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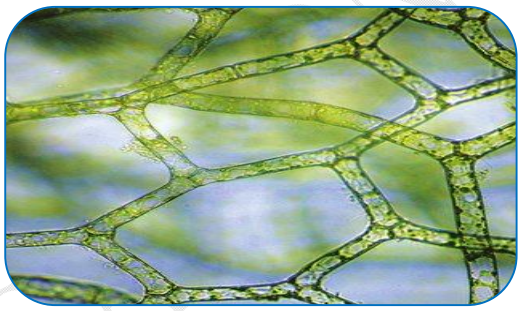
HYDRODICTYON RETICULATUM (L.) LAGERHEIM, A FRESH WATER MACRO ALGAE CAUSING NUISANCE EUTROPHICATION ON PADDY FIELD OF WEST BENGAL, INDIA

Parimal Mandal
Department of Botany, Raiganj University, Raiganj, Uttar Dinajpur.

ABSTRACT :



Hydrodictyon reticulatum (L.) Lagerheim (Hydrodictyaceae, Chlorophyta), a filamentous water net algae was found during March to June in the year 2014-16 on paddy field of West Bengal, India. The water-net has a characteristic cylindrical fishing net like coenobium. The algae form a dense water bloom and eutrophication on paddy field. In the present study growth of Hydrodictyon reticulatum and its effect on different environmental parameters viz. dissolved oxygen (DO), pH and temperature were measured at different growth conditions. Growth of Hydrodictyon reticulatum was found prolific in the present study which showed 2-fold increase of fresh weight in the 3rd day and 3-fold increase at the 7th day. Dissolve oxygen (DO) was measured in the following test which showed significant decline at night. The pH was also found to increase from 7.4-9.00 at day time which approaches to neutral at night. Temperature was found to decrease. Prolific growth of the algae forms a dense water bloom on paddy field which may lead to mass eutrophication.

KEYWORDS : *Hydrodictyon reticulatum, water-net, Dissolve Oxygen, eutrophication, pH,*

INTRODUCTION :

Hydrodictyon reticulatum (L.) Lagerheim (Hydrodictyaceae, Chlorophyta) is a rare fresh water free-floating filamentous macroalga of which several thousand of cylindrical cells joined together by their adjacent edges to form different mesh structure viz. trigonal, tetragonal, pentagonal, hexagonal and heptagonal that form a net like or fishing net like cylindrical coenobium, so, it is commonly called as "water-net" can be easily seen by naked eyes. It multiply so fast and form a dense bloom on water bodies. During propagation nuclei were aggregated together with cytoplasm to form multiple miniature daughter water-nets within mother cells which were released when mother cells were disintegrated at maturity (Chou *et al*., 2006). Under favourable condition several hundreds of these mother cells of a single water-net start its propagation with multiple miniature daughter nets in each cell; therefore, this alga can become a real pest in eutrophic water (Eva and Aloisie 2004) that is related to the degree of water mass eutrophication and usually has ecological impacts on aquatic flora and fauna (Wells *et al*. 1999; Wells and Clayton, 2001). The water-net has been reported from rice paddy fields in northern Taiwan as a weed (Chou *et al*., 2006). The water-nets were free-floating or secondarily attached and treated as water pest or weed in New Zealand, United Kingdom and northern Taiwan (Hawes *et al.,* 1991; Wells *et al.,* 1999; Chou *et al*., 2006) as it clogs waterways and irrigation ditches, taints potable water, causes economic losses to trout fisheries, smothers aquatic flora and fauna, negatively impact boating, fishing, swimming and tourism (Wells and Clayton, 2001). *H. reticulatum* likes eutrophic water and can sometimes reproduce so fast that it behaves like a pest. The water net could be treated as a

potential ecological disaster with prolific growth causing oxygen depletion, shading, and smothering of flora and benthic fauna in water body (Hawes *et al.,* 1991). *H. reticulatum* has frequently been recorded in paddy fields in Asia (Pocock, 1960) but it has first time been reported in water bodies as pest in West Bengal, India in my present study. In the present study, its growth, morphological characters and effect on environmental parameters in water body are described in details.

