Sari_2022_IOP_Conf._Ser._3A_Earth_Environ._Sci._1119_012011.pdf

by

The abundance and species assemblages of dinoflagellate cysts at sediments in the three estuaries of the Southern part of South Sulawesi

To cite this article: S Nur Inda Sari and Nita Rukminasari 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1119** 012011

The abundance and species assemblages of dinoflagellate cysts at sediments in the three estuaries of the Southern part of South Sulawesi

Nur Inda Sari S[1] and Nita Rukminasari[2]

[1] Master's Program in Fisheries Science, Graduate School, Hasanuddin University, Makassar, Indonesia
[2] Department of Fisheries, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, Indonesia

E-mail: nurindahsaris.nis@gmail.com

Abstract. Harmful algal blooms (HAB) are a phenomenon of drastically increasing phytoplankton populations, which can cause problems in aquatic ecosystems. Dinoflagellate cysts are a type of phytoplankton that are the main source of causing the HAB phenomenon; this occurs due to unfavorable environmental conditions. The Southern Estuary of South Sulawesi has high fishery resources and high primary productivity. The coastal areas around these waters are widely used for anthropogenic activities that trigger nutrient increases. There are no studies on HAB, especially the abundance and community structure of dinoflagellate cysts at this location. This study aims to identify the types, abundance, and species assemblages of dinoflagellate cysts in the three estuaries of southern South Sulawesi. Sampling was carried out at three locations, namely the Pappa River Estuary, the Kelara River Estuary, and the Calendu River Estuary, in January 2022. Each location consists of 4 stations, 3 sub-stations with 3 repetitions sampling for each substation. Results showed that there were 34 species of dinoflagellate cysts belonging to 6 families, namely Gonyaulacaceae, Gymnodiniaceae, Osteropsidaceae, Peridiniaceae, Polykrikaceae, and Protoperidiaceae. The highest abundance of dinoflagellate cysts was at the Calendu River estuary station III, accounting for 82 cysts g^{-1}, while the lowest abundance of dinoflagellate cysts was found at Pappa River estuaries stations I and II, accounting for 8 cysts g^{-1}. The level of diversity, uniformity, and richness of dinoflagellate cysts was not significantly different in the three study sites. The family Osteropsidaceae was the most common type of dinoflagellate cyst found in the three study sites. The Osteropsidaceae family is a type of dinoflagellate cyst that contains toxins, so it can be assumed that the three research sites have the potential for HAB.

1. Introduction

Harmful algal blooms (HAB) are a phenomenon of drastically increasing phytoplankton populations, which can cause problems in aquatic ecosystems. Dinoflagellates are a unique group of eukaryotes that have various important ecological roles, especially as the core of the food chain [1]. Dinoflagellates can also form harmful and often toxic algae [2]. Dinoflagellates have a unique ability to survive the competition of natural selection. Under favorable conditions, dinoflagellates are able to reproduce in the water column in the form of swimming cells that actively divide in bulk. In poor environmental conditions, dinoflagellates stop dividing and then mate and produce a zygote which will continue at the encystment stage to produce resting cysts that can survive on the bottom of the water for years [3].

Dinoflagellate cysts are a type of phytoplankton that are the main source of causing the HAB phenomenon; this occurs due to unfavorable environmental conditions. Dinoflagellate cysts can survive in unfavorable environmental conditions. The dinoflagellate cyst stage is of great ecological importance as a "seed bank" for dinoflagellates [4].

Observation of cysts in waters is carried out to predict the possibility of rapid development of dinoflagellate species that can trigger the phenomenon of Harmful Algal Blooms (HABs). The continued discovery of new species suggests that there may be more dinoflagellate lineages to be identified [2].

The coastal areas around these waters are widely used for anthropogenic activities that trigger nutrient increases. There are no studies on HAB, especially the abundance and community structure of dinoflagellate cysts at this location. This study aims to identify the types, abundance, and species assemblages of dinoflagellate cysts in the three estuaries of the southern part of Makassar Strait, South Sulawesi.

2. Materials and methods

2.1. Study site

The determination of the research location is based on the existence of community activities around the location with the assumption that community activities have the potential to affect the quality of the surrounding waters because they can produce anthropogenic disturbances with high levels of organic pollution. The study was conducted in January 2022. Each research location consisted of 4 stations and 3 sub-stations as sampling replication. The sampling locations selected were Pappa River Estuary (Takalar Regency), Kelara River Estuary (Jeneponto Regency), and Calendu River Estuary (Bantaeng Regency). The three locations are Southern part of South Sulawesi (Figure 1).

