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Palynomorph assemblage from Keratong, Pahang: its age and emergence of angiospermlike pollen

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Abstract: The identified palynomorph assemblage from a rock sequence which is exposed at Felda Keratong 8, southeastern part of Pahang, resembles the *Paradoxa* Assemblage and it is suggested that its age is late Lower Cretaceous (Barremian-Albian). The occurrence of monosulcate pollen of *Clavatipollenites hughesii* indicates that the emergence of angiosperms has taken place during the deposition of the sediments in this area.

Abstrak: Himpunan palinomorf yang dikenal pasti dari jujukan batuan yang tersingkap di Felda Keratong 8, bahagian tenggara Pahang, mempunyai persamaan dengan Himpunan *Paradoxa* dan dicadangkan usianya sebagai akhir Kapur Awal (Barremian-Albian). Kehadiran polen jenis monosulkat *Clavatipollenites hughesii* menunjukkan kemunculan angiosperma semasa pengendapan sedimen berlaku di kawasan ini.

INTRODUCTION

Objectives and general geological aspects

This study deals with the palynomorph assemblage yielded from the studied samples collected from Felda Keratong 8, southeastern part of Pahang (Fig. 1A) and emphasis is also given on the occurrence of pollen grains which indicate the first appearance of the angiosperms in Peninsular Malaysia. The occurrence of the palynomorphs from this area was briefly reported by Uyop Said and Ahmad Jantan (1994). Based on the identified palynomorph assemblage, the age of the rock sequence in the southeast Pahang can be ascertained to a more specific age limit. Previously, due to scarcity of palaeontologic evidence, it was dated by previous workers as only Jurassic-Cretaceous age.

The rock sequence of typically fining upward sequence (Fig. 1B), consists predominantly of fine to coarse-grained cross-bedded sandstone, parallel-laminated siltstone and mudstone which was mapped as Gerek Formation (Cook and Sutharalingam, 1970), and it is interpreted that the sediments were deposited in a fluvial depositional environment. However, Shaw (1971) correlated the sedimentary rock sequences in the southeastern parts of Pahang to the Gemas Formation. The Felda Keratong area and its vicinity was later mapped by Yusri Ramly (1999), and it was found that the Jurassic-Cretaceous rocks are commonly exposed on higher ground of approximately at the contour line of 100 ft high. In general, as for most of the Jurassic-Cretaceous sedimentary rocks in Peninsular Malaysia, the gently dipping Jurassic-Cretaceous sedimentary rocks in the southeastern parts of Pahang overlie the older rocks of either igneous or metasediments.

Brief notes on the origin of the angiosperms

It has been accepted that issues concerning the origin and early evolution of the angiosperms are more geological rather than botanical. Palynological data are vital and they play an important role in attempts to clarify the problems. Several authors (such as Beck, 1976 and more recently Hughes, 1994) discussed in depth of the possibilities on the type of pollen which were believed to be the first pollen produced by the angiosperm plants. It was realised that the slow progress in solving their origin is because of the disagreement among workers in determining the actual time of the first appearance of the angiosperms. Generally, beliefs on the time of the origin of angiosperms were divided into two. They are angiosperms originated in the late Palaeozoic and secondly, the most accepted hypothesis was that the origin of the angiosperms started in Lower Cretaceous times. Hughes (1961a) stated that angiosperms evolved during Barremian and Aptian times and gradually diversified from Albian through Cenomanian times. This hypothesis was supported by Doyle (1969) and Muller (1970). Some workers tried to describe the absence of the angiosperms records in the pelaeontological works due to the nature of the primitive angiosperm plants of being small and shrubby living in hilly or mountainous areas, and therefore they were very unlikely to be preserved as fossils.

Several theories on types of pollen grains related to the pollen of the earliest angiosperms were suggested. Among the pollen grains which were considered to be the earliest angiosperm pollen was monosulcate pollen. But after a thorough study, it was found that identification by palynological methods is difficult to distinguish between the very primitive angiosperms and those of real

angiosperms. Monosulcate pollen grain of *Clavatipollenites* was possibly derived from angiosperm plants that appeared in the geologic record during the Barremian to Aptian stages. Another pollen grain of tricolpate in nature identified as *Eucommiidites* (Erdtman, 1949) was earlier thought to be angiospermlike and possibly the pollen of a primitive angiosperm recorded from Lower Jurassic-Barremian strata. However, it was later rejected as *in situ* studies clearly proved that it was produced by gymnosperms (Hughes, 1961b and Brenner, 1967).

