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Note and Comment

Occurrence report of Triassic and Jurassic radiolarians from the Jurassic accretionary complexes of the Ashio belt in eastern Mt. Narukami, Ashio Mountains, central Japan

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Abstract: This article reports radiolarian occurrences from the Omama and Kurohone–Kiryu complexes of Jurassic accretionary complex of the Ashio belt, in eastern Mt. Narukami, Ashio Mountains, central Japan. Triassic radiolarians and conodont fragments were obtained from chert recovered from the Omama Complex. Bajocian and early Bathonian (Middle Jurassic) radiolarians were also extracted from mudstone in both the Omama and Kurohone–Kiryu complexes. In previous studies, Bajocian radiolarians had represented the youngest samples recovered from the mudstone at these complexes. Consequently, the lower Bathonian mudstone reported in the present study constitutes the youngest rock recovered from the Omama and Kurohone–Kiryu complexes to date.

Keywords: radiolaria, conodont, Ashio Mountains, accretionary complexes, Jurassic, Triassic, Ashio belt

1. Introduction

Jurassic accretionary complex of the Ashio belt is exposed around the Ashio Mountains in central Japan (Fig. 1). Kamata (1996) classified the complex into three tectonostratigraphic units: the Omama, Kurohone–Kiryu and Kuzu complexes. There are numerous radiolarian occurrence reports from the Kuzu Complex (e.g. Arakawa, 1986, 1997, 1998; Masuda, 1989; Kamata, 1995, 1996, 1997, 1999, 2000; Isogawa *et al.*, 1998; Ootaka *et al.*, 1998; Takayanagi *et al.*, 2001; Motoki and Sashida, 2004), but fewer studies have reported those from the Omama and Kurohone–Kiryu complexes (Aono, 1985; Hayashi *et al.*, 1990; Kamata, 1996; Takayanagi *et al.*, 2001).

The authors (K. Nakamura and T. Hinohara) investigated the accretionary complex in eastern Mt. Narukami, part of the Ashio Mountains. As a result, some radiolarians were obtained from chert and mudstone. In particular, Middle Jurassic radiolarians were obtained from mudstone, which is significant because previous studies have shown just a few radiolarian images from the mudstone of the Kurohone–Kiryu Complex (Takayanagi *et al.*, 2001) and no images from the mudstone of the Omama Complex. This article reports these radiolarian occurrences, which show Middle Jurassic radiolarians with images produced by scanning electronic microscopy (SEM) from the mudstone of the complexes. Furthermore, mudstone samples from both complexes in this study also yielded early Bathonian (Middle Jurassic) radiolarians. The youngest radiolarians from these complexes in previous studies were Bajocian species (e.g. Kamata, 1996), indicating that the present results represent the new youngest samples recovered from these complexes.

2. Geologic outline

The Jurassic accretionary complex is exposed widely in the Ashio Mountains (Fig. 1). Kamata (1996) classified the complex into three tectonostratigraphic units: the Kurohone–Kiryu, Omama and Kuzu complexes. The Kurohone–Kiryu Complex comprises mainly mudstone and chert, as well as common siliceous claystone and small amounts of limestone, siliceous mudstone and sandstone. The Omama Complex is composed mainly of basalt, chert and pelitic rock, while also featuring small amounts of limestone, siliceous mudstone and sandstone.

The study area is located in eastern Mt. Narukami. The Omama and Kurohone–Kiryu complexes are

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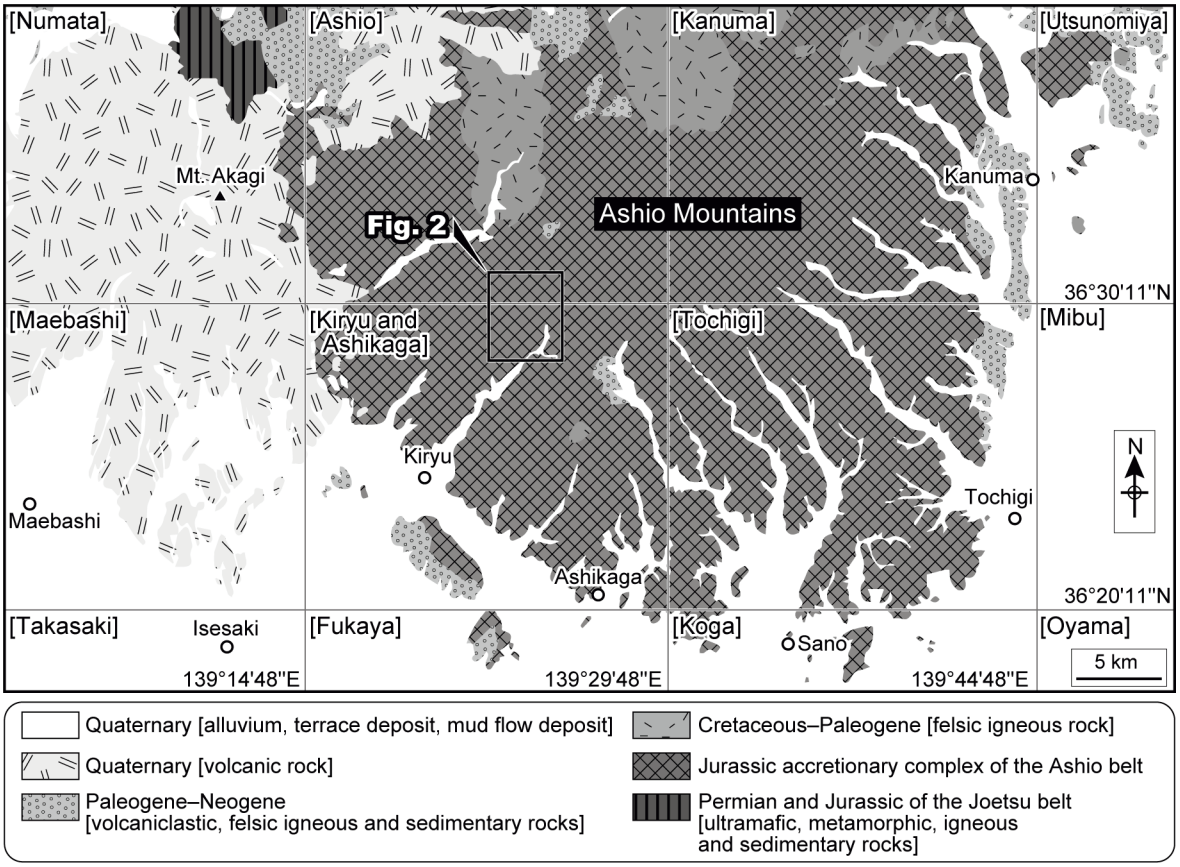

Fig. 1 Simplified geologic map of the Ashio Mountains (modified from Sudo *et al.*, 1991; Geological Survey of Japan, AIST, 2018). Geographical names in brackets indicate 1:50,000 topographic maps published by Geospatial Information Authority of Japan.

distributed over this area (Kamata, 1996). Based on both an investigation by the author (Ito, T.) and previously-published geologic map (e.g. Sudo *et al.*, 1991; Kamata, 1996; Geological Survey of Japan, AIST, 2018), four sample localities (110823-2, 111011-1, 111013-5 and 111013-4) are located in the distributional area of the Omama Complex, whereas two sample localities (OYK53-02, HTH12-01) are located in that of the Kurohone–Kiryu Complex (Fig. 2).

3. Materials and methods

In total, 232 samples were collected. The samples were soaked in a 5% hydrofluoric acid (HF) solution for 10–24 hours. Following this process, residues were collected through a sieve (opening: 64 μm), with the residues then washed using ethanol. Radiolarian tests within the dried residues were picked up using a stereomicroscope. The chosen radiolarian tests were conducted using SEM (JEOL JSM-5600) at Niigata University.

4. Radiolarian fauna and age assignments

As mentioned previously, four radiolarian occurrence sites are located in the distributional area of the Omama Complex, whereas two in the Kurohone–Kiryu Complex. The age assignments of each sample, summarized in Fig.3, are described in this section.

