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The significance of Upper Permian brachiopods from Merapoh area, northwest Pahang

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Abstract: Several localities of Upper Permian brachiopod dominated shelly fauna have been discovered from the Merapoh area in northwest Pahang. The fauna consists of more than forty species of free living and pedunculate brachiopods, associated with other benthic elements such as bivalves, gastropods, fenestrate and stony bryozoans, solitary rugose corals, trilobites etc. Most of the fossils are preserved as moulds and casts, but they show very good biocoenosis assemblages. The brachiopods assemblages belong to the Upper Permian *Leptodus* Shale fauna which shows some similarities with other Upper Permian fauna from southern Tethyan region. Stratigraphically, the brachiopod fauna can be divided into two zones, the *Oldhamina dicipens* and the *Haydenella minuta* Zones, equivalent to the lower and middle Dorashamian (= Changshingian) Stages, respectively. The *Leptodus* Shale fauna is developed on shallow carbonate and volcanic high during a period of active volcanism.

Abstrak: Beberapa lokaliti fauna cengkerang berusia Perm Akhir yang didominasi oleh brakiopod telah ditemui daripada kawasan Merapoh di baratlaut Pahang. Fauna ini mengandungi lebih daripada empat puluh spesies brakiopod yang hidup bebas serta yang melekat dengan pedikel. Fauna ini berasosiasi dengan unsur-unsur bentos lain seperti bivalvia, gastropod, briozoa fenestrat dan briozoa membatu, karang rugosa tunggal, trilobit dan lain-lain. Kebanyakan fosil terawet sebagai acuan dan kas, tetapi fosil-fosil ini menunjukkan himpunan biosinosis yang baik. Himpunan brakiopod ini kepunyaan fauna syal *Leptodus* berusia Perm Akhir yang menunjukkan beberapa persamaan dengan fauna berusia Perm Akhir dari daerah Tethys selatan yang lain. Secara stratigrafi, fauna brakiopod ini dapat dibahagi kepada dua zon, iaitu Zon *Oldhamina dicipens* dan Zon *Haydenella minuta*, setara dengan Tahap Dorashamian (= Changshingian) awal dan tengah. Fauna syal *Leptodus* ini terbentuk di atas karbonat dan volkanik yang cetek ketika volkanisme agak aktif.

INTRODUCTION

Although the Permo-Triassic Gua Musang formation dominates the geology of northwest Pahang, very little is known in the past about the Permian fauna especially in Merapoh area. This is partly due to poor accessibilities to the area prior to the opening of the Dada Kering (Pahang)-Gua Musang (Kelantan) highway in 1987. In 1966, Jones *et al.* recorded the occurrence of several Upper Permian genera of brachiopods and molluscs as well as lophophylidiid corals and trilobite pygidium from Sg. Yu, Sg. Chiniau and Sg. Serau.

The Triassic faunas, on the other hand, were much better studied in the past. Numerous descriptive works on various groups of bivalves by Tamura (1968, 1970 and 1973a, b) and by Kobayashi & Tamura (1968) established the presence of Lower and Middle Triassic fauna in Merapoh and Chegar Perah areas.

The opening of the Dada Kering-Gua Musang highway in 1987, had inevitably brought into light some very rich and diverse Permian fauna in this area. During the construction of the highway, Abdul Halim Yusoff (1986) reported the occurrences of some Upper Permian fauna in this area. Subsequently, Mohd Shafeea Leman (1988) recorded the occurrences of some Permian brachiopod and molluscan genera, trilobites, corals, bryozoans as well as some plant genera along the highway, and the discovery of uppermost Permian ammonoid genus *Paratirolites* near Sungai Temau. Some of these fauna (i.e. the productidinid brachiopods) have been used by the author as a part of his Ph.D. research (Mohd Shafeea Leman, 1990).

