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Research article

Nitella flagelliformis A. Br. and *Chara braunii* Gm. - two new records of Charophytes from fresh water bodies in Hooghly district, West Bengal, India

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Abstract: The present paper was dealt with morpho-taxonomic descriptions of two Charophycean algal species such as *Nitella flagelliformis* and *Chara braunii*, from one each of genera *Nitella* and *Chara* of the family Characeae under the order Charales with different valuable information like habitats, altitude of collection sites, phenologies, limnological notes, threats and significances for the first time from Hooghly district, West Bengal, India. Both the species were collected from freshwater aquatic ecosystems. They were found as waterlogged or submerged conditions and attached with bottom muddy soil in water bodies by rhizoids (anchorage organ). The physico-chemical parameters that favoured their distribution and growth in water bodies were recorded and found to be congenial. The analysis of water revealed some important characteristics like slight alkaline pH, lower level of essential nutrient contents (nitrate-nitrogen, phosphate) and salinity; moderate total alkalinity and, higher chemical oxygen demand at the time of their collections from freshwater bodies. Out of these two Charophycean algal species, *Nitella flagelliformis* is a new report of occurrence from the state of West Bengal, India.
Keywords: Taxonomic description - Characeae - Hooghly district - West Bengal.

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INTRODUCTION

Geographically, the state of West Bengal is located between 21°38' to 27°10' N latitude and 85°50' to 89°50' E longitude and one of the most biodiversity rich states of phycoflora in India. Hooghly district (20°01'–23°30' N and 87°30'–80°30'E) covers a total area of about 3137.55 km^2 and occupies different types of water resources such as rivers, lakes, ponds, moats and flood plain wetlands (Halder & Sinha 2013a, b). This district possesses a typical tropical monsoon and thus, supports the magnificent reserve of plant resources including algae. The monthly temperature of this district varied between 14°C and 35°C and, the average annual rainfall is 1500 mm during monsoon (Halder & Sinha 2015a, b).

Charophytes are also known as "Stonewort's" (James & Jones 2016). They are submerged, heterotrichous macroalgae (Schubert & Blindow 2003). Their plant bodies are grass-green, branched, differentiated into nodes and internodes; bear two types of branches–branches of limited and unlimited growths. They are very common in temporary and permanent aquatic ecosystems (Caisová & Gabka 2009) like ponds, lakes, man-made reservoirs, canals, swampy lands, water logged rice fields and rivers. Both the male (globule) and female (nucule) sex organs are complicated and well protected by a sterile jacket. The zygotes of Charophycean members are very resistant to dry and cold conditions that might be due to development of sporopollenin layer surrounding the zygotes. From cytological point of view, presence of Golgi bodies and network of microtubules, the formation of phragmoplasts and cell plates during late cytokinesis are the key characters of Charophytes (Bennici 2008). Few species of *Chara* L. are bioindicator of water quality (Gudrun *et al*. 1996). Presently, Charophytes are of great interests regarding biological control of pest management because of their pesticidal properties that affect the central nervous system of insects (Sherby *et al*. 1986). Ecologically, Charophytes are

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distinct because they release some chemical substances which causing a strong and characteristic smell and, suggested inhibition of phytoplankton growth due to allelopathic effects (Van den Berg *et al*. 1998, Schubert & Blindow 2003). In the line of monophyletic origin of embryophytes, Charophyceae is considered as an ancestor of land plants/bryophytes. Considerable evidences support this hypothesis (Graham 1993, Renzaglia *et al*. 2000, Blackwell 2003, Qiu *et al*. 2006). The occurrence, distribution, species composition and productivity of algae are regulated by several extrinsic forces of environments including physical and chemical delimiting factors and by interactions among the species (Chambers & Prepas 1990, Dawes 1998). Hence, some limnological parameters like temperature, pH, dissolved oxygen (DO), nitrate-nitrogen (NO_3-N), phosphate (PO_4^{3-}), chemical oxygen demand (COD), total alkalinity, total suspended solids (TSS), salinity and turbidity of water were assessed to find out correlations between environmental factors and algae.