4. 1 Omama Complex

4. 1. 1 Chert [110823-2]

This sample yielded *Pseudostylosphaera*? sp. (Figs. 4.1–4.6), *Triassocampe*? sp. (Fig. 4.7), *Hozmadia*? sp. (Fig. 4.8) and conodont fragments (Figs. 4.9–4.11). The occurrence ranges of *Pseudostylosphaera*, *Triassocampe* and *Hozmadia* are the late Olenekian–early Carnian (Early–Late Triassic), Anisian–early Norian (Middle–Late Triassic) and late Olenekian–Carnian (Early–Late Triassic) ages, respectively (O'Dogherty *et al.*, 2009b). Thus, this study tentatively regards the sample as corresponding in age to the Anisian–early Carnian (Middle–Late Triassic).

4. 1. 2 Mudstone [111011-1]

This sample yielded *Striatojaponocapsa* sp. cf. *S. synconexa* O'Dogherty, Goričan and Dumitrica (Figs. 5.13, 5.25), *Japonocapsa* sp. cf. *J. japonica* (Yao) (Fig. 5.3) and *Yaocapsa* sp. cf. *Y. mastoidea* (Yao) (Fig. 5.32).

Striatojaponocapsa synconexa occurred in the upper *Striatojaponocapsa plicarum* Zone (JR4) to the lower *Striatojaponocapsa conexa* Zone (JR5) of the Bathonian,

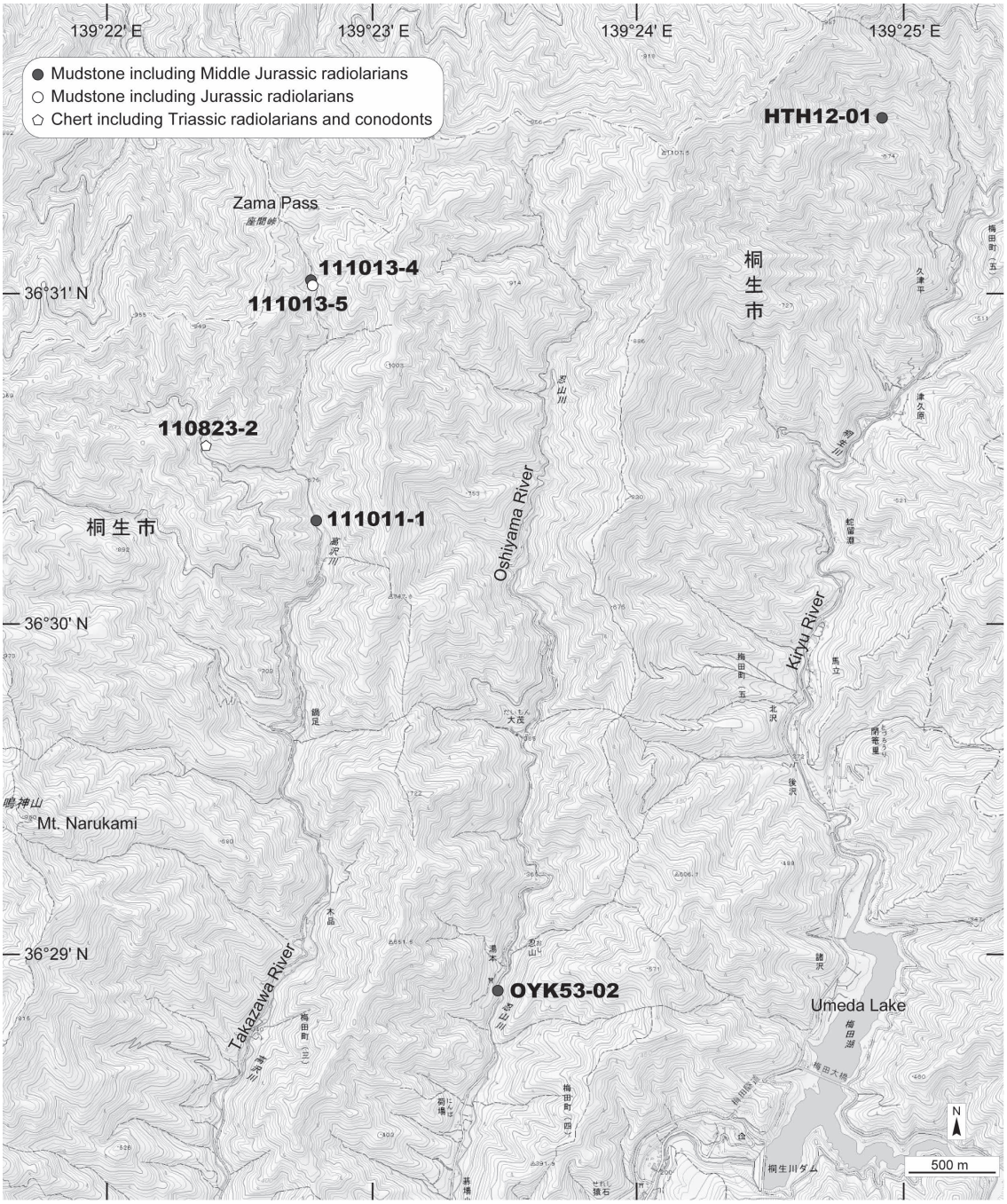

Fig. 2 Localities of radiolarian occurrence sites. Base is after 1:25000 maps of "Kouzuke-Hanawa", "Sori", "Omama" and "Bamba", according to the Geospatial Information Authority of Japan.

Middle Jurassic (Matsuoka and Ito, 2019); *Yaocapsa mastoidea* occurred only in upper JR4, lower Bathonian, Middle Jurassic (Matsuoka, 1995). The co-occurrence of S*triatojaponocapsa synconexa* and *Yaocapsa mastoidea* is limited in upper JR4 of the lower Bathonian. Consequently, the age of this sample is dated to the early Bathonian.

4. 1. 3 Mudstone [111013-4]

This sample yielded *Striatojaponocapsa plicarum* (Yao) (Fig. 6.1). According to the occurrence range shown by Matsuoka and Ito (2019), this species occurred mainly in lower–middle JR4, Bajocian, Middle Jurassic. Thus, this sample is the Bajocian in age.

4. 1. 4 Mudstone [111013-5]

This sample yielded no radiolarian valuable in terms of detailed age assignment. However, closed nassellarians that occurred abundantly in the Jurassic (e.g. O'Dogherty *et al.*, 2009a) were obtained from this sample (Fig. 7). This article tentatively regards the age of this sample as being

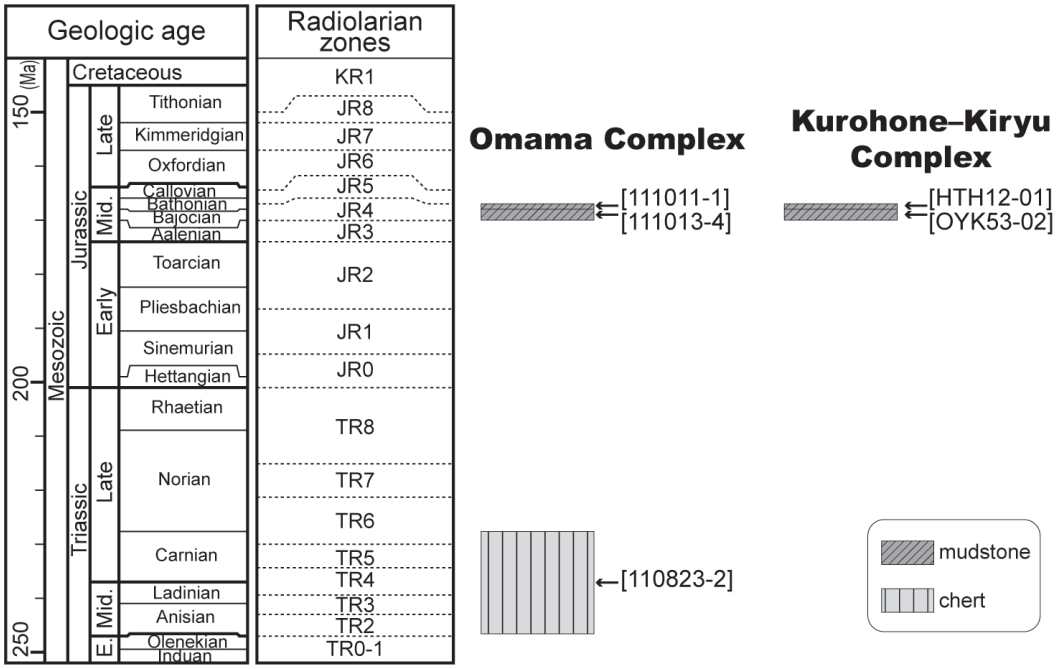

Fig. 3 Age of the sample reported in this study. The radiolarian zones are based on Sugiyama (1997) and Matsuoka and Ito (2019).

