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Mesozoic radiolarians from the Bagh Complex in the Muslim Bagh area, Pakistan: Their significance in reconstructing the geologic history of ophiolites along the Neo-Tethys suture zone

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KOJIMA Satoru, NAKA Takahito, KIMURA Katsumi, MENGAL Jan Mohammad, SIDDIQUI Muhammed Rehanul Haq and BAKHT Malik Sikander (1994) Mesozoic radiolarians from the Bagh Complex in the Muslim Bagh area, Pakistan: Their significance in reconstructing the geologic history of ophiolites along the Neo-Tethys suture zone. *Bull. Geol. Surv. Japan*, vol. 45(2), p. 63–97, 8figs., 1table, 6plates.

Abstract: Triassic, Jurassic and Cretaceous radiolarians are described from the Bagh Complex in the Muslim Bagh area, Pakistan. The Bagh Complex is composed of serpentinite melange (Bsm), mudstone melange (Bmm), ultramafic-mafic rock unit (Bum), basalt-chert unit (Bbc), hyaloclastite-mudstone unit (Bhm), Triassic sedimentary rock unit (Bls) and Jurassic to Cretaceous(?) sedimentary rock unit (Bus). Radiolarian fossils indicate that the siliceous sedimentary formations of the Bbc and Bhm are Cretaceous in age, while Bls and Bus yield Triassic and Jurassic Radiolaria, respectively. The radiolarian ages of Bls and Bus are consistent with the ages indicated by macrofossils such as ammonite and *Halobia*. Since chert blocks in the Bsm and Bmm include Cretaceous (Berriasian to Turonian) Radiolaria and the Eocene limestone covers the Bagh Complex together with the Muslim Bagh Ophiolite, the melanges formed in post-Turonian and pre-Eocene time. Moreover the radiometric ages of basalts in the Bagh Complex (68–81 Ma) and the Muslim Bagh Ophiolite (64–82 Ma) limit the timing of ophiolite obduction between the latest Cretaceous and Paleocene, which seems to be closely associated with the melange formation on the basis of field occurrence. Correlation with the Bela (southwestern Pakistan), Oman and Yarlung-Zangbo (near Lhasa in southern China) ophiolitic complexes suggests that the ophiolites and ophiolitic melanges along the Neo-Tethys formed in Cretaceous time and was obducted before the main phase of collision between the Indian and Eurasian continents.

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1. Introduction

Although the geology of the Himalayan orogenic belt between the Eurasian and Indian continents has been extensively studied as a

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typical continent-continent collision zone (e.g. Gansser, 1964; Sengör, 1984; Nakazawa and Dickins, 1985), its geologic evolution is still one of the major problems among the world geology because of the scarcity of basic geologic data. The Muslim Bagh area in Pakistan (Fig. 1) is one of the best fields to clarify the geologic development of the Indo-Eurasian suture, because the mountains there are not so steep compared with the Karakoram and Nepal Himalayas and are easy to access.

The purpose of this paper is to describe the occurrence of radiolarian fossils from the Muslim Bagh area and discuss the ages of the radiolarian assemblages and their significance in order to provide basic age data of the sedimentary rocks, essential for modeling the evolution of the Indo-Eurasian suture zone. This is one of a series of papers reporting the results obtained during the investigations in 1991, which were financially supported by the Japan International Cooperation Agency (JICA). Detailed geologic descriptions of the Bagh Complex, radiometric ages and geochemistry of igneous rocks of the Muslim Bagh Ophiolite, and their geologic syntheses will be published in separate papers.

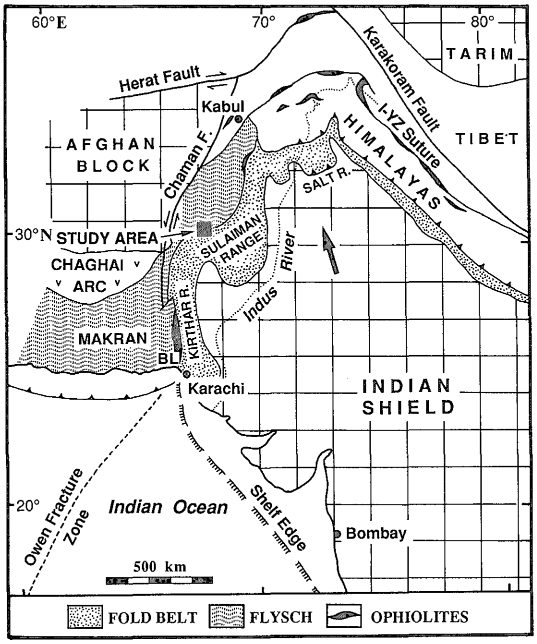

Fig. 1 Tectonic map in and around Pakistan (simplified from Humayon *et al.*, 1991). Black square shows the study area (Muslim Bagh area), and the big arrow indicates direction of the general convergence of the Indian subcontinent relative to Asia. Cross stripes indicate the Indian shield and microcontinents. I–YZ Suture: Indus Yarlung-Zangbo suture, BL: Bela Ophiolite.

2. Previous works

Western part of Pakistan was systematically mapped during the Colombo Plan Project, and a series of comprehensive geologic maps on a scale of 1:253,440 including the Muslim Bagh area were published (Hunting Survey Corporation, 1961). Sedimentary formations in the area were all regarded as northern extensions of calcareous facies rocks in the Sulaiman Range (Fig. 1), and were subdivided into the Alozai Group (Permo-Carboniferous to Early Jurassic), Loralai Limestone (Jurassic) and Parh Group (lower and middle Cretaceous) (Hunting Survey Corporation, 1961). After the mapping, lithostratigraphic and biostratigraphic works (e.g., Fatmi, 1969) carried out in Baluchistan made great contributions to summarizing the stratigraphy of Pakistan (Shah, 1977; Iqbal and Shah, 1980). Sedimentary and igneous rock complexes (Bagh Complex in Fig. 2) in the study area, however, did not receive much attention during the course of these studies.

On the other hand, studies of the Muslim Bagh Ophiolite (Fig. 2; Asrarullah *et al.*, 1979; Ahmad and Abbas, 1979; Gansser, 1979; Hoshino and Anwar, 1989) reveal the composition, nature, origin and structural relationship with the surrounding rock formations of the ultramafic-mafic rock complexes. For example, Ahmad and Abbas (1979) described that the rocks overthrust onto the basalt-chert-sedimentary rock complexes, intervening the serpentinite melanges between them. Allemann (1979) revealed the age of emplacement of the ophiolite by determining the oldest age of limestone (Eocene) covering the ultramafic rock bodies.

Otsuki *et al.* (1989) subdivided the Muslim Bagh area into the following three zones from south to north; (1) Calcareous zone (Figs. 2 and

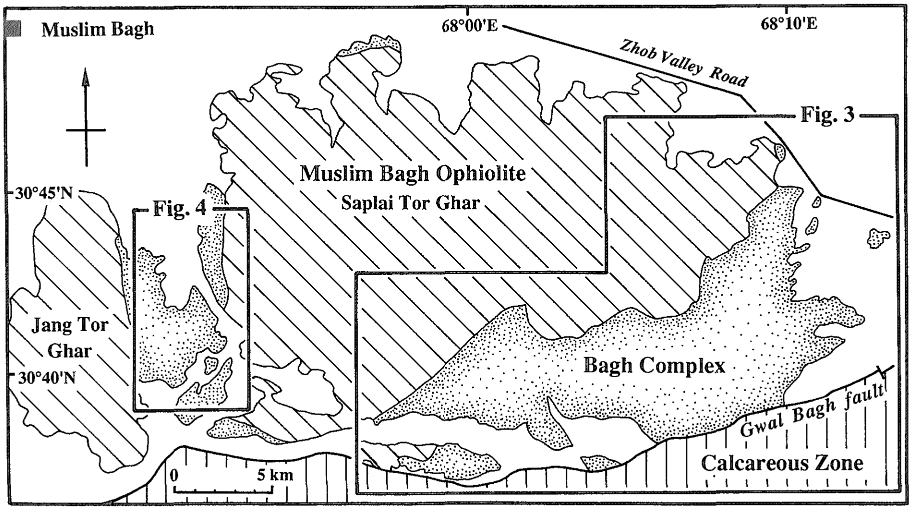

Fig. 2 Map showing the lithologic subdivision of the Muslim Bagh area in Pakistan, and also showing the areas of Figs. 3 and 4.

3) composed of Triassic(?) to Tertiary calcareous facies rocks, (2) Axial zone (Bagh Complex + Muslim Bagh Ophiolite in Fig. 2) characterized by ophiolite, hyaloclastite and deep-sea sediments, and (3) Flysch zone (Fig. 1) composed of the Tertiary clastic rocks and limestone. All the sedimentary rocks in the Axial zone were regarded to be Triassic in age with *Halobia* fossils found in calcareous shales. On the basis of the *Halobia* age, they constructed a model explaining the development of the Muslim Bagh Ophiolite, although the occurrence of Upper Jurassic to Lower Cretaceous radiolarians was noted in a separate paper (Japanese-Pakistani Research Group, 1989) contained in the same volume. Just before our field survey in 1991, Okamura (1991, written communication) found Jurassic to Cretaceous radiolarian fossils from many localities in the Muslim Bagh area.

Kimura *et al.* (1992) preliminarily reported the lithology and composition of the Bagh Complex which is nearly equal to the volcanic and sedimentary rocks in the Axial zone of Otsuki *et al.* (1989). They subdivided the rocks into the following units; serpentinite melange (Bsm), mudstone melange (Bmm), ultramafic-mafic rock unit (Bum), basalt-chert unit (Bbc), hyaloclastite-mudstone unit (Bhm), Triassic sedimentary rock unit (Bls), Jurassic to Cretaceous sedimentary rock unit (Bus). All the units were explained to be bounded by north-dipping reverse faults, although not all the relationships can be ascertained in the field.

Sawada *et al.* (1992) made geochemical studies of the igneous rocks in the area, and subdivided the basalts of the Bagh complex into the tholeiite and alkaline groups. The tholeiite group occurs in the Bbc, while the alkaline group is included in the Bhm. They also inferred that the alkaline group originated from the hot-spot activity.

3. Geologic setting

The Muslim Bagh area (Figs. 1 and 2) in the boundary zone between the Indian and Eurasian continents is sandwiched between the Tertiary Flysch zone to the north and the Calcareous zone to the south (Otsuki *et al.*, 1989), and is underlain by the Muslim Bagh Ophiolite and Bagh Complex. In this paper we follow the lithologic subdivision by Kimura *et al.* (1992); namely the Bagh Complex is subdivided into the Bsm, Bmm, Bum, Bbc, Bhm, Bls and Bus (see above): The Bsm is characterized by metamorphic-rock blocks like amphibolite and greenschist together with chert, basalt and limestone within the serpentinite matrix, whereas the Bmm includes only the sedimentary- and igneous-rock blocks in the mudstone matrix. The Bum is a tectonic slice

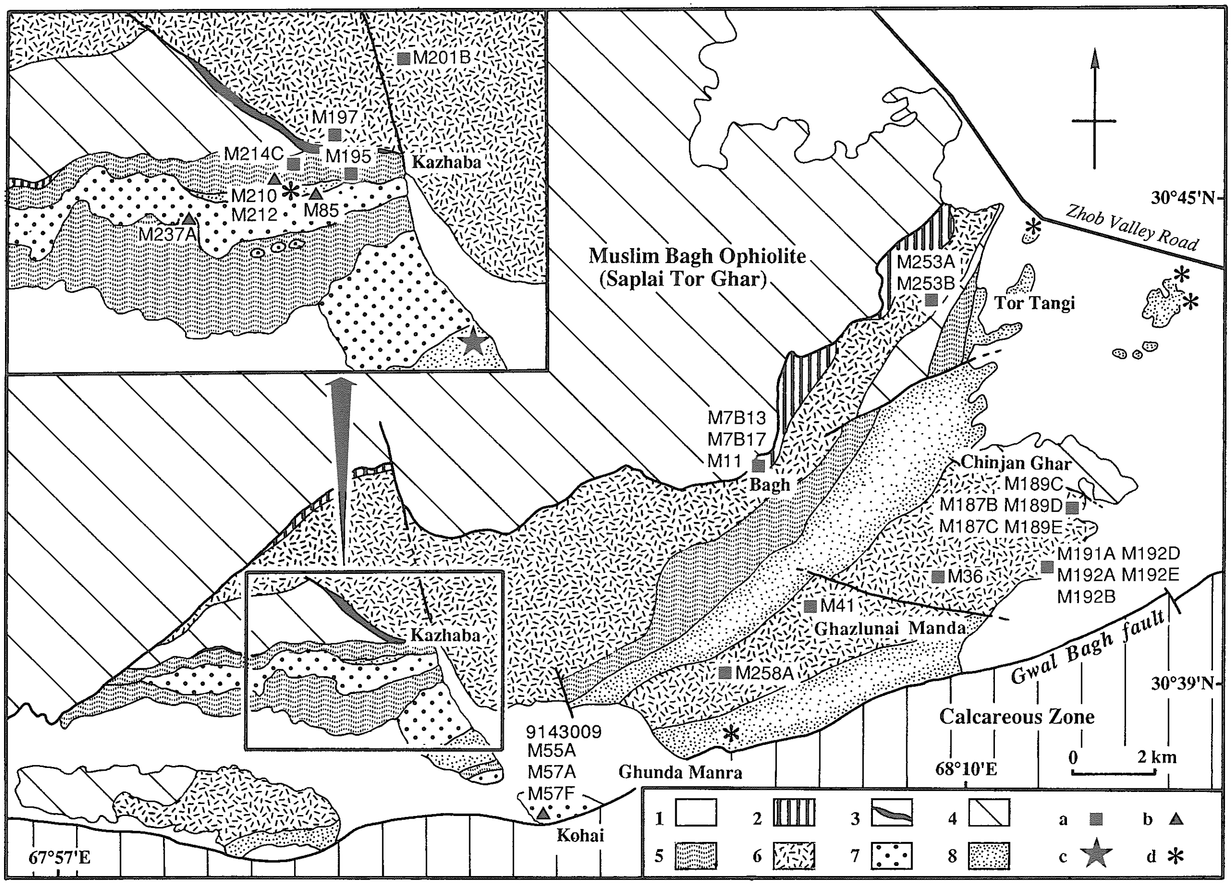

Fig. 3 Geologic map of the southeastern part of the Muslim Bagh area, modified from Mengal *et al.* (1994). Localities of samples yielding well-preserved radiolarians are shown by their numbers. 1: Quaternary, 2: serpentinite melange, 3: mudstone melange, 4: ultramafic-mafic rock unit (including Muslim Bagh Ophiolite), 5: hyaloclastite-mudstone unit, 6: basalt-chert unit, 7: Jurassic to Cretaceous(?) sedimentary rock unit, 8: Triassic sedimentary rock unit, a–d: localities of fossils, a: Cretaceous radiolarians, b: Triassic or Jurassic radiolarians (some samples may be Cretaceous in age, see text for details), c: Triassic ammonite (*Juvavites angulatus*), d: *Halobia*.

composed of ultramafic and mafic rocks. The Bbc is composed of tholeiitic pillow basalt (Sawada *et al.*, 1992) covered by thin limestone and thick radiolarian bedded chert. The Bhm consists of basaltic hyaloclastite of alkaline composition (Sawada *et al.*, 1992) interbedded with limestone and radiolarian siliceous shale. The Bls and Bus seem to be deposited as continuous sedimentary formations composed of interbedded calcareous shale, limestone, radiolarian siliceous shale, sandstone and conglomerate, which are deeper-facies equivalents of sedimentary rocks in the Calcareous zone to the south (for details of the platform formations, see Shah, 1977; Iqbal and Shah, 1980). After the deposition these units are separated by north dipping thrust faults. At present we have no fossil evidence on the Cretaceous part of this unit in the Muslim Bagh area. Stratigraphic and structural relationships between the units described above are discussed by Mengal *et al.* (1994).

