Mem. Fac. Sci. Shimane Univ.,
21, pp. 169–188 Dec. 20, 1987

Radiolarian Biostratigraphy of the Maizuru Group in Yanahara area, Southwest Japan

Kouichi NISHIMURA* and Hiroaki ISHIGA*

(Received September 5, 1987)

Radiolarian biostratigraphy of the Maizuru Group was examined in the Yanahara area, eastern part of the Okayama Prefecture, Southwest Japan. Six radiolarian assemblages (A–F) are discriminated within the radiolarians from the Maizuru Group. It is disclosed that the age of the Maizuru Group in this area incldues whole of the Middle Permian based on the radiolarian biostratigraphy, which indicates rather older age than previously supposed. Five species of *Pseudoalbaillella* including two new species are described in this paper.

Introduction

The Maizuru Group (SHIMIZU *et al.*, 1962) mainly composed of basic volcanic rocks, black mudstones and alternating beds of sandstone and mudstone, is important compor-

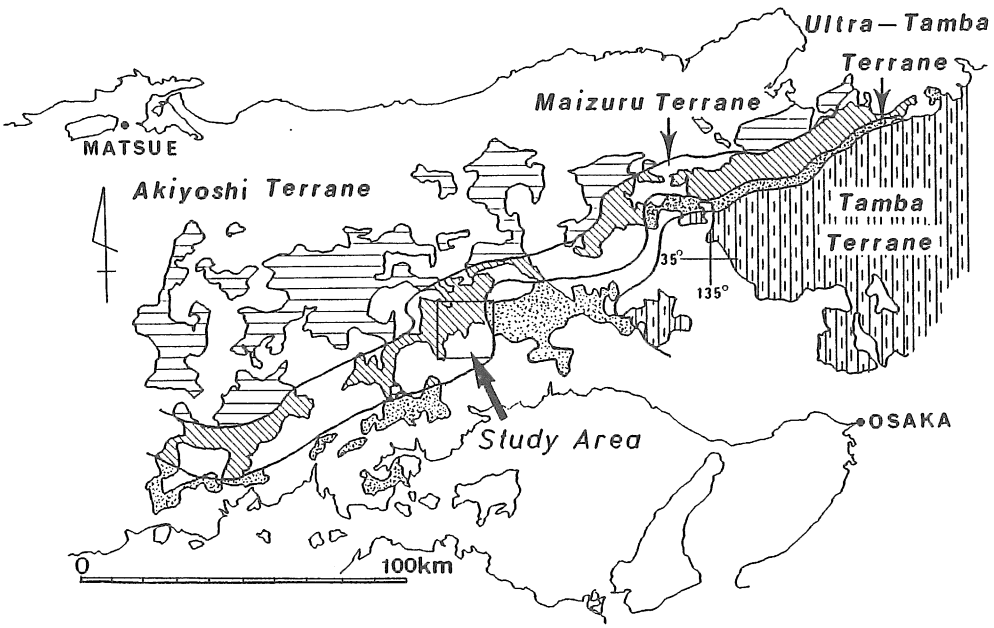


Fig. 1. Index map of the study area and geologic division of Chugoku district, SW Japan.

* Department of Geology, Faculty of Science, Shimane University, Matsue 690, Japan.

nent of the Maizuru Terrane of the A terrane-group (pre-Jurassic terranes of ICHIKAWA, 1987). The Maizuru Group is unconformably overlain by the Triassic shallow marine sediments (NAKAZAWA *et al.*, 1957). The Maizuru Terrane is in fault contact with the Akiyoshi Terrane to the north and it thrusts over the Ultra-Tamba Terrane to the south (HAYASAKA and HARA, 1986; ISHIGA, 1986a) (Fig. 1). The Upper Paleozoic strata of the Akiyoshi and the Ultra-Tamba Terranes include the sequence from bedded chert to mudstones or shale, which represents the lithologic change from oceanic to the terrigionus materials. In contrast to the lithologic characteristics of the Akiyoshi and Ultra-Tamba Terranes, the Maizuru Group does not include bedded chert, even though the group includes basic volcanic rocks in the lower part. The exact age of the Upper Paleozoic of the Akiyoshi and Ultra-Tamba Terranes has recently been clarified on the basis of study of radiolarians, however, radiolarian study of the Maizuru Terrane is just undergone by few geologists. This paper presents recent results of presise radiolarian biostratigraphy of the Maizuru Group in the Yanahara area in addition to recent research of adjacent areas referring to NAKA and ISHIGA's (1987) compiles of the radiolarian data of the A terrane-group appeared in this journal.

Geologic Setting of the Maizuru Terrane

A. Brief outline of geology

The Maizuru Terrane of the A terrane-group (pre-Jurassic terrane of Japan of ICHIKAWA, 1987) comprises the Permian Maizuru Group and uncomformably overlying Triassic shallow marine sediments, such as the Yakuno and Nabae Groups, and the Yakuno ophiolitic complex unit, which is regarded to have been the basement of the Maizuru Group (see TOKUOKA *et al.* 1987). The Maizuru Terrane thrusts over the Ultra-Tamba Terrane (see ISHIGA, 1986a) and is tectonically overlain by the Akiyoshi Terrane of the A terrane-group. Detail description and historical review of the Maizuru Terrane is given in TOKUOKA *et al.* (1987).

B. Maizuru Group of the Yanahara area

The Maizuru Group in this ares studied by NAKAZAWA *et al.* (1954), MITSUNO and OHMORI (1965) and MITSUNO *et al.* (1975) etc., is composed of mudstones, sandstones, alternating beds of sandstones and mudstones, and intercalating acidic tuffs. The Maizuru Group is uncomformably overlain by the Triassic Fukumoto Group mainly composed of sandstone and mudstones, forms syncline and anticline with axis of NW–SE trends. Generalized geologic column is shown in Fig. 3, in which the two formations (Upper and Lower Formations) are litho-stratigraphically discriminated by one of the present authors (K.N.). The Lower Formation is composd of mudstones and acidic tuffs, while the Upper Formation consists of mudstones, alternationg beds of sandstone

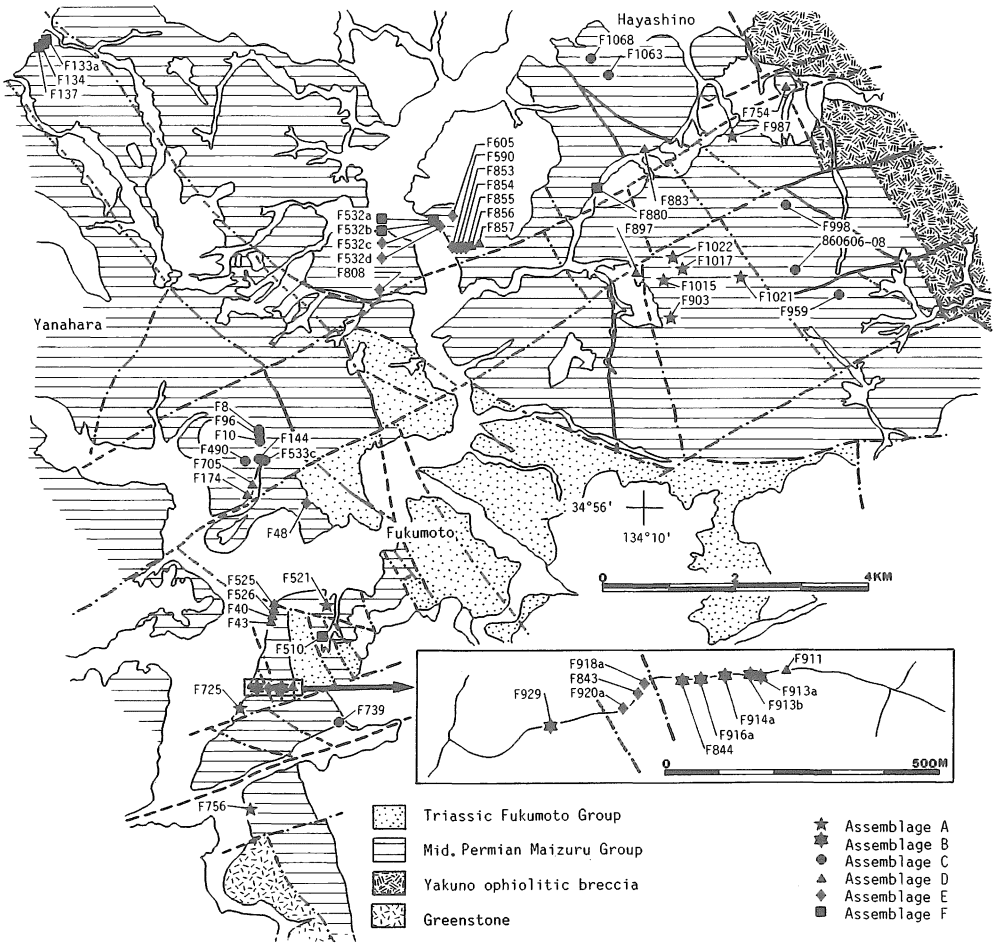


Fig. 2. Generalized geologic map of the Yanahara area and localities of radiolarian fossils.

and mudstone and intercalating conglomerate.

