



## **Significance of Early Jurassic Radiolaria from West Sarawak, Malaysia**

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**Abstract:** The dacitic tuff-chert sequence is exposed at several road-cuts along the road to Tebedu 2.5 km to 4 km west of Piching. The sequence is composed of bedded dacitic tuff interbedded with cherts and mudstone. The sequence is informally assigned as the Binong bed which is closely related to the Serian Volcanics and may represent the top part of the formation. Twenty seven taxa of Radiolaria were identified from the chert samples. The occurrence of *Parahsuum simplum* Yao, *Parahsuum directiporatum* (Rust), *Praecocaryomma media* Pessagno and Poisson, *Praeconocaryomma decora* Yeh, *Paracanoptum anulatum* (Pessagno and Poisson), *Canutus izeensis* Pessagno and Whalen, and *Paracanoptum rugosum* (Pessagno and Poisson) suggests that the radiolarian faunas belong to the *Parahsuum directiporatum* Zone. Based on the radiolarian faunas, the whole chert-dacitic tuff sequence was deposited during Pliensbachian-early Toarcian, Early Jurassic. The radiolarian chert was deposited in a deep marine marginal basin environment very close to an island arc.

### **INTRODUCTION**

The Kedadom Formation is exposed only in the Kedadom valley, southwest of Serian town. The occurrence of radiolarian faunas in the dacitic tuff at the base of the Kedadom Formation was noted by Wilford and Kho (1965). Several radiolarian taxa were identified *i.e.* *Cenosphaera*, *Dictyomitra*, *Flustrella*, *Hexastylus*, *Siphocampium*, *Stylostaurus* and *Thecospira* indicating a Jurassic age. This identification was based mainly on the thin sections. Wilford and Kho (1965) indicated that the age of the Kedadom Formation ranges from Late Kimmeridgian to Tithonian based on the Ammonites.

Basir Jasin *et al.*, (1996) have retrieved some whole specimens of the radiolarian faunas from two chert samples collected from a dacitic tuff sequence at a road-cut 2.5 km west of Piching. In this preliminary study, seventeen taxa of Early Jurassic radiolarian faunas were identified. Recently, we have carried out a more detailed study of the area and collected more chert and dacitic tuff samples from the sequence exposed at new road-cuts near Binong Pass. The aims of this study are to identify more radiolarian faunas, their stratigraphic distribution, their depositional environment and their significance in the geology of the area.

### **GEOLOGICAL SETTING**

The oldest rocks in the area consist of the Upper Triassic Serian Volcanics and the Sadong Formation. The Sadong Formation is interbedded with the Serian Volcanics. Both formations were deposited in a marine environment. These formations are unconformably overlain by the Kedadom Formation. The Kedadom Formation is in part interfingering and in part conformably overlain by the Bau Limestone. The Bau Limestone is overlain by the Pedawan Formation (Fig. 1).

The basal part of the Kedadom Formation consists of basal conglomerate, carbonaceous sandstone, shale and thin beds of limestone. These rocks are overlain by radiolarian dacitic tuff followed by thick conglomerate, massive to thickly bedded sandstone, lenses of dark, poorly fossiliferous limestone, and calcareous and carbonaceous sandstone at the top part. The thickness of the formation is about 770 m. The Kedadom Formation was laid down in a shallow marine probably nearshore environment during Late Jurassic (Wilford and Kho, 1965).

The dacitic tuff-chert sequence was previously included in the Kedadom Formation (Wilford and Kho, 1965; Basir Jasin *et al.*, 1996). Discovery of an unconformity which separates the Early Jurassic

