

Posidonomya (Bivalvia) from Northwest Peninsular Malaysia and Its Significance

(*Posidonomya* (Bivalvia) dari Barat Laut Semenanjung Malaysia dan Kesignifikannya)

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ABSTRACT

Posidonomya is common in the Kubang Pasu and Singa Formations in northwest Peninsular Malaysia. It was discovered from the red mudstone layers (redbeds) in many localities in Langkawi Islands, Perlis and Kedah. Previous studies suggested that the age of *Posidonomya* ranged from Middle Devonian to Carboniferous. *Posidonomya* beds in Kedah and Perlis are located above the Tournaisian radiolarian chert layers. The age of *Posidonomya* from Peninsular Malaysia is comparable to those of Europe, Morocco, Turkey and South China which range from Tournaisian to Serpukhovian, Early Carboniferous. The fossil specimens exhibit morphological features closely related to *Posidonomya becheri* Bronn. Two taxa were identified namely *Posidonomya becheri* Bronn and *Posidonomya cf. kochi* (von Koenen). The occurrence of *Posidonomya* indicates that the age of the lower part of the Kubang Pasu and Singa Formations is Early Carboniferous. Its geographic distribution formed a wide paleobiogeographic province in the Paleo-Tethys. The province was located in the warm tropical-subtropical climatic zone. Therefore, *Posidonomya* can be a good indicator for warm climate. Its wide distribution and short stratigraphic range make it a good index fossil for the Early Carboniferous.

Keywords: Early carboniferous; paleobiogeography; *Posidonomya*; redbeds; stratigraphy

ABSTRAK

Posidonomya banyak ditemui dalam Formasi Kubang Pasu dan Formasi Singa di barat laut Semenanjung Malaysia. Ia dijumpai dalam lapisan batu lumpur merah di beberapa lokaliti di Kepulauan Langkawi, Perlis dan Kedah. Kajian terdahulu mencadangkan usia *Posidonomya* berjulat dari Devon Tengah hingga Karbon. Lapisan *Posidonomya* di Kedah dan Perlis terletak di atas lapisan rijang yang mengandungi radiolaria berusia Tournaisian. Usia *Posidonomya* dari Semenanjung Malaysia setara dengan yang terdapat di Eropah, Maghribi, Turki dan China Selatan yang berjulat dari Tournaisian hingga Serpukhovian, Karbon Awal. Spesimen fosil memperlihatkan fitur morfologi berkait rapat dengan *Posidonomya becheri* Bronn. Dua takson dikenal pasti iaitu *Posidonomya becheri* Bronn dan *Posidonomya cf. kochi* (von Koenen). Kewujudan *Posidonomya* menunjukkan bahagian bawah Formasi Kubang Pasu dan Formasi Singa berusia Karbon Awal. Sebaran geografinya membentuk satu wilayah paleobiogeografi yang luas dalam Palaeo-Tethys. Wilayah ini terletak dalam zon iklim panas tropika-subtropika. Oleh itu *Posidonomya* boleh dijadikan penunjuk iklim panas. Taburannya yang luas dan julat stratigrafi yang pendek menjadikannya fosil penunjuk yang baik untuk Karbon Awal.

Kata kunci: Karbon awal; lapisan merah; paleobiogeografi; *Posidonomya*; stratigrafi

INTRODUCTION

Bronn (1828) coined the term *Posidonia* for the bivalves he discovered near Herborn, Germany. The name *Posidonia* was first used by König (1805) for a sea-grass which is commonly found in the temperate regions. Bronn (1837) proposed *Posidonomya* as a replacement name for the preoccupied genus *Posidonia*. *Posidonomya* is supposed to be a valid nomenclature for the Bivalvia but the genus *Posidonia* has been retained by some paleontologists such as Amler (2004), Amler and Winkler Prins (1999), Cox et al. (1969), Hoşgör et al. (2012) and Okan and Hoşgör (2007).

Posidonomya is a thin-shelled bivalve which was commonly found as imprints on the bedding surface of mudstone and very rare on the sandstone. The thin-shells

are easily dissolved. Most of the fossils are found as tectonically deformed. It is very difficult to find the well-preserved specimens. The identification of the genus is based on the external features only such as overall shape, presence of concentric growth lines and the position of an umbo.

