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HITHERTO UNREPORTED ALGA, *CHARA* (*C. palanense*) SP. NOV. FROM THE EOCENE LIGNITE OF BARSINGHSAR NEAR BIKANER, RAJASTHAN, INDIA

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ABSTRACT

The lignite deposite at Barsinghsar possess almost all plant groups either in form of spores and portions or fragmented portions of vegetative and fertile form. The present paper deals with a macroscopic green alga *Chara* L. collected from Barsinghsar Eocene lignite near Bikaner. The lignite sample has both parts; the vegetative portion (thallus / filament) and the fertile organs (globule and nucule) of the *Chara* L. This is first record of occurrence of all the body portions of an alga in one specimen. Palaeoecological conditions during Eocene in Rajasthan are also described.

Keywords: Eocene; lignite; barsinghsar; alga *Chara* L.; Rajasthan; India.

INTRODUCTION

In Western Rajasthan lignite deposits are exposed at several places either in subsurface (about 20-30 meter below the ground level) or as open mines, e.g. Palana, Barsinghsar, Gurha, Giral, Matasukh etc. Palynological studies of Bikaner-Nagaur Basin have been made by many workers like Singh & Dogra (1988), Kar (1995), Ambwani & Singh (1996), Kar & Sharma (2001), Tripathi et al. (2008) etc., and of Palana beds by Rao and Mishra (1949) and Sah and Kar (1974). The occurrence of oil bearing fresh and brackish water alga *Botryococcus braunii* Kutzing was reported for the first time in the lignite of Palana by Rao and Mishra (1949). Rao and Vimal (1950, 1952), Sah and Kar (1974) described pollen and spores from Palana lignite. Harsh and Sharma (1992) studied a carbonized wood from Palana and identified its inorganic and organic content. Tripathi, Srivastava and Sharma (1998) described plant microfossil of many plants from the lignite of Barsinghsar. These microfossils include algal filaments, fungal hyphae, sporangia, spores, cuticle, pollen grains as well as peculiar kind of seed and fructification.

Fossil algae related to *Chara* L. have been described from many other portion of India e.g. Sahni and Rao (1943), Rama Rao

(1955), Horn af Rantzien (1957), Bhatia and Mathur (1978), Tewari and Sharma (1972a, b), Lakhanpal et al. (1976), Singh (1980). The first record of Charophyte from India is *Chara malcolmsonii* Sowerby. Rao and Rao (1939) described 13 species of charophytes from Rajahmundry. Other contributors in this field are Sahni and Rao (1943). Interestingly none of the above mentioned researchers could report a material bearing all body organs of an alga. The present report includes filaments as well as its sex organ i.e. globule and nucule of *Chara palanense.*

MATERIALS AND METHODS

The present lignite sample of Eocene age was collected from Barsinghsar situated 20 Km South of the Bikaner city and six km west of the Palana lignite deposit of Bikaner district. It is an open mine having an approximately 45m thick layer of lignite at 20-30m below ground level. 20 gram sample of lignite blackish in colour and friable on drying intermingled with yellow coloured resin also. For maceration we followed Howard (1964) and Salvador ENCISO-DE LA VEGA (1992). Sample was first washed and heated in Bunsen busner flame to remove any superficial contamination and then crushed and washed with distilled water and transferred to Schultze's macerating fluid (concentrated HNO_3) for one week to oxidize coal minerals like Sulphate, Sulphide and Carbon into humic acid. After a week it was washed with distilled water again and treated with 10 % KOH for an hour to dissolve humic acid and liberate pollen and spores The material which settled down at the bottom was washed 4-5 times with distilled water. Plant microfossils recovered were first mounted in Canada balsam, but microfossil remain aggregated in it, so mounted in glycerin jelly as they mostly remain away from each other, if there is an aggregation they may be separated by using pressure on cover slip. Precautions were taken to prevent contamination of living material were taken. The microfossils were examined in transmitted light with low(40X) and high power(1000X) objectives of the QUASMO advanced trinocular coaxial microscope with magnification range 40X to 1600X. As microscope was connected to computer through digital USB Camera having software named **Capture Pro**, so photograph were taken by this camera stored automatically in a computer. This software has also facility of measurement. As some structures were not very clear, so hand drawings were also prepared. For classification and phylogeny of charophytes Grambast (1962, 1974) and for terminology Horn af Rantzien (1958) were followed. All figured specimens/slides are stored in Palaeobotany laboratory of M. S. Govt. Girls College Bikaner

DESCRIPTION

Vegetative part (branchlet) as well as both reproductive organ of *Chara* i.e. Nucule (female) and Globule (male) are present in this sample. 3 sample of vegetative part, 3 sample of Globule and 2 sample of Nucule were observed in present macerated sample. Preservation is very good for explaining almost details of the organs.

