Geological Society of Malaysia Bulletin 52
June 2006 p.27-33

Some Deep Water Middle Triassic Foraminifera from the Semanggol Formation

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Abstract: Eight benthic foraminiferal taxa were retrieved from siliceous mudstone samples collected from the Semanggol Formation at Bukit Lada and Merbau Pulas. The foraminifera consist of *Pseudonodosaria densa, Pseudonodosaria lata, Psuedonodosaria obconica, Pseudonodosaria simpsonensis, Prodentalina* sp A, *Prodentalina* sp B, *Cryptoseptida* sp., and *Protonodosaria* spp. The assemblage indicates that the depositional environment was a deep marine basin above the calcite compensation depth.

Abstrak: Lapan taksa foraminifera bentos telah didapatkan semula daripada sampel batu lumpur bersilika yang dikutip dari Formasi Semanggol yang tersingkap di Bukit Lada dan Merbau Pulas. Foraminifera terdiri daripada *Pseudonodosaria densa, Pseudonodosaria lata, Psuedonodosaria obconica, Pseudonodosaria simpsonensis, Prodentalina* sp A, *Prodentalina* sp. B., *Cryptoseptida* sp., dan *Protonodosaria* spp. Himpunan ini menunjukkan sekitaran pengendapannya merupakan sekitaran lembangan samudera dalam di atas kedalaman pampasan kalsit.

INTRODUCTION

Triassic foraminifera in Peninsular Malaysia are very rare and have only been recorded from several limestone formations exposed in the vicinity of the Kodiang town, Kedah (Gazdzicki and Smit, 1977), Chuping, Perlis and Gunung Senyum, Pahang (Fontaine et al., 1988), Bukit Tunjung, Perlis (Fontaine et al. 1990), and southwest Kelantan and north Pahang (Fontaine et al., 1995). The identifications of the foraminifera were based on the study of thin sections.

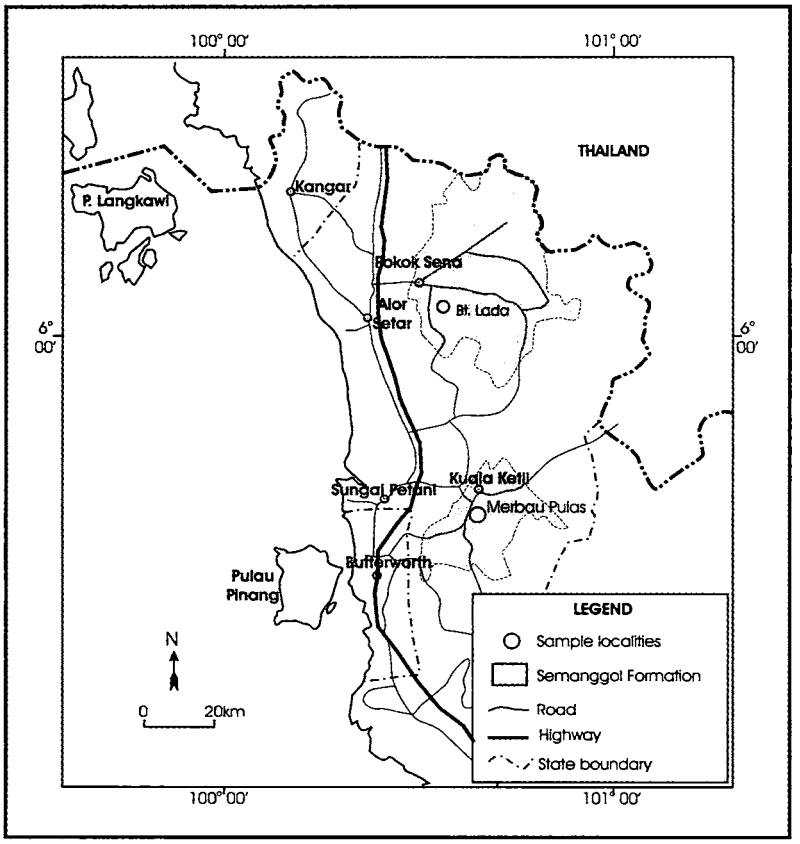

Figure 1: Map showing sample localities

Gazdzicki and Smit (1977) have recorded 52 species of foraminifera from the Kodiang Limestone. Fontaine et al (1988) discovered eleven taxa from the Chuping Limestone, Perlis and eight taxa from the limestone at Sungai Senyum, Pahang. Seven taxa were recorded from limestone at Bukit Tunjung, Perlis (Fontaine et al 1990). Several Triassic genera i.e. *Glomospira, Meandrospira, Pilaminella, Endothyra,* and *Malayaspirina* have been reported from southwest Kelantan and North Pahang (Fontaine et al., 1995). All the species were obtained from limestones which were deposited in shallow marine environments.

Recently, while extracting radiolaria, some well-preserved foraminifera (Lagenina) were discovered together with radiolaria from the chert samples of the Semanggol Formation. To date, this is the first recovery of foraminifera from siliceous rocks in Peninsular Malaysia.

GEOLOGICAL SETTING

The Semanggol Formation is exposed in three areas in northwest Peninsular Malaysia i.e. north Perak, south Kedah and north Kedah. Burton (1973) divided the Semanggol Formation into three members (in ascending order)

i.e. The Chert Member, Rhythmite Member and Conglomerate Member. Teoh (1992) replaced the term member with unit. Discovery of Middle Triassic radiolarians has changed the stratigraphy of the unit (Basir Jasin, 1994). The three units are partly of the same age ranging from Early Permian to Late Triassic.

Outcrops in north Perak belong to two of the units namely the interbedded turbiditic sandstone and mudstone (Rhythmite) and conglomerate units. Exposures in south Kedah are composed of mainly chert and interbedded turbiditic sandstone and mudstone units. All the three units are well-exposed in north Kedah. The Semanggol Formation was folded and faulted as a result of the post-Triassic tectonic event. The Semanggol Formation was deposited in a graben of a deep marine environment ranging from deep sea fan to basin (Ahmad Jantan et al., 1989). The conglomerate unit was deposited in the proximal part of a deep-sea fan. The interbedded sandstone and mudstone (rhythmite) units represent the distal part of a deep-sea fan, and the chert unit was deposited in the basin environment.

In south and north Kedah, the chert unit forms prominent ridges. Extensive quarrying and land clearing have exposed more rock sequences in those areas. The chert unit comprises (in ascending order) black laminated mudstone, interbedded sandstone and mudstone, tuff, interbedded chert and thin mudstone, tuffaceous mudstone and finally thinly bedded chert.

DESCRIPTION OF OUTCROPS

Foraminifera have been retrieved from chert samples from Bukit Lada, north Kedah and Merbau Pulas, south Kedah.

Bukit Lada (N6^0 7.85', E 100^0 33.7')

Bukit Lada is a strike ridge oriented in a north-south direction (Fig.1). More than 70m wide outcrop was exposed at an abandoned earth quarry. The chert sequence consists of thinly bedded chert intercalated with siliceous mudstone. The chert sequence is tightly folded and faulted due to slumping and tectonic deformation. Three siliceous mudstone samples were found to contain foraminifera.

Merbau Pulas (N50 32.7', E1000 38.8')

An approximately 8m thick chert sequence is exposed in a rubber plantation 4 km south of the Merbau Pulas town in south Kedah (Fig. 1). The chert strikes 45^0 and dips 80^0 and is composed of interbedded chert and siliceous mudstone. The chert layers range from 1 cm to 5 cm. Only one siliceous mudstone sample contains foraminifera.

MATERIALS AND METHODS

A total of 20 chert and siliceous mudstone samples were collected from Bukit Lada and 10 samples were collected from the Merbau Pulas area. Each sample was crushed to 1cm fragments and soaked in 10% hydrofluoric acid for 48 hours. The sample was washed with water through a sieve with aperture of 45μ and then dried. Microfossils were picked and identified. Well-preserved specimens were photographed by using scanning electron microscope.

RESULT AND DISCUSSION

The samples from both Bukit Lada and Merbau Pulas yielded abundant radiolarians.

Three samples from Bukit Lada and one sample from Merbau Pulas yielded the same assemblage of foraminifera. It is very rare that the calcareous foraminifera can be retrieved from the siliceous mudstone by using dilute hydrofluoric acid as the calcite wall would usually be dissolved even in a weak acid. However this is an exceptional case. Several taxa were identified i.e. *Pseudonodosaria densa* (Tappan), *Pseudonodosaria lata* (Tappan), *Pseudonodosaria obconica* (Reuss), and *Pseudonodosaria simpsonensis* (Tappan), Other forms could not be properly identified due to lack of references. They might be new species. The forms were assigned to *Prodentalina* sp.A, *Prodentalina* sp B, *Cryptoseptida* sp., and *Protonodosaria* spp.

The foraminifera coexist with several species of radiolaria i.e. *Eptingium manfredi* Dumitrica, *Parasepsagon variabilis* (Nakaseko and Nishimura), *Parasepsagon* sp., *Pseudostylosphaera japonica* (Nakaseko and Nishimura), *Astrocentrus* cf. *pulcher* Kozur and Mostler, *Spongostephanidium longispinosum* Sashida, and *Hozmadia rotunda* (Nakaseko and Nishimura) (Plate 1). The occurrence of *Eptingium manfredi* indicates an age of Anisian, Middle Triassic (Sashida et al., 2000).

During the Triassic, most radiolarians were planktic organisms, which dwelled near the surface of the sea. Their occurrence is indicative of an open marine environment. The radiolarian chert and siliceous mudstone were usually deposited in the basin of deep-marine environments. The identified foraminifera are *Pseudonodosaria densa*, *Pseudonodosaria lata*, *Psuedonodosaria obconica*, *Pseudonodosaria simpsonensis*, *Protdentalina* sp A., *Prodentalina* sp. B., *Cryptoseptida* sp., and *Protonodosaria* spp. These faunas are all marine benthic organisms. The foraminifera are well-preserved and there was no indication of post-mortem transportation. This assemblage represents a natural biocoenosis, which can be used as an indicator of deep marine environment. The state of preservation suggests that the foraminifera had not undergone dissolution. They were probably deposited above the Calcite Compensation Depth. Therefore we infer that the foraminiferal assemblage lived in a deep-water environment above the Calcite Compensation Depth. The occurrence of benthic foraminifera together with radiolaria in the siliceous mudstone is indicative of the ability of the foraminifera to live on siliceous substrate.

CONCLUSIONS.

Most Triassic foraminifera from the Peninsular Malaysia were recorded from the limestones, which were deposited in shallow marine environments. To date, there was no record of the discovery of calcareous foraminifera from siliceous mudstones. The foraminifera obtained from this study are not good index fossils and the age of the assemblage is determined by the associated radiolaria as Middle Triassic. The foraminifera assemblage was a deep marine fauna living on siliceous substrate in a basin of an open sea above the Calcite Compensation Depth.

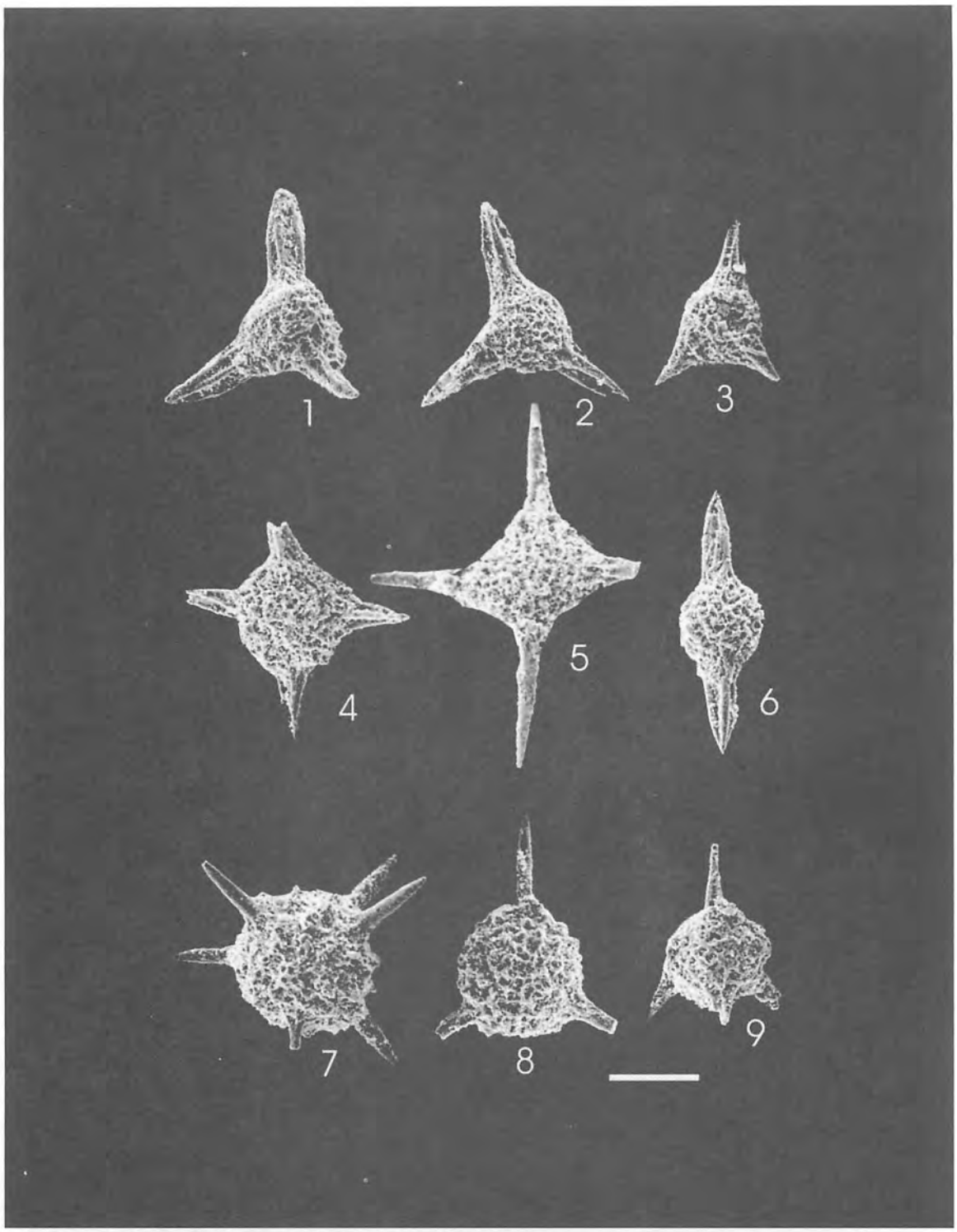

Plate 1. Middle Triassic radiolaria (Scale bar = 100µm)

1, 2, 3. *Eptingium manfredi* Dumitrica
4. *Parasepsagon variabilis* (Nakaseko and Nishimura)
5. *Parasepsagon* sp.
6. *Pseudostylosphaera japonica* (Nakaseko and Nishimura)
7. *Astrocentrus* aff. *pulcher* Kozur and Mostler
8. *Spongostephanidium longispinosum* Sashida
9. *Hozmadia rotunda* (Nakaseko and Nishimura)

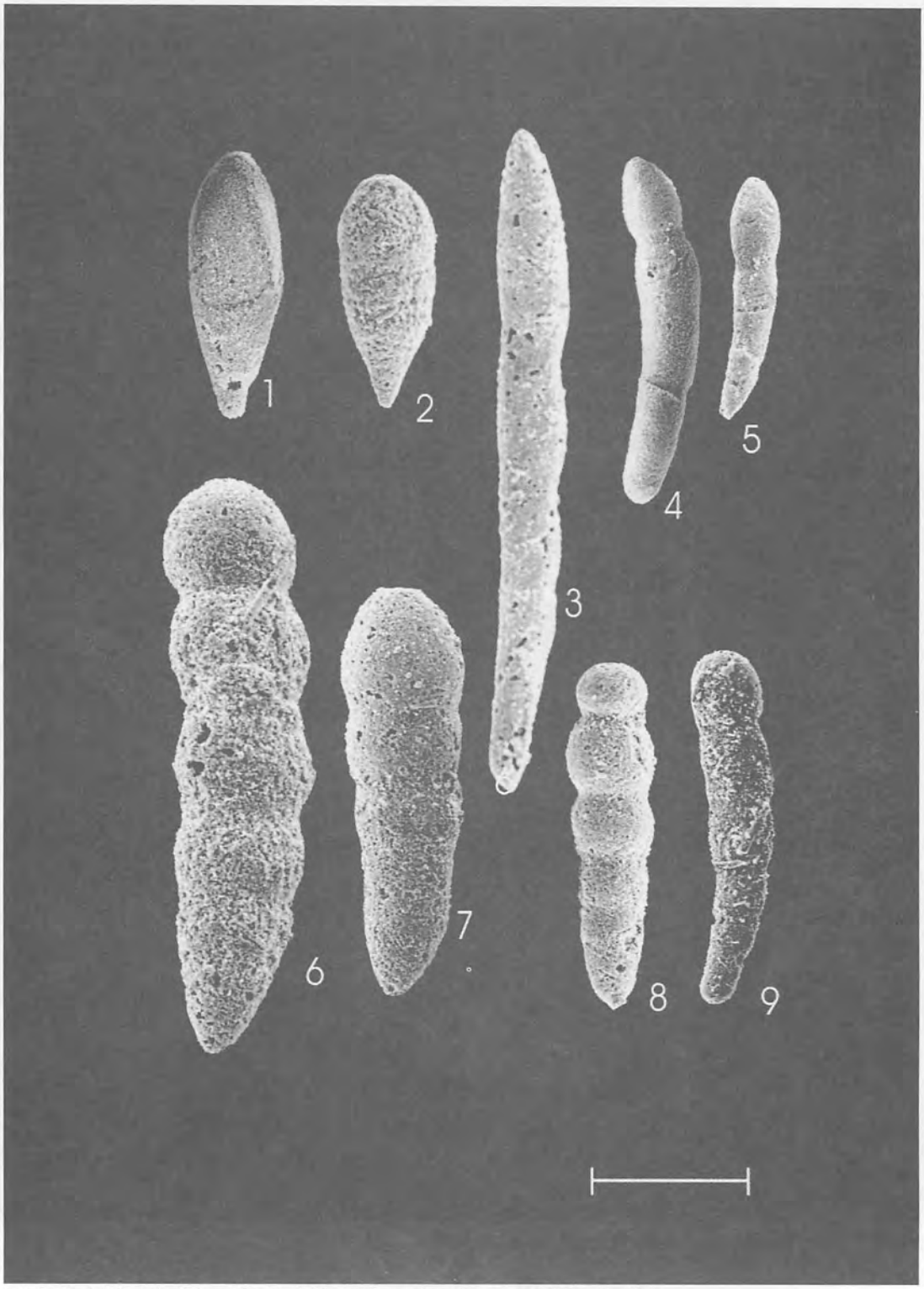

Plate 2. Ichthyolariidae (Foraminifera) from the Semanggol Formation (Scale bar= 200µm)

1, 2. *Cryptoseptida* sp.
3. *Prodentalina* sp A.
4, 5. *Prodentalina* sp B.
6, 7, 8, 9. *Protonodosaria* spp.

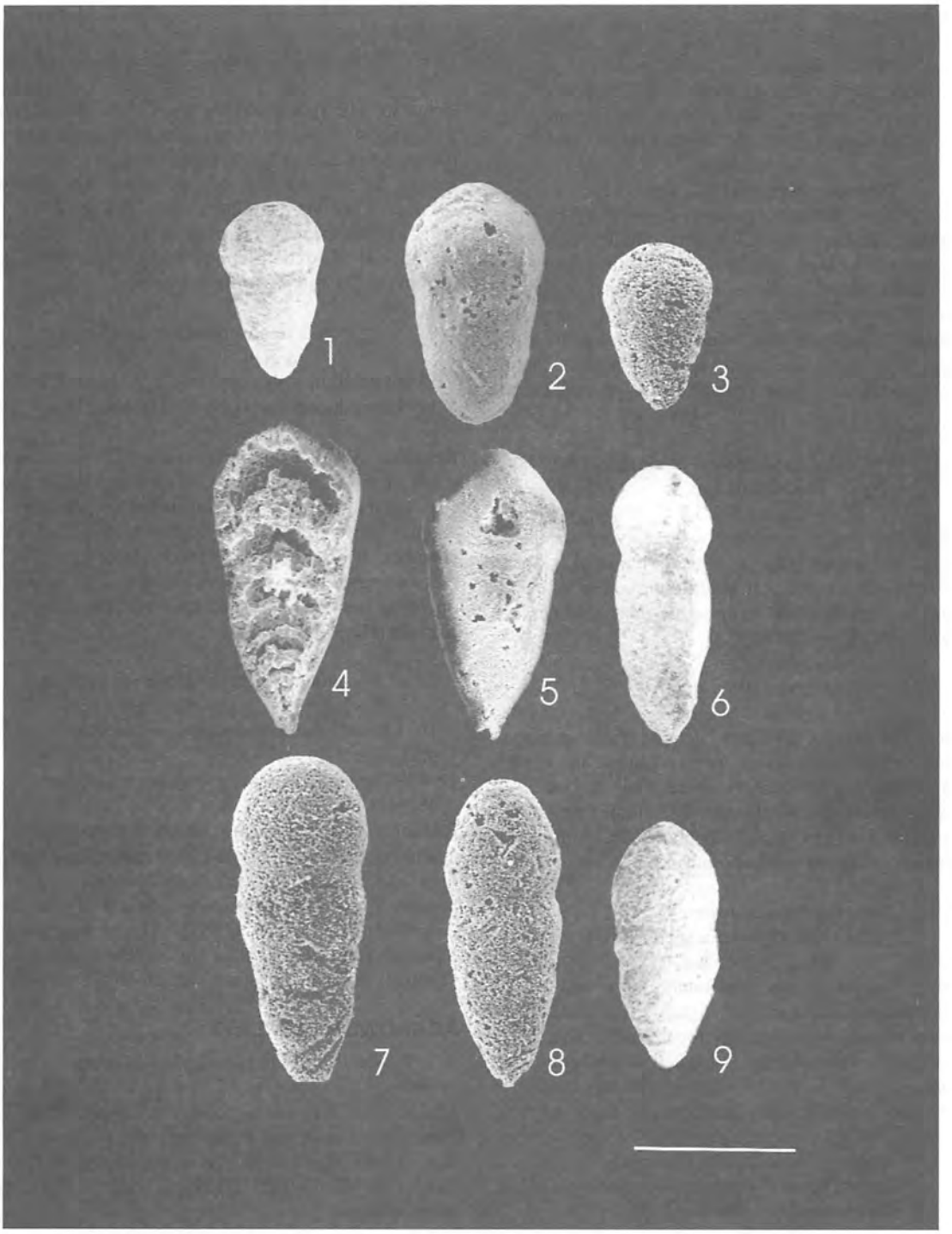

Plate 3. Nodosariidae (Foraminifera) from the Semanggol Formation
(Scale bar = 200 µm)

1, 2. *Pseudonodosaria densa* (Tappan)
3. *Pseudonodosaria lata* (Tappan)
4, 5. *Pseudonodosaria obconica* (Reuss)
6, 7, 8, 9. *Pseudonodosaria simpsonensis* (Tappan)

SYSTEMATIC CLASSIFICATION

The foraminifera are classified in the orders established by Loeblich and Tappan (1987).

Order: Foraminiferida Eichwald
Suborder: Lagenina Delage and Hérouard
Family: Ichthyolariidae Loeblich and Tappan
Genus: *Cryptoseptida* Sellier de Civrieux and Dessauvagie

Cryptoseptida sp. (Pl. 2, figs. 1, 2)

Remarks: The present specimens exhibit elongate, compressed uniserial tests. Chambers rapidly increase in size in the early stage and increase gradually later. The aperture forms a small oval opening at terminal of the final chamber. The species cannot be specifically identified. The morphology of the specimens closely resemble to the genus Cryptoseptida. The genus is cosmopolitan ranging from Late Permian to Late Triassic (Loeblich and Tappan 1997)

Genus Prodentalina Norling

Prodentalina sp. A
(Pl. 2 , fig. 3)

Remarks: The test is moderately large, very similar to Dentalina. Chambers are elongate, uniserial, rapidly increasing in size, rectilinear slightly curved on one side. Aperture is located at the terminal of the final chamber. This is probably a new form.

Prodentalina sp.B
(Pl. 2, fig. 4, 5)

Remarks: The present specimens consist of elongate tests. Chambers are arranged in uniserial, rectilinear and slightly curved. Chambers are slowly increasing in size. This species cannot be specifically identified and is probably a new species. It differs from Prodentalina sp. A in having smaller size and fewer number of chambers.

Genus Protonodosaria Gerke

Protonodosaria spp.
(Pl. 2, figs. 6, 7, 8, 9)

Remarks: Specimens are moderately large and exhibit uniserial tests with straight and slightly depressed sutures. Chambers are inflated, gradually increasing in size. It has a smooth wall. The aperture is located at the terminal of the final chamber. The present specimens cannot be properly identified to species level; may be a new species.

Family: Nodosariidae Ehrenberg
Genus: Pseudonodosaria Boomgaart

Pseudonodosaria densa (Tappan)
(Pl. 3, figs. 1, 2)

1951 Pseudoglandulina densa Tappan, p. 12, pl. 4, figs 9-13.

Remarks: The present specimens are very similar to the paratype (Fig. 9) described by Tappan (1951). It has a robust uniserial test. Chambers are overlapping, five in number, gradually increasing in size and the final chamber is inflated. Aperture is located at the terminal of the final chamber. The species has been reported from the Triassic of Arctic Slope of Alaska (Tappan, 1951)

Pseudonodosaria lata (Tappan)
(Pl. 3, fig. 3)

1951 Pseudoglandulina lata Tappan, p. 12, pl. 3, figs. 15,16.

1999 Pseudonodosaria lata (Tappan) He, p. 48, pl. 3, fig. 16.

Remarks: The specimens are small cone-shaped, uniserial with only 4 chambers very much overlapped and rapidly increasing in size. It has a smooth wall. Aperture is simple located at the terminal of final chamber. The present specimens are very similar to that described by Tappan (1951). The species was originally been described from the Triassic of Arctic Slope of Alaska. He (1999) reported it from the Triassic of western Yunnan.

Pseudonodosaria obconica (Reuss)
(Pl. 3, fig. 4, 5)

1868 Glandulina obconica Reuss, p. 104, pl. 1, fig. 7.

1999 Pseudonodosaria obconica (Reuss) He, p. 39-40, pl. 3, fig. 6.

Remarks: Test is elongate, uniserial, cone-shaped and small in size. Chambers are inflated rapidly increasing in size. Final chamber is globular. It has a smooth wall and a simple aperture is located at the terminal of the final chamber. It differs from Pseudonodosaria lata in having more elongate test with more chambers. Pseudonodosaria obconica has been recorded from the Triassic of western Yunnan (He, 1999).

Pseudonodosaria simpsonensis (Tappan)
(Pl. 3, figs. 6, 7, 8, 9)

1951 Pseudoglandulina simpsonensis Tappan, p. 12-13, pl. 3, figs. 9-14.

1999 Pseudonodosaria simpsonensis (Tappan), He, p. 48, pl. 3, fig. 2.

Remarks: Test is elongate, uniserial, consisting of many chambers gradually increasing in size. Final chamber is high and slightly tapering with terminal aperture. The present specimens are closely similar to the holotype described by Tappan (1951). The species has been reported from the Triassic of Arctic Slope of Alaska (Tappan, 1951) and western Yunnan (He, 1999)

ACKNOWLEDGEMENTS

I would like to thank Siti Norhajar Hassan for preparing the samples. I thank Encik Abdul Razak Mokhtar for his assistance in drafting the map. I thank Prof. Dr. Lee Chai Peng for his comments on the manuscript. This research is financed by MOSTI under IRPA 09-02-02-0028-EA097, which is gratefully acknowledged.

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Manuscript received 14 March 2006