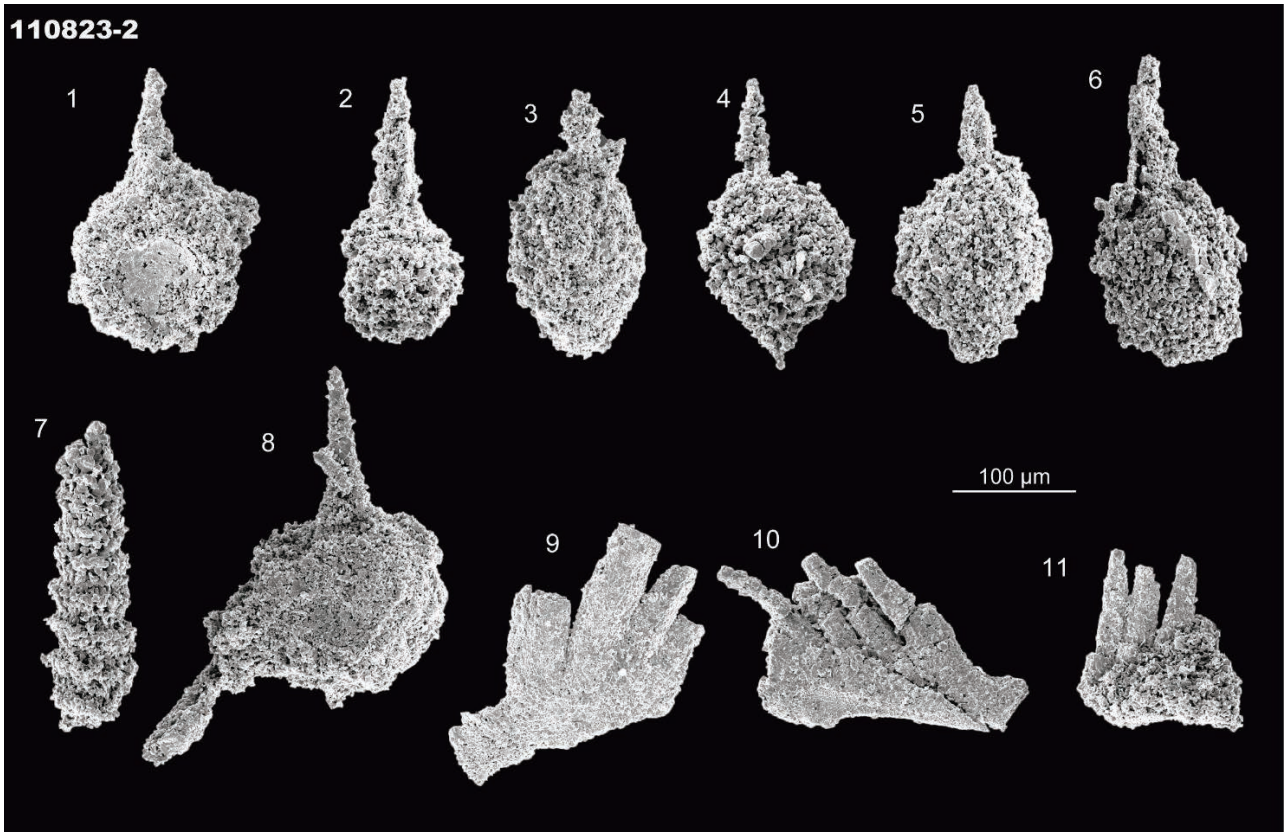

Fig. 4 Triassic radiolarian and conodont fragment from the chert of the Omama Complex. (1–6) *Pseudostylosphaera*? sp. (7) *Triassocampe*? sp. (8) *Hozmadia*? sp. (9–11) Conodont fragment.

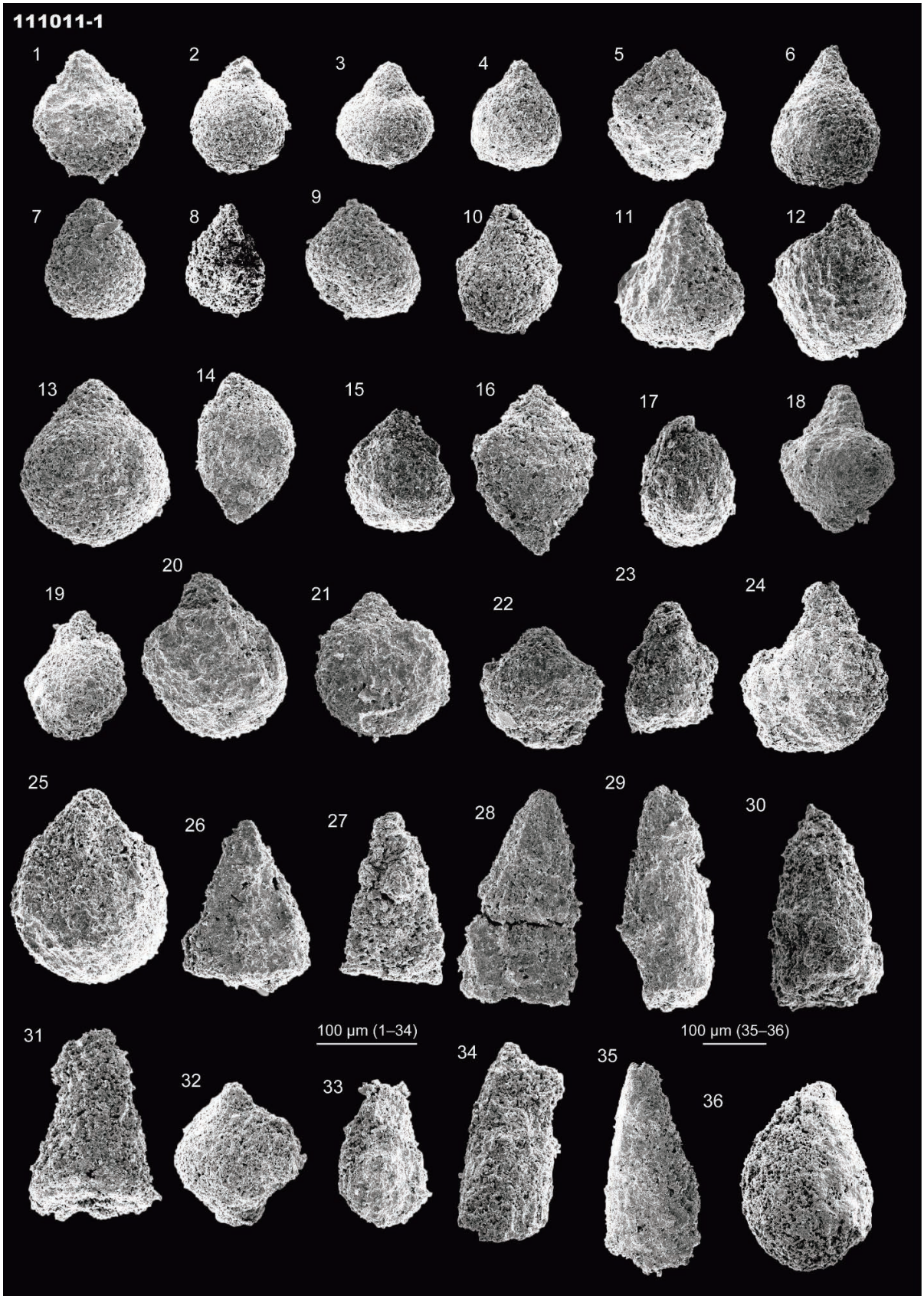

Fig. 5 Middle Jurassic radiolarians from the Omama Complex. (1, 2, 4–12, 14–17, 19–22, 24, 36) Closed nassellarian. (3) *Japonocapsa* sp. cf. *J. japonica* (Yao). (13, 25) *Striatojaponocapsa* sp. cf. *S. conexa* (Matsuoka). (23, 26–31, 33–35) Nassellaria gen. et sp. indet. (18, 32) *Yaocapsa* sp. cf. *Y. mastoidea* (Yao).

