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HILATE SPORES FROM THE UPPER GONDWANA DEPOSITS OF PALAR BASIN, TAMIL NADU

C. G. K. RAMANUJAM
Department of Botany, Science College, Saifabad, Hyderabad
&
Y. N. R. VARMA
Department of Botany, Sardar Patel College, Secunderabad, India

ABSTRACT

Various species of hilate spore genera, viz., *Coptospora*, *Aquitriradites* and *Cooksonites* from the subsurface Sriperumbudur beds of the Palar Basin have been described. *Aequitriradites spinulosus* and *A. verrucosus* are the more commonly encountered taxa. The occurrence of hilate spores and their association with a number of characteristic Lower Cretaceous sporomorphs is indicative of a Lower Cretaceous (Neocomian-Aptian) age for these beds.

Key-words — Hilate spores, Palynology, Sriperumbudur beds, Lower Cretaceous (India).

सारांश

तमिलनाडु में पलार बेसिन के उपरि गोंडवाना निक्षेपों से हाइलेट बीजाणु – सी०जी०के० रामानुजम एवं वाई० ऍन० आर० वर्मा

पलार बेसिन के उपसतही श्रीपेरमबडर संस्तरों से हाइलेट बीजाणुओं की प्रजातियाँ, कोप्टोस्पोरा, ऍक्वीट्राईरेडाइटिस एवं कुक्सोनाइटिस, वर्णित की गई हैं। ऍक्वीट्राईरेडाइटिस स्पाइनुलोसस एवं ऍ० वेरुकोसस सामान्यतया मिलने वाले वर्गक हैं। इन बीजाणुओं की प्राप्ति तथा लाक्षणिक अवर क्रीटेश्यस कालीन अनेक बीजाणविकरूपकों से इनका साहचर्य इन संस्तरों के लिए अवर क्रीटेश्यस (निओकोमियन-ऍप्शियन) आयु इंगित करते हैं।

INTRODUCTION

THE Upper Gondwana rocks of the Palar Basin in the Chingleput District of Tamil Nadu, consisting of conglomerates, shales sandstones and mottled grits are usually classified under two more or less discrete lithic units, viz., the Satyavedu and Sriperumbudur beds. The Satyavedu beds confined to the northern part of the Palar Basin consist of arenaceous units such as ferruginous sandstones, grits and conglomerates, while the underlying Sriperumbudur beds include arenaceous and argillaceous units, viz., sandstones, grits, micaceous sandy shales and whitish or greyish fossiliferous shales (Venkatram, 1953).

A few years back, the Geological Survey of India drilled five boreholes around Kattavakkam (CK1, CK2, CK3) and Orikkai (CO1, CO2) in the vicinity of Conjeevaram for suspected coal reserves. The rocks penetrated form a part of the Sriperumbudurs overlying unconformably a horizon of khakhi-green splintery shales (equivalent of the Talchir Series) resting directly over the basement complex of Charnockites (Krishnaswamy, 1964; Murthy & Ahmed, 1971). The sandstones and shales of the subsurface Sriperumbudur beds have yielded a typical Upper Gondwana megaflora comprising *Ptilophyllum*, *Dictyozamites*, *Pterophyllum*, *Cladophlebis*, *Gleichenites*, *Taeniopteris*, etc..

The authors have recently undertaken a comprehensive study of the palynology

of the Sriperumbudur beds encountered in the above boreholes with the purpose of furnishing a basic information on the spore and pollen complex and its bearing on the geological age of these beds. Except the samples from the borehole CK2 of the Kattavakkam area, the rest of the samples have yielded a rich, varied and excellently preserved palynoassemblage (Ramanujam & Varma, 1977).

The material encompasses numerous core samples of dark grey, hard compact shales and carbonaceous shales with stringers of coaly matter. Usual techniques of maceration for the recovery and concentration of the sporae dispersae were employed.

