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New distributional records of three Naviculales (Naviculaceae) from the Bhitarakanika National Park of Odisha, India

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ABSTRACT

Bhitarkanika Wildlife Sanctuary, situated in the north-eastern part of Kendrapada district of Odisha, India, spreads over an area of about 672 sq. km. Within the sanctuary, an area of approximately 145 sq.km. is designated as Bhitarkanika National Park and obtained the status of a Ramsar site on 19th August 2002. It is the second largest mangrove ecosystem of India consisting of huge mangrove forests, river deltas, estuaries, backwaters and mud flats etc. They serve as the base of an elaborate and productive food web in this extraordinarily diverse estuarine ecosystem. The present investigation aims at enumeration and ultrastructural examination of certain diatom taxa collected as a part of our ongoing studies on diatom diversity of major areas of Bhitarkanika national park *viz*. Dangmal, Kalibhanjdian, Khola, Bhitarkanika and Ragarapatia. The present paper reports the occurrence of three diatom species namely, *Navicula subrostellata* Hustedt, *Navicula torneensis* Cleve and *Caloneis oregonica* (Ehrenberg) R.M. Patrick belonging to order Naviculales under the family Naviculaceae from Bhitarkanika National Park as the new distributional records from India based on examination of morphological features and ultrastructure through scanning electron microscopy (SEM). Occurrence of these 3 diatom species in Bhitarkanika Wildlife Sanctuary is of considerable phytogeographical significance and important addition to the checklist of least-explored diatom flora of this important mangrove habitat.

1. Introduction

Mangroves are one of the most extraordinarily diverse evergreen estuarine open ecosystems, formed by a variety of salt tolerant species growing in the inter-tidal areas and estuary mouth, can provide critical habitat for a diverse marine, brackish and terrestrial flora and fauna. They act as nutrient sinks and protect offshore ecosystems and often referred to as bio-shields or natural sea defence (Roy *et al.*, 2009). Nearly 60-70% of the world's tropical and subtropical coastlines are covered with mangroves, which are known to be world's most productive ecosystems of remarkable ecological value (Thatoi *et al.*, 2013). The dynamic mangrove ecosystem supports the growth of many phosphate solubilizing, nitrogen fixing, sulphate reducing and methanogenic bacteria, wood degrading fungi as well as photosynthetic algae like diatoms, cyanobacteria, green-algae and other microalgae, which play significant role in maintaining nutrient cycling and ecological balance in this unique ecosystem. One of the major groups of microalgae in mangroves is diatoms, which is a very valuable environment indicator. About one-fifth of the photosynthesis on earth is carried out by these fabulous photosynthetic workhouses. Therefore, exploration of these bioresources from different ecosystems will definitely help us to understand their role in ecosystem functioning and show the path for bioprospecting for commercial applications.

Bhitarkanika, the second largest mangrove ecosystem of India, consists of mangrove forests, river deltas, creeks, estuaries, backwater, accreted land and mud flats. Most of the published literature on this sanctuary pertains to documentation of flora and fauna. Due to inaccessible forest cover and vast expanse of water, the microbes of thisnational park have remained poorly studied. Though scanty reports are available on phytoplankton and other microalgal diversity (Rath & Adhikary, 2006; Chakraborty *et al*., 2012; Thatoi *et al*., 2012; Dash *et al.*, 2019), not much work has been done

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on the taxonomy and diversity of diatoms of Bhitarkanika. In the present investigation, attempt has been made, for the first time, to examine the ultrastructure of three brackish water diatoms through scanning electron microscopy (SEM).

