Bull. Mizunami Fossil Mus., no. 21 (1994), p. 1-11, 7 figs., pls. 1-5.

原著 (Original Articles)

Lower Miocene New Nassellarians (Radiolaria) from the Toyohama Formation, Morozaki Group, Central Japan

Kazuhiro Sugiyama

Department of Earth and Planetary Sciences, School of Science, Nagoya University
Chikusa, Nagoya 464-01, Japan

Abstract

Six new nassellarians, each of them is the type species of new genus, are described from the Lower Miocene Toyohama Formation, Morozaki Group, central Japan. The family assignments are as following based on their internal skeletal structures; *Sertiseria batlax* n. gen., n. sp. is assigned to the family Artostrobiidae, *Chitascenium cranites* n. gen., n. sp. and *Genetrix petrushevskayae* n. gen., n. sp. to the family Sethophormidae emend. herein, and *Ectotoxon xetton* n. gen., n. sp., *Entepipedus zophyi* n. gen., n. sp. and *Gomisterna hospes* n. gen., n. sp. are treated as Nassellaria incertae sedis. *Ectotoxon xetton* has no arches diagnostic for the family assignment. *Entepipedus zophyi* has two secondary lateral rays but lacks two primary lateral rays. *Gomisterna hospes* has lophophaenid-like lobate cephalis, but has two secondary lateral rays.

Key words : Lower Miocene, Radiolaria, Nassellaria, systematics, Morozaki Group, central Japan.

Introduction

In the course of analyzing a radiolarian assemblage from the Lower Miocene Toyohama Formation, Morozaki Group, central Japan, some nassellarians were encountered that did not fit into any of the existing genera, and two genera *Steganocubus* and *Syscioscenium* were established in my previous papers (Sugiyama, 1992, 1993). The purpose of this study is to present systematic paleontology of the remainders by careful attention to clarifying their internal skeletal structures, at which much interest of investigators in recent years has been directed in order to establish a natural system of nassellarians (e.g. Nishimura, 1990; Funakawa, 1994).

Descriptive terms of spicule (**MB, A, D, L, l, V** and **Ax**) follows Dumitrica (1991) who presented their intelligible historical review. With respect to those of connecting arches, this study adopts not recently prevalent expression which is the combination of two initials of the spicule elements (**AD, Ll, LV**, etc.) but Petrushevskaya's (1968, 1971b, etc.) method combining two letters of branches or verticils (***ac, cp, pd,*** etc.; Fig. 1). It is based mainly on the reason mentioned in the remarks of the family Sethophor-

midae. In addition, terms **PR**, **D'** and **V'** defined by Sugiyama (1993) are used for a few genera.

Six new genera are proposed below. One of them is assigned to the family Artostrobiidae Riedel, 1967, and two to the family Sethophormidae Haeckel, 1881, emend. herein. However, the other three possessing rather bizzare skeletal characters are not assigned to the existing families. It is expected that the results of this study will contribute to accumulating knowledge of nassellarian internal skeleton, although they may await a certain extent of revision in future.

The studied samples TH-1 to 4 are decapod-bearing calcareous nodules, whose detailed information is given in Sugiyama (1993). All holotype and paratype specimens are deposited in Department of Earth and Planetary Sciences, Nagoya University, designated by the ESN prefix.

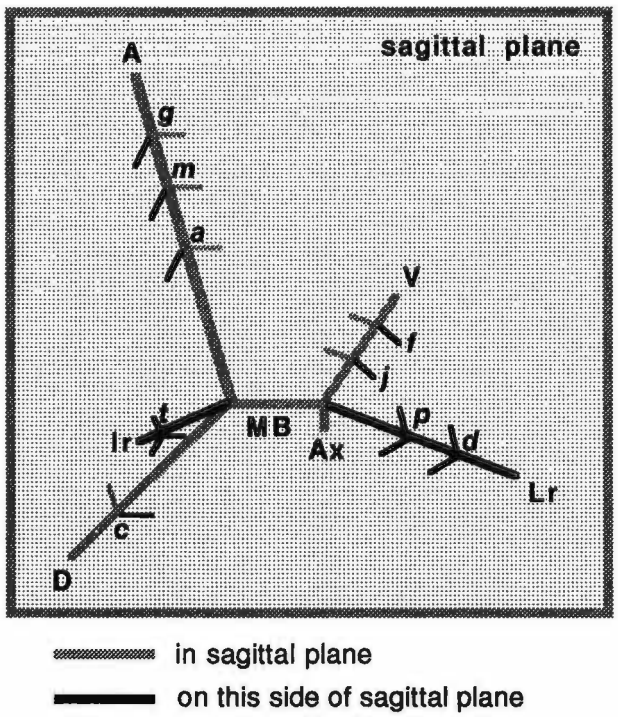


Fig. 1. Nomenclature of nassellarian internal skeleton with verticils in right lateral view, modified from Petrushevskaya (1968, 1971b). **MB:** Median bar; **A:** Apical ray; **D:** Dorsal ray; **Lr:** Right primary lateral ray, **lr:** Right secondary lateral ray, **V:** Ventral ray, **Ax:** Axial ray. Names of verticils (other letters) are abbreviations of anterior (***a***), pectral (***p***), jugal (***j***) and so on (see Petrushevskaya, 1968).

Systematic Paleontology

Order Nassellaria Ehrenberg, 1875

Suborder Cyrtida Haeckel, 1862, emend. Petrushevskaya, 1971a

Family Artostrobiidae Riedel, 1967, emend. Foreman, 1973

Genus *Sertiseria* Sugiyama n. gen.

Etymology: From the Latin *sertus*, joined, and *seria*, barrel, feminine gender.

Type species: *S. batlax* Sugiyama n. sp.

Diagnosis: Test consisting of a hemispherical cephalis, a truncated conical thorax and three or more, barrel-shaped post-thoracic segments; collar stricture indistinct and subsequent ones distinct externally; pores circular to subcircular, horizontally and diagonally aligned on post-thoracic segments. Internal skeleton including arches is of artostrobiid type; spicule composed of **MB**, **A**, **D**, two **L** (**Lr** and **Ll**), two **l** (**lr** and **ll**), **V** and simple **Ax**. **MB** and two **L** without long, downward projection at the middle on the base. **A**, **D**, two **L** and **V** extending into short, conical spines. **V** has a horizontal branch ***j*** between the proximal end and the junction of arch ***pf***, which extends to lattice of the cephalis. Arches ***cl***, ***lp*** and ***pj*** distinct. Presence of arch ***pp*** not certain. The details of arches locating in the upper half of cephalis are not known.

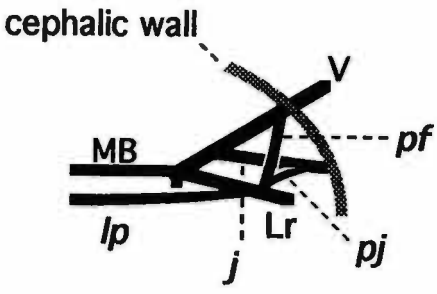


Fig. 2. Schematic illustration of internal skeleton of *Sertiseria batlax* n. gen., n. sp. in ventral side, right lateral view.

Ventral tube (vertical tube of Foreman, 1973) is absent.

Remarks: The ventral half of the internal skeletal structure is given in Fig. 2, which corresponds to the Structure Type-XII of Nishimura (1990, Figs. 10-12a, b). *Botryostrobus* Haeckel, 1887, has the same internal skeletal structure, but differs from *Sertiseria* n. gen. in having long downward projections at the middle on the base of **MB** and two **L** and ventral tube, and lacking small spines prolonged from **D** and two **L**. *B. kerguelensis* Caulet, 1991, is apparently included in this genus. It is, however, uncertain that this genus includes *B. joides* Petrushevskaya, 1975, so that the precise geologic range of *Sertiseria* n. gen. is not clear in the Paleogene.

Range: Eocene (?) to Miocene so far as known.

Sertiseria batlax Sugiyama n. sp.
(Pl. 1, Figs. 1a-3b)

? *Botryostrobus* (?) sp., Petrushevskaya and Kozlova, 1979, fig. 360.

Botryostrobus sp., Caulet, 1985, p. 861, pl. 6, fig. 2.

Description: Test as with genus, commonly more than five-segmented, more or less curved to the ventral side beyond thorax, and having bristle-like by-spines around the shell wall. Maximum width is commonly recognized in the fourth or fifth segment, whereas the highest segment is inconstant in a population. Cephalis pierced by small pores irregularly arranged. **A** is relatively short in cephalic cavity, incorporated with cephalic wall in the distal part, and prolonged into a conical spine which extends just overhead or to obliquely ventral direction. **D** and two **L** also penetrate the cephalic wall as short spines near the collar stricture. **V** extending 45° upward from the horizontal, and commonly forming a small spine outside. Ventral pore (vertical pore of Goll, 1968) is not conspicuous externally due to its porous and shaggy cephalis. Each of post-thoracic segment has more than three horizontal rows of pores, in which more than ten pores are visible in lateral view. Termination of the final segment in well-preserved specimens is a thin, horizontal ring.

