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# 634. MIOCENE MOLLUSCS FROM THE BIHOKU GROUP AT MIYAUCHI-CHO, SHOBARA CITY, SOUTHWEST JAPAN*

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西南日本庄原市宮内町における備北層群からの中新世貝類について：庄原市宮内町（旧称新築町）の OTUKA (1938) の Loc. 2 に露出する中期中新世備北層群下部砂岩層に含まれる貝類化石を再検討した。その結果，*Crassostrea-Cyclina-Geloina* および *Batillaria-Crassostrea* の 2化石群集が識別された。これら群集は“門ノ沢型動物群”の要素から構成されるが，前者は後者の下位層準にあると同時に，両者は指交関係にある。前者について考察し，*Geloina yamanei* を記載した。 岡本和夫・寺地雅美

## Introduction and Acknowledgements

Miyauchi-chô (formerly shinchiku-chô) of Shôbara City, Southwest Japan has been well known as a locality of the Miocene fossil molluscs, since OTUKA (1938) reported *Ostrea*, *Soletellina*, *Cyclina*, *Batillaria*, and other well preserved shells. OYAMA (1967) mentioned that the fossil molluscs from the locality may be regarded as one of the typical examples of the tidal zone communities in the inner bay facies of the transgressive phase. We have restudied the Miocene molluscs occurred in the Shôbara area from the paleoecological point of view, and as a result of our research, we will report here on the fossil molluscan assemblages of the Lower Sandstone member of the Bihoku group (IMAMURA, 1953) at Miyauchi-chô. Two types of combination of molluscan species, i. e. *Batillaria-Crassostrea* and *Crassostrea-Cyclina-Geloina* assemblages are recognized in this member. The former is found in the most part of the member, and the latter is restricted in its distribution within a part of the basal horizon. The *Crassostrea-Cyclina-Geloina* assemblage is comparable with the *Telescopium-Geloina* assemblage of the Miocene Kadonosawa-type fauna found in the other areas of Japan, and is very interesting to us because of its peculiar combination of species.

We wish to express our sincere thanks to Dr. Katura OYAMA of the Geological Survey of Japan at Kawasaki for help to discriminate some fossils and Dr. Tadashige HABE of the National Science Museum at Tokyo for suggestion on the taxonomy of Recent geloinas. We are indebted to Associate Professor Kiyotaka CHINZEI of the University of Tokyo for reading the manuscript. Acknowledgements are due to Dr. Yasuhide IWASAKI of the University of Tokyo for suggestion and permission to study the specimens stored at the

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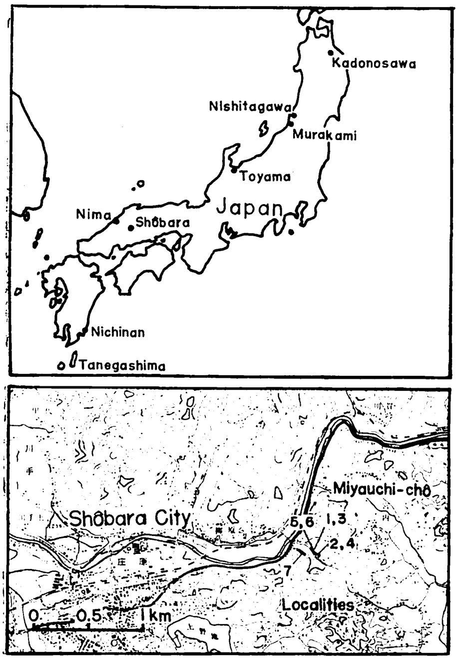



Text-fig. 1. Locality map.

## Notes on Geology

According to IMAMURA (1953), the Miocene formations distributed in the Shôbara, Miyoshi, and Mirasaka areas of Hiroshima Prefecture are divided into the Shiomachi formation in the lower and the Bihoku group in the upper, and their stratigraphic relation is recognized as a parallel unconformity. The nonmarine Shiomachi formation, 10-45 m thick, is composed of conglomerate, sandstone, shale, and tuff. It yields fossil plants, such as *Trapa yokoyamae* NATHORST, *T.* cf. *borealis* HEER, and *Liquidamber formosana* HANCE.

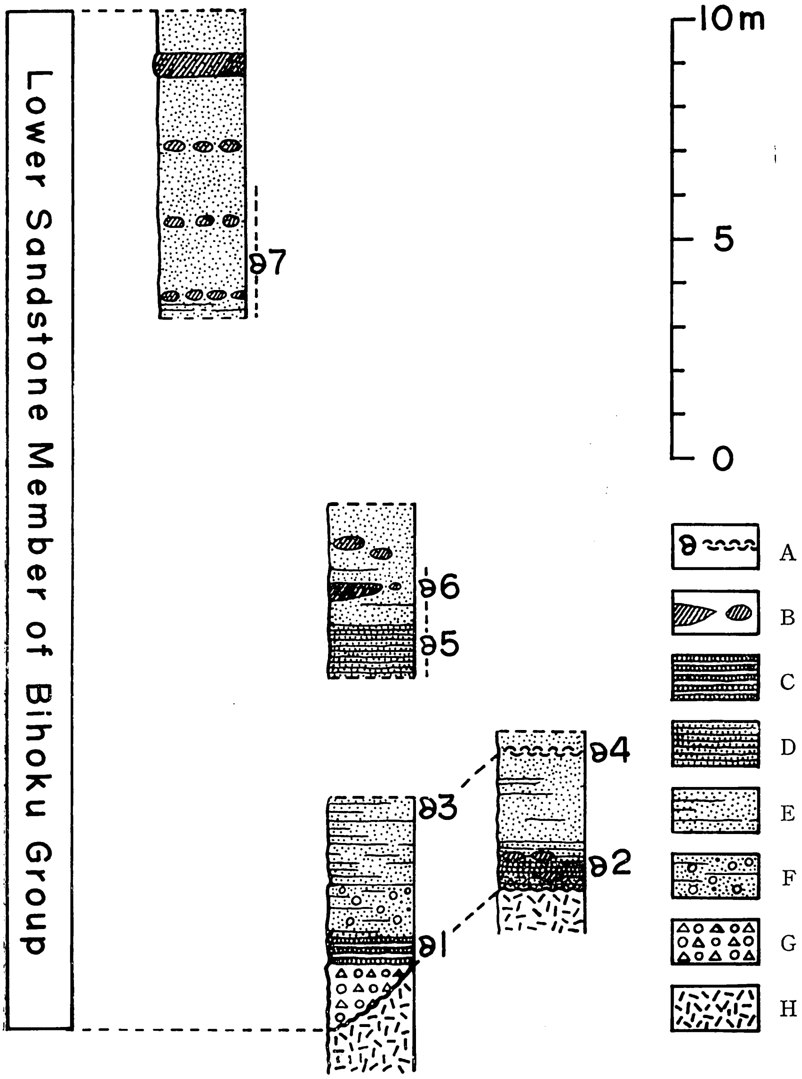
The marine Bihoku group is subdivided into the Lower Sandstone and Upper Shale members (IMAMURA, 1953). The Lower Sandstone member, 15-45 m thick, is made up of conglomerate, sandstone, and alternation of sandstone and shale. It contains larger foraminifera and various molluscs. The characteristic fossils are as follows:

Larger foraminifera: *Miogypsina "kotoi* HANZAWA", *Operculina complanata japonica* HANZAWA.

Molluscs: *Anadara daitokudoensis* (MAKIYAMA), *Vepricardium ogurai* (OTUKA), *Dosinia suketoensis* OTUKA, *Tapes siratoriensis* (OTUKA), *Vicarya callosa japonica* YABE and HATAI, *Batillaria yamanarii* MAKIYAMA.

The Upper Shale member, about 50 m thick, is composed of shale containing a small number of molluscs, such as *Acila submirabilis* MAKIYAMA, *Propeamussium* cf. *tateiwai* KANEHARA, *Fissidentalium* sp., etc. The study of smaller foraminifera from this group was carried out by TAI (1953). The geologic age of the Lower Sandstone member of the Bihoku group is assigned to the Early to Middle Miocene, or in other words tothe Zones N. 8 to N. 9 of BLOW's planktonic foraminiferal zonation (IKEBE et al., 1972).

The geologic columns of the Lower Sandstone member of the Bihoku group shown in Text-fig. 2 is observed at a small valley of Miyauchi-chô (Loc. 2 of OTUKA, p. 23, text-fig. 1, 1938) in Text-fig. 1. The Lower Sandstone member covers unconformably the undulated surface of the basement rock, i. e. tuff of rhyolite or rhyodacite of Late Cretaceous. This member, approximately 23 m thick, is made up of angular pebble to cobble conglomerate, gray mudstone with thin coal layers, medium- to coarse-grained sandstone, gray mudstone to fine-grained sandstone, and bluish gray fine- to medium-grained




Text-fig. 2. Geologic columns of the Miocene Bihoku group in Miyauchi-chô, Shôbara City.
A: Molluscs, B: Nodules, C: Coaly shale, D: Mudstone to fine-grained sandstone, E: Sandstone, F: Pebble-bearing Sandstone, G: Conglomerate, H: Rhyolite tuff.

sandstone in upward succession. The lithofacies of the member seems to be variable laterally, and the member contains coaly laminae and drifts of plant fragments besides molluscs.

### Molluscan Assemblages

The fossil molluscs were collected from the 7 horizons of different localities in the Lower Sandstone member of the Bihoku group at Miyauchi-chô (Text-figs. 1, 2 and Table 1). The shells are abundantly found at Horizons 2, 4, 5, 6, and 7, but rare at Horizons 1 and 3. Accordingly, the relative abundance of each species at each of the former horizons is noted in Table 1, whereas that of the latter ones is not shown. The molluscs reported by OTUKA (1938) might be obtained from the middle part of the columns (Horizons 5 and 6 in Text-fig. 2). The brief description of lithology, modes of molluscan occurrence, and species composition of molluscs at each horizon are as follows:

Hor. 1:—Light brown mudstone to medium-grained sandstone. A few fragmental molluscs are found with plant remains. They are *Crassostrea* sp., *Cyclina* sp., *Batillaria tateiwai*, *B. yamanarii*, etc.

Hor. 2:—Purplish gray mudstone to fine-grained sandstone with coaly laminae. Shells are clustered or sporadic. The shells of oysters are not articulated. A large number of specimens of *Crassostrea* sp. were collected with a few individuals of *Cyclina takeyamai*.

Hor. 3:—Light to moderate brown fine-grained sandstone. A few fragments of molluscs occur sporadically. Among them, *Batillaria yamanarii* is noticeable.

Hor. 4:—Yellowish brown, muddy, medium- to coarse-grained sandstone. Most shells are obtained from a discontinuous fossil layer, and crassostreas occur as the nodules of fossil clusters. Some geloinas are articulated, but the other bivalves are scarcely jointed. *Cyclina takeyamai* is very abundant. *Crassostrea gravitesta*, *Geloina yamanei*, and *Anadara daitokudoensis* are common. Few or rare species are *Saxolucina k-hataii*, *Soletellina minoensis*, *Vicarya callosa japonica*, *Batillaria tateiwai*, etc. The species association is peculiar to this horizon.

Hors. 5 and 6:—Dark gray mudstone to fine-grained sandstone. Most molluscs are scattered, but the lens at Hor. 6 is made up of densely aggregated oyster shells. *Batillaria tateiwai*, *B. yamanarii* and *Crassostrea gravitesta* are the dominant species, and *Cyclina takeyamai* and *Vicarya callosa japonica* are commonly found. The rare forms are *Anadara daitokudoensis*, *Lunatia meisensis*, etc.

Hor. 7:—Medium gray mudstone to fine-grained sandstone. Molluscs occur sporadically or clusteringly, and some nodules are composed of clustered shells. Some bivalves remain intact. *Batillaria yamanarii* and *Crassostrea gravitesta* are abundant as well as at Hors. 5 and 6. *Cyclina takeyamai* and *Vicarya callosa japonica* are associated commonly. The rare species are *Anadara daitokudoensis*, *Saxolucina k-hataii*, *Meretrix* sp., *Trapezium* sp., *Cardilia* cf. *toyamaensis*, *Soletellina minoensis*, etc. The number of rare species are more than those of Hors. 5 and 6.

The molluscan species listed in Table 1 are all common constituents of the Early to Middle Miocene Kadonosawa (Kurosedani)-type fauna (CHINZEI and IWASAKI, 1967; IWASAKI, 1970; TSUDA, 1960) which was distributed widely in Japan and Korea at that time. Judging

Table 1. Fossil molluscs from the Miocene Bihoku group at Miyauchi-chô, Shôbara City (Loc. 2 of OTUKA, 1938).

| Fossil Name \ Horizon | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Horizon unknown | OTUAD (1938) |
|---|---|---|---|---|---|---|---|---|---|
| *Barbatia* sp. | | | | | R | | | × | |
| *Anadara* (*Hataiarca*) *daitokudoensis* (MAKIYAMA) | | | | C | | R | R | | |
| *A.* sp. | | | | R | | | R | | |
| *Crassostrea gravitesta* (YOKOYAMA) | | | | R | F | | }A | | × |
| *C.* sp. | × | VA | | C | A | R | | | |
| *Geloina yamanei* (OYAMA) | | | | R | | | | | |
| *G.* sp. | | | | C | | | | | |
| *Felaniella* ? sp. | | | | R | | | | | |
| *Saxolucina k-hataii* (OTUKA) | | | | R | | | R | × | |
| *S.* ? sp. | × | | | F | | | | | |
| *Meretrix* sp. | | | | | | | R | | |
| *Cyclina takeyamai* OYAMA | | R | | F | R | R | F | | × |
| *C.* sp. | × | | | A | | | R | | |
| *Nipponomarcia* sp. | | | | R | | | R | × | |
| *Tapes* (*Siratoria*) *siratoriensis* (OTUKA) | | | | | | | R | | |
| *Trapezium* (*Neotrapezium*) sp. | | | | | | | R | × | |
| *Cardilia* cf. *toyamaensis* TSUDA | | | | | | | R | | |
| *Soletellina minoensis* YOKOYAMA | | | | R | | | R | × | × |
| *S.* ? sp. | | | | R | | | | | |
| *Tellina notoensis* MASUDA | | | | | R | | | | |
| *T.* sp. | | | | | R | | | | |
| *Solen* sp. | | | | R | | | R | | |
| *Nerita* sp. | | | | | | | R | | |
| *Vicarya callosa japonica* YABE and HATAI | | | | R | R | C | F | | |
| *V.* sp. | | | | | R | | | | |
| *Vicaryella bacula* (YOKOYAMA) | | | | | R | | R | | |
| *Cerithidea tokunagai* OTUKA* | | | | | | | R | | × |
| *C.* ? sp. | | | | | R | R | | | |
| *Batillaria* (*Tateiwaia*) *tateiwai* MAKIYAMA | × | | × | R | C | A | R | | × |
| *B.* (*T.*) *yamanarii* MAKIYAMA | × | | | | C | C | A | | × |
| *B.* sp. | × | | × | | VA | VA | F | | |
| *Lunatia meisensis* (MAKIYAMA) | | | | | | R | R | | |
| *Pseudomurex* ? *tukiyoshiensis* OYAMA and SAKA | | | | | | R | | | |
| *Trigonaphera* sp. | | | | | | | R | | |
| *Nekewis* ? sp. | | | | | | | R | | |

R <5%, F 5-10, C 10-20, A 20-30, VA>30. 1, 3, 5, 6, 7 : *Batillaria-Crassostrea* assemblage, 2, 4 : *Crassostrea-Cyclina-Geloina* assemblage.

* OTUKA (1938) indicated that the type locality of *Cerithidea tokunagai* is Loc. 1 (at Suketo) of Text-fig. 1 on p. 40 of his article. On the other hand he marked the occurrence of *C. tokunagai* only at Loc. 2 (in Shinchiku-chô) in his Table 1, and he also noted that the locality is Shinchiku-chô (Loc. 2) on the label of the type specimen stored in the University Museum, University of Tokyo. Accordingly, the type locality of *C. tokunagai* seems to be OTUKA's Loc. 2 at Miyauchi-chô (formerly Shinchiku-chô).

from the species composition at each horizon, the molluscan fauna found in the Lower Sandstone member can be divided into the following two assemblages, namely *Batillaria-Crassostrea* assemblage (Hors. 1, 3, 5, 6 and 7) and *Crassostrea-Cyclina-Geloina* assemblage (Hors. 2 and 4).

The former assemblage is distributed in most parts of the member, but the occurrence of the latter is restricted within a part of the basal horizon of the member. The idealized relationship of both assemblages to the other Kadonosawan assemblages is shown in Table 2. These molluscan habitats might not be so far from the place of burial, judging from the observation of modes of fossil occurrence and sediments enclosing fossils.

OTUKA (1938) concluded that the marine fauna of the Lower Sandstone member of the Bihoku group is rich in genera that are common with the inhabitants of estuaries or shallow inland seas. In addition to OTUKA's conclusion, the mangrove coast (SHEPARD, 1963) or the estuarine mangrove swamp (EMERY et al., 1957) of tropical or subtropical regions is possibly inferred as a depositional environment of the Lower Sandstone member of the group, judging from the generic composition of the *Crassostrea-Cyclina-Geloina* assemblage and lithofacies as OYAMA (1950) inferred on the Kurosedani fauna of the Toyama basin.

Table 2. Correlation table of the bay head assemblages in the Kadonosawa-type fauna.

| Shôbara<br>OKAMOTO & TERACHI (1973) | Eastern Setouchi Region<br>ITOIGAWA (1971) | Toyama<br>TSUDA (1965) | Idealized Kadonosawa-type Fauna<br>IWASAKI (1970) |
|---|---|---|---|
| *Batillaria-Crassostrea* | *Crassostrea-Batillaria* | Arcid-Potamid fauna | *Ostrea* |
| | | | *Batillaria* |
| *Crassostrea-Cyclina-Geloina* | | | *Telescopium-Geloina* |

## Remarks on the Molluscan Assemblages

The *Batillaria-Crassostrea* assemblage at Miyauchi-chô is equivalent with *Crassostrea-Batillaria* assemblage which is commonly found at the basal part of the Bihoku group distributed in the eastern Setouchi region (ITOIGAWA, 1971). It also corresponds to the *Batillaria* and *Ostrea* assemblages of the Kadonosawa area in Northeast Japan where the typical Kadonosawa fauna is developed (CHINZEI and IWASAKI, 1967). At Miyauchi-chô, it is impossible to divide the *Batillaria-Crassostrea* assemblage into two assemblages, since batillarias are usually associated with crassostreas at the basal part of the Bihoku group, as pointed by ITOIGAWA (1971). The *Batillaria* and *Ostrea* assemblages, however, were separated from each other in the Kadonosawa area (CHINZEI and IWASAKI, 1967).

The combination of *Crassostrea-*

*Cyclina-Geloina* is new to science and much interesting to us. Up to now, geloinas have been reported from the Eocene of Hokkaido (NAGAO and ÔTATUME, 1943; MINATO, 1950), and from the Early to Middle Miocene of the area near Toyama City (OYAMA, 1950) and two other areas in Japan. The Early to Middle Miocene geloinas were found in the Arcid-potamid fauna (TSUDA, 1965) of the Kurosedani fauna (TSUDA, 1960). The Arcid-potamid fauna, also belonging to the Kadonosawa-type fauna, was collected from the lower part of the Kurosedani formation of the Yatsuo group near Toyama City of the Hokuriku district. According to TSUDA (1965), the characteristic and abundant species of the fauna are as follows: *Anadara kakehataensis*, *A. kurosedaniensis*, *Striarca uetsukiensis*, *Cuculaea toyamaensis*, *Ostrea gravitesta*, *Geloina stachi*, *G. yamanei*, *Cyclina mitsuchii*, *Phaxas izumoensis*, *Protorotella yuantaniensis*, *Cerithidea kanpokuensis*, *C. yatsuoensis*, *Vicarya yokoyamai*, *Vicaryella notoensis*, *Chicoreus asanoi*, and *C. notoensis*.

Judging from the constituents mentioned above as well as from the species list of the Kurosedani fauna (TSUDA, 1960), the Arcid-potamid fauna is considered to be the mixture of the *Ostrea*, *Batillaria*, and *Telescopium-Geloina* assemblages in the idealized Kadonosawa-type fauna (IWASAKI, 1970), or of the *Batillaria-Crassostrea* and *Crassostrea-Cyclina-Geloina* assemblages at Miyauchi-chô. The *Telescopium-Geloina* assemblage was named at first as the *Telescopium-Geloina* biocoenosis by OYAMA (1950), and was regarded as the fauna proper to mangrove swamps of tropical and subtropical regions. In this assemblage (Assemblage I of the Kurosedani fauna by TSUDA, 1960), the forms of mangrove swamps proper, such as *Geloina* and *Telescopium*, are associated with *Anadara*, *Ostrea*, *Vicarya*, *Vicaryella*, *Cerithidea*, etc., which are the constituents of the *Batillaria* and *Ostrea* assemblages of the Kadonosawa-type fauna.

Comparing the *Crassostrea-Cyclina-Geloina* assemblage with the *Telescopium-Geloina* assemblage, *Crassostrea*, *Cyclina*, *Geloina*, and *Anadara* are common in both assemblages, but the former lacks the other characteristic elements of mangrove swamps, such as *Littorinopsis miodelicatula* and *Telescopium schencki* of the latter assemblage. However, the *Crassostrea-Cyclina-Geloina* assemblage is certainly comparable with the *Telescopium-Geloina* assemblage in the Kadonosawa-type fauna, since the principal constituents are common with each other.

TSUDA (1965) reported *Geloina yamanei*, *Littorinopsis miodelicatula*, and *Terebratulina* spp. from the Miocene Iwafune formation near Murakami of Niigata Prefecture, Northeast Japan. NISHIDA and CHIHARA (1966) listed the following molluscs from the Miocene Ôyama formation of the Kamigô group in the Nishitagawa coal-field area of Yamagata Prefecture, Northeast Japan, besides the molluscus reported by TANAI (1951): *Anadara kakehataensis*, *Arca* spp., *Clementia papyracea*, *Cultellus* sp., *Geloina yamanei*, *Joanisiella takeyamai*, and *Vicarya yokoyamai* (discriminated by TSUDA).

Of the other characteristic form of *Telescopium* from the Miocene formations in Japan, SHUTO (1963) reported *Telescopium* sp. with *Anadara? daitokudoensis* and *Trachycardium shiobaraensis* from the Miocene Ôyatori formation of the Sakatani subgroup of the Nichinan group in the Nichinan area, Miyazaki Prefecture, Kyushu. IWASAKI (1970) found *Telescopium telescopium* along with *Anadara "kakehataensis"*, *Ostrea gravitesta*, *Batillaria yamanarii*, *Joanisiella cumingi*, *Cyclina japonica*, *Clementia papyracea*, *Polinices meisensis*, etc. in the Miocene Sakai formation of Tanegashima Island, Kagoshima Prefecture, Kyushu. OKAMOTO, TAKAHASHI and TERACHI (1971) also found a specimen of *Telescopium schencki* in the *Modiolus-Cyclina-Turritella-Patinopecten* assemblage from the Miocene Kawai formation of Nima-chô, Shimane Prefecture, Sanin district.

