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A Novel Diatom –Cyanobacteria Symbiosis

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Abstract

The occurrence of symbiosis between centric diatom *Hyalodiscus laevis* Ehrenberg and a filamentous non heterocystous cyanobacterium Oscillatoria sp. is reported for the first time. The samples are collected from the Bay of Bengal. Even though symbiosis is already recorded in many others forms like *Richelia* _ *Rhizosolenia* and other forms from the Indian Ocean, a novel symbiotic condition is found in the case of *Hyalodiscus* - *Oscillatoria*.

Key words: Cyanabacterium, , Endosymbionts, Filamentous, Heterocystous, *Hyalodiscus laevis* , *Oscillotoria*, Periplasmic space, Plasmalemma, Planktonic, Symbiosis.

Introduction

Symbiosis is defined as mutually advantageous association of two different organisms attached to each other or one with in the other. Planktonic diatom – cyanobacteria symbiosis is very common in surface ocean and this symbiosis plays a major role in the ecology and biogeochemistry of the oceans. In many regions of the ocean chain forming diatoms are found living in close association with heterocystous cyanobacteria. The heterocystous cyanabacterium *Richelia intercellularis* Schmidt and non-heterocystous *Trichodesmium* are believed to be the major nitrogen fixers in world's tropical and subtropical oceans (Ventrick, 1974, Carpenter & Romans 1991, Capone et al. 1997). The relationship between the diatoms and cyanobacteria is assumed to be symbiotic and it has frequently been reported from different seas (e.g.

De Yoe *etal*. 1992, Villareal 1994, Carpenter & Janson2000). Gomez *et al*. (2005) reported the occurrence of large number of *Richelia- Chaetoceros* consortia in western Pacific Ocean. *Hemiaulus hauckii- Richelia* blooms are very common in different parts of the world. *Richelia* associated with *Rhizosolenia clevei* Osten. present in the surface waters. Kimor, et al. (1978) recorded the unusual occurrence of *Hemiaulus membranaceus* Cleve with *Richelia intercellularis* Schmidt off the coast of Southern California. Sundström (1984) recorded the cyanobacterium *Richelia intercellularis* Schmidt as an endosymbionts in the diatom *Rhizosolenia clevei* Osten. .Villareal (1990) recorded the widespread occurrence of *Hemiaulus* - cyanobacterial symbioses in Southwest-North Atlantic Ocean. Heinbokei (1986) studied the occurrence of Richelia intercellularis Schmidt with diatom *Hemiaulus hauckii* and *Hemiaulus membranaceus* off Hawaii. In the Baltic Sea (Snoeijs and .Murasi 2004) recorded the diatom communities found to occur in nitrogen fixing cyanobacterium *Rivularia atra* Roth. They reported these communities for the first time, among these the dominant forms pennate genera include *Amphora, Berkeleya, Cymbella, Entomoneis, Epithemia, Mastogloia* etc. The main advantage of this symbiotic condition includes protection against grazing, protection against physical disturbances, and suitable substratum for mobility. Brehm, *et al*. (2003) published a short communication on symbiosis of cyanobacteria, diatom with bacteria. They observed in the case of filamentous cyanobacterium (*Phormidium*) together with benthic diatom genus *Navicula* in culture condition. In cultures they found that *Phormidium* filaments tightly inter twined with each other and formed a surface of spheres, trapping the diatoms inside. The presence of *Richelia intracellularis* epiphytically associated with *Chaetoceros compressus* is restricted to Indian Ocean and western Pacific Ocean. The common occurrence of *Rechelia intracellularis* as an endosymbiotic condition is ubiquitous in all warm seas and substantial inputs of nitrogen.

Interestingly a novel symbiotic condition of *Hyalodiscus laevis* Ehrenb. with *Oscillotoria* sp. has been observed in samples collected soon after monsoon in the Bay of Bengal. In the present study shows the chain forming planktonic diatom Hyalodiscus is hosting the filamentous cyanobacterium Oscillotoria sp. Here the symbiosis is not interdependent in the sense that they occur independently in the same sample.

