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# Biodiversity of Echinodermata in Marsegu Island

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**Abstract**

Echinoderms are key species that govern the structure and balance of communities and influence the sustainability of other organisms in different types of ecosystems in sea water. This research aimed at examining the biodiversity of echinoderms, and environmental physical-chemical factors that affect the diversity of echinoderms in coastal waters of Marsegu Island. The data were collected with direct observation and all research variables were recorded. The data collection of echinodermata type was done on each plot in the middle intertidal zone and the lower intertidal zone. The results of this research found that the population of echinoderms in coastal water of Marsegu Island was composed of 4 classes, namely Ophiuroidea, Asteroidea, Echinoidea and Holothuriodea. The most common type found was Asteroidea which consisted of 3 families, 4 genera and 4 species. The results of observation showed there was a difference in echinoderm species found in the middle intertidal zone and the lower intertidal zone. The number of echinoderms species found in the middle intertidal zone was 8 species, while in the lower intertidal zone was 10 species, and there were some species that were not found in the middle intertidal zone, but they were found in the lower intertidal zone, namely *Ophiopholis aculeafa, Linckia laevagata* and *Protoreaster nodusus.* The *Synapta maculata* species was found in the lower intertidal zone, but it was not found in the midle intertidal zone. About 52% variation in echinoderms diversity can be explained by the regression equation model, while the remaining 48% was the influence of other factors that could not be explained by the regression equation model.

*Keywords: biodiversity, echinoderms, Marsegu Island.*

**Abstrak (Indonesian)**

Echinodermata merupakan spesies kunci yang mengatur struktur dan keseimbangan komunitas serta mempengaruhi keberlanjutan organisme lain pada berbagai jenis ekosistem di perairan laut. Penelitian ini bertujuan untuk mengkaji biodiversitas echinodermata, dan faktor fisika-kimia lingkungan yang mempengaruhi keanekaragaman echinodermata di perairan pantai Pulau Marsegu. Pengumpulan data dilakukan dengan cara pengamatan (observasi) langsung dan dilakukan pencatatan terhadap semua variabel penelitian. Pengumpulan data jenis Echinodermata dilakukan pada tiap plot yang ada di zona intertidal tengah (middle intertidal zone) dan zona intertidal bawah (lower intertidal zone). Hasil penelitian menemukan populasi echinodermata di perairan pantai Pulau Marsegu tersusun dari 4 kelas yaitu Ophiuroidea, Asteroidea, Echinoidea dan Holothuriodea. Jenis yang paling banyak ditemukan adalah Asteroidea dimana ada 3 famili, 4 genus dan 4 spesies. Hasil pengamatan menunjukkan ada perbedaan spesies echinodermata yang ditemukan pada zona midle intertidal dan lower intertidal. Jumlah spesies echinodermata yang ditemukan di zona midle intertidal adalah 8 spesies, sedangkan pada zona lower intertidal adala 10 spesies, dan ada beberapa spesies yang tidak ditemukan di zona midle intertidal tetapi ditemukan di zona lower intertidal, yakni Ophiopholis aculeafa, Linckia laevagata dan Protoreaster nodusus. Untuk spesies Synapta maculata ditemukan di zona lower intertidal tetapi tidak ditemukan di zona midle intertidal. Sekitar 52% variasi pada keanekaragaman echinodermata dapat dijelaskan oleh model persamaan regresi, sedangkan sisanya 48% merupakan pengaruh dari faktor-faktor lainnya yang tidak dapat dijelaskan oleh model persamaan regresi.

*Kata kunci:biodiversitas, echinodermata, Pulau Marsegu.*

## 1. Introduction

Continuous assessment of marine water systems is one of the topics that continues to receive ecological and management attention. Assessment of marine water systems is essential to understand the ecological patterns and ecosystem functions. Comprehensive understanding will greatly assist the management of marine resources and identify conservation priorities. What gets a lot of attention is to investigate factors that may affect diversity [1]. One of the marine organisms that is often used to assess the condition of marine water systems is echinoderms. Williams & García-Sais [2] explains that echinoderms are marine animals that are very important, and most of its species are key species that govern the structure and balance and affect the sustainability of communities and other organisms in

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various types of ecosystems. Supono [3] assert that echinoderms are a major part of marine biodiversity, especially in the context of biomass and macroinvertebrates that play an important role in ecosystem functions.

