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Diversity of Gastropods at Jatipapak Mangrove Forest, Kucur Resort, Alas Purwo National Park

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Background: Research related to the existence and diversity of Gastropod species in the Alas Purwo National Park is still very minimal, especially in mangrove forests. This study aimed to determine the diversity of gastropods in the mangrove forests of Jatipapak Resort Kucur, Alas Purwo National Park. **Methods:** This study was conducted from April to December 2020. The method used was plot sampling by following systematic transects of mangrove vegetation. **Results**: The research results obtained were 420 Gastropods belonging to 6 tribes, 11 genera, and 14 species. The diversity of Gastropods in the mangrove forests of Jatipapak TN Alas Purwo is in the moderate category, this is indicated by a diversity value of 1.966, and the similarity of Gastropods is quite evenly distributed with a value of 0.745. **Conclusion**: Based on these results, the most common species found were *Nerita articulata*, while the most diminutive species found was *Ellobium aurisjudae.*

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Kata kunci:
Gastropoda;
Keanekaragaman Jenis;
Kesamarataan Jenis;

A B S T R A K

Background: Penelitian terkait dengan keberadaan dan keanekaragaman jenis Gastropoda di kawasan Taman Nasional Alas Purwo masih sangat minim khususnya di hutan mangrove. Tujuan dari penelitian ini adalah menentukan keanekaragaman jenis Gastropoda di hutan mangrove Jatipapak Resort Kucur TN Alas Purwo. **Metode:** Penelitian ini dilaksanakan pada bulan April sampai Desember 2020. Metode yang digunakan Plot dengan mengikuti transek sistematis vegetasi mangrove. **Hasil:** Hasil penelitian yang diperoleh, ditemukan sebanyak 420 individu Gastropoda yang tergolong dalam 6 suku, 11 marga, dan 14 jenis. Keanekaragaman jenis Gastropoda pada hutan mangrove Jatipapak TN Alas Purwo tergolong dalam kategori sedang, hal tersebut ditunjukkan dengan nilai indeks keanekaragaman jenis 1,966 dan kesamarataan jenis Gastropoda tergolong cukup merata dengan nilai 0,745. **Kesimpulan:** Berdasarkan hasil tersebut jenis yang paling banyak ditemukan adalah *Nerita articulata* sedangkan jenis yang paling sedikit ditemukan *Ellobium aurisjudae.*

Introduction

Gastropods are a group of mollusc phyla with soft bodies, and most of their bodies are protected by shells (Brusca & J., 2003). The gastropod body consists of a head, legs, visceral mass, and mantle. This group has an essential role for ecosystems, especially in the food chain, as primary consumers and some types fall into the detritivores group. The distribution of these animals in ecosystems is extensive, can be found living on substrates of rock, sand, and mud (Nurfitriani. et al., 2017). One of the gastropod habitats can be found in mangrove forests.

Mangrove forests are ecosystems between land and the ocean affected by the tides. These ecosystems provide suitable habitat characteristics for the Gastropod group. These characteristics include substrates containing many nutrients or organic matter, the abundance of detritus as a source of nutrients, and tree vegetation as a shelter (Mujiono & Nova., 2009; Romdhani et al., 2016). Mangrove

ecosystems with these characters can be found on the Alas Purwo National Park (TN) coast.

Alas Purwo TN area is geographically located at the eastern end of Java Island and is directly adjacent to the Indian Ocean and Bali. Research related to the existence and diversity of gastropod types in this region is still very minimal. Gastropod type diversity research has been conducted by (Ardiyansyah et al., 2013) in Blok Bedul Segoro Anak TN Alas Purwo with a moderate category and found 37 types of Gastropods.

Some areas of mangrove ecosystems in TN Alas Purwo are still many that have not been explored related to the diversity of gastropod types, one of which is in the Jatipapak mangrove ecosystem, Resort Kucur. The importance of research on the diversity of gastropod types in mangrove ecosystems can illustrate how environmental conditions in the region. This study aims to determine the diversity of gastropod types in the mangrove forest of Jatipapak Resort Kucur TN Alas Purwo.

Methods

Location, Time, and Equipment

The study was conducted from April to December 2020. Data collection was taken in the mangrove forest of Jatipapak Resort Kucur TN Alas Purwo. Geographical location of Jatipapak mangrove forest between 8°30' - 8°36' LSdan 114°20' - 114°26' BT. Identification of gastropod types is done by way of specimen description by observing the size, shape, color, surface, and direction of shell rotation. Identification of gastropod types is done by matching their morphological characteristics with book guides and drawings from identification books: (Abbott & Dance., 1982). The process of deskripsion, identification, and analysis of data is carried out at the Ecology Laboratory of the Department of Biology FMIPA University of Jember. Some of the equipment used in the study were refractormeter, pH meter, plot size 1 x 1 meter, digital camera, plastic ziplok, plastic tray, mine, raffia rope, tweezers, fuses, label paper, and stationery.

