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Study of Dinoflagellate Species in the Waters of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia: Diversity and Morphological Variations

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ABSTRACT--- ***Dinoflagellates are important phytoplankton as primary producers in the waters. Dinoflagellates are found in all types of waters both fresh, salty, brackish, ice, wetlands and other moist places. Dinoflagellates are the second largest phytoplankton after diatom and can undergo morphological changes in response the environmental changes. This research has been conducted on March until June 2009, in the waters of Bayur gulf and Bungus gulf, Padang city, West Sumatera, Indonesia, using survey method and direct collection in the field. Sampling stations are set purposively as many as 11 stations with consideration of land use. Results showed that there were 30 species of dinoflagellates in the waters of Bayur Gulf and Bungus Gulf, 26 species were found in the waters of Bayur Gulf and 25 species were found in the waters of Bungus Gulf. Attendance frequency of 11 species were found was 100%, five of them experience morphological variation, namely Ceratium carriense, C. horridum, C. macroceros, C. trichoceros and C. tripos.***

Keywords--- Diversity, Morphological Variations, Dinoflagellate, Bayur Gulf and Bungus Gulf

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1. INTRODUCTION

Dinoflagellates are important group of phytoplankton that live in freshwater and marine (Carty and Fazio 2003; Graham and Wilcox 2000) and also found in brackish waters, ice and wet sand (Holt 2010; Clowes 2003). Dinoflagellate is unique because it has character of plants and animals character (Arinardi et al. 1996; Steidinger and Tangen 1997; Clowes 2003). In addition, dinoflagellate also has intermediate character between prokaryotes and eukaryotes (Kimball 1999; Costas and Goyanes 2005) so that dinoflagellate incorporated into the intermediates kingdom, Mesokariote (Dodge 1965 *cit*. Hackett et al. 2004). This group has a diversity of forms, content of nutrients and fossil data are very diverse since hundreds millions years ago (Handy et al. 2009).Dinoflagellates along with the group of diatoms is a leading producer in the tropical and subtropical waters, and plays an important role in the carbon cycle (MacRae 2009).

Marine waters are home to most of dinoflagellates, but over the last 10 years, sea water temperature has increased because of the increase of the earth's atmosphere temperature and the concentration of CO_2 (Syahailatua 2008). The increase of sea temperature is also caused by the influx of sewage from the mainland and diversity of human activities in marine waters (Misran 2002). This is the case in almost all marine waters on the earth's surface.

Changes in environmental conditions affect aquatic biota such as dinoflagellates. The increase in water temperature will affect the dinoflagellate populations, especially its ability to adapt. Edwards et al. (2008) states that the sea water temperature changes cause changes in plankton species were found. In addition, changes in water temperature cause the changes of the morphology of plankton. Forms of morphological adaptations to temperature found in one type of diatom, Thalassiosira rotula (Hastle and Syvertsen 1997).

Bayur Gulf is one of the ocean waters in West Sumatera that accommodate a variety of human activities, especially its function as a port, but it is also a fish auction, a tourist destination and industrial activities. The dense of human activities in the waters Bayur Gulf and surrounding area for a long time and continuously will certainly affect the physico-chemical conditions of the waters. Changes in environmental conditions could be expected to lead the certain adaptations in dinoflagellates, so it is expected to change in morphology. Associated with the important role of dinoflagellates in carbon sequestration, it is necessary to do this research with the aim to obtain the data of diversity and the presence or absence of morphological variation of dinoflagellate in the water of Bayur Gulf and surrounding area.

2. RESEARCH METHODS

This researchhas beenconducted onMarchuntilJune 2009, used survey method and direct collection in the field. Samplingareawerein the waters ofBayur gulfand Bungus gulf, Padang city, West Sumatera, Indonesia. Sampling stations were set purposively as many as 11 stations with land use considerations That stations were Bayur Gulf I: Waters near fisher village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock. Collection were conducted during the day using plankton nets with vertically (planktonnetwas droppedat eachsampling pointto the depth oflighttransparency) and horizontally (planktonnetis pulledas far as5minthe surface of waters). Beside that, also done the measurement of water chemical physics factor (Table 1).After collection, samples were identified in the laboratory with microscopicidentification.

Table 1. Chemical physics conditions ofdinoflagellates sampling stationin the Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia

Parameter	Bayur Gulf					Bungus Gulf					
	Stations					Stations					
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
pH	7.7	7.8	7.6	8.0	7.5	7.7	7.8	7.8	7.7	8.0	7.6
Temperature (^oC)	30	29	30	30	30	28	29	28	28	28	30
Salinity (‰)	35	35	34	35	35	35	37	37	37	35	35
Transparency (m)	2.5	3.0	5.0	4.0	2.5	10.0	2.9	5.0	6.0	7.0	5.0
Dissolved O_2 (ppm)	4.64	4.84	4.84	5.64	5.64	4.44	6.05	6.45	6.45	5.64	5.04
Dissolved CO_2 (ppm)	10.56	8.80	3.52	12.32	3.52	7.04	12.32	5.28	5.28	8.80	1.76
N-total (mg/L)	0.116	0.146	0.120	0.158	0.193	0.168	0.185	0.182	0.172	0.119	0.130
P-total (mg/L)	0.071	0.075	0.072	0.077	0.084	0.059	0.061	0.057	0.053	0.037	0.045
Pb (mg/L)	0.0146	0.0161	0.0145	0.0176	0.0194	0.0163	0.0185	0.0171	0.0165	0.0146	0.0155
Mg (mg/L)	0.0035	0.0045	0.0037	0.0062	0.0084	0.0048	0.0051	0.0046	0.0044	0.0042	0.0052

Description:Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

2.1 Data Analysis

Analysis of morphological variations on the dominant species that found were conducted using Kluster analysis with UPGMA method (Unweighted Pair Group Method Arithmetic Average) using a computer program NT SYST (Rohlf 2001). Stages of analysis is the determination of the taxonomic units operational of each dominant species of dinoflagellate, selection of characters (Table 2).

