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Permian, Triassic and Jurassic radiolarians from Omura and Ogura Islands in the eastern part of the Shima Peninsula, Southwest Japan

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ABSTRACT

Omura Island is underlain mainly by pebbly shale, chert, siliceous shale and sandstone, and subordinately by pillow basalt, dolerite, bedded limestone and conglomerate. Middle-Upper Permian radiolarians such as *Follicucullus scholasticus* were first discovered from siliceous shale and bedded chert in the western part of Omura Island, and Middle-Upper Jurassic radiolarians of the *Tricolocapsa plicarum*, *Tricolocapsa conexa* and *Stylocapsa* (?) *spiralis* Zones were discovered from siliceous shale blocks and mudstone in the eastern part of Omura Island. Limestone blocks associated with basalt yield Middle Permian fusulinids of *Neoschwagerina simplex* and *Minojapanella elongata*. The sedimentary complex on Ogura Island consists of sandstone, siliceous shale and chert; chert and siliceous shale yield Triassic and Jurassic radiolarians, respectively. Triassic radiolarians include *Triassocampe coronata* and *Pseudostylosphaera japonica*, and Jurassic ones include *Tricolocapsa* (?) sp. aff. *T.* (?) *fusiformis* and *Tricolocapsa plicarum*. On the basis of geological and radiolarian studies, the sedimentary complex of Omura Island is divided into two units: Jurassic pebbly shale unit that includes a number of blocks and slabs of pillow basalt, Permian limestone and chert, and Jurassic sandstone-rich unit that includes chert, pebbly shale, siliceous shale, alternation of sandstone and shale, and conglomerate. Ogura Island is underlain by a Jurassic sedimentary complex similar to the sandstone-rich unit on Omura Island.

INTRODUCTION

The southeastern part of the Shima Peninsula, central Japan, consists of the Chichibu and Shimanto terranes; the Butsuzo Tectonic Line (B T L in Fig. 1) separates the Chichibu terrane from the Shimanto terrane. The sedimentary complex on Omura and Ogura Islands (Fig. 1), located to the east of the Shima Peninsula, has been believed to belong to the Chichibu terrane. Up to now, however, no detailed geological, paleontological and sedimentological studies have been done on the sedimentary complex of these islands, except for only a few reports on the occurrence of fusulinid and radiolarian fossils (Yamagiwa and Ishii, 1958, Yamagiwa and Saka, 1967, Nakaseko and Nishimura, 1979, Sugano et al., 1980).

We thus made a detailed field investigation on the sedimentary complex

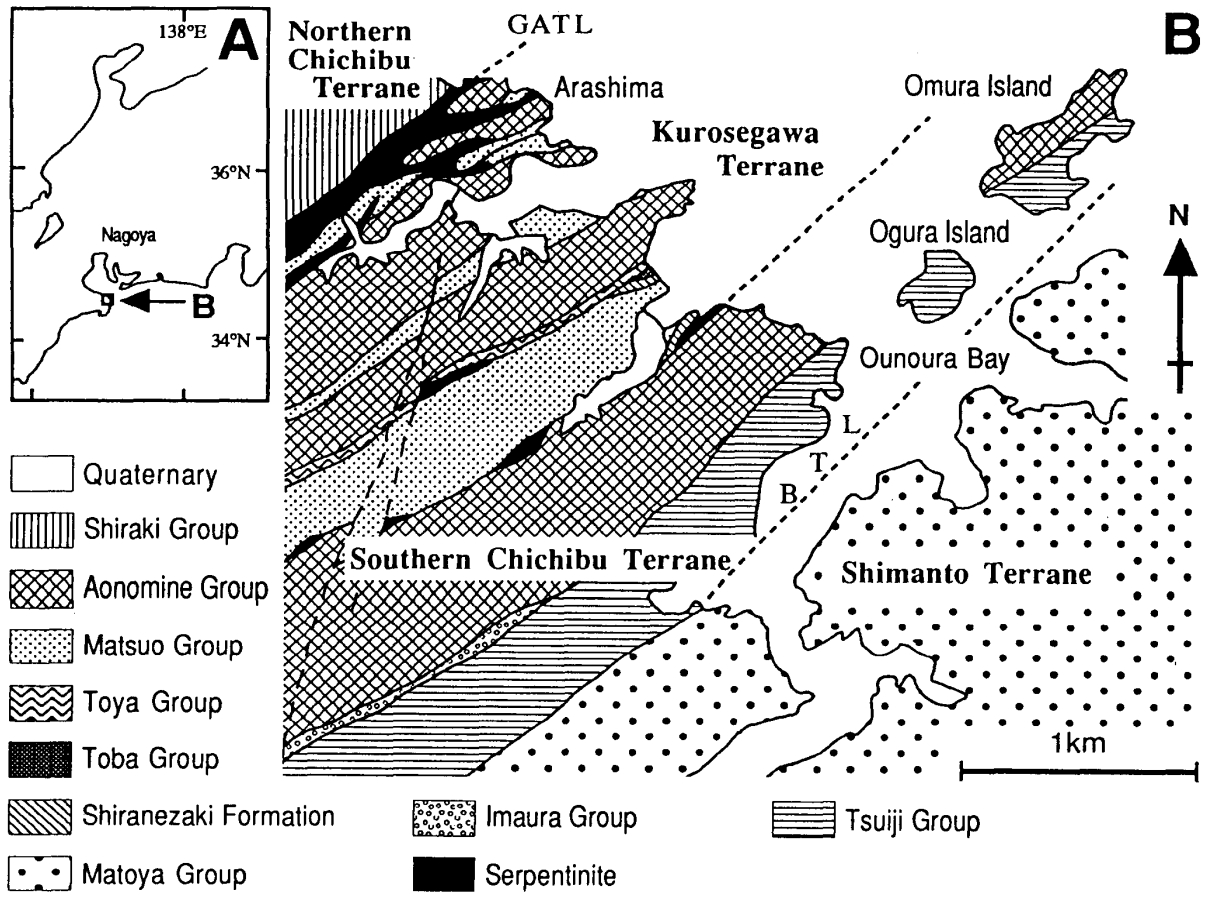

Fig. 1. Geologic map of Omura and Ogura Islands (this study), together with that of the eastern Shima Peninsula area (compiled from Yamagiwa and Saka, 1967, Saka et al., 1988, Isozaki et al., 1992 and Sugiyama et al., 1993). B T L: Butsuzo Tectonic Line, G A T L: Gokasho-Arashima Tectonic Line.

exposed continuously in the seashore of these islands, together with the sedimentary complex in the adjoining Shima and Atsumi Peninsulas. In the course of our investigation on Omura Island, we found well-preserved Permian and Jurassic radiolarians from chert, siliceous shale and mudstone (Ohba and Adachi, 1995). In this paper, we present fossil data on Permian, Triassic and Jurassic radiolarians obtained from Omura and Ogura Islands and discuss the tectonic framework of these islands. The correlation of the sedimentary complex on these islands with that on the Shima and Atsumi Peninsulas is also briefly discussed.

GEOLOGIC OUTLINE OF THE EASTERN SHIMA PENINSULA

The sedimentary complex of the eastern Shima Peninsula area belongs to the Chichibu and Shimanto terranes (Fig. 1). The Chichibu terrane in this area is bordered on the north by the Mikabu Tectonic Line (M K T L in Fig. 5) and on the south by the Butsuzo Tectonic Line. The width of the Chichibu terrane becomes narrower to the east in the Shima Peninsula; only 2.5km

on the east coast. The Chichibu terrane is divided into three subterranes: the Northern Chichibu, Kurosegawa and Southern Chichibu terranes (Fig. 1; Saka et al., 1988, Isozaki et al., 1992). The sedimentary complex of the Southern Chichibu and Kurosegawa terranes trends northeast-southwest and dips steeply to the north or south.

The Northern Chichibu terrane is occupied by the Shiraki Group (Yamagiwa and Saka, 1967) that consists mainly of chert, sandstone and shale, and subordinately of limestone having *Neoschwagerina* sp. (Yamagiwa, 1957).