2.2. Sediment sampling

Sediment sampling was carried out using a corer sediment trap. The corer sediment is lowered vertically until it reaches the bottom sediment of the water. After reaching the bottom of the water, the corer sediment is inserted as deep as ± 5 cm for sediment collection. The sediment sample that has been taken will then be put into a box container. Before processing, the sediment sample is stored at 4°C.

2.3. Sediment processing

The separation between sediment and cyst uses the method [5] where the sample which has been weighed using an analytical balance is put into a beaker then added seawater until it reaches a size of 50 ml, then sonication is carried out, the process is carried out for 15 minutes using an ultrasonic sonicator. This process aims to release the cyst attached to the sediment particles. Furthermore, the sieving process is carried out using a sieve that is arranged in stages based on its size. In this study, three mesh sizes were used, i.e., 250 µm, 125 µm, and 20 µm. The filtered sample was then deposited using a petri dish, then filtered again using a 20 µm mesh size.

2.4. Cysts count and identification of dinoflagellate cysts using light microscope

Observation on the identification of dinoflagellate cysts was carried out by taking a sample to be observed using 1 ml dropper pippet, then transferred to haemocytometer container. Then, observed under a light microscope with a magnification 40-100 times. Each dinoflagellate cyst sample was identified at the species level. Dinoflagellate cysts were identified based on published descriptions [6-12]. The unit of cyst abundance was the number of cysts g^{-1} dry weight sediment. To measure the water content of each sample, a subsample was weighed wet and then dried in a 70°C oven for 24 h to obtain the dry weight. The water content and dinoflagellate cyst abundance were calculated following the formula: Cysts/g = N/W(1-R) [5]. Where: N = Observed cyst number; W = wet sediment weight and R = water content rate.

IOP Conf. Series: Earth and Environmental Science 1119 (2022) 012011 doi:10.1088/1755-1315/1119/1/012011

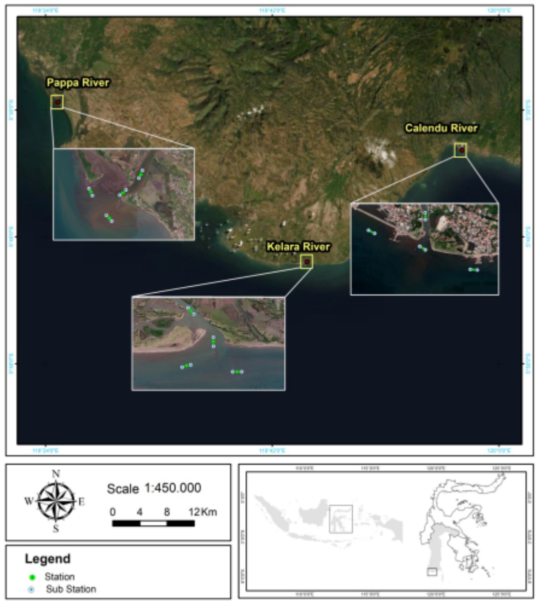


Figure 1. Research site map.

2.5. Identification dinoflagellate cysts using a scanning electron microscope

Dinoflagellate cysts samples were centrifuged for 5 minutes at 5000 rpm. Then a sample of 500 µl was put into a microtube, and 1% osmium tetraoxide was added with a ratio of 1:1. Then, the sample was left at room temperature for one hour and then filtered through a 0.22 mm filter membrane. The next step is the dehydration process in stages with the concentration of ethyl alcohol, including 30%, 50%, 70%, and 96%, and left for 10 minutes at each concentration. After that, the sample was allowed to dry overnight at room temperature. Then the sample is coated with gold powder. After that, the sample was identified using a scanning electron microscope.

2.6. Data analysis

PRIMER - version 5 (PRIMER–E Ltd. Plymouth, UK) was used for analysis Shannon–Wiener's diversity index (H'), Margalef's species richness (d), and Pielou's evenness (J'). To examine a spatial variation of dinoflagellate cyst abundance, Shannon–Wiener's diversity index (H'), Margalef's species richness (d), and Pielou's evenness (J').