In Bengal, some earlier reports were available on taxonomy of Charophytes by the investigations of Griffith (1849), Agarkar & Kundu (1937), Kundu (1929, 1934–1935, 1937, 1941, 1959), Chaterjee (1975, 1979a), Pal & Santra (1987) and Mandal & Ray (2004). As far as the karyotype is concerned, the work of cyto-taxonomy on Charophytes by Chaterjee (1976, 1979b), Ray & Chaterjee (1987, 1994), Mukhopadhyay (1995) enriched our knowledge of this interesting plant group. As, there was no comprehensive report of Charophytes from this district the present study was undertaken. The main objective of the present work was to explore the occurrences and diversities of Charophytes from this state.

MATERIALS AND METHODS

Samples of macroscopic algae were picked up by hands from different places *viz.* Khamargachi (23.05°N, 88.43°E), Tribeni (22.99°N, 88.40°E), Dumurdaha (23.03°N, 88.43°E), Dwarkeshwar river at Arambag (22.53°N, 87.47°E) and Chinsurah (22.90°N, 88.39°E) of Hooghly district, West Bengal, India. Fresh algal samples were brought to laboratory in glass containers and polythene packets. For species identification of algae upto species level detailed taxonomic study was made by examining these specimens under Olympus microscope (Model-CH20i) for identification of species. Preservation was done in 4% formalin and the voucher specimens were deposited in the Departmental Herbarium of University of Kalyani, Nadia, West Bengal. Identifications of the taxa were done through authentic literatures (Imahori 1954, Pal *et al*. 1962, Wood & Imahori 1964–65, Pal & Santra 1987, Subramainian 2002). The physicochemical characteristics of water bodies were analyzed as described earlier (Halder & Sinha 2015b).

RESULTS AND DISCUSSIONS

A total number of two algal taxa namely *Nitella flagelliformis* A. Br. and *Chara braunii* Gm. belonging to the family Characeae under the order Charales of the class Chlorophyceae were described morpho-taxonomically for the first time from Hooghly district of West Bengal, India. Currently accepted name had been provided with its author/s name. Asterisk mark (*) indicated new report from West Bengal.

Morphotaxonomic Enumeration

*1. ***Nitella flagelliformis*** A. Braun in Hookers J. Bot. 1: 294, 1849; Braun in Abh. Kon. Akad. Wiss. Berlin.10, 1847; Mukherji in Proc. 19th Indian Sci. Congr. Bangalore. 328, 1932. (**Figs. 1, 3A, B**)

Thallus greyish-green, dioecious; grows on sandy mud as submerged condition; stem rather slender, 384.0 to 600.0 µm thick; lower internodes as long as branchlets, upper ones shorter; sterile branchlets long similar to the fertile branchlets; fertile branchlets 5–7 in a whorl, 4–5 times furcated; primary rays half as long as the entire branchlets; secondary rays 5–6 of which 3–4 again furcated into 2–3 quinary rays; dactyls of sterile and fertile brachlets similar and 2–4, unequal in 3–5 tertiary rays; 2–3 of these again furcated into 3–4 quaternary rays; some of the quaternary rays sometimes again furcated and length 2-celled; ultimate cell usually conical but sometimes allantoid; male and female (globule & nucule) reproductive structures sessile, solitary and globule lies above the nucule; globule spherical, 320.0 to 380.0 µm in diameter; nucule 400.0 to 450.0 µm long (including coronula), 340.0 to 360.0 µm broad; spiral cells showing 8-9 convolutions; coronula 45.0 to 58.0 µm high and 106.0 µm broad at the base; oospores dark brown, ellipsoid, 310.0 to 340.0 µm long, 250.0 to 280.0 µm broad with 6–8 prominent sharp flange ridges and imperfectly reticulated.

Habitat: Canal water at Khamargachi in Hooghly district, West Bengal, India . 14 m (above sea level).

Collection No: NH 1045; **Dated:** 10.03.11.