DESCRIPTION

Anteturma — *Sporites*
Turma — *Hilates* Dettmann, 1963

Remarks — Dettmann (1963) instituted the Turma Hilates to accommodate spores possessing a hilum on the distal facet. The hilum represents an irregular thin area developing from a natural breakdown of the sclerine (exine) towards the distal polar area. Under this Turma, Dettmann (1963) directly included azonate, zonate and cingulate spore types. The authors contend that in view of the distinctive nature of the spores possessing a zona or a cingulum from those lacking such equatorial structures, it would be meaningful in a morphographic system of classification, to assign these spore types into two different subdivisions, viz., *Azonohilates* and *Zonohilates*. The following is the formal circumscription of these subdivisions.

Azonohilates — Subturma novo

This includes hilate spores which do not possess either a zona or a cingulum, eg. *Coptospora* Dettmann, 1963.

Zonohilates — Subturma novo

This includes hilate spores which may be either with a membraneous zona (e.g. *Aequitriradites* (Delc. & Sprum.) Cookson & Dettmann, 1961) or a cingulum, e.g. *Cooksonites* (Pocock) Dettmann, 1963.

Subturma — *Azonohilates*

Genus — *Coptospora* Dettmann, 1963

Type Species — *Coptospora striata* Dettmann, 1963

Remarks on Generic Circumscriptions — The genus includes azonate, hilate and variously sculptured spores.

Coptospora kutchenis Venkatachala, 1969

Pl. 1, fig. 11

Description — Spores non-aperturate or hilate, amb circular, disc-shaped, 70-82 μm. Exine up to 1·5 μm thick, infrapunctate, punctae fine locally. Hilum rather irregular, represented by thinner area on distal(?) side, 23-35 μm, *extrema lineamenta* of spore slightly wavy

Comments — The Palar Basin spore is strikingly similar to the specimens recorded from the Bhuj exposures (Venkatachala, 1969). *Coptospora kutchensis* has been recorded from both the Kattavakkam and Orikkai areas.

Coptospora cauveriana Venkatachala, 1973

Pl. 1, fig. 12

Description — Spores non-aperturate or hilate, amb circular to subcircular, 50-65 μm. Exine up to 2 μm thick, psilate or locally finely granular. Hilum up to 25 μm in diameter, following same contour of equatorial margin, generally bordered by 1-3 semilunar folds

Comments — *Coptospora cauveriana* was originally recorded from the Lower Cretaceous subcrops of the Cauvery Basin, Tamil Nadu (Venkatachala, 1973). Rao and Venkatachala (1971) recorded this spore type from the Dalmiapuram grey shale of Aptian to Lower Albian age. This is an occasional spore type of the Sriperumbudur beds of the Palar Basin. The semilunar folds bordering the hilum impart a characteristic look to the spore.

Coptospora sp.

Pl. 1, fig. 13

Description — Spores non-aperturate or hilate, amb circular to subcircular, disc-

shaped, 75-90 μm. Exine up to 1·5 μm thick, forms an irregular rugulate pattern. Hilum on distal side up to 40 μm in diameter, contour, undulating locally with fractures. Tetrad mark occasionally in the form of faint, short subradial folds. *Extrema lineamenta* firm, smoothly rounded.

Comments — Only a few specimens of this interesting spore form were encountered in our preparations. They, however, exhibit striking similarities with the spore *Coptospora* sp. recorded from the Lower Cretaceous of South Africa (Scott, 1978). *Coptospora williamsi* from the Lower Cretaceous of Manitoba, Canada has a two layered exine which is vermiculate-punctate (Playford, 1971). *C. striata* from the Lower Cretaceous of South-eastern Australia (Dettmann, 1963) shows a distal finely striate pattern of exine.