4. Radiolarian assemblages and their ages

During the field survey in the Muslim Bagh area we collected more than 120 rock specimens for radiolarian biostratigraphic examinations; they were taken from all the lithologic units except for the Bum. Of these, about 60 samples yield radiolarian remains. We use the extraction methods of radiolarians from siliceous rocks described by Pessagno and Newport (1972) and Mizutani (1981). Within the 60 samples, 36 specimens include Radiolaria preserved well enough to determine the ages. Localities of these rocks are shown in Figs. 3 and 4, and their modes of occurrence are described in Appendix (A). The fossil individuals were observed only by using SEM. Although observation of inner structure is essential to identification of some groups of genera like *Holocryptocanium*, etc., inner fillings of the tests with silica prevent the transmit-light microscope analyses; the identification of such genus and species was made by external morphological characters.

Radiolarian fossils obtained from the Muslim Bagh area are grouped into the following six assemblages: (1) *Pseudodictyomitra pseudomacrocephala—Novixitus weyli* assemblage, (2) *Mirifusus baileyi—Pseudodictyomitra lilyae* assem-

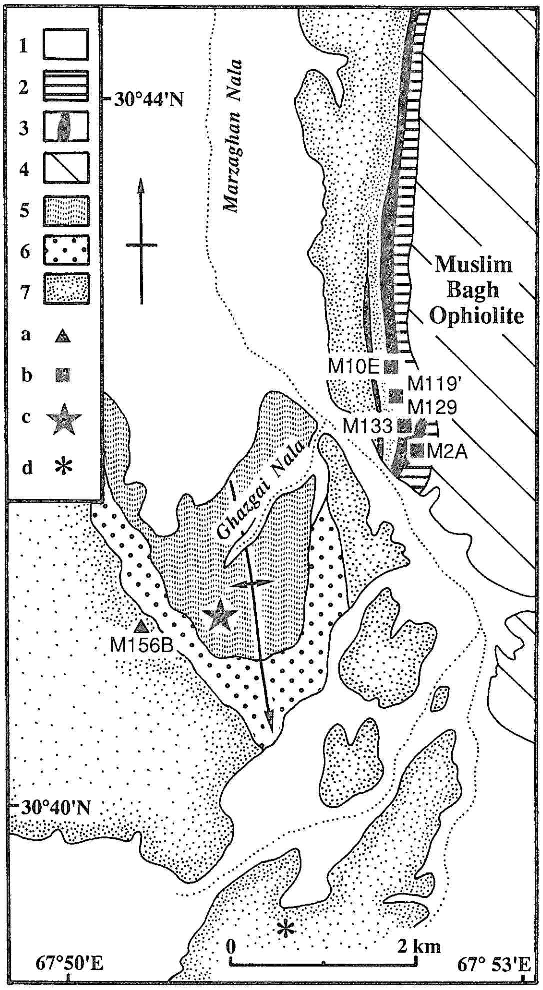

Fig. 4 Geologic map of the western part of the Muslim Bagh area, modified from Mengal *et al.* (1994). Localities of samples yielding well-preserved radiolarians are shown by their numbers. 1: Quaternary, 2: serpentinite melange, 3: mudstone melange, 4: ultramafic-mafic rock unit (including Muslim Bagh Ophiolite), 5: hyaloclastite-mudstone unit, 6: Jurassic to Cretaceous(?) sedimentary rock unit, 7: Triassic sedimentary rock unit, a–d: localities of fossils, a: Cretaceous radiolarians, b: Triassic radiolarians, c: Jurassic(?) ammonite from scree, d: *Halobia*.

Table 1 Radiolarian ages of samples obtained from the Muslim Bagh area, Pakistan.

Radiolarian assemblage	Lithologic unit and sample number	Age
Pseudodictyomitra pseudomacrocephala–Novixitus weyli assemblage	Bmm: M2A Bsm: M11, M119' Bbc: M36, M41, M192A, M192B, M192E, M201B	Cenomanian to Turonian
Mirifusus baileyi–Pseudodictyomitra lilyae assemblage	Bmm: M129, M133 Bhm: M214C Bbc: M187B, M189C, M189D, M189E, M191A, M192D, M253A	Berriasian to Hauterivian, most probably Valanginian
Pseudodictyomitra spp. assemblage	Bmm: M10E Bsm: M7B13, M7B17 Bhm: M197 Bbc: M187C, M253B	early Cretaceous
Other assemblage	Bhm: M195 Bbc: M258A	Cretaceous
Stylocapsa(?) *spiralis* assemblage	Bus: 9143009	early Late Jurassic
Unuma echinatus assemblage	Bus: M57A, M57F	latest Early to Middle Jurassic
Other assemblage	Bus: M55A	Jurassic to Early Cretaceous
Other assemblage	Bhm: M237A Bus: M212	Jurassic to Cretaceous
Other assemblage	Bhm: M210	Jurassic ?
Triassocampe sp.–*Pseudostylosphaera* sp. assemblage	Bls: M85, M156B	Triassic

blage, (3) *Pseudodictyomitra* spp. assemblage, (4) *Stylocapsa*(?) *spiralis assemblage,* (5) *Unuma echinatus* assemblage, (6) *Triassocampe* sp. —*Pseudostylosphaera* sp. assemblage. Age assignment of the radiolarian assemblages is based mainly on the radiolarian biostratigraphic studies by Pessagno (1976, 1977a, 1977b), Sanfilippo and Riedel (1985), Schaaf (1984), Nakaseko *et al.* (1979) and Matsuoka and Yao (1986). The ages of the samples are summarized in Table 1.

***Pseudodictyomitra pseudomacrocephala—Novixitus weyli* assemblage**

Samples M2A, M11, M36, M41, M119', M192B, M192E and M201B yield Cenomanian-Turonian radiolarians of the *Pseudodictyomitra pseudomacrocephala-Novixitus weyli* assemblage (Fig. 5; Plates 1 and 2). Of these, samples M11, M36, M41, M119' and M192B are characterized by the coexistence of *Pseudodictyomitra pseudomacrocephala* and *Novixitus weyli,* both of which are excellent index fossils of Cenomanian to Turonian age (e.g. Schaaf, 1984; Schmidt-Effing, 1980). Although samples M2A, M192E and M201B include only one of these two species, the age can be assigned to the Cenomanian to Turonian. The radiolarian assemblage from M192A having *Thanarla veneta* is assignable to the same age, because *T. veneta* has a short range from Cenomanian to Turonian according to Pessagno (1977a) and Sanfilippo and Riedel (1985). Other species characteristic of this assemblage are *Archaeodictyomitra* sp. A, *Holocryptocanium astiensis, H. barbui, H. geysersensis, Mita*(?) sp. A, *Thanarla elegantissima* and Nassellaria sp. A.

***Mirifusus baileyi—Pseudodictyomitra lilyae* assemblage**

Samples M129, M133, M187B, M189C, M189D, M189E, M191A, M192D, M214C and M253A are assigned to the age interval of the Berriasian to Hauterivian, and most probably to the Valanginian. Diagnostic species (Fig. 6; Plates 2–5) are *Acanthocircus dicranacanthos, Archaeodictyomitra apiara, Cecrops septemporatus, Mirifusus*

Cenomanian-Turonian Radiolaria ■ : present ▩ : cf.	M2A	M11	M36	M41	M119'	M192A	M192B	M192E	M201B
Acanthocircus sp.							■		■
Archaeodictyomitra sp. A		■					■		
Archaeodictyomitra sp.			■			■			■
Dictyomitra sp.									■
Holocryptocanium astiensis		▩		■					
Holocryptocanium barbui		■		■			■		
Holocryptocanium gaserensis							■		
Mita(?) sp. A		■		■			■		
Napora sp.								■	
Novixitus sp.						■			
Novixitus weyli	■	■	■	■	■		■		
Pseudodictyomitra pseudomacrocephara		■	■	■	▩		■	▩	■
Pseudodictyomitra sp.				■					■
Rhopalosyringium majuroensis							▩		
Ristola sp.				■					
Thanarla elegantissima		▩					■		▩
Thanarla veneta				■		■	■		
Thanarla sp.				■					
Zifondium sp.							■		
Nassellaria sp. A		■		■	■	■	■		■

Fig. 5 List of Cenomanian–Turonian Radiolaria from the Muslim Bagh area in Pakistan.

baileyi, Pseudodictyomitra lilyae, Sethocapsa uterculus and *Siphocampium*(?) *davidi*, all of which have a range of the Valanginian in common.

***Pseudodictyomitra* spp. assemblage**

Although this assemblage lacks diagnostic species, the occurrence of *Acaeniotyle umbilicata, Mita* sp., *Pseudodictyomitra carpatica, P.* cf. *leptoconica, P.* sp., *Thanarla* sp. and *Xitus* sp. indicates that samples M7B13, M7B17, M10E, M187C, M197 and M253B are of early Cretaceous in age (Fig. 6; Plates 2–5).

***Stylocapsa*(?) *spiralis* assemblage**

Sample 9143009 yields a radiolarian assemblage characterized by *Stylocapsa*(?) *spiralis* (Fig. 7; Plate 5), which is described by Matsuoka (1982) from Shikoku, Japan, and is considered to have a range of early Late Jurassic age (Matsuoka and Yao, 1986). Other species of this assemblage are *Hsuum* sp., *Tricolocapsa* sp., etc.

***Unuma echinatus* assemblage**

Samples M57A and M57F commonly include *Unuma echinatus* which typically occurs in the latest Early to Middle Jurassic of Japan. Sample M57A has a rich fauna (Fig. 7; Plate 6) composed of *Archicapsa pachyderma, Eucyrtidiellum disparile, E. quinatum, Hsuum hisuikyoense, H.*(?) *matsuokai* and *Trillus* sp., which are main components of the radiolarian assemblage reported by Isozaki and Matsuda (1985), *Laxtorum*(?) *jurassicum* zone of Matsuoka and Yao (1986) or *Hsuum hisuikyoense* zone of Hori (1990). According to their studies together with Takemura (1986) and Nagai and Mizutani (1990), the age of the sample, M57A, is assignable to the latest Early to early Middle Jurassic. The age of sample M57F is difficult to determine precisely, and we just mention it as latest Early to Middle Jurassic in this paper.

***Triassocampe* sp.—*Pseudostylosphaera* sp. assemblage**

Both samples M85 and M156B yield *Pseudostylosphaera* sp., and the former also includes *Capnuchosphaera* sp. and *Triassocampe* sp. (Fig. 7; Plate 6), all of which characteristically occur in the middle to upper Triassic samples from European Alps (e.g. Dumitrica *et al.*, 1980), North America (e.g. Pessagno *et al.*, 1979) and Japan (e.g. Nakaseko and Nishimura, 1979). Since the preservation of the fossils is too poor to discuss more detailed age of the samples, in this paper we just mention their ages as the Triassic.

Other assemblages

Radiolarian assemblages from samples M195 and M258A are composed of *Pseudodictyomitra* sp., *Xitus* sp., etc. (Fig. 6), but also include *Holocryptocanium* sp. It is difficult to assign the age range of these assemblages to the Lower Cretaceous, and we can safely say that they are Cretaceous in age.

