

RECENT DISCOVERIES OF FOSSIL ALGAE IN INDIA

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ABSTRACT

Ever since the discovery of abundant fossil algae in the Niniyur group (Danian) of the Trichinopoly Cretaceous, S. India, was reported in 1931, a large amount of work on fossil algae from the Cretaceous and Eocene rocks of India has been done. Several new genera and species belonging to the two important families, Dasycladaceae and Corallinaceae, have been figured and described, which constitute substantial additions to our knowledge of fossil algae in general. The present paper gives a brief review of these investigations and discusses their stratigraphical and palaeontological importance on the background of similar work done outside India. The great scope and immense possibilities in India for further research in this field are indicated.

INTRODUCTION

IT was about twenty years ago, while examining sections of some of the rocks of the Trichinopoly Cretaceous area, that I noticed some interesting organic structures whose exact nature was at first not readily recognizable. As work progressed, it was found that these structures were becoming increasingly common, and in some of them, particularly in the limestones of the Niniyur group¹, the details of the cellular structure were exceedingly well preserved. These were soon recognized as belonging to fossil algae, and the common form was provisionally identified as *Lithothamnium*. In view of the fact that this was the first abundant occurrence of fossil algae in India, a report of this interesting discovery was published in *Nature* in August 1931; and it was obvious that a more detailed study of these fossils was bound to be of great interest and importance. I immediately approached Prof. Birbal Sahni for advice and guidance in the matter; and with his characteristic promptness and

enthusiasm he responded to my request and suggested that Prof. Julius Pia of Vienna, one of the best known authorities on fossil algae, was the right man to help us in the furtherance of this research, and that I should, therefore, contact him and enlist his valuable co-operation. Prof. Sahni went a step further; he himself wrote immediately to Prof. Pia introducing me to him and drawing his attention to this interesting occurrence of fossil algae in India. Accordingly I got into touch with Prof. Pia and submitted to him all the sections of these algae-bearing rocks; and I must say at once that he evinced considerable interest in this material. After about four years of collaboration, an elaborate memoir on the "Fossil algae from the uppermost Cretaceous beds (the Niniyur Group) of the Trichinopoly Dt., S. India" was published in the *Palaeontologia Indica* series of the Geological Survey of India (L. R. RAO & J. PIA, 1936, pp. 1-49) wherein a detailed account, with numerous figures and photographs, of the several types of fossil algae noticed in these rocks was given by Prof. Pia; and these constituted, according to him, "the most interesting algal flora" he had ever studied. It is gratifying to find that the publication of this memoir opened out a whole field of research, and quite a number of papers have since been published describing the fossil algae from the Cretaceous and Eocene rocks of different parts of India — particularly by my erstwhile colleagues, Messrs S. R. Narayana Rao and K. Sripada Rao. It is intended to give in this paper a brief review of this work, and in doing so, we wish to acknowledge with gratitude the valuable advice and guidance given by Prof. Sahni in initiating and developing this line of research in India; and to pay our tribute to that great and lovable personality to whose revered memory this special number is being dedicated.

PREVIOUS WORK

Before proceeding to review this recent work, it will be useful, as furnishing a suit-

1. The Cretaceous of the Trichinopoly district, S. India, is divided into 4 groups. Starting from the oldest, these are (i) the Utatur, (ii) the Trichinopoly, (iii) the Ariyalur, and (iv) the Niniyur. The entire succession ranges in age from the Cenomanian to the Danian of the European stratigraphical scale. A full description of these rocks has been given by the author elsewhere (L. R. RAO, 1942, pp. 1-74).

