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Research Article

Understanding the concept of diversity, abundance, and distribution of marine invertebrates through practicum students of the Biology Education, Pattimura University

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ABSTRACT

The application of marine biology courses cannot be separated from field practicum activities which are integrated with the main scientific pattern of Pattimura University, namely build nobleh marine, meaning that the marine biology lecture process is a goal of developing human resources. One of the competencies of marine biology courses which emphasizes is that students must understand the life of various types of marine invertebrates that live in each coastal water ecosystem and must also master how to observe and research various types of marine invertebrate life found in each zone of coast (intertidal zone and subtidal). The results of the findings of various types of marine invertebrates were carried out by diversity analysis, the results were 2.0 <H'=2.363836 ≤ 3.0, meaning the level of diversity was medium. The relative density of invertebrates on various substrates includes sand 25%, density on sandy gravel substrates 9.9%, muddy substrates 11.4%, coral substrates 15%. The distribution patterns of various types of invertebrates can also be explained according to the results of analyzes including (1) clustered distribution patterns occur in Crustacea (*Emita* sp, *Harpiosquilla raphidae*, *Ocypoda cursor*), Gastropoda (*Nerita polita*, *Conus sponalis*), Bivalvia (*Venerupis corrugate*), (2) The distribution pattern is uniformly occurs in invertebrates of Bivalvia (*Anadara broughtonii*, *Mytilus trossulus*, *Tridacna rosewateri*, *Pinctada radiate*), (*Diadema setosum*, *Holothuria scabra*), Gasropoda (*Strombus decorus*). Proving the truth of the concept or theory of various types of invertebrates in biology courses the truth of the sea has been tested through field practicums in the coastal waters of Salahutu District, Ambon Island.

Keywords: Marine invertebrates, diversity, density, distribution patterns

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INTRODUCTION

All academic activities within Pattimura University must be guided by the main scientific pattern, namely Pattimura University's noble marine development, which is defined as an image development system to glorify the coast and

sea, so that in the process of forming superior and competent human resources who have the ability to develop and manage resources. Coastal and marine waters, so the lecture process must integrate with marine noble development. According to Pagaya (2020), marine noble development is a characteristic of Pattimura University, considering that Maluku is an archipelagic region that is rich in various types of marine biota including marine invertebrates must be the foundation of hope for the development of human resources in managing the potential of water and marine resources in this area. Thus, the application of marine biology courses cannot be separated from field practicum activities which are integrated with the main scientific pattern of Pattimura University, namely build nobleh marine, meaning that the marine biology lecture process is a goal and objective of developing human resources, which is carried out in every study program within Pattimura University. Mastery of concepts, principles, applications of marine biology courses, especially developing and saving marine invertebrates which are biological resources for human life. Silaban et al. (2021) that marine invertebrates in several areas in Maluku have experienced a lot of living plece damage due to the extraction of material from coastal waters, thus affecting the life of the marine invertebrates themselves.

One of the competencies in marine biology courses is that students must understand the lives of various types of marine invertebrates that live in each coastal water ecosystem and must also master how to observe and research various types of marine invertebrates that live in each zone of coastal waters, (intertidal and subtidal zones). According to Fitria et al. (2019), in order for students or students to become more familiar with the zoology of marine invertebrates such as Spong, Colenterata, Mollusca, Crustacea, Anelida, Echinodermata, direct observation through field practicum is needed. Field practicum is a proof of theories regarding marine biology concepts, and environmental factors in coastal waters, which influence various marine life. According to Margunayasa (2018), field practicum can improve students' skills in assessing the success of their level of understanding of the biological concepts they are studying. Fitria et al. (2019) that practicum provides experience in understanding the concepts being studied or lecture material.

The study of marine biology relates to environmental factors, diversity, abundance and distribution patterns of various marine biota through field practical activities, which is a direct survey of marine biota in coastal and marine waters. Sirait and Lubis (2018) stated that courses related to practicum are held so that students are able to develop problem-solving and creative thinking skills, increase understanding of science and scientific methods for the concepts being studied. According to Suryaningsi (2017) and Hikmah (2022), field practicum provides knowledge to students in proving the truth of the biological concepts being studied, especially regarding understanding the basic theoretical framework of the biological concepts being studied.