MATERIALS AND METHODS

Hydrodictyon reticulatum or water-net was collected with clear water at a depth of 20-30 cm from water body at Balurghat sub-division of West Bengal, India (latitude 25°13´N, longitude 88°46´E) on 25 June 2014. About 500g fresh miniature water-nets (3-5cm in length) was collected and stored at 5°C in a refrigerator immediately. Fifty liter clean water sample were also collected from the field to study environmental parameters of water body in laboratory. The collected water sample was treated as natural medium for growth of *H. reticulatum*. In the present study 12 rectangular glass jars (2 liter capacity each) were taken for four different experimental setups to measure the affect of *Hydrodictyon reticulatum* on water body parameters viz. dissolve oxygen (DO), pH and temperature. The four experimental setups were (N1) shading and fresh biomass (living) of *H. reticulatum*; (N2) no shading and fresh biomass of *H. reticulatum*; (N3) no shading and dry biomass (non-living) of *H. reticulatum* (as control); (N4) no shading and no biomass of *H. reticulatum* (as control). Each rectangular glass jars were provided with 1.5L of water collected from the field. In both the target setups (N1 and N2) 50g of fresh *H. reticulatum* were added. In control (N3) 5g of air dried *H. reticulatum* was was added in place of 50g fresh (Living) biomass. In control (N4) neither fresh nor air dried biomass was added. For shading, the experimental setup was kept in a normal room to avoid direct sunlight. For each experimental setup three replicas were maintained. Dissolve Oxygen (DO), pH and temperature were measured at every 2h intervals from 6:00 am to 18:00 pm with portable Water Analyzer 371(SYSTRONICS Serial No. 689). Growth of *H. reticulatum* was measured for a week (Day 1, Day 2 Day 3, Day 4, Day 5, Day 6 and Day 7) by weighing method. Fresh specimens were examined under microscope for morphological study. The photographs were taken using microscope attachment camera. Voucher specimens were preserved in 3-5% formalin solution and deposited at the Museum, Department of Botany, Shyampur Siddheswari Mahavidyalaya, Howrah, West Bengal (India).

RESULTS AND DISCUSSION

The water-net, *Hydrodictyon reticulatum* was seldom found throughout the water body of paddy fields and irrigation ditches during summer March to June in the year 2014 at Balurghat sub-division of West Bengal, India. During my study young *H. reticulatum* were found as free-floating, elongated coenobium, white to green in colour, balloon like water net (2-30mm in length and 2-3mm in diameter) on paddy field. Water-nets were found to grow so fast on water ways of irrigation ditches to generate large scale dense water bloom within a short period. The individual water-net was ranged from 5-80cm in length and 5-8cm in diameter**.** It was seldom reached its nuisance levels in a number of paddy fields and irrigation ditches in 2014 in my study area (**Figure-1**). So, the water-nets were removed as a pest or weed for clearing paddy fields and irrigation ditches by the cultivars as it clogs drainage and ditches and reduce water flow. *H. reticulatum* is a macroscopic, fishing netlike, both side closed, cylindrical, single layered coenobium of about 1500-3500 cells joint by their adjacent edges. In water-net coenobium 3-7 individual cells join together by their adjacent edges at specific angles to form different geometric mesh- trigonal, tetragonal, pentagonal, hexagonal and heptagonal structure respectively. The different geometric mash can easily be seen by naked eyes in an average size coenobium of *H. reticulatum*, which make it porous or fishing net like in structure, so it is called water-net. In coenobium, 2 cells connected to their adjacent edge with angle of 180° to form straight structure; three cells connected to the angle of 120° to form trigonal mesh structure; four cells connected to the angle of 90° to form tetragonal mesh structure. Five, six and seven cells connected together by their adjacent edges and form pentagonal, hexagonal and heptagonal mesh structure respectively The major mesh structure of a coenobium was found to be hexagonal and pentagonal that was 75% and 20% respectively. The

rest of mesh structures (trigonal, tetragona and heptagonal) were found very little. It was also observed that the Y-shaped cells occurring at the polar ends of the coenobium do not contact with other cells (**Figure-2)**. The angle between the two arms and the main axis of the Y-shaped cell was also 120°. These facts show epical growth with bifurcation of the cell end at an angle of 120° to the long axis of the cell. Y-shaped cells have also been reported in normal colonies for performing epical growth with bifurcation (McReynolds, 1961; Tiwari *et al.*, 1980). Each individual cell of *H. reticulatum* consists of many nuclei, dense protoplasm and reticulated chloroplast with pyrinoids. When the cells reach at maturity, the neuclei are aggregated together with cytoplasm, and form multiple miniature new daughter coenobia or water-nets within mother cells. These daughter water-nets are released from mother cells when mother cells disintegrate at maturity (Chou *et al.* 2006). The algal coenobium were found to be co-existed with *Cladophora*, *Oedogonium* and *Spirogyra,* and invertebrates (Pocock 1960; Wells *et al*., 1999).