Remarks: This species is distinguished from *Botryostrobus kerguelensis* Caulet by having a larger number of circular pores on the test. The former also differs from the latter in having shorter segments, which results in forming a conical outline of the test. The abundance is very rare (1>@>0.5 %) in the examined samples.

Dimensions (in μm): Length of test 73-123; of apical spine 7-15; of cephalothorax 23-33; of abdomen 13-33. Maximum width of test 20-63; of abdomen 43-58; of fourth segment 48-63.

Holotype: ESN 147051 from the sample TH-4 (Pl. 1, Figs. 1a-b).

Etymology: Named by an arbitrary combination of letters.

Family Sethophormidae Haeckel, 1881, emend.

Emended diagnosis: One or more segmented nassellarians without distinct external lobation on cephalis. Internal spicule composed of **MB**, **A**, **D**, two **L** and **Ax**. **V** is present or absent. **A** extending in cephalic cavity as a columella and having at least one verticil of three branches (***a*** of Petrushevskaya, 1968) which cross one another at 120° from apical or basal view, direct horizontally or slightly upward and arise almost from one level. **D** and two **L** also have at least one verticil of three branches (***c*** and ***p*** of Petrushevskaya, 1968), two of which locating on horizontal plane are always well-developed. Arches ***cp*** and either ***pp*** or ***pj***, often accompanied with ***cD*** and ***pL***, usually define cephalic margin. Development of other arches is more or less variable.

Remarks: Defined as above mentioned, the family Sethophormidae in this study apparently comprises members of Sethopformidae and two subfamilies Sethoperinae and Clathromitrinae of Plagiacanthidae in the sense of Petrushevskaya (1971b).

It seems that expression of connecting arches by Petrushevskaya (1968) is better especially for this family than recent one such as arch **AL**, since none of skeletal elements directly connect neighboring rays of the spicule as a single element. For example as shown in Fig. 3, it is obvious that arch **DL** by recent expression is composed of two branches and one arch; namely ***c*+*cp*+*p*** of Petrushrevskaya (1968). This is also

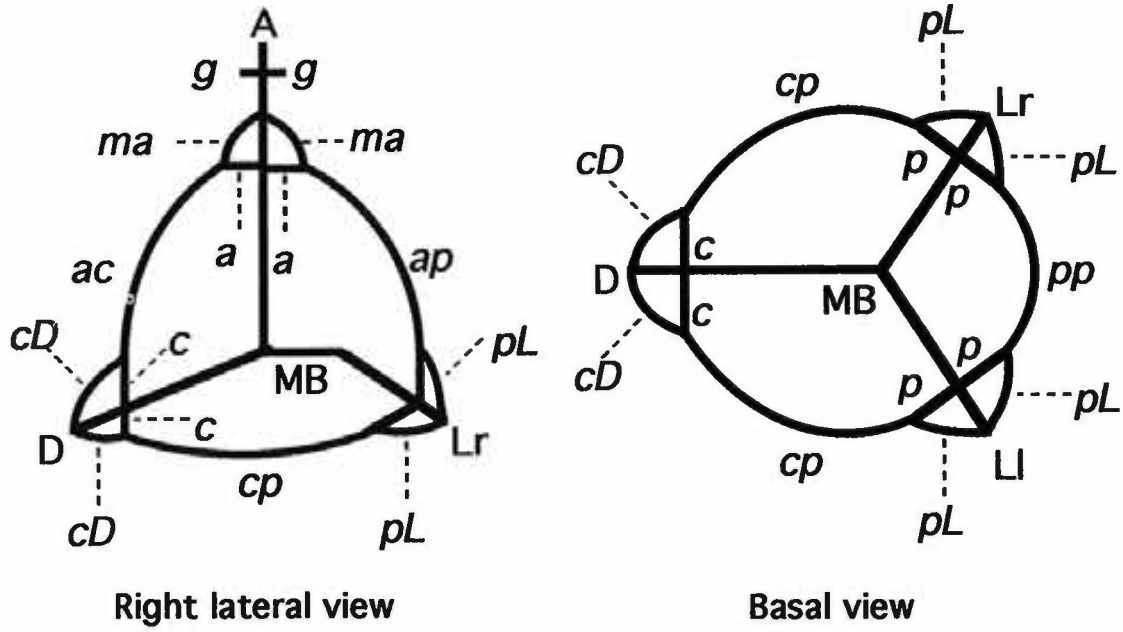


Fig. 3. Schematic illustration of sethoperid skeleton without **V**. Expression of arches follows Petrushevskaya (1968). If **V** is present and attaches to arch ***pp***, the name arch ***pp*** should be changed to arch ***pj*** (two ***pj*** correspond to one ***pp***).

applicable to other arches connecting **A** and other rays (e.g. Pl. 2, Figs. 2a, b). Although some genera with lamellar or solid cephalic wall (e.g. *Clathrocorys murrayi* Haeckel, 1887, Pl. 2, Figs. 1a, b; *Clathrolychnus* sp., Pl. 2, Figs. 3a, b; *Euscenarium joergenseni* (Dumitrica, 1978), Pl. 2, Figs. 8a, b) look to have arches **AL** and **AD** as single skeletal elements especially from the basal view, it may be due to secondary thickening of wall and skeleton.

In general arches ***ac*** and ***ap*** are ambiguous or not recognized in genera with delicately latticed or spongy cephalic wall (e.g. *Callimitra* sp. A, Pl. 2, Figs. 6a, b). Moreover, highly spicular forms lack even arch ***cp*** as well as ***ac*** and ***ap*** (e.g. *Tetraplecta* sp. A, Pl. 2, Fig. 4; *Plectaniscus* sp. A, Pl. 2, Fig. 5). Therefore, absence of those arches is not decisively significant for family classification. Much more important morphology, as a synapomorphous feature of the family members, are that they have one verticil of three branches ***a*** (corresponding to **AD**-, **ALr**- and **ALl**-branches of Sugiyama, 1992) at the middle to distal part in non-lobate cephalis without exception. This is the stablest character independent of any other features, such as shell form, intersecting position of **V**, angles between **D**, two **L** and **V**, *etc*. (e.g. *Sethophormis* sp. aff. *S. aurelia* Haeckel, 1887, Pl. 1, Figs. 7a, b; *Clathromitra* sp., Pl. 2, Figs. 7a, b).

Presence or absence of **V** and, if **V** is present, the intersecting position on cephalic wall which regulate arch structure in the ventral side of cephalis may be important criteria for the subfamily classification, but it is beyond the scope of this study.

Genus *Chitascenium* Sugiyama n. gen.

Etymology: Derived from the type locality Chita Peninsula and the Greek *skene,* a tent, neuter gender.

Type species: *C. cranites* Sugiyama n. sp.

Diagnosis: One-segmented sethophormid genus with the same internal skeletal structure to *Syscioscenium* Sugiyama, 1992. **A** penetrates cephalis as a spine outside. **D** and two **L** also extends into long feet. Arches ***ac*** and ***ap*** may be present as lattice bars of cephalic wall. The wall is composed of thick bars with rounded cross section, and lacking spongy structure but having by-spines of various length and direc-

tions.

Remarks: This genus differs from *Protoscenium* Jørgensen, 1905, in its smaller dimensions and having thick lattice bars. It is somewhat similar to *Syscioscenium* Sugiyama, 1992, especially *S.* sp. A (Pl. 1, Figs. 5a, b), but is distinguished from the latter genus by lacking spongy cephalic wall and thorax.

Range: Early Miocene so far as known.

Chitascenium cranites Sugiyama n. sp.
(Pl. 1, Figs. 4a-4d, 6a-6b)

Description: Test as with genus. Cephalis nearly hemispherical and pierced by oval to circular pores of various size. **A**, **D** and two **L** has small nodes, and extend into an apical spine and feet that direct nearly downward, respectively. Long by-spines are scattered on the cephalic wall. There are also very long by-spines just like feet at the middle of arches ***cp*** and ***pp***. Lattice bars are often developed on a small scale around the proximal part of feet and the feet-like by-spines.

Remarks: Refer to the generic remarks. The abundance is extremely rare (less than 0.5 %) in the examined samples.

Dimensions (in μm): Length of apical spine up to 30; of cephalis 30-45; of by-spine up to 50; of feet 33-50; Maximum width of cephalis 35-43.

Holotype: ESN 147054 from the sample TH-4 (Pl. 1, Figs. 4a-d).

Etymology: From the Greek *kranos* meaning a helmet.

Genus *Genetrix* Sugiyama n. gen.

Etymology: From a by-name of the Roman goddess *Venus*, feminine gender.

Type species: *G. petrushevskayae* Sugiyama n. sp.

Diagnosis: Test large, consisting of two segments of small cephalis and large thorax that is longer than wide. Internal spicule composed of **MB**, **A**, **D**, two **L**, **V** and **Ax**. **A** has three, prominent branches ***a*** that are nearly parallel to **D** and two **L**, and protrudes cephalic wall as an apical spine. **D** and two **L** incorporated with thoracic wall, forming three ribs, and further extending beyond thoracic margin as divergent feet. Branches ***c*** and ***p*** are stout, and arches ***cD*** and ***pL*** are as thick as ***cp*** and ***pp***. **V** extending obliquely upward (nearly 30°-45° upward from the horizontal), and penetrating cephalic wall above arch ***pp***. Arches ***ac*** and ***ap*** present or absent. There are three, delicate panels (Goll, 1979) outside shell wall, which extends from the distal part of the apical spine along the thoracic ribs.