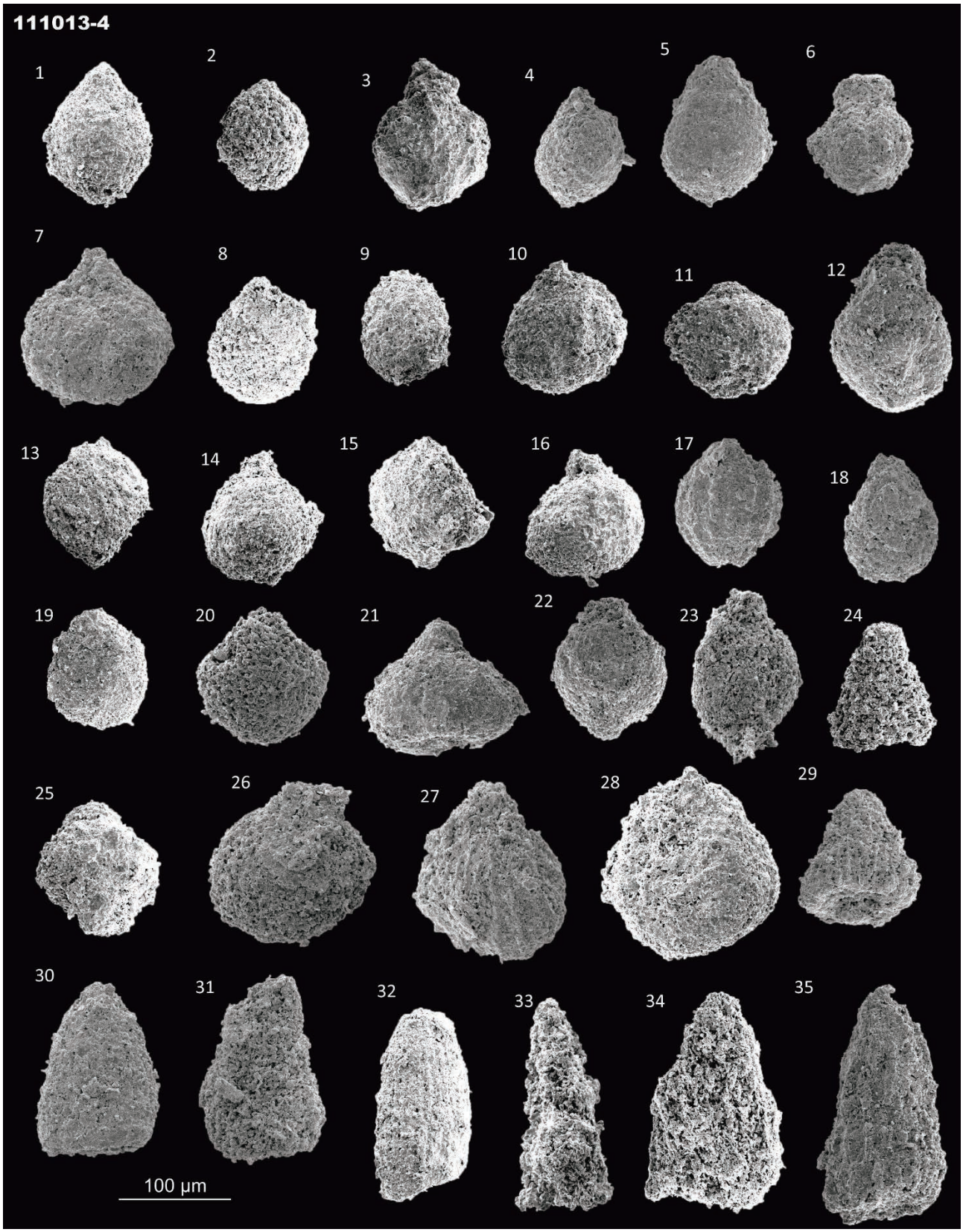

Fig. 6 Middle Jurassic radiolarians from the Omama Complex. (1) *Striatojaponocapsa* sp. cf. *S. plicarum* (Yao). (2–20, 22, 23, 25–28) Closed nassellarian. (21, 29) *Eucyritidiellum* sp. (24, 30–35) Nassellaria gen. et sp. indet.

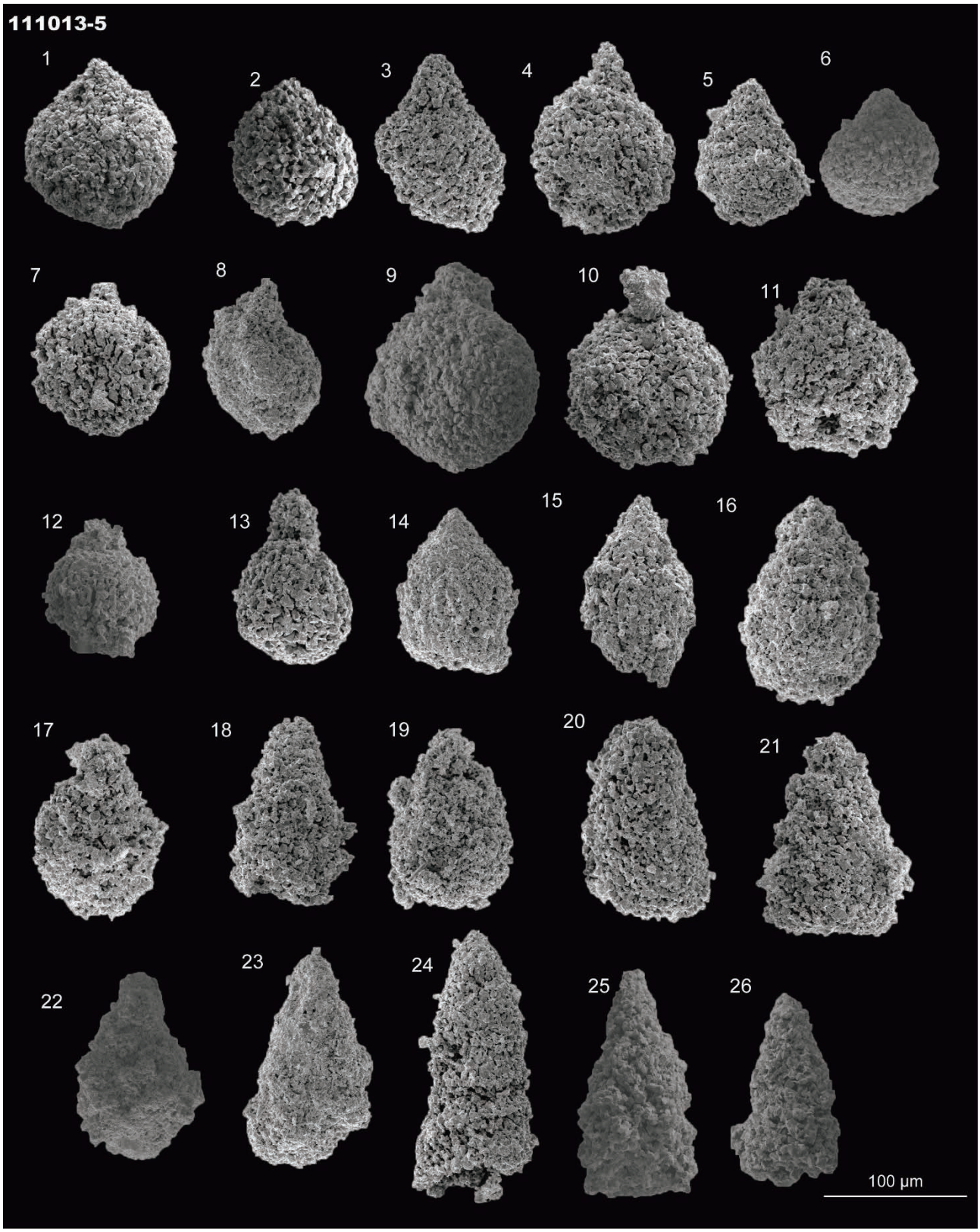

Fig. 7 Middle Jurassic radiolarians from the Omama Complex. (1–17) Closed nassellarian. (18–26) Nassellaria gen. et sp. indet.

from the Jurassic.

