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Some Late Jurassic-Early Cretaceous radiolarian faunas from the Pedawan Formation, Sarawak

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Abstract: Radiolaria were found in radiolarite and tuff in the lowermost part of the Pedawan Formation in the Bau and Tubeh areas, Sarawak. Fifty-three taxa of Radiolaria were identified. These radiolarian assemblages represent latest Jurassic and earliest Cretaceous age. The occurrence of index species such as *Loopus primitivus* in sample B2 indicates that the age of the lower part of the chert belongs to Unitary Association Zone 12 of Baumgartner *et al.* (1995) early late Tithonian. The occurrence of *Artocapsa* (?) *amphorella* and *Hsuum raricostatum* in sample B5 suggests the age of the top part belongs to Unitary Association Zone 13 to 15, late Tithonian to Berriasian. The whole chert sequence was deposited during early late Tithonian to Berriasian. It seems there was no break in sedimentation at the Jurassic-Cretaceous boundary. The mudstone and radiolarian chert sequence was deposited in a deep marine environment. The vertical succession, from shallow marine Bau Limestone to deep water radiolarian chert suggests a transgression episode during the latest Jurassic-earliest Cretaceous time.

INTRODUCTION

Occurrence of Radiolaria in the Pedawan Formation was reported by Wilford and Kho (1965). The Radiolaria were found in radiolarite which is interbeded with mudstone, and tuff in the lowermost part of the Pedawan Formation. The Pedawan Formation is divided into three divisions based on fossils i.e. lower, middle and upper divisions. Fifty-three radiolarian taxa were identified from several thin sections by G.F. Elliott of British Museum Natural History (Wilford and Kho, 1965). This identification was made mostly up to the generic level. The radiolarian assemblages in the lower division indicate a probable Late Jurassic to Early Cretaceous age. Radiolaria from the middle division were not stratigraphically significant. The radiolarian faunas from the upper division contain *Dictyomitra* cf. *multicostata* Zittel which indicates an Upper Cretaceous age. Most of the cherts described by Wilford and Kho (1965) were exposed along the Pedawan and Tebedu roads.

Recently, several siliceous radiolarian samples were collected from the base of the Pedawan Formation. The aims of this study are to identify the radiolarian faunas based on the whole specimens, their stratigraphic range, and their significance in the study of depositional environment.

GEOLOGICAL SETTING

The Pedawan Formation comprises a thick sequence of mudstone, sandstone, with conglomerate, limestone, radiolarian chert and tuffs. The formation is at least 4,500 m thick. The Pedawan Formation conformably overlies the Bau Limestone and is unconformably overlain by the Plateau Sandstone. The age of the formation ranges from Late Jurassic to Late Cretaceous (Wilford and Kho, 1965). Wilford and Kho (1965) suggested that the Pedawan Formation was deposited in a rapidly subsiding shallow marine environment. The radiolarian chert sequence is found in the lower part of the Pedawan Formation.

DESCRIPTION OF THE OUTCROPS

A lenticular bedded chert crops out about 3 km southeast of Tubeh. The chert sequence is 1.5 m thick with strike and dip 15°/50°. Another radiolarian chert locality is exposed in the Sungai Sarawak Kanan near the Bau Water Treatment Plant, Pang Bau, 1.5 km northwest of Bau Town (Fig. 1). The exposure is approximately 4 m thick consists of 2–10 cm thick radiolarian chert interbeded with tuff and mudstone. The sequence strikes 190°–200° and dips 30°–38°. The sequence