able background, to give an idea of our knowledge of fossil algae in India prior to 1931. Apart from one or two casual references to doubtful fossil algae here and there, the first specific mention of the occurrence of fossil algae in India is by Hayden in his paper on "The geology of the provinces of Tsang and U in Central Tibet", published in 1907 (H. H. HAYDEN, 1907). In describing the Tuna limestone (as part of the Kampa system of Tibet) which, according to him, is Maestrichtian in age, Hayden merely mentioned that "certain bands of the rock are composed almost entirely of large spheroidal nullipores apparently belonging to the genus *Lithothamnium*", and there is no further description or identification given of these nullipores. About 20 years later, Walton (J. WALTON, 1926, pp. 213-219) gave a brief account of a calcareous alga belonging to the Triploporellae (Dasycladaceae) from one of the Ranikot beds of Sind. After giving a description and 'comparisons' of this fossil, Walton considered it as a new species of *Triploporella* which he named *T. ranikotensis*. In the same year, Das Gupta reported the presence of certain algae in the Nummulitic rocks (of middle Kirthar age) of Cherrapunji, Assam (H. C. DAS GUPTA, 1926, pp. 1-10). These were referred to the genus *Lithothamnium*, and, on the basis of more detailed studies including cell measurements, he recognized 2 species of this form — *L. grandis* and *L. cherrapunjiensis*. In the year 1927, the occurrence of fossil algae was reported by Gee in some of the limestones of post-Eocene age in the Middle Andaman Island (E. R. GEE, 1927, pp. 208-232). The common alga is said to be *Lithothamnium*, and 2 types of this form were recognized — one with conceptacles similar to those of *L. suganum* of Rothpletz, and the other with pear-shaped conceptacles arranged in a row as in *L. nummuliticum*. Three years later, Pia described (J. PIA, 1930, pp. 177-181) a new Dasycladaceae, *Holosporella siamensis*, from an upper Triassic limestone occurring near Kamawkala on the Burmo-Siamese frontier. After giving a full description of this fossil, Pia has compared it with *Diplopora phanerospora* and *Aciculella bacillum*, and established the fact that the present alga is distinct from both and must, therefore, be recognized as a new form to which he gave the name *Holosporella siamensis*.

RECENT WORK

This was practically all our knowledge of fossil algae in India prior to the publication of our memoir in 1936 on the fossil algae from the Niniyur group. A perusal of this memoir shows that we have the occurrence here of an extremely rich and varied algal flora, of exceptional interest and importance. The two great families, Dasycladaceae and Corallinaceae, are both well represented, and it is now recognized that these are the two groups most helpful in stratigraphical correlation. One important point, however, which comes out very strikingly from Pia's tabular statement of the species present in each section, is that the Dasycladaceae and the Corallinaceae never seem to occur together in the same rock. They appear to be mutually exclusive; probably it was a case of an ecological environment favourable to one being repugnant to the other.

The Dasycladaceae of the Niniyur group include several new genera and species, and are, according to Pia, of "special interest from a botanical and stratigraphical point of view". Here we have a new form *Dissocladella savitriae* which is very well preserved and is perhaps the most complete *Dissocladella* yet known, throwing an important light on the origin and inter-relationship of the Thyrsoporellae and the Triploporellae. We have also the new genus *Indopolia* which, though closely resembling *Neomeris* in certain respects, is still distinct in possessing two cortical cells and two sporangia on each primary branch. There is also a new species of *Acicularia* — *A. dyumatsenae*, with club-shaped spicules about $2\frac{1}{2}$ times as long as thick. The existence of *Aciculariae* with very stout spicules in the upper Cretaceous is important and supports the idea of a possible connection between this genus and *Terquemella*. In addition to these, we also get here the remains of another interesting form, *Orioporella malaviae*, which, according to Pia, "was the stateliest plant among the Dasycladaceae of the Trichinopoly strata".