4. 2 Kurohone–Kiryu Complex

4. 2. 1 Mudstone [HTH12-01]

This sample yielded *Japonocapsa* sp. cf. *J. mastoidea* (Figs. 8.1–8.5) and others (Fig. 9). *Japonocapsa mastoidea* occurred only in upper JR4 of the lower Bathonian, Middle Jurassic, according to Matsuoka (1995). The age of this sample is therefore the early Bathonian.

4. 2. 2 Mudstone [OYK53-02]

This sample yielded *S. plicarum* (Figs. 10.1, 10.4) and others. *Striatojaponocapsa plicarum* occurred mainly in lower–middle JR4, Bajocian, Middle Jurassic (Matsuoka and Ito, 2019). Consequently, the age of this sample is the Bajocian.

5. Paleontological note

The preservation of radiolarian fossils is generally poor; however, some radiolarians were identifiable. This section notes representative radiolarian species among the identifiable specimens. Descriptions of the species examined in this study mainly employ the taxonomic classification used by De Wever *et al.* (2001) and O'Dogherty *et al.* (2009a, b).

Subclass **RADIOLARIA** Müller, 1858
Order **ENTACTINARIA** Kozur and Mostler, 1982
Family **HINDEOSPHAERIDAE** Kozur and Mostler, 1981
Genus ***Pseudostylosphaera*** Kozur and Mostler, 1981
Type species *Pseudostylosphaera gracilis* Kozur and Mock in Kozur and Mostler, 1981

***Pseudostylosphaera*? sp.**
Figs. 4.1–4.6
Remarks: This genus is characterized by having a spherical shell with two robust polar spines (Kozur and Mostler, 1981). Because of their poor preservation, the specimens are placed under *Pseudostylosphaera* with a question mark.

Order **NASSELLARIA** Ehrenberg, 1875
Family **RUESTICYRTIIDAE** Kozur & Mostler, 1979
Genus ***Triassocampe*** Dumitrica, Kozur and Mostler, 1980
Type species *Triassocampe scalaris* Dumitrica, Kozur and Mostler, 1980

***Triassocampe*? sp.**
Fig. 4.7
Remarks: The genus *Triassocampe* is characterized by having a long, slightly conical to subcylindrical multi-segmented shell without an apical horn (Dumitrica *et al.*, 1980). The specimen also possesses a conical multi-segmented shell. Meanwhile, some genera, such as *Annulotriassocampe* Kozur, have similar outlines (e.g., Kozur and Mostler, 1994). Because of poor preservation, the specimen lacks pores in segments, which are one of the distinguishable characteristics. This study therefore regards the specimen as *Triassocampe* with a question mark.

Family **POULPIDAE** De Wever, 1981
Genus ***Hozmadia*** Dumitrica, Kozur and Mostler, 1980
Type species *Hozmadia reticulata* Dumitrica, Kozur and Mostler, 1980

***Hozmadia*? sp.**
Fig. 4.8
Remarks: The specimen has a globular cephalis with an apical horn and downward spine. The genus *Hozmadia* Dumitrica, Kozur and Mostler, is characterized by having a globular cephalis with an apical horn and three downward spines (Dumitrica *et al.*, 1980). Meanwhile, some genera, such as Yeharaia Nakaseko and Nishimura, possess similar shells (e.g. Nakaseko and Nishimura, 1979). This study therefore regards the specimen as *Hozmadia* with a question mark.

Family **SYRINGOCAPSIDAE** Foreman, 1973, emend. Kozur, 1984
Subfamily **JAPONOCAPSINAE** Kozur, 1984
Genus ***Japonocapsa*** Kozur, 1984
Type species *Tricolocapsa*(?) *fusiformis* Yao, 1979

Japonocapsa* sp. cf. *J. japonica (Yao, 1979)
Fig. 5.3
Remarks: *Japonocapsa japonica* is characterized by having a spherical cephalis, a truncate-conical thorax and abdomen and a flattened-spherical fourth segment (Yao, 1979). The outline of the specimen is similar to this species, although the surface structure is not preserved.

Genus ***Yaocapsa*** Kozur, 1984
Type species *Cyrtocapsa mastoidea* Yao, 1979

Yaocapsa* sp. cf. *Y. mastoidea (Yao, 1979)
Figs. 5.18, 5.32, 8.1–8.5
Remarks: *Yaocapsa mastoidea* is characterized by having a large last segment (Yao, 1979). The specimens also have large last segment, although its preservation is poor.

Genus ***Striatojaponocapsa*** Kozur, 1984
Type species *Tricolocapsa plicaru*m Yao, 1979

Striatojaponocapsa* sp. cf. *S. synconexa O'Dogherty, Goričan and Dumitrica, 2005
Figs. 5.13, 5.25
Remarks: Hatakeda *et al.* (2007) studied the morphology and lineage of *Striatojaponocapsa plicarum* (Yao) and its affinities, such as *Striatojaponocapsa synconexa* and *Striatojaponocapsa conexa* (Matsuoka), in detail. According to the study, *Striatojaponocapsa synconexa* has

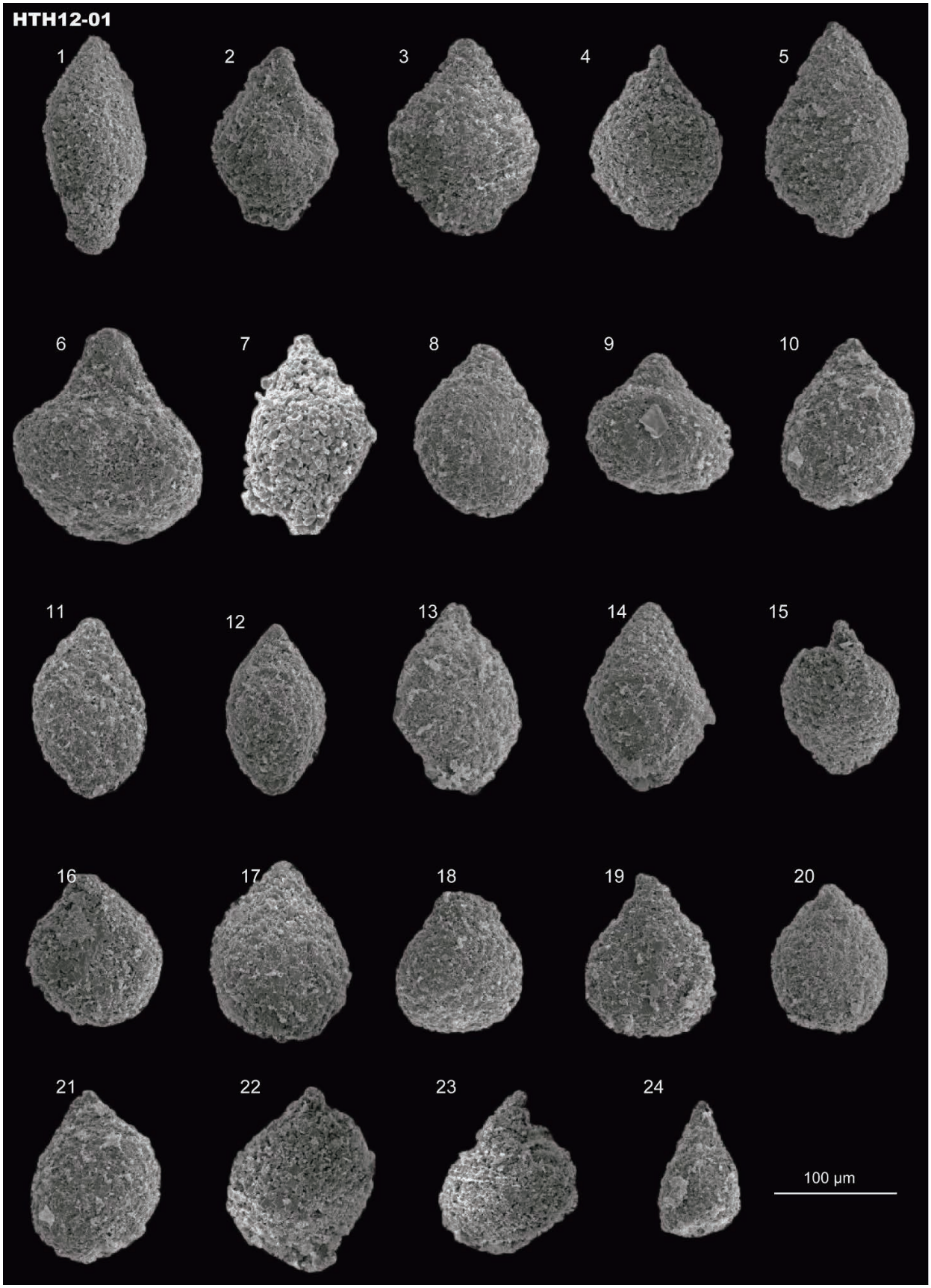

Fig. 8 Middle Jurassic radiolarians from the Kurohone–Kiryu Complex. (1–5) *Yaocapsa* sp. cf. *Y. mastoidea* (Yao). (6–23) Closed nassellarian. (24) *Eucyritidiellum* sp.