Remarks: This genus resembles *Clathromitra* Haeckel, 1881, from which it is distinguished by having a long thorax, extensions of **D** and two **L** incorporated with thorax, and **V** intersecting above thick arch ***pp***.

Range: Early Miocene so far as known.

Genetrix petrushevskayae Sugiyama n. sp.
(Pl. 3, Figs. 1a-3)

Description: Test as with genus. Cephalis pierced by a lot of subcircular pores of various size. Some specimens have arches ***ac*** and ***ap***, but they are not traceable in others. Collar stricture is marked by a gentle change in contour. Thorax divided into barrel-shaped upper and frustum lower parts by a central constriction without internal structures. The upper thorax more or less sinuated, with the maximum width at the middle, pierced by larger, subcircular to subangular pores arranged without regularity; bars thin, oval to circular in cross section. Cephalis and the upper thorax generally covered by a spongy mantle. The lower thorax is as long as or slightly shorter than the upper part, and the margin is commonly wider than the maximum diameter of the upper part. Pores of the lower thorax commonly subangular, and bars are thin. Feet slightly curved inward and three-bladed.

Remarks: Refer to the generic remarks. The abundance is very rare to extremely rare in the examined samples.

Dimensions (in μm): Length of apical spine 35-60; of cephalis 40-60; of thorax including feet 150-250. Maximum width of the upper thorax without panels; 90-150.

Holotype: ESN 147064 from the sample TH-4

(Pl. 3, Figs. 1a-c).

Etymology: This species is named after Dr. M. Petrushevskaya, Russia, in honor of her great contributions to Cenozoic radiolarian study.

Nassellaria incertae sedis

Genus *Ectotoxon* Sugiyama n. gen.

Etymology: From the Greek *ectos*, without, and *toxon*, arch, neuter gender.

Type species: *E. xetton* Sugiyama n. sp.

Diagnosis: Multisegmented nassellarian genus whose internal spicule consists of **MB**, **A**, **D**, two **L**, **V**, and wart-like **Ax**. Very small **D'** (Sugiyama, 1993) and **Ax**-like projections may be present on the base of **D**, two **L** and **V**. There are no arch structures. **A**, **D**, two **L** and **V** penetrate shell wall as well-developed spines and feet outside. Cephalis is subhemispherical, more or less sinuated especially in the dorsal side, and distinguished from thorax by a change in contour. Post-cephalic segment are barrel-shaped or inverted frustum, wider than long, separated one another externally by constrictions and internally by ring-like septa.

Remarks: *Pterocorythium* Haeckel, 1887, and *Stichopilium* Haeckel, 1882, are similar to *Ectotoxon* n. gen. with respect to the multisegmented test with stout two spines and three feet. Moreover, the former genera usually have **Ax**-like projections on **D**, two **L** and **V** as well as the latter. These facts strongly suggest a certain phylogenetic relationship of these genera. However, *Ectotoxon* n. gen. do not have any arch structures although *Pterocorythium* and *Stichopilium* have a internal skeleton in highly common with lophophaenids. In my present opinion, there exists a compact, monophyletic taxon represented by *Stichopilium*, to which *Ectotoxon* n. gen. belongs as an extraordinary member. This is contradictory to a recent doctrine that insist exclusively on detailed cephalic arch structure for suprageneric taxonomy.

Range: Oligocene to Early Miocene so far as known.

Ectotoxon xetton Sugiyama n. sp.

(Pl. 3, Figs. 4a-c; Pl. 4, Figs. 1a-2)

Stichopilium bicorne Haeckel, 1887; Petrushevskaya, 1981, fig. 170.

Description: Test as with genus, increasing the width distally. Cephalis pierced by circular to subcircular pores, with many rod-like spines of various length and thickness. Two of the spines, which are longer and thicker than the others, are prolongations of **A** and **V**. **D** and two **L** extending obliquely downward along thoracic wall, and prolonged into long, rod-like feet which often incorporated with abdominal wall. Thorax pierced by circular pores horizontally aligned and cuincuntially arranged. Abdomen and the fourth segment are sometimes spinose like the proximal two segments. Pores of post-thoracic segments become larger distally. Thin connector bars developed between post-thoracic segments and feet. The final segment has thinner lattice bars.

Remarks: This species is very similar to *Lophocorys* (?) sp. A (Pl. 4, Figs. 3a-c) which belongs to a new genus comprising ***L. polyacantha*** Popofsky, 1913. The former differs from the latter in having more than four segments and lacking arches in the skeleton. The abundance is extremely rare in the examined samples.

Dimensions (in μm): Length of apical spine 30-50; of test except spines 95-133; of cephalis 23-33; of thorax 13-20; of feet 50-85. Maximum width of test except feet 80-93; of cephalis 33-40; of thorax 53-63.

Holotype: ESN 147067 from the sample TH-4 (Pl. 3, Figs. 4a-c).

Etymology: Named by an arbitrary combination of letters.

Genus *Entepipedus* Sugiyama n. gen.

Etymology: From the Greek *entos*, within, and *epipedos*, a plane, alluding to the arrangement of spines, masculine gender.

Type species: *E. zophyi* Sugiyama n. sp.

Diagnosis: Test composed of lobate cephalis and thorax. Internal spicule composed of **MB**, **A**, **D**, two **I**, **V**, **V'** (Sugiyama, 1993) and **Ax**. Two **L** are completely absent. There are two arches ***aj*** that horizontally or obliquely connect **A** and **V**, corresponding to

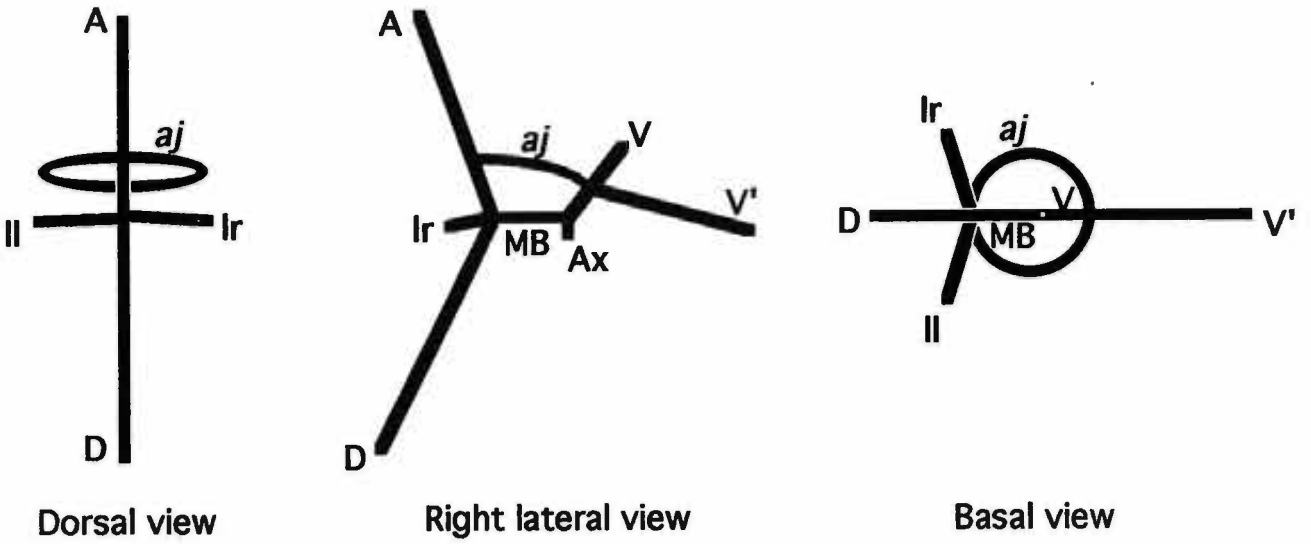


Fig. 4. Schematic illustration of internal skeleton of *Entepipedus zophyi* n. gen., n. sp.

PR of Sugiyama (1993). **V'** extends from the junction of those arches and **V**.

Remarks: This genus is distinguished from hitherto known Cenozoic nassellarians by its peculiar internal skeletal structure missing two **L** (Fig. 4), but the cephalic lobation highly suggests a certain phylogenetic relationship between *Entepipedus* n. gen. and lophophaenid genera. **PR** of this genus thus seems to be homologous with arches ***ap*** plus ***pj*** (***pp*** if **V** is absent) of ordinary lophophaenids as discussed by Sugiyama (1993). However, there exists a quite similar internal skeletal structure in the Mesozoic monogeneric family Eucyrtidiellidae Takemura, 1986 (type genus *Eucyrtidiellum* Baumgartner, 1984). In fact, since *Eucyrtidiellum* seems to have two **I** embedded in the cephalic wall, presence or absence of **V'** is the only significant difference between *Entepipedus* and *Eucyrtidiellum*. I however hesitate about the family assignment to Eucyrtidiellidae in spite of their skeletal similarity, because cephalic externality of *Eucyrtidiellum* is very similar to theoperids rather than *Entepipedus* n. gen. and lophophaenids. This genus may represent a new subfamily of Lophophaenidae.