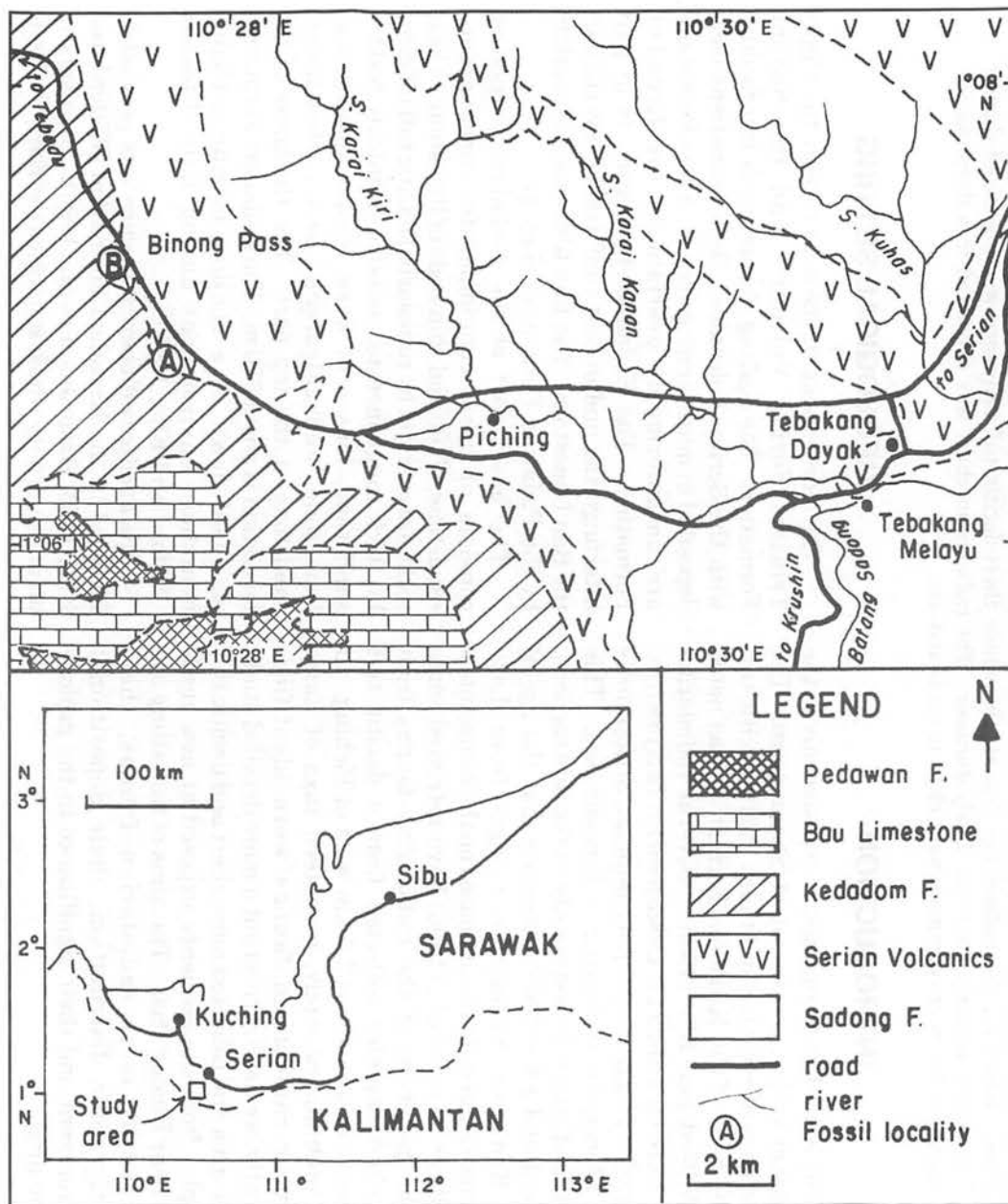


Figure 1. Geological map of the area showing radiolarian localities.

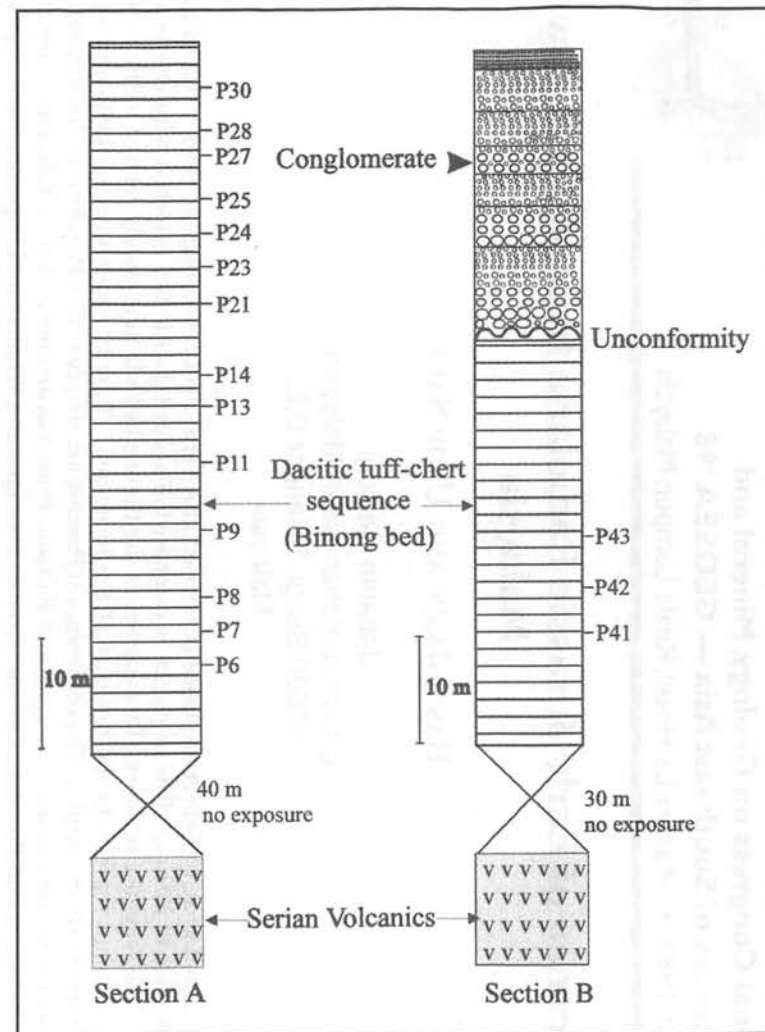


Figure 2. Lithological log of section A and section B in the vicinity of Binong Pass.

**Table 1.** Major element composition of the chert samples.

Major Elements (Weight percentage)					
	P6	P14	P25	P42	P43
SiO <sub>2</sub>	83.30	83.01	77.87	75.24	73.28
TiO <sub>2</sub>	0.23	0.30	0.50	0.30	0.43
Al <sub>2</sub> O <sub>3</sub>	6.05	7.32	9.37	13.15	11.67
Fe <sub>2</sub> O <sub>3</sub>	3.92	4.07	4.31	3.12	5.69
MnO	0.04	0.04	0.03	0.05	0.04
MgO	0.50	0.47	0.80	0.58	1.07
CaO	0.03	0.03	0.03	0.15	0.23
Na <sub>2</sub> O	bdl*	bdl*	0.03	4.73	1.21
K <sub>2</sub> O	1.41	1.06	1.83	1.01	2.13
P <sub>2</sub> O <sub>4</sub>	0.07	0.04	0.06	0.05	0.06
L.O.I.	4.13	3.71	4.34	2.20	4.59
Total	99.66	100.02	99.18	100.58	100.40
Fe <sub>2</sub> O <sub>3</sub> /TiO <sub>2</sub>	17.04	13.57	8.62	10.40	13.23
Al <sub>2</sub> O <sub>3</sub> /(Al <sub>2</sub> O <sub>3</sub> + Fe <sub>2</sub> O <sub>3</sub> )	0.61	0.64	0.68	0.81	0.67

bdl\* below detection limit

dacitic tuff-chert sequence from the Late Jurassic Kedadom Formation suggests that the dacitic tuff-chert sequence is a separate lithologic unit.