2. Materials and methods

Bhitarkanika, a mangrove wetland in Odisha is surrounded by Bay of Bengal on east, the villages of Kendrapara district on west, Dhamra estuary on north and the Mahanadi estuary on south. Field visits were made to Bhitarkanika and diatom samples were collected randomly from different niches of mangrove sediments, mud surfaces, attached to pneumatophores of some selected mangrove species. Sample collections were made from sites such as Khola, Dangmal, Kalibhanjdian, Bhitarkanika and Ragarapatia of Bhitarkanika Wildlife Sanctuary and National Park during November-December, 2018. Samples were collected in sterile specimen tubes (Tarson) of 25 × 50 mm size in duplicate of which one set was stored in ethanol. Ethanol was added to reach final concentration of 20% by volume (Kolbe, 1948; Krammer & Lange-Bertalot, 2000; Krammer, 2002; Karthic *et al*., 2010). Diatoms were cleaned by acid wash method using HCL and pre-oxidant potassium permanganate (Hasle, 1978; Round *et al*., 1990; Karthic *et al.*, 2010) and hot hydrogen peroxide method (Van Der Werff, 1955; Karthic *et al*., 2010). After that, cleaned diatoms were stored in 70% of ethanol for further study. For identification, the permanent slides of cleaned diatoms were prepared and observed under the microscope (Hund Wetzlar Trinocular Compound Microscope with Canon-EOS 550D Camera attachment), followed by photomicrography. The processed diatoms were diagnosed under a Scanning Electron Microscope (Zeiss EVO 18 special edition). The diatom species were identified through morphometrical analysis following standard monographs and literature (Cleve, 1894; Hustedt, 1930; Cleve-Euler, 1953; Desikachary, 1988). Taxonomy of each species and the protologues were verified as cited in algaebase.org (https://www.google.com) (Guiry & Guiry, 2019) and diatombase.org (https://www.diatombase.org).

3. Enumeration of species

3.1. ***Navicula subrostellata*** Hustedt 1955: 27 (Plate 1, Fig. 1-2)

Lanceolate to linear-lanceolate valves with protracted apices, length of valve (AA) 29-31.5 µm, width of valve (TA) 6.5 -7 µm. The axial area is narrow and straight. The central area is round to elliptical. External proximal raphe ends are straight and very close to each other. Striae are radiated around the centre, parallel then gently convergent at the apices, transapically elongated areolae, number of striae 14 in 10 µm.

Place of collection: Bhitarkanika.

Mode of occurrence: Benthic and epiphytic.

3.2. ***Navicula torneensis*** Cleve 1891: 33 (Plate 1, Fig. 3)

Synonym: *Schizonema torneense* (Cleve) Kuntze

Valve wide lanceolate with cuneate to slightly rostrate ends, length of the valve 35-36.9 µm, width of the valve 16-17 µm. Striae slightly curved around central area, radiate throughout the valve, no of striae 12-13 in 10µm, some short striae are found around the central area. The first group of areolae is slightly more elongated, slits like areolae are present surrounding the central area. Axial area narrow and linear. Small central area, circular to transversely elliptical due to position of striae. Raphe straight, thin with simple drop like central endings, apical endings are simple and slightly deflected to opposite side of the valve.

Place of collection: Bhitarkanika.

Mode of occurrence: Benthic.

3.3. ***Caloneis oregonica*** (Ehrenberg) R.M. Patrick 1966: 581 (Plate 2, Fig. 1-7)

Basionym: *Pinnularia oregonica* Ehrenberg

Synonyms: *Navicula oregonica* (Ehrenberg) Kützing; *Navicula liburnica* Grunow; *Caloneis liburnica* Grunow; *Navicula amphisbaena* var. *liburnica* (Grunow) M. Peragallo

Valve elliptic to linear-elliptic, flat valve external surface with rounded apices, length of valve (AA) 40-75 µm, width of valve (TA) 13-17 µm. Axial area slightly irregular, lanceolate, comparatively wider at centre, tapering towards the valve apices and situated more closely to the raphe on one side than the other. Central area distinctly separated from axial area and almost circular to transversally elliptical to slightly rhombic due to the position of striae. Central nodule slightly depressed externally. External raphe branches thin, straight, central raphe fissures end in pore-like expansions; large, hooked, sickle-shaped terminal raphe endings extending up to the end mantle area, both deflected to same side of the valve. A single longitudinal line runs parallel with the valve margin at about two-third of the distance from the raphe to the valve rim which is quite distinct (Fig.1). Internally the axial area quite distinct, at the centre a slightly siliceous thickening occurs on one side of the central raphe ends. Internally raphe straight with simple central raphe endings, slightly bent towards siliceous thickening and terminal endings with simple coaxial pore, small compressed and horseshoe-shaped helictoglossa (Fig.6). Striae slightly radiate to parallel, number of stria density: 15-16.

Place of collection: Bhitarkanika.

Mode of occurrence: Benthic.