Tabel 2. Morphological charactersobserved to dinoflagellates species found at the water of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia

No.	Character	Character State
1	Sulcus	0. no exist; 1. exist
2	Girdle	0. no exist; 1. exist
3	Spine	0. no exist; 1. exist
4	The number of spines	0. no exist; 1. two; 2. more than two
5	Corona	0. no exist; 1. exist
6	Wings	0. no exist; 1. exist
7	Epiteka	0. no exist; 1. exist
8	Hipoteka	0. no exist; 1. exist
9	The number of epiteka spine	0. no exist; 1. one

10	The number of hipoteka spine	0. no exist; 1. one; 2. two
11	Direction of the right hipotekaspine	0. no spine; 1. parallelwith epiteka spine (straight up); 2. Straight down; 3. curvedtowardepiteka spine
12	Direction of the left hipotekaspine	0. no spine; 1. parallelwith epiteka spine (straight up); 2. Straight down; 3. curvedtowardepiteka spine
13	Cell length	
14	Cell width	
15	Epiteka spine length	
16	The right hipotekaspine length	
17	The lefthipoteka spine length	

Then tabulation and standardization of data and the measurement data using the equation character by Radford (1986) with the formula:

$$Z = \frac{(X - \bar{X})}{S} \qquad\qquad S = \sqrt{\frac{\sum(Xi - X)^2}{(n-1)}}$$

Description:
Z = Standard value S = Standard deviation
X = Character value n = Number of data
$\bar{X}$ = The average value of character

The final result was dendrogram that described the grouping of stations and morphological variation of dominant species of dinoflagellate .

3. RESULTS AND DISCUSSION

3.1 Species of Dinoflagellates were Found in the Waters of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia

Based on the result of this research, were found as many as 30 species of dinoflagellates in the waters of Bayur Gulf and Bungus Gulf which belongs to class Desmophyceae and Dinophyceae (Table 3). Based on the data known that species of class Dinophyceae more common than class Desmophyceae. This is because most of dinoflagellates species belonging to the class Dinophyceae, whereas class Desmophyceae consists only one order Prorocentrales and one family Prorocentraceae (Steidinger and Tangen 1997). Additionally, Loeblich (1976) and Taylor (1980) *cit*. Steidinger and Tangen (1997) states that Prorocentrales were the ancestors of the order Peridiniales and Gymnodiniales, both belong to Dinophyceae class.

Based on research, *Ceratium*is genere of dinoflagellate which most commonly found in the waters of Bayur Gulf and Bungus Gulf. This is because of this genere dispersed as cosmopolitan in water (water with low temperature, hot, tropical waters). Beside that, this genera tolerant to salinity with large variations. One of them, *Ceratium fusus*, widespread in the coastal waters (5-70 ‰) (Taylor et al. 1995).

Based on the research of Margalef (1962) *cit*. Peres (1982) in one of the temperate waters, phytoplankton community formed on three stages. In the first stage, temperate waters are dominated by species of diatoms. In the second stage, species of diatoms more diverse and followed by an abundance of dinoflagellates from *Ceratinum* and *Peridinium* groups. In the third stage, group of dinoflagellates (*Ceratinum*, *Dinophysis*, G*onyaulax* and *Ornithocercus*) will dominate the waters.

Table 3. Classification of dinoflagellates species are found in the waters of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia (Dawes, 1981; Bold and Wynne, 1985; Steidinger and Tangen, 1997)

Division	Class	Order	Family	Genus	Species
PHYRROPHYTA	DESMOPHYCEAE	Prorocentrales	Prorocentraceae	Prorocentrum	1. *Prorocentrum gracile* Schūtt.
					2. *P. micans* Ehrenberg.
	DINOPHYCEAE	Dinophysiales	Dinophysiaceae	Dinophysis	3. *Dinophysis caudata* Saville-Kent.
					4. *D. miles* Cleve.
					5. *D. norvegica* Claparède & Lachmann.
					6. *D. odiosa* (Pavillard) Tai & Skogsberg
				Ornithocercus	7. *Ornithocercus magnificus* Stein.
				Phalacroma	8. *Phalacroma rapa* Stein.
		Gymnodiniales	Gymnodiniaceae	Gymnodinium	9. *Gymnodinium catenatum* Graham.
		Noctilucales	Noctilucaceae	Noctiluca	10. *Noctiluca scintillans* (Macartney) Kofoid & Swezy.
		Gonyaulacales	Ceratiaceae	Ceratium	11. *Ceratium carriense* Gourret.
					12. *C. concillians*
					13. *C. declinatum* (Karsten) Jörgensen.
					14. *C. furca* (Ehrenberg) Claparède & Lachmann.
					15. *C. fusus* (Ehrenberg) Dujardin.
					16. *C. gibberum* Gourret.
					17. *C. horridum* (Cleve) Gran.
					18. *C. kofoidii* Jörgensen.
					19. *C. lineatum* (Ehrenberg) Cleve.
					20. *C. macroceros* (Ehrenberg) VanHöffen.
					21. *C. symmetricum* Pavillard.
					22. *C. trichoceros* (Ehrenberg) Kofoid.
					23. *C. tripos* (O.F. Müller) Nitzsch.
					24. *Ceratium* sp.
			Goniodomataceae	Alexandrium	25. *Alexandrium cohorticula* (Balech) Balech.
			Gonyaulaceae	Gonyaulax	26. *Gonyaulax spinifera* (Claparède & Lachmann) Diesing.
		Peridiniales	Protoperidiniaceae	Protoperidinium	27. *Protoperidinium conicum* (Gran) Balech.
					28. *P. crassipes* (Kofoid) Balech.
					29. *P. depressum* (Bailey) Balech.
					30. *P. oceanicum* (VanHöffen) Balech.

