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Bioliths in Some Indian Soils

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Abstract: Electron microscopic examination of clay size fractions of some soils separated by sonification revealed the occurrence of two types of bioliths, (Diatoms and Cocoliths) both of plant origin, *viz.* phytoliths. Different types of silicious frustules (shells) of diatoms (*Bacillariophyta*) have been detected. Evidence of disintegration of these silicious frustules were also observed. Pore size range on the frustules have been measured. Cocolith, a calcite phytolith, originating from a marine algae (*Cocolithopores*) was also found to occur in one of the soils. (***Key words:*** *Bioliths, diatoms, cocolith*)

Bioliths are mineral remnants of organisms and consist of such parts as shells and teeth of these organisms or crystallites and other materials secreted and deposited by them. In soil they come mainly by inheritance from the parent materials and therefore are very important in determining age and environment of their deposition. Some bioliths may enter the soil during its development as large number of organisms producing inorganic secretions and having skeletons grow and perish every year. The residues from these organisms contribute substantially to the mineral fraction of the soil. Depending on their composition, size and morphology they also affect many soil properties. They have, therefore, attracted the attention of many workers. Phytoliths in some Australian dust have been reported by Baker (1960) and distribution of opal phytolith in some Great Groups of Illinois has been studied by Jones and Beavers (1974). Phytoliths have been reported in marine sediments also (Folger *et al.* 1967). So far no studies has been made to find out the occurrence of bioliths in Indian soils except that by Ghosh and Tomar (1974) who reported the occurrence of skeleton of diatom in the clay of a submountain soil from Katrain (Himachal Pradesh). The present study is an attempt to explore the occurrence of bioliths in some soils of India.

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Materials and Methods

Surface soil samples (0-0.23 m) were collected from Jorhat (Assam), Kohima (Nagaland), Katrain (Himachal Pradesh) and Thottappally (Kerala) for the present investigation. The general information on these soils is given in table 1. The soil samples in 1 : 2 of soil : water suspension were subjected to ultrasonic vibration using a SONIPROBE (Type 1130 A of DAWE Instruments Ltd., London, England) of solid titanium step horn (1/2" diameter) having output power density at tip of 500 w/inch^2 giving frequency of 20 kC, pulsed at 100 cps. After sonification of the sample for a specified time, the suspension was diluted to one per cent strength and clay-organic complex was separated by gravity sedimentation method. The method is essentially that described by Watson (1971). A portion of the clay-organic complex was treated with 30 per cent H_2O_2 till apparently organic matter was oxidized. Both H_2O_2 treated and untreated samples were examined in a Philips EM 300 model electron microscope at an operating voltage of 80 kV. For this purpose a drop of the 0.03

Table 1. General information on soil

Location	Parent material	Soil order	pH	Org. matter (g kg^{-1})	Clay (%)	Free iron oxides (%)
Jorhat (Assam)	Bramhaputra alluvium	Entisol	5.5	10.5	8.5	1.54
Kohima (Nagaland)	Laterite derived from granite gneiss	Oxisol	5.5	40.2	12.2	3.93
Katrain (Himachal Pradesh)	Mica schist and calcareous shales	Alfisol	5.2	17.2	14.0	2.86
Thottappally (Kerala)	Alluvium	Entisol	5.7	10.0	22.0	1.10

per cent suspension of the sample was mounted on a copper grid covered with formvar film. Number of grids of each sample were scanned under the electron microscope for detection of bioliths. The equivalent valve view diameters (EVVD's) for diatom frustules based on similar concept of equivalent spherical diameter (ESD) which is used to describe sizes of soil particles (Jackson 1956) was made use of. The EVVD for a diatom frustule was found by calculating the diameter of a circle having the same surface areas as the valve view.

Results and Discussion

Different types of silicious frustules (shells) of diatoms (*Bacillariophyta*) were detected from different soils used in this investigation. Based on their shape and size these were conveniently grouped into six distinct types.

