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On *Pseudoschwagerina miharanoensis* AKAGI

(An Upper Palaeozoic Fauna from Miharanoro,
Hiroshima Prefecture, Japan. 1st. Note)

by

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(with 2 Plates)

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The Upper Palaeozoic limestones developed in Miharanoro, are divided by AKAGI (1958b) into the following fusulinid zone and subzones in descending order:

Miharanoro formation—Zone of *Pseudoschwagerina*

Pseudofusulina krotowi subzone

Pseudoschwagerina miharanoensis subzone

Triticites nishikawai (MS) subzone

Our preliminary investigation on fusulinids of the Miharanoro formation has arrived at a somewhat similar result to that of AKAGI.

In the western part of Miharanoro, there lie limestones with a number of species of *Triticites*. And, narrow middle strip extending probably from north to south is characterized by *Pseudoschwagerina* species. While in the east, there develop limestones with abundant *Schwagerina* of *S. vulgaris* group, whose lithologic character is remarkably of sparry calcite.

Pseudoschwagerina does not seem to occur in *Triticites* limestone, neither in the upper part of *Schwagerina* limestone. Therefore it appears to be not appropriate to call the Miharanoro limestone formation collectively the zone of *Pseudoschwagerina* as AKAGI did.

Pseudoschwagerina miharanoensis occurs abundantly in the lower part of *Schwagerina* limestone, together with *Schwagerina vulgaris* (SCHELLWIEN). Materials herein described are all collected by Mr. Isao NISHIKAWA from the locality no. 2054, Miharanoro. He removed all friable matrix of limestone to separate fusulinid shells by percussion method.

We thank heartily to Mr. NISHIKAWA for his painstaking efforts in collecting fossils for a long time. Prof. M. MINATO and Dr. S. HONJO have discussed with us on some problems concerning the fusulinid taxonomy. Mr. S. KUMANO has taken trouble to prepare all photographs. To all those who kindly assisted us in

various ways our cordial thanks are offered.

Family Schwagerinidae DUNBAR et HENBEST

Recently CHANG (1963) further introduced Pseudoschwagerininae, a new subfamily of Schwagerinidae to include the genera *Pseudoschwagerina* and *Zellia*.

Genus *Pseudoschwagerina* DUNBAR et SKINNER, 1936

Type species: *Schwagerina uddeni* BEEDE et KNIKER, 1924

There has been much confusion as to the recognition of generic status of *Schwagerina* MÖLLER. However, International Commission of Zoological Nomenclature, Opinion 213 issued in 1954, already fixed the type species of *Schwagerina* to be *Borelis princeps* EHRENBERG. Syntype of *Borelis princeps* was sectioned and illustrated by DUNBAR & SKINNER (1936). According to their study *Borelis princeps* has vaulted shell, and externally resembles shells of what are presently known as *Pseudoschwagerina* and *Paraschwagerina*, although its internal features are not quite unlike those of "*Fusulina*" *krotowi* SCHELLWIEN.

Thus *Schwagerina* has thick spirotheca, strongly fluted septa but no chomata. However, *Pseudoschwagerina* has closely coiled, compact juvenarium volutions and much inflated outer whorls. Chomata are remarkably developed especially in juvenarium. Septal folding is (usually) rather weak. Therefore the two forms should be generically distinguished from each other as DUNBAR & SKINNER advocated in 1936.

RAUSER-CHERNOUSSOVA, on the contrary, considered *Schwagerina princeps* MÖLLER = *Schwagerina moelleri* RAUSER (non *Borelis princeps* EHRENBERG) as the type of the genus *Schwagerina*, and has stuck to the usage of *Schwagerina* in her sense. This procedure is unfortunately contradictory to ICZN Opinion. *Schwagerina moelleri* undoubtedly belongs to *Pseudoschwagerina* sensu DUNBAR & SKINNER, and should be generically distinguishable from *Borelis princeps*.

