

Fresh-water Fossil algae from the Eocene lignite of Barsinghsar near Bikaner, Rajasthan, India

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भारत में राजस्थान बीकानेर के बरसिंहसर की इयोसिन लिग्नाइट के स्वच्छ जलीय जीवाश्म शैवाल

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सारांश

बरसिंहसर के लिग्नाइट निक्षेपण में लगभग सभी पादप समूह, बीजाणु अथवा विखंडित कायिक अथवा जननक्षम अंग के रूप में पाये जाते हैं। इस शोध-पत्र में बरसिंहसर, बीकानेर के इयोसिन लिग्नाइट से प्रथम बार सूक्ष्मदर्शीय शैवाल *क्लोस्टेरियम* निट्ज़, *हाइड्रोडिक्ट्योन* रॉथ तथा *वॉल्वॉक्स* लि. को प्रलेखित किया गया है। इसके अतिरिक्त राजस्थान में इयोसीन काल के दौरान पुरा-पारिस्थितिकी परिस्थितियों का भी वर्णन किया गया है।

ABSTRACT

The lignite deposits at Barsinghsar in Rajasthan possess almost all plant groups either in the form of spores and portions or fragmented portions of vegetative and fertile forms. The present paper reports the occurrence microscopically of green algae belonging to the genera *Closterium* Nitzsch, *Hydrodictyon* Roth and *Volvox* L. from Barsinghsar, a Eocene lignite site near Bikaner. Palaeo-ecological conditions during Eocene in Rajasthan is also described.

Keywords: Alga, Barsinghsar, *Closterium*, Eocene, *Hydrodictyon*, India, Lignite, Rajasthan, *Volvox*.

INTRODUCTION

Lignite deposits are present in many parts of Western Rajasthan. These are present either in subsurface from 20 to 30 m below the ground level or as open mines found in places such as Barsinghsar, Gurha, Giral, Matasukh and Palana etc. Studies on the palynology of Bikaner-Nagaur basin and of Palana beds have been made by many workers namely Singh & Dogra (1988), Kar (1995), Ambwani & Singh (1996), Tripathi & al. (1998), Kar & Sharma (2001), Rao & Mishra (1949) and Sah & Kar (1974). Fresh and brackish water alga, *Botryococcus braunii* Kuetzing was first reported in the lignite of Palana by Rao & Mishra (1949). Pollen and spores from Palana lignite were described by Rao & Vimal (1950, 1952), Sah & Kar (1974). Chemical analysis (inorganic and organic content) of a carbonized wood from Palana was described by Harsh & Sharma (1992). Microfossils of several plants from the

lignite of Barsinghsar were described by Tripathi & al. (1998). These microfossils include so many plant taxa as well as plant parts such as algal filaments, fungal hyphae, sporangia, spores, cuticle, pollen grains as well as various kinds of seeds and fructifications.

Recently a new species of fresh-water algae *Chara* (*C. palanense*) reported from Barsinghsar near Bikaner by Harsh & Shekhawat (2018). The present report includes three genera of fresh-water algae- *Closterium*, *Hydrodictyon* and *Volvox*.

MATERIALS AND METHODS

The present sample of lignite of Eocene age was collected from Barsinghsar. This site is 20 km south of the Bikaner city and 6 km west of the Palana lignite deposit. This is an open mine having about 45m thick layer of lignite at 20-30m below ground level. A quantity of 100 g sample



Barsinghsar lignite mine, Bikaner, Rajasthan

of lignite, which is of blackish in colour and friable on drying consists so many yellow- coloured resin material. Material was first heated in Bunsen burner flame after that crushed and washed with distilled water. This powder was transferred to macerating fluid (concentrated HNO_3) for one week. After a week it was again washed with distilled water and treated with 10% KOH for an hour. The settled downed material at the bottom was washed for 4 or 5 times with distilled water. Plant microfossils recovered after

above process were mounted in glycerin jelly. To prevent contamination of living material, precautions were taken. The microfossils were examined under transmitted light microscope. Microscope was connected to computer through camera having the software called **Capture Pro**, and the photographs that were taken by this camera were stored automatically in the computer. The software also has measurement facility. Hand drawings were also prepared because some structures were not very clear.

All figured specimens/slides are stored in Palaeobotany Laboratory of M.S. Govt. Girls College, Bikaner.