Of the Corallinaceae, the subfamily Melobesieae is well represented. We have the abundant occurrence of *Archaeolithothamnium*, the most primitive genus of this family, the most common form being *A. lugeoni*, a species so far known only from the Eocene proper (not Palaeocene) of Spain. A form closely similar to *A. provinciale* Pfender is also commonly noticed. From

some of the sections it is clear that we get here truly branched species of Melobesieae — “the inner part of the branch being built up by the medullary hypothallium, with marked arched transverse cell layers, surrounded by perithallium”. From a careful study of such sections, “it becomes obvious that the difference between perithallium and medullary hypothallium, between protuberances and branches, is not a fundamental one in *Archaeolithothamnium*. This seems to be one of the many primitive characters of the genus.”

Another remarkable feature of the Niniyur algal flora is the occurrence, though limited to only one form, of the family Solenoporaceae, the classification and systematic position of which are still matters of controversy. The form found here is a new species of the genus *Parachaetetes* and is named by Pia *P. asvapatii* which he defines as follows: “*P. asvapatii* builds up small calcareous nodules measuring a few millimeters only composed of several more or less broad and blunt lobes. The tissue is fairly well differentiated into a hypothallium and a perithallium. The latter shows in longitudinal sections a ‘lattice work’ formed by the transverse cell walls (situated at identical height in adjoining cell rows) and by the longitudinal ones. The cells measure 0.04 to 0.06 mm. across, and are one to three times as long as broad.” In addition to the above three families, the Chaetophoraceae (an obscure but interesting family of ‘perforating thallophyta’) is also represented in the Niniyur material by a species of *Palaeachyla*.

After giving the description and identification of these Niniyur algae, Prof. Pia has also discussed their stratigraphical character, and pointed out the ‘transitional’ position of this flora between the Cretaceous and the Tertiary system, and that, therefore, they cannot be employed to decide stratigraphic questions in Southern India, particularly since many of the species are new. The most important point, however, is, as Pia points out, “that the sequence of strata in this region will later on be a typical section. Algae will be used to correlate strata in other parts of the earth with those in the Trichinopoly District and thus to fix the geologic age of these foreign sediments.”

The publication of this memoir on the Niniyur algae naturally gave us a great impetus for further work, and the Geology

Department of the Mysore University soon became an active centre of research on fossil algae. Apart from the Niniyur group, there were the three other subdivisions in the Trichinopoly Cretaceous area, and an examination of the limestones of these groups also revealed the presence of numerous algae, chiefly the Corallinaceae. Among these rocks, particular mention may be made of the ‘coral reef limestone’ found at the base of the Utatur group which has yielded quite a good algal flora, which still remains to be fully investigated. The other South Indian Cretaceous rocks, for example those from near Pondicherry and Rajahmundry, were also tackled, and there again we noticed plenty of algae. Several samples of Cretaceous and early Tertiary limestones were also obtained from other parts of India; and many of these were found to contain very interesting algal remains. Thus the whole field of study widened itself out very rapidly, and attention may be drawn to some important results of these investigations.

In the year 1936, S. R. Narayana Rao and K. Sripada Rao recorded the occurrence of a *Holosporella* cf. *H. siamensis* from an intertrappean limestone of the Rajahmundry area (S. R. N. RAO & K. S. RAO, 1936, pp. 397-399). This was a most unexpected find in view of the fact that the *H. siamensis* of Pia was an upper Triassic species, and here in Rajahmundry we see the same form in a much younger (early Tertiary) bed, associated with later forms like *Acicularia* and *Neomeris*. Prof. Pia, who also examined this material, considered this occurrence of an endosperm Dasycladaceae in so high a geological horizon as “most perplexing”; according to him this is “probably a new instance of the survival of primitive forms in tropical regions”. A full paper dealing with the Dasycladaceae from the Rajahmundry area was later published under the joint authorship of these three workers (J. PIA, S. R. N. RAO & K. S. RAO, 1937, pp. 227-234). In the year 1939, we reported the occurrence of fossil algae — the Dasycladaceae — in the Eocene beds of the Salt Range (L. R. RAO & K. S. RAO, 1939, p. 512). It is interesting to find that here again we have, side by side with late Cretaceous or early Tertiary genera like *Dissocladella*, *Acicularia* and *Neomeris*, forms like *Oligoporella* and *Diploporella* which are elsewhere unknown in beds younger than the Trias. The algal flora of

these beds is quite rich and varied; they have yet to be examined in greater detail. There is no doubt that such a study will be most interesting, particularly since these algae come from an Eocene succession which has been most thoroughly worked out from the stratigraphical and palaeontological points of view.