GEOLOGY

The geology of Merapoh area is made of rocks of the Permo-Triassic Gua Musang formation which is locally intruded by granitic stocks of various sizes. These intrusions seem to have partly contributed to the deformation of the Gua Musang formation. The lithology of the Gua Musang formation in Merapoh area is similar to those in the Gua Musang area. It comprises three main lithofacies, i.e. the calcareous, argillaceous and

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volcanic lithofacies. The detail distribution and thickness of each lithofacies are not very well established due to lack of complete and continuous section. The calcareous lithofacies formed several boxed-like limestone hills in this area, some of which are more than seventy meters high. Most of the limestone hills show more or less horizontal beds. The argillaceous lithofacies usually formed hills with rather low relief in between the limestone hills, while the moderate to high and rounded hills are usually underlain by volcanic lithofacies. All these lithofacies occurred side by side with interfinguring contact from a possible ?Middle Permian age to ?Middle Triassic age. Mixed facies are also commonly observed especially between the argillaceous lithofacies and the calcareous and volcanic lithofacies. Macrofaunas and floras commonly occur within a horizon which has been termed "the *Leptodus* Shale" by Muir-Wood (1948). The limestones are generally less fossiliferous compared to the argillaceous rocks.

Argillaceous lithofacies

The argillaceous lithofacies of the Gua Musang formation in Merapoh area is dominated by thinly bedded to massive shales and mudstones. The shales and mudstones are interbedded with minor tuffaceous siltstones, sandstones or pebbly sandstone layers and locally with thin limestone lenses. In places, the mudstones and shales are slightly metamorphosed with slaty cleavage and re-oriented folded fossils showing a north-south trend. Outside the study area, the argillites are known to have exposed to a much higher degree of metamorphism around the Bukit Tujuh granites (south of the area) and other granites in the vicinity of Gua Musang.

Leptodus Shale

A band of massive and richly fossiliferous *Leptodus* shales, or slates occurs about twelve kilometers south of Merapoh Station. This fossil band extends for about ten kilometers in a north-south direction from Gua Kalong to Sungai Jeleteh, where seventeen fossiliferous localities have been discovered. Around Sungai Yu, the fossiliferous *Leptodus* shale or slate are commonly thin to thickly bedded and calcareous in nature (locality MSY11, MSY13, MSY14 and MSY15 — see Fig. 1). At locality MSY11, the slates interfinger with the less fossiliferous limestones. The shales at locality MSY14 are underlain by limestones while a thin limestone bed is seen interbedded with the shales/slates at locality MSY15. The beds are commonly horizontal or sometimes gently folded with north-south strike. Toward the south, however the beds are strongly folded due to the granite intrusion.

An isolated Upper Permian fauna was found in fine tuffaceous sandstones and tuffaceous mudstones at locality MSY18 (Fig. 1), at the fringes of the Bukit Tujuh granite. The lithology of *Leptodus* shale at this locality clearly shows a fining upward sequence. It is not known whether this isolated fauna represents an extension of the Sungai Yu fossil band (localities MSY1-17), but there are some fauna resemblance between them. Similarly, it is also very difficult to establish the relationship between the Sungai Yu fossil band with another fossil band in Kuala Tuang (Gua Musang) area which is about thirty kilometers north-northwest of the study area.

Preservation

The fossils are mostly preserved as moulds and casts with traces of iron oxide in some of the fresh specimens. Some pyritized and calcified shells were also found. The faunal assemblages generally show very strong evidence of biocoenosis which would reflect their actual living assemblages. The brachiopod spines are usually well preserved and the brachiopod and bivalvian valves are very commonly preserved intact. These evidences suggest that the fauna has undergone very little transportation.

FAUNAL COMPOSITION

The fauna is dominated by the brachiopods except for that from locality MSY14 in which the bivalves are more dominant. Beside the brachiopods and the bivalves, the rest of the fauna are made up of gastropods, bryozoans, corals, trilobites, cephalopods, algae, sponges, crinoids and fusulinid foraminifera. Floral remains were mixed together with other fauna at localities MSY5 and MSY13, but at the horizon of locality MSY18 they seem to have developed their own horizon.

The brachiopods

The brachiopods represent about eighty percent of the total fossil population forty three brachiopod and genera have been identified. Most of the brachiopod fauna are difficult to identify beyond generic level due to the lack of actual shells. Therefore, the number of identified species from this study are rather low. A much bigger collection and more detailed taxonomic work are needed to solve this identification problem. The complete lists of brachiopod genera and species and their distribution in the study area is presented in Table 1.

