FOSSIL *PEDIASTRUM* FROM THE KHARI NADI FORMATION (LOWER MIOCENE) OF KACHCHH, GUJARAT*

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ABSTRACT

A few *Pediastrum* colonies have been recovered along with spores, pollen grains and microplankton from the Khari Nadi Formation (Lower Miocene) in the district of Kachchh, Gujarat. *Pediastrum simplex* var. *duodenarium* (Bailey) Rabenhorst, *Pediastrum* cf. *P. ovatum* (Ehrenberg) Braun, *P. boryanum* var. *undulatum* Wille, *P. boryanum* var. *longicorne* Reinsch have been identified. The fossils have been compared with the known *Pediastrum* from India, and their significance has been discussed.

INTRODUCTION

The genus *Pediastrum* belongs to the family Hydrodictyaceae of the order Chlorococcales. *Euastropsis*, *Sorastrum* and *Hydrodictyon* are the other genera of this family. *Pediastrum* has a disc-shaped coenobia growing abundantly as one of the fresh water planktons in ponds and ditches. Some species, like *Pediastrum simplex* var. *duodenarium*, *P. duplex* vars. *clathratum*, *reticulatum* and *gracillimum*, occur in large numbers in ponds to constitute an almost exclusive bloom (PHILIPOSE, 1967).

Pediastrum is cosmopolitan in distribution. PHILIPOSE (1967) recorded many living species of *Pediastrum* from India. The fossil records of *Pediastrum* in India are mostly from Subathu Formation (Palaeocene-Eocene) of Himachal Pradesh. MATHUR (1963, 1964, 1965) and SALUJHA, SRIVASTAVA AND RAWAT (1969) reported *Pediastrum* from this formation. SINGH AND KHANNA (1978) described seven new species from the Subathu. VARMA AND SRIVASTAVA (1965) recorded *Pediastrum delicatites* var. *majus* from the Ankleshwar deep well no. 65, Gujarat at the depth of 1425-1455 metres belonging to Eocene. MISRA (1974) noted the occurrence of *Pediastrum* from Lower Jurassic to Plio-Pleistocene in different sediments of India. KAR (1968) described a *Pediastrum*-like colony from the Barren Measures (Permian) of Jharia coalfield, Bihar.

MATERIAL AND METHOD

The samples belong to the Khari Nadi Formation of BISWAS AND RAJU (1971, 1973) in the district of Kachchh, Gujarat. The lithology of the said formation is composed of laminated to very thin-bedded, red and yellow, mottled to variegated siltstone with occasional bands of grey and brown gypseous clay-stone. At the lower part, a bluish grey claystone bed is persistently found. The *Pediastrum* colonies have been obtained from the bluish grey claystone which are exposed at the Khari Nadi between the Aida and Laiyari villages.

SYSTEMATIC DESCRIPTION

Pediastrum simplex var. **duodenarium** (Bailey) Rabenhorst
Pl. 1, Figs. 1-2 ; Text-fig. 1

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Description—Colonies circular to oval, of 4-8-16-32 or more cells with large intercellular spaces. Inner face of marginal cells more or less concave while the outer face tapered to form a single process. Interior cells also somewhat similar to marginal cells but the processes are short in comparison to the outer ones. Cell wall laevigate, individual cells 8-24 μ broad and 10-45 μ long.