Materials and Method

Samples were collected at 1200 localities by one of the present authors (K. N.) Among them radiolarians have been recovered from 57 localities, which are shown in Fig. 2.

These samples were broken into small fragments and put into a bowl with about 5% HF solution for 6–12 hours. Subsequently, the residue was gathered by using #200 sieve and radiolarian skeletons were picked up with a fine brush under stereoscopic microscope.

Type and figured specimens are registered and deposited in the Department of

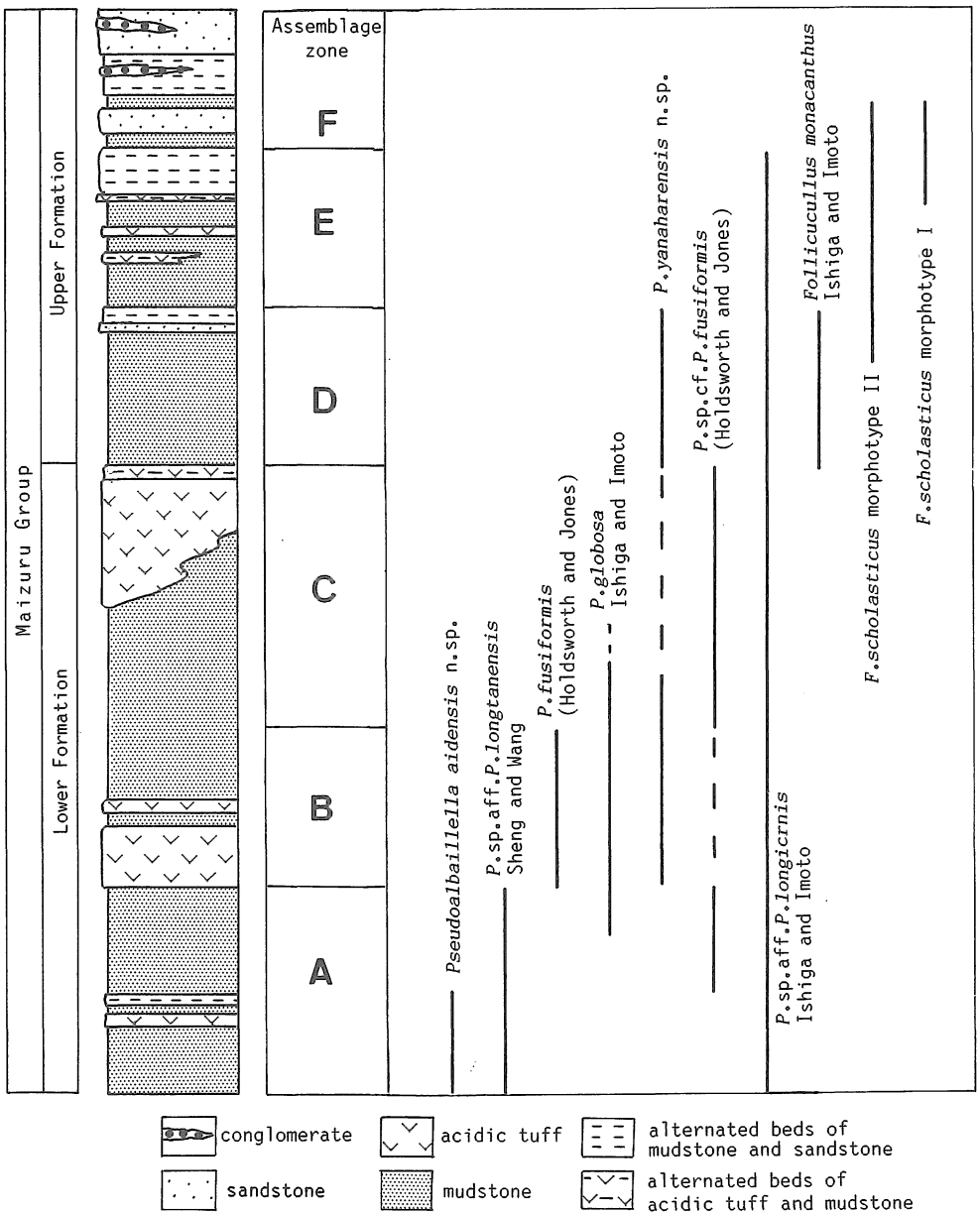


Fig. 3. Generalized columnar section of the Maizuru Group, range of some species of *Pseudoalbaillella* and *Follicucullus* and radiolarian assemblages in the text. (*P. longicrnis* should be *P. longicornis*).

Geology, Shimane University (DGSU PR).

Systematic Paleontology

Subclass RADIOLARIA MÜLLER
Superorder POLYCYSTINA EHRENBERG, 1938,
emend. RIEDEL, 1967
Suborder Albaillellaria DEFLANDRE, 1953
emend. HOLDSWORTH, 1969
Family Albaillellidae Deflandre

Genus *Pseudoalbaillella* HOLDSWORTH and JONES, emed. KOZUR

Type species. *Pseudoalbaillella scalprata* HOLDSWORTH and JONES from Leonardian, Nevada, HOLDSWOTH and JONES (1980)

Pseudoalbaillella yanaharensis NISHIMURA and ISHIGA n. sp.
Pl. 2, Figs. 1–8

1985 *Pseudoalbaillella* sp.-MIYAKE, pl. IV, fig. 7
1986 *Pseudoalbaillella globosa* ISHIGA and IMOTO-KANMERA and SANO, pl. 1, figs. 4–6, 10, 11.
1986 *Pseuaodlbaillella* sp. A-UCHIYAMA, SANO and KANMERA, pl. 8, fig. 10.

Materials. Eight specimens figured in Pl. 2 and more than 20 specimens from the Maizuru Group in the Yanahara area, Okayama Prefecture. Holotype is DGSU PR 1001 and paratypes are DGSU PR 1002–1008.

Specific diagnosis. A species of *Pseudoalbaillella* characterized by slightly inflated pseudothorax with fine and long wings and short pseudoabdomen deeply slitted both sides of long flaps.

Measurements (in μm). Based on 15 specimens from the Maizuru Group in the Yanahara area, Okayama Prefecture.

Length of shell excluding flaps: 200–320 (av. 258)
Length of apical cone: 80–140 (av. 107)
Length of pseudothorax: 50–100 (av. 72)
Length of pseudoabdomen: 40–100 (av. 72)
Width of pseudoabdomen: 70–130 (av. 94)

Description. Shell clearly distinguished into, apical cone, pseudothorax and pseudoabdomen. Apical cone long about 2/5 length of shell, without constriction, curving slightly to ventral side. Pseudothorax inflated, spherical shape, with long fine wings, recurved distally. Thick blade-like ridges running along outer margin of pseudothorax in bilaterally symmetry, and wings extending obliquely downward from lowest end of ridges. Pseudoabdomen globular and having same length with that of

pseudothorax. Both side of ventral and dorsal flaps deeply slitted. Flaps extending downward with two or three by-spines, distally curving outward.

Comparison. Specimens of *Pseudoalbaillella* sp. from black shale of the Permian olistostrome complex in the Katsuyama area (MIYAKE, 1985, pl. IV, fig. 7) and black mudstone of the Akiyoshi area (KANMERA and SANO, 1986, pl. 1, figs. 4–6), and *P.* sp. aff. *P. longicornis* ISHIGA and IMOTO from black shale of the Tsunemori Formation in the Akiyoshi area have the same configuration with that of *P. yanaharaensis* NISHIMURA and ISHIGA n. sp. considering the inflated pseudothorax and short pseudoabdomen.