The majority of the brachiopods examined belong to the free living strophomenid group with twenty two genera identified. They include some

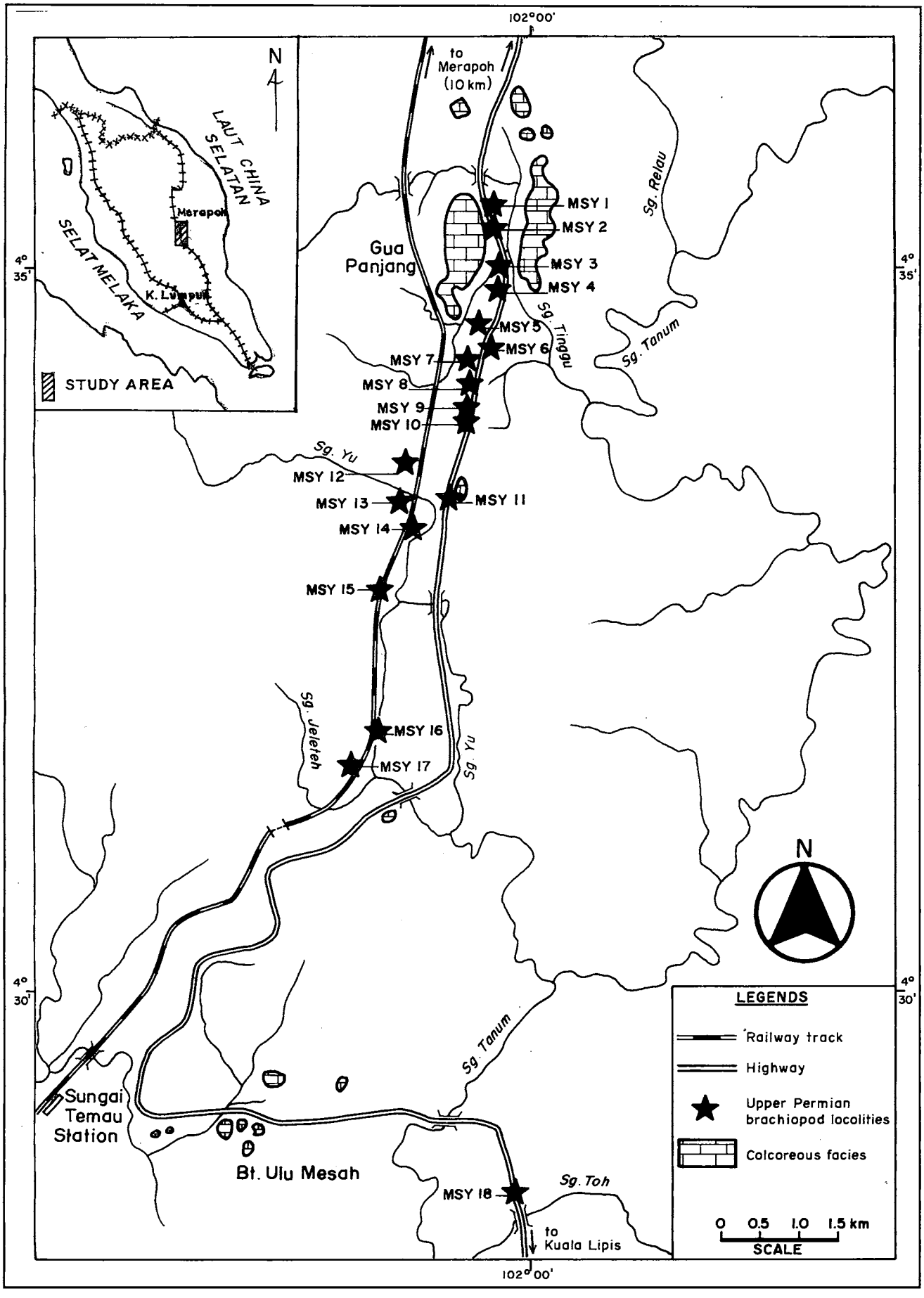


Figure 1. Upper Permian Brachiopod localities in Merapoh area.

Table 1. Upper Permian brachiopods from Merapoh area.