Echnodermata is the oldest intertebrate phylum in animalia kingom. There are about 7000 species that have already been identified, and about 13.000 have become extinct [4]. The species of echinoderms are members of watershed community spreading across polar areas and tropical regions. Echinoderm phylum is divided into four classes: Asteroidea, Echinoidea, holothuridea and Crinoidea [5]. Phylum echinoderms contains several tropic groups, namely detrivor, filter-feeder, grazer, scavenger and active predators, and it plays an important role in the structure of the benthos community [6]. Bellwod [7] explains that echinoderms are important components of the reef ecosystem. Alvarado [8] also found that there was an association between the diversity of echinoderms and coral reefs. The high richness and diversity of echinoderms is an indication the high diversity of coral reefs. Therefore, Chenelot [9] asserts that understanding the distribution of echinoderms in the context of space and time can help improve the functional understanding of coastal ecosystems. The spread of echinoderms in coastal water is affected by environmental factors.

The distribution of echinoderms in the intertidal zone in coastal water is a theme that continues to receive attention. Gutt & Starmans [10] explains that echinoderms are generally distributed in small groups in space and time. Therefore, its diversity in both spatial and temporal contexts is the result of these small groups that are also part of its largest community. The main factors that cause the echinoderms to be found in small groups are the enviremnmental physical-chemical conditions, the dynamics of recruitment, the flow of nutrients, predation or flocking behavior of certain types [11, 9]. Human activity and physico-chemical factors, such as temperature, salinity, pH and dissolved oxygen are some factors suspected to affect the distribution of echinoderm species and other macroinvertebrates [12]. These factors are thought to affect the distribution of echinoderms because of their effects on growth rates, metabolic activity, immune responses and their association with stress levels and reproductive success [13]. Therefore, the assessment of environmental factors that affect the distribution of ehinoderms in water is very important.

One of the coastal areas that have potential of echinodermata is Marsegu Island in West Seram District, Maluku Province, Indonesia. Marsegu Island is a coral island with an area of 240.20 Ha. Based on literature study, research related to the presence of echinoderms in coastal areas of Marsegu Island has not been done.

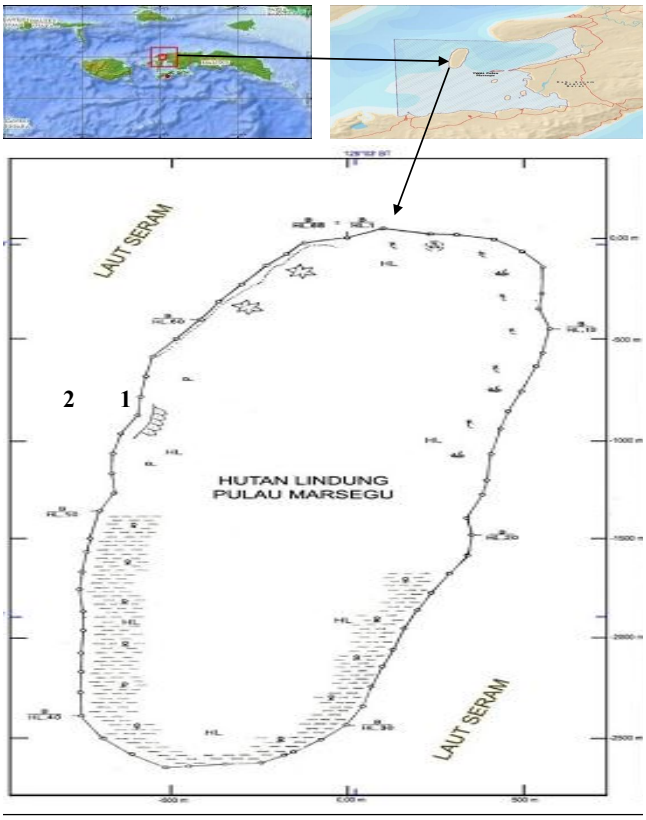


Figure 1. Research Location

Therefore, this research is very important to investigate the ecological status of echinoderms and environmental factors that affect echinoderms.

