A palynological study on an Early Cretaceous rock sequence at Bukit Belah, Batu Pahat, Johor

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Abstract: The palynomorph assemblage from a rock sequence exposed at Bukit Belah, Batu Pahat, Johor is interpreted to be of Early Cretaceous age. The assemblage is characterised by the presence of some significant species such as Cicatricosisporites australiensis, C. ludbrooki and Reticulatisporites pudens, and it closely resembles the Speciosus Assemblage which was reported from lower Cretaceous strata (Valanginian-Aptian). Based on its similarity in having some common species with that of the older assemblage, therefore, the present palynomorph assemblage is suggested to be correlated with the lower part of the Speciosus Assemblage (Valanginian-? Hauterivian).

INTRODUCTION

Recent quarrying activities at about 15km to the north of Batu Pahat expose several new outcrops, especially at Bukit Payong and Bukit Belah ridges. A palynological study was carried out on one particular outcrop at the latter ridge (Figure 1). Based on field observation on the rock sequences at Bukit Payong which is predominantly reddish brown in colour of coarse-grained sandstone and conglomerate, it was found that they were not suitable for a detailed palynological study. Random sampling on the most potential samples for palynological study from some localities at Bukit Payong was carried out and they were processed, but nevertheless, they were found to be devoid of palynomorphs.

Various geological aspects in and around the study area were reported by previous workers. On the age and the sedimentological aspects of the rock sequence exposed at Bukit Payong and Bukit Belah, Burton (1973) interpreted the rock sequence as molasse deposits of Upper Triassic age. It was also correlated and interpreted to be similar to the Bukit Resam Member of the Jurong Formation by Md Shahid Ayub (1978). A detailed sedimentological study was carried out by Noor Bakri Endut (1981) and he estimated the thickness of the rock sequence as approximately 2000 m, and it can be divided into three sections, namely lower, middle and upper section. The lower section is characterised by the presence of tuff and andesite which is only exposed at Bukit Medan (north of the study area). The middle section is dominated by conglomerate which is interbedded with sandstone and minor siltstone layers, whilst the top-most section is predominantly sandstone and siltstone. Based on its similarity in lithology with other localities, he also proposed a longer age limit as Late Triassic to Early Cretaceous. Consequently, Tan (1988) studied in great detail the sedimentological aspects of the area and proposed the Payong Formation to include the rock sequences at Bukit Belah, Bukit Payong, Bukit Bindu and Bukit Inas of Late Triassic to Early Jurassic age which conformably overlies a pyroclastic unit (as observed at Kangkar, north of Bukit Payong).

The scarcity in palaeontological evidence of well-preserved macrofossils, which is not uncommon for most of the Jurassic-Cretaceous rocks in Peninsular Malaysia, seems to be the main cause for the inconsistency in interpreting the age of the rock by previous workers. There are several records on the presence of poorly-preserved plant fragments from some localities at Bukit Belah and the adjacent areas, such as reported by Noor Bakri Endut (1981) and Tan (1988). In a recent study by Syahrul Salehadin (in prep.) on several new outcrops at Bukit Belah, a considerable number of fairly well-preserved Late Jurassic- Early Cretaceous plant fossils attributable to Gleichenites (Gleichenoides) pantiensis Ko'no 1967, Frenelopsis malaiana Ko'no 1967, Cupressinoclados acuminifolia Ko'no 1968, Otozamites malayana Smiley 1970, Ptilophyllum cf. pterophylloides Yokoyama, and P. cf. ayobanum Smiley 1970 were identified. Based on the latest edition of geological map of Peninsular Malaysia published...
by the Geological Survey of Malaysia, the rock sequence in the study area was mapped as sedimentary rocks of Jurassic-Cretaceous age. Khoo (1983) described the occurrence and distribution of Jurassic-Cretaceous sedimentary rocks in the Malay Peninsula. The most recent synthesis on the formation and structural styles of the Jurassic-Cretaceous rocks was discussed by Tjia (2000). He, among other conclusions arose from the synthesis, highlighted that, a major tectonic deformation of Peninsular Malaysia occurred in Late Triassic-Early Jurassic time, followed by the deposition of Jurassic-Cretaceous sediments which was later deformed (tilted or uplifted) by wrench-faulting along several pull-apart boundaries.