After taking various aspects into consideration, most palynologists agree that angiosperms were not present anywhere in the world before Barremian time. Consequently, they also agree upon the fact that the oldest tricolpate pollen to be the first definite evidence of angiosperms, and the first appearance of such pollen is also considered by many palynologists as the indicator of the uppermost part of the Lower Cretaceous. The earliest angiosperm pollen of Berremian age, *Clavatipollenites* Couper 1953 was described as small and smooth to simply reticulate monosulcate grains (Couper, 1958). Based on the palynological studies on the Barremian-Cenomanian sediments from various localities, it was found that the oldest tricolpate pollen were found from the tropical latitudes and they were relatively fewer recorded in younger sediments towards higher latitudes.

Material and method

Three samples of fine-grained sandstone and mudstone were collected from a rock sequence exposed at Felda Keratong 8 and they were processed for palynological study using the standard method of palynological preparation techniques. The samples were treated in hydrofluoric acid to dissolve the silica and subsequently oxidised with Schulze solution for fifteen to twenty minutes. The residues were then mounted on glass slides using Canada balsam as mounting medium. All slides were examined under transmitted light microscope to identify the presence of palynomorphs and some selected ones were illustrated.

Results and discussions

Plynomorph assemblage

Only one sample (282) yields a considerable number of well-preserved palynomorphs. The identified palynomorphs are *Araucariacites australis*, *Polypodiaceoisporites* sp., *Classopollis* spp., *Balmeisporites holodictyus*, *Inaperturopollenites* sp., *Triorites* cf. *minutipori*, *Pilosporites* sp., *Microfoveolatosporis* sp., *Matonisporites* sp., *Aequitriradites* sp., *Ceratosporites equalis*, *Ephedripites* sp., *Leptolepidites* sp., *Cyathidites australis*, *Clavatipollenites hughesii*, *Dictyophyllidites pectinataeformis*, *Tricolporonites punctatus*, *Cycadopites nitidus*, *Reticolpites vulgaris*, *Calamospora* sp. and *Laevigatosporites* sp.. The most commonly (ten or more

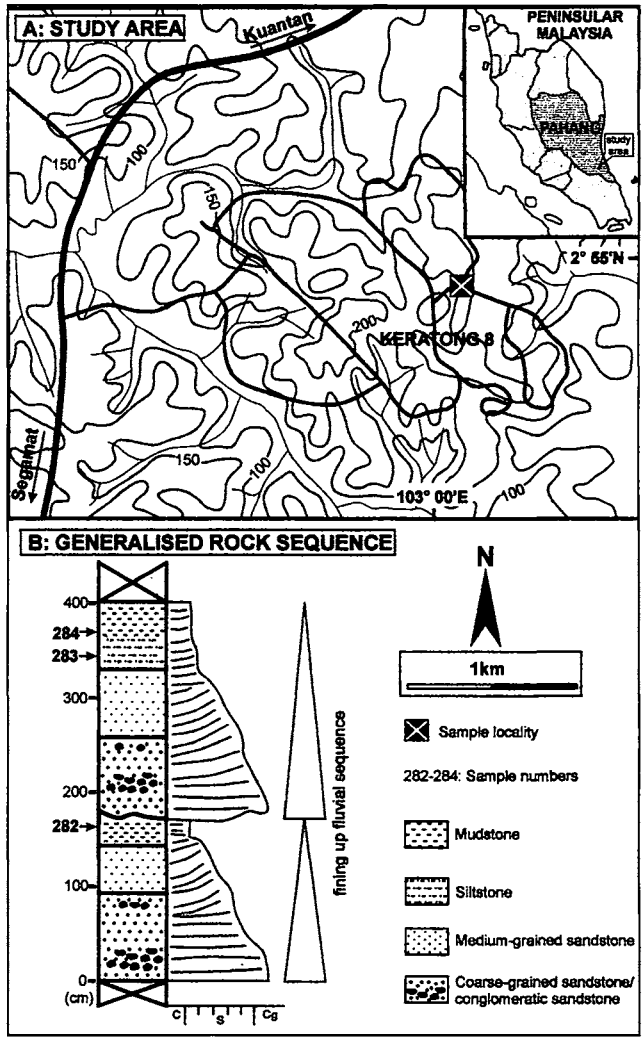

Figure 1. Study area (A) and generalised rock sequence showing the sample horizons (B).