The Kurosegawa terrane comprises the Aonomine (Yamagiwa and Saka, 1967), Matsuo (Yamagiwa, 1957), Toba (Yamagiwa and Saka, 1972) and Toya (Yamagiwa and Saka, 1967) Groups and the Shiranezaki Formation (Sugiyama et al., 1993) (Fig. 1). The Aonomine Group consists mainly of pebbly shale having blocks of sandstone, chert, greenstone and limestone. The size of blocks ranges from a few centimeters to a few hundred meters. The matrix of pebbly shale partly contains Jurassic radiolarians (Kato et al., 1984, Saka et al., 1985), and Permian fusulinids such as *Yabeina katoi* and *Neoschwagerina* sp. have been reported from limestone blocks (Yamagiwa, 1957). The lower Cretaceous Matsuo Group consists of coherent bedded sandstone and alternations of sandstone and mudstone. The weakly metamorphosed Toya Group, whose K-Ar muscovite age is approximately 200Ma (Isozaki et al., 1992), is narrowly exposed between the Aonomine and Toba Groups. The Toba Group consists of pebbly shale that includes blocks of sandstone, tuff, chert and limestone. Pebbly shale of the Toba Group includes *Lepidolina kumaensis* and *Yabeina* sp. aff. *Y. globosa* as detrital grains (Yamagiwa and Saka, 1972), and some acidic tuff blocks contain Permian radiolarians (Sugiyama et al., 1993). The Shiranezaki Formation consists of sandstone and mudstone alternations and conglomerate. Middle to Upper Jurassic radiolarians such as *Tricolocapsa tetragona* and *Stylocapsa* (?) *spiralis* have been reported from mudstone of the Shiranezaki Formation (Sugiyama et al., 1993). Glaucophane schist that is diagnostic of the Kurosegawa terrane occurs as xenolith in serpentinite between the southeasternmost Shiranezaki Formation and the Southern Chichibu terrane (Saka et al., 1988). In the northwest of this area, the Kurosegawa terrane is cut by the Gokasho-Arashima Tectonic Line (G A T L in Fig. 1) (Hamada, 1963) that is characterized by serpentinite.

The Southern Chichibu terrane comprises the Aonomine, Imaura and Tsuiji Groups (Yamagiwa and Saka, 1967). The Imaura Group consists predominantly of shale that includes Torinosu-type limestone. The Tsuiji Group consist mainly of chert, siliceous shale and sandstone. Triassic and Jurassic radiolarians have been reported from chert and shale (Sugano et al., 1980, Saka and Tezuka, 1988).

GEOLOGY OF OMURA ISLAND

Omura Island, an uninhabited island about 2km around, is underlain mainly by pebbly shale, chert and sandstone; they trend northeast-southwest

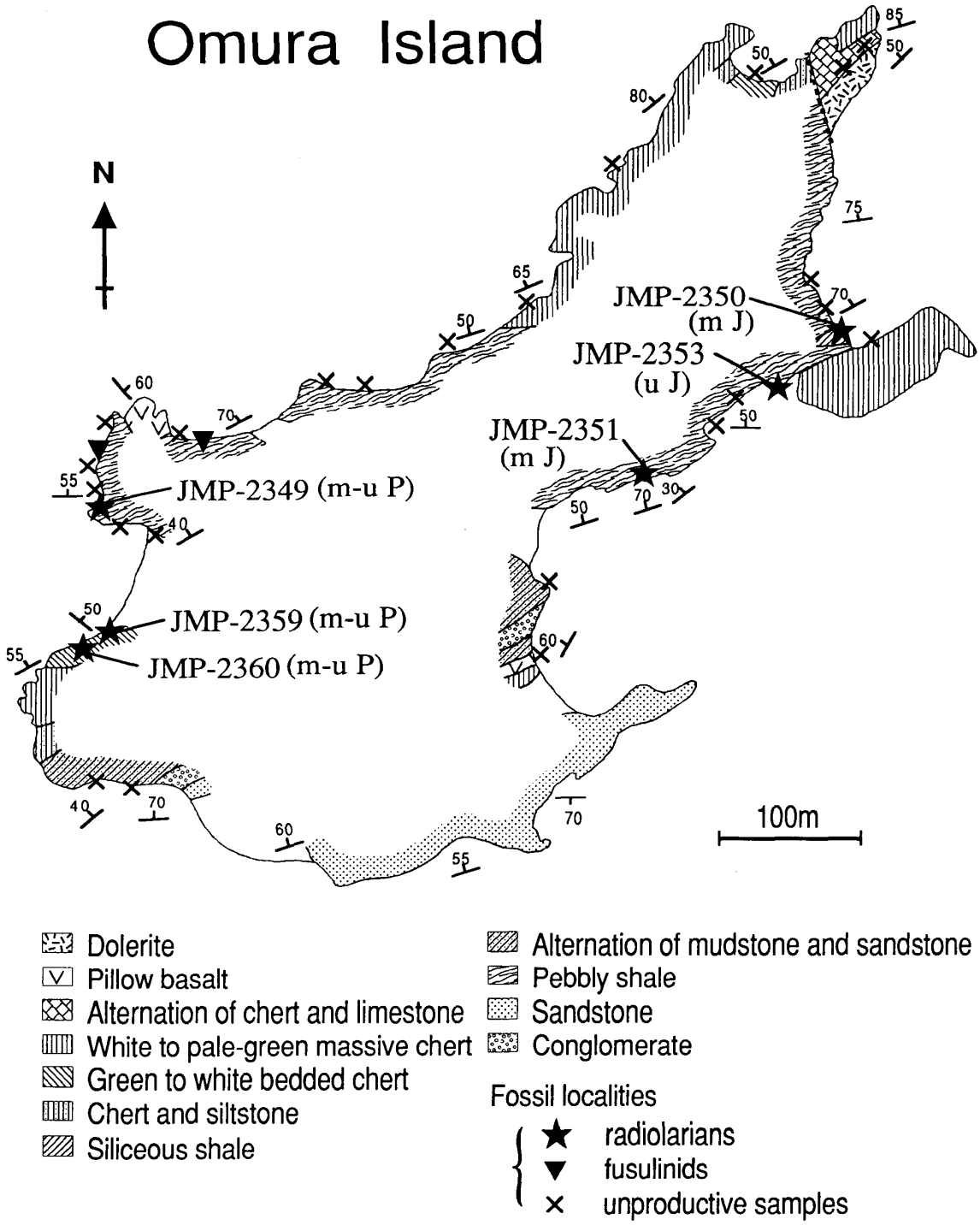

Fig. 2. Route map on Omura Island.

and dip steeply (Fig. 2). Pebbly shale is widespread and includes many small blocks of sandstone, siliceous shale, chert, limestone and greenstone. *Yabeina packardi shimensis* and *Yabeina omurensis* have been reported from limestone blocks in pebbly shale in the western part of Omura Island (Yamagiwa and Ishii, 1958). We newly found *Neoschwagerina simplex*, *Minojapanella elongata* and *Mesoschubertella* sp. (Plate 7) from limestone blocks near the

limestone blocks examined by Yamagiwa and Ishii (1958). Green to gray, massive, small lenticular siliceous shale blocks in pebbly shale in the western part of the island yield Middle-Upper Permian radiolarians. Some green siliceous shale blocks in the western part contain many sponge spicules. Pale green to gray bedded siliceous shale blocks, approximately a few meters in size, occur in pebbly shale in the eastern part of the island. They are interbedded with relatively thick tuffaceous shale and partly associated with a sandstone dike. These siliceous shales yield Middle Jurassic radiolarians. Cherts are exposed mainly in the northern and southwestern parts, and their colors are off-white to pale green, brown or pink. Most of the cherts are not well-bedded, namely massive, and yield no radiolarians. Well-bedded green chert that occurs near massive white chert in the western part of the island contains Middle-Upper Permian radiolarians.

Sandstone occurs extensively in the southern part of the island. Sandstone is generally massive but in part alternated with shale; garnet, zircon, epidote, tourmaline, micas and opaques occur as accessory minerals. Minor lithologies are pillow basalt, dolerite, alternation of chert and dolomitic limestone, and conglomerate (Fig. 2). Pillow basalt having clear pillow structures (Plate 1) occurs only in the western part of Omura Island. It is dark green and about 30m in size. A small block of dark green to purple pillow lava, composed largely of pillow breccia, occurs near the conglomerate outcrop in the central part (Fig. 2). Massive, green to dark green dolerite occurs in the northeastern corner of the island (Fig. 2). Dolerite is conformably overlain by alternation of chert and dolomitic limestone (calcarenite) and is composed essentially of plagioclase and clinopyroxene; secondary minerals include chlorite, actinolite, epidote, sphene, garnet and quartz. Chemical composition of relic clinopyroxene is given in Table 1 and Fig. 3. Geochemical features of relic pyroxene suggest that the dolerite is of tholeiite affinity. The dolerite, chert and dolomitic limestone succession is at least 20m thick, and its western end is obscured by a fault. No fossils have been found from the chert and limestone. Both pillow basalt and dolerite, chert and dolomitic limestone are likely to be huge blocks in pebbly shale, judging from their modes of occurrence. Conglomerate occurs in the central and southwestern parts of this island. The conglomerate is about 5m thick, clast-supported and poorly-sorted, and appears to be an intraformational conglomerate embedded with sandstone. Partly it is matrix-supported. The matrix of conglomerate is medium-grained graywacke. Most of the clasts are rounded, composed mainly of acidic volcanic rocks and leucogranitoids and subordinately of diorite, schist, basalt and limestone. The largest clast, about 50cm in diameter, is of leucocratic granite.