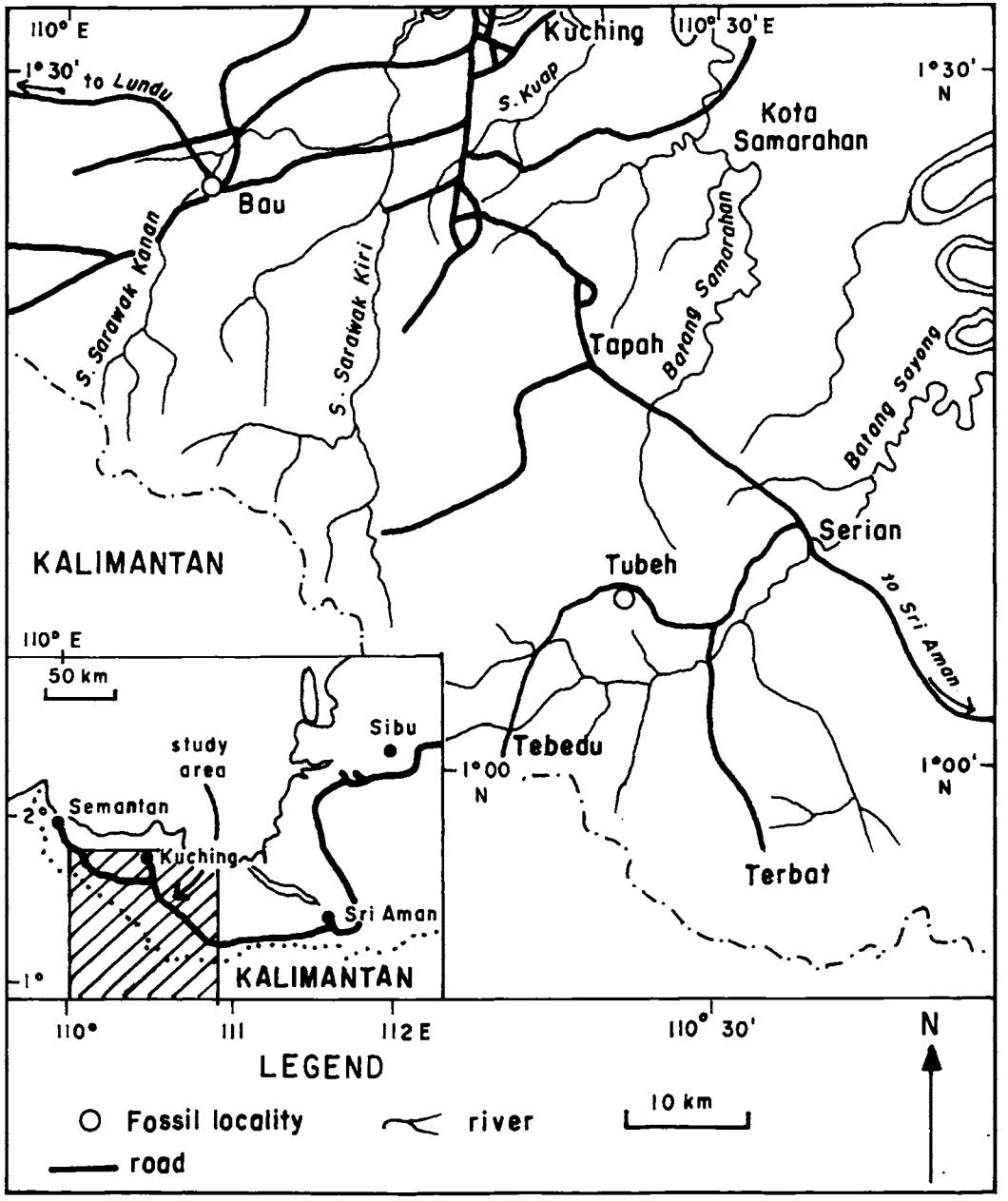

Figure 1. Map showing radiolarian localities.

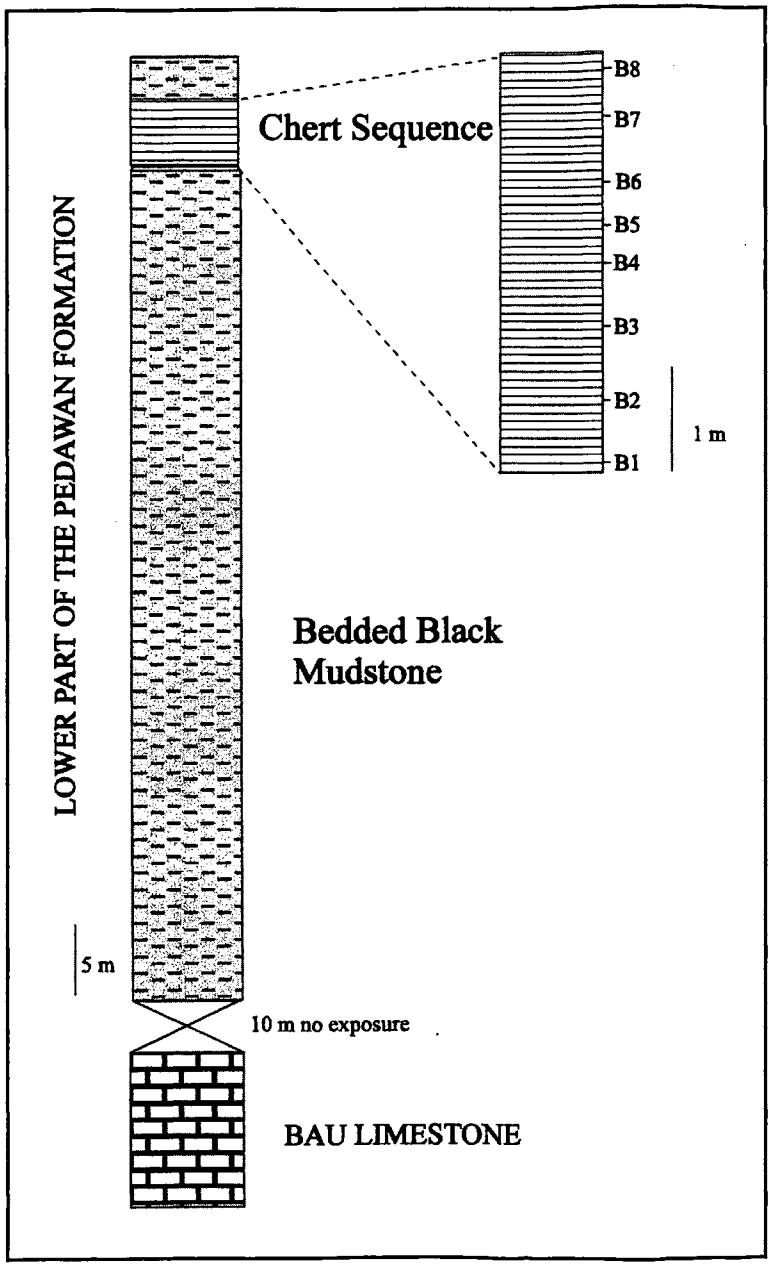

Figure 2. Lithologic log of the outcrop near Pang Bau.

is underlain by approximately 53 m thick bedded black mudstone which is located a the base of the Pedawan Formation (Fig. 2). The chert is overlain by thinly bedded sheared black mudstone. The contact with the underlying Bau Limestone was not observed. The chert consists of radiolarian skeletons, glass shards and few sponge spicules embedded in siliceous mud matrix.

RADIOLARIA AND AGE

Two samples were collected from a lenticular chert body exposed at a road-cut of the Tebedu road about 3 km from Tubeh and 8 samples were picked from the chert sequence at Pang Bau. The samples were treated with hydrofluoric acid to release the radiolarians from the siliceous matrix. The radiolarians are quite well-preserved. Sample B5 yielded very high diversity and well-preserved specimens. Fifty three taxa of Radiolaria were identified (Plates 1–4). These taxa are listed in Table 1. These taxa are very much different from those identified by G.F. Elliott. Most of the radiolarian faunas in the present material have been recorded mainly in the Tethyan realm.

