Spatial distribution of plankton in Riau islands province, Indonesia

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Abstract. Riau Islands which is located at 4°LU – 1°LS and 104°BT – 107°BT, consist of around 3200 islands. It has high marine biodiversity, especially micro-plankton. Biodiversity of marine phytoplankton is usually dominated by diatom and zooplankton by micro-crustacean and early stage of marine biota. Nowadays, biodiversity of micro-plankton is an important study to identify their origin and potential as alien and invasive species. The aim of this research was to determine the biodiversity of marine micro-plankton in Riau Islands. This research was conducted in 14 small islands (Karanggerih, Pemping, Panjang, Melur, Palantuah, Dendun, Mantang, Bunut, Kelong, Mercusuar, Tokong Hiu Kecil, Tokong Hiu Besar, Karimun, Penyengat) in Riau Islands Province. Samples of micro-plankton were collected from surface water using plankton net. Samples were observed under light microscope and identified morphologically. Biodiversity index was calculated. There were found 20-34 taxa of phytoplankton and 10-17 taxa of zooplankton in all sites. Phytoplankton was dominated by Bacillariophyceae group and zooplankton by Crustacean and Protozoa groups. This result is expected for biodiversity bank information and further research.

1. Introduction

Riau Islands Province is a fast growing province since becoming part of a Demilitarized Zone with Singapore in 2006. It has 252.601 km^2 large and consists of 2.408 islands. Seawater ecosystem is becoming a popular destination in tourism sector in Riau islands. Possibilities of marine biodiversity could find in Riau Islands. Indonesia probably has the most diverse assemblage of marine habitats in the world [1].

Nowadays natural resources information, especially biodiversity in marine waters ecosystems has an important role. Alien and invasive species belong to trending topics biodiversity, especially micro-plankton diversity related to various aspect of aquatic ecosystem function [2]. Plankton in micro cell size has varied characteristic among genera and define diversity of organism in ecosystem. Riau islands may have diverse aquatic biota; include micro-plankton which varied in spatial distribution. A quantitative understanding of the abundance, distribution, and diversity ofplankton is essential for estimating their biogeochemical impact, particularly under a changing environment [3]. The aim of this research was to determine biodiversity of micro-plankton in Riau Islands Province, Indonesia.

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2. Materials and Methods

Plankton sampling were carried out in 2015 at 14 Islands of Riau Islands (Figure 1). There were 19 stations consist of Karanggerih (B1, B2), Pemping (B3), Panjang (B4), Melur (B5), Palantuah (B6), Dendun (B7), Mantang (B8), Dendun (B9), Bunut (B10), Kelong (B11, B12), Mercusuar (B13), Tokong Hiu Kecil (B14), Tokong Hiu Besar (O3), and Karimun (O4, O5, O6), and Penyengat (O7).