GEOLOGY OF OGURA ISLAND

Ogura Island is also an uninhabited island that is about 0.5km around. The geology of Ogura Island is simple compared with that of Omura Island. The

Table 1. Representative analytical data of relic clinopyroxenes from dolerite on Omura Island.

Analysis No.	22	40	52	53	74	77	81	83	84	85	89	90
SiO_2	52.8	51.9	53.2	52.5	51.3	51.5	53.0	51.5	52.5	51.6	52.1	52.3
TiO_2	0.52	0.72	0.54	0.70	0.80	0.68	0.53	0.65	0.71	1.21	0.71	0.68
Al_2O_3	1.89	2.77	2.23	2.12	1.88	1.33	1.86	2.98	2.54	2.10	2.78	2.90
Cr_2O_3	0.17	0.36	0.18	0.09	0.35	0.01	0.14	0.24	0.17	0.33	0.23	0.27
FeO*	7.99	8.36	7.92	10.3	9.44	14.4	8.86	8.62	8.35	10.3	8.32	8.46
MnO	0.21	0.18	0.22	0.24	0.20	0.40	0.23	0.20	0.21	0.23	0.17	0.26
MgO	16.0	15.8	15.6	15.1	14.8	13.2	16.3	15.1	15.1	14.6	14.7	16.1
NiO	0.03	0.00	0.03	0.06	0.01	0.00	0.00	0.04	0.01	0.05	0.06	0.03
CaO	19.4	19.1	19.5	18.0	19.4	16.9	18.3	19.2	19.0	18.8	19.6	18.6
Na_2O	0.26	0.31	0.26	0.30	0.32	0.30	0.29	0.35	0.30	0.38	0.30	0.28
K_2O	0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.02	0.02	0.02	0.01	0.01
Total	99.3	99.5	99.7	99.4	98.5	98.7	99.5	98.9	98.8	99.7	99.0	99.8

* total iron as FeO Analyst: H. Ohba

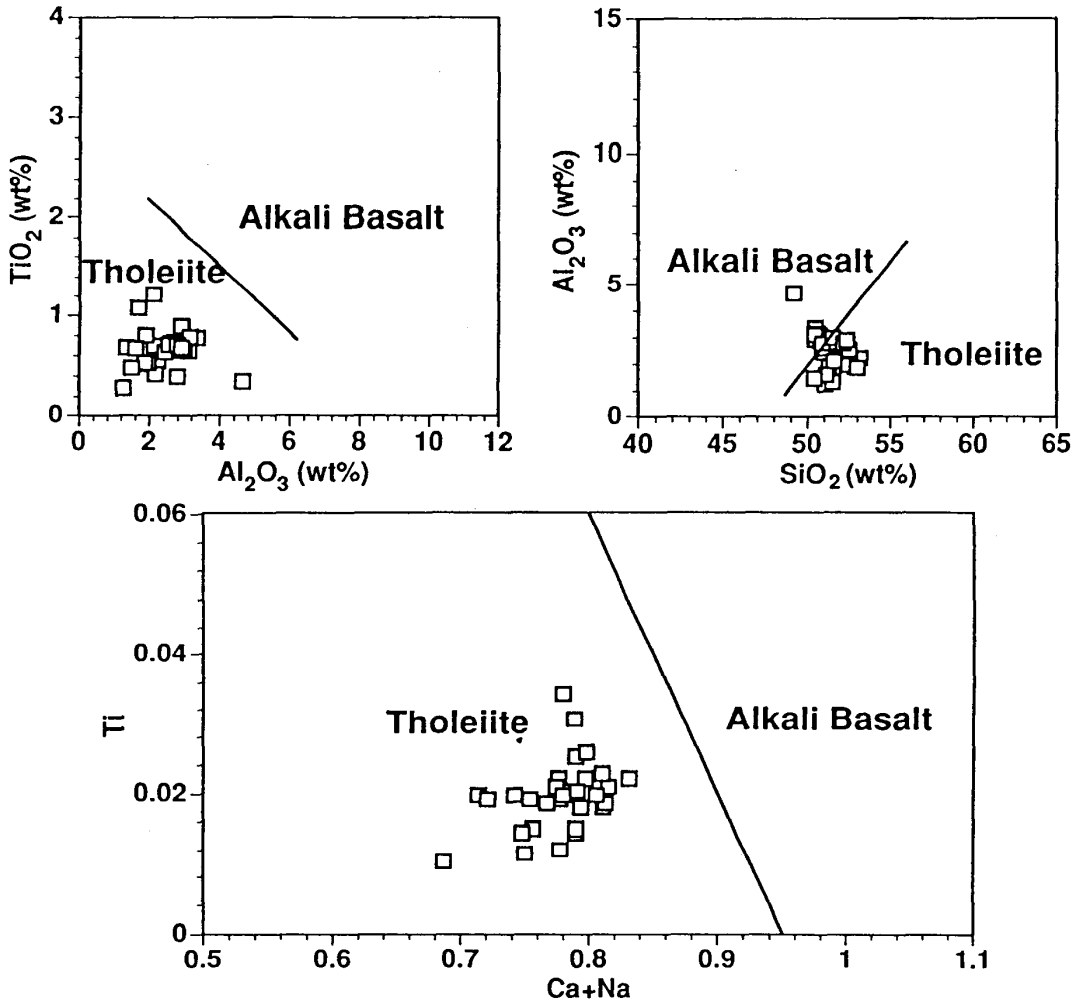

Fig. 3. Plots of chemical composition of relic clinopyroxenes on the TiO_2-Al_2O_3, Al_2O_3-SiO_2 diagrams (Maruyama, 1981) and on the Ti-Ca+Na diagram (Leterrier et al., 1982).

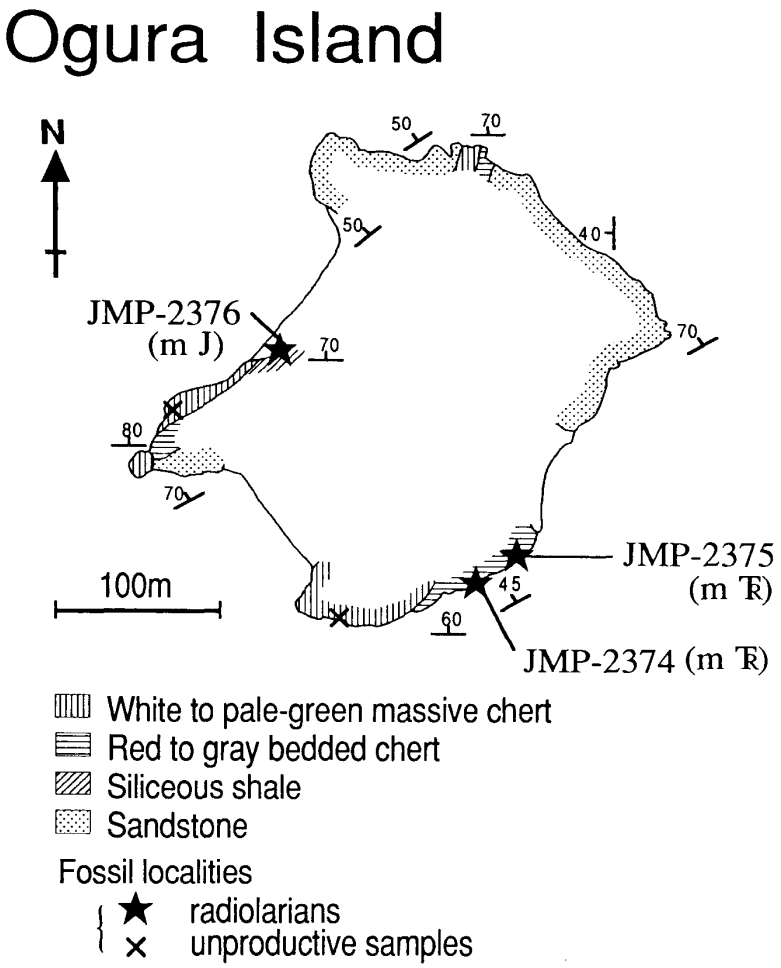

Fig. 4. Route map on Ogura Island.

island is underlain by massive white chert that is barren of fossils, Triassic bedded red to gray radiolarian chert, Jurassic bedded radiolarian siliceous shale and sandstone (Fig. 4). Jurassic siliceous shale is pale green, interbedded with thick tuffaceous shale, and includes sandstone dikes. The beds trend northeast-southwest and dip steeply to the north. Neither pillow lava nor conglomerate occurs in this island.