Range: Early Miocene so far as known.

Entepipedus zophyi Sugiyama n. sp.
(Pl. 4, Figs. 4a-f)

Description: Cephalis composed of relatively large, subspherical eucephalic lobe and small ante- and postcephalic ones. The former lobe is thick walled with circular pores of various sized and many tiny by-spines, whereas the latter lobes have loosely latticed wall. Thorax long and undulated; the upper part having similar wall to that of eucephalic lobe, and the lower part characterized by relatively smooth and thin wall with oval to circular pores. Internal skeletal structure as with genus; **A** extending into rod-like spine, **D** proximally being a part of thoracic wall and distally detached from thorax as a rod-like spine, two **I** attached to wall without extrusion, **V** also without extrusion, **V'** extending 30° downward from the horizontal and forming a rod-like spine outside. Long by-spine arising from the ventral side of eucephalic lobe in sagittal plane. Thick connector bars developed between shell wall and spines.

Remarks: Refer to the generic remarks. The abundance is extremely rare.

Dimensions (in μm): Length of apical spine 18-30; of test except spine 90-110; of eucephalic lobe 22-27. Maximum width of eucephalic lobe 22-28; of thorax 40-50.

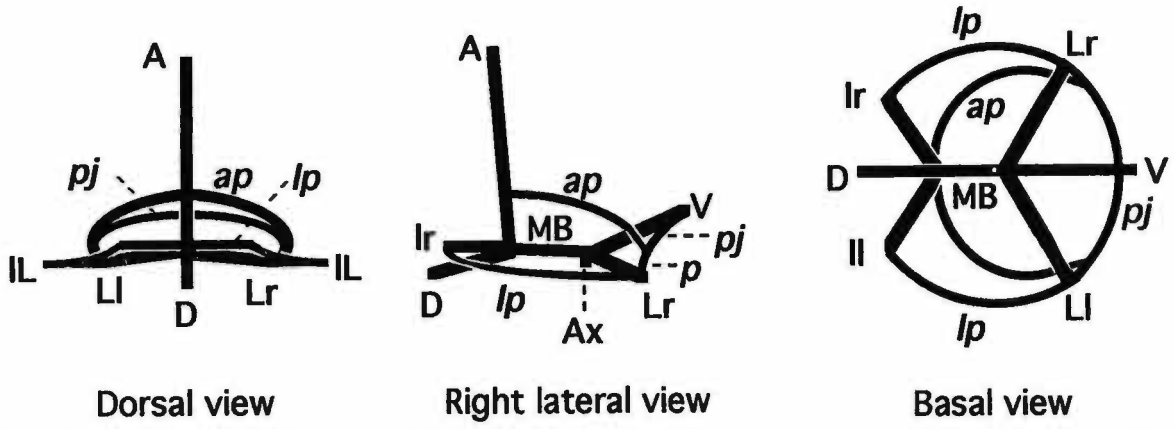


Fig. 5. Schematic illustration of internal skeleton of *Gomisterna hospes* n. gen., n. sp. Arches ***cl*** and ***pp*** are omitted.

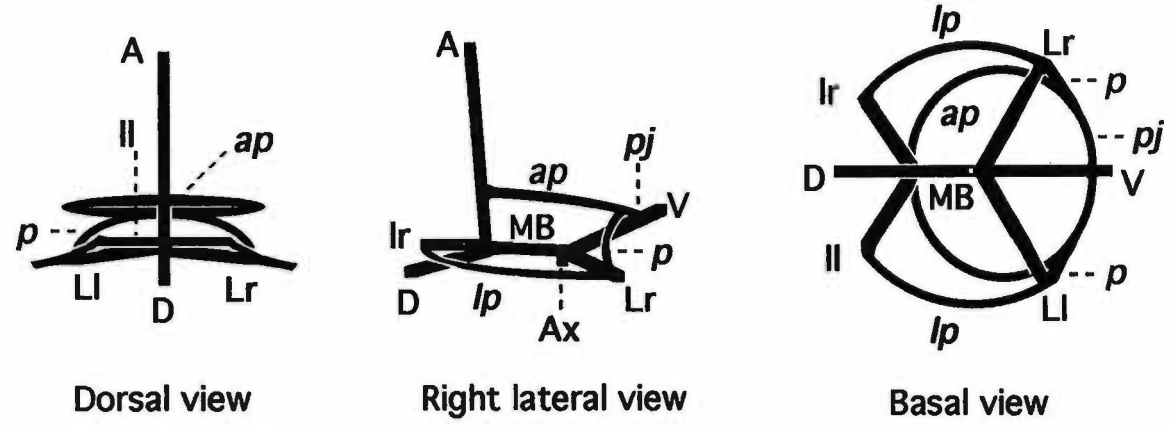


Fig. 6. Schematic illustration of internal skeleton of *Tripodocorys* sp. A. Arches ***cl*** and ***pp*** are omitted.

Holotype: ESN 147071 from the sample TH-4 (Pl. 4, Figs. 4a-f).

Etymology: Named by an arbitrary combination of letters.

Genus *Gomisterna* Sugiyama n. gen.

Etymology: Named by an arbitrary combination of letters, feminine gender.

Type species: *G. hospes* Sugiyama n. sp.

Diagnosis: Test composed of lobate cephalis and long thorax that is wider than cephalis. Internal spicule composed of **MB**, **A**, **D**, two **l**, two **L**, **V** and simple **Ax**. Arches ***ap*** and ***pj*** internally separate ante-, eu- and postcephalic lobes. Arches ***cl***, ***lp*** and ***pp*** define cephalic margin.

Remarks: This genus, as well as the preceding genus *Entepipedus* n. gen., seems to have phylogenetic relationship to lophophaenid genera based on its lobate cephalis. The former is, however, distinguished from the latters internally by having distinct two **l** (Fig. 5). One can notice that arch ***ap*** of this genus is impossible to be expressed as arch **AL** since it does not attach to **L** (Pl. 5, Fig. 1e). This feature is more remarkably recognized in *Tripodocorys* sp. A (Fig. 6; Pl, 5, Figs. 3a-d) in which the junction of branch ***p*** and arch ***ap*** is much closer to **V** than in *Gomisterna* n. gen. as if arch ***aj*** were present, and it is known that even the Cretaceous *T. megalocarena* Foreman, 1968 (Pl. 3, Figs. 4a, b), has the same skeletal structure to *T.* sp. A. The internal skeletla structure of *Gomisterna* n. gen. is, therefore, considered to be derived from reduction of branch ***p*** and simultaneous elongation of arch ***pj*** during evolutional process. Recently Funakawa

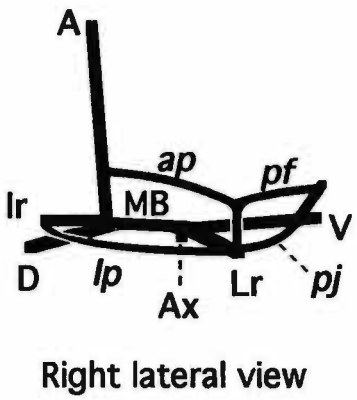


Fig. 7. Schematic illustration of internal skeleton of *Botryopyle* sp. A. In order to make a correlation with *Gomisterna hospes* and *Tripodocorys* sp. A easy, many skeletal elements are omitted in the figure.

(1994) established the genus *Marimoum*, also having two **l** and a complicated arch structure in the skeleton, from the Upper Miocene of Hokkaido as the type species *M. robustum* Funakawa (possibly a junior synonym of *Botryopera* (*?*) *whitei* (Børklund, 1976), see Sugiyama (1993) for the SEM illustrations). This genus is clearly distinguished from *Marimoum* by the shell externality. Cannobotrids also have lobate cephalis comprising an internal skeleton characterized by having two **l** (e.g. *Botryopyle* sp. A, Pl. 5, Figs. 2a, b), but is distinguished from *Gomisterna* n. gen. and *Tripodocorys* by having arch ***pf*** as shown in Fig. 7. This genus also somewhat resembles the theoperid (?) genus *Lipmanella* Loeblich and Tappan, 1961, which also has two **l** and arch ***ap***. The cephalis of the latter genus is, however, not lobated externally and is thick walled rather than porous.

Range: Early Miocene so far as known.

Gomisterna hospes Sugiyama n. sp.
(Pl. 5, Figs. 1a-e)

Description: Test as with genus. Eucephalic lobe subspherical, with a long, bladed spine prolonged from **A** and a short, bladed spine prolonged from **V** near the collar region; pores small and circular; bars rugged by numerous microgranular, and bearing bladed by-spines. Antecephalic lobe formed by coarser lattice work; pores suboval to subcircular, larger than eucephalic ones; bars also having microgranular, and by-spines that are thinner than eucephalic ones. Postcephalic lobe small and indistinct externally. **D** and two **L** are incorporated in shell wall proximally, and protrudes it as slender spine outside. Thorax being approximately twice of cephalis in diameter, cylindrical, longer than wide, pierced by small, circular to subcircular pores, having microgranular ornament as with antecephalic lobe and short by-spines of a small number in the upper part, and gradually becoming thinner walled distally.

