JURNAL BIOLOGI PAPUA
Volume 17, Number 1, pages: 10–17
April 2025

ISSN 2086-3314
E-ISSN 2503-0450
DOI: 10.31957/jbp.2853
http://ejournal.uncen.ac.id/index.php/JBP

Mangrove Forest Bioecology in Dasun Village, Lasem Sub-District, Rembang Regency, Central Java

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Received: 18 July 2024 – Accepted: 2 October 2024

ABSTRACT

Mangroves are one of the biotic components that form ecosystems in coastal areas. They are flowering plants with a tree habit that are highly tolerant of elevated salt levels. Mangrove ecosystems serve as habitats for various species of flora and fauna, and are therefore known for their high bioecological diversity. This study aims to analyze the bioecology of the mangrove ecosystem in Dasun Village, Lasem Sub-district, Rembang Regency, Central Java. The research method used was a survey with the transect line technique. Sampling of mangrove vegetation was conducted using square plots measuring 20 × 20 m, while fauna sampling was conducted within a 10-meter radius of the vegetation plots. All flora and fauna found within the plots were recorded as bioecological data of the mangrove ecosystem. Sampling was conducted in three different locations within the mangrove ecosystem area of Dasun Village. The results revealed three families of mangrove flora: Primulaceae (9 species), Combretaceae (5 species), and Rhizophoraceae (171 individuals). The mangrove fauna identified consisted of eight families from the class Gastropoda, two families from the class Malacostraca, and one family each from the classes Pisces, Aves, and Mammalia. Abiotic factors such as temperature, humidity, pH, and salinity were also measured. Temperature ranged from 29.3–33.8 °C, humidity from 68–73%, pH from 6.8–6.9, and salinity from 0.2–0.5 ppt. These results indicate that the mangrove ecosystem in Dasun Village supports a diverse range of mangrove flora and fauna, demonstrating its bioecological richness.

Key words: bioecology; Dasun Village; fauna; flora; mangrove.

INTRODUCTION

Mangroves are a key component of coastal ecosystems. A distinctive characteristic of mangrove trees is their high tolerance to salinity, which exceeds that of most other tree species (Peters *et al*., 2020). The coastal ecosystem plays a significant role in influencing the growth and development of mangroves. This ecosystem, situated at the interface between land and sea, is marked by high salinity levels, making mangroves particularly adapted to such conditions. The mangrove ecosystem is known for its high biodiversity, encompassing a wide range of both flora and fauna (Siburian, 2016). Mangroves typically grow in intertidal zones, along shorelines, estuaries, and lagoons, and are associated with various tropical plant communities in both tropical and subtropical regions. Mangroves provide numerous ecological benefits, including shoreline protection against erosion, carbon storage, supporting aquatic biological cycles, and serving as a habitat for diverse animal species (Darmawan *et al*., 2020).

The mangrove ecosystem interacts with a variety of environmental factors, enabling it to support a wide range of animal, plant, and microbial life specific to mangrove habitats

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(Ginantra *et al*., 2020). Mangroves also form highly productive habitats, where their robust root systems serve as substrates and living spaces for marine plants, invertebrates such as gastropods, mollusks, crustaceans, and arthropods, as well as certain vertebrates including fish, reptiles, and birds (Mitra *et al*., 2019). As a unique vegetation community, the mangrove ecosystem demonstrates remarkable adaptability to varying environmental conditions (Blegur *et al*., 2022). It is distributed across the intertidal zone and categorized into three types: major mangroves, minor mangroves, and associate mangroves (Noor *et al*., 2015). Major mangroves are adapted to high salinity conditions, while minor mangroves tend to thrive in areas with lower salinity (Nurrohman *et al*., 2020).

The study of the presence and dynamics of flora and fauna in mangrove ecosystems is referred to as mangrove bioecology (Pradana *et al*., 2013). In bioecological studies, two general factors are considered to be influential: abiotic and biotic factors. Abiotic factors are non-biological elements of the environment, such as light intensity, air humidity, temperature, and other physical conditions. These abiotic conditions are inherently unstable, dynamic, and vary across spatial scales (Afriana *et al*., 2021). The second category includes biotic factors, in which living organisms interact and influence each other (Vebri *et al*., 2017). Bioecology also encompasses the interaction of these factors, forming what is known as complex factors. Meanwhile, factors that fluctuate independently of time—on scales such as hours, days, or seasons—are known as dynamic factors.