RADIOLARIAN FOSSILS

1: Omura Island

Well-preserved radiolarians have been found from 6 samples of Omura Island (Fig. 2, Table 2). Middle-Upper Permian radiolarians, *Pseudoalbaillella* sp. aff. *Ps. longicornis* and *Follicucullus scholasticus*, have been found from siliceous shale blocks in pebbly shale (JMP-2349, Plate 2). These fossils indicate the Middle-Upper Permian *Follicucullus monacanthus* Range-zone and *Follicucullus scholasticus* Assemblage-zone of Ishiga (1986). Pale green bedded cherts (JMP-2359 and JMP-2360) yield Middle-Upper Permian radiolarians of *Follicucullus scholasticus* (Plate 2), indicating the *Follicucullus scholasticus*

Assemblage-zone to possibly *Neoalbaillella ornithoformis* Assemblage-zone of Ishiga (1986). Bedded siliceous shales (JMP-2350 and JMP-2351) yield Middle Jurassic radiolarians of *Tricolocapsa conexa*, *Tricolocapsa tetragona*, *Tricolocapsa plicarum*, *Tricolocapsa* (?) *fusiformis*, *Protunuma* (?) *ochiensis* and so on (Plate 3). The Jurassic fossils indicate the *Tricolocapsa conexa* Zone of Matsuoka and Yao (1986). Dark gray mudstone (JMP-2353), partly silty, yields Upper Jurassic radiolarians such as *Stylocapsa* (?) *spiralis*, *Cinguloturris carpatica* and *Eucyrtidiellum ptyctum* (Plate 3) indicative of the *Stylocapsa* (?) *spiralis* Zone of Matsuoka and Yao (1986).

2: Ogura Island

Radiolarians have been found from 3 samples of Ogura Island (Fig. 4, Table 2). Bedded cherts (JMP-2374 and JMP-2375) yield Middle Triassic radiolarians such as *Triassocampe coronata*, *Triassocampe* sp. and *Pseudostylosphaera japonica* (Plate 2), indicating the Middle Triassic TR 2B: *Triassocampe coronata* Lowest-Occurrence Zone and TR 2C: *Triassocampe deweveri* Lowest-Occurrence Zone of Sugiyama (Sugiyama, 1995). Bedded siliceous shale (JMP-2376) yields Middle Jurassic radiolarians of *Tricolocapsa plicarum* and *Tricolocapsa* (?) *fusiformis* (Plate 4). These fossils indicate the *Tricolocapsa plicarum* Zone of Matsuoka and Yao (1986).

Table 2. List of radiolarians from Omura and Ogura Islands, the eastern Shima Peninsula and the Atsumi Peninsula.

Radiolarians \ Sample No. & Lithology	2349 SSH	2359 CH	2360 CH	2374 CH	2375 CH	2350 SSH	2351 SSH	2376 SSH	2358 SSH	2450 SSH	2451 SSH	2353 MS	2452 CH
Stylocapsa (?) *spiralis*											○	○	
Eucyrtidiellum ptyctum												○	
Cinguloturris carpatica												○	
Guexella nudata										○			
Dictyomitrella (?) *kamoensis*									○	○	○		
Tricolocapsa conexa						○	○		○	○	○		
Tricolocapsa tetragona							○		○				
Tricolocapsa ruesti						○							
Tricolocapsa (?) *fusiformis*							○	○					○
Tricolocapsa (?) sp. aff. *T.* (?) *fusiformis*								○		○			○
Tricolocapsa plicarum						○	○	○	○	○			○
Protunuma sp.								○					
Protunuma (?) *ochiensis*						○				○			
Eucyrtidiellum sp.								○		○			○
Hsuum spp.								○		○			○
Parvicingula sp.										○			
Pseudostylosphaera japonica				○	○								
Triassocampe coronata					○								
Triassocampe sp.				○	○								
Pseudoalbaillella sp.aff. *Ps. longicornis*	○												
Follicucullus scholasticus	○	○	○										

CH : chert, SSH : siliceous shale, MS: mudstone

3: Tsuiji Group in the east seashore of the Shima Peninsula

Pale green to gray bedded siliceous shales (JMP-2358 and JMP-2450) intercalated in thick tuffaceous shale, partly associated with sandstone dikes, yield the Middle Jurassic radiolarians including *Tricolocapsa tetragona*, *Tricolocapsa conexa*, *Tricolocapsa plicarum*, *Dictyomitrella* (?) *kamoensis*, *Protunuma* (?) *ochiensis* and *Guexella nudata* (Fig. 5, Table 2, Plate 5). Siliceous shale (JMP-2451), not far from JMP-2450 shale, yields Upper Jurassic radiolarians such as *Stylocapsa* (?) *spiralis* (Plate 6). These siliceous shales appear to be originally the same because they are similar to each other in color, fossils and their mode of occurrence; they are interbedded with thick tuffaceous shale. These fossils indicate the Middle-Upper Jurassic *Tricolocapsa plicarum* Zone to *Stylocapsa* (?) *spiralis* Zone of Matsuoka and Yao (1986).

4: Atsumi Peninsula

The Atsumi Peninsula, to the east of Omura Island, is also underlain mainly by the Sambagawa-Mikabu and Chichibu terranes (Fig. 5). No radiolarian fossils have hitherto been reported from the sedimentary complex of the Atsumi Peninsula. Our preliminary examinations on the sedimentary complex have revealed the occurrence of Middle Jurassic radiolarians such as *Tricolocapsa* (?) sp. aff. *T.* (?) *fusiformis*, *Tricolocapsa* (?) *fusiformis*, *Tricolocapsa plicarum*, *Eucyrtidiellum* sp. and *Hsuum* sp. (Table 2, Plate 6) from gray bedded chert (JMP-2452) interbedded with sandstone, although most cherts are barren of fossils.

DISCUSSION AND CONCLUDING REMARKS

The sedimentary complex on Omura Island has long been considered to belong to the Aonomine Group (Yamagiwa and Saka, 1967) (Fig. 6A). However, pale green to gray bedded siliceous shale in the eastern part of Omura Island is lithologically very similar to that of the Tsuiji Group in that it is interbedded with thick tuffaceous shale accompanied with sandstone dikes. In addition, it yields Jurassic radiolarians such as *Tricolocapsa plicarum* and *Tricolocapsa tetragona* that are common in those from the Tsuiji Group in the eastern Shima Peninsula (Saka and Tezuka, 1988). Permian radiolarian chert as well as pebbly shale that includes blocks of Permian siliceous shale and Permian limestone can be regarded as part of the Aonomine Group, because Permian fusulinid limestone and Permian radiolarian siliceous shale have been reported only from the Aonomine Group in the eastern Shima Peninsula. On the other hand, *Stylocapsa* (?) *spiralis*-bearing dark gray mudstone (JMP-2353) in the eastern part of Omura Island may be correlatable with the Imaura Group, for its occurrence has been known from the Imaura Group (Saka and Tezuka, 1988). However, this correlation may not be true because the Imaura Group appears to thin out about 2km southwest of the seashore of the Shima Peninsula (see Fig. 1). The dark gray mudstone on Omura Island does not appear to occur between the eastern extension of the Aonomine and Tsuiji