Sample M55A yields *Eucyrtidiellum* sp. and *Hsuum* sp. (Fig. 7), both of which range in age from Jurassic to Early Cretaceous. Samples M212 and M237A lack in well-preserved Radiolaria, and it is difficult to determine their precise ages. But the occurrence of radiolarians limited to the Jurassic to Cretaceous interval such as *Archaeodictyomitra* sp., *Archaeospongoprunum* sp., *Pantanellium* sp. and *Pseudodictyomitra* sp. (Plate 5, fig. 12) indicates that the samples are Jurassic or Cretaceous in age. Sample M210 yields *Dictyomitrella*(?) sp. A (Plate 5, fig. 11) and *Tricolocapsa*(?) sp. A (Plate 5, fig. 10). *D.*(?) sp. A is similar to the middle Jurassic Radiolaria, *D.*(?) *kamoensis*, described from the Mino terrane, Japan (see Appendix (B) below). *T.*(?) sp. A has a characteristic form, but it has not been de-

Cretaceous Radiolaria (■ : present, cf. : cf.)	M7B13	M7B17	M10E	M129	M133	M187B	M187C	M189C	M189D	M189E	M191A	M192D	M195	M197	M214C	M253A	M253B	M258A
Acaeniotyle diaphorogona				■						■								
Acaeniotyle umbilicata	■							■	■									
Acanthocircus dicranacanthos				cf.														
Acanthocircus sp.	■																	■
Alievium sp.				■		■		■				■						
Archaeodictyomitra apiara												cf.				cf.		
Archaeodictyomitra lacrimula				cf.					■									
Archaeodictyomitra sp.	■			■			■		■				■		■			
Archaeospongoprunum sp.		■				■			■		■							
Cecrops septemporatus								■										
Dictyomitra(?) sp. A				■				■		■	■							
Emiluvia sp.			■				■											
Eucyrtidiellum ptyctum						cf.			cf.			cf.						
Eucyrtis sp.									■									
Hemicryptocapsa sp.								■	■						■	■		
Holocryptocanium sp.													■					■
Mirifusus baileyi				■								■						
Mita sp.								■			■			■				
Napora sp.				■														
Novixitus sp.				■					■									
Pantanellium sp. A								■	■									
Pantenellium sp.	■	■	■	■		■			■			■	■			■		
Parvicingula sp.	■	■	■							■	■					■		
Parvicingula(?) sp. A				■														
Podobursa triacantha									■									
Podobursa sp.	■											■						
Podobursa(?) sp.		■				■		■	■		■							
Pseudodictyomitra carpatica		■		cf.	cf.			■		■								
Pseudodictyomitra leptoconica		cf.		■				■	■	■	■							
Pseudodictyomitra lilyae				■				■		■								
Pseudodictyomitra rigida									■									
Pseudodictyomitra sp.			■				■		■	■			■	■	■	■	■	■
Sethocapsa uterculus					■			■							■			
Sethocapsa(?) sp.					■		■		■	■		■						
Siphocampium(?) *davidi*									cf.		■							
Thanarla conica								■	■	■						cf.		
Thanarla sp.		■		■	■			■		■	■			■				■
Triactoma sp.									■									
Tricolocapsa(?) sp. A				■				■										
Williriedellum peterschmidttae									■		■							
Xitus alievi								cf.										
Xitus spicularius				■				cf.		■								
Xitus sp.		■		■				■		■								■

Fig. 6 List of Lower Cretaceous Radiolaria from the Muslim Bagh area in Pakistan.

scribed yet. As a result, it is difficult to define the age of sample M210, although it is most probably Jurassic.

5. Discussion

5.1 Correlation of radiolarian ages with ammonite, *Halobia* and radiometric ages

Together with the radiolarian fossils, we found some ammonites from the study area. Upper Triassic *Juvavites angulatus*, identified by A. N. Fatmi of the Geological Survey of Pakistan, occurs in the Bls distributed south of Kazhaba (Fig. 3). *Juvavites angulatus* was originally described by Diener (1908) from the Lower Norian formation of Spiti in the Himalayas. Beside the ammonite, *Halobia* fossils were found from many localities (Figs. 3 and 4) by us, and also by Otsuki *et al.* (1989); all the localities are in the Bls. The ammonite and *Halobia* ages, though not accurate-

Triassic, Jurassic and Cretaceous(?) Radiolaria (■ : present; ▩ : cf.)	9143009	M55A	M57A	M57F	M210	M212	M237A	M85	M156B
Archaeodictyomitra sp.				■			■		
Archaeospongoprunum sp.						■			
Archicapsa pachyderma			■						
Dictyomitrella(?) sp. A					■				
Eucyrtidiellum disparile			■						
Eucyrtidiellum quinatum			■						
Eucyrtidiellum sp.		■							
Eucyrtis sp.							■		
Hsuum hisuikyoense			■						
Hsuum(?) *matsuokai*			■						
Hsuum sp.	■	■	■						
Pantanellium sp. A						■			
Pantanellium sp.			■			■			
Pseudodictyomitra sp.							■		
Stylocapsa(?) *spiralis*	■								
Tricolocapsa sp.		■	■						
Tricolocapsa(?) sp. A					■				
Trillus sp.			■						
Unuma echinatus			▩	■					
Unuma sp.			■	■					
Capnuchosphaera sp.								■	
Pseudostylosphaera sp.								■	■
Triassocampe sp.								■	

Fig. 7 List of Triassic, Jurassic and Cretaceous (?) Radiolaria from the Muslim Bagh area in Pakistan.

ly determined, are consistent with the radiolarian ages of samples M85 and M156B from the Bls. From the locality shown in Fig. 4, we found an ammonite fossil from scree on hillside, which is questionably identified as lower Jurassic *Grammoceras* by A. N. Fatmi. As the ammonite was found in scree, it is difficult to determine the origin. If it is derived from the Bus distributed to the southwest of the locality, it is consistent with the radiolarian ages; if it is derived from the Bhm distributed at the locality, the depositional age of the Bhm should come down to the lower Jurassic.

Sawada *et al.* (1993, written communication) measured K–Ar ages of the igneous and metamorphic rocks in the Muslim Bagh area; the ages are 81–82 Ma for amphibolite in the Muslim Bagh Ophiolite, 64–67 Ma for hornblende gabbro in the ophiolite, 76–81 Ma for amphibolite in the Bsm and 68–81 Ma for trachybasalt in the Bhm. As the Muslim Bagh Ophiolite is younger than the basalt of the Bbc overlain by the Lower Cretaceous Radiolaria-bearing bedded chert, the ophiolite cannot be a deeper unit of the Bbc. The difference in chemical composition between the basalt and ophiolite (Sawada *et al.*, 1992), although both are tholeiites, also suggests that the Muslim Bagh Ophiolite has no relationship in origin with the Bbc. The radiometric ages of trachybasalts and the radiolarian ages of siliceous shales in the Bhm show that the formation of the Bhm covers the time span of the almost whole Cretaceous.

5.2 Structural implication of the radiolarian ages

The radiolarians, ammonites and *Halobia* obtained from the Muslim Bagh area together with the radiometric dating provide the age constraints on the lithologic units of the Bagh Complex as shown in Fig. 8. Berriasian to Turonian radiolarians occur in bedded chert of the Bbc, and siliceous shale and chert of the Bhm yield early Cretaceous radiolarians (M197 and M214); these rocks are also intermingled as blocks in the Bsm and Bmm. Since the youngest age of the Bagh Complex is 68–81 Ma of the trachybasalt in the Bhm and the Eocene limestone covers the Bagh Complex and the Muslim Bagh Ophiolite (Hunting Survey Corporation, 1961), the ophiolite is considered to have been overthrust onto the Bagh Complex in Maastrichtian or Paleocene time. The occurrence of the Bsm and Bmm (Figs. 3 and 4; Mengal *et al.*, 1994) strongly indicates that the melanges formed at the same time with the emplacement of the Muslim Bagh Ophiolite.

The Bls and Bus yield Triassic and Jurassic radiolarians together with the Norian and Jurassic (?) ammonites and Triassic *Halobia*. In this study we cannot ascertain the presence of the Cretaceous formations in the Bus. Kimura *et al.* (1992), however, suggested that the sedimentation of the Bus continued up to the Cretaceous on the basis of radiolarian data in the Gwal area about 60 km southwest of Muslim Bagh.

Otsuki *et al.* (1989) explained the formative process of the Bagh Complex on the basis of *Halobia* fossils from the Bls; they ascribed the formation of the Bbc and Bhm and their melanges to the Triassic rifting and the related deep ocean basin development along the northwestern margin of the Indian continent. The fossil data described in the present paper, however, indicate that the Bbc and Bhm were deposited during the Cretaceous time, and the Bsm and Bmm formed in latest Cretaceous or Paleocene time.

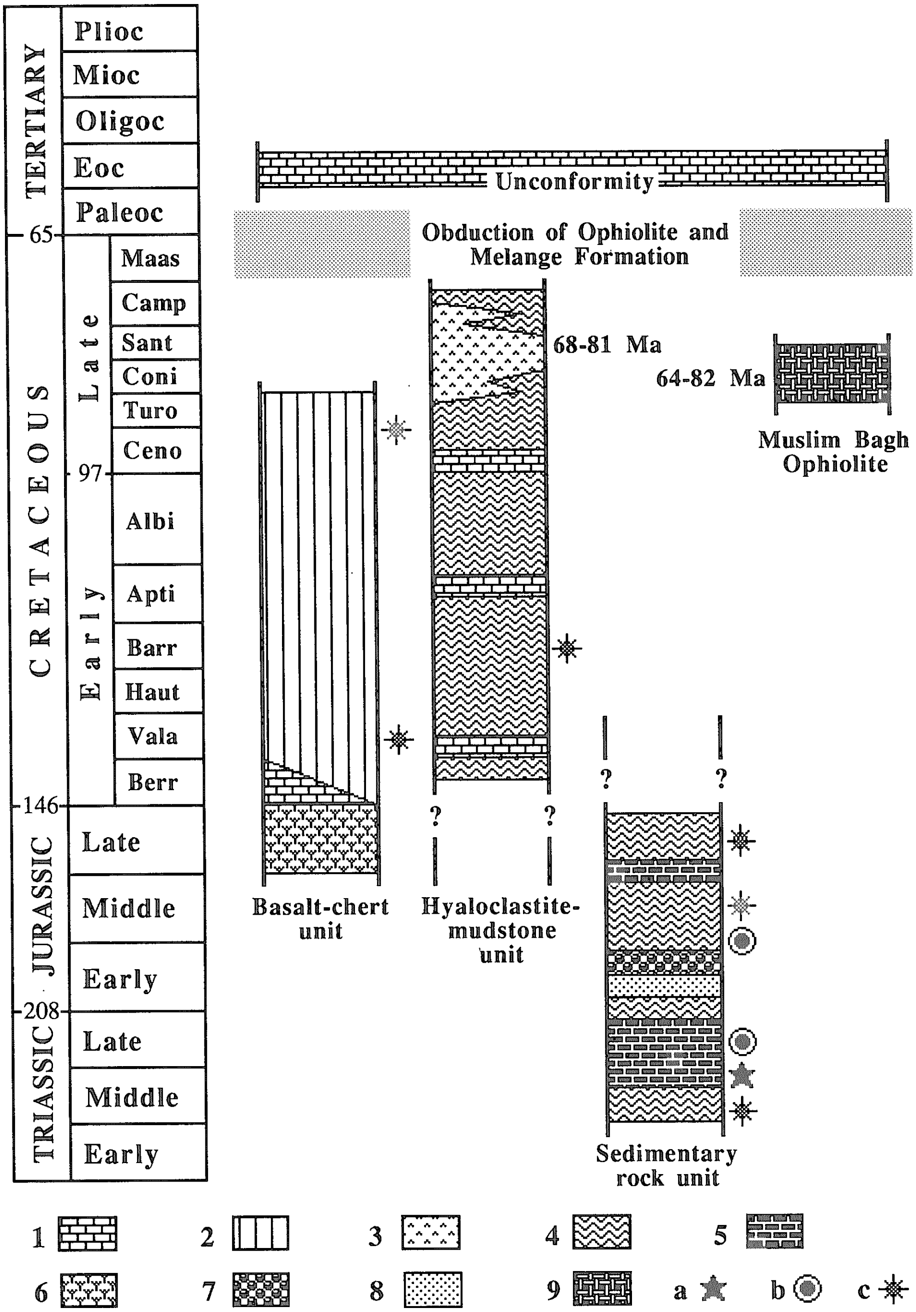

Fig. 8 Schematic columnar sections of the Bagh Complex, Muslim Bagh Ophiolite and overlying Eocene limestone in the Muslim Bagh area, Pakistan. Radiometric ages in the time scale are taken from Harland *et al.* (1989). 1: limestone, 2: bedded chert, 3: hyaloclastite, 4: (siliceous) mudstone, 5: interbedded limestone and shale, 6: pillow basalt, 7: conglomerate, 8: sandstone, 9: ultramafic rocks, a: *Halobia*, b: ammonite, c: radiolarians.

5.3 Correlation of the Muslim Bagh Ophiolite with the Bela, Oman and Yarlung-Zangbo Ophiolites

The Bela Ophiolite is a southwestern extension of the Muslim Bagh Ophiolite, and the geology is described by Gansser (1979), DeJong and Subhani (1979) and Sarwar and DeJong (1984). The ophiolite consists of the Aptian-Maastrichtian mafic and ultramafic igneous rocks, and the associated Kanar Melange is underlain by Cretaceous shelf-slope sediments and tectonically overlain by the ophiolite (Sarwar and DeJong, 1984). They proposed a model that the melange was formed during oblique convergence at Paleocene time between the western margin of the Indian plate and the adjoining Neo-Tethys. Ages and occurrence of the Bela Ophiolite and the Kanar Melange are similar to those of the Muslim Bagh Ophiolite and part of the Bagh Complex, respectively, except that the Bmm and Bsm are in fault contact with the other units of the Bagh Complex and calcareous facies rocks in the Sulaiman Range. Oblique subduction or transform fault settings for the origin of the Muslim Bagh Ophiolite and the Bagh Complex are also plausible, considering the late Mesozoic to Cenozoic plate motion of this region (Fig. 1; Smith *et al.*, 1981; Powell, 1979).

Ophiolite and the related rocks in the Oman Mountains are one of the best studied ophiolites in the world (e.g. Robertson and Searle, 1990). Allochthonous rock units covering platform sediments on the Arabian plate are composed of the Sumeini Group (Permian to Late Cretaceous carbonate platform slope sediments), Hawasina Complex (tectonically sliced Permian to Late Cretaceous basinal sediments), Haybi Complex (Permian to Cretaceous highly-deformed sedimentary, igneous and metamorphic rock complexes), Semail Ophiolite (a 600 km long by up to 150 km wide slab of Cretaceous oceanic crust and mantle) and Batinah Complex in ascending order (Robertson and Searle, 1990). The Bagh Complex might be correlated with the Hawasina and Haybi Complexes on the basis of lithological, age and structural similarities (Robertson and Searle, 1990; Bernoulli *et al.*, 1990; De Wever *et al.*, 1990).

