

ON THE ALGAL GENERA *NEOMERIS* AND *ACICULARIA* FROM THE
NINIYUR (DANIAN) BEDS OF THE TRICHINOPOLY AREA (S. INDIA)

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INTRODUCTION

The Cretaceous system of South India exposed in the Trichinopoly district comprises (in descending order) the following stages:—

Niniyur (Danian),
Ariyalur (Maestrichtian),
Trichinopoly (Turonian-Senonian), and
Utatur (Cenomanian).

Rocks of the Niniyur group comprise fossiliferous limestones and cherts. The presence of fossil algae in these rocks was first recognised by L. R. Rao (1931) and they were described by Pia (1936). The algae described in this paper are from the same horizon and include forms which were either not described previously or were insufficiently described by Pia (Rao and Pia, 1936) in their memoir on the Niniyur algae. The present material was collected by Prof. S. R. N. Rao from the Mattur and Nattakuli localities. As the rock is of a very compact nature the algae had to be studied in thin sections of the rock.

GENERIC CHARACTERS AND THE CLASSIFICATION OF THE GENUS *NEOMERIS*

Diagnostic characters of the genus *Neomeris*, according to Pia (1927, p. 82), 'Die Enden der Äste zweiter Ordnung bilden eine zusammenhängende Rindenschicht. Das Sporangium ist birnförmig, nicht so kugelig, wie bei *Meminella* und *Lemoinella*. Es scheint, dass bei der Gattung *Neomeris* und vielleicht bei der ganzen Untertribus niemals halbrund geschlossene obere Enden der kalkschale auftreten, sondern dass diese stets beiderseits offen ist.'

It is clear from the above diagnosis that the genus is characterised by a pyriform (birnförmig) sporangium, a fact which helps to separate this genus from the allied genera *Meminella* and *Lemoinella* which possess spherical sporangia. Fritsch (1945, p. 391) notes the occurrence of spherical to ovoid gametangia (sporangia) also in the living representatives of this genus.

Fossil *Neomeris* has been treated into two sections *Decaisnella* Mun.-Ch. and *Vaginopora* Defrance by Morellet and Morellet (1913, 1939). *Decaisnella* includes these species of the genus *Neomeris* which are found as detached complete rings or fragments of rings. In *Vaginopora* the rings are found cemented together in the form of a tube. Pia has, however, treated (1927, p. 82-83) the genus *Neomeris* into three sections, viz. *Decaisnella*, *Vaginopora* and *Larvaria*. The genus *Larvaria* Defrance according to him does not possess characters sufficient to deserve a generic status and has, therefore, been included under *Neomeris*.

GEOLOGICAL HISTORY OF *NEOMERIS* AND ITS PREVIOUS RECORDS IN INDIA

Out of the twenty-three species of fossil *Neomeris* 22 belong to the Tertiary formations and only one, viz. *N. cretacea* Steinmann (1899, p. 149) is known from the

Cenomanian stage of the Cretaceous system. The alga described by Raineri (1922) as *N. cretacea undulata* from (Lüneburgian flora) Libya has been revised by Pia (1936, pp. 4-5) to *Dissocladella undulata*, but several other fragments from the same rock have been assigned to *Neomeris* without specific identifications. In India this genus has been recorded from the Inter-trappean (Paleocene) beds of Rajahmundry (J. Pia, S. R. N. Rao and K. S. Rao, 1937) from where the authors have described four forms *a*, *b*, *c* and *d*.

Neomeris (*Decaisnella*) sp. A.

(Pl. IX, figs. 1 and 7)

Description.

Algae from this area have been recognised only in thin rock sections. The genus (Pl. IX, fig. 1) is represented by a broken ring, the section passing somewhat obliquely. Since a section passing through the length of a tube of rings has so far not been obtained and a sporangium with its secondary branches lies in the same plane, the specimen is provisionally referred to the section *Decaisnella*.

In one fragment of ring (Pl. IX, fig. 1) 5 oval sporangia (4 distinctly and one indistinctly) are noticeable with a corresponding number of parts belonging to the calcified primary branches. That each sporangium had two lateral branches is evident from the sporangium on the extreme left. Branches from the adjacent verticil may be noticed owing to the somewhat oblique nature of the section. The sporangia are ovoid (Pl. IX, figs. 1 and 7). In *Neomeris* sp. A. the calcification extends to the primary branches which are, therefore, well preserved (cf. *N. dumetosa*). The most well preserved part of the fragmented ring (Pl. IX, fig. 1) shows the two laterals (secondary branches) arising out of the primary branch, and surround an ovoid sporangium. The sporangia seem to be nearly sessile to sub-sessile.

Measurements.