Figure 1. Map of Research Locations in Mangrove Forest Jatipapak TN Alas Purwo

Research Procedure

Gastropod data retrieval technique uses plot methods on mangrove trees (Bookhout, 1996). Gastropoda data collection is carried out in 5 blocks in the Jatipapak Resort Kucur area, namely Jatipapak Block, Gendoh Block, Aseman Block, Wuluh Bulk Block, and Plorotan Block. The stage of taking gastropod data in mangrove forests begins by choosing mangrove trees that are suspected of having the potential as gastropod habitats. Furthermore, the laying of the plot with a size of 1x1 meters is placed in each transect, with a distance between plots of 20 meters, while the distance between transects is 50 meters. The number of transects obtained is 12 transects with 63 plots. Gastropod data retrieval is done when conditions recede. This aims to facilitate the recording and observation of data. Systematic images of data retrieval can be seen in Figure 1 (Total 63 plots).

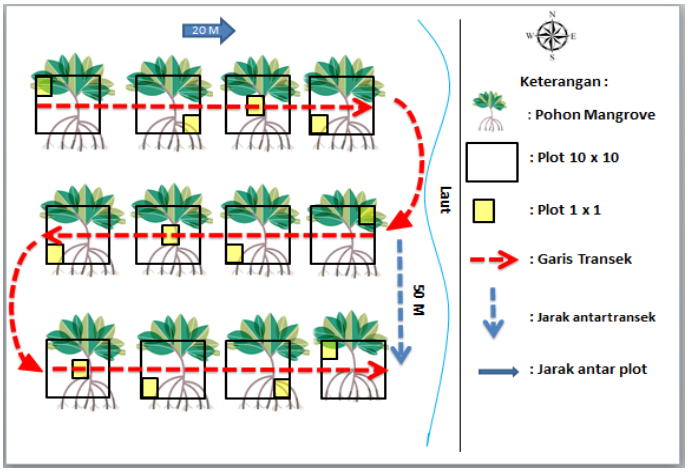

Figure 2. Data Retrieval Engineering Design

Gastropod data collection in each plot is based on its habitat, namely epifauna, tree fauna, and infauna. The data retrieval of epifauna gastropods is done by directly taking the gastropods above the substrate's surface. The tree fauna collection was done by directly taking gastropods on the roots and stems of mangroves. The retrieval of infauna gastropods is carried out by extracting substrates with a depth of ± 20 to 30 cm. The taking of infauna gastropods is carried out at three points on one observational plot (corner, centre and corner) with an area of 30 x 30 cm using a shovel. Gastropods that have been taken are placed on plastic trays for data recording. The historical gastropod data include morphological character (colour, shape, direction of shell rotation), number of individuals of each type, the total number of individuals of all types, and type of mangroves that are gastropod habitats.

Measurement of abiotic data pH water, water temperature, Salinity, and substrate type is taken measurements when seawater conditions recede. The measurements were taken three times in three different locations.

a. PH and Water Temperature

pH and water temperature are measured using Hanna's pH meter. Use this tool by pressing the on button, then dipping the tip to the limit of the probe, then waiting until the stable number, pressing the hold button, then recording the measurement results.

b. Salinity

Determination of salinity levels is measured using a refractometer ETC. Refractometers are used by dripping one drop of water with a pipette on the refractometer prism, then slowly exhaling the prism with a cover. Point the prism at sunlight, view the salinity value on the scale, and record the measurement results.

Data Analysis

Type Composition

Determination of the composition of gastropod types is done utilizing description and identification of specimens found representing each type found. The process of describing the type of gastropod is done by looking at the shape of the apex, the colour of the shell, the surface of the shell, the number of sutures, the shape of the aperture, the direction of the shell rotation, the shape of the columella, and the absence of the operculum. Each type found matched its morphological characteristics with book guides and drawings from identification books:

a. *The Larousse Guide to Shells of The World* (Oliver, 1980);
b. Indonesian Snails and Shellfish 1(Dharma, 1988);
c. Recent & Fossil Indonesia Shells (Dharma, 2005);
d. *Compendium Of Seashells* (Abbott & Dance., 1982)

The results of the identification of Gastropod specimens in the Jatipapak mangrove forest produce data on the composition of gastropod types. The data is then tabulated along with the number of individuals of each type and type of mangrove that is their habitat. Individual composition and number data are used to determine type abundance, type diversity index value (H'), and type equality index (J').