Material and Methods

Samples of *Hyalodiscus –Oscillatoria* consortia were collected from the Adyar Estuary, Bay of Bengal. Live specimens were observed under the light microscope to study these consortia. Specimens for Light Microscopy (LM) were preserved in 4% commercial formalin in seawater. Permanent slides were prepared for LM studies.

Results and Observations

The consortia appeared in the centric diatom *Hyalodiscus laevis* Ehrenb. with cyanobacterium *Oscillatoria sp.* is different from the earlier reports.The symbiotic condition of filamentous non-heterocystis cyanobacterium with *Hyalodiscu*s will definitely enhance the nitrogen fixation. The availability of enriched nutrient content is one of the reasons for this novel bloom soon after monsoon. The *Oscillatoria* sp. filaments moves to the *Hyalodiscus laevis* frustule and forms a beautiful spherical structure. The formation of these spheres was the result of radial and synchronous movement of cyanobacterium. Snoejis and Murasi (2004) studied the symbiosis in *Rivularia* –diatom that is living with in multicellular colonies of the nitrogen fixing ctyanobacterium *Rivularia altra* Roth in brackish Baltic sea in autumn –winter. The present consortium is also reported from the brackish Bay of Bengal sea in the month of October. In fresh samples the filaments move towards the diatom and closely intertwined together to form a beautiful sphere. While transferring these into artificial medium its movement is in opposite direction and filaments move away from diatom. In old cultures the direction of cyanobacterial movement has turned in opposite direction, away from the sphere (Brehm,. *et al.*2003).

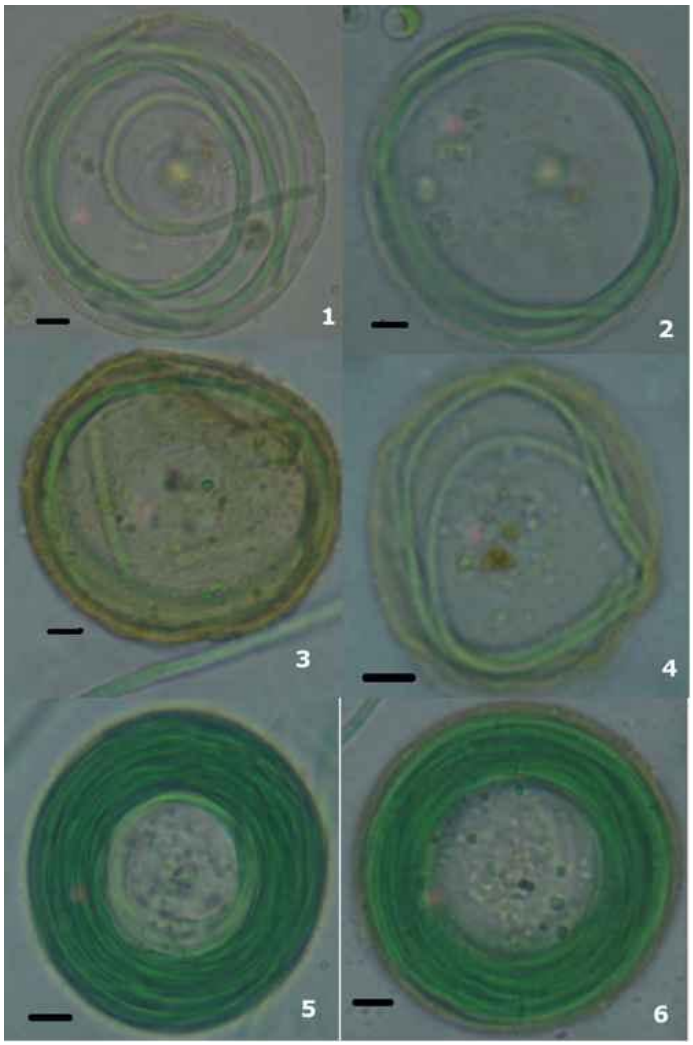

Plate 1. Figs 1, 2, 3, 4. *Oscillatoria* filament attached to the diatom frustule is moving towards the margin. Figs 5,6. *Oscillatoria* firmly positioned in the diatom Hyalodiscus laevis Ehrenb. valve and formed a ring of filaments.