Brachiopod species/Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Oldhamina dicipens (de Koninck)	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	*
Oldhamina sp.	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Leptodus nobilis (Waagen)	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	*
Leptodus cf. *L. tenuis* (Waagen)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Leptodus cf. *L. catenata* (Waagen)	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	*
Leptodus sp.	*	*	-	*	*	-	*	-	-	*	*	*	-	-	-	-	-	*
Pseudoleptodus sp.	-	-	-	-	-	-	-	-	-	-	*	-	-	-	*	-	-	-
Parallytonia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Haydenella minuta Sarytcheva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	*
Retimarginifera sp.	-	-	*	-	*	-	*	*	-	*	*	-	-	-	-	-	*	*
Marginifera sp.	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-
Dictyoclostus gratiosus (Waagen)	-	-	*	-	*	*	*	*	-	*	*	*	-	*	-	*	*	*
Dictyoclostus sp.	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-
Antiquatonia sp.	-	-	-	-	-	*	*	-	-	-	-	*	-	-	-	-	-	-
Reticulatia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Plicatifera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	-	*
Costispinifera sp.	-	-	-	-	-	*	*	*	*	-	*	*	-	-	-	-	-	-
Echinauris sp.	-	-	-	-	*	*	*	-	-	-	-	*	-	-	-	-	-	-
Linoproductus lineatus (Waagen)	-	-	-	*	*	*	-	-	*	-	-	-	-	-	-	-	-	-
Linoproductus sp.	*	-	*	*	-	-	-	-	-	*	*	-	-	-	-	*	-	*
Waagenoconcha sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	*
Echinoconchus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Spinifrons sp.	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-
Choanosteges sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-
Neochonetes sp.	-	-	-	-	*	-	-	-	-	-	*	*	-	*	-	-	-	*
Waagenites sp.	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	*
Micraphelia sp.	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Derbyia sp.	-	-	*	*	-	*	-	-	-	*	*	*	*	-	*	-	-	*
Derbyoides sp.	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	*
Schizophoria sp.	*	-	-	-	-	-	-	-	-	-	*	*	*	-	*	*	*	*
Enteletes sp.	-	-	*	-	-	-	-	-	-	-	*	-	-	-	*	-	-	*
Parenteletes sp.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-
Meekella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Orthotichia sp.	-	-	-	*	*	*	-	-	-	-	*	-	-	-	*	*	-	-
Rhipidomella sp.	-	-	*	-	-	*	*	-	-	*	*	-	-	-	-	-	-	-
Reticularina sp.	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neospirifer sp.	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Crenispirifer sp.	*	*	*	-	-	-	-	-	*	*	*	-	*	-	*	-	-	*
Spiriferellina sp.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraspiriferina sp.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spiriferella sp.	-	-	-	-	*	-	-	*	-	-	*	-	-	-	*	-	-	-
Crurithyris sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Neophricadothyris sp.	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Hustedia sp.	*	-	-	-	-	-	*	*	-	*	-	-	*	-	*	-	-	*
Rhynchopora sp.	*	-	-	-	-	-	-	-	-	-	*	-	-	-	-	*	-	-
Stenoscisma sp.	*	-	-	*	-	-	-	-	-	-	-	-	-	-	*	-	-	*
Uncinunellina timorensis (Beyrich)	-	-	-	-	-	-	-	-	-	-	-	-	*	-	*	-	-	*
Dielasma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*
Isogramma sp.	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-