A number of ophiolites and ophiolitic melanges are known to occur along the Indus Yarlung-Zangbo (I–YZ) suture zone (e.g. Ren *et al.*, 1980; Zhang *et al.*, 1984; Searle *et al.*, 1987; Dewey *et al.*, 1988). The ophiolites occur in thrust sheets obducted southward onto the northern continental margin of the Indian plate or in discontinuous lenses tectonically disrupted within the I–YZ suture zone; the age of the ophiolite and ophiolitic melanges is dated or estimated to be Cretaceous irrespective of the occurrence (Searle *et al.*, 1987; Wu and Li, 1982; Li and Wu, 1985; Wu, 1986). The obduction of the ophiolites (Maastrichtian-Danian; Dewey *et al.*, 1988) predates the main phase (Eocene) of collision of India with the Lhasa block, and this might be a general phenomena along the Neo-Tethys suture zone.

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(CE): in Chinese with English abstract
(D): in Dutch
(FE): in French with English abstract
(G): in German
(GE): in German with English abstract
(I): in Italian
(J): in Japanese
(JE): in Japanese with English abstract
(R): in Russian

パキスタン，モスリムバーグ地域のバーグコンプレックスから産した中生代放散虫化石—ネオテーチス収束帯に沿うオフィオライトの地史復元上の意義—

小嶋　智・中　孝仁・木村克己・J. M. Mengal・M. R. H. Siddiqui・M. S. Bakht

要　旨

パキスタン，モスリムバーグ地域に分布するバーグコンプレックスから三畳紀，ジュラ紀，白亜紀の放散虫化石を記載した．バーグコンプレックスは，蛇紋岩メランジュ(Bsm)，泥岩メランジュ(Bmm)，超塩基性-塩基性岩ユニット(Bum)，玄武岩-チャートユニット(Bbc)，ハイアロクラスタイト-泥岩ユニット(Bhm)，三畳紀堆積岩ユニット(Bls)，ジュラ紀-白亜紀(?)堆積岩ユニット(Bus)からなる．放散虫化石によれば，Bbc と Bhm の珪質岩の年代は白亜紀であり，Bls, Bus からはそれぞれ三畳紀，ジュラ紀の放散虫化石が得られた．Bls, Bus の放散虫年代はアンモナイト，ハロビアなどの大型化石に

よる年代と調和的である．Bsm, Bmm 中のチャートブロックは白亜紀の Berriasian から Turonian の放散虫化石を含むこと，バーグコンプレックスと，それに密接に伴われ超塩基性岩からなるモスリムバーグオフィオライトは，始新世の石灰岩に覆われることから，メランジュの形成年代は Turonian より新しく始新世より古いことがわかる．さらに，バーグコンプレックスの玄武岩とモスリムバーグオフィオライトの同位体年代は，それぞれ，68–81 Ma, 64–82 Ma であり，この値は，オフィオライトのオブダクションの時代を，最後期白亜紀～暁新世に限定する．また，オフィオライトの定置は，野外における観察事実から，バーグコンプレックスのメランジュの形成と密接な関係があったと推定される．モスリムバーグ地域のオフィオライトコンプレックスを，ベラ(パキスタン南西部)，オマーン，雅魯蔵布(南中国ラサ近辺)などネオテーチス沿いの白亜紀のオフィオライトコンプレックスと比較すると，これらオフィオライトのオブダクションはインドとユーラシアの衝突よりも前であったことがわかる．

(受付：1993年６月７日；受理：1993年11月19日)

Appendix (A): Descriptions of Samples and Localities

Following descriptions of rock samples and localities were made during the field survey in 1991 by K. Kimura, S. Kojima and T. Naka. Latitude and longitude are measured on the 1:50,000 scale topographic maps (sheets 34 N/14 and 39 B/2) published by the government of Pakistan. GSJ numbers in parentheses are register numbers of rock specimens in the Geological Museum of Geological Survey of Japan. In the following descriptions, the term bedded chert means alternating beds of chert and siliceous shale; the ratio and thickness of chert and shale are variable.

9143009 (Kohai: 30°37.6'N 68°03.8'E, GSJ R60715) Bedded siliceous shale associated with minor micritic limestone (Bus).

M2A (Marzaghan Nala: 30°42.0'N 67°52.3'E, GSJ R60716) Reddish-brown bedded chert block in scaly shale matrix. Other blocks include basalt, basaltic tuff, pale-green radiolarian tuffaceous shale and limestone (Bmm).

M7B13 (Bagh: 30°41.8'N 68°07.0'E, GSJ R60717) Hard, bedded, dark reddish-brown chert block (5 m in diameter) in sheared reddish-brown shale. Limestone blocks are also recognized (Bsm).

M7B17 (Bagh: 30°41.8'N 68°07.0'E, GSJ R60718) Muddy reddish-brown chert block (60×40 cm) in scaly reddish brown shale matrix (Bsm).

M10E (Marzaghan Nala: 30°42.5'N 67°52.1'E, GSJ R60719) Hard reddish-brown bedded chert block in basic tuff and scaly shale matrix (Bmm).

M11 (Bagh: 30°41.6'N 68°07.0'E, GSJ R60720) Reddish-brown bedded chert block (2.5×1 m) in scaly greenish shale matrix (Bsm).

M36 (Ghazlunai Manda North: 30°40.3'N 68°09.6'E, GSJ R60721) Reddish-brown bedded siliceous shale with foraminifer fossils (Bbc).

M41 (Ghazlunai Manda: 30°40.0'N 68°07.7'E, GSJ R60722) Reddish-brown bedded chert (Bbc).

M55A (Kohai: 30°37.5'N 68°03.9'E, GSJ R60723) Greenish siliceous shale alternating with calcareous sandstone (Bus).

M57A (Kohai: 30°37.5'N 68°03.9'E, GSJ R60724) Alternating beds of pale-green and reddish-brown siliceous shales (Bus).

M57F (Kohai: 30°37.5'N 68°03.9'E, GSJ R60725) Reddish-brown siliceous mudstone (Bus).

M85 (Kazhaba: 30°39.4'N 68°01.8'E, GSJ R60726) 5 cm-thick pale-green chert (or radiolarite) interbedded with mudstone (Bls).

M119' (Marzaghan Nala: 30°42.4'N 67°52.1'E, GSJ R60727) Reddish-brown bedded chert block in 5 m-thick melange zone between serpentinite and greenschist. Blocks of reddish brown siliceous shale are also recognized in the melange zone (Bsm).

M129 (Marzaghan Nala: 30°42.1'N 67°52.1'E, GSJ R60728) Reddish-brown bedded chert block in a basalt-shale-chert complex (Bmm).

M133 (Marzaghan Nala: 30°42.1'N 67°52.1'E, GSJ R60729) Dark reddish-brown siliceous shale (Bmm).

M156B (Ghazgai Nala: 30°41.1'N 67°50.7'E, GSJ R60730) Reddish or greenish buff-colored siliceous shale alternating with sandstone (Bls).

M187B (Chinjan Ghar: 30°41.3'N 68°11.6'E, GSJ R60731) 8 m-thick reddish-brown bedded chert (Bbc).

M187C (Chinjan Ghar: 30°41.3'N 68°11.6'E, GSJ R60732) 8 m-thick reddish-brown bedded chert (Bbc).

M189C (Chinjan Ghar: 30°41.3'N 68°11.5'E, GSJ R60733) Reddish-brown bedded chert (Bbc).

M189D (Chinjan Ghar: 30°41.3'N 68°11.5'E, GSJ R60734) Reddish-brown bedded chert (Bbc).

M189E (Chinjan Ghar: 30°41.3′N 68°11.5′E, GSJ R60735) Reddish-brown bedded chert (Bbc).

M191A (Chinjan Ghar South: 30°40.5′N 68°11.0′E, GSJ R60736) 5 m-thick reddish-brown nodular chert underlain by pillow basalt (Bbc).

M192A (Chinjan Ghar South: 30°40.4′N 68°11.0′E, GSJ R60737) Folded reddish-brown bedded chert (Bbc).

M192B (Chinjan Ghar South: 30°40.4′N 68°11.0′E, GSJ R60738) Folded reddish-brown bedded chert (Bbc).

M192D (Chinjan Ghar South: 30°40.4′N 68°11.0′E, GSJ R60739) Folded reddish-brown bedded chert (Bbc).

M192E (Chinjan Ghar South: 30°40.4′N 68°11.0′E, GSJ R60740) Folded reddish-brown and greenish-gray bedded chert (Bbc).

M195 (Kazhaba: 30°39.5′N 68°02.0′E, GSJ R60741) Laminated greenish tuffaceous siltstone or shale (Bhm).

M197 (Kazhaba: 30°39.7′N 68°01.8′E, GSJ R60742) Folded reddish-brown bedded chert showing pinch and swell structure (Bhm).

M201B (Kazhaba: 30°40.2′N 68°02.4′E, GSJ R60743) Dark reddish-brown bedded chert (Bbc).

M210 (Kazhaba: 30°39.5′N 68°01.5′E, GSJ R60744) Bioturbated greenish-gray siliceous shale (Bhm).

M212 (Kazhaba: 30°39.5′N 68°01.5′E, GSJ R60745) Hard, bedded, Radiolaria-rich siliceous shale (Bus).

M214C (Kazhaba: 30°39.5′N 68°01.6′E, GSJ R60746) Hard bedded siliceous shale (Bhm).

M237A (Kazhaba: 30°39.3′N 68°00.8′E, GSJ R60747) Greenish-gray bedded siliceous shale or radiolarite (Bhm).

M253A (Tor Tangi: 30°43.7′N 68°09.4′E, GSJ R60748) Reddish-brown to greenish-gray bedded chert just above the contact with pillow basalt (Bbc).

M253B (Tor Tangi: 30°43.7′N 68°09.4′E, GSJ R60749) Greenish-gray bedded chert 5 m above the contact with pillow basalt (Bbc).

M258A (Gunda Manra North: 30°39.3′N 68°06.8′E, GSJ R60750) 15 m-thick bedded calcareous chert underlain by bedded limestone (Bbc).

Appendix (B): Taxonomic Notes

The phylogenetic study of Mesozoic Radiolaria is still in its infancy, and the suprageneric classification is confusing among researchers. In this appendix we listed radiolarian genera and species treated in this paper in alphabetical order, except for Nassellaria sp. A described last, irrespective of suprageneric relationships, and also listed synonyms in order to provide reference of morphologic variability of the taxon. Synonyms are mainly taken from paleontologically important papers with SEM photomicrographs of Radiolaria, because the radiolarian fossils described in this paper were identified by using SEM. Paleontological remarks were made upon some species. All the species listed below are figured in Plates 1–6. For explanations of numbers in the parentheses after the plate and figure numbers, see caption of Plate 1.

Acaeniotyle diaphorogona Foreman

Plate 3, fig. 7 (59136/M189E)

Acaeniotyle diaphorogona Foreman, 1973, p. 258, pl. 2, figs. 2–5.

Acaeniotyle diaphorogona Foreman: Foreman, 1975, p. 607, pl. 2F, figs. 1–5, pl. 3, figs. 1, 2.

Acaeniotyle diaphorogona Foreman: Schaaf, 1981, p. 431, pl. 15, fig. 2.

Acaeniotyle diaphorogona Foreman: Mizutani, 1981, p. 175, pl. 61, figs. 1, 2.

Acaeniotyle diaphorogona Foreman: Nakaseko and Nishimura, 1981, p. 141, pl. 1, fig. 12.
Acaeniotyle diaphorogona Foreman s.l.: Baumgartner, 1984, p. 753, pl. 1, fig. 1.
Acaeniotyle diaphorogona Foreman: Aita, 1987, p. 63, pl. 12, fig. 12.

Acaeniotyle umbilicata **(Rüst)**

Plate 3, fig. 6 (59077/M189D)

Xiphosphaera umbilicata Rüst, 1898, p. 7, pl. 1, fig.9.
Acaeniotyle umbilicata (Rüst): Foreman, 1973, p. 258, pl. 1, figs. 12–14, 16.
Acaeniotyle umbilicata (Rüst): Foreman, 1975, p. 607, pl. 2E, figs. 14–17, pl. 3, fig. 3.
Acaeniotyle umbilicata (Rüst): Baumgartner *et al.*, 1980, p. 48, pl. 2, fig. 8.
Acaeniotyle umbilicata (Rüst): Nakaseko and Nishimura, 1981, p. 141, pl. 1, fig.7, pl. 14, fig. 2.
Acaeniotyle umbilicata (Rüst): Schaaf, 1981, p. 431, pl. 6, fig.11, pl. 15, figs. 3a, b.
Acaeniotyle umbilicata (Rüst): Baumgartner, 1984, p. 754, pl. 1, fig. 5.
Acaeniotyle umbilicata (Rüst): Aita, 1987, p. 63, pl. 12, fig. 2.

Acanthocircus **cf.** ***dicranacanthos*** **(Squinabol)**

Plate 3, fig. 11 (58923/M129)

Saturnalis dicranacanthos Squinabol, 1914, p. 289, fig. 1, pl. 22, figs. 4–7, pl. 23, fig. 8.
Spongosaturnalis dicranacanthos (Squinabol): Moore, 1973, p. 824, pl. 3, figs. 1, 3.
Acanthocircus dicranacanthos (Squinabol): Foreman, 1975, p. 610, pl. 2D, figs. 5, 6.
Acanthocircus dicranocanthos (Squinabol): Pessagno, 1977a, p. 31, pl. 2, fig. 6.
Acanthocircus dicranocanthos (Squinabol): Pessagno, 1977b, p. 73, pl. 3, fig. 5.
Acanthocircus dicranacanthos (Squinabol): Baumgartner *et al.*, 1980, p. 49, pl. 1, fig. 11.
Acanthocircus dicranacanthos (Squinabol): Schaaf, 1981, p. 431, pl. 7, fig. 1, pl. 16, fig. 3.
Acanthocircus dicranacanthos (Squinabol): Nakaseko and Nishimura, 1981, p. 141, pl. 1, fig. 6.
Acanthocircus dicranacanthos (Squinabol): Baumgartner, 1984, p. 754, pl. 1, fig. 7.