The concept of marine biota in marine biology courses which is a basic competency for students is understanding the concept of the ecological and economic functions of various marine invertebrate species in their habitats, especially coastal ecosystems. According to Oktavia (2018) that coastal waters have various ecosystems and have high biodiversity to support ecological functions and economic functions for the benefit of community life. Marwadi et al. (2021) that for the survival of marine biota in a living place, one of the most determining factors is environmental factors that influence the diversity and abundance of various types of aquatic biota, in the growth of a community of various types of marine invertebrates in their habitat. To understand the formation of a community of marine invertebrate species in a coastal aquatic living place, can be carried out through ecological studies regarding diversity indices, abundance indices, distribution pattern indices, as well as measuring environmental factors in coastal waters, which really helps students understand the ecological functions and economic functions for marine invertebrate life itself as well as for human interests in utilizing marine biota. According to Hartati et al. (2018), the high diversity in a living place indicates the high biodiversity of several fauna which are biota that inhabit the ecosystem, especially invertebrates that live in the ecosystem of each living place. Nugraha et al. (2018) explains that the density of marine biota is largely determined by the substrate characteristics of a habitat.

The characteristics of the tidal areas of the coast of Salahutu Island Ambon District vary from sandy, sandy coral, muddy and rocky substrate types and rocky substrates with intertidal widths ranging from 30-100 m. According to Marwadi et al. (2021), that the ecological and economic function of marine biota can be determined through the survival of marine biota in the habitat, one of the factors that really determines the abundance and diversity of this aquatic biota. The existence of various types of marine biota in the coastal waters of Salahutu District, Ambon Island is very good for studying the ecological function and economic function of various species of marine biota in the form of diversity, abundance and distribution patterns of various species of marine biota. Santhanam (2018) that the distribution and abundance of marine biota is closely related to environmental factors and influences the lives of various marine biota in each habitat. Thus, the aim of field practicum is through observing various types of marine biota so that students understand a community of marine biota in the intertidal and subtidal zones through analysis of

diversity indices, abundance, distribution patterns and measurement of environmental factors in coastal waters in Wai village, Tulehu village beach and village beach Suli, Salahutu District, Ambon Island.

METHODS

To obtain accurate data, use a marine biology field practicum guide related to the diversity, abundance and distribution patterns of various types of marine biota in coastal waters with steps, including (1) conducting a survey of each substrate (habitat) where marine biota live, (2) carrying out techniques for collecting marine biota by making 4 quadrants in each habitat with a size of 1.5 m^2 (length times width), (3) observing, digging and capturing, taking types of marine biota found in the quadrants that have been made , (4) measure environmental factors in every place where marine biota is found (salinity, temperature, pH of sea water, dissolved O_2 dissolved CO_2,). The data obtained was analyzed using the formula proposed by Odum (1989) in Tuaputty and Alimudi (2022), as follows:

1. Analyze species diversity using the following formula: The diversity index is calculated using the Shannon–Wiener formula H' = -∑ Pi. ln Pi; Pi= ni/N Where: Pi = Relative abundance of the nith species = Number of individuals of the ith species. N = Total number of all individuals H' = Shannon Wienner Index. The Diversity Index category is adjusted to the diversity index obtained from the calculation results according to the criteria in table 1, as follows:

Table 1. Species diversity index categories

Diversity Index (H')	Category
H' < 2.0	Low
2.0 < H' ≤ 3.0	Medium
H' ≥ 3.0 Hig	High

2. Index analysis of distribution patterns of various types of marine biota, to determine the distribution pattern index, the ecological formula, morista, is used and for abundance, the ecological formula is used as explained below, where the calculation of the distribution pattern is:

Morista distribution formula

$$Id = \frac{(\sum x^2)^2 - \sum x}{n(\sum x^2) - \sum x}$$

Where: Id = Morista index, n = Number of quadrants, ∑x = Number of individuals in each quadrant, $\sum x^2$ = Number of individuals in each quadrant in the quadrant, where the results of the Morista index if it shows Id < 1 The distribution pattern is uniform, Id = 1 The distribution pattern is random, and Id > 1 The distribution pattern is group

3. Analysis of Relative Abundance of Marine Biota

Calculated based on the number of individuals compared to the area of the religious caudate using the formula

$$Kr = \frac{S}{A}$$

Where: Kr = Relative Abundance of Each Species, S = Average number of individuals of various types of marine biota found, A = Size of the observation area 1.5 m x 1.5 m or 150 cm^2 = 900 cm^2

RESULTS AND DISCUSSION

Results

Study of various marine invertebrates, especially observing various species of marine biota, analysis of diversity, abundance and distribution patterns of various types of invertebrates by students in field practicum activities requires essential skills and the scientific process plays an important role in understanding the life of various types of marine invertebrates. This can be implemented and developed in the form of collaboration between groups of students in carrying out field practicums, thus providing direct experience for students. Carrying out observations of various types of marine invertebrates on various types of marine invertebrates along coastal waters, various species were found in each habitat with different coastal water substrates. Observations of marine invertebrate types in the coastal waters of

Salahutu District, Ambon Island in the three coastal waters of Wai village, Tulehu village and Suli village, according to field practicum activities carried out by several groups of students, various species of marine invertebrates were obtained, in various habitats with different substrates, in Obtaining observation results and identification results for each type of marine invertebrate can be explained Figure 1 below.