The occurrence of index species such as *Loopus primitivus* (Matsuoka and Yao) in sample B2 in the section near Bau indicates that the age of the lower part of the chert belongs to Unitary Association Zone 12 of Baumgartner *et al.* (1995). The occurrence of *Artocapsa* (?) *amphorella* Jud and *Hsuum raricostatum* Jud, *Syringocapsa longitubus* Jud, *Obesacapsula rusconensis umbriensis* Jud, *Angulobracchia* (?) *rugosa* Jud and *Cinguloturris cylindrica* Kemkin & Rudenko in sample B5 suggests the age of the top part belongs to Unitary Association Zone 13 to 15. The age of the whole chert ranges from the Unitary Association Zone 12 to 15., late Tithonian to Berriasian (Fig. 3). It seems there was no break in sedimentation at the Jurassic-Cretaceous boundary. The occurrence of *Obesacapsula rusconensis umbriensis* Jud in sample T2 indicates that the chert near Tubeh is of the same age.

DEPOSITIONAL ENVIRONMENT

The bedded black mudstone and the chert sequence characterize deep-water depositional environment along a continental margin where the upwelling nutrients are abundant (Murray, 1994). A vertical succession from shallow-water Bau Limestone upward to deep-water radiolarian chert indicates a subsidence-induced lithologic change. This rock sequence represents a subsidence association (Girty *et al.*, 1996; Jones and Murchey, 1986). The Bau Limestone was deposited in a shallow marine environment during the Late Jurassic and, there was a rapid subsidence of the basin during Early Cretaceous which accompanied by an increased influx of tuff and clastic material of the Pedawan Formation (de Coo and Lau, 1977; Tan, 1986; Tate, 1991). The sea level was relatively low during the latest Jurassic and rose during the early Cretaceous (Fig. 4). This also may indicate the early phase of transgression which was caused by the global warming during Cretaceous.

The occurrence of radiolarian faunas in the sequence was related to the high planktonic productivity in the sea associated with the supply of siliceous material by volcanic tuff. The source of tuff was probably from the Raya Volcanics, Northwest Kalimantan.

CONCLUSION

Radiolarian chert of the Pedawan Formation yielded very high diversity of radiolarian faunas. The occurrence of several index forms such as *Loopus primitivus, Artocapsa* (?) *amphorella, Hsuum raricostatum, Syringocapsa longitubus, Obesacapsula rusconensis umbriensis, Angulobracchia* (?) *rugosa* and *Cinguloturris cylindrica* indicates that the age of the chert sequence is late Tithonian to Berriasian.

The radiolarian chert was deposited in a deep marine environment. The change of lithology from the Bau Limestone to black mudstone and chert suggests that there was a transgression or a subsidence episode during latest Jurassic-earliest Cretaceous. This transgression is probably related to the global warming.

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REFERENCES

BAUMGARTNER, P.O., O'DOGHERTY, L., GORICAN, S., URQUHART, E., PILLEVIUT, A. AND DE WEVER, P., 1995. Middle Jurassic to Lower Cretaceous Radiolaria of Tethys: Occurrences, Systematics, Biochronology. *Memoires de Geologie (Lausanne), 23.*

DE COO, J.C.M. AND LAU, J.W.E., 1977. Recognition of reef facies in the Bau Limestone (Upper Jurassic-Lower Cretaceous) Sarawak. *Geological Survey Malaysia Geological Papers 2,* 72–78.

GIRTY, G.H., RIDGE, D.L., KNAACK, C., JOHNSON, D. AND AL-RIYAMI, R., 1996. Provenance and depositional setting of