Dasun Village, located in Lasem Sub-district, Rembang Regency, is one area characterized by a relatively extensive mangrove zone. This mangrove area is situated to the west of the village, separated by the Lasem River, with growth patterns extending along the river channel directly to the sea (Rosyadi *et al*., 2021). The expansive condition of the mangrove area enables it to support a rich bioecology of mangrove flora and fauna. This study aims to examine the mangrove bioecology in Dasun Village, Lasem Sub-district, Rembang Regency, Central Java. The diversity of flora and fauna found in the area reflects the high level of bioecological complexity in the Dasun mangrove ecosystem, which is influenced by both biotic and abiotic factors.

MATERIALS AND METHODS

Time and location of the study

The study was conducted in March 2023 in the mangrove forest area of Dasun Village, Lasem Subdistrict, Rembang Regency, Central Java. The study site was divided into three plots: Plot 1 was located at coordinates 6°40′18.46″S 111°26′35.11″E, Plot 2 at 6°40′28.87″S 111°26′37.83″E, and Plot 3 at 6°40′34.03″S 111°26′36.17″E.

Data collection

Several instruments were used in this study, including a thermo-hygrometer to measure air temperature and humidity, a soil tester to measure soil pH, a refractometer to measure salinity, raffia rope to mark plots, plastic jars as containers for fauna samples, a Canon 700D camera to photograph samples, and writing tools to record data on research worksheets. The study began by establishing vegetation plots for flora sampling measuring 20 x 20 meters (with mangrove trees having a diameter greater than 20 cm). A radius of 10 meters from the flora sampling plot was used to observe fauna samples. Observations of flora and fauna within each plot were conducted and documented accordingly. The final stage involved identification of flora and fauna samples in the biology laboratory at the Faculty of Teacher Training and Education, Muhammadiyah University of Surakarta (FKIP UMS).

Sample's collection

The biotic factors of mangrove samples within the 20 x 20 m plots were observed by examining their morphological characteristics, including leaves, stems, fruits, flowers, and roots, and the total number of each was counted (Figure 2).

Fauna samples within a 10-meter radius were observed for one hour, and their numbers were recorded. Subsequently, samples were collected and preserved using 70% alcohol. The abiotic factors measured included temperature, air humidity, soil pH, and salinity.

Data analysis

The observational data were analyzed using quantitative descriptive methods. The bioecology was analyzed descriptively through morphological observations of the mangrove flora and fauna encountered. Mangrove flora samples were identified using the *Mangrove Guidebook of Indonesia* (Noor *et al*., 2012). Fauna samples were identified with reference to the *Compendium of Seashells* (Abbott & Dance, 1986), and birds were identified using the *Field Guide to the Birds of Java and Bali* (MacKinnon, 1990). Quantitative analysis involved recording the data of flora samples and mangrove leaves found in each research plot.

RESULTS AND DISCUSSION

Mangrove flora

The study was conducted across three distinct plots, each with unique characteristics. Plot 1 is located in an open area near the coast but separated by land, categorizing it as a basin mangrove forest and isolated from the other plots.

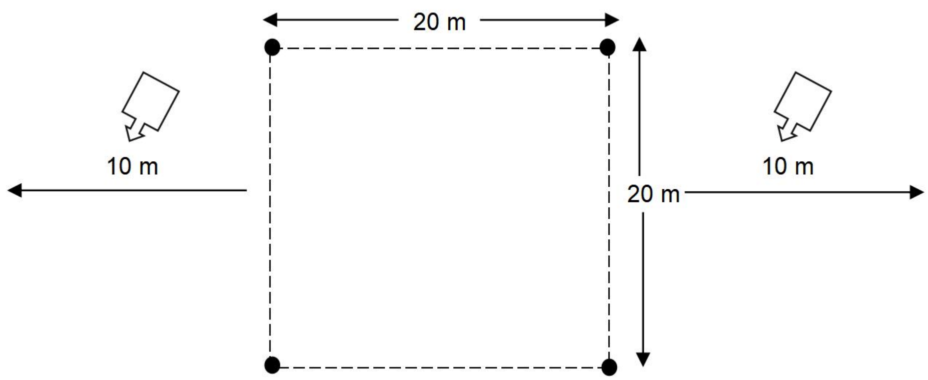

Figure 2. Design transects and observation plots in the field.