(a) Vegetative axis (branch let)/ Characeits (Tuzson 1914) / Charaxis (Harris 1939) (Fig. A, B, C)

ManMany samples preserving short axis were collected. The preserved length of fragmented axis is 780 µm. It is a corticated species (comparable to *C. fragilis* Desv. in Lois., *C. zeylenica* Willd. and *C. hatei* S. C. Dixit). It has longitudinal lines indicating marks of contiguous cortical cell (Fig. A, C) as seen in the living species (Fig. B). Cortical cells of both lateral sides are

comparative lighter in colour. Average diameter of a cortical cell is 50 µm. Two nodes are indistinctly visible (Fig. A arrow) but clear in hand drawing (Fig. C). Length of an internode is about 550 µm. The diameter of an axis is about 190 µm. Normally it ranges from 150-250 µm (Reid & Grove 1921). At a node darker spots are visible which probably marks of bract cells these are either not preserved well or detached during maceration.

(b) Nucule (the female sex organ) (Fig. G, H, I)

An ellipsoid oogonium is visible, base is broad and round whereas apex is comparatively narrower (Fig. G). Complete body is not compressed as the shape is not deformed. Preserved size is 530 µm long including corona and 280 µm across in middle, widest i.e. 310 µm at the base. The L/W (length / width) ratio of nucule is 1.89. Length of corona itself is 70 µm and width is 160 µm. As it is detached from the branch let either on maturity or during centrifugation the stalk is not visible. Sinistrally coiled five spirals cells, each of about 40 µm wide, making more than two turns completely covers the body of oogonium except the apex and it is visible as light coloured covering on both side (Fig. G, H I). Equatorial angle is about 13° Constriction of tube cell in both lateral sides are sharp and distinct (Fig. G arrow). It forms about 13-14 convolution. At the tip, tube cells forms a crown (only two seen in Fig. H).

Complete structure consists of centrally placed ellipsoid central cell and of about 430 µm X 210 µm in size. The central cell has a large darker zone indicating an egg at the top (Fig. G.)

(c) Globule (the male sex organ) (Fig. D,E,F)

The complete structure is dark brown in colour and spherical in shape. It's diameter is 200 µm. It shows two distinct zones: i.e. the peripheral light coloured (transparent) zone and the central darker zone. Peripheral zone is made up of curved cell (shield cell) forming spherical covering. Its width is about 30 µm.

Distinct constrictions are visible (Fig. G arrow) at the joining of two shield cells.

In the centre of inner side (concave side) of each shield cell a rod shaped dark line is clearly visible indicating the manubrium. Manubrium has primary and secondary capitulum which ultimately develops 2-4 long antheridial filaments, is not preserved in sample. About 200-250 cells of each antheridial filament forms biflagellate, coiled antherozoids. Due to manubrium, primary and secondary capitulum and thousands of antherozoids. The central portion looks darker than the peripheral zone.

AFFINITIES

Charophytes commonly known as stonewort are multicellular, macroscopic, filamentous branched complex, non marine green algae found in fresh to hypersaline water. Unlike other algae their female reproductive parts are covered by sterile cells. Chyrophytes are phylogenetically advanced as development of oogonium is always superficially like bryophytes. In some Charophytes spiral cells around oogonium become calcified during ontogeny and develop fossiliable structure known as