Phenology: Winter to early summer (December–March)

Limnological note: The limnological data after analysis of water which was collected from the above spot was given. Water temperature: 21ºC; pH: 7.2; NO_3-N: 0.15 mgl^{-1}; PO_4^{3-}: 0.20 mgl^{-1}; DO: 7.2 mgl^{-1}; COD: 160.0 mgl^{-1}; Total alkalinity: 128.0 mgl^{-1}; TSS: 136.0 mgl^{-1}; salinity: 12.0 mgl^{-1}; turbidity: 16.6 NTU.

Threat: Disturbances by cattle grazing and anthropogenic activities of human beings were found responsible for the death and disappearance of this algal flora during taxonomic investigation.

Significance: It acts as primary producer and a part of aquatic food chain in freshwater ecosystem. Further the alga provides shelter of zooplanktons.

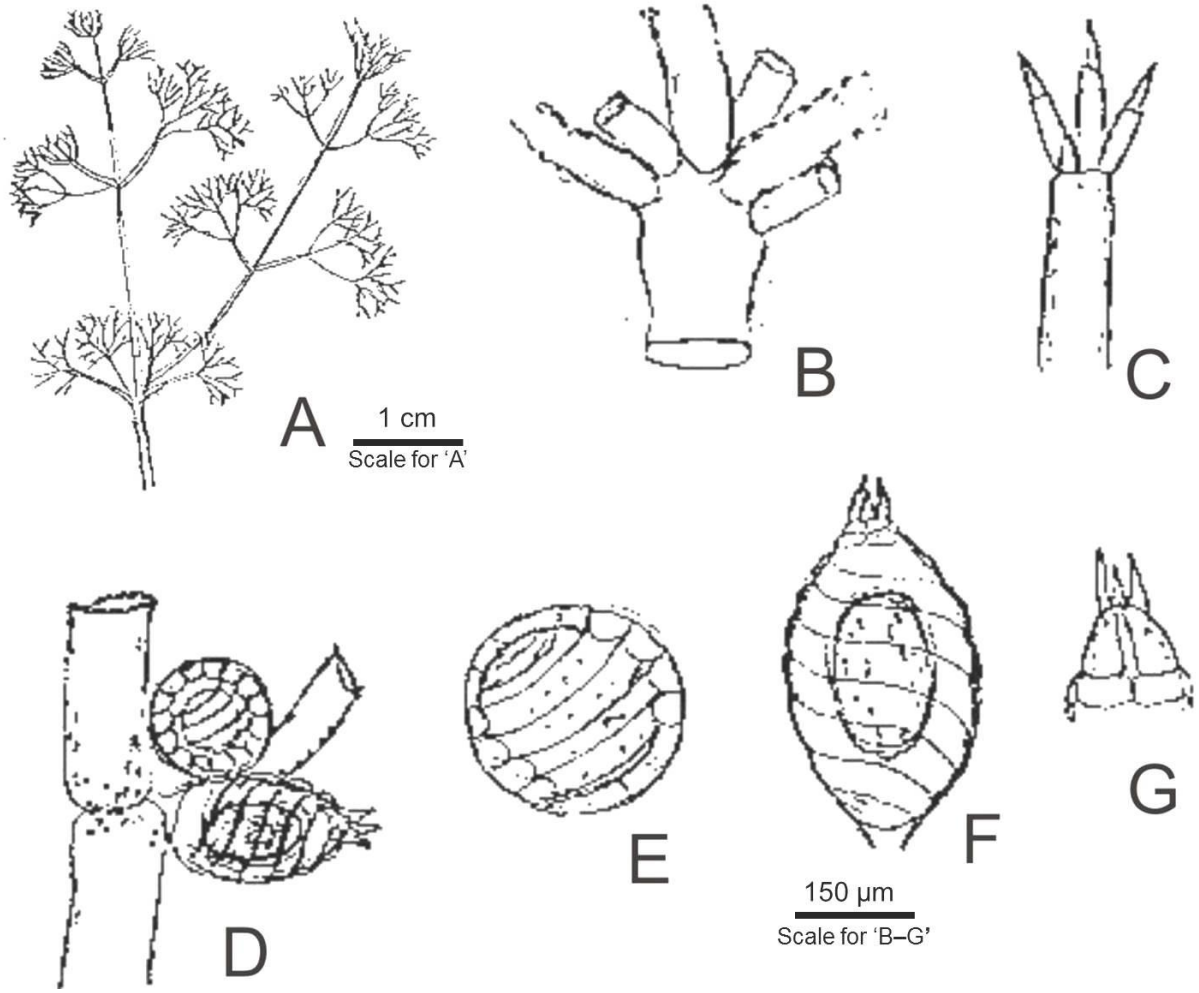

Figure 1. , *Nitella flagelliformis* A. Br.: **A** plant body; **B**, Branchlet; **C**, Dactyl tips; **D**, Sex organs; **E**, Globule; **F**, Nucule; **G**, Coronula with apex.

2. ***Chara braunii*** Gm. in Flor. Badens. Alsat. (suppl.) 646, 1826; Pal, Kundu, Sundaralingam & Venkataraman in Charophyta 89. figs. 200–203, 1962; Moore in Charophytes Great Britain and Ireland 80, figs.12 a-d, 1986 (**Figs. 2, 3C, D**).

Thallus grass-green, monoecious, grows on sandy mud as submerged condition; stem stout, 400.0 to 620.0 µm in diameter; plant body ecorticated entirely; internodes a little longer or as long as the branchlets; branchlets long; 9–11 in number with 4–5 segments each, lower segments elongated than the upper; stipulodes 9–10 in a single whorl, alternating with the branchlets and elongated; 300.0 to 470.0 µm long, 50.0 to 70.0 µm broad at base