Description:
[ ] = mangrove observation area (plot: 20 x 20 m)
● = corner point of the plot
◇ = direction and distance between plots (10 m)

Figure 3. Mangrove species *R. mucronata* which is dominant in the Mangrove Area of Dasun Village, Lasem District, Rembang Regency.

Plot 2 is adjacent to a road and serves as an area for fishermen's activities, including boat docking and departure. Plot 3 is situated further inland and is less disturbed by fishermen's activities. Both plots 2 and 3 are classified as riverine mangrove forests, located at the land-sea interface (Rosadi *et al*., 2018).

A total of 185 species from three different families were found in the mangrove habitat of Desa Dasun, Kecamatan Lasem (Table 1). The majority of mangroves belong to the Rhizophoraceae family, with *Rhizophora mucronata* accounting for 171 individuals, distributed as 67 species in plot 2 and 104 species in plot 3. The second most common species was *Aegiceras corniculatum* from the Primulaceae family, with 9 individuals found in plot 1. The last species recorded was *Lumnitzera racemosa* from the Combretaceae family, with 5 individuals also found in plot 1.

All three species identified are classified as true mangroves. These species are generally influenced by tidal movements and possess stems and leaves adapted for excreting excess salt. True mangroves can also grow on land unaffected by tides, as their seeds are often dispersed by animals to terrestrial areas (Irmayanti *et al*., 2019). Variation in mangrove species was observed in plot 1, where *A. corniculatum* and *L. racemosa* were found growing on sandy substrates flooded with freshwater. These species prefer open habitats with abundant sunlight and thrive in tidal-flooded terrestrial areas (Shinta *et al*., 2022). Plots 2 and 3 showed no species variation, with only *R. mucronata* found growing on muddy substrates. The genus *Rhizophora* dominates these areas due to its preference for muddy substrates (Hilmi *et al*., 2015). Furthermore, *R. mucronata* demonstrates strong adaptation through efficient nutrient and water absorption as well as solar energy utilization. Its large propagule seeds contain substantial food reserves, resulting in higher survival rates compared to other species (Mayor *et al*., 2017).

Mangrove fauna

The research in the mangrove area of Desa Dasun identified 17 mangrove fauna species belonging to 13 families and 6 classes, with a total of 228 individuals observed. The class Gastropoda includes families Bursidae, Ellobidae, Littorinidae, Melonginidae, Muricidae, Onchidiidae, Pottamididae, and Turritellidae. The class Insecta is represented by the family Nymphalidae. The class Malacostraca includes families Sesarmidae and Grapsidae. The class Aves is represented by the family Ardeidae. The class Mammalia consists of the family Felidae, and the class Pisces includes the family Gobiidae.

The distribution of mangrove fauna in Dasun village, Lasem Sub-district, is uneven. In plot 1, only two species were found: *Metopograpsus* sp. from the family Grapsidae and *Danaus genutia* from the family Nymphalidae, indicating low species diversity. Plot 2 exhibited higher fauna diversity, with 10 species representing 10 families across the classes Gastropoda, Aves, Malacostraca, and Mammalia. The gastropods recorded were *Bursa rana*, *Cassidula nucleus*, *Hemifusus carinifer*, *Littoraria scabra*, *Littoraria melanostoma*, *Murex trapa*, and *Turritella terebra*. Malacostraca were represented by *Episesarma* sp. and *Metopograpsus* sp., Mammalia by *Felis catus*, and Aves by *Nycticorax nycticorax*.