Spores morphologically similar to *Coptospora* are encountered in Bryophytes such as Sphaerocarpaceae, Ricciaceae and Riellaceae (Dettmann, 1963). The genus *Coptospora* has been recorded to date from the various Lower Cretaceous deposits of India, viz., Bhuj Series in Kachchh, Jabalpur beds, Cauvery, Godavari-Krishna and Pranhita-Godavari basins (Venkatachala, 1969; Kumar, 1973; Venkatachala, Sharma & Jain, 1972; Venkatachala & Sharma, 1974; Rao & Venkatachala, 1971; Rao, 1977; Ramanujam & Rao, 1976, 1977).

Subturma — *Zonohilates*

Genus — *Aequitriradites* (Delc. & Sprum.) Cookson & Dettmann, 1961

Type Species — Aequitriradites dubius (Delc. & Sprum.) Cookson & Dettmann, 1961

Remarks on Generic Circumscription — The genus *Aequitriradites* is a tetrahedral spore with a membraneous zona; the proximal facet is non-aperturate and generally with an incomplete tetrad mark with the Y-ridges seen prominently in the subequatorial region and extending to the margin of zona. The distal side shows an irregular thin area, the hilum, formed by the exinous breakdown. Proximal and distal facets variously sculptured.

Aequitriradites spinulosus Cookson & Dettmann, 1961

Pl. 1, figs 1-4

Description — Spores tetrahedral, zonate, hilate, biconvex, amb subtriangular to rounded-triangular with convex sides, overall size 55-65 μm, central body 26-35 μm. Zona membraneous, 8-13 μm broad, margin slightly wavy, rather finely serrate and with spinules or grana. Exine of central body 2-4 μm thick, studded with spinules intermingled with bacules on both proximal and distal facets. Spinules of different sizes, blunt-tipped or acute, more numerous at distal polar area where they are aligned in an irregular radial pattern. Y-mark ridges seen clearly towards equator, but faint or lacking towards proximal polar area. Hilum on distal side formed by exinous breakdown at polar area, irregular in contour, 2-12 μm.

Comments — Aequitriradites spinulosus is the most commonly encountered member of the hilate spores in the Sriperumbudur beds. In some core samples spores of this species are in considerable numbers. Some of our specimens are remarkably similar in their size, shape and sculptural pattern to those recorded from the Lower Cretaceous of Australia (Cookson & Dettmann, 1958, 1961; Dettmann, 1963) and Canada (Playford, 1971). We have noticed a substantial degree of variation in this species with regard to size, shape, width of zona and the nature of sculptural processes. Figures 1-4 of Plate 1 bring out to some extent this variation. A critical study of this species in future may warrant its splitting into a few new taxa.

Aequitriradites spinulosus has been hitherto recorded consistently from the Cretaceous (particularly the Lower Cretaceous) sediments of various parts of the world, viz., Neocomian-Aptian of Australia (Cookson & Dettmann, 1958, 1961; Dettmann, 1963), Hauterivian of U.S.S.R. (Chlonova, 1969; Samoilovitch & Mthedlishvili, 1961), Wealden of Germany (Doring, 1964), Valanginian-Albian and Maestrichtian of Canada (Pocock, 1962; Singh, 1964, 1971; Vagvolvi & Hills, 1969; Srivastava, 1972, 1978), Barremian-Lower Aptian of England (Kemp, 1970), Barremian-Aptian of Argentina (Archan-

gelsky & Gamerro, 1965, 1967). From India it is known from the Godavari-Krishna Basin of Andhra Pradesh (Rao Venkatachala, 1971; Sharma, Jain & Venkatachala, 1977). Further the spore (Pl. 7, fig. 86) described from the Lower Cretaceous of Kachchh by Singh, Srivastava and Roy (1964) as *Aequitriradites triangulus* looks remarkably like *A. spinulosus* and merits inclusion in this species. Similarly the spores designated as *Aequitriradites* sp. and recorded from the Jabalpur Series (Singh, 1966) also belong to *A. spinulosus*.