Abiotic Factors

Data on each abiotic parameter to determine the physical condition of an environment. The data obtained is entered into a table, then determined the value of the smallest to largest range by using Microsoft Excel. The results of the analysis are to support the diversity of gastropod types in the mangrove forest of Jatipapak Resort Kucur TN.

Abundance, Diversity and Equality of Gastropod Types

Analysis of the abundance of gastropod types can be calculated relatively using equations, as follows (Odum, 1998):

$$K = \frac{ni}{\sum N} X\ 100\%$$

Information: ni = Number of individuals of each type
$\sum$ N = Total of all individuals

Analysis of Gastropod type diversity data using the calculation of Shanon-wiener type diversity index (Magurran, 1983), the formula as follows::

$$H' = -\sum Pi\ ln\ Pi$$

Note:
H' = Type diversity index
Pi = ni/N (Number of individual types; i: total type of individual type)
ni = number of individuals of each type i
N = Total Number of individuals of the type

The category of type diversity is defined as follows (Odum, 1998):

Jika : H' > 3 = High type diversity.
1 ≥ H' ≤ 3 = Medium type diversity.
H' < 1 = Low type diversity.

Analysis of type equality data (Evenness/J') is used to determine the equality of an individual in an area. The type equality index (Evenness/J') can be calculated by the following equations (Odum, 1998): J'= H'/ *ln S* or J' = H'/ Hmax.

Note:
J': Type Equality Index
H': Type Diversity Index
S: Number of types found
Hmax: *ln* S

The criteria for determining the generality index of gastropod types are (Soegianto, 1994):
If: **J' ≈ 1** It is high equality.
J' ≈ 0 It is low equality.

Result

The study results found that as many as 420 individuals belonged to 6 tribes, 11 clans, and 14 types (Table 1). This type of gastropod was associated with mangrove vegetation, including *Bruguiera gymnorrhiza, B. sexangula, Ceriops tagal, Excoecaria agallocha, Sonneratia alba, S. ovata, Rhizophora apiculata,* dan *R. mucronata*.

Table 1. Composition of Gastropod Types in Mangrove Forest Jatipapak Resort Kucur TN Alas Purwo

Tribe	Clan	Types of Gastropods	Number	Category	Types of Mangroves
Littorinidae	*Littorina*	*Littorina carinifera*	6	*Tree Fauna*	*Ra, Bg*
		L. melanostoma	3	*Tree Fauna*	*Ct, Bg*
		L. scabra	90	*Tree Fauna*	*Ct, Bg, Ra, So, Sa, Rm*
Potamididae	*Cerithidea*	*Cerithidea quardata*	70	*Tree Fauna, Epifauna*	*Ct, Bg, Ra, Sa*
	Cherithideopsilla	*Cerithideopsilla alata*	14	*Tree Fauna, Epifauna*	*Ea, Ra*
	Telescopium	*Telescopium telescopium*	4	*Tree Fauna*	*Ct, Ra, Sa*
	Terebralia	*Terebralia sulcata*	35	*Tree Fauna*	*Ct, Bg, Ra, Sa*
Neritidae	*Nerita*	*Nerita articulata*	129	*Tree Fauna*	*Ct, Bg, Ra, So, Sa, Rm*
		N. undata	11	*Tree Fauna*	*Ra, Rm, Sa*
	Neritina	*Neritina turrita*	3	*Tree Fauna*	*Bs*
Muricidae	*Chicoreus*	*Chicoreus brunneus*	23	*Tree Fauna*	*Ct, Bg, Ra, Sa*
Ellobiidae	*Cassidula*	*Cassidula aurisfelis*	29	*Tree Fauna, Epifauna*	*Ct, Bg,Ra, Sa*
	Ellobium	*Ellobium aurisjudae*	1	*Tree Fauna*	*Bs*
Onchidiidae	*Platevindex*	*Platevindex* sp.	2	*Tree Fauna*	*Ct*

Note**:** *Bruguiera gymnorrhiza* (Bg), *B. sexangula* (Bs), *Ceriops tagal* (Ct), *Excocaria aghaloca* (Ea), *Sonneratia alba* (Sa), *S. ovata* (So), *Rhizophora apiculata* (Ra), *R. mucronata* (Rm). (Abbott & Dance., 1982; Dharma, 1988, 2005; Oliver, 1980).