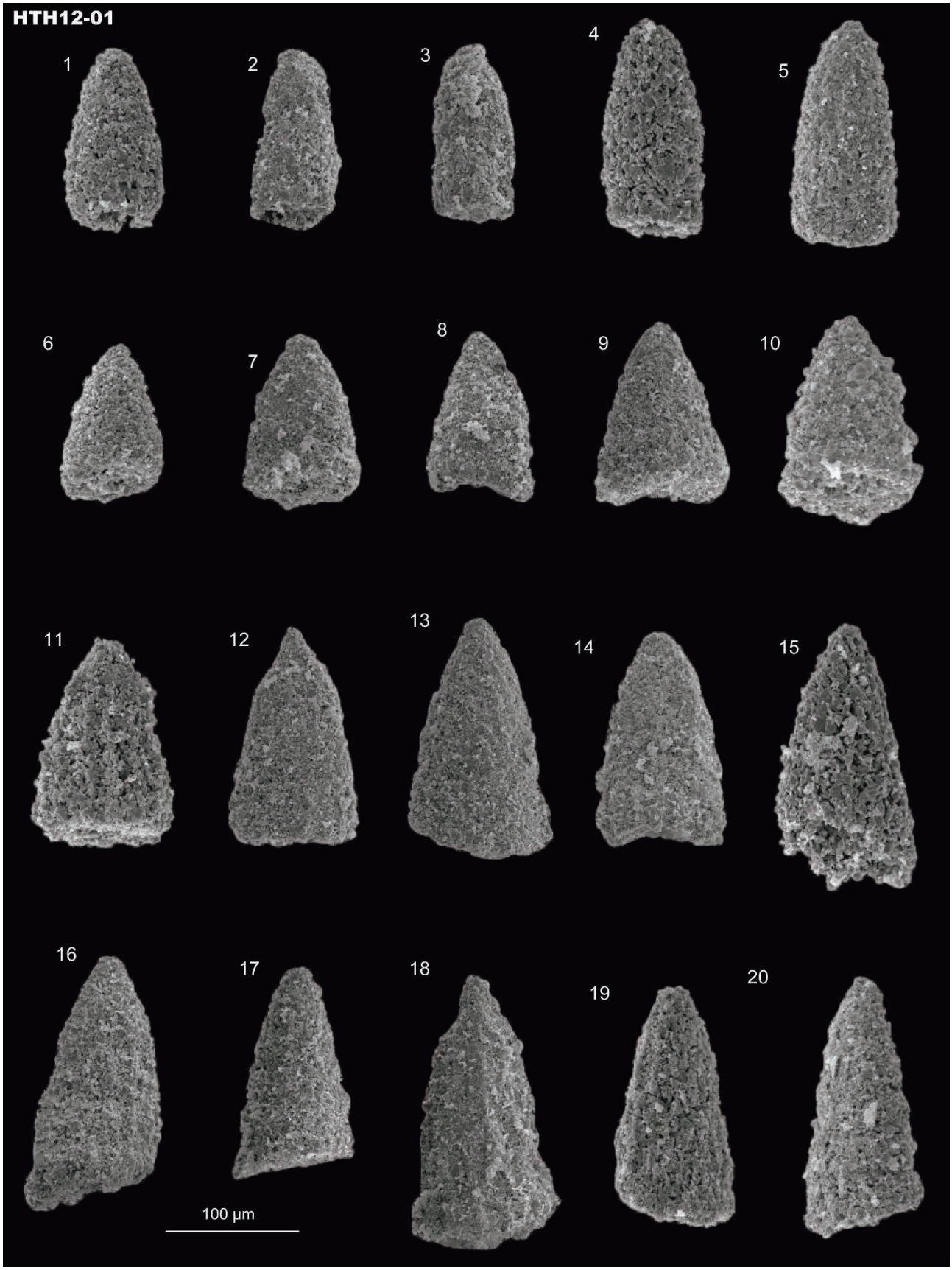

Fig. 9 Middle Jurassic radiolarians from the Kurohone–Kiryu Complex. (1–20) Nassellaria gen. et sp. indet.

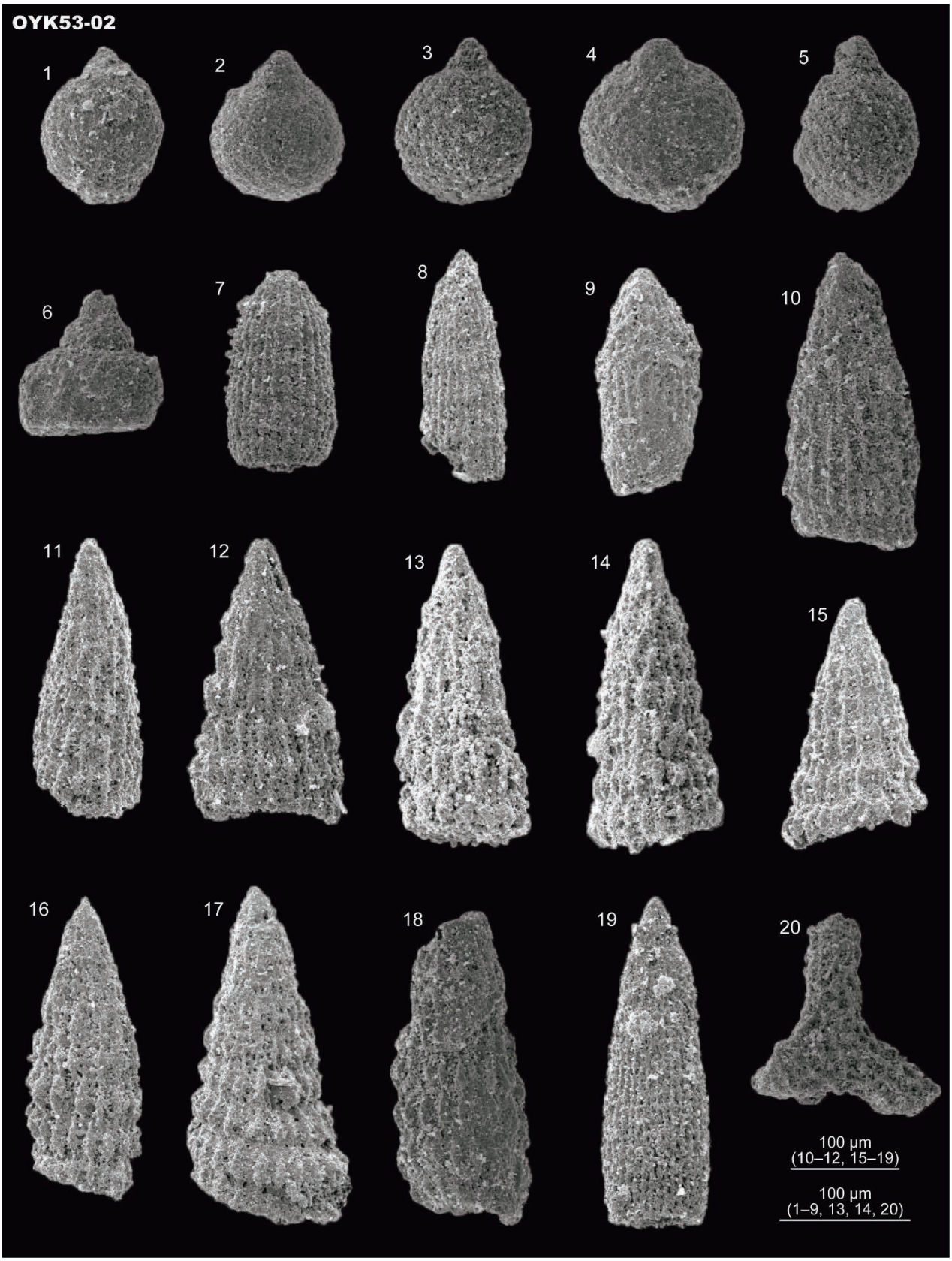

Fig. 10 Middle Jurassic radiolarians from the Kurohone–Kiryu Complex. (1, 4) *Striatojaponocapsa* sp. cf. *S. plicarum* (Yao). (2, 3, 5) Closed nassellarian. (6) *Eucyritidiellum* sp. (7) *Archaeodictyomitra* sp. (8–18) *Hsuum* sp. (19) *Parahsuum* sp. (20) *Paronaella*? sp.