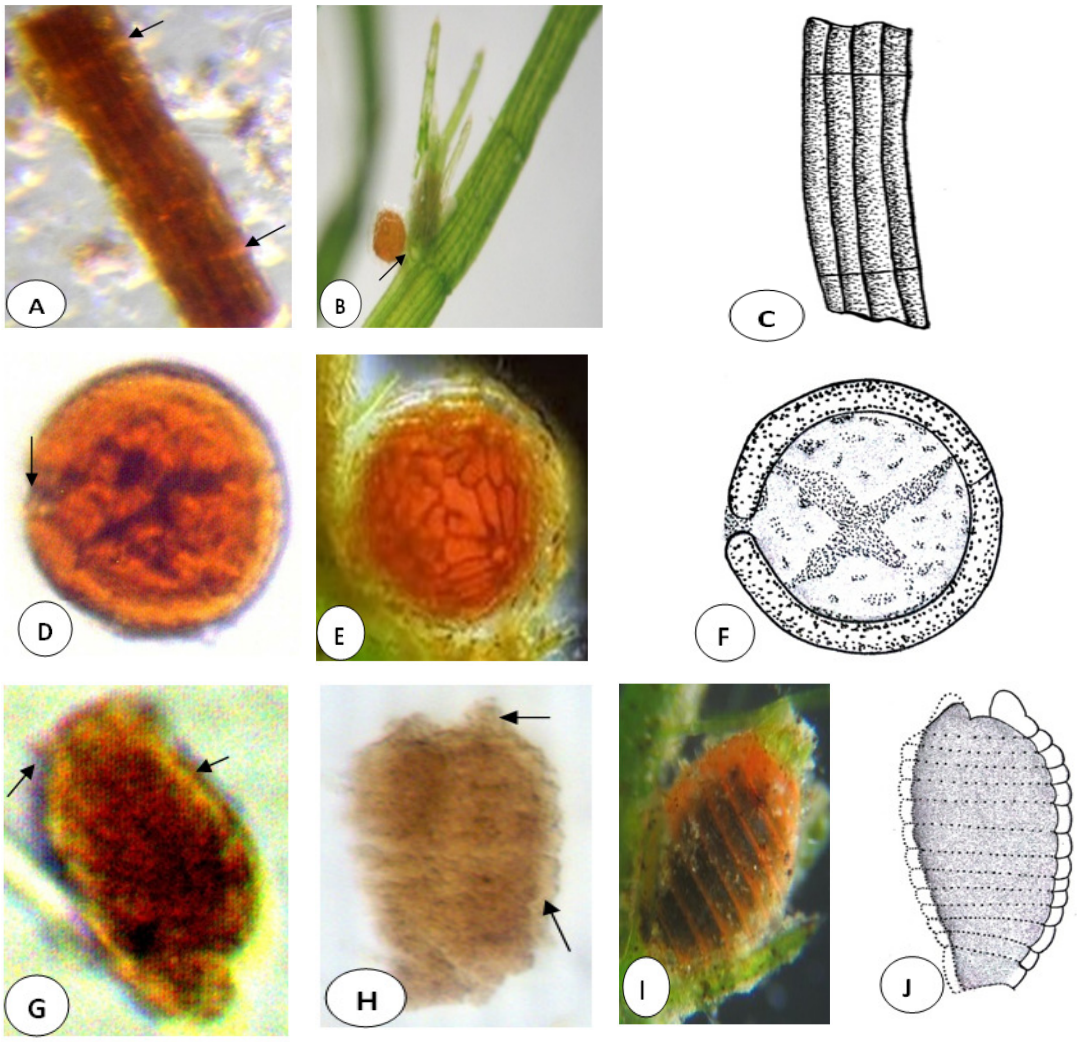

Plate. 1. *Chara palanense* sp.nov. A. branchlet with two nodes (arrow) having longitudinal lines showing marks of cortical cells X 85. B. Branchlet of living *Chara,*with fertile organs originating from nodal portion (arrow), C. Drawing of branchlet with longitudinal ribs and two nodes X 85. D. Globule of fossil showing peripheral shield cells having constriction (arrow) between two neighbouring cells and central darker zone of manumbrium X 215. E. Globule of living *Chara* showing almost same structure, F. Drawing of globule indicating curved shield cells, manumbrium and mass of spermatozoids X 215. G–H. Nucule of fossil *Chara* clearly showing light coloured spiral cells on both sides (arrow) and central dark coloured oogonium at top corona represent by two tubercles (arrow) X 90. I. nucule of living *Chara sp.* for comparison, J. Drawing of nucule showing about 13-14 convolution of tube cells, At the tip, tube cells forms a crown X 90.

gyrogonites which are principal charophyte fossils. Fossil charophytes were initially regarded as molluscs due to calcified spirally coiled covering. Garcia (1998, 2001) emphasizes his study for identification of oospores and gyrogonites.