## 2. Experimental Section

This research is an ecological research with the type of descriptive correlational research. The population of this research was all Echinodermata in the tidal area in the water of Marsegu Island, Seram regency. The samples were all types of Echinoderms in each plot in the tidal area. The determination of transect line and plot mapping was done by making horizontal transect line from each intertidal zone boundary as many as 10 transect lines. On each transect were

Table 1. Result of measurement of environmental physico chemical factor in coastal water of Marsergu Island

| Parameter | Intertidal | Time | | |
|---|---|---|---|---|
| | | Morning | Afternoon | Evening |
| Temperature | Midle | 27.8 | 29.9 | 26 |
| | Lower | 28 | 30.16 | 26 |
| Salinity | Midle | 51 | 51 | 51 |
| | Lower | 51 | 51 | 52 |
| pH | Midle | 7.09 | 7.09 | 7.09 |
| | Lower | 7.09 | 7.09 | 7.09 |
| DO | Midle | 4.16 | 3.02 | 2.38 |
| | Lower | 4.06 | 3.19 | 2.07 |

Table 2. The composition of echinodermata taxa in coastal water on Marsegu Island

| Order | Family | Genus | Species |
|---|---|---|---|
| Ophiurida | Ophiuridaea | Ophiura | *Ophiopholis aculeafa* |
| Valvatida | Ophidiasteridae | Linckia | *Linckia laevagata* |
| | Archasteridae | Archaster | *Arachaster typicus* |
| | Oriasteridae | Culcita | *Culcita novaeguinea* |
| | | Protoreaster | *Protoreaster nodusus* |
| Deadematoida | Diadematidae | Diadema | *Deadema setosum* |
| | | Echinotrix | *Echinothrix calamari* |
| Echinoida | Strongylocentrotidae | Strongylocentrotus | *Strongylecentrotus purpuratus* |
| Aspidochirotida | Holothuriidae | Holothuria | *Holothuria vagabunda* |
| | | | *Bohadschia marmorata* |
| Apodida | Synaptidae | Synaptida | *Synapta maculata* |

made 10 pieces of plot with a size of 1x1 $m^2$ with a distance between plots 10 m. The data were collected by using direct observation and all research variables were recorded. The data collection of Echinodermata type was carried out on each plot in the middle intertidal zone and the lower intertidal zone. The data were collected during the low tide, which was in June 2016. The data were collected in every observation plot measuring 1x1 $m^{2}$. The specimen inside the observation plot was recorded, retrieved and photographed, and then inserted one example of the type into the jar containing 70% alcohol solution and given a label. The label was given the station number, transect number, individual code, and date of pickup. The data collection on the physico-chemical factors of the environment (temperature, salinity, dissolved oxygen, and pH) was carried out at each quadrature (plot) in each intertidal zone based on the measurement results using a measuring instrument.

To identify the types of Echinodermata then was used a book entitled Soft-Sediment Marine invertebrates of Southeast Asia and Australia: A Guide to Identification [14]. Diversity index was alculated using the formula of diversity index Shannon - Wiener [15], as follows:

$$H' = -\sum P_i \ln P_i \quad \text{Where} \quad P_i = \frac{nini}{N\,N}$$

Note :

H ' = index of diversity
$P_i$ = probability of the i-th species
*ni* = Number of individuals per i-th species
*N* = the total number of species
*Ln* = logarithm nature
Σ = number of individual species

The correlation analysis was performed between physico-chemical factors of the environment (temperature, salinity, dissolved oxygen and sea water pH) with the diversity of Echinodermata in the intertidal zone of coastal waters on Marsegu Island of West Seram District.

## 3. Results and Discussion

### 3.1. Physico-Chemical Factors of Water

The measurement of the physico-chemical factors of the environment was done 3 times a day. The measurements were carried out in the morning, afternoon and evening. This was done to know the fluctuation of physico-chemical factors of the environment in the intertidal zone.

In the midle interidal zone (Table 1), the temperature of the water in the morning was 27.8° C, in the afternoon was 29.9° C and in the evening was 26° C. Then, in the lower intertidal zone, it appears that the average temperature in the morning was 28° C, in the afternoon was 30.16 and in the evening was 26° C. The results of the measurements of seawater salinity showed that the average salinity of sea water was 51‰. These results were seen at all three measurements in the midle intertidal zone, while in the lower intertidal zone, the salinity of seawater looked different in the evening. In the morning and in the afternoon, the salinity of sea water was 51‰, whereas in the evening it was 52‰. The results of the pH measurements of the sea water showed that the pH average of the sea water in both zones was relatively stable in the morning, afternoon and evening as much as 7.09. The measurement results of dissolved oxygen *(demand oxigen / DO)* showed that the average DO varied widely in both zones. In the midle intertidal zone, the average DO in the morning was 4.16, in the afternoon 3.02 and in the evening 2.38. Then, in the lower intertidal zone, the average DO in the morning was 4.06, afternoon 3.19 and in the evening 2.07.