In the earlier works, *Posidonomya* Bronn *sensu lato* was considered to have a stratigraphic range from Early Carboniferous to Late Cretaceous (Cox et al. 1969). The genus *Posidonomya* is separated into three genera; the large *Posidonomya* is assigned to Carboniferous, smaller *Peribositra* Kurushin and Trushchelev for Triassic and *Bositra* de Gregor for the Jurassic bivalves. Chen and Stiller (2011) regarded *Peribositria* Kurushin and Trushchelev as a junior synonym of *Bositra*.

Sarkar (1972) described four new species of *Posidonomya* from Rebak Island, Langkawi namely *Posidonomya elongata*, *Posidonomya dilatata*, *Posidonomya intermedia* and *Posidonomya conspicua*. Only *Posidonomya elongata* seems to be well-preserved but the rest are poorly preserved. He assigned these species to be Early Carboniferous in age. No holotypes have been designated and the species are considered invalid (article 73 of International Code Zoological Nomenclature). To date, the species have not been well understood.

The aims of this paper were to review and revise the stratigraphic position of redbeds based on the occurrence of *Posidonomya* and to establish its paleobiogeographic province in the Early Carboniferous.

POSIDONOMYA OCCURRENCE IN NORTHWEST PENINSULAR MALAYSIA

Posidonomya has been recorded from redbeds exposed at Pulau Rabak Besar (Sarkar 1972; Yancey 1972) and Pulau Langgun (Jones 1981). In Perlis, *Posidonomya* was discovered in several earth quarries at Hutan Aji, Guar Sanai, Bukit Wang Kelian, and Hulu Pauh. It was also

found from several earth quarries at Tunjang, Pokok Sena, Bukit Telaga Jatoh, Kampung Jelutong and Bukit Jambul in Kedah (Figure 1).

Posidonomya has a large shell (height approximately 40-50 mm and length about 45-55 mm). It is very thin and usually preserved as internal moulds. It has ovate to rhombic shells more or less equivalved with concentric undulation or growth lines. An umbo is located at the short hinge. Due to its delicate shells many features are not preserved. Hence it hinders from the proper identification of species. Most of the *Posidonomya* found in Perlis and Kedah exhibit external morphology very closely related to *Posidonomya becheri* Bronn (Figure 2). Three different forms are identified; they are *Posidonomya becheri* Bronn (Figure 2(a)), *Posidonomya cf. kochi* (von Koenen) (Figure 2(b)) and *Posidonomya cf. becheri* Bronn (Figure 2(e)). Other specimens are assigned as *Posidonomya* sp.

Hamada (1969, 1968) reported that *Posidonomya* was found together with other fossils namely the trilobite *Cyrtosymbole (Waribole) perlisensis* Kobayashi and Hamada, the brachiopods *Tornquistia burtonae* Hamada, *Malayanoplia demiluna* Hamada, *Malayanoplia convexa* Hamada, *Semenewia (?) orientalis* Hamada, *Perakia (?)*