RESULTS

Vegetative parts of three algal genera *Closterium*, *Volvox* and *Hydrodictyon* were identified in lignite sample. Details of all three are as follows-

TAXONOMIC DESCRIPTION OF THE FOSSILE SAMPLES

CLOSTERIUM Nitzsch

Present specimen showing elongated cell being broadest in the middle and tapering towards the ends. The unicellular alga is elongated, markedly attenuated at the poles and without a median constriction. The cell walls are longitudinally striated having delicate pores clearly visible (**Fig. a & b**). Many rounded structures are present in an axil, and are scattered in the cytoplasm, which may be pyrenoids. Specimen entire length is 200 μm , width at middle is 22 μm , one side of pole is 15 μm , comparatively broader than the other. Another side of pole width is 8 μm . For clear presentation of morphological details, hand drawing of specimen (**Fig. d**) is also prepared. Morphological characters of this microfossil resemble with a Charophycean alga *Closterium* (**Fig. c**). However, identify of specimens up to species level are not possible due to lack of detail.

The genus *Closterium* (Gr. Kloster = spindle), which is the closest unicellular relative of land plant. It is the best characterized Charophycean alga with respect to the kind of sexual reproduction found in it. *Closterium* species are found in drains, ponds, slow streams and stagnant waters; mostly found mixed with slime and some other free-floating fresh-water algae.

HYDRODICTYON Roth

About 8 samples of net-like specimens (**Fig. e**) were observed in lignite sample. The cells are typically arranged in pentagons or hexagons. Cylindrical cells linked at each end with two other cells, forming a polygonal net. Size of the present thallus is 110 μm . This sample is showing resemblance with colonial Chlorophyta alga *Hydrodictyon* Roth. For clear presentation of morphological details, hand drawing of specimen (**Fig. g**) is also prepared. The cellular details are not so distinct to identify this genus up to species level

The genus *Hydrodictyon* Roth belongs to the green algae division, Chlorophyta. It is also known as "water net", and the species of *Hydrodictyon* Roth are sometimes considered as weed or pest organisms, because they are so prolific that they can overwhelm aquaculture facilities, lakes, irrigation ditches, and even rice fields, especially

where they have been introduced as alien water plants.

VOLVOX L.

In the lignite sample collected from Palana presence of colonial alga was observed. Shape of colony is not spherical. It is pear-shaped (**Fig. h, j**) either due to pressure during fossilization or due to fossilize at the time of bursting of colony during asexual reproduction. Size of colony is 300 μm . Daughter colonies are clearly visible (**Fig. H, j**). At periphery, towards lower side flagella-like structures are also visible. In centre daughter colony is also visible, which is clearer in hand drawing (**Fig. j**). This sample is showing resemblance with colonial Chlorophyta alga, *Volvox* L. (**Fig. i**).

Volvox L. is a polyphyletic genus of Chlorophyta in the family Volvocaceae. It forms spherical colonies of up to 50,000 cells. Numerous flagellate somatic cells and a smaller number of germ cells lacking in soma that are embedded in the surface of a hollow sphere or coenobium. The cells have anterior eyespots that enable the colony to swim towards light. They live in a variety of freshwater habitats. *Volvox* L. diverged from unicellular ancestors, approximately 200 million years ago.

CONCLUSIONS

Biodiversity indicates the climatic conditions of an area. Each type of habitat has specific types of plants and animals who effect the environment and vice-versa. From the data of fossil plants available from the Tertiary rocks of Rajasthan it is clear that the plants show wide variations in their habitats. Extinct remains of *Cocos*, *Mesua*, *Garcinia* and pollen grains of *palm*, *Barringtonia*, *Rhizophora*, etc. certainly depict the existence of marine conditions in this area. Occurrence of marine fishes and Echinoderm fossils also supports to this hypothesis. But Rao & Vimal (1952) reported spores and pollen grains of Pteridophytes, Tripathi & Sharma (1996, 1997) reported microfossils from the lignite mine, Angiospermous woods by Harsh & Sharma (1992) certainly not favour about sea habitat. The reports on the occurrence of green algal, *Chara* (Harsh & Shekhawat 2018) and three algal taxa in this paper *Volvox*, *Closterium* and *Hydrodictyon* suggest the presence of fresh-water lake in the area at the time of deposition of the lignite. These reports also oppose the opinion that entire Thar was covered by the sea-water. Infact only a few sites of small portion not the whole area was under sea-water. Remnants of those places are present at Sambhar, Pach-Padara, and Luni River. To justify both evidences, i.e. marine and non-marine conditions it is presumed that during the Tertiary era there were low land and high land areas. In the former, probably the sea intruded quite deep in the land making gulf like structure and had vegetation types such as *Cocos*, *Mesua*, *Garcinia* and *Rhizophora* and the

