A STUDY OF THE POLLEN GRAINS OF *CTENOLOPHONIDITES* FROM THE WARKALLI DEPOSITS OF SOUTH INDIA WITH A NOTE ON THE GEOLOGICAL HISTORY OF CTENOLOPHON*

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ABSTRACT

The paper deals with a systematic study of the pollen grains of *Ctenolophonidites* Van Hoeken Klinkenberg recovered in fair abundance from a lignite sample near Warkalli (Varkalai) in Kerala State. The geological age of the Warkalli lignite is Miocene, possibly Upper Miocene. The following species have been described in the paper, viz. *Ctenolophonidites costatus*, *C. keralensis* sp. nov., *C. erdtmanii* sp. nov. and *C. saadii* sp. nov. The fossil pollen grains show remarkable similarities with the pollen of the modern genus *Ctenolophon* of Ctenolophonaceae and are undoubtedly related to the latter. The paper comments upon the geological history of *Ctenolophon* both in time and space. The known geological history of this genus indicates that it enjoyed a much wider phytogeography during the Tertiary period compared to its present rather highly circumscribed distribution.

INTRODUCTION

DURING a palynological investigation of the lignites from near Warkalli (Varkalai) in Kerala State, South India, the authors have come across in one of the samples (WLS. 2) a number of well-preserved pollen grains of *Ctenolophonidites* Van Hoeken-Klinkenberg, resembling the pollen of the modern *Ctenolophon* of Ctenolophonaceae. It was Erdtman (1956) who for the first time pointed out the affinities of some fossil pollen grains from the Warkalli lignite, with the modern *Ctenolophon*. These were originally reported by Rao and Vimal (1952) and Vimal (1953) as Hexacolpites and Septacolpites pollen types. There has been so far, however, no detailed systematic study of the fossil pollen of *Ctenolophon* type from India. *Ctenolophonidites* pollen grains have been hitherto recorded from the Upper Cretaceous and Tertiary of Nigeria in West Africa (Van Hoeken-Klinkenberg, 1964, 1966), Palaeocene of Venezuela, Columbia and Caribbean area, and Upper Tertiary of Borneo (Kuyl *et al.*, 1955; Germeraad *et al.*, 1968).

MATERIAL AND METHODS

The lignite sample from near Warkalli (WLS. 2) was pulverized and treated with commercial grade HF for 24 hours to remove silica. It was then washed repeatedly with distilled water. The residue was then treated with conc. HNO_3 and left overnight. After removing the traces of acid by further repeated washings the macerated material was treated with 5% KOH for a few minutes only. The alkali treated residue was then immediately washed. Permanent slides were made in Canada balsam. A few slides, however, were also made in 60% glycerine to which a little phenol was added. The prepared slides and the untreated lignite material are in the palaeobotanical collection of one of us (CGKR) at the Dept. of Botany, Osmania University, Hyderabad.

SYSTEMATIC DESCRIPTION

Family — Ctenolophonaceae

***Ctenolophonidites* — Van Hoeken-klinkenberg 1966**

C. costatus Van Hoeken-klinkenberg 1966
Pl. 1, Figs. 1-5

Description — Pollen grains somewhat stellate-spherical in polar view, barrel-shaped (sub-oblate) equatorially; 35-55 μ in polar diam., 6-8 colpate, radially symmetrical, isopolar. Colpae 15-20 μ long, with prominently incrassate margins, ends blunt. One conspicuous ring-like endexinous thickening around apocolpium of each hemisphere, interconnected by meridional mesocolpial ridges or radial costae 2·5-4·5 μ thick. Ring-like apocolpial thickenings smoothly rounded or angular, often somewhat irregular. Polar area inside apocolpial ring smooth and unthickened or minutely punctate; additional irregular endexinous

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MAP 1 — Showing the modern distribution (circles) *Ctenolophon* and the fossil records (solid black dots facing arrows) of *Ctenolophonidites*.

thickenings often present inside apocolpial ring. Radial costae either of low height and inconspicuous or very prominent (up to 6 μ high) in polar view.

