# DISCOVERY OF URALIAN FUSULINIDS FROM THE UPPER PERMIAN CONGLOMERATE IN THE SOUTHERN KITAKAMI MOUNTAINS, JAPAN.

*by*

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(with 2 text-figures and 2 plates)

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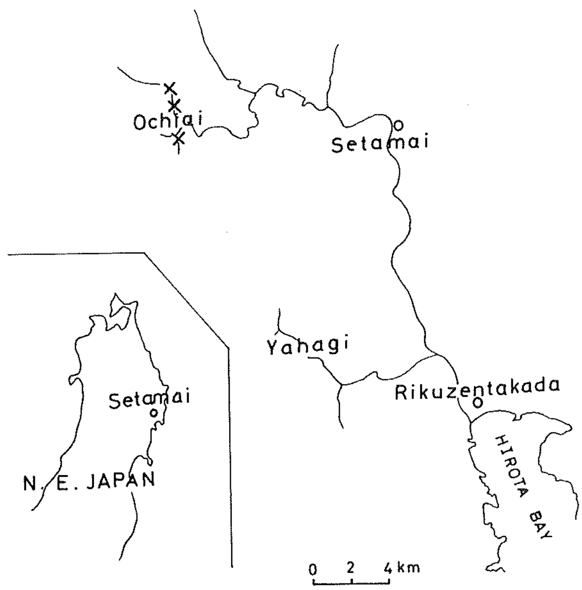
Southern Kitakami Mountain region is one of the classical fields for the Permian and the Carboniferous stratigraphy in Japan. Thanks to the effort of many previous investigators, the Permian and Carboniferous lithostratigraphy and biostratigraphy of this area have been clarified step by step, except for some problems on zonation of the upper Caboniferous and the uppermost Permian.

In the Southern Kitakami mountains the upper Carboniferous is present which is the Nagaiwa series, representing the *Millerella* to *Profusulinella* zone (MINATO, TAKEDA, KAKIMI, and KATO, 1959). The younger formations of the upper Carboniferous correlatable to the *Fusulinella-Fusulina* zone to *Triticites* zone (Moscovian to Uralian) have been unknown from the Kitakami mountains up to date, although they are rather well developed elsewhere in Japan. This fact may be generally interpreted as a result of erosion caused by the pre-Permian upheaval so called Setamai folding proposed by MINATO (1942). He has long investigated the upper Paleozoic strata in the Setamai district. As a matter of fact a clinounconformity was detected by him between the lower Permian and the underlying formations, the Nagaiwa series for instance. This unconformable relationship was subsequently ascertained by YAMADA (1959) in the Sakari district adjacent to Setamai.

However, it has not been thoroughly settled yet, whether Moscovian and Uralian formations actually once deposited in the Kitakami mountains or not.

On the other hand, the thick coglomerate which bears pebbles, cobbles and even bouldetes of granitic rocks has been noticed by many authors for its peculiar sedimentological feature as well as its tectonical significance. The conglomerate is intercalated in thick black slate formation of the upper Permian in rough estimation. Moreover, a similar type of conglomerates is widely developed throughout Japan.




**Text-fig. 1.**
Index map showing the locality of Ochiai.

In the course of stratigraphical investigation of the author for the Permian formations developed in the Southern Kitakami mountains, he has tried to extend his research on the source area and source material of the pebbles of the Usuginu-type conglomerate since limestone pebbles and cobbles are also included in this conglomerate at places. Quite unexpectedly he found Uralian together with lower to middle Permian fusulinid remains in these limestone pebbles, exposed at Ochiai, Sumita-cho (town).

The Usuginu-type conglomerate developed there carries abundant pebbles and cobbles of acidic plutonics as much as 15% of the total number of pebbles and cobbles. Limestone pebbles are always well rounded and attain about 30 cm diameter at its maximum. The conglomerate cropping out there is intercalated in thick black slate with laminations composed of sandy black slate and fine to medium grained sandstone in alternation. This is especially well developed in the lower stratigraphical position, with graded bedding, load cast and occasional ripple mark. And they are collectively called as Toyoma formation. Within the observed sequence of the Toyoma formation at this locality, two conglomerate beds are discriminated. From the lower conglomerate bed that is divisable into two main cycles with some more minor cycles, the following fusulinids were yielded.

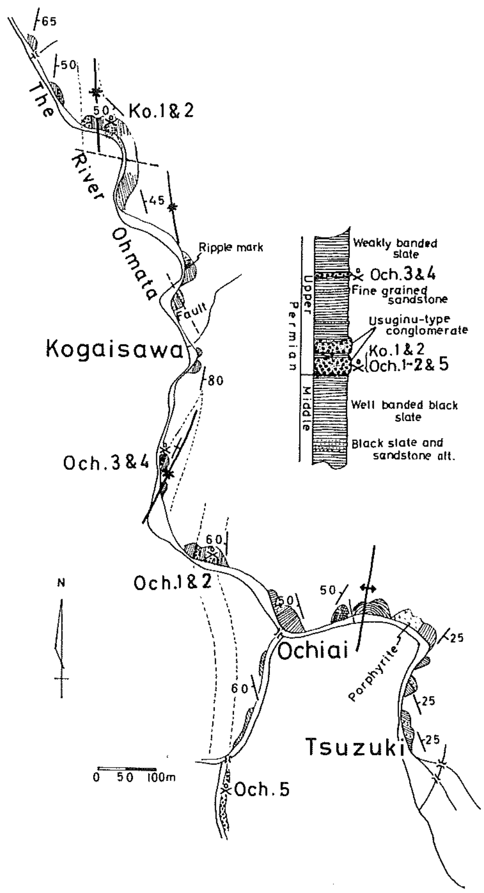
*Misellina otakiensis* (Huzimoto) (Och. 1, Och. , Och. 5)

*Nagatoella minatoi* Kanmera and Mikami (Och. 2, Och. 5, Ko. 2)

*"Pseudofusulina" kraffti* (SCHELLWIEN and DYHRENFURTH) (Och. 5, Ko. 3)
*Pseudofusulina fusiformis* (SCHELLWIEN and DYHRENFURTH)(Och. 5)
*"Pseudofusulina" vulgaris* (SCHELLWIEN and DYHRENFURTH)(Ko. 2)
*Pseudofusulina* sp. (Och. 1)
*Triticites* sp. (Och. 1)

From the localities Och. 3 and Och. 4 of the upper conglomerate bed, the following Uralian *Triticites* with middle Permian fusulinids were found.

*Triticites matsumotoi* KANMERA (Och. 3)
*Triticites*? sp. (Och. 3)
*Pseudodoliolina* aff. *pseudolepida* (DEPRAT) (Och. 4)
*Misellina* sp. (Och. 4)




**Text-fig. 2.**
Geological sketch map along the river Ohmata around Ochiai, and columnar section showing the stratigraphical positions from where limestone pebbles were collected.

According to the present author's study on lower Permian fusulinids in the Setamai-Yahagi district, *Triticites* sp. in the above list is also obtained from the middle Sakamotosawa series, while *Misellina otakiensis* from the middle to the upper, *"Pseudofusulina" vulgaris* from the middle, *"Pseudofusulina" kraffti* ranges from the middle to the upper, *Pseudofusulina fusiformis* from the upper and *Nagatoella minatoi* from the middle to the upper Sakamotosawa series, respectively.

*Pseudodoliolina* aff. *pseudolepida* obtained in association with *Misellina* sp. represents *Neoschwagerina* zone outside the Kitakami mountains, although no comparable forms have been described from the Kitakami mountains by now.

*Triticites matsumotoi* Kanmera and *Triticites*? sp. are the most significant species among the forms above listed, since they indicate Uralian in age, so far as the present knowledge is concerned. The former species is close to the group of genus *Protriticites* Putrja from its spirothecal structure, though the former possesses distinct keriotheca in the wall. A number of species of *Protriticites* have been described mainly from the USSR and also from Chinese and Japanese Uralian. The detailed discussion on the species will be given in the part of description.

Although previous investigators (Saito, 1968; Iwasawa, 1967 in Onuki, 1969) also found some lower to middle Permian fusulinids such as *Misellina clauiae, Parafusulina* sp., *Pseudodoliolina pseudolepida* etc. from the limestone pebbles in the Usuginu-type conglomerate cropped out in Ochiai and its neighbouring localities including the localities from where the present author found fusulinid fossils, they considered that the limestone might be contemporaneous lenses of the conglomerate and therefore the conglomerate might be of early middle Permian in age.

However, the discovery of lower to middle Permian fusulinids and even Uralian fusulinids from the Usuginu-type conglomerate at the same localities proved that the limestone pebbles do not constitute the conglomerate matrix at least at Ochiai district. To be sure these limestone pebbles must have been derived from a certain source area where both the lower Permian and Uralian formations had cropped out in those days.

The discovery of Uralian fusulinids from the Southern Kitakami mountains may be significant in the following points.

1. At least in certain places, probably not far from the Kitakami mountains, the Uralian formations represented by *Triticites* fauna were once deposited.
2. Therefore the absence of the Moscovian and the Uralian formations may be due to erosion caused by the pre-Permian Setamai folding, and not by non-deposition.
3. There may be a possibility that the upper part of the Nagaiwa series may

denote still higher horizons than *Profusulinella* zone as has hitherto so considered. Detailed biostratigraphy on the entire Nagaiwa series may be of importance to settle this problem.

In the following pages description of species of the Uralian fusulinids will be presented. Description of the lower to the middle Permian fusulinids is going to be given in another paper, now in preparation, although the representative forms in the Usuginu-type conglomerate both Permian and upper Carboniferous are illustrated herein for the sake of completion.

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## Description of species

Family Schwagerinidae DUNBAR and HENBEST, 1930
Subfamily Schwagerininae DUNBAR and HENBEST, 1930
Genus *Triticites* GIRTY, 1904
*Triticites matsumotoi* KANMERA

Pl. 1, figs. 1-9.

1955 *Triticites matsumotoi* KANMERA, pp. 184-185, pl. 11, figs. 6-25.
1962 *Triticites matsumotoi kattoi* SUYARI, pp. 15-16, pl. 5, figs. 1-3.
1962 *Triticites matsumotoi suitaensis* SUYARI, pp. 17-18, pl. 5, figs. 4-6.

*Holotype*: KANMERA (1955) designated pl. 11, fig. 8 as holotype of this species.
*Material*: A number of ill-preserved specimens have been obtained. They are UHR 19511-19520, and UHR 19537-19541.
*Description*: Shell is small, fusiform to slightly inflated fusiform, and possesses 6 volutions or more at maturity. Owing to missing of the outer volutions of the specimens at the author's disposal, the size of the full-grown shell is difficult to determine, but it may range 3.0 to 3.8 mm in length and 1.4 to 1.7 mm in width, giving form ratio of 1.8 to 2.2. The shell in inner volutions is tightly coiled, subspherical in shape, then relatively quickly expanded outwards, gradually assuming fusiform in shape. Height of the volutions from the first to the fourth volution in an illustrated specimen (pl. 1, figs. 2 & 3) gives, 50, 70, 155 and 160 microns, respectively. And that of the sixth volution in other

specimens is 230 to 270 microns.

Proloculus is small, measures at most 130 microns, and usually about 100 microns in outside diameter.

Spirotheca is composed of tectum and keriotheca in outer volutions. The keriotheca appears from the fourth or the fifth volution. The structure of the inner wall is unfortunately almost indeterminable owing to ill-preservation of the specimens at hand. However, in some well preserved specimens, the spirotheca seems to consist of three layers, tectum and upper and lower rectoria in inner volutions; and four layers, tectum and transparent diaphanotheca-like layer and upper and lower tectoria in the middle volutions. The diaphanotheca-like transparent layer gradually shifts into keriothecal structure in outer volutions. The thickness of the spirotheca from the first to the sixth volution is 10?, 20, 28, 36, 50, and 65 microns respectively in average.

Septa are not fluted throughout the shell except for the pole regions of the outer volutions where they are weakly fluted. Septal count is 10? in the second, 15-16 in the third, 17 to 18 in the fourth 18 to 19 in the fifth, and about 20 in the sixth volution.

Chomata are prominant, massive, broadly based and gently sloped towards pole regions. Tunnel is comparatively narrow and low.

*Remarks*: This form is characteristic in possessing the small fusiform shell with almost unfluted septa throughout the shell, massive chomata, tightly coiled inner volutions, and nature of the spirothecal structure, that is *Profusulinella* type three layered infant stage, *Fusulinella* type four layered middle stage, and *Triticites* type adult stage.

The present form is quite identical with *Triticites matsumotoi* KANMERA from the upper Carboniferous Yayamadake limestone, Kyushu in all available characteristics, although ideally preserved and cut specimens have not been obtained from the Kitakami mountains to make detailed comparison with the Yayamadake form. SUYARI (1962) described *Triticites matsumotoi suitaensis* and *Triticites matsumotoi kattoi* from the upper Carboniferous *Triticites* zone in Shikoku. Both of these subspecies do not essentially differ from the typical Yayamadake form and may be included within specific variation of *Triticites matsumotoi*. Therefore subspecific separation seems to be needless.

SADA (1965) restudied the structure of the wall of the topotype material of *Triticites secalicus* (SAY), the type species of the genus *Triticites*, and he clarified that the spirotheca of *Triticites secalicus* was composed of tectum and upper and lower tectoria (*Profusulinella* type wall) in inner four volutions, tectum, diaphanotheca and upper and lower tectoria (*Fusulinella* type wall) in the fifth volution, and tectum and keriotheca (*Triticites* type wall) beyond that volution. He also discriminated the two wall types in *Triticites* group; the first type possesses *Profusulinella* wall-*Fusulinella* wall-*Triticites* wall, and the other group, *Profusulinella* wall-*Triticites* wall in ontogeny. The former is represented by *Triticites secalicus* (SAY), *Triticites matsumotoi* KANMERA from the Yayamadake limestone, *Triticites exsculptus* IGO from Fukuji, central Japan, and the present Kitakami form as well. While the latter is represented by *Triticites* sp. A by SADA from the Onogahara limestone, Shikoku, *Triticites montiparus* by KANMERA from the Yayamadake limestone, *Triticites* cf. *kagaharensis* HUZIMOTO described by IGO from Fukuji and others. The species of the former group is mostly found from the upper Carboniferous, whereas those of the latter group mainly from the lower Permian.

Genus *Protriticites* may be close to the former group. It was established on the basis of its spirothecal structure which is *Fusulinella* type wall in inner volutions, and tectum and protheca with pores in outer volutions. The protheca with pores is considered a transitional stage from diaphanotheca to keriotheca. ISHII (1958) discussed the genus *Protriticites* and suggested the phylogeny of *Fusulinella*-*Protriticites*-*Triticites* lineage. Чзнь Цэинь — Ши (1963) considered the genus *Protriticites* was a transitional form from *Fusulinella* to *Triticites* and *Obsoletes*. These opinions appear reasonable. However, the author considers that the appearance of distinct keriotheca in the spirotheca of *Triticites* should be regarded as generic criterion in distinguishing *Triticites* from *Fusulinella*. Since the type species of *Protriticites* is said to lack the distinct keriotheca in the wall, and furthermore certain forms of *Fusulinella* provide protheca with pores in outer volutions, genus *Protriticites* should be better supressed.

*Protriticites globulus*, the type species of the genus *Protriticites* very closely resembles *Triticites matsumotoi* KANMERA in shell shape and size, mode of development of chomata, and nature of septal fluting, although the former contains no distinct keriotheca, and in general has more concave lateral slopes, more tightly coiled inner volutions and smaller proloculus than the latter. The morphological relationships among *Triticites matsumotoi*, *Protriticites globulus*, *Protriticites pseudomontiparus*, *Protriticites schwagerinoides*, and *Protriticites ovatus* need to be reinvestigated in future. Some of them may be synonymous with each other.

*Protriticites praesimplex* (LEE) from China possesses more elongate shell than the present form. *Protriticites niumalongensis* SHENG and *Protriticites rarus* SHENG are readily distinguishable from *Triticites matsumotoi* in smaller shell with less numerous volutions than the latter.

The spirotheca of *Triticites montiparus*, the type species of genus *Montiparus* ROSOVSKAYA, which resembles the present form in many respects, lacks four layered stage in inner volutions, and consists of tectum and upper and lower tectoria in inner volutions. From these characteristics the former is safely distinguishable from the latter. *Montiparus* group may belong to a different stock from *Protriticites* group.

*Triticites*? sp.

pl. 1, figs. 10 & 11.

*Remarks:* Single subcylindrical form was obtained in association with *Triticites matsumotoi* KANMERA. This form is thoroughly replaced by secondary minerallization throughout the shell, and consequently detailed spirothecal structure is hardly known. Therefore the generic assignment is impossible, although all available informations show close relationship to genus *Triticites.*

This form somewhat resembles the elongate forms of *Triticites* such as *Triticites yayamadakensis* KANMERA from the Yayamadake limestone. But the former has more elongate shell with more distinct chomata. In subcylindrical shell with massive chomata and almost unfluted septa, the present form is compared with *Triticites procerus* MYERS, *Triticites nebraskensis* THOMPSON, *Triticites submagdalium* MYERS, and *Triticites marathonensis* ROSS, all from the upper Pennsylvanian in Texas. But more precise comparison is impossible as the former is too poorly preserved and scanty in number to make more detailed comparison at present.

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**Explanation of Plate 1**

*Triticites matsumotoi* KANMERA

Figs. 1, 2 & 3: Axial sections of inner volutions. 1; UHR 19512, x20, 2; A well oriented specimen. UHR 19515, x20. 3, Enlarged part of fig. 2, showing massive chomata and the structure of the spirotheca in immature stage. x100.

Fig. 4: Diagonal section of inner shell. UHR 19514b, x20.

Fig. 5: Slightly obliquely cut sagittal section. UHR 19516, x20.

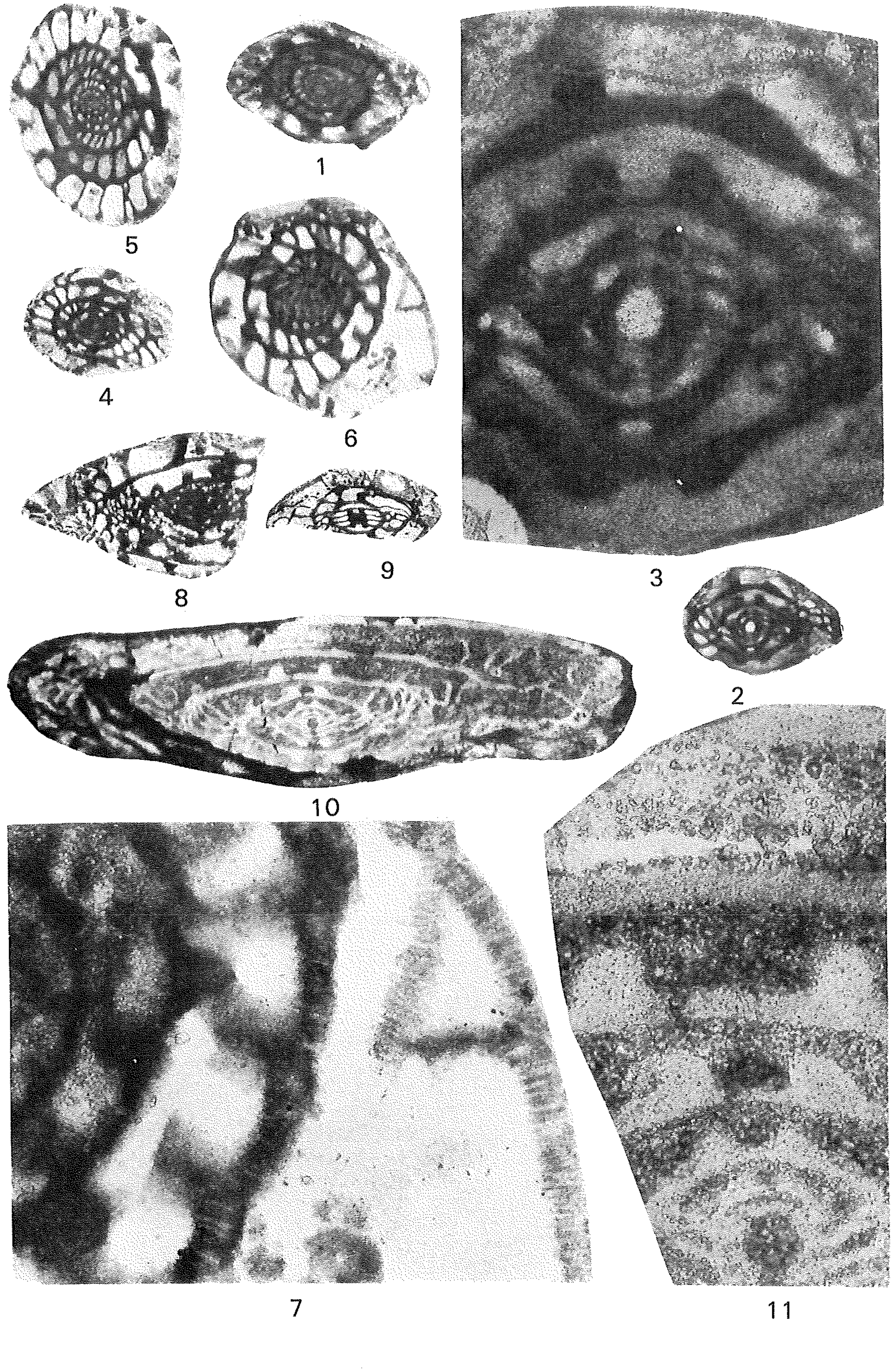
Fig. 6 & 7: Parallel sections, showing the structure of the spirotheca. Fig. 6 is x20, and fig. 7 is x100. Both are UHR 19517c. Note the gradual appearance of the keriotheca in the wall in outer volutions.

Figs. 8 & 9: Two tangential sections. Figs. 8 UHR 19538, x20, and fig. 8 is UHR 19516, x10.

*Triticites*? sp.

Figs. 10 & 11: Axial section. Fig. 11 is x100, enlarged figure of fig. 10 which is x20. UHR 19511, x100. Note the elongate shell with nearly platy septa, massive chomata and thorough replacement of the whole shell by secondary minerallization.

(All specimens were obtained in a limestone pebble of the upper Permian Usuginu-type conglomerate developed in Ochiai district, Sumita-cho (Town), Southern Kitakami Mountains)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**Explanation of Plate 2**

All figures are ten times natural size, except for fig. 11 which is twenty times natural size.

Figs. 1-3: *"Pseudofusulina" vulgaris* (SCHELLWIEN and DYHRENFURTH)
- 1; Slightly oblieque axial section. UHR 19478.
- 2; Axial section. UHR 19475.
- 3; Sagittal section. UHR 19470.

Figs. 4-6: "Pseudofusulina" kraffti (SCHELLWIEN and DYHRENFURTH)
- 4; Axial section. Outer volutions are missing. UHR 19483.
- 5; Axial section. UHR 19484.
- 6; Sagittal section. UHR 19485.

Fig. 7: *Pseudofusulina fusiformis* (SCHELLWIEN and DYHRENFURTH)
Axial section. Outer volutions are eroded away. UHR 19504.

Fig. 8: *Nagatoella minatoi* KANMERA and MIKAMI
Axial section. UHR 19471.

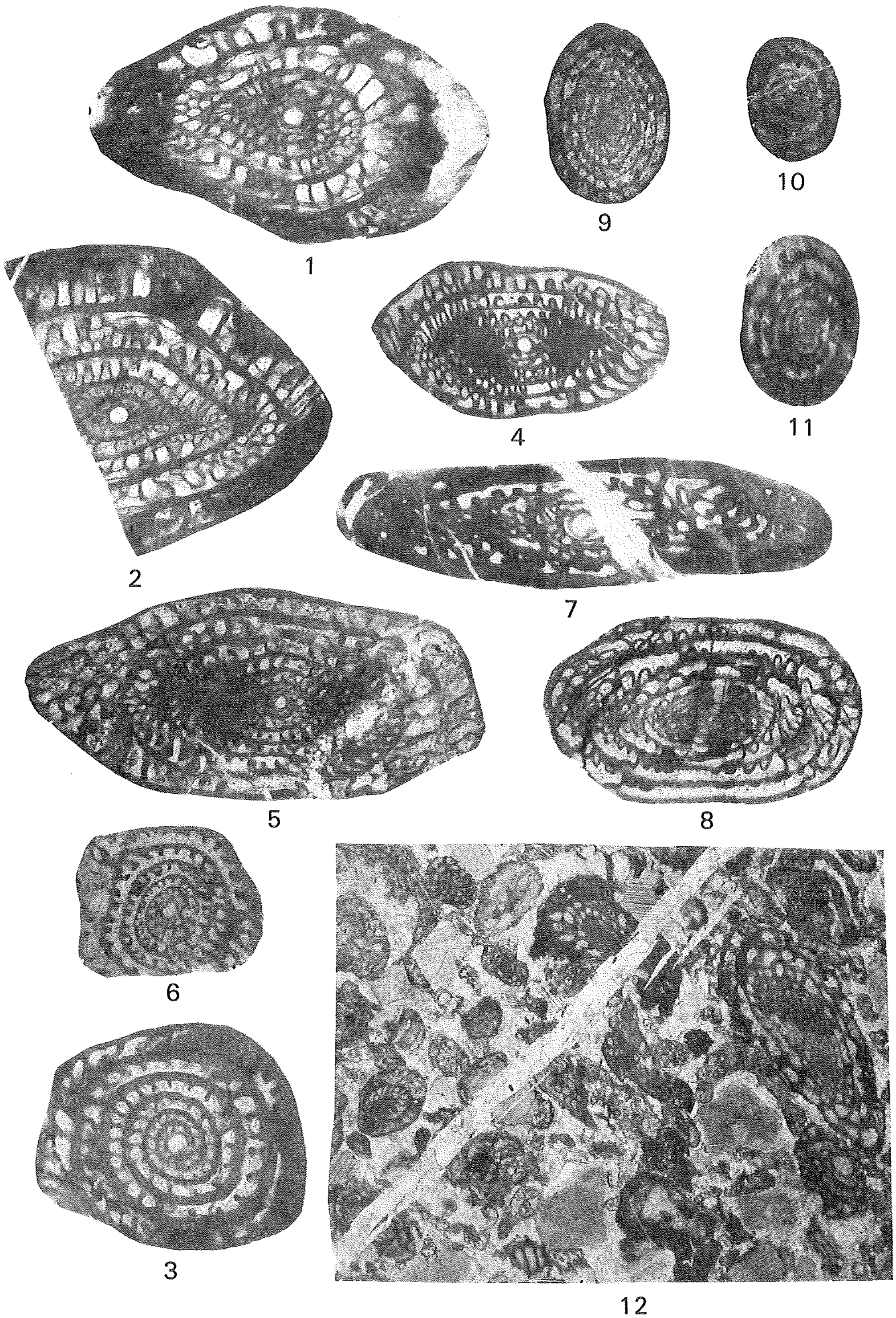
Fig. 9: Deep parallel section of *Pseudodoliolina* aff. *pseudolepida* (DEPRAT), UHR 19522a.

Fig. 10: *Misellina* sp. Tangential section. UHR 19522b.

Fig. 11: *Misellina otakiensis* (HUZIMOTO). Axial section. UHR 19506.

Fig. 12: A photo micrograph showing limestone lithology and the mode of occurrence of *Misellina otakiensis* (HUZIMOTO), *Triticites* sp. and *Pseudofusulina* sp.

(All specimens were obtained from limestone pebbles of the upper Permian Usuginu-type conglomerate, developed in Ochiai, Sumita-cho (Town), Southern Kitakami Mountains)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