



HOKKAIDO UNIVERSITY

Title	Classification and Phylogeny of Genus <i>Misellina</i> with Description of Some <i>Misellina</i> from the Lower Permian in the Southern Kitakami Mountains, Japan
Author(s)	Choi, Dong Ryong
Citation	Journal of the Faculty of Science, Hokkaido University. Series 4, Geology and mineralogy, 15(3-4), 625-646
Issue Date	1972-06
Doc URL	https://hdl.handle.net/2115/36016
Type	departmental bulletin paper
File Information	15(3-4)_625-646.pdf



CLASSIFICATION AND PHYLOGENY OF GENUS
MISELLINA WITH DESCRIPTION OF SOME *MISELLINA*
FROM THE LOWER PERMIAN IN THE
SOUTHERN KITAKAMAI MOUNTAINS, JAPAN.

by

DONG RYONG CHOI

(With 4 text-figures and 1 plate)

(Contribution from the Department of Geology and Mineralogy,
Faculty of Science, Hokkaido University, No. 1243)

Misellina, a primitive Verbeekiniid, is one of the important Tethyan fauna in the lower to middle Permian, and it is widely accepted as ancestral of Neoschwagerinids. However, the phylogenetical study on primitive Verbeekiniids has not been thoroughly made until present, although that of the Neoschwagerinids has been discussed by many authors. This may be mainly due to the comparatively rare production of *Misellina*, especially that of the primitive *Misellina* as to make comprehensive palaeontological and phylogenetical study on it.

The primitive forms of *Misellina* have been known to occur from the USSR and Japanese Permian. They are *Misellina dyhrenfurthi* (DUTKEVICH) from USSR, and *Misellina otakiensis* (HUZIMOTO), *Misellina ibukiensis* KOBAYASHI, and *Misellina otai* SAKAGUCHI and SUGANO, from Japan.

In the course of investigation of lower Permian fusulinids in Setamai-Yahagi district, Southern Kitakami mountains, the author found numerous specimens that are assignable to *Misellina otakiensis* (HUZIMOTO) from many localities stratigraphically ranging from the middle to the upper Sakamotosawa series, lower Permian.

At the same time, *Misellina claudiae* (DEPRAT) was also found in thin sections deposited in our University obtained from the upper Sakamotosawa series in the same district above mentioned.

The yield of both primitive and advanced *Misellina* from the different stratigraphical positions of the lower Permian in the Southern Kitakami mountains the author is now investigating lead him into the taxonomical and phylogenetical investigation on *Misellina*.

In this study, all available morphological characteristics, geographical distribution, stratigraphical occurrence, and ontogeny of each species of

previous *Misellina* and the present Kitakami form are examined.

I. Morphology

Shell form: *Misellina* is staffelloidal to ellipsoidal in shape. *Misellina ovalis* represent the ellipsoidal form, while *Misellina compressa* represents the staffelloidal one. And *Misellina claudiae* stands between the two. Of these, *Misellina compressa* has been treated as representing the genus or subgenus *Brevaxina*. However, the generic or subgeneric separation of *Brevaxina* from *Misellina* seems to be needless, since morphological boundaries between them are successive and difficult to be determined with certainty.

The author plotted the shell form of previously described species of *Misellina*. Although their boundaries are gradual, five main groups in *Misellina* are discriminated so far as the shell form is concerned, as is shown in text-fig. 1.

The first group is represented by *Misellina otakiensis*, and includes *Misellina dyhrenfurthi*, *Misellina ibukiensis*, *Misellina otai*, *Misellina cylindrica*, and *Misellina hataii*. The shell of this group is smallest among *Misellina* and staffelloidal to subspherical with length of 0.6 to 1.6 mm, and width of 0.75 to 1.30.

The second group covers *Misellina ovalis*, *Misellina confragaspira*, and *Misellina iisakai* with query, and is typically represented by *Misellina ovalis*. This group commonly possesses ellipsoidal shell, ranging 1.25 to 3.8 mm in length, and 0.8 to 2.28 mm in width.

Misellina claudiae is typical in the third group, which includes *Misellina termieri*, *Misellina subelliptica*, *Misellina minor*, *Misellina cycloidea*, *Misellina aliciae*, and *Misellina californica*. But the last two species is questionably assigned to the group. These forms of the group are subspherical in shape and commonly have larger shell than *Misellina otakiensis*. It is 1.35 to 2.6 mm long and 1.15 to 2.28 mm wide.

Misellina olgae represents the fourth group. No other species is assigned in this group. It is closely similar to *Misellina otakiensis* in many characteristics, but the former provides larger shell and slightly thicker and well developed parachomata than the latter.

The last group is characterized by planispiral shell with depressed axis of coiling. Single species, *Misellina compressa* is the representative of this group.

Proloculus: Generally speaking, proloculus becomes larger and tends to show broad variation in diameter towards advanced *Misellina*. And elongation of the shell causes the enlargement of proloculus diameter. *Misellina otakiensis* has the proloculus of 40 to 100 microns in diameter while that of *Misellina ovalis*

ranges from 50 to 250 microns. Proloculus of *Misellina claudiae* is smaller than 240 microns. *Misellina compressa* contains the proloculus of less than 150 microns in diameter.

Spirotheca: The structure of the spirotheca of *Misellina* is essentially alveolar. The minor differences in the thickness of the spirotheca and coarseness of alveoli, however, are present.

Misellina otakiensis and *Misellina ovalis* provide comparatively thin spirotheca with fine alveoli. They commonly measure 20 to 30 microns in thickness. While *Misellina claudiae* generally possesses relatively thick spirotheca with rather coarse alveoli, which generally ranges 20 to 40 microns in thickness. *Misellina compressa*, and *Misellina olgae* stands between the two in structure and in thickness of the spirotheca.

Parachomata: Nature of the parachomata appears to be one of the important biocharacters of *Misellina*. But the mode of development of parachomata is various from specimen to specimen. Nevertheless, the following tendency is observable. Parachomata of *Misellina ovalis* are low and broadly based. But on the contrary, parachomata of *Misellina compressa* are high and narrow, while those of *Misellina claudiae* have the intermediate nature between *Misellina ovalis* and *Misellina compressa*.