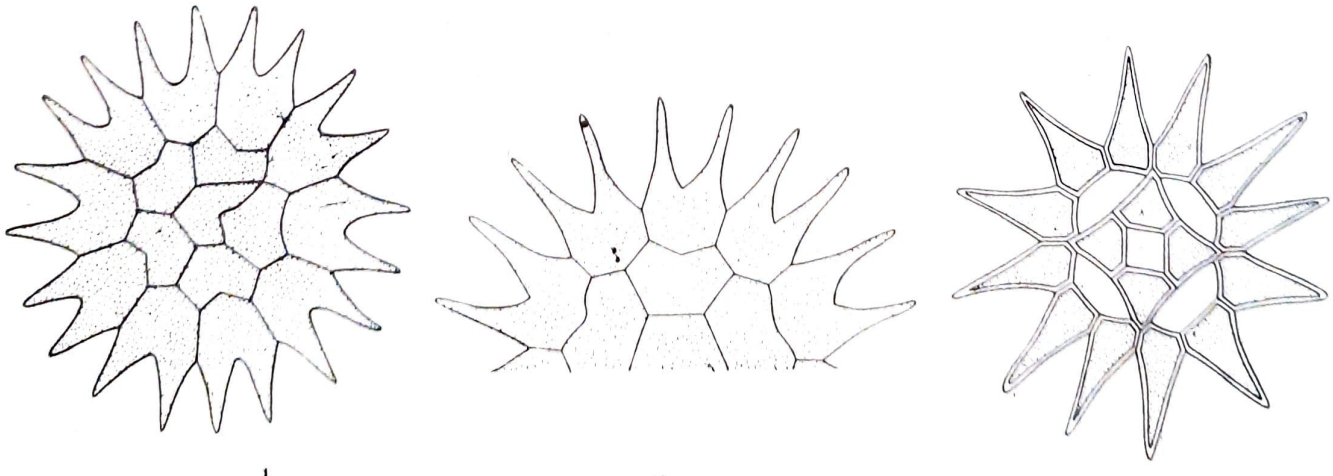
Remarks—This variety is cosmopolitan in distribution and in India it occurs as a planktonic organism in standing water of ponds, tanks and rivers. BRUHL AND BISWAS (1926) described this species as *P. clathratum* var. *baileyanum* Lemm while SINGH (1939) reported it as *P. clathratum* var. *duodenarium* (Bailey) Lemm. KAMAT (1962), PATEL (1970) and PATEL AND GEORGE (1977) noted its presence in Gujarat.

WILSON AND HOFFMEISTER (1953) instituted four new species of *Pediastrum* from the Lower Formation (Paleogene) of southern Sumatra. Amongst them, *P kajaites* resembles very closely the present species in the presence of single layered coenobia with large intercellular spaces and a tapering process from each outer cell which may be slightly dichotomising at ends. WILSON AND HOFFMEISTER (1953) also commented that this species seems to be most closely related to *P. clathratum* (Schroeter) Lemmermann and to *P. simplex* var. *duodenarium* (Bailey) Rabenhorst. In fact, from the latter species *P. kajaites* could not be differentiated. *Pediastrum* sp. illustrated by ELSIK (1969, pl. 1, fig. 8) from the late Neogene of northern gulf of Mexico also seems to belong to this species.

Pediastrum sp. cf. **P. ovatum** (Ehrenburg) Braun
Pl. 1, Fig. 3

Description—Colonies usually 4-8-16-32-celled, cells in middle compact without any perceptible perforations. Outer margins of peripheral cells often convex. Cell wall smooth, individual cells 6-20 μ broad and 8-40 μ long.

Remarks—In *Pediastrum ovatum* the cells are generally arranged in a ring around a central space or with more inner cells and a number of marginal cells with distinct perforations. Sometimes, however, the cells in the opinion of PHILIPOSE (1967) may be almost imperforate. For this reason, the present specimen has only been compared with *P. ovatum.*



1. *Pediastrum simplex* var. *duodenarium* (Bailey) Rabenhorst showing the intercellular spaces and tapering marginal cells. 2. *Pediastrum boryanum* var. *longicorne* Reinsch. showing bifurcated spine-like projections of marginal cells. 3. *Pediastrum boryanum* var. *undulatum* Wille showing undulated, bifurcating, marginal cells.

PHILIPOSE (1967) thinks that *P. ovatum* is quite similar to *P. simplex* and to its variety *duodenarium* but the outer sides in the former are markedly convex in contrast to the nearly straight or concave sides of *P. simplex* and var. *duodenarium*. BIGEARD (1934-35) opines that the shape of cells in *Pediastrum* varies with the maturity, the convex shape being found in very mature cells only. He places *P. ovatum* and all the varieties of *P. simplex* into *P. simplex* only. According to PHILIPOSE (1967), the occurrence of *P. simplex* var. *duodenarium* and *P. ovatum* side by side in many collections is probably a point in favour of this view. This simplified treatment of BIGEARD (1934-35) has not been accepted by many algologists.

Pediastrum ovatum has world-wide distribution. From India this species has been recorded from north-east region, Bengal, Orissa, Bihar and Tamil Nadu (PHILIPOSE, 1967). *P. simplex* var. *typica* reported by BRUHL AND BISWAS (1922) has been transferred to *P. ovatum* by PHILIPOSE (1967). KAMAT (1962, 1963) and PATEL AND GEORGE (1977) reported its occurrence from western India.