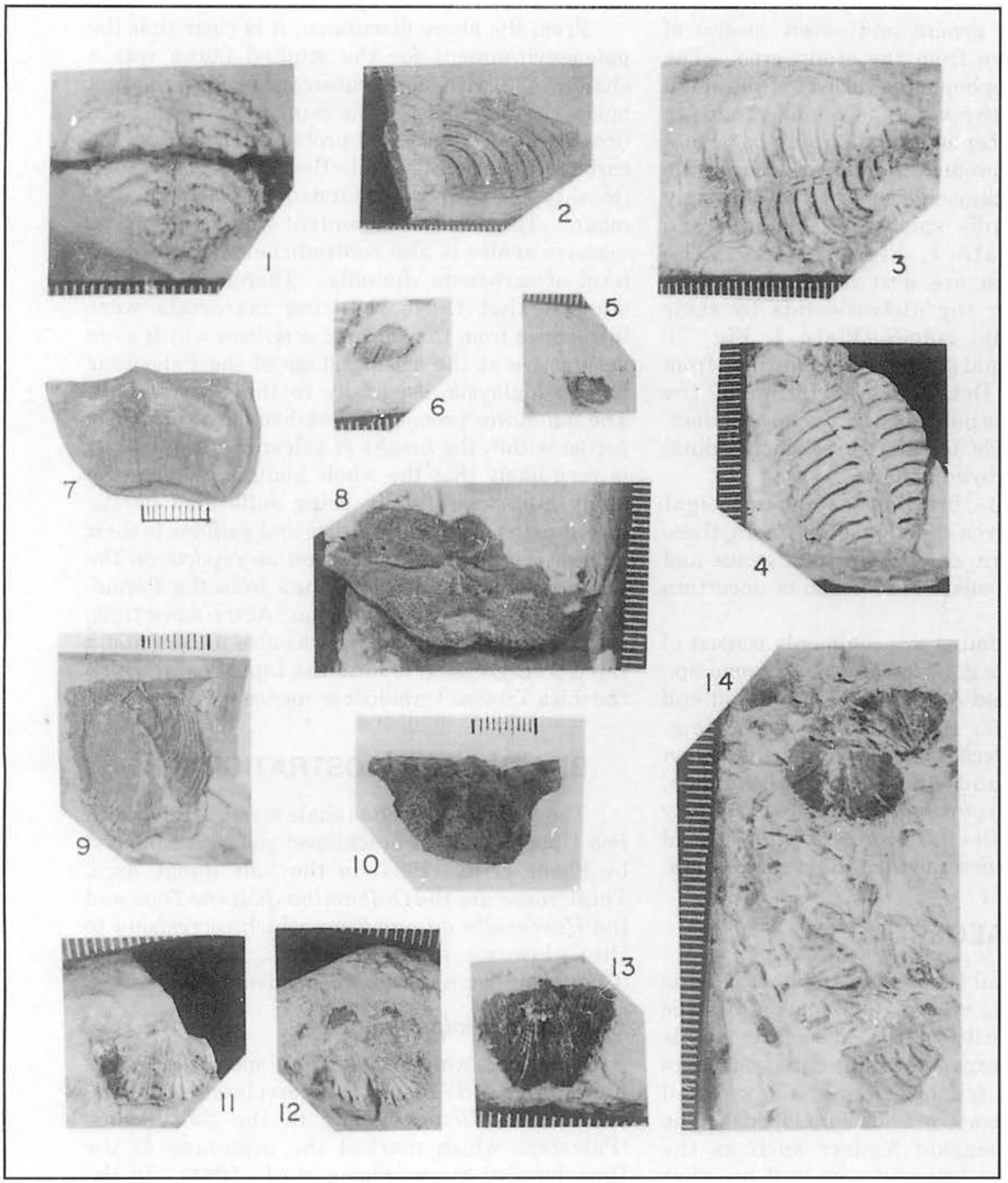


Plate 1. Figure 1. *Oldhamina dicipens* (Lophophore, ventral view — loc. MYS 11). Figure 2. *Leptodus* cf. *L. catenata* (lophophore, ventral view — loc. MSY 11). Figures 3 & 4. *Leptodus nobilis* (lophophore, ventral view — loc. MSY 18). Figures 5 & 6. *Haydenella minuta* (ventral valve — loc. MSY 16). Figures 7, 8 & 9. *Retimarginifera* sp. (7-internal mould of ventral valve, 8-external mould of dorsal and ventral valves, 9-compressed dorsal and ventral valve — loc. MSY 11). Figure 10. *Reticulatia* sp. (latex mould of ventral valve. Figures 11, 12 & 13. *Dictyoclostus gratiosus* (11, 12-dorsal and ventral valves — loc. MSY 18, 13-ventral valve — loc. MSY 16). Figure 14. Rhipidomellid and oldhaminidinid from loc. MSY 18. (Scale in mm)

ry interesting brachiopod groups like the bizzare ıking llytoniids and the highly varied ıductidinids. The llytoniids, with their partly ıosed lophophores, are in many sense a unique ıchiopods. Four genera and seven species of toniids are known from the study area. The silized llytoniid lophophores varied in from small d simple in *Parallytonia* and *Pseudoleptodus* to ge and rib-like in *Leptodus* and *Oldhamina* (Plate Figs. 1–4). The productidinids varied from the avily spinosed echinochonchids to the strongly iculated but hardly spinosed *Reticulatia* and *ctyoclostus* (Plate 1, Figs. 10–13). The ırginiferids which are also reticulate can be fferentiated from the dictyoclostids by their ominent marginal ridges (Plate 1, Fig. 7). ırteen productidinid genera were identified from e study area. Detailed description of the ıductidinids will be published in a separate paper. her strophomenids include three chonetidinid nera and two derbyiid genera.