Type I

Shape: Elongated ellipse with tapering at end (Fig. 1a)
Size: 13 μm × 4.6 μm (overall)
Ribs: 0.4 μm × (1.6-1.8 μm) in size, capsular in shape, arranged in rows parallel to raphe with the ribs at right angle to the raphe. The distance between ribs and raphe at the centre is 0.9 μm, at the middle 0.6 μm and near apex 1.9 μm. The distance between ribs near apex is 0.4 to 0.6 μm.
Striae: Striae are separating the ribs and are having 0.2 μm width.
Pore: Two sizes were observed *i.e.* (1) 0.06 μm and (2) 0.08-0.12 μm in diameter

Type II

Shape: Elliptical (Fig. 1b)
Size: 9 μm × 4.5 μm
Striae: 0.025-0.075 μm × 0.25 μm in size. Transverse striae are parallel to centre but radiate at apex. The apical striae curves round the end.
Hyaline: 8 μm × 1.2 μm in size and present centrally in the structure.
Pores: 0.1-0.25 μm in diameter. They are circular near the major axis but slightly elliptical away from it. Pores are in grooves arranged in rows of 4-5 at the centre but only one at the apex.
Remark: Resembles *Pelphineis penellipta*

Type III

Shape: Unknown (Fig. 1c)
Size: Unknown
Striae: Both forms of striae *i.e.* transverse and longitudinal are present. The transverse striae have two sizes (1) 0.14-0.17 μm and (2) 0.09 μm. The longitudinal striae also have two sizes (1) 0.07-0.09 μm and (2) 0.04 μm
Pores: These are arranged in square array. Two sizes were observed, *viz.* (1) 0.04 and (2) 0.14 μm in diameter.

Type IV

Shape: Elongated elliptical (Fig. 1d & e)
Size: 16 μm × 6.5 μm
Raphe: Raphe occurs in between two ridges and fused at the centre with 0.1 μm width at the centre and distance (bridges) between raphe is 1.2 μm.

Ribs: 4.6-5 μm × 1.5-3 μm in size. The ribs are arranged in rows on two sides of the central hyaline.
Hyaline: 8 μm × 1.2 μm in size
Pores: Having diameter of 0.05-0.1 μm
Remark: Resembles *Naviculaceae*

Type V
Shape: Unknown (Fig. 1f & g)
Size: Unknown
Ribs: 0.5-0.13 μm in size, capsular in shape. Ribs are present at a distance of about 0.34 μm from the raphe.