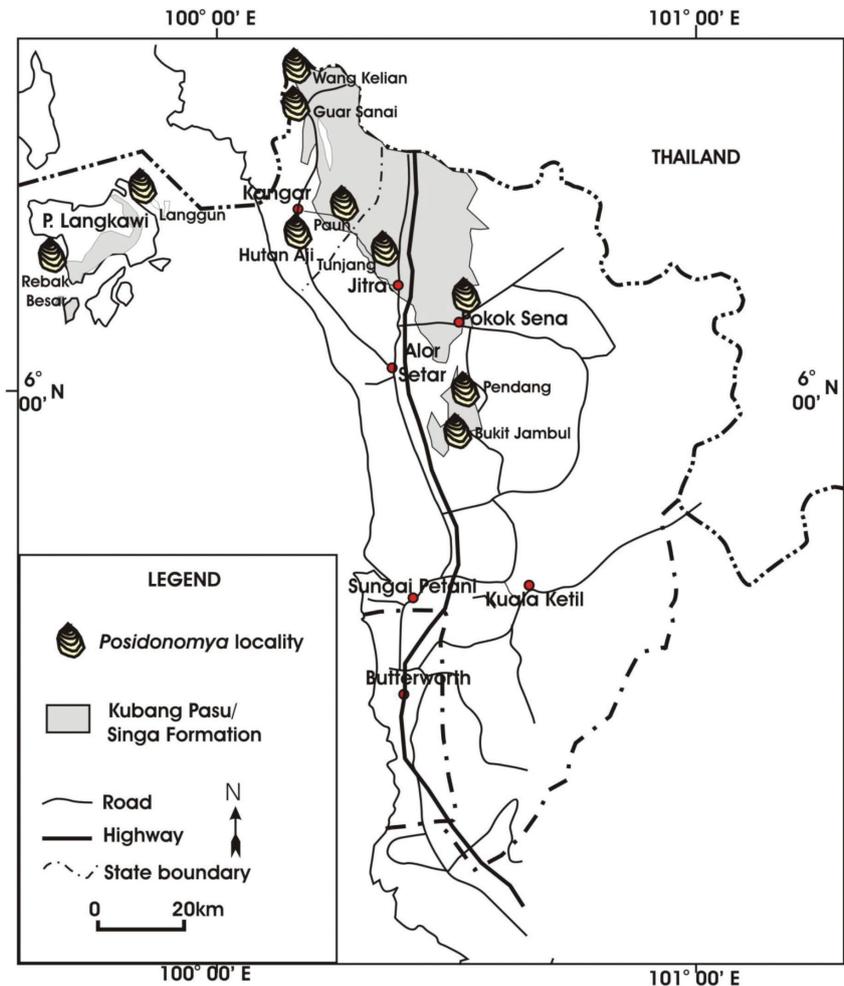


FIGURE 1. Distribution of *Posidonomya* in northwest Peninsular Malaysia

placentiformis Hamada, *Langkawia jonesae* Hamada, *Echinocoeliopsis sculpta* Hamada, *Echinocoeliopsis ladjoidea* Hamada and '*Emanuella*' *malayensis* Hamada. All the brachiopod species described by Hamada are endemic and they are of little stratigraphic value.

AGE OF *POSIDONOMYA*

Several different ages have been suggested for the *Posidonomya* beds of northwest Peninsular Malaysia. The *Posidonomya* bearing redbeds were considered as Middle to Late Devonian age (Hamada 1968; Yancey 1972); Late Devonian-Early Carboniferous (Hamada 1969; Jones et al. 1966) and Early Carboniferous (Gobbett 1973; Jones 1981; Sarkar 1972). Elsewhere, *Posidonomya* has been recorded from Early Carboniferous of Arkansas, North America (Gordon 1964), Ireland (Yates 1962), North England (Lebour 1885), Central Europe (Amler 2004), Poland (Nicolous 1963), Spain (Amler & Winkler Prins 1999), Morocco (Huvelin 1961), Turkey (Hoşgör et al. 2012; Okan & Hoşgör 2007), South China (Renjie & Daoping 1993) and Thailand (Lumjuan 1993; Reed 1920). Cox et al. (1969) also indicate the oldest *Posidonomya* is

Early Carboniferous. Amler (2004) has identified several species of *Posidonomya*, namely *Posidonomya becheri* Bronn, *Posidonomya kochi* (von Koenen), *Posidonomya corrugata* (Etheridge), *Posidonomya trapezoedra* Ruprecht as zonal markers for the Visean - Serpukhovian (Early Carboniferous). It is evident that the *Posidonomya* beds of the northwest Peninsular Malaysia representing the same age.

The outcrops at Guar Sanai, Bukit Tuntung and Bukit Meng show that the beds containing *Posidonomya* are located above of the bedded cherts which contain Tournaisian radiolarians (Basir & Zaiton 2011). This suggests that *Posidonomya* beds are younger than the Tournaisian (Figure 3).

STRATIGRAPHIC IMPLICATIONS

Several thrust faults are observed in the lower part of the Kubang Pasu Formation at Guar Sanai and Hutan Aji areas in Perlis. There are repetitions of the redbeds containing the same fossil assemblage. The rock sequence must be properly mapped to avoid repetition of the same succession. The division of the lower part of the Kubang Pasu Formation