## DESCRIPTION OF THE OUTCROPS

There are several new outcrops of dacitic tuff-chert sequence exposed along the Tebedu new road 2.5 km to 4 km west of Piching, in the vicinity of Binong Pass (Fig. 1). The sequence overlies the Serian Volcanics and is overlain by thick channelised conglomerate (Fig. 2). The contact between the sequence and the Serian Volcanics was not exposed. The basal conglomerate, carbonaceous sandstone, shale and thin beds of limestone at the base of the Kedadom Formation which were reported by Wilford and Kho (1965) were not observed in the area.

The dacitic tuff-chert sequence is composed of rhythmically bedded dacitic tuff interbeds with cherts and mudstone. The thickness of the sequence varies. In the valley (Section A), the total thickness of the sequence is approximately 67 m. The lowermost part is slightly folded due to slumping. The sequence strikes 143°–150° and dips 45°–55°. The thickness of the individual chert and tuff layers ranges from 2 cm to 12 cm. Chert beds are easily distinguishable from the tuff in the field by their white to gray colour, extreme hardness, highly fractured and tendency to break along conchoidal fractures when struck with a hammer. The dacitic tuff is highly weathered and soft. The top part of the sequence is well-exposed at the top of Binong Pass (section B) where the bedding strikes 155°

and dips 75°–80°. The bedded tuff was cut by a normal fault and overlain by thickly bedded channelised conglomerate. The conglomerate is composed of well-rounded granule to boulder sized clasts of tuff, volcanic, siliceous mudstone and felspathic sandstone.

The dacitic tuff-chert sequence is separated from the younger rocks of the Kedadom Formation by an unconformity. The sequence is genetically related to the Serian Volcanic and may represent the top part of the formation.

## PETROGRAPHY AND CHEMICAL COMPOSITION OF THE CHERT

In thin-section, the chert consists of fairly abundant radiolarian tests and fine angular glass shards with very rare sponge spicules embedded in siliceous mud matrix. Samples contain very high iron oxide are red in colour. Some chert samples exhibit laminae which composed of fairly packed radiolarian tests intercalated with siliceous mud. The most common primary structures are plane-parallel lamination and graded bedding.

The abundance of major elements of five selected chert samples have been determined using X-ray fluorescence method. The results are listed in Table 1.

## RADIOLARIAN FAUNAS AND AGE

A total of 29 samples were collected from section A in the valley and 4 samples were collected from section B. Only seventeen samples yielded moderate

to well-preserved radiolarians. Radiolarians are more common in the chert samples and less common in the tuff. Three chert samples, P7, P42 and P47 yielded high diversity and number of individuals.

Twenty seven taxa of Radiolaria were identified (Table 2). The occurrence of *Parahsuum simplum* Yao, *Parahsuum directiporatum* (Rust), *Praecocaryomma media* Pessagno and Poisson, *Praeconocaryomma decora* Yeh, *Paracanoptum anulatum* (Pessagno and Poisson), *Canutus izeensis* Pessagno and Whalen, and *Canoptum rugosum* (Pessagno and Poisson) suggests that the radiolarian faunas belong to the *Parahsuum directiporatum* Zone of Nishizono *et al.* (1997). Based on the stratigraphic distribution of some selected radiolarian faunas (Fig. 3), the whole dacitic tuff-chert sequence was deposited during Pliensbachian-early Toarcian, Early Jurassic.

Wilford and Kho (1965) include the dacitic tuff-chert sequence in the Kedadom Formation which ranges from Middle Kimmeridgian to Tithonian in age, Late Jurassic. The occurrence of Lower Jurassic radiolarian assemblages in the chert indicates that the sequence is older than the Kedadom Formation. In order to avoid confusion we assigned the sequence into a new lithostratigraphic unit which informally called Binong bed. The Binong bed is separated from the Kedadom Formation by an unconformity which is located at the base of grain-supported channelised conglomerate.

The dacitic tuff chert sequence (Binong bed)

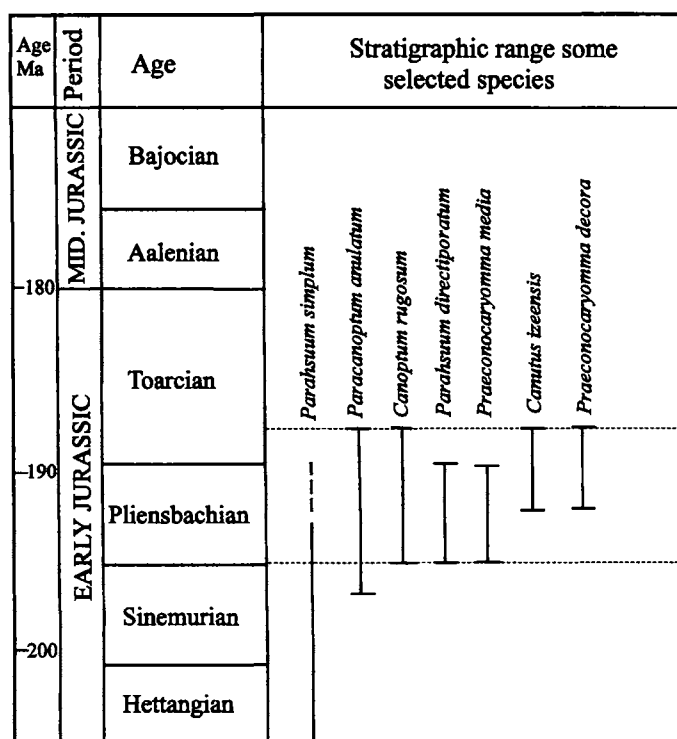


Figure 3. Stratigraphic distribution of some selected taxa.

was previously included in the Kedadom Formation (Wilford and Kho, 1965; Basir Jasin *et al.*, 1996). The age of the Kedadom Formation was considered to extend from Pliensbachian, Early Jurassic to Tithonian, Late Jurassic. It is not appropriate because the Lower Jurassic Binong bed is separated from the Upper Jurassic Kedadom Formation by an unconformity and the Middle Jurassic sediments are missing.