3.2 Distribution, Abundance (Ind/L), Relative Abundance (%) and Attendance Frequency (%) of Dinoflagellates Species were Found in the Waters of Bayur Gulf and Bungus Gulf Padang City, West Sumatera, Indonesia

From 30 species of dinoflagellate were found in the waters of Bayur Gulf and Bungus Gulf, there were 11 species distributed in all of sampling stations (Table 4). Based on Table 4 can be seen that there were 26 species of dinoflagellate in the waters of Bayur Gulf (five of them were not found in the Bungus Gulf) and 25 species were found in the Bungus Gulf (four of them were not found in the Bayur Gulf). Species of dinoflagellate most commently found in the station VI (Water at the mouth of the Bungus gulf)as much as 22 species and at least found in the Station III (tourism waters of Nirwana Gardens) as many as 14 species.

Table 4. Distribution, Abundance/A (ind/L), Relative Abundance/RA (%) and Attendance Frequency/AF (%) of dinoflagellates species found in the waters of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia

No	Species	Sampling Stations																						AF
		Bayur Gulf										Bungus Gulf												
		I		II		III		IV		V		VI		VII		VIII		IX		X		XI		
		A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	A	RA	
1	*Alexandrium cohorticula* (Balech) Balech.	16.3	3.3	35.3	7.7	0	0	0	0	21.7	12.6	5.4	4.6	0	0	0	0	5.4	0.8	0	0	0	0	45.4
2	*Ceratium carriense* Gourret.	5.4	1.1	21.7	4.8	8.2	6.5	8.2	6.4	5.4	3.2	2.7	2.3	5.4	2.3	21.7	2.4	10.9	1.6	2.7	1.4	13.6	11.0	100
3	*Ceratium concillians*	0	0	0	0	0	0	1.0	0.7	0	0	1.1	0.9	0	0	0	0	0	0	0	0	0	0	18.2
4	*Ceratium declinatum* (Karsten) Jörgensen.	27.2	5.5	5.4	1.2	0	0	2.7	2.1	8.2	4.7	10.9	9.2	10.9	4.5	17.7	2.0	29.9	4.3	9.9	5.2	4.1	3.3	90.9
5	*Ceratium furca* (Ehrenberg) Claparède & Lachmann.	2.7	0.6	2.7	0.6	16.3	12.9	2.7	2.1	5.4	3.2	2.7	2.3	10.9	4.5	24.5	2.8	95.1	13.6	15.0	7.9	7.6	6.1	100
6	*Ceratium fusus* (Ehrenberg) Dujardin.	2.7	0.6	2.7	0.6	8.2	6.5	5.4	4.2	2.7	1.6	5.4	4.6	5.4	2.3	6.2	0.7	10.9	1.6	2.7	1.4	2.7	2.2	100
7	*Ceratium gibberum* Gourret.	0	0	5.4	1.2	0	0	2.7	2.1	0	0	2.7	2.3	0	0	1.4	0.2	0	0	0	0	1.4	1.1	45.4
8	*Ceratium horridum* (Cleve) Gran.	5.4	1.1	5.4	1.2	5.4	4.3	2.7	2.1	5.4	3.2	9.8	8.3	10.9	4.5	1.4	0.2	27.2	3.9	5.4	2.9	20.4	16.4	100
9	*Ceratium*	0	0	0	0	1.0	0.8	1.0	0.7	0	0	1.0	0.8	0	0	0	0	0	0	0	0	0	0	27.3

	kofoidii Jörgensen.																							
10	*Ceratium lineatum* (Ehrenberg) Cleve.	2.7	0.6	2.7	0.6	0	0	0	0	2.7	1.6	11.4	9.7	16.3	6.8	48.9	5.5	67.9	9.7	10.9	5.7	2.7	2.2	81.8
11	*Ceratium macroceros* (Ehrenberg) VanHöffen.	2.7	0.6	2.7	0.6	5.4	4.3	5.4	4.2	8.2	4.7	2.7	2.3	5.4	2.3	2.7	0.3	5.4	0.8	5.4	2.9	12.2	9.9	100
12	*Ceratium* sp.	0	0	0	0	0	0	2.7	2.1	2.7	1.6	1.6	1.4	0	0	0	0	16.3	2.3	0	0	2.7	2.2	45.4
13	*Ceratium symmetricum* Pavillard.	46.2	9.3	97.8	21.4	16.3	12.9	10.9	8.5	8.2	4.7	12.0	10.2	40.8	17.0	61.2	6.9	47.6	6.8	16.3	8.6	9.0	7.2	100
14	*Ceratium trichoceros* (Ehrenberg) Kofoid.	8.2	1.6	16.3	3.6	5.4	4.3	27.2	21.2	5.4	3.2	10.9	9.2	10.9	4.5	13.6	1.5	27.2	3.9	8.2	4.3	11.7	9.4	100
15	*Ceratium tripos* (O.F. Müller) Nitzsch.	62.5	12.6	138.6	30.4	21.7	17.3	16.3	12.8	13.6	7.9	10.9	9.2	21.7	9.1	24.5	2.8	32.6	4.7	9.5	5.0	9.0	7.2	100
16	*Dinophysis caudata* Saville-Kent.	274.5	55.2	54.4	11.9	8.2	6.5	2.7	2.1	21.7	12.6	8.2	6.9	8.2	3.4	543.5	61.1	159.0	22.8	19.0	10.0	2.7	2.2	100
17	*Dinophysis miles* Cleve.	10.9	2.2	32.6	7.1	2.7	2.2	2.7	2.1	2.7	1.6	5.4	4.6	19.0	8.0	40.8	4.6	61.2	8.8	14.3	7.5	5.4	4.4	100
18	*Dinophysis norvegica* Claparède & Lachmann.	0	0	2.7	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1
19	*Dinophysis odiosa* (Pavillard) Tai & Skogsberg	0	0	0	0	0	0	0.4	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1
20	*Gonyaulax spinifera* (Claparède & Lachmann) Diesing.	2.7	0.6	2.7	0.6	0	0	0	0	1.0	0.6	0	0	0	0	0.8	0.1	2.7	0.4	0	0	0	0	45.4
21	*Gymnodinium catenatum* Graham.	0	0	0	0	0	0	5.4	4.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1
22	*Noctiluca*	13.6	2.7	16.3	3.6	21.7	17.3	13.6	10.6	48.9	28.4	2.7	2.3	32.6	13.6	48.9	5.5	40.8	5.8	13.6	7.2	13.6	11.	100