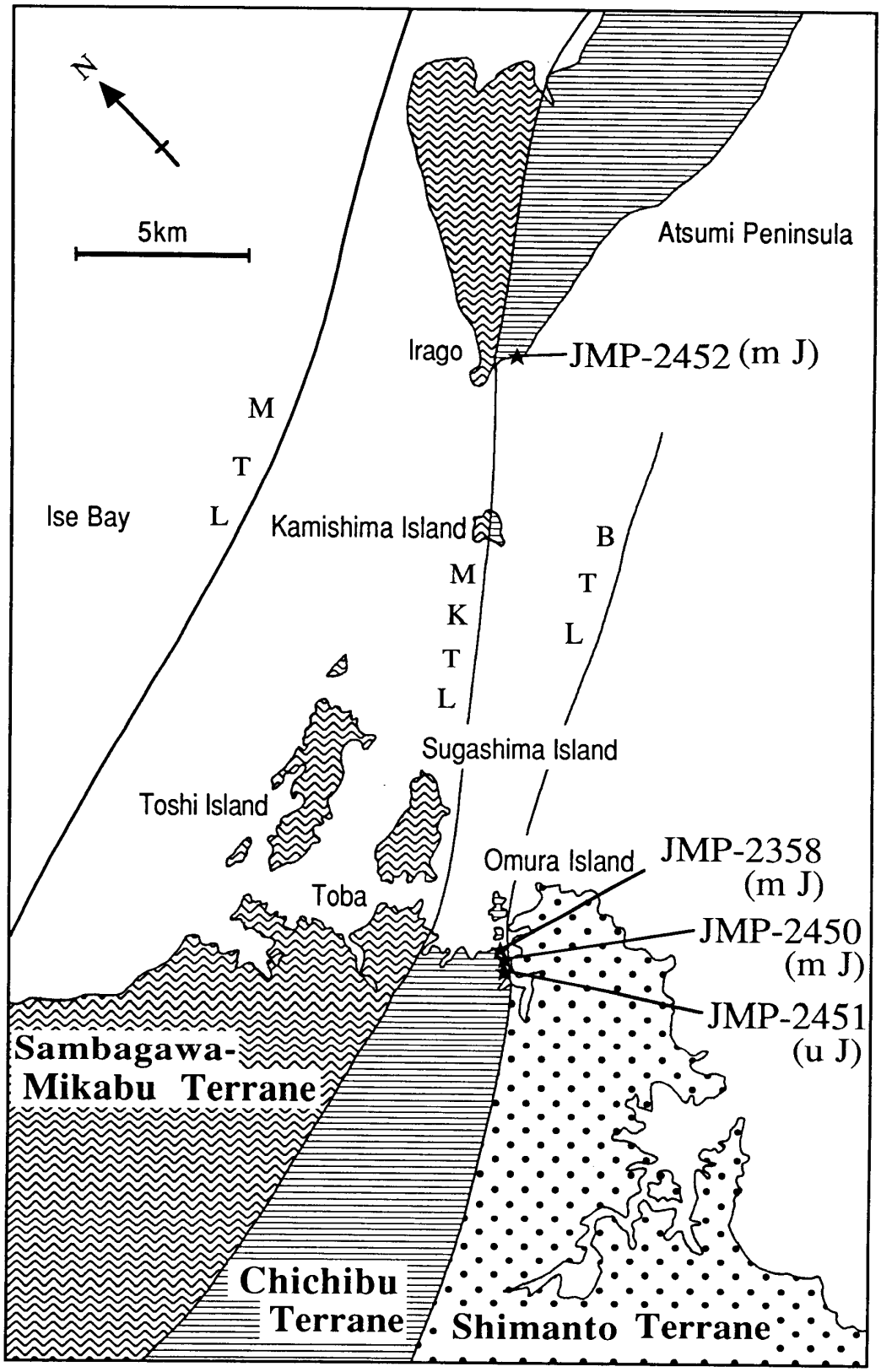

Fig. 5. Map showing radiolarian fossil locality and tectonic framework in the eastern Shima and Atsumi Peninsulas. M T L: Median Tectonic Line, M K T L: Mikabu Tectonic Line, B T L: Butsuzo Tectonic Line.

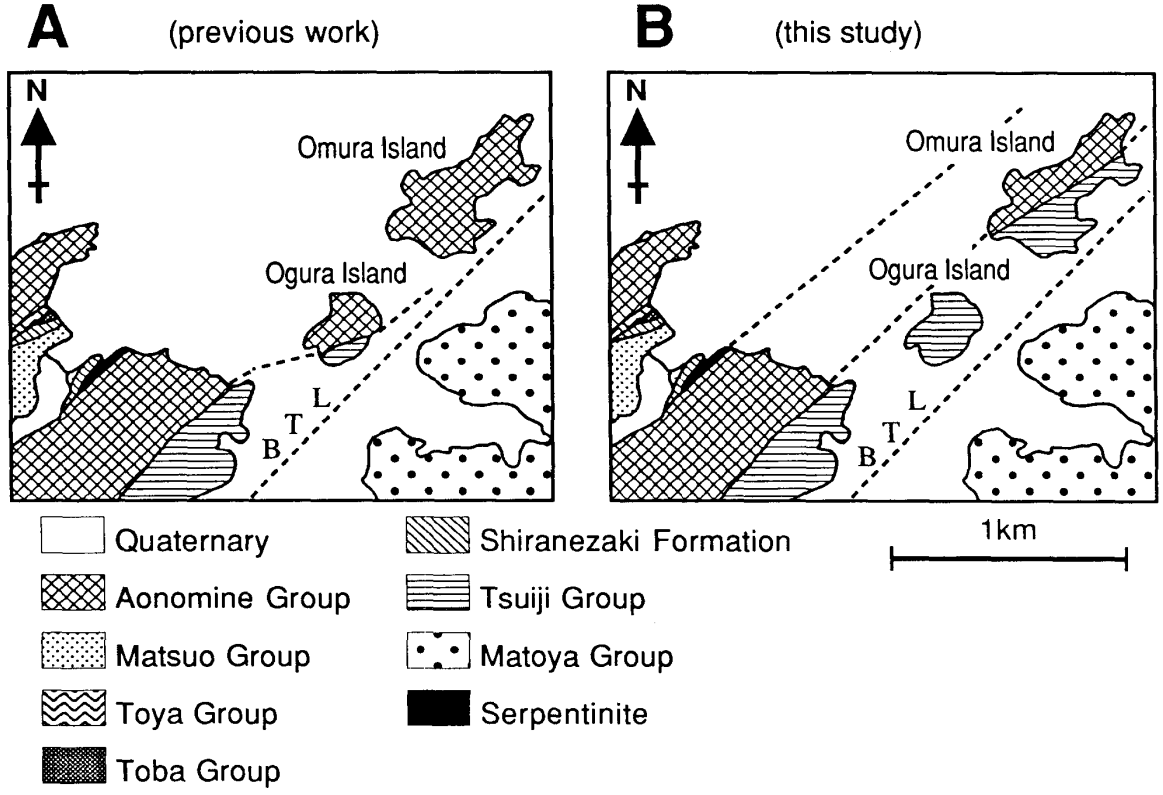

Fig. 6. Comparison of geologic division of Omura and Ogura Islands. A: Yamagiwa and Saka (1967), Saka et al. (1988), B: this study.

Groups, but within the extension of the Tsuiji Group in Omura Island. Consequently, this mudstone is likely to belong to the Tsuiji Group (Fig. 6B).

Triassic and Jurassic radiolarians have been reported from the Tsuiji Group in the eastern Shima Peninsula (Sugano et al., 1980, Saka and Tezuka, 1988), and Triassic radiolarians have been reported from chert on Ogura Island (Nakaseko and Nishimura, 1979, Sugano et al., 1980). These data as well as our data of Triassic and Jurassic radiolarians from chert and siliceous shale on Ogura Island show that the whole sedimentary complex on Ogura Island belongs to the Tsuiji Group (Fig. 6B).

Summarizing the above, the sedimentary complex on Omura Island can be divided into two units: pebbly shale unit and sandstone-rich unit. The pebbly shale unit is widespread in the northern part of the island and consists of shale with many blocks and slabs of white-pale green chert, siliceous shale, limestone and basalt. The sandstone-rich unit occupying the southern part consists mainly of massive sandstone, chert, sandstone-shale alternations, conglomerate and pebbly shale associated with Jurassic siliceous shale. The pebbly shale and sandstone-rich units are considered to be the eastern extension of the Aonomine and Tsuiji Groups, respectively (Fig. 6B). Judging from the occurrence of *Stylocapsa* (?) *spiralis* in the sandstone-rich unit, the sedimentation of the sandstone-rich unit is likely to have occurred in the late Jurassic. The sedimentary complex of Ogura Island constitutes one geologic

unit, namely the Tsuiji Group composed of chert, siliceous shale and sandstone (Fig. 6B). Since serpentinite, blueschist, gneiss, acidic igneous rocks and/or acidic radiolarian tuff that are diagnostic of the Kurosegawa terrane are totally absent in Omura and Ogura Islands, it is probable that all of the sedimentary complex on Omura and Ogura Islands belongs to the Southern Chichibu terrane.

Further work on microfossils, provenance analysis of sandstone and conglomerate, and greenstone chemistry is necessary to shed more light on the Mesozoic history of the Chichibu terrane in the area between the Shima and Atsumi Peninsulas.

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PLATE 1

Pillow basalt in the western part on Omura Island, Toba City, central Japan.

PLATE 2

Permian and Triassic radiolarians from Omura and Ogura Islands.

1-3. *Follicucullus scholasticus* Ormiston and Babcock
  1-2: JMP-2349
  3: JMP-2359

4. *Pseudoalbaillella* sp. aff. *Ps. longicornis* Ishiga and Imoto
  JMP-2349

5. *Triassocampe coronata* Bragin
  JMP-2375

6-8. *Triassocampe* spp.
  6-7: JMP-2375
  8: JMP-2374

9-11. *Pseudostylosphaera japonica* (Nakaseko and Nishimura)
  JMP-2375

Scale bars are 0.1mm.