Aequitriradites verrucosus Cookson & Dettmann, 1961

Pl. 1, figs 5-7

Description — Spores tetrahedral, zonate, hilate, biconvex, amb subcircular to rounded-triangular with convex sides, overall size 55-75 μm, central body 25-36 μm. Zona membraneous, scabrate, 8-12 μm broad, margin smooth to slightly wavy. Exine of central body up to 3 μm thick, proximally granulose, granules locally coarse; distally verrucate. Verrucae prominent at distal polar area, up to 3 μm high, angular in surface view. Y-mark conspicuous towards equator, faintly discernable or lacking towards proximal polar area. Hilum on distal side at polar area rather irregular in contour, 10-14 μm.

Comments — Next only to *Aequitriradites spinulosus*, this is also a very frequently encountered hilate spore type in most of our preparations. *A. verrucosus* has been recorded to date rather extensively from the Lower Cretaceous deposits of Australia (Dettmann, 1963), U.S.S.R. (Grazeva, 1968), Germany (Doring, 1964), and Argentina (Archangelsky & Gamerro, 1965, 1967). From India it has been recorded from the Cauvery Basin, Pranhita-Godavari Basin and Godavari-Krishna Basin (Venkatachala, Sharma & Jain, 1972; Sharma, Venkatachala & Jain, 1977; Rao, 1977; Ramanujam & Rao, 1976-1977).

Aequitriradites sp.

Pl. 1, fig. 8

Description — Spores tetrahedral, zonate, hilate, amb subtriangular with convex sides, 53-60 μm, central body 22-32 μm. Zona membraneous, smooth, flange-like, 9-11 μm broad, margin smooth, extensions of exine from equatorial region of central body into zona seen locally. Exine of central body up to 25 μm thick, proximally smooth, distally sparsely verrucae, verrucae low, confined to subequatorial region, rounded to angular in surface view. Y-mark lacking, not clear even at subequatorial region. Hilum subcircular, up to 16 μm.

Comments — Only a few specimens of this type were found in our preparations. They seem to be, however, quite different from the known species of this genus. The lack of sculpture at distal polar area, indistinct nature or the absence of Y-mark, and the local extensions of exine of central body into the zona are the characteristic features of this sporomorph. *Aequitriradites fusus* from the Lower Cretaceous of Kachchh also lacks Y-mark as in our specimen, but the former is coarsely granulo-foveolate (Singh, Srivastava & Roy, 1964). The affinities of *Aequitriradites* are with the Sphaerocarpaceae of Hepaticae (Dettmann, 1963).

Genus — *Cooksonites* (Pocock) Dettmann, 1963

Type Species — Cooksonites variabilis Pocock, 1962.

Remarks on Generic Circumscription — As emended by Dettmann (1963) the genus *Cooksonites* includes cingulate, non-aperturate or hilate spores, variously sculptured.

Cooksonites variabilis Pocock, 1962

Pl. 1, figs 9, 10

Description — Spores non-aperturate or hilate, amb subcircular or rounded triangular to somewhat irregular, overall size 50·5-61 μm, cingulate. Cingulum 10-15 μm broad, smooth to rather irregular in contour. Exine 2·5-3·5 μm thick proximally, occasionally with a triradiate ridge. Distal exine up to 5 μm thick (or even thicker occasionally). Proximally psilate or granular, distally irregularly flattened at polar area where distinct hilum is seen. Hilum 9-13 μm, more or less rounded in outline.

Comments — A number of specimens of this spore type were encountered in our preparations, particularly from the Orikkai area. Instead of a distinct hilum some of

the specimens show irregularly disposed fractures or slits at the distal polar area. In almost all the specimens examined the cingulum appears to be rather dense. *Cooksonites variabilis* has been hitherto recorded from the Lower Cretaceous of Canada (Pocock, 1962; Singh, 1964, 1971), and South-eastern Australia (Dettmann, 1963). From India this genus has been recorded from the Lower Cretaceous of the Cauvery Basin, Godavari-Krishna Basin, Dharangadhra Formation of Gujarat, Jabalpur and Bhuj series and the Pranhita-Godavari Basin (Venkatachala, Sharma & Jain, 1972; Rao & Venkatachala, 1971; Sharma, Jain & Venkatachala, 1977; Singh, 1966; Venkatachala, 1969a, 1969b; Rao, 1977; Ramanujam & Rao, 1976, 1977). The botanical affinities of *Cooksonites* are also similar with the Hepaticae (Dettmann, 1963).