	scintillans (Macartney) Kofoid & Swezy.																						0	
23	*Ornithocercus magnificus* Stein.	0	0	0	0	0	0	0	0	0	0	1.1	0.9	0	0	0.7	0.1	0	0	0	0	0	0	18.2
24	*Phalacroma rapa* Stein.	0	0	0	0	0	0	1.0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1
25	*Prorocentrum gracile* Schūtt.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.1	0	0	0	0	0.5	0.4	18.2
26	*Prorocentrum micans* Ehrenberg.	0	0	0	0	0	0	0	0	0	0	1.1	0.9	2.7	1.1	0	0	1.4	0.2	0	0	0	0	27.3
27	*Protoperidinium conicum* (Gran) Balech.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.1	0	0	0	0	0	0	9.1
28	*Protoperidinium crassipes* (Kofoid) Balech.	2.7	0.6	2.7	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18.2
28	*Protoperidinium depressum* (Bailey) Balech.	5.4	1.1	5.4	1.2	2.7	2.2	8.2	6.4	5.4	3.2	5.4	4.6	27.2	11.4	27.2	3.1	54.4	7.8	54.4	28.6	0	0	91.0
30	*Protoperidinium oceanicum* (VanHöffen) Balech.	5.4	1.1	2.7	0.6	2.7	2.2	5.4	4.2	0	0	2.7	2.3	10.9	4.5	2.7	0.3	2.7	0.4	2.7	1.4	0	0	81.8
Amount		497.4		456.6		126.0		128.3		169.4		117.8		239.2		889.3		698.5		190.0		119.3		

The highest abundance value owned by*Dinophysis caudata*, it is caused by the influence of the content of phosphorus in the water. Phosphorus is one of the essential nutrients which needed by phytoplankton for growth (Nybakken 1992). Research of Santhanam and Srinivasan (1996) *cit*. Praseno and Sugestiningsih (1999) showed that in the waters with content of phosphate between 1.65 to 5.23 mg/L was found *D. caudata* with an abundance of 1.5 x 106 cells/L. Praseno and Sugestiningsih (1999) stated that *D. caudata* common found in the waters of Bayur Gulf and Bungus Gulf.

3.3Morphological Variation Analysis of Dominant Species of Dinoflagellates were Found in the Waters of Bayur Gulf and Bungus Gulf, Padang City, West Sumatera, Indonesia

Based on 11 dominant species of dinoflagellate were found was done an analysis of morphological variation. Based on the analysis of the data found that five species of *Ceratium* undergo morphological variation at a particular station. That species are *Ceratium carriense* (Fig. 1)undergo morphological variations on the water of Pertamina dock, *C. horridum* (Fig. 2)undergo morphological variations on themouth of Bungus Gulf, *C. macroceros* (Fig. 3)undergo morphological variations on theBayur Gulf ship dock, *C. trichoceros* (Fig. 4)undergo morphological variations on the tourism water of Nirwana Gardens and *C. tripos* (Fig. 5)undergo morphological variations on the near Bayur Gulf fisher villages.