MATERIAL AND METHOD

A total of 57 samples were collected from three localities at Bukit Belah and one locality at Bukit Payong. 51 samples were collected from the former localities and only six samples from the latter. However, only the rock sequence at one of the localities at Bukit Belah is discussed in this paper. This rock sequence was measured and 33 samples were collected and processed for palynological study. A generalised rock section and sample horizons are shown in Figure 2. Most of the samples are grey to dark grey siltstone and fine to medium-grained sandstone, and they were processed according to the standard procedure of palynological preparation techniques. All the samples were oxidised by Schulze solution for a duration varying from 20 to 45 minutes.

RESULT AND DISCUSSION

The Rock Sequence

The rock sequence was described by Syahrul Salehudin (in prep.) as having three main lithofacies, namely conglomerate facies, sandstone facies and siltstone facies which can be divided into several subfacies. In general, the section studied is dominated by siltstone and fine to medium-grained sandstone. The bottom-most measurable part of the section is characterised by several layers of fine-grained sandstone and thickly bedded siltstone. Based on the grain size which is typically fining upwardly and the sedimentary structures, the depositional environment of the observed section is interpreted as a braided river system.

Palynomorph Assemblage

Only six samples from the section studied yielded different states of preservation of palynomorphs assignable to 21 taxa. Other samples found to be devoid of
The less common species described as form. Each palynomorph observed in the specimens in sample from each taxon were photographed using transmitted light of every taxon in each sample was not possible due to the occurrence of palynomorphs which were counted (up to dominated by apiculate spores, varying in types of ornament, australiensis, Classopollis classoides, Ceratosporites microsphere and illustrated in very low number of palynomorphs. However, based on the processes. This assemblage is compared to upper Mesozoic palynomorph species was estimated.

Most of the palynomorphs discussed in the present study are systematically described and representatives of every taxon in each sample was not possible due to the very low number of palynomorphs. However, based on the occurrence of palynomorphs which were counted (up to 40 specimens in sample 1051) and the percentage of each palynomorph species was estimated. Araucaricites australis seems to be the most common species (approximately 15%), followed by Cicatriciosporites annulatus, C. ludbrooki, and Inaperturapollenites sp. (10%).

The less common species (5-10%) are Cicatriciosporites australiensis, Classopollis classoides, Ceratosporites equalis, Klukisporites variyegatus, Leptolepidites major and Callialasporites dampieri. Some specimens are only described as form. Each palynomorph observed in the present study is systematically described and representatives from each taxon were photographed using transmitted light microscope and illustrated in Plates 1 and 2.

In general, the identified palynomorph assemblage is dominated by apiculate spores, varying in types of ornament, from simple grana or verrucae to spines or elongated processes. This assemblage is compared to upper Mesozoic palynological zones proposed by previous authors. Most of the constituents in the present palynomorph assemblage are stratigraphically long-ranged spores and pollen, spanning the Jurassic to Cretaceous or even the entire Upper Mesozoic, and therefore, they are considered as the least useful for interpreting the age of the rock sequence. Nevertheless, after thorough comparative study with other palynomorph assemblages of comparable age, it is found that some species are more restricted in their age ranges. The most comparable palynological zones are those reported from Upper Jurassic and Lower Cretaceous strata (Dettmann, 1963; Balme, 1964; Backhouse, 1988).