As was briefly noted above, the shell form, thickness of the spirotheca, proloculus size, mode of development of parachomata, are considered to be mutually closely related. And it seems to be quite reasonable to divide *Misellina* into five groups, *Misellina otakiensis*, *Misellina claudiae*, *Misellina olgae*, *Misellina ovalis* and *Misellina compressa*, as is typically indicated in the difference of shell form in text-fig. 1. Therefore these groups are better treated as independent species.

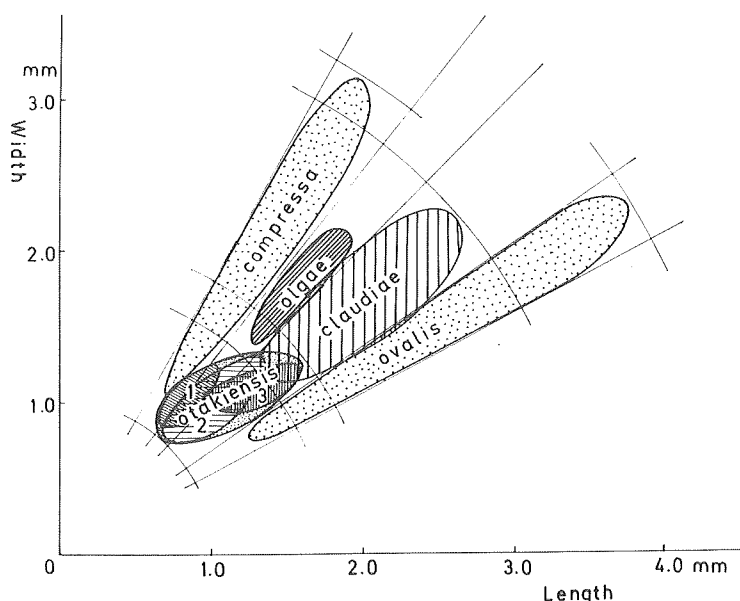


Fig. 1: Shell form of previously described *Misellina*. 1; *Misellina otakiensis* s. str., 2; "*Misellina dyhrenfurthi*", 3; "*Misellina ibukiensis*".

II. Classification of *Misellina*.

Based on the above consideration, a detailed discussion on the classification of each species is given here.

1. *Misellina otakiensis*

This species is characteristic in the possession of very small shell with comparatively ill-developed chomata, minute proloculus, few number of volution, and thin spirotheca for *Misellina*. Stratigraphically it occurs from the middle to the upper lower Permian (Sakmarian to Artinskian).

In this species, the following three varieties are recongnized though they are morphologically closely related and difficult to distinguish with each other, *Misellina otakiensis* (HUZIMOTO), 1936, *Misellina dyhrenfurthi* (DUTKEVICH), 1939, and *Misellina ibukiensis* KOBAYASHI, 1957.

First variety, "*Misellina otakiensis*" s. str.; The following forms are designable to this variety.

Misellina otakiensis (HUZIMOTO), 1936

Misellina dyhrenfurthi (DUTKEVICH), of LEVEN (1970), non
DUTKEVICH (1939)

The present variety very closely resembles *Misellina dyhrenfurthi* in many respects. But the former possesses less developed parachomata throughout the

shell.

Misellina otakiensis was first described from Kwanto Mountains, central Japan by HUZIMOTO (1936) in association with *Pseudofusulina tschernyschewi* (SCHELLWIEN). It still preserves many vestiges of ancestral form of *Misellina*, and it is considered as the most primitive *Misellina* known to date. *Misellina otakiensis* possesses planispiral shell with umbilicated poles, few volutions (5 to 6), very thin spirotheca (less than 30 microns), small proloculus (less than 80 microns in diameter), and poorly developed parachomata which are almost absent in inner one or two volutions. Parachomata are indistinct in middle volutions, but are distinct in the outermost few volutions. From these primitive characteristics, *Misellina otakiensis*, at a glance, looks even similar to *Pamirina*, *Pseudostaffella* or *Staffella*.

Recently LEVEN (1970) illustrated *Misellina dyhrenfurthi* from Artinskian in Darwas with *Pamirina darvasica* LEVEN. However, Darwas form is nothing but *Misellina otakiensis* although some specimens of the former possess transitional natures between *Misellina otakiensis* s. str. and *Misellina dyhrenfurthi*.

Geographically this variety occurs in Japan and USSR (Darwas). Second variety, *Misellina dyhrenfurthi*; The following forms are referable to this variety.

Misellina dyhrenfurthi (DUTKEVICH), 1939

Misellina otai SAKAGUCHI and SUGANO, 1966

Misellina hataii ISHIZAKI, 1963

Misellina subelliptica (DEPRAT), of ISHIZAKI (1963)

Misellina sp. A, SUYARI (1962)

Misellina (*Brevaxina*) sp. nov., of T. OZAWA (1970)

This variety is represented by *Misellina dyhrenfurthi*, and commonly possesses small shell with few volutions (7 to 8), few septa, small proloculus (up to 1.00 microns), and thin spirotheca (generally 20 to 30 microns) for *Misellina*.

Misellina otai SAKAGUCHI and SUGANO from Akiyoshi limestone well coincides with *Misellina dyhrenfurthi*. So the former may be synonymous with the latter. ISHIZAKI (1963) described a new species *Brevaxina hataii* from the lower Permian in Shikoku with many other species of *Misellina*. However, all statistic data and essential natures of the species fall within the specific variation of *Misellina dyhrenfurthi*. ISHIZAKI's form also may be a synonym of *Misellina dyhrenfurthi*. *Misellina* sp. A described by SUYARI from Shikoku is quite identical with *Misellina dyhrenfurthi* although the former contains slightly larger shell than the latter.

Geographical distribution; Krimea, Darwas, Pamirs, and Japan.

Third variety, "*Misellina ibukiensis*";

Misellina ibukiensis KOBAYASHI, 1957

Misellina cylindrica ISHIZAKI, 1963

Misellina aliciae (DEPRAT), of ISHIZAKI (1963)

Misellina minor (DEPRAT), of IGO (1956)

Misellina sp., of T. OZAWA (1970)

Igo's *Misellina minor* from the Osobudani conglomerate in Fukuji, central Japan, yielded in association with *Pseudoschwagerina* (*Robustschwagerina*) *schellwieni* and "*Pseudofusulina*" *vulgaris*, appears to differ from *Misellina minor*, because DEPRAT's original form contains larger shell with more numerous volutions and more distinct parachomata than IGO's form. Further, the former was yielded from higher horizon than the latter. The latter should be better regarded as a member of this variety. Likewise, *Misellina* sp. illustrated by T. OZAWA (1970) from the Kwanto mountains is best considered as a variation of *Misellina otakiensis*. *Misellina cylindrica* ISHIZAKI from Shikoku appears to be included in the present variety. But, as this form seems to be slightly deformed, and single axial section is illustrated, precise specific contents are unknown for us at present.