Figure 1. Results of species findings of various types of marine invertebrates

The results of the findings of biology education study program students regarding various types of marine invertebrates in field practicum activities in marine biology courses carried out in the coastal waters of Salahutu District, Ambon Island can be explained according to the position of the taxonomic structure of invertebrates from the class level to the species level as explained in Table 2, below.

Table 2. Position of invertebrate types consumed by the community

Class	Ordo	Familly	Genus	Spesies
Crustacea	*Malacostraca*	*Hippidae*	*Emirita*	*Emita Emiritus* *Emirita talpoida*
	Stomatopoda	*Squillidae*	*Harpiosquilla*	*Harpiosquilla raphidae*
	Decapoda	*Ocypodidae*	*Ocypoda*	*Ocypoda cursor*
Gastropoda	*Archaeogastropoda*	*Neritidae*	*Nerita*	*Nerita polita*
	Mesogastropoda	*Strombidae*	*Strombus*	*Strombus decorus*
	Neogastropoda	*Conidae*	*Conus*	*Conus sponalis*
Echinodermata	*Ophiurida*	*Ophiothricidae*	*Ophiothrix*	*Ophiothrix fragilis*
	Echinodea	*Diadematidae*	*Diadema*	*Diadema setosum*
	Aspidochirotida	*Holothuriidae*	*Holothuria*	*Holothuria scabra*
Analida	*Terricolae*	Lumbricidae	*Lumbricus*	*Lumbricus terrestris*

Bivalvia	*Veneroida*	*Veneridae*	*Venerupis*	*Venerupis corrugata*
	Taxodonata	*Arcidae*	*Anadara*	*Anadara broughtonii*
	Mytiloida	*Mytilidae*	*Mytilus*	*Mytilus trossulus*
	Heterodonta	*Mactridae*	*Tridacna*	*Tridacna rosewateri*
	Pectinoida	*Pinidae*	*Pinctada*	*Pinctada radiata*

Based on Table 3 above, it shows that the number of species found was 16, consisting of 4 species in the Crustacea class, 3 species in the Echinodemata class, 3 species in the Gastropoda class, 5 species in the Bivalvia class. Of the 16 marine invertebrate species found in various substrates, analysis was carried out according to the Shannon–Wiener diversity index formula (Odum, 1989) in Tuaputty et al. (2022), as described in Table 4 below.

Table 3. Diversity of marine invertebrates

Spesies	Total	Pi = n/N	Log Pi	Pi. Log Pi
Emita Emiritus	82	0,147217	-0,832041	-0,172496
Emirita talpoida	76	0,136445	-0,865041	-0,158335
Harpiosquilla raphidae	28	0,050269	-1,298697	-0,065284
Ocypoda cursor	35	0,062836	-1,201787	-0,175515
Nerita polita	29	0,052064	-1,283457	-0,066822
Strombus decorus	18	0,032315	-1,490582	-0,148168
Ophiothrix fragilis	37	0,066427	-1,177653	-0,078227
Conus sponalis	24	0,043088	-1,365643	-0,058842
Lumbricus terrestris	32	0,057450	-1,240705	-0,171278
Venerupis corrugata	22	0,039497	-1,403432	-0,355431
Diadema setosum	42	0,075403	-1,122605	-0,084647
Anadara broughtonii	63	0,113105	-0,946514	-0,107055
Mytilus trossulus	19	0,034111	-1,467101	-0,055044
Tridacna rosewateri	17	0,030521	-1,515406	-0,456252
Pinctada radiata	15	0,026929	-1,569763	-0,162272
Holothuria scabra	18	0,032315	-1,490582	-0,048168
∑	557			2,363836

Based on the results of the diversity index analysis in table 4 above, it shows that there is a level of diversity in marine invertebrate species greater than value two, the diversity index obtained is $2.0 < H'=2.363836 \leq 3.0$, this means a medium level of diversity. Thus, the moderate diversity index means that the community of various types of marine invertebrates in each substrate in each living place in the coastal water ecosystem is a medium community, however, interactions within the coastal water ecosystem environment between each species are well established, so it is said to be a community of various types. Marine invertebrate populations in each coastal water habitat, interaction is still good.