DISCUSSION

The taxa recorded from the Upper Gondwana Sriperumbudur beds are, viz., *Coptospora kutchensis*, *C. cauveriana*, *C.* sp., *Cooksonites variabilis*, *Aequitriradites spinulosus*, *A. verrucosus*, and *A.* sp. Of these, *Aequitriradites spinulosus* and *A. verrucosus* represent the more frequently encountered ones. A well-developed hilum is seen generally in most of the specimens examined and the formation of hilum by the natural exinous breakdown at the distal polar area is quite obvious in the majority of the specimens.

A critical survey of various Mesozoic microfloras of India shows significantly that the hilate spore types are confined essentially to the Lower Cretaceous (Neocomian-Aptian) sediments. Thus all the three hilate genera, *Coptospora*, *Cooksonites* and *Aequitriradites* are known to date from the Lower Cretaceous sediments of Umia and Bhuj in Kachchh, Jabalpur Series of Madhya Pradesh, Palar and Cauvery basins of Tamil Nadu, and Pranhita-Godavari and Godavari-Krishna basins of Andhra Pradesh. Further, two of these taxa, viz., *Aequitriradites* and *Cooksonites* are also known from the Dhrangadhra Formation of Saurashtra in Gujarat (Singh, Srivastava & Rao, 1964; Venkatachala, 1967, 1969a, 1969b; Venkatachala & Kar, 1969; Singh, 1966; Kumar, 1973; Venkatachala, Sharma & Jain, 1972; Venkatachala & Jain, 1970; Rao & Venkatachala, 1971; Sharma, Jain & Venkatachala, 1977; Rao, 1977; Ramanujam & Rao, 1976, 1977). The only exception to this geological record appears to be the rare occurrence of *Coptospora* in the Upper Jurassic Katrol sediments of Kachchh (Venkatachala, Kar & Raza, 1969; Venkatachala & Kar, 1970).

In the Palar Basin as is the case with the Cauvery Basin, Pranhita-Godavari and Godavari-Krishna basins, the hilate spores are characteristically associated with *Impardecispora* (*I. apiverrucata*), *Foraminisporis*, *Contignisporites* (*C. globulentus*, *C. multimuratus*), *Cicatricosisporites* (*C. australiensis*, *C. hughesi*), *Crybelosporites*, *Polycingulatisporites*, *Klukisporites*, *Ischyosporites*, *Staplinisporites*, *Biretisporites*, *Ornamentifera*, *Taurocusporites* (*T. segmentatus*) and *Microcachryidites* (*M. antarcticus*). And almost the same state of affairs is with the palynoassemblage of the Bhuj Series in Kachchh. It is pertinent to mention that more or less similar association of spore types is characteristic of the various Lower Cretaceous (Neocomian-Aptian) deposits of Australia, Canada, South Africa, and Argentina (Dettmann, 1963; Balme, 1964; Archangelsky & Gamerro, 1967; Singh, C. 1964, 1971; Scott, 1976; Srivastava, 1978). In the light of this impressive evidence it is considered that the hilate spores and their association with a number of accredited Lower Cretaceous spore types clearly point towards a Lower Cretaceous (Neocomian-Aptian) age for the Sriperumbudur beds.

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EXPLANATION OF PLATE

PLATE 1

1-4. *Aequitriradites spinulosus.*× 750.
5-7. *A. verrucosus.*× 750.
8. *A.* sp.× 600.
9, 10. *Cooksonites variabilis.*× 750.
11. *Coptospora kutchensis.*× 750.
12. *C. cauveriana.*× 750.
13. *C.* sp.× 600.