This variety occurs only in Japan.

2. *Misellina ovalis*

This species includes the following previously described forms.

Misellina ovalis (DEPRAT), 1915

Misellina confragaspira LEVEN, 1967

Misellina iisakai (TORIYAMA), 1947

These forms above listed are characterized by large ellipsoidal shell with comparatively thin spirotheca (commonly 20 to 30 microns), and broad variation in the size of the proloculus (50 to 250 microns), for *Misellina*.

Compared to *Misellina claudiae*, the present species possesses more elongate shell with thinner spirotheca.

Geological distribution; Artinskian to kungrian.

Geographical distribution; Pamirs, North and South China, Southeast Asia, and Japan.

3. *Misellina claudiae*

The following species are included in this species.

Misellina claudiae (DEPRAT), 1912

Misellina termieri (DEPRAT), 1915

Misellina subelliptica (DEPRAT), 1915

Misellina minor (DEPRAT), 1915

Misellina subcycloidea ISHIZAKI, 1962

?*Misellina aliciae* (DEPRAT), 1912

?*Misellina californica* DOUGLASS, 1967

This species contains forms with subspherical shell with numerous volutions (9 to 10), thick spirotheca (30 to 40 microns in outer volutions) for *Misellina*.

Misellina termieri and *Misellina subelliptica* may be synonymous with each other. The synonymy between them was already pointed out by SUYARI (1962). In external shell shape, *Misellina aliciae* (DEPRAT) may be close to this group, although the original form of the former has smaller shell with fewer volutions than the latter.

In external shell form, *Misellina californica* stands between *Misellina ovalis* and *Misellina claudiae*.

Geological distribution; Artinskian to kungrian.

Geographical distribution; Yugoslavia, Turkey, Darwas, Karakorum, Southeast Asia, South China, Japan, and California.

4. *Misellina olgae*

This species was described from Artinskian in Pamirs by LEVEN. It constitutes a distinct group of its own, and is characteristic in the possession of staffelloidal to subspherical shell with slightly umbilicate poles, and is very close to *Misellina otakiensis* or "*Misellina dyhrenfurthi*" in many respects. So, the former may be direct descendant of the latter species.

5. *Misellina compressa*

The present species is known to represent the genus or subgenus *Brevaxina*, which should be suppressed into *Misellina*.

SUYARI's *Misellina* sp. from Shikoku, Japan, may be assignable to this species, though the latter contains far smaller shell compared to the typical *Misellina compressa*.

Geological distribution; Artinskian to kungrian.

Geographical distribution; Southeast Asia and Japan.

III. Phylogeny of the genus *Misellina*

The lowest stratigraphical occurrence of *Misellina* extends down to the base of "*Pseudofusulina*" *vulgaris* zone, middle lower Permian as was ascertained in the Kitakami mountains and East Lake Biwa. *Misellina otakiensis* yielded from the "*Pseudofusulina*" *vulgaris* zone reveals wide specific variation; *Misellina*

otakiensis s. str. possesses staffelloidal shell with poorly developed parachomata, while *Misellina dyhrenfurthi* and *Misellina ibukiensis* varieties contain staffelloidal to subspherical shell with well developed parachomata. From these stratigraphical evidences and morphological features, the ancestor of *Misellina otakiensis* should be sought to a certain form of the lowest Permian though it is not yet discovered. The author thinks that the ancestor of it may be related to such form as *Misellina otakiensis* s. str., since it provides the most primitive natures amongst *Misellina* known to date.

On the other hand, *Misellina otakiensis* s. str. is quite similar to *Pamirina* LEVEN in every respect except for poor development of parachomata in the former. Although *Pamirina darvasica* LEVEN from Darwas was yielded from the Artinskian which indicates slightly higher stratigraphic level than that of *Misellina otakiensis* from the Kitakami mountains, a certain related form of *Pamirina* may have given rise to the most primitive *Misellina* in the lowest Permian, in all possibility. In other words, *Misellina otakiensis*-like ancestral form may have been derived from some form of *Pamirina* in the earliest Permian, and it may have evolved towards *Misellina dyhrenfurthi* and *Misellina ibukiensis* varieties in the succeeding epoch.

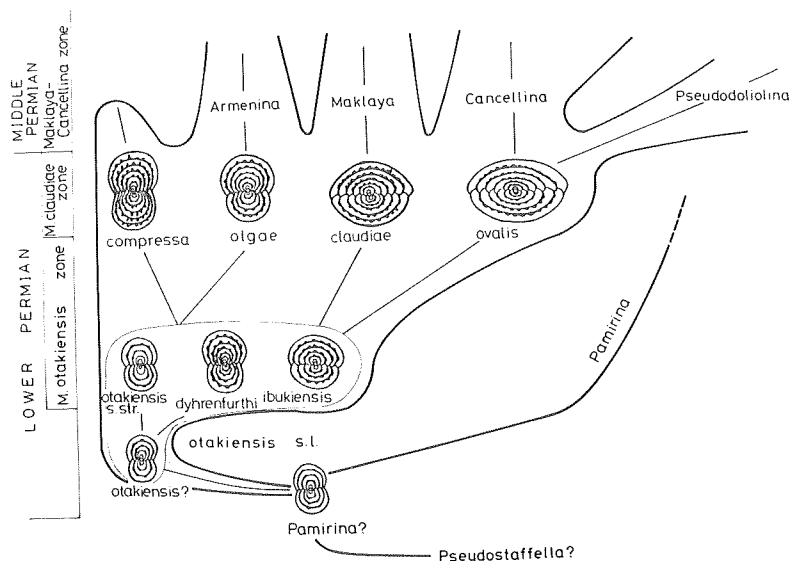
As to the ancestor of genus *Pamirina*, the author considers that one of the evolved form of *Pseudostaffella* is most probable, although all known forms of it were produced from the middle Carboniferous, and consequently the direct phylogenetical relationship between them is here unable to discuss.