The present palynomorph assemblage is not comparable to the Upper Jurassic palynological zones. It was reported that the Upper Jurassic palynological zones are characterised by a relatively common occurrence of certain species such as Retitriletes watheroensis and Aequitriradites acusus which were not recorded in the present study. Although the diagnostically occurring species in the Lower Cretaceous palynological zones were also not recorded in the present assemblage, it shows some similarities with the zones by having other distinctive species. For instance, the present assemblage lacks the common species of Cymbelosporites stylosus and Dictyotosporites speciosus which characterise the Lower Cretaceous palynological zones of Stylosus and Speciosus Assemblages respectively, but it shows a close resemblance in having other constituents.

The palynomorph assemblage from Bukit Belah closely resembles Speciosus Assemblage (Dettmann, 1963) or Balmeiopsis limbata Zone (Backhouse, 1988) of Lower Cretaceous age (Valanginian-Aptian). The rarer occurrence of Biretisporites eneabaenensis distinguishes the present assemblage from Berriasian palynological zonation scheme of either Biretisporites eneabaenensis Zone or Stylosus Assemblage. It is not comparable with the slightly older assemblage reported from Panti (Uyop Said and Che Aziz Ali, 2000), located at approximately 110 km to the southeast of the study area, because of its relatively rarer occurrence in Convallissimispores variverrucatus. Furthermore, the present assemblage is also distinguished from the older zone or assemblage by the absence of some significant species, namely Aequitriradites dandaraganensis, Laevigatosporites belfordii, Matonisporites agatonensis and Janasporites multispinus. The interpreted age of the studied rock sequence based on the identified palynomorph assemblage is strongly supported by the presence of Cicatriciosporites ludbrooki and Reticulatisporites pudens. The former species was reported as a significant species in Speciosus Assemblage and it was not recorded in the older assemblage, whilst the latter species is categorised as one of the typical or exclusive species which is confined in the Cretaceous age, especially in the Speciosus Assemblage.

A detailed description on the Speciosus Assemblage was discussed by Dettmann (1963). The presence of certain significant species was utilised in delineating the lower and upper limits of the assemblage. It was stated that, its type is not younger than Aptian, and the lower limit is probably no older than Valanginian. The assemblage can be divided into stratigraphically lower and upper horizons. The former horizon is characterised by the consistently
occurring species Murospora florida, Cyclosporites hughesi, Contignisporites cooksonii, Krauselisporites linears and Cooksonites variabilis which are absent in the upper horizon, together with the diagnostic species Dicrytoporopites speciosus. The stratigraphically younger horizon is distinguished by the presence of Cybelosporites striatus, Rouseisporites radiatus, Coptospora striata and Pyrobolspora reticulata. Based on the presence of Cicatricosisporites australiensis which is also recorded as a rarer occurrence in the underlying assemblage, the present palynomorph assemblage shows some similarities with the Stylosus Assemblage. However, it is distinguished from the older assemblage by the presence of Cicatricosisporites ludbrooki which is not recorded in the latter. Thus, from this evidence, it is believed that the present palynomorph assemblage is more comparable to the Speciosus Assemblage rather than to the older Stylosus Assemblage. But, the presence of some common species recorded in both Stylosus and Speciosus Assemblage, for example, Reticulatisporites pudens, Cyathidites australis and Araucaricites australis, as observed in present assemblage, it is probably at the juncture of the two palynological zones, and therefore, from the present available palynological data, it is suggested that the Bukit Belah palynomorph assemblage is more appropriate to be placed at the lower part of the Speciosus Assemblage of Valanginian- Hauterivian (Figure 3).

**Brief Notes on Systematic Palynology**

The identification of the observed palynomorphs in the present study is based on previously described taxa by Couper (1958), Dettmann (1963), Balme (1964) and Backhouse (1988), and they also provided an extensive lists of references for taxonomic study. All the identified palynomorphs together with their stratigraphic ranges and the present occurrences are listed below.