In the present study *Hydrodictyon reticulatum* showed prolific growth (fresh biomass) in water body of Paddy field. In normal light (without shading) 6 fold increase of growth was found at 6th day, 3 fold increase of growth was found at 3rd day. After 7 day *Hydrodictyon reticulatum* growth was found decline. It may be due to complete utilization of minerals present in the water sample. In the shaded experiment, mild growth of *Hydrodictyon reticulatum* was found. (**Figure-3**) The effect of *H. reticulatum* in changes of dissolve oxygen (DO), pH and temperature in water body were measured. In the following experiment fresh biomass of *H. reticulatum* was found to increase dissolve oxygen in water body at day time (8:00 am – 18:00 pm), but it was shown significant decline of DO at night in both the target setups (N1 and N2). It may due to huge respiration of *H. reticulatum* at night. Both the control setups (dry biomass and without biomass) was shown no significant changes of DO in the test **(Figure-4).** Temperature was also found to decrease at day in the following experiment with fresh biomass of *H. reticulatum* in compare to control. It is because water temperature may be absorbed by fresh biomass of *H. reticulatum*. (**Figure-5**) In the experiment pH was found to increase in the target test at day time from 7.4 to 9.0. But at night it approaches to neutral pH (**Figure-6**).

There were concerns that *H. reticulatum* could be a potential ecological disaster with dense water bloom causing oxygen depletion, shading, and smothering of plants and benthic fauna (Hawes *et al.,* 1991). Mass occurrence of *H. reticulatum* can be often found in slow-moving streams, rivers, standing shallow waters, pools, fishponds and irrigation ditches (Hindak, 1978). Its prominent bloom is related to the degree of water-mass eutrophication and usually has ecological impacts (Wells *et al*. 1999; Wells and Clayton, 2001) on flora and fauna. *H. reticulatum* has been considered a nuisance where it occurs (Coffey and Miller, 1988), as resistant to herbicides such as copper sulphate (Fitzgerald, 1981), and re-grows rapidly after re-watering (Pocock, 1960). The serious nuisance growth of *H. reticulatum* is responsible for clogging of irrigation ditches and prominent thick water bloom on paddy fields which has ecological and economical impacts have first time been reported in West Bengal, India in this present work.

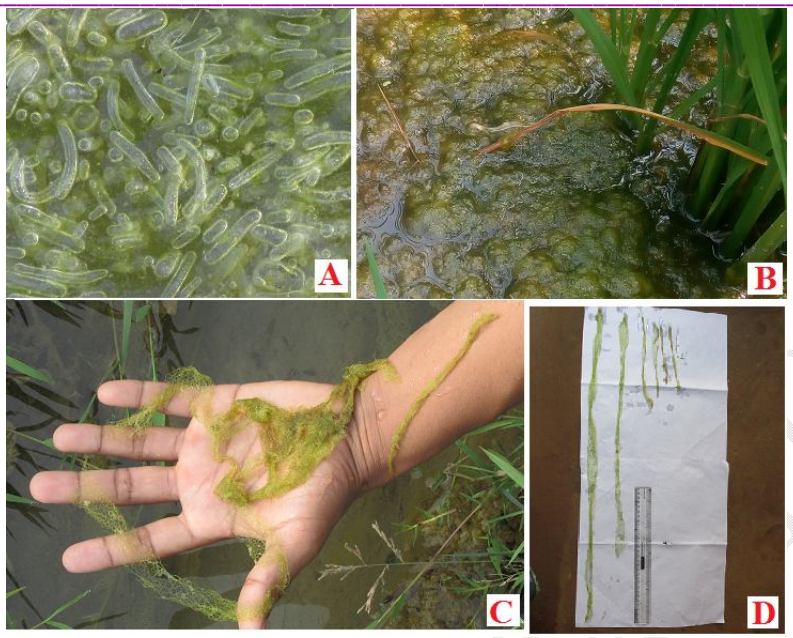


Figure-1: ***Hydrodictyon reticulatum*** **bloom on paddy field. A-** Miniature balloon like *H. reticulatum* bloom*;* **B-** Dense algal bloom; **C-** Large size single coenobium (80 cm length); **D-** coenobiums (2-30mm in length and 2-3mm in diameter) found on paddy field.