3. Results and discussion

Dinoflagellate cyst species found based on observations in three river estuaries in the southern part of the Makassar Strait, South Sulawesi, were 34 species from 6 families (Table 1), namely Gonyaulacaceae, Gymnodiniaceae, Osteropsidaceae, Peridiniaceae, Polykrikaceae, and Protoperidiniaceae. In the Gonyaulacaceae family, 4 species were found, namely *Gonyaulax polygramma, Gonyaulax scrippsae, Gonyaulax spinifera,* and *Gonyaulax verior*. Two species were found in the *Gymnodiniaceae family, namely Cochlodinium polykrikoides* and *Gymnodinium instriatum*. Family Osteropsidaceae found five species, namely *Alexandrium affine, Alexandrium catenella, Alexandrium minutum, Alexandrium peruvianum,* and *Alexandrium tamarense*. Family Peridiniaceae found 9 species, namely *Kryptoperidinium foliaceum, Pentapharsodinium tyrrhenicum, Peridinium quinquecorne, Scrippsiella crystalline, Scrippsiella lachrymose, Scrippsiella rotunda, Scrippsiella trifida, Votadinium calvum,* and *Votadinium spinosum*. Family Polykrikaceae found 3 species, namely *Pheopolykrikos hartmannii, Polykrikos kofoidii,* and *Polykrikos schwartzii*. Family Protoperidiniaceae found 11 species, namely *Preperidinium meunieri, Protoperidinium achromaticum, Protoperidinium claudicans, Protoperidinium conycoides, Protoperidinium latissimum,* *Protoperidinium leonis, Protoperidinium obtusum, Protoperidinium pentagonum, Protoperidinium punctulatum,* and *Protoperidinium punctulatum*.

The results of the analysis of the abundance of dinoflagellate cysts in the Three Estuaries of the Southern Makassar Strait, South Sulawesi showed the highest abundance was at the Calendu River Estuary station I which had a value of 565 cyst g^{-1} while the lowest abundance was at the Pappa River estuary station III which had a value of 145 cyst g^{-1} (Figure 2a). The results of the analysis of the diversity index, uniformity, and richness of dinoflagellate cysts in the three Southern Estuaries of the Makassar Strait did not have significant differences (Figures 2b, 2c, and 2d).

The abundance of dinoflagellate cysts by family showed the highest abundance in the Peridiniaceae family with a percentage value of 44%, followed by the Osteropsidaceae family with a 40% value, the Gonyaulacaceae family with an 8% percentage value, the Protoperidinaceae family with a 5% value, and the Polykrikaceae family with a 3 %, percentage value. and Family Gymnodiniaceae with a percentage value of 0% (Figure 3). The results of the morphology images of dinoflagellate cysts observed using a light microscope and scanning Electron Microscope based on Family can be seen in Figure 4.

Table 1. Species compotition of Dinoflagellate cysts in sediment of Three Estuaries Southern Part Makassar Strait, South Sulawesi.

Family	Genus	Species	River Estuary		
			Pappa	Kelara	Calendu
Gonyaulacaceae	Gonyaulax	Gonyaulax polygramma	-	-	√
		Gonyaulax scrippsae	-	-	√
		Gonyaulax spinifera	√	√	√
		Gonyaulax verior	-	√	-
Gymnodiniaceae	Cochlodinium	Cochlodinium polykrikoides	√	√	√
	Gymnodinium	Gymnodinium instriatum	-	-	√
Osteropsidaceae	Alexandrium	Alexandrium affine	-	-	√
		Alexandrium catenella	√	√	√
		Alexandrium minutum	√	√	√
		Alexandrium peruvianum	√	-	-
		Alexandrium tamarense	√	√	√
Peridiniaceae	Kryptoperidinium	Kryptoperidinium foliaceum	-	-	√
	Pentapharsodinium	Pentapharsodinium tyrrhenicum	√	√	√
	Peridinium	Peridinium quinquecorne	-	-	√
	Scrippsiella	Scrippsiella crystallina	√	√	√
		Scrippsiella lachrymosa	√	√	√
		Scrippsiella rotunda	-	-	√
		Scrippsiella trifida	√	√	√
	Votadinium	Votadinium calvum	√	-	-
		Votadinium spinosum	-	√	√
Polykrikaceae	Pheopolykrikos	Pheopolykrikos hartmannii	-	-	√
	Polykrikos	Polykrikos kofoidii	-	-	√
		Polykrikos schwartzii	√	-	√
	Preperidinium	Preperidinium meunieri	-	-	√
Protoperidiniaceae	Protoperidinium	Protoperidinium achromaticum	-	-	√
		Protoperidinium claudicans	-	-	√
		protoperidinium conycoides	√	-	-
		Protoperidinium latissimum	-	-	√
		Protoperidinium leonis	-	√	√
		protoperidinium obtusum	-	-	√
		Protoperidinium pentagonum	√	√	√
		protoperidinium punctulatum	-	√	-
		Protoperidinium subinerme	-	-	√
		protoperidinium tyrrhenicu	-	-	√