Archaeodictyomitra **cf.** ***apiara*** **(Rüst)**

Plate 5, fig. 3 (58606/M253A)

Lithocampe apiarium Rüst, 1885, p. 314, pl. 39(14), fig. 8.
Dictyomitra apiarium (Rüst): Foreman, 1975, p. 613, pl. 2G, figs. 7, 8.
Archaeodictyomitra apiara (Rüst): Pessagno, 1977a, p. 41, pl. 6, figs. 6, 14.
Archaeodictyomitra apiara (Rüst): Schaaf, 1981, p. 432, pl. 18, figs. 2a, b.
Archaeodictyomitra apiara (Rüst): Nakaseko and Nishimura, 1981, p. 145, pl. 6, figs. 1–4, pl. 15, figs. 2, 6, 7.
Archaeodictyomitra apiara (Rüst): Wu and Li, 1982, p. 67, pl. 1, figs. 15, 16.
Archaeodictyomitra apiara (Rüst): Baumgartner, 1984, p. 758, pl. 2, figs. 5, 6.

Archaeodictyomitra lacrimula **(Foreman)**

Plate 5, fig. 4 (59101/M189D)

Dictyomitra(?) *lacrimula* Foreman, 1973, p. 263, pl. 10, fig. 11.
Dictyomitra(?) *lacrimula* Foreman: Foreman, 1975, p. 614, pl. 2G, figs. 5, 6, pl. 6, fig. 1.
Archaeodictyomitra lacrimula (Foreman): Schaaf, 1981, p. 432, pl. 22, figs. 3a, b.
Archaeodictyomitra lacrimula (Foreman): Nakaseko and Nishimura, 1981, p. 146, pl. 6, figs. 5, 6, pl. 15, fig. 10.

***Archaeodictyomitra* sp. A**

Plate 1, fig. 6 (59223/M192B)

Remarks-Archaeodictyomitra sp. A differs from *A. sliteri* Pessagno by having more cylindrical test, and differs from other *Archaeodictyomitra* by the slender form.

***Archicapsa pachyderma* (Tan Sin Hok)**

Plate 6, fig. 8 (58571/M57A)

Cyrtocalpis pachyderma Tan Sin Hok, 1927, p. 41, pl. 7, fig. 28.

Remarks-Archicapsa pachyderma is thought to be an important marker species of the Lower Jurassic of Japan, and Matsuoka and Yao (1986), though not systematically examined, figured the species as the fig. 5 in their Plate 1.

***Cecrops septemporatus* (Parona)**

Plate 3, fig. 4 (59051/M189C)

Staurosphaera septemporata Parona, 1890, p. 22, pl. 2, figs. 4, 5.
Staurosphaera septemporata Parona: Foreman, 1973, p. 259, pl. 3, fig. 4.
Staurosphaera septemporata Parona: Foreman, 1975, p. 609, pl. 2E, fig. 7, pl. 3, fig. 6.
Cecrops septemporatus (Parona): Pessagno, 1977a, p. 33, pl. 3, fig. 11.
Cecrops septemporatus (Parona): Baumgartner *et al.*, 1980, p. 51, pl. 2, fig. 7.
Staurosphaera septemporata Parona: Nakaseko and Nishimura, 1981, p. 161, pl. 1, fig. 2
Cecrops septemporatus (Parona): Baumgartner, 1984, p. 761, pl. 2, figs. 17, 18.

***Dictyomitra* (?) sp. A**

Plate 4, fig. 10 (59061/M189C)

Remarks- This form has characteristics of the genus *Dictyomitra* emended by Pessagno (1976); it has continuous costae and strictures at segments sandwiched by two rows of pores. He also showed that *Dictyomitra sensu* Pessagno (1976) first appeared in the middle Turonian. In our sample, however, *D.* (?) sp. A is coexistent with Lower Cretaceous radiolarians such as *Acaeniotyle umbilicata, Cecrops septemporatus, Pseudodictyomitra leptoconica* and *P. lilyae.* Although this form is similar to *Archaeodictyomitra puga* of Schaaf (1981), we questionably assigned this Radiolaria to a species of *Dictyomitra* because of its well-developed strictures.

***Dictyomitrella* (?) sp. A**

Plate 5, fig. 11 (58537/M210)

Remarks- This form is similar to the Middle Jurassic Radiolaria, *Dictyomitrella* (?) *kamoensis* described by Mizutani and Kido (1983), but differs from *D.* (?) *kamoensis* by having one row of pores and one row of circular pits instead of two rows of circular pits between circumferential ridges. Moreover, *D.* (?) *kamoensis* has pores on both sides of the circumferential ridges, while *D.* (?) sp. A has a row of pores under the circumferential ridges.

***Eucyrtidiellum disparile* Nagai and Mizutani**

Plate 6, fig. 7 (58558/M57A)

Eucyrtidiellum disparile Nagai and Mizutani, 1990, p. 594, figs. 3, 6–8c.

Eucyrtidiellum cf. *ptyctum* (Riedel and Sanfilippo)

Plate 5, fig. 7 (59261/M192D)

Eucyrtidium ptyctum Riedel and Sanfilippo, 1974, p. 778, pl. 5, fig. 7, pl. 12, figs. 14, 15.
Eucyrtidium (?) *ptyctum* Riedel and Sanfilippo: Pessagno, 1977b, p. 94, pl. 12, fig. 7.
Eucyrtidium ptyctum Riedel and Sanfilippo: Baumgartner *et al.*, 1980, p. 53, pl. 3, fig. 13.
Eucyrtidium (?) *ptyctum* Riedel and Sanfilippo: Mizutani, 1981, p. 182, pl. 64, figs. 1a–2.
Eucyrtidium (?) *ptyctum* Riedel and Sanfilippo: Mizutani *et al.*, 1982, p. 57, pl. 4, fig. 5.
"Eucyrtidium" ptyctum Riedel and Sanfilippo: Pessagno *et al.*, 1984, p. 30, pl. 4, figs. 12–14.
Eucyrtidiellum ptyctum (Riedel and Sanfilippo): Baumgartner, 1984, p. 764, pl. 4, figs. 1–3.
Eucyrtidium (?) *ptyctum* Riedel and Sanfilippo: Aita and Okada, 1986, p. 109, pl. 6, figs. 14–17, pl. 7, figs. 3a, b.
Eucyrtidiellum ptyctum (Riedel and Sanfilippo): Kojima and Mizutani, 1987, p. 260, figs. 4–(12, 13).
Eucyrtidiellum ptyctum (Riedel and Sanfilippo): Aita, 1987, p. 65, pl. 4, figs. 12a, b, pl. 14, fig. 3.
Eucyrtidiellum ptyctum (Riedel and Sanfilippo): Nagai and Mizutani, 1990, p. 595, figs. 3–(5a, b).
Remarks- Aita and Okada (1986) subdivided the genus *Eucyrtidiellum* (designated as *Eucyrtidium* (?) in their paper) with longitudinal plicae on the abdomen into three species: *E. ozaiense*, *E. ptyctum* and *E. pyramis*. Although Radiolaria in our specimens are not well-preserved, trace of pores on the thorax indicates the form to be assigned to *E. ptyctum*.

Eucyrtidiellum quinatum Takemura

Plate 6, fig. 6 (58553/M57A)

Eucyrtidiellum quinatum Takemura, 1986, p. 67, pl. 12, figs. 16–18.

Holocryptocanium astiensis Pessagno

Plate 2, fig. 2 (58468/M41)

Holocryptocanium astiensis Pessagno, 1977a, p. 40, pl. 6, figs. 16, 21, 26.
Remarks- As mentioned above, *Holocryptocanium astiensis* is identified only by the external morphology by using SEM.

Holocryptocanium barbui Dumitrica

Plate 2, fig. 1 (58862/M11)

Holocryptocanium barbui Dumitrica, 1970, p. 76, pl. 17, figs. 105–108b, pl. 21, fig. 136.
Holocryptocanium barbui Dumitrica: Foreman, 1975, p. 618, pl. 1F, fig. 9, pl. 6, fig. 13.
Holocryptocanium barbui Dumitrica: Pessagno, 1977a, p. 40, pl. 6, fig. 18.
Holocryptocanium barbui barbui Dumitrica: Nakaseko and Nishimura, 1981, p. 153, pl. 3, figs. 1–4.
Holocryptocanium barbui Dumitrica: Schaaf, 1981, p. 435, pl. 2, figs. 1a, b, pl. 10, figs. 6a, b.
Holocryptocanium barbui Dumitrica: Taketani, 1982, p. 67, pl. 7, figs. 1a, b, pl. 13, figs. 18, 19.
Holocryptocanium barbui Dumitrica: Baumgartner, 1984, p. 768, pl. 4, fig. 14.
Remarks- As mentioned above, *Holocryptocanium barbui* is identified only by the external morphology by using SEM. Nakaseko and Nishimura (1981) subdivided the species *Holocryptocanium barbui* into two subspecies: *H. barbui barbui* and *H. barbui japonicum*. The form in our material lacks hexagonal pore frames characteristic of *H. barbui japonicum*, and is identified as *H. barbui barbui*.

Holocryptocanium geysersensis **Pessagno**

Plate 2, fig. 3 (59246/M192B)

Holocryptocanium geysersensis Pessagno, 1977a, p. 41, pl. 6, figs. 19, 25, 26.
Holocryptocanium geysersensis Pessagno: Nakaseko and Nishimura, 1981, p. 154, pl. 4, figs. 3a, b, pl. 14, fig. 8.
Holocryptocanium geysersensis Pessagno: Taketani, 1982, p. 67, pl. 7, figs. 4a, b, pl. 13, fig. 20.
Remarks- As mentioned above, *Holocryptocanium geysersensis* is identified only by the external morphology by using SEM.

Hsuum hisuikyoense **Isozaki and Matsuda**

Plate 6, fig. 1 (58560/M57A)

Hsuum hisuikyoense Isozaki and Matsuda, 1985, p. 437, pl. 2, figs. 10–18.

Hsuum **(?)** ***matsuokai*** **Isozaki and Matsuda**

Plate 6, fig. 2 (58563/M57A)

Hsuum (?) *matsuokai* Isozaki and Matsuda, 1985, p. 439, pl. 3, figs. 1–14.

Mirifusus baileyi **Pessagno**

Plate 5, fig. 1 (58484/M129); Plate 5, fig. 2 (59255/M192D)

Lithocampe mediodilatata Moore, 1973, p. 828, pl. 2, figs. 5, 6.
Lithocampe mediodilatata Riedel and Sanfilippo, 1974, p. 779, pl. 7, figs. 3, 4.
Mirifusus baileyi Pessagno, 1977b, p. 83, pl. 10, figs. 6–8, pl. 11, figs. 9–11.
Mirifusus baileyi Pessagno: Pessagno, 1977a, p. 48, pl. 8, figs. 1, 8, 9, 26.
Mirifusus baileyi Pessagno: Mizutani, 1981, p. 177, pl. 60, fig. 1.
Mirifusus baileyi Pessagno: Pessagno *et al.*, 1984, p. 26, pl. 2, figs. 1–3, 10, 13, 17, 21–23.
Mirifusus mediodilatatus baileyi Pessagno: Baumgartner, 1984, pl. 5, figs. 10, 18.
Remarks- Mirifusus baileyi was described by Pessagno (1977b) from the California Coast Ranges, and later regarded by many authors (e.g. Baumgartner *et al.*, 1980; Schaaf, 1984) as a synonym of *Mirifusus mediodilatatus*. We, however, are thinking that it is possible to recognize the morphological difference between *M. baileyi* and *M. mediodilatatus* as discussed by Mizutani (1981) and Pessagno *et al.* (1984). Our *M. baileyi* is *M. baileyi sensu* Pessagno (1977a), Pessagno *et al.* (1984) and Mizutani (1981), *M. mediodilatatus baileyi* of Baumgartner (1984), or included in *M. mediodilatatus sensu lato*, but is neither *M. mediodilatatus mediodilatatus* of Baumgartner (1984) nor *M. mediodilatatus sensu stricto*.

Mita **(?) sp. A**

Plate 1, fig. 5 (59244/M192B)

Remarks- Although costae of this form are not so distinct, compared with other species of *Mita* (e.g. *Mita magnifica, M.* sp. A and *M.* sp. B of Pessagno, 1977a), it is questionably placed in this genus. This form characteristically occurs together with the Cenomanian—Turonian radiolarians like *Pseudodictyomitra pseudomacrocephala* and *Novixitus weyli*.

Novixitus weyli Schmidt-Effing

Plate 1, fig. 3 (59248/M192B)

Novixitus weyli Schmidt-Effing, 1980, p. 252, fig. 33.
Novixitus weyli Schmidt-Effing: Nakaseko and Nishimura, 1981, p. 155, pl. 10, figs. 1, 2, pl. 16, fig. 10.
Novixitus weyli Schmidt-Effing: Taketani, 1982, p. 62, pl. 5, figs. 9a, b, pl. 12, fig. 11.

Pantanellium sp. A

Plate 3, fig. 2 (59103/M189D); Plate 3, fig. 3 (59117/M189D); Plate 5, fig. 14 (58578/M212)
Remarks- This form differs from other species of *Pantanellium* by having slender polar spines.

Parvicingula (?) sp. A

Plate 4, fig. 7 (58921/M129)

Remarks- Although this form is similar to *Pseudodictyomitra carpatica*, in this paper, it is questionably placed in the genus *Parvicingula* because of the costae-like knobs on the circumferential ridges between chambers.