In plot 3, 12 species from 12 families were identified, representing the classes Gastropoda, Malacostraca, Mammalia, and Pisces. Gastropod species found in this plot included *Bursa rana*, *Cassidula aurisfelis*, *Cassidula nucleus*, *Hemifusus carinifer*, *Littoraria scabra*, *Littoraria melanostoma*, *Onchidum griseum*, *Cerithidea obtusa*, and *Cerithidea quoyii*. Malacostraca was represented by *Episesarma* sp., Mammalia by *Felis catus*, and Pisces by *Periothalamus* sp. The highest fauna diversity was observed in plot 3 with 12 species, likely due to its location deep within the mangrove area, far from fisherfolk activities. This finding aligns with research by Kartika *et al.* (2022), which found characteristic mangrove species such as crabs and mudskippers in stations with minimal human activity due to their distance from settlements.

The most abundant mangrove fauna across all plots were crabs from the class Malacostraca. Within Gastropoda, the most prevalent species belonged to the family Ellobiidae, specifically

Cassidula aurisfelis and *Cassidula nucleus*, distributed in plots 2 and 3. These species were found attached to the stems and roots of *R. mucronata*. The habitat preference of gastropods is

Table 1. Composition of mangrove flora species in Dasun Village, Lasem Subdistrict, Rembang Regency.

No	Family	Species	Individuals
1.	Primulaceae	*Aegiceras corniculatum*	9
2.	Combretaceae	*Lumnitzera racemosa*	5
3.	Rhizophoraceae	*Rhizophora mucronata*	171
	Total number of individuals		185

Table 2. Composition of the mangrove fauna of Dasun Village, Lasem Sub-district, Rembang Regency.

Class	Family	Species	Plot 1	Plot 2	Plot 3	Individuals
Gastropoda	Bursidae	*Bursa rana* (Linnaeus, 1758)	-	+	+	3
	Ellobiidae	*Cassidula aurisfelis* (Bruguire, 1789)	-	-	+	28
		Cassidula nucleus (Gmelin, 1791)	-	+	+	34
	Littorinidae	*Littoraria melanostoma* (Gray, 1839)	-	+	+	8
		Littoraria scabra (Linnaeus, 1758)	-	-	+	10
	Melongenidae	*Hemifusus carinifer* (Habe & Kosuge, 1966)	-	+	+	7
	Muricidae	*Murex trapa* (Roding, 1798)	-	+	-	3
	Onchidiidae	*Onchidium griseum* (Plate, 1893)	-	-	+	3
	Pottamididae	*Cerithidea obtusa* (Lammarck, 1822)	-	-	+	5
		Cerithidea quoyii (Hombron & Jacquinot, 1848)	-	-	+	3
	Turritellidae	*Turritella terebra* (Linnaeus, 1758)	-	+	-	1
Insecta	Nympalidae	*Danus genutia* (Cramer, 1779)	+	-	-	1
Malacostraca	Sesarmidae	*Episesarma* sp.	-	+	+	64
	Grapsidae	*Metopograpsus* sp.	+	+	-	51
Aves	Ardeidae	*Nyvticorax nycticorax* (Linnaeus, 1758)	-	+	-	1
Mammalia	Felidae	*Felis catus*	-	+	+	2
Pisces	Gobiidae	*Periothalamus* sp. (Bloch & Schneider, 1801)	-	-	+	4
Total number of individuals						228

Notes.: + found; - not found

Table 3. Temperature, air humidity, and soil acidity conditions at the research site

Plot	Coordinate point	Temperature (°C)	Humidity (%)	Acidity (pH)	Salinity (ppt)
1	6°40′18.46″S 111°26′35.11″T	31,8	69	6,8	0,5
2	6°40′28.87″S111°26′37.83″T	31,0	68	6,9	0,2
3	6°40′34.03″S111°26′36.17″T	29,3	73	6,9	0,2

closely related to mangrove vegetation, as it provides optimal conditions for their survival (Nurfitriani *et al*., 2019). Other gastropod species were found attached to muddy substrates, typical of mangrove environments, which facilitate their attachment and serve as a suitable habitat (Niko *et al*., 2020).