To determine the abundance and distribution pattern of marine invertebrates in the coastal waters of Salahutu District, a study was carried out using an observation area of 1.5 m^2 x 4 quadrants = 9 m^2 or 900 cm^2 (quadrant area of 900 cm^2 in each substrate in the living place) where marine invertebrates were found in coastal waters. Salahutu District as explained in Table 4, below

Table 4. Results of the Relative Abundance of Marine Invertebrates on Several Substrates in Each Habitats in the Coastal Waters of Salahutu District, Ambon Island

Habitats/ Substrate	Species	Relative Abundance Id = n / A x 100%	
Sandy	*Emita Emiritus*	9.1%	
	Emirita talpoida	8.4%	25%
	Ocypoda cursor	3.8%	
	Lumbricus terrestris	3.5%	
Gravel Rock	*Holothuria scabra*	2.0%	
	Pinctada radiate	1.6%	9.9%
	Mytilus trossulus	2.1%	
	Ophiothrix fragilis	4.1%	

Muddy	*Anadara broughtonii*	7.0%	11.4%
	Strombus decorus	2.0%	
	Venerupis corrugate	2.4%	
Coral Rock	*Nerita polita*	3.2%	15.3%
	Tridacna rosewateri	1.8%	
	Conus sponalis	2.6%	
	Diadema setosum	4.4%	
	Harpiosquilla raphidae	3.1%	
Amount	16 Spesies	557	

Based on the findings in Table 4 above, several things can be explained, including: (1) On sandy substrates, three types of marine invertebrates of the Crustacean class and one class of Annelida were found in the sandy beach area during low tide, with a relative abundance index of marine invertebrates according to the area of observation on the sandy substrate of 25%. (2). On the fine gravel substrate, two types of invertebrates of the Echinodermata class and two types of Bivalvia class were found in the coastal waters of the intertidal zone at low tide and the relative abundance of marine invertebrates on this substrate was 9.9%. (3). Three species of invertebrate class Gastropoda and two species of Gastropoda were found in the muddy substrate in the mangrove living place at low tide, with a relative abundance of marine invertebrates of 11.4%. (4). On the dead coral substrate, two types of Grastropoda class invertebrates were found, one species of the Bivalvia class and two species of the Echinodermata class, with a relative density level on this substrate of 15.3%

Data obtained from the results of the marine biology practicum course in coastal waters in Ambon Island District on various coastal substrates at low tide, as many as 16 species of the classes Crustacea, Echinoderms, Analelida, Gastropodans and Bivalves, were analyzed qualitatively and quantitatively based on the number of quadrants used, namely 4 quadrants. Qualitative data analysis can be calculated using the Morisita Distribution Index (Nazar et al., 2017), with the formula. $Id= (\sum x^2)^2 - \sum x)/ n\sum x^2 - \sum x$, The results of the analysis are shown in Appendix 6 below:

Table 5. Analysis of Distribution Patterns of Various Types of Marine Invertebrates Found in the Coastal Waters of Salahutu District, Ambon Island

Species	Amount	$(\sum x^2)^2 - \sum x)$	$n\sum x^2 - \sum x$	Id =	Distribution Pattern
Emita Emiritus	82	45.212	26.568	1,701 >1	Group nature
Emirita talpoida	76	33.362	22.800	1,463 >1	Group nature
Harpiosquilla raphidae	28	6.002	3.024	1,986 > 1	Group nature
Ocypoda cursor	35	15.005	4.760	3,152 > 1	Group nature
Nerita polita	29	7.072	3.248	2,177 > 1	Group nature
Strombus decorus	18	1.049.58	1.224	0,857 < 1	Unifrom nature
Ophiothrix fragilis	37	1.874.	5.336	3,512 > 1	Group nature
Conus sponalis	24	33.175	2.208	1,502 > 1	Group nature
Lumbricus terrestris	32	1.048.576	3.968	0,264 < 1	Unifrom nature
Venerupis corrugata	22	2.342.340	1.914	1,223 > 1	Group nature
Diadema setosum	42	3.111.654	6.888	0,451 <1	Unifrom nature
Anadara broughtonii	63	15.752.898	15.813	0,996 < 1	Unifrom nature
Mytilus trossulus	19	1.303,022	1.425	0,724 < 1	Uniform nature
Tridacna rosewateri	17	8.350.004	11.390	0,733 < 1	Uniform nature
Pinctada radiata	15	5.061.005	8.400	0,6025 < 1	Uniform nature
Holothuria scabra	18	1.049.58	1.224	0,857 < 1	Uniform nature

Based on Table 5, the results of the analysis of distribution patterns of various types of invertebrates found in the coastal waters of Salahutu District, Ambon Island, for each marine invertebrate species can be explained as follows: (1) the clustered distribution pattern occurs in crustacean class invertebrates (species *Emerita talpoida, Harpiosquilla raphidae, Ocypoda cursor*.), Gastropoda (*Nerita polita, Conus sponalis*,) Bivalvia (*Venerupis corrugate*), (2) Uniform distribution patterns occur in invertebrate Class Bivalvia *Anadara broughtonii, Mytilus*

trossulus. Tridacna rosewateri, Pinctada radiate, Class Echinodermata species (*Diadema setosum, Holothuria scabra*), Class Gasropoda (*Strombus decorus*), and class Annalida (*Lumbricus terrestris*).