Comments — Each radial costae is flanked by two peg-like elevated areas representing the incrassate margins of the colpus and this feature is seen clearly in polar views of the pollen grains. This is the most common type of *Ctenolophonidites* pollen grains from the Warkalli lignites. In fact in the sample studied (WLS. 2) *C. costatus* constitutes one of the abundant angiosperm taxa. While conforming with the specific circumscription of *C. costatus* as given by Van Hoeken-klinkenberg (1964, 1966) and Gemeraad *et al.* (1968), the Warkalli grains exhibit a considerable degree of variation in the nature of radial costae and the additional thickenings inside the apocolpial ring. However, as these variations overlap and gradually merge with each other we have considered all the grains with the variations under *C. costatus* itself.

The fossil pollen grains of *C. costatus* show remarkable resemblances with the pollen of the modern *Ctenolophon engleri*, which is now confined only to tropical West Africa (Nigeria, Angola etc.).

C. erdtmanii sp. nov.
Pl. 1, Fig. 6

Diagnosis— Pollen grains rounded in polar view, 40-50 μ in diam., 7-colpate, radially symmetrical, isopolar. Colpi gaping, 12-16 μ long with incrassate margins. Colpi margins not much raised in polar view. One conspicuous irregular ring-like endexinous thickening around apocolpium of each hemisphere, interconnected only at one or two places by meridional mesocolpial ridges or radial costae, 2-3·5 μ thick. Majority of mesocolpial radial costae subequatorial as seen in polar view. More than one radial costae often in some mesocolpia. Additional thickenings present inside apocolpial ring, joining the latter locally. Unthickened wall finely granular.

Comments — Only a few grains of this type have been encountered in our slides.

These are however, easily distinguishable by the following features viz., apocolpial rings connected by only one or two radial costae, presence of single or pairs of sub-equatorial radial costae, and the much less incrassate margins of the colpi. The specific name is in honour of Prof. G. Erdtman.

Locality — Warkalli, S. India.

Age — Upper Miocene.

Holotype — Pl. 1, Fig. 6, Slide WLS. 2-9; coordinates 9·0×80·2.

C. keralensis sp. nov.

Pl. 1, Fig. 7; Text-fig. 1

Diagnosis— Pollen grains stellate-spherical in polar view, 47-66 μ in diam., sub-oblate equatorially, 7 or 8 colpate, radially symmetrical, isopolar. Colpae broad, gaping, 13-19 μ long, more or less spindle-shaped, with incrassate margins. One conspicuous but highly irregular, sinuous, ring-like endexinous thickening in apocolpium of each hemisphere, interconnected by meridional, mesocolpial radial costae, 2·5-4·5 μ thick. Radial costae 2 to 4 in each mesocolpium. Additional incomplete ring-like sinuous thickening within main apocolpial ring; unthickened wall smooth.

Comments — Grains of this type are met with frequently in our slides and some of these appear to be conspicuous by their large size. In the regular presence of two to four radial costae in each mesocolpium, and the possession of extremely sinuous apocolpial endexinous thickening *Ctenolophonidites keralensis* is easily distinguishable from the other species of this genus. The specific name is after the Kerala State from which the species is recorded.

Locality — Warkalli, S. India.

