資料論文 **Data Paper**

Survey on Diversity of Planktonic Diatoms in Sinfong Mangrove, Taiwan

新豐紅樹林浮游矽藻多樣性調查

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Abstract

There has yet to be a study that has specifically explored the diatom species population in Taiwanese mangrove forests. The present study investigates the diversity of planktonic diatom species and water quality environmental factor parameters from the Sinfong Mangrove forest in Sinfong Township, Hsinchu County, Taiwan. Furthermore, we established a dataset for diatom and related environmental data to serve as a reference for future monitoring research. In this study, 65 genera and 136 species of planktonic diatoms were identified, among which 15 species of *Nitzschia* were the most diverse taxon group.

Key words: plankton, diatom, Sinfong Mangrove

摘要

國內有關紅樹林矽藻相關研究甚少，本調查係針對新竹縣新豐紅樹林的浮游矽藻進行採集鑑定，並建立了矽藻名錄及環境因子資料庫，做為未來的監測研究參考。已鑑定出矽藻 65 屬 136 種，其中以 *Nitzschia* 屬 15 種多樣性最高。

關鍵詞：浮游生物、矽藻、新豐紅樹林

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Introduction

Coastal mangrove forests are crucial ecosystems that provide natural habitats for wildlife, prevent coastal erosion, digest pollutants, enhance water quality, and exhibit high ecological productivity (Kuo *et al.* 2012). Moreover, mangrove ecosystems are important breeding grounds for fish and are therefore crucial fishery areas. The maintenance of fishery resources relies on plankton communities, including phytoplankton (Robertson and Blaber 1992). Phytoplankton including chlorella, cyanobacteria, diatoms, and haptophyceae are the primary producers in mangrove ecosystems (Jeffrey and Vask 1997). Most diatoms are sensitive to and respond rapidly to environmental changes because they have a short life cycle and reproduce rapidly. In addition, they are easy to sample, prepare, and identify, entailing low sampling and analysis costs (Dixit *et al.* 2001; Gell *et al.* 2007; Reid and Ogen 2009; Soeprobowati *et al.* 2012), making

them the ideal biological indicators of environmental changes.

The mangrove forests in Taiwan are mainly distributed along the west coast of Taiwan from Tamsui (Taipei City) to Donggang and Linbian (Pingtung County), and the main mangrove species found here are *Kandelia obovata*, *Avicennia marina*, *Lumnitzera racemosa*, and *Rhizophora stylosa* (Hsueh 1995). Sinfong Mangrove forest is located at the estuary of Sinfong River, Sinfong Township, Hsinchu County, and was formerly known as "Hongmaogang (紅毛港)." According to previous studies, the mangrove forests of "Hongmaogang" are believed to have been imported from Guangdong Province in the 1790s, and by the time when Taiwan was under Japanese rule, they were already thriving (Chao 2005). Currently, the main mangrove species found in the Sinfong Mangrove forest are *K. obovata* and *A. marina* (Wang *et al.* 2015).

Taiwanese studies have mainly focused on the identification of diatom species or taxa (Shen 1956; Chang 1966; Li 1976; Li and Chiang 1979; Huang 1981). The community composition of algae is closely related to water quality and can serve as powerful biological indicators of environmental changes. Therefore, to understand the relationship between algae and water quality, a series of studies have been conducted on planktonic algae found in reservoirs (Chang *et al.* 1995; Chi *et al.* 1988). Thereafter, several studies have explored the role of epiphytic diatoms in rivers as water quality indicators (Wu 1984; Yu *et al.* 1995; Huang 1992; Chen and Lai 1984, 1985; Lai 1997). Studies related to aquaculture along Taiwanese coasts have primarily investigated the distribution of planktonic diatom populations (Wang 2002; Chou 2001; Chen 1998; Tsai 2008). In particular, these studies have separated and purified diatoms from the southwestern coast of Taiwan and investigated the phylogeny of these

species. Pen (2015) investigated the productivity of planktonic algae. Chen (2003) studied the clustering of diatoms in estuarine flats in central Taiwan. Hsu (2009) analyzed the spatiotemporal changes in benthic diatom coenosium in Gaomei Wetland. Some studies have also explored the use of bait in aquaculture (Chen 2007). There has yet to be a study that has specifically explored the diatom species population in Taiwanese mangrove forests.

Project description

Survey on Diversity of Planktonic Diatoms in Sinfong Mangrove.