Staffella may be considered as ancestral to *Pamirina* in many points. However, since the shell of all species of *Staffella* is more or less mineralized, the former actually may not be ancestral to the latter.

T. OZAWA (1970) placed *Misellina minor* as an ancestor of *Misellina*. However, his opinion can not be accepted. Because the original form of *Misellina minor* described by Deprat from Cammon, Southeast Asia is associated with *Pseudofusulina ambigua* which indicates the uppermost lower Permian. Not only the occurrence, but also in shell size, mode of development of parachomata, *Misellina minor* provides more evolved features than *Misellina otakiensis*. *Misellina minor* is considered as a member of *Misellina claudiae*. Therefore, *Misellina minor* may not be placed as a base of *Misellina* stock.

Based on the general evolutionary trends of each feature of *Misellina*, with statistic data, phylogenetical tree shown in text-fig. 2 was compiled, and the following four phylogenetical stocks are discriminated.

1. *Misellina otakiensis*-*Misellina ovalis* stock.
2. *Misellina otakiensis*-*Misellina claudiae* stock.
3. *Misellina otakiensis*-*Misellina olgae* stock.
4. *Misellina otakiensis*-*Misellina compressa* stock.



Text-fig. 2: Compiled phylogeny of *Misellina*.

The main characteristics of each phylogenetical stock are briefly summarized as follows.

The first stock possesses elongate shell with relatively thin spirotheca, large proloculus, and low and broadly based parachomata.

The second stock possesses subspherical shell with comparatively thick spirotheca.

The third stock contains spherical shell with weakly depressed axial region, and moderately thick spirotheca.

The last stock is typical in staffelloidal shell, high and narrow parachomata and small proloculus.

These four stocks evolved into various genera in the middle Permian succeedingly and developing each morphological attribute above referred; *Cancellina* and *Pseudodoliolina* which are commonly characterized by sub-spherical to elongate shell, comparatively ill-developed parachomata, and thin spirotheca may be derived from *Misellina ovalis*.

Maklaya possessing subspherical shell with thick spirotheca and small proloculus may be direct descendant of *Misellina claudiae*.

Armenina which possesses spherical shell with ill-developed parachomata

may be budded from *Misellina olgae*.

No descendant, however, is present from *Misellina compressa* stock in the middle Permian.

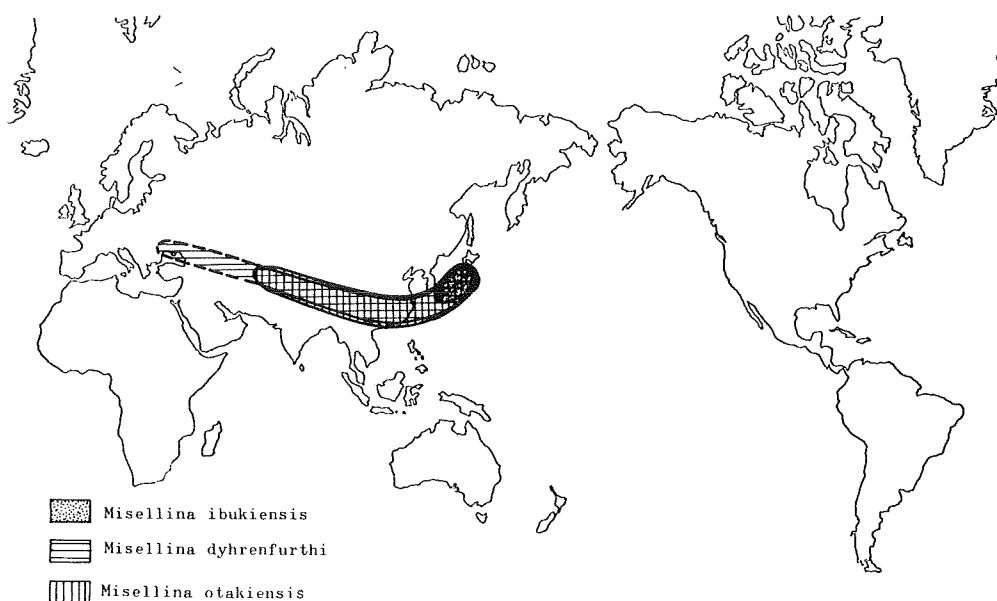
IV. Geographical distribution

As was stated in the foregoing pages, a *Misellina otakiensis* s. str.-like ancestor may have appeared in the lowest Permian, though no evidences are presented at present. The genus then spreaded to the main part of the Tethys Sea region in Sakmarian, with broad specific variation, represented by *Misellina dyhrenfurthi* and *Misellina ibukiensis* varieties.

In Artinskian, *Misellina* expanded throughout the Tethys and reached as far as California, being differentiated into many independent species, such as *Misellina ovalis*, *Misellina claudiae*, *Misellina olgae* and *Misellina compressa*.

Of these, *Misellina claudiae* is found all over the Tethys Sea region and even to California, showing the broadest distribution. *Misellina ovalis* and *Misellina compressa* are distributed in eastern Tethys Sea region.

Text-figs. 3 and 4 show the distribution of *Misellina* in Sakmarian, and Artinskian and kungrian, respectively.



Text-fig. 3: Geographical distribution of *Misellina* in Sakmarian.