Description: (√) = there is; (-) = there is no any

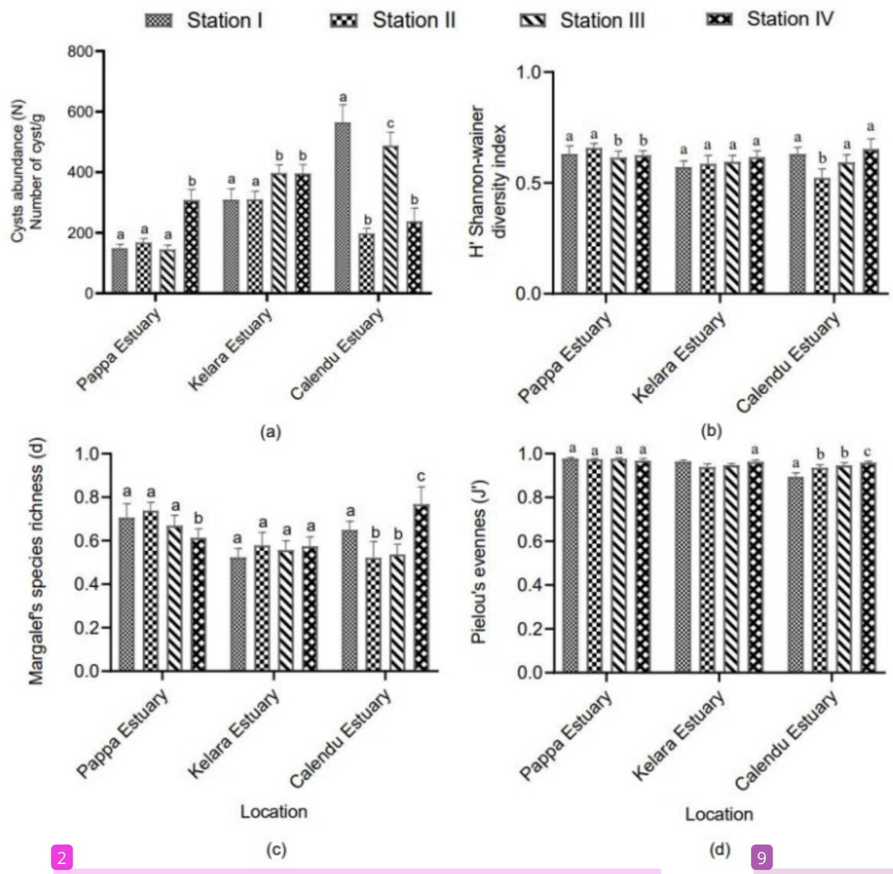


Figure 2. Spatial variation (a) dinoflagellate cyst abundance, (b) Shannon-Wiene's diversity index: H', (c) Margalef's species richness: d, and (d) Pielou's eveness: J'at three Estuaries of Southern Part Makassar Strait.