The pedunculate brachiopods include eight iriferid genera, seven rhipidomellid genera, three ynchonellid genera, one terebratulid genus and *ıgramma*, an articulate brachiopod of uncertain der.

The associated fauna are commonly consist of ctinoid bivalves (e.g. *Chlamys* sp., *Oxytoma* sp., *iculopecten* sp. and *Entolium* sp.), mytiloid and ıculoid bivalves, small gastropods (e.g. *urchisonia* sp., *Meekospira* sp. and *Bellerophon* .), ammonoid and nautiloid cephalopods, epostome and cryptostome bryozoans, solitary rals, some trilobites (?*Timoraspis* sp.), crinoid cicles, algae, sponges and fusulinid foraminifera.

PALAEOECOLOGY

The studied fossil fauna indicate a biocoenosis living assemblage of a shallow marine benthic mmunity. Majority of the biota are sessile spension feeders except for some detrital feeders e. bivalves and trilobites) and a few small rnivours (i.e. gastropods and cephalopods). The phophorate suspension feeders such as the achiopods and the bryozoans as well as other spension feeders (i.e. corals and crinoids) required warm, shallow, clear and regularly agitated water get maximum nutrients. Pedunculate achiopods, like many other sessile suspension eders also required a hard ground to settled down. though most strophomenids are more tolerable a softer ground, their juvenile usually attached other sessile benthic organisms. Therefore, a ırd or at least semi-consolidated substratum is sential for the listed brachiopods and other sociated fauna. The unique development of spines plane in *Retimarginifera* (Plate 1, Fig. 9) might have prevented them from sinking where the sediments are unconsolidated (Mohd Shafeea Leman, 1991).

From the above discussion, it is clear that the paleoenvironment for the studied fauna was a shallow sea with hard substratum, perhaps just below the wave base. The Sungai Yu fossil band (localities MSY1-17) was probably formed on the carbonate platforms, while the Sungai Toh fauna (locality MSY18) was founded on volcanic seamount. The rich sulfide content which darken the massive shales is also contradicted with the high level of carbonate contents. Therefore, I would suggest that these reducing materials were introduced from the volcanic activities which were very active at the closing stage of the Palaeozoic Era in Malaysia, especially in the Central Belt. The fauna was probably flourished for a very short period within the breaks of volcanic eruptions. It is very likely that the whole benthic biota in the study area were finally being suffocated by the introduction of too much ashes and sulfides to their niches. So far, there has been no reports on the occurrence of any benthic fauna from the Permo-Triassic boundary in this region. At the same time, the basin in the study area was also undergoing a rapid transgression to form the Lipis Sea in which the thick Triassic turbiditic sequence was deposited.