**Genus Cyathidites** Couper 1953

- *Cyathidites australis* Couper 1953 (Plate 1, fig. 1)
  - Stratigraphic distribution: Common in Jurassic- Early Cretaceous strata (Couper, 1953)
  - Present occurrence: Samples 1041, 1047 and 1051.

**Genus Dicytophyllidites** (Couper) Dettmann 1963

- *Dicytophyllidites equiexinus* (Couper) Dettmann 1963 (Plate 1, fig. 2)
  - Stratigraphic distribution: Jurassic-Early Cretaceous, Britain (Couper, 1958)
  - Present occurrence: Samples 1041, 1045 and 1051.

**Genus Deltoidospora** (Miner) Potonié 1956

- *Deltoidospora hallii* Miner 1935 (Plate 1, fig. 3)
  - Stratigraphic distribution: Early Cretaceous, Canada (Singh, 1964)
  - Present occurrence: Samples 1041 and 1051.

Deltoidospora psilostoma Rouse 1959 (Plate 1, fig 4)

- Stratigraphic distribution: Bathonian-Late Cretaceous, Alberta (Pocock, 1962)
  - Present occurrence: Samples 1045, 1047 and 1051.

Infraturma APICULATI Bennie and Kidston emend. Potonié 1956

**Genus Concavissimisporites** Delcourt and Sprumont emend. Delcourt et al. 1963

- *Concavissimisporites crassatus* (Delcourt and Sprumont) Delcourt et al. 1963 (Plate 1, fig. 5)
  - Stratigraphic distribution: Neocomian, Belgium (Delcourt and Sprumont, 1955)
  - Present occurrence: 1038, 1041 and 1051.

**Genus Leptolepidites** Couper 1953

- *Leptolepidites bossus* (Couper) Schulz 1967 (Plate 1, fig. 6)
  - Stratigraphic distribution: Middle Jurassic, Britain (Couper, 1958)
  - Present occurrence: Samples 1038 and 1051.

- *Leptolepidites major* Couper 1958 (Plate 1, fig. 7)
  - Stratigraphic distribution: Middle Jurassic, Britain (Couper, 1958)
  - Present occurrence: Samples 1041, 1050 and 1051.

**Genus Ceratospores** Cookson and Dettmann 1958

- *Ceratospores equalis* Cookson and Dettmann 1958 (Plate 1, figs. 8 and 9)
  - Stratigraphic distribution: Neocomian-Aptian, East Australia (Cookson and Dettmann 1958)
  - Present occurrence: Samples 1041 and 1051.

Infraturma MURORNATI Potonié and Kremp 1954

**Genus Reticulatisporites** Ibrahim emend. Potonié and Kremp 1954

- *Reticulatisporites pudens* Balme 1956 (Plate 1, figs. 10 and 11)
  - Stratigraphic distribution: Neocomian-Aptian (Balme, 1957)
  - Present occurrence: Samples 1041 and 1051.

**Genus Klukisporites** Couper 1958

- *Klukisporites variegatus* Couper 1958 (Plate 1, figs. 12 and 13)
  - Stratigraphic distribution: Middle Jurassic, Britain (Couper, 1958)
  - Present occurrence: Samples 1041 and 1051.

**Genus Cicatricosisporites** Potonié and Gelletich 1933

- *Cicatricosisporites annulatus* Archangelsky and Gamerro 1966 (Plate 2, fig. 1)
  - Stratigraphic distribution: Middle Albian, Alberta (Singh, 1964)
  - Present occurrence: Samples 1050 and 1051.

- *Cicatricosisporites australiensis* (Cookson) Potonié 1956 (Plate 2, fig. 2)
  - Stratigraphic distribution: Lower Cretaceous (Balme 1957)
  - Present occurrence: Samples 1047 and 1051.
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**Genus Cicatricosisporites hudsonii** Dettmann 1963 (Plate 2, figs. 2, 3 and 4)
Present occurrence: Sample 1051.