Length of the sporangium	..	..	..	0.130 mm.
Breadth of the sporangium	..	..	..	0.106 mm.
Length of the secondary branch	..	..	..	0.208 mm.
Breadth of the secondary branch at the base	..	..	..	0.02 mm.
Breadth of the secondary branch at the tip	..	..	..	0.052 mm.

Comparison.

The above description indicates that the specimen belongs to the tribe Neomereae and warrants comparison with the sub-genus *Decaisnella* characterised by 2 sterile secondary branches and a fertile one, borne on a primary branch, all lying in the same plane.

Lemoinema, *Meminella*, *Larvaria* and *Neomeris* are the forms possessing a single sporangium with two sterile secondary laterals on each primary branch arranged in verticils. *Lemoinema* shows a polygonal cross-section of the axial tube bearing a spherical sporangium surrounded by two secondary branches. Although the shape of the cross-section of the axis of our specimen is not revealed, yet it can be distinguished from *Lemoinema* by the ovoid shape of the sporangium. It is also distinguished from *Meminella* in which the sporangium is spherical and lateral, while the two secondary branches lie in the plane of the primary branch extensions. The genus *Larvaria* possesses ovoid sporangia which are placed in a plane different from that of the two laterals.

Montiella is quite different in having only two secondary branches on each primary branch, one (upper) which becomes swollen at the distal end forming an ovoid sporangium which in *Neomeris* terminates in the primary branch. Our specimen cannot be referred to any of the above and its characters indicate that it belongs to *Neomeris*.

N. sp. A. is different from *N. cretacea* Steimann which possesses distinctly stalked and pyriform sporangia.

The species described from Rajahmundry (Pia *et al.*, 1937) do not offer any similarity with this form. Thus the form seems to represent a new species in having a decidedly sessile to sub-sessile ovoid sporangia but a specific name has not been given in view of the incomplete information available at present.

Neomeris (Vaginopora) sp. B.

(Pl. IX, figs. 2 and 3)

Description.

This species is represented by many fragments representing parts of rings. In all cases the segments of rings are seen to possess the characteristic pear-shaped sporangia (Pl. IX, figs. 2 and 3). In one of the best fragments (Pl. IX, fig. 2) which is cut obliquely there are seen six sporangia represented entirely or in parts. The first, second and third sporangia counting from the left are well preserved and their pyriform shape indicates that the specimen is a *Neomeris*. Owing to the oblique nature of the section the secondary branches of an adjacent ring are also seen. At the bases of the first and the third sporangia there are definite clues of the two secondary laterals borne by evidently uncalcified branches of the first order. The third sporangium shows a secondary branch which approaches on the left side of the stalk of the sporangium very closely so that its attachment could be reasonably inferred, while on the right side the secondary branch is represented only by a small basal fragment. This form does not seem to have had calcified primary branches.

Measurements.

Length of the sporangium	0.165 mm.
Breadth of the sporangium	0.066-115 mm.
Width of the secondary branches	0.02 mm.

Comparison.

Neomeris sp. B. shows a great similarity with *N. cretacea* Steinmann with respect to the size and shape of the sporangia. While describing the sporangia Steinmann (1899, p. 150) states, 'Die birn-oder keulenförmige Ausweitung ist 0.13-0.16 mm. lang und bis zu 0.1 mm. dick; die Länge des Stiel beträgt durchschnittlich 0.1 mm.' But in *N. sp. B.*, as in *N. sp. A.*, we do not know the external and internal diameter of the axial cell and therefore, it is difficult to assign *N. sp. B.* directly to *N. cretacea* with which it resembles so much.

REMARKS ON *ACICULARIA* AND THE ALLIED GENERA OF THE FAMILY ACETABULARIACEAE.

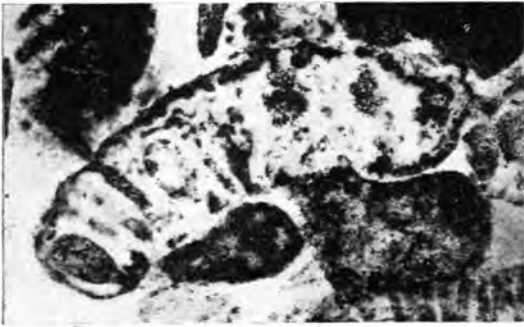
Among the Dasycladaceae, Acetabulariaceae display a highly specialised structure. The various genera included in the tribe exhibit an upright main axis generally bearing alternate verticils of the sterile and fertile whorls extending laterally. A great majority of the forms included in the sections: *Acetabuloides* and *Acetabulum*, produce only a single fertile whorl at the tip. *Acetabularia* (Section: *Acetabuloides*) *crenulata* Lmx. is an exception where the sterile and fertile whorls alternate as in the case of *Halicoryne* Harvey. The most peculiar feature of the sub-family is the form of its reproductive bodies which are much elongated assuming a digitate (as in some fossil forms) to pod-like shape bearing the rounded gametes. Only two of the four living genera, viz. *Acetabularia* and *Acicularia* are represented by their fossil forms. The genera *Chalmasia* Solms and *Halicoryne*