These Miocene assemblages containing *Geloina* and *Telescopium*, except the *Modiolus-Cyclina-Turritella-Patinopecten* assemblage in Nima-chô, can be compared with the *Telescopium-Geloina* assemblage. Accordingly, it is concluded that *Telescopium*, *Geloina*, and the other elements of mangrove swamps proper are usually associated with the constituents of the *Batillaria* and *Ostrea* assemblages or the Arcid-potamid fauna in the Kadonosawa-type fauna. The occurrence of the *Telescopium-Geloina* assemblage may be expected from the Early to Middle Miocene formations containing the Arcid-potamid fauna in Japan when the collection of fossils is made carefully.

TAN (1938) studied the *Telescopium-Geloina* fossil biocoenosis from the T'ouk'oshan (Tôkazan) group in Taiwan. The association of his Loc. B in the Upper Pliocene to Lower Pleistocene "Konglin (Kyûrin)" formation at Saokeng, Kuanhsi-chen, Hsinchu-Hsien (Sôko, Kansai-syô, Sintiku Prefecture) is characterized by the occurrence of following common or abundant species: *Cyclina sinensis*, *Assiminea kansaiensis*, *Melanoides subscabroides*, *Cerithidea ornata*, *C. cingulata*, *Telescopium telescopium*, and *Ellobium aurisjudae*.

In this association *Ostrea gigas*, *Polymesoda (Geloina) luchuana*, and *Cyclina sinensis* are more or less rare constituents. Comparing this with the *Crassostrea-Cyclina-Geloina* assemblage from Miyauchi-chô, however, *Crassostrea gravitesta*, *Geloina yamanei*, and *Cyclina takeyamai* are rather abundant and main constituents at Miyauchi-chô. MARTENS (1897) listed the recent brackish water molluscs from Indonesia. In generic level, the molluscs of Miyauchi-chô are in some common with those of Indonesia.

## Description of *Geloina* Species

Family Corbiculidae GRAY, 1847

Genus *Geloina* GRAY, 1842

*Geloina yamanei* OYAMA, 1950

Pl. 47, figs. 1, 2, 3, and 4

1950. *Geloina yamanei* OYAMA, *Rep. Geol. Surv. Japan*, No. 132, pp. 13–14, pl. III, figs. 3a and 3b.

*Material*:—Twenty five specimens of *Geloina* were collected; most of them are ill-preserved. A few specimens (GSEH-OK-H001—H003) are fairly well-preserved and enough to identify with *G. yamanei*. The specimens are kept at the Geological Laboratory, Shinonome School, Faculty of Education, Hiroshima University.

*Description*:—Shell medium to large in size for the genus, quadrangularly or subtrigonally oval, inequilateral and moderately thick; umbo at about a third from the anterior end, blunt, prosogyrous, and somewhat below the summit of valve; antero-dorsal margin straight and steeply sloped; anterior end roundly angulated; postero-dorsal margin almost straight or slightly convex, posterior margin slghtly convex, subvertical; posterior end subtruncated, making blunt angles with the postero-dorsal and -ventral margins; antero- to postero-ventral margin forms a large arc. Surface ornamented with concentric fine growth-lines and low wrincles; and with weak furrows running from the umbo to the postero-ventral extremity. Internal margin smooth; ligamental suture distinct; ligamental groove long and excavated; nymph also long; post-ligamental cutting deeply V-shaped; hinge broad and solid; dentition of left valve three cardinal and an antero-lateral and a postero-lateral teeth; anterior cardinal tooth short and sub-vertical, middle one medium and oblique, and posterior one long and very oblique; bifurcation observable only on the middle cardinal; anterior lateral tooth short and very strong like cuspid, posterior one long and weak.

*Measurements* (in mm):—

| | Specimen | Length | Height | Depth | H/L | D/L |
|---|---|---|---|---|---|---|
| 1 | Shôbara Pl. 47, fig. 1 | 73.0 | 65.4 | (1/2)19.3 | 0.90 | 0.53 |
| 2 | Shôbara Pl. 47, fig. 3 | 57.2 | 50.5+ | (1/2)12.8 | 0.88+ | 0.45 |
| 3 | Topotype Pl. 47, fig. 4 | 60.2 | 53.4 | 34.8 | 0.89 | 0.58 |
| 4 | Holotype OYAMA (1950) | 57.5 | 52 | (1/2)14 | 0.90 | 0.49 |

*Remarks:*—The present specimens are morphologically quite similar to the holotype of *Geloina yamanei* (OYAMA, pl. 3, figs. 3a, b, 1950) and the topotype (pl. 47, fig. 4), which were collected from the Kurosedani formation of the Yatsuo group in the Hokuriku district. The topotype is more or less trigonal than the holotype and the present specimens, and has furrows running from the umbo to the postero-ventral end. The length-height proportion among the specimens of *yamanei* is fairly constant, i. e. 0.88+ to 0.90, but the length-depth proportion of them is more variable, i. e. 0.45 to 0.58 as seen on the table of measurements.

*Geloina stachi* (OYAMA, pl. 3, figs. 1-2a, b, 1950) is found in association with *G. yamanei* from the Kurosedani formation, but *G. stachi* is discriminated from the latter in having laterally elongated and more oval shell form (Length-height proportion is 0.80 to 0.85).

*Geloina yamanei* differs from *Geloina hokkaidoensis* (NAGAO and ÔTATUME, pl. 1, figs. 1-4; pl. 2, figs. 1-7, 1943; MINATO, fig. 10, 1950), which occurred in the Eocene of Hokkaido, in having larger and lower shell form. The present specimens are distinctive from *Geloina bibaiensis* (NAGAO and ÔTATUME, pl. 1, fig. 5, 1943; MINATO, fig. 11, 1950), which was collected also from the Eocene of Hokkaido, in having not protruded umbo and truncated posterior end.

The present species has a close resemblance in the shell form to the recent *Geloina sinuosa* (DESHAYES)* (CLESSIN, pl. 45, fig. 1, 1879; OYAMA and ISHIYAMA, in fig. 6, 1963; SHIKAMA, pl. 40, fig. 6, 1964), which includes *Geloina fissidens*

(PILSBRY, pl. 8, figs. 5-6, 1895) as the synonym, distributed in the southwestern Pacific region and Okinawa, but it has rather angulated and trapezoidal outline and weaker furrows on the posterior surface than those of *G. sinuosa.*

The present form is less similar to the recent *Geloina papua* (LESSON) (CLESSIN, pl. 14, figs. 7-8, 1879; KURODA and HABE, fig. 943, 1965), which includes *Geloina luchuana* (PILSBRY, pl. 9, figs. 4-5, 1895; HABE, fig. 233, 1951-'53; HABE, pl. 55, fig. 5, 1961) and *Geloina yaeyamaensis* (PILSBRY, pl. 8, fig. 7; pl. 9, fig. 6, 1895) as the synonym, found in Okinawa and the southwestern Pacific region. It is distinguished from *G. papua* in having more rounded and higher shell outline and furrows on the posterior area.

*Locality:*—Miyauchi-chô, Shôbara City, Hiroshima Prefecture (Loc. 4 in Text-fig. 1).

*Lithology:*—Yellowish brown (or medium gray) medium- to coarse-grained sandstone.

## References

CHINZEI, K. and IWASAKI, Y. (1967): Paleoecology of shallow sea molluscan faunae in the Neogene deposits of Northeast Honshu, Japan. *Trans. Proc. Palaeont. Soc. Japan. N. S.*, No. 67, p. 93-113.

CLESSIN, S. (1879): Die Familie der Cycladeen. 282 p., 46 Taf. Im *Systematisches Conchylien-Cabinet* von MARTINI und CHEMNITZ. Bauer & Raspe, Nürnberg.

EMERY, K. O., STEVENSON, R. E. and HEDGPETH, J. W. (1957): Estuaries and lagoons. In HEDGPETH, J. W. (ed.): Treatise on Marine Ecology and Paleoecology. *Geol. Soc. Amer., Mem. 67,* Vol. 1, p. 673-750.

HABE, T. (1951-53): Genera of Japanese Shells Pelecypoda and Scaphopoda 326 p., 770 text-figs. Kairui-Bunken-Kankokai, Kyoto (in Japanese).

—— (1961): Coloured Illustrations of the Shells of Japan (II). 183 p., 66 pls. Hoikusha, Osaka (in Japanese).

IKEBE, N., TAKAYANAGI, Y., CHIJI, M. and CHINZEI, K. (1972): Neogene biostratigraphy and radiometric time scale of Japan—An attempt at intercontinental correlation. *Pacific Gealogy,* Vol. 4, p. 39-78.

IMAMURA, S. (1953): In IMAMURA et al.: Guide Book of Geological Excursion, Kamine, Funasa, Miyoshi, Mirasaka, Shôbara and Shôkozan, 50 p. Inst. Geol. Min., Fac. Sci., Hiroshima Univ., Hiroshima (in Japanese).

ITOIGAWA, J. (1971): Miocene molluscan fauna from the eastern district of Chugoku, Southwest Japan, *Kaseki (Fossils)*, No. 22, p. 29-36 (in Japanese).

IWASAKI, Y. (1970): A Miocene molluscan fauna in the Philippines. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, No. 17, p. 205-228, text-figs. 1-6, pl. 23.

KURODA, T. and HABE, T. (1965): In OKADA, K. et al. (ed.): New Illustrated Encyclopedia of the Fauna of Japan (II). 803 p., 1462 text-figs. Hokuryukan, Tokyo (in Japanese).

MARTENS, E. VON (1897): Süss- und Brackwasser-Mollusken des indischen Archipels. *Zool. Ergebn. einer Reise in Nied. O. Indien v. DR. MAX WEBER*, Bd. IV, 331 p., 12 Taf.

MINATO, M. (1950): Fossil corbiculids from Hokkaido. *Shinseidai-no-Kenkyu (Cenozoic Research)*, No. 3, p. 18-19, 1 pl. (in Japanese).

NAGAO, T. and ÔTATUME, K. (1943): The fossil corbiculids from the Palaeogene Isikari Series in the Ishikari Coal-fields, Hokkaidô. *Jour. Fac. Sci. Hakkaidô Imp. Univ., Ser. IV,* Vol. 7, No. 1, p. 1-13,

* The name of *Geloina sinuosa* is generally used for the geloinas having furrows on the posterior area, but *G. sinuosa* (DESHAYES) 1854 is regarded as a synonym of *Geloina coaxans* (GMELIN) 1791 according to Dr. HABE (personal communication).

text-fig. 1, pls. 1-3.

NISHIDA, S. and CHIHARA, K. (1966) : Neogene Tertiary stratigraphy in the Nishitagawa Coal-field, Yamagata-Niigata Prefecture, North Japan. *Contr. Dept. Geol. & Min., Niigata Univ.*, No. 1, p. 31-57 (in Japanese).

OKAMOTO, K., TAKAHASHI, Y. and TERACHI, M. (1971) : Molluscan assemblages from the Miocene Kawai Formation in Nima-chô, Shimane Prefecture. *Mem. Vol. Prof. H. MATSUSHITA*, p. 179-185, pl. 14 (in Japanese).

OTUKA, Y. (1938) : Mollusca from the Miocene of Tyûgoku, Japan. *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. II*, Vol. 5, Pt. 2, p. 21-46, pls. 1-4.

OYAMA, K. (1950) : Studies of fossil molluscan biocoenosis, No. 1. Biocoenological studies on the mangrove swamps, with descriptions of new species from Yatuo Group. *Rep. Geol. Surv. Japan*, No. 132, p. 1-16, pls. 1-3.

—— (1967) : Paleoecological problems of the development of coastal waters. *Jub. Publ. Comm. Prof. Y. SASA 60th Birthday*, p. 267-278 (in Japanese).

—— and ISHIYAMA, S. (1963) : Molluscan fossils and paleoecology. *Chishitsu-news (Geological News)*, No. 104, p. 4-8, 6 text-figs (in Japanese).

PILSBRY, H. A. (1895) : Catalogue of the Marine Mollusks of Japan. 196 p., 10 pls. Frederic Sterns, Detroit.

SAKAMOTO, T. and NOZAWA, T. (1960) : Geological Map of Yatsuo (Scale 1: 50,000) and its Explanatory Text. Geol. Surv. Japan, Kawasaki (in Japanese).

SHEPARD, F. P. (1963) : Submarine Geology 2nd ed. 557 p. Harper & Row, New York.

SHIKAMA, T. (1964) : Sellected Shells of the World Illustrated in Colours (II). 212 p., 245 text-fig., 70 pls. Hokuryu-kan, Tokyo (in Japanese).

SHUTO, T. (1963) : Geology of the Nichinan area with special reference to the Takachiho disturbance. *Sci. Reps. Fac. Sci., Kyushu Univ., Geol.*, Vol. 6, No. 2, p. 135-166 (in Japanese).

TAI, Y. (1953) : Miocene Foraminifera from the Shôbara Basin, Hiroshima Prefecture. *Jaur. Sci. Hiroshima Univ., Ser. C*, Vol. 1, No. 3, p. 1-9.

TAN, K. (1938) : Some Miocene fossils of the Syokkôzan Formation. *Japan. Jour. Geol. Geogr.*, Vol. 15, Nos. 1-2, p. 17-30, text-figs. 1-2, pls. 2-3.

TANAI, T. (1951) : La structure géologique de la partie septentrionale du gîte du charbon de Nishitagawa, préfecture de Yamagata. *Jour. Geol. Soc. Japan*, Vol. 57, No. 668, p. 157-170 (in Japauese).

TSUDA, K. (1960) : Paleo-ecology of the Kurosedani fauna. *Jour. Fac. Sci., Niigata Univ., Ser. II*, Vol. 3, No. 4, p. 171-203.

—— (1965) : Neogene Molluscan assemblages in the inner zone of Northeast Japan with special reference to the Middle Miocene assemblages. *Kaseki (Fossils)*, No. 10, p. 20-30 (in Japanese).

| | | | |
|---|---|---|---|
| Bihoku | 備　北 | Setouchi | 瀬戸内 |
| Kadonosawa | 門ノ沢 | Shinchiku | 新　築 |
| Kurosedani | 黒瀬谷 | Shiomachi | 塩　町 |
| Miyauchi | 宮　内 | Shôbara | 庄　原 |
| Murakami | 村　上 | Suketo | 助　藤 |
| Nichinan | 日　南 | Tanegashima | 種子島 |
| Nima | 仁　摩 | Toyama | 富　山 |
| Nishitagawa | 西田川 | Yatsuo | 八　尾 |

## Explanation of Plate 47

(All figures in about natural size, unless otherwise stated)

Figs. 1-4. *Geloina yamanei* OYAMA. 1. Reg. No. GSEH-OK-H001 ×0.9; 2. Reg. No. GSEH-OK-H002; 3. Reg. No. GSEH-OK-H003; Loc. No. 4. 4. Topotype, Reg. No. GSEH-OK-T002 ×0.9; Loc. Kakebata, Yatsuo-chô, Toyama Prefecture (Loc. No. 206 on Geological Map of Yatsuo (1/50,000) (SAKAMOTO and NOZAWA, 1960)).

Figs. 5a, b-7a, b. *Anadara* (*Hataiarca*) *daitokudoensis* (MAKIYAMA). 5a, b. Reg. No. GSEH-OK-H004; Loc. No. 4. 6a, b. Reg. No. GSEH-OK-H0005; 7a, b. Reg. No. GSEH-OK-H006; Loc. No. 7.

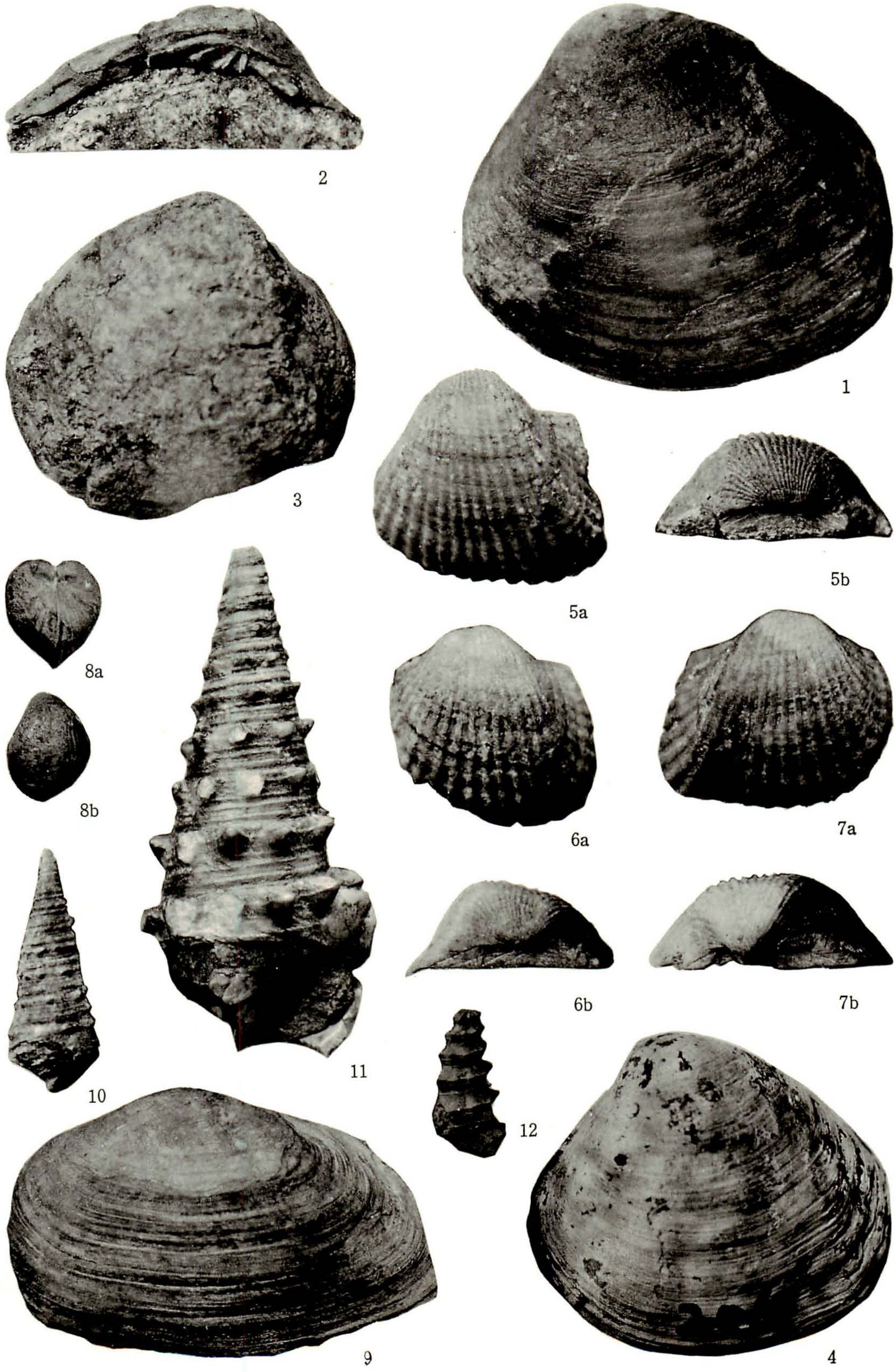
Figs. 8a, b. *Cardilia* cf. *toyamaensis* TSUDA. Reg. No. GSEH-OK-H007; Loc. No. 7.

Fig. 9. *Soletellina minoensis* YOKOYAMA. Reg. No. GSEH-OK-H008; Loc. No. 7.

Fig. 10. *Vicaryella bacula* (YOKOYAMA). Reg. No. GSEH-OK-H009; Loc. No. 6.

Fig. 11. *Vicarya callosa japonica* YABE and HATAI. Reg. No. GSEH-OK-H010; Loc. No. 7.

Fig. 12. *Batillaria* (*Tateiwaia*) *yamanarii* MAKIYAMA. Reg. No. GSEH-OK-H011; Loc. No. 6.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5a
5b
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8b
6a
7a
6b
7b
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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 95, pp. 353-363, pls. 48, 49, September 20, 1974

# 635. ONTOGENIES OF TWO MIDDLE ORDOVICIAN TRILOBITES FROM THE EDINBURG FORMATION, VIRGINIA

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Department of Earth Science, Cheng Kung University, Taiwan

バージニア州エディンバーグ層産中期オルドビス紀三葉虫2種の個体発生：RAYMOND によって立てられた2種，*Raymondaspis gregarius* および *Amphilichas* cf. *prominulus* の珪化標本について記載するとともに，それらの発生過程を研究した結果，前種の幼虫は *Illaenus valvulus*, *Isotelus* sp., *Remopleurides caelatus*, *Phaseolaspis canus* などの幼虫に，また後種のそれは *Diacanthaspis*, *Apianurus* および "*Lichas*" の幼虫に類似することを明らかにした。このことは，上記2組の三葉虫類がそれぞれの間で互いに近縁な関係にあることを示唆するものである。 胡　忠　恒

## Introduction

The ontogenies of two species of Middle Ordovician trilobites are described. They are *Raymondaspis gregarius* (RAYMOND) and *Amphilichas* cf. *prominulus* (RAYMOND). The growth sequences of the two species are incompletely known, both lack their early developmental stage: either of anaprotaspid and/or metaprotaspid stages. The studied material of the present report is in black colored fine-grained limestone, containing very abundant silicified trilobites, bryozoans, ostracodes, a few brachiopods and conodonts skeletons, and was collected from the Edinburg Formation, 1.5 mile southeast of Strasburg Junction, Virginia by Dr. F. RASETTI some years ago. The described specimens are all etched from the limestone in the 5-10% diluted glacial acetic acid as employed by WHITTINGTON and EVITT (1953). About 17 species of trilobites with complete growth sequence are recognizable from the original material. These are *Remopleurides caelatus* WHITTINGTON, *Illaenus valvulus* RAYMOND, *Otarion trilobus*, n. sp. (MS), *Lonchodomas carinatus* COOPER, *Acanthoparypha perforata* WHITTINGTON and EVITT, *Ceraurinella typa* COOPER, *Diacanthaspis lepidus* WHITTINGTON, *Amphilichas* cf. *prominulus* (RAYMOND), *Raymondaspis gregarius* (RAYMOND), *Isotelus* sp., *Mesotaphraspis acris*, n. sp. (MS), *Dimero- pyge virginiensis* WHITTINGTON and EVITT, " *Proetus* " *strasburgensis* COOPER, *Ceratocephala laciniata* WHITTINGTON and EVITT, *Apianurus barbatus* WHITTINGTON, *Ceratocephala* (*Ceratocephalina*) *tridens* WHITTINGTON, and *Trinodus elspethi* (RAYMOND). All are with very well preserved ontogenic sequences. The present report is a part of ontogenic research of these species, and the rest species will be continuously described during the coming period.

The early ontogenies of *Raymondaspis gregarius* is closely similar to those of *Illaenus valvulus*, *Isotelus* sp., *Remopleur-*

* Received August 1, 1973; read Oct. 19, 1974, at Nagoya.

*ides caelatus* (WHITTINGTON, 1959; WHITTINGTON and EVITT, 1953), and *Phaseolupis canus* (HU, 1971). Thus, they possibly have the closely related phylogenetic development. The *Amphilichas* cf. *prominulus* is similar to those of *Diacanthaspis*, *Apianurus* (WHITTINGTON, 1956c), and "*Lichas*" (BEECHER, 1895; WHITTINGTON, 1956a), except that the skeletal surface of *A. prominulus* bears no stout spines. However, they possibly shows the similar phylogenetic relationship as that of the former group.

The writer wishes to thank to Dr. K. E. CASTER, University of Cincinnati, Ohio, for his supervision and kindly reading over the present manuscript. The writer also gives his thanks to Dr. F. RASETTI, Universita Degli Studi, Roma, for a permission to study his collections. The figured specimens are all stored in the Geology Museum, University of Cincinnati, Ohio (U. C. G. M.).