specimens encountered in one slide) found species are *Tricolporopollenites punctatus*, *Cyathidites australis* and *Cycadopites nitidus*. Five to ten specimens of the monosulcate pollen of *Clavatipollenites hughesii* were found in one slide. The stratigraphic range of some selected (also recorded in present sample) Cretaceous palynomorphs are shown in Figure 2.

The identified palynomorph assemblage from Keratong shows a very close resemblance with the *Paradoxa* Assemblage (Dettmann, 1963) of Aptian-Albian age. It is characterised by the presence of diagnostic species namely *Coptospora* paradoxa, *Pilosporites grandis*, *Dictyophyllidites pectinataeformis*, *Trilobosporites trioreticulosus* and *Kraeuselisporites majus*. Furthermore, it is also characterised by the presence of common species of *Balmaesporites holodictyus*, *Crybelosporites striatus*, *Aequitridites spinolosus*, *Cyathidites major*, *Cyathidites australis*, *Araucariacites australis* and *Baculatisporites* sp.. Although the age of the *Paradoxa* Assemblage was suggested as Aptian-Albian, the presence of *Clavatipollenites hughesii* which was reported to have appeared for the first time in the Barremian, it is suggested

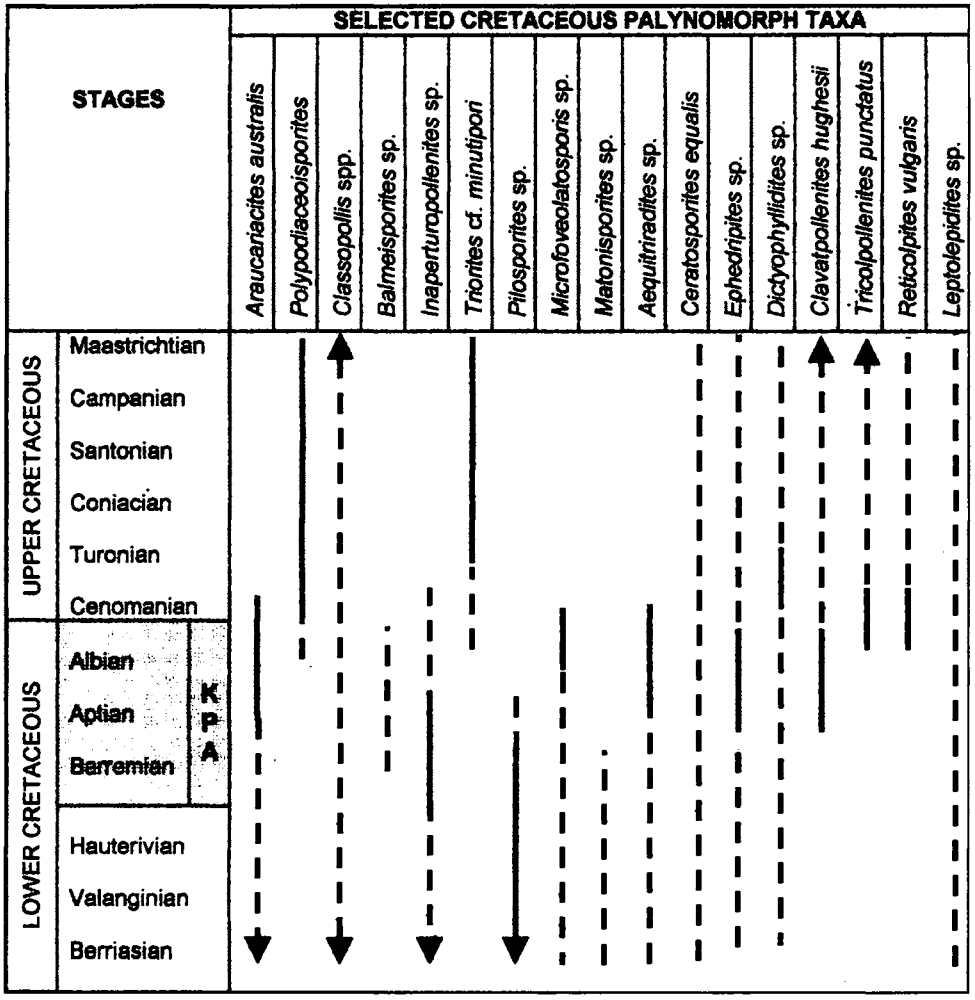

Figure 2. Stratigraphic range chart of some selected Cretaceous palynomorphs and the proposed age of the Keratong palynomorph assemblage (KPA).