The presence of gyrogonites suggests that charophytes appeared in Late Silurian and diversified in two different lines during Devonian and Cretaceous. Those having dextrally spiraled sterile cells, Sycidiales (numerous cells) and Trochiliscales (few but more than five cells) become extinct whereas having sinistrally spiraled cells, Charales (five spiraled sterile cells) is group of extant genera. Including sterile cells, shape of apex and base of gyrogonites, number of circumvolution and size and shape of basal plug are also parameters of identification.

Fossil of charophytic oogonia always been found detached and devoid of coronula. Order Charales has single family with six genera. On the basis of morphology (Wood 1962) and analysis of fossil characters i.e. gyrogonites (Grambast1974), these six genera are being classified under two tribes. First one is **Chareae**, which has four genera i.e. *Chara* Linnaeus, *Lamprothmnium* J. Grove*, Nitellopsis* Hy. *Lycnothamnus* (Rupr) Leonhardi*,* and second one is **Nitelleae** which has two genera i.e. *Nitella* Agardh and *Tolypella* (A. Br.) Leonhardi*.*

Tribe Chareae has some diagnostic characters which differentiate it from Nitelleae*,* these are: corticated branchlet, large number of bract cells at node, large sized elongated oospore, calcified sterile cells having more convolutions, coronula is of single tier of five cells. On the basis of above character, present sample belongs to Chareae.

In tribe Chareae three genus i.e. ***Lamprothmnium*** J. Grove*,* ***Nitellopsis*** Hy. and ***Lycnothamnus*** (Rupr) Leonhardi*,* cannot be compared with present sample because all three are ecorticated species. Differences are also present in shape and size of oogonium as well as in coronula. We consider that nucule, globule and branchlet described in this paper are part of same plant as all are present in small piece of lignite of about 20 gram. Descriptions of different parts of plant clearly indicate that *Chara* L. is the only genus to which reference can be made*.* Nevertheless genus *Chara* L. is normally being used for detached nucule having five spiral cells.

COMPARISIONS

Present species of *Chara* L. is being compared on basis of only those characters which are preserved in it. We know that specific identification of Charophytes is mainly based on character of oogonia which is devoid of coronula and mostly found separate from branchlet. We have already considered that all three parts of plant (branchlet, nucule & globule) are parts of one and same plant.

A thorough comparison was made for identification of present material upto species on the basis of species of *Chara* L. described in detail by Singh (1980), Caisova &Gabka (2009) etc. The L/W (length/ width) ratio (1.89) of nucule of present material is not showing affinities with other species, even than on the basis of measurement of nucule and globule, present species may not be compared except with *C. braunii* Gm. *C. canescens* Desv. in Lois, *C. globularis* Thuill*, C. gymnophylla* A. Br., *C. vulgaris* L. and *C. polyacantha* A. Br.

C. braunii Gm. is ruled out because it is an ecorticated species. *C. canescens* Desv.

in Lois, *C. gymnophylla* A. Br. and *C. vulgaris* L. species show affinities with present species in size of nucule but size of globule of these species is either double or more than double than present species.

C. polyacantha A. Br. resemble with present species in size of globule but its nucule size is almost double than present species.

Among above all species so far only *C. globularis* Thuill. seems nearer to present species which shows similarity in nucule size but size of globule is still more.

From above comparison it is clear that combination of characters of present material is not showing exact similarity so present material of *Chara* L. must be considered as a new species.

C. palanense sp. nov. Harsh and Shekhawat

DIAGNOSIS

Corticated branchlet, length of internode is 550 um, width is of 190 um and diameter of cortical cell is about 50 um. Medium sized ellipsoid oogonium, 530 um long and 280-310 um broad, ellipsoid Oospore is 430 um long and 210 um broad, Spiral cells show 13-14 convolutions having about 13^0 equatorial angle. Coronula is 70 um long and 160 um broad. Globule is spherical and of 200 um diameter, width of shield cell is 30 um.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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