with acute apex; bract cells 3–4 with 2–3 small bracteoles at each node; terminal node with 2–3 bracts forming a corona like termination; bracts 250.0 to 400.0 µm long and 60.0 to 80.0 µm wide but bracts of terminal node upto 150.0 µm long and 60.0 µm broad; lower 2-3 nodes (except the base of the branchlet whorl) with globule and nucule; both reproductive organs (globule & nucule) solitary, situated at the same node and globule lies below the nucule; globule 250.0 to 310.0 µm in diameter, nucule 460.0 to 520.0 µm long excluding coronula and 360.0 to 500.0 µm broad at the middle region; spiral cells showing 8–9 convolutions; coronula

ovoid-conical with rounded apex,140.0-180.0 µm high and 182.0–230.0 µm broad at base; oospore black, ellipsoid-cylindrical, 550.0 to 580.0 µm long and 360.0 to 410.0 µm (-550.0 µm) broad with 8–9 ridges.

Habitat: Dwarkeshwar river, pond water at Chinsurah and Tribeni and, moat water at Dumurdaha. 14.2 m (above sea level zone).

Collection No: NH 817, NH 1048; **Dated:** 03.01.11, 25.03.11.

Phenology: Winter to early summer (December–March)

Limnological note: The limnological parameters after analysis of water which was collected from a pond at Dumurdaha had been depicted. Water temperature: 20.5ºC; pH: 7.3; NO_3-N: 0.3 mgl^{-1}; PO_4^{3-}: 0.42 mgl^{-1}; DO: 7.0 mgl^{-1}; COD: 180.0 mgl^{-1}; Total alkalinity: 112.0 mgl^{-1}; TSS: 142.0 mgl^{-1}; salinity: 12.0 mgl^{-1}; turbidity: 15.0 NTU.

Threat: Same as mentioned for *Nitella flagelliformis*.

Significance: It provides shelter of zooplanktons, acts as primary producer and a constituent of aquatic food chain in water body.