that a more appropriate interpretation of the age of the identified palynomorph assemblage from Keratong is Barremian-Albian.

The present palynomorph assemblage which is characterised by the dominance of tricolpate and triporate pollen grains is comparable with that of Tertiary palynomorph assemblage. However, the latter assemblage is not represented by the palynomorph species characterising the late Early Cretaceous assemblage. Furthermore, from the sedimentological point of view, the studied rock sequence is clearly not comparable to any Tertiary age rock sequences reported throughout Peninsular Malaysia by having typically cross-bedded medium to coarse-grained sandstone unlike the latter which is generally characterised by almost flat-lying unconsolidated predominantly fine-grained sandstone and mudstone. Due to the lack of species which are used in characterising palynologic zones, the identified palynomorph assemblage is not assignable to the older reported palynomorph assemblages. This view is supported by the presence of a considerable number of monosulcate and triporate pollen grains which were reported to have appeared for the first time in Middle Cretaceous time. The presence of monosulcate and triporate pollen grains distinguishe the Keratong palynomorph assemblage from other Jurassic-Cretaceous palynomorph assemblages which were previously reported (Uyop Said and Che Aziz Ali, 2000; Uyop Said and Syahrul Salehudin, 2001) from the southern parts of Peninsular Malaysia.

Angiospermlike pollen grain

The presence of angiospermlike pollen grains from the genus *Clavatipollenites* is assignable to *Clavatipollenites hughesii* (Couper, 1958). The genus was diagnosed as a monosulcate pollen grain with broad and long sulcus, broadly elliptical to spherical in equatorial view and the exine is stratified. Despite being slightly larger in maximum diameter, the present specimens (Fig. 3) conform to the description of *Clavatipollenites hughesii* given by Couper (1958). The maximum diameter of the present specimens is between 25-35 μm (5 specimens). In comparison, the measurement given by Couper was 18-29 μm. The difference in maximum diameter is probably due to the different chemicals used during sample preparation.

Several discussions on the origin of the angiosperms by previous workers as summarised above seem to agree that the monosulcate pollen grain of *Clavatipollenites* to be considered as the earliest angiosperm pollen. Couper