Study area description:

The two sampling points were St1 and St2, as shown in Fig. 1. St1, was located within the mangrove forest and St2 was located by the riverbank of Sinfong River on the edge of the mangrove forest. Both sampling points were tidal sections.

Sampling methods

Sampling description:

Water quality

To measure the quality of water in Sinfong Mangrove, we used a portable water quality sensor (HANNA, Multiparameter Meter, HI9829) to determine the water temperature, conductivity, dissolved oxygen, and pH value. Collected water samples underwent ethanol extraction to determine the concentration of chlorophyll a in the water body according to the Environmental Protection Administration. A total of four sampling events were performed in May, August, October, and December, 2017.

Data on the water quality in the study region are presented in Table 3. Data on the water temperature in May was unavailable. For the other months, the maximum water temperature was recorded at St1 in August (26.5℃), whereas the minimum water temperature was recorded at St2 in December (16.3℃). In general, the water temperature in areas within the

Fig. 1 The sampling stations in Sinfong Mangrove.

圖 1 新豐紅樹林及各樣點位置圖。

mangrove was higher than that in areas outside the mangrove. The maximum dissolved oxygen was found at St1 in October (11.8 mg/L), whereas the minimum dissolved oxygen was recorded at St1 in August (0.7 mg/L). The maximum electrical conductivity was recorded at St1 in May (26.9 μmS/cm), whereas the minimum electrical conductivity was recorded at St2 in August (6.2 μmS/cm). In general, the electrical conductivity of water was higher in areas within the mangrove than in those outside the mangrove. The soil pH at St2 in October was 6.0, indicating slightly acidic conditions, whereas the soil pH at St1 in May was 8.1, indicating slightly basic soil conditions. In general, the pH of the water within the mangrove forest was slightly basic, whereas that outside the mangrove forest was slightly acidic. The maximum salinity was recorded at St1 in May (16.3 psu), whereas the minimum salinity was recorded at St2 in August (3.4 psu). In general, the salinity of water within the mangrove forest was higher than that of water outside the mangrove forest during the same season. The maximum chlorophyll a concentration in water was observed at St1 in October (162.7 μg/L), whereas the minimum chlorophyll a concentration was observed at St1 in December (1.5 μg/L). In general, the chlorophyll a concentration in water within the mangrove forest was higher than that in water in regions outside the mangrove forest, indicating that the algal biomass within the mangrove forest was higher than that outside the mangrove forest.

Plankton diatoms

During each sampling event, 500 ml of water samples were collected from each sampling point and taken back to the laboratory for observation and identification (Hsieh *et al.* 2019).

Quality control:

For diatom identification, some manuals were used (Round *et al.* 1990). Scientific names of diatom taxon names

were according to Guiry and Guiry (2022).

Step description:

1. Samples were collected from habitat. The sampling locations are the same habitat type. Each sample was collected in the same type of tidal flat habitat, regardless of whether it was at St1 within the mangrove forest or at St2 along the mangrove forest's edge.
2. The samples were acid-wash treatment for identification.
3. Photograph the samples with an electron microscope.
4. Conversion of paper-based records from the field and laboratory into an electronic data format (Excel spreadsheets).
5. Organizing the datasets into a standardized format.
6. Export of data as a Darwin Core Archive.
7. Generation of dataset-level metadata.

Geographic coverage

Description:

The Sinfong Mangrove forest is located at the estuary of Sinfong River, Sinfong Township, Hsinchu County.

Coordinates:

St1 (24.908387, 120.97173); St2 (24.908907, 120.971857).

Taxonomic coverage

Description:

All diatoms were identified to genus or species level. In total, 136 species taxa were identified belonging to three classes, 22 orders, 38 families, and 65 genera. The taxonomic coverage of the diatoms found in the studied material is given in Table 1. A list of diatom species found in sample stations is in Table 3.

Temporal coverage

Notes:

Sample in May, August, October, and December, 2017.

Usage license

Usage license:

Data resources

Data package title:

Darwin Core Archive Survey Data of Planktonic Diatoms in Sinfong Mangrove

Resource link:

https://www.gbif.org/dataset/6bd0551c-f4e9-4e85-9cec-6cefae343234

Alternative identifiers:

https://doi.org/10.15468/d23vg3

https://ipt.taibif.tw/resource?r=survey_data_of_diatoms_in_hsinfong_mangrove

Data set name:

Survey Data of Planktonic Diatoms in Sinfong Mangrove

Data format:

Darwin Core Archive

Data format version:

1.8 published on December 4, 2023

Table 1 Taxonomic coverage of diatoms from studied samples
表 1 調查樣本中矽藻各目下分類群數目

Orders	Families	Genera	Species
Achnanthales	4	4	11
Aulacoseirales	1	1	2
Bacillariales	1	7	26
Chaetocerotales	1	1	1
Coscinodiscales	2	3	3
Cyclophorales	1	1	1
Cymatosirales	1	1	1
Cymbellales	2	4	10
Eupodiscales	1	2	2
Fragilariales	1	2	2
Hemiaulales	1	1	1
Licmophorales	1	2	2
Melosirales	1	1	2
Naviculales	11	19	44
Plagiogrammales	1	1	1
Rhaphoneidales	1	2	2
Rhizosoleniales	1	1	1
Stephanodiscales	1	3	5
Surirellales	2	4	6
Thalassionematales	1	1	2
Thalassiophysales	1	1	2
Thalassiosirales	2	3	9

Table 2 List of diatom species found in sample stations (*presence)
表 2 各樣站調查矽藻名錄

		St1				St2			
	Abbreviation	May	Aug	Oct	Dec	May	Aug	Oct	Dec
Achnanthes brevips C. Agardh	Achbre			*		*	*		*
Achnanthes rupestoides Hohn	Achrup	*							
Achnanthes subconstricta (Meister) Toyoda	Achsub							*	
Achnanthidium convergens (Kobayasi) Kobayasi	Achiucon	*							
Achnanthidium exiguum (Grunow) Czarn	Achiuexi	*			*	*	*	*	*
Actinocyclus normanii (Gregory) Hustedt	Actnor	*		*	*				
Amphora libyca Ehrenberg	Amplib					*			
Amphora sp.	Amp sp.						*		
Aulacoseira ambigua (Grunow) Simonsen	Aulamb								*
Aulacoseira granulata (Ehrenberg) Simonsen	Aulgran	*	*		*	*	*	*	*
Azpeitia nodulifera (A.W.F. Schmidt) G.A. Fryxell & P.A. Sims	Azpnod					*			
Bacillaria paxillifera (O.F. Müller) T. Marsson	Bacpax	*	*	*	*	*			*
Berkeleya rutilans (Trentepohl ex Roth) Grunow	Berrut	*		*					
Biremis lucens (Hustedt) Sabbe, Witkowski et vyverman	Birluc	*							
Campylosira cymbelliformis (A. Schmidt) Grunow ex van Heurck	Camcym				*		*	*	*
Chaetoceros decipiens Cleve	Chadec	*	*	*	*	*	*		
Cocconeis placentula var. euglypta (Ehrenberg) Cleve	Coceug					*			
Cocconeis molesta Kützing	Cocmol						*		
Cocconeis placentula var. *placentula* Ehrenberg	Cocpla					*			
Coscinodiscus radiatus Ehrenberg	Cosrad							*	
Cosmioneis hawaiiensis R.L. Lowe & A.R. Sherwood	Coshaw		*						
Craticula cuspidata (Kützing) D.G. Mann	Cracus					*			
Cyclotella cryptica Reimann, Lewin & Guillard	Cyccry	*							
Cyclotella meneghiniana Kützing	Cycmen	*		*	*	*	*	*	*
Cyclotella baltica (Grunow) H. Håkansson	Cycbal	*	*	*	*				
Cyclophora tenuis Castracane	Cycten				*				
Cylindrotheca closterium (Ehrenberg) Reimann & J.C. Lewin	Cylclo								*
Cymbella affinis Kützing	Cymaff					*			
Delphineis minutissima (Hustedt) Simonsen	Delmin				*	*		*	*
Denticula hyalina (Schrader) Simonsen	Denhya	*			*				
Diadesmis confervacea Kützing	Diacon	*				*	*	*	
Dimeregramma fulvum (Gregory) Ralfs in Pritchard	Dimful	*							
Diploneis caffra (Giffen) A. Witkowski, H. Lange-Bertalot & D. Metzeltin	Dipcaf	*	*		*				
Diploneis oblongella (Nägeli ex Kützing) Cleve-Euler	Dipobl	*					*	*	
Diploneis smithii (Brébisson) Cleve	Dipsmi	*	*	*	*		*		
Discostella sp.	Dis sp.	*							

Encyonopsis leei K. Krammer	Enclee				*						
Entomoneis alata (Ehrenberg) Ehrenberg	Entala	*	*	*	*		*	*	*	*	
Entomoneis ornata (Bailey) Reimer	Entorn	*	*								
Eucampia cornuta (Cleve) Grunow	Euccor									*	
Fallacia nicobarica	Fallnic	*	*	*	*						
Fallacia pseudosemilyrata (R. Simonsen) D.G. Mann	Fallpse	*	*		*			*		*	
Fallacia sp.	Fall sp.				*						
Fragilaria capucina Desmazières	Fracap								*		
Gomphoneis sp.	Gom sp.						*				
Gomphonema augur Ehrenberg	Gomaug									*	
Gomphonema gracile Ehrenberg	Gomgra								*		
Gomphoneis clevei (Fricke) Gil	Gomcle						*			*	
Gomphonema insigne Gregory	Gomins								*		
Gomphonma minutum (C. Agardh) C. Agardh	Gommin						*				
Gomphonema parvulum (Kützing) Kützing	Gompar	*	*	*	*		*	*	*	*	
Gomphonema sp.	Gom sp.							*			
Gyrosigma acuminatum (Kützing) Rabenhorst	Gyracu		*								
Gyrosigma attenuatum (Kützing) Rabenh	Gyratt	*	*							*	
Gyrosigma balticum (Ehrenberg) Rabenhorst	Gybal								*	*	
Gyrosigma eximium (Thwaites) Boyer	Gyrexi	*									
Halamphora bistriata Stepanek & Kociolek	Halbis				*						
Halamphora coffeiformis (C.Agardh) Mereschkowsky	Halcof		*	*			*				
Halamphora holsatica (Hustedt) Levkov	Halhol	*						*	*		
Hantzschia amphioxy (Ehrenberg) Grunow	Hanamp	*		*	*		*	*	*		
Hippodonta neglecta Lange-Bertalot, Metzeltin & Witkowski	Hipneg	*									
Hippodonta sp.	Hip sp.		*		*						
Hobaniella longicruris (Greville) P.A. Sims & D.M. Willioms	Hoblon								*		
Humidophila biscutella (Gerd Moser, Lange-Bertalot & Metzeltin) Lowe, Kociolek, Johansen, van de vijver, Lange-Bertalot & Kopalová	Humbis	*									
Luticola intermedia (Hustedt) Levkov, Metzeltin & A. Pavlov	Lutint							*			
Luticola goeppertiana (Bleisch) D.G. Mann ex J. Rarick, S. Wu, S.S. Lee & Edlund	Lutgoe	*			*		*				
Luticola ventriconfusa Lange-Bertalot	Lutven								*		
Melosira nummuloides C. Agardh	Melnum	*	*								
Melosira varians C. Agardh	Melvar						*			*	
Minidiscus comicus Takano	Mincom	*		*						*	
Navicula antonii Lange-Bertalot	Navant						*				
Navicula capitatoradiata Germain	Navcap						*	*		*	
Navicula gregaria Donkin	Navgre	*	*		*				*		
Navicula longa (Gregory) Ralfs ex Pritchard	Navlon						*				
Navicula perminuta Grunow	Navperm				*						
Navicula seminuloides Hustedt	Navsem							*			
Navicula symmetrica Patrick	Navsym						*		*		
Navicula taraxa M.H. Hohn & J. Hellerman	Navtar						*		*		
Navicula tripunctata (O.F. Müller) Bory	Navtri	*		*							
Navicula veneta Kützing	Navven							*	*		