Podobursa triacantha (Fischli)

Plate 2, fig. 11 (59088/M189D)

Theosyringium acanthophorum Rüst var. *triacanthus* Fischli, 1916, p. 47, fig. 38.
Theosyringium acanthophorum Rüst var. *tetracanthus* Fischli, 1916, p. 47, fig. 39.
Theosyringium acanthophorum Rüst var. *polyacanthus* Fischli, 1916, p. 47, fig. 41.
Podobursa triacantha (Fischli): Foreman, 1973, p. 266, pl. 13, figs. 1–7.
Podobursa triacantha (Fischli): Foreman, 1975, p. 617, pl. 2L, figs. 4–6.
Podobursa triacantha (Fischli): Pessagno, 1977a, p. 57, pl. 11, fig. 6.
Podobursa triacantha (Fischli): Pessagno, 1977b, p. 92, p. 12, fig. 6.
Podobursa triacantha (Fischli): Mizutani, 1981, p. 181, pl. 59, fig. 6.
Podobursa triacantha (Fischli): Schaaf, 1981, p. 436, pl. 5, fig. 11, pl. 25, figs. 1a, b.

Pseudodictyomitra carpatica (Lozyniak)

Plate 4, fig. 5 (59036/M189C)

Pseudodictyomitra cf. _carpatica_ (Lozyniak)

Plate 4, fig. 6 (58519/M133)

Dictyomitra carpatica Lozyniak, 1969, p. 38, pl. 2, figs. 11–13.
Pseudodictyomitra carpatica (Lozyniak): Foreman, 1973, p. 263, pl. 10, figs. 1–3, pl. 16, fig. 5.
Pseudodictyomitra carpatica (Lozyniak): Foreman, 1975, p. 614, pl. 2G, figs. 11–14, pl. 7, figs. 6, 7.
Pseudodictyomitra carpatica (Lozyniak): Nakaseko and Nishimura, 1981, p. 158, pl. 9, figs. 6, 11.
Pseudodictyomitra carpatica (Lozyniak): Schaaf, 1981, p. 436, pl. 3, figs. 1a–c, 2, pl. 20, figs. 4a, b.
Pseudodictyomitra carpatica (Lozyniak): Baumgartner, 1984, p. 782, pl. 8, fig. 1.

Pseudodictyomitra leptoconica **(Foreman)**

Plate 4, fig. 3 (59153/M189E)

Dictyomitra leptoconica Foreman, 1973, p. 264, pl. 10, fig. 4, pl. 16, fig. 6.
Pseudodictyomitra leptoconica (Foreman) group: Schaaf, 1981, p. 437, pl. 3, fig. 3, pl. 18, figs. 3a, b.
Pseudodictyomitra leptoconica (Foreman): Nakaseko and Nishimura, 1981, p. 159, pl. 9, fig. 7.

Pseudodictyomitra lilyae **(Tan Sin Hok)**

Plate 4, fig. 1 (59146/M189E); Plate 4, fig. 2 (58881/M129)

Dictyomitra lilyae Tan Sin Hok, 1927, p. 55, pl. 10, fig. 83.
Dictyomitra lilyae Tan Sin Hok: Riedel and Sanfilippo, 1974, p. 778, pl. 4, figs. 7–9, pl. 12, fig. 13.
Pseudodictyomitra lilyae (Tan Sin Hok): Schaaf, 1981, p. 437, pl. 3, fig. 8, pl. 18, figs. 5a, b.
Pseudodictyomitra lilyae (Tan Sin Hok): Nakaseko and Nishimura, 1981, p. 159, pl. 9, fig. 12.

Pseudodictyomitra pseudomacrocephala **(Squinabol)**

Plate 1, fig. 1 (59241/M192B); Plate 1, fig. 2 (58472/M41)

Dictyomitra pseudomacrocephala Squinabol, 1903, p. 139, pl. 10, fig. 2.
Dictyomitra macrocephala Squinabol: Moore, 1973, p. 829, pl. 9, figs. 8, 9.
Dictyomitra macrocephala Squinabol: Riedel and Sanfilippo, 1974, p. 778, pl. 4, figs. 10, 11, pl. 14, fig. 11.
Dictyomitra pseudomacrocephala Squinabol: Foreman, 1975, p. 614, pl. 7, fig. 10.
Dictyomitra (?) *pseudomacrocephala* Squinabol: Pessagno, 1976, p. 53, pl. 3, figs. 2, 3.
Pseudodictyomitra pseudomacrocephala (Squinabol): Pessagno, 1977a, p. 51, pl. 8, figs. 10, 11.
Pseudodictyomitra pseudomacrocephala (Squinabol): Schmidt-Effing, 1980, p. 247, fig. 8.
Pseudodictyomitra pseudomacrocephala (Squinabol): Schaaf, 1981, p. 437, pl. 24, figs. 1a, b.
Pseudodictyomitra pseudomacrocephala (Squinabol): Nakaseko and Nishimura, 1981, p. 159, pl. 9, figs. 1–4, pl. 16, figs. 5–8.
Pseudodictyomitra pseudomacrocephala (Squinabol): Mizutani *et al.*, 1982, p. 70, pl. 4, figs. 10, 11.
Pseudodictyomitra pseudomacrocephala (Squinabol): Taketani, 1982, p. 61, pl. 5, figs. 4a, b, pl. 12, figs. 7, 8.

Pseudodictyomitra rigida **Wu**

Plate 4, fig. 4 (59106/M189D)

Pseudodictyomitra rigida Wu, 1986, p. 358, pl. 2, figs. 15, 22.

Rhopalosyringium **cf.** ***majuroensis*** **Schaaf**

Plate 1, fig. 11 (59224/M192B)

Rhopalosyringium majuroensis Schaaf, 1981, p. 437, pl. 6, figs. 2, 3, pl. 23, fig. 5.
Rhopalosyringium majuroensis Schaaf: Nakaseko and Nishimura, 1981, p. 161, pl. 8, fig. 16, pl. 17, fig. 7.
Rhopalosyringium majuroensis Schaaf: Taketani, 1982, p. 70, pl. 8, figs. 7a, b.

Sethocapsa uterculus (Parona)

Plate 2, fig. 9 (58514/M133)

Theocapsa uterculus Parona, 1890, p. 39, pl. 5, fig. 17.
Sethocapsa uterculus (Parona): Schaaf, 1981, p. 437, pl. 5, figs. 8a, b, pl. 26, figs. 5a, b.
Sethocapsa uterculus (Parona): Baumgartner, 1984, p. 784, pl. 8, fig. 15.

Siphocampium (?) _davidi_ Schaaf

Plate 2, fig. 8 (59189/M191A)

Siphocampium (?) *davidi* Schaaf, 1981, p. 437, pl. 5, fig. 7, pl. 27, figs. 10a, b.
Siphocampium (?) *davidi* Schaaf: Li and Wu, 1985, p. 70, pl. 1, fig. 20.

Stylocapsa (?) _spiralis_ Matsuoka

Plate 5, fig. 13 (59512/9143009)

Stylocapsa (?) *spiralis* Matsuoka, 1982, p. 77, pl. 3, figs. 1–8.

Thanarla conica (Aliev)

Plate 5, fig. 6 (59133/M189E)

Cornutanna conica Aliev, 1965, p. 34, pl. 6, fig. 1.
Cornutanna conica Aliev: Moore, 1973, p. 830, pl. 14, figs. 1, 2.
Thanarla conica (Aliev): Pessagno, 1977a, p. 45, pl. 7, figs. 1, 13, 15.
Thanarla conica (Aliev): Taketani, 1982, p. 59, pl. 4, figs. 11a–c.

Thanarla elegantissima (Cita)

Plate 1, fig. 8 (59231/M192B)

Lithocampe elegantissima Cita, 1964, p. 148, pl. 12, figs. 2, 3.
Lithocampe elegantissima Cita: Riedel and Sanfilippo, 1974, p. 779, pl. 6, figs. 8–10, pl. 13, figs. 2–4.
Lithocampe elegantissima Cita: Foreman, 1975, p. 616, pl. 2G, figs. 3, 4.
Lithocampe (?) *elegantissima* Cita: Pessagno, 1976, p. 55, pl. 3, fig. 6.
Thanarla elegantissima (Cita): Pessagno, 1977a, p. 46, pl. 7, fig. 10.
Thanarla elegantissima (Cita): Schmidt-Effing, 1980, p. 246, figs, 2, 21, 22.
Thanarla elegantissima (Cita): Mizutani *et al.*, 1982, p. 69, pl. 5, fig. 2.
Thanarla elegantissima (Cita): Taketani, 1982, p. 59, pl. 4, fig. 12, pl. 11, figs. 17, 18.

Thanarla veneta (Squinabol)

Plate 1, fig. 13 (59239/M192B)

Lithocampe veneta Squinabol, 1903, p. 141, pl. 9, fig. 15.
Dictyomitra veneta (Squinabol): Foreman, 1973, p. 264, pl. 14, fig. 11.
Dictyomitra veneta (Squinabol): Riedel and Sanfilippo, 1974, p. 778, pl. 5, figs. 5, 6.
Dictyomitra veneta (Squinabol): Foreman, 1975, p. 614, pl. 1G, fig. 4.
Thanarla veneta (Squinabol): Pessagno, 1977a, pl. 7, figs. 5, 12, 17, 19, 25, pl. 12, fig. 8.
Thanarla veneta (Squinabol): Schmidt-Effing, 1980, p. 247, figs. 2, 23.
Thanarla veneta (Squinabol): Nakaseko and Nishimura, 1981, p. 164, pl. 6, figs. 13, 15, pl. 15, fig. 15.

Thanarla veneta (Squinabol): Taketani, 1982, p. 60, pl. 5, figs. 1a–c, pl. 11, figs. 20, 21.

Tricolocapsa(?) sp. A

Plate 5, fig. 9 (58492/M129); Plate 5, fig. 10 (58541/M210)

Remarks- This form is questionably placed in the genus *Tricolocapsa* on the basis of the external morphological characters. This form differs from other species of *Tricolocapsa* in having a characteristic appendage.

Unuma echinatus Ichikawa and Yao

Plate 6, fig. 3 (58964/M57F)

Unuma cf. *echinatus* Ichikawa and Yao

Plate 6, fig. 5 (58566/M57A)

Unuma (*Spinunuma*) *echinatus* Ichikawa and Yao, 1976, p. 112, pl. 1, figs. 5, 6, pl. 2, figs. 5–7.
Unuma echinatus Ichikawa and Yao: Takemura, 1986, p. 58, pl. 8, figs. 14, 15.

Williriedellum peterschmittae Schaaf

Plate 2, fig. 6 (59100/M189D)

Williriedellum peterschmittae Schaaf, 1981, p. 440, pl. 1, figs. 3a, b, pl. 9, figs. 3a, b.

Xitus cf. *alievi* (Foreman)

Plate 4, fig. 11 (59046/M189C)

Dictyomitra alievi Foreman, 1973, p. 263, pl. 9, fig. 10, pl. 16, fig. 4.
Dictyomitra alievi Foreman: Foreman, 1975, p. 613, pl. 2H, figs. 8, 9, pl. 7, fig. 2.
Xitus alievi (Foreman): Schaaf, 1981, p. 440, pl. 5, figs. 4a, b, pl. 19, figs. 1a, b, 8a, b.

Xitus spicularius (Aliev)

Plate 4, fig. 8 (59155/M189E); Plate 4, fig. 9 (59174/M189E)

Dictyomitra spicularia Aliev, 1965, p. 39, pl. 6, fig. 9.
Xitus spicularius (Aliev): Pessagno, 1977a, p. 56, pl. 9, fig. 7, pl. 10, fig. 5.
Xitus spicularius (Aliev): Schaaf, 1981, p. 440, pl. 4, fig. 11, pl. 5, figs. 12a, b, pl. 19, figs. 2a, b.

Nassellaria sp. A

Plate 1, fig. 9 (59236/M192B); Plate 1, fig. 10 (59230/M192B)

Remarks- This form has no suitable genus name describing its characters, and should be probably assigned to a new genus. Although a variety of slender (Plate 1, fig. 10) to wider (Plate 1, fig. 9) forms are included in one species in this paper, they might be placed in different species in future. This form characteristically occurs in the Cenomanian-Turonian assemblage.

Plate 1 Cretaceous Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. Numbers in the parentheses after the radiolarian names indicate the SEM photograph registration number in the Nagoya University Furukawa Museum (numerator) and the registration number of the rock specimen (denominator) from which the Radiolaria was extracted; the rock specimens are registered and stored in the Geological Museum, Geological Survey of Japan. The register numbers are described in Appendix (A). Scale bar (lower right) indicates 174 μm for figs. 2, 5, 7 and 10; 100 μm for figs. 1, 3, 4, 6 and 9; 73 μm for figs. 8, 12 and 13; 49 μm for fig. 11.

1, 2. *Pseudodictyomitra pseudomacrocephala* (Squinabol), 1: (59241/M192B), 2: (58472/M41)
3. *Novixitus weyli* Schmidt-Effing, (59248/M192B)
4. *Zifondium* sp., (59233/M192B)
5. *Mita* (?) sp. A, (59244/M192B)
6. *Archaeodictyomitra* sp. A, (59223/M192B)
7. *Ristola* sp., (58450/M41)
8. *Thanarla elegantissima* (Cita), (59231/M192B)
9, 10. Nassellaria sp. A, 9: (59236/M192B), 10: (59230/M192B)
11. *Rhopalosyringium majuroensis* Schaaf, (59224/M192B)
12. *Thanarla* sp., (58462/M41)
13. *Thanarla veneta* (Squinabol), (59239/M192B)

Plate 2 Cretaceous Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. For explanations of numbers in the parentheses after the radiolarian names, see caption of Plate 1. Scale bar (lower right) indicates 174 μm for fig. 4; 100 μm for figs. 1–3; 73 μm for figs. 5–7 and 9–11; 49 μm for fig. 8.