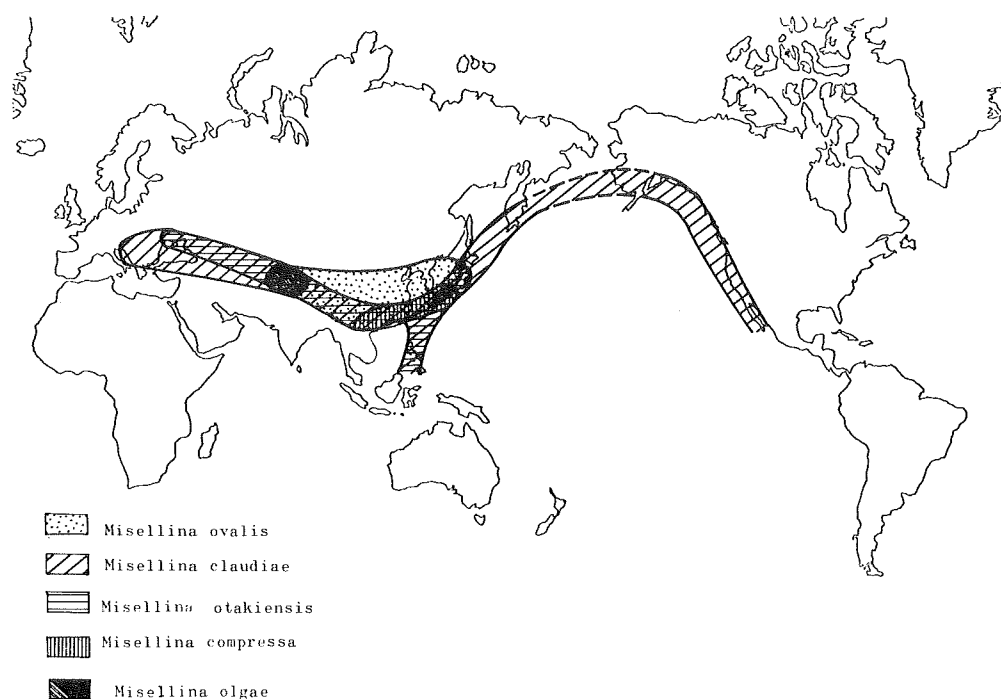


Fig. 4. Geographical distribution of *Misellina* in Artinskian and Kungrian

V. Description of species from the Kitakami Mountains

Genus *Misellina* SCHENCK and THOMPSON, 1940

- 1940 *Misellina* SCHENCK and THOMPSON, p. 587.
- 1942 *Misellina*, DUNBAR and HENBEST, p. 86.
- 1942 *Brevaxina*, DUNBAR and HENBEST, p. 86.
- 1948 *Misellina*, THOMPSON, pp. 58-59.
- 1948 *Brevaxina*, THOMPSON, p. 59.
- 1956 *Misellina*, CHEN, p. 10, 50.
- 1959 *Brevaxina*, M.-MACLAY, RAUSER-CHERNOUSOVA, and ROSOVSKAYA in Основы Палеонтологии, p. 214.
- 1959 *Misellina*, M.-MACLAY, RAUSER-CHERNOUSOVA, and ROSOVSKAYA in Основы Палеонтологии, p. 214.
- 1963 *Brevaxina*, ISHIZAKI, pp. 51-54.
- 1963 *Misellina*, KANMERA, p. 110.
- 1963 *Misellina*, M.-MACLAY, p. 262.
- 1963 *Brevaxina*, M.-MACLAY, p. 261.

- 1963 *Misellina*, SHENG, pp. 90, 221.
 1963 *Brevaxina*, SHENG, pp. 92, 223.
 1964 *Brevaxina*, THOMPSON, p. C427.
 1964 *Misellina*, THOMPSON, p. C427.
 1964 *Misellina*, LEVEN, pp. 28-30.
 1968 *Misellina*, HANZAWA, pp. 249-251.
 1968 *Brevaxina*, HANZAWA, p. 251.
 1970 *Misellina*, OZAWA, pp. 45-46.

Type species: *Misellina ovalis* (DEPRAT), 1915

Generic diagnosis: Shell is minute to small, staffelloidal to ellipsoidal. Inner one or two volutions are mostly endothyroidal. Spirotheca is thin to moderate in thickness, and alveolar. Parachomata are well developed throughout growth. Foramina are well developed. Septula are thoroughly absent.

Misellina otakiensis (HUZIMOTO)

Pl. 1, figs. 3-17.

- 1936 *Pseudodoliolina otakiensis* HUZIMOTO, pp. 110-111, pl. 22, figs. 1-5.
 1939 *Doliolina dyhrenfurthi* DUTKEVICH, p. 42, figs. 3-5.
 1956 *Misellina minor*, IGO, pp. 299-23-, pl. 19, figs. 10, 11.
 1957 *Brevaxina dyhrenfurthi*, M.-MACLAY, pp. 110, 113, pl. 3, fig. 1.
 1957 *Misellina ibukiensis* KOBAYASHI, pp. 297-298, pl. 1, figs. 20-28.
 1959 *Brevaxina dyhrenfurthi*, Основы Палеонтологий, pl. 10, fig. 8.
 1961 *Misellina ibukiensis*, MORIKAWA and ISOMI, pp. 25-26, pl. 21, figs. 1-18.
 1962 *Misellina* sp. A, SUYARI, p. 34, pl. 10, fig. 12.
 1963 *Misellina cylindrica*, ISHIZAKI, pp. 56-57, 59, pl. 9, figs. 3-5.
 1963 *Misellina* aff. *ibukiensis*, ISHIZAKI, p. 9, figs. 6, 7.
 1963 *Misellina subelliptica*, ISHIZAKI, pp. 61-62, pl. 9, figs. 8-18.
 1963 *Brevaxina hataii* ISHIZAKI, pp. 62-63, pl. 9, figs. 19-22.
 1963 *Misellina aliciae*, ISHIZAKI, pp. 55-56, pl. 9, figs. 1, 2.
 1966 *Misellina otai* SAKAGUCHI and SUGANO, pp. 145-147, figs. 1-12.
 1967 *Misellina otakiensis*, LEVEN, pp. 182-183, pl. 29, figs. 1-3.
 1968 *Misellina ibukiensis*, KOIKE, HASHIMOTO and SATO, p. 207, pl. 32, figs. 1, 2.
 1970 *Misellina* (*Brevaxina*) sp. nov., T. OZAWA, pl. 2, figs. 12-14.
 1970 *Misellina* sp., T. OZAWA, pl. 3, figs. 14, 15.

Lectotype: The author here chooses the lectotype of this species as fig. 2, on plate 22, illustrated by HUZIMOTO (1936).

Material: UHR 19590-19595 and UHR 19463. All specimens are deposited in our University.

Description: Shell is very small, almost spherial to subspherical with weakly umbilicated pole regions, giving form ratio of 0.9 to 0.93. Mature shell possesses $5\frac{1}{2}$ to 7 volutions, with axial length of 0.56 to 1.2 mm and the width of 0.6 to 1.3 mm. The shell is endothyroidal in the first volution, then assumes subspherical in shape. Form ratio of the half length to the half width of the first to the seventh volution is about 0.49, 0.63, 0.81, 0.82, 0.84, 0.94, and 0.94, respectively, in average of three specimens.