Remarks: Refer to the generic remarks. The abundance is extremely rare in the examined samples.

Dimensions (in μm): Length of apical spine up to 15; of cephalis 40-48, of thorax 80-88; Maximum width of eucephalic lobe 30-33; of thorax 70-73.

Holotype: ESN 147072 from the sample TH-4 (Pl. 5, Figs. 1a-e).

Etymology: From the Latin *hospes* meaning a stranger.

Acknowledgements

I thank Hiroaki Karasawa of the Mizunami Fossil Museum for providing me a radiolarian-bearing sample from the Upper Cretaceous of Hokkaido, and Tomowo Ozawa and other members of Laboratory of Geobiology, Department of Earth and Planetary Sciences, Nagoya University, for their daily discussions.

References

Baumgartner, P. O. (1984), A Middle Jurassic-Early Cretaceous low-latitude radiolarian zonation based on Unitary Associations and age of Tethyan radiolarians. *Eclogae geol. Helv.*, **77** (3), 729-837, pls. 1-10.

Bjørklund, K. R. (1976), Radiolaria from the Norwegian Sea, Leg 38 of the Deep Sea Drilling Project. *Init. Repts. DSDP*, **38**, 1101-1168.

Caulet, J. - P. (1985), Radiolarians from the Southwest Pacific. *Init. Repts. DSDP*, **90**, 838-861.

Caulet, J. - P. (1991), Radiolarians from the Kerguelen Plateau, Leg 119. *Proc. ODP, Sci. Res.*,

119, 513-546.

Dumitrica, P. (1978), Badenian Radiolaria from Central Paratethys. *In* Brestenska, E. (ed.), *Chronostratigraphie und Neostratotypen, Miozan der Zentralen Paratethys,* VEDA, Bratislava, **6**, 231-261.

Dumitrica, P. (1991), Middle Triassic Tripedurnulidae, n. fam. (Radiolaria) from the Eastern Carpathians (Romania) and Vicentinian Alps (Italy). *Rev. Micropaléont.*, **34** (4), 261-278.

Ehrenberg, C. G. (1875), Fortsetzung der mikrogeologischen Studien als Gesammt-Uebersicht der mikroskopischen Paläeontologie gleichartig analysirter Gebirgsarten der Erde, mit specieller Rücksicht auf den Polycystinen-Mergel von Barbados. *Kgl. Akad. Wiss. Berlin, Abh.*, Jahre 1875, 1-225, pls. 1-30.

Foreman, H. P. (1968), Upper Maaestrichtian Radiolaria of California. *Palaeontol. Assoc., London, Special Paper,* no. 3, iv+1-82, pls. 1-8.

Foreman, H. P. (1973), Radiolaria of Leg 10 with systematics and ranges for the families Amphipyndacidae, Artostrobiidae, and Theoperidae. *Init. Repts. DSDP*, **10**, 407-474.

Funakawa, S. (1994), Plagiacanthidae (Radiolaria) from the Upper Miocene of eastern Hokkaido, Japan. *Trans. Proc. Palaeont. Soc. Japan,* N. S., no. 174, 458-483.

Goll, R. M. (1968), Classification and phylogeny of Cenozoic Trissocyclidae (Radiolaria) in the Pacific and Caribbean Basins. Part 1. *Jour. Paleont.*, **42** (6), 1409-1432, pls. 173-176.

Goll, R. M. (1979), The Neogene evolution of *Zygocircus, Neosemantis* and *Callimitra*: their bearing on nassellarian classification. A revision of the Plagiacanthoidea. *Micropaleont.*, **25** (4), 365-396.

Jørgensen, E. (1905), The protist plankton and the diatoms in bottom samples. *Bergens Mus. Skr.*, no. 1905, 49-151, 195-225, pls. 1-18.

Haeckel, E. (1862), *Die Radiolarien (Rhizopoda Radiolaria)*, xiv+572 pp., atlas, iv+35 pls.

Haeckel, E. (1881), Entwurf eines Radiolarien-Systems auf Grund von Studien der Challenger-Radiolarien. *Jenaisch Zeitscher. Naturwiss.*, **15** (n. ser., 8, no. 3), 418-472.

Haeckel, E. (1887), Report on the Radiolaria collected by H. M. S. Challenger during the years 1873-76. *Rept. Voy. Challenger, 1873-1876, Zool.*, **18**, pts. 1-2, pp. i-clxxxviii, 1-1803, pls. 140, 1 map.

Loeblich, A. R., Jr. and Tappan, H. (1961), Remarks on the systematics of the Sarkodina (Protozoa), renamed homonyms and new and validated genera. *Proc. Biol. Soc. Wash.*, **74**, 213-234.

Nishimura, H. (1990), Taxonomic study on Cenozoic Nassellaria (Radiolaria). *Sci. Rep., Inst. Geosci., Univ. Tsukuba*, Sec. B, no. 11, 69-172.

Petrushevskaya, M. G. (1968), Gomologii v skeletakh radiolyarii Nassellaria. 1. Osnovnye dugi v semeistve Cyrtoidea. *Zool. Zhurnal*, **47** (9), 1296-1310.

Petrushevskaya, M. G. (1971a), On the natural system of polycystine Radiolaria (Class Sarcodina). *In* Rarinacci, A. (ed.), *Proc. II Planktonic Conference*, 981-992, Technoscienza, Rome.

Petrushevskaya, M. G. (1971b), Radiolarii Nassellaria v planktone Mirovogo Okeana. Issled. Fauny Morey, Leningrad, Nauka, **9** (17), Radiolarii mirovogo okeana po materialam sovetskikh ekspeditsii, 5-287.

Petrushevskaya, M. G. (1975), Cenozoic radiolarians of the Antarctic, Leg 29, DSDP. *Init. Repts. DSDP*, **29**, 541-675.

Petrushevskaya, M. G. (1981), Radiolyarii otryada Nassellaria Mirovogo Okeana. Opredeliteli po Faune SSSR. *Izdav. Zool. Inst. Akad. Nauk. SSSR*, no. 128, 1-406.

Petrushevskaya, M. G. and Kozlova, G. E. (1979), The history of the microplankton of the Norwegian Sea. Chapter 5. Description of the radiolarian genera and species. *Issled. Fauny Morei*, **23** (31), 86-157 (in Russian).

Popofsky, A. (1913), Die Nassellarien des Warmwassergebietes. *Deutsche Südpolar-Exped. 1901-1903,* **14** (Zool., vol. 2), 217-416, pls. 28-38.

Riedel, W. R. (1967), Some new families of Radiolaria. *Proc. Geol. Soc. London*, no. 1640, 148-149.

Sugiyama, K. (1992), *Scyscioscenium velamen gen.* et sp. nov., a new sethoformid Radiolaria from the Lower to Middle Miocene of central Japan. *Bull. Mizunami Fossil Mus.*, no. 19, 215-218.

Sugiyama, K. (1993), Skeletal structures of Lower and Middle Miocene lophophaenids from central Japan. *Trans. Proc. Palaeont. Soc. Japan,* N. S., no. 169, 44-72.

Takemura, A. (1986), Classification of Jurassic nassellarians (Radiolaria). *Palaeontographica,* Abt. A, Bd. 195, 29-74, pls. 1-12.

下部中新統師崎層群豊浜累層産の Nassellaria 目放散虫化石

杉 山 和 弘

要　　旨

下部中新統師崎層群豊浜累層より得られた放散虫化石のうち6新属新種を記載し，それらの内部骨格構造を明らかにした．また，Sethophormidae 科の定義について再検討を行った．その結果，*Sertiseria batlax* n. gen., n. sp. は Artstrobiidae 科に，*Chitascenium cranites* n. gen., n. sp. と，*Genetrix petrushevskayae* n. gen., n. sp. は Sethophormidae 科に所属することが判明したが，骨格中に arch を持たない *Ectotoxon xetton* n. gen., n. sp., 内部骨針に primary lateral ray を欠く *Entepipedus zophyi* n. gen., n. sp., そして通常は secondary lateral ray を持たない Lophophaenidae 科放散虫類に類似した頭部殻室を持ちながらも，発達した secondary lateral ray を持つ *Gomisterna hospes* n. gen., n. sp. についての所属は不明である．

Manuscript received on 24, September, 1994; accepted on 29, September, 1994.

Plate 1

Figs. 1a–3b. *Sertiseria batlax* Sugiyama n. gen., n. sp.

1a: Holotype, ESN 147051, left lateral view, TH–4. 1b: Basal view showing the details of the internal skeleton. Left two arrows indicate arches ***pj***.

2a: ESN 147052, sectioned specimen, dorsal view, TH–4. 2b: Enlargement of the cephalis, oblique dorsal view. One of arrows indicates a horizontal branch ***j***.

3a: Paratype, ESN 147053, left lateral view, TH–4. 3b: Enlargement of the proximal part, oblique ventral view.

Figs. 4a–d, 6a, b. *Chitascenium cranites* Sugiyama n. gen., n. sp.