Hyalodiscus laevis Ehrenberg, C.G. 1845. Ber.Bekanntm. Verh. Konigl.Preuss Akad. Wiss. Berlin.P.71.
Cells lens shaped, occurring singly or in pairs united by copulae, plastids several ,irregularly discoid, valves deep, watch glass shaped to hemispherical , areolae fasciculate, flat area at the centre, rimoportulae scattered over the valve, cells are attached to each other by conspicuous blocks of mucilage.

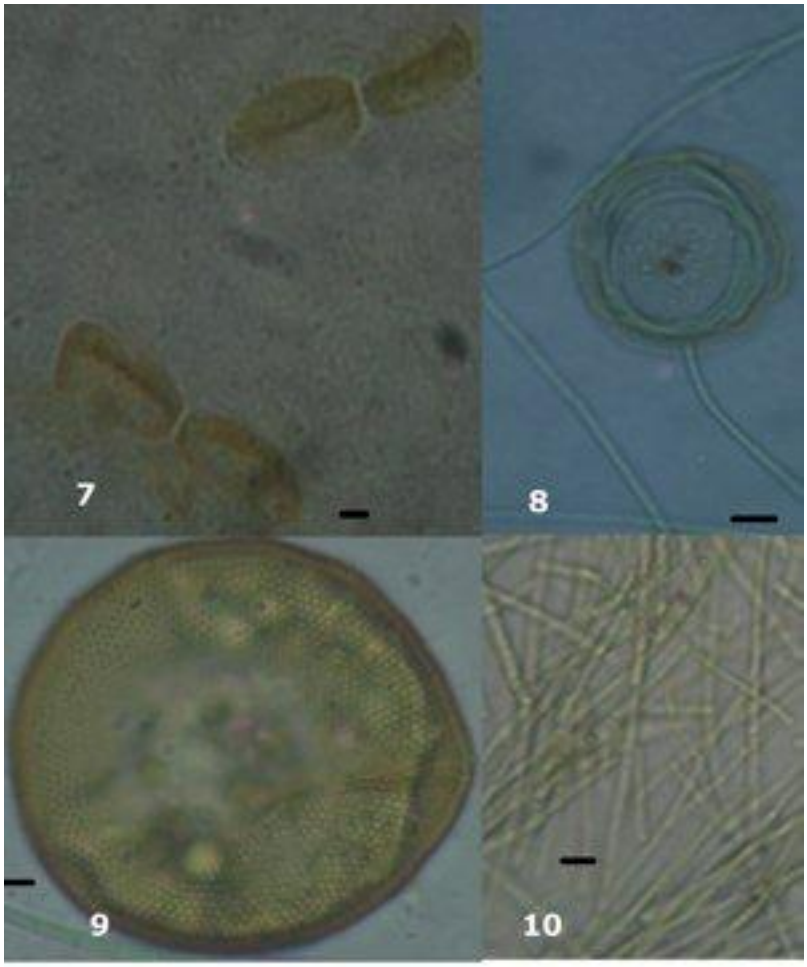

Plate 2 Fig 7. Hyalodiscus laevis Ehrenb. Girdle view of Hyalodiscus in chain formation before the symbiosis condition. Fig 8. Oscillatoria filament started moving on the diatom valve and moving towards the marginal part , Fig 9 Oscillatoria filaments are scattered outside the diatoms valve,10. Oscillatoria sp. Cultured in artificial medium.

Discussion

Richelia intracelluris is an endosymbiont, which locates itself in the periplasmic space between the plasmalemma and silica wall in the diatom *Rhizosolenia clevei* Ostenfeld. A novel consortia of *Hyalodiscus laevis* Ehrenb.with *Oscillatoria* sp. reported here seems to be extracellular and it will contribute more knowledge to the symbiotic nature in diatom and cyanobacteria. This consortium is restricted to Indian Ocean and Western Pacific. The *Hyalodiscus laevis* Ehrenberg -*Oscillatoria sp*. consortia needs to be studied further to establish its role in nitrogen fixation in seas.

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