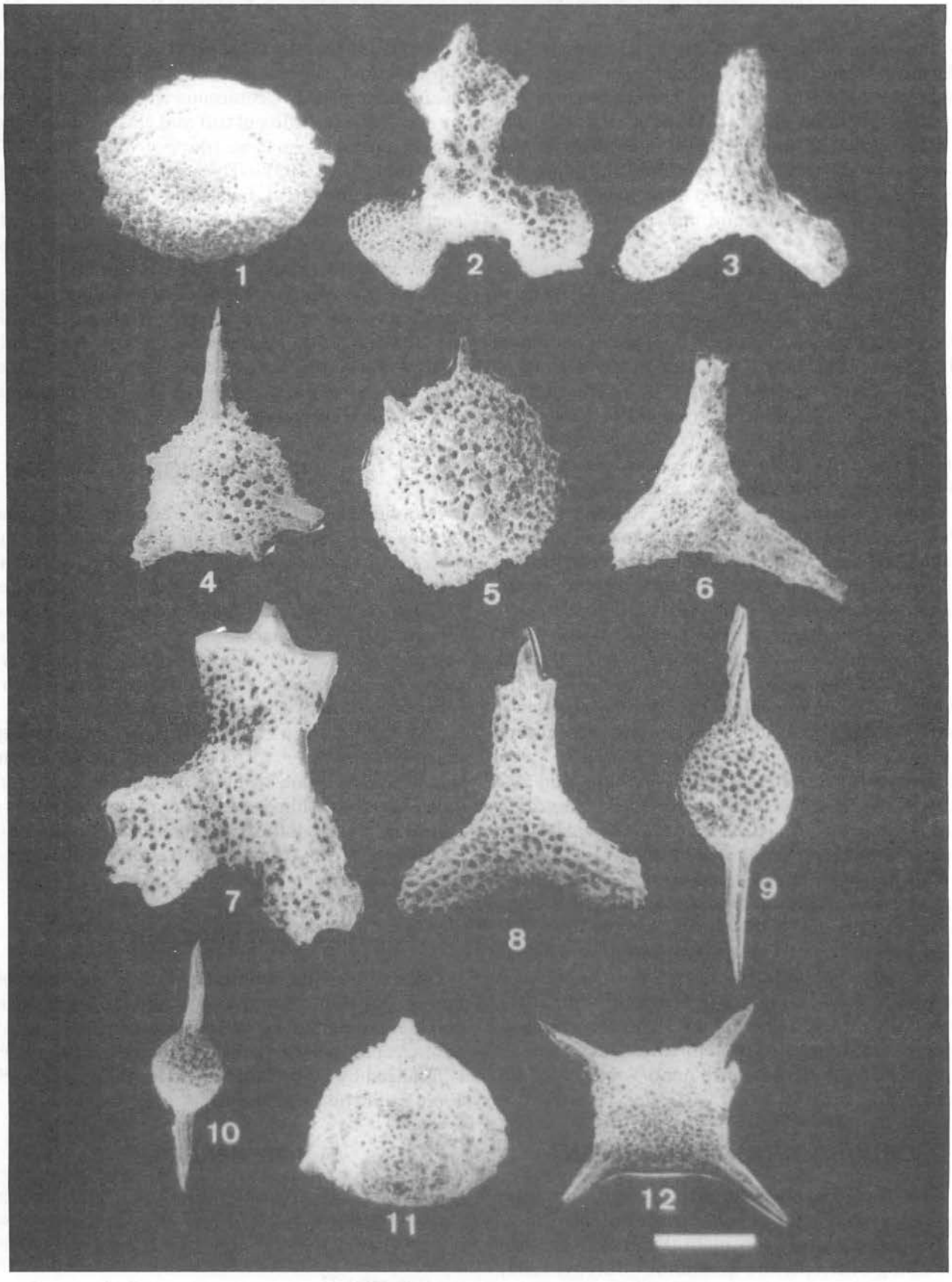

Plate 1. Scale bar in μm is indicated in the parentheses.

1. *Orbiculiforma* sp. (100 μm)
2. *Angulobracchia* (?) *rugosa* Jud (133 μm)
3. *Angulobracchia* sp. (133 μm)
4. *Alievium helenae* Schaaf (100 μm)
5. *Alievium* sp. (100 μm)
6. *Paronaella* (?) *tabulata* Steiger (133 μm)
7. *Paronaella* sp. A (100 μm)
8. *Paronaella* sp. B (100 μm)
9. *Archaeospongoprunum patricki* Jud (114 μm)
10. *Archaeospongoprunum patricki* Jud (133 μm)
11. *Pyramispongia* sp. (100 μm)
12. *Spongostaurus compactus* Kiessling (100 μm)