Pediastrum boryanum var. **longicorne** Reinsch
Pl. 1, Figs. 4, 4a, 5 ; Text-fig. 2

Description—Coenobia subcircular, internal cells closely spaced, generally without or with very few perforations in between. Outer face of marginal cells with deep emargination to form two projected, tapering spine-like projections; individual cells sometimes granulose, 6-18 μ long ; processes 6-14 μ long.

Remarks—PHILIPOSE (1967) recorded its occurrence from Bihar and Orissa while PATEL AND GEORGE (1977) reported it from Gujarat. *Pediastrum angulatus* Singh & Khanna (1978, pl. 1, figs. 8-9), *P. magnus* Singh & Khanna (1978, pl. 1, fig. 11) and *P. indicus* Singh & Khanna (1978, pl. 1, fig. 12) closely resemble *P. boryanum* var. *longicorne* Reinsch in the presence of emargination on the outer marginal cells to form two long, tapering, spine-like projections on each cell. *P. bifidites* Wilson & Hoffmeister (1953, pl. 1, figs. 9, 12) is also very similar to the species described here.

Pediastrum figured by EVITT (1963, figs. 1, 4) from the Lower Cretaceous of Pakistan and Upper Cretaceous of California also seems to belong to this species. Similar specimen has also been illustrated by ELSIK (1969, pl. 1, fig. 9) from the late Neogene of Mexico gulf.

Pediastrum boryanum var. **undulatum** Wille
Pl. 1, Figs. 6-8 ; Text-fig. 3

Description—Colonies subcircular, 4-8-16-32-celled. Internal cells more or less compact, generally without any internal space; in some colonies a few perforations, however, observed. Cell walls smooth, peripheral cells broader than long, internal cells more or less hexagonal. Each outer cell has two blunt processes.

Remarks—The present specimens are very much similar to *P. boryanum* var. *longicorne* except the latter has long, tapering processes. PATEL AND GEORGE (1977) reported its occurrence from Gujarat.

DISCUSSION

There is considerable difference of opinion amongst the phycologists regarding the characters to be used for demarcating the various species of *Pediastrum* (PHILIPOSE, 1967; SINGH & KHANNA, 1978; EVITT, 1963 ; BIGEARD, 1934 ; SMITH, 1918).

PHILIPOSE (1967) while describing various species of *Pediastrum* from India took the presence or absence and number of processes on the marginal cells and presence or absence of perforation in the colony as important characters for demarcating various species.

Presence of *Pediastrum* in a sediment is significant in deciphering palaeoecology since *Pediastrum* grows only in fresh water. COOKSON (1953) on the presence of *Pediastrum* along with *Botryococcus* in the Cootabarlow shale and Werona clay interpreted them as fresh water lake deposits. EVITT (1963) questioned this contention and commented that *Pediastrum* by itself is not a reliable indicator of a fresh water depositional environment for the strata in which it occurs. According to him, it seems more likely that the resistant cell walls of *Pediastrum* enabled them to be transported from fresh water condition in which they lived to be transported into marine water where they were ultimately preserved. SINGH AND KHANNA (1978) remarked that when *Pediastrum* occurs in a microplankton rich assemblage, it may be considered as a derived element from the near-shore fresh water channels or connections which might have existed along the coast line. The present assemblage is also overwhelmingly dominated by microplanktons and it seems possible that *Pediastrum*, like spores and pollen grains, were derived from inland sources to be deposited ultimately in marine sediments.

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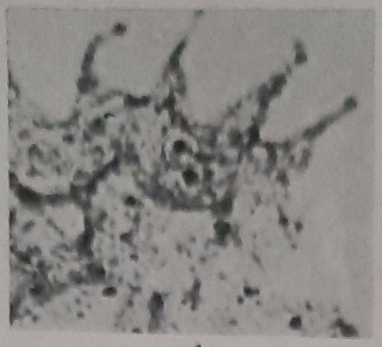

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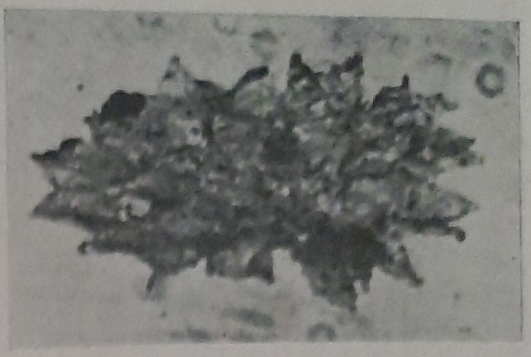