4a: Holotype, ESN 147054, dorsal view, TH–4. 4b: Oblique apical view showing around the intersecting point of **A** and the cephalic wall. Arrows indicate three branches ***a***. 4c: Basal view showing the details of the internal skeleton. Arrows indicate three branches ***a***. 4d: Basal view, different angle from 4c. Arrows indicate two branches ***p***.

6a: Paratype, ESN 147055, ventral view, TH–4. 6b: Basal view showing the details of the internal skeleton. Arrows indicate three branches ***a***.

Figs. 5a, b. *Syscioscenium* sp. A.

5a: ESN 147056, right lateral view, TH–4. 5b: Basal view showing the details of the internal skeleton. Arrows indicate three branches ***a***.

Figs. 7a, b. *Sethophormis* sp. aff. *S. aurelia* Haeckel, 1887.

7a: ESN 147091, oblique apical view. This specimen was obtained from a surface sediment sample of the Oki Bank, the Sea of Japan. 7b: Basal view showing the details of the internal skeleton. Arrows indicate three branches ***a***. Note that three branches a retain a crossing angle of 120° although **D**, two **L** and **V** cross one another at right angles.

All scale bars=20 μm.

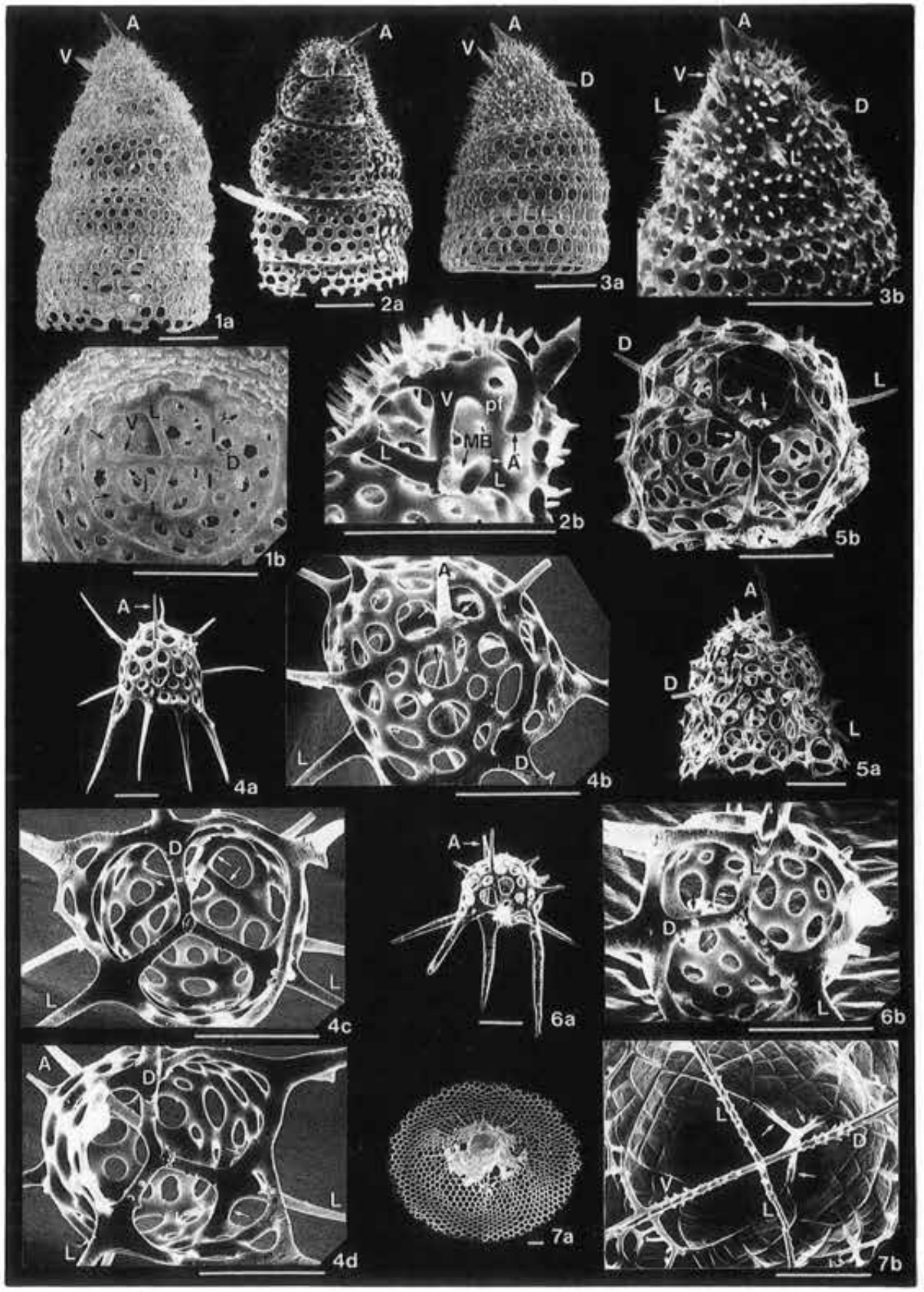

A
V
1a
A
2a
A
V
D
3a
A
V
L
D
L
3b
V
L
D
1b
V
pf
MB
A
L
2b
D
L
5b
A
4a
A
L
D
4b
A
D
L
5a
D
L
L
4c
A
6a
L
D
L
6b
A
D
L
L
4d
7a
L
D
V
L
7b

Plate 2

Figs. 1a, b. *Clathrocorys murrayi* Haeckel, 1887.

1a: ESN 147057, left lateral view, TH-4. 1b: Oblique basal view, showing the details of the internal skeleton. Branches ***a***, ***c***, ***p*** (pointed by seven arrows) and connecting arches are well-developed. Arches ***cD*** and ***pL*** are also distinct.

2a: ESN 147058, stripped specimen, left lateral view, TH-2. 2b: Enlargement of **A** showing the details of three branches ***a*** and arches.

Figs. 3a, b. *Clathrolychnus* sp.

3a: ESN 147059, right lateral view, TH-4. Arrows indicate branches ***m*** (lower two) and ***g*** (upper two).

3b: Basal view showing the internal skeleton. Arrows indicate two branches ***a***. One a is hidden by ***D***.

Fig. 4. *Tetraplecta* sp. A, ESN 147060, right lateral view, TH-4.

Fig. 5. *Plectaniscus* sp. A, ESN 147061, left lateral view, TH-4.

Figs. 6a, b. *Callimitra* sp. A.

6a: ESN 147062, left lateral view, TH-4. 6b: Enlargement of 6a showing the details of the cephalis.

Figs. 7a, b. *Clathromitra* sp.

7a: ESN 147101, right lateral view. This specimen was obtained from a surface sediment sample of the Oki Bank, the Sea of Japan. 7b: Basal view showing the internal skeleton. Two arrows indicate branches ***a***. One ***a*** is hidden by **A**. Note that the internal skeletal structure is similar to *Sethophormis* sp. aff. *S. aurelia*.

Figs. 8a, b. *Euscenarium joergenseni* Dumitrica, 1978.

8a: ESN 147063, right lateral view, TH-2. 8b: Basal view showing the internal skeleton. Two arrows indicate branches ***a***. Arches are embedded in the thick cephalic wall.

Scale bar of 6a=100μm; of others=20μm.