## Systematic Description

### Family Styginidae VOGDES, 1890

### Genus *Raymondaspis* PŘIBYL, 1948

### *Raymondaspis gregarius* (RAYMOND)

Pl. 48, figs. 1-34; Text-fig. 1

*Bronteopsis gregaria* RAYMOND, 1920, p. 283-294; 1925, p. 69-70, pl. 3, figs. 12-14; B. N. COOPER, 1953, pl. 9, figs. 1-7, 12-16, p. 24.
*Raymondaspis gregarius* (RAYMOND), WHITTINGTON, 1965, p. 402.

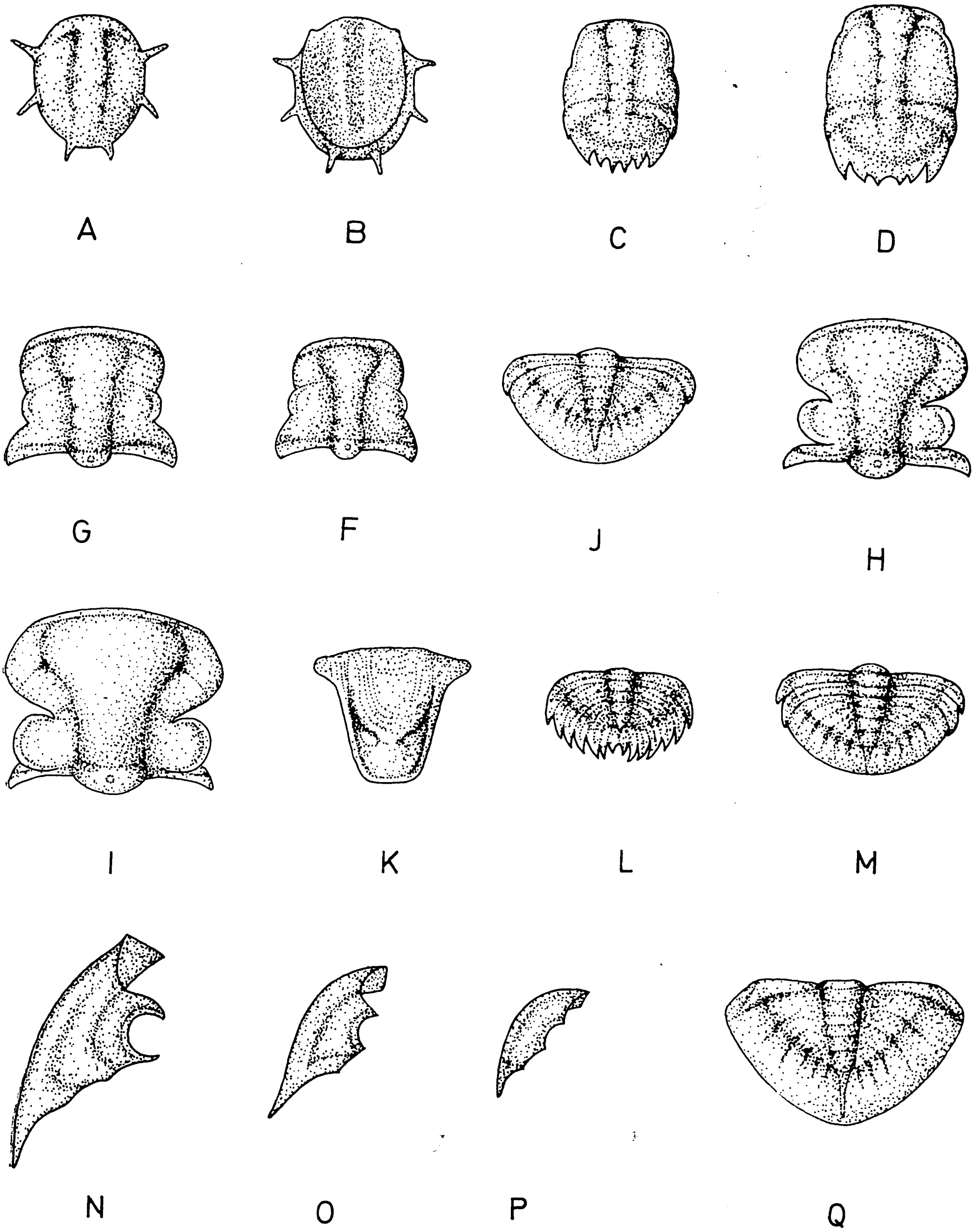
*Remarks:*—The present species is represented by more than one hundred immature and mature specimens, which show a very good growth sequence. WHITTINGTON's (1965) generic and specific identification is followed. The characteristics of the present species during its ontogenetic development are that the glabella expands forwardly; the palpebral lobe is located posteriorly; the rear fixigena becomes narrower; the librigena increases in width, and its anterior facial suture is longer than the posterior one; the distal side of the pygidium made up of thoracic segments, and the proximal side shows a reduction of the marginal spines.

The early protaspis is closely similar to that of *Illaenus valvulus* RAYMOND, *Isotelus* sp., *Remopleurides caelatus* WHITTINGTON (WHITTINGTON, 1953, 1959), and *Phaseolupis canus* HU (HU, 1971), but differs in having an elongate skeleton, less convexity, and three pairs of slender marginal spines.

*Figured specimens:*—Cranidia, U.C.G.M. 40419n-q. Librigenae, U.C.G.M. 40419s-w. Hypostoma, U.C.G.M. 40419r, x. Pygidia, U.C.G.M. 40419d′-f′.

*Raymondaspis gregarius* (RAYMOND), ontogeny:—The ontogenetic development of the present species is subdivided into four stages: the early protaspid, paraprotaspid, early meraspid, and late meraspid. The "early protaspid" stage is an informal division, which belongs either to the anaprotaspid or the metaprotaspid stage, but since it is so rare, its stage is indefinitely known.

*Early protaspid stage* (Pl. 48, figs. 1-3, and text-figs. 1 A, B).—The convex shield is about 0.4-0.45 mm in length (sag.), elongate, oval, and has three pairs of very slender and short marginal spines; these marginal spines are about equally spaced and radiate from the shield margin; the axial lobe is well defined by a dorsal furrow; it is elongate fusiform, and no transverse segmental furrows are recognizable; a pair of superciloid ridges is indented lateral from the sides of the anterior axial lobe, and run a short distance to terminate in front of




Text-fig. 1. An ontogenetic sequence of *Raymondaspis gregarius* (RAYMOND).

A, B, dorsal and ventral views of an early protaspid shield, ×45; C, D, two paraprotaspid shields, ×25; F, G, two early meraspid cranidia, ×25, ×10; H, a late meraspid cranidium, ×22; I, an holaspid cranidium, ×9; J, M, two late meraspid pygidia, ×8, ×10; K, hypostoma, ×5; L, an early meraspid pygidium, ×20; N, an holaspid librigena, ×10; O, P, a late and an early meraspid librigenae, ×18; Q, an holaspid pygidium, ×10. (All drawings were made from photographs.)

the first pair of marginal spines. The surface is covered by very faint granules.

*Paraprotaspid stage* (Pl. 48, figs. 4-6, and text-figs. 1C, D.).—The shield is rectangular in outline, rounded both anteriorly and posteriorly, moderately convex, and is about 0.5-0.8 mm in sagittal length; the glabella is well dilimited by dorsal furrows, slenderly cylindrical, with anterior end strongly expanded forward; three pairs of glabellar furrows are recognizable, all across the central axis shallowly and deepen laterally; the occipital ring is smaller than the glabellar segments, transverse elliptical and situated slightly behind the mid-line of the shield (tr.); no anterior border and the preglabellar field are seen, except for a pair of superciloid ridges which extend laterally from the side of the anterior glabella; the posterior fixigenal border has not been observed; the cranidial and the protopygidial shield are indistinctly separated by a segmental furrow; the protopygidium is transversely obovate, and without distinct dorsal and pleural furrows; the posterior margin is broad, decorated by three or four pairs of serrate spines. The skeletal surface is covered by faint granules.

This stage is differentiated from the previous one in having the shield well differentiated into axial and pleural lobes, the facial suture now appears on the dorsal surface, and the protopygidium is well developed.

*Early meraspid stage* (Pl. 48, figs. 7-11, 27, 28, and text-figs. 1L, F, P.).—The cranidium is trapezoidal in outline, convex, and about 0.7-0.9 mm in length (sag.); the glabella is about the same width as the fixigena, expanding anteriorly from the occipital furrow, and divided into four incomplete glabellar segments; the occipital ring is distinctly impressed by the occipital furrow, elliptical-transverse to crescentic, convex, and bearing a minute median granule; the anterior border is rather narrow, and gently arching forward; there is no preglabellar field, but a deeply marked frontal furrow. The fixigena is slightly wider than or of the same width as the glabella, and convex; the posterior fixigena is triangular, convex, and sloping downward; the posterior border is about twice as wide as the occipital ring (tr.), narrow, convex, and gently arches forward; the crescentic palpebral lobe is small, indistinctly delimited by the palpebral furrow, and is located on the mid-line of the cranidium; the anterior facial suture is gently divergent-convex, and the posterior one is divergent-straight or slightly convex at the extreme lateral end. The librigena is crescentic, moderately convex, with a small ring located on the mid-line of the facial suture; the lateral border is faintly delimited by a furrow, narrow, and convex; the ocular platform is more than twice as wide as the lateral border, and gently convex; the genal spine is short, stout, and with the distal portion broad and the proximal end slender.

The pygidium is semicircular in outline, convex, and contains more than seven non-ankylosed segments; the axis is convex above the pleural lobe, it is slenderly cylindrical, tapering backward, and not extending the full length of the pygidium; each pleural band is distinctly impressed by an intrapleural furrow, and ending into a short and broad spine; the inner marginal furrow is faint but well impressed at the terminal portion. The skeletal surface is covered by faint granules.

The present stage is differentiated from the previous one in having the cranidium appearing of the anterior border, the palpebral lobe is located on the mid-line of the glabella, the fixigena becomes narrower, and the pygidium has freely articulated thoracic segments.

*Late meraspid stage* (Pl. 48, figs. 12-15, 22, 23, 30, 31, and text-figs. 1H, J, M, O.).—The cranidium is trapezoidal in outline, convex, about 0.9-1.2 mm in length; the glabella is strongly expanded forward, convex, well delimited by deep and broad furrows, and two pair of glabellar furrows are faintly impressed behind the mid-line of the glabella; the crescentic occipital ring is convex, well set off from the glabellar base by the occipital furrow and bearing a tiny median tubercle; the narrow anterior border is separated by a deeply impressed frontal furrow, and arches forward without any preglabellar field; the fixigena is about the same width as the glabella, convex, turning upward from the deep dorsal furrow, and occupied by a pair of rounded palpebral lobes at the lateral free margin; the medium-sized palpebral lobe is situated behind the mid-line of the glabella (tr.), convex, with the palpebral furrow faintly marked; the posterior fixigena is subtriangular, convex, with the posterior border about the same width as the occipital ring (tr.); both anterior and posterior facial suture are strongly devergent-convex. The librigena is short and broad, and its broad lateral border is flat; the ocular platform is convex; the genal spine is short and stout; the broad flat doublure is located along the lateral margin and with the obtuse projection directed anteriorly.

The pygidium is semicircular in outline, convex, with the dorsal furrows well impressed; the axis is slenderly conical, tapering posteriorly and has a posterior axial ridge directed to the marginal furrow; one or two free articulated thoracic segments. The skeletal surface is generally granulated; wrinkles are faintly impressed on the cranidial surface.

The distinct features of the present stage are that the palpebral lobe becomes rounded, and located posteriorly from the mid-line of the glabella, that the posterior fixigena is narrower, and that the marginal spines of the thoracic segments and of the pygidium are reduced in size.

*Figured specimens:*—Early protaspides, U.C.G.M. 40419, 40419a. Paraprotaspides, U.C.G.M. 40419b-d. Early meraspides, U.C.G.M. 40419e-i, y, z, a′. Late meraspides, U.C.G.M. 40419j-m, b′, c′.

## Family Lichidae HAWLE and CORDA, 1847

### Genus *Amphilichas* RAYMOND, 1905

### *Amphilichas* cf. *prominulus* (RAYMOND)

Pl. 49, figs. 1-31 and text-fig. 2

cf. *Acrolichas priminulus* RAYMOND, 1925, p. 126, pl. 8, figs. 11, 12; TRIPP, 1958, p. 577, table 1.

*Diagnosis:* — Cranidium trapezoidal, strongly convex; glabella broadly rounded, divided into three lobes by deep furrows; anterior brim narrow without preglabellar field; fixigena narrow, triangular, located behind of the crescentic palpebral lobe, and about the same width as the occipital ring (tr.). Librigena narrow blade-like, concave laterally; lateral border narrow, delimited without lateral furrow; genal spine broad, medium-sized. Pygidium triangular; axis broader than pleural lobe, divided by one or two rings and a terminal portion. Four pairs of different sized marginal spines present. Surface cover-

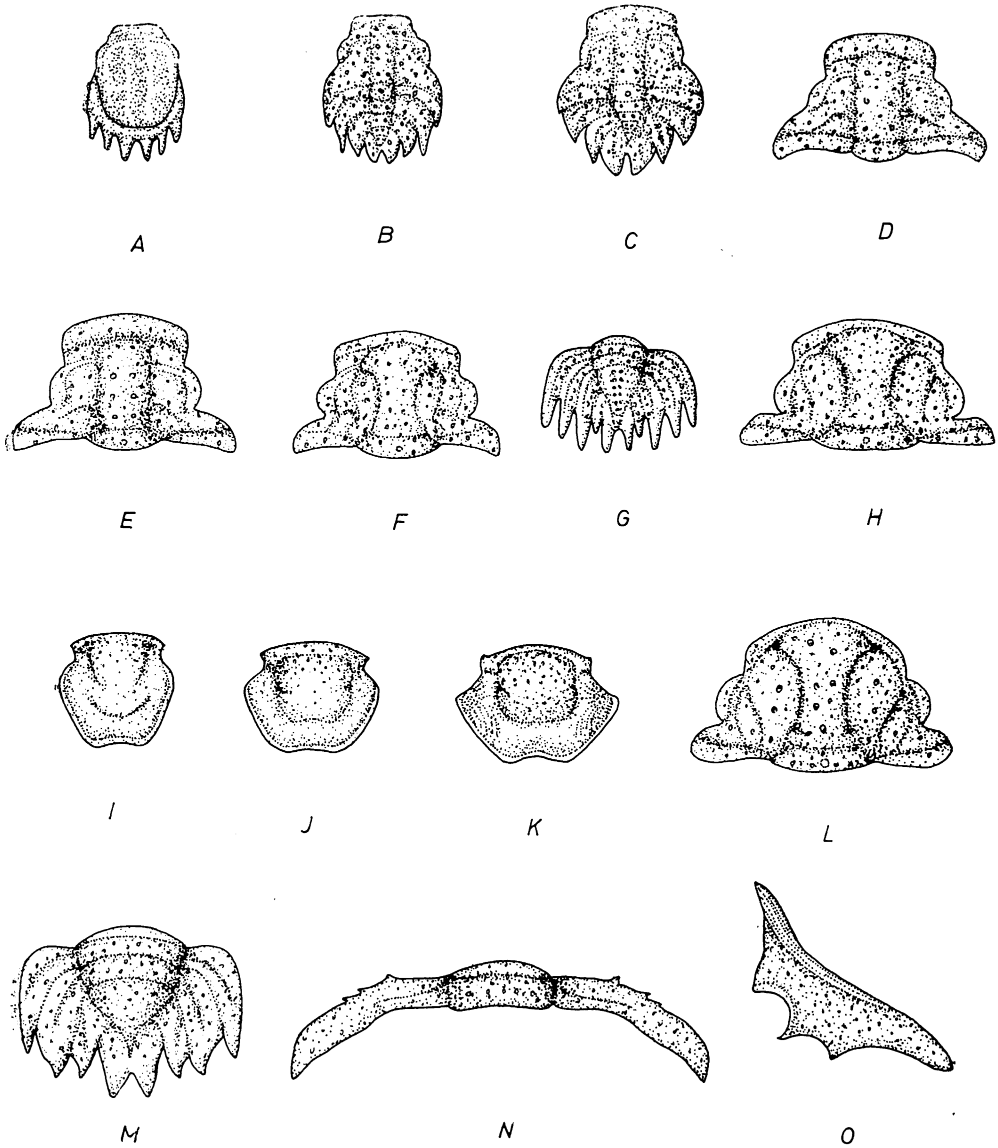
covered by fine and coarse pustules.

*Description:*—The cranidium is regularly trapezoidal in outline, strongly convex, and with the anterior glabellar rather prominent; the glabella is divided into three lobes by deeply impressed longitudinal furrows; the median lobe is expanded antero-laterally and arches forward; the lateral lobes are elongate oval; the paired longitudinal glabellar furrow is deeply marked at nearly the base of the central lobe, and ends with a pair of rounded pits; the anterior glabellar furrows are shallow, and somewhat more prominent laterally along the side of the glabellar lobe; the occipital ring is transverse-triangular, convex, up-turned from the well-marked occipital furrow and with the posterior margin bearing tiny indentations; a rather large granule occurs on the center of the occipital ring; the anterior border is rather narrow, convex, and surrounds the anterior glabellar margin directly, without any preglabellar field. The fixigena is well demarked by deep dorsal and pleural furrows, it is narrow triangular and located behind the lateral glabella and the palpebral lebes; no anterior fixigena is recognizable; the postero-lateral border is narrower than occipital ring (tr.), and turned upward from the well-developed border furrow. The librigena is a narrow blade with both ends curving laterally; the lateral border is narrow, vertical, without distinct border furrow; the ocular platform is of medium width and gently convex; the rounded eye-ring occupies the inner free margin; the genal spine is broadly flat, with the posterior end obtusely pointed. The underside of the librigena is furnished with a broad doublure lateral and posterior to the genal spine.

The hypostoma is hexagonal in outline, convex, and with the posterior margin curving inward; the broadly subquadrate median body is well delimited by deeply impressed furrows, and is divided into an anterior and posterior half by a pair of macular furrows; the inner margin is broad and sorrounds the posterior median body with nearly equal width; it is convex along the axis (sag.) and depressed laterally; the marginal border is rather narrow, elevated along the antero-lateral median body with a pair of rather short, downward sloping lateral wings.

The thoracic segment is of medium width and convex; the pleural lobes arch pestero-laterally, and are of almost equal width from the dorsal furrow to the lateral ends; the axial ring is convex above the pleuron, and it is divided into a small anterior half-ring and a large posterior one by a narrow but deeply incised furrow; the axial furrow is distinct; the pleural lobe is extended laterally and posteriorly, and has three short spines directed forward from the anterior margin; the intrapleural groove is fine and distinct, and runs from the anterior end of the axial furrow postero-laterally to end at the mid-length of the pleuron.

The pygidium is triangular in outline, convex, and has the axis broader than the pleural lobe; the axial lobe is convex above the pleuron, well set off by dorsal furrows, and is divided into one or two axial rings and a terminal portion, which is convex, triangular, and with the posterior end pointed to the rear pygidial margin. The pleural lobe consists of three or three and a half segments, and is well divided by the interpleural furrows; the intrapleural furrow is shallow but distinct; each of the pleural segments ends with a pair of blunt spines, which are directed postero-laterally; no marginal furrow or




Text-fig. 2. A growth sequence of *Amphilichas* cf. *prominulus* (RAYMOND).

A–C, three different sized paraprotaspides, ×30; D–E, two early meraspid cranidia, ×20; F, H, two late meraspid cranidia, ×14, ×10; G, a meraspid pygidium, ×9; I, J, K, three different sized hypostomata, ×20, ×15, ×10; L, a large sized cranidium, ×9; M, a large sized pygidum, ×7; N, a thoracic segment, ×4, an adult librigena, ×2. (All drawings were made from photographs.)

border are known.

The surface of the skeleton is covered by fine- and medium-sized granules, among which the large-sized pustules are sparsely scattered. The lateral margin of the librigena is marked by parallel ridges and the hypostoma is with granules anteriorly and ridges laterally.

*Remarks:*—According to TRIPP (1958) about 23 species of *Amphilichas* have been described from North America. They belong to both the Middle and Upper Ordovician. The present material conforms to RAYMOND's (1925) report. The narrow anterior border and the prominent anterior glabella are the same, although RAYMOND's specimens are much larger and may represent fully grown forms. RAYMOND's material was collected from MCNutt Quarry, near Sharon Spring, and from the Hoge farm, in Bland County, Virginia. This is the same general locality as that from which the present material came.

*Figured specimens:*—Cranidia, U.C.G.M. 40420u, z, a′-d′. Librigenae, U. C. G. M. 40420n, o. Hypostoma, U.C.G.M. 40420k-m. Thoracic segments, U.C.G.M. 40420p, q. Pygidia, U.C.G.M. 40420v-y.

*Amphilichas* cf. *prominulus* (RAYMOND), ontogeny:—*Paraprotaspid stage* (Pl. 49, figs. 1-8, and text-figs. 2 A-C.).—The shield is composed of the cranidium and the pygidium; it is about 0.5-1.0 mm in sagittal length, oval and convex; the glabella is cylindrical, without glabellar

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Explanation of Plate 48

Figs. 1-34. *Raymondaspis gregarius* (RAYMOND).

1-3. Two early protaspid shield, showing the three pairs of marginal spines and the well differentiated axial and pleural lobes; 1, ×45, U.C.G.M. 40419; 2, 3, dorsal and ventral views of two shields, ×45, U.C.G.M. 40419a.

4-6. Three paraprotaspid shields, showing the appearence of the protopygidium; 4, ×25, U.C.G.M. 40419b; 5, ×25, U.C.G.M. 40419c; 6, ×25, 40419d.

7-11. Five early meraspid cranidia, showing the palpebral lobes, located on the mid-line of the cranidium (tr.); 7, ×25, U.C.G.M. 40419e; 8, ×25, U.C.G.M. 40419f; 9, ×25, U.C.G.M. 40419g; 10, ×22, U.C.G.M. 40419h; 11, ×29, U.C.G.M. 40419i.

12-15. Dorsal and ventral views of four late meraspid cranidia, showing the palpebral lobes, situated behind the mid-length of the cranidium, and the great expansion of the anterior glabella; 12, ×18, U.C.G.M. 40419j; 13, ×16, U.C.G.M. 40419k; 14, ×22, U.C.G.M. 404191; 15, ×22, U.C.G.M. 40419m.

16-19. Four holaspid cranidia; notice the rounded palpebral lobes, narrow fixigenae, and the postero-laterally directed fixigenal region; 16, ×16, U.C.G.M. 40419n; 17, ×16, U.C.G.M. 40419o; 18, ×9, U.C.G.M. 40419p 19, ×9, U.C.G.M. 40419q.