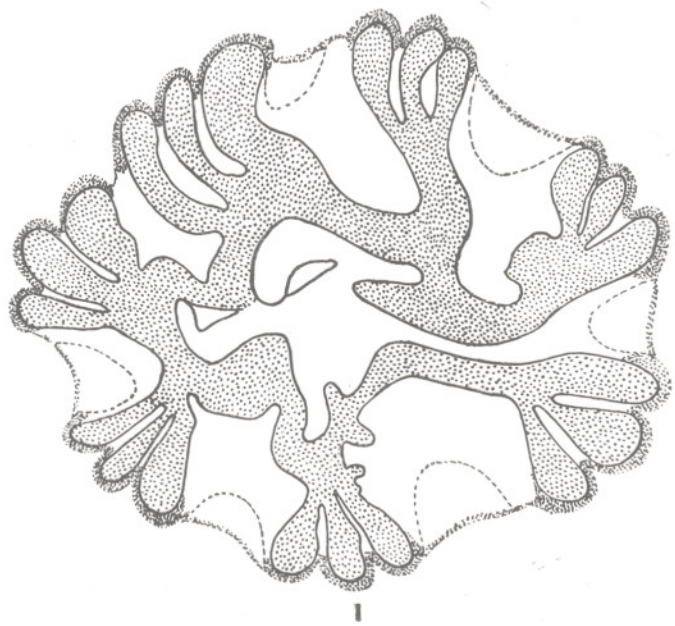
Age — Upper Miocene.

Holotype — Pl. 1, Fig. 7; Text-fig. 1, Slide WLS. 2-79, co-ordinates 17·5×77·3.

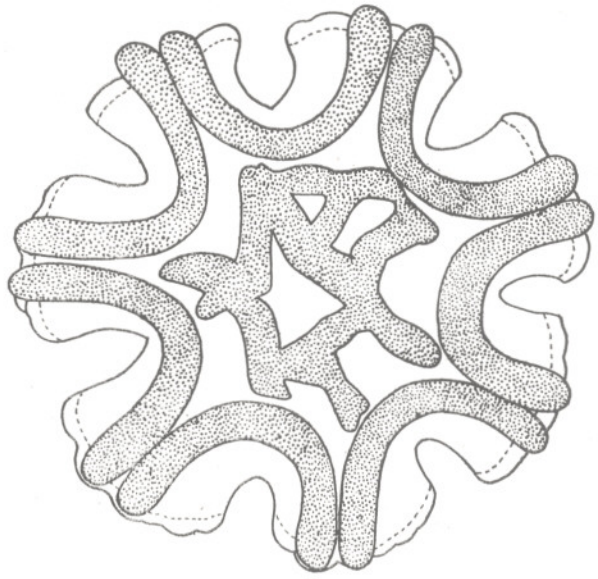
C. saadii sp. nov.

Pl. 1, Figs. 8, 10; Text-fig. 2

Diagnosis — Pollen grains rounded to stellate-rounded in polar view, 31-50 μ in diam., sub-oblate equatorially, 5-7 colpate, radially symmetrical, isopolar. Colpae short, 10-13 μ long, 6·5 μ broad, with incrassate margins, ends blunt. Locally anastomosing irregular strips of endexinous thickening in apocolpium of each hemisphere. Pairs of radial costae in mesocolpia arching over colpus ends on either side and fusing;



Text-fig. 1 — *Ctenolophonidites keralensis* sp. nov. × 1200.



TEXT-FIG. 2 — *Ctenolophonidites saadii* sp. nov. × 1200.

neighbouring arcs of radial costae seldom join towards apocolpial region. Unthickened wall minutely granular.

Comments — Only half a dozen specimens of this type have been found in our slides. In all the cases the grains are highly characteristic morphologically. In lacking a distinct apocolpial ring of endexinous thickening and in the possession of pairs of mesocolpial radial costae which arch over colpus ends and fuse *C. saadii* can easily be distinguished from other species of *Ctenolophonidites*. *C. lisame* described from the Palaeocene of Columbia and Caribbean islands (Germeraad *et al.* 1968) resembles the South Indian species in the possession of pairs of radial costae which occasionally arch over the colpi ends on either side and fuse with each other, but differs from the latter in its smaller size (17-31 μ) and in lacking additional apocolpial thickenings. Further, the wall in *C. lisame* is finely scabrate and apparently densely perforated whereas in *C. saadii* it is minutely granular. The specific name is in honour of Dr. Saad who for the first time provided a critical account of the pollen morphology of the modern species of *Ctenolophon*.