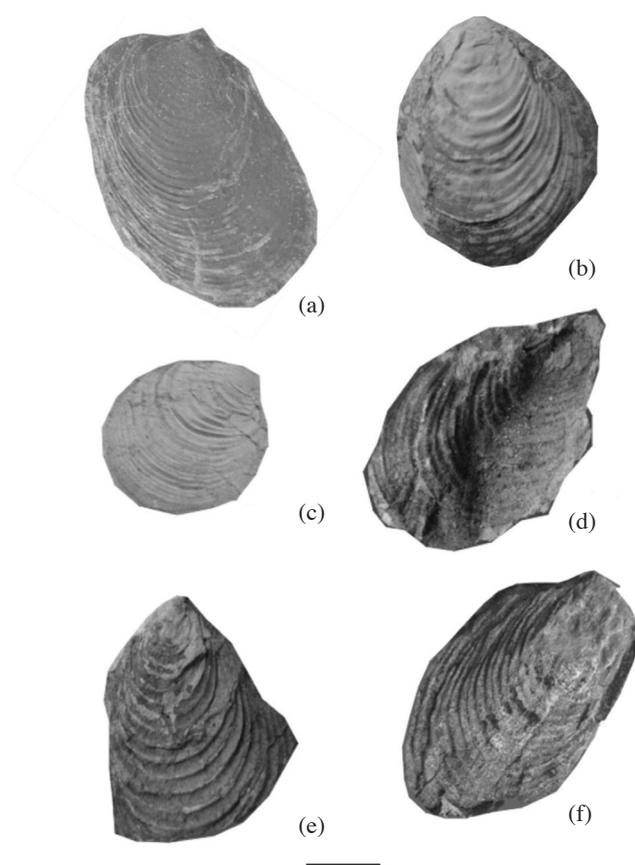


FIGURE 2. *Posidonomya* from northwest Peninsular Malaysia (Bar scale = 1cm). *Posidonomya becheri* Bronn (left valve, internal mould) from grey mudstone of the Kubang Pasu Formation, Hutan Aji, Perlis, (b) *Posidonomya* cf. *kochi* (von Koenen) (left valve, internal mould) from red mudstone Hulu Pauh, Perlis, (c) *Posidonomya* sp. juvenile (right valve, internal mould) from Guar Sanai, Perlis, (d) *Posidonomya* sp. (right valve, internal mould) from Ulu Pauh, Perlis, (e) *Posidonomya* cf. *becheri* (right valve, internal mould) from Bukit Meng, Pokok Sena, Kedah and (f) *posidonomya* sp. (left valve, internal mould) from Hutan Aji, Perlis

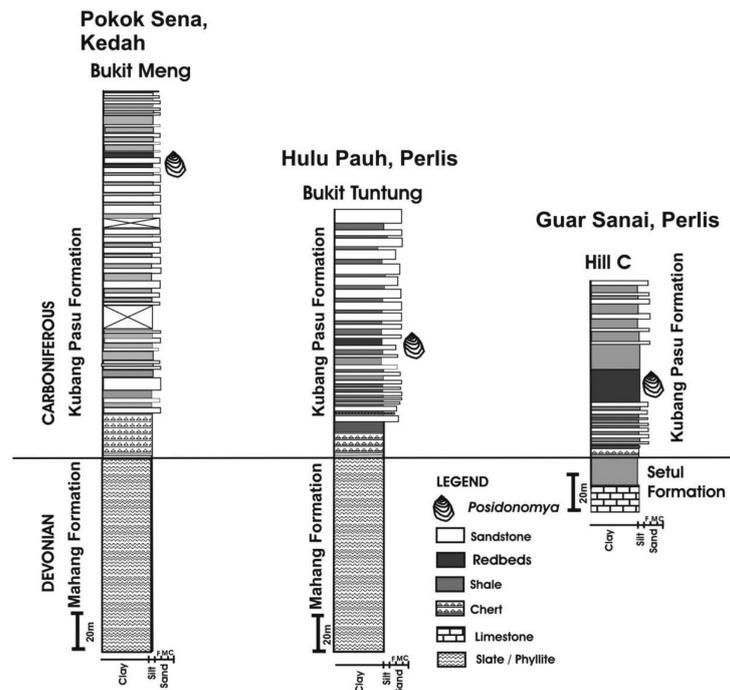


FIGURE 3. Lithologic log from three localities Guar Sanai, Bukit Tuntung and Bukit Meng showing the *Posidonomya* beds