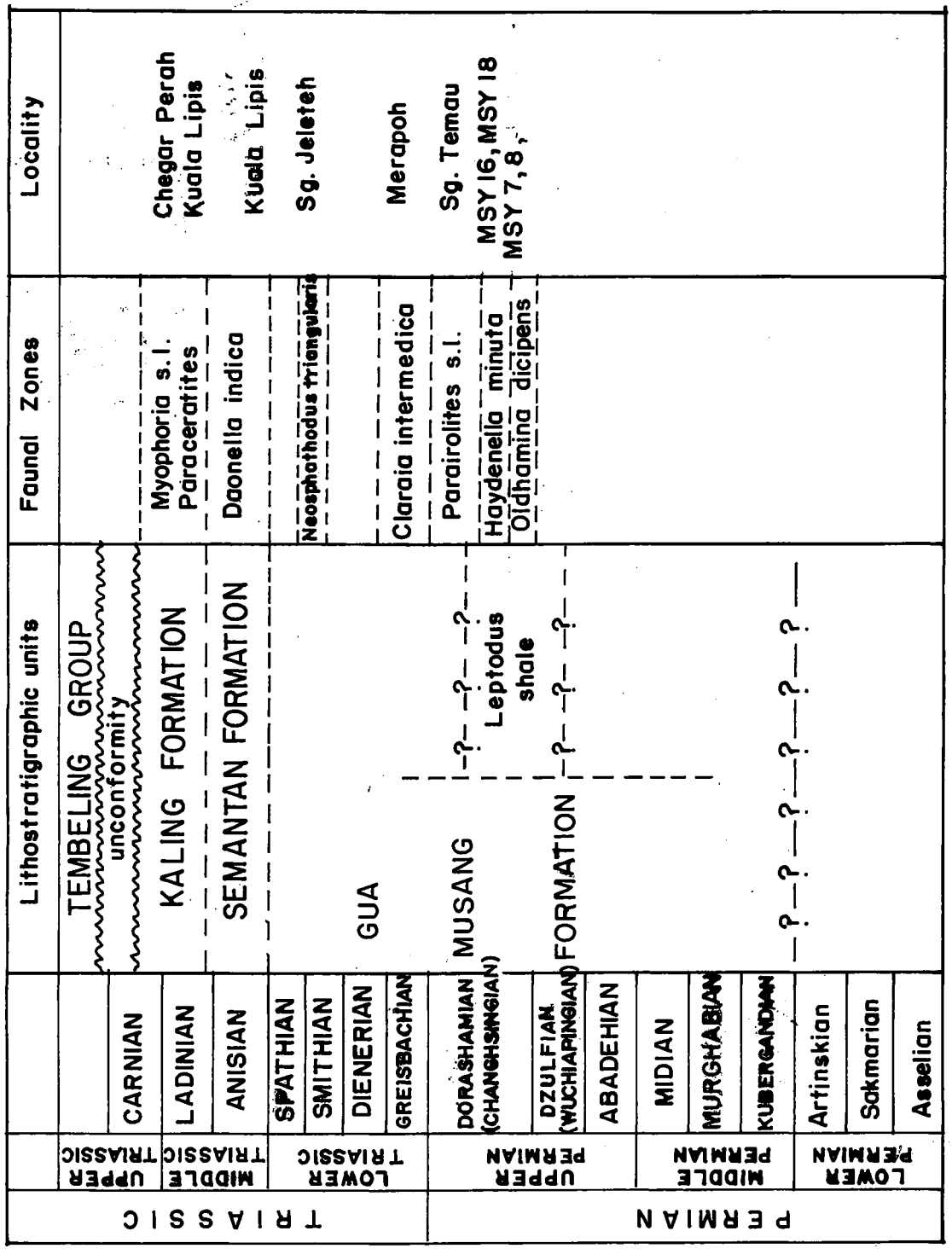
BRACHIOPOD BIOSTRATIGRAPHY

The Merapoh *Leptodus* shale is comparable with two Upper Permian brachiopod zones established by Sheng *et al.* (1984) in the Salt Range area. These zones are the *Oldhamina dicipens* Zone and the *Haydenella minuta* Zone which correspond to the lower and middle Dorashamian (Changhshingian) Stage, respectively (Table 2).

Oldhamina dicipens Zone

This zone, which is best developed at localities MSY7 and MSY18 can be correlated with the *Oldhamina dicipens* Zone in the Salt Range (Pakistan) which marked the beginning of the Dorashamian Stage (Sheng *et al.*, 1984). In the lower section of locality MSY18, *Oldhamina dicipens* is found together with common Upper Permian *Lobatannularia* flora and they disappear towards the middle part of the section before the appearance of somewhat dwarf fauna of *Haydenella minuta* at the top of the section. Llytoniids are very common in this zone. They include *Leptodus nobilis* (Waagen), *L. tennuis* (Waagen) and *L. catenata* (Waagen). Other common brachiopods are *Retimarginifera* sp., *Linoproductus* sp., *Derbyia* sp., *Ortotichia* sp., *Crenispirifer* sp., *Spiriferella* sp.,

Table 2. Permo-Triassic biostratigraphy of northwest Pahang.



Hustedia sp. and *Dictyoclostus gratiosus* (Waagen). The later become more abundant towards the top of the *Leptodus* shale bed.

Haydenella minuta Zone

The richly fossiliferous middle section of locality MSY18 seems to be devoid of either *Oldhamina dicipens* or *Haydenella minuta*. It is then overlain by a lesser fossiliferous interval, but one which has a typically dwarf fauna including the tiny *Haydenella minuta*. It seems that the *Haydenella minuta* Zone in Malaysia represents a separate biozone beginning from the middle Dorashamian i.e. above the *Oldhamina dicipens* Zone. Other fauna commonly associated with *Haydenella minuta* are *Dictyoclostus gratiosus*, *Linoproductus* sp. and *Schizophoria* sp. Llytoniid seems to be absent in this horizon.

It is not known whether *Haydenella minuta* survived the Permian-Triassic event in this region, but this species is known to have passed through the Permo-Triassic boundary in other part of the Tethyan region (Sheng *et al.*, 1984). Locality MSY18 shows that the horizon with *Haydenella minuta* is very thin and it is only developed at the basal part of a barren, massive, fine-grained tuffaceous mudstone. A very similar rock sequence can be seen north of Sungai Jeleteh, above another exposure of *Haydenella minuta* zone (locality MSY16) and below the Lower Triassic (Spathian) limestones (Metcalfe, 1990).

The succession below and above these two zones is not very well known in the study area. The thickness of the Gua Musang formation below the *Oldhamina dicipens* Zone is not known, because the base of this formation has never been established. The relationship between the *Leptodus* shale and the thinly bedded black shales with *Paratirolites* sp. at Sungai Temau and *Colaniella*-bearing limestone at Gua Panjang (Merapoh) is also not well established. Towards the Triassic, however, can be found the Merapoh *Claraia* Beds (?Greisbachian-Dienerian) and the much younger *Myophoria* Beds from Chegar Perah.

BRACHIOPOD AFFINITIES

The studied fauna suggests some resemblances with the Sungai Jemuru fauna (Muir-Wood, 1948) and the Sungai Paloh fauna (Yanagida & Aw, 1979). The Sungai Jemuru fauna is more comparable with the lower part of the Merapoh *Leptodus* shale, while the Sungai Paloh fauna might be equivalent to the upper part of the studied *Leptodus* shale bed. These brachiopod fauna shows very close affinities with the equivalent Upper Permian fauna in other Tethyan region from Trans-Caucasia to South China (Sheng *et al.*, 1984; Yanagida, 1984).

The llytoniids, especially the *Leptodus* and *Oldhamina* are commonly sighted in many part of southern Tethyan region. Some llytoniids like *Leptodus nobilis* (Waagen), *L. tenuis* (Waagen) and *Oldhamina dicipens* (de Koninck) indicate a late Permian age in the Salt Range (Waagen, 1884) and in southwest China (Huang, 1932). The llytoniids have flourished in this region since Middle Permian time.

The productidinids also belong to Tethyan groups, lacking the strophalosiaceans and the aulostegaceans (Mohd Shafeea Leman, 1990). *Dictyoclostus gratiosus* (Waagen) is very common in the Upper Permian of the Salt Range, Pakistan (Waagen, 1884), Southwestern China (Huang, 1932) and Timor, Indonesia (Broili, 1918). *Haydenella* is also a common Upper Permian genus in many part of Asia and *Haydenella minuta* is known from the Upper Permian to Lower Triassic in the Trans-Caucasian region (Yanagida, 1984). *Retimarginifera* is a rare genus and is only known from Asia and Russia. *Uncinellina timorensis* (Beyrich) is also known from the Upper Permian of Timor.

SUMMARY

The late Permian *Leptodus* shale fauna in Merapoh area was developed on shallow carbonate flatform and volcanic highs during a period of active volcanism. The fauna was dominated by brachiopods which were mostly sessile or free living suspension feeders. Lack of post-mortem transportation has given us very good living assemblages to study. The llytoniids and many other brachiopods indicate warm climate in this region during the Upper Permian time. The Merapoh *Leptodus* shale fauna can be divided into the *Oldhamina dicipens* and *Haydenella minuta* zones, correspond to the lower and middle Dorashamian (or Changshingian) Stage, respectively. The late Permian faunal expansion in Merapoh area was shortly terminated by active volcanism which might have killed all the benthonic forms in this region before reaching the Permo-Triassic boundary.

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