Discussion

Composition of Gastropod Types

Based on the habitat of gastropods in jatipapak mangrove forests, all types found fall into the category of tree fauna. Specialty three types (Cerithidea quardata, cerithideopsilla alata, and Cassidula aurisfelis), are also included in the epifauna theory. These animals are found in a variety of mangrove species that are used as shelters and foraging. In addition, environmental conditions support the presence of gastropods due to the presence of biotic and abiotic factors. Biotic factors in the form of mangrove vegetation are used as shelters and litter is used as the main food source for gastropods. This is in accordance with (Rahmawaty, 2011), the composition of gastropod types can be affected by the abundance of food sources and disturbances of conditions from the surrounding environment such as polluted substrates. Gastropods' ability to survive in an environment is due to supportive environmental conditions such as substrate type and relatively high organic material content (Jailani & Nur., 2012).

Abiotic factors that are the limiting factors are pH, temperature, and Salinity. Based on the results of pH measurements that have been done, the range of pH values in mangrove forest waters is 6.5-7.9 (Table 2), when viewed from the range of pH values are still within normal limits. Typical pH values are caused by ups and downs that occur every day so that the pH value tends to be stable. pH becomes a limiting factor because very acidic and very alkaline water conditions can endanger the survival of gastropods because they cause metabolic and respiration disorders (Mathius et al., 2018). According to (Gundo, 2010), the size of a suitable water pH ranges from 6.8 to 8.5 for the survival and reproduction of gastropods.

Temperature becomes a limiting factor because aquatic ecosystems affect organisms' survival, growth, reproduction, and behaviour. Water temperatures at the study site ranged from 26.5 to 28.5 °C (Table 2). Viewed from the range of values are still within the ideal limits to support gastropod life. It can be caused by a tight canopy and light intestinal entering the closed canopy. The temperature value is supported by the results of (Masni. et al., 2016), a water temperature value of 27-32 °C that allows biota living around mangrove forests, including gastropods, to live, grow and develop properly. Following the results of (Suwondo. et al., 2006), gastropods can perform optimal metabolic processes in the water temperature range between 23-32 °C. That animals that live in tidal zones will often experience drought so that they have more excellent resistance to temperature changes.

Table 2. Abiotic Factors of Mangrove Jatipapak Forest

Abiotic Factors	Lowest Value	Highest Score	Gastropod range
pH water	6,5	7,9	6-8,5 (Gundo, 2010)
Temperature (˚C)	26,3	28,5	25-32 (Suwondo. et al., 2006)
Salinity (‰)	32	34	28-34 (Satria, 2014)

Salinity is an environmental factor that is suspected to be the presence of gastropods in mangrove forests. The salinity range value at the research site is 32-34 ‰ (Table 2). The value is still within the ideal limit because of the position of mangrove forests in the intertidal region. This is supported by the results of (Satria 2014), optimal Salinity for gastropod life is in the range of 28 - 34 ‰. The rise and fall of Salinity in water can be affected by heat absorption, rainfall, river flow, and current circulation patterns.

The abundance of Gastropod Types

Based on the abundance value of gastropod types found with the highest abundance, namely Nerita articulata by 30.7% and *Littorina scabra* by 21.4% (Figure 3). Types *N. articulata* and *L. scabra* distributed attached to the roots of mangrove vegetation *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Rhizophora apiculata, R. mucronata, Sonneratia alba*, and *S. ovata.*

The *N. articulata* type is found most with a total of 129 individuals. This is due to food sources and adaptability to the environment. This type is attached to the roots, stems, and leaves of mangrove trees (tree fauna). These animals are found clustered, and when installed, the animal moves to the top of the mangrove—stated that *N. articulata* includes gastropod visitors because of its natural habitat on the substrate of rock and sand. At the time of tidal conditions, the gastropod is carried away by currents to carry it into mangrove forests. These animals are able to adapt to environmental changes and can be associated with mangrove plants. This is supported by the statement (Febriyanti et al., 2017) that type *N. articulata* can adapt to the way it moves actively up and down following the tides of sea water, so it is resistant to environmental changes. This makes the abundance of *N. articulata* higher and found in every research site.