Locality — Warkalli, S. India.

Age — Upper Miocene.

Holotype — Pl. 1, Figs. 8-10; Text-fig. 2, Slide WLS. 2-66, co-ordinates 11·2×78·3.

DISCUSSION

The fossil pollen grains described above are undoubtedly related to the modern riparian tropical taxon *Ctenolophon* of Ctenolophonaceae. Exactly similar pollen grains are unknown in any other angiospermous family. For a number of years the exact systematic position of *Ctenolophon* has been rather enigmatic, and this genus has been included in various families viz., Olacaceae, Celastraceae, Linaceae, etc. by various authors (see Saad, 1962). Exell and Mendonca (1951), however, raised this genus to the level of a family Ctenolophonaceae. Hutchinson (1967) included this family in the order Malphigiales between Erythroxylaceae and Ledocarpaceae. According to Saad (1962) palynologically *Ctenolophon* shows some similarities with certain members of Malphigiaceae.

Gemeraad *et al.* (1968) recognized three types of *Ctenolophon* pollen grains viz., 1. *C. engleri* type, 2. *Ctenolophon* type A, and 3. *C. parvifolius* type. *Ctenolophonidites costatus* belongs to the *C. engleri* type, and

Ctenolophonidites lisame and the newly described *C. saadii* belong to *Ctenolophon* type A. *Ctenolophonidites erdtmanii* and *C. keralensis* although do not fit exactly in any of the above three types appear to be however, broadly related to *Ctenolophon engleri* type.

Ctenolophon engleri type of pollen as represented by *Ctenolophonidites costatus* is the oldest known type to date and pollen grains of this type occur as early as Senonian (Upper Cretaceous) in Nigeria. Although apparently absent in the Palaeocene, this type has been found to occur throughout the rest of the Tertiary period in Nigeria (Germeraad *et al.* 1968). *C. engleri*, incidentally is still living in tropical West Africa. *C. engleri* type of pollen grains are now known from the Upper Miocene of South India also. *Ctenolophonidites lisame* pollen grains are known so far only from the Palaeocene of the Caribbean area. *C. saadii* somewhat related to *C. lisame* is, however, known from the Upper Miocene of South India. *Ctenolophon parvifolius* type of pollen grains have been recorded from the Palaeocene of Nigeria and Neogene of Borneo (Gemeraad *et al.* 1968).

The only known extant species of *Ctenolophon* are *C. engleri* and *C. parvifolius* (*C. grandifolius*); the former is confined to tropical West Africa (Nigeria, Angola) and the latter to Malayan Archipelago and Philippines in South East Asia (Hutchinson, 1967). The occurrence of fossil pollen undoubtedly related to *Ctenolophon* in the Tertiary deposits of South America, Caribbean area, and the West coast of South India where this genus is not represented in the modern floras clearly indicates its more extensive distribution during the Tertiary period compared to its present rather highly restricted and discontinuous phytogeography (Map 1).

According to Germeraad *et al.* (1968) *Ctenolophon* probably originated in Africa during the Upper Cretaceous times and soon differentiated into an *engleri* and *parvifolius* pollen types. The available data indicate that plants of the *C. engleri* type migrated eastwards sometime during the Miocene epoch as evidenced by the occurrence of *Ctenolophonidites costatus* pollen grains in the Upper Miocene Warkalli lignite of S. India. From deposits younger than Upper Miocene age, *Ctenolophonidites* pollen grains are not known so far from India and as mentioned previously *Ctenolophon* genus itself is not found in the modern floras of India. One may then infer that after a brief period of existence along the West coast of S. India during the Upper Miocene age, the genus *Ctenolophon* became extinct. The reasons for the extinction of this genus from India, however, are not known.