a small basal appendage with a circular depression. The specimens examined in this study have these characteristics as well. Although their surfaces are poorly preserved, the basal appendages seem to be small (possibly less than 30 μm in width). This is consistent with the measurement of the basal appendages of *Striatojaponocapsa synconexa* by Hatakeda *et al.* (2007).

Striatojaponocapsa* sp. cf. *S. plicarum (Yao, 1979)
Figs. 6.1, 10.1, 10.4
Remarks: *Striatojaponocapsa plicarum* is characterized by having a dish-like basal appendage with longitudinal rows of pores (Yao, 1979; Hatakeda *et al.*, 2007). The basal appendage with pores is recognized in one specimen (Fig. 6.1). Other specimens (Figs. 10.1, 10.4) also have a basal appendage, although the surface structure and pores are unclear.

Family **EUCYRTIDIELLIDAE** Takemura, 1986
Genus ***Eucyrtidiellum*** Baumgartner, 1984
Type species *Eucyrtidium*(?) *unumaensis* Yao, 1979

***Eucyrtidiellum* sp.**
Figs. 6.21, 6.29, 8.24, 10.6
Remarks: The examined specimens have a subspherical cephalis, a truncated conical to hemispherical thorax and an inflated cylindrical abdomen. These characteristics fit within the parameters of *Eucyrtidiellum* (*Monosera* Takemura and Nakaseko, by Takemura and Nakaseko, 1986).

Family **ARCHAEODICTYOMITRIDAE** Pessagno, 1976
Genus ***Archaeodictyomitra*** Pessagno, 1977
Type species *Archaeodictyomitra squinaboli* Pessagno, 1976

***Archaeodictyomitra* sp.**
Fig. 10.7
Remarks: The examined specimen has linearly arranged, continuous costae with pores in a single row between the costae. The specimen possesses no primary pores. These are the characteristics of *Archaeodictyomitra* (Pessagno, 1977).

Family **HSUIDAE** Pessagno and Whalen, 1982
Genus ***Hsuum*** Pessagno, 1977
Type species *Hsuum cuestaensis* Pessagno, 1977

***Hsuum* sp.**
Fig. 10.8–10.18
Remarks: The examined specimen has linearly-arranged, continuous costae with pores in two or three rows between the costae. These are the characteristics of Hsuum (Pessagno, 1977).

Genus ***Parahsuum*** Yao, 1982
Type species *Parahsuum simplum* Yao, 1982

***Parahsuum* sp.**
Fig. 10.19
Remarks: The examined specimen has linearly-arranged, continuous costae with pores in a single row between the costae, with primary pores. These are the characteristics of *Parahsuum* (Yao, 1982).

Order **SPUMELLARIA** Ehrenberg, 1875
Family **ANGULOBRACCHIDAE** Baumgartner, 1980
Genus ***Paronaella*** Pessagno 1971
Type species *Paronaella solanoensis* Pessagno, 1971

***Paronaella*? sp.**
Fig. 10.20
Remarks: The examined specimen has three rays with meshwork surfaces. The shell of the specimen is similar to this genus; however, some genera, such as *Patulibracchium* Pessagno, have similar outlines (e.g. Pessagno, 1971). This article therefore regards the specimen as *Paronaella* with a question mark.

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References

Aono, H. (1985) Geologic structure of the Ashio and Yamizo Mountains with special reference to its tectonic evolution. *Science reports of the Institute of Geoscience, University of Tsukuba. Section B, Geological Sciences*, **6**, 21–57.

Arakawa, R. (1986) Upper Paleozoic and Mesozoic strata in the southeastern part of the Ashio Mountains. *Bulletin of the Tochigi Prefectural Museum*, no. 3, 1–37. (in Japanese with English abstract)

Arakawa, R. (1997) Jurassic radiolarian succession from the siliceous mudstone in the Kuzuu area of the Ashio terrane, central Japan. *Bulletin of the Tochigi Prefectural Museum*, no. 14, 1–19. (in Japanese with English abstract)

Arakawa, R. (1998) Middle Jurassic radiolarian assemblages from Manganese dioxide nodules, Kuzuu area of Ashio terrane, central Japan. *Bulletin of the Tochigi Prefectural Museum*, no. 15, 51–76. (in Japanese with English abstract)

Baumgartner, P. O. (1980) Late Jurassic Hagiastridae and Patulibrachiidae (Radiolaria) from the Argolis Peninsula (Peleponnese, Greece). *Micropaleontology*, **26**, 274–322.

Baumgartner, P. O. (1984) A Middle Jurassic–Early

Cretaceous low latitude radiolarian zonation based on unitary associations and age of Tethyan radiolarites. *Eclogae Geologicae Helvetiae*, **77**, 729–841.

De Wever, P. (1981) Une nouvelle sous-famille, les Poulpinae, et quatre nouvelles espèces de Saitoum radiolaires mésozoïques tethysiens. *Geobios*, **14**, 5–15. (in French with English abstract)

De Wever, P., Dumitrica, P., Caulet, J. P., Nigrini, C. and Caridroit, M. (2001) *Radiolarians in the Sedimentary Record*. Gordon and Breach Science Publishers, Singapore, 533p.

Dumitrica P., Kozur H. and Mostler H. (1980) Contribution to the radiolarian fauna of the Middle Triassic of the Southern Alps. *Geologisch Paläontologische Mitteilungen Innsbruck*, **10**, 1–46.

Ehrenberg C. G. (1875) *Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersichtder mikroskopischen Palaontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rucksicht auf den Polycystinen-Mergel von Barbados*. Abhandlungen der königlichen preussichen Akademie der Wissenschaften zu Berlin, 1–225. (in German)

Foreman, H.P. (1973) Radiolaria from DSDP Leg 20. *In* Heezen, B.C., MacGregor, I.D., Foreman, H.P., Forristall, G., Hekel, H., Hesse, R., Hoskins, R.H., Jones, E.J.W., Kaneps, A.G., Krasheninnikov, V.A., Okada, H. and Ruef, M.H., Eds., *Initial Reports of the Deep Sea Drilling Project*, **20**, Washington, U.S. Government Printing Office, 249–305.

Geological Survey of Japan, AIST (2018) Seamless digital geological map of Japan 1: 200,000. January 26, 2018 version. Geological Survey of Japan, AIST. https://gbank.gsj.jp/seamless/v2full/ (Accessed:2018-1-26)

Hatakeda, K., Suzuki, N. and Matsuoka, A. (2007) Quantitative morphological analyses and evolutionary history of the Middle Jurassic polycystine radiolarian genus *Striatojaponocapsa* Kozur. *Marine Micropaleontology*, **63**, 39–56.

Hayashi, S., Iijima, S., Ishii, I., Nakajima, T., Sawaguchi, H., Tanaka, H. and Yoshida, T. (1990) Late Paleozoic to Mesozoic formations in the southwestern Ashio Mountains. *Bulletin of the Gunma Prefectural Museum of History*, no. 11, 1–34. (in Japanese with English abstract)

Isogawa, J., Aita, Y. and Sakai, T. (1998) Early Triassic radiolarians from the bedded chert in the Minowa quarry, Kuzuu Town, Tochigi Prefecture. *News of Osaka Micropalaeontologists (NOM), Special Volume*, no. 11, 81–93. (in Japanese with English abstract)

Kamata, Y. (1995) Early Triassic radiolarians from black siliceous shale and black chert in the Kuzu area of the Ashio terrane, central Japan. *Fossils (Kaseki)*, **59**, 23–31. (in Japanese with English abstract)

Kamata, Y. (1996) Tectonostratigraphy of sedimentary complex in the southern part of the Ashio terrane, central Japan. *Science reports of the Institute of Geoscience, University of Tsukuba. Section B, Geological Sciences*, **17**, 71–107.