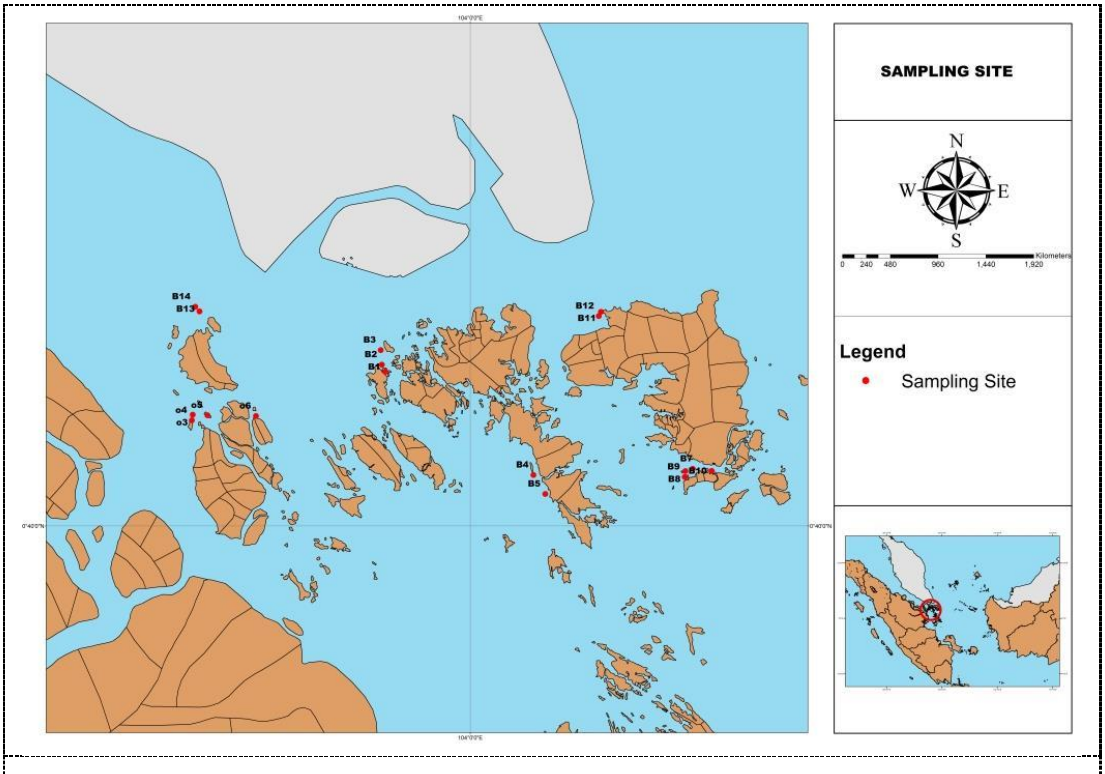


Figure 1. Sampling location of plankton in Riau Islands, Indonesia

Water sample were collected using plankton net with 23 µm mesh size to filter 100 L at surface water. Plankton samples were preserved in situ with Lugol solution [4] methods. Plankton samples were analyzed with microscope following APHA (2005) methods and identified followed [5,6,7, 8, 9, and 10]. Ecological indices, the Shannon-Wiener diversity index (H') [11], Evenness index (E) [11], and domination index (C) [12] were calculated to understand the community structure of plankton. Clustering analysis was calculated by Bray Curtis similarity index. Clustered of dendrogram will show cluster of spatial distribution of plankton. The equations of ecological indices are described as follows.

$$H' = -\sum_{i=1}^{S} p_i \ln p_i \quad (1)$$

with:

H' : Diversity index
p_i : n_i/N
n : total number of organism of particular species
N :total number of organism of all species

$$E = \frac{H'}{H_{maks}} = \frac{H'}{\ln(S)} \quad (2)$$

with:

E : Evenness index
H' : Diversity index

H_{max} : ln S
S : number of genus

$$C = \sum_{n=1}^{n} \left(\frac{n_i}{N}\right)^2 \quad (3)$$

with:
C : Simpson Domination index
n_i : total number of organism of particular species
N : total number of organism

3. Result and Discussion

Structure of plankton community in Riau province island was described by ecological indices, both of phytoplankton and zooplankton show different spatial distribution, which described by clustering analysis. All of phytoplankton taxa were belong to group of Cyanophyceae (2 genera), Bacillariophyceae (17 genera), Dinophyceae (5 genera), Chlorophyceae (2 genera), and Chrysophyceae (1 genera). The number of taxa of each site ranged from 14 to 31 species and the composition of phytoplankton was dominated by Diatom or Bacillariophyceae. The least number of taxa was found in Karimun 4, and the most was found in P. Tokong Hiu Kecil. Karimun 4 also showed the lowest abundance of phytoplankton. The highest abundance was found in P. Dendun. The total of phytoplankton abundance ranged from 61,800 to 11,554, 665 ind/l. The composition of phytoplankton abundance was shown in Figure 2.