An important contribution to our knowledge of the fossil Corallinaceae was made in 1941 when S. R. Narayana Rao published his paper on "An algal flora from the Lockhart limestone (Ranikot series) of the Samana Range" (S. R. N. RAO, 1941, pp. 41-51). In this paper, some new species of *Archaeolithothamnium* (*A. samanensis*, *A. ranikotensis*), *Lithophyllum* (*L. lockharti*) and *Mesophyllum* (*M. daviesi*) have been described, and their relationship with other known allied genera and species fully discussed. Special attention is drawn to the fact that the new species *A. samanensis* "is unique in showing a tendency for concentric arrangement of the cells of the hypothallium, and represents an intermediate type between *Archaeolithothamnium* and *Lithophyllum*". A couple of years later, K. Sripada Rao published a paper on the Corallinaceae from Assam which further advanced our knowledge of this important group (K. S. RAO, 1943, pp. 265-299). The occurrence of a rich algal flora "comparable in importance with that discovered in Southern India" in some limestones of doubtful age (Cretaceous or Eocene?) from Assam was first noticed by Prof. Sahni, and it was through his kindness that the entire material was made available to us for detailed study. In this paper Sripada Rao has given detailed descriptions, 'comparisons', and measurements of 4 new species of *Archaeolithothamnium*, 4 species of *Lithothamnium* (of which 2 are new), 1 new species of *Melobesia* and 1 species of *Distichoplax*. The evidence of these algae on the problem of the age of the containing rocks has also been discussed, and it has been concluded that they are of early Tertiary age, thus confirming a similar suggestion made by Dr. C. S. Fox and A. M. N. Ghosh on the basis of their field studies. It is further reported by Sripada Rao that these limestones also contain numerous Dasycladaceae, which he proposes to describe in a separate paper.

More recently S. R. Narayana Rao has described 2 species of *Solenopora* — *S. jurassica* and *S. coromandelensis* sp. nov.— from

the well-known Cullygoody limestone of the Trichinopoly district (S. R. N. RAO, 1947, pp. 331-336). In view of the comparatively rare occurrence of the Solenoporaaceae so far, this record of their presence in the Cullygoody limestone is important. After describing and discussing the diagnostic characters of the genus *Solenopora* and the 2 species found here, S. R. N. Rao thinks that on the strength of the occurrence of *S. jurassica* (which is specifically identical with the European Jurassic species), the Cullygoody limestone must be assigned a Jurassic age—a conclusion strongly at variance with the current view on stratigraphical and other palaeontological evidences that this limestone is Cretaceous in age, forming part of the Trichinopoly Cretaceous succession. This difference of opinion is a matter which evidently requires looking into.

In the course of a recent visit to the Trichinopoly area, I have collected some specimens of limestones and flints from near Otakoil, about 8 miles south-west of Niniyur. A preliminary examination of these shows the rocks to be crowded with exceedingly well-preserved remains of Dasycladaceae together with milioline foraminifers. A study of these algae and their comparison with those already described from the Niniyur group is under progress.