Occurrence. This species occurs from black mudstone, tuffaceous shale and acidic tuff of the Maizuru Group at localities of F705 and F40 and other 7 localities (Fig. 4) in the Yanahara area together *P. fusiformis* (HOLDSWORTH and JONES), *P. globosa* ISHIGA, KITO and IMOTO, and *Follicucullus monacanthus* ISHIGA, KITO and IMOTO.

Pseudoalbaillella aidensis NISHIMURA and ISHIGA n. sp.
Pl. 2, Figs. 9–14

Materials. Specimens figured in Pl. 2 and more than 15 specimens from the Maizuru Group in the Yanahara area.

Holotype is DGSU PR 1009 and paratypes are DGSU PR 1010–1012.

Specific diagnosis. A species of *Pseudoalbaillella* characterized by straightly elongated pseudoabdomen with 5–7 annulations.

Measurements (in μm). Based on 9 specimens from the Maizuru Group in the Yanahara area.

Length of shell without flaps: 420–610 (av. 519)
Length of apical cone: 40–130 (av. 78)
Length of pseudothorax: 40–100 (av. 66)
Length of pseudoaldomen: 320–450 (av. 373)
Width of pseudoabdomen: 100–120 (av. 109)

Description. Apical cone short in places slightly annulated. Pseudothorax small with strongly curving short wings. Pseudoabdomen long about 3/4–2/3 length of whole shell, slightly flattened in cross section, with 5–7 annulations. Short flaps with 2–3 by spines extending horizontally outward.

Remarks. This species differs from Middle Permian *P. longtanensis* SHENG and WANG in having long and annulated pseudoabdomen and differs from Late Carboniferous to Early Permian *P. annulata* ISHIGA in having straightly elongated pseudoabdomen.

Occurrence. This species occurs from black mudstone of the Maizuru Group at localities of F521, F725 and 756 (Fig. 4) in Yanahara area together *P. longtanensis*. This species also reported from siliceous mudstone of the Shimomidani Formation in the Shidaka sub-terrane of the Akiyoshi Terrane (ISHIGA and SUZUKI, in press), with same specific composition of the assemblage A mentioned below as those of the Yanahara fauna.

Pseudoalbaillella fusiformis (HOLDSWORTH and JONES)
Pl. 3, Figs. 1–7

1980 *Parafollicucullus fusiformis* HOLDSWORTH and JONES, appendix-fig. 1; D, E.
1982a *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-ISHIGA *et al.*, pl. 2, figs. 1, 2.
1982 *Parafollicucullus* sp. cf. *P. fusiformis* HOLDSWORTH and JONES-KOJIMA, pl. 4, fig. 2.
1982b *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-ISHIGA *et al.*, pl. 4, 10–12.
1982 *Parafollicucullus* sp.-WAKITA and OKAMURA, pl. 4, Fig. 4.
1983 *Parafollicucullus fusiformis* HOLDSWORTH and JONES-WAKITA, pl. 4, fig. 11.
1984 *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-TAZAWA *et al.*, p. 265, fig. 2; 5, 8.
1985 *Pseudoalbaillella nanjingensis*-SHENG and WANG, pl. 1, figs. 1–5, 7–10.
1986 *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-ISHIGA *et al.*, pl. 1, fig. 16.
1986 *Neoalbaillella*? sp.-KANMERA and SANO, pl. 1, figs. 7–9.
cf. 1986 *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-BLOME *et al*, pl. 8.1, figs. 3–6, 11.

Materials. Seven specimens figured in Pl. 3 and more than 30 specimens from the Maizuru Group in the Yanahara area.

Specific diagnosis. A species of *Pseudoalbaillella* consisting of short apical cone, small pseudothorax and inflated pseudoabdomen with constrictions. Long wings terminating with by-spines of flaps.

Measurements (in μm). Based on 16 specimens from the Maizuru Group in the Yanahara area.

Length of shell excluding flaps: 230–400 (av. 328)
Length of apical cone: 60–110 (av. 82)
Length of pseudothorax: 30–60 (av. 44)
Length of pseudoabdomen: 160–250 (av. 206)
Maximum width of pseudoabdomen: 80–190 (av. 125)

Description. Shell consisting of short apical cone (about 1/4 length of shell), small spherical pseudothorax and inflated pseudoabdomen with constrictions. Apical cone without constrictions, slightly curving to ventral side. Division between apical cone and pseudothorax clear represented by stricture. Wings long extending downward joining with horizontal by-spines of flaps, forming framework structure. Pseudoabdomen consisting three parts, namely, upper short ring like swell, middle inflated barrel shaped part and lower short skirt like apertural part, divided by two constictions. Lower margine of apertural part tapered and ventral flap extending nearly downward with

horizontal by-spine which terminating with ventral wing, while dorsal flap short and small, with horizontally extending by-spine.

Comparison. Juding from the illustration by ISHGA *et al.*, 1986 (pl. 1, fig. 16), specimens of *Pseudoalbaillella fusiformis* from the Nishiki Group of the Muikaichi area in the Akiyoshi Terrane, have the same configuration with the that of the Yanahara fauna. Specimens of *P.* sp. aff. *P. fusiformis* from the Leonardian Born Spring Limestone, west Texas (CORNELL and SIMPSON, 1985, pl. 1, fig. 6), has the same configuration concerning framework of wing and by-spine of flap, however, it can be assignable to *P. longtanensis* SHENG and WANG for their specimens has long pseudoabdomen with several annulations.

Occurrence. This species occurs from black mudstones, tuffaceous shales and acidic tuffs of the Maizuru Group at localities F 844, F 916a, F 914a, F 913b, F 913a and F 929 in the Yanahara area.

This species was originally reported from the Clearwater Mountains of Alaska (HOLDSWORTH and JONES, 1980) and subsequently from the *P. globosa* Assemblage-zone in red bedded chert sequence of the Mino-Tamba Terrane (ISHIGA *et al.*, 1982a, b). Furthermore, this species (=*P. nanjingensis* SHENG and WANG) was also described from in the Maokouan Kufeng Formation at Longtan, Nanjing (SHENG and WANG, 1985).

Pseudoalbaillella sp. cf. *P. fusiformis* (HOLDSWORTH and JONES)
Pl. 1, Figs. 13–18

1986 *Pseudoalbailla fusiformis* (HOLDSWORTH and JONES)-KANMERA and SANO, pl. 1, figs. 1–3.

1986 *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)-UCHIYAMA, SANO and KANMERA, pl. 8, fig. 7.

Material. Six specimens figured in Pl. 1 and more than 30 specimes from the Maizuru Group in the Yanahara area.

Measurements (in μm). Based on 9 specimens from the Maizuru Group in the Yanahara area.

Length of shell excluding flaps: 270–380 (av. 337)
Length of apicalcone: 30–100 (av. 79)
Length of pseudothorax: 30–60 (av. 47)
Length of pseudoabdomen: 180–250 (av. 203)
Width of pseudoabdomen: 70–130 (av. 104)

Remarks. This species closely resemble the specimens of *P. fusiformis* in having long and inflated pseudoabdomen, however, wings of this species are short never connecting with the flaps in the distal part of wings. Length of shell of this species is slightly longer than that of *P. fusiformis* which has more inflated pseudoabdomen.

Occurrence. This species occurs from black mudstones, tuffaceous shales and

acidic tuffs of the Maizuru Group at localities of F739, F 1017 and other 26 localities shown in Fig. 4.

Pseudoalbaillella globosa ISHIGA and IMOTO
Pl. 4, Figs. 1–5

1982b *Pseudoalbaillella globosa* ISHIGA and IMOTO-ISHIGA *et al.*, pl. 1, figs. 1–6.
1986 *Pseudoalbaillella globosa* ISHIGA and IMOTO-ISHIGA *et al.*, pl. II, figs. 1–3.

Material. Five specimens figured in Pl. 4 and more than 20 specimens from the Maizuru Group in Yanahara area.

Specific diagnosis. A species of *Pseudoalbaillella* characterized by spherical pseudothorax with carina like wings and short pseudoabdomen with two constrictions.

Measurements (in μm). Based on 9 specimens from the Maizuru Group in the Yanahara area.