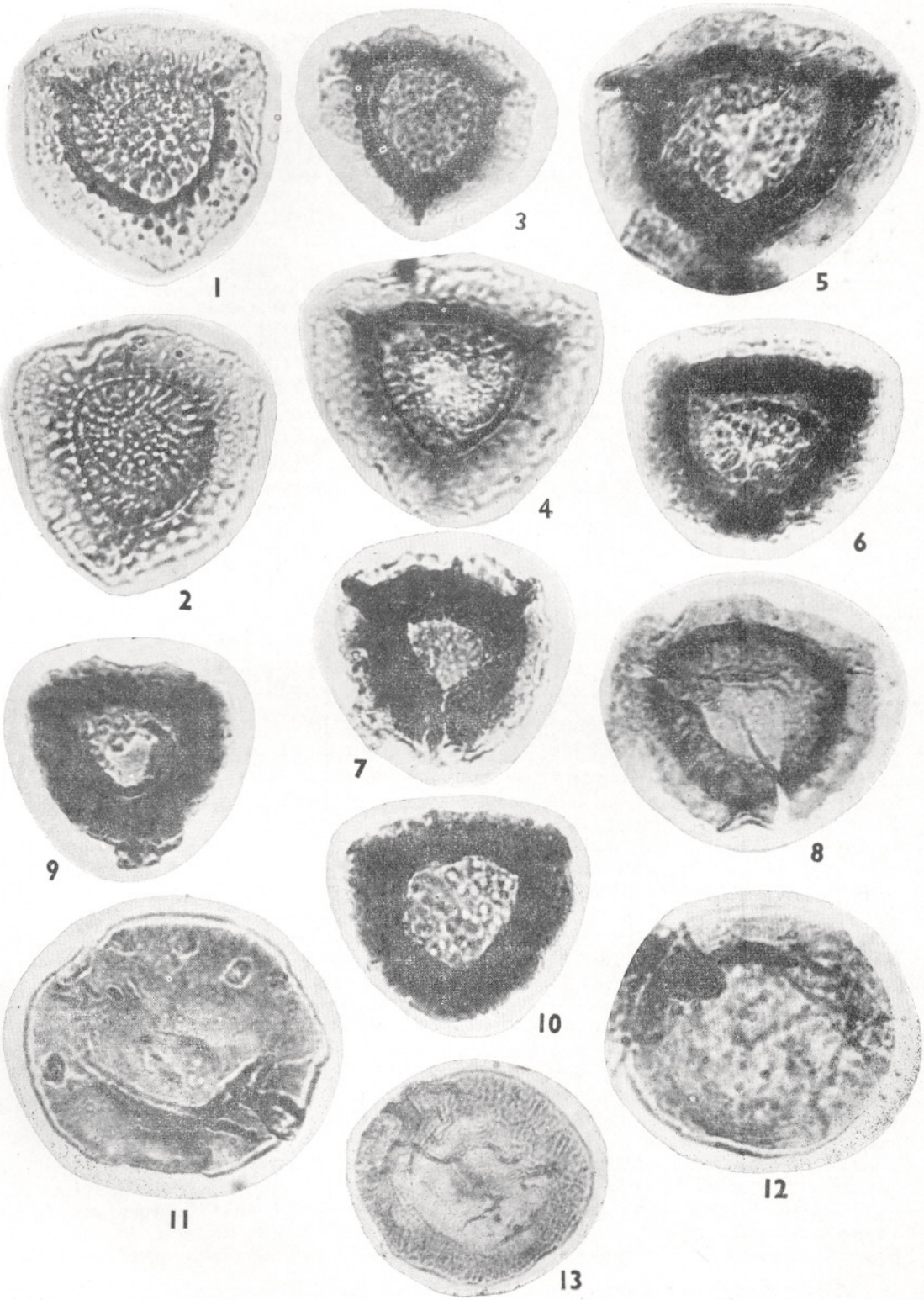

PLATE 1