (*Corbicula fluminea*) Extract on Serum Tumor Necrosis Factor-Alpha (TNF-α) in Prediabetic Patients in Taiwan. Marine Drugs, 10;20(4):261. doi: 10.3390/md20040261. PMID: 35447934; PMCID: PMC9027770.

Huber M., 2010. *Compendium of Bivalves Volume 1*. Hackenheim: ConchBooks. 901 pp.

Huber M., 2015. *Compendium of Bivalves Volume 2*. Hackenheim: ConchBooks. 907 pp.

Jung A. S., Van Der Veer H. W., Van Der Meer M. T., Philippart C. J., 2019. Seasonal variation in the diet of estuarine bivalves. *PLoS One*, *14*(6), e0217003.

Krebs C. J., 1989. Ecology The Experiment Analysis of Distribution and Abundance. Harper and Row Publisher. New York.

Kurniawan E.R., Ambarwati R., Isnaningsih N.R., 2024. Short communication: diversity, abundance, and utilization of bivalves on the south coast of Pamekasan, Madura Island, Indonesia. *Biodiversitas* 25: 2454–2462.

Liu C-l, Xu Q, Wang Z, Jiang X-b, Ding G-m, Ren Q-q, Song J-h and Liu M., 2023.Community structure of benthic molluscs shaped by environmental and ecological variables in the coastal waters of Changle, Fujian Province, China. *Front. Mar. Sci*. 10:1045393. doi: 10.3389/fmars.2023.1045393

Williams C.M.L., Esteve G.B., Luis M.V., Borg J. A., Álvarez E., Deudero S., 2013. Impact of Boat Anchoring on The Mediterranean Endemic Bivalve Pinna nobilis: An Experimental Approach. *Rapport du Congrès de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée 40*.

Myers, P., Espinosa R., Parr C.S., Jones T., Hammond G. S., and Dewey T. A., 2024. *The Animal Diversity Web* (online). Accessed at https://animaldiversity.org

Nans B., Rónadh C., Gerd M., 2019. From Fine Sand to Boulders: Examining the Relationship between Beach-face Slope and Sediment Size. Marine Geology. 417: 106012. doi: https://doi.org/10/1016/j.margeo.2019.10612.

Odum E. P., 1993 Dasar-Dasar Ekologi. Edisi Ketiga. Gajah mada University Press. Jogjakarta. Pp. 134–162.

Paujiah E., Cahyanto T., Sariningsih I., Maspupah M., Suryani Y., 2019. Composition and Abundance of Bivalves in the Intertidal Zone, Karang Papak Coastal, West Java, Indonesia: Based on lunar phase. In *Journal of Physics: Conference Series* (Vol. 1402, No. 3, p. 033028). IOP Publishing. http://dx.doi.org/10.1088/1742-6596/1402/3/033028

Prasadi O., Setyobudiandi I., Butet N. A., Nuryati S., 2016. Karakteristik morfologi famili Arcidae di perairan yang Berbeda (Karangantu dan Labuan, Banten). *Jurnal Teknologi Lingkungan*, *17*(1), pp. 29–36. https://dx.doi.org/10.29122/jtl.v17i1.1462

Ramadhan M. F., Nasution S., Efriyeldi E., 2017. Karakteristik Habitat dan Populasi Kerang Bambu (*Solen lamarckii*) di Zona Intertidal Desa Teluk Lancar Kecamatan Bantan Kabupaten Bengkalis. *Jurnal Perikanan dan Kelautan*, *22*(1), pp. 36–43. http://dx.doi.org/10.31258/jpk.22.1.36-43

Saeedi H., 2016. Biogeography and Taxonomy of Razor Clams (Bivalvia: Solenidae) (Doctoral dissertation, ResearchSpace @ Auckland).

Silaban, R., Silubun D.T., Jamlean A.A.R., 2021. Aspek ekologi dan pertumbuhan Kerang Bulu (*Anadara Antiquata*) di perairan Letman, Kabupaten Maluku Tenggara. *Jurnal Kelautan* 14(2) : 120–131.

Sitompul M. K., 2020. Identifikasi Keanekaragaman Jenis-Jenis Kerang (Bivalvia) Daerah Pasang Surut di Perairan Desa Teluk Bakau. *Jurnal Maritim*, *2*(1), pp. 42–51. https://doi.org/10.51742/ojsm.v2i1.107

Smaal A. C., Ferreira J. G., Grant J., Petersen J. K., Strand Ø., 2019. Goods and Services of Marine Bivalves. Springer Nature. 4–5. https://doi.org/10.1007/978-3-319-96776-9_28

Supriyantini E., Widowati I., Ambariyanto A., 2007. Kandungan Asam Lemak Omega-3 (Asam Linolenat) pada Kerang Totok *Polymesoda Erosa* yang Diberi Pakan *Tetraselmis chuii* dan *Skeletonema costatum*. *ILMU KELAUTAN: Indonesian Journal of Marine Sciences*, *12*(2), pp. 97–103. https://doi.org/10.14710/ik.ijms.12.2.97-103

Szałkiewicz E., Kałuża T., Grygoruk M., 2022. Detailed analysis of habitat suitability curves for macroinvertebrates and functional feeding groups. *Scientific Reports*, *12*(1), 10757.

Tan K., Lu S.Y., Ransangan J., Cai X., Cheong K.L., 2023. Bioactivity of polysaccharides derived from bivalves. *Int J Biol Macromol*. doi: 10.1016/j.ijbiomac.2023.126096.

Trisyani N., 2022. The Role of Mineral Content in Bamboo Shell Meat (Shell Meal) and Calm Flour (Meat Meal) and Formation Process on the Health of Living-Being in Indonesia. *AgBioForum*, *24*(1), pp. 95–105. https://hdl.handle.net/10355/91411

Veras D. R., Martins I. X., Matthews-Cascon H., 2013. Mollusks: How are They Arranged in The Rocky Intertidal Zone?. *Iheringia. Série Zoologia*, *103*, pp. 97–103. https://doi.org/10.1590/S0073-47212013000200003

Wijayanti D., 2015. Ekspresi Metallothionein (MT) pada Insang Tiram (*Crassostrea cuccullata*) dengan Metode Imunohistokimia di Pantai Prenduan, Kabupaten Sumenep, Jawa Timur (Doctoral dissertation, Universitas Brawijaya). http://repository.ub.ac.id/id/eprint/133988

World Register of Marine Species, https://marinespesies.org/