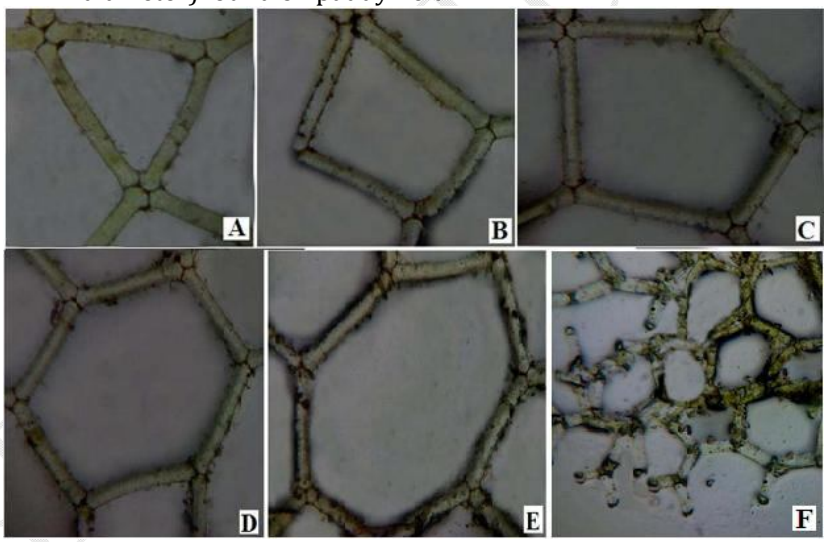


Figure-2: ***Hydrodictyon reticulatum*** **coenobium mesh structure. A-** Three cells connected to the angle of 120^{o} forming trigonal mesh structure; B- Four cells connected to the angle of 90^{o} to form tetragonal mesh structure. **C-** Five cells connected together by their adjacent edges to form pentagonal; **D-** Six cells connected together by their adjacent edges to form hexagonal mesh; **E-** Seven cells connected together by their adjacent edges and form heptagonal mesh structure**. F-** Show Y- shaped epical growth with bifurcation at an angle of 120° to the long axis.

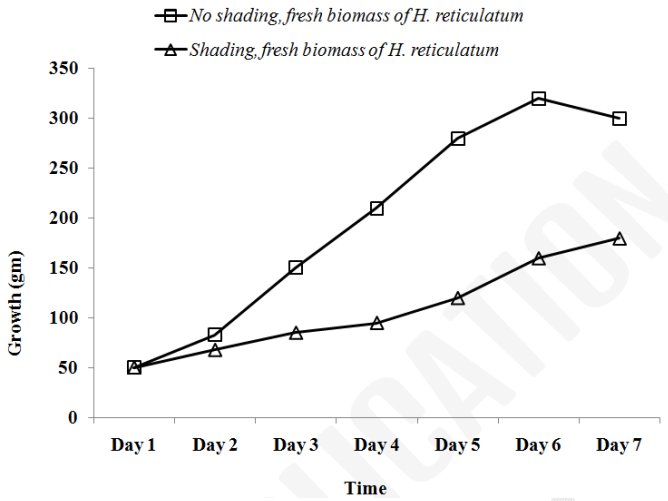


Figure-3 Growth of *Hydrodictyon reticulatum* on water body of paddy field. Line with square indicates no shading and fresh biomass (living) of *H. reticulatum*; Line with triangle indicates shading and fresh biomass of *H. reticulatum*.

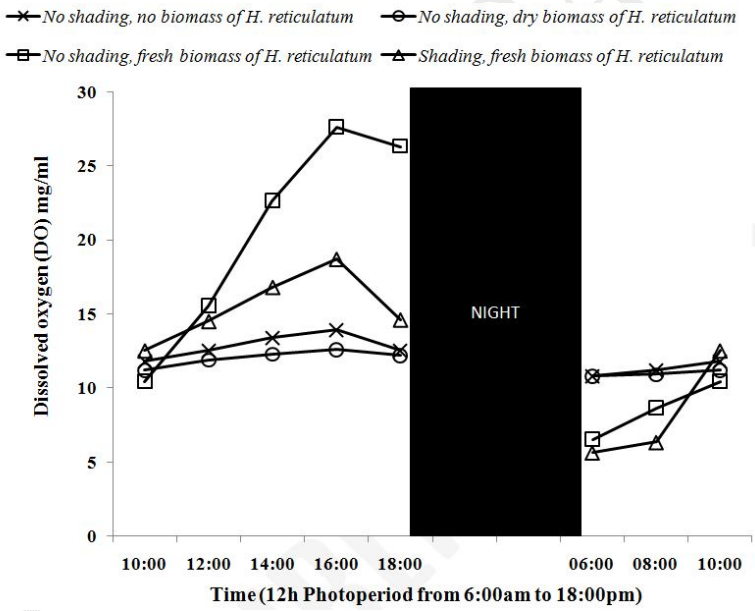


Figure -4: Effect of *Hydrodictyon reticulatum* on dissolved oxygen (DO) concentration (mg/L) during 12h photoperiod from 6:00am to 18:00pm. Line with cross indicates no shading and no biomass (neither fresh nor dried) of *H. reticulatum*; Line with circle indicates no shading and dried biomass of *H. reticulatum*; Line with square indicates no shading and fresh biomass of *H. reticulatum*; Line with triangle indicates shading and fresh biomass of *H. reticulatum*.

