Oceanologia (2019) 61, 395—399

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SHORT COMMUNICATION

First new record of two diatoms (*Caloneis africana* (Giffen) Stidolph and *Luticola nivalis* (Ehrenberg) D. G. Mann) from South West Coast of India (Cochin backwaters)

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Received 23 October 2018; accepted 14 December 2018
Available online 28 December 2018

KEYWORDS
South West Coast of India;
Diatoms;
Caloneis africana;
Luticola nivalis

Summary The main objective of this paper is to report two diatoms (*Caloneis africana* (Giffen) Stidolph and *Luticola nivalis* (Ehrenberg) D. G. Mann) from Cochin backwaters, which prove to be a new finding from Indian waters. Surface water samples were collected monthly from twelve stations covering the ecosystem from May 2015 to April 2016. The analysis of physicochemical parameters and the preparation of permanent slides of diatoms were performed based on standard procedures. Descriptions, world distribution and photographs of the two diatoms are included in this paper. These two new species further enrich the diatom floristic diversity of Cochin backwaters in India.

Diatoms are the most species-rich group of algae. The number of diatoms has been estimated to include approximately 100,000 species over 1000 genera. Diatoms are widely used in ecological monitoring and paleoecological reconstruction (Mann, 1999). The net primary production from diatoms is more than that of all the worlds' tropical rainforests (Field et al., 1998). Diatoms produce 20—25% of global oxygen (Smol and Stoermer, 2010). In an aquatic ecosystem, they represent

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Peer review under the responsibility of Institute of Oceanology of the Polish Academy of Sciences.

Production and hosting by Elsevier

https://doi.org/10.1016/j.oceano.2018.12.002

the overall ecological conditions and reflect the pollution status of the system (Dakshini and Soni, 1982). The habitats of diatoms at the regional and global scale are changing due to natural and anthropogenic activities. Therefore, scientific understanding of the ecological conditions of diatoms is important in order to use them as bioindicators.

Diatoms from tropics are least documented. Approximately 7000 diatom taxa in freshwater, brackish, marine environment and fossils have been reported from the Indian subcontinent (Kale and Karthick, 2015). The scientific study of diatoms in India was reported long back in 1845 on diatoms of Calcutta (Ehrenberg, 1845). Skvortzow (1935) reported 56 forms of diatoms from Calcutta and Biswas (1936) reported common diatoms of the Loktak Lake, Manipur, Assam. Venkataraman (1939) reported 98 diatoms from south India. The diatom floristic diversity of Indian waters was enriched by many Indian diatom taxonomists (Das and Santra, 1982; Desikachary and Devi, 1986; Desikachary et al., 1987; Gandhi, 1959a,b, 1961, 1962, 1967; Gonzalves and Gandhi, 1952; Karthick et al., 2011; Karthick and Kociolek, 2011; Menon, 1945; Roy, 1954; Sarode and Kamat, 1979; Subrahmanyan, 1946). The present study sheds light on the occurrence of two new diatom taxa from Cochin backwaters.

Cochin backwater ecosystem is situated on the southwest coast of India. It is approximately 320 km^2 in the area of Vembanad lake and surrounding islands with six rivers flowing to the backwater. The tidal intrusion from the Arabian Sea and the annual freshwater discharge (20,000 $\times$ 10^6 m^3) from six rivers maintain the dynamism of the system (Srinivas et al., 2003). The climate of Cochin backwater is typical of tropical features with monsoon yielding 60–65% of total rainfall (Menon et al., 2000). The samples were collected from the Cochin backwater ecosystem, running parallel (9°48′ and 10°9′N and 76°10′ and 76°19′E) to the south-west coast of India (Fig. 1). The depth of the ecosystem varies from 2 to 7 m, but the ship channel regions are dredged and maintained at 10–13 m (Qasim, 2003). The backwater system got two permanent connections to the Arabian Sea, one at the Cochin bar mouth (450 m) and the other at Azhikode (100 m) (Sankaranarayanan and Qasim, 1969).

Surface water samples were collected monthly from twelve stations covering the ecosystem from May 2015 to April 2016. The surface water temperature was recorded using 0–50°C precision thermometer and pH by eco tester PH1. The surface water samples were collected in 500 ml Tarsons narrow mouth bottles (Code: 583140) and nutrients (nitrate, nitrite, phosphate and silicate) were analysed within 6 h from collection, based on a standard protocol, using UV 1800 Shimadzu spectrophotometer (APHA, 2005). The collected diatom samples were incubated overnight to settle after adding the fixative ethyl alcohol (98%). Concentrated diatom samples were cleared by hot HCl and $KMnO_4$ method (Taylor et al., 2007) and permanent slides were prepared by Naphrax mounting medium. The samples were observed under Leitz BIOMED research microscope and digital photographs were taken with Nikon Cool pix 4500 camera attached with 100X objectives. The measurements were taken using ocular and stage micrometry. The diatoms were identified according to Krammer and Lange-Bertalot (1986) and Witkowski et al. (2000), based on the classification of Cox (2015).