Length of shell excluding flaps: 280–400 (av. 333)
Length of apical cone: 100–130 (av. 111)
Length of pseudothorax: 120–190 (av. 147)
Length of pseudoabdomen: 40–100 (av. 69)
Width of pseudoabdomen: 140–210 (av. 157)

Description. Apical cone short without constrictions slightly curving to ventral side. Pseudothorax strongly inflated, nearly spherical with two beak like wings extending slightly downward. Wings showing keel shaped concavity, distally tapered. Sharp stricture running around between pseudothorax and pseudoabdomen. Pseudoabdomen short about 1/4 length of shell with two week constrictions. Althogh flaps not fully preserved, small spine like flps extending vertically down ward from inner side of apertural margin.

Comparison. *P. globosa* in the Yanahara area of this study have the same configuration with that of the specimens of *Pseudoalbaillella globosa* ISHIGA and IMOTO from mudstones of the Nishiki Group in the Muikaichi area (ISHIGA *et al.*, 1986), however, which is different from *P. globosa* from bedded chert of the Tamba-Mino Terrane in having slightly shorter pseudoabdomen.

Occurrence. This species occurs from black mudstones of the Maizuru Group in the Yanahara area, Okayama Prefecture together *P. fusiformis* (HOLDSWORTH and JONES), P. yanaharensis NISHIMURA and ISHIGA n. sp. and *P.* sp. aff. *P. longicornis* ISHIGA and IMOTO.

This species occurs from the *P. globosa* Zone of ISHIGA (1986b) and recently *P.* sp. aff. *P. globosa* was reported from the Leonardian Born Spring Limestone, West Texas (CORNELL and SIMPSON, 1985) which resembles the specimens of Japanese *P. globosa,* however, differs from it in having pseudoabdomen with one constriction.

Radiolarian Assemblages from the Maizuru Group in the Yanahara area

Although the study of radiolarian biostratigraphy of the Maizuru Group has been attempted in the two areas (ISHIGA, 1984; WAKITA, 1985), examination of the radiolarian assemblages in the broader area has first reported in this paper, which indicates that the age of the Maizuru Group includes the older age than that has been supporsed. Radiolarians from the Maizuru Group in the Yanahara area are mainly composed of Albaillellaria listed in Fig. 4 and entactiniids and latentifisutulids shown in Pl. 4. Their locations in Fig. 2 are arranged from southwest to northeast in Fig. 4.

Six radiolarian assemblages from assemblages A to F in ascending order can be discriminated considering the specific composition with emphasis on component of species of *Pseudoalbaillella* HOLDSWORTH and JONES and *Follicucullus* ORMISTON and BABCOCK (Fig. 3).

Assemblage A

Specific composition: This assemblage consists of *Pseudoalbaillella aidensis* n. sp. NISHIMURA and ISHIGA, *P.* sp. aff. *P.* longtanensis SHENG and WANG, *P.* sp. cf. *P. fusiformis* (HOLDSWORTH and JONES) and *P.* sp. aff. *P. longicornis* ISHIGA *et al.* Among the species listed above, *P. aidensis* n. sp. and *P.* sp. aff. *P. longtanensis* is the identical species of this aseemblage.

Occurrence: This assemblage occurs from black mudstones at localities of F 756, F 725, F 521, F903, F1015, F1017, F1022, F1021 and F987 which are stratigraphically situated in the lower part of Lower Formation of the Maizuru Group.

Comparison: This assemblage is the newly discriminated assemblage, for *P. aidensis* is first described herein and has been reported from the Shimomidani Formation of the Shidaka Subterrane of the Akiyoshi Terrane (ISHIGA and SUZUKI, in press). So it can be said that this assemblage corresponds to that from the *P. longtanensis* Zone of ISHIGA (1987).

Age: The *P. longtanensis* Zone is set up between the *Albaillella sinuata* Zone, and the *Pseudoalbaillella globosa* Zone and is assigned to late Leonardian in age (ISHIGA, 1986). The age of the assemblage A is regarded to be late Leonardian or certain age of the Maokoan on the basis of Chinese radiolarian data by SHENG and Wang (1985) discussed in ISHIGA (1986b, 1987).

Assemblage B

Specific composition: This assemblage is composed of *P. fusiformis* (HOLDSWORTH and JONES), *P. globosa, P. yanaharensis* NISHIMURA and ISHIGA n. sp. and *P.* sp. aff. *P. longicornis,* and among these *P. fusiformis* is diagnostic species of this assemblage.

Occurrence: This assemblage occurs from black mudstones, tuffaceous shales and acidic tuffs at localities F 929, F 844, F 916a, F 914a and F 913a, b, which are stratigraphically situated in the middle part of the Lower Formation of the Maizuru Group. This horizon is characterized by thick beds of acidic tuffs and black mudstones

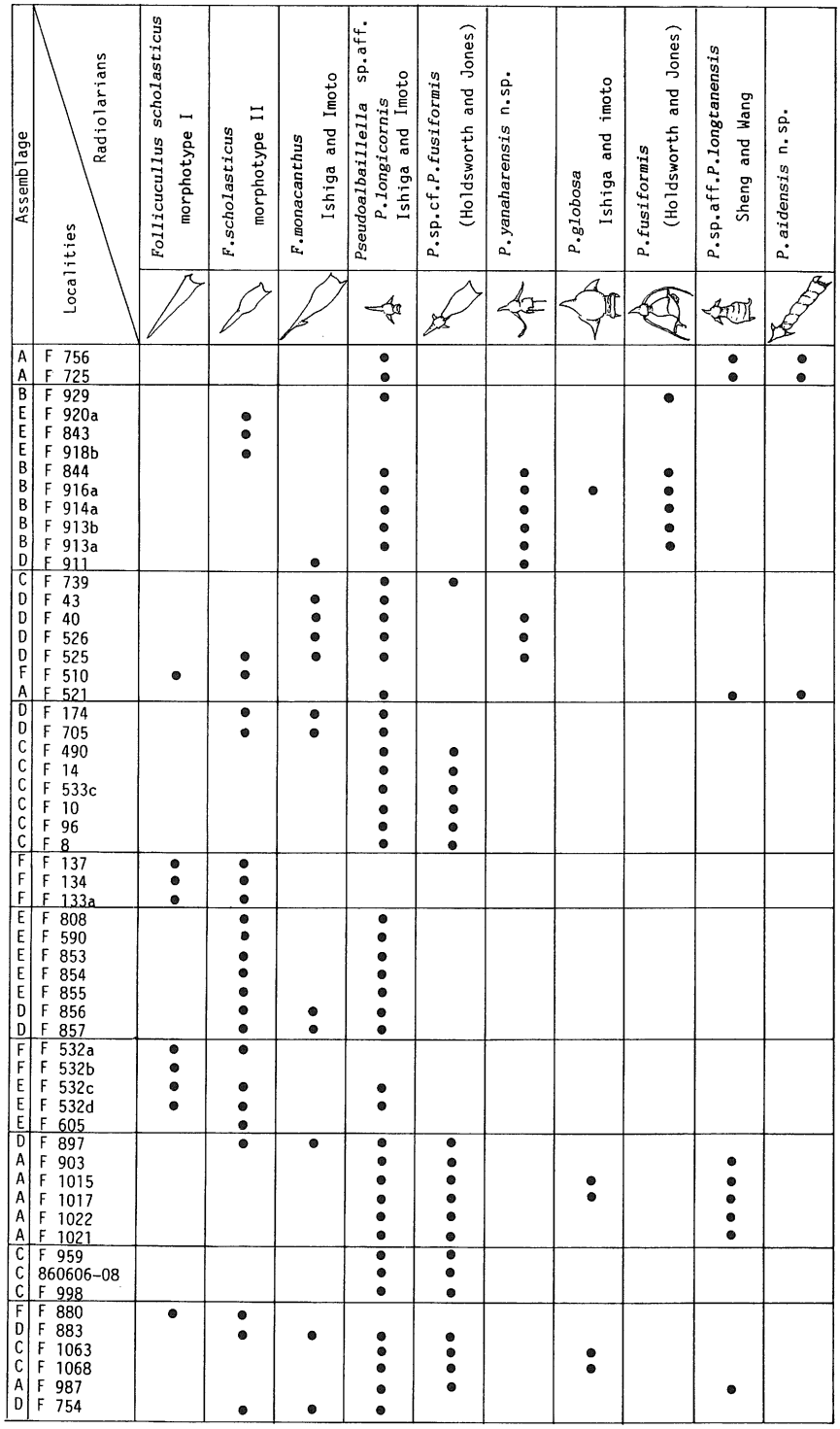


Fig. 4. List of radiolarians from Maizuru Group in the Yanahara area.