3.3.1 *Ceratium carriense*

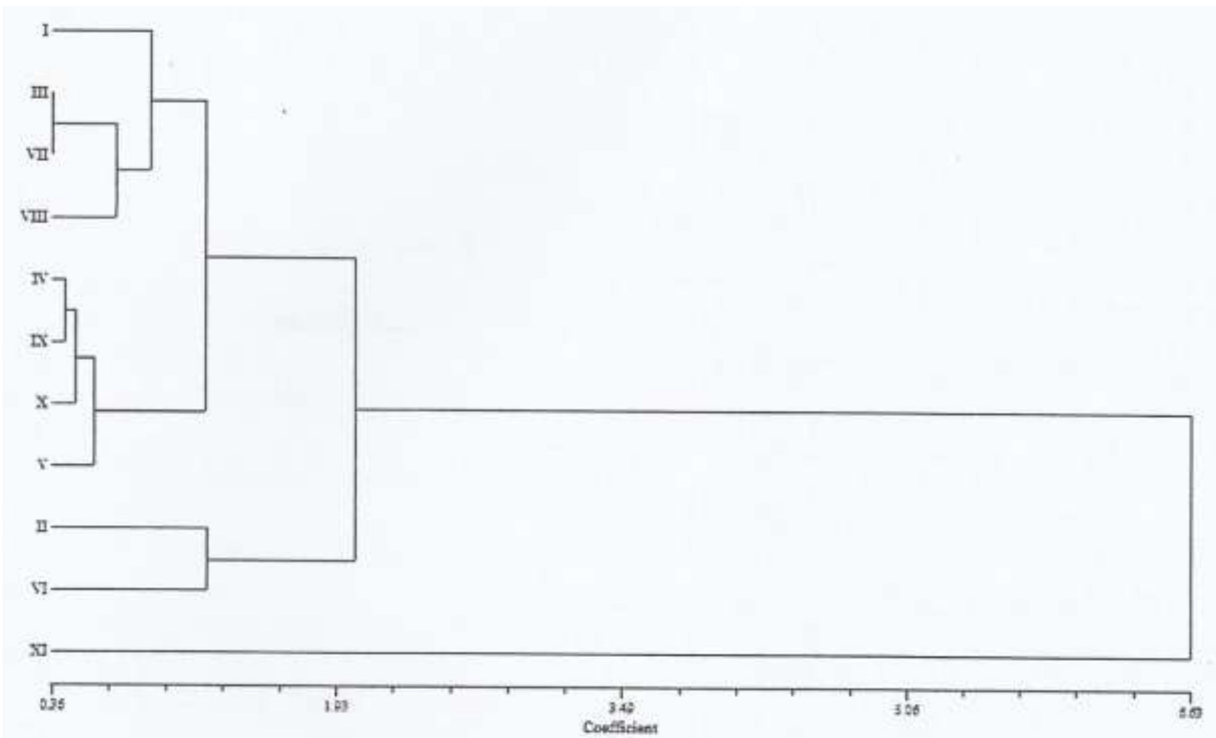

Figure 1. Dendrogam of Morphological Variation Analysis of *Ceratium carriense*
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

In Fig. 1 can be seen that *C. carriense* formed four large groups in general. Station III and VII there are in a straight line, it is mean that*C. carriense* have a morphology that are quite similar in both stations. Stations XI apart from 10 other stations. This indicates that*C. carriense* at station XI has a different morphology from*C. carriense* in other stations. *Ceratium carriense* variation in station XI occurs in the size of the morphology, it is smaller than other stations. It is occur because the content of nitrogen and phosphorus in the station XI is lowerthan other stations. Nybakken (1992) states that these two elements are an essential element for the growth of phytoplankton.

Pertamina dock watershave the largest activities of oil transportation on the west coast of Sumatera. According Dahuri (2003), the port is one of the human activities that potential to change the condition of marine habitats. Pollutants such as oil and other organic materials can reduce the level of productivity of marine waters. Similar studies have been conducted by Susanti (2009). There were eight species of 80 diatoms species was found undergo morphological variation at some sampling stations. Five of eight species of diatoms undergo morphological variations in the waters of Bungus Gulf pertamina dock.

3.3.2 *Ceratium horridum*

In Fig. 2 can be seen that *C. horridum* formied five large groups in general. Stations VI apart from 10 other stations. This shows the difference in morphology of *C. horridum* at station VI compared to other stations.*Ceratium horridum* variation occurs in the size of the morphology, it is larger than the other stations. The content of nitrogen and phosphorus in station VI is low, beside that this station is a station with the deepest transparency (10 m). Transparency indicates the extent of the solute in the waters. This is due to fishermen transport and other ships that are not dense, thus reducing the pressure of environment.

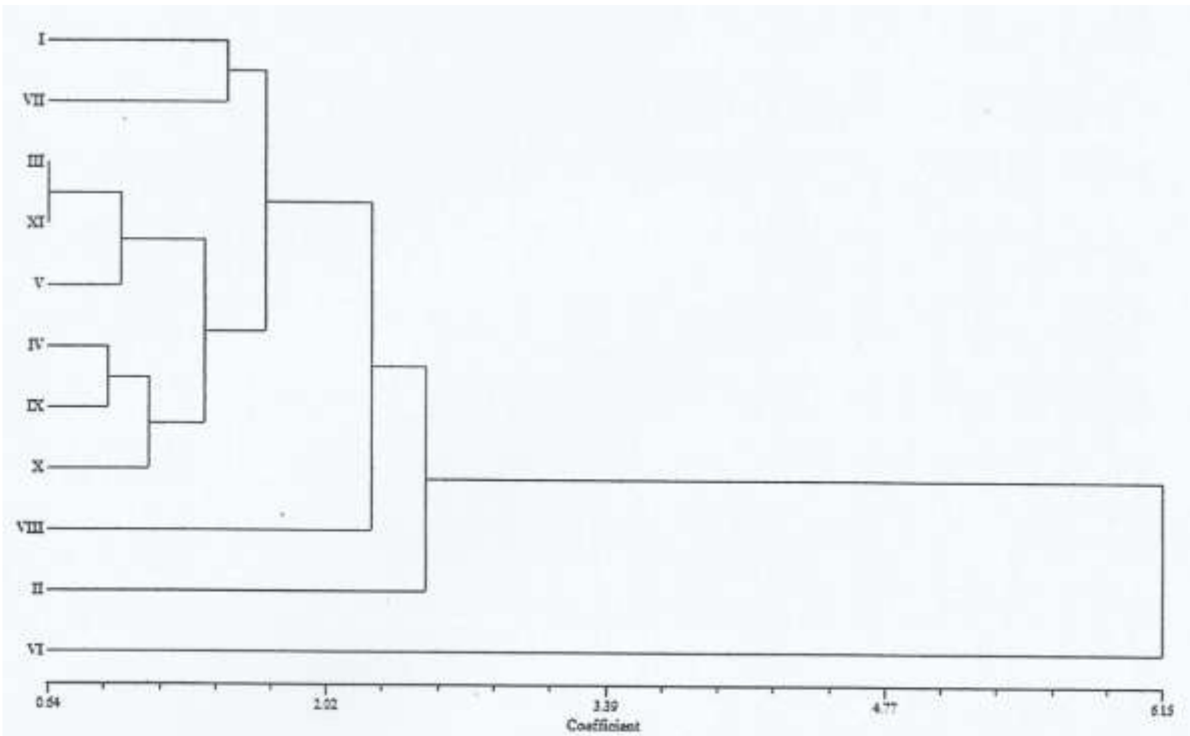

Figure 2. Dendrogam of Morphological Variation Analysis of *Ceratium horridum*
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