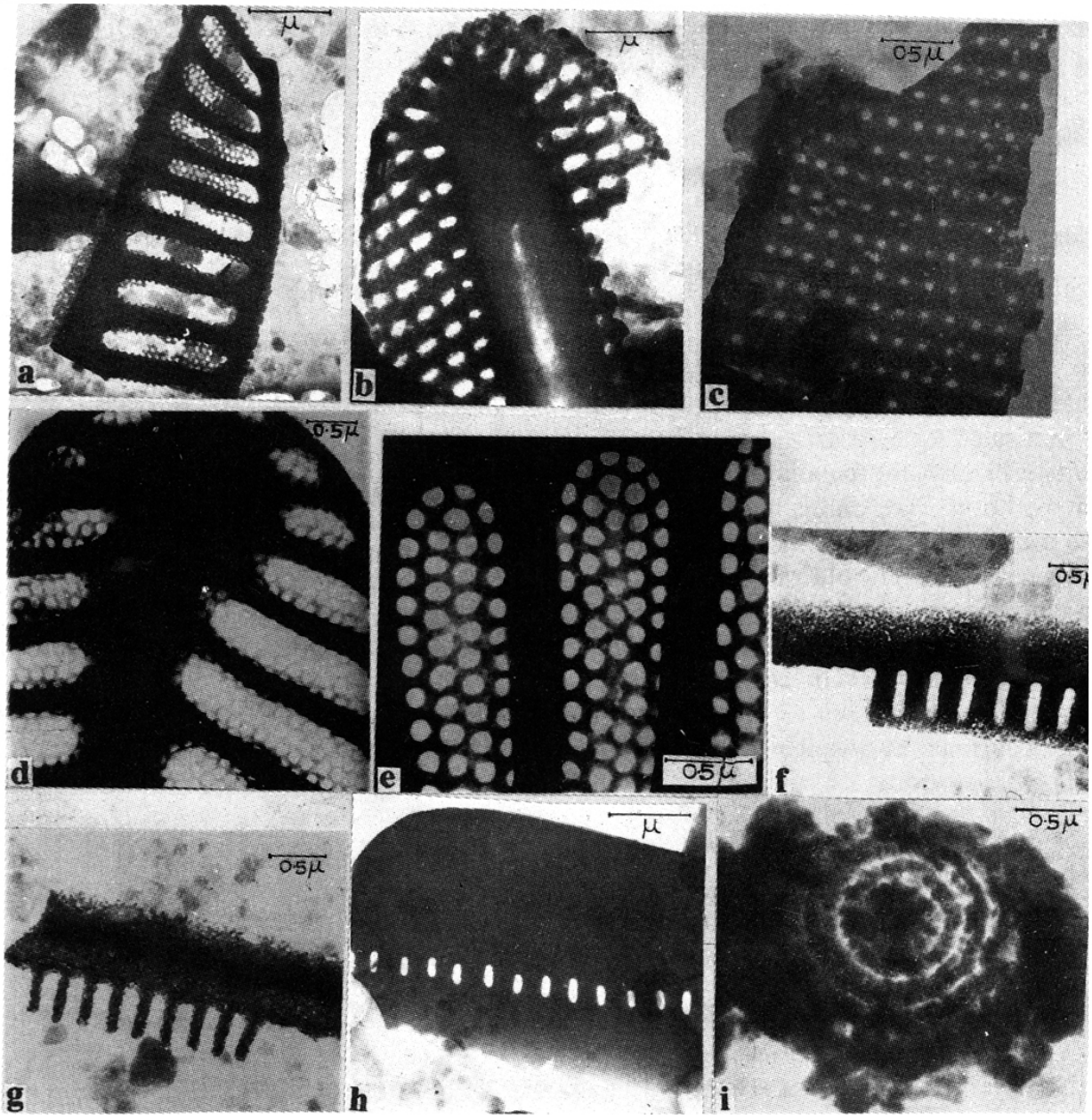

Fig. 1. Electron micrographs of different types of diatom frustules (a-h) and a cocolith (i) in some Indian soils
a. Elongated ellipse with tapering at end (Type I)
b. Elliptical type (Type II)
c. Unknown shape (Type III)
d&e. Elongated elliptical (Type IV)
f&g. Unknown shape (Type V)
h. Cylindrical with rounded ends (Type VI)
i. Cocolith

Raphe: Has the width of 0.8 μm

Striae: Two types of inter striae distances were seen with two different poroid diameter.

	(A)	(B)
Striae:	0.1-0.2 μm	0.13 μm
Pore diameter:	0.07 μm	0.17 μm

Pores: These are arranged only in one row perpendicular to raphe on either side. The inter pore distance (only the adjoining circumference distance) is 0.03 μm.

Type VI

Shape: Cylindrical with rounded ends (Fig. 1h)

Size: Length variable, width 5.6 μm

Pores: The pores are oval in shape. They are arranged in one row. The distance of pore row from periphery is 0.18 μm. The pores are of two different sizes, *viz.* (1) 0.07 × 0.25 μm and (2) 1.5 × 2.6 μm.

In one of the soils (Katrain), a calcic phytolith (Fig. 1i) formed by a marine algae known as *Cocolithopores* was also found, indicating that this was inherited from shale parent material. This also points to the marine origin of the soil parent material. The presence of phytolith of calcium depositions in clay fraction may be of great significance from the point of view of supply of calcium to the plant root when they are in contact with these cocoliths.

The occurrence of frustules in soils is indicative of udic moisture regimes over a longer period and presence of adequate organic matter fostering the growth of these algaes (Barron 1975). Persistence of diatoms (frustules) of various size, shape and pore spaces/ poroids in clay fraction indicates that, during the process of disintegration of their siliceous frustules and presence of various sized poroids, their presence may have great bearing on soil properties, *viz.* physical, chemical, biological and water and nutrient retention-release characteristics. Further investigations are needed in this direction to isolate and concentrate the diatoms from different size particles and to study their nature and possible effect on soil properties.

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Landscape-Soil Relationship on a Transect in Central Assam

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Abstract: Eight pedons representing major soils in a varying physiographic stretch, across the central Assam were studied for their characteristics and classification. The soils are derived from sedimentary and metamorphic parent materials grading from the most ancient to the recent. Field morphology, physical and chemical properties show variation in pedogenic

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