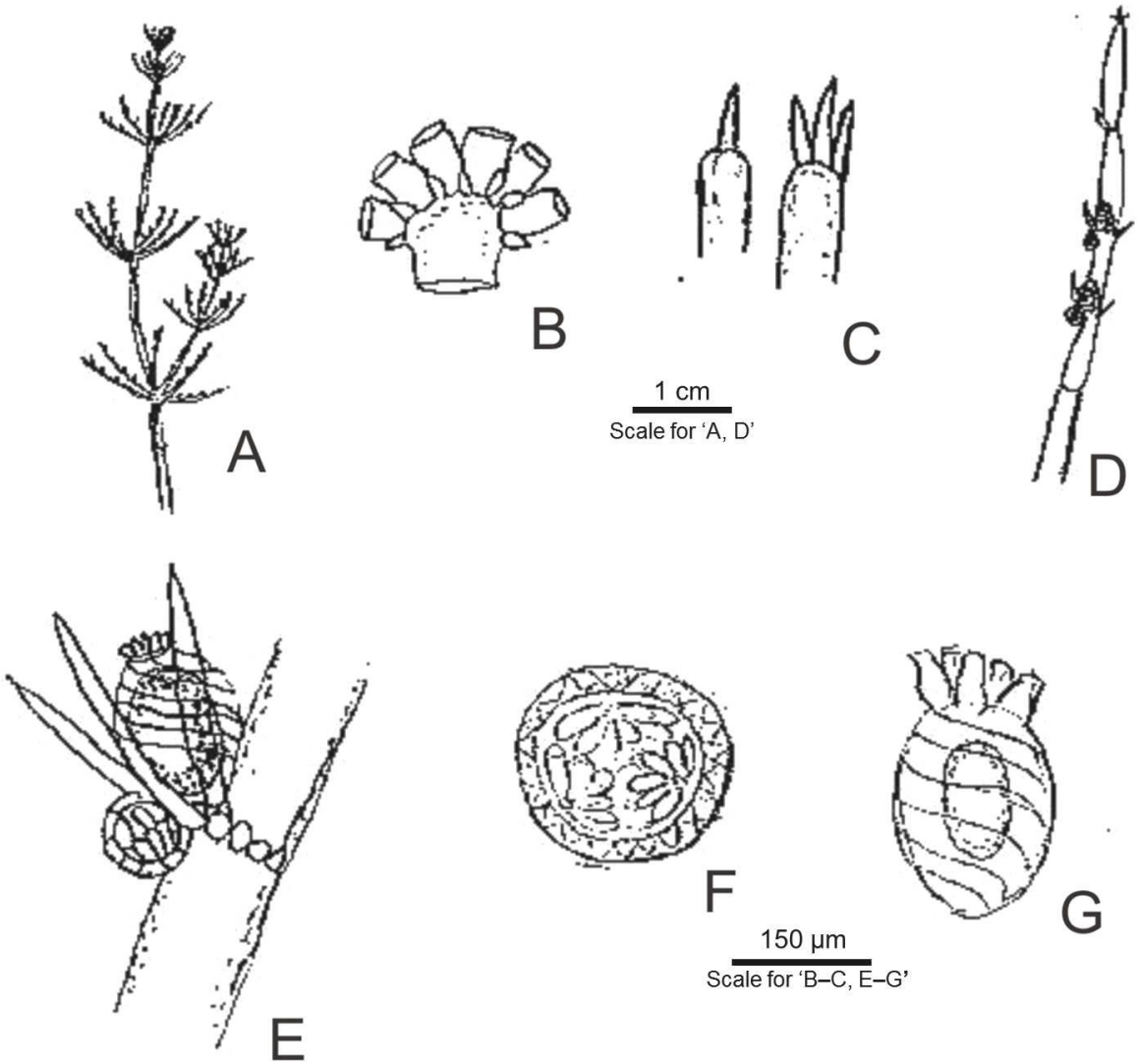

Figure 2. *Chara braunii* Gm.: **A**, *Chara braunii* plant body; **B**, Branchlet; **C**, Dactyl tips; **D**, Showing branchlets & stipulodes; **E**, Sex organs; **F**, Globule; **G**, Nucule.