Kamata, Y. (1997) Reconstruction of chert–clastic sequence of the Ashio terrane in the Kuzu area, central Japan. *The Journal of the Geological Society of Japan*, **103**, 343–356. (in Japanese with English abstract)

Kamata, Y. (1999) Lower Triassic (Spathian) radiolarians from the Kuzu area (Tochigi Prefecture, central Japan). *Geodiversitas*, **21**, 657–673.

Kamata, Y. (2000) Imbricate structure of chert–clastic sequence of the Kuzu Complex in the Shiraiwa area of the Ashio belt, central Japan. *The Memoirs of the Geological Society of Japan*, no. 55, 203–221. (in Japanese with English abstract)

Kozur, H. (1984) New radiolarian taxa from the Triassic and Jurassic. *Geologisch Paläontologische Mitteilungen Innsbruck*, **13**, 49–88.

Kozur, H. and Mostler, H. (1979) Beiträge zur Erforschung der mesozoischen Radiolarien. Teil III: Die Oberfamilien Actinommacea Haeckel, 1862 emend., Artiscacea Haeckel,1882, Multiarcusellacea nov. der Spumellaria und triassische Nassellaria. *Geologisch Paläontologische Mitteilungen Innsbruck*, **9**, 1–132. (in German with English abstract)

Kozur, H. and Mostler, H. (1981) Beiträge zur Erforschung der mesozoischen Radiolarien. Teil IV: Thalassosphaeracea Haeckel, 1862, Hexastylacea Haeckel, 1862 emend. Petrushevskaya, 1979, Sponguracea Haeckel, 1862 emend. und weitere triassische Lithocycliacea, Trematodiscacea, Actinommacea und Nassellaria. *Geologisch-Paläontologische Mitteilungen Innsbruck*, **1**, 1–208. (in German with English abstract)

Kozur, H. and Mostler, H. (1982) Entactinaria Subordo nov., a new radiolarian suborder. *Geologisch Paläontologische Mitteilungen Innsbruck*, **11**, 399–414.

Kozur, H. and Mostler, H. (1994). Anisian to Middle Carnian radiolarian zonation and description of some stratigraphically important radiolarians. *Geologisch-Paläontologische Mitteilungen, Innsbruck*, **3**, 39–255.

Masuda, S. (1989) Jurassic radiolarian fossils in the Hachioji Hill. *Research reports, Ashikaga Institute of Technology*, no. 15, 207–214. (in Japanese with English abstract)

Matsuoka, A. (1995) Jurassic and Lower Cretaceous radiolarian zonation in Japan and in the Western Pacific. *The Island Arc*, **4**, 140–153.

Matsuoka, A. and Ito, T. (2019) Updated radiolarian zonation for the Jurassic in Japan and the western Pacific. *Science Reports of Niigata University (Geology)*, no. 34, 49–57.

Motoki, H. and Sashida, K. (2004) Preliminary report on the chronological and lithostratigraphical studies of the Toishi-type shale (siliceous claystone) distributed in the Ashio Mountains, central Japan. *News of Osaka*

Micropalaeontologists (NOM), Special Volume, no. 13, 47–57. (in Japanese with English abstract)
Müller, J. (1858) *Uber die Thalassicollen, Polycystinen und Acanthometren des Mittelmeeres*. Konigliche Preussische Akademie der zu Berlin, Abhandlungen, Jahre., 1–62. (in German)
Nakaseko, K. and Nishimura, A. (1979) Upper Triassic Radiolaria from southwest Japan. *Science Reports, College of General Education Osaka University*, **28**, 61–109.
O'Dogherty, L., Bill, S., Goričan, Š., Dumitrica, P. and Masson, H. (2005) Bathonian radiolarians from an ophiolitic mélange of the Alpine Tethys (Gets Nappe, Swiss-French Alps). *Micropaleontology*, **51**, 425–485.
O'Dogherty, L., Carter, E. S., Dumitrica, P., Goričan, Š., De Wever, P., Bandini, A. N., Baumgartner, P. O. and Matsuoka, A. (2009a) Catalogue of Mesozoic radiolarian genera. Part 2: Jurassic–Cretaceous. *Geodiversitas*, **31**, 271–356.
O'Dogherty, L., Carter, E. S., Dumitrica, P., Goričan, Š., De Wever, P., Hungerbuhler, A., Bandini, A. N. and Takemura, A. (2009b) Catalogue of Mesozoic radiolarian genera. Part 1: Triassic. *Geodiversitas*, **31**, 213–270.
Ootaka, M., Aita, Y. and Sakai, T. (1998) Middle Triassic radiolarian biostratigraphy of the bedded chert in the Minowa quarry, Kuzuu Town, Ashio Mountains. *News of Osaka Micropalaeontologists (NOM), Special Volume*, no. 11, 95–113.
Pessagno, E. A. (1971) Jurassic and Cretaceous Hagiastridae from the Blake-Bahama Basin (Site 5A, JOIDES Leg 1) and the Great Valley Sequence, California Coast Ranges. *Bulletin of American Paleontology*, **60**, 5–83.
Pessagno, E. A. (1976) Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley Sequence, California Coast Ranges. *Micropaleontology Special Publication*, **2**, 1–95.
Pessagno, E. A. (1977) Upper Jurassic Radiolaria and radiolarian biostratigraphy of the California Coast Ranges. *Micropaleontology*, **23**, 56–113.
Pessagno, E. A. and Whalen P. (1982) Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B. C. *Micropaleontology*, **28**, 111–169.
Sudo, S., Makimoto, H., Hata, M., Unozawa, A., Takizawa, F. and Sakamoto, T. (1991) *Geological map of the Utsunomiya district*. Quadrangle Series, 1:200,000, Geological Survey of Japan.
Sugiyama, K. (1997) Triassic and Lower Jurassic radiolarian biostratigraphy in the siliceous claystone and bedded chert units of the southeastern Mino terrane, central Japan. *Bulletin of the Mizunami Fossil Museum*, **24**, 79–193.
Takayanagi, A., Hori, N. and Sashida, K. (2001) Tectonostratigraphy of sedimentary complex of the Ashio terrane in the northern part of the Ashikaga area, Tochigi Prefecture, and the occurrence of radiolarians. *News of Osaka Micropalaeontologists (NOM), Special Volume*, no. 12, 113–127. (in Japanese with English abstract)
Takemura, A. (1986) Classification of Jurassic Nassellarians (Radiolaria). *Palaeontographica. Abteilung A: Palaozoologie-Stratigraphie*, **195**, 29–74.
Takemura, A. and Nakaseko, K. (1986) The cephalic skeletal structure of Jurassic "*Eucyrtidium*" (Radiolaria). *Journal of Paleontology*, **60**, 1016–1024.
Yao, A. (1979) Radiolarian fauna from the Mino belt in the northern part of the Inuyama Area, central Japan, Part II: Nassellaria 1. *Journal of Geosciences, Osaka City University*, **22**, 21–72.
Yao, A. (1982) Middle Triassic to Early Jurassic radiolarians from the Inuyama area, central Japan. *Journal of Geosciences, Osaka City University*, **25**, 53–70.

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足尾山地鳴神山東方地域から産出した三畳紀・ジュラ紀放散虫化石の報告

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要　旨

本論では，足尾山地鳴神山東方に分布する足尾帯ジュラ紀付加体の大間々コンプレックス及び黒保根–桐生コンプレックスから産出した放散虫を報告する．三畳紀放散虫及びコノドント片が大間々コンプレックスのチャートから産出した．中期ジュラ紀のバッジョシアン期及びバトニアン前期の放散虫が大間々コンプレックスと黒保根–桐生コンプレックスの泥岩から得られた．先行研究で両コンプレックスから報告された中では，泥岩に含まれるバッジョシアン期の放散虫が最も若い記録であった．従って，本研究で報告したバトニアン階下部の泥岩は，より若い記録となる．