Diversity, abundance and composition of phytoplankton with special reference to toxic dinoflagellates in Colombo harbour

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Abstract

Since phytoplankton serve as a basic food source for animals in the sea, their presence in large numbers may indicate the abundance of commercially important fish and shellfish populations. They also serve as good indicators of water quality. Dinoflagellates are a group of phytoplankton that are associated with the production of many marine toxins.Phytoplankton samples were collected using a plankton net with a mesh size of 20 μmand preserved with Lugol's solution. Triplicate vertical and horizontal tows were composited before analysis. Samples were analyzed for phytoplankton cell density and taxonomic identification to determine composition. The microscopic analysis showed that abundance varied from 55,500 to 255,000 cells m^{-3}. A total of 125 taxa were reported from the area. Ninety one taxa were identified upto species level while 35 taxa were identified to genera. Eighty five (85) taxa were identified as diatoms, while 38 taxa were dinoflagellates. Diatoms accounted for 77.4% of the total phytoplankton population in the area followed by dinoflagellates, which contributed 22.6%. The most dominant phytoplankton species is *Lithodesmium undulatus,*which contributed 5.9% of the total population, followed by *Ceratium lineatum (3.9%), Melosira sp.* (3.9%), *Thalassionema nitzschiodes* (3.4%), *Thalassiotrix sp.* (3.3%), *Tintinopsis strigosa* (3.3%) and *Chaetoceros dicipiens* (3.0%). High species diversity was observed for*Ceratium* sp., *Rhizosolenia* sp., *Biddulphia* sp. and *Dinophysis* sp. According to the mean composition of reported species, ninety three (93) taxa were rare species, while 29 species had moderate abundanceand three species were dominant taxa. The presence of 13 species of toxic dinoflagellates out of 42 speciesmay be a future threat for marine organisms as well as humans.

Keywords: phytoplankton, toxic dinoflagellates, Colombo harbor

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Introduction

Plankton are tiny organisms that drift through the layers of the ocean and comprise the productive base of both marine and freshwater ecosystems. As a human resource, plankton has only begun to be developed and used as indicators for ecological changes of marine environment. Since phytoplankton serve as a basic food source for animals in the sea, their presence in large numbers may indicate the abundance of commercially important fish and shellfish populations. They also serve as good indicators of water quality. Availability of light, nutrients and the degree to which the water is mixed are the main agents governing the growth of phytoplankton. In turn, these variables are modulated by climate and weather variability and are highly dependent on wind strength,direction and frequency, cloudiness, water turbidity, precipitation and river runoff.

Dinoflagellates are a group of phytoplankton associated with the production of marine toxins that poison fish, other wildlife and humans. Approximately 2000 species of living dinoflagellates have been identified and less than 150 are known to produce cysts. At least 90 of these cyst-producing species are known to be harmful, and a minimum of 45 species are considered as toxic.Ship transport is a major vector for biologicalinvasions, namely through the seawater carriedin ballast tanks (Fofonoff et al. 2003). Ballastwater is carried onboard ships to provide balancestability, and maintain safe transit conditions.Ballast tanks may also carry unpumpableresidual water and sediments that can containviable organisms (Bailey et al. 2005). This study is a part of the port biological baseline survey conducted by Marine Environment Protection Authority. We describe the diversity, abundance and composition of phytoplankton in Colombo harbor with special reference to toxic dinoflagellates.

Figure 1: Phytoplankton sampling stations in Colombo harbour

Materials and Methods

Phytoplankton samples were collected at 22 sites using a plankton net with a mesh size of 20 µm from 6 to 10 August, 2013 in Colombo harbour (Fig. 1). Samples were preserved with Lugol's solution. Triplicate vertical and horizontal tows were composited before analysis of phytoplankton cell density and taxonomic identification to determine composition. Supernatant of the preserved water sample was decanted without disturbing the settled cells using a tube, the portion of the tube touching the sample was covered with a net of very fine mesh. Thus the sample volume was concentrated to a known volume. One ml of this concentrated sample was placed in the Sedgwick rafter cell and the number of phytoplankton was counted under the light microscope at a magnification of 100X. Samples were analyzed for phytoplankton abundance, composition and diversity. Phytoplankton were identified to species or genera (Jayasiri, 2009).Community structure was analyzed using two diversity indices: Margalef's index (d') and Shannon-Weiner index(H'). Evenness and dominance were analyzed using Pielou's evenness index (J'). These indices were calculated for each sampling station following standard formulae.

Results and discussion

Table 1: List of Phytoplankton reported at the study area (D-dominant;>4.99%, M-moderate;1.00-4.99%, R-rare, <0.99%)

Group	Genus	Species	Mean composition (%)	Relative abundance
Bassilariophyceae (Diatoms)	Achnanthes	sp.	0.03	R
	Actinoptychus	sp.	0.04	R
	Asterionellopsis	glacialis	0.07	R
	Asterionella	sp.	0.20	R
	Asterionella	Japonica	0.11	R
	Bacillaria	sp.	0.11	R
	Bacteriastrum	sp.	0.13	R
	Bacteriastrum	delicatulum	0.02	R
	Bacteriastrum	malleus	0.71	R
	Biddulphia	sp.	0.56	R
	Biddulphia	mobiliensis	0.49	R
	Biddulphia	aurita	0.29	R
	Biddulphia	sinensis	0.02	R
	Biddulphia	regla	0.02	R

	Biddulphia	seriata	0.66	R
	Cerataulina	sp.	0.50	R
	Cerataulina	pelagica	0.78	R
	Chaetoceros	sp.	1.69	M
	Chaetoceros	dicipiens	2.99	M
	Coscinodiscus	exemtricus	6.40	D
	Coscinodiscus	sp.	6.42	D
	Coscinodiscus	radiatus	0.24	R
	Coscinodiscus	asteromphalus	0.00	R
	Cyclotella	sp.	0.06	R
	Cyclotella	comta	0.07	R
	Diatoma	sp.	0.21	R
	Ditylum	brightwelli	0.38	R
	Disodinium	sp.	0.02	R
	Eucampia	zodiacus	0.73	R
	Eucampia	sp.	0.61	R
	Fragilaria	sp.	0.40	R
	Guinardia	delicatula	0.81	R
	Guinardia	flaccida	0.08	R
	Guinardia	striata	0.10	R
	Gonyaulax	sp.	1.83	M
	Hyalodiscus	stelliger	1.00	M
	Licmophora	ehrenbergii	0.28	R
	Leptocylindricus	sp.	0.05	C
	Lithodesmium	undulatus	5.92	D
	Melosira	sp.	3.91	M
	Melosira	moniliforms	0.40	R
	Melosira	nummuloides	2.46	M
	Navicula	sp.	1.57	M
	Navicula	ramosissima	0.04	R
	Navicula	vanhoeffenii	0.13	R
	Navicula	granii	0.03	R
	Navicula	septentrionalis	1.40	M
	Nitzschia	sp.	0.96	M
	Nitzschia	closterium	1.02	M
	Nitzschia	sigma	1.53	M
	*Nitzschia	seriata	1.11	M
	Nitzschia	paleacea	0.84	R
	Odontella	mobilensis	0.43	R
	Odontella	aurita	0.12	R
	*Odontella	sinensis	0.06	R
	Ornithoceros	stelnii	0.06	R
	Paralia	sp.	0.06	R

	Paralia	sulcata	0.33	R
	Planktoniella	sp.	1.20	M
	Pleurosigma	directum	1.21	M
	Pseudosolenia	sp.	0.59	R
	Rhizosolenia	hebetata	0.38	R
	Rhizosolenia	imbricata	0.63	R
	Rhizosolenia	stolterfothi	0.82	R
	Rhizosolenia	alata	0.46	R
	Rhizosolenia	setigera	0.11	R
	Rhizosolenia	acicularis	0.17	R
	Rhizosolenia	shrubsolei	2.40	M
	Skeletonema	sp.	0.49	R
	Stephanopyxis	sp.	0.06	R
	Stephanopyxis	turis	0.01	R
	Tintinopsis	stelliger	0.09	R
	Tintinopsis	strigosa	3.33	M
	Thalassionema	nitzschiodes	3.36	M
	Thalassionema	sp.	2.57	M
	Thalassionema	frauenfeldii	1.16	M
	Thalassionema	bacillare	1.05	M
	Thalassionema	frauenfeldii	0.50	R
	Thalassiosira	sp.	2.01	M
	Thalassiotrix	sp.	3.34	M
Dynophyceae (Dinoflagellates)	*Alexandrium	minutum	0.10	R
	*†Alexandrium	tamarense	0.01	R
	Ceratium	lineatum	3.93	M
	Ceratium	furca	0.67	R
	Ceratium	tripos	0.17	R
	Ceratium	macroceros	0.07	R
	Ceratium	fusus	0.12	R
	Ceratium	lanula	0.02	R
	Ceratium	extensum	0.01	R
	Ceratium	trichoceros	0.02	R
	Ceratium	longipes	0.23	R
	Ceratium	articulum	0.17	R
	Ceratium	granii	0.36	R
	†Dinophysis	acuminata	0.03	R
	†Dinophysis	rotundata	0.23	R
	†Dinophysis	caudata	0.99	M
	†Dinophysis	tripos	0.20	R
	Dinophysis	miles	0.07	R

	†Dinophysis	fortii	0.32	R
	†Gyrodinium	brave	1.97	M
	†Gyrodinium	mikmotoi	0.17	R
	†Gyrodinium	sanguincum	0.09	R
	*Gyrodinium	catenatum	0.07	R
	†Lingulodinium	polyedrum	0.03	R
	Preperidinium	claudicans	0.34	R
	Preperidinium	sp.	0.45	R
	Noctilua	sp.	0.84	R
	†Noctilua	scintillans	2.02	M
	Peridinium	depressum	2.74	M
	Peridinium	quinquecorne	0.10	R
	Peridinium	granii	2.28	M
	Protoperidinium	sp.	0.67	R
	†Prorocentrum	micans	0.30	R
	Prorocentrum	sigmoides	0.26	R
	Prorocentrum	redfeildil	0.05	R
	†Prorocentrum	lima	0.13	R
	†Prorocentrum	maxlcanum	0.21	R
	Protoperidinium	sp.	0.15	R
	Protoperidinium	pellucidum	0.03	R
	Triceratium	americanum	0.06	R
	Triceratium	sp.	0.03	R
	Triceratium	favus	0.31	R
	Gonlaulax	sp.	0.27	R
	Gonlaulax	spinifera	1.36	M
	Pyrodinium	bahamense	0.01	R

*Invasivespecies

:http://www.fish.wa.gov.au/Documents/occasional_publications/fop057.pdf

†Harmful dinoflagellates (Faust and Gulledge, 2002).

The phytoplankton analysis showed that abundance varied from 55,500 to 255,000cells m^{-3} (Fig. 2). The highest and lowest abundances were observed at stations SAGT and DN1, respectively. A total of 125 taxa were reported from the area. Ninety one taxa were identified to species level while 35 taxa were identified to genera. Eighty five (85) taxa were identified as diatoms, while 38 taxa belonged to dinoflagellates (Table 1). Diatoms accounted for 77.4% of the total phytoplankton population at the area followed by dinoflagellates, which contributed22.6%. However, 65-99% of diatoms have been reported in the Palk Strait followed by dinoflagellates (0-33%) (Jayasiri, 2007). The most dominant phytoplankton species was *Lithodesmium undulatus,*which contributed 5.9% of the total population, followed by *Ceratium lineatum (3.9%), Melosira sp.* (3.9%), *Thalassionema nitzschiodes* (3.4%), *Thalassiotrix sp.* (3.3%), *Tintinopsis strigosa* (3.3%) and *Chaetoceros dicipiens* (3.0%) (Table 1). High species diversity was observed for*Ceratium* sp., *Rhizosolenia* sp., *Biddulphia* sp. and *Dinophysis* sp. (see Table 1). According to the mean composition of reported species, ninety three (93) taxa were rare species, while 29 species had moderate abundances, and three species were dominant taxa (Table 1). The highest species richness wes reported for the NDPE location, while the lowest was at DN1 and JCT2.Thirteen of the42 speciesof dinoflagellates in Colombo harbour were toxic species. Casas-Monroy (2011) identified 14 non-indigenous dinoflagellate cyst species not yet reported from Canadian coasts, including 4 potentially harmful/toxic species, representing a possibility of newintroductions. The Margalef 's diversity varied from 3.93 to 9.07. Shannon index varied from 1.86 to 2.25, and the evenness index varied from 0.55 to 0.65.

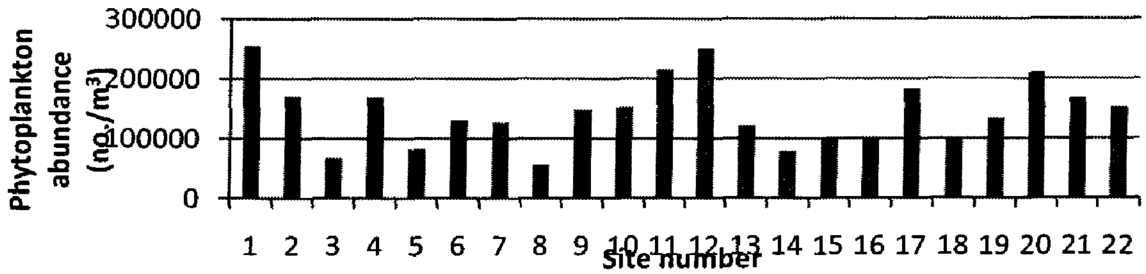

Figure 2: Variation of phytoplankton abundance in Colombo harbour

Conclusion

The presence of thirteen species of toxic dinoflagellayes out of 42 species reported in Colombo harbour may be a future threat for marine oraganisms as well as human. Thus, monitoring of harmful algal blooms in marine waters of Sri Lanka is recommended.

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