

An Early Permian (Early Sakmarian) brachiopod fauna from the Sungai Itau Quarry and its relationship to other Early Permian brachiopod horizons in Langkawi, Malaysia

MOHD SHAFEEA LEMAN

School of Environmental Sciences and Natural Resources
Faculty of Science and Technology, Universiti Kebangsaan Malaysia
43600 Bangi, Selangor Darul Ehsan

Abstract: A rich brachiopod bed was discovered in a quarry exposure at Kampung Sungai Itau, Langkawi. At least twelve species of brachiopod were identified from this bed. The fauna is dominated by the heavily spinosed brachiopod genus *Spirelytha* and the large thickly shelled genus *Sulciplica*. The Kampung Sungai Itau brachiopod fauna exhibits strong correlation with those of Kilim in Langkawi Island and Ko Muk in south Thailand. The fauna can be assigned to the upper part of the *Arctitreta–Bandoproductus* assemblage Zone of Early Permian (Early Sakmarian). The stratigraphic position of other Early Permian brachiopod horizons in Langkawi Islands is revised herewith.

Abstrak: Satu lapisan kaya brakiopod telah ditemui dalam sebuah singkapan kuari di Kampung Sungai Itau, Langkawi. Sekurang-kurangnya empat belas spesies brakiopod telah dikenalpasti daripada lapisan ini. Fauna ini didominasi oleh brakiopod genus *Spirelytha* yang berdeduri lebat dan *Sulciplica* yang bersaiz besar dan bercengkerang tebal. Fauna brakiopod Kampung Sungai Itau mempunyai korelasi yang sangat hampir dengan fauna brakiopod Kilim di Pulau Langkawi dan Ko Muk di Thailand selatan. Fauna ini boleh diletakkan pada bahagian atas Zon himpunan *Arctitreta–Bandoproductus* berusia Perm Awal (Sakmarian Awal). Kedudukan stratigrafi beberapa lapisan brakiopod berusia Perm Awal di Kepulauan Langkawi telah dinilai semula.

INTRODUCTION

The presence of Early Permian brachiopods was first noted by Basir Jasin *et al.* (1992) from the bryozoan limestone at Kilim Quarry. A much richer brachiopod fauna from a younger mudstone bed at the same quarry was later described by Mohd Shafeea Leman (1996) and Shi *et al.* (1997) as being among the most important evidence linking Langkawi Island with the Gondwana supercontinent during Early Permian time. Since then, several other rich Early Permian brachiopod faunas have been reported from the upper part of the Singa Formation, commonly associated with massive pebbly mudstones. These massive pebbly mudstones, normally dark gray in colour, are commonly found in the middle and upper parts of the Singa Formation. These beds have been interpreted by Stauffer and Mantajit (1981), Stauffer and Lee (1986) and Mohd Shafeea Leman (1997, 2000) as diamictites of glacial marine origin, closely related with the colder climate of Gondwanaland. Most of the Early Permian brachiopod beds (Fig. 1) are located on the main Langkawi Island in the vicinity of Kilim, Kisap and Batu Asah, except for an isolated occurrence at Pulau Singa Besar reported by Mohd Shafeea Leman (2000).

In the vicinity of Kilim, brachiopod faunas have been reported from the Kilim Quarry by Basir Jasin *et al.* (1992), Mohd Shafeea Leman (1996, 1997) and Shi *et al.* (1997). Basir Jasin *et al.* (1992) considered the brachiopod bearing bryozoan limestone of Kilim Quarry as of Artinskian age. However, according to Mohd Shafeea Leman (1996), the Kilim brachiopod faunal composition was very similar to

that described by Waterhouse (1982) from Ko Muk, south Thailand. According to Waterhouse (1982), the Ko Muk brachiopod fauna which belongs to the upper part of the Phuket Group is late Asselian to early Sakmarian in age. Thus, Mohd Shafeea Leman (1996) suggested that the Kilim brachiopod fauna is older than the age previously assigned by Basir Jasin *et al.* (1992) for the underlying

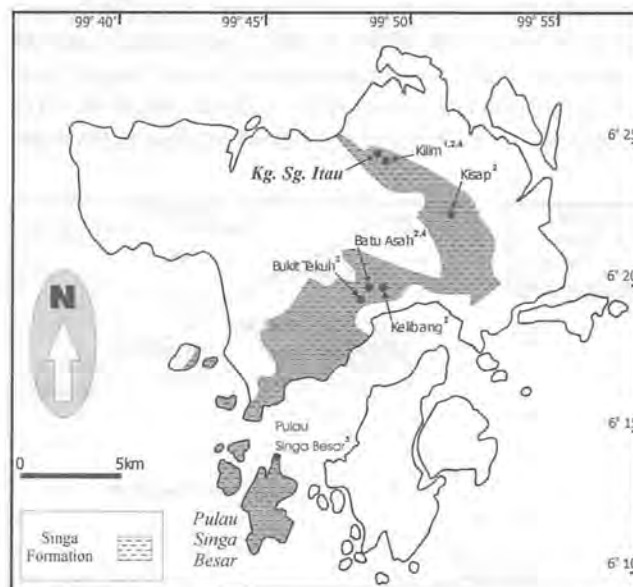


Figure 1. Distributions of the Early Permian brachiopods from the Singa Formation (data from Mohd Shafeea Leman 1996¹, 1997², 2000³ and Shi *et al.* 1997⁴).

bryozoan limestone. On the other hand, Shi *et al.* (1997) generalized that the Kilim brachiopod fauna as of Sakmarian age based on the abundance of *Spirelytha petaliformis* (Pavlova), a common associate of *Spinomartina prolifica* Waterhouse in the *Spinomartina prolifica* assemblage Zone.

Another rich Permian brachiopod fauna was recently reported by Mohd Shafeea Leman and Asmaniza Yop (2002) from shale quarry at Kampung Sungai Itau, near Air Hangat. Recently, the Kampung Sungai Itau brachiopod fauna has been re-studied and a much larger fossil collection was obtained during a subsequent visit to the quarry. This article will highlight some of the additional important genera and species found at the Kg. Sungai Itau quarry, particularly those which bear significant contributions to the stratigraphic position of the fauna.

SUNGAI ITAU SECTION

The Kampung Sungai Itau quarry exposure is located about 500 m north-northwest of the Kilim Quarry brachiopod locality (Fig. 2) of Mohd Shafeea Leman (1996). The lithology of the Kampung Sungai Itau quarry exposure is generally made up of interbedded sandstone and shale (Fig. 3) in its lower part and thick to massive sandstone in its upper part. The beds dip at 20° to 30° to the east-northeast. In the lower part of the sequence, a series of massive black pebbly mudstone with rare well rounded pebbles interbedded with calcareous sandstone and shale are prominent. Mohd Shafeea Leman and Asmaniza Yop (2002) suggested that these rhythmically repeated series of massive dark gray pebbly mudstone and calcareous sandstone/shale represented cycles of minor glacial and interglacial periods during the Early Permian deglaciation of Gondwanaland. Several fossiliferous horizons were found at Kampung Sungai Itau quarry (Fig. 3). As reported by Mohd Shafeea Leman and Asmaniza Yop (2002), most of these fossil beds (SIF1 to SIF4) are related with the calcareous beds, the composition of which ranges from calcareous sandstone to marly bioclastic limestone. The main fossil constituent of the limestone beds is bryozoan

skeleton. Brachiopods are rare and scattered in these calcareous beds. Among the brachiopods found in the calcareous horizon are spiriferid genera of *Sulciplica* and *Spirelytha*. Above these calcareous horizons, a massive greenish to yellowish gray siltstone (SIF5) however yields an interval which is very rich in brachiopods to be discussed in this paper. This brachiopod rich horizon is located on the slope face of the second terrace. The exact geographic position of this fossil locality from a Magellan GPS Tracker is at a latitude of 6°24.806'N and longitude of 99°49.512'E.

THE COMPOSITION AND AGE OF THE SUNGAI ITAU FAUNA

As mentioned earlier, brachiopods are scattered throughout the Sungai Itau sequence, concentrated particularly in the massive siltstone bed SIF5 and other calcareous beds SIF1 to SIF4 (Fig. 3). Most of the brachiopods discussed in this paper came from the 30 cm thick SIF5 spanning more than 80 m along the bedding strike (see Mohd Shafeea Leman and Asmaniza Yop, 2002). The Sungai Itau brachiopod fauna is generally made of those with thick large shells and those with heavily spinose shells. Almost all brachiopods are preserved as complete external or internal moulds. The distribution of particular brachiopod species tends to be restricted within the fossiliferous intervals of bed SIF5 except for the dominant species of *Spirelytha* and *Sulciplica* which are more widely distributed.

Eleven brachiopod genera were identified from the Kampung Sungai Itau quarry, dominated by *Spirelytha* and *Sulciplica*. Among twelve species identified are *Arctitreta percostata* Waterhouse, *Streptorhynchus* sp., *Bandoproductus* cf. *monticulus* (Waterhouse), *Kasetia* cf. *kaseti* Waterhouse, *Taeniothaerus* sp., *Strophalosia* sp., *Spirelytha petaliformis* (Pavlova), *Spirelytha buravasi* (Hamada), *Sulciplica thailandica* (Hamada), *Sulciplica* sp., *Lamniplica sapa* (Waterhouse), *Trigonotreta* sp. and *Rhynchopora culta* Waterhouse. These brachiopods were accompanied by some fenestellid bryozoa, pectinid bivalve and fragments of cephalopods, crinoid stems and echinoid plates.

The composition of the Sungai Itau brachiopod fauna seem to be very close to that of the Kilim brachiopod fauna described by Mohd Shafeea Leman (1996, 1997) and Shi *et al.* (1997). About 83 percent of the brachiopod species were shared between these two faunas, with both faunas dominated by *Spirelytha* and *Sulciplica*. Table 1 shows the distribution and abundance of brachiopod species in three main beds of Early Permian brachiopods in Langkawi Island. This table also exhibits stronger correlation between the Sungai Itau and Kilim fauna, but lesser so with the Batu Asah fauna. Another strong correlation is shown in Table 2 between the Sungai Itau and Ko Muk fauna described firstly by Hamada (1960), subsequently revised by Waterhouse (1982) and Shi and Archbold (1995).

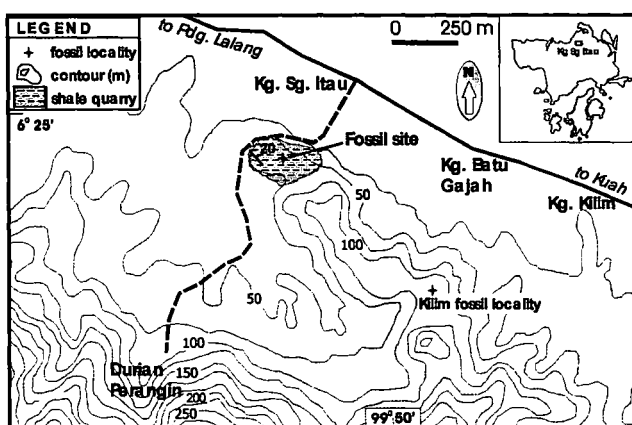


Figure 2. Location of the Sungai Itau Quarry and the major brachiopod site.

of Early Permian age, most probably Sakmarian.

Apart from these brachiopod localities, Jones (1981) mentioned the occurrence of supposedly Carboniferous brachiopods from Ko Klang, Pulau Kueh Besar and Pulau Singa Besar. The Pulau Singa Besar fauna has been revised by Mohd Shafeea Leman (2000) as of Early Permian (Late Sakmarian) age, based on the abundance of *Spinomartinia prolifica* Waterhouse. Meanwhile, among the Pulau Kueh Besar and Ko Klang faunas, Jones (1981) listed "*Linoproductus*" cf. *umariensis* (Reed), *Dielasma* sp. and *Reticularia* sp. The *Linoproductus umariensis* (Reed) has been re-designated into the genus *Stepanoviella* by Waterhouse (1970), *Globiella* by Archbold (1983) and finally to *Bandoproductus* by Archbold and Gupta (1986). The Umaria bed from the Indian Peninsula in which the

Bandoproductus umariensis (Reed) was originally described is also of Early Permian, Late Asselian-Early Sakmarian age as suggested by Archbold and Gupta (1986) and Archbold *et al.* (1996). Therefore, the Pulau Kueh Besar and Ko Klang brachiopod faunas may also be of Early Permian age.

CONCLUSION

The Sungai Itau brachiopod fauna consists of *Arctitreta percostata* Waterhouse, *Streptorhynchus* sp., *Bandoproductus* cf. *monticulus* (Waterhouse), *Bandoproductus* sp., *Kasetia* cf. *kaseti* Waterhouse, *Taeniothaerus* sp., *Strophalosia* sp., *Spirelytha petaliformis* (Pavlova), *Spirelytha buravasi* (Hamada), *Sulciplica*

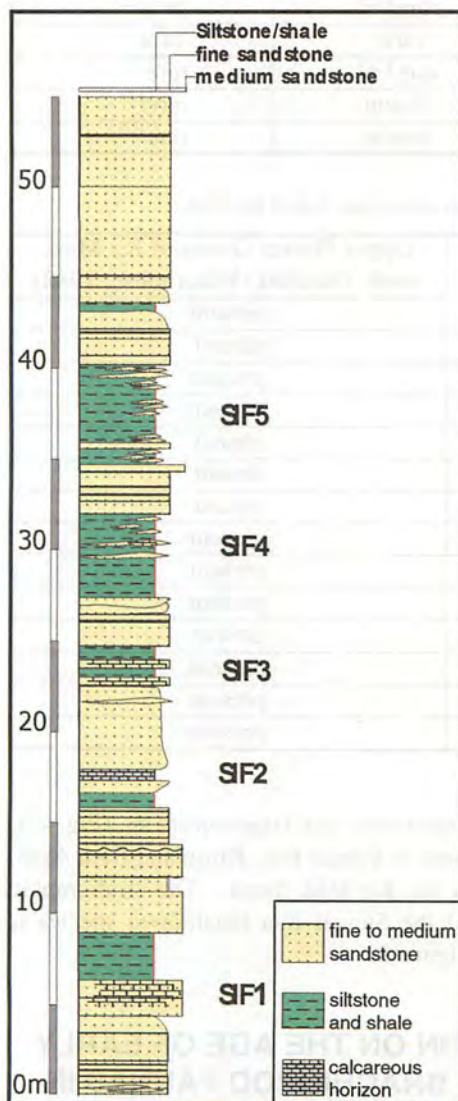


Figure 3. Position of the Sungai Itau brachiopod bed in the Sungai Itau section (modified after Mohd Shafeea Leman and Asmaniza Yop 2002).



Figure 4. Some representative brachiopods from the Sungai Itau brachiopod bed. A-C – *Sulciplica thalandica* Waterhouse; D-F – *Trigonotreta* sp.; G – *Lamnuplica sapa* (Waterhouse); H – *Arctitreta percostata* Waterhouse; I-J – *Spirelytha petaliformis* (Pavlova); K-M – *Spirelytha buravasi* (Hamada); N – *Strophalosia* sp.; O-Q – *Bandoproductus* cf. *monticulus* (Waterhouse); R – *Taeniothaerus* sp.; S – *Rhynchopora culta* Waterhouse.

Table 1. Distribution of Early Permian brachiopods species in major fossil localities of the Singa Formation.

Brachiopod species	Kampung Sungai Itau quarry (this paper)	Kilim Quarry (Mohd Shafeea Leman, 1996 ¹ , 1997 ² ; Shi <i>et al.</i> , 1997 ³)	Batu Asah (Shi <i>et al.</i> , 1997 ¹ ; Mohd Shafeea Leman, 1997 ²)
<i>Arctitreta percostata</i> Waterhouse	rare	rare ^{1,2}	absent
<i>Streptorhynchus</i> sp.	rare	rare ^{1,2,3}	absent
<i>Bandopproductus</i> cf. <i>monticulus</i> (Waterhouse)	common	common ^{1,2}	absent
<i>Bandopproductus</i> cf. <i>umariensis</i> (Reed)	absent	absent	common ²
<i>Kasetia</i> cf. <i>kaseti</i> Waterhouse	rare	rare ^{1,2,3}	rare ^{1,2}
<i>Taeniothaerus</i> sp.	rare	absent	absent
<i>Strophalosia</i> sp.	rare	absent	absent
<i>Spirelytha petaliformis</i> (Pavlova)	abundant	abundant ^{1,2,3}	common ^{1,2}
<i>Spirelytha buravasi</i> (Hamada)	common	common ^{1,2}	absent
<i>Spinomartinia prolifica</i> Waterhouse	absent	absent	abundant ^{1,2}
<i>Sulciplea thailandica</i> (Hamada)	common	common ^{1,2}	common ²
<i>Lamniplica sapa</i> (Waterhouse)	rare	rare ^{1,2,3}	rare ^{1,2}
<i>Trigonotreta</i> sp.	rare	rare ²	rare ²
<i>Rhynchopora culta</i> Waterhouse	rare	rare ^{1,2,3}	rare ^{1,2}
<i>Stenosiscma quasimutabilis</i> Waterhouse	absent	absent	rare ^{1,2}
<i>Elasmata</i> sp.	absent	absent	rare ^{1,2}

Table 2. Comparison between the Sungai Itau brachiopod faunal composition and that of Ko Muk.

Brachiopod species	Kg. Sungai Itau quarry (this paper)	Upper Phuket Group of Ko Muk, south Thailand (Waterhouse, 1982)
<i>Arctitreta percostata</i> Waterhouse	rare	present
<i>Streptorhynchus</i> sp.	rare	absent
<i>Bandopproductus</i> cf. <i>monticulus</i> (Waterhouse)	common	present
<i>Kasetia</i> cf. <i>kaseti</i> Waterhouse	rare	absent
<i>Taeniothaerus</i> sp.	rare	absent
<i>Strophalosia</i> sp.	rare	absent
<i>Spirelytha petaliformis</i> (Pavlova)	abundant	absent
<i>Spirelytha buravasi</i> (Hamada)	common	present
<i>Sulciplea thailandica</i> (Hamada)	common	present
<i>Lamniplica sapa</i> (Waterhouse)	rare	present
<i>Trigonotreta</i> sp.	rare	absent
<i>Rhynchopora culta</i> Waterhouse	rare	present
<i>Jakutochonetes solita</i> (Waterhouse)	absent	present
<i>Elasmata retusus</i> Waterhouse	absent	present

The close relationship between the Sungai Itau, Kilim and Ko Muk faunas suggest that they have a close age range. *Arctitreta percostata* Waterhouse (Fig. 4H), *Bandopproductus monticulus* (Waterhouse) (Fig. 4O-Q), *Spirelytha buravasi* (Hamada) (Fig. 4K-M) indicating Late Asselian-Early Sakmarian age (Shi and Archbold, 1995) were found only in these three localities. However, the discovery of the genus *Strophalosia* (Fig. 4N) and *Taeniothaerus* (Fig. 4R) should constrain the age of the Sungai Itau fauna to Early Sakmarian, for the first appearance of these genera was during Early Sakmarian (Brunton *et al.*, 2000). *Sulciplea thailandica* (Hamada) (Fig. 4A-C), *Lamniplica sapa* (Waterhouse) (Fig. 4G) were also found in Kilim and Ko Muk, as well as Batu Asah. However, *Spirelytha petaliformis* (Pavlova) (Fig. 4I-J),

Kasetia kaseti Waterhouse and *Trigonotreta* sp. (Fig. 4D-F) which are present in Sungai Itau, Kilim and Batu Asah, do not appear in the Ko Muk fauna. The stratigraphic range for each of the Sungai Itau brachiopod species is summarized in Figure 5.

DISCUSSION ON THE AGE OF EARLY PERMIAN BRACHIOPOD FAUNAS IN LANGKAWI ISLAND

In Malaysia, particularly the western belt of Peninsular Malaysia the Early Permian brachiopod has so far only been reported from the Kinta Valley (Shi and Waterhouse 1991) and the Langkawi Islands (Mohd Shafeea Leman

thailandica (Hamada), *Sulciplica* sp., *Lamniplica sapa* (Waterhouse), *Trigonotreta* sp. and *Rhynchopora culta* Waterhouse. The fauna can be assigned to the upper part of the *Arctitreta-Bandoproductus* assemblage Zone of Early Permian (Early Sakmarian). The closely associated Kilim fauna was also re-assigned to the same brachiopod Zone, while the Batu Asah and Pulau Singa Besar faunas remained in the succeeding *Spinomartinia prolifica* assemblage Zone of Late Sakmarian. For other brachiopod beds, a better collection is needed to enable them to be designated to any particular brachiopod zone.

ACKNOWLEDGEMENT

This research was funded by the Malaysian Ministry of Science, Technology and Environment's IRPA Research Grant no 02-02-02-0012-EA186 and University Kebangsaan Malaysia Research Grant no ST-oi4-2002 to which the author would like to express his gratitude. The author would like to thank Dr. Lee Chai Peng for his constructive comments.

REFERENCES

- ARCHBOLD, N.W., 1983. Studies on Western Australian Permian brachiopods 3. The family Linoproductidae Stehli 1954. *Proceedings of the Royal Society of Victoria*, 95, 237-254.
- ARCHBOLD, N.W. AND GUPTA, V.J., 1986. Permian brachiopod faunas of the Himalaya and Western Australia: A comparison. *Bulletin of the Indian Geologists' Association*, 19(2), 81-96.
- ARCHBOLD, N.W., SHAH, S.C. AND DICKINS, J.M., 1996. Early Permian brachiopod faunas from Peninsular India: Their Gondwanan relationships. *Historical Biology*, 11, 125-135.
- BASIR JASIN, WAN FUAD WAN HASSAN AND MOHD SHAFEEA LEMAN, 1992. The occurrence of bryozoan bed in the Singa Formation, Bukit Durian Perangin, Langkawi. *Warta Geologi*, 18(2), 29-35.
- BRUNTON, C.H.C., LAZAREV, S.S., GRANT, R.E. AND JIN YU-GAN, 2000. Productidina. In: Kaessler, R.L. (Ed.), *Treatise on Invertebrate Paleontology, Pt. H-Brachiopoda (revised), Vol. 3 - Linguliformea, Craniiformea and Rhynchonelliformea (part)*, 424-708.
- HAMADA, T., 1960. Some Permo-Carboniferous fossils from Thailand. *University of Tokyo Scientific Papers, College of General Education*, 10(2), 337-361.
- JONES, C.R., 1981. The geology and mineral resources of Perlis, North Kedah and Langkawi Islands. *Geological Survey Malaysia Memoir* 17, 257p.
- LEONOVA, T., MOHD SHAFEEA LEMAN AND SHI, G.R., 1999. Discovery of Early Permian (Late Sakmarian) ammonoid from Langkawi Islands, Malaysia. *Alcheringa*, 23, 277-281.
- MOHD SHAFEEA LEMAN, 1996. The occurrence of brachiopods from pebbly mudstone near Kilim, Langkawi: Their age, paleobiogeography and paleoclimatic implication. *Warta Geologi*, 22(2), 100-102 (abstract).
- MOHD SHAFEEA LEMAN, 1997. Batuan Formasi Singa di Pulau Langkawi. In: Ibrahim KOMOO, MOHD SHAFEEA LEMAN, KADDERI MD DESA AND IBRAHIM ABDULLAH (Eds.), *Geological Heritage of Malaysia: Conservation Geology for Ecotourism*. LESTARI UKM, 185-207.
- MOHD SHAFEEA LEMAN, 2000. Langkawi dropstones: outstanding glaciogenic sedimentological features in Malaysia. In: Ibrahim Komoo and Tjia, H.D. (Eds.), *Geological Heritage of Malaysia: Resource Development for Conservation and Nature Tourism*. LESTARI UKM, 59-82.
- MOHD SHAFEEA LEMAN AND ASMANIZA YOP, 2002. Early Permian sequence from Sungai Itau quarry, Langkawi: its age, depositional environment and palaeoclimatic implication. *Geological Society of Malaysia Bulletin* 46, 163-170.
- SHI, G.R. AND ARCHBOLD, N.W., 1995. Permian brachiopod faunal sequence of the Shan-Thai terrane: biostratigraphy, palaeobiogeographical affinities and plate tectonics/palaeoclimatic implications. *Journal of Southeast Asian Earth Sciences*, 11(3), 177-187.
- SHI, G.R. AND WATERHOUSE, J.B., 1991. Early Permian brachiopods from Perak, west Malaysia. *Journal of Southeast Asian Earth Sciences*, 6(1), 25-39.
- SHI, G.R., MOHD SHAFEEA LEMAN AND TAN, B.K., 1997. Early Permian brachiopods of Gondwanan affinity from the Singa Formation, Langkawi Island, northwestern Peninsular Malaysia. In: Phisit Dheeradilok and 8 others (Eds.), *Proceedings of the International Conference on Stratigraphy and Tectonic Evolution of Southeast Asia and the South Pacific and the Associated Meetings of IGCP 359 and IGCP 383*, Bangkok, 62-72.
- STAUFFER, P.H. AND LEE, C.P., 1986. Late Paleozoic glacial marine facies in Southeast Asia. *Geological Society of Malaysia Bulletin*, 20, 363-397.
- STAUFFER, P.H. AND MANTAJIT, N., 1981. Late Palaeozoic tilloid of Malaya, Thailand and Burma. In: M.J. Hambrey and W.B. Harland (Eds), *Earth's Pre-Pleistocene Glacial Records*, Cambridge University Press, Cambridge, 331-337.
- WATERHOUSE, J.B., 1970. Gondwanan occurrences of the Upper Paleozoic brachiopod *Stepanoviella*. *Journal of Paleontology*, 44, 37-50.
- WATERHOUSE, J.B., 1982. An Early Permian cool-water fauna from pebbly mudstones in South Thailand. *Geological Magazine*, 119(4), 337-354.
- WATERHOUSE, J.B., PITAKPAIVAN, K. AND MANTAJIT, N., 1981. Early Permian brachiopods from Ko Yao Noi and near Krabi, southern Thailand. *Geological Survey Thailand Memoir* 4, 43-35214.

Manuscript received 3 March 2003