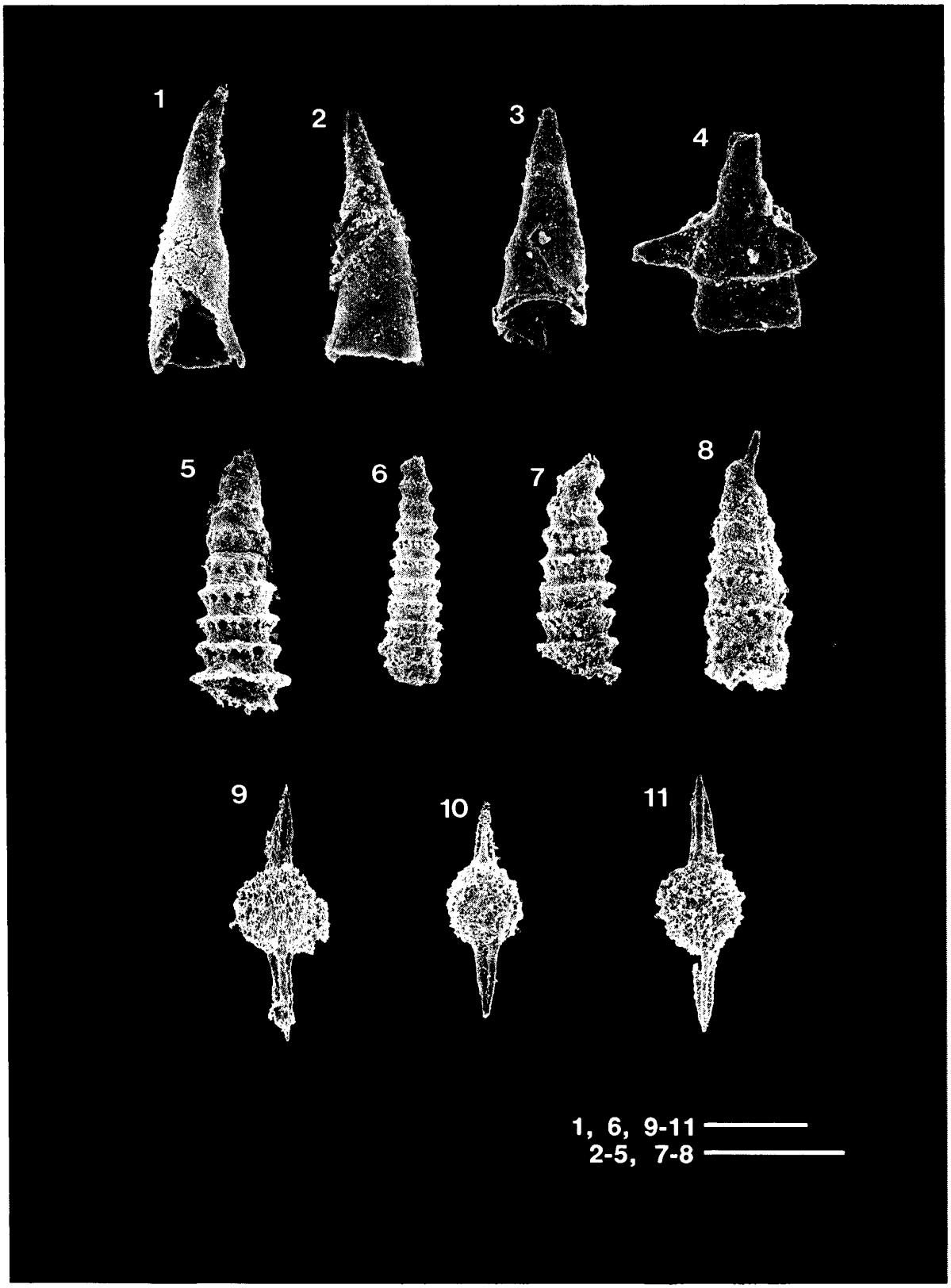
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PLATE 3

Jurassic radiolarians from Omura Island.

1, 4. *Tricolocapsa plicarum* Yao
1: JMP-2350
4: JMP-2351

2-3. *Tricolocapsa conexa* Matsuoka
JMP-2350

5. *Tricolocapsa tetragona* Matsuoka
JMP-2351

6. *Tricolocapsa* (?) *fusiformis* Yao
JMP-2351

7. *Tricolocapsa ruesti* Tan
JMP-2350

8. *Protunuma* (?) *ochiensis* Matsuoka
JMP-2350

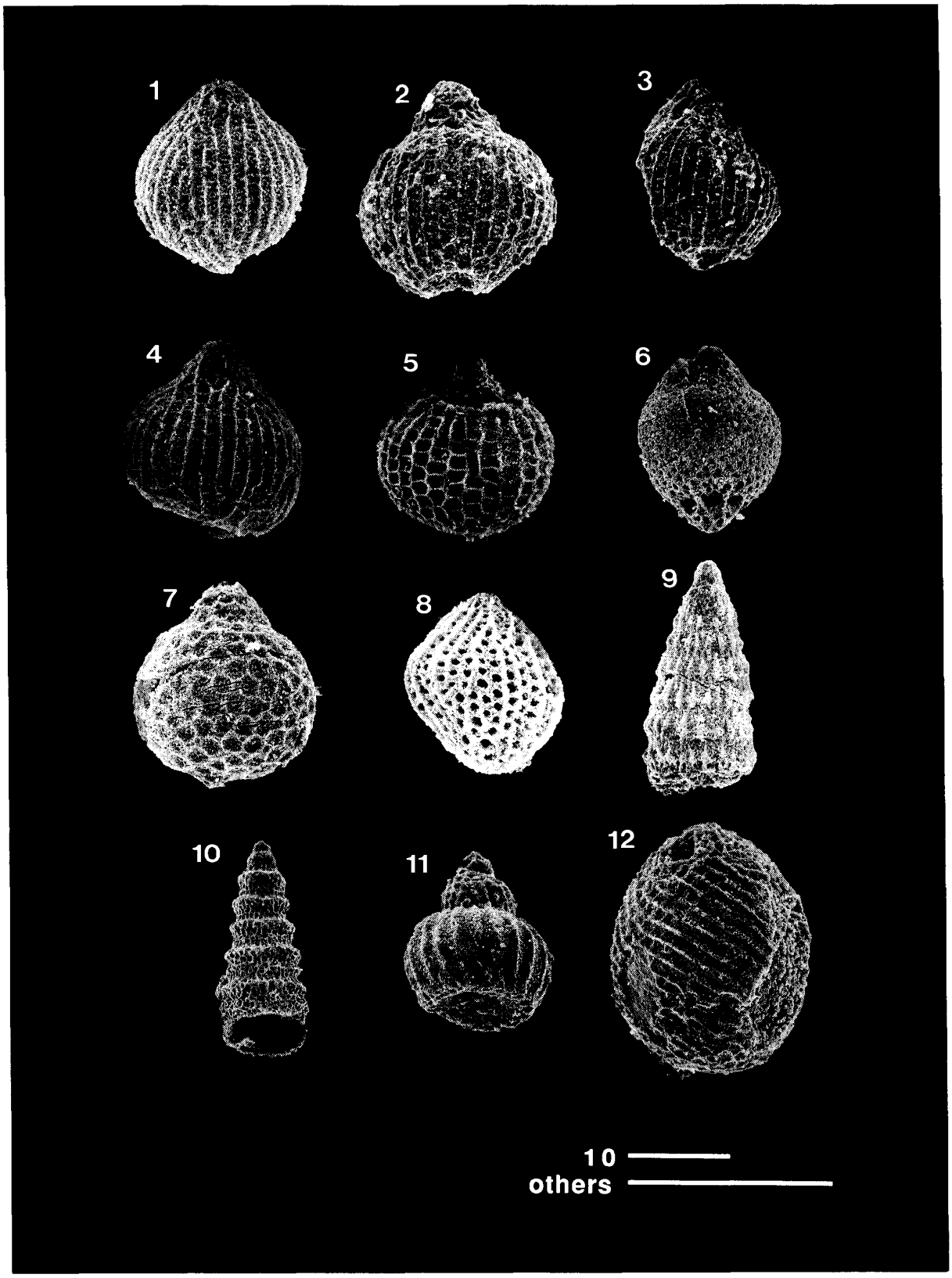
9. *Hsuum* sp.
JMP-2350

10. *Cinguloturris carpatica* Dumitrica
JMP-2353

11. *Eucyrtidiellum ptyctum* (Riedel and Sanphilippo)
JMP-2353

12. *Stylocapsa* (?) *spiralis* Matsuoka
JMP-2353

Scale bars are 0.1mm.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others

PLATE 4

Jurassic radiolarians from Ogura Island.

1-2. *Hsuum* spp.
JMP-2376
3. *Parvicingula* sp.
JMP-2376
4-5. *Tricolocapsa* (?) sp. aff. *T.* (?) *fusiformis* Yao
JMP-2376
6. *Tricolocapsa* (?) *fusiformis* Yao
JMP-2376
7. *Tricolocapsa plicarum* Yao
JMP-2376
8. *Protunuma* (?) sp.
JMP-2376
9. *Eucyrtidiellum* sp.
JMP-2376

Scale bars are 0.1mm.