(Fig. 3).

Comparison: This assemblage corresponds to that from the upper part of the *P. longtanensis* Zone or lower part of the *P. globosa* Zone, considering the occurrence of *P. fusiformis*.

Age: If this assemblage could correspond to the assemblage from the lower part of the *P. globosa*, then the age of this assemblage could be latest Leonardian. The *P. longtanensis* Assemblage-zone is assigned to certain part of the Maokouan age (ISHIGA, 1986b).

Assemblage C

Specific composition: This assemblage consists of *P.* sp. cf. *P. fusiformis* and *P.* sp. aff. *P. longicornis* and in the lower part of this assemblage-zone of the Maizuru Group *P. globosa* occur.

Occurrence: This assemblage occurs from black mudstones, tuffaceous shales and acidic tuffs of the Maizuru Group at localities of F 739, F 490, F 14, F 533c, F 10, F 96, F 8, F 959, 860606–08, F 998, F 1063 and F 1068, which are stratigraphically situated in the upper part of the Lower Formation of the Maizuru Group.

Comparison: Diagnostic species of this assemblage are *P.* sp. cf. *P. fusiformis* and *P.* sp. aff. *P. longicornis*, which have rather long range of occurrences in the bedded chert sequence in the Tamba Terrane (ISHIGA *et al.*, 1982b) and lacks characteristic species. It is however, characterized by absence of species of *Follicucullus*, the upper limit of this assemblage-zone is clearly determined by the first appearance of *F. monacanthus* which corresponds to the top of the acidic tuffs of the lower formation. If *P.* sp. cf *P. fusiformis* could be the ill-preserved specimens of *P. fusiformis*, this assemblage corresponds to that from upper part of the *P. globosa* Zone.

Age: Middle Middle Permian, on the basis of stratigraphic position over the *P. longtanensis* Assemblage and specific composition of this assemblage.

Assemblage D

Specific composition: This assemblage consists of *P. yanaharensis* n. sp., *P.* sp. aff. *P. longicornis* and *Follicucullus monacanthus* ISHIGA, KITO and IMOTO, among these species, *F. monacanthus* is identical species of this assemblage and in the upper part, *F. scholasticus* morphotype II occurs.

Occurrence: This assemblage occurs from black mudstones of the Maizuru Group at localities F 43, F 40, F 526, F 525, F 174, F 705, F 897, F 883 and F 754 which are stratigraphically situated within the lower part of the Upper Formation of the Maizuru Group, mainly composed of black mudstones.

Comparison: This assemblage possibly directly corresponds to the assemblage of the *F. monacanthus* Range-zone, for the base of this assemblage-zone corresponds to the last appearence of *P.* sp. cf. *P. fusiformis*.

Age: Middle to late Middle Permian, on the basis of stratigraphic position and specific components discussed in ISHIGA (1986b, 1987).

Assemblage E

Specific composition: This assemblage consisits of *P.* sp. aff. *P. longicornis, F. scholasticus* morphotype II and in the upper part, *F. scholasticus* m. I occurs. This assemblage is characterized by the combination of species of *Pseudoalbaillella* and *Follicucullus.*

Occurrence: This assemblage occurs from black mudstones and bedded mudstones with thin sandstone beds of the Maizuru Group at F 48, F 808, F 590, F 853, F 854, F 855, F 532, F 552d which are stratigraphically situated in the middle part of the Upper Formation of the Maizuru Group.

Comparison: This assemblage directly corresponds to the asemblage characterized by both occurrence of *F. scholasticus* morphotypes I and II of ISHIGA (1986b, c, 1987).

Age: Early Late Permian, for age determination of the *Follicucullus scholasticus* m. I by ISHIGA (1986b, 1987).

Assemblage F

Specific composition: This assemblage is composed of *Follicucullus scholasticus* morphotypes I and II without any species of *Pseudoalbaillella.*

Occurrence: This assemblage occurs from black mudstones within alternating beds of sandstone and mudstone of the Maizuru Group at localities of F 510, F 532b, F 532a, F880, F 134, F 133a and F 133b, which are stratigraphically situated in the upper part of the Upper Formation of the Maizuru Group.

Comparison: This assemblage is directly correlated with that from the *F. scholasticus* Zone, considering the component of this assemblage, especially occurrence of *F. scholasticus* morphotype I.

Age: The *F. scholasticus* Zone occurs from the Upper Permian *Lepidolina kumaensis* Zone of the Kuma Formation, Kyushu (ISHIGA and MIYAMOTO, 1985). The assemblage characterized by the occurrence of *F. scholasticus* morphotype I is recently assigned to early Late Permian.

Conclusions

The Maizuru Group is mainly composed of coarser clastic rocks and the study of radiolarians from this group has not been progressed in recent years. ISHIGA (1985) and WAKITA (1985), succeeded to extract radiolarians from this group, which are assigned to *Follicucullus scholasticus* and *F. monacanthus,* and *F. scholasticus* and *Neoalbaillella?* sp., respectively. No other works have been reported on the Maizuru radiolarian faunas. The present study reveals that the Maizuru Group includes whole of the Middle Permian and lower Upper Permian in view of radiolarian biostratigraphy, which are rather older than those supposed. The lower part of the Maizuru Group consists of greenstones, so the early Middle Permian radiolarians from mudstone formation of the Maizuru Terrane proves that the greenstone formation of it includes the Lower Permian or older strata hidden in other areas of the Maizuru Terrane.

Acknowledgement. The authors would like to express their sincere thanks to Professor T. TOKUOKA of Shimane University for his constant encouragement and valuable suggestions through this work. Dr A. YAO of Osaka City University kindly provided facilities of SEM.

References

BLOME, C. D., JONES, D. L., MURCHEY, B. L. and LINIECKI, M., 1986: Geological implications of radiolarian-bearing Paleozoic and Mesozoic rocks from the Blue Mounatains province, eastern Oregon. *USGS Prof. Paper, 1435,* 79–93.

CORNELL, W. C. and SIMPSON, R. D., 1985: New Permian albaillellids radiolarians from West Texas. *Micropaleont.,* **31**, 271–279.

HAYASAKA, Y. and HARA, I., 1986: Permian-Jurassic tectonic evolution of the southeastern front of the Hida-Hida marginal belt, Southwest Japan. *Rep., Abst. international Symposium on Pre-Cretaceous East Asia, IGCP Project 224,* 76–81.

HOLDSWORTH, B. K. and JONES, D. L., 1980: Preliminary radiolarian zonation for Late Devonian through Permian time. *Geology,* **8**, 281–284.

ICHIKAWA, K., 1987: Pre-Cretaceous terrane-groups of Southwest Japan: majour classification-. *The 94th Ann. Meet. Geol. Soc. Japan,* 58–59 (in Japanese).

ISHIGA, H., 1984: *Follicucullus* (Permian radiolaria) from Maizuru Group in Maizuru Belt, Southwest Japan. *"Earth Sci."* (*Chikyu Kagaku*), **38**, 427–434.

———, 1985: Discovery of Permian radiolarians from Katsumi and Oi Formations along south of Maizuru Belt, Southwest Japan and its significance. *"Earth Sci."* (*Chikyu Kagaku*), **39**, 175–185.

———, 1986a: Ultra-Tamba Zone of Southwest Japan. *Jour. Geosci., Osaka City Univ.*, **29**, 45–88.

———, 1986b: Late Carboniferous and Permian radiolarian biostratigraphy of Southwest Japan. *Jour. Geosci., Osaka City Univ.*,**29**, 89–100.

———, 1986c: Late Carboniferous-Permian radiolarian biostratigraphy in Japan with special reference to distribution and phyletic lineage of *Follicucullus* in Late Permian time. *News of Osaka Micropaleont. Spec. Vol.,* no 7, 1–8 (in Japanese with English abstract).

———, 1987: Paleozoic radiolaria. *In* ICHIKAWA, K. (ed.), Pre-Creataceous Terranes of Japan. *IGCP Project 224* special publication.

——— and IMOTO, N., 1980: Some Permian radiolarians in the Tamba district, Southwest Japan. *"Earth Sci."* (*Chikyu Kagaku*), **34**, 333–345.

ISHIGA, H., KITO, T. and IMOTO, N., 1982a: Permian radiolarian biostratingraphy. *News of Osaka Micropaleontologists Special Vol.,* 5, 17–26.