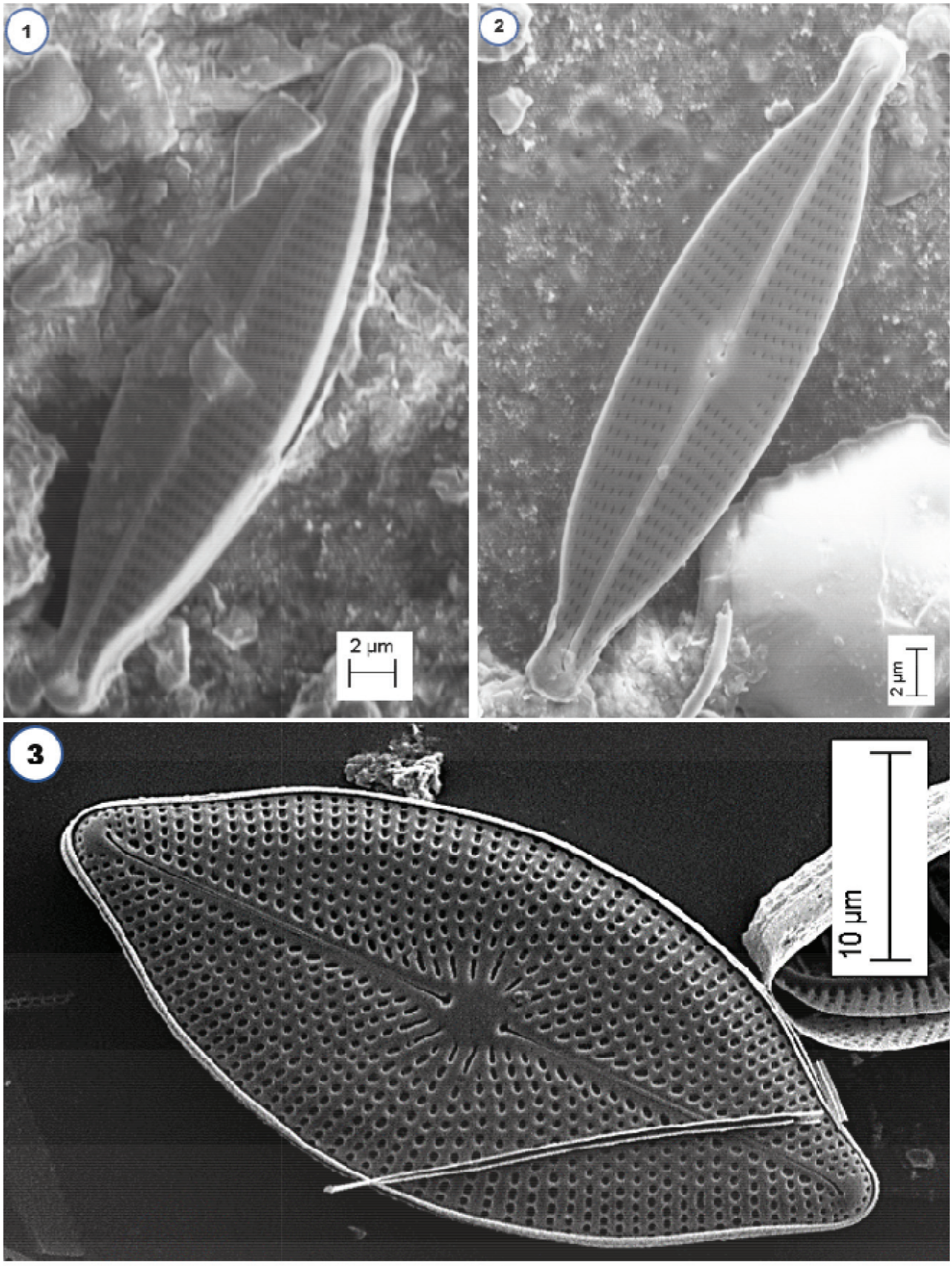

Plate 1 (Figs. 1-3): Fig. 1-2 *Navicula subrostellata*; **Fig. 3** *Navicula torneensis*