Measurement of the physical and chemical factors of waters in the habitat of various types of marine invertebrates found on various substrates in each intertidal zone of coastal waters in Salahutu District. Measurements were made of the environmental factors of various types of habitats when sea water experienced high tides, presented in Table 6 below.

Table 5. Aquatic environmental factors in finding marine invertebrates

Location/Habitats	Aquatic environmental factors				
	Temperature (^{0}C)	pH	O_2 dissolved	CO_2 dissolved	Salinity ($^0/_{00}$)
Sandy	26	7,0	6,8	6,2	32
Maddy	25	6,7	6,2	5.8	30
Gravel rock	26	6,7	6,6	5.2	31
Coral rock	27	7.0	6,6	4.5	32

The results of measuring environmental factors in coastal waters where marine invertebrates are found are explained based on the substrate as a place for invertebrates to live, including sea water temperature of 25 ^{0}C to 27 ^{0}C, sea water pH ranging from 6.7 - 7.2, dissolved O_2 6.6 -7, 4, dissolved CO_2 5.2 – 6.7, sea water salinity 30 $^0/_{00}$ to 32 $^0/_{00}$.

Discussion

Skills in carrying out field practicums in marine biology courses carried out by students in understanding the concepts, theories in marine biology courses, field practicums must be integrated with abilities which include: observation, measurement, prediction, collecting data, grouping, recording data, interpreting data, controlling variables, making operational definitions, as well as the ability to analyze data, especially various types of marine invertebrates found in the coastal waters of Salahutu District, Ambon Island. Observations were made on various types of marine biota at low tide in each coastal water living place on various substrates.

The results of students' findings in field practicum were 16 species from several classes of marine invertebrates in various substrates in each intertidal and subtidal zone living place, such as Echinoderms, Crustacea, Annalida, Gastropoda and Bivalves in the coastal waters of Salahutu District. This is in accordance with the views of Maya and Nurhidayah (2020), and Rachmawati et al. (2023) that various types of marine biota or marine invertebrates can be found along coastal waters, where the various types of marine biota or marine invertebrates are different because of the living place they occupy. different too.

In order to better understand each Invertebrate class, students need the ability to identify various morphological and anatomical characteristics of each species in the invertebrate class, starting from the Crustacea class, including: *Emerita talpoida, Harpiosquilla raphidae, Ocypoda cursor*. Crustacean animals have book-shaped bodies, some live by burying themselves in the sand to avoid predators, especially for the *Harpiosquilla raphidae* species, protecting them from predators by hiding. In the cracks of the coral at the bottom of the coral is a layer of sand (Maya & Nurhidayah, 2020; Pratiwi, 2018).

On muddy substrates and sandy rocky substrates and also on eye or living coral substrates, various types of marine invertebrates of the bivalve class are found, such as *Anadara broughtonii* and *Venerupis corrugate*, both of these species live buried in muddy substrates, *Mytilus trossulus* and *Pinctada radiate* prefer to inhabit the intertidal zone on rocky substrates. mixed with gravel, for the species *Tridacna rosewateri* it is found on rocky substrates of dead coral and live coral, because this animal eats zeosantellah algae. Bivalves have two symmetrical shells with varying sizes and on the dorsal side, they have muscular legs shaped like axes that function to anchor themselves or dig into the substrate where the bivalves bury themselves (Indrawan, 2019). Based on research, it is known that animals from the mollusca group, both the gastropod class and the bivalve class, are often found in various different habitats and substrates and are used as environmental bioindicators based on their species diversity index (Widowati et al., 2019).

Gastropods are a type of invertebrate that is often found in intertidal and subtidal areas. From the results of students' findings, it shows that the types of invertebrates of the Gastropoda class are very varied, found in muddy substrates (*Strombus decorus* habitat in sandy substrates, *Nerita polita* and *Conus sponalis* habitat in rocky substrates). According to Supratman et al. (2018) that gastropods are usually found in sandy, rocky and muddy

substrates, apart from that environmental factors such as light, brightness, turbidity, temperature, salinity and pH also influence their reproduction. Gastropods are one of the most important groups in coastal ecosystems due to their role as ecological function. According to Toby et al. (2017) states that Gastropods are often found in marine waters in various habitats in the intertidal and subtidal zones and gastropods are the most successful species and have a very wide distribution, namely from the coast to the deep sea, apart from This invertebrate is a constituent of macrozoobenthos communities in coastal areas.