Among the Aves class, *Nycticorax nycticorax* from the family Ardeidae was observed nesting in the mangrove canopy. Birds from the Ardeidae family can adapt to *Rhizophora* mangroves, which provide food sources and nesting sites (Zaida & Rahayuningsih, 2020). The presence of *Felis catus* (domestic cats) from the family Felidae is suspected to result from the absence of geographical barriers between local settlements and the mangrove area, supported by the proximity of the mangroves to residential zones.

Environmental Conditions

Temperature

Measurements showed that the temperature at the study site ranged from 29.3 to 33.8°C. The highest temperature, recorded at plot 1, was 31.8°C. This measurement was taken between 10:00 and 11:00 AM local time, coinciding with increasing sunlight intensity. Additionally, plot 1 is located in an open area with less canopy cover compared to plots 2 and 3 (Table 2). Light intensity influences temperature, with open areas generally experiencing higher temperatures than shaded regions (Safar, 2023). Gastropod species prefer habitats with temperatures between 25–32 °C for optimal growth and reproduction (Islami, 2015), while mangrove crabs thrive within a temperature range of 25–35 °C (Hastuti et al., 2019). Mangroves generally grow best in temperatures ranging from 20 to 40 °C (Kalor et al., 2018).

Humidity and salinity

Humidity was measured between 68 and 73%. The highest humidity was recorded at plot 3 (73%) during sampling between 7:00 and 8:00 AM, a location characterized by the densest mangrove vegetation compared to plots 1 and 2. High humidity combined with lower air temperature typically indicates a more closed vegetation canopy (Sari *et al*., 2022). Air humidity affects transpiration rates, which in turn impact mangrove growth (Hidayah *et al*., 2022).

Salinity fluctuated with tidal cycles, decreasing as water receded and freshwater flow increased. This demonstrates that salinity levels are directly influenced by tidal movements (Sinaga *et al*., 2019). Salinity measured during low tide ranged between 0.2 and 0.5 ppt. The highest salinity (0.5 ppt) was found at plot 1, located near the coastline, while plots 2 and 3, situated farther from the river mouth, showed lower salinity levels (0.2 ppt).

Acidity

Soil pH values at the research site ranged from 6.8 to 6.9, indicating that mangroves grow in slightly acidic substrates. The acidity is largely due to the high organic matter content from decomposing mangrove leaf litter, which acidifies the soil environment (Asnindar *et al*., 2019). Mangroves generally thrive in substrates with pH ranging from 6.0 to 8.0 (Rakhmadi *et al*., 2019), while mollusk associations tend to survive within a broader pH range of 5.0 to 9.0 (Baderan *et al*., 2019).

CONCLUSION

The mangrove forest in Dasun village harbors diverse flora and fauna. Three species of mangrove flora from three different families were identified, with *R. mucronata* being the dominant species. Additionally, various fauna species were found, representing four classes: Gastropoda, consisting of eight families (Bursidae, Ellobiidae, Littorinidae, Melonginidae, Muricidae, Onchidiidae, Potamididae, and Turritellidae); Malacostraca, consisting of two families (Sesarmidae and Grapsidae); Aves, represented by the family Ardeidae; Insecta, represented by the family Nymphalidae; Mammalia, represented by the family Felidae; and Pisces, represented by the family Gobiidae.

Abiotic factors such as temperature, air humidity, pH, and salinity were measured and found to be consistent with the requirements of the mangrove flora and fauna. The interrelation between biotic and abiotic factors must be continuously maintained to ensure that the mangrove ecosystem in Desa Dasun remains a suitable habitat for a wide variety of mangrove flora and fauna.

REFERENCES

Abbot, R.T., and S.P. Dance. 1986. Compendium of seashells. Odyssey Publishing. USA.

Afriana, M., C. Darwin., R. Lubis, and S. Saparudin. 2021. Keanekaragaman jenis tumbuhan paku (Pteridophyta) di Kecamatan Ketahun Kabupaten Bengkulu Utara. *Jurnal Riset dan Inovasi Pendidikan Sains*. 1(1): 1–18.

Asnindar., I.N. Korja, and Rukmi. 2019. Sifat kimia tanah pada hutan mangrove di Desa Tolai Barat Kecamatan Torue Kabupaten Parigi Moutong. *Jurna Warta Rimba*. 7(3): 113–120.