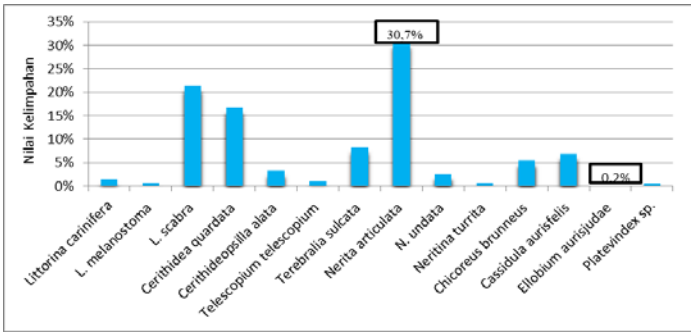

Figure 3. An abundance of Gastropod Types in Jatipapak Mangrove Forest

The *L. scabra* type is also found the most, with a total of 90 individuals, found living in groups attached to roots, stems, and leaves from mangrove vegetation (tree fauna). This animal is found most because it likes a hard subtract to stick and live to cluster and at high tide will rise to the top of the mangrove attached to the leaves and stems. This type has a close relationship with mangrove plants, considering the type includes herbivorous gastropods whose food in the form of algae is obtained from mangrove plants (Salim & Haidir, 2019). In addition, the type of *L. scabra* has a high tolerance to inundated and dry conditions (Sasekumar, 1974). This type includes facultative gastropods that make mangrove forests one of their habitats, having a high frequency and density.

The presence of gastropods with the lowest abundance value is Platevindex sp. 0.50% and *Ellobium aurisjudae* 0.20%. Type Platevindex sp. Chiton is found at the back of mangrove forests, living attached to the roots of *Ceriops tagal,* which only two individuals found. This type is rarely encountered at the observation site because it is suspected that this animal is carried away by currents so that it enters the mangrove forest and makes the roots of mangrove vegetation as a shelter from predators. In general live cycling, Habitats are tightly attached to rigid substrates such as rocks and coral surfaces (Sjafrie, 1989).

The type *E. aurisjudae* found in the back area of mangrove vegetation attached to the roots of *Brugueira sexangula* was found in only one individual. Factors that affect the number of individuals *E. Aurisjudae* a little are suspected because inflows carry this type into the back of mangrove forests. This type usually lives attached to the roots, stems, and leaves of mangroves. In addition, it can be found on mangrove floors that are substrates mud. According to (Indrasti, Dias., Nuri Andarwulan., Eko Hari Purnomo, 2018), *E. aurisjudae* has high frequencies and densities only under conditions that allow its life.

Diversity of Gastropod Types

Based on the results of calculations using the Shannon-Wiener formula, the diversity index of gastropod types in mangrove forests Jatipapak TN Alas Purwo belongs to the moderate category, which is indicated by a value of 1,966. This is because the number of individuals in each type is different. This is supported by the statement (Odum, 1998), which states that the high value of the diversity index can be influenced by the number of individuals each species obtained, and some species found the number of individuals more than others. The current diversity can show that the mangrove ecosystem in Jatipapak is quite balanced, and ecological pressures are moderate. The value of diversity of the type is supported by equality (J') 0.745, which is classified as a reasonably even category because there is no dominant type. This is following the opinion of (Nento et al., 2013), the spread of animals based on dietary factors, and animals will live in an area when quickly getting food. Gastropods generally live at ground level, move downwards at low tide, and rise again at high tide (Febriyanti et al., 2017).

Reasonably fair equality values and moderate diversity values in Jatipapak mangrove forests can be caused by the

tides and abundance of food sources, thus affecting the distribution and composition of gastropod types. The difference in the distribution of gastropods in Jatipapak mangrove forests is more widely found in areas with much water and in the front zone of mangroves. For example, the types of *Littorina scabra* and *Nerita articulata* are more commonly found in the outer areas of mangrove forests, while at the back of mangrove forests are rarely found. This causes differences in the generality of gastropod types in the Jatipapak mangrove forest area. This statement is supported by Odum (1998) that a community is said to have low equality if the value of the equality index is less than one.

Conclusion

This study concludes that the composition of gastropods found in Jatipapak mangrove forests has as many as 14 types, namely *L. melanostoma, L. scabra, L. carinifera, Ce. quardata*, *Telescopium telescopium, Terebralia sulcata, Nerita articulata, N. undata, Neritina turrita, Ch. brunneus, Ca. aurisfelis, Ellobium arisjudae, Cr. alata*, and *Platevindex sp.* The gastropod type with the highest abundance value is *N. articulata* and the lowest is *E. aurisjudae*. The value of diversity of gastropod types in mangrove jatipapak forests still falls into the moderate category. The equality value of the type belongs to the category spread relatively evenly.

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Declaration statement

The authors reported no potential conflict of interest.

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