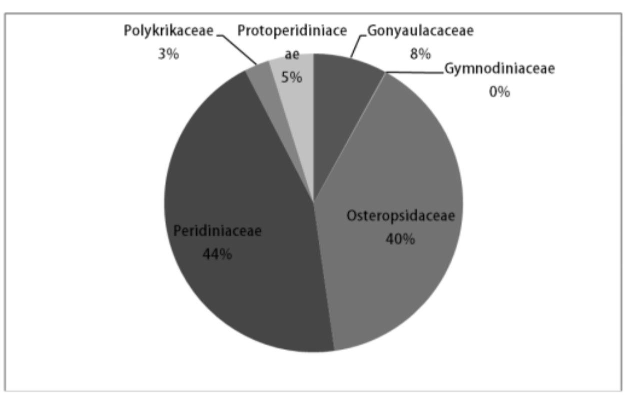
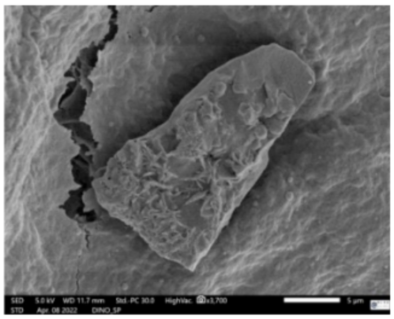
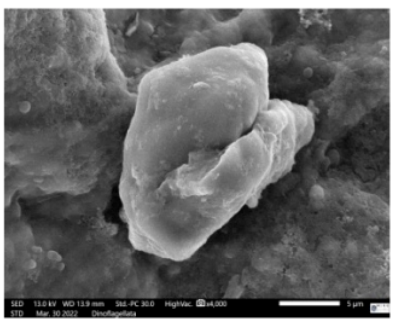
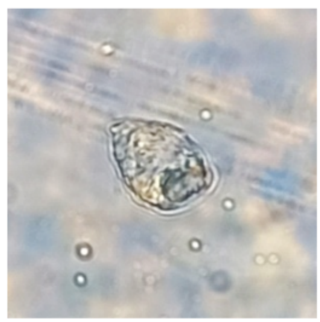
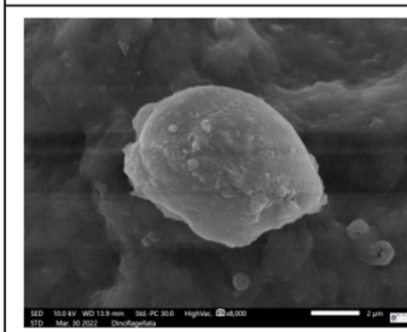


Figure 3. Abundance of dinoflagellata cysts by family.

Family : Gonyaulacaceae	
Genus : Gonyaulax	
	
Family : Gymnodianiaceae	
Genus : Gymnodinium	
	
Family : Osteropsidaceae	
Genus : Alexandrium	
	

IOP Conf. Series: Earth and Environmental Science 1119 (2022) 012011 doi:10.1088/1755-1315/1119/1/012011

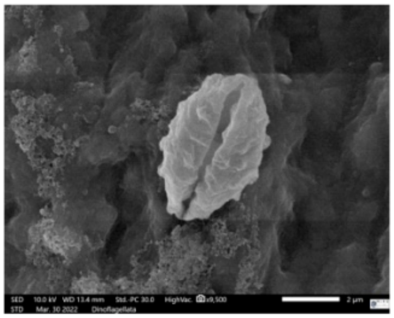
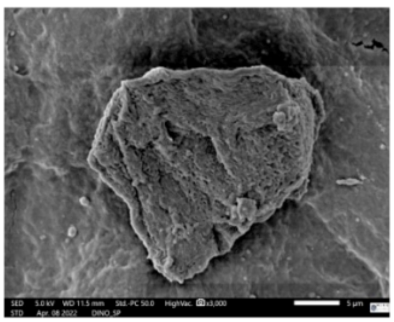
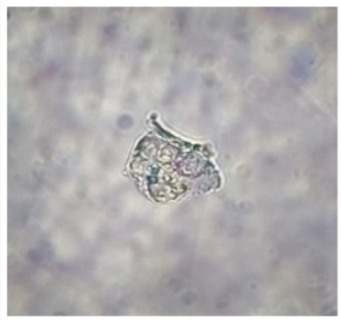
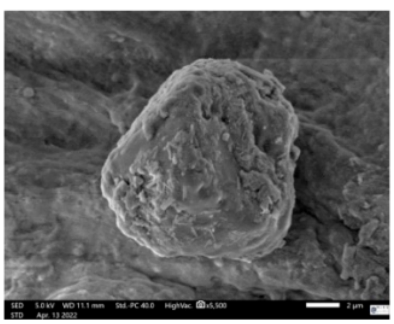
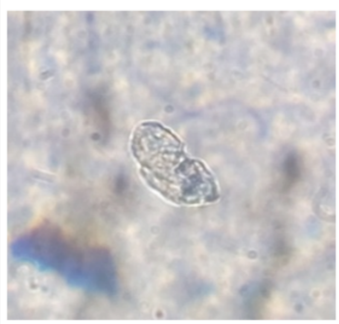
Family : Perdiniceae	
Genus : Scrippsiella	
	
Family : Perdiniceae	
Genus : Pentapharsodinium	
	
Family : Protoperiniaceae	
Genus : Protoperidinium	
	

Figure 4. Dinoflagellate cysts by family with light microscope and scanning electron microscope.