ISHIGA, H., ——— and ———, 1982b: Middle Permian radiolarian assemblage from the Tamba district and adjacent area, Southwest Japan. *"Earth Sci."* (*Chikyu Kagaku*), **36**, 272–281.

——— and MIYAMOTO, T., 1986: *Follicucullus* (radiolaria) from Upper Permian Kuma Formation, Kyushu, Southwest Japan. *Trans. Proc. Palaeont. Soc. Japan N.S.,* **141**, 322–335.

——— and SUZUKI, S., in press: Reexamination of stratigraphy of the Shimomidani Formation in the Shidaka sub-terrane, of Akiyoshi Terrane, Southwest Japan. *Jour. Geol. Soc. Japan.*

———, WATASE, H. and NAKA, T., 1986: Permian radiolarians from Nishiki Group in Sangun-Chugoku Belt, Southwest Japan. *"Earth Sci."* (*Chikyu Kagaku*), **40**, 124–136.

KANMERA, K. and SANO, H., 1986: Stratigraphic and structural relationships among Pre-Creataceous accretionary and collisional systems in Akiyoshi Terrane. *IGCP Project 224, Guide book for excursion,* 51–88.

KOJIMA, S., 1982: Some Jurassic, Triassic and Permian radiolarians from the eastern part of Takayama

City, Central Japan. *News of Osaka Micropaleontologists Special Vol.*, **5**, 81–91 (in Japanese with English abstract).

KURIMOTO, C., 1986: Ultra-Tamba zone in Fukuchiyama area, Kyoto Prefecture-its constituent rocks and distribution-(Short Report), *"Earth Sci."* (*Chikyu Kagaku*), **40**, 64–67 (in Japanese).

MITSUNO, C. and OHMORI, N., 1964: Geological map of Japan and its explanatory text. 1:50,000 "Susai Sheet", *Geol. Surv. Japan.* 58 p. (in Japanese with English abstract).

————, NUREKI, T., SUGITA,M. and ASAMI, M., 1975: Geology and modes of occurrence of iron sulfide deposits in the Yanahara mining distrit: studies on geology and ore deposits in the Yanahara mining district-Part I, *Mining Geol.*, **25**, 331–345 (in Japanese with English abstract).

MIYAKE, K., 1985: Permian olistostrome complex in the Katsuyama area, Okayama Prefecture, Southwest Japan. *Jour. Geol. Soc. Japan,* **91**, 463–475 (in Japanese with English abstract).

NAKA, T. and ISHIGA, H., 1987: Carboniferous to Jurassic (especially Permian) radiolarians recovered from the Chugoku region (a review). *Mem. Fac. Sci., Shimane Univ.*, **21**, 153–167.

NAKAZAWA, K., SHIKI, T. and SHIMIZU, D., 1954: Paleozoic and Mesozoic Formations in the vicinity of Fukumoto, Okayama Prefecture-a study of the stratigraphy and geologic structure of the "Maizuru Zone" (Part 1). *Jour. Geol, Soc. Japan,* **60**, 97–105 (in Japanese with English abstract).

———— and NOGAMI, Y., 1957: Summary of the Lower and Middle Triassic System in the Maizuru Zone-A study on the stratigraphy and geologic structure of the "Maizuru Zone" (Part 8). *Jour. Geol. Soc. Japan,* **64**, 125–137 (in Japanese with English abstract).

OHOKA, T., 1984MS: A study on stratigraphy and geologic structure of the Kozuki district, Sayo-gun, Hyogo Prefecture, Japan. *Master thesis of Hiroshima Univ.* (in Japanese with English abstract).

SHENG, J. and WANG, Y., 1985: Fossil radiolaria from Kufeng Formation at Longtan, Nanjing. *Acta Palaeont. Sinica,* **24**, 171–180 (in Chinese with English abstract).

SHIMIZU, D., NAKAZAWA, K., SHIKI, T. and NOGAMI, Y., 1962: Stratigraphy of the Permian Maizuru Group, Southwest Japan.-A study of the Maizuru Zone (Part 10)-. *Jour. Geol. Soc. Japan,* **68**, 237–246 (in Japanese with English abstract).

SUZUKI, S., NISHIOKA, T., SUGITA, M., MITSUNO, T. and ISHIGA, H., 1987 in press: Ultra-Tamba zone in the Seto area, Okayama Prefecture. *Jour. Geol. Soc. Japan* (in Japanese).

TAZAWA, J., AITA, Y., YUKI, T. and OTSUKI, K., 1984: Discovery of Permian radiolarians from the "non-calcareous Paleozoic strata" of Ohmi, Central Japan (Short Report). *"Earth Sci."* (*Chikyu Kagaku*), **38**, 264–267 (in Japanese).

TOKUOKA, T., WATANABE, T., ISHIGA, H., LANDIS, C. A., PILLAI, D. D. L., NISHIMURA, K., and CHOI, J. Y., 1987: Permian Maizuru Group and Yakuno Ophiolitic rocks in the northeastern part of Yanahara area in Okayam Prefecture, Southwest Japan. *Mem. Fac. Sci., Shimane Univ.*, **21**, 189–208.

UCHIYAMA, F., SANO, H. and KANMERA, K., 1986: Depositional and tectonic setting of cherts around the Akiyoshi Limestone Group, Southwest Japan. *mem. Fac. Sci., Kyushu Univ., D,* **26**, 51–68.

WAKITA, K., 1983: Discovery of Middle-Late Permian radiolarians in the Karita and Hachimandai Formations in the northeast environs of Hiroshima, Japan. *"Earth Sci."* (*Chikyu Kagaku*), **39**, 237–240 (in Japan).

———— and OKAMURA, Y., 1982: Mesozoic sedimentary rocks containing allochthonous blocks, Gujo-hachiman, Gifu Prefecture, Central japan. *Bull Geol. Surv., Japan,* **33**, 161–185 (in Japanese).

Explanation of Plates

Plate 1

Figs. 1–3. *Follicucullus scholasticus* ORMISTON and BABCOCK morphotype I ISHIGA
Occurrence; Figs. 1, 3, F 137. Fig. 2, 137a.
Figs. 4–6. *Follicucullus scholasticus* ORMISTON and BABCOCK morphotype II ISHIGA
Occurrence; Fig. 4, F. 510a. Figs. 5, 6, F 137.
Figs. 7–10. *Follicucullus monacanthus* ISHIGA and IMOTO
Occurrence; Figs. 7, 8, 10, F 756. Fig. 9 F 526.
Figs. 11–12. *Pseudoalbaillella* sp. cf. *P. aidensis* NISHIMURA and ISHIGA n. sp.
Occurrence; Figs. 11, 12, F 521.
Figs. 13–18. *Pseudoalbaillella* sp. cf. *P. fusiformis* (HOLDSWORTH and JONES)
Occurrence; Fig. 13, F 856. Fig. 14, F 739. Fig. 15, F 521. Figs. 16–18, F 1017.
Magnification; Figs. 1–7, 16, 18, ×125. Figs. 8–10, 12–15, 17, ×100. Fig. 11, ×75.