ACKNOWLEDGEMENT

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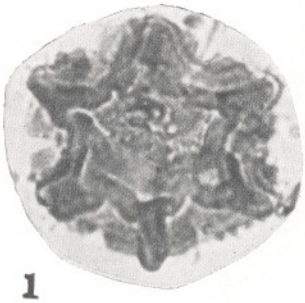

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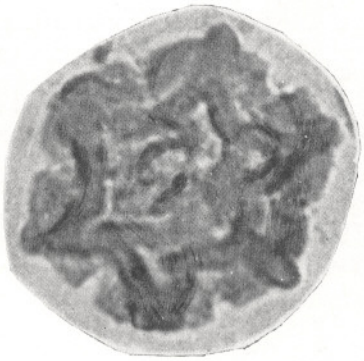

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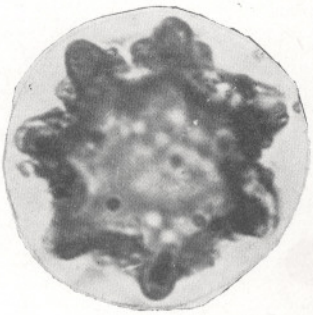

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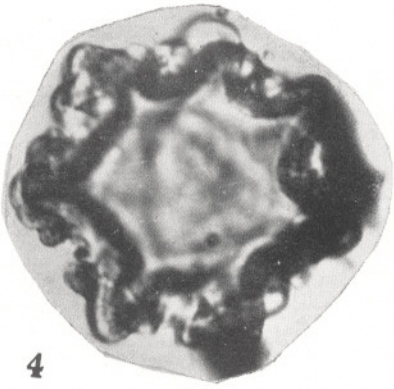

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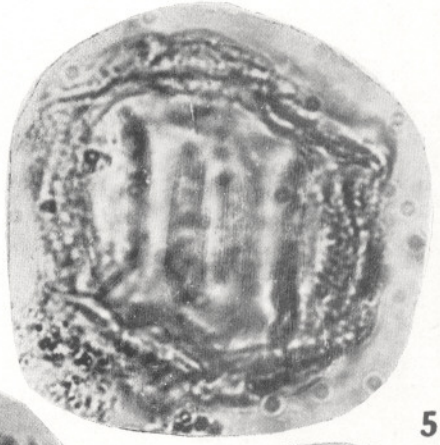

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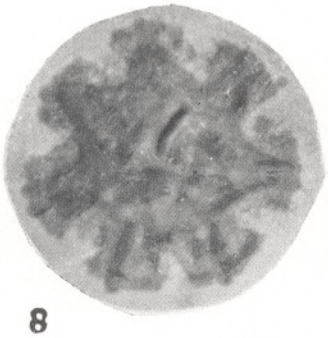

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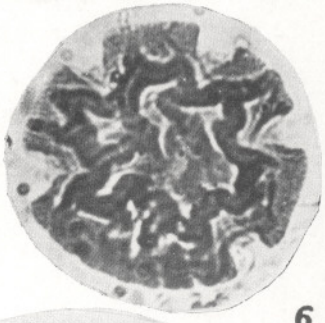

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EXPLANATION OF PLATE

PLATE 1

1, 2. *Ctenolophonidites costatus*, polar views of two grains. Note the additional thickenings in the apocolpia. × 870.

3. *C. costatus* with prominently incrassate colpi margins. × 870.

4. Another specimen of *C. costatus* in deep focus. Note the prominently incrassate colpi margins. × 1150.

5. *C. costatus* in equatorial view. × 1150.

6. *C. erdtmanii* sp. nov. (Holotype) polar view. × 870.

7. *C. keralensis* sp. nov. (Holotype) polar view. × 1000.

8. *C. saadii* sp. nov. (Holotype) polar view. × 750.

9. *C. saadii*. Part of holotype enlarged. × 1500.

10. *C. saadii*, same as in Fig. 8 but in a different focus. Note the nature of radial costae. × 660.