Conclusion

The Results showed that there were 34 species of dinoflagellate cysts belonging to 6 families, namely Gonyaulacaceae, Gymnodiniaceae, Osteropsidaceae, Peridiniaceae, Polykrikaceae, and Protoperidiaceae. The highest abundance of dinoflagellate cysts was at the Calendu River estuary station I accounting for 565 cysts g^{-1}, while the lowest abundance of dinoflagellate cyst was found at Pappa River estuaries stations III, accounting for 145 cysts g^{-1}. The level of diversity, uniformity, and richness of dinoflagellate cysts was not significantly different in the three study sites. The family Osteropsidaceae was the most common type of dinoflagellate cyst found in the three study sites. The

Osteropsidaceae family is a type of dinoflagellate cyst that contains toxins, so it can be assumed that the three research sites have the potential for HAB.

References

[1] Murray S A, Garby T, Hoppenrath M and Neilan B A 2012 Genetic diversity, morphological uniformity and polyketide production in dinoflagellates (Amphidinium, Dinoflagellata) *PLoS One* **7**
[2] Lin S, Zhang H, Hou Y, Zhuang Y and Miranda L 2009 High-level diversity of dinoflagellates in the natural environment, revealed by assessment of mitochondrial cox1 and cob genes for dinoflagellate DNA barcoding *Appl. Environ. Microbiol.* **75** 1279–90
[3] Panggabean L M G 2006 Kista dinoflagellata penyebab hab *Oseana* **XXXI** 11–8
[4] Mertens K N, Rengefors K, Moestrup O and Ellegard M 2012 A review of recent freshwater dinoflagellate cysts: taxonomy, phylogeny, ecology and palaeocology *Phycologia* **51** 612–9
[5] Matsuoka K and Fukuyo Y 2000 Technical guide for modern dinoflagellate cyst study *WESTPAC-HAB, Japan Soc. Promot. Sci. Tokyo, Japan* **47**
[6] Alkawri A 2016 Seasonal variation in composition and abundance of harmful dinoflagellates in Yemeni waters, southern Red Sea *Mar. Pollut. Bull.* **112** 225–34
[7] Aydin H, Matsuoka K and Minareci E 2011 Distribution of dinoflagellate cysts in recent sediments from Izmir Bay (Aegean Sea, Eastern Mediterranean) *Mar. Micropaleontol.* **80** 44–52
[8] Bravo I, Garcés E, Diogène J, Fraga S, Sampedro N and Figueroa R I 2006 Resting cysts of the toxigenic dinoflagellate genus Alexandrium in recent sediments from the Western Mediterranean coast, including the first description of cysts of A. kutnerae and A. peruvianum *Eur. J. Phycol.* **41** 293–302
[9] Godhe A, Karunasagar I, Karunasagar I and Karlson B 2000 Dinoflagellate cysts in recent marine sediments from SW India *Bot. Mar.* **43** 39–48
[10] Joyce L B, Pitcher G C, Randt A Du and Monteiro P M S 2005 Dinoflagellate cysts from surface sediments of Saldanha Bay, South Africa: An indication of the potential risk of harmful algal blooms *Harmful Algae* **4** 309–18
[11] Kim S Y, Lim D Il and Cho H J 2012 Dinoflagellate cyst assemblages from the northern shelf sediments of the East China Sea: An indicator of marine productivity *Mar. Micropaleontol.* **96** 75–83
[12] Mohamed Z A and Al-Shehri A M 2011 Occurrence and germination of dinoflagellate cysts in surface sediments from the Red Sea off the coasts of Saudi Arabia *Oceanologia* **53** 121–36

Sari_2022_IOP_Conf._Ser._3A_Earth_Environ._Sci._1119_0120...