Baderan, D.W.K., M.S. Hamidun., R. Utina., S. Rahim, and R. Dali. 2019. The abundance and diversity of mollusks in mangrove ecosystem at coastal area of North Sulawesi, Indonesia. *Biodiversitas*. 20(4): 987–993.

Blegur, W.A., K.J.T. Seran, and A.K.D. Lestari. 2022. Penguatan literasi mangrove di OKL SL bagi keberlanjutan ekologis mangrove di Desa Debunaruk Kabupaten Malaka. *Jurnal Aplikasi Teknik dan Pengabdian Masyarakat*. 6(3): 37–42.

Darmawan, S., D.K. Sari., K. Wikantika., A. Tridawati., R. Hernawati, and M.K. Sedu. 2020. Identification before-after forest fire and prediction of mangrove forest based on Markov-cellular automata in part of Sembilang national park, Banyuasin, South Sumatra, Indonesia. *Remote Sensing*. 12(22): 1–25.

Ginantra, I.K., I.K. Muksin., I.B.G. Suaskara, and M. Joni. 2020. Diversity and distribution of mollusks at three zones of mangrove in Pejarakan, Bali, Indonesia. *Biodiversitas*. 21(10): 4636–4643.

Hastuti, Y.P., R. Affandi., R. Millati., S. Tridesianti, and W. Nurusslam. 2019. The best temperature assessment to enhance growth and survival of mud crab *Scylla serrata* in resirculating system. *Jurnal Ilmu dan Teknologi Kelautan Tropis*. 11(2): 311–322.

Hidayah, I., Hardiansyah, and Noorhidayati. 2022. Keanekaragaman herba di kawasan mangrove Muara Aluh-Aluh. *Jurnal Al-Azhar Indonesia Seri Sains dan Teknologi*. 7(1): 58–64.

Hilmi, E., A.S. Siregar, and L. Febryanni. 2015. Struktur komunitas, zonasi dan keanekaragaman hayati vegetasi mangrove di Segara Anakan Cilacap. *Omni-Akuatika*. 11(2): 20–32.

Irmayanti, L., M. Nur., S.H.M. Mayor, and M.C. Kamarullah. 2019. Analisis vegetasi hutan mangrove di Selat Pogo-pogo Kabupaten Halmahera Selatan. *Jurnal Ilmu Kelautan Kepulauan*. 2(2): 48–54.

Islami, M.M. 2015. Distribusi spasial gastropoda dan kaitannya dengan karakteristik lingkungan di pesisir Pulau Nusalaut, Maluku Tengah. *Jurnal Ilmu dan Teknologi kelautan Tropis*. 7(1): 365–378.

Kalor, J.D., L. Dimara., O.G. Swabra, dan K. Paiki. 2018. Status kesehatan dan uji spesies indikator biologi ekosistem mangrove Teluk Yotefa Jayapura. *Biosfera*. 35(1): 1–9.

Kartika, W.D., J. Siburian, and T. Wulandari. 2022. Kajian bioekologi crustacea berbasis teknologi dalam upaya pengembangan edu-ekowisata di Kabupaten Tanjung Jabung Barat. *Biospecies*. 15(2): 80–88.

MacKinnon, J. 1990. *Panduan lapangan pengenalan burung-burung di Jawa dan Bali*. Gadjah Mada University Press. Yogyakarta.

Mayor, T., H.E.I. Simbala, and R. Koneri. 2017. Biodiversitas mangrove di Pulau Kabupaten Raja Ampat Provinsi Papua Barat. *Jurnal Bioslogos*. 7(2): 41–48.

Mitra, S., S. Shaw, and S.S. Mishra. 2019. Animal diversity in the mangrove forest at Bichitrapur of Balasore district, Odisha, India- A case study. *Records of the Zoological Survey of India*. 119(1): 9–17.

Niko., H. Darwati, and S. Rifanjani. 2020. Keanekaragaman jenis gastropoda pada ekosistem hutan mangrove di Desa Sentebang Kabupaten Sambas, Kalimantan Barat. *Jurnal Hutan Tropika*. 15(2): 130–137.