3.3.3*Ceratium macroceros*

In Fig. 3 can be seen that *C. macroceros* formed four large groups in general. Stations V apart from 10 other stations. This indicates that*C. macroceros*in this station have a different morphology from the other stations.*Ceratium macroceros* variation occurs in the size of the morphology.It is smaller than other stations because the content of nitrogen and phosphorus in station V is highest than other stations, but havethe lowest transparency than other stations (2.5 m). Beside that, it is caused by the density of shipping activities on this station.

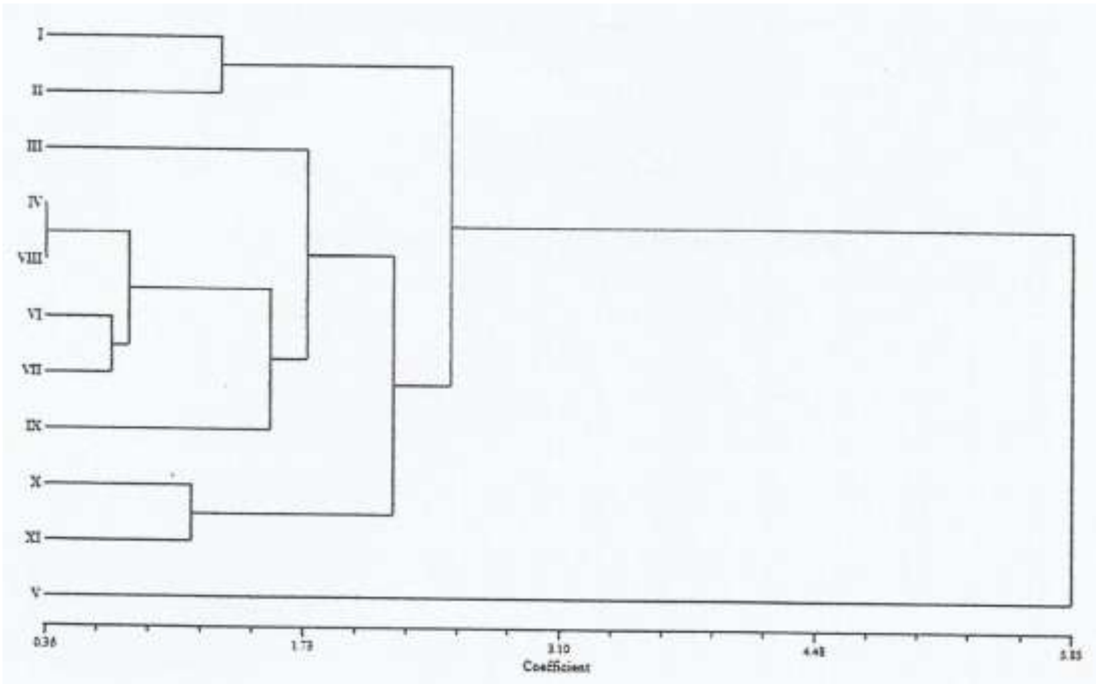

Figure 3. Dendrogam of Morphological Variation Analysis of *Ceratium macroceros*
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

3.3.4*Ceratium trichoceros*

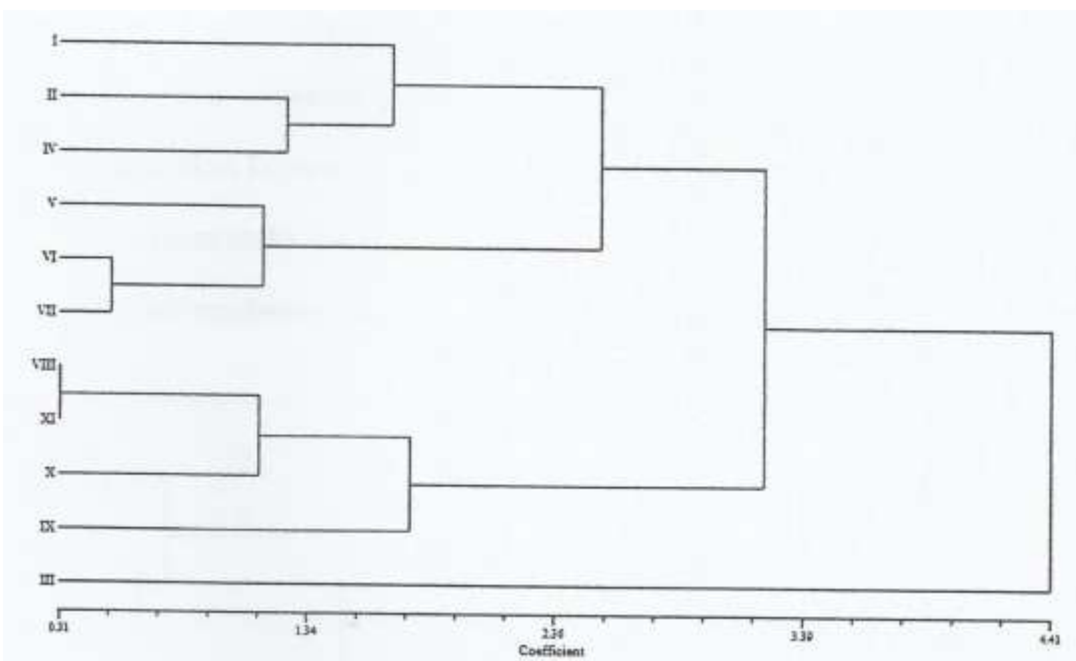

Figure 4. Dendrogam of Morphological Variation Analysis of *Ceratium trichoceros*
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