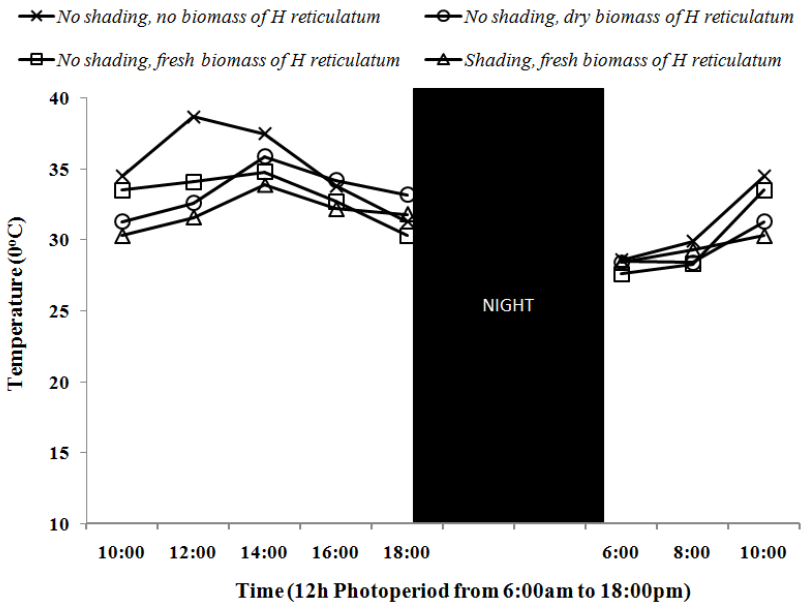


Figure-5: Effect of *Hydrodictyon reticulatum* on temperature (^{0}C) during 12h photoperiod from 6:00 am to 18:00 pm. Line with cross indicates no shading and no biomass (neither fresh nor dried) of *H. reticulatum*; Line with circle indicates no shading and dried biomass of *H. reticulatum*; Line with square indicates no shading and fresh biomass of *H. reticulatum*; Line with triangle indicates shading and fresh biomass of *H. reticulatum*.

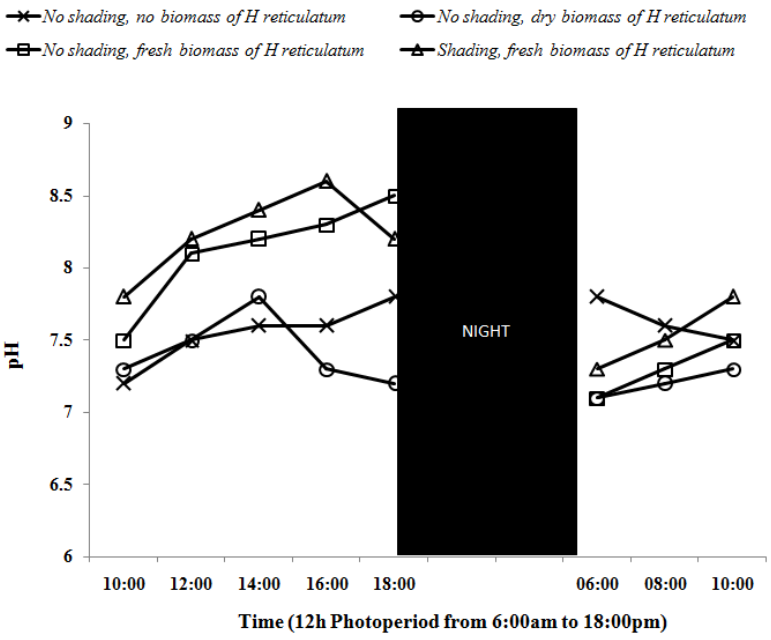


Figure-6: Effect of *Hydrodictyon reticulatum* on pH during 12h photoperiod from 6:00am to 18:00pm. Line with cross indicates no shading and no biomass (neither fresh nor dried) of *H. reticulatum*; Line with circle indicates no shading and dried biomass of *H. reticulatum*; Line with square indicates no shading and fresh biomass of *H. reticulatum*; Line with triangle indicates shading and fresh biomass of *H. reticulatum*.

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Parimal Mandal
Department of Botany, Raiganj University, Raiganj, Uttar Dinajpur.