In general, however, *Schwagerina* sensu RAUSER has more globular shell, smaller proloculus, weaker septal fluting in both inner and outer whorls, and smaller chomata, compared to *Pseudoschwagerina uddeni*, the type species of the genus *Pseudoschwagerina*. Therefore, it is easily conceivable that *Schwagerina* sensu RAUSER could be morphologically distinguished from typical *Pseudoschwagerina* of *uddeni* group. However, it could not possibly be called by the name of *Schwagerina*. If one thinks it necessary to separate these two groups as generically or subgenerically distinct from each other, *Sphaeroschwagerina* M-MACLAY (Type species = *Sphaeroschwagerina carnica* SCHERBOVICH) may be available for forms which RAUSER called "*Schwagerina*". *Pseudoschwagerina carniolica* complex of ROSS (1962) may correspond to the group of "*Schwagerina*" or *Sphaero-*

schwagerina.

There are, of course, several other species groups recognizable within *Pseudoschwagerina* s.l. (KAHLER & KAHLER, 1937, 1941; RAUSER-CHERNOUSSOVA, 1961; ROSS, 1962; ANOSOVA et al., 1964) According to these authors each of these morphological groups seems to represent respective phyletic series, and thus merit generic or subgeneric separation.

Classification of inflated schwagerinids, however, often encounters difficulty by finding many transitional and gradational forms between these morphological groups. So, we avoid adhering to, or employing many hitherto proposed, and narrowly defined genera, and taking rather broadly understood single genus *Pseudoschwagerina*.

Morphological groups of *Pseudoschwagerina* of our scheme may be tabulated as below:

Shell commonly large, spherical to inflated fusiform. Keriotheca present. Compact juvenarium present, is in contrast to loosely coiled outer whorls. Juvenarium resembles *Triticites* with well developed chomata. Proloculus is large, compared to that of *Paraschwagerina*.....*Pseudoschwagerina* s.l.

1. Juvenarium small. Proloculus large. Shell umbilicated. Spirotheca very thick. Shell expansion moderate.
.....*Zellia* group.
2. Juvenarium small. Proloculus large. Spirotheca in inner volutions thin. Shell expands quickly.....*miharanoensis* group.
3. Distinct juvenarium with weak septal fluting. Proloculus small. Chomata not prominent. Septal fluting in outer whorls is also weak.
.....*Sphaeroschwagerina* group.
4. Compact juvenarium with moderate septal fluting. Proloculus moderate in size. Chomata prominent. Septal fluting in outer whorls is also moderate.....*Pseudoschwagerina* s.str. group.
5. Septal fluting in both outer and compact inner volutions almost planar. Chomata large and strongly developed in inner volutions. Proloculus moderate in size.....*Robustoschwagerina* group.

A number of new species have been proposed for pseudoschwagerinas of Japan. *Pseudoschwagerina munosei* may be classed in the group of *Zellia*, though its inner volutions have much thinner spirotheca than in typical *Zellia*. *Pseudoschwagerina schellwieni*, *hidense* and *subsphaerica* are all of the group of *Robustoschwagerina*. *Pseudoschwagerina saigusai* and *orientale* may be members of *Sphaeroschwagerina*, though the former species has somewhat stronger septal fluting than in normal Russian "*Schwagerina*". *Pseudoschwagerina miharanoensis*, of course

belongs to *miharanoensis* group. Other pseudoschwagerinas in Japan may be classified as members of *Pseudoschwagerina* s.str. which may be further divided into several subgroups. Among them *Pseudoschwagerina minatoi*, *morikawai* and *kanmerai* constitute a subgroup, while *Pseudoschwagerina nakazawai* may represent another subgroup.

***Pseudoschwagerina miharanoensis* AKAGI**

Pl. 31, figs. 1-11; Pl. 32, figs. 1-9

1932. Cfr. *Schwagerina* sp., CHEN, p. 97-98, pl. 15, fig. 5.
 1958. *Pseudoschwagerina (Pseudoschwagerina)* sp., TORIYAMA, p. 161, pl. 19, fig. 10, ? fig. 11.
 1958. *Pseudoschwagerina miharanoensis* AKAGI, p. 18, text-figs. 9-16, 18, 24.
 1958. *Pseudoschwagerina miharanoensis*, AKAGI, p. 153, pl. 1, figs. 1-15.
 1963. *Pseudoschwagerina miharanoensis*, CHANG, p. 213-4, pl. 8, fig. 3.
 1964. *Parazellia miharanoensis*, ANOSOVA et al., p. 71 (listed only).
 Compare with; *Pseudoschwagerina nucleolata prisca* KOCHANSKY-DEVIDE, 1959, p. 36, pl. 5, figs. 4-10. pl. 6, fig. 1.