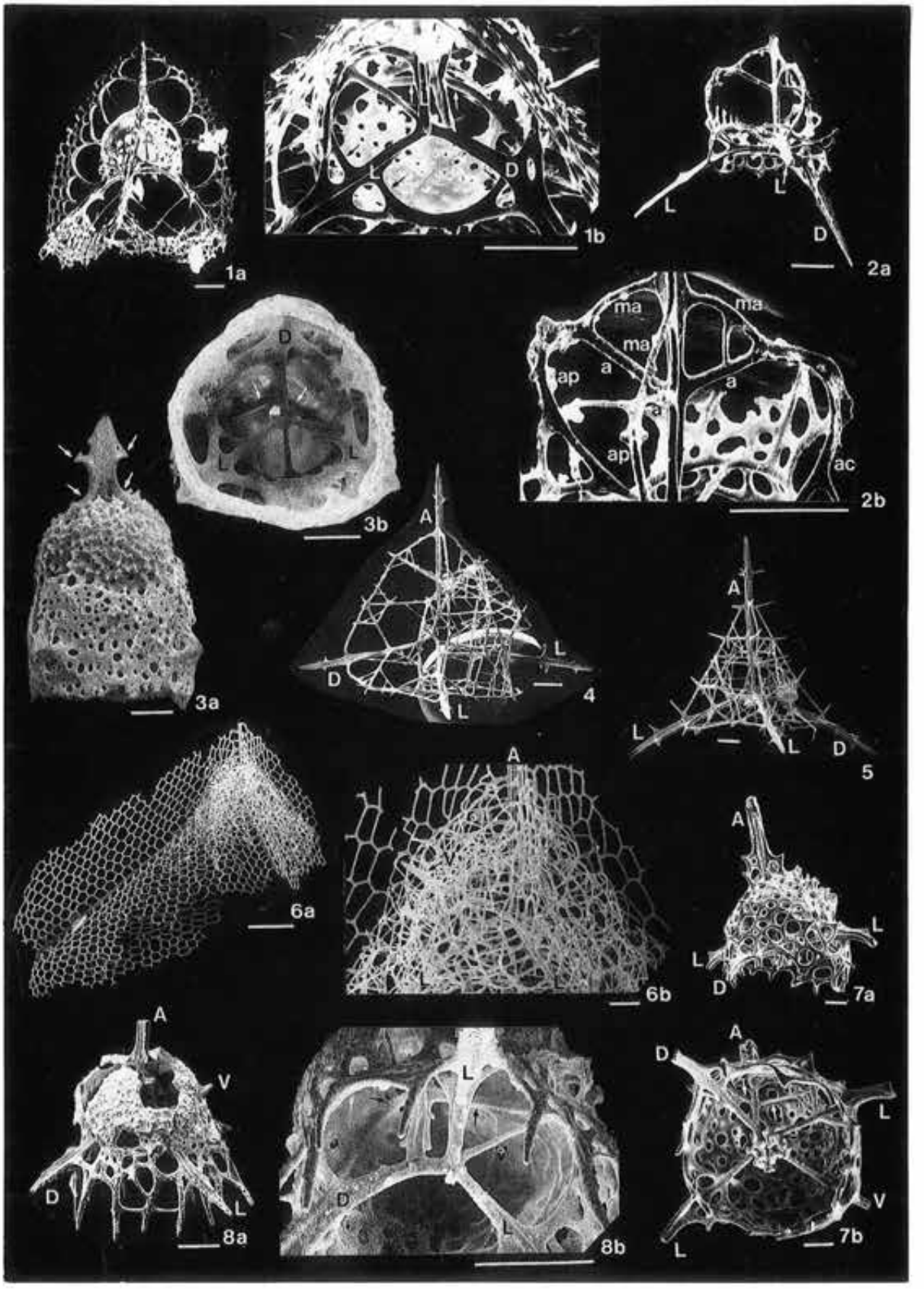

1a
1b
L
D
2a
L
L
D
ma
ma
ma
ap
a
a
a
ap
ac
2b
D
3b
3a
A
L
D
L
4
A
L
L
D
5
6a
A
6b
A
L
L
D
7a
A
V
D
L
8a
L
D
L
8b
A
D
L
V
L
7b

Plate 3

Figs. 1a–3. *Genetrix petrushevskayae* Sugiyama n. gen., n. sp.

1a: Holotype, ESN 147064, left lateral view, TH–4. 1b: Enlargement of 1a showing the details of the proximal part. 1c: Basal view showing the internal skeleton. Two arrows indicate branches ***a***.

2a: Paratype, ESN 147065, right lateral view, TH–4. 2b: Basal view showing the internal skeleton. Three arrows indicate branches ***a***.

3: Paratype, ESN 147066, transmitted light micrograph, TH–4.

Figs. 4a–c. *Ectotoxon xetton* Sugiyama n. gen., n. sp.

4a: Holotype, ESN 147067, right lateral view, TH–4. 4b: Basal view of 4a. Note that no arches are visible.

Figs. 5a, b. *Pterocorythium rhinoceros* Haeckel, 1887.

5a: ESN 147075, right lateral view, TH–4. 5b: Basal view showing the internal skeleton. Two arrows indicate arches ***ap***. 5c: Enlargement of 5a showing the details of the lobate cephalis.

All scale bars=20μm.

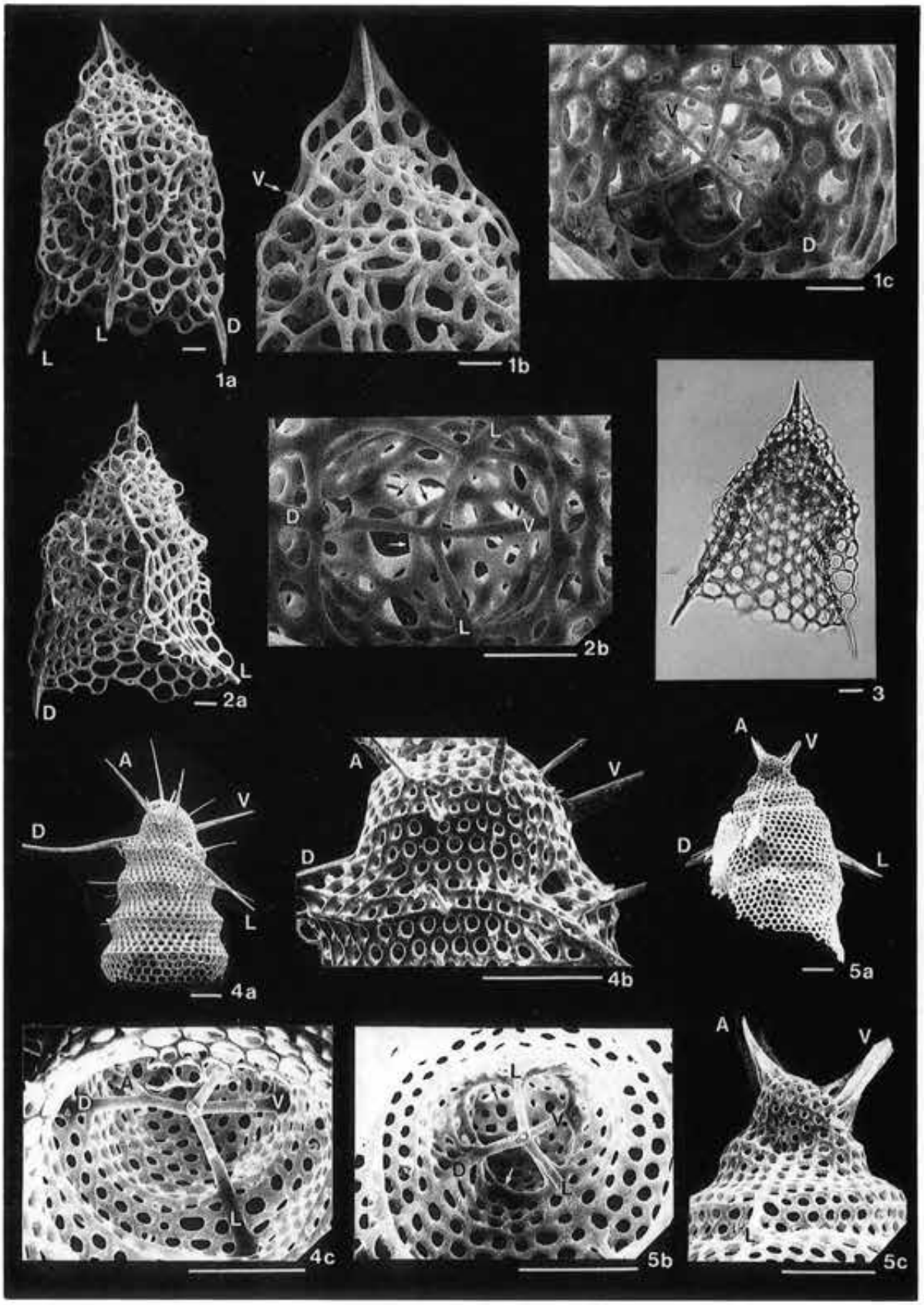

L
L
D
1a
V
1b
V
L
D
1c
L
D
L
2a
D
V
L
2b
3
A
V
D
L
4a
A
V
D
4b
A
V
D
L
5a
D
V
L
4c
L
V
D
L
5b
A
V
L
5c

Plate 4

Figs. 1a-2. *Ectotoxon xetton* Sugiyama n. gen., n. sp.

1a: Paratype, ESN 147068, oblique ventral view, TH-4. 1b: Basal view showing the internal skeleton. 2: Paratype, ESN 147069, transmitted light micrograph, TH-4.

Figs. 3a-c. *Lophocorys* (?) sp. A.

3a: ESN 147070, dorsal view, TH-4. 3b: Left lateral view of the proximal part. 3c: Basal view showing the internal skeleton. Two arrows indicate arches ***ap***.

Figs. 4a-f. *Entepipedus zophyi* Sugiyama n. gen., n. sp.

4a: Holotype, ESN 147071, right lateral view, TH-4. 4b: Enlargement 4a showing the details of the collar region. 4c: Basal view showing the internal skeleton. Four arrows indicate arches ***aj*** (=**PR**). 4d: Ventral view of the proximal part. 4e: Dorsal view of the proximal part. 4f: Enlargement of postcephalic lobe. Arrow indicates the junction of **V** and **V'**.

All scale bars=20μm.