1



5



2



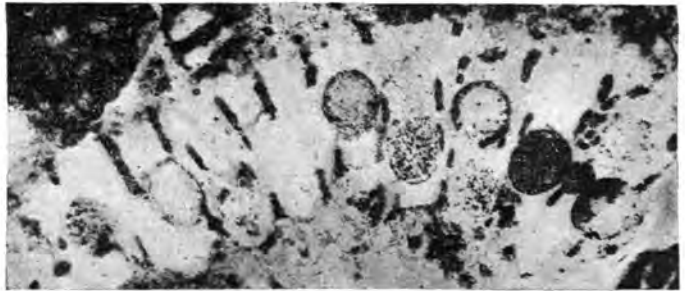
6



3



4



7

Harvey are living forms without a fossil record while (?) *Orioporella* Mun.-Ch., and *Clypeina* Mich. have been recorded only as fossils. It is interesting to note here that the systematic position of the genus *Clypeina* Mich. is still undecided. Pia (1927, p. 68) has put it under the tribe—Dipolporeae and the sub-tribe Macro-porellinae while Morellet and Morellet (1913, 1918, 1922, 1939) have included it under Acetabularieae.

Acetabularia and *Acicularia* are the only two genera of the family Acetabularieae which have both living and fossil forms. *Acicularia* is distinguished from *Acetabularia* in having a deposit of lime even in the cavity of the sporangium which results, on disintegration of the fertile verticils, in dissociating into a number of calcareous spicules pointed at the proximal and broader at the other (distal) end, affording a honey-combed structure due to a peculiar arrangement of the calcified spore cavities.

It is very interesting to note that *Acicularia* was first discovered as a fossil and later found to be represented by a living species also. *Acicularia* was the name given by d'Archiac in 1843 to small longish bodies, pointed at one end, broad and emarginate at the other. D'Archiac did not know the exact nature of these bodies when he named them and referred them to Bryozoa. The opinion was shared by Michelin and Ruess, while Carpenter placed them among the foraminifera. It was as late as in 1877 when Munier-Chalmas recognised the radial partition walls and their radially disposed habit which led him to remove *Acicularia* from the animal kingdom and place them with the Acetabularieae. Though a plant nature had been suggested, there was yet no proof to substantiate the proposition till a living species of the genus *Acicularia schenckii* (Möb) Solms (1895–1901) came to light.

DIAGNOSIS AND CLASSIFICATION OF FOSSIL ACICULARIAS.

The diagnostic characters of the genus as noted by Morellet's (1913, p. 31) are as follows:—

'Spicules calcaires (sporangies), élargis à une extrémité, isolés ou associés latéralement, à section circulaire ou aplatie, creusés à la périphérie d'un grand nombre de petites cavités sphériques (spores).'

The genus *Acicularia* is divided into two sections *Acicularia* (sensu-stricto) and *Briardina* Mun.-Ch. *Acicularia* (sensu-stricto) includes spicules in which the rounded cavities are generally distributed peripherally round the spicule. In section *Briardina* are included flattened spicules in which the circular cavities are distributed along the superior and inferior margins only.

GEOLOGICAL HISTORY AND PREVIOUS RECORDS OF ACICULARIA IN INDIA.

Acicularia is represented by a single living form *A. schenckii* Solms and has about 18 fossil species. It makes its first appearance in the Cretaceous. The fossil history of the allied genus *Acetabularia* extends back to Oligocene only.

In India the genus *Acicularia* has so far been recorded from Trichinopoly (Rao and Pia, 1936) Rajahmundry (Pia, Rao and Rao, 1937) and the Punjab Salt Range (Rao and Varma, 1950).

Acicularia indica sp. nov.

(Pl. IX, figs. 4, 5 and 6)

Diagnosis.

Spicules short, stout and club-shaped; about 5 times as long as its maximum breadth. Biconvex to lenticular in cross-section and studded with about eight rows of gamete cavities.

Measurements.

Length of the spicule	..	..	..	1.62 mm.
Maximum breadth of the spicule	..	..	..	0.38 mm.
Breadth at the proximal part	..	..	..	0.18 mm.
Gamete cavity	..	..	..	0.08-0.12
			mostly	0.09 mm.

Description.

Acicularia indica is represented by many sections cutting the spicules crosswise and one section passing in an oblique plane exposing the structure of the spicule lengthwise and the typical arrangement followed by the calcified spore cavities (gamete cavities).