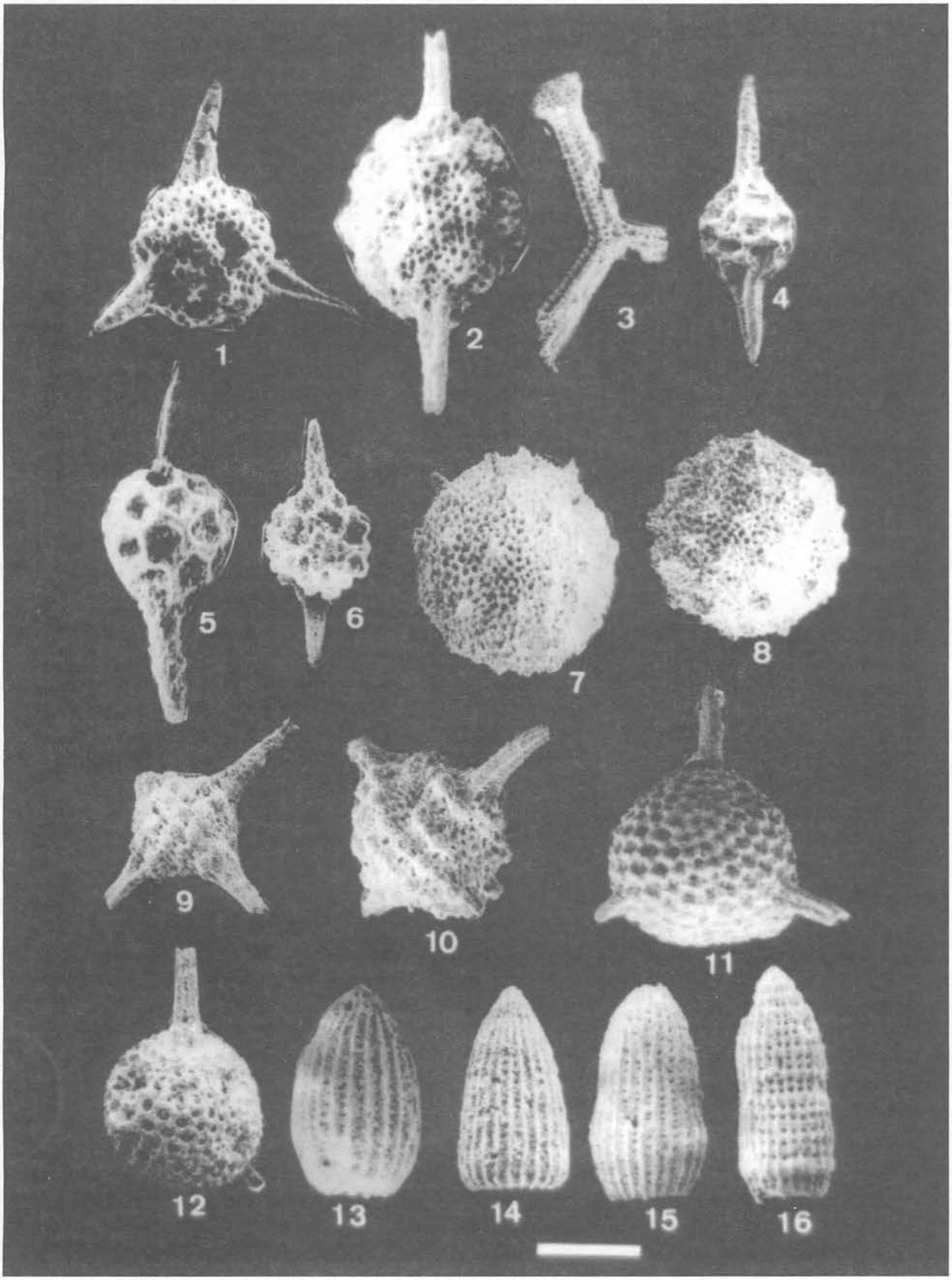

Plate 2. Scale bar in μm is indicated in the parentheses.

1. *Acaeniotyle diaphorogona* Foreman (100 μm)
2. *Acaeoniotyle umbilicata* (Rust) (100 μm)
3. *Tritrabs* sp. (200 μm)
4. *Pantanellium squinaboli* (Tan) (100 μm)
5. *Pantanellium squinaboli* (Tan) (80 μm)
6. *Pantanellium cf. riedeli* Pessagno (100 μm)
7. *Praeconocaryomma sp A* (100 μm)
8. *Praeconocaryomma sp.B* (100 μm)
9. *Emiluvia chica* Foreman (133 μm)
10. *Emiluvia* sp. (100 μm)
11. *Triactoma tithonianum* Rust (133 μm)
12. *Triactoma tithonianum* Rust (133 μm)
13. *Archaeodictyomitra apiarum* (Rust) (100 μm)
14. *Archaeodictyomitra apiarum* (Rust) (100 μm)
15. *Archaeodictyomitra excellens* (Tan) (100 μm)
16. *Archaeodictyomitra excellens* (Tan) (100 μm)

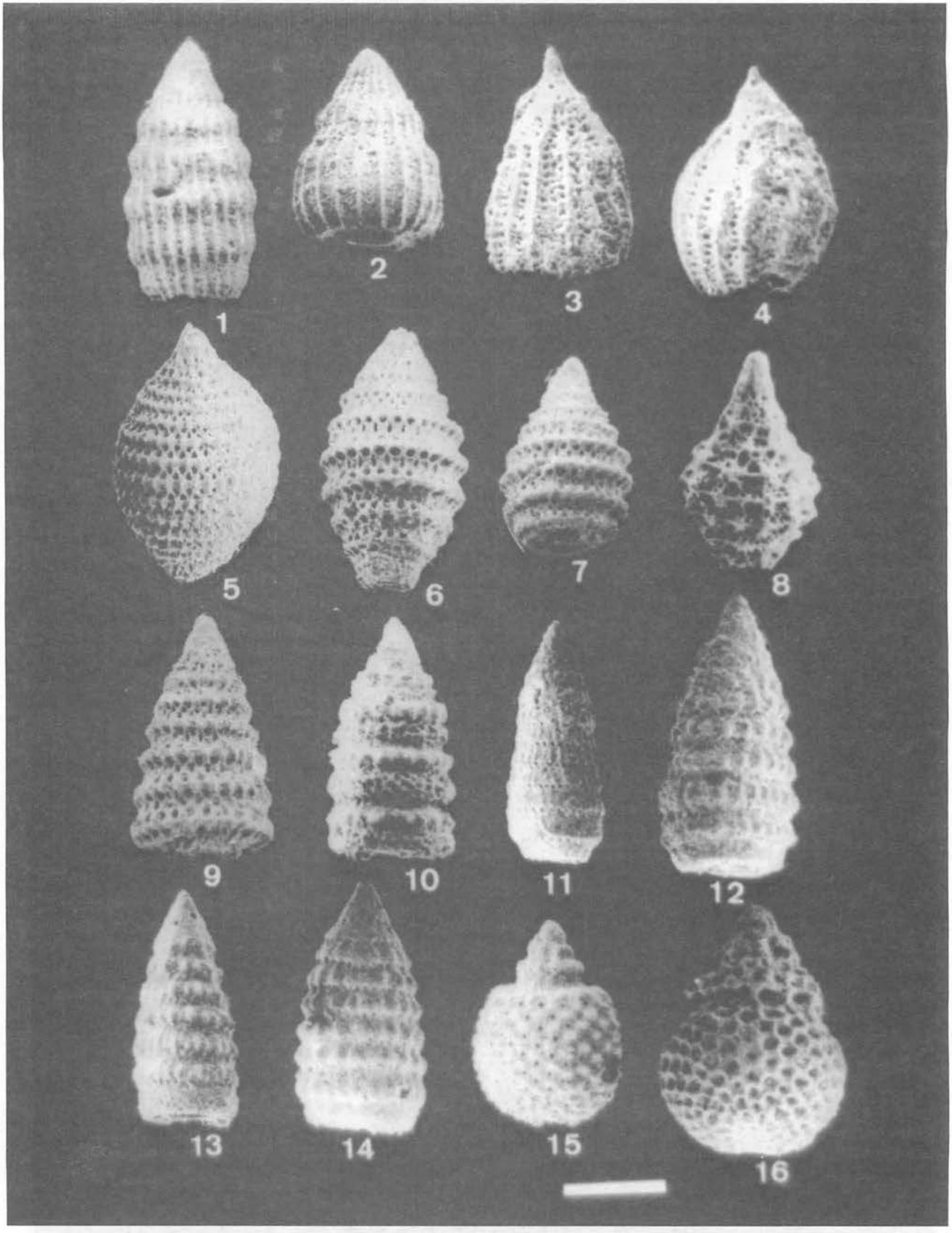

Plate 3. Scale bar in μm is indicated in the parentheses.