Noor, T., N. Batool., R. Mazhar, and N. Ilyas. 2015. Effects of siltation, temperature and salinity on mangrove plants replace chemical fertilizers view project plant physiology view project. *European Academic Research*. 2(11): 14171–14179.

Noor, Y.R., M. Khazali, and I.N.N. Suryadiputra. 2012. *Panduan pengenalan mangrove di Indonesia*. PHKA/WI-IP. Bogor.

Nurfitriani, S., W. Lili., H. Hamdani, and A. Sahidin. 2019. Density effect of mangrove vegetation on gastropods on Pandansari mangrove ecotourism forest, Kaliwlingi Village, Brebes Central Java. *World Scientific News*. 133: 98–120.

Nurrohman, H.A., L.L. Muhammad, N.A. Rahmah, P. Ramadhanty, Q. Hannum, S.M. Hamidah, Hardiyanti, N. Azizah, and T.P. Hardani. 2020. Structure community of mangrove in Tidung Kecil Island, Thousands Island National Park Jakarta. *IOP Conference Series: Earth and Environmental Science* 457.

Peters, R., M. Walther., C. Lovelock., J. Jiang, and U. Berger. 2020. The interplay between vegetation and water in mangroves: new perspectives for mangrove stand modelling and ecological research. *Wetlands Ecology and Management*. 28(4): 697–712.

Pradana, O.Y., Nirwani, and Suryono. 2013. Kajian bioekologi dan strategi pengelolaan ekosistem mangrove: Studi kasus di Teluk Awur Jepara. *Journal of Marine Research*. 2(1): 54–61.

Rakhmadi, A., S. Astuti, I. Gumilar, and W. Pamungkas. 2019. Kesesuaian kondisi bioekologi ekosisten mangrove sebagai kawasan rehabilitasi mangrove di Desa Gebang Mekar Kabupaten Cirebon Jawa Barat. *Jurnal Perikanan dan Kelautan*. 10(1): 1–7.

Rosadi, A., R. Ario, and R. Pribadi. 2018. Struktur dan komposisi vegetasi mangrove di Kabupaten Sampang, Pulau Madura, Provinsi Jawa Timur. *Journal of Marine Research*. 7(3): 212–218.

Rosyadi, M.I., P. Hardati, and Haryanto. 2021. Persebaran hutan mangrove dan tingkat pengetahuan serta perilaku konservasi di Desa Dasun Kecamatan Lasem Kabupaten Rembang. *Edu Geography*. 9(1): 30–35.

Safar, N. 2023. Tingkat kelangsungan hidup mangrove Ceriops tagal yang dibudidayakan dengan sistem pot bambu. *Jurnal Program Studi Budidaya Perikanan*. 2(1): 1–14.

Sari, D.P., M.H. Idris., I.M.L. Aji, H. Anwar, and K. Webliana B. 2022. Iklim mikro dan tingkat kenyamanan termal pada kawasan ekowisata mangrove Tanjung Batu Kabupaten Lombok Barat. *Jurnal Agrifor*. 21(2): 315–324.

Shinta, M.L. Syamsudin, and Y.A. Subiyanto. 2022. Identification of mangroves type in mangrove ecosystem area in Pangandaran Regency. *Jurnal Akuatek*. 3(1): 9–18.

Siburian, R. 2016. *Konservasi mangrove dan kesejahteraan masyarakat*. Yayasan Pustaka Obor Indonesia. Jakarta.

Sinaga, H.H., S. Hero, and G. Diansyah. 2019. Penzonasian mangrove dan keterkaitannya dengan salinitas di Muara Sungai Upang Kabupaten Banyuasin Sumatera Selatan. *Jurnal Penelitian Sains*. 21(2): 66–77.

Vebri, O., P.F. Dibah, and A. Yani. 2017. Asosiasi dan pola distribusi tengkawang (*Shorea* spp) pada Hutan Tembawang Desa Nanga Yen Kecamatan Hulu Gurung Kabupaten Kapuas Hulu. *Jurnal Hutan Lestari*. 5(3): 704–713.

Zaida, A., and M. Rahayuningsih. 2020. Development of biodiversity booklet in Mangunharjo Area. *Journal of Biology Education*. 9(3): 332–340.