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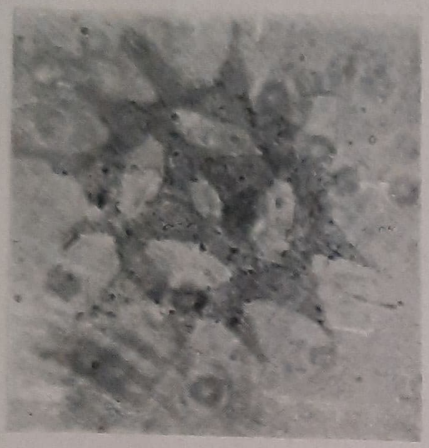

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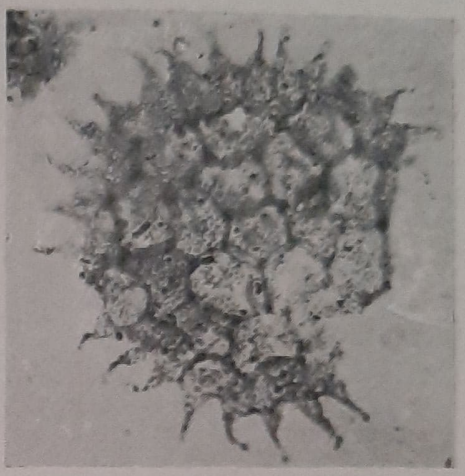

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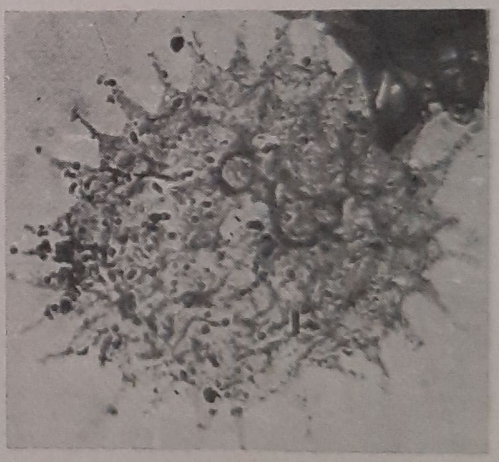

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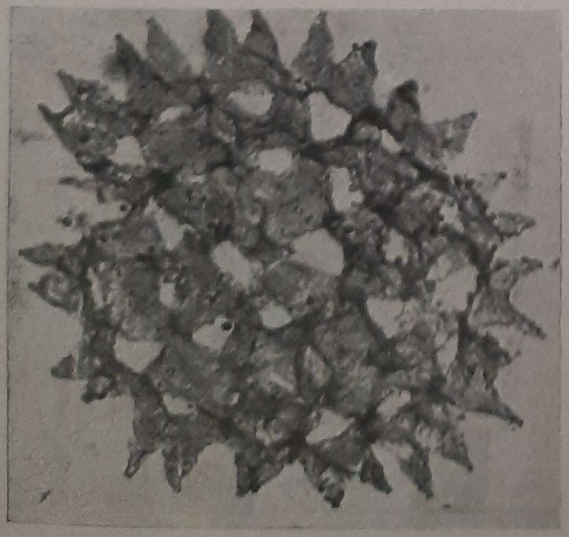

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EXPLANATION OF PLATE—1

(All photomicrographs are enlarged *ca* × 500 except otherwise mentioned)

1-2. *Pediastrum simplex* var. *duodenarium* (Bailey) Rabenhorst, Slide nos. 6632/7, 6633/14.

3. *Pediastrum* cf. *P. ovatum* (Ehrenburg) Braun, Slide no. 6632/1.

4-5. *Pediastrum boryanum* var. *longicorne* Reinsch, Slide nos. 6633/17, 6634/4.

4a. Part of same specimen showing granular ornamentation. *ca* × 1000 Slide no. 6633/17.

6-8. *Pediastrum boryanum* var. *undulatum* Wille, Slide no. 6632/15, 6632/16, 6632/16.

9-10. cf. *Pediastrum*, Slide no. 6633/14,6633/4.