The paper presents the description, world distribution and ecology of the two diatoms from Cochin backwaters in India. Physico-chemical parameters of the sampling site are given in Table 1.

Order: Naviculales
Family: Pinnulariaceae
Genus: Caloneis
Species: ***Caloneis africana* (Giffen) Stidolph** (Fig. 2A)
Basionym: *Caloneis brevis* f. *africana* M. H. Giffen
Reference: Witkowski et al. (2000) (p. 152, Figs. 1 and 2)
Dimensions: Valve length: 36–108 μm, Valve breadth: 20–24.5 μm, Stria density: 11–12/10 μm.
Diagnosis: Valves elliptic with broadly rounded or with obtusely rounded apices. Raphe straight, external central endings expanded, distant apical endings sickle-shaped, curved on one side, axial area at apices narrow, broadening towards the middle, central area weakly separated, large and usually circular. Transapical striae radiate throughout the valves.
Distribution: Marine water species widespread in the Northern sea tidal flat (Brockmann, 1950), Southern hemisphere (Giffen, 1967), White Sea (Witkowski et al., 2000), New Zealand (Harper et al., 2012), Korea (Joh, 2012) and Australia (John, 2016).
Distribution in India: New Record
Order: Naviculales
Family: Diadesmidiaceae
Genus: Luticola
Species: ***Luticola nivalis* (Ehrenberg) D. G. Mann** (Fig. 2B)
Basionym: *Navicula nivalis* Ehrenberg 1854
Reference: Krammer and Lange-Bertalot (1986) (Fig. 61, 17–20).
Dimensions: Valve length: 12–14 μm, Valve breadth: 5–13 μm, Stria density: 17–20 (24)/10 μm.
Diagnosis: Shells linear, in smaller specimens linear-elliptic, with ± pronounced triangular edges. Raphe branches thread-fencing with weakly one-sided bent central pores. Axial artery moderately narrow, linear or slightly lanceolate to the middle, central artery forming a transverse band extending to almost the edges with a punctiform isolated stigma on the side remote from the central pores.
Distribution: Marine and freshwater species recorded from Germany (Reichardt, 1984), Australia (Day et al., 1995), Romania (Caraus, 2002), Germany (Mauch and Schmedtje, 2003), United States of America (Kociolek, 2005), Czech Republic (Hasler et al., 2007), China (Liu, 2008) and Israel (Barinova et al., 2010).
Distribution in India: New Record

Round et al. (1990) considered the genera Caloneis and Pinnularia as synonyms and eliminated the genus Caloneis from his book. Cox (2015) placed Caloneis under Pinnulariaceae. The present study agrees with the discussions of Mann (2001) regarding the genus level identification difficulties of Caloneis and Pinnularia. The identification of *C. africana* (Giffen) Stidolph in this study was completely based on Witkowski et al. (2000). Moreover, the characteristics exhibited by the present specimen is not matching with any of the Pinnularia species reported in the literature, and at the same