The Annalida discovered by the students was carried out by digging the sandy substrate to a depth of 10 cm - 30 cm, so it was found that this type of *Lumbricus terrestris* species lives along the sandy substrate on the beach and is easy to find, its body size is 2 mm - 4 mm with a length reaching 15 cm - 30 cm. Pamungkas (2009) explained that one aspect that has not been studied much regarding the Annelida and Polycheta worms which have quite good habits in the coastal waters of Ambon Island, is that these worms are known among the people of Ambon as wawo worms which live along sandy beaches and coral rocks. Annelid worms, in addition to their segmented bodies, are also covered by cuticles which are the result of secretions from the epidermis and already have a nervosum system, a closed cardiovascular system, and a body cavity or coelom. There are around 15,000 species of annelids with body lengths ranging from 1 mm to 30 cm, According to Rahmadina and Eriri (2018) explained that annelids have body segments and each segment, except the last segment, has para-podia equipped with many setae. These setae are used to dig sand in rock crevices.

Observation results of the invertebrate Echinordermata species *Diadema setosum*, *Holothuria scabra*, *Ophiothrix fragilis* in the coastal waters of Salahutu District, especially in the intertidal areas of sandy substrates and rocky substrates. Tuaputty et al. (2022) states that Echinodermata class invertebrates are found in almost all intertidal and subtidal zones of the coastal waters of Ambon Island at depths of 0.5 m to 15 m at low tide. Yusron and Yusron and Edward (2019), Most echinoderm groups are found in certain places or have zones. This is thought to be related to vegetation, namely seaweed or seagrass that grows in the area and also the presence of dead coral. It is also said that Echinoderms can be found in various places on aquatic substrates, especially in the waters of Osi Island, West Seram, Central Maluku.

According to Triacha et al. (2021), based on field observations, the intertidal zone of Cibuaya Beach has a variety of animals, including sea stars, sea urchins, star snakes, and sea cucumbers which have the same characteristic, namely a spiny body. These animals are known as the Echinodermata group. Echinoderms are a phylum. The Echinodermata phylum has five classes, namely the Asteroidea class which is known as starfish; class Echinoidea or sea urchins; class Ophiuroidea or snake stars; class Crinoidea or sea lilies, and class Holothuroidea or sea cucumbers. According Lalombombuida et al. (2019), explained that all Echinodermata species live in the sea, but some Echinoderms can live in the intertidal zone or tidal areas. The intertidal zone is one part of this zone, which is a zone that is bounded by the intertidal lines of sea water, as well as being a zone that has more diverse living place than other marine zones.

The results of the analysis of marine invertebrate diversity show a diversity index value of $2.0 < H' = 2.363836 \leq 3.0$, which means that the diversity of invertebrates found living on various substrates is said to be moderate, meaning that individuals from each type of marine invertebrate form a community. by the population of each type of invertebrate in an ecosystem is still in a normal condition, has not experienced damage, in other words there is still interaction between marine biota or invertebrates, both regarding environmental factors and the need for food sources by each type of invertebrate still running well in the habitat where marine biota or invertebrates are alive. According to Guntara et al. (2020) the diversity and composition of invertebrate types that live on various substrates, where the substrate is a place to obtain the nutritional supply needed for the survival of various types of marine invertebrates. According to Supratman et al. (2018) that all intertidal beaches, sand gravel substrates and rocky beaches are composed of rocky material which is the area with the most density of microorganisms and has the greatest diversity of both invertebrate animal species where this invertebrate diversity is influenced by environmental factors and nutritional sources. in the waters.

Thus, the diversity of marine invertebrates in the coastal waters of Salahutu District, Ambon Island with a moderate level of diversity index means that there is quite good interaction, so that the habitat as a place for marine invertebrates to live as well as environmental factors that have a big influence on the populations of various types of invertebrates are quite developed in the area. any substrate in the intertidal zone of coastal waters. The results of the diversity analysis provide a comprehensive description in the form of data characterizing the structure of life to make it easier to analyze information about types of marine invertebrates during the process of interaction between types of marine invertebrates in a habitat through a diversity index according to the percentage composition of the population in the ecosystem in the coastal waters of Salahutu District, Ambon

Island. According to Lalombombuida et al. (2019) that the more types of marine invertebrate populations in an ecosystem or habitat, the greater the diversity, but often diversity also really depends on the total number of individuals for each type of marine invertebrate population. Oktavia (2018) that based on the diversity of various types of marine biota, interactions between them are possible, due to adaptation to environmental factors so that a better life can be formed, or it can be said that coastal waters become habitable places for various types of marine biota. Thus, geographically, the coastal waters of Salahutu District, Ambon Island, are a good place for population growth of various types of marine invertebrates, so that there is a diversity of marine invertebrates which is a potential water and marine resource for the survival of marine invertebrates themselves and also the people in this area.