The Binong bed is genetically related to the Serian Volcanics. It is more appropriate to be included in the Serian Volcanics. It is located at the top of the Serian Volcanics and the age of the Serian Volcanics extends from Late Triassic to Early Jurassic. The Serian Volcanics is separated from the Kedadom Formation by Middle Jurassic unconformity which was also recorded at the top of Bengkayang Group in the northwest Kalimantan (Tate, 1991).

## DEPOSITIONAL ENVIRONMENT

The Binong bed was deposited in a marine environment. The rock association which is composed of admixture of dacitic tuff, chert and mudstone characterises the island-arc chert association (Jones and Murchey, 1986). The rock association is also found in a basin adjacent to rift environment (Williams and McBirney, 1979; Karl, 1989). This association together with basalt, andesite and agglomerate of the Serian Volcanics indicates a marginal basin which is very close to an island arc (Karl, 1989). The occurrence of rhythmic and graded beddings indicate the presence of weak turbidity currents.

Geochemical data of the chert samples plot on the  $Fe_2O_3/TiO_2$  versus  $Al_2O_3/(Al_2O_3 + Fe_2O_3)$  discrimination diagram (Murray, 1994; Girty *et al.*, 1996) reveal that all the points is located within the continental margin-island arc field (Fig. 4). The occurrence of quite high percentage of  $Al_2O_3$  suggests that there was a supply of fine grain detritus material from a continent. Therefore, the depositional environment of the Binong bed was in a marginal basin which was located between a continent and an island-arc.

The occurrence of radiolarian chert in the tuff sequence indicates that there was a high productivity of radiolarians which associates with the supply of nutrients and silica during the volcanic eruption. The environment of deposition of the tuff was probably similar to that of the Serian Volcanics which have tholeiitic affinities indicating that they formed on the oceanic side of an Island arc (Tate, 1991). A widespread volcanic activity which was recorded in the latest Triassic (Pimm, 1965) might have extended to the Early Jurassic time.

Table 2. Distribution of Radiolaria from the dacitic tuff-chert sequence.

	Section A													Section B			
	P6	P7	P8	P9	P11	P13	P14	P21	P23	P24	P25	P27	P28	P30	P41	P42	P43
<i>Paracanoptum anulatum</i>	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
<i>Parahsuum simplum</i>	X	X	X	X	X	X	X	X	X	X						X	X
<i>Orbiculiforma</i> sp.	X	X		X											X	X	X
<i>Praeconocaryomma</i> sp.	X	X							X		X					X	X
<i>Archaeocenospaera</i> sp.		X	X	X				X	X					X		X	X
<i>Praeconocaryomma decora</i>		X		X	X	X		X	X							X	
<i>Praeconocaryomma media</i>		X		X					X								X
<i>Parahsuum directiporatum</i>		X				X			X							X	X
<i>Canoptum rugosum</i>		X	X	X			X				X	X	X		X		
<i>Canoptum</i> sp.			X	X			X					X			X		
<i>Canutus izeense</i>		X														X	X
<i>Katroma</i> cf. <i>neagui</i>		X															
<i>Praeconocaryomma</i> (?) <i>fasciata</i>		X														X	X
<i>Katroma</i> sp.		X	X	X			X		X	X						X	X
<i>Parahsuum</i> sp.		X		X	X	X					X			X		X	X
<i>Tricolocapsa</i> sp.		X		X												X	
<i>Bagotum</i> sp.		X															
<i>Bagotum</i> cf. <i>maudense</i>		X	X						X				X	X		X	X
<i>Canutus</i> sp.		X														X	
<i>Pantanellium</i> cf. <i>sanrafaelense</i>		X															
<i>Pantanellium</i> sp.		X															
<i>Droltus</i> sp.		X														X	X
<i>Perispyridium</i> sp.		X															
<i>Crucella</i> sp. A															X	X	X
<i>Crucella</i> sp. B															X	X	X
<i>Archicapsa</i> cf. <i>pachyderma</i>																X	X
<i>Wrangellium</i> cf. <i>izeense</i>		X														X	X

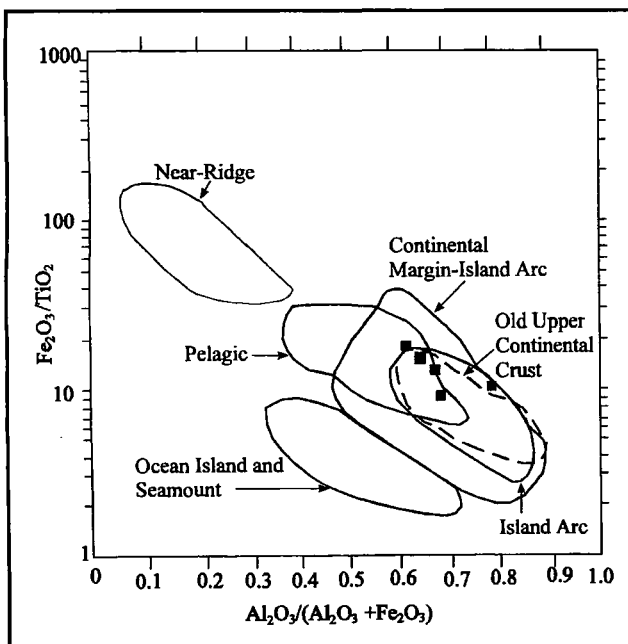
## CONCLUSION

The dacitic tuff-chert sequence (Binong bed) is genetically related to the Serian Volcanics. Therefore it is included in the Serian Volcanics. The age of the Serian Volcanics ranges from late Triassic to Early Jurassic. This age is comparable to the age of Bengkayang Group in Kalimantan. The Serian Volcanics and the Kedom Formation is separated by Middle Jurassic unconformity.