Intertidal zone is an area that has a wide range of physico-chemical factors influenced by waves, sea water temperature and substrate. These factors have long been known to affect organisms in the intertidal zone [16,17]. In addition, the physico-chemical conditions of the environment in the intertidal zone are very influenced by various human activities [18].

### 3.2. The compositions of Echinodermata type

The data of echinodermata specimen obtained from the water of Marsegu Island were further identified and determined by the order of the taxa. Based on the results of the identification, it was known

Table 3. Types of Echinoderms of Coastal Waters on Marsegu Island

| No. | Species | Intertidal | |
|---|---|---|---|
| | | Midle | Lower |
| 1 | *Ophiopholis aculeafa* | - | + |
| 2 | *Linckia laevagata* | - | + |
| 3 | *Arachaster typicus* | + | + |
| 4 | *Culcita novaeguinea* | + | + |
| 5 | *Protoreaster nodusus* | - | + |
| 6 | *Deadema setosum* | + | + |
| 7 | *Echinothrix calamari* | + | + |
| 8 | *Strongylecentrotus purpuratus* | + | + |
| 9 | *Holothuria vagabunda* | + | + |
| 10 | *Bohadschia marmorata* | + | + |
| 11 | *Synapta maculata* | + | - |

that there were 4 classes that made up the population of echinoderms in Marsegu Island (Table 2).

The population of echinoderms in coastal water of Marsegu Island was composed (Table 2) of 4 classes: Ophiuroidea, Asteroidea, Echinoidea and Holothuriodea. The most common type was Asteroidea where there were 3 families, 4 genera and 4 species found. Furthermore, there were also differences in the echinoderm species found in the midle *intertidal* zone and *the lower intertidal zone.*

Based on the results of observations (Table 3), it was revealed that there was a difference in the types of echinoderms found in midle intertidal and lower intertidal zones. The number of species of echinoderms found in the midle interleidal zone were 8 species, while in the lower intertidal zone were 10 species. There were some species which were not found in the midle intertidal zone, but they were found in the lower intertidal zone. These species included *Ophiopholis aculeafa, Linckia laevagata* and *Protoreaster nodusus.* Meanwhile, *Synapta maculata* species were found in the lower intertidal zone, but they were not found in the midle intertidal zone. The results of research conducted by Chenelot [9] found 24 species of 4 classes in coastal water of Alaska. Llacuna [5] found 10 species of 4 classes in the water of Babanlagan, Talisayan, Philippines. Deja [19] reported as many as 32 species of echinoderms found in the water of the island of Spitsbergen, Norway. Bollar [20] found 45 species which spreaded over 5 classes, 23 families and 32 genera echinnodermata in Reunion Island.

### 3.3. Diversity, Evenness, and Richness of Echinoderms

Table 4. Index of Diversity, Evenness and Richness of the Types of Echinoderms

| Intertidal | Diversity Index | Evenness Index | Richess Index |
|---|---|---|---|
| Midle | 1.86 | 0.89 | 1.2 |
| Lower | 2.01 | 0.87 | 0.44 |

Table 5. Results of multiple Linear Regression Analysis

| Model | R | R Square | Adjusted R Square | R Square Change | F Change | Sig. F Change |
|---|---|---|---|---|---|---|
| 1 | 0.721(a) | 0.52 | 0.5 | 0.52 | 25.766 | 0 |

A Predictors: (Constant), Temperature, Salinity,pH, DO

The data on the number and types of individuals were then analyzed to determine the index of diversity, sensitivity and richness of echinoderms in the water of Marsegu Island (Table 4).