1. *Holocryptocanium barbui* Dumitrica, (58862/M11)
2. *Holocryptocanium astiensis* Pessagno, (58468/M41)
3. *Holocryptocanium geysersensis* Pessagno, (59246/M192B)
4. *Acanthocircus* sp., (59289/M201B)
5. *Hemicryptocapsa* sp., (58607/M253A)
6. *Williriedellum peterschmittae* Schaaf, (59100/M189D)
7. *Sethocapsa* (?) sp., (59132/M189E)
8. *Siphocampium* (?) *davidi* Schaaf, (59189/M191A)
9. *Sethocapsa uterculus* (Parona), (58514/M133)
10. *Sethocapsa* (?) sp., (59087/M189D)
11. *Podobursa triacantha* (Fischli), (59088/M189D)

Plate 3 Cretaceous Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. For explanations of numbers in the parentheses after the radiolarian names, see caption of Plate 1. Scale bar (lower right) indicates 100 μm for figs. 2, 3, 5–9 and 11; 73 μm for figs. 1, 4 and 10.

1. *Pantanellium* sp., (58946/M10E)
2, 3. *Pantanellium* sp. A, 2: (59103/M189D), 3: (59117/M189D)
4. *Cecrops septemporatus* (Parona), (59051/M189C)
5. *Archaeospongoprunum* sp., (59074/M189D)
6. *Acaeniotyle umbilicata* (Rüst), (59077/M189D)
7. *Acaeniotyle diaphorogona* Foreman, (59136/M189E)
8. *Emiluvia* sp., (58947/M10E)
9. *Triactoma* sp., (59091/M189D)
10. *Alievium* sp., (58978/M187B)
11. *Acanthocircus* cf. *dicranacanthos* (Squinabol), (58923/M129)

Plate 4 Cretaceous Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. For explanations of numbers in the parentheses after the radiolarian names, see caption of Plate 1. Scale bar (lower right) indicates 174 μm for fig. 11; 100 μm for figs. 2, 4–8 and 10; 73 μm for figs. 1, 3 and 9.

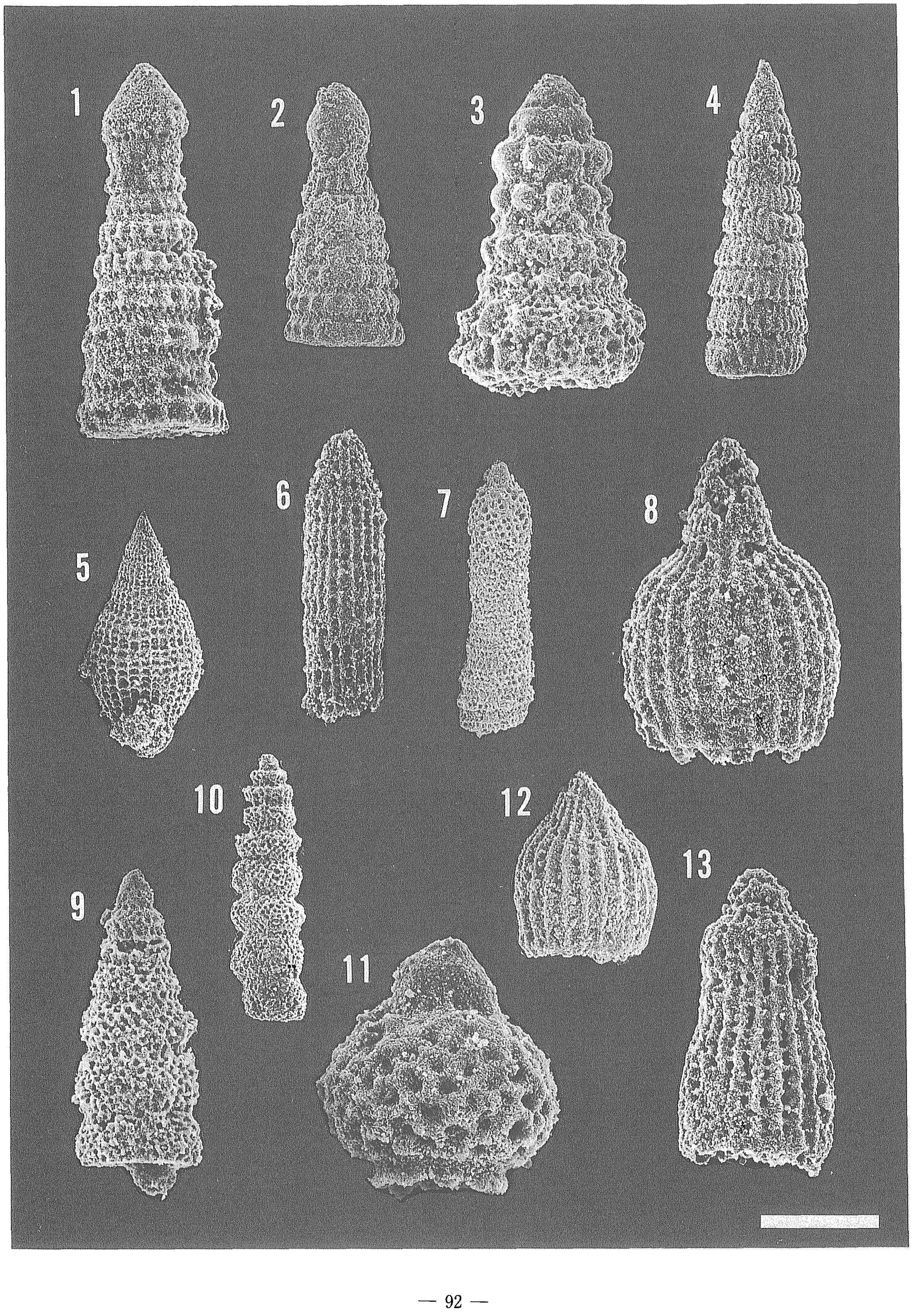
1, 2. *Pseudodictyomitra lilyae* (Tan Sin Hok), 1: (59146/M189E), 2: (58881/M129)
3. *Pseudodictyomitra leptoconica* (Foreman), (59153/M189E)
4. *Pseudodictyomitra rigida* Wu, (59106/M189D)
5. *Pseudodictyomitra carpatica* (Lozyniak), (59036/M189C)
6. *Pseudodictyomitra* cf. *carpatica* (Lozyniak), (58519/M133)
7. *Parvicingula* (?) sp. A, (58921/M129)
8, 9. *Xitus spicularius* (Aliev), 8: (59155/M189E), 9: (59174/M189E)
10. *Dictyomitra* (?) sp. A, (59061/M189C)
11. *Xitus* cf. *alievi* (Foreman), (59046/M189C)

Plate 5 Cretaceous and Jurassic Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. For explanations of numbers in the parentheses after the radiolarian names, see caption of Plate 1. Scale bar (lower right) indicates 174 μm for fig. 1; 100 μm for figs. 2, 3, 5, 8 and 14; 73 μm for figs. 4, 6 and 9–12; 49 μm for figs. 7 and 13.

1, 2. *Mirifusus baileyi* Pessagno, 1: (58484/M129), 2: (59255/M192D)
3. *Archaeodictyomitra* cf. *apiara* (Rüst), (58606/M253A)
4. *Archaeodictyomitra lacrimula* (Foreman), (59101/M189D)
5. *Mita* sp., (59325/M197)
6. *Thanarla conica* (Aliev), (59133/M189E)
7. *Eucyrtidiellum* cf. *ptyctum* (Riedel and Sanfilippo), (59261/M192D)
8. *Eucyrtis* sp., (59116/M189D)
9, 10. *Tricolocapsa* (?) sp. A, 9: (58492/M129), 10: (58541/M210)
11. *Dictyomitrella* (?) sp. A, (58537/M210)
12. *Pseudodictyomitra* sp., (58511/M237A)
13. *Stylocapsa* (?) *spiralis* Matsuoka, (59512/9143009)
14. *Pantanellium* sp. A, (58578/M212)

Plate 6 Jurassic and Triassic Radiolaria from the Bagh Complex in the Muslim Bagh area, Pakistan. For explanations of numbers in the parentheses after the radiolarian names, see caption of Plate 1. Scale bar (lower right) indicates 100 μm for figs. 1, and 12; 73 μm for figs. 2–6 and 9–11; 49 μm for figs. 7 and 8.