Abundance can be defined as the number of individuals occupying coastal waters in a particular habitat or the number of individuals of a species per square or unit of measured or defined observation area. Measurements of marine invertebrate abundance carried out by students refer to the number of species or types of invertebrates or various types of marine biota found according to the structure in the community in the coastal waters of Salahutu District, Ambon Island. The measurement and analysis of the abundance of marine invertebrates in coastal waters was carried out based on the substrate where various types of marine invertebrates were found. From the results of the analysis it turned out that the highest abundance of marine invertebrates was on sandy substrates at 25%, on coral rocky substrates at 15%, on muddy substrates at 11%. 3% and gravel substrate at 9.9%. This shows the highest abundance on sandy substrates because the number of species *Emerita talpoida*, *Harpiosquilla raphidae*, *Ocypoda cursor* is 221 individuals more than invertebrates on other substrates. Nugraha et al. (2018) that coastal areas with sandy substrates are places where various types of marine invertebrates live, such as crustaceans, such as sea turtles and various types of sand crabs and even gastropods and bivalves are also found. According to Rachmawati (2023) the high abundance of a species in a habitat or ecosystem is due to the support of nutrients and aquatic environmental factors, especially sandy substrates which always receive a supply of nutrients from water flows from land, thus allowing their abundance to be quite high compared to other substrates.

On several substrates where invertebrate types were found, the relative abundance varied, so as a result of discussions between fellow students it was decided that the abundance of marine invertebrates varied between each substrate in the coastal waters of Ambon Island District because the range of aquatic environmental factors was also different for each sandy substrate. Temperature 26 ^{0}C, pH 7.0 Dissolved O_2 6.8, dissolved CO_2 6.2, Salinity 32 $^0/_{00}$, compared to muddy substrate shows Temperature 250C, pH 6.7 Dissolved O_2 5.4, dissolved CO_2 5.8, Salinity 30 $^0/_{00}$, so environmental factors greatly influence the abundance of several species marine invertebrates especially on muddy substrates. Low abundance of invertebrates, due to overfishing or the area being dense with community activities which results in the discharge of household waste which can affect water environmental factors, so that some types of invertebrates cannot adapt. According to Thrush et al. (2008), the abundance of a species in a habitat is influenced by environmental factors, food availability, predators, competition, as well as chemical and physical factors that are still within the tolerance range for an invertebrate species.

The students found 16 species of invertebrates with a total of 557 individuals on the beaches of Salahutu District, Ambon Island. In understanding the concept of invertebrate distribution patterns in various coastal water substrates in the intertidal zone, it turned out that from the calculation results according to the distribution pattern formula, the analysis carried out by the students showed that there was a clustered distribution pattern. and uniform distribution patterns. According to Nazar et al. (2017) that distribution patterns are one of the sub-materials studied in the Animal Ecology course and also the Invertebrate course. This course is one of the courses in the Biology discipline which studies the reciprocal relationship between animals and the environment, as well as studying the distribution and abundance patterns of invertebrate organisms, especially knowing the distribution of a species in an ecosystem and the environmental factors that influence these invertebrates.

The results of the analysis of distribution patterns of marine invertebrates in the coastal waters of Salahutu District, Ambon Island by students showed the nature of clustered distribution patterns in the species *Emita Emiritus, Emirita talpoida, Harpiosquilla raphidae, Ocypoda cursor, Nerita polita, Ophiothrix fragilis, Conus sponalis, Venerupis corrugate*. One of the causes of this group distribution pattern is that the nutritional content and environmental factors in coastal waters really support the prosperity of each type of population. On the following substrate Temperature 26 ^{0}C, pH 6.7, dissolved O_2 6.6, dissolved CO_2 5.2, Salinity 31 $^0/_{00}$, on visible rocky substrate Temperature 27 ^{0}C, pH 6.7 Dissolved O_2 5.8, dissolved CO_2 4.8, Salinity 30 $^0/_{00}$, on rocky substrate Temperature 27 ^{0}C, pH 7.0, dissolved O_2 6.6, dissolved CO_2 4.5, Salinity 32 $^0/_{00}$, from the results of measurements of aquatic environmental factors there are similar environmental factor values between sandy

substrates and bark coral substrates. According to Nugroho et al. (2018) that the distribution pattern of invertebrate species is group in nature because individuals of invertebrate species are always present in groups and are very rarely seen separately, this is due to the availability of nutrients in the substrate which is always available and the ability to adapt to environmental factors in coastal waters that greatly influence the abundance of a species in groups, there is no competition for obtaining nutrients from each type of invertebrate.