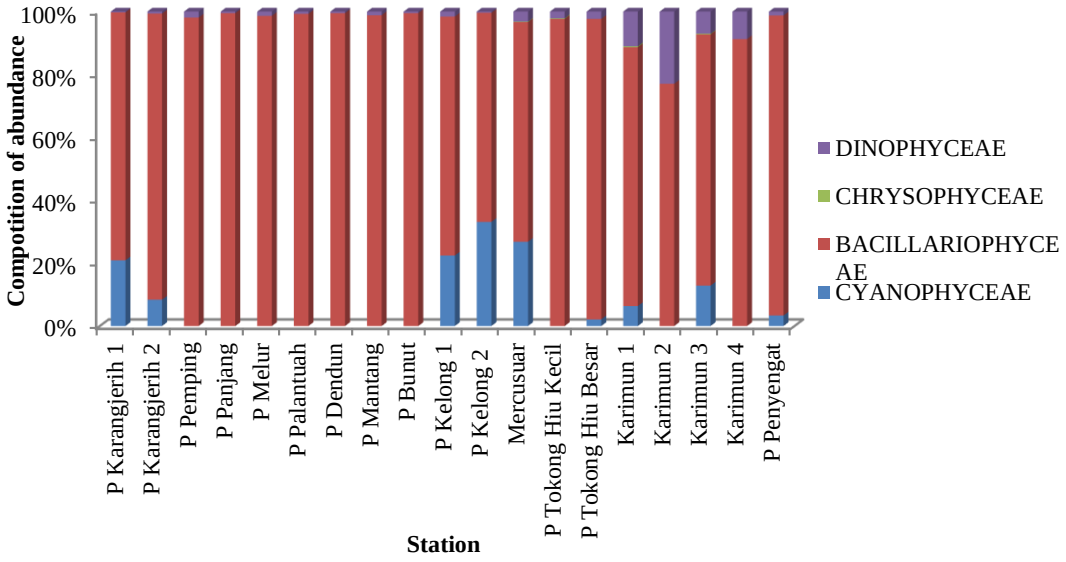


Figure 2. Composition of phytoplankton abundance

Biodiversity within a group of organisms in each site was described by diversity index. Biodiversity may be determined numerically in relation to a variety of parameters (referred to as importance values) including biomass, productivity, and organism count. Most estimates of species diversity are determined from species counts, which can be used to generate bio-indices of three main types species richness, species evenness/dominance, and a combined index of biodiversity [2]. Biodiversity index of phytoplankton and zooplankton was shown in Table 1 and 2.

Table 1. Biodiversity index of phytoplankton in sampling sites

Indices	Stations																		
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	O3	O4	O5	O6	O7
H'	2,13	1,32	0,94	1,58	1,40	1,56	1,67	1,75	1,53	1,96	1,80	1,95	2,69	2,47	2,77	2,54	2,70	2,38	1,01
E	0,64	0,43	0,31	0,51	0,44	0,48	0,56	0,57	0,47	0,60	0,57	0,61	0,78	0,73	0,85	0,84	0,81	0,90	0,31
C	0,21	0,50	0,67	0,36	0,39	0,34	0,32	0,31	0,35	0,21	0,23	0,21	0,10	0,16	0,08	0,10	0,09	0,11	0,64

Table 2. Biodiversity index of zooplankton in sampling sites

Indices	Stations																		
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	O3	O4	O5	O6	O7
H'	1.46	1.55	1.88	1.66	1.90	1.82	1.82	1.43	1.87	1.80	1.43	1.69	1.86	1.47	1.80	1.91	1.26	1.02	1.57
E	0.63	0.80	0.78	0.67	0.79	0.64	0.67	0.58	0.73	0.72	0.74	0.71	0.72	0.64	0.75	0.73	0.55	0.52	0.63
C	0.33	0.26	0.20	0.29	0.22	0.29	0.25	0.39	0.23	0.25	0.35	0.26	0.22	0.35	0.22	0.21	0.39	0.54	0.33

P. Tokong Hiu besar, which has high number of species, showed high evenness and low dominancy of phytoplankton species. The lowest dominancy was shown in Karimun 1, which has the greatest evenness of all sites. Different with zooplankton, the greatest diversity was shown in P. Melur with low dominancy and the lowest dominancy of zooplankton species was shown in P Palangtuah. The values of Evennes index showed a high similarity of proportion among species which compose the community. The low values of domination index shows that there are not any predominant species in the plankton community.

On the other hand, all of the zooplankton taxa were belong to the group of Protozoa (12 genera), Crustaceae (6 genera), Urochordata (1 genera), Pelecypoda (1 genera), Gastropoda (1 genera), and Echinodermata (1 genera). The abundance of zooplankton was relatively high. The number of taxa of each site ranged from 7 to 17 and the composition of zooplankton was dominated by Crustacea and Protozoa. As on phytoplankton, the least number of taxa was found in Karimun 4. The highest taxa number of zooplankton was found in Palangtuah. Palangtuah also had the highest abundance. The lowest abundance was found in Karangjerih 2. The total zooplankton densities ranged from 2.205 to 40.907 ind/L. The composition of zooplankton abundance was shown in Figure 3.

Spatial distribution of plankton, which shown by Bray Curtis similarity index was use to cluster the stations. There were developed four groups, based on number of species of phytoplankton. The first group consist of P. Karangjerih 1 and P. Dendun; group two consist of P. Karangjerih 2, Kelong 1, Kelong 2, Penyengat, and P. Tokong Hiu Besar; group three consist of P. Pemping, Karimun 2, Mercusuar, P. Panjang, Karimun 3, P. Melur, Palantuah, P. Bunut, and Karimun 4, group four consist of P. Mantang, Karimun 1, and P. Tokong Hiu Kecil (Figure 4). Different with zooplankton, there were developed three groups, based on number of zooplankton species. The first group consist of Karangjerih 1, Kelong 1, Karimun 2, and Karimun 4; P. Kelong 2 belong to group three; and rest of the stations belong to group two (Figure 5). The similarity between sites also shows similarity of spatial distribution of plankton. Plankton diversity between sites was varied, which could be influenced by physics or chemical water parameters. Plankton diversity, especially in spatial distribution has benefit for biodiversity bank information and further research.