Proloculus is small with outside diameter of 60 to 70 microns.

Spirotheca is thick for the size of the shell. It is coarsely alveolar. Its thickness is 8 microns in the first, 12.5 in the second, 12.6 in the third, 19.7 in the fourth, 22.8 in the fifth, 29.5 in the sixth, and 24.7 in the seventh volutions in average of four specimens, respectively.

Parachomata are dense, broad and low, of which the top bluntly rounded. Foramina are small, and almost spherical.

Remarks: The present form is characteristic in its small, subspherical to staffelloidal shell. It reveals broad variation in shell shape and size, mode of development of chomata, thickness of the spirotheca and size of proloculus. Some of specimens are close to *Misellina ibukiensis* (Fig. 10), and the others are to *Misellina dyhrenfurthi* or *Misellina otakiensis* s. str. (figs. 3, 6, 12, 14, 17). However, they are here collectively included in *Misellina otakiensis*.

The present form is one of the most primitive *Misellina* from its morphological characteristics and stratigraphical evidences, although it is slightly different in general from *Misellina otakiensis* s. str. which is considered as an ancestor of *Misellina* in the mode of development of parachomata, and it is rather included in *Misellina dyhrenfurthi* variety.

The present form is associated with "*Pseudofusulina*" *vulgaris*, *Pseudofusulina* sp., *Parachwagerina* (*Acervoschwagerina*) sp., *Nagatoella minatoi*, *Triticites* spp., *Ferganites langsonensis*, and *Toriyamaia laxiseptata* etc. in the lowest stratigraphical position, and *Parafusulina* aff. *multiseptata*, *Pseudofusulina fusiformis* and *Nagatoella minatoi* in the highest horizon. Therefore, it ranges from the middle to the upper Sakamotosawa series, lower Permian.

Misellina claudiae (DEPRAT), 1912

Pl. 1, fig. 1, 2 (?)

- 1912 *Doliolina claudiae* DEPRAT, pp. 44-45, pl. 4, figs. 5-9.
- 1915 *Doliolina termieri* DEPRAT, pp. 17-18, pl. 3, figs. 15-20.
- 1915 *Doliolina minor* DEPRAT, pp. 18-19, pl. 3, figs. 21-25.
- 1915 *Doliolina subelliptica* DEPRAT, pp. 19-20, pl. 3, figs. 5, 6.
- 1925a *Verbeekina claudiae*, OZAWA, pl. 2, figs. 1, 2.
- 1925b *Verbeekina claudiae*, OZAWA, pp. 52-53, pl. 11, figs. 9-11.

- 1927 *Verbeekina claudiae*, OZAWA, pl. 34, figs. 1-3.
 1934 *Doliolina claudiae*, LEE, pl. 2, figs. 5, 5a.
 1934 *Doliolina claudiae*, CHEN, pp. 99-100, pl. 16, figs. 13-20.
 1935 *Doliolina* aff. *claudiae*, GUBLER, p. 103, pl. 5, fig. 13.
 1936 *Doliolina claudiae*, HUZIMOTO (FUJIMOTO), pp. 104-105, pl. 21, figs. 4-9.
 1936 *Doliolina minor*, HUZIMOTO (FUJIMOTO) pp. 105-106, pl. 21, figs. 10-12.
 1936 *Doliolina claudiae*, THOMPSON, p. 20, pl. 2, fig. 3.
 1949 *Misellina (Misellina) claudiae*, M.-MACLAY, p. 106.
 1956 *Misellina* aff. *claudiae*, KANMERA, pl. 36, fig. 15.
 1957 *Misellina* cf. *M. claudiae*, KOBAYASHI, pp. 296-297, pl. 1, fig. 19.
 1958 *Misellina claudiae*, SAKAGUCHI, pp. 89-90, pl. 4, figs. 1a, 1b, 2.
 1958 *Misellina claudiae*, TORIYAMA, pp. 208-211, pl. 39, figs. 1-19.
 1960 *Misellina claudiae*, KANUMA, pp. 64-65, pl. 11, figs. 2-9.
 1961 *Misellina claudiae*, NOGAMI, pp. 169-171, pl. 7, figs. 7-9.
 1962 *Misellina claudiae*, ISHIZAKI, pp. 166-167, pl. 10, figs. 11-17.
 1962 *Misellina cycloidea*, ISHIZAKI, pp. 167-169, pl. 10, figs. 18-21; pl. 11, figs. 1, 2.
 1962 *Misellina* cf. *M. termieri*, SUYARI, p. 33, pl. 10, figs. 6-8.
 1963 *Misellina claudiae*, HANZAWA and MURATA, pl. 6, fig. 7, 8.
 1963 *Misellina claudiae*, KANMERA, pp. 110-112, pl. 14, figs. 7-14.
 1963 *Misellina claudiae*, SHENG, p. 91, 222-223, pl. 28, figs. 15; pl. 30, figs. 12-19.
 1963 *Misellina subelliptica*, ISHIZAKI, pp. 61-62, pl. 9, figs. 8-18.
 1964 *Misellina termieri*, LEVEN, pl. 1, figs. 7-9.
 1968 *Misellina claudiae*, KOIKE, HASHIMOTO and SATO, pp. 206-207, pl. 32, figs. 3, 4.

Material: UHR 18339b, UHR 18343a, and some other ill-oriented and ill-preserved specimens.

Lectotype: Lectotype of this species was chosen by TORIYAMA (1958) as DEPRAT's (1912) fig. 5, on plate 4.

Description: Shell is minute, almost spherical. Outer few volutions are always missed as to prevent to measure the size of full grown shell. But the mature shell possessing eight volutions is estimated to have the length of 1.84 mm and the width of 1.66 mm, giving form ratio of about 1.1. The first one or two volutions are more or less staffelloidal with slightly umbilical pole regions. But beyond the second volution the axis becomes gradually extended laterally. Height of volution is 0.035° in the first volution, 0.085, in the fourth, and 0.16 mm in the outermost volutions in an illustrated specimen (pl. 1, fig. 1).

Proloculus is minute and larger than 0.050 mm in diameter. Spirotheca is composed of tectum and coarse alveoli. Its thickness is gradually thickened towards outer volutions; 0.020 mm in the fourth. Septa are straight. Number of septa in the middle volutions is 17 to 18 in a parallel section. Parachomata are well developed throughout the shell. They are broadly based with rounded surface in cross section.

Remarks: Although material is not unfavorable for detailed investigation, the present form is comparable with *Misellina claudiae* in all available features.

This form is associated with "*Pseudofusulina*" *krafftii*, and stratigraphically it occurs from the upper Sakamotosawa series. A specimen which is questionably assigned to this species (pl. 1, fig. 2) was yielded from the lower Sakamotosawa series in association with "*Pseudofusulina*" *vulgaris*, *Nagatoella minatoi*, *Schwagerina* cf. *krotowi*, and "*Pseudofusulina*" *krafftii*. This specimen may be a primitive form of *Misellina claudiae*.

Acknowledgements: The author here acknowledges with best regards to Prof. M. KATO who read the paper in manuscript and gave him fruitful suggestions. His cordial thanks are also extended to Prof. M. MINATO for his kind guidance throughout his fusulinid study.

References cited

- CHEN, S. (1934): Fusulinidae of South China. part I. *Palaeont. Sinica*, ser. B, vol. 4, fas. 2, pp. 1-133, pls. 1-16.
- (1956): Fusulinidae of South China, part 2. *ibid.*, new ser. B, no. 6, pp. 17-71, pls. 1-14.
- DEPRAT, J. (1912): Etude des Fusulinidés de Chine et d'Indochine et Classification des Calcaires à Fusulines. *Mem. Serv. Geol. de l'Indochine*, vol. 1, fas. 3, pp. 1-76, pls. 1-9.
- (1915): Les Fusulinidés des Calcaires Carbonifériens et Permians du Tonkin, du Laos et du Nord-Annam. *ibid.* Vol. 4, fas. 1, pp. 1-30, pls. 1-3, pls. 1-3.
- DOUGLASS, R. (1967): Permian Tethyan fusulinids from California. *Geol. Surv. Prof. Paper* 593-A, Cont. Paleont., pp. A1-A13, pls. 1-6.
- DUNBAR, C. O. and HENBERT, L. G. (1942): Pennsylvanian fusulinidae of Illinois. *Illinois State Geol. Surv. Bull.*, no. 67, pp. 1-218, pls. 1-23.
- GUBLER, T. (1935): Les Fusulinidés du Permien de l'Indochine, leur structure et leur classification. *Soc. Géol. France, Mém.*, new ser., tome XI, fas. 4, no. 26, pp. 1-173, pls. 1-8.
- HANZAWA, S. (1968): Larger foraminifera, *Asakura Shoten*, pp. 1-300, pls. 1-90. (In Japanese)
- and Murata, M. (1963): The paleontologic and Stratigraphic

- considerations on the Neoschwagerininae and Verbeekininae, with the descriptions of some fusulinid foraminifera from the Kitakami Massif, Japan. *Sci. Repts. Tohoku Univ., Sendai*, ser. 2, (Geol.), vol. 35, no. 1, pp. 1-31, pls. 1-20.
- HUZIMOTO, H. (=FUJIMOTO, H) (1936): Stratigraphical and palaeontological studies of the Titibu system of the Kwantō-Mountainland. Part II, Palaeontology. *Sci. Rep. Tokyo Bunrika Daigaku*, sec. C, vol. 1, no. 2, pp. 29-125, pls. 1-26.
- IGO, H. (1956): Notes on the Osobudani conglomerate and some lower Permian fusulinids contained in its limestone pebbles. Part II. (On a new type of the wall structure of fusulinids). *Sci. Rep. Tokyo Kyoiku Daigaku*, sec. C, (Geol. Mineral. & Geogr.), vol. 4, no. 40, pp. 293-302, pls. 18-19.
- ISHIZAKI, K. (1962): Stratigraphical and paleontological studies of the Onogahara and its neighbouring area Kochi and Ehime Prefectures, Southwest Japan. *Sci. Rep. Tohoku Univ., Sendai*, vol. 34, no. 2, pp. 95-185, pls. 7-12.
- (1963): Verbeekininae from the inferred upper Wolfcampian limestone in the west of Ryoseki, Kochi Prefecture. *Trans. Proc. Palaeont. Soc. Japan*, new ser., no. 50, pp. 51-64, pl. 9.
- KANMERA, K. (1956): *Toriyamaia*, a new Permian fusulinid genus from the Kuma Massif, Kyushu, Japan. *Trans. Proc. Palaeont. Soc. Japan*, new ser., no. 24, pp. 251-257, pl. 36.
- (1963): Fusulines of the middle Permian Kozaki formation of Southern Kyushu. *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Geol., vol. 14, no. 2, pp. 79-141, pls. 11-19.
- KANUMA, M. (1960): Stratigraphical and Paleontological studies of the Southern part of the Hida Plateau and the North-eastern part of the Mino Mountainland, central Japan. Part 2, Paleontology, no. 4, *Bull. Tokyo Gakugei Univ.*, vol. 11, pp. 55-83, pls. 10-13.
- KOBAYASHI, M. (1957): Paleontological study of the Ibukiyama limestone, Shiga Prefecture, central Japan. *Sci. Rep. Tokyo Kyoiku Daigaku*, sec. C, Geol. Mineral. & Geogr., vol. 5, no. 48, pp. 247-311, pls. 1-10.
- KOIKE, T., Hashimoto, W., and SATO, T. (1968): Fusulinid-bearing limestone pebbles found in the Agbahag Conglomerate, Mansalay, Oriental Mindoro, Philippines. *Geol. Paleon. Southeast Asia*, vol. 4, pp. 198-210, pls. 31-32.
- LEE, J. S. (1934): Taxonomic criteria of fusulinidae with notes on seven new Permian genera. *Mem. National Research Inst. Geology*, no. 14, pp. 1-32, pls. 1-5.
- LEVEN, A. Ya. (1964): К систематике семейства Verbeekinidae (Fusulinida). Палеонтол. Журн., no. 4, Изд. АН СССР, pp. 23-31, pl. 1.
- (1967): Стратиграфия и фузулиниды Пермских отложений Памира. Труды Геол. Ин-та, АН СССР, вып. 167, pp. 1-224, pls. 1-39.
- (1970): О происхождении высших фузулинид. Палеонтол. Журн., no. 3, pp. 18-25, pls. 1-2.

- М.-MacLay, A. D. (1957): Некоторые фузулиниды Перми Крыма. Ученые Записки ЛГУ, no. 225. Сер. Геол. Наук, вып. 9, pp. 93-159, pls. 1-14.
- (1963): Верхний Палеозой Средней Азии. Изд. Ленинград. Ун-та, pp. 1-328.
- , Rauser-CHERNOUSOVA, D. M. and ROSOVSKAYA, S. A. (1959): Отряд Fusulinida, Основы Палеонтологии, общая часть простейшие, Изд. АН СССР.
- MORIKAWA, R. and ISOMI, H. (1961): Studies of Permian fusulinids in the East of Lake Biwa, central Japan. *Geol. Surv. Japan, Rep.*, no. 191, pp. 1-30, pls. 1-21.
- NOGAMI, Y. (1961): Permische Fusuliniden aus dem Atetsu-Plateau Südwest-japans. Teil 2, Verbeekinae, Neoschwagerininae u. a., *Mem. Coll. Sci. Univ. Kyoto*, Ser. B, vol. 28, no. 2, Geol. Mineral., Art. 3, pp. 159-242, pls. 1-7.
- OZAWA, T. (1970): Notes on the phylogeny and classification of the superfamily Verbeekinoidea (Studies of the Permian Verbeekinoidean Foraminifera-I). *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, Geol., vol. 20, no. 1, pp. 17-58, pls. 1-9.
- OZAWA, Y. (1925a): On the classification of fusulinidae. *Jour. Coll. Sci., Tokyo Imp. Univ.*, vol. 45, art. 4, pp. 1-26, pls. 1-4.
- (1925b): Paleontological and stratigraphical studies on the Permo-Carboniferous limestone of Nagato. Part II. Paleontology. *ibid.*, vol. 45, art. 5, pp. 1-90, pls. 1-14.
- (1927): Stratigraphical studies of the fusulina limestone of Akasaka, Province of Mino. *Jour. Fac. Sci., Imp. Univ. Tokyo*, sec. 2, Geol., Mineral., Geogr., Seismol., vol. 2, part 3, pp. 121-164, pls. 34-45.
- SAKAGAMI, S. (1958): Fusulinids from the upper Permian conglomerates of the northern part of Itsukaichi, Tokyo-to, Japan. *Jour. Hokkaido Gakugei Univ.*, vol. 9, no. 2, pp. 72-97, pls. 1-4.
- SAKAGAMI, S. and SUGANO, K. (1966): A new species of *Misellina* from the Akiyoshi limestone at the Kaerimizu Sink Hole, Yamaguchi Prefecture, Southwest Japan. *Mem. Osaka Gakugei Univ.*, B. Natur. Sci., no. 15, pp. 143-149, figs. 1-12.
- SCHENCK, H. G. and THOMPSON, M. L. (1940): *Misellina* and *Brevaxina*, new Permian fusulinid foraminifera. *Jour. Paleont.*, vol. 14, no. 6, pp. 584-589.
- SHENG, J. C. (1963): Permian fusulinids of Kwangsi, Kueichow Szechuan. *Palaeont. Sinica*, new ser. 10, pp. 1-247, pls. 1-36.
- SUYARI, K. (1962): Geological and palaeontological studies in central and eastern Shikoku, Japan. Part 2, Palaeontology. *Jour. Gakugei Tokushima Univ.*, vol. 12, pp. 1-64, pls. 1-12.
- THOMPSON, M. L. (1936): *Nagatoella*, A new genus of Permian fusulinids. *Trans. Proc. Palaeont. Soc. Japan*, nov. 2, pp. 15-22, pl. 2.
- (1948): Studies of American fusulinids. *Univ. Kansas Paleont.*

Contr., Protozoa, Art. 1, pp. 1-184, pls. 1-38.

————— (1964): Fusulinacea. In *treatise* on Invertebrate Palaeontology, Part C, Protista 2, pp. C358-C436.

TORIYAMA, R. (1947): On some fusulinids from Tosayama, Koti-Ken, Sikoku, with a note on the stratigraphical range of *Neoschwagerina*. *Jap. Jour. Geol. Geogr.*, vol. 20, no. 2-4, pp. 63-82, pls. 16-17.

————— (1958): Geology of Akiyoshi. Part 3, Fusulinids of Akiyoshi, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Geol., vol. 7, pp. 1-264, pls. 1-48.

(Manuscript received September 17, 1971)

PLATE 1 AND EXPLANATION

Explanation of Plate 1

Misellina claudiae (DEPRAT)

Fig. 1: Tangential section. UHR 10339b. Loc. East of Suwa shrine, Yahagi-cho (town), collected by T.YASUDA. x20.

?Fig. 2: Tangential section. Note the well developed parachomata. A primitive form? of *Misellina claudiae*, obtained from the lower Sakamotosawa series, lower Permian, in Aibata, a small tributary of the Yukisawa. x20.

Misellina otakiensis (HUZIMOTO)

Axial sections:

Fig. 3: UHR 19592-1c, x20, **fig. 4;** UHR 19592 9, **fig. 5;** Enlarged figure of **fig. 14,** UHR 19592 3a, x60, **fig. 6;** Enlarged part of **fig. 3,** UHR 19592-1b, x50, **fig. 10;** Slightly deformed, UHR 19592-1a, x20. **fig. 12;** A deformed specimen. UHR 19592-3b, x20. **fig. 13;** UHR 19592 4b. x20. **fig. 14;** UHR 19592-3a, x20. **fig. 17;** UHR 19591-1c, x10. All specimens are from Kattisawa, Setamai.

Sagittal sections:

Fig. 7: UHR 19592-2c, x20. **fig. 8;** UHR 19592-3c, x20. **fig. 9;** Slightly obliquely cut sagittal section. UHR 19463b, x20. **fig. 15;** UHR 19590, x10.

Tangential sections:

Fig. 11: UHR 19595-8, x20, **fig. 16;** UHR 19592-6a, x10. **Fig. 18** shows the association of *Misellina otakiensis* with *Ferganites langsonensis* (SAURIN) and *Pseudofusulina* sp., UHR 19592-2, x10.

(All specimens were obtained from Setamai-Yahagi district, Southern Kitakami Mountains, Japan.)