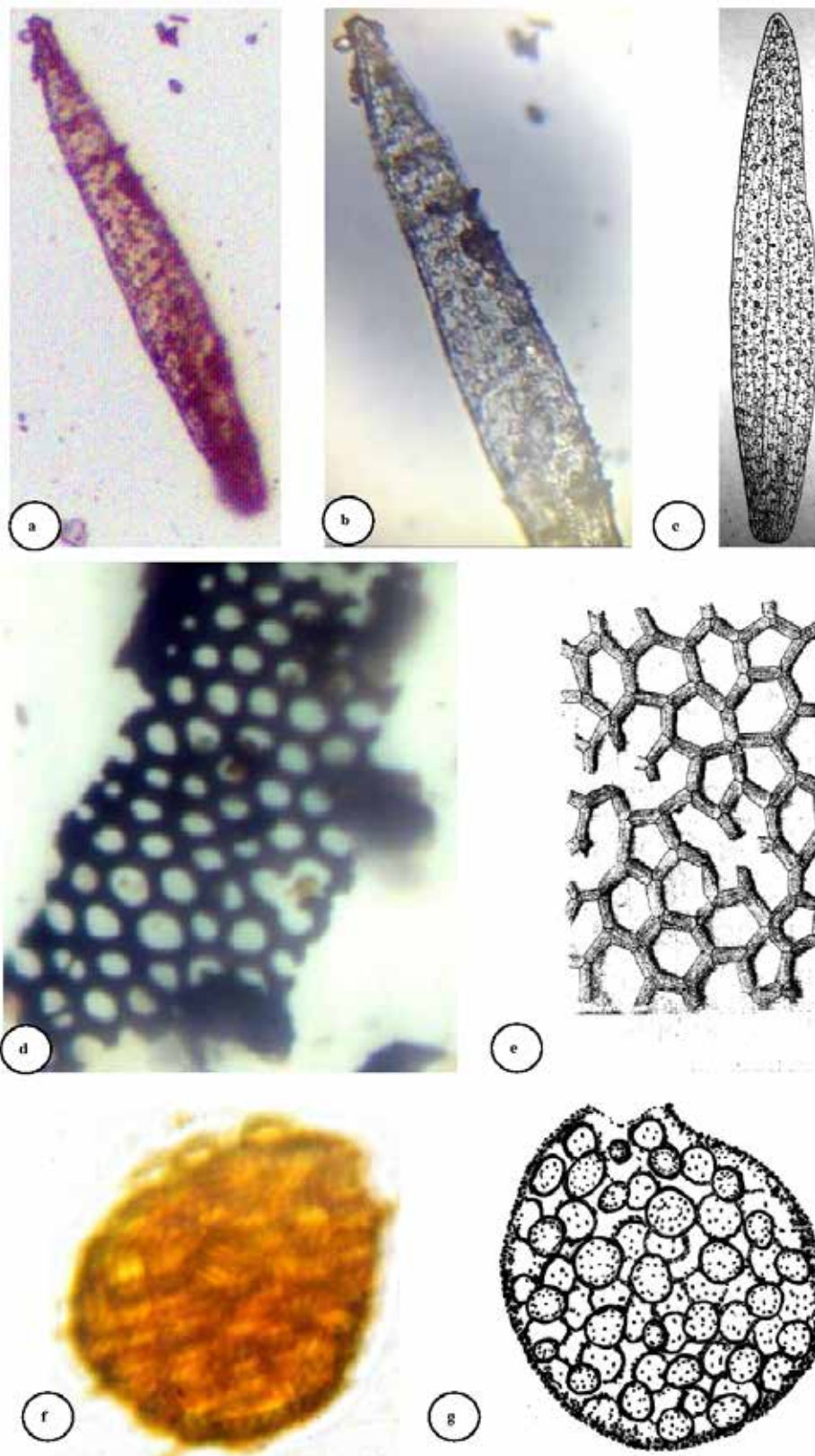


Plate: **a.** Cell of fossil *Closterium* showing out line and pore like structure. $\times 200$. **b.** Same enlarged vegetative part showing tip of cell. $\times 300$. **c.** Hand diagram of fossil *Closterium* showing details. $\times 200$. **d.** Fossil remains of *Hydrodictyon* showing net like appearance. $\times 650$. **e.** Hand diagram of fossil *Hydrodictyon*. $\times 800$. **f.** Fossil *Volvox* showing out line (pear shaped) of colony having daughter colony. $\times 100$. **g.** Hand diagram of fossil *Volvox* colony. $\times 100$.

occurrence of green algal taxa such as *Chara* (Harsh & Shekhawat 2018), *Volvox*, *Closterium* and *Hydrodictyon* in the Palana lignite (Eocene) near Bikaner, Rajasthan, which suggests the presence of fresh-water lake in the area at the time of deposition of the lignite. While in the 'upland' areas though the climatic conditions were humid and warm and not effected by 'sea gulf' that is why broad and large-sized leaves are found in some of the Eocene localities. However, further investigations are required on lignite deposits of Rajasthan.

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