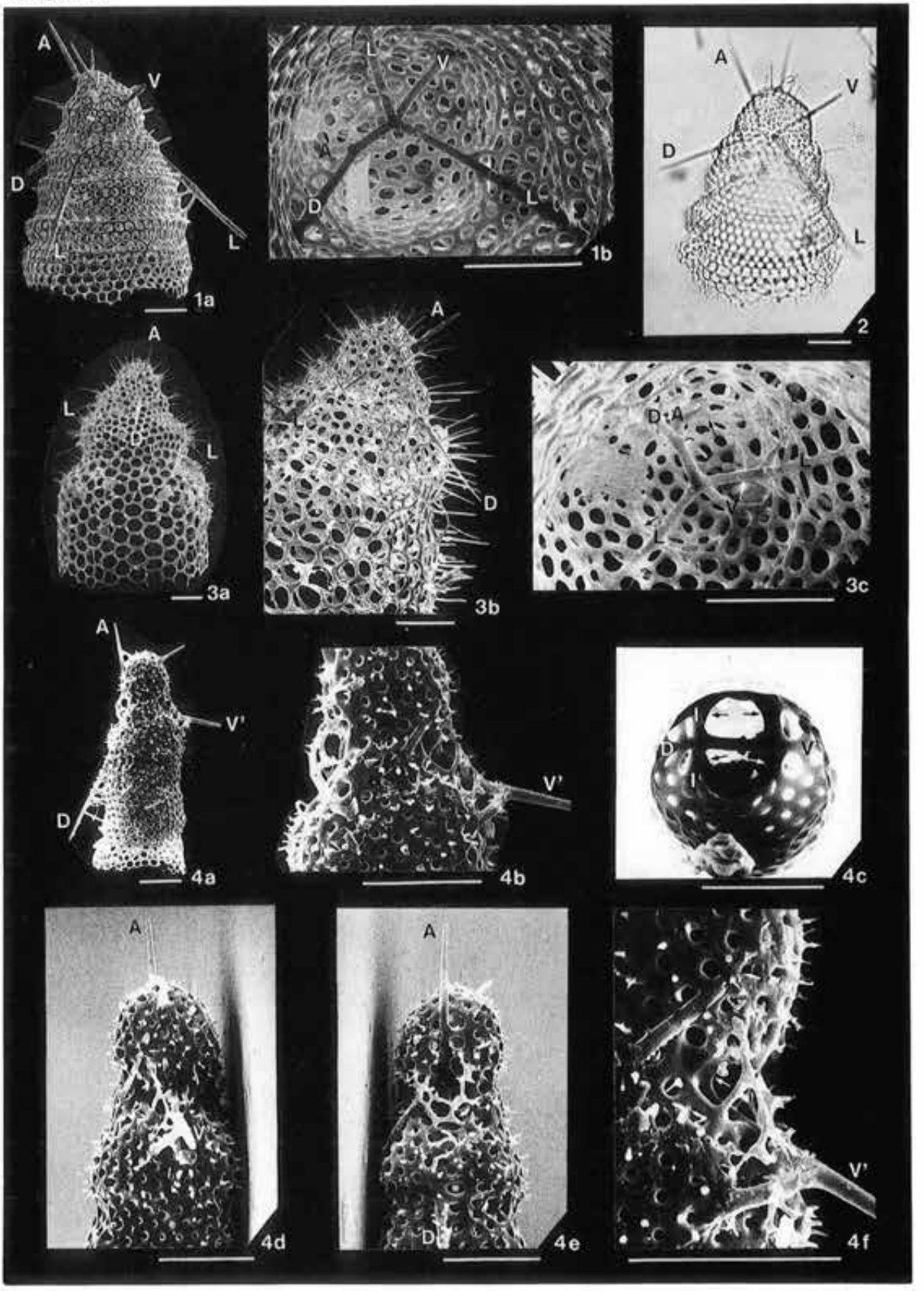

A
V
D
L
1a
L
V
A
D
L
1b
A
V
D
L
2
A
L
D
L
3a
A
L
D
3b
D
A
L
3c
A
V'
D
4a
V'
4b
D
V
4c
A
4d
A
D
4e
V'
4f

Plate 5

Figs. 1a–e. *Gomisterna hospes* Sugiyama n. gen., n. sp.

1a: Holotype, ESN 147072, left lateral view, TH–4. 1b: Enlargement of 1a showing the details of cephalis. 1c: Basal view showing the internal skeleton. White arrows indicate arches ***lp***. Black arrow indicates arch ***ap***. 1d: Enlargement of the collar region, oblique ventral view. 1e: Basal view through a more ventral angle than 1c. Note the location of the end of arch ***ap***.

Figs. 2a, b. *Botryopyle* sp. A.

2a: ESN 147073, right lateral view, TH–4. 2b: Basal view showing the internal skeleton. Left two arrows point to arches ***ap***, right upper to arch ***pj***, and right lower to arch ***pf***.

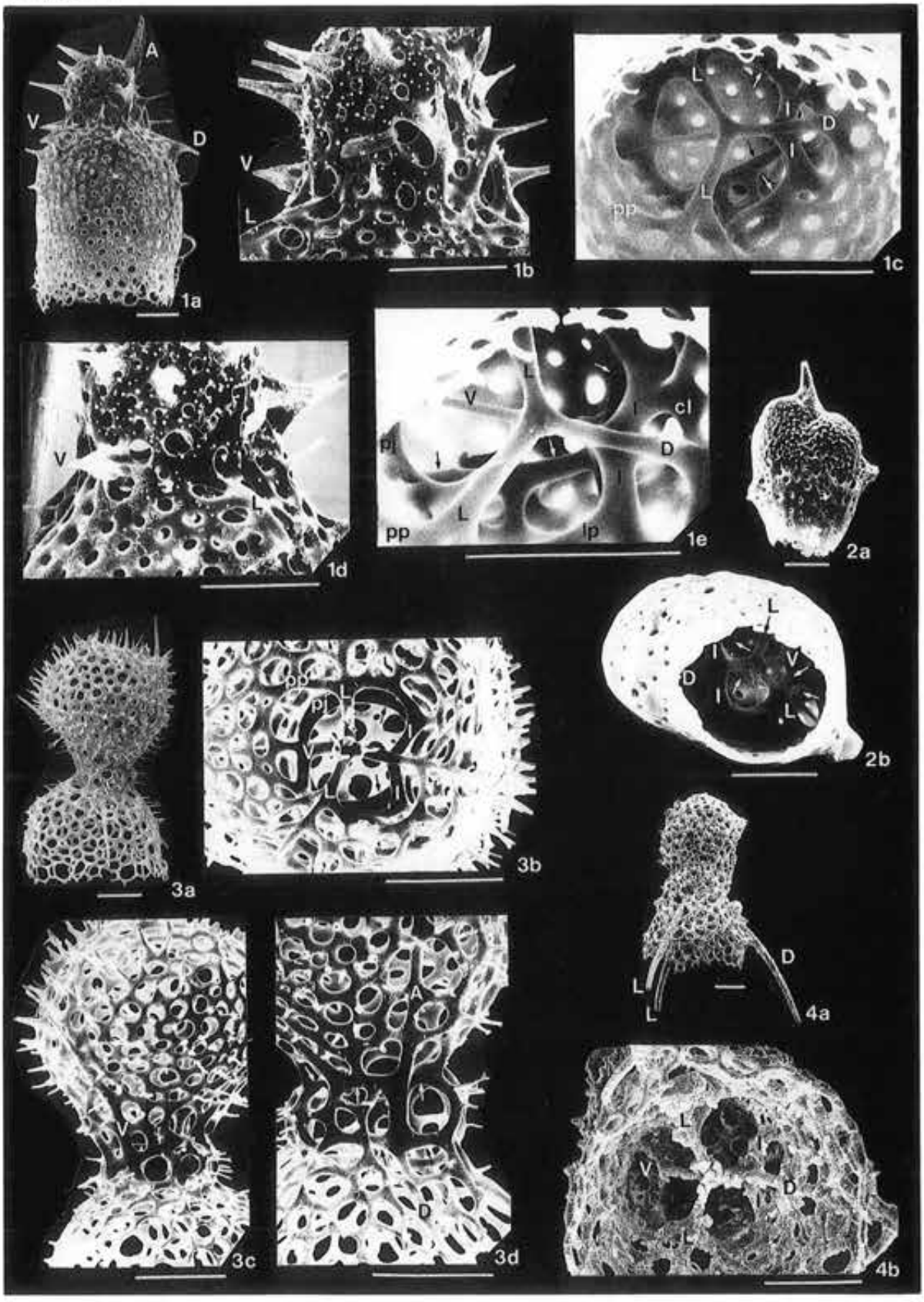
Figs. 3a–d. *Tripodocorys* sp. A.

3a: ESN 147074, left lateral view, TH–4. 3b: Basal view showing the details of the internal skeleton. Two arrows indicate arches ***ap***. 3c: Enlargement of the collar region, oblique ventral view. Right arrow points to arch ***ap***, and left to the junction of arch ***ap*** and branch ***p***. 3d: Enlargement of the collar region, oblique dorsal view. Black arrows indicate two ***l***. Three white arrows indicate arch ***ap***.

Figs. 4a, b. *Tripodocorys megalocarena* Foreman.

4a: ESN 147081, left lateral view. This specimen was obtained from the Turonian inoceramid-bearing nodule of the Yezo Group, Hokkaido. 4b: Basal view showing the internal skeleton.

All scale bars=20μm.


A
V
D
1a
V
L
1b
L
I
D
pp
1c
V
L
1d
L
V
cl
I
D
pl
pp
lp
1e
2a
L
V
D
L
2b
pp
pl
V
L
3a
3b
D
L
4a
V
A
D
3c
3d
L
V
D
4b