Meanwhile, several types of marine invertebrates from the calculation results of the morista index show a uniform distribution pattern, especially the species *Lumbricus terrestris, Diadema setosum, Anadara broughtonii, Mytilus trossulus. Tridacna rosewateri, Pinctada radiate, Holothuria scabra.* The uniform distribution pattern suggests that the availability of nutrients on each substrate occupied by marine invertebrates is very limited so that the living needs of deepsea invertebrates obtain nutrients according to the size and size of the marine invertebrate's body. According to Setiawan et al. (2019) that each type of substrate has a different organic material content, so that the substrate in each habitat influences the existence of each type of marine invertebrate in each habitat, as a result of the interaction between individuals in a community in obtaining nutrients is slightly limited, as well environmental factors that influence the uniform distribution pattern of marine invertebrates.

Thus, it can be said that there is a distribution pattern of marine invertebrates in the coastal waters of Salahutu District, Ambon Island, with a uniform distribution pattern which occurs because competition between individual marine invertebrates is very strong in obtaining nutrients and space in the substrate they occupy. The most common clustered distribution pattern for marine invertebrates in coastal water environments is where each individual type of invertebrate has the opportunity to obtain nutrition and space to grow and develop, increasing the population of each type so that a good community is formed in each coastal water environment.

Having students understand the concept of diversity, abundance and distribution patterns of various types of marine invertebrates as well as understanding the measurement of aquatic environmental factors on the life of various types of marine invertebrates through field practicum activities in coastal waters in Salahutu District, Ambon Island is a process of proving concepts and theories in college. Ocean biology is a lecture process that is in line with the competencies desired by every student who offers this course. According to Nugroho et al. (2018), the diversity, abundance and distribution patterns of a species can be studied through horizontal and vertical sediment types which are determined by the process during which the sediment is deposited, in addition to the condition of the source material. The physical, chemical and biological capabilities of sediment are the basis for analysis of the diversity, abundance and distribution patterns of marine invertebrate species. According to Nazar et al. (2017) and Fitria et al. (2019) that the application of courses related to proving theories needs to be supported by field observations, especially those related to invertebrate zoology. Thus, proving the diversity, abundance, distribution patterns of various types of marine invertebrates as well as measuring environmental factors in coastal waters are closely related to the life of various types of marine invertebrates.

CONCLUSION

Based on the research results, it is concluded that (1) students understand and are able to analyze the concepts of diversity, abundance and distribution patterns of marine invertebrates found living in various substrates in coastal waters through field practicum activities in coastal waters, Salahutu District, Ambon Island, Central Maluku Regency. (2) The results of the analysis of marine invertebrate diversity show a diversity index value of $2.0 < H' = 2.363836 \leq 3.0$, which means that the diversity of invertebrates found living in various substrates in coastal waters, Salahutu District, Ambon Island, Central Maluku Regency has a moderate level of diversity, meaning individuals of each type of marine invertebrate in a community, interactions are still running well. Each type of population of each type of invertebrate in an ecosystem is still in normal condition, apart from the availability of nutrients, there are also environmental factors in coastal waters. (3) The results of measurements and analysis of the abundance of marine invertebrates in coastal waters, Salahutu District, Ambon Island, Central Maluku Regency according to the substrate where marine invertebrate types were found, show the highest abundance of marine invertebrates on sandy substrates at 25%, followed by coral rocky substrates at 15%, muddy substrates. by 11.3% and gravel substrate by 9.9%. This difference in abundance is also due to differences in the environmental conditions of coastal waters on each substrate where marine invertebrates live. (4) The students showed the distribution pattern of marine invertebrates in the coastal waters of Salahutu District, Ambon Island, the results of the morista index analysis showing the nature of the clustered distribution pattern in the species *Emita Emiritus*, *Emirita talpoida*, *Harpiosquilla raphidae*, *Ocypoda cursor*, *Nerita polita*, *Ophiothrix fragilis*, *Conus sponalis*, *Venerupis corrugate*. Meanwhile, the types of marine invertebrates whose distribution patterns are uniform include the species *Lumbricus terrestris*,

Diadema setosum, *Anadara broughtonii*, *Mytilus trossulus*, *Tridacna rosewateri*, Pinctada radiate*, Holothuria scabra*. The cause of this distribution pattern is one of the consequences of the different nutritional content and environmental factors in coastal waters in each substrate

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