There is a difference in the value of diversity index, evenness index, richness index of the echinoderms species in the midle intetidal zone and the lower intertidal zone in the water of the Marsegu Island. In the midle intertidal zone, the diversity value was 1.86, whereas the diversity value in the lower intertidal zone was 2.01. The research conducted by Tuapattinaja [21] found that the diversity of echinoderms in Tanjung Tiram Bay in Ambon Island was moderate, ranging from 1.52 to 2.27. Morris [22] explains that biodiversity represents the diversity and heterogeneity of organisms or traits at all levels of the hierarchy of life, from molecules to ecosystems. The heterogeneity of organisms also represents a feature that the ecosystem is more stable.

The results of analysis also showed that the the values of evenness at both sampling sites were not very different. In the midle intertidal zone, the evenness value was 0.89 while in the lower intertidal zone was 0.87. Heip [23] explain that the evenness expresses how individuals of different species were distributed evenly within a community. Evenness indicates whether or not there is individual dominance in the community. Then,the next is the richness index, where the results of the analysis showed that the richness index in midle intertidal zone was 1.20, and in the lower intertidal zone was 0.44. Aslam [24] explains that richness shows the number of species present in an area that becomes the sampling site. The indexes of diversity, evenness and richness are important ecological indicators to measure the stability of a community.

### 3.4. The correlation Between Physico Chemical Factors and the Diversity of Echinoderms

After the analysis to know the linearity assumption of each independent variable with dependent variable was done, then analysis could be continued with multiple regression analysis (Table 5).

Results of multiple linear regression analysis (Table 5) showed that the simultaneous correlation coefficient of the variables of temperature, salinity, pH and dissolved oxygen (DO) was R = 0.721 with significance level of regression coefficient 0,00. This illustrates that there is a significant simultaneous correlation between each independent variable with the dependent variables. These results provide an illustration that the regression equation model can be used to predict ecinodermata diversity in the water of the Marsegu Island. Thus, it can be concluded that the physico-chemical factors of the encironment have a correlation with the diversity of echinoderms.

The magnitude of the effect of independent variables simultaneously on the dependent variable can be explained by the magnitude of the determination coefficient (R Square) (Table 5) that is equal to 0:52 or 52%. Thus, it can be explained that 52% of the diversity in echinoderms can be explained by the regression equation model, whereas the remaining 48% is the influence of other factors that cannot be explained by the regression equation model. Based on the multiple regression test results indicating that there was a significant correlation between independent variables and dependent

Table 6. Summary of the Regression Coefficients of each Independent Variable

| Model | | Unstandardized Coefficients | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | | B | Beta | | |
| 1 | (Constant) | -8.919 | | -3.906 | 0 |
| | Temperature | 0.142 | 0.364 | 2.468 | 0.015 |
| | Salinity | -0.21 | -0.851 | -3.058 | 0.003 |
| | pH | 1.727 | 1.919 | 6.774 | 0 |
| | DO | 1.109 | 1.136 | 5.519 | 0 |

variable simultaneously, then the analysis was proceeded to see the level of significance of the regression coefficient of each independent variable. The testing of the significance level of the regression coefficient of each independent variable was performed using T test (Table 6).

All of the physico-chemical factors of the envoronment used in this research have significant correlations with the diversity of echinoderms (Table 6). The water temperature factor is known to have a significant correlation with the diversity of echinoderms. Temperature factors have long been known to play a role in regulating the distribution of aquatic organisms. Various studies have documented the effect of temperature on physiology, phenology and biogeography. Byrne [25] found that increasing sea temperatures will hinder the process of division in sea urchin embiogenesis. Thus, it can be explained that the temperature of the sea water affects the reproductive success of echinoderms. Zang [26] also found that increasing temperature by 3°C would change the behavior of organisms *Strongylocentrotus intermedius.*

Another factor is salinity of seawater, where the results of the analysis show a significant correllation with the diversity of echinoderms. Various other studies have documented the effect of salinity on morphology and biochemia of echinoderms and various other types of marine organisms. The effect of salinity on organisms is closely related to the mechanism of anisoosmotic regulation which is the process of ionizing agents to maintain the stability of osmotic pressure in the tissues. This function is performed by several epithelial enzymes, such as the Na+/K+, ATPase, V-ATPase, HCO3 – ATPase, carbonic anhydrase [27, 28]. The results of this research are consistent with Iken [1] who found that salinity affects the distribution of echinoderms in shallow waters. The results of this research found that the higher the salinity, the lesser the diversity of echinoderms will be. Geng [29] conducted an experiment and found that too high salinity pressure can cause tissue damage of echinoderm species *Apostichopus japonicas*