The radiolarian assemblages in the chert confirm the existence of Lower Jurassic sequence in West Sarawak. The chert was deposited during Pliensbachian-early Toarcian, Early Jurassic. The productivity of radiolarian faunas is related to volcanic eruption which supply nutrient and siliceous material. The rock association and the geochemical data indicate that the chert was probably deposited in a marginal basin which was located between a continental margin and volcanic arc. The rhythmic sequence of the chert is suggestive of the presence of a weak turbidity current.

## SYSTEMATIC PALEONTOLOGY

Class ACTINOPODA Calkins, 1909.  
Subclass RADIOLARIA Muller 1858.  
Order POLYCYSTIDA Ehrenberg, 1838.  
Suborder SPUMELLARIINA Ehrenberg, 1875.  
Superfamily SPONGODISCEA Haeckel, 1881;



**Figure 4.** Geochemical data from this study plotted on the  $\text{Fe}_2\text{O}_3/\text{TiO}_2$  vs.  $\text{Al}_2\text{O}_3/(\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3)$  discrimination diagram of Murray (1994).

emend. Pessagno 1971, 1973.

Family ORBICULIFORMIDAE Pessagno, 1973.

Genus *Orbiculiforma* Pessagno 1973, emend. Pessagno 1976.

### *Orbiculiforma* sp. (Pl. 1, fig. 1)

**Remarks:** Specimens are not well-preserved and the species cannot be identified with certainty. Only seven specimens were retrieved.

Family PATULIBRACCHIIDAE Pessagno 1971; emend. Baumgartner, 1980.

Genus *Crucella* Pessagno 1971; emend. Baumgartner, 1980.

### *Crucella* sp. A (Pl. 1, fig. 2)

**Remarks:** Test has four slender rays of uniform width at right angles. Entire test is composed of spongy meshwork of subcircular and polygonal pore frames with weakly developed nodes. This form is probably a new species.

### *Crucella* sp. B (Pl. 1, fig. 3)

**Remarks:** Specimens are not well-preserved and cannot be identified to species level.

Family PANTANELLIIDAE Pessagno, 1977b.

Genus *Pantanellium* Pessagno, 1977a; sensu Pessagno and Blome, 1980.

### *Pantanellium* cf. *sanrafaelense* Pessagno and Blome (Pl. 1, fig. 4)

**Remarks:** Specimen is very similar to those described by Pessagno and Blome (1980) except the spines of the present specimens are broken. Genus *Trillus* Pessagno and Blome, 1980.

### *Trillus elkhornensis* Pessagno and Blome (Pl. 1, fig. 5)

*Trillus elkhornensis* Pessagno and Blome 1980, p. 249, pl. 6, figs. 11, 12, 16, 20, 25; pl. 9, fig. 11.

**Remarks:** The specimen exhibits subsphaerical shell with two triradiate polar spines of unequal length. The shorter one is  $3/4$  length of the longer spine.

**Stratigraphic range:** It has been recorded from Upper Pliensbachian to middle Bajocian of Oregon (Pessagno and Blome, 1980).

Family PRAECONOCARYOMMIDAE Pessagno, 1976.

Genus *Praeconocaryomma* Pessagno, 1976.

### *Praeconocaryomma decora* Yeh (Pl. 1, fig. 6)

*Praeconocaryomma decora* Yeh 1987, p. 39, pl. 6, fig. 15, pl. 20, figs. 1–2, 16.

**Remarks:** The specimen is quite well-preserved. It exhibits a cortical shell with moderately large imperforate mammae. It is very similar to the holotype described by Yeh (1987).

**Stratigraphic range:** It was recorded from late Pliensbachian to early Toarcian of Oregon (Yeh, 1987).

***Praeconocaryomma media* Pessagno and Poisson (Pl. 1, fig. 7)**

*Praeconocaryomma media* Pessagno and Poisson 1981, p. 57–58, pl. 8, figs. 1–4.

**Remarks:** The cortical shell has mammae with radially arranged primary spines originate in the centre. Surface of mammae is hexagonal in outline. Each mamma has six very large equilateral pore frame. The specimen is quite well-preserved and exhibits all the morphological features of the species as described by Pessagno and Poisson (1981).

**Stratigraphic range:** It is known only in Pliensbachian (Pessagno and Poisson, 1981).

***Praeconocaryomma* (?) *fasciata* Carter *et al.* 1988 (Pl. 1, fig. 8)**

*Praeconocaryomma* (?) *fasciata* Carter *et al.* 1988, p. 31, pl. 1, fig 5.

**Remarks:** The species is characterised by a large shell with many closely spaced mammae. Mammae are connected to each other by thick bars. The present specimen is closely similar to the holotype described by Carter *et al.* (1988).

**Stratigraphic range:** It was recorded from late Pliensbachian to Aalenian (Carter *et al.*, 1988).

***Praeconocaryomma* sp. (Pl. 1, fig. 9)**

**Remarks:** The surface of the specimen is covered by tubercles. Each tubercle has many pores. The specimen is probably a new species.

Family XIPHOSTYLIDAE Haeckel, 1881; emend. Pessagno and Yang, 1989.

Genus *Archaeocenosphaera* Pessagno and Yang, 1989.

***Archaeocenosphaera* sp. (Pl. 1, fig. 10)**

**Remarks:** The specimen has a large spherical cortical shell with polygonal pore frame. It is probably a new species.

Suborder NASSELLARIINA Ehrenberg, 1875.

Family EPTINGIIDAE Dumitrica, 1978.

Genus *Perispyridium* Dumitrica, 1978.

***Perispyridium* sp. (Pl. 1, fig. 11)**

**Remarks:** The specimen is not well-preserved one of the three spines is broken.

Family BAGOTIDAE Pessagno and Whalen, 1982.