Shell large, subglobular to fusiform, with straight axis of coiling, blunt and rounded poles. Lateral slope uniform. Mature individuals have 4 to 5 volutions, and measure 7.6 to 8.8 mm. in length, and 5.2 to 6.5 mm in diameter; form ratio 1.15 to 1.68, but usually about 1.3. Only the first volution constitutes tightly coiled juvenarium, which is followed by loosely coiled adult stage; in fully grown specimens final whorl is reduced slightly in height to form gerontic stage. Spirotheca composed of tectum and comparatively coarse keriotheca, 30 to 80 microns thick in the third volution, averaging about 50 microns; 75 to 110 microns in the fourth volution, averaging about 90 microns; in earlier volutions its thickness is less than 30 microns. Septa nearly planar in all volutions except at lower margin where they are weakly folded and show small and low septal loops in outer volutions as observed in axial sections. Septa number 11 in the first volution, 15 in the second, and 18 in the third, in a specimen. Septal pores abundant. Proloculus large but is rather variable in size, its outside diameter 340 to 650 microns, averaging about 500 microns. Wall of proloculus is moderately thick, being 40 to 65 microns. Strongly inflated specimens have somewhat discoidal proloculi, while common forms have spherical ones. Tunnel low, and narrow; path straight; tunnel angle in the third volution about 35 degrees. Chomata small and very narrow, but rather well developed until the third volution, but entirely absent in later whorls.

Remarks: *Pseudoschwagerina miharanoensis* shows considerable variation in shell form, in the size of proloculus, and in the development of chomata. The form of shell varies from subglobular to ellipsoidal, further even to fusiform.

However, the rate of shell expansion seems to be rather constant throughout the specimens at hand. Chomata often disappear even in earlier volutions except for the proloculus. Observation from the outside of shell reveals that the distribution of septal furrows which correspond to the density of septal arrangement is also fairly constant. Distance between those furrows is rather sparse, and the species is easily distinguishable from the other Miharano fusulinids by this character in association with its more inflated, large shell. At our disposal, however, there is one specimen which has fusiform shell and finely arranged septal furrows (pl. 31, fig. 1), though its tangential section (pl. 32, fig. 1) is not at all distinguishable from typical *Pseudoschwagerina miharanoensis* in every detail. We consider that this specimen represents a varietal form of the latter species, in which number of septa per volution may be somewhat more than in the typical one.

AKAGI (1958b) first compared the present species with *Pseudoschwagerina nucleolata* CIRY, which is, according to ANOSOVA et al. (1964) classified as a *Robustoschwagerina*. We, unfortunately have not been able to refer to CIRY's original article, and consequently it is impossible to make any further comment on the similarity between the two.

Pseudoschwagerina (Pseudoschwagerina) sp. of TORIYAMA (1958) from the *Triticites simplex* subzone of Akiyoshi limestone group closely resembles the present form from Miharano, but has a little stronger septal fluting compared with the latter. It may, however, be regarded identical with the latter species in the general physiognomic features.

Pseudoschwagerina miharanoensis described by CHANG (1963) from the Shingang province, China has somewhat concave lateral slope, but otherwise, looks identical with the type material.

ROSS (1962) listed *Pseudoschwagerina nucleolata prisca* and *Pseudoschwagerina (Zellia) nunosei* as members of *Pseudoschwagerina miharanoensis* complex. But the latter species has completely planer septa, and a little umbilicated shell. Thus it is very close to *Zellia*, although spirotheca are thin in inner whorls in *nunosei*. On the other hand, *Pseudoschwagerina miharanoensis* and *nucleolata prisca* show very close affinity to the common forms of *Pseudoschwagerina*, though *Triticites*-like compact juvenarium is not well demonstrated in the above two former species. *Pseudoschwagerina nucleolata prisca* was described from the "Rattendorfer Schichten" of Velebit, Croatia by KOCHANSKY-DEVIDE (1959) found in association with *Quasifusulina*, *Pseudoschwagerina* of *alpina* type and *Schwagerina* aff. *incisa*. The combination of the above-mentioned species suggests the Lower Asselian age of *Pseudoschwagerina nucleolata prisca*. In morphology, the Velebit species is almost indistinguishable from *miharanoensis*, although shell expansion is perhaps more rapid in *miharanoensis* than in *prisca*.