The next factor is pH, where the results show that there is a significant correlation between sea water pH and the diversity of echinoderms. Some studies have indicated that increased human economic activity have increased the level of $CO_2$ in the atmosphere, and most of it will be absorbed into the oceans. This leads to the accumulation of $CO_2$ in seawater, and it results in the increase in the acidity of sea water. This high level of acidity will bring negative effects toward different types of marine organisms. The $CO_2$ absorbed by the ocean water will induce the modification of carbonate balance system to be less saturated, causing the polymorphism of calcium carbonate. It will have an effect on a variety of physiological processes, such as calcification, nutrition, metabolism and reproduction [30, 31]. However, the organism's response to this increasing degree of acidity varies greatly. The review results by Dubois [32] (2014) found that the level of water acidity (pH) has an effect on echinoderms system. The lower the pH of the water will affect the integrity of the echinoderms system. Moulin [33] explains that the pH affects the early development of sea urchin *Paracentrotus lividus*.

Another factor that also has an effect on the diversity of echinoderms is DO. The results of the analysis show a significant correlation between DO and the diversity of echinoderms. The oxygen content in water is also known to be one of the factors governing the distribution of aquatic organisms. Low oxygen concentration in seawater will cause hypoxia. Vaquer-Sunyer & Duarte [34] revealed that the condition of hypoxia in coastal waters continues to increase globally and is a serious threat to the ecosystems of coastal water. Rabail [35] explain that hypoxia can trigger death which results in loss of metazoids in ecosystems. An area which experiences hypoxia can be called as the 'Dead zone' which is a condition without any fish, shrimp or shell resources. Hypoxia triggers the loss of biodiversity through its influence in reducing growth and reproduction, physiological stress, enhancing migration, reducing habitat stability, increasing vulnerability to predation and destroy life cycles [36].

## 4. Conclusion

Based on the results of the data analysis and discussion above,it can be drawn some conclusions: (1) There is a fluctuation of physico-chemical factors of environment in the midle intertidal zone and lower intertidal zone. In the midle intertidal zone, the water temperature was 27.8°C in the morning, 29.9°C in the afternoon and 26°C in the eveninng. Then, in the lower intertidal zone, it appears that the average temperature in the morning was 28, in the afternoon 30.16 and in the evening 26°C. (2) The results of salinity measurements show that the average salinity of the seawater was 51. These results were seen at the three measurement time in the midle intertidal zone. While in the lower intertidal zone, the salinity of sea water looks different in the evening. In the morning and in the afternoon, the salinity of seawater was 51, while in the evening the salinity was 52. (3) The results of the measurement show that the average pH of sea water in both zones was relatively stable in the morning, afternoon and evening with a value of 7.09 . (4) The results of the measurement show that the average of oxygen varies greatly in both zones. In the midle intertidal zone, the average of dissolved oxygen in the morning was 4.16, in the afternoon 3.02 and in the evening 2.38. Then, in the lower intertidal zone, the average of dissolved oxygen in the morning was 4.06, in the afternoon 3.19 and in the evening 2.07. (5) The population of echinoderms in the water of Marsegu Island was composed of four classes, namely Ophiuroidea, Asteroidea, Echinoidea and Holothuriodea. The most common type was Asteroidea where there were 3 families, 4 genera and 4 species found. Furthermore, there was also a difference in the echinoderm species found in the midle intertidal zone and the lower intertidal zone(6) the number of echinoderm species found in the

midle of the intertidal zone were 8 species, while in the lower intertidal zone were 10 species. There were also some species which were not found in the midle intertidal zone, but they were found in the lower intertidal zone. These species included *Ophiopholis aculeafa, Linckia laevagata* and *Protoreaster nodusus.* Meanwhile, *Synapta maculata* species was found in the lower intertidal zone, but it was not found in the midle intertidal zone. (7) There was a correlation between physico chemical factors of environment and the diversity of echinodermata. The magnitude of the simultaneous effect of the independent variables on the dependent variable was 0.52 or 52%. Thus, it could be explained that 52% variation in the diversitity of echinoderms can be explained by the regression model, while the remaining 48% was the effect of other factors that could not be explained by the regression model.

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