Genus *Bagotum* Pessagno and Whalen, 1982.

***Bagotum* cf. *maudense* Pessagno and Whalen (Pl. 1, fig. 12)**

**Remarks:** The specimen is not well-preserved and

the test is covered by matrix. It exhibits morphology similar to *Bagotum maudense* Pessagno and Whalen (1982).

***Bagotum* sp. (Pl. 1, fig. 13)**

**Remarks:** The specimen is not well-preserved and the species cannot be identified.

Genus *Droltus* Pessagno and Whalen, 1982.

***Droltus* sp. (pl. 1, fig. 14)**

**Remarks:** Specimen is not well-preserved and slightly deformed.

Family HSUIDAE Pessagno and Whalen, 1982.

Genus *Parahsuum* Yao, 1982.

***Parahsuum simplum* Yao (Pl. 2, figs. 1, 2)**

*Parahsuum simplum* Yao 1982, p. 61, pl. 4, figs. 1–8; Sashida, 1988, p. 19, pl. 1, figs. 1–5, 16, 17

**Remarks:** More than ten specimens were retrieved. They are very similar to the original specimens described by Yao (1982).

**Stratigraphic range:** It was reported from the *Parahsuum simplum* Zone to *Parahsuum directiporatum* Zone Lower Jurassic (Nishizono *et al.*, 1997).

***Parahsuum directiporatum* (Rust) (Pl. 2, fig. 3, 4)**

*Stichocapsa directiporata* Rust, 1885, p. 318, pl. 41. Fig. 10.

*Parahsuum takarazawaense* Sashida, 1988, p. 19–20, pl. 1, figs. 6, 11.

*Parahsuum ovale* Hori and Yao, 1988, p. 51–53, pl. 1, figs. 3–9.

*Parahsuum directiporatum* (Rust), Nishizono *et al.*, 1997, pl. 1 fig. 5.

**Remarks:** This species exhibits a inflated conical test with a hemispherical cephalis and thick longitudinal costae. Nishizono *et al.* (1997) found that *Parahsuum ovale* Hori and Yao and *Parahsuum takarazawaense* Sashida are synonymous with *Parahsuum directiporatum* (Rust). The present specimens closely resemble the holotype described by Rust (1885).

**Stratigraphic range:** The species has been reported from the *Parahsuum directiporatum* Zone to the *Hsuum* sp. G Subzone, Lower Jurassic (Nishizono, *et al.*, 1997).

***Parahsuum* sp. (Pl. 2, fig. 5)**

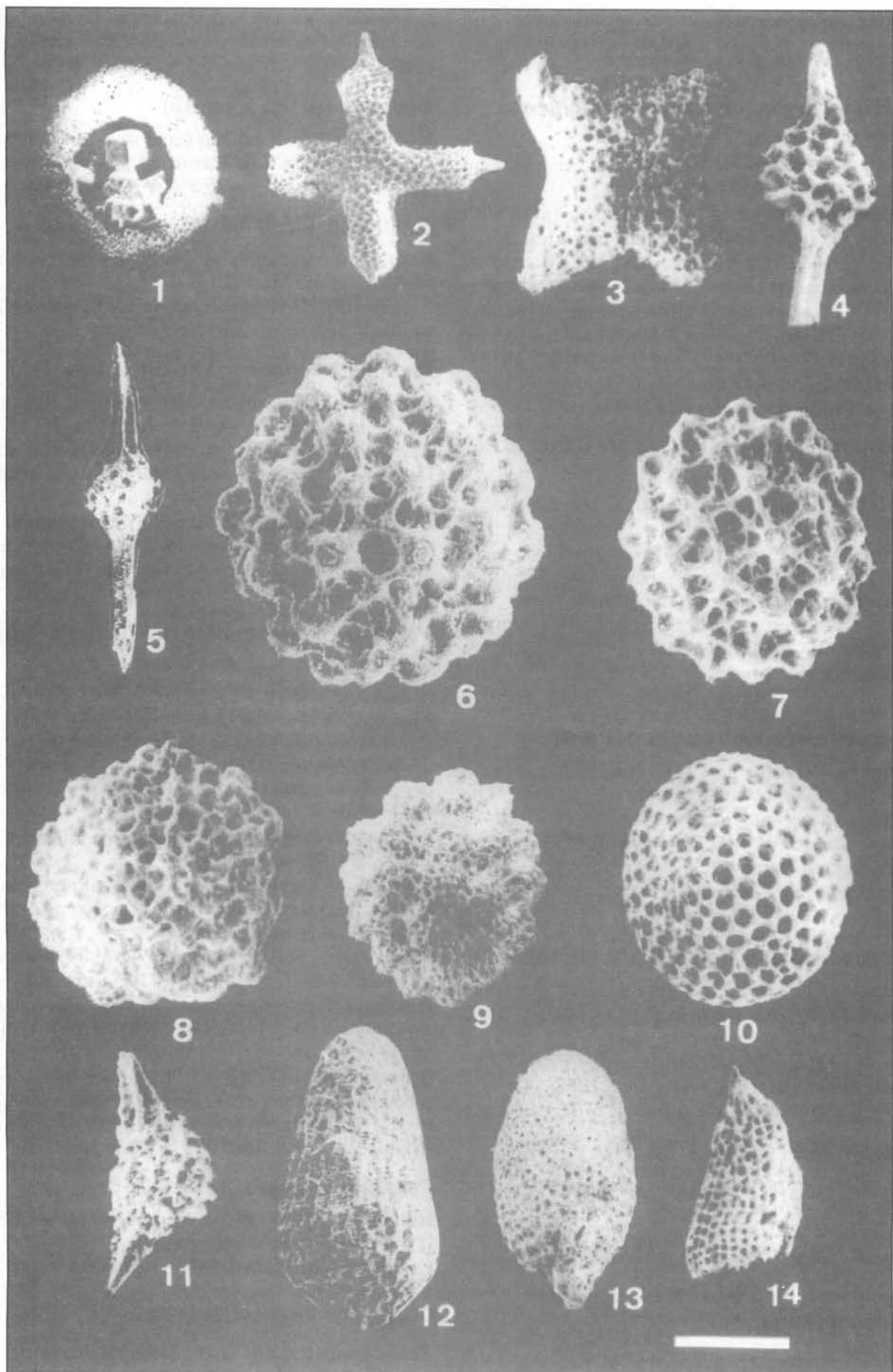
**Remarks:** This form cannot properly be identified. It is probably a new species.