A spicule of *A. indica* is seen containing the gamete cavities all round the margin (Pl. IX, fig. 5). It typically shows a narrow proximal end and rounded, emarginate distal part. The narrow proximal end does not show any trace of a corona like part. Some of the gamete cavities, generally rounded, seem to open on the surface of the spicule. The spicules of this species are short, stout and slightly curved attaining a club-shaped structure but not hooked as in *A. dyumatsenae*. The spicules seem to possess about eight rows of spore cavities studded along the periphery (Pl. XI, fig. 4).

Comparisons.

In assigning this species to *Acicularia* and not to *Terquemella* I have been guided by the following differences between the two genera noted by Pia (1936, p. 25): 'The calcareous substance contained in the compartments of the disc of *Acicularia* has the form of a spicule or a slender club. *Terquemella* is represented by calcareous bodies of a similar general structure (and with similar spore cavities), but of a spherical, discoid or tuberous form.'

For a generic identification we have obviously to consider *Acetabularia*, *Terquemella* and *Acicularia* only. Though *Acetabularia* and *Acicularia* both possess the type of spicules we are dealing with, the former possesses calcified gametangia with uncalcified cysts. Thus *Acetabularia* is ruled out simply by the presence of the rounded gamete cavities inside the gametangium (spicule). Similar spore cavities are present in another genus *Terquemella* with a spherical, discoid or tuberous form. *Terquemella* is segregated because of the presence of club-shaped spicules, a character which directly favours its inclusion among the *Acicularias*. As explained by Pia, Pfender and Termier (1932, p. 14) it is extremely difficult to compare accurately the *Acicularias* in rock sections with those found in loose material. Also one more difficulty arises because the authors of the Tertiary *Acicularias* have in majority of cases, not given the measurements of the gamete cavities.

As already indicated the gamete cavities are arranged all round the periphery and not restricted to the inferior and superior margins only, thereby calling forth only those species for comparison which belong to the section *Acicularia* (sensu stricto). The following Tertiary species *A. michelini*, *A. micropora* and *A. (?) clavata* have been stated to be slightly curved but differ in not having bi-convex or lenticular cross-sections and possess spicules of smaller dimensions as compared to *A. indica*. Moreover, the size of the gamete cavities is not known making a comparison more difficult. Another species with elliptical sections is *A. persica* Morellet and Morellet (1939, p. 31-32) which differs in having spicules of much greater length with marginate, truncated (slightly rounded) distal ends showing no curvature, possessing vaguely distributed gamete cavities measuring 0.1 mm. The maximum breadth of the spicules on average is not mentioned but a calculation from the photograph indicates the maximum breadth to be about 0.5 mm.

Among the Cretaceous species known so far, only two in number, *A. dyumatsenae* Pia and *A. antiqua* Pia are to be considered. Length of the spicules of *A. dyumatsenae* is stated to be about $2\frac{1}{2}$ times its maximum breadth, with hooked spicules and gamete cavities measuring about .05 mm. It is clearly marked out from *A. indica* found in the same rock by the shape and size of the spicules and the dimensions of the gamete cavities. *A. antiqua* known from Tripoly (N. Africa) in the form of oblong discs, unhooked spicules, length not exceeding twice its breadth (breadth 0.33) with gamete cavities .04–.05 mm., is again different from the new form.

Another Indian *Acicularia* sp. Ind. is described from Rajahmundry (Pia *et al.*, 1937, p. 283) as possessing long needle-shaped spicules with their gamete cavities about 0.07 mm. in diameter. This species also does not bear any specific similarity with *A. indica*. I have not been able to collect the data for *A. italica* Clerici, which could not, therefore, be considered.

SUMMARY

From the Cretaceous (Danian) rocks of the Trichinopoly district *Neomeris* sp. A. *Neomeris* sp. B. and *Acicularia indica* sp. nov. have been figured and described.

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EXPLANATION OF PLATE IX

- FIG. 1. *Neomeris* sp. A. A somewhat oblique section of a fragment of ring showing parts of the calcified primary branches, the four sessile to sub-sessile ovoid sporangia with secondary branches (Type specimen). $\times 72$.
- FIG. 2. *Neomeris* sp. B. An oblique section of a fragment of a ring showing six sporangia with some secondary branches. (Type specimen.) $\times 72$.
- FIG. 3. *Neomeris* sp. B. A nearly vertical section passing through the wall showing the stalked pear shaped sporangia and the secondary branches. $\times 72$.
- FIG. 4. *Acicularia indica* sp. nov. A transverse section of the spicule indicating about eight rows of circular gamete (spore) cavities. $\times 45$.
- FIG. 5. *Acicularia indica* sp. nov. A longitudinal section passing through the entire length of a spicule. (Type specimen). $\times 45$.
- FIG. 6. *Acicularia indica* sp. nov. An obliquely longitudinal section passing through the thickness of a spicule. $\times 45$.
- FIG. 7. *Neomeris* sp. A. An oblique section cutting through three adjoining rings. $\times 72$.

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