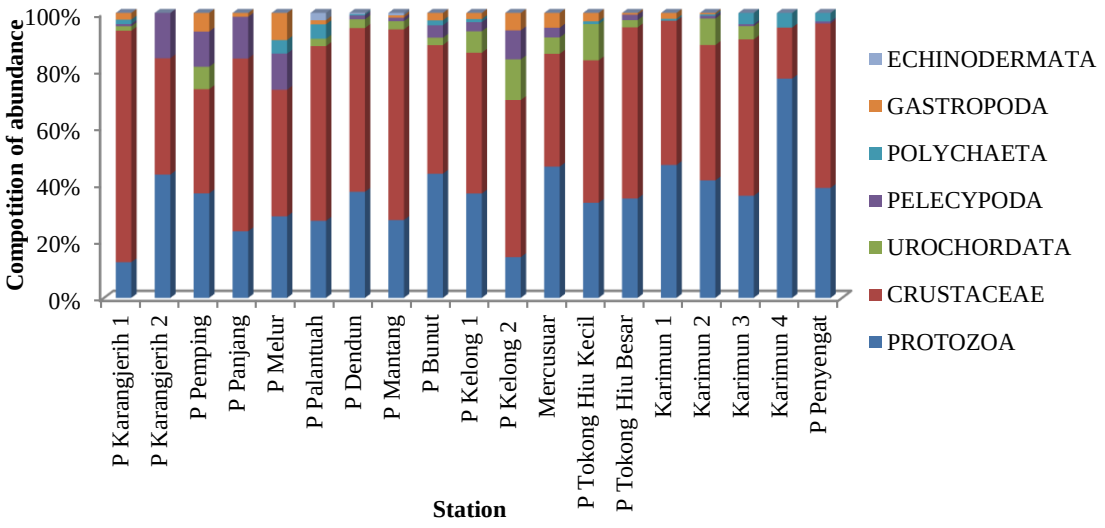


Figure 3. Composition of zooplankton abundance

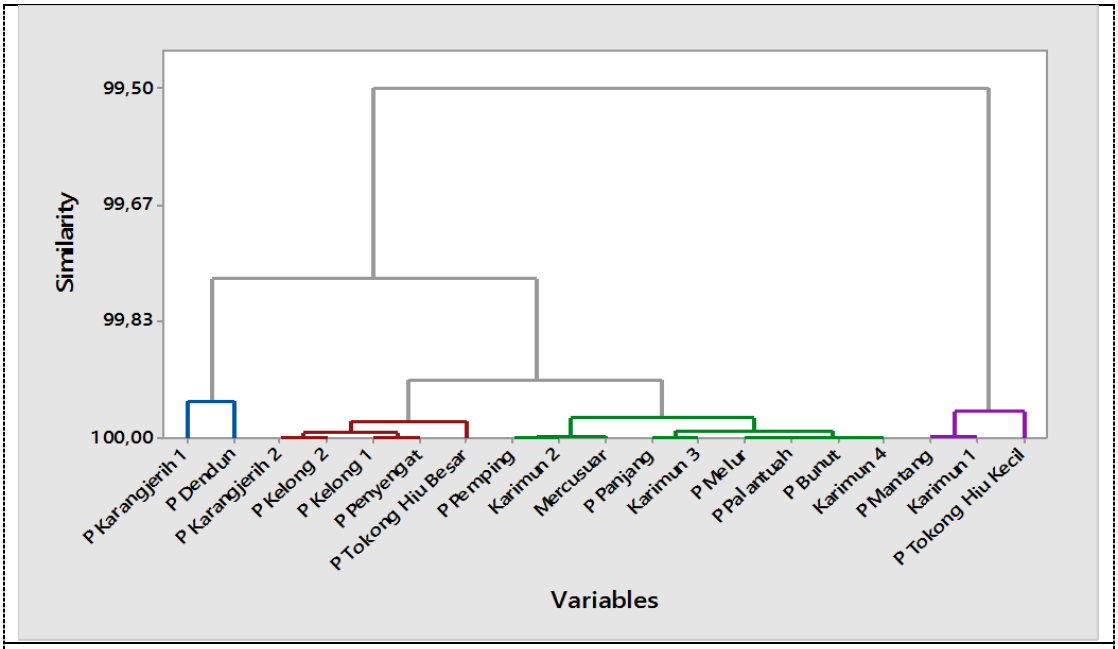


Figure 4. Cluster of stations based on number of phytoplankton species.