into new formations such as, Chepor Formation, Binjal Formation, Telaga Jatoh Formation and Wang Kelian Formation by Meor and Lee (2005) is more confusing. The lithostratigraphic units are not properly described and their boundaries are not well defined. They are very difficult to identify in the field. Meor and Lee (2005) placed the *Posidonomya* bearing beds of the Chepor and Wang Kelian Formations into two different ages. The Chepor Formation was placed in the Upper Devonian and the Wang Kelian Formation was placed in Viséan, Early Carboniferous. Both the Chepor and Wang Kelian Formations contain similar fossil assemblage and should be of the same age. The Binjal Formation was tentatively assigned to the Tournaisian without any fossil evident. It is underlying the Telaga Jatoh Formation. The Telaga Jatoh Formation is thin and is not suitable to be established as a formation. It is more appropriate to assign it as a member. Lee (2009) has abandoned most of the units except the Chepor Formation. Lee (2009) emended the Chepor Formation and divided it into two members namely Langgun Redbeds and Hutan Aji Member. Lee (2009) stated that the Langgun redbeds was Middle to Late Devonian age based on the occurrence of '*Emanuella*' *malayensis* Hamada. '*Emanuella*' *malayensis* Hamada is an endemic species which was found together with other faunas including *Posidonomya* (Hamada 1968). The occurrence of *Posidonomya* in the Langgun redbeds suggested that the age of the redbeds is Early Carboniferous. *Posidonomya* is a reliable index fossil for the Early Carboniferous age because its stratigraphic range is well-established and it has worldwide distribution (Amler 2004; Hoşgör et al. 2012). The redbeds and all the *Posidonomya*

bearing sedimentary sequence in northwest Peninsular Malaysia are now placed in the Early Carboniferous age (Figure 4). The stratigraphy of the lower part of the Kubang Pasu Formation at Guar Sanai has been reviewed and revised by Ong and Basir (2007).

The Langgun redbeds at Pulau Rebak Besar and Pulau Langgun in Langkawi form the basal part of the Singa Formation (Jones 1981) and have been included in the Rebak Member. The redbeds and other *Posidonomya* bearing rocks in Perlis and Kedah belong to the Kubang Pasu Formation.

Upper Devonian fossils have not been discovered. There is apparently a hiatus above the black dactyloconarid mudstone beds (Lalang Member *sensu*, Meor & Lee 2005). Ong and Basir (2007) suggested that the hiatus was developed due to erosion or non/slow deposition during the Middle and Late Devonian followed by deposition Tournaisian chert although no erosional features are observed in the hiatus. A rock succession in the Guar Sanai area, reflects the rise of sea-level and reach the maximum sea-level in the Middle and Late Devonian where the supply of clastic sediments was scarce and followed by deposition of Tournaisian pelagic radiolarian chert. Similar stratigraphic gap was recorded from the Pa Samed Formation in Peninsular Thailand where the Lower Devonian Member 1 (dactyloconarid beds) is overlain by Lower Carboniferous Member 2. The Middle and Upper Devonian sequence is apparently missing (Wongwanich et al. 2004). The gap was also observed in Satun Province, where the Lower Carboniferous redbeds of the Khuan Klang Formation is overlying the Lower Devonian black dactyloconarid mudstone of the Pa Samed Formation (Ridd. 2007).

The Kubang Pasu Formation is already established. Jones (1981) included the *Posidonomya* beds in the Kubang Pasu and Singa Formations. Basir and Zaiton (2011) proposed the lower boundary of the Kubang Pasu to be placed at the radiolarian chert layers which are widespread in Perlis and Kedah. The upper boundary of the Kubang Pasu Formation in Perlis is identified at Bukit Temiang, Bukit Chondong and Bukit Tengku Lembu. The new lithostratigraphic units identified within the Kubang Pasu Formation should be assigned as members rather than formations.

PALEOGEOGRAPHIC SIGNIFICANCE

Posidonomya was a pseudoplanktic bivalve which had a wide geographic distribution. It is a common fossil in

shallow marine deposits, especially in shale and sandstones. In northwest Peninsular Malaysia, *Posidonomya* was discovered from shallow marine continental shelf in the Singa Formation to deep-sea fan environment in the Kubang Pasu Formation.