WORK OUTSIDE INDIA

Before concluding this review, brief reference may be made to the recent studies of similar fossil algae outside India. In the year 1936, Prof. Pia published a paper on the "Calcareous green algae from the upper Cretaceous of Tripoli (N. Africa)" which had already been briefly described by Miss Rita Raineri in 1922 (J. PIA, 1936, pp. 3-14). The material comes from rocks of Cenomanian or Turonian age, and Pia's paper deals only with the Dasycladaceae contained in them. This is an important paper since Pia has compared these Tripoli forms with the Niniyur Dasycladaceae whose description he had himself just published. After critically reviewing Miss Raineri's descriptions and identifications, Pia points out that the Tripoli and Niniyur beds resemble each other in the frequent occurrence of *Dissocladella* and *Acicularia*. The Tripoli flora, however, differs from that of Niniyur in including the presence of

Neomeris and *Bouenia*, and in the absence of *Indopolia* and *Orioporella*. The form *Trinocladus tripolitanus* of the Tripoli beds is shown to be an "excellent transitional type between the genera *Dissocladella* and *Thyrso-porella*". A species of *Acicularia*, *A. antiqua*, closely resembling the *A. dyumatsenae* of Niniyur has also been described, and the suggestion has been put forward that *A. antiqua*, together with *A. dyumatsenae*, "represents a new genus transitional between *Terquemella* and *Acicularia*". Quite recently, in the year 1948, Johnson and Ferris have published an account of the Corallinaceae from the upper middle Eocene beds of Florida (H. JOHNSON & B. J. FERRIS, 1948, pp. 762-766). In this paper, detailed descriptions and measurements have been given of 4 species of *Archaeolithothamnium*, 2 species of *Lithophyllum* and 1 species of *Amphiroa*. This flora is considered to be of special interest because "these species are the first Eocene coralline algae to be described from the Atlantic or Gulf Coasts of the United States". The same authors have also just published a paper dealing with the Tertiary (Eocene to Miocene) Coralline algae from the Dutch East Indies (H. JOHNSON & B. J. FERRIS, 1949, pp. 193-198). The algae found here belong to the following genera: *Archaeolithothamnium*, *Lithothamnium*, *Lithophyllum*, *Amphiroa*, *Corallina* and *Jania*. The authors express the view that "*Mesophyllum* is intermediate structurally between *Lithothamnium* and *Lithophyllum*, having conceptacles similar to the first and tissue similar to the second". In describing the above forms, 5 new species — 2 of *Lithothamnium*, 1 of *Mesophyllum*, 1 of *Lithophyllum* and 1 of *Corallina* — have been recognized and defined.

A perusal of these papers dealing with the extra-Indian occurrences of fossil algae indicates that they are all concerned more or less with forms similar or allied to those described in India. It is unfortunate that these outside workers have not compared

(except briefly in one case) their genera and species with the Indian types. Such comparative studies must now be undertaken and pursued hereafter in dealing with these fossil algae, since they are sure to clarify many doubtful points and help us in the better understanding of their stratigraphical value and evolutionary inter-relationships.

CONCLUSION

From the above brief review of the work done on fossil algae in India, and a reference to the original papers mentioned therein, it is clear that we have here a most interesting field of research, with immense possibilities. What we have done so far is only to describe *some* of the algae found in the Cretaceous and Eocene rocks of India; there is still a lot of material from these formations which remains to be investigated. There is no reason to think that the algae are confined only to these rocks; we must now look for them in the older formations also — Jurassic, Triassic, Permian, and so on — many of which in different parts of India are sure to contain their own algal floras. The further back we go in time, the more interesting will be their algal contents; when we go down to the Pre-Cambrians of which we have such a good development in our country, the search for fossil algae becomes positively exciting (M. R. S. RAO, 1949, pp. 67-72). The importance of fossil algae from both the stratigraphical and palaeontological points of view is being increasingly realized all over the world, thanks to the classical contributions made by such pioneer workers as A. Rothpletz, Madame Lemoine, L. & J. Morrelet, J. Pfender, E. J. Garwood and Julius Pia. There is excellent scope for such studies in India; a good beginning has been already made, and it is up to us now to pursue these investigations further, and do the best that we can in this most promising and fascinating field of palaeobotanical research.

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