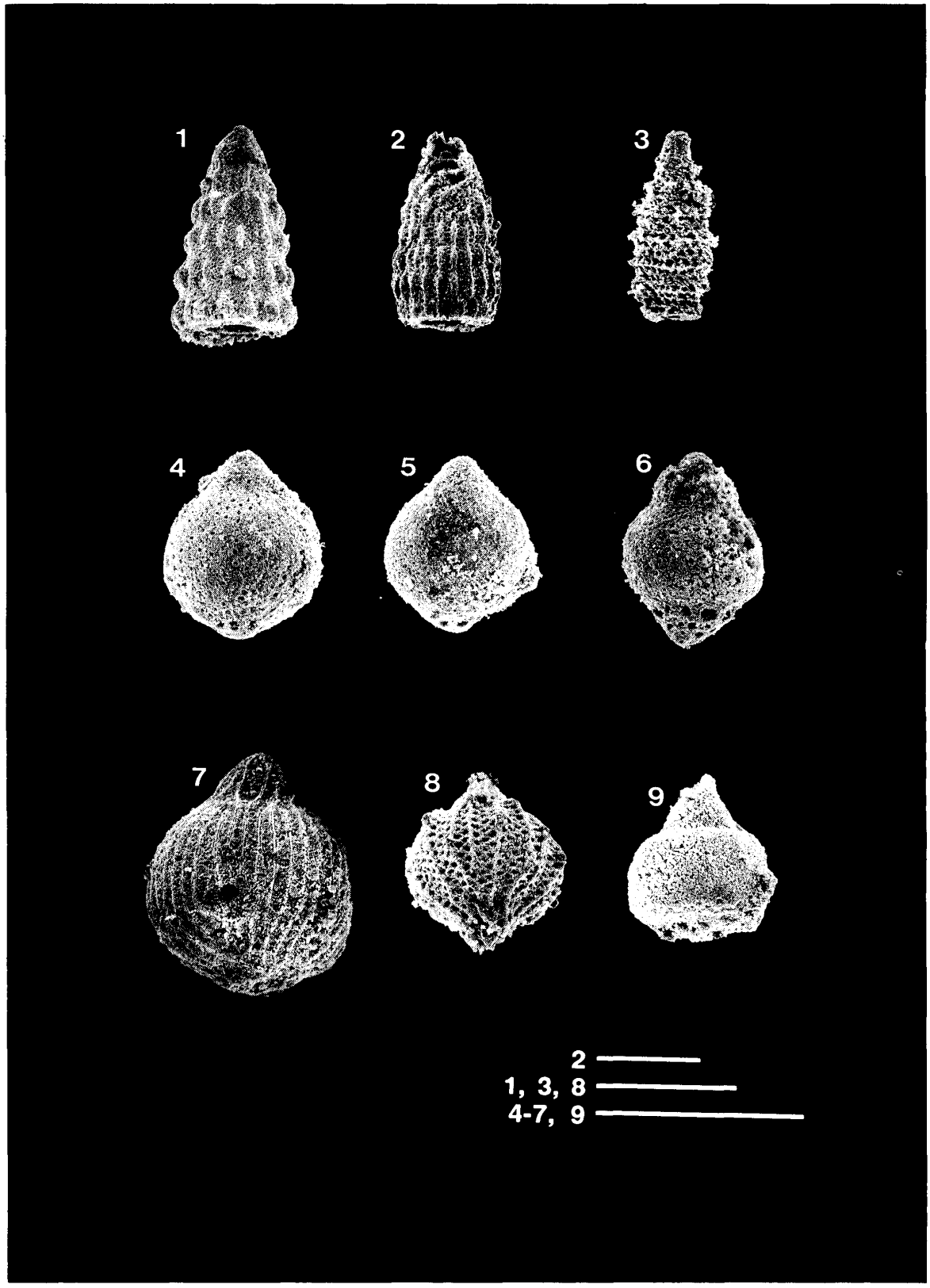
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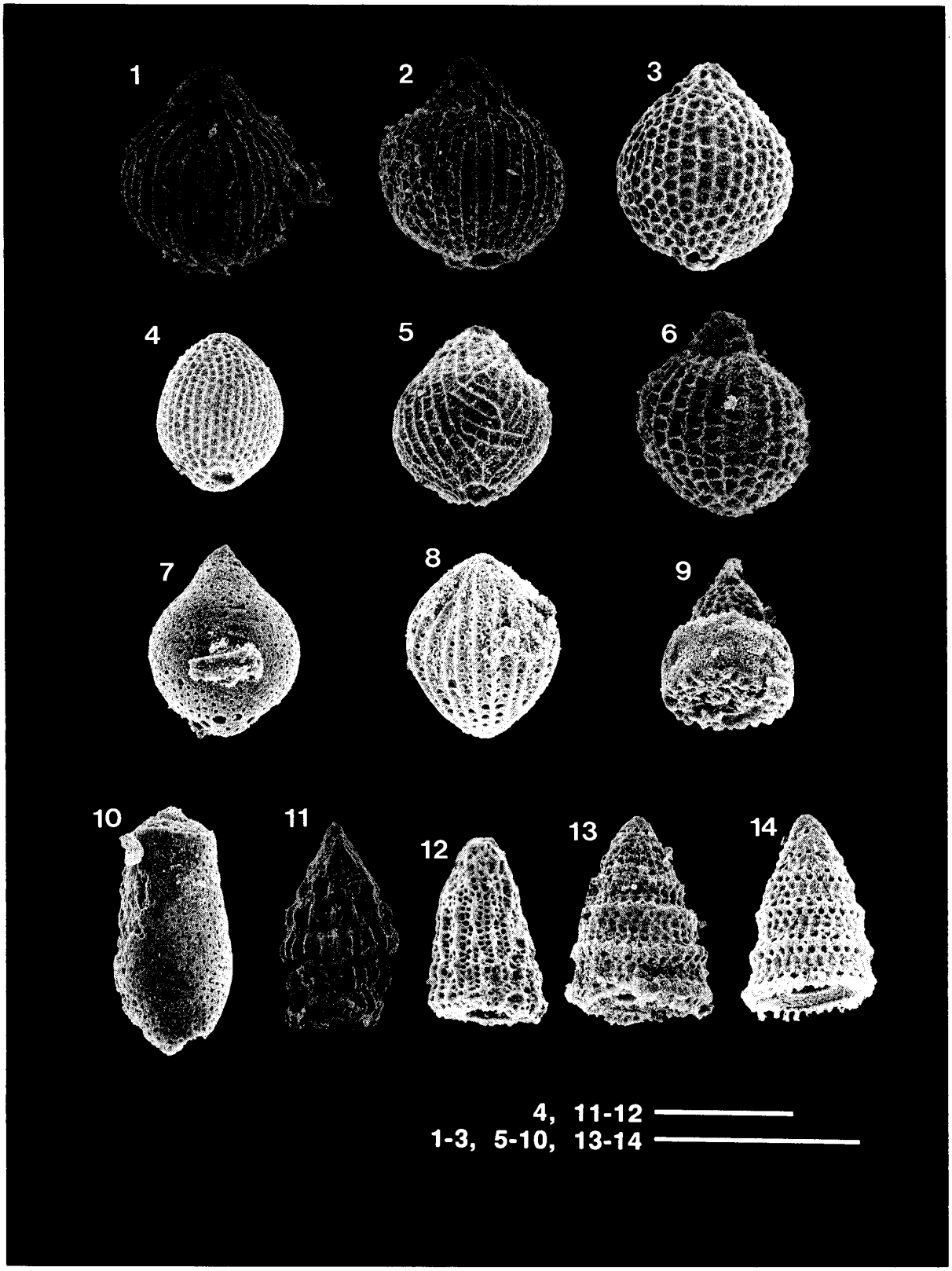
PLATE 5

Jurassic radiolarians from the Tsuiji Group in the eastern Shima Peninsula.