Posidonomya flourished and widely distributed during Early Carboniferous time. A worldwide distribution of the genus is very important for the paleobiogeographic interpretation. Geographic distribution of *Posidonomya* suggests that the genus was occupying the continental margin of Palaeo-Tethys during the Early Carboniferous which extended from North America, Europe, North Africa, Turkey, South China and Southeast Asia (Figure 5). *Posidonomya* is a good indicator for warm tropical and subtropical climate (Hoşgör et al. 2012). Vertical succession of the Singa Formation in Langkawi Islands from the

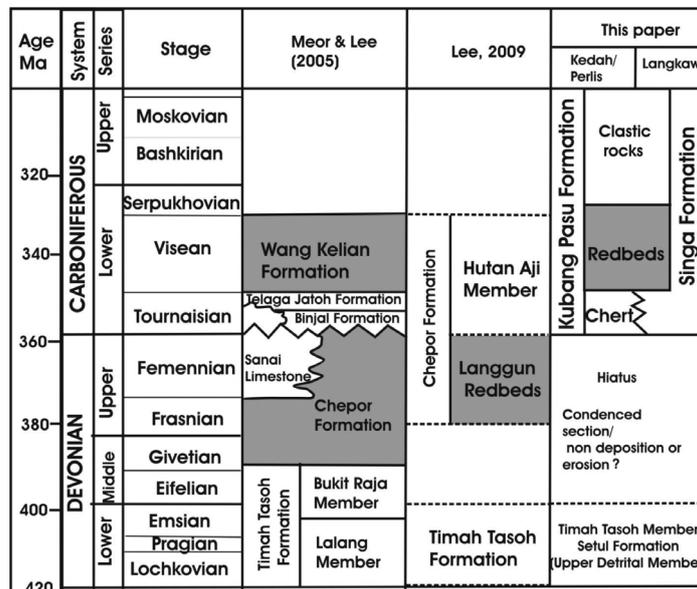


FIGURE 4. Stratigraphy of *Posidonomya* bearing redbeds in northwest Peninsular Malaysia

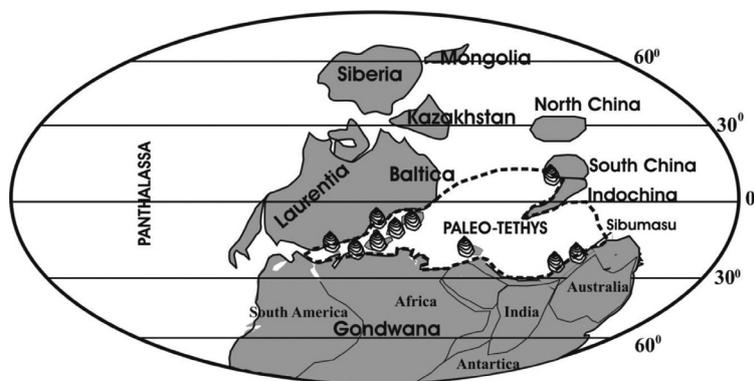


FIGURE 5. Paleogeographic map (Modified after Metcalfe 1996)

Distribution of *Posidonomya* in the Paleo-Tethys during Early Carboniferous based on various records from Arkansas, North America (Gordon 1964), Ireland (Yates 1962), North England (Lebour 1885), Central Europe (Amler 2004), Poland (Nicolous 1963), Morocco (Huvelin 1961), Turkey (Hoşgör et al. 2012; Okan & Hoşgör 2007), South China (Renjie & Daoping 1993) and Southeast Asia (Jones 1981; Lumjuan 1993; Reed 1920; Sarkar 1972; Yancey 1972)

Posidonomya redbeds to glacio-marine deposits (Stauffer & Lee 1986) and the occurrence of Lower Permian cold-water brachiopods (Mohd Shafeea & Asmaniza 2002) suggest the change in paleoclimate from warm in Early Carboniferous to cool climate in the Late Carboniferous and Early Permian. Similar event has been recorded in the Kubang Pasu Formation where diamictites are rare (Jones 1981) but the presence of *Monodioxodina shiptoni* (anti-tropical species) indicate a cool climate during Early Permian (Basir 1991).

CONCLUSION

Posidonomya was a pseudoplanktic bivalve which has short stratigraphic range in the Early Carboniferous and has a wide geographic distribution. It is a good index fossil and very important for age determination especially for the Upper Paleozoic sequence in northwest Peninsular Malaysia where the fossil assemblage is mostly dominated by endemic species. The redbeds which were previously thought to be Middle and Upper Devonian are now considered to be Lower Carboniferous. Similar rock succession was also recognized in Peninsular Thailand. Worldwide distribution of *Posidonomya* indicates its wide paleobiogeographic province in the Paleo-Tethys which located in tropical and subtropical belts. It suggests a warm paleoclimate prevailed in the Early Carboniferous of the Paleo-Tethys prior to cool climate during Late Carboniferous and Early Permian.

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