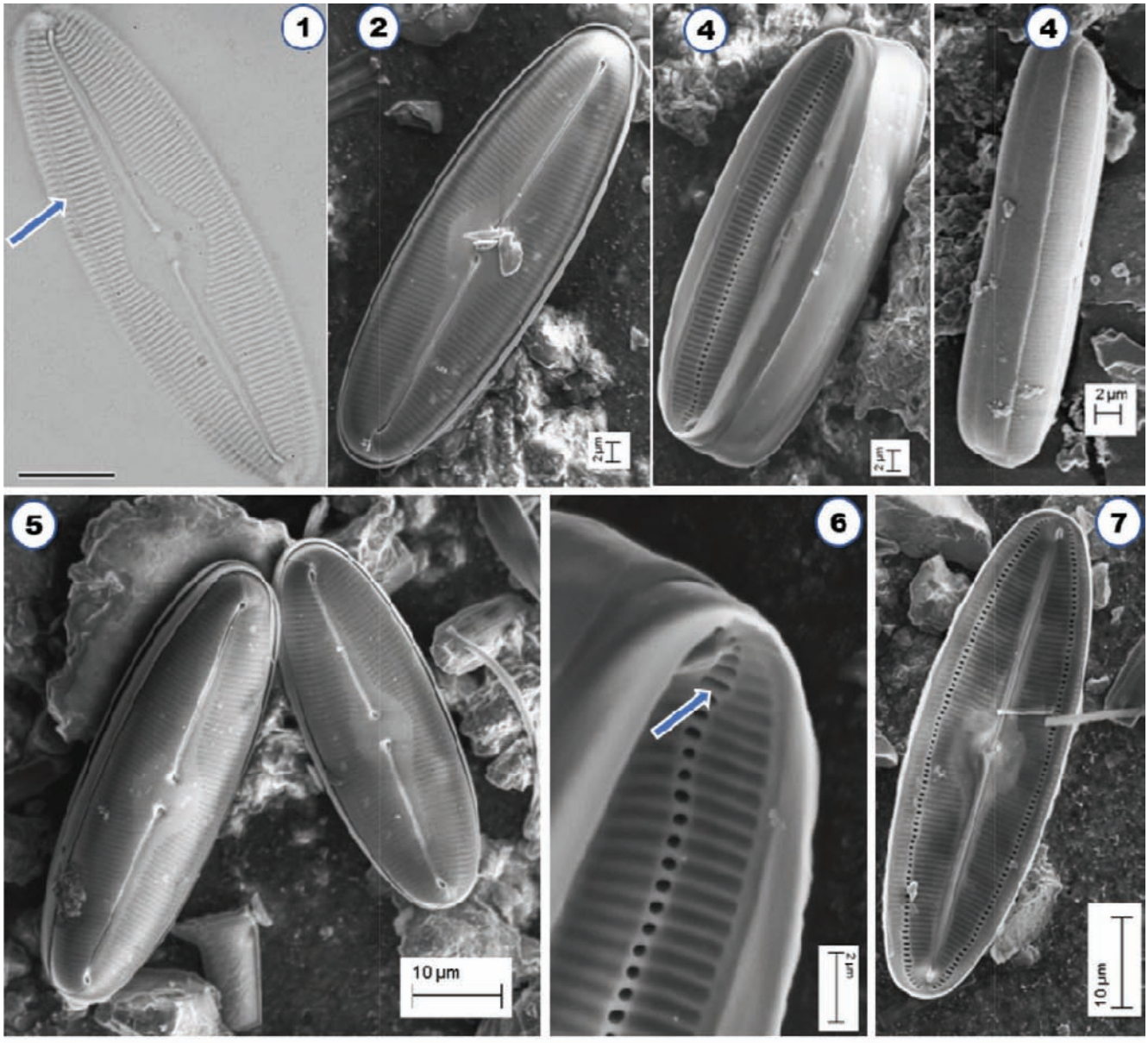

Plate 2 (Figs. 1-7): *Coloneis oregonica*, LM = 10X

4. Discussion

The present investigation discloses the occurrence of three Naviculales, namely, *Navicula subrostellata* Hustedt, *Navicula torneensis* Cleve, *Caloneis oregonica* (Ehrenberg) R.M. Patrick belonging to family Naviculaceae from Bhitarkanika, this being the first report from India. According to earlier distributional records, *Caloneis oregonica* was reported to be mostly confined to brackish water habitat worldwide (Kociolek, 2005; Maulood *et al*., 2013), but *Navicula subrostellata* was a marine form (Hafner *et al*., 2018). *Navicula torneensis* Cleve was the most common species of different estuaries of Korea (Joh, 2013) and mostly found as epipssamic forms. Exploring diatom diversity from this unexplored area will not only provide an opportunity for exploring of different endemic taxa and new distributional records from those unique habitats but also unlatch the opportunity for obtaining different novel organisms for various commercial purposes.

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