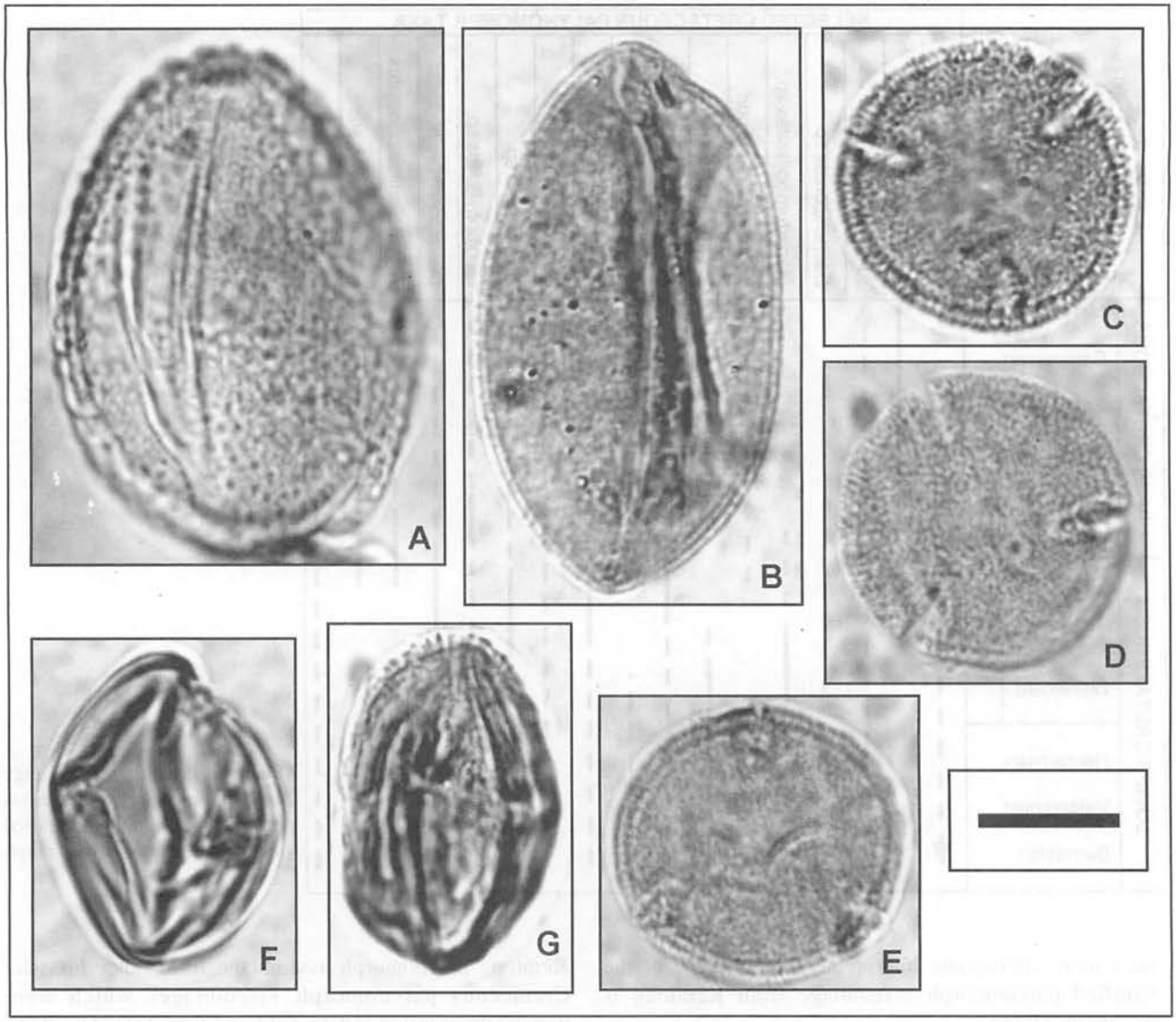

Figure 3. Selected palynomorphs from Keratong. A & B: *Clavatipollenites hughesii* Couper 1958 (A: 282-SU4-H36, B: 282-SU3-H47/2), C-E: *Tricolporopollenites punctatus* Pacltova 1971 (C: 282-SU3-N49, D: 282-SU1-Q34/3, E: 282-SU1-W47/4), F & G: *Cycadopites* sp. (282-SU1-U28/4, G: 282-SU3-D32). All specimens were photographed under transmitted light microscope. Sample number, slide number and England's finder reference are in bracket. Scale bar = 10 μm.

(1958) stated that the monosulcate pollen grain *C. hughesii* which is characterised by stratified and tectate exine is similar to that of pollen from present day Angiospermae. Therefore, the writer, based on the similarities of the present specimens with that of *Clavatpollenites hughesii*, suggests that the identified Keratong palynomorph assemblage bears the earliest angiosperm pollen grains. The presence of *Clavatipollenites* sp. was also reported from central part of Pahang (Shamsudin Jirin and Morley, 1994).

As agreed by many workers, the tricolpate pollen is a definite angiosperm pollen and many palynologists interpret the topmost of Lower Cretaceous is marked by the first appearance of such pollen. Similarly, the present palynomorph assemblage is also represented by tricolpate pollen, and therefore, the palynomorph assemblage from Keratong is more appropriate to be assigned to late Lower Cretaceous palynomorph assemblage.

CONCLUSIONS

From the available palynological data, the age of the sedimentary rocks sequence from Keratong is suggested to be late Early Cretaceous (Barremian-Albian). The identified palynomorph assemblege is comparable to the *Paradoxa* Assemblage (Aptian-Albian). The presence of *Clavatipollenites hughesii* in the identified palynomorph assemblage indicates that the emergence of angiosperms has taken place in late Early Cretaceous.

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