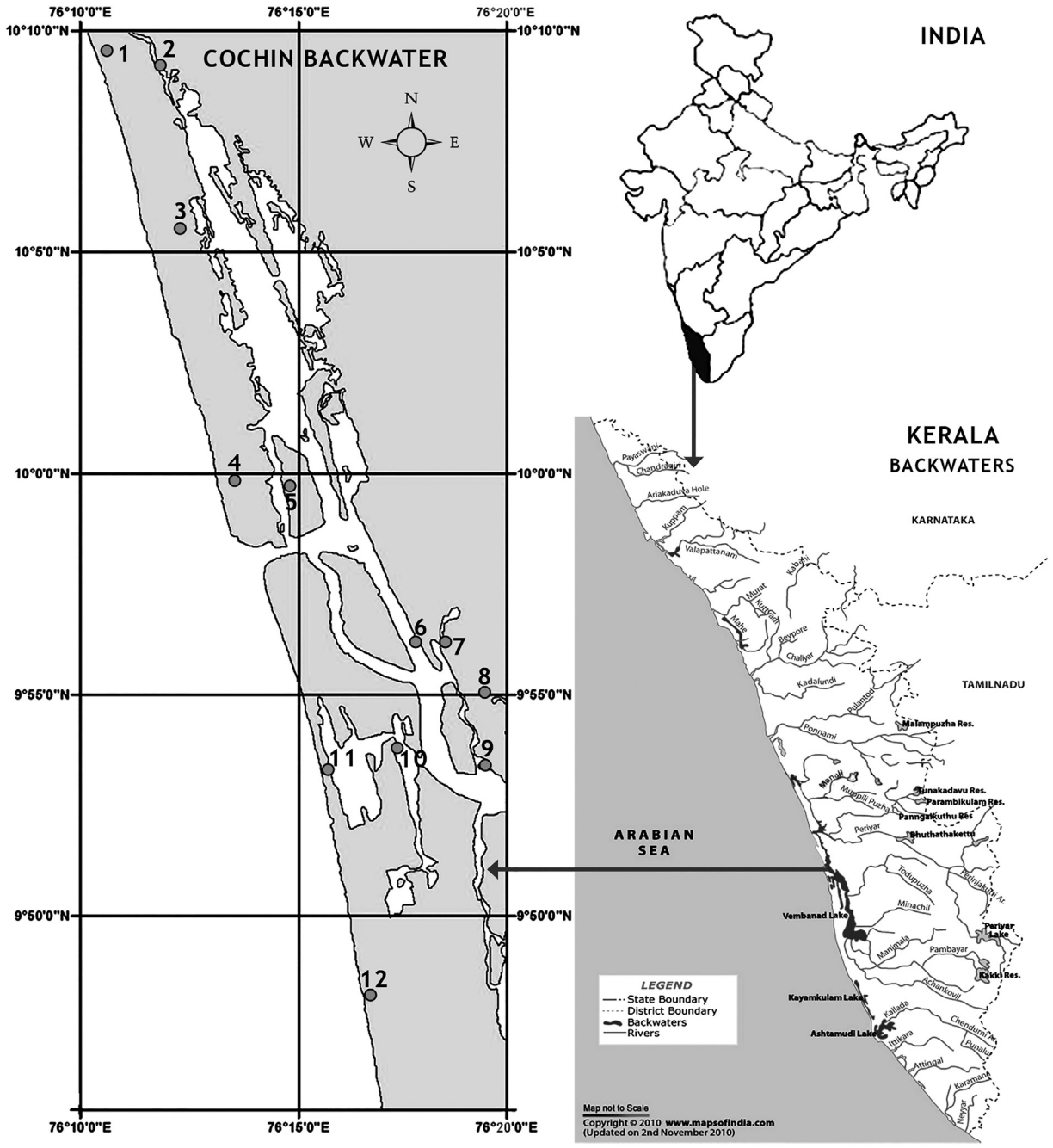

Figure 1 Map of the station in the South West Coast of India (Cochin backwaters) where *Caloneis africana* and *Luticola nivalis* have been recorded.

time it perfectly matches with the *C. africana* (Giffen) Stidolph. Hence future research works on gene sequence data of Caloneis species will provide substantial evidence for proper identification and classification of the taxa. Even though several studies have been carried on diatom flora of Cochin backwaters (Aneeshkumar and Sujatha, 2012; Dayala et al., 2014; Gopinathan, 1975; Gopinathan et al., 1984; Jyothibabu et al., 2015; Kumar et al., 2014; Madhu et al., 2010, 2017; Sanilkumar et al., 2009; Selvaraj et al., 2003), the two diatoms reported in this paper from Cochin backwaters are new to Indian diatom flora.

The new record of diatoms reported from the Cochin estuary will act as a bioindicator of the ecosystem and it will implicate the importance of continuous assessment of diatom diversity in India, for exploring new taxa and new records. The floristic study of diatoms at the regional scale will provide information regarding the endemism in diatoms. To understand the distribution of two diatoms presently reported, detailed and systematic studies are required in different aquatic ecosystems that will further enrich the biodiversity list of diatoms in India.

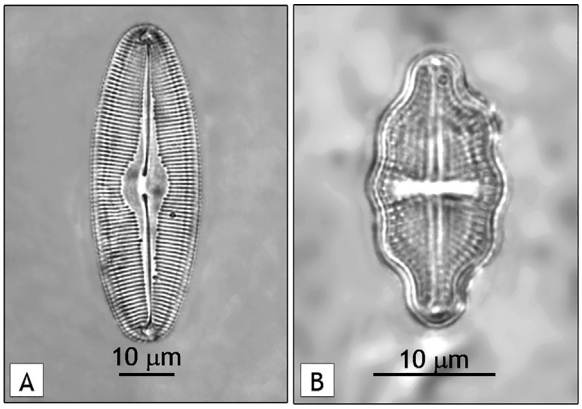

Figure 2 Light microscopy images of diatom species; (A) *Caloneis africana* (Giffen) Stidolph; (B) *Luticola nivalis* (Ehrenberg) D. G. Mann.

Table 1 Water quality parameters at the sampling sites.

	Caloneis africana	*Luticola nivalis*
Locality	Chellanam, Site XII	Pattanam, Site II
Month/year	(76°16′38.6″E and 9°48′14.4″N) 09/2015	(76°11′50.4″E and 10°9′19.7″N) 09/2015
Temperature (°C)	30	30
pH	8.9	7.2
Salinity (ppt)	6	4.8
Nitrate (μmol L^{-1})	0.58	0.76
Nitrite (μmol L^{-1})	2.13	0.27
Phosphate (μmol L^{-1})	0.57	0.86
Silicate (μmol L^{-1})	1.53	4.55

Acknowledgements

The study was supported by Kerala State Biodiversity Board, Kerala, India. The authors are thankful to the Principal and Head, Department of Botany, Sacred Heart College, Thevara, Cochin for providing necessary facilities to carry out the work.

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