Members of Charophytes occurred in both freshwater and brackish water habitats (Krause 1997) but they are mostly freshwater and occasionally grown in brackish water (Blindow 2000). In the present investigation, the species of Charophytes had been only collected from freshwater bodies. Environmental factors such as water temperature, light, salinity and altitude exert a immense impact on the distribution of Charophytes (Pełechaty *et al*. 2004, Gąbka *et al*. 2007, Boszke & Bociąg 2008). This opinion was found to be true in this study. Water temperature below 25°C and moderate intensity of light due to grown in winter months, low level of salinity

because of freshwater and low altitude (not more than 20 m elevation) had been recorded during their collections time form the above sites. When total phosphorus and turbidity values were lower and the impact of regional environmental influences decreased, the dominance of Charophytes was noticed in aquatic bodies (Rosqvist 2010). Here, more or less same finding was noticed because authors also recorded low level of phosphate concentrations (0.20–0.42 mgl^{-1}) and turbidity values (15.0 NTU–16.6 NTU) from the sites. It was noticeable that both the species occurred in slight alkaline water (7.2–7.3). The limnological study also revealed a higher COD values (160.0– 180.0 mgl^{-1}) which is an indication of stressed ecosystem. Moreover, the species were preferred to grow in winter probably lower temperature was one of the most important controlling factors to persist them in water bodies.

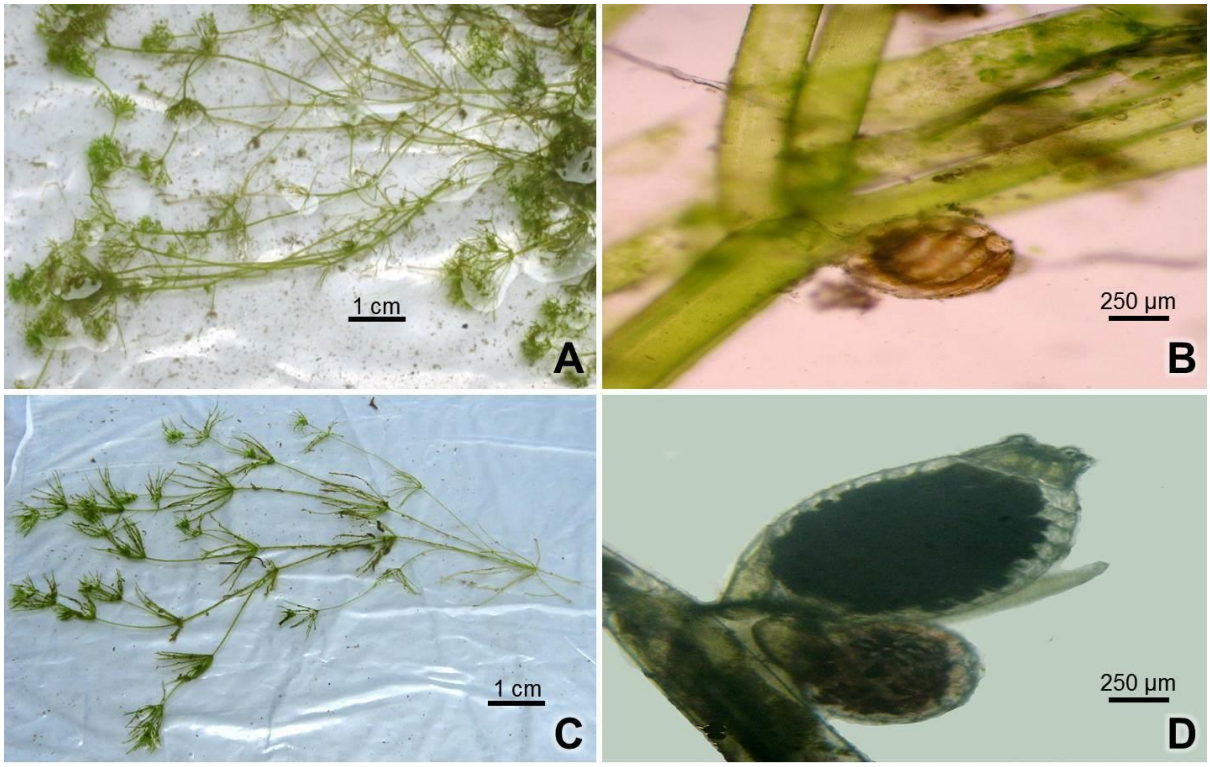

Figure 3. *Nitella flagelliformis*: **A,** plant body; **B,** globule and *Chara braunii*: **C,** plant body; **D,** sex organs (globule & nucule).

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