Pseudoschwagerina miharanoensis is found associated with *Schwagerina vulgaris* (SCHELLWIEN), and small schwagerinids with axial filling. Its age may be roughly

considered to range from the late Asselian to the early Sakmarian. Correlation of Miharano fusulinid fauna with other regions will be presented in other occasion.

As to the systematic position of *miharanoensis* there have been a number of different opinions presented. AKAGI (1958a, b) regarded it a *Pseudoschwagerina*, and CHANG (1963) followed this. ROSS (1962) considered the species as the representative of the same-named species complex within the genus *Pseudoschwagerina*. But recently ANOSOVA et al. (1964) placed the species under the genus *Parazellia*. *Parazellia* was established by RAUSER (1961) with *Fusulina muongthensis* DEPRAT as the type species. Morphologically *Parazellia* stands just between *Zellia* and *Pseudoschwagerina* sensu RAUSER. Zoogeographically *Parazellia* may be regarded as a group of *Pseudoschwagerina* which lived within Tethyan region.

As CHANG (1963) pointed out, however, it is rather hard at the moment, to distinguish *Parazellia* from *Pseudoschwagerina*.

While there are a number of forms with large proloculus, and the compact juvenile volutions are almost lacking. *Zellia*, of course, belongs to this category, but has very thick spirotheca, flat septa and umbilicated shell. A form figured by BEEDE & KNIKER (1924) as a "megalospheric form" of *Pseudoschwagerina uddeni*, as well as *Pseudoschwagerina elegans* KAHLER et KAHLER (1941) fall in the category above described. Some of recent illustrations of *Pseudoschwagerina robusta* given by SKINNER & WILDE (1965) show similar features. All these pseudoschwagerinas together with *Pseudoschwagerina miharanoensis* and *prisca* may be morphologically grouped as the one listed in the foregoing pages. Possibility that this morphological group represent a certain stage or generation of several different species groups such as *Pseudoschwagerina uddeni* group, *muongthensis* group, etc. must be taken into account in considering true phyletic relationship between forms superficially resembling *Pseudoschwagerina miharanoensis*.

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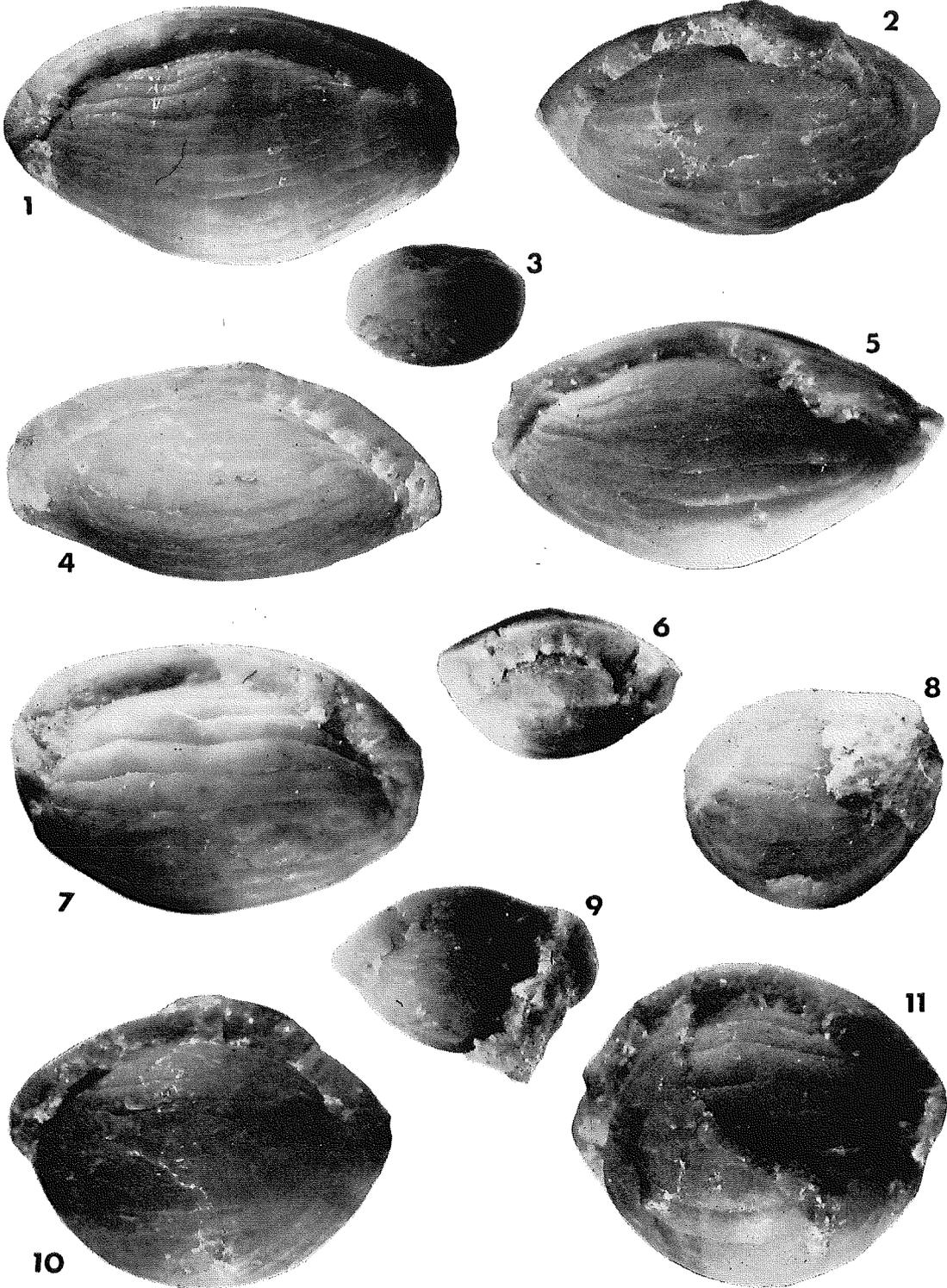
PLATE AND EXPLANATION 31

Explanation of Plate 31

(All figures eight times natural size).

Figs. 1-11. *Pseudoschwagerina miharanoensis* AKAGI p. 268
A suit of specimens showing stages of growth and various shell forms. Miharanoro limestone formation, loc. no. 2054, Miharanoro, Jinseki-gun, Hiroshima Pref., Japan.
Coll. by Mr. I. NISHIKAWA.

Plate 31



S. KUMANO photo

PLATE AND EXPLANATION 32

Explanation of Plate 32

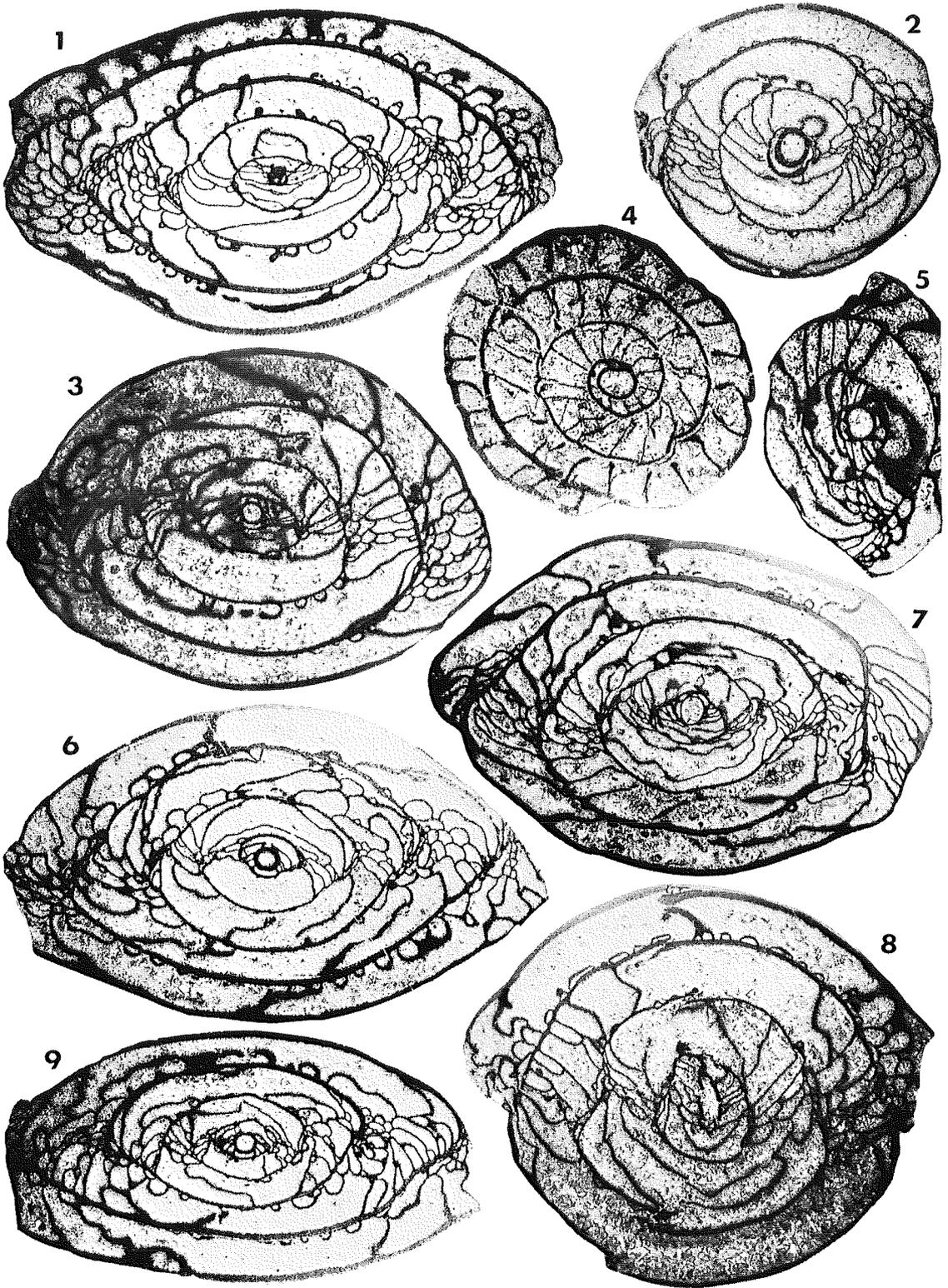
(All figures ten times natural size).

Figs. 1-9. *Pseudoschwagerina miharanoensis* AKAGI.

1-Tangential section of an inflated fusiform specimen (plate 31, fig. 1) UHR 18572 ;
2-Axial section of a nearly spherical specimen (plate 31, fig. 8) showing thick wall of proloculus. UHR 18570 ; 3-Axial section of much vaulted specimen (plate 1, fig. 10) UHR 18567 ; 4-Sagittal section of a specimen (plate 31, fig. 2)UHR 18574 ; 5-Axial section of an immature specimen (plate 31, fig. 9) UHR 18568 ; 6-Axial section of an inflated fusiform specimen (plate 31, fig. 5) UHR 18571 ; 7-Axial section of an elliptical specimen (plate 31, fig. 7) showing nearly platy septa. UHR 18576 ; 8-Axial section of a much inflated, globular specimen (plate 31, fig. 11) showing somewhat laterally compressed proloculus. UHR 18565 ; 9-Axial section of a fusiform specimen (plate 31, fig. 4) UHR 18575.

Specimens are all from loc. no. 2054, Miharanoro, Jinseki-gun, Hiroshima Prefecture, Japan. Coll. by I NISHIKAWA.

Plate 32



S. KUMANO photo.