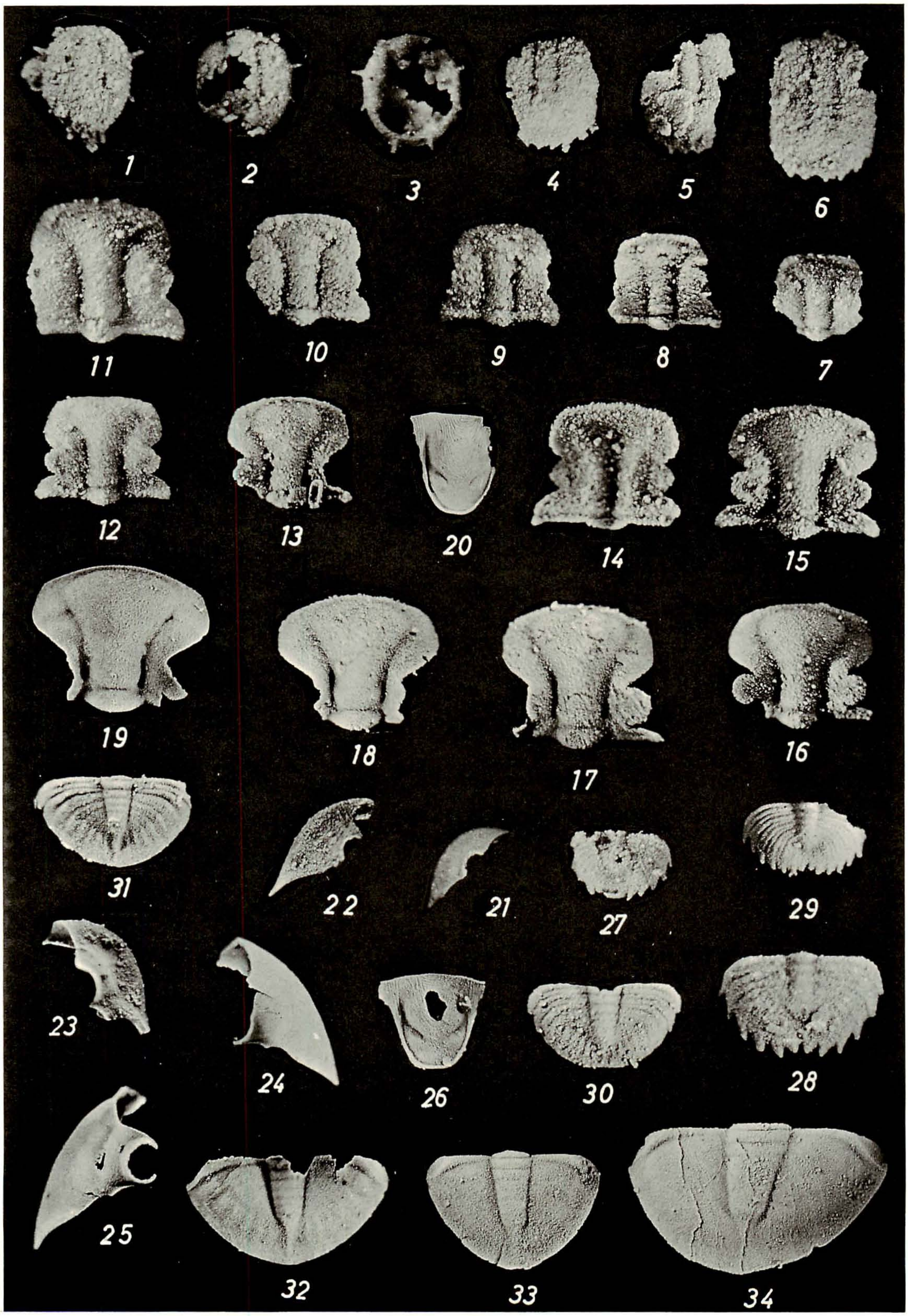
21-25. A growth series of librigenae, showing the change of the ocular position during the different growth stages; 21, 22, two possible early meraspid librigenae; ×18, U.C.G.M. 40419s; ×18, U.C.G.M. 40419t; 23, a possible late meraspid librigena; ×15, U.C.G.M. 40419u; 24, an incomplete librigena, ×10, U.C.G.M. 40419v; 25, ×10, U.C.G.M. 40419w.

20, 26. Two large hypostomata; ×7.5, U.C.G.M. 40419r, x.

27-29. Three early meraspid pygidia; notice the marginal spines and the distinct segments; 27, ×15, U.C.G.M. 40419y; 28, ×20, U.C.G.M. 40419z; 29, ×20, U.C.G.M. 40419a′.

30, 31. Two late meraspid pygidia, each associated with one or two thoracic segments; ×10, U.C.G.M. 40419b′; ×8, 40419c′.

32-34. Three mature pygidia, showing the absence of the distinct pleural bands or furrows; 32, ×10, U.C.G.M. 40419d′; 33, ×5, U.C.G.M. 40419e′; 34, ×6, U.C.G.M. 40419f′.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furrows; instead four pairs of tubercles exist; the occipital ring is convex, well divided by an occipital furrow and the posterior cranidial suture; the anterior border is narrow, horizontal, elevated, and bearing a row of granules; the fixigena is triangular, broad posteriorly and narrower forward, with the width slightly narrower than the glabella between the palpebral and the dorsal furrows; the small, well elevated palpebral lobe is located in front of the mid-length of the glabella, and its anterior end is continuous with the elevated ocular ridge; the posterior fixigena is broad, with the elevated postero-lateral border well demarked by a border furrow; the lateral end of the posterior fixigenal border is extended postero-laterally, and ends in a pair of projections. The protopygidium is triangular, convex, and possibly composed of three indistinct pygidial segments; the axis is conical, tapering posteriorly, and is well delimited by dorsal furrows; the pleural segments end with a pair of marginal spines; no marginal furrow or border is known.

The surface of the small skeleton is covered by both small- and large-sized granules, of which the larger ones are mostly regularly arranged. The large granules are markedly developed along the anterior border; eight pairs occur on both of the glabella and the fixigenae, one row of tubercles on the occipital ring, and seven or eight pairs on both the pygidial axis and the pleural lobes.

*Early meraspid stage* (Pl. 49, figs. 9-11, 19, 23, and text-figs. 2D, E, I.).—The cranidium is trapezoidal in outline, convex, about 0.8-1.0 mm in length (sag.); the glabella is deeply and broadly delimited by dorsal furrows, it is oblong or nearly truncato-conical, convex, and without glabellar furrows, except for a pair of A-shaped ridges which extend from the glabellar base to the fixigenal regions. These suggest the initiations of the lateral glabellar lobes. The occipital ring is convex and well separated by the occipital furrow. The anterior border is convex, arching forward, about one-third the length of the glabella. The triangular fixigena is medium-wide, convex, at about the same level as the glabella; the medium-sized palpebral lobe is situated in front of the mid-line of the glabella (tr.). It is crescentic, convex, and extends continuously forward to the antero-lateral glabellar margin; the postero-lateral border is broader than the occipital ring (tr.), convex, and has its lateral end directed slightly posteriorly.

The triangular pygidium is convex, divided into two segments and a terminal portion, no marginal furrow or border is seen; the axial lobe is slightly wider than the pleuron, convex above the axis, and divided into two axial rings and a triangular terminal portion by distinct furrows; the anterior pygidial segment ends with a pair of medium-sized marginal spine; and that the terminal spines are large and stouter than the rest.

The hypostoma is elongate, hexagonal, convex, and divided into three sections by the macular and the median body furrows; the posterior margin curves slightly inward, and the lateral wings are small.

The skeletal surface is covered by fine- and large-sized pustules; the pygidial segment has two rows of granules along the anterior and the posterior pleural bands.

The present stage differs from the previous one in having the oblong or truncato-conical glabella, the anterior border is wider, and the fixigena becomes narrower.

*Late meraspid stage* (Pl. 49, figs. 13, 20, 21, 24, and text-figs. 2F, G, J.).—The cranidium is trapezoidal in outline, convex, and about 1.0-1.5 mm in length (sag.); the glabella is oval and divided into a large central lobe and a pair of small lateral nodes by a deep furrow; the central glabellar lobe is convex, broadly expanded antero-laterally, and the lateral lobes are elongate oval, small, and located behind of the anterior glabellar expansion; the longitudinal furrows do not extend to the occipital furrow; the occipital lobe is crescentic, convex, bearing a median tubercle; the anterior border is medium wide, convex, arching slightly forward and presents no preglabellar field. The fixigena is narrow, triangular, convex, has the postero-lateral border slightly narrower than the occipital ring (tr.); the medium sized palpebral lobe is crescentic, located on the mid-line of the glabella (tr.), its anterior end is continuous with the well-elevated ocular ridge, and end at the side of the antero-lateral margin of the glabella.

The hypostoma is nearly hexagonal, convex along the axis, and divided into three sections; the anterior section is large and transverse oval; the posterior two sections are about the same width (sag.); the margin of the hypostoma is surrounded by a narrow elevated marginal border.

The pygidium is triangular in outline, convex; the axial lobe is convex above the pleural lobe, and divided into two narrow axial rings and a triangular terminal portion by the indistinct ring furrow; the posterior terminal portion is short and sharply pointed; no marginal border or furrow is seen; four or

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Explanation of Plate 49

Figs. 1–31. *Amphilichas* cf. *prominulus* (RAYMOND).

1–8. Ventral and dorsal views of eight paraprotaspid shields; notice the cylindrical glabella and the appearence of the anterior border. 1, ×30, U.C.G.M. 40420; 2, ×30, U.C.G.M. 40420a; 3, ×30, U.C.G.M. 40420b; 4, ×30, U.C.G.M. 40420c; 5, ×25, U.C.G.M. 40420d; 6, ×25, U.C.G.M. 40420e; 7, ×25, U.C.G.M. 40420f; 8, ×25, U.C.G.M. 40420g.

9–11, 19. Dorsal view of four incomplete early meraspid cranidia; notice the subquadrate glabella, and the presence of the glabellar nodes. 9, ×20, U.C.G.M. 40420h; 10, ×20, U.C.G.M. 40420i; 11, ×20, U.C.G.M. 40420j; 19, ×20, U.C.G.M. 40420r.

12–14. Three different sized hypostomata, showing the morphologic changes of the median body. 12, ×20, U.C.G.M. 40420k; 13, ×15, U.C.G.M. 404201; 14, ×10, U.C.G.M. 40420m.

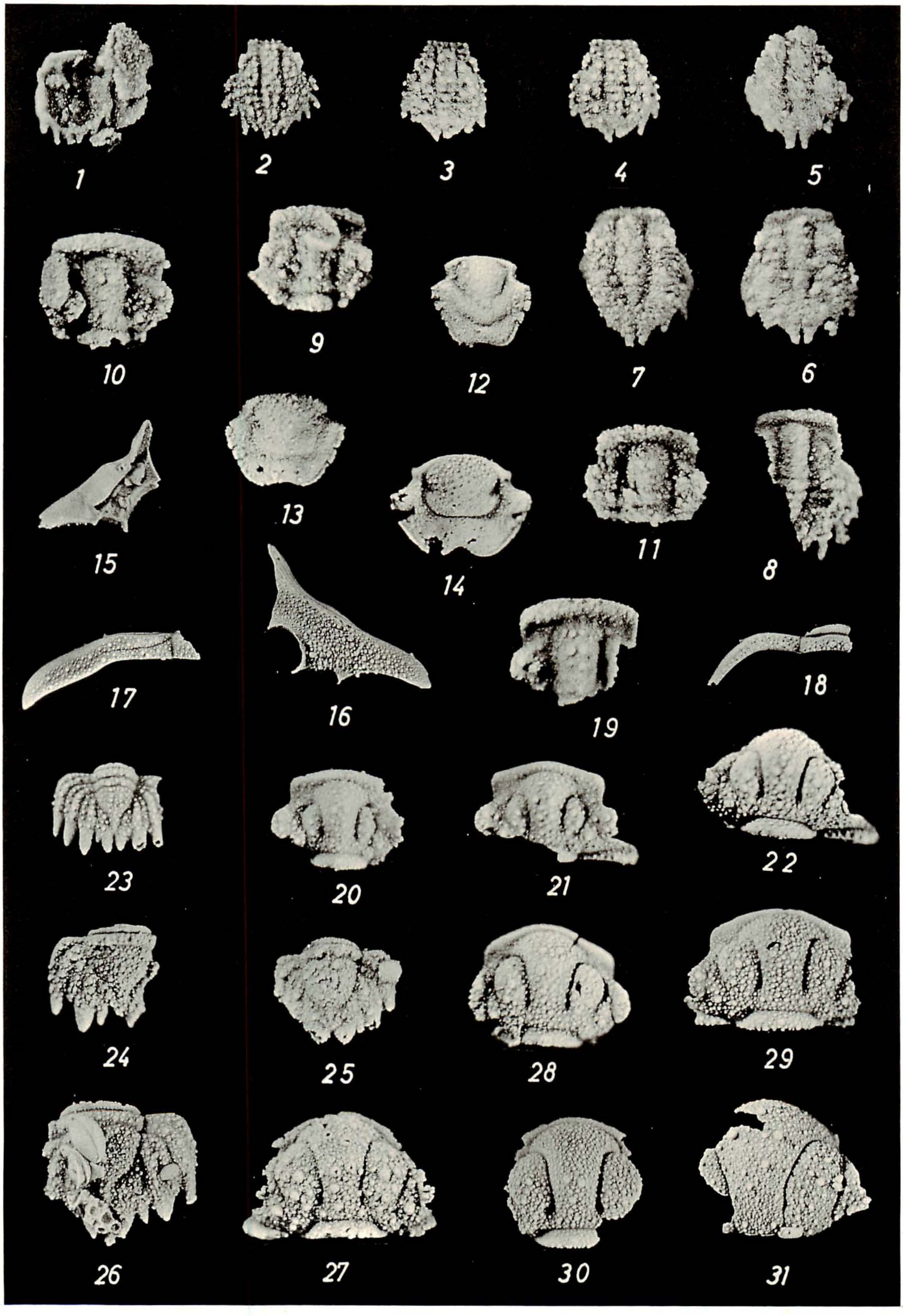
15, 16. Ventral and dorsal views of two librigenae. ×7, U.C.G.M. 40420n; ×21, U.C.G.M. 40420o.

17, 18. A large and a small thoracic segments. ×4, U.C.G.M. 40420p; ×6, U.C.G.M. 40420q.

20, 21. Dorsal view of two incomplete late meraspid cranidia. ×14, U.C.G.M. 40420s; ×10, U.C.G.M. 40420t.

23–26. Four small and large sized pygidia, showing the differentiations of the pleural spines. 23, ×9, U.C.G.M. 40420v; 24, ×6, U.C.G.M. 40420w; 25, ×6, U.C.G.M. 40420x; 26, ×7, U.C.G.M. 40420y.

22, 27–31. Five different sized holaspid cranidia; notice the enlarging of the second glabellar node and the reduction of the anterior border. 22, ×14, U.C.G.M. 40420u; 27, ×9, U.C.G.M. 40420z; 28, U.C.G.M. 40420a′; 29, ×10, U.C.G.M. 40420b′; 30, ×9, U.C.G.M. 40420c′; 31, ×6, U.C.G.M. 40420d′.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five pairs of marginal spines run continuously from the pleural bands; the first and the third pairs of spines are large and stouter, and the second, fourth, and fifth pairs are short and slender.

The present stage is differentiated from the early meraspid stage by the presence of the lateral glabellar lobes, the narrower anterior border, and the presence of the fixigena, the shorter and broader hypostoma, and three pairs of short pygidial spines. It is differentiated from the holaspid stage by its wider anterior border, small lateral glabellar lobes, narrower hypostoma, and the slender terminal spines.

*Remarks:*—A well-preserved immature specimens of "*Lichas*", which were recovered by BEECHER (1895) from the Lower Devonian New Scotland limestone, Albany Co., New York, and restudied by WHITTINGTON (1956b), show similar structure to that here examined, but BEECHER's specimen is rounder, and the palpebral lobe is broader, whereas the present specimens are oval, and the palpebral lobe is elongate as compared with specimens of the same age.

*Figured specimens:*—Paraprotaspides, U. C. G. M. 40420, 40420a-g. Early meraspides, U. C. G. M. 40420h-j, r. Late meraspides, U. C. G. M. 40420s, t.

## References


BEECHER, C.E. (1893): Larval forms of trilobites from the Lower Helderberg group. *Am. Jour. Sci.*, ser. 3, v. 46, p. 142-147, pl. 2.

—— (1895): The larval stages of trilobites: *Am. Geol.*, v. 16, p. 166-197, pl. 8-10.

COOPER, B.N. (1953): Trilobites from the Lower Champlainian formation of the Appalachian Valley. *Geol. Soc. America, Mem.* 55, 66 p, pls. 1-19, 2 text-figs., 1 table.

HU, C.H. (1971): Ontogeny and sexual dimorphism of Lower Paleozoic Trilobita. *Palaeontogr. Americana*, v. 7, no. 44, p. 31-125, pls. 8-26, 58 text-figs.

RAYMOND, P.E. (1920): Some new Ordovician trilobites. *Mus. Comp. Zool., Bull.*, v. 64, no. 2, p. 273-286.

—— (1925): Some trilobites of the Lower Middle Ordovician of eastern North America. *Ibid.*, v. 67, no. 1, 180 p., pls. 1-10.

TRIPP, R.P. (1958): Stratigraphical and geographical distribution of the named species of the trilobites Superfamily Lichacea. *Jour. Paleont.*, v. 32, no. 3, pp. 574-582, pl. 85.

WHITTINGTON, H.B. (1941): Silicified trendon trilobites. *Jour. Paleont.*, vo. 15, no. 1, p. 492-522, pls. 72-75, 13 text-figs.

—— (1956a): BEECHER's supposed odontopleuried protaspis is a phacopid. *Ibid.*, v. 30, no. 1, p. 104-109, pl. 24, 2 text-figs.

—— (1956b): BEECHER's lichid protaspis and *Acanthopyge consanguinea* (Trilobites). *Ibid.*, v. 30, no. 5, p. 1200-1204, pl. 131, 1 text-fig.

—— (1956c): Silicified Middle Ordovician trilobites (the Odontopleuridae). *Mus. Comp. Zool., Bull.*, v. 114, no. 5, p. 159-289, pls. 1-24, 25 text-figs.

—— (1959): Silicified Middle Ordovician trilobites (Remopleurididae, Trinucleidae, Raphiophuridae, Endymioniidae). *Ibid.*, v. 121, no. 8, p. 373-496, pls. 1-36, 8 text-figs.

—— (1965): Trilobites of the Ordovician Table Head Formation, western Newfoundland. *Ibid.*, v. 132, no. 4, pp. 281-441, 68 pls.

WHITTINGTON, H.B. and EVITT, W.P. (1953): Silicified Middle Ordovician trilobites. *Geol. Soc. America, Mem.* 59, 135 p. pls. 1-33, 27, text-figs. 2 tables.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 95, pp. 364-370, pl. 50, September 20, 1974

# 636. MARINE FOSSILS FROM THE MONIWA FORMATION ALONG THE NATORI RIVER, SENDAI, NORTHEAST HONSHU, JAPAN, PART 2. PROBLEMATICA FROM THE MONIWA FORMATION*

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仙台市名取川流域茂庭層産海棲化石，その2. 茂庭層産プロブレマティカ：仙台市南西部の茂庭層基底部より，ほぼ完全個体の状態で産出した細長卵形状化石を検討した。その外周は薄質の石灰殻で被われ，その外表面には何ら彫刻・斑紋もなく，滑めらかで，両端がやゝ太さを異にする所謂卵の特徴を示すものである。此の様な化石は本邦における，すくなくとも新生代における記録は全くなく，化石の産状と化石・現生種の近似の形態をとり得るものとの比較検討を行なった結果，*Moniopterus japonicus* なる新属・新種とし，海棲爬虫類ウミヘビの類と判断した。

畑井小虎・増田孝一郎・野田浩司

## Introduction

From the basal part of the marine Moniwa Formation exposed in a cliff facing the Natori River at Moniwa, Sendai City, several peculiar shaped fossils were discovered. The description and discussion of the problematica of unknown systematic position and nature forms the scope of the present article. The peculiar shaped fossils were found at several centimeters above the base of the marine Moniwa Formation in association with such fossils as pelecypods, gastropods, brachiopods, bryozoans and foraminifers. Of the mentioned fossils, the brachiopods from the Moniwa Formation distributed along the Natori River are described in Part 1 of the series of the articles planned to be published on the marine fauna of the formation.

A review of the fossils published previously from the Moniwa Formation, the stratigraphic position of the formation in the geological column of the Sendai area, and remarks on the

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lithology were given in Part 1 of the series and repetition will be omitted at this place. The peculiar shaped fossils are from two localities, each of the basal part of the Moniwa Formation. One locality is the basal part of the formation exposed in the cliff facing the Natori River, south of the Oide Bridge crossing the Natori River and about 250 meters south of the type locality of the formation. This locality yielded three specimens, one complete and two with only half preserved. The complete one is taken as the type specimen. The fourth specimen is from the second locality, which is the basal part of the Moniwa Formation cropping out in the southern cliff of the Aoba Golf Links (under construction), north of Osawa, Sendai City and situated at about 2 kilometers southeast of the locality mentioned above. At both localities, the specimens were found embedded in brownish colored medium-grained sandstone sporadically with granules or pebbles.

The invertebrate fauna found in association with the four specimens mentioned above consisted of *Kotorapecten kagamianus* (YOKOYAMA), *Nanaochlamys notoensis* (YOKOYAMA), *Vasticardium ogurai* (OTUKA), *Crassatellites* sp., *Dosinia* sp., *Panope* cf. *nomurae* KAMADA, *Coptothyris grayi* (DAVIDSON), *Terebratalia* sp., *Flabellum* sp., abundant balanid specimens and also with gastropods, scaphopods and echinoid spines. Benthonic and planktonic foraminifers and ostracodes were also found in association with the specimens forming the scope of the present article.

The fossils upon which this article is based were evidently exposed on the sea-bottom for some period of time as is judged from the surface of one of the fossils having adhered to it several specimens of bryozoans resembling the genus *Actinopora*. The bryozoan specimens are somewhat worn, and this suggests that after the bryozoans adhered to the surface of the fossil, it was rolled by aqueous agencies which caused erosion of the surface before burial. The peculiar-shaped fossil is confusing for several reasons, first, forms identical with the present one have not been found through a research of literature bearing on organisms of probable similarity, second, the systematic position of the fossil is difficult to determine because shapes as the present one among marine organisms are not known to the writers, and third, the present record seems to be the first of its kind from the Cenozoic rocks of Japan. For the reasons just mentioned, it seems worthy to describe and discuss the present fossil from the viewpoint of its systematic position and significance in the Moniwa marine fauna.

## The Peculiar-shaped Fossil

*Occurrence:*—Two of the peculiar shaped fossil of elongate narrowly oval outline, and well inflated thin calcareous shell were found in a position parallel with the bedding plane of the Moniwa Formation and two others at an oblique angle. They were found in a medium-grained sandy patch with sporadic granules and pebbles intercalated in the conglomerate facies. As mentioned above they were found in association with pelecypods, gastropods, bryozoans, foraminifers, balanids, echinoid spines, ostracodes and brachiopods, the latter of which formed the first part of the series of articles on the fossil marine fauna. Of these fossils mentioned, the majority of the pelecypods (including all of the scallops) and some of gastropods are thought to have been drifted into the area of their burial. On the other hand, the bryozoans, foraminifers and brachiopods probably lived in or at least very near to the place where were buried. Thus the fossil fauna represents in part both thanatocoenosis and biocoenosis. From the mode of occurrence of the peculiar-shaped fossil it is suggested that they may have been drifted to the place of their burial either by aqueous or eolian agencies. Their mode of transportation to their place of burial if they did not actually live in the environment where they were found depends upon the nature of the fossil, as will be stated later.

