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Marine micro-phytoplankton of Singapore, with a review of harmful microalgae in the region

Toh Hii Tan[1], Chui Pin Leaw[2], Sandric Chee Yew Leong[3], Lay Peng Lim[3], Siew Moon Chew[3], Sing Tung Teng[4], Po Teen Lim[2]*

Abstract. A survey of marine phytoplankton in the Singapore Strait was carried out between May and June 2013, as part of an effort to determine the diversity of phytoplankton in Singapore's coastal waters. A total of 34 microalgal samples were collected using a 20 µm-mesh plankton net and from coastal sediments. Living samples and preserved samples in Lugol's solution were identified to species as far as possible under the microscope. A checklist of marine micro-phytoplankton was updated to encompass 270 taxa, including 49 new records from Singapore waters. Some 37 species from 15 families were dinoflagellates, and 233 species from 50 families were diatoms. Harmful microalgae, categorized as biotoxin-producers and fish killers, were also found in this survey. These were in the genera *Alexandrium*, *Amphidinium*, *Ceratium*, *Cochlodinium*, *Coolia*, *Dinophysis*, *Gambierdiscus*, *Karenia*, *Karlodinium, Ostreopsis*, *Prorocentrum*, *Nitzschia*, and *Pseudo-nitzschia*.

Key words. Diatoms; dinoflagellates; harmful; phytoplankton; microalgae; Singapore

INTRODUCTION

Phytoplankton, or plant plankton, refers to a group of microscopic unicellular cells containing photosynthetic pigments that convert light energy into chemical energy for the organisms' activity, although some species are mixotrophic (feeding on organic or inorganic compounds as a source of energy) or phagotrophic (feeding on other organisms). These microscopic cells form the basis of all marine food webs by acting as a food source for organisms from higher trophic levels. They release oxygen into the water as a byproduct of photosynthetic activity but consume oxygen due to respiration. Micro-phytoplankton is most abundant in coastal regions, as these organisms are dependent upon nutrient run-off from the terrestrial environment. Diatoms and dinoflagellates dominate the phytoplankton in the marine environment (Hasle & Syvertsen, 1997).

The term 'diatom' originated from the genus name *Diatoma* De Candolle (1805). They reproduce vegetatively by binary fission, and most are heterovalvate, i.e., comprising two valves. Their siliceous cell wall sets them apart from dinoflagellates, which only have a membranous cell wall. Dinoflagellates possess two flagella that are used in locomotion and feeding. The shapes and patterns of their thecal membranous cell walls are used in identification (Steidinger & Tangen, 1997).

Singapore is a small country situated about 100 km north of the equator, with a typical equatorial climate, having temperatures ranging from 23 to 34°C annually. Rainfall is mostly uniform throughout the year and not affected by the Northeast or Southwest Monsoons (National Environment Agency, Singapore) although some months may be drier than others. As an island state located in the South China Sea between the Indian Ocean and Pacific Oceans, it is one of the busiest ports in the world. Despite its status as a developed country, phytoplankton diversity along the 200 km coastline of water body of this country has yet to be documented. Wee (1994) compiled a marine and freshwater phytoplankton checklist of 292 species of diatoms and two species of dinoflagellates. Subsequently, Pham et al. (2011) updated the list to 292 diatoms and 15 dinoflagellate species.

During the Singapore Strait Biodiversity Workshop hosted by the National Parks Board and National University of Singapore, phytoplankton sampling was conducted around the Singapore waters, focusing on the Singapore Strait. Phytoplankton samples were collected from various locations and sediment samples were collected from the mudflats, with the aim to survey and update the marine micro-phytoplankton checklist of Singapore waters. Potential harmful species were also identified and discussed in this study.

[1]Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

[2]Bachok Marine Research Station, Institute of Ocean and Earth Sciences, University of Malaya, 16310 Bachok, Kelantan, Malaysia; Email: ptlim@um.edu.my; poteenlim@gmail.com (*corresponding author)

[3]Tropical Marine Science Institute, National University of Singapore, S2S, 18 Kent Ridge Road, Singapore 119227

[4]Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

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