ORIGINALITY REPORT

17%	13%	15%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.eri.u-tokyo.ac.jp Internet Source	2%
2	repository.ias.ac.in Internet Source	1%
3	Hyeon Ho Shin, Zhun Li, Hyun Jung Kim, Bum Soo Park et al. "Alexandrium catenella (Group I) and A. pacificum (Group IV) cyst germination, distribution, and toxicity in Jinhae-Masan Bay, Korea", Harmful Algae, 2021 Publication	1%
4	A. Amoresano, P. Iodice, G. Langella, L. Mocerino, F. Quaranta. "Analisys of particles transportation applied to a ship's ballast system by using fastcam recorded images", Journal of Physics: Conference Series, 2021 Publication	1%
5	R.V. Rodrigues, J.S. Patil, A.C. Anil. "Dinoflagellates cyst assemblage concerning trophic index for eutrophication from major	1%

ports along the west coast of India", Marine Pollution Bulletin, 2022
Publication

6	Maija Heikkilä, Vera Pospelova, Alexandre Forest, Gary A. Stern, Louis Fortier, Robie W. Macdonald. "Dinoflagellate cyst production over an annual cycle in seasonally ice-covered Hudson Bay", Marine Micropaleontology, 2016 Publication	1 %
7	cinto.invemar.org.co Internet Source	1 %
8	journals.plos.org Internet Source	1 %
9	Amel Hannachi, Ahmed Nasri, Mohamed Allouche, Abdelwaheb Aydi et al. "Diuron environmental levels effects on marine nematodes: Assessment of ecological indices, taxonomic diversity, and functional traits", Chemosphere, 2022 Publication	1 %
10	genialgproject.eu Internet Source	1 %
11	hocityu.com Internet Source	1 %
12	Pospelova, V.. "Environmental factors influencing the spatial distribution of	<1 %

dinoflagellate cyst assemblages in shallow lagoons of southern New England (USA)", Review of Palaeobotany and Palynology, 200401
Publication

13	repository.kopri.re.kr Internet Source	<1 %
14	tel.archives-ouvertes.fr Internet Source	<1 %
15	worldwidescience.org Internet Source	<1 %
16	Dowsett, N.. "Uptake, distribution and depuration of paralytic shellfish toxins from Alexandrium minutum in Australian greenlip abalone, Haliotis laevigata", Toxicon, 201107 Publication	<1 %
17	Francis Chung, Tianyu Yang, Yang Yang. "Ultrasound modulated bioluminescence tomography with a single optical measurement", Inverse Problems, 2020 Publication	<1 %
18	bioone.org Internet Source	<1 %
19	irgu.unigoa.ac.in Internet Source	<1 %

20	Priya M. D'Costa, Arga Chandrashekar Anil, Jagadish S. Patil, Sahana Hegde, Maria Shamina D'Silva, Molji Chourasia. "Dinoflagellates in a mesotrophic, tropical environment influenced by monsoon", Estuarine, Coastal and Shelf Science, 2008 Publication	<1 %
21	Shin, H.H.. "Reconstruction of historical nutrient levels in Korean and Japanese coastal areas based on dinoflagellate cyst assemblages", Marine Pollution Bulletin, 201008 Publication	<1 %
22	docplayer.net Internet Source	<1 %
23	link.springer.com Internet Source	<1 %
24	openaccess.ahievran.edu.tr Internet Source	<1 %
25	repository.dl.itc.u-tokyo.ac.jp Internet Source	<1 %
26	Giannakourou, A.. "Dinoflagellate cysts in recent marine sediments from Thermaikos Gulf, Greece: Effects of resuspension events on vertical cyst distribution", Continental Shelf Research, 200512 Publication	<1 %

27 D'Silva, Maria Shamina, Arga Chandrashekar Anil, Dnyandev Vaman Borole, Bejugam Nagender Nath, and Rakesh Kumar Singhal. "Tracking the history of dinoflagellate cyst assemblages in sediments from the west coast of India", Journal of Sea Research, 2012. <1%
Publication

28 Maija Heikkilä, Vera Pospelova, Klaus P. Hochheim, Zou Zou A. Kuzyk, Gary A. Stern, David G. Barber, Robie W. Macdonald. "Surface sediment dinoflagellate cysts from the Hudson Bay system and their relation to freshwater and nutrient cycling", Marine Micropaleontology, 2014 <1%
Publication

Exclude quotes	On	Exclude matches	< 5 words
Exclude bibliography	On		