Plate 2

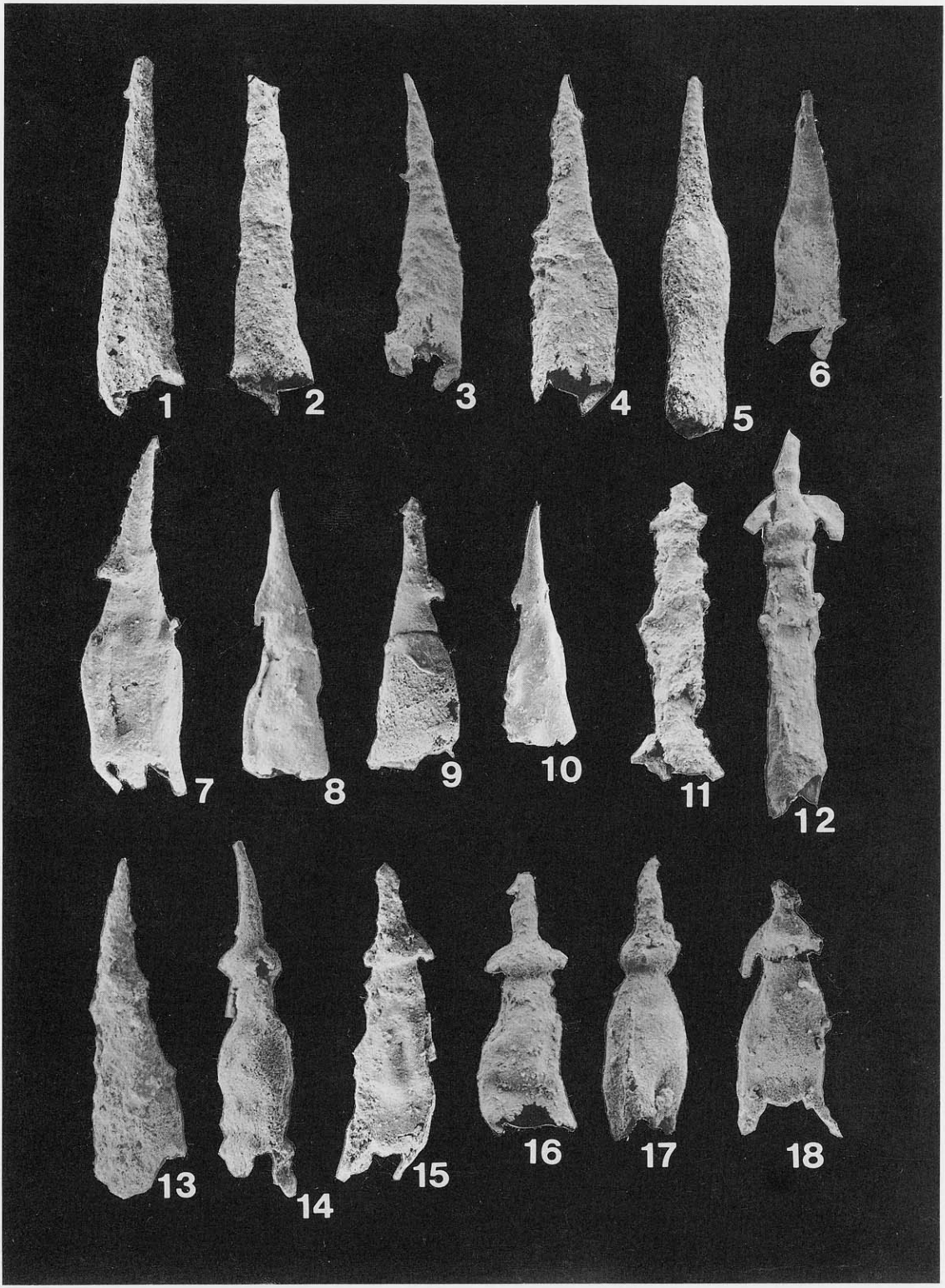
Figs. 1–8. *Pseudoalbaillella yanaharensis* NISHIMURA and ISHIGA n. sp.
Fig. 1, holotype DGSU PR 1001, Figs. 2–8, paratype DGSU PR 1002–1008.
Occurrence; Figs. 1–6, F 914a. Fig. 7, F 526. Fig. 8, F 40.
Magnification; Figs. 1, 2, 4, 6, ×125. Fig. 3, ×100. Figs. 4, 6, ×150.
Figs. 9–14. *Pseudoalbaillella aidensis* NISHIMURA and ISHIGA n. sp.
Fig. 11 holotype. DGSU PR 1009. Figs. 10, 12, 13, paratypes. DGSU PR 1010, 1011, 1012.
Occurrence; Fig. 9, F 1017. Figs. 10–14, F 521.
Magnification; Fig. 9, ×125. Figs. 10–14, ×100.