1. *Archaeodictyomitra* cf. *pseudoscalaris* (Tan) (100 μm)
2. *Tharnala conica* (Aliev) (80 μm)
3. *Hsuum raricostatum* Jud (80 μm)
4. *Hsuum raricostatum* Jud (100 μm)
5. *Mirifusus dianae minor* Baumgartner (200 μm)
6. *Parvicingula boesii* (Parona) (100 μm)
7. *Parvicingula boesii* (Parona) (100 μm)
8. *Novixitus* sp. (100 μm)
9. *Parvicingula* cf. *cosmoconica* (Foreman) (100 μm)
10. *Cinguloturris cylindrica* Kemkin & Rudenko (133 μm)
11. *Loopus primitivus* (Matsuoka and Yao) (100 μm)
12. *Pseudodictyomitra carpatica* (Lozyniak) (100 μm)
13. *Pseudodictyomitra carpatica* (Lozyniak) (100 μm)
14. *Pseudodictyomitra* sp. (100 μm)
15. *Sethocapsa uterculus* (Parona) (100 μm)
16. *Sethocapsa (?) zweilii* Jud (67 μm)

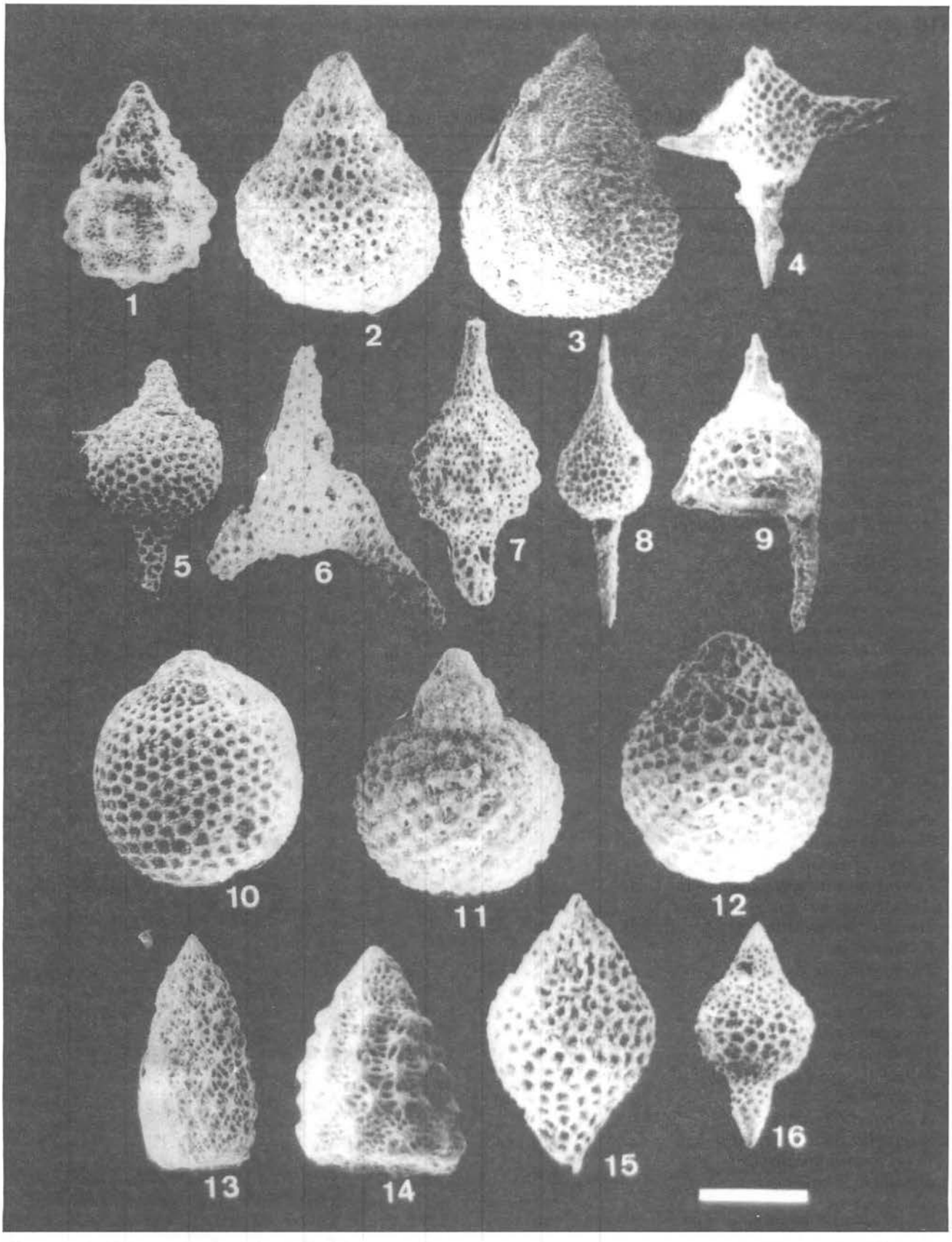

Plate 4. Scale bar in µm is indicated in the parentheses.