Family CANOPTIDAE, Pessagno, 1979; emend. Yeh 1987.

Genus *Paracanoptum* Yeh, 1987.

***Paracanoptum anulatum* (Pessagno and**







**Poisson) (Pl. 2, figs. 6, 7)**

*Canoptum anulatum* Pessagno and Poisson 1981, p. 60–61, pl. 9, figs. 6–9; pl. 10, figs. 1–9; pl. 15, figs. 2, 4.

*Paracanoptum anulatum* (Pessagno and Poisson) Yeh, 1987, p. 67, pl. 1, figs. 12–13.

**Remarks:** The species is very common in the present material. The specimens are very similar to the holotype described by Pessagno and Poisson (1981).

**Stratigraphic range:** It has been recorded from upper Sinemurian to lower Toarcian, Lower Jurassic (Yeh, 1987).

Genus *Canoptum* Pessagno, 1979.

***Canoptum rugosum* Pessagno and Poisson (Pl. 2, figs. 8)**

*Canoptum rugosum* Pessagno and Poisson, 1981, p. 61, pl. 11, figs. 5–9; pl. 13, fig. 3; pl. 14, figs. 1, 2; Pessagno and Whalen 1982, p. 125, pl. 6, fig. 7; Sashida, 1988, p. 23, pl. 2, figs. 13, 14, 22, 23.

**Remarks:** The species has a shorter and broader test with widely spaced circumferential ridges and rugose surface of the post-abdominal chambers compared to *Paracanoptum anulatum*.

**Stratigraphic range:** It was originally recorded from lower Pliensbachian of Turkey (Pessagno and Poisson, 1981). Pessagno and Whalen (1982) recorded it from the late Pliensbachian to lower Toarcian of the North America.

***Canoptum* sp. (Pl. 2, fig. 9)**

**Remarks:** This specimen resembles *Canoptum spinosum* Yeh (1987) but the spines are missing. Genus *Wrangellium* Pessagno and Whalen, 1982.

***Wrangellium* cf. *izeense* Yeh (Pl. 2, fig. 10)**

**Remarks:** This form is closely related to *Wrangellium izeense* Yeh but it is not well-

preserved.

Family CANUTIDAE Pessagno and Whalen, 1982  
Genus *Canutus* Pessagno and Whalen, 1982.

***Canutus izeensis* Pessagno and Whalen (Pl. 2, fig. 11)**

*Canutus izeensis* Pessagno and Whalen, 1982, p. 129, pl. 6, figs. 8, 10, 15; Carter *et al.*, 1988, p. 51, pl. 3, fig. 2.

**Remarks:** The present specimen is identical to the original specimen described by Pessagno and Whalen 1982. The final abdominal chamber is broken.

**Stratigraphic range:** It has been recorded from the late Pliensbachian to early Toarcian of North America (Pessagno and Whalen, 1982; Carter *et al.* 1988).

***Canutus* sp. (Pl. 2, fig. 12)**

**Remarks:** The specimen is similar to *Canutus blomei* Pessagno and Whalen (1982) except the present specimen is not well-preserved.

Family AMPHIPYNDACIDAE Riedel 1967.

Subfamily SYRINGOCAPSINAE Foreman 1973.

Genus *Katroma* Pessagno and Poisson, 1981; emend. De Wever, 1982.

***Katroma* cf. *neagui* Pessagno and Poisson (Pl. 2, fig. 13)**

**Remarks:** The specimen resembles *Katroma neagui* Pessagno and Poisson (1981) except the horn and the cylindrical, open tubular extension are broken.