1. *Hsuum hisuikyoense* Isozaki and Matsuda, (58560/M57A)
2. *Hsuum* (?) *matsuokai* Isozaki and Matsuda, (58563/M57A)
3. *Unuma echinatus* Ichikawa and Yao, (58964/M57F)
4. *Unuma* sp., (58545/M57A)
5. *Unuma* cf. *echinatus* Ichikawa and Yao, (58566/M57A)
6. *Eucyrtidiellum quinatum* Takemura, (58553/M57A)
7. *Eucyrtidiellum disparile* Nagai and Mizutani, (58558/M57A)
8. *Archicapsa pachyderma* (Tan Sin Hok), (58571/M57A)
9. *Trillus* sp., (58546/M57A)
10. *Triassocampe* sp., (58438/M85)
11. *Pseudostylosphaera* sp., (59312/M156B)
12. *Capnuchosphaera* sp., (58440/M85)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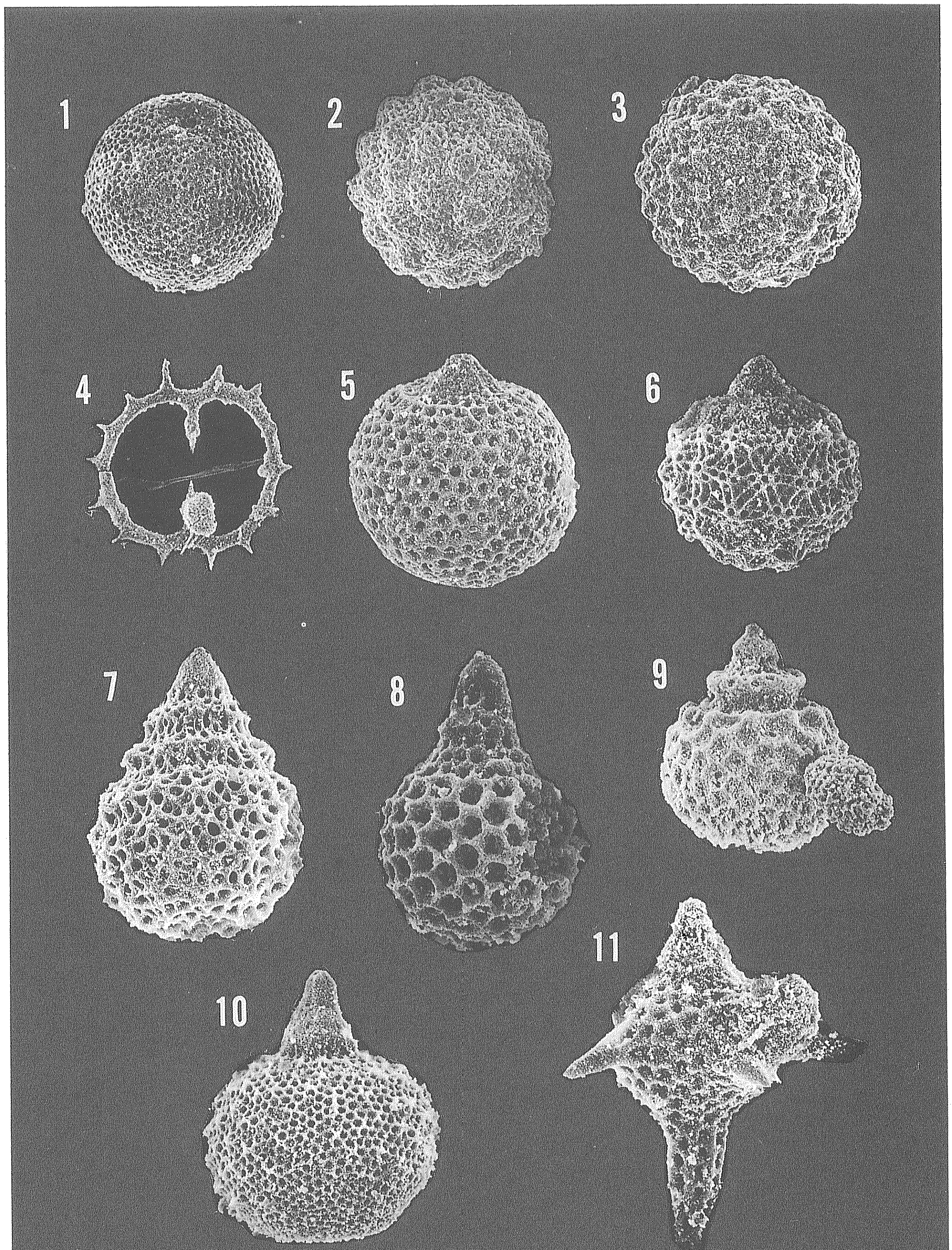
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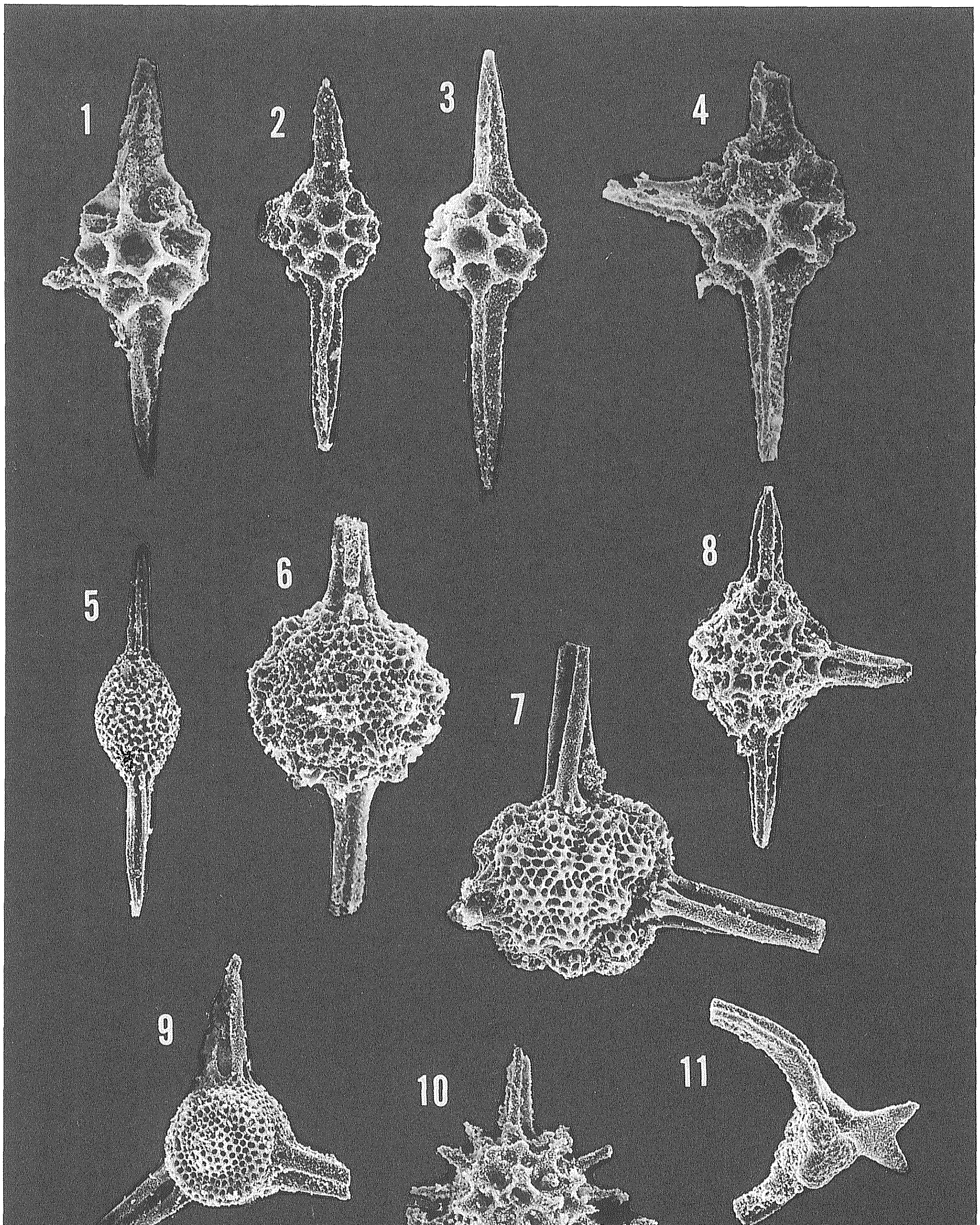
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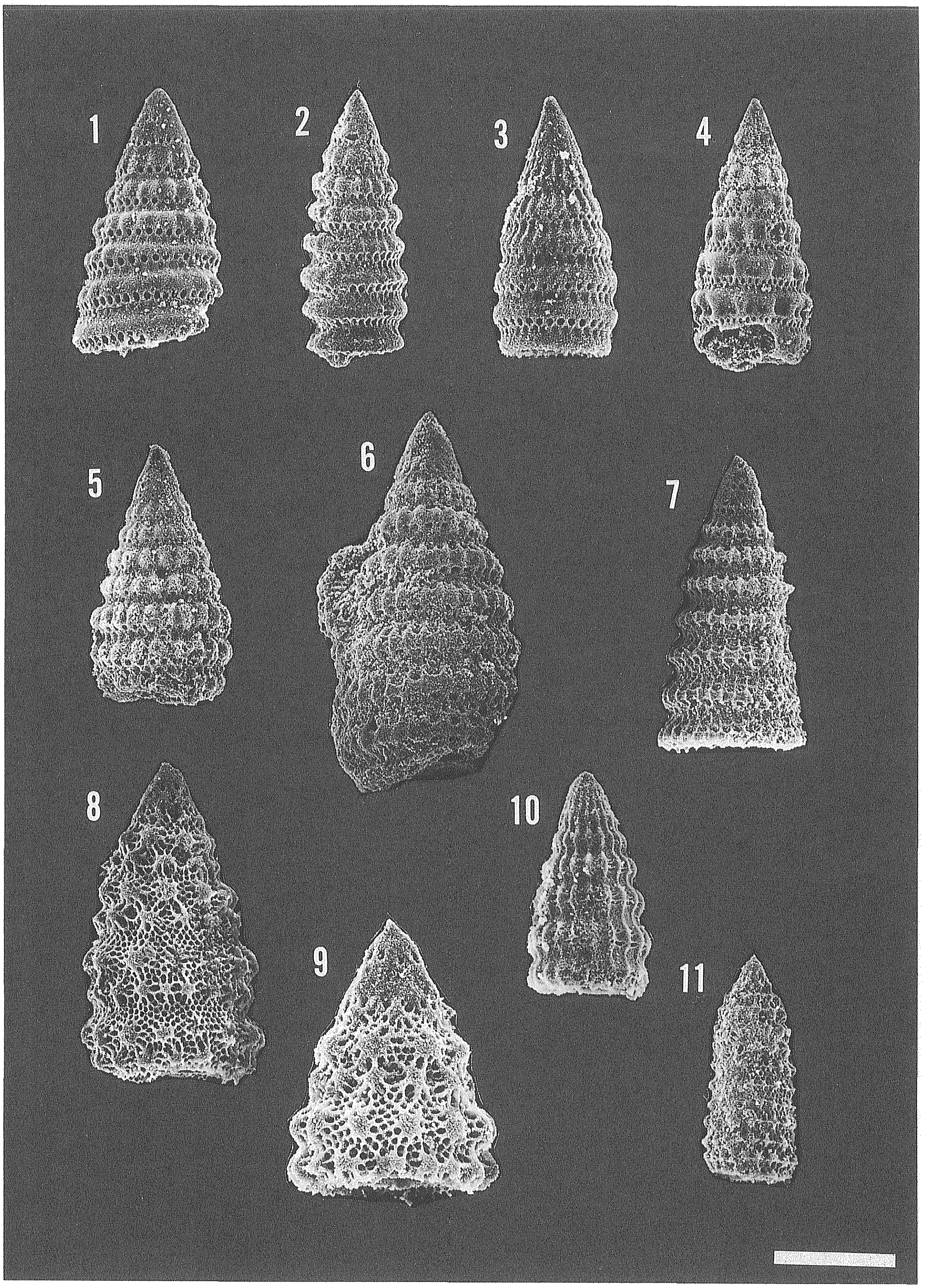
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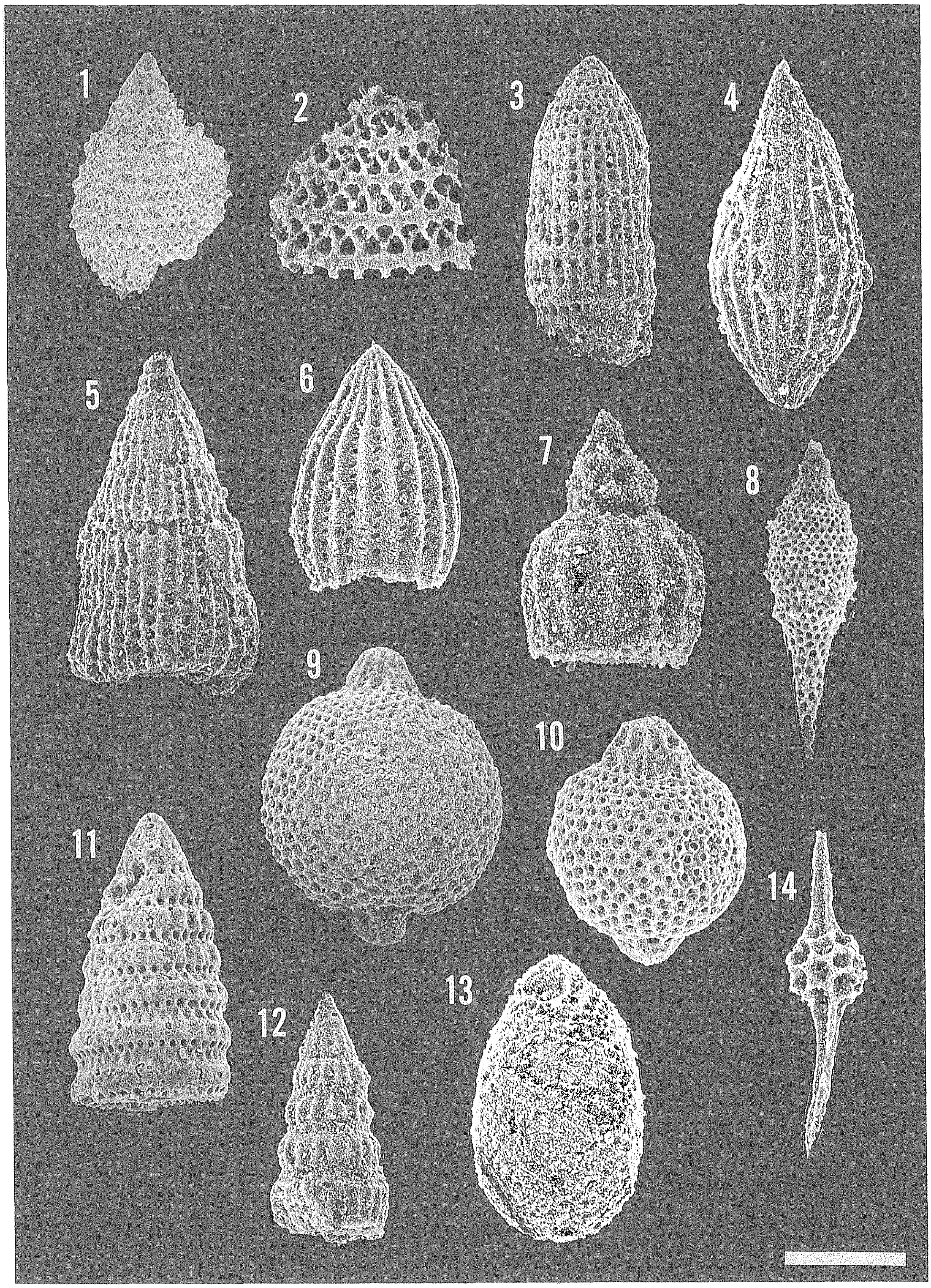
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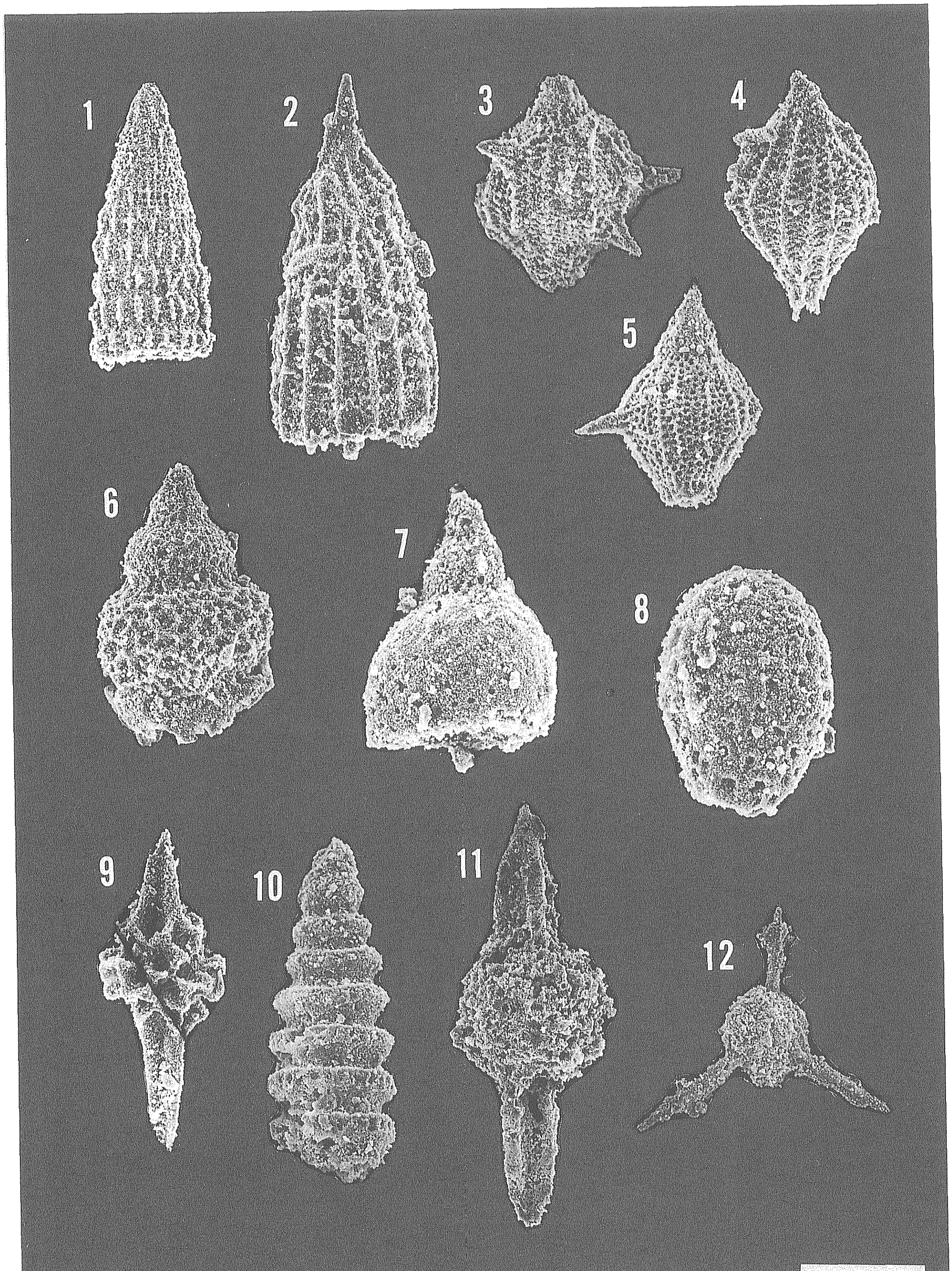
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