1. *Tricolocapsa plicarum* Yao
   JMP-2358
2-5. *Tricolocapsa conexa* Matsuoka
   2: JMP-2358
   3-5: JMP-2450
6. *Tricolocapsa tetragona* Matsuoka
   JMP-2358
7. *Tricolocapsa* (?) sp. aff. *T.* (?) *fusiformis* Yao
   JMP-2450
8. *Protunuma* (?) *ochiensis* Matsuoka
   JMP-2450
9. *Eucyrtidiellum* sp.
   JMP-2450
10. *Guexella nudata* (Kocher)
   JMP-2450
11-12. *Hsuum* spp.
   11: JMP-2358
   12: JMP-2450
13-14. *Dictyomitrella* (?) *kamoensis* Mizutani and Kido
   13: JMP-2358
   14: JMP-2450

Scale bars are 0.1mm.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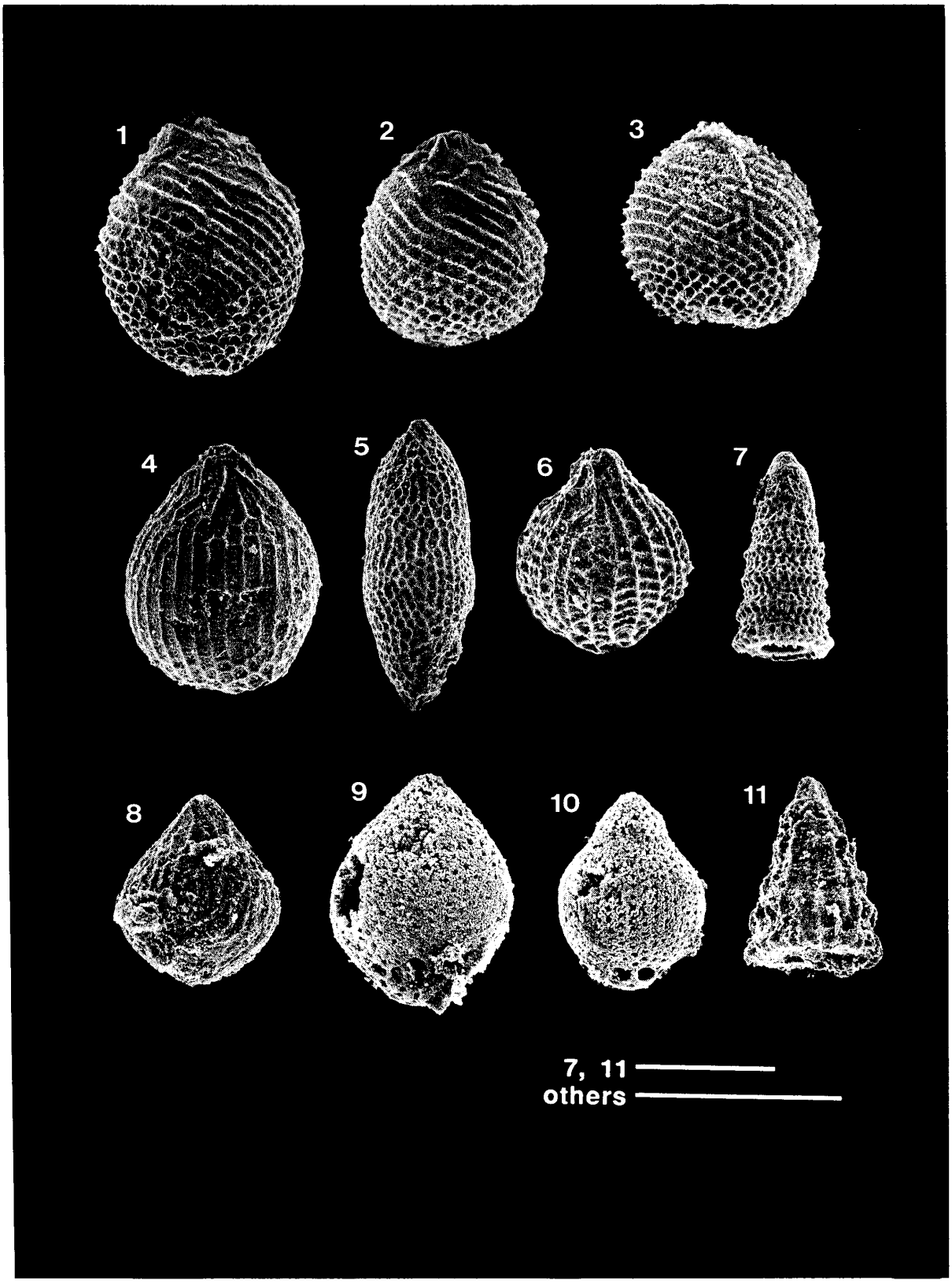
1-3, 5-10, 13-14

PLATE 6

Jurassic radiolarians from the Tsuiji Group in the eastern Shima Peninsula (1-7) and the Atsumi Peninsula (8-11).

1-3. *Stylocapsa* (?) *spiralis* Matsuoka
JMP-2451
4-6. Unnamed Nassellarians
JMP-2451
7. *Dictyomitrella* (?) *kamoensis* Mizutani and Kido
JMP-2451
8. *Tricolocapsa plicarum* Yao
JMP-2452
9. *Tricolocapsa* (?) *fusiformis* Yao
JMP-2452
10. *Tricolocapsa* (?) sp. aff. *T.* (?) *fusiformis* Yao
JMP-2452
11. *Hsuum* sp.
JMP-2452

Scale bars are 0.1mm.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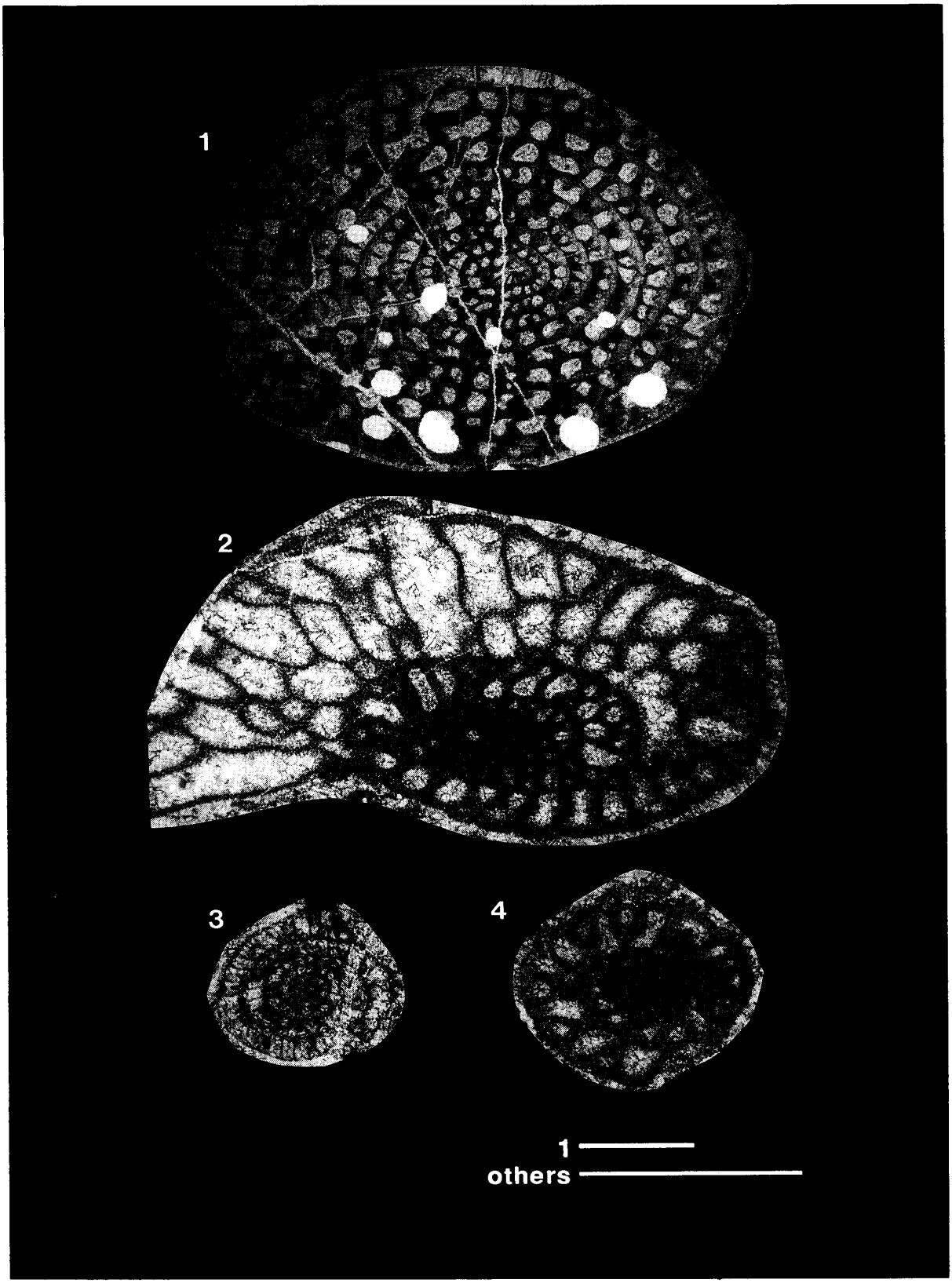
others

PLATE 7

Permian fusulinids from limestone blocks on Omura Island.

1. *Neoschwagerina simplex* Ozawa
2. *Schwagerina* sp.
3. *Minojapanella elongata* Fujimoto and Kanuma
4. *Mesoschubertella* sp.

Scale bars are 1mm.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others