***Katroma* sp. (Pl. 2, fig. 14)**

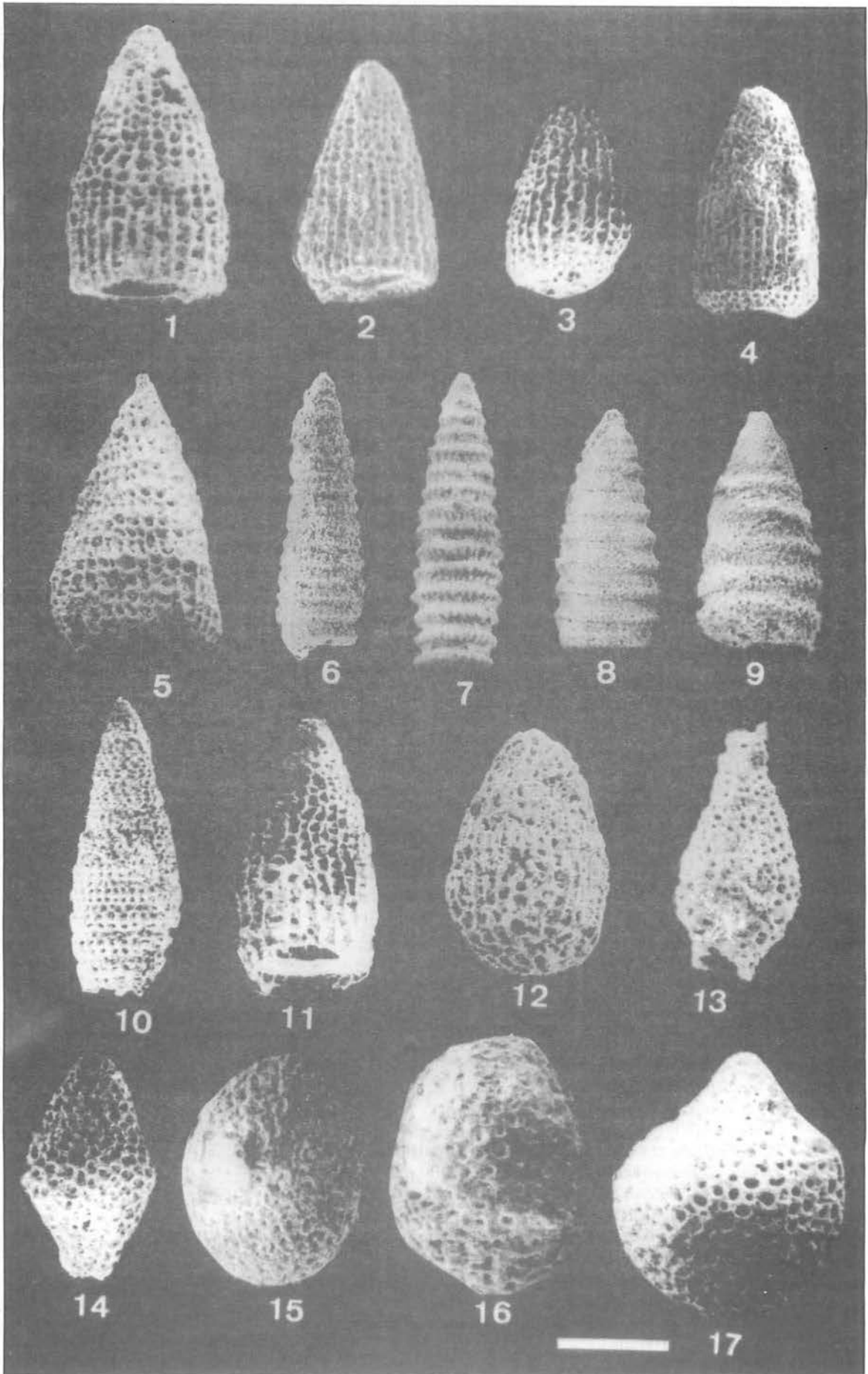
**Remarks:** The specimen is not well-preserved but it exhibits characters of the genus *Katroma*.

Family SETHOCAPSIDAE Haeckel, 1881.

Genus *Archicapsa* Haeckel, 1881.

**Plate 1.** Scale bar in  $\mu\text{m}$  is indicated in the parentheses.

1. *Orbiculiforma* sp. (200  $\mu\text{m}$ )
2. *Crucella* sp. A (100  $\mu\text{m}$ )
3. *Crucella* sp. B (100  $\mu\text{m}$ )
4. *Pantanellium* cf. *sanrafaelense* Pessagno & Blome (80  $\mu\text{m}$ )
5. *Trillus elkhornensis* Pessagno & Blome (100  $\mu\text{m}$ )
6. *Praeconocaryomma decora* Yeh (100  $\mu\text{m}$ )
7. *Praeconocaryomma media* Pessagno & Poisson (100  $\mu\text{m}$ )
8. *Praeconocaryomma* (?) *fasciata* Carter (67  $\mu\text{m}$ )
9. *Praeconocaryomma* sp. (160  $\mu\text{m}$ )
10. *Archaeocenospaera* sp. (100  $\mu\text{m}$ )
11. *Perispyridium* sp. (80  $\mu\text{m}$ )
12. *Bagotum* cf. *maudense* Pessagno & Whalen (80  $\mu\text{m}$ )
13. *Bagotum* sp. (100  $\mu\text{m}$ )
14. *Droltus* sp. (80  $\mu\text{m}$ )



**Archicapsa cf. pachyderma Tan (Pl. 2, figs. 15, 16)**

**Remarks:** Specimen exhibits morphology similar to *Archicapsa pachyderma* Tan (1927) except its surface is covered by smaller pores.

Family WILLIRIEDELLIDAE Dumitrica, 1970.

Genus *Tricolocapsa* Haeckel, 1881.

**Tricolocapsa sp. (Pl. 2, fig. 17)**

**Remarks:** The specimen exhibits characters of the genus *Tricolocapsa* but the species cannot be determined.

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**Plate 2.** Scale bar in  $\mu\text{m}$  is indicated in the parentheses.

1. *Parahsuum simplum* (Yao) (80  $\mu\text{m}$ )
2. *Parahsuum simplum* (Yao) (80  $\mu\text{m}$ )
3. *Parahsuum directiporatum* (Rust) (100  $\mu\text{m}$ )
4. *Parahsuum directiporatum* (Rust) (100  $\mu\text{m}$ )
5. *Parahsuum* sp. (67  $\mu\text{m}$ )
6. *Paracanoptum anulatum* Pessagno & Poisson (133  $\mu\text{m}$ )
7. *Paracanoptum anulatum* Pessagno & Poisson (100  $\mu\text{m}$ )
8. *Canoptum rugosum* Pessagno & Poisson (100  $\mu\text{m}$ )
9. *Canoptum* sp. (80  $\mu\text{m}$ )
10. *Wrangellium* cf. *izeense* Yeh (100  $\mu\text{m}$ )
11. *Canutus izeensis* Pessagno & Whalen (100  $\mu\text{m}$ )
12. *Canutus* sp. (80  $\mu\text{m}$ )
13. *Katroma* cf. *neagui* Pessagno & Poisson (80  $\mu\text{m}$ )
14. *Katroma* sp. (100  $\mu\text{m}$ )
15. *Archicapsa* cf. *pachyderma* Tan (100  $\mu\text{m}$ )
16. *Archicapsa* cf. *pachyderma* Tan (80  $\mu\text{m}$ )
17. *Tricolocapsa* sp. (80  $\mu\text{m}$ )

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