1. *Sethocapsa kaminogoensis* Aita (80 µm)
2. *Obesacapsula rusconensis umbriensis* Jud (133 µm)
3. *Obesacapsula verbana* (Parona) (133 µm)
4. *Podocapsa amphitreptra* Foreman (160 µm)
5. *Dibolachras apletopora* Foreman (160 µm)
6. *Parapodocapsa furcata* Steiger (133 µm)
7. *Syringocapsa limatum* Foreman (133 µm)
8. *Syringocapsa longitubus* Jud (200 µm)
9. *Napora* sp. (100 µm)
10. *Cryptamphorella sphaerica* (White) (80 µm)
11. *Praezhamoidellum frequens* (Tan) (80 µm)
12. *Tricolocapsa* sp. (80 µm)
13. *Xitus spicularius* (Aliev) (133 µm)
14. *Xitus gifuensis* Mizutani (100 µm)
15. *Stichocapsa* sp. (100 µm)
16. *Artocapsa* (?) *amphorella* Jud (100 µm)

Table 1. Distribution of Radiolaria in the chert sequence.

	Bau								Tubeh	
	B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8	T 1	T 2
Pseudodictyomitra carpatica	X	X	X	X	X			X		
Parvicingula cf. *cosmoconica*	X	X	X	X	X	X				
Acaeoniotyle umbilicata	X		X	X	X				X	
Archaeodictyomitra apiarium	X	X	X	X	X				X	
Tharnala conica	X	X	X	X	X			X	X	
Sethocapsa uterculus	X		X	X	X					
Parvicingula boesii	X	X	X	X	X		X	X		X
Xitus gifuensis	X	X		X	X			X		
Alievium helenae	X	X	X	X	X	X	X			
Tricolocapsa sp.	X	X	X		X		X	X		
Cryptamphorella sphaerica	X	X	X	X	X		X	X		
Stichocapsa sp.	X	X	X		X	X	X	X		
Praeconocoryomma sp. A	X	X	X	X	X				X	
Praeconocoryomma sp. B	X	X	X	X	X				X	X
Archaeospongoprunum patricki	X	X			X	X				
Aleivium sp.	X	X	X	X	X	X	X	X	X	X
Orbiculiforma sp.	X									X
Syringocapsa limatum		X			X					
Loopus primitivus		X								
Archaeodictyomitra excellens		X		X	X					
Acaeniotyle diaphorogona		X	X	X	X		X		X	X
Pantanellium squinaboli		X	X	X	X	X	X		X	
Spongostaurus compactus		X		X	X		X			
Dictyomitra cf. pseudoscalaris		X	X		X	X				
Mirifusus dianae minor		X	X	X	X	X	X		X	
Praezhamoidellum frequens		X	X	X	X		X	X		
Xitus spicularius			X	X	X					X
Sethocapsa uterculus			X	X	X					
Pseudodictyomitra sp.			X	X	X		X			X
Sethocapsa kaminogoensis				X	X					
Sethocapsa (?) zweilii					X					X
Obesacapsula rusconensis umbriensis					X	X				X
Angulobracchia sp.					X	X	X			
Hsuum raricostatum					X					
Emiluvia sp.					X					
Paronaella sp. A					X				X	
Paronaella (?) tabulata					X					
Obesacapsula verbana					X					
Triactoma tithonianum					X		X			
Emiluvia chica					X					
Parapodocapsa furcata					X					
Tritrabs sp.					X					
Artocapsa (?) amphorella					X					
Angulobracchia (?) rugosa					X					
Podocapsa amphitreptra					X					
Dibolachras apletopora					X					
Novixitus sp.					X					
Syringocapsa longitubus					X					
Pantanellium cf. *riedeli*					X		X			
Paronaella sp. B					X					
Napora sp.					X					
Cinguloturis cylindrica					X					
Pyramispongia sp.									X	

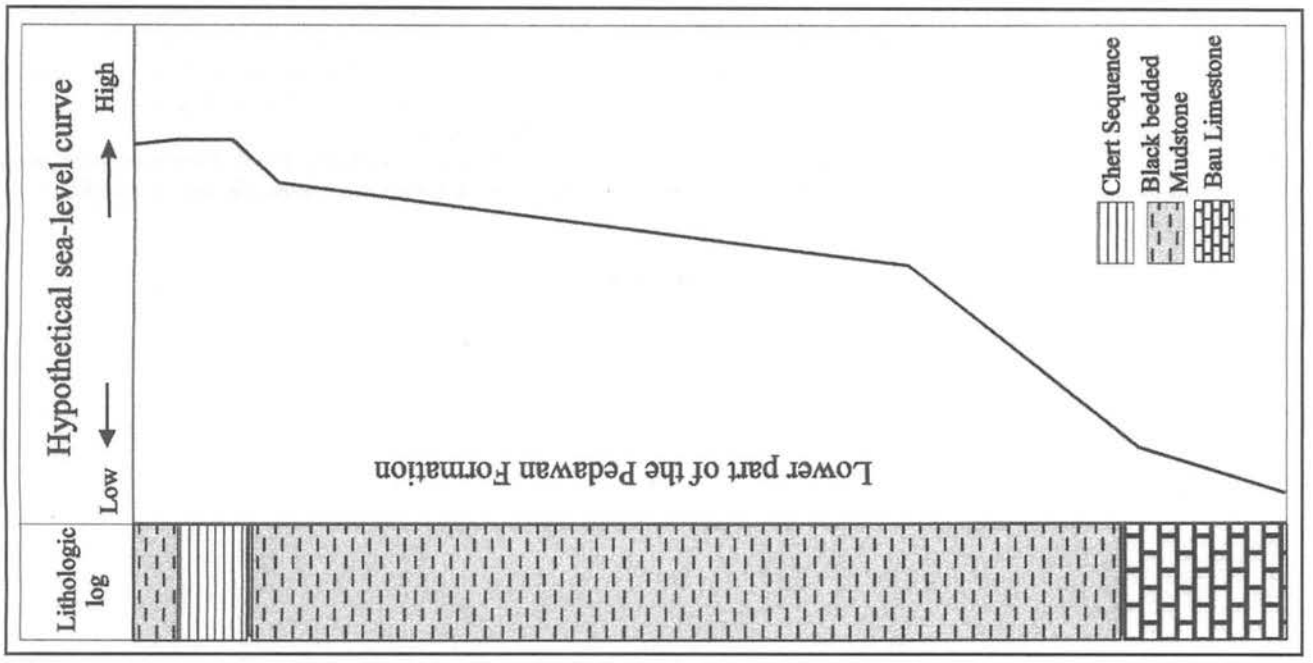

Figure 4. Hypothetical sea-level curve.