Nitzschia amabilis Suzuki	Nitama					*					
Nitzschia bilobata W. Smith	Nitbil	*									
Nitzschia capitellata Hustedt	Nitcap				*						
Nitzschia clausii Hantzsch	Nitcla							*			
Nitzschia dissipata (Kützing) Rabenhorst	Nitdis	*	*								
Nitzschia fasciculata (Grunow) Grunow	Nitfas										*
Nitzschia frustulum (Kützing) Grunow	Nitfru	*				*		*	*	*	*
Nitzschia gracilis Hantzsch	Nitgra	*				*		*	*	*	*
Nitzschia hybrida Grunow	Nithyb							*	*		*
Nitzschia intermedia Hantzsch ex Cleve & Grunow	Nitint	*	*								*
Nitzschia longissima (Brébisson) Ralfs	Nitlon	*	*			*					
Nitzschia nana Grunow	Nitnan									*	*
Nitzschia palea (Kützing) W. Smith	Nitpal	*	*			*		*	*		*
Nitzschia scalpelliformis Grunow	Nitsca	*				*					*
Nitzschia sigma (Kützing) W. Smith	Nitsig	*									*
Odontella aurita (Lyngbye) C. Agardh	Odolon							*			*
Petrodictyon gemma (Ehrenberg) D.G. Mann	Petrgem		*								
Pinnularia sp.	Pin sp.	*	*	*	*			*	*	*	*
Planothidium delicatulum (Kützing) Round & Bukhtiyarova	Pladel					*		*			*
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot	Plafre							*			
Planothidium rostratoholarcticum Lange-Bertalot & Bąk in Bąk & Lange-Bertalot	Plaros	*							*	*	
Pleurosigma acuminatum (Kützing) W. Smith	Pleacu				*	*					
Pleurosigma angulatum (Queckett) W. Smith	Pleang	*				*					
Pleurosigma patagonicum (Ferrario & Sar) Sterrenburg & Sar	Plepat					*					
Pleurosigma salinarum (Grunow) Grunow	Plesal							*			
Pseudofrustulia lancea Y. Sawai & T. Nagumo in Sawai & al	Pselan	*									
Pseudo-nitzschia australis Frenguelli	Pseaus					*					
Pseudo-nitzschia subpacifica (Hasle) Hasle	Psesub							*			
Punctastriata linearis D.M. Williams & Round	Punlin							*			*
Rhaphoneis amphiceros (Ehrenberg) Ehrenberg	Rhaamp	*				*				*	*
Rhizosolenia imbricate Brightwell	Rhiimb							*			
Sellaphora pupula (Kützing) Mereschkovsky	Selpup	*				*			*	*	*
Seminavis strigosa (Hustedt) Danieledis & Economou-Amilli	Semstr	*			*	*		*	*	*	*
Skeletonema tropicum Cleve	Sketro	*	*	*	*					*	
Stauroneis gracilis Ehrenberg	Stagra	*									
Stauroneis sp.	Sta sp.							*			
Stephanodiscus minutulus (Kützing) Cleve & Möller	Stemin										*
Surirella angusta Kützing	Surang	*									
Surirella ovata Kutzing	Surova	*							*		
Tabularia tabulata (C.Agardh) Snoeijs	Tabtab					*					
Thalassionema nitzschioides (Grunow) Mereschkowsky	Thanit							*	*	*	*
Thalassionema pseudonitzschioides (Schuette & Schrader) Hasle in Hasle & Syvertsen	Thapse				*	*					

Thalassiosira angulata (W. Gregory) Hasle	Thaang	*								
Thalassiosira cedarkeyensis A.K.S.K. Prasad	Thaced			*	*					
Thalassiosira duostra C. Pienaar	Thaduo							*		
Thalassiosira minuscula Krasske	Thamin						*			
Thalassiosira nanolineata (A.Mann) Fryxell & Hasle	Thanan				*			*	*	*
Thalassiosira weissflogii (Grunow) G.Fryxell & Hasle	Thawei		*	*	*		*	*	*	
Thalassiosira sp.	Tha sp.						*			
Tryblionella coarctata (Grunow) D.G. Mann	Tryper							*		
Tryblionella compressa (J.W. Bailey) M. Poulin	Trycoa	*		*	*		*			
Tryblionrlla hungarica (Grunow) Frenguelli	Trycom								*	*
Tryblionella persuadens (Cholnoki) K.P. Cavalcante. P.I. Tremarin &T.A.V. Ludwig	Tryhun	*	*	*	*					
Tryblionella perversa (Grunow) D.G. Mann	Tryper	*	*		*				*	
Trybliоptychus cocconeiformis (Grunow) Hendey	Trycoc						*			
Ulnaria ulna (Nitzsch) P. Compère	Ulnuln						*	*	*	*
Number of species		59	28	25	49		50	36	38	41

Table 3 The water quality results for Sinfong Mangrove in 2017
表 3 新豐紅樹林各樣區水質監測數值

	St1				St2			
	May	Aug	Oct	Dec	May	Aug	Oct	Dec
Water temperature (℃)	_	26.5	22.2	17.5	_	24.7	21.7	16.3
Dissolved oxygen (mg/L)	4.5	0.7	11.8	3.7	6.3	3.3	7.7	5.4
Conductivity (μmS/cm)	26.9	20.4	23.2	17.0	11.1	6.2	19.3	15.2
pH	8.1	7.7	7.0	7.5	7.7	7.3	6.0	7.4
Salinity (psu)	16.3	12.2	14.1	10.1	6.2	3.4	11.5	8.9
Chlorophyll a (μg/L)	38.8	24.3	162.7	1.5	8.3	5.1	5.3	7.8

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