**Genus Pelleteria** Bolkhovitina 1961
*Pelleteria minutaestriatus* Bolkhovitina 1961 (Plate 2, fig. 5)
Present occurrence: Sample 1051.

Suprasubtuma: [CAMERATITRILETES](https://example.com) Neves and Owens 1966
Subtuma: [MEMBRANATITRILETES](https://example.com) Neves and Owens 1966
Infratuma: [CINGULICAMERATITES](https://example.com) Neves and Owens 1966

**Genus Polycingulatisporites** Simonics and Kedd emend Playford and Dettmann 1965
*Polycingulatisporites redundans* (Bolkhovitina) Playford and Dettmann 1965 (Plate 2, fig. 6)
Stratigraphic distribution: Jurassic to Late Cretaceous, worldwide (Bolkhovitina, 1953; Stover, 1962).


Present occurrence: Sample 1051.

**Anteturma POLLENITES** Potonie 1931
**Turma SACITIES** Erdtmann 1947
**Subturma MONOSACCITES** Chitaley emend Potonie and Kremp 1954

Infraturma SACCIZONATI Bhawardj 1957

**Genus Callialasporites** Sukh Dev. 1961
*Callialasporites dampieri* (Balme) Dev. 1961 (Plate 2, figs. 7 and 8)
Stratigraphic distribution: Jurassic, Cretaceous, Eocene, Western Australia and Aptian- Albian, Papua (Balme 1957).
Present occurrence: Samples 1038, 1050 and 1051.

**Turma ALETES** Ibrahim 1933.
**Subturma AZONALETES** Lube emend Potonie and Kremp 1954

**Genus Araucariacites** Cookson 1947, Couper 1953
*Araucariacites australis* Cookson 1947 (Plate 2, figs. 9 and 10)

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Present occurrence: Samples 1045, 1047, 1050 and 1051.

Genus *Inaperturopollenites* Pflug and Thomson in Thomson and Pflug 1953

*Inaperturopollenites* sp. (Plate 2, fig. 11)

Present occurrence: Samples 1041 and 1051.

Turma POROSES Naumova emend. Potonie 1960

Subturma MONOPORINES Naumova 1939

Genus *Classopollis* (Pflug) Pocock and Jansonius 1961

*Classopollis classoides* (Pflug) Pocock and Jansonius 1961 (Plate 2, figs. 12 and 13)

Stratigraphic distribution: Jurassic-Early Cretaceous, Britain (Couper, 1958).

Present occurrence: Samples 1038, 1045, 1050 and 1051.


*Ephedrites multicostatus* Brenner 1963 (Plate 2, fig. 14)

Stratigraphic distribution: Barremian-Albian, Maryland (Brenner, 1963).

Sulcate gymnosperm pollen

Genus *Cycadopites* (Wodehouse) Wilson and Webster 1946

*Cycadopites nitidus* (Balme) Pocock 1970 (Plate 2, fig. 15)

Stratigraphic distribution: Jurassic-Early Cretaceous, (Horowitz, 1970); Barremian-Albian, Maryland (Brenner, 1963).

Present occurrence: Samples 1041 and 1051.

Spore A (Plate 2, figs. 16 and 17)

Present occurrence: Sample 1051

**CONCLUSION**

This palynological study provides the first palynological evidence reported from this area, and it is concluded that the age of the rock sequence at Bukit Belah, Batu Pahat Johor is Lower Cretaceous (Valanginian-Aptian) which is comparable with the palynological zonation scheme of *Speciosus* Assemblage. Based on the occurrence of certain palynomorph species that characterise the assemblage, it is


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believed that the identified palynomorph assemblage is probably more appropriate to be placed at the stratigraphically lower horizon of the Speciosus Assemblage (Valanginian- ? Hauterivian). This finding contributes towards a better understanding in interpreting the age of the formerly known as Jurassic-Cretaceous (? or even older) rocks exposed in this area.

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REFERENCES