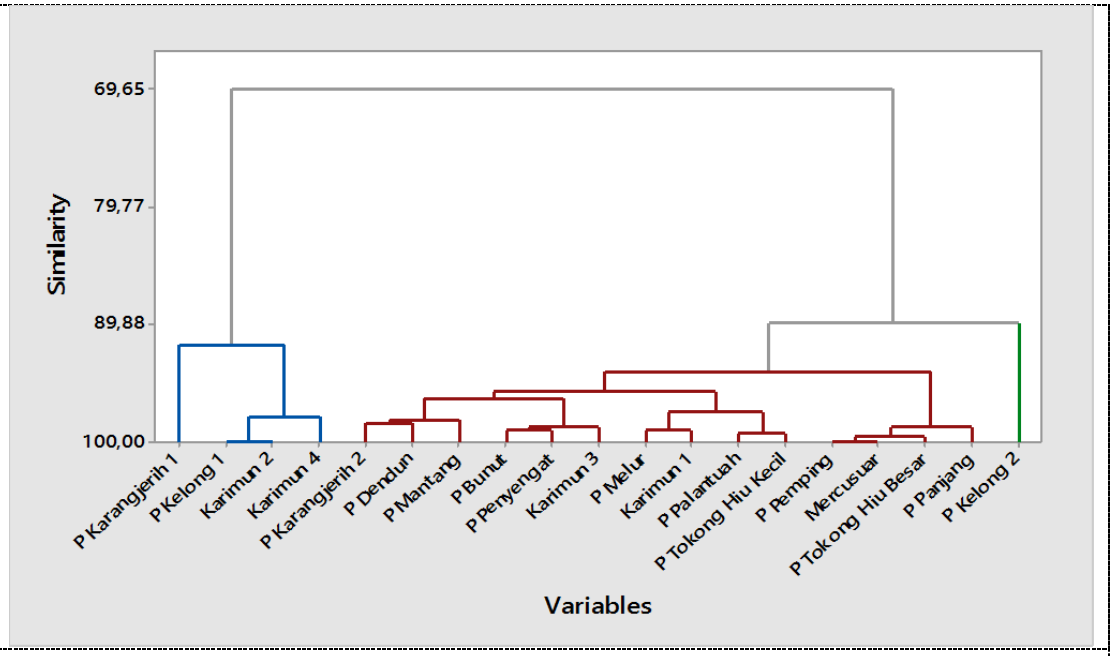
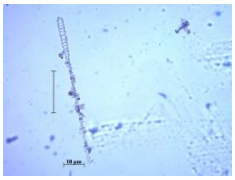


Figure 5. Cluster of stations based on number of zooplankton species.

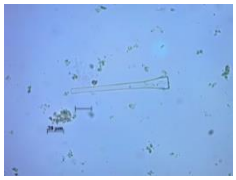
Some genera of plankton in Riau Islands Province were illustrated in Figure 6



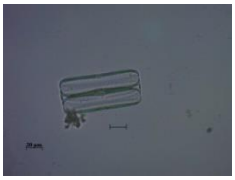
Cyclotella sp.



Climacosphenia sp.



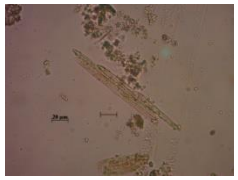
Asterionella sp.



Diploneis sp.



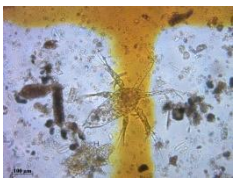
Amphora sp.



Bacillaria sp.



Chaetoceros sp.



Nauplius



Amphiprora sp.



Tintinnopsis sp.

Figure 6. Dominant plankton found in sampling site of Riau Islands waters

4. Conclusion

There were found 14-31 taxa of phytoplankton belong to group Cyanophyceae, Bacillariophyceae, Dinophyceae, Chlorophyceae, Chrysophyceae and 7-17 taxa of zooplankton belong to group Protozoa and Crustaceae in Riau Islands Province, Indonesia.

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