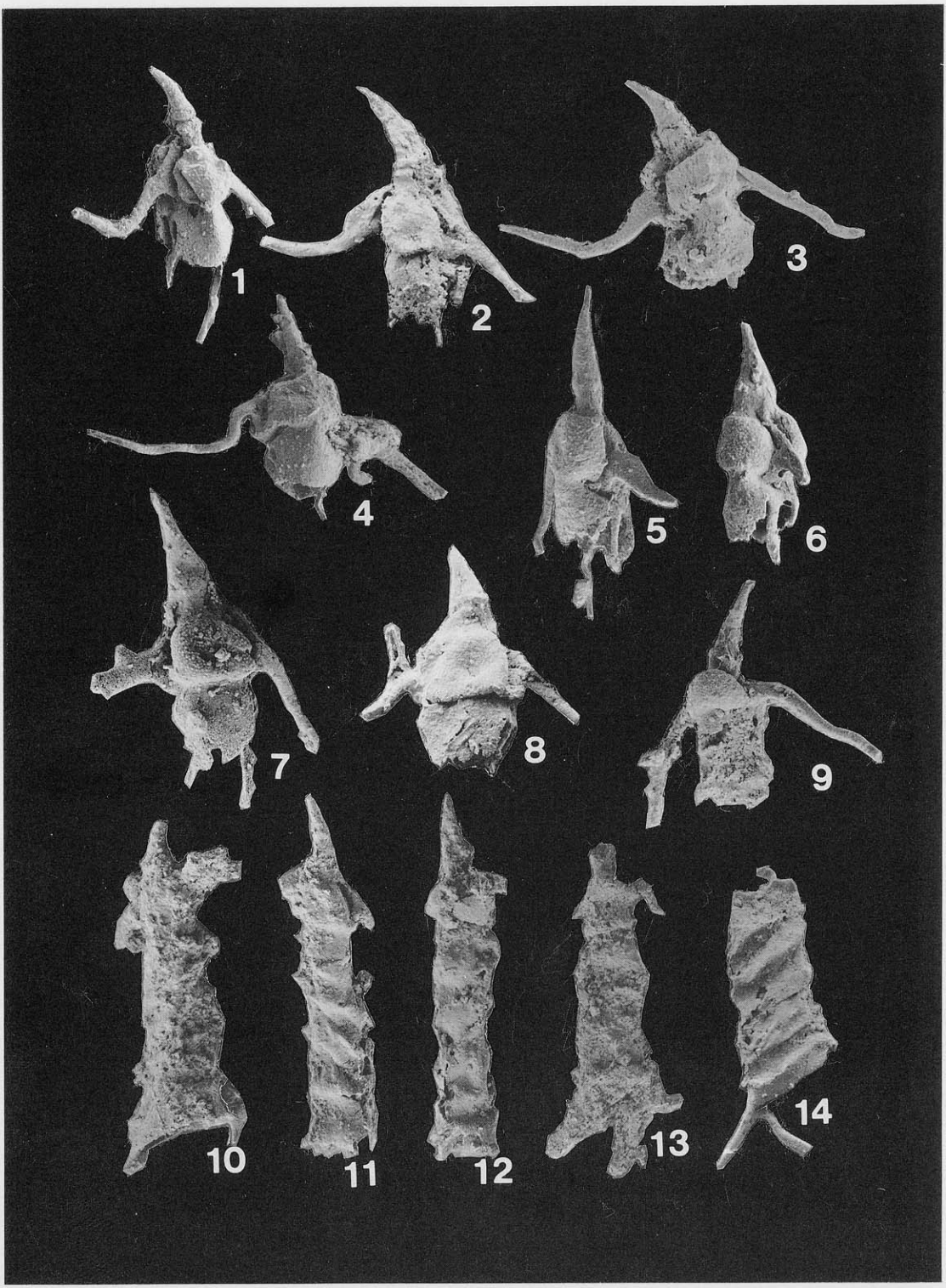
Plate 3

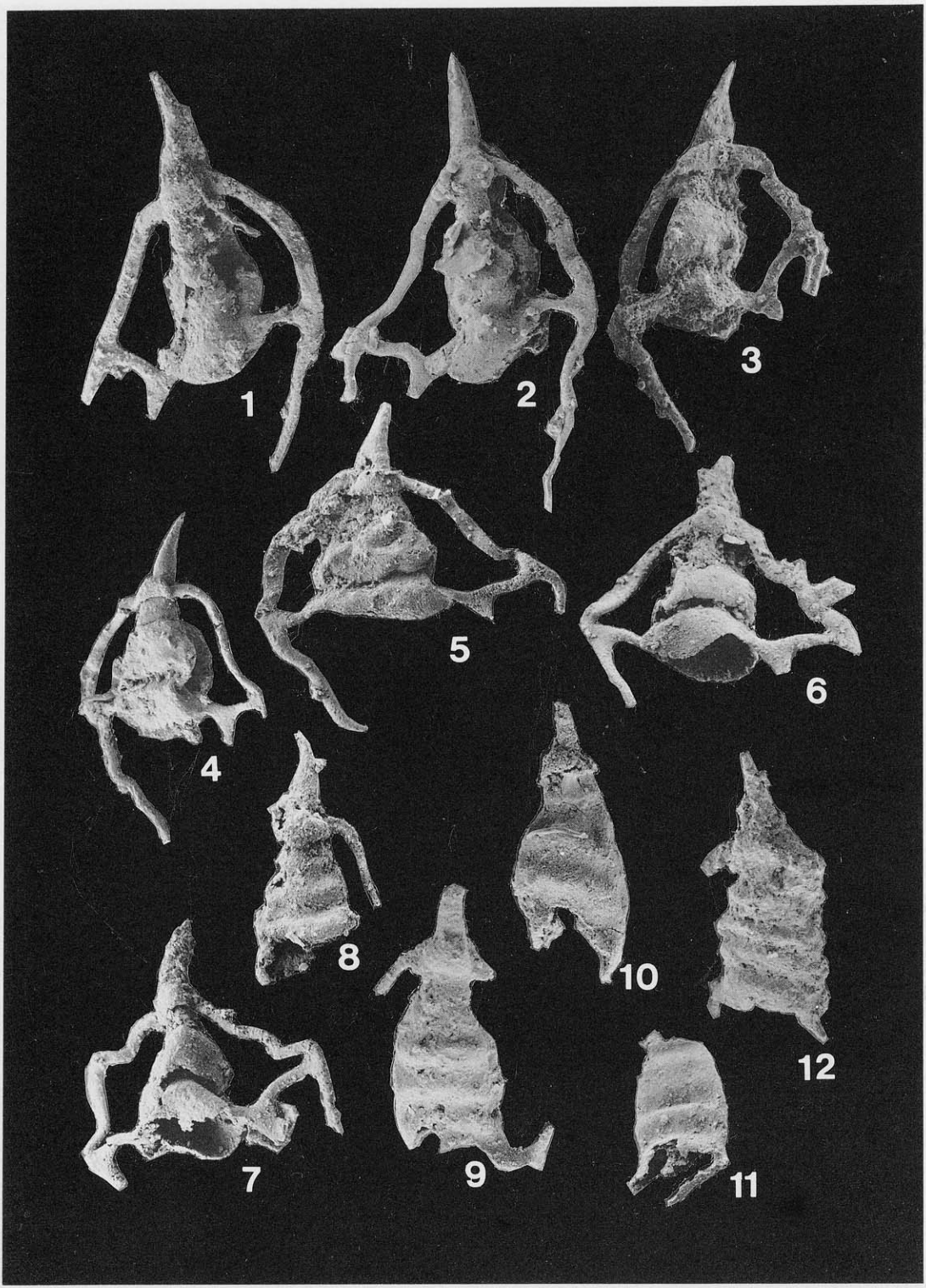
Figs. 1–7. *Pseudoalbaillella fusiformis* (HOLDSWORTH and JONES)
Occurrence; Figs. 1–7, F 914a. Magnification; Figs. 1–7, ×100.
Figs. 8–12. *Pseudoalbaillella* sp. aff. *P. longtanensis* SHENG and WANG
Occurrence; Figs. 8, 11, F 1017 and Fig. 12, F 725.
Magnification; Figs. 8, 11, ×100. Figs. 9, 10, ×125.

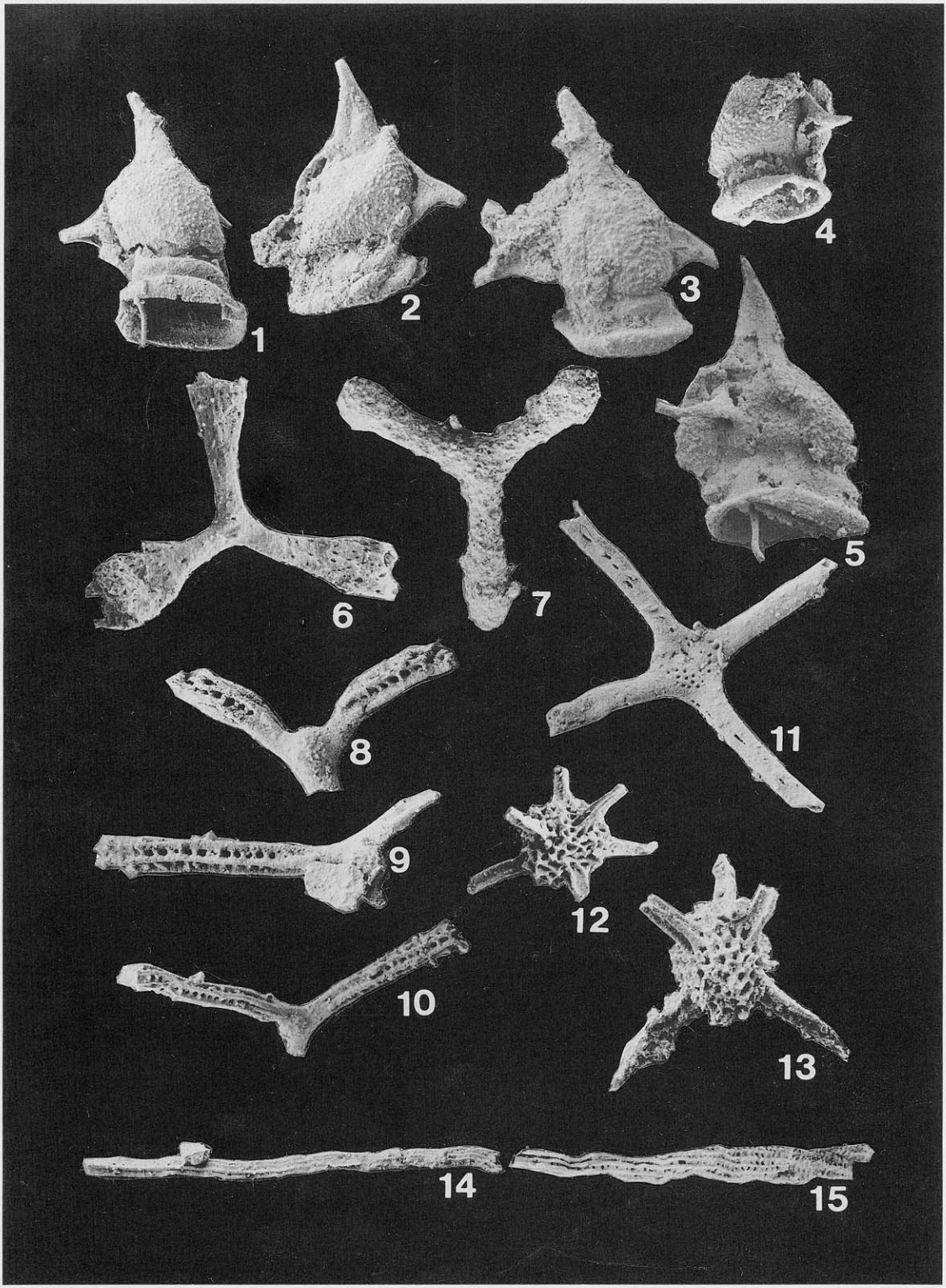
Plate 4

Figs. 1–5. *Pseudoalbaillella globosa* ISHIGA, KITO and IMOTO
Occurrence; Figs. 1–5, F 916a. Magnification; Figs. 1–3, 5 ×125. Fig. 4, ×100.
Figs. 6, 7 *Ishigaum* sp.
Occurrence; Fig. 6, F 998. Fig. 7, F 134. Magnification; Figs. 6, 7, ×100.
Figs. 8–10 *Nazarovella* sp.
Occurrence; Fig. 8, F 40. Fig. 9, F 526. Fig. 10, F 844.
Magnification; Figs. 8, 9 ×150. Fig. 10, ×100.
Figs. 11, 12, 13 unnamed entactiniids
Occurrence; Fig. 11, F 844. Fig. 12, F 40. Fig. 13, F 913a.
Magnification; Fig. 11, ×100. Figs. 12, 13, ×150.
Figs. 14, 15 *Nazarovella* sp.
Occurrence; Figs. 14, 15 F 844.
Magnification; Figs. 14, 15, ×50.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18


1
2
3
4
5
6
7
8
9
10
11
12
13
14


1
2
3
4
5
6
7
8
9
10
11
12


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15