In Fig. 4 can be seen that *C. trichoceros* formed four large groups in general. Stations III apart from 10 other stations. This indicates that *C. trichoceros*in this station have a different morphology from the other stations. *Ceratium trichoceros* variation occurs in the size of the morphology. It is smaller than other stations. The water of Nirwana Garden (Stations III) is a tourism area that has a mangrove forest. Mangrove forest has a high population with various species of crustaceans, mollusks and fish (Dahuri 2003), It is suspected as the cause of the changes of *C. trichoceros* morphological at this station.

3.3.5*Ceratium tripos*

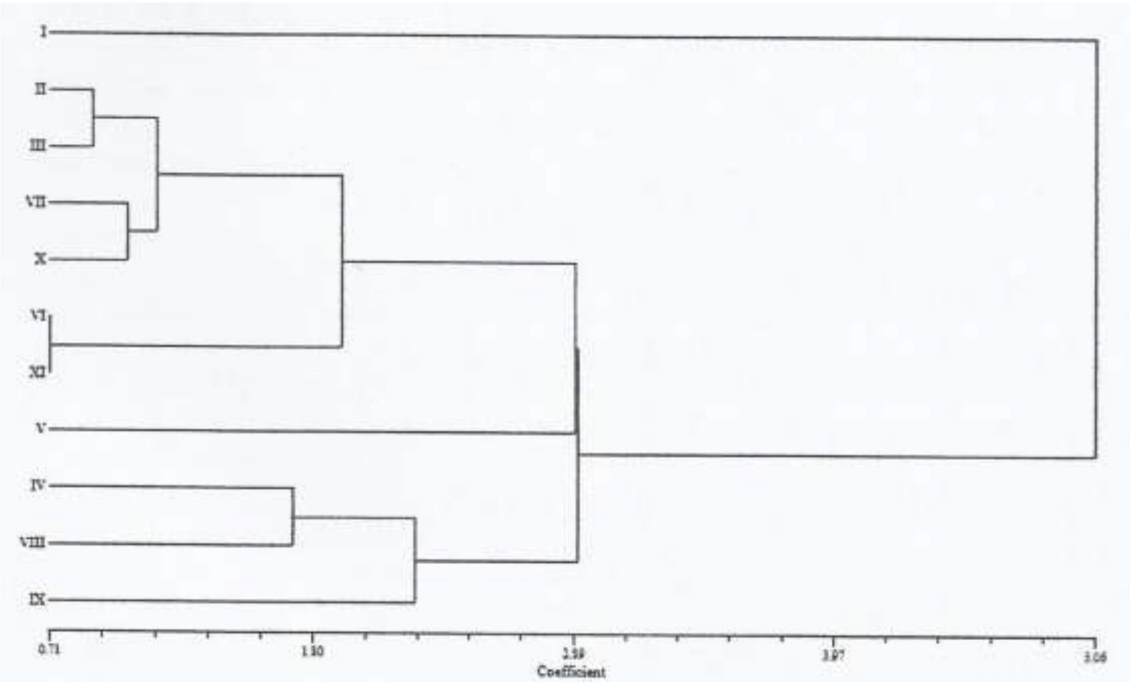

Figure 5. Dendrogam of Morphological Variation Analysis of *Ceratium tripos*
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

In Fig. 5 can be seen that *C. tripos* formed five large groups in general. Station I apart from 10 other stations. This indicates that the *C. tripos*in this station have a different morphology from other stations. *Ceratium tripos* variation occurs in the size of the morphology, it is greater than any other station. This variation is due to station I have a fairly dense shipping activities including the fish auction.

In Fig. 6 can be seen five species of dinoflagellates experience morphological variation at a particular station. *Ceratium carriense*, *C. horridum* and *C. macroceros* have one separated point from the group. While, *C. trichoceros* and *C. tripos* also have one point separated from the group but not overpower. This separation represent morphological variations in the cells size or cell ornaments. Morphological variations occur in length and width of the cell and the length of the spine. The change of environmental factors due to human activities suspected as the cause of morphological variation of dinoflagellate in the waters of Bayur Gulf and Bungus Gulf.

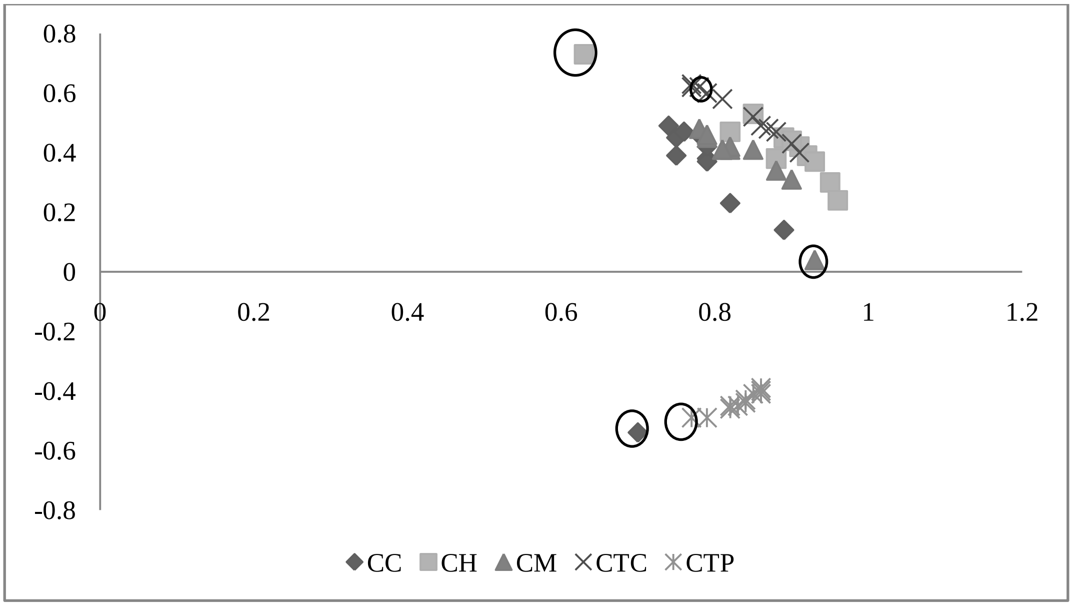

Figure 6. Curves of Morphological Variation Analysis of Five Dinoflagellates Species
CC: *Ceratium carriense*, CH: *Ceratium horridum*, CM: *Ceratium macroceros*, CTC: *Ceratiumtrichoceros*, CTP: *Ceratium tripos*, O: Morphological Variation

3.4 Analysis of Grouping Sampling Stations in the Waters of Bayur Gulf and Bungus Gulf Padang City, West Sumatera, Indonesia

Diversity of environmental conditions at the sampling stations and the uneven distribution of dinoflagellates species are found in the Bayur Gulf and Bungus Gulf indicate the differences at each sampling station. Based on the presence or the absence of certain species in each sampling station, the grouping sampling stations can be seen in Fig. 7.

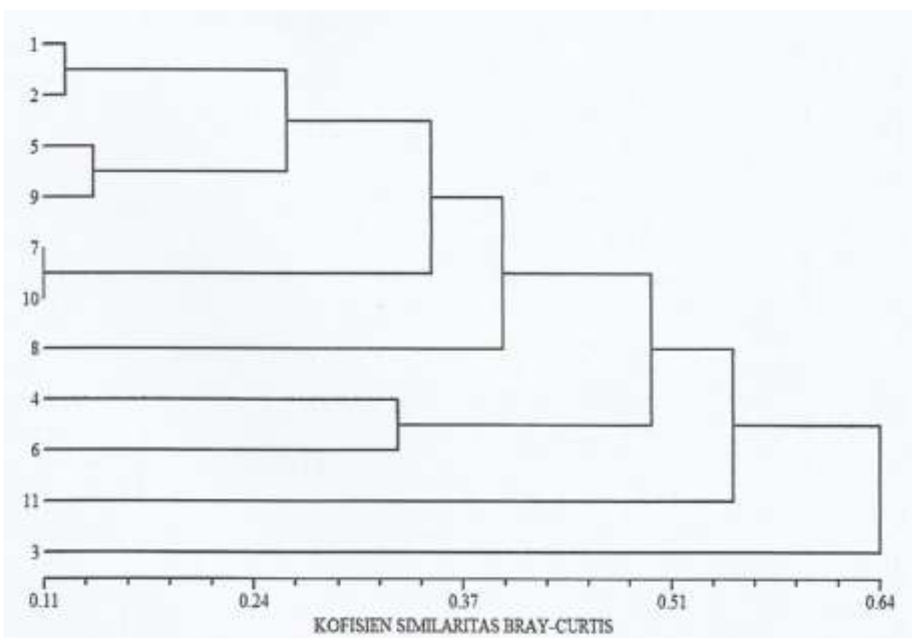

Figure 7. Dendrogam of Grouping Sampling Stations in The Waters of Bayur Gulf and Bungus Gulf I, II,..., XI: Sampling Station
Bayur Gulf I: Waters near fishing village, II: Water near Mount Meru, III: Tourism water of Nirwana Garden, IV: Water near the Kasiak Island, V: Water of ship dock; Bungus Gulf VI: Water at the mouth of the gulf, VII: Water near the fish auction place, VIII: Tourism water of Carolina Beach, IX: Waters near mangrove, X: The waters off the coast, XI: Water of pertamina dock

In Fig. 7 can be seen that station III located at the grouping bottom and split from other groups. In this station found the fewest number of dinoflagellate (14 species). This station has the lowest value of dissolved O_2, dissolved CO_2 and N-total than other stations. Nybakken (1992) states that the dissolved O_2 and dissolved CO_2 rarely becomes the limiting factor for marine plants, but nitrogen is an essential element for the growth of phytoplankton.Station VII and X are on one straight line, it is mean that both waters have similar dinoflagellates. Stations I and II have a human activity that is quite dense, grouping with stations V and IX. Stations IV grouping with stations VI that have a few human activity.

Based on grouping obtained, a variety of human activities greatly affect the existence of dinoflagellates in the water. Transport lines is the main factor affecting the grouping station in this study, particularly the transportation of conventional fishing ship. Dahuri (2003) states that the pollution in coastal and marine areas can also occur due to high frequency of transport traffic.

4. CONCLUSION

Found 26 species of dinoflagellates in the waters of Bayur Gulf and 25 species of dinoflagellates in the waters of Bungus Gulf that including to 10 genera, 8 families, 6 orders and 2 classes.Five species of dinoflagellates (*Ceratium carriense, C. horridum, C. macroceros, C. trichoceros, C. tripos*) undergo morphological variation in cell size or ornaments.

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