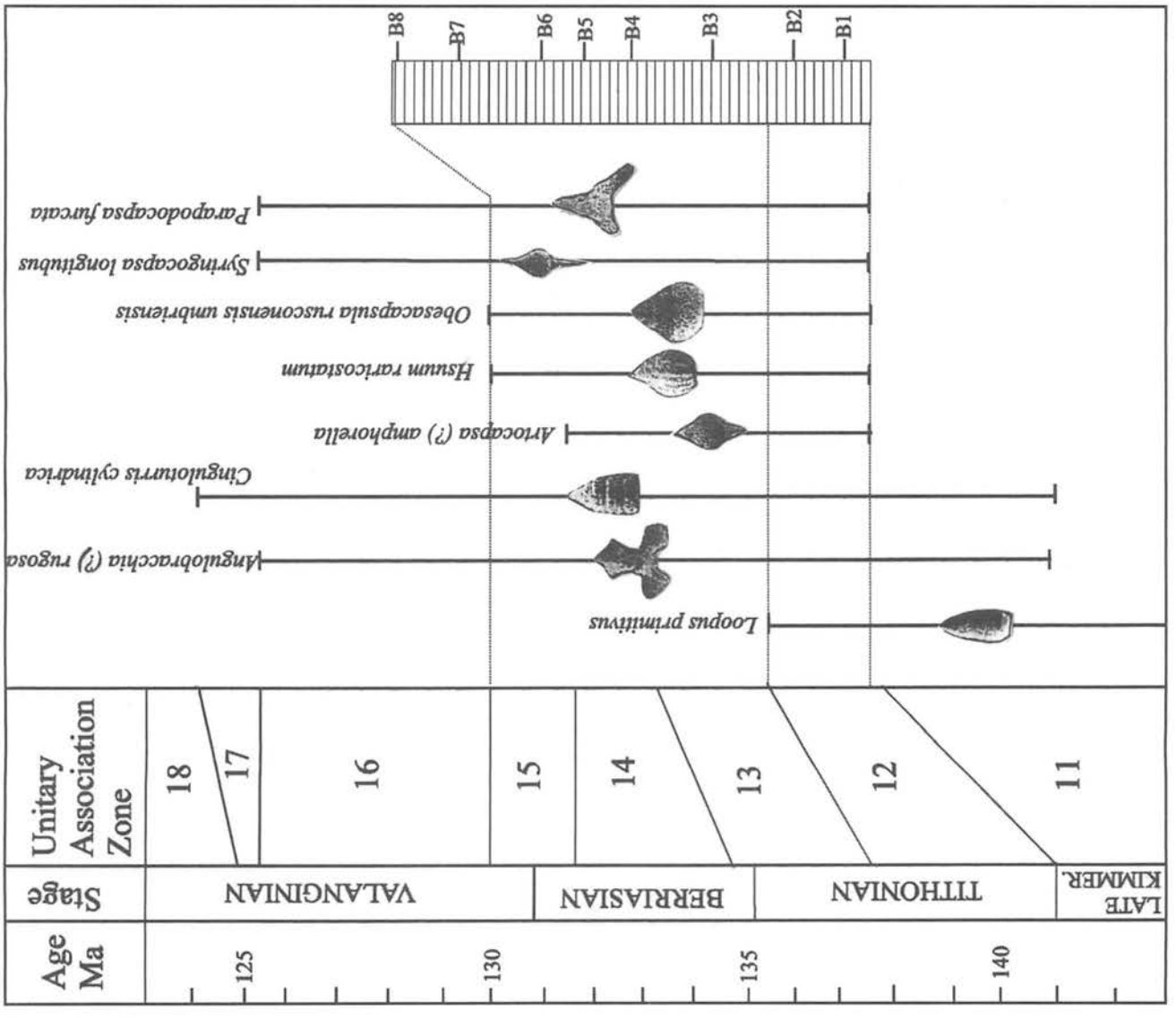

Figure 3. Stratigraphic distribution of some selected species.

Paleozoic chert and argillite Sierra Nevada, California. *Journal of Sedimentary Research, 66(1)*, 107–118.

JONES, D.L. AND MURCHEY, B., 1986. Geologic significance of Paleozoic and Mesozoic radiolarian chert. *Ann. Rev. Earth Planet Sci. 14*, 455–492.

MURRAY, R.W., 1994. Chemical criteria to identify the depositional environment of chert: general principles and applications. *Sedimentary Geology, 90*, 213–232.

TAN, D.N.K., 1986. Palaeogeographic development of west Sarawak. *Geol. Soc. Malaysia Bull. 19*, 39–49.

TATE, R.B., 1991. Cross-border correlation of geological formations in Sarawak and Kalimantan. *Bull Geol. Soc. Malaysia, 28*, 63–95.

WILFORD, G.E. AND KHO, C.H., 1965. Penrissen area, west Sarawak, Malaysia. *Geol. Surv. Malaysia Borneo Reg. Rept. 2*.

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