*Comparison:* The present specimens which are characterized by their elongated shell, thin and smooth calcareous covering, rounded ends and in being well inflated, can be distinguished from such pelecypods as *Musculus* (*Ryenella*) *cupreus* (GOULD), *Lithophaga* (s. s.) *straminea* (REEVE), and *Lithophaga* (*Leisolenus*) *curta* (LISCHKE) all described and illustrated by TAKI (1960, p. 90, pl. 45, figs. 2, 7, 8, respectively), and all which have rounded anterior margin, elongate outline, rather bluntly rounded posterior side and inflated shells, by lacking growth lines or other kinds of external sculpture, not having two valves or shells, more uniform outline, thinner covering and more uniformly inflated shell. Other pelecypods with outline similar to the present fossil can also be distinguished from the fossil by the features mentioned above. Compared with the coprolites described and illustrated by HÄNTZSCHEL, EL-BAZ and AMSTUTZ (1968), the present specimens differ in several important features, such as having no external sculpture so characteristic of the coprolites, more uniform outline and inflation, no noteworthy interior structure of the sediments possessing a thin covering, and showing no evidence of having been sausaged.

Although the eggs of certain Pisces can probably be preserved as fossil, there seem to be none that can be compared in shape, size and external morphology with the present specimen. Most preservable as fossil are probably the eggs of the Selachians (MCCORMICK, ALLEN and YOUNG, 1963) but their shapes are different from the present specimens and thus need not be brought into comparison.

So far as the general shape is concerned, the present specimens show a remote resemblance with such echinoid genera as *Echinometra*, *Fibularia*, *Lovenia* and *Brissopsis* (NISIYAMA, 1968), but the very thin ectoderm or covering and complete lack of echinoderm structures, serve to easily distinguish the present fossil from the echinoids.

The Aves are well known to have oval shaped eggs with a thin covering and without sculpture on the outer surface although different color patterns exist. The sizes and oval-shaped eggs of the Aves vary with genus and species, and show a remote resemblance with the present specimen now under consideration. If the shape of the present specimen is the original one, then it can be distinguished from the eggs of Aves by being much more elongated and with more narrowly rounded ends. Also since the present specimen was found embedded in sediments in association with *Coptothyris grayi miyagiensis* HATAI, MASUDA and NODA (1973), pelecypods, gastropods and cirripeds as well as with small bryozoans, such an environment may not be natural for Aves eggs, although there remains of possibility of their being preserved in marine deposits by accident.

Another possibility for the origin of the elongate-oval fossil under consideration may be that they are nothing but the eggs of the sea turtle. It is well known that sea-turtles crawl up upon the beach to lay their eggs in holes dug in the sand. The eggs are whitish with soft and elastic cover, without noteworthy sculpture. The number of eggs laid by the turtle is numerous as many as about 30-50, and it is quite possible that they could be reworked by aqueous or other agencies to be transported and deposited in the nearshore deposits. By such undertakings it could be possible or probable that fracturing or cracking during the drying and hardening egg-cover would permit penetration or impregnation of sediments into the shell and at the same time, by burial, the shell would be subjected to compression which would result in the fracturing and elongation of the partially elastic calcareous covering. Although the above mentioned process is quite possible, there is no positive data to uphold the view. Another possibility is that the present elongate-oval fossil is a fossilized sea-snake-egg that was either drowned, fractured and impregnated with sandy sediment at the time of continued rise of the sea-level during the transgressive phase that resulted in the deposition of the Moniwa Formation. Also it may be that the snake-egg rolled down from a higher relief to the seashore, and by continued drying the thin and elastic covering gradually hardened and became fractured at several parts, through which sediment flowed-in and filled the chamber. Subsequently the rounded or oval snake eggs by the filling sediments expanded to become elongate-oval in shape and thenafter became buried in the sediments deposited by the transgressing sea. The sea-snake is known for its strong poison, rising to the surface to breathe by its lung, is not a member of the Pisces but that of the Reptile that once lived on the land but latter took to life in water. Thus, just as the land snake, the sea-snake also lays eggs with thin, soft, calcarous, elastic covering of whitish color and probably at or near the shore-line. Therefore, the burial of the snake egg in the shallow water sediments of the basal part of the Moniwa Formation can be expected. Also it is known that the sea-snake lives in warm and shallow water, that is to say, in areas where coral reefs and reef corals exist, thus it is a tropical to subtropical eel-shaped reptile. The thermal conditions during deposition of the Moniwa Formation is judged to have been about subtropical as may be interpreted from the fossil occuring from the formation.

The warm water condition during deposition of the Moniwa Formation is documented by the occurrence of tropical to subtropical foraminifers as *Lepidocyclina* (*Nephrolepidina*), molluscs as *Trochus*, *Xenophora*, *Morum*, *Cypraea*, *Conus*, *Bursa* and others among the gastropods, *Vasticardium*, *Venus* among the pelecypods, corals as *Dendrophyllia* and bryozoans besides other fossils.

A comparison of the fossil egg-like specimens under consideration was made with the eggs of the land snake, *Elaphe climacophora* (BOIE), which was captured in July 1937 in the environs of Sendai City. The eggs of the land snake are not spherical or rounded and of ping-pong size as those of the turtle, not ovoid in shape like those of the Aves, but are elongate oval with well rounded ends and equidistantly separated parallel sides, smooth surface of whitish color and with no noteworthy sculpture on the surface of the thin shell or covering. The snake eggs just mentioned and shown in the annexed illustrations closely resemble the fossil specimens decribed in the present article, and are of similar size, almost the same shape, have the same or very similar kind of whitish coloration of the shell covering, and have thin covering. Also the orientation of the eggs of *Elaphe climacophora* seem to be at random, some have the longer axis parallel with the ground surface, whereas in others the longer axis may be oblique to nearly vertical to the ground surface, and it seems that the direction of the longer axis of the eggs depends upon ground configuration and degree of coiling of the snake because the eggs are protected in the coils. This remarkable resemblance of the fossil specimens to the Recent ones just mentioned strongly points to or suggests that the fossil ones are the eggs of a snake, and being marine in origin, they are considered to be of a sea-snake of which bones have not yet been discovered from the Moniwa Formation, although they are expected to be found, and in a state quite dismembered because their bones are very thin, weak and easily destroyed by aqueous or other physical and chemical agencies.

Although some assumptions on the nature of the fossil can be given there seems to be no positive evidence for adopting one of the views given above. Regardless of the different views concerning the peculiar fossil, it can be said that a description and illustrations of the fossil should be given as a contribution to the study of problematical fossils. Further, it seems best to give a name to the fossil, which is thought to be the eggs of a sea-snake and thus belongs to the Reptilia, but to what genus or family it belongs is a question should be reserved for another opportunity. Under such consideration, the writers propose the generic and specific name of *Moniopterus japonicus*, n. gen. et n. sp.

Class Reptilia

Order Apodes

Suborder Enchelycephali

Series Congoidei

Family Ophichthyidae

Genus *Moniopterus*, HATAI, MASUDA and NODA, n. gen.

*Type species:—Moniopterus japonicus* HATAI, MASUDA and NODA, n. sp.

*Diagnosis:* — Elongate-oval, ends rounded, covering thin, calcareous, semipolished, with no external sculpture.

*Moniopterus japonicus* HATAI, MASUDA and NODA, n. sp.

Pl. 50, figs. 2-6

*Type locality* and *Formation:*—Cliff of the Natori River, south of the Oide Bridge, Moniwa, Sendai City, Miyagi Prefecture, Early Mizuho Tô, Moniwa Formation (Moniwan). Three specimens, the best is chosen as the type specimen.

*Desription:*—Shell elongate-ovate, one end bluntly rounded, other end more narrowly rounded, measuring about 51 mm in length and 20 mm in diameter (Holotype specimen), shell covering thin, calcareous, smooth, semipolished, without external sculpture. The fourth specimen is well preserved except for lacking the very thin and semipolished covering. It measures about 43 mm in length and 21 mm in diamter (Paratype specimen), of the same shape as the Holotype, with bluntly rounded ends and apparently with smooth surface.

*Remarks*:—The shell is fractured both longitudinally and transversally at several places and on the surface several worn bryozoans are attached. The bryozoans resemble somewhat the genus *Actinopora* D'ORBIGNY, which is said to range from the Cretaceous to Recent (BASSLER, 1953, p. 57). The bryozoans in being worn suggest that after becoming attached to the surface covering, and growing to an adult, the host was subjected to rolling on the sea-bottom probably by aqueous agencies, thus explaining the worn condition of the bryozoans. From the fractured thin calcareous shell, it may be assumed that after the yolk and white part of the egg died, the covering gradually hardened and by fracturing due to the overlying sediments during burial and impaction due to transportation from the shell, which may have aided in elongating the originally more globular shape. This process may explain the shape of the fossil, if it was originally globular or rounded during life and the sediments filling the shell.

A comparison with organisms capable of making structures similar to the present fossil have been given in earlier lines of this article and here it may be added that whatever the true nature of the fossil, it is of interest because it forms the first discovery of a probable sea-snake egg from the Cenozoic rocks of Japan.

## Acknowledgments

The writers thank Dr. Yoshio SUGAWARA of the Department of Fisheries, Faculty of Agriculture of the Tohoku University, for his information on the sea-snake, Mr. Kenshiro OGASAWARA of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University for his many supports in the field and Mr. Kimiji KUMAGAI of the same Institute for taking the necessary photographs.

## References Cited

BASSLER, R. S. (1953): Bryozoa. *in* Treatise on Invertebrate Paleontology, Part G. p. 1–253, figs. 1–175, *Geol. Soc. America* and *Univ. Kansas Press*, *edited* by R. C. Moore.

HATAI, K., MASUDA, K. and NODA, H. (1973): Marine fossils from the Moniwa Formation distributed along the Natori River, Sendai, Northeast Honshu, Japan. Part 1. Brachiopoda from the Moniwa Formation. *Satio Ho-on Kai Mus., Res. Bull.*, no. 42, p. 9–18, pls. 2, 3.

HÄNTZCHEL, W., EL-BAZ, F. and AMSTUTZ, G. C. (1968): Coprolites. An annotated bibliography. *Geol. Soc. Amer., Mem.* 108, p. 1–132, pls. 1–11, figs. 1–6.

JORDAN, D. S. (1963): The genera of fishes and a classification of fishes. p. 1–800, *Stanford Univ. Press*.

MCCORMICK, H. W., ALLEN, T. and YOUNG, E. (1963): Shadows in the sea. p. 1–415, with numerous illustrations, *Chilton Co.*, New York.

NISIYAMA, S. (1968): The echinoid fauna from Japan and adjacent regions. *Palaeont. Soc. Japan, Spec. Pap.*, no. 13, p. 1–491, pls. 19–30.

NOMURA, S. (1940): Molluscan fauna of the Moniwa shell bed exposed along the Natori-gawa in the vicinity of Sendai, Miyagi Prefecture, Japan. *Sci. Rep., Tohoku Imp. Univ., Ser. 2*, vol. 21, no. 1, p. 1–46, pls. 1–3.

TAKI, I. (1960): Mollusca. *in* Encycl. Zool. Illust. Colors, vol. 3, *edited* by OKADA, K. and TAKI, I., Hokuryukan Book Co. Inc., Tokyo.

| | | | |
|---|---|---|---|
| Moniwa | 茂 庭 | Osawa | 大 沢 |
| Natori | 名 取 | Takadate | 高 館 |
| Oide | 生 出 | | |

## Explanation of Plate 50

Fig. 1. View of the type locality of *Moniopterus japonicus*. The massive lower part consists of the Takadate Andesite. This is superposed by the conglomeratic facies with medium-grained sandy patches of the basal part of the Moniwa Formation. Note the very irregular boundary between the Takadate Andesite and Moniwa Formation. The sea-snake egg specimens were obtained from the lower part of the Moniwa Formation, about 10 centimeters above the base. Cliff south of the Oide Bridge crossing the Natori River, Sendai City.

Fig. 2. Two broken specimens *in situ*. Locality same as above.

Fig. 3. *Moniopterus japonicus*, n. gen. et n. sp., (×1), Holotype, (IGPS coll. cat. no. 92956), Note fractured parts, thin covering, elongated shape, and adhering bryozoans. Locality same as above.

Figs. 4–6. *Moniopterus japonicus*, n. gen. et. n. sp., (×1), Paratype, (IGPS coll. cat. no. 92957), 4, lateral view of entire specimen. 5, view of rounded end. 6, view of other rounded end. Locality: Southern cliff of the Aoba Golf Links, north of Osawa, Sendai City.

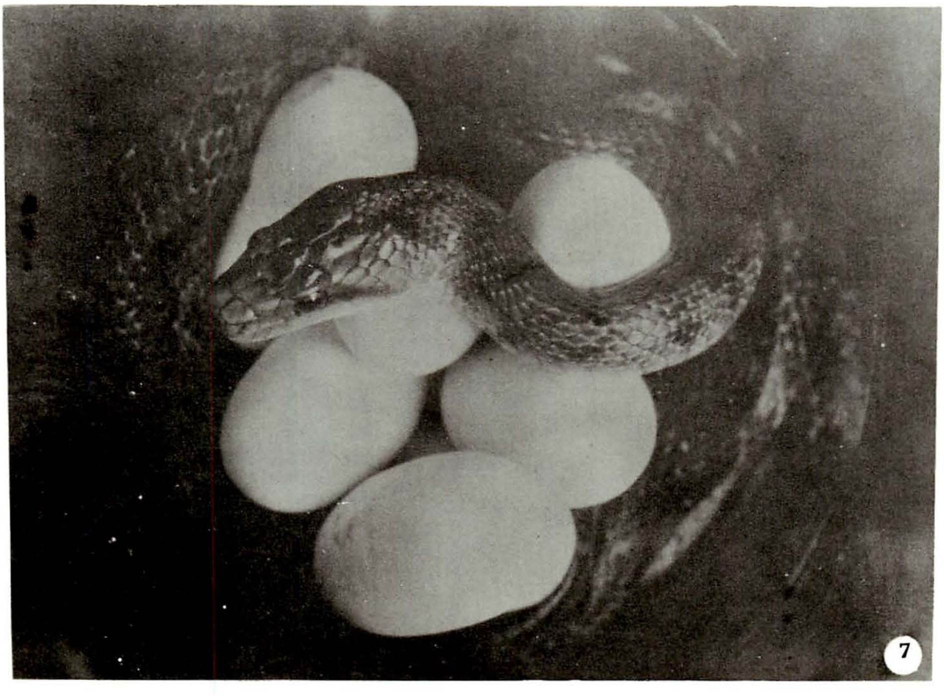
Fig. 7. Photograph of *Elaphe climacophora* (BOIE) captured in the environs of Sendai City and placed in a broken beer bottle of which rim can be seen vaguely. This photograph was taken of the snake where it laid eggs during capture. The photograph is slightly enlarged and the morphology of the eggs, their orientation enclosed by the snake and the number laid at a time can be seen. The snake was captured in July 1937.

3

4

5

6



Trans. Proc. Palaeont. Soc. Japan, N.S., No. 92, pp. 371-394, pls. 51-53, September 20, 1973

# 637. *PROFUSULINELLA* ASSEMBLAGE IN THE OMI LIMESTONE, NIIGATA PREFECTURE, CENTRAL JAPAN

## (STUDIES OF CARBONIFEROUS FUSULINACEAN OF OMI, PART I)

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青海石灰岩産の *Profusulinella* と その共存種（青海石灰岩石炭系の紡錘虫，その 1）：板ケ峰地域の青海石灰岩中にいわゆる *Profusulinella* 帯の存在することを明らかにし，本帯は，下位の *Profusulinella omiensis* n. sp.-*P. daiyamensis* 帯，上位の *Akiyoshiella ozawai* 帯の 2 帯で特徴づけられることをのべた。2 帯を構成する種は，*Profusulinella* 2 新種，*Fusulinella* 1 新種，*Akiyoshiella* 2 種を含む 7 属 16 種で，これらの紡錘虫によって特徴づけられる青海石灰岩の *Profusulinella* 帯は秋吉石灰岩の *Profusulinella beppensis* 帯，ソ連の Verei-Kashir 層準（下部モスコビアン）の *Profusulinella* 化石動物群に対比される。

渡 辺 耕 造

### Introduction and Acknowledgements

The Carboniferous and Permian Omi Limestone Group distributed in the Omi district, Niigata Prefecture, has been studied by many workers since the classical paleontological investigation of HAYASAKA (1924). ISHII (1934), KATO and IISAKA (1934) worked out general geology of this district. OZAWA (1925), KAWADA (1954), FUJITA (1958), IGO (1960) and HASEGAWA (1969) contributed to fusulinacean biostratigraphy. Comprehensive study on fossil bryozoa was published by SAKAGAMI (1962). IGO and KOIKE (1964) described some Pennsylvanian conodonts, and ROWETT and MINATO (1969) and others studied rugose corals.

Of these studies, rather detailed fusulinacean biostratigraphy and geological structure were elucidated by KAWADA (1954) and FUJITA (1958). Recently, HASEGAWA (1969) has divided the Permo-Carboniferous limestone distributed in the Itagamine district, Kurohime-yama, and the adjacent regions into nine zones on the basis of fusulinacean and endothyracean foraminifers. These biostratigraphic studies of the Omi Limestone are summarized in Table 1.

The author has studied rich fusulinaceans of the Limestone and their stratigraphic distribution since 1967. As a result, he recognized eight fusulinacean zones in the Carboniferous part. In the present paper, the author described some interesting species from the zone of *Profusulinella* of HASEGAWA (1969).

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## Faunal composition of the Zone of *Profusulinella*

Fusulinacean fossils are extraordinalily abundant in various levels of the Omi Limestone Group in Itagamine district. There have been recognized eight assemblage zones of Carboniferous fusulinacea in decending order as follows:

| | |
|---|---|
| Gzhelian …. | *Triticites* (*Montiparus*) *montiparus* Zone (T) |
| Moscovian .. | *Fusulinella pulchra* Zone ($F_3$) |
| | *Fusulinella biconica* Zone ($F_2$) |
| | *Fusulinella simplicata-F. itoi* Zone ($F_1$) |
| | *Akiyoshiella ozawai* Zone ($Pr_2$) |
| | *Profusulinella omiensis-P. daiyamensis* Zone ($Pr_1$) |
| Bashikirian-Namurian-Visean? | *Pseudostaffella antiqua* Zone ($M_2$) |
| | *Eostaffella kanmerai* Zone ($M_1$) |

In this paper, the author describes fusulinaceans from two assemblage zones of *Profusulinella omiensis-P. daiyamensis* ($Pr_1$) and *Akiyoshiella ozawai* ($Pr_2$). The two "zones" comprise the zone of *Profusulinella* of HASEGAWA (1969). This Zone comformably overlies the *Pseudostaffella antiqua* Zone, and is overlain by the *Fusulinella simplicata-F. itoi* Zone.

The most complete faunal assemblages of "*Profusulinella* Zone" are recognized in the northern and southern cliffs of Itagamine district (Text-fig. 1). The limestone in these localities is light grey to white massive biosparite, biooosparite and oomicrite.

*Profusulinella omiensis-P. daiyamensis* Zone: The fauna of this zone consists of *Profusulinella omiensis* WATANABE, n. sp., *P. daiyamensis* HASEGAWA, *P.* sp. A, *Pseudostaffella kanumai* IGO, *Eostaffella postmosquensis* KIREEVA, *Nankinella yokoyamai* SADA and *Ozawainella vozhgalica* SAFONOVA.

*Profusulinella daiyamensis* HASEGAWA is one of most representative fusulinaceans in the Omi Limestone, and it was originally described from the Zone of *Profusulinella beppensis* in the Akiyoshi Limestone Group, Yamaguchi Prefecture, Japan. *Profusulinella taishakuensis* SADA and *P. toriyamai* SADA described from the Zone of *Profusulinella* of the Taishaku Limestone, Hiroshima Prefecture, seem to be fall within the specific variation of this species. *Profusulinella* sp. B described by SADA (1965) from the *Profusulinella* Zone in the middle part of the Kodani formation of the Atetsu Limestone, is closely allied to this species. The similarity between these two species indicates that they are apparently conspecific each other. *Profusulinella biconiformis* KIREEVA, *P. prolibrovichi* RAUSER and its related species, which were known from the lower to middle Kashir horizon of the Russian Platform, are very similar to this species.

*Profusulinella omiensis* WATANABE n. sp. is yielded only from ScI-G and is closely related to *Aljutovella arissionis* LEONTOVICH and *A. arissionis molotovensis* SAFONOVA which were described

Table 1. Historical review of the Carboniferous to Lower Permian Fusulinacean Biostratigraphy.

| Period | Stage | Zone | KAWADA (1954) | FUJITA (1958) | HASEGAWA (1969) | Present Paper | |
|---|---|---|---|---|---|---|---|
| PERMIAN | ASSELIAN | *Pseudoschwagerina* | P 1 Formation<br>*Pseudoschwagerina Pseudofusulina* Zone | Zone of *Pseudoschwagerina* | Zone of *Pseudoschwagerina* | *Triticites simplex* Zone | $Ps_1$ |
| UP. CARB. | GZHELIAN | *Triticites* | C 3 Formation<br>*Triticites* Zone | Zone of *Triticites* | | *Triticites* (M.) *montiparus* Zone | T |
| MIDDLE CARBONIFEROUS | MOSCOVIAN | *Fusulinella-Fusulina* | C 2 Formation<br>*Fusulinella* Zone | Zone of *Fusulinella* | Zone of *Fusulinella* | *Fusulinella pulchra* Zone | $F_3$ |
| | | | | | | *Fusulinella biconica* Zone | $F_2$ |
| | | | | | | *Fusulinella simplicata-F. itoi* Zone | $F_1$ |
| | | *Profusulinella* | | | Zone of *Profusulinella* | *Akiyoshiella ozawai* Zone | $Pr_2$ |
| | - ? -<br>BASHKIRIAN | | | | | *Profusulinella omiensis-P. daiyamensis* Zone | $Pr_1$ |
| | | *Eostaffella-Millerella* | C 1 Formation<br>Coral-Brachiopods Zone | Zone of *Millerella*-Coral-Brachiopod | Zone of *Eostaffella-Millerella* | *Pseudostaffella antiqua* Zone | $M_2$ |
| L. CARB. | NAMURIAN | | | | | *Eostaffella kanmerai* Zone | $M_1$ |

from the middle Verei horizon of the Russian Platform (RAUSER-CHERNOUSSOVA et al., 1951).

*Pseudostaffella kanumai* IGO was known from the uppermost *Millerella bigemmicula-Pseudostaffella kanumai* Subzone (IGO, 1957) in the Ichinotani Formation of Fukuji, Gifu Prefecture. *Nankinella yokoyamai* SADA is less common in the Omi Limestone. This species was reported from the *Profusulinella* Zone (SADA, 1972) in the Taishaku Limestone.

*Ozawainella vozhgalica* SAFONOVA is abundant but limited in distribution in this area. This species was known from the upper Verei to lower Kashir horizons of the Russian Platform, and also described by SHENG (1958) from the *Fusulina konnoi* Subzone to the *Fusulina cylindlica-F. quasicylindrica* Subzone in the Taitzeho Valley region, Northeast China.

*Eostaffella postmosquensis* RAUSER-CHERNOUSSOVA is common in the Omi Limestone. This species was described from the Bashikirian to the middle Verei horizons of the Russian Platform (RAUSER-CHERNOUSSOVA, 1951).

According to the above mentioned evidence, the *Profusulinella omiensis-P. daiyamensis* Zone is characterized by the species described previously from the Zone of *Profusulinella* in the Omi Limestone Group. *Profusulinella omiensis* is similar to the species of *Aljutovella* which was confined into the middle Verei in Russia. Therefore, *Profusulinella omiensis-P. daiyamensis* Zone established in the Omi Limestone is evidently correlated to the Verean to Kashirian in the Russian Platform and to the *Profusulinella beppensis-P. toriyamai* Zone or the Atetsuan in Japan.

*Akiyoshiella ozawai* Zone: This zone overlies the *Profusulinella omiensis-P. daiyamensis* Zone, but the stratigraphic relationship to the *Fusulinella simplicata-F. itoi* Zone is obscure yet. The following fusulinacean species makes up this zone: *Akiyoshiella ozawai* TORIYAMA, *A. toriyamai* THOMPSON, PITRAT and SANDERSON, *Staffella akagoensis* TORIYAMA, *Profusulinella probiconica* WATANABE n. sp., *P. pseudorhomboidea* PUTRJA, *P.* sp. B, *Fusulinella hayasakai* WATANABE, n. sp. and *F. jamesensis* THOMPSON, PITRAT and SANDERSON.

*Akiyoshiella ozawai* was described from the *Profusulinella beppensis* Zone in the Akiyoshi Limestone Group, where it is associated with *Profusulinella toriyamai* SADA and *Staffella akagoensis* TORIYAMA.

*Fusulinella hayasakai* WATANABE, n. sp. includes *Fusulinella* sp. B and *F.* sp. C which were originally described by TORIYAMA (1958) from the *Profusulinella beppensis* Zone.

The other associations are *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON and *Profusulinella pseudorhomboidea* PUTRJA. The former is originally described by THOMPSON (1953) from the Cache Creek area in British Columbia, Canada. This species is closely related to *Palaeofusulina trianguliformis* PUTRJA described from Northeast Greenland (DUNBAR et al. 1962), and *Verella postspicata* BENSH described from the Tashikent area in Russia (BENSH, 1969). These species were also described from the Kashir horizon in the Russian Platform. The Canadian and Japanese species are related to the genera *Eofusulina* RAUSER, 1951 and *Palaeofusulina* PUTRJA, 1956. The author is of the opinion that *Akiyoshiella* and *Eofusulina* (s. s.) are not distinct genetically, although he tentatively treated *Akiyoshiella* as a valid genus herein.

*Profusulinella pseudorhomboidea* PUT-

RJA was originally described from the Verei to Kashir horizons of the Russian Platform (RAUSER-CHERNOUSSOVA 1951).

*Profusulinella probiconica* WATANABE, n. sp. has a large subellipsoidal or short fusiform shell and seems to be a biologically advanced type. This species is associated with *Akiyoshiella ozawai* TORIYAMA.

Based on the faunal evidence, *Akiyoshiella ozawai* Zone can be correlated to the *Profusulinella beppensis* Zone of the Akiyoshi Limestone (TORIYAMA, 1958) and the Kashirian of the Russian Platform.

## Collecting Locality

Fusulinacean treated in this paper were obtained from the following sites in Itagamine district.

ScI-2: White to light grey oosparitic limestone. Scattered specimens of *Profusulinella* sp. B and *Staffella akagoensis* TORIYAMA were found.

ScI-5: White brownish massive oosparitic limestone, including rarely *Akiyoshiella ozawai* TORIYAMA, *Profusulinella probiconica* n. sp., *Fusulinella hayasakai* n. sp..

ScI-7: Black to dark grey, massive biomicritic limestone, yielding *Profusulinella probiconica* n. sp. and *Fusulinella hayasakai* n. sp..

ScI-14: White to light grey massive bio-oosparitic limestone, including commonly *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON, *Profusulinella pseudorhomboidea* PUTRJA and *P.* spp.

ScI-18: Dark grey bio-oomicritic massive limestone, including many *Profusulinella daiyamensis* HASEGAWA, *Pseudostaffella kanumai* IGO and *Nankinella yokoyamai* SADA.

ScI-18u: Grey massive bio-oomicritic limestone. The limestone yields a number of *Ozawainella vozhgalica* SAFONOVA and *Eostaffella postmosquensis* KIREEVA.

ScI-21: White to grey oosparitic massive limestone. Scattered specimens of *Profusulinella pseudorhomboidea* PUTRJA were found.

ScI-G: White oosparitic limestone, yielding *Profusulinella omiensis* n. sp. and *Eostaffella* sp..

IT-1 and IT-2: Light grey to white massive bio-sparitic limestone. Scattered specimens of *Profusulinella daiyamensis* HASEGAWA were found.

IT-3: Light grey to white bio-oosparitic bedded limestone, including many specimens of *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON.

G-1: White oosparitic limestone, including rarely *Akiyoshiella toriyamai.*

ScII-5: Light grey massive bio-sparitic limestone. Scattered specimens of *Profusulinella* sp. A, *Ozawainella* sp. and *Eostaffella* sp. were found. SAKAGAMI (1962) seems to have found first *Profusulinella* sp. from the same locality.

ScII-7: White massive oosparitic limestone. Scattered specimens of *Akiyoshiella?* sp. and *Eoschubertella obscure* (LEE et CHEN) were found.

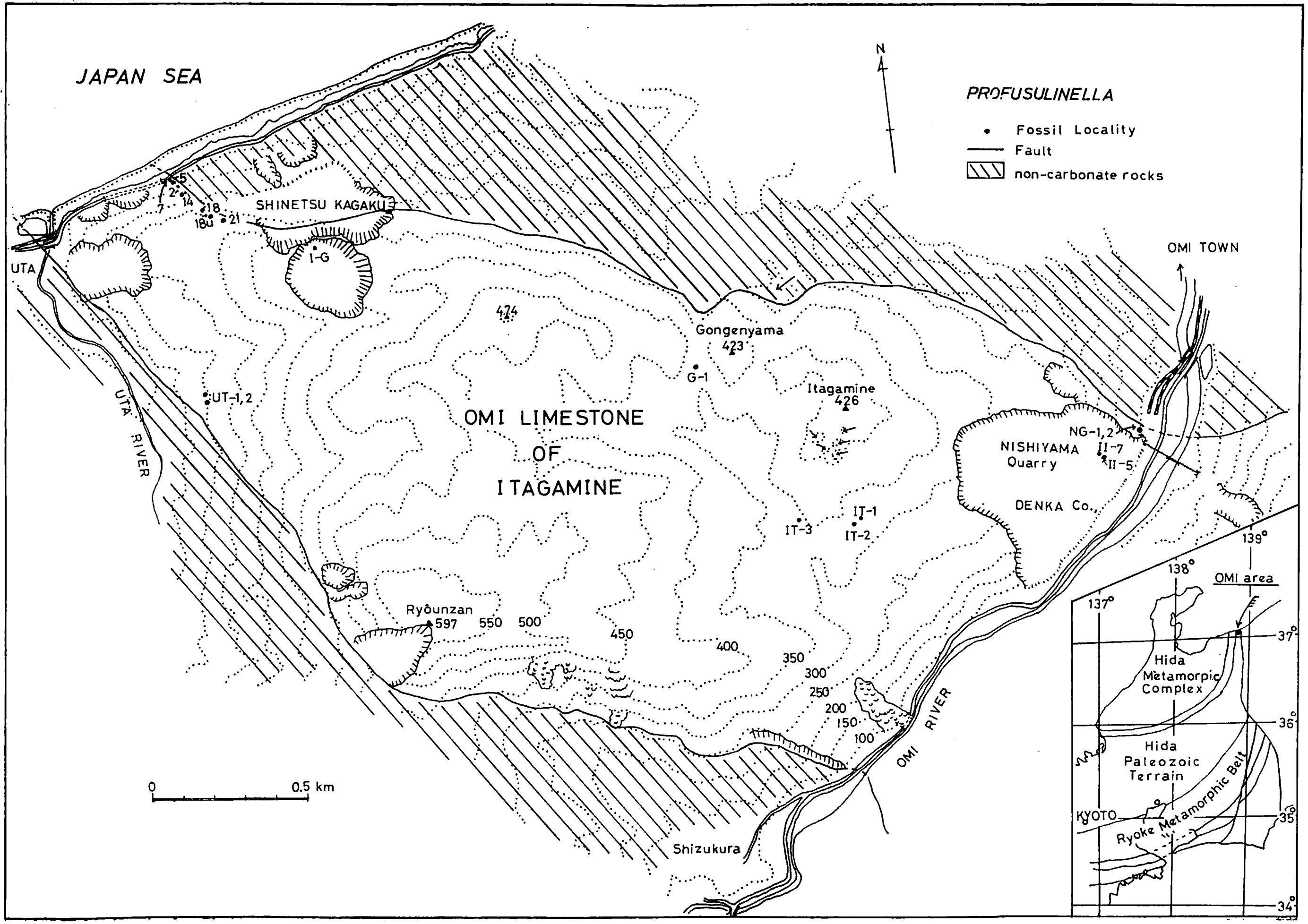
UT-1 and UT-2: Dark to light brown biosparitic limestone, including a number of *Fusulinella hayasakai* n. sp., *F. jamesensis* THOMPSON, PITRAT and SANDERSON and *Akiyoshiella?* sp.

Collections NG-1 and NG-2 were obtained from the Gojunko-dori of the Nishiyama Quarry.

NG-1 and NG-2: Dark to light grey sparitic limestone. Scattered specimens of *Profusulinella* sp., *Akiyoshiella* sp. were found.

## Systematic Description

Genus *Eostaffella* RAUSER-CHERNOUSSOVA, 1948




Text-fig. 1. Topographic Map of the Omi area showing the fossil localities.

*Eostaffella postmosquensis* KIREEVA

Pl. 51, figs. 9-14

1951. *Eostaffella postmosquensis* KIREEVA in RAUSER-CHERNOUSSOVA et al., p. 48, pl. 1, figs. 1-2.

*Description:*—Shell minute, discoidal with short axis of coiling, narrowly rounded periphery and convex lateral slopes. Shell involute throughout growth in most specimens. Mature specimens have 4 volutions measuring 0.12-0.19 mm in length and 0.36-0.42 mm in width. Form ratios of four volutions 0.33-0.52. Proloculus minute, with outside diameter 12-24 microns. Shell expanded slowly and uniformly. Heights of volutions rapidly increase, last one about two times larger than proceeding one. Chomata low and poorly developed. Tunnel very low, rather broad and path slightly irregular.

*Remarks:*—The present specimens resemble the Russian materials in the size and shape of shell, weak chomata and other biocharacters. This species is more or less related to *Eostaffella etoi*

Table 2. Measurements of species of *Eostaffella* and *Staffella* in mm.

| | | *Eostaffella postmosquensis* | | | | | | *S. akagoensis* | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fig. 9 | Fig. 10 | Fig. 11 | Fig. 12 | Fig. 13 | Fig. 14 | Fig. 16 | Fig. 17 |
| Length | | 0.172 | 0.192 | 0.120 | 0.168 | 0.180 | 0.152 | 0.672 | 0.624 |
| Width | | 0.420 | 0.372 | 0.364 | 0.360 | 0.372 | 0.400 | 1.152 | 1.008 |
| Form Ratio | | 0.41 | 0.52 | 0.33 | 0.47 | 0.48 | 0.38 | 0.58 | 0.62 |
| Proloculus | | 0.024 | 0.012 | 0.012 | 0.020 | 0.020 | 0.020 | 0.048 | 0.052 |
| | Vol. | | | | | | | | |
| Radius Vector | 1 | 0.036 | 0.036 | 0.036 | 0.020 | 0.048 | 0.052 | 0.060 | 0.072 |
| | 2 | 0.080 | 0.084 | 0.076 | 0.048 | 0.084 | 0.096 | 0.144 | 0.144 |
| | 3 | 0.136 | 0.140 | 0.120 | 0.100 | 0.140 | 0.156 | 0.192 | 0.240 |
| | 4 | 0.232 | 0.240 | 0.212 | 0.200 | 0.204 | 0.240 | 0.262 | 0.360 |
| | 5 | —— | —— | —— | —— | —— | —— | 0.432 | 0.528 |
| | 6 | —— | —— | —— | —— | —— | —— | 0.600 | —— |
| Half Length | 1 | 0.016 | —— | —— | —— | 0.024 | 0.022 | 0.024 | 0.024 |
| | 2 | 0.034 | 0.036 | 0.034 | 0.034 | 0.040 | 0.042 | 0.048 | 0.072 |
| | 3 | 0.060 | 0.056 | 0.049 | 0.042 | 0.060 | 0.068 | 0.120 | 0.096 |
| | 4 | 0.086 | 0.094 | 0.060 | 0.086 | 0.090 | —— | 0.144 | 0.216 |
| | 5 | —— | —— | —— | —— | —— | —— | 0.216 | 0.288 |
| | 6 | —— | —— | —— | —— | —— | —— | 0.336 | —— |
| Form Ratio | 1 | 0.44 | —— | —— | —— | 0.50 | 0.42 | 0.40 | 0.34 |
| | 2 | 0.43 | 0.43 | 0.45 | 0.71 | 0.48 | 0.44 | 0.33 | 0.50 |
| | 3 | 0.44 | 0.40 | 0.41 | 0.42 | 0.43 | 0.44 | 0.63 | 0.40 |
| | 4 | 0.37 | 0.39 | 0.28 | 0.43 | 0.44 | 0.28 | 0.55 | 0.60 |
| | 5 | —— | —— | —— | —— | —— | —— | 0.50 | 0.55 |
| | 6 | —— | —— | —— | —— | —— | —— | 0.56 | —— |

OTA but differs from it in more rounded periphery.

*Occurrence:* — Common in collection ScI-18u, associated with *Ozawainella vozhgalica* SAFONOVA and *O. angulata* (COLANI).

*Reg. Nos.:*—TGU-72001-72006

Genus *Nankinella* LEE, 1931

*Nankinella yokoyamai* SADA

Pl. 51, figs. 6-8

1972. *Nankinella yokoyamai* SADA, p. 441-443, pl. 53, figs. 1-2.

*Description:*—Shell small, inflated lenticular, with bluntly pointed or arched periphery and convex or straight lateral slopes. Shell involute throughout growth. Mature individuals 5 to 6 volutions and 0.39-0.55 mm in length and 0.87-1.00 mm in width. Form ratios of three volutions 0.43-0.55. Proloculus minute, its outside diameter 20-50 microns.

Spirotheca relatively thick for size of shell due to secondary mineralization, but showing four-layered structure in a part of shell. Chomata low and poorly developed. Tunnel angles of the fourth to fifth volutions 14 and 15 degrees, res-

Table 3. Measurements of *Nankinella yokoyamai* in mm.

| | | N | MEAN | SD | Fig. 6 | Fig. 7 | Fig. 8 |
|---|---|---|---|---|---|---|---|
| Form Ratio | | 3 | 0.48 | —— | 0.55 | 0.46 | 0.43 |
| Length | | 3 | 0.45 | —— | 0.55 | 0.40 | 0.39 |
| Width | | 3 | 0.92 | —— | 1.00 | 0.87 | 0.90 |
| Proloculus | | 3 | 0.04 | —— | 0.02 | 0.04 | 0.05 |
| | Vol. | | | | | | |
| | 1 | 3 | 0.04 | —— | 0.02 | 0.05 | 0.05 |
| | 2 | 3 | 0.09 | —— | 0.04 | 0.12 | 0.10 |
| Radius | 3 | 3 | 0.14 | —— | 0.08 | 0.17 | 0.18 |
| Vector | 4 | 3 | 0.23 | —— | 0.12 | 0.25 | 0.32 |
| | 5 | 3 | 0.36 | —— | 0.22 | 0.37 | 0.50 |
| | 6 | 2 | 0.43 | —— | 0.35 | 0.50 | —— |
| | 1 | 3 | 0.04 | —— | 0.03 | 0.04 | 0.05 |
| | 2 | 3 | 0.05 | —— | 0.05 | 0.05 | 0.06 |
| Half | 3 | 3 | 0.07 | —— | 0.07 | 0.07 | 0.08 |
| Length | 4 | 3 | 0.12 | —— | 0.13 | 0.13 | 0.11 |
| | 5 | 3 | 0.18 | —— | 0.15 | 0.20 | 0.18 |
| | 6 | 2 | 0.26 | —— | 0.26 | 0.25 | —— |
| | 1 | 3 | 1.10 | —— | 1.50 | 0.80 | 1.00 |
| | 2 | 3 | 0.67 | —— | 1.00 | 0.42 | 0.60 |
| Form | 3 | 3 | 0 58 | —— | 0.88 | 0.41 | 0.44 |
| Ratio | 4 | 3 | 0.64 | —— | 1.08 | 0.52 | 0.34 |
| | 5 | 3 | 0.53 | —— | 0.68 | 0.54 | 0.36 |
| | 6 | 2 | 0.62 | —— | 0.74 | 0.50 | —— |

pectively.

*Remarks*:—The present specimens are very similar to *Nankinella yokoyamai* SADA described from the Zone of *Profusulinella* of the Taishaku Limestone, Hiroshima Prefecture, but differ slightly from the latters in the shape of shell. Besides, the Omi specimens have a rather inflated lenticular shell compared with a lenticular shape of the latters.

*Occurrence*:—Rare in collection ScI-18, associated with *Profusulinella daiyamensis* HASEGAWA and *Pseudostaffella kanumai* IGO.

*Reg. Nos.*:—TGU-72007-72009

Genus *Staffella* OZAWA, 1925

*Staffella akagoensis* TORIYAMA

Pl. 51, figs. 15-20

1958. *Staffella akagoensis* TORIYAMA, p. 22-24, pl. 1, figs. 6-8.
1972. *Staffella akagoensis* SADA, p. 443-444, pl. 53, fig. 3.

*Description*:—Shell small, subspherical and planispiral, with broadly rounded periphery. The axis of coiling straight. Mature specimens 5 to 6 volutions and 0.62-0.67 mm in length and 1.01-1.15 mm in width. Form ratios from 0.58 to 0.62. Proloculus small, its outside diameter about 50 microns. Shell expanded slowly in inner two volutions, but somewhat rapidly and uniformly in outer ones.

Spirotheca thick, consisting of four layers of tectum, diaphanotheca and inner and outer tectoria. However, detailed spirothecal structure obscure in inner volutions. Chomata low and poorly developed. Tunnel low and rather narrow. Tunnel angles of the forth and fifth volutions 12 and 15 degrees, respectively.

*Measurement*:—See Table 2.

*Remarks*:—The present specimens resemble closely *Staffella akagoensis* TORIYAMA from the *Profusulinella beppensis* Zone of the Akiyoshi Limestone.

*Occurrence*:—Common in collections ScI-2, 5, 7, 14 and IT-3, associated with *Akiyoshiella ozawai* TORIYAMA and *A. toriyamai* THOMPSON, PITRAT & SANDERSON and *Profusulinella* sp. B.

*Reg. Nos.*:—TGU-72010-72015

Genus *Ozawainella* THOMPSON, 1935

*Ozawainella vozhgalica* SAFONOVA

Pl. 51, figs. 21-24

1951. *Ozawainella vozhgalica* SAFONOVA in RAUSER-CHERNOUSSOVA et al., pl. 11, p. 138-139, figs. 3-4.
1958. *Ozawainella vozhgalica* SHENG, p. 73-74, pl. 1, figs. 30-34, pl. 2, fig. 1.

*Description*:—Shell minute, lenticular in shape with slightly convex lateral slopes and rather bluntly pointed poles. Mature specimens 6 to 7 volutions, 0.28-0.37 mm in length and 0.58-1.10 mm in width. Form ratios from 0.35 to 0.47, averaging 0.36 for the fifth volution. Proloculus small, its outside diameter about 50 microns.

Spirotheca composed of tectum and less dense upper and lower layers. Inner tectorium partly appeared in the last volution. Tunnel angle essentially equal throughout growth, mostly 9 to 11 degrees. Chomata well developed, asymmetrical, massive and continue to poles. Tunnel path regular, narrow and low.

*Measurement*:—See Table 4.

*Remarks*:—*Ozawainella vozhgalica* SAFONOVA was originally described from the Russian Platform, and then was from the Taitzeho Valley region in Northeast China (SHENG, 1956). These specimens closely resemble the Chinese ones.

*Occurrence*:—Abundant in collection

ScI-18u, and rare in ScII-5, associated with *Profusulinella* sp. A., *Ozawainella angulata* (COLANI) and *Eostaffella postmosquensis* KIREEVA.

*Reg. Nos.*:—TGU-72016-72019

*Ozawainella angulata* (COLANI)

Pl. 51, figs. 25-26

1924. *Ozawainella angulata* COLANI, p. 74-75, 112-113, pl. 2, figs. 4, 7-14, 16-18, 20-21, 34-35, 41.

(For further synonyms see IGO, 1957)

*Remarks*:—The Omi specimens are very similar to the previously described specimens. *Ozawainella vozhgalica* SAFONOVA is similar to this species in many respects, but the polar regions of the former one is more inflated and with more rounded periphery.

Table 4. Measurements of species of *Ozawainella* in mm.

| | | | | | *Oz. voghgalica* | | | | *O. angulata* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | MEAN | SD | Fig. 21 | Fig. 22 | Fig. 23 | Fig. 24 | Fig. 25 | Fig. 26 |
| Length | | 16 | 0.368 | 0.09 | 0.375 | 0.350 | 0.330 | 0.280 | 0.300 | 0.300 |
| Width | | 16 | 0.896 | 0.15 | 1.100 | 1.000 | 0.875 | 0.575 | 0.975 | 1.025 |
| Form Ratio | | 16 | 0.36 | —— | 0.38 | 0.35 | 0.38 | 0.47 | 0.31 | 0.29 |
| Proloculus | | 16 | 0.050 | 0.01 | 0.020 | 0.040 | 0.050 | 0.040 | 0.030 | 0.030 |
| | Vol. | | | | | | | | | |
| | 1 | 15 | 0.05 | 0.01 | 0.03 | 0.05 | 0.05 | 0.05 | 0.05 | 0.07 |
| | 2 | 16 | 0.10 | 0.02 | 0.06 | 0.08 | 0.10 | 0.08 | 0.09 | 0.13 |
| Radius | 3 | 15 | 0.16 | 0.04 | 0.12 | 0.13 | 0.19 | 0.13 | 0.24 | 0.18 |
| Vector | 4 | 16 | 0.26 | 0.05 | 0.18 | 0.21 | 0.28 | 0.20 | 0.34 | 0.28 |
| | 5 | 16 | 0.39 | 0.09 | 0.28 | 0.43 | 0.43 | 0.30 | 0.53 | 0.45 |
| | 6 | 16 | 0.50 | 0.08 | 0.48 | —— | —— | —— | —— | 0.58 |
| | 7 | 1 | —— | —— | 0.55 | —— | —— | —— | —— | —— |
| | 1 | 7 | 0.03 | 0.01 | —— | —— | —— | 0.03 | —— | 0.03 |
| | 2 | 15 | 0.04 | 0.01 | 0.02 | 0.03 | 0.05 | 0.04 | 0.04 | 0.06 |
| Half | 3 | 16 | 0.07 | 0.02 | 0.05 | 0.05 | 0.10 | 0.06 | 0.08 | 0.08 |
| Length | 4 | 15 | 0.12 | 0.03 | 0.07 | 0.08 | 0.13 | 0.11 | 0.11 | 0.10 |
| | 5 | 16 | 0.16 | 0.03 | 0.10 | 0.18 | 0.18 | 0.14 | 0.14 | 0.13 |
| | 6 | 4 | 0.15 | —— | —— | —— | —— | —— | —— | —— |
| | 7 | 1 | —— | —— | —— | 0.19 | —— | —— | —— | —— |
| | 1 | 8 | 0.61 | 0.12 | —— | —— | —— | 0.60 | —— | 0.43 |
| | 2 | 15 | 0.45 | 0.13 | 0.33 | 0.38 | 0.50 | 0.50 | 0.44 | 0.38 |
| Form | 3 | 15 | 0.48 | 0.13 | 0.42 | 0.38 | 0.53 | 0.46 | 0.33 | 0.33 |
| Ratio | 4 | 15 | 0.46 | 0.12 | 0.39 | 0.38 | 0.46 | 0.55 | 0.32 | 0.29 |
| | 5 | 15 | 0.41 | 0.16 | 0.36 | 0.42 | 0.42 | 0.42 | 0.26 | 0.22 |
| | 6 | 4 | 0.33 | 0.09 | 0.42 | —— | —— | —— | —— | 0.22 |
| | 7 | 1 | —— | —— | 0.35 | —— | —— | —— | —— | —— |

Table 5. Measurements of *Profusulinella omiensis* n. sp. in mm.

| | | N | MEAN | SD | Fig. 1 | Fig. 2 | Fig. 3 | Fig. 4 | Fig. 5 | Fig. 6 | Fig. 7 | Fig. 8 | Fig. 9 | Fig. 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length | | 23 | 1.43 | 0.20 | 1.125 | 1.925 | 1.350 | 1.525 | 1.500 | 1.350 | 1.375 | 1.000 | — | — |
| Width | | 26 | 0.19 | 0.09 | 0.725 | 0.925 | 0.850 | 1.000 | 0.910 | 0.825 | 0.810 | 0.750 | 1.025 | 0.960 |
| Form Ratio | | 5 | 1.63 | — | 1.55 | 2.08 | 1.59 | 1.53 | 1.65 | 1.64 | 1.70 | 1.33 | — | — |
| Proloculus | | 25 | 0.08 | 0.01 | 0.075 | 0.075 | 0.038 | 0.100 | 0.070 | 0.075 | 0.063 | 0.088 | 0.060 | 0.100 |
| | Vol. | | | | | | | | | | | | | |
| Radius Vector | 1 | 26 | 0.08 | 0.02 | 0.07 | 0.08 | 0.06 | 0.08 | 0.06 | 0.08 | 0.07 | 0.08 | 0.08 | 0.10 |
| | 2 | 26 | 0.13 | 0.02 | 0.12 | 0.13 | 0.10 | 0.15 | 0.12 | 0.10 | 0.13 | 0.16 | 0.10 | 0.18 |
| | 3 | 26 | 0.21 | 0.04 | 0.16 | 0.18 | 0.16 | 0.25 | 0.19 | 0.18 | 0.18 | 0.26 | 0.16 | 0.28 |
| | 4 | 26 | 0.34 | 0.06 | 0.28 | 0.33 | 0.28 | 0.40 | 0 33 | 0.28 | 0.30 | 0.40 | 0.25 | 0.45 |
| | 5 | 21 | 0.46 | 0.05 | 0.38 | 0.48 | 0.41 | 0.51 | 0.47 | 0.43 | 0.43 | — | 0.38 | — |
| | 6 | 3 | 0.57 | — | — | — | — | — | — | — | — | — | — | — |
| Half Length | 1 | 19 | 0.06 | 0.02 | 0.05 | 0.05 | — | 0.08 | 0.40 | 0.05 | 0.05 | 0.08 | — | — |
| | 2 | 22 | 0.13 | 0.02 | 0.10 | 0.11 | 0.08 | 0.15 | 0.13 | 0.11 | 0.10 | 0.15 | — | — |
| | 3 | 23 | 0.26 | 0 06 | 0.13 | 0.25 | 0.19 | 0.30 | 0.23 | 0.25 | 0.20 | 0.35 | — | — |
| | 4 | 23 | 0.45 | 0.06 | 0.28 | 0.48 | 0.35 | 0.53 | 0.43 | 0.40 | 0.50 | 0.50 | — | — |
| | 5 | 21 | 0.70 | 0.08 | 0.53 | 0.80 | 0.63 | 0.80 | 0.78 | 0.65 | 0.73 | — | — | — |
| | 6 | 2 | 0.77 | — | — | — | — | — | — | — | — | — | — | — |
| Form Ratio | 1 | 19 | 0.66 | 0.29 | 0.71 | 0.63 | — | 0.89 | 0 67 | 0.63 | 0.71 | 1.00 | — | — |
| | 2 | 22 | 1.03 | 0.23 | 0.83 | 0.85 | 1.19 | 0.94 | 1.08 | 1.10 | 0.77 | 0.94 | — | — |
| | 3 | 23 | 1.24 | 0.21 | 0.81 | 1.25 | 1.35 | 1.35 | 1.21 | 1.39 | 1.11 | 1.35 | — | — |
| | 4 | 23 | 1.37 | 0.19 | 1.00 | 1.46 | 1.47 | 1.25 | 1.30 | 1.43 | 1.67 | 1.25 | — | — |
| | 5 | 19 | 1.49 | 0.20 | 1.40 | 1.67 | 1.44 | 1.57 | 1.66 | 1.51 | 1.70 | — | — | — |
| | 6 | 3 | 1.41 | — | — | — | — | — | — | — | — | — | — | — |
| Thickness of Spirotheca | 1 | 10 | .010 | — | .012 | .010 | .012 | .007 | .010 | .005 | .007 | .012 | .007 | .019 |
| | 2 | 10 | .015 | — | .020 | .012 | .019 | .012 | .014 | .012 | .012 | 0.17 | .012 | .024 |
| | 3 | 10 | .021 | — | .024 | .024 | 019 | .019 | .017 | .019 | .017 | .024 | .019 | .024 |
| | 4 | 10 | .033 | — | .043 | .048 | .022 | .048 | .026 | .024 | .024 | .024 | .024 | .044 |
| | 5 | 8 | .031 | — | .024 | .043 | .024 | .036 | .048 | .020 | .020 | — | .029 | — |
| | 6 | — | — | — | — | — | — | — | — | — | — | — | — | — |

*Occurrence:*—ScI-18u.
*Reg. Nos.:*—TGU-72020-72021

### Genus *Profusulinella* RAUSER-CHERNOUSSOVA and BELJAEV, 1936

### *Profusulinella omiensis* WATANABE, n. sp.

Pl. 52, figs. 1-10

*Description:*—Shell small, short fusiform, with bluntly pointed poles. Mature specimens 5 to 6 volutions and 1.13-1.93 mm in length and 0.73-1.00 mm in width. Form ratios of the first to sixth volutions of mean values 0.66, 1.03, 1.24, 1.37, 1.49 and 1.41, respectively. Proloculus small, its outside diameter from 40 to 100 microns, averaging 80 microns for 25 specimens.

Spirotheca composed of three layers, dense tectum, upper tectorium and diaphanotheca. Fine porous structure rather distinct in outer volutions. Thicknesses of spirotheca rather variable, attaining 31 microns in outer volutions. Septa weakly fluted in polar regions, but almost flat in other parts of shell. Septal counts increased very slowly toward outer regions, 8, 11, 13, 15 and 16 in some well-oriented saggital specimens. Tunnel path almost straight or more or less irregular. Tunnel angle in typical specimens: 10, 19, 30, 29 and 24 degrees. Chomata well developed, narrow and high, massive in outer volutions with steep sides.

*Remarks:*—The present new species differs from the previously described species of *Profusulinella* in its shell shape. *Aljutovella arrisionis* LEONTOVICH and *A. arrisionis molotovensis* SAFONOVA described from the upper Verei horizon of the Russian Platform are related to *Profusulinella omiensis* n. sp. The formers have shape and size of shell and septal fluting similar to those of this new species, but they have more strongly fluted septa in the polar regions and different structure of spirotheca.

*Occurrence:*—Found only in collection ScI-G.

*Reg. Nos.:*—TGU-72022-72032 (Holotype 72021)

### *Profusulinella daiyamensis* HASEGAWA

Pl. 52, figs. 11-16

1967. *Profusulinella daiyamensis* HASEGAWA, p. 9-15, pls. 1-3, figs. 1-38.
1972. *Profusulinella fusiformis* SADA, p. 439-440, pl. 52, figs. 5-12.
1965. *Profusulinella* sp. B. SADA, p. 107, pl. 10, figs. 4-8, 12-13.

*Description:*—Shell small, short fusiform, with slightly concave lateral slopes and rather bluntly pointed poles. Mature specimens 5 volutions and 0.84-1.60 mm in length and 0.58-0.80 mm in width. Form ratios from 1.37 to 2.00, averaging 1.72 for 5 specimens. Proloculus small, its outside diameter varing from 40 to 70 microns, averaging 50 microns for 18 specimens.

Spirotheca thin, composed of tectum, outer tectorium and diaphanotheca. Septa numerous, almost unfluted throughout. Chomata well developed and massive in outer volution. Tunnel path almost straight. Tunnel angle in typical specimens: 29, 21 and 23 degrees. Axial filling weakly developed polar regions.

*Remarks:*—In the shape and size of shell, the number of volutions, the rate of expansion, the spirothecal structure, and the development of chomata, *Profusulinella daiyamensis* HASEGAWA from the Omi Limestone is closely allied to the type specimens described from the Akiyoshi Limestone. *Profusulinella li-*

Table 6. Measurements of *Profusulinella daiyamensis* in mm.

| | | N | MEAN | SD | Fig. 11 | Fig. 12 | Fig. 13 | Fig. 14 | Fig. 15 | Fig. 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| Length | | 11 | 1.25 | 0.21 | 1.32 | 1.04 | 0.84 | — | 1.36 | 1.60 |
| Width | | 15 | 0.75 | 0.06 | 0.72 | 0.76 | 0.58 | 0.76 | 0.70 | 0.80 |
| Form Ratio | | 5 | 1.72 | — | 1.83 | 1.37 | 1.45 | — | 1.94 | 2.00 |
| Proloculus | | 18 | 0.05 | 0.01 | 0.04 | 0.04 | 0.04 | 0.04 | 0.07 | 0.04 |
| | Vol. | | | | | | | | | |
| Radius Vector | 1 | 17 | 0.05 | 0.01 | 0.04 | 0.06 | 0.04 | 0.06 | 0.04 | 0.04 |
| | 2 | 18 | 0.08 | 0.10 | 0.02 | 0.08 | 0.11 | 0.07 | 0.08 | 0.06 |
| | 3 | 18 | 0.16 | 0.03 | 0.10 | 0.17 | 0.12 | 0.16 | 0.12 | 0.10 |
| | 4 | 18 | 0.25 | 0.04 | 0.16 | 0.28 | 0 18 | 0.24 | 0.20 | 0.18 |
| | 5 | 18 | 0.38 | 0.06 | 0.24 | 0.44 | 0.28 | 0.40 | 0.36 | 0.30 |
| Half Length | 1 | 4 | 0.03 | — | 0.02 | — | — | — | 0.04 | 0.02 |
| | 2 | 9 | 0.14 | 0.06 | — | — | — | 0.12 | 0.10 | — |
| | 3 | 14 | 0.25 | 0.09 | 0.16 | 0.16 | 0.14 | 0.28 | 0.28 | 0.26 |
| | 4 | 13 | 0.45 | 0.11 | 0.48 | 0.32 | 0.22 | 0.52 | 0.48 | 0.60 |
| | 5 | 8 | 0.59 | 0.12 | 0.64 | 0.49 | 0.40 | — | 0.64 | 0.70 |
| Form Ratio | 1 | 4 | 0.49 | — | 0.50 | — | — | — | 1.00 | 0.50 |
| | 2 | 9 | 1.47 | 0.60 | — | — | — | 1.50 | 1.25 | — |
| | 3 | 14 | 1.75 | 0.72 | 1.60 | 0.94 | 1.17 | 1.17 | 2.33 | 2.60 |
| | 4 | 13 | 1.92 | 0.76 | 3.00 | 1.14 | 1.22 | 2.17 | 2.40 | 3.33 |
| | 5 | 8 | 1.78 | 0.52 | 2.67 | 1.11 | 1.43 | — | 1.78 | 2.33 |
| Thickness of Spirotheca | 1 | 6 | .010 | — | .012 | .012 | .007 | .007 | .007 | .012 |
| | 2 | 6 | .014 | — | .012 | .014 | .019 | .010 | .012 | .014 |
| | 3 | 6 | .020 | — | .012 | .024 | .024 | .024 | .019 | .019 |
| | 4 | 6 | .025 | — | .019 | .024 | .024 | .024 | .029 | .029 |
| | 5 | 6 | .023 | — | .019 | .024 | .024 | .024 | .020 | .026 |

*brovichi* and its related species described from the Kashir horizon are similar to the present species in many respects. The present species has also the similality to the genus *Fusiella* in many biocharacters.

*Occurrence:*—Common in collections ScI-18 and IT-1, 2, associated with *Pseudostaffella kanumai* IGO, and *Nankinella yokoyamai* SADA.

*Reg. Nos.:*—TGU-72033-72038

*Profusulinella probiconica* WATANABE, n. sp.

Pl. 52, figs. 21-24

*Description:*—Shell medium in size, ellipsoidal to short fusiform with convex lateral slopes and broadly rounded poles. Mature individuals 5 to 6 volutions and 2.20-2.44 mm in length and 1.48-2.00 mm in width. Form ratios from 1.22 to 1.49. Proloculus small, its outside diameter 75-135 microns.

Spirotheca thin in inner volutions but comparatively thick in outer volutions. Spirotheca composed of three layers, dense tectum, upper tectorium and thick diaphanotheca. Thicknesses of spirotheca of the first to sixth volutions in typical specimens: 12, 21, 24, 26, 53 and 48 microns, respectively. Chomata well developed, symmetrical, high and massive with steep sides. Tunnel path straight and high. Tunnel angle of the first to fifth volution in holotype 14, 22, 23, 33 and 42 degrees, respectively.

*Remarks:*—This species closely resembles *Profusulinella* sp. A described by SADA (1965) from the Atetsu Limestone. However, the Atetsu specimens have slightly larger form ratio and weaker chomata. The present specimens seem to represent the transitional form between *Profusulinella* and *Fusulinella*.

*Occurrence:*—Rare in collections ScI-5 and ScI-7, associated with *Akiyoshiella ozawai* TORIYAMA.

*Reg. Nos.:*—TGU-72039 (Holotype), 72040-72042 (Paratypes)

*Profusulinella pseudorhomboidea* PUTRJA

Pl. 52, figs. 19-20

1951. *Profusulinella pseudorhomboidea* PUTRJA in RAUSER-CHERNOUSSOVA et al., p. 171, pl. 17, fig. 2.

*Description:*—Shell small, rhombic in shape, having highly vaulted median portion aud bluntly pointed poles. Lateral slopes almost straight to slightly concave. Mature specimens 6 volutions and 2.60 mm in length and 1.48 mm in width. Form ratio 1.53 in well-oriented mature specimens. The first volution almost spherical, beyond the second volution shell becomes rhombic in shape. Proloculus small, its outside diameter 120-150 microns.

Spirotheca thin in inner volutions but comparatively thick in outer volutions. Spirotheca composed of three layers, dense tectum, upper tectorium and diaphanotheca. Thicknesses of spirotheca rather variable, attaining 40 to 50 microns in outer volutions. Septa numerous, weakly fluted in polar regions, but almost flat in other parts of shell. Tunnel path almost straight and rather narrow. Tunnel angles of the first to fifth volutions: 11, 13, 16, 19 and 26 degrees in typical specimen. Chomata generally symmetrical, high and well developed with steep sides.

*Remarks:*—The present material closely resembles *Profusulinella pseudorhomboidea* PUTRJA described from the Russian Platform. This is also related to *Profusulinella rhomboidea* (LEE et CHEN) reported from Japan in the shape of shell and other biocharacters. Because the specimens of the latter species were not so well oriented, more sufficient materials are necessary for more exact identification.

*Occurrence:*—Rare in collections ScI-14 and ScI-21, associated with *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON.

*Reg. Nos.:*—TGU-72043-72044

*Profusulinella* sp. A

Pl. 52, figs. 17-18

*Description:*—Shell small, short fusiform with pointed poles. Mature individuals 6 volutions and 2.16 to 2.51 mm in length and 1.10 to 1.23 mm in width. Form ratio from 1.91 to 2.05. Shell has endothyroid juvenarium of one volution followed by five to six planispiral ones. Proloculus small, its outside diameter about 50 microns.

Table 7. Measurements of species of *Profusulinella* in mm.

| | | *P.* sp. A | | *P. pseudorhomboidea* | | *P. probiconica* | | | *P.* sp. B | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fig. 17 | Fig. 18 | Fig. 19 | Fig. 20 | Fig. 21 | Fig. 22 | Fig. 23 | Fig. 24 | Fig. 25 |
| Length | | 2.510 | 2.160 | ? | 2.600 | 2.560 | 2.440 | 2.200 | —— | 2.320 |
| Width | | 1.225 | —— | ? | 1.480 | 1.675 | 2.000 | 1.480 | 1.350 | 1.150 |
| Proloculus | | —— | 0.050 | 0.125 | 0.120 | 0.150 | 0.130 | 0.135 | 0.075 | 0.100 |
| Form Ratio | | 2.05 | —— | 1.67 | 1.77 | 1.53 | 1.22 | 1.49 | —— | 2.02 |
| | Vol. | | | | | | | | | |
| Radius Vector | 1 | 0.13 | 0.08 | 0.13 | 0.08 | 0.13 | 0.13 | 0.13 | 0.10 | 0.08 |
| | 2 | 0.15 | 0.12 | 0.20 | 0.13 | 0.23 | 0.20 | 0.27 | 0.15 | 0.14 |
| | 3 | 0 25 | 0.18 | 0.28 | 0.23 | 0.33 | 0.31 | 0.38 | 0.24 | 0.23 |
| | 4 | 0.35 | 0.30 | 0.40 | 0.33 | 0.48 | 0.45 | 0.54 | 0.38 | 0.33 |
| | 5 | 0.50 | 0.43 | —— | 0.48 | 0.65 | 0.68 | 0.75 | 0.58 | 0.48 |
| | 6 | 0.71 | —— | —— | 0.68 | 0.88 | 0.88 | —— | 0.75 | 0.61 |
| Half Length | 1 | —— | —— | 0.15 | 0.18 | 0.15 | 0.15 | 0.16 | —— | 0.08 |
| | 2 | 0.13 | 0.13 | 0.25 | 0.28 | 0.28 | 0.28 | 0.33 | —— | 0.18 |
| | 3 | 0.28 | 0.30 | 0.45 | 0.43 | 0.55 | 0.53 | 0.50 | —— | 0.35 |
| | 4 | 0.58 | 0.55 | 0.65 | 0.60 | 0 73 | 0.73 | 0.75 | —— | 0.63 |
| | 5 | 1.05 | 0.81 | —— | 1.00 | 0.88 | 1.05 | 1.03 | —— | 1.05 |
| | 6 | 1.25 | 0.98 | —— | 1.40 | —— | 1.25 | —— | —— | —— |
| Form Ratio | 1 | —— | —— | 1 25 | 0.94 | 1.20 | 1.20 | 1.23 | —— | 1.20 |
| | 2 | 0.83 | 1.08 | 1.25 | 2.12 | 1.20 | 1.38 | 1.20 | —— | 1.20 |
| | 3 | 1.10 | 1.71 | 1.64 | 1.89 | 1.69 | 1.69 | 1.32 | —— | 1.69 |
| | 4 | 1.64 | 1.83 | 1.63 | 1.82 | 1.53 | 1.61 | 1.39 | —— | 1.53 |
| | 5 | 2.10 | 1.91 | —— | 2.11 | 1.35 | 1.56 | 1.37 | —— | 1.35 |
| | 6 | 1.76 | —— | —— | 1 48 | —— | 1.43 | —— | —— | —— |
| Thickness of Spirotheca | 1 | —— | .007 | 012 | .012 | .019 | .012 | .019 | .012 | .012 |
| | 2 | .012 | .012 | .019 | .019 | .024 | .021 | .012 | .012 | .012 |
| | 3 | .024 | .021 | .024 | .024 | .026 | .024 | .024 | .024 | .017 |
| | 4 | .028 | .024 | .024 | .041 | .036 | .026 | .034 | .034 | .019 |
| | 5 | .024 | .024 | —— | .050 | .043 | .053 | .048 | .048 | .024 |
| | 6 | .036 | .015 | —— | .048 | —— | .048 | .048 | .048 | —— |

Spirotheca thin, composed of tectum, upper tectorium and diaphanotheca. Septa numerous, unfluted throughout. Tunnel path straight, narrow and its angle 10 to 19 degrees. Chomata rather massive. Axial filling weakly developed in polar regions.

*Remarks:*—The present specimens is similar to some specimens of *Profusulinella daiyamensis* HASEGAWA in general shape of shell. The latter, however, is more tightly coiled, and a larger shell.

*Occurrence:*—Rare in collections ScII-5, IT-1 and IT-2 associated with *Ozawainella* sp. and *Eostaffella* sp.

*Reg. Nos.:*—TGU-72045-72046

*Profusulinella* sp. B

Pl. 52, figs. 25-26

*Remarks:*—Only one axial section and many oblique sections were obtained, being impossible for the specific identification.

*Occurrence:*—Rare in collection ScI-2, associated with *Staffella akagoensis* TORIYAMA.

*Reg. Nos.:*—TGU-72047-72048

Genus *Pseudostaffella* THOMPSON, 1942

*Pseudostaffella kanumai* IGO

Pl. 51, figs. 1-5

Table 8. Measurements of *Pseudostaffella kanumai* IGO in mm.

| | | N | MEAN | SD | Fig. 1 | Fig. 2 | Fig. 3 | Fig. 4 |
|---|---|---|---|---|---|---|---|---|
| Length | | 11 | 0.56 | 0.13 | 0.725 | 0.625 | 0.650 | —— |
| Width | | 13 | 0.58 | 0.12 | 0.674 | 0.675 | 0.625 | 0.725 |
| Form Ratio | | 3 | 1.02 | —— | 1.08 | 0.93 | 1.04 | —— |
| Proloculus | | 13 | 0.03 | 0.01 | 0.025 | 0.038 | 0.030 | 0.040 |
| | Vol. | | | | | | | |
| | 1 | 13 | 0.05 | 0.01 | 0.05 | 0.04 | 0.07 | 0.07 |
| | 2 | 13 | 0.10 | 0.03 | 0.09 | 0.07 | 0.14 | 0.11 |
| Radius | 3 | 13 | 0.16 | 0.04 | 0.16 | 0.10 | 0.23 | 0.20 |
| Vector | 4 | 13 | 0.26 | 0.04 | 0.28 | 0.18 | 0.30 | 0.33 |
| | 5 | 5 | 0.33 | 0.05 | 0.38 | 0.25 | —— | —— |
| | 6 | 2 | —— | —— | —— | 0.38 | —— | —— |
| | 1 | 6 | 0.04 | 0.01 | —— | 0.03 | —— | —— |
| | 2 | 6 | 0.10 | 0.03 | —— | 0.05 | 0.13 | —— |
| Half | 3 | 10 | 0.15 | 0.03 | 0.13 | 0.11 | 0.23 | —— |
| Length | 4 | 11 | 0.24 | 0.05 | 0.24 | 0.16 | 0.34 | —— |
| | 5 | 3 | 0.29 | —— | 0.35 | 0.25 | —— | —— |
| | 6 | — | —— | —— | —— | —— | —— | —— |
| | 1 | 6 | 0.76 | 0.21 | —— | 0.75 | —— | —— |
| | 2 | 6 | 0.89 | 0.17 | —— | 0.71 | 0.93 | —— |
| Form | 3 | 10 | 0.92 | 0.13 | 0.81 | 0.91 | 1.00 | —— |
| Ratio | 4 | 11 | 0.90 | 0.12 | 0.86 | 0.89 | 1.13 | —— |
| | 5 | 3 | 0.92 | —— | 0.92 | 1.00 | —— | —— |
| | 6 | — | —— | —— | —— | —— | —— | —— |

1957. *Pseudostaffella kanumai* IGO, p. 194-195, pl. 4, figs. 26, pl. 5, figs. 1-5.
1964. *Pseudostaffella* cf. *kanumai* SADA, p. 234-235, pl. 22, figs. 4, 8-9.

*Description:*—Shell small, subquadangular or spherical with broadly rounded periphery and slightly umblicated or convex poles. Mature specimens 4 to 5 volutions measuring 0.63-0.73 mm in length and 0.63-0.73 mm in width. Form ratio 0.93 to 1.08. Proloculus minute, its outside diameter averaging 30 microns for 13 specimens. Inner first or second volution with slightly different axis of coiling.

Spirotheca thin, composed of dense tectum, upper tectorium and diaphanotheca. Septa numerous, closely attached, unfluted throughout. Tunnel path irregular, low and tunnel angles about 20 to 30 degrees. Chomata well developed, massive, asymmetrical. Tunnel sides steep and polewards slope gradually decrease towards poles.

*Remarks:*—The present specimens resemble the type specimens in the mode of coiling of inner volutions and in other biocharacters.

*Occurrence:*—Common in collection ScI-18, associated with *Profusulinella daiyamensis* HASEGAWA and *Nankinella yokoyamai* SADA.

*Reg. Nos.:*—TGU-72049-72053

Genus *Akiyoshiella* TORIYAMA, 1953

*Akiyoshiella ozawai* TORIYAMA

Pl. 53, figs. 1-4

1953. *Akiyoshiella ozawai* TORIYAMA, p. 253-255, pl. 35, figs. 1-9.

*Description:*—Shell medium, fusiform to inflated fusiform with narrowly rounded to pointed poles. Inner one or two volutions elongated rhomboidal in shape and tightly coiled. Outer volutions rather rapidly increased their axial length. Axis of coiling straight to gently arched. Mature individuals have 5 to 6 volutions measuring 3.32-4.64 mm in length and 1.40-2.18 mm in width. Form ratio from 2.13 to 2.37. Proloculus small, its outside diameter 130-150 microns.

Spirotheca thin, composed of three layers of almost same thickness. Septa numerous, consisting of same element of spirotheca. In axial sections, septal fluting arranged in a series of inverted arch on the surface of outer tectorium, and club-shaped in saggital sections.

Chomata rather poorly developed in the first volution and tunnel path almost straight. Tunnel narrow, rather high and its angle gradually widened. Axial filling developed in inner three volutions.

*Measurement:*—See Table 9.

*Remarks:*—*Akiyoshiella ozawai* TORIYAMA was originally described from the *Profusulinella beppensis* Zone of the Akiyoshi Limestone, Yamaguchi Prefecture (TORIYAMA, 1958). The present specimens is closely related to the type specimens, in the size and shape of shell, septal fluting and other important biocharacters, although the present specimens lack uncoiled volution.

*Occurrence:*—Collections ScI-5 and ScI-7, associated with *Profusulinella probiconica* n. sp., *Fusulinella hayasakai* n. sp. and *Staffella akagoensis* TORIYAMA.

*Reg. Nos.:*—TGU-72054-72057

*Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON

Pl. 53, figs. 5-10

1953. *Akiyoshiella toriyamai* THOMPSON, PITRAT & SANDERSON, p. 550-551, pl. 58, figs. 1-14.

*Description:*—Shell medium in size, elongated and slender fusiform with

Table 9. Measurements of *Akiyoshiella ozawai* in mm.

| | | N | MEAN | SD | Fig. 1 | Fig. 3 | Fig. 4 |
|---|---|---|---|---|---|---|---|
| Length | | 9 | 3.667 | 0.56 | 3.320 | 4.640 | — |
| Width | | 9 | 1.703 | 0.33 | 1.400 | 2.175 | 2.050 |
| Form Ratio | | 2 | 2.25 | — | 2.37 | 2.13 | — |
| Proloculus | | 10 | 0.139 | 0.03 | 0.125 | 0.150 | 0.125 |
| | Vol. | | | | | | |
| | 1 | 9 | 0.13 | 0.03 | 0.10 | 0.18 | 0.15 |
| Radius | 2 | 9 | 0.23 | 0.06 | 0.18 | 0.20 | 0.25 |
| Vector | 3 | 9 | 0.40 | 0.07 | 0.33 | 0.40 | 0.43 |
| | 4 | 9 | 0.65 | 0.09 | 0.53 | 0.63 | 0.70 |
| | 5 | 4 | 0.89 | 0.08 | 0.78 | 0.10 | 0.90 |
| | 1 | 8 | 0.22 | 0.06 | 0.20 | 0.23 | — |
| Half | 2 | 8 | 0.46 | 0.09 | 0.38 | 0.48 | — |
| Length | 3 | 8 | 0.84 | 0.08 | 0.75 | 0.93 | — |
| | 4 | 8 | 1.35 | 0.15 | 1.38 | 1.38 | — |
| | 5 | 6 | 1.80 | 0.32 | 1.75 | 2.18 | — |
| | 1 | 8 | 1.68 | 0.48 | 2.00 | 1.29 | — |
| Form | 2 | 8 | 2.04 | 0.21 | 2.14 | 2.38 | — |
| Ratio | 3 | 8 | 2.12 | 0.29 | 2.31 | 2.31 | — |
| | 4 | 8 | 2.12 | 0.26 | 2.26 | 2.20 | — |
| | 5 | 2 | 2.22 | — | 2.26 | 2.18 | — |
| | 1 | 3 | .019 | — | .017 | .024 | .017 |
| Thickness | 2 | 3 | .026 | — | .022 | .031 | .024 |
| of | 3 | 3 | .029 | — | .024 | .038 | .026 |
| Spirotheca | 4 | 3 | .041 | — | .026 | .048 | .048 |
| | 5 | 2 | .035 | — | .026 | — | .043 |

sharply pointed poles. Axis of coiling straight to broadly curved in outer volutions. Mature specimens 4 to 5 volutions measuring 2.96–4.04 mm in length and 0.88–1.23 mm in width. Form ratio from 3.04 to 3.66. Proloculus small, its outside diameter 100 to 175 microns.

Spirotheca thin, composed of tectum, upper tectorium and diaphanotheca of almost same thickness. Septa rather strongly and more or less regularly fluted, and septal loopes conspicuous in axial sections. Tunnel rather wide and its angle commonly 20 degrees. Rudimentary chomata present on outer surface of proloculus and probably in the first but lacks in later volutions. Axial filling developed in inner three volutions.

*Remarks:*—The present materials are more closely related to the typical *Akiyoshiella toriyamai* THOMPSON, PITRAT and SANDERSON, although the difference is only in its form ratio, suggesting a gradational change with each other.

*Occurrence:*—Found in collections ScI-14, G-1 and IT-3, associated with

Fig. 10. Measurements of *Akiyoshiella toriyamai* in mm.

| | Vol. | N | MEAN | SD | Fig. 6 | Fig. 7 | Fig. 8 | Fig. 9 | Fig. 10 |
|---|---|---|---|---|---|---|---|---|---|
| Length | | 19 | 3.425 | 0.50 | 4.040 | 3.760 | 2.960 | 3.200 | 3.258 |
| Width | | 23 | 1.113 | 0.16 | 1.225 | 1.160 | 0.975 | 0.875 | 1.025 |
| Proloculus | | 22 | 0.137 | 0.03 | 0.125 | 0.175 | 0.100 | 0.140 | 0.125 |
| Form Ratio | | 5 | 3.28 | —— | 3.30 | 3.24 | 3.04 | 3.66 | 3.18 |
| Radius Vector | 1 | 23 | 0.12 | 0.03 | 0.13 | 0.11 | 0.06 | 0.13 | 0.11 |
| | 2 | 23 | 0.22 | 0.05 | 0.28 | 0.21 | 0.12 | 0.23 | 0.21 |
| | 3 | 23 | 0.35 | 0.07 | 0.43 | 0.35 | 0.20 | 0.35 | 0.35 |
| | 4 | 21 | 0.51 | 0.08 | 0.60 | 0.50 | 0.33 | 0.45 | 0.50 |
| | 5 | 1 | —— | —— | —— | —— | 0.55 | —— | —— |
| Half Length | 1 | 23 | 0.27 | 0.11 | 0.35 | 0.15 | 0.06 | 0.35 | 0.30 |
| | 2 | 23 | 0.61 | 0.21 | 1.08 | 0.33 | 0.20 | 0.75 | 0.55 |
| | 3 | 23 | 1.12 | 0.34 | 1.70 | 0.63 | 0.45 | 1.15 | 1.00 |
| | 4 | 20 | 1.51 | 0.29 | 2.03 | 1.00 | 1.18 | 1.58 | 1.08 |
| | 5 | 1 | —— | —— | —— | —— | 1.53 | —— | —— |
| Form Ratio | 1 | 23 | 2.18 | 0.70 | 2.69 | 1.20 | 1.05 | 2.69 | 2.73 |
| | 2 | 23 | 2.79 | 0.69 | 3.91 | 1.63 | 1.67 | 3.33 | 2.62 |
| | 3 | 23 | 3.13 | 0.59 | 4.00 | 1.89 | 2.25 | 3.27 | 3.07 |
| | 4 | 18 | 2.67 | 0.52 | 3.38 | 2.20 | 3.67 | 3.50 | 2.15 |
| | 5 | 1 | —— | —— | —— | —— | 2.77 | —— | —— |
| Thickness of Spirotheca | 1 | 5 | .015 | —— | .012 | .012 | .012 | .020 | .019 |
| | 2 | 5 | .024 | —— | .024 | .024 | .024 | .024 | .024 |
| | 3 | 5 | .037 | —— | .043 | .048 | .028 | .031 | .036 |
| | 4 | 5 | .040 | —— | .048 | .043 | .041 | .024 | .045 |
| | 5 | 1 | —— | —— | —— | —— | .040 | —— | —— |

*Profusulinella pseudorhomboidea* PUTRJA and *Staffella akagoensis* TORIYAMA.

*Reg. Nos.*:—TGU-72058-72063

Genus *Fusulinella* MÖLLER, 1877

*Fusulinella hayasakai* WATANABE n. sp.

Pl. 53, figs. 11–14

1958. *Fusulinella* sp. B. TORIYAMA, p. 56–57, pl. 5, figs. 4–7.

1958. *Fusulinella* sp. C. TORIYAMA, p. 58–59, pl. 5, figs. 8–10.

*Description*:—Shell medium, fusiform with convex and bluntly pointed poles. Mature individuals 6 to 7 volutions and 3.28 to 3.60 mm in length and 1.48 to 2.15 mm in width. Form ratio from 1.60 to 1.73. Proloculus small, its outside diameter 60 to 150 microns. The first volution spherical, and beyond the second volutions shell gradually becoming ellipsoidal to fusiform.

Spirotheca thick for the genus, composed of tectum, diaphanotheca and upper and lower tectoria. Lower tectorium first appeared in the third volution and clearly discernible in most part of outer volutions. Average thicknesses of spirotheca in central part of shell measured 15, 23, 37, 34, 40 and 60 microns, respectively. Septal counts uncertain because of lack of well oriented saggital sections. Tunnel high, narrow and its path irregular. Tunnel angle ranging commonly up to 15 degrees and rarely up to 30 degrees or more. Chomata well developed its sides very steep, vertical and sometimes overhanging, but poleward slopes very gentle, extending down lateral slopes.

*Remarks:*—The present species is conspecific with *Fusulinella* sp. B and *F.* sp. C described by TORIYAMA (1958) from the *Profusulinella beppensis* to *Fusulinella biconica* Zones of the Akiyoshi Limestone.

*Occurrence:*—Common in collections ScI-5, ScI-7 and UT-1, associated with *Akiyoshiella ozawai* TORIYAMA and *Fusulinella* sp.

*Reg. Nos.:*—TGU-72064 (Holotype), 72065-72067 (Paratypes)

*Fusulinella jamesensis* THOMPSON, PITRAT and SANDERSON

Pl. 53, figs. 15-16

1953. *Fusulinella jamesensis* THOMPSON, PITRAT & SANDERSON, p. 545-549, pl. 57, figs. 8-10 (partim).

*Description:*—Shell small, short and inflated fusiform with pointed polar ends and convex lateral slopes. Mature specimens 1.68-2.44 mm in length and 0.90-1.25 mm in width. Form ratio 1.68-2.09. Proloculus small, its outside diameter 50 to 100 microns.

Spirotheca composed of tectum, diaphanotheca and upper and lower tectoria. Lower tectorium first appeared in the third volution and clearly discernible in a part of median portion of shell. Septa unfluted throughout, but slightly complicated near poles. Chomata, its sides very steep, and sometimes overhanging down lateral slopes. Tunnel narrow and path regular. Tunnel angle ranging from 11 to 29 degrees.

*Measurement:*—See Table 12 (p. 393).

*Remarks:*—The present specimens closely resemble the holotype from the Cache Creek Areas, British Columbia, Canada.

*Occurrence:*—Found only in collection UT-1, associated with *Fusulinella hayasakai* n. sp., and *Akiyoshiella* sp..

*Reg. Nos.:*—TGU-72068-72070

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Explanation of Plate 51

Figs. 1-5. *Pseudostaffella kanumai* IGO
1, 2. Axial sections; 3, 4. Oblique sections; 5. Saggital section: ×50, Loc. ScI-18.
Figs. 6-8. *Nankinella yokoyamai* SADA
6-8. Axial sections: ×50, Loc. ScI-18.
Figs. 9-14. *Eostaffella postmosquensis* KIREEVA
9-11. Axial sections; 12-14. Slightly tangential sections: ×70, Loc. ScI-18u.
Figs. 15-20. *Staffella akagoensis* TORIYAMA
15-18. Axial sections; 19. Oblique section; 20. Saggital section: ×20, Loc. IT-3, ScI-7.
Figs. 21-24. *Ozawainella vozhgalica* SAFONOVA
21-24. Axial sections: ×50, Loc. ScI-18u.
Figs. 25-26. *Ozawainella angulata* (COLANI)
25, 26. Axial sections: ×50, Loc. ScI-18u.

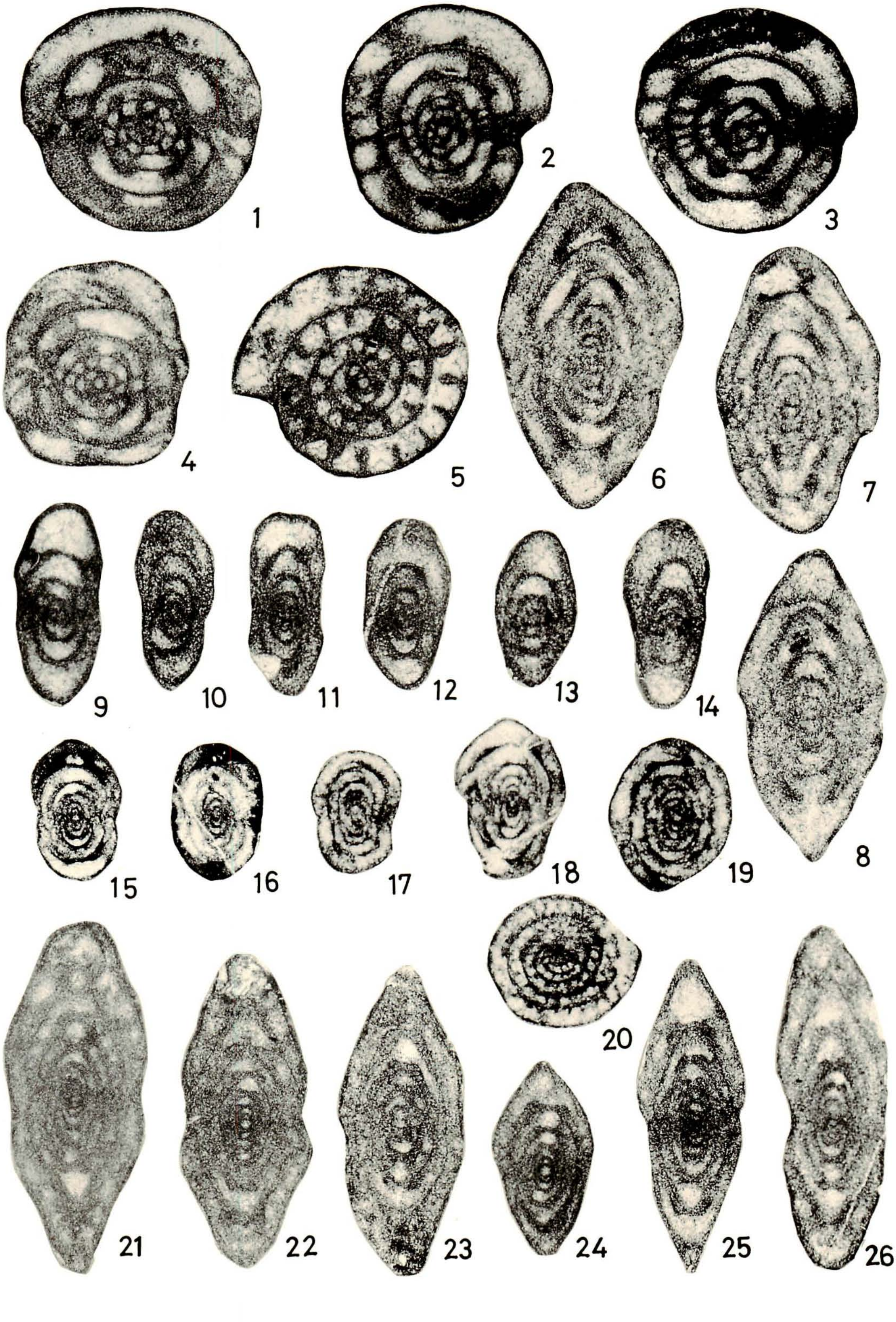
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Table 11. Measurements of *Fusulinella hayasakai* n. sp. in mm.

| | | N | MEAN | SD | Fig. 11 | Fig. 12 | Fig. 13 | Fig. 14 |
|---|---|---|---|---|---|---|---|---|
| Length | | 6 | 3.027 | 0.48 | 3.280 | 1.960 | —— | 3.600 |
| Width | | 7 | 1.632 | 0.32 | 1.900 | 1.225 | 1.475 | 2.150 |
| Form Ratio | | 3 | 1.67 | —— | 1.73 | 1.60 | —— | 1.67 |
| Proloculus | | 7 | 0.139 | 0.03 | 0.125 | 0.100 | 0.060 | 0.150 |
| | Vol. | | | | | | | |
| Radius Vector | 1 | 7 | 0.12 | 0.03 | 0.13 | 0.10 | —— | 0.13 |
| | 2 | 7 | 0.19 | 0.02 | 0.20 | 0.16 | 0.08 | 0.23 |
| | 3 | 7 | 0.31 | 0.03 | 0.33 | 0.25 | 0.13 | 0.35 |
| | 4 | 7 | 0.44 | 0.05 | 0.45 | 0.35 | 0.20 | 0.50 |
| | 5 | 7 | 0.63 | 0.07 | 0.65 | 0.48 | 0.28 | 0.73 |
| | 6 | 7 | 0.82 | 0.11 | 0.90 | 0.65 | 0.40 | 1.00 |
| | 7 | 1 | —— | —— | —— | —— | 0.78 | —— |
| Half Length | 1 | 6 | 0.14 | 0.05 | 0.18 | 0.12 | 0.09 | 0.18 |
| | 2 | 6 | 0.25 | 0.05 | 0.23 | 0.20 | 0.18 | 0.25 |
| | 3 | 6 | 0.47 | 0.09 | 0.48 | 0.35 | 0.25 | 0.58 |
| | 4 | 6 | 0.73 | 0.12 | 0.70 | 0.58 | 0.40 | 0.88 |
| | 5 | 5 | 1.10 | 0.18 | 0.93 | 0.88 | 0.63 | 1.25 |
| | 6 | 4 | 1.49 | —— | 1.30 | —— | 0.93 | 1.70 |
| | 7 | 1 | —— | —— | —— | —— | 1.28 | —— |
| Form Ratio | 1 | 6 | 1.17 | 0.14 | 1.40 | 1.00 | 1.13 | 1.40 |
| | 2 | 6 | 1.33 | 0.27 | 1.13 | 1.25 | 1.40 | 1.11 |
| | 3 | 6 | 1.52 | 0.21 | 1.46 | 1.43 | 1.25 | 1.64 |
| | 4 | 6 | 1.66 | 0.14 | 1.56 | 1.64 | 1.45 | 1.75 |
| | 5 | 5 | 1.67 | 0.28 | 1.42 | 1.84 | 1.56 | 1.72 |
| | 6 | 4 | 1.76 | —— | 1.44 | —— | 1.61 | 1.70 |
| | 7 | 1 | —— | —— | —— | —— | 1.65 | —— |
| Thickness of Spirotheca | 1 | 4 | .015 | —— | .012 | .017 | .010 | .019 |
| | 2 | 4 | .023 | —— | .024 | .024 | .019 | .026 |
| | 3 | 4 | .037 | —— | .048 | .026 | .024 | .048 |
| | 4 | 4 | .034 | —— | .048 | .036 | .024 | .029 |
| | 5 | 4 | .040 | —— | .026 | .048 | .031 | .053 |
| | 6 | 4 | .060 | —— | .084 | .048 | .048 | .060 |
| | 7 | 1 | —— | —— | —— | —— | .031 | —— |

## References


BENSH, F.R. (1969): Carboniferous stratigraphy and Foraminifera from the southwestern and southern slope of the Gissar Ridge. *Tashikent Inst. Geol. Geophysics, Acad. Nauk, USSR.*, p. 1–184, pls. 1–22 (in Russian).

COLANI, M. (1924): Nouvelle contribution à l'étude des fusulinides de l'Extrême-

Orient. *Indochine Service Géol., Mém.*, vol. XI, fasc. 1, p. 1-191, pls. 1-29.

DUNBAR, C.O., ROSS, C. et al. (1962): Faunas and correlation of the Late Paleozoic rocks of Northeast Greenland. *Meddel. om Grønland.* Bd. 167, Nr. 4, p. 1-16; Nr. 5, p. 5-55, pls. 1-7.

FUJITA, H. (1958): Geology of the Omi Limestone (Permo-Carboniferous), Niigata Prefecture. *Contr. Inst. Paleont., Tohoku Univ.*, vol. 48, p. 1-60 (in Japanese).

HASEGAWA, Y. (1967): *Profusulinella daiyamensis* n. sp., from the Akiyoshi Limestone Group. *Sci. Rep. Fac. Sci., Niigata Univ., Ser. E*, no. 1, p. 9-15, pls. 1-3.

—— (1969): Paleozoic formations of the Omi districts, Niigata Prefecture. Guidebook of Geology in Niigata. *Geol. Soc. Japan*, p. 1-25 (in Japanese).

HAYASAKA, I. (1924): On the fauna of the authoracolithic limestone of the Omimura in the western part of Echigo. *Sci. Rep. Tohoku Imp. Univ. Ser. 2*, vol. 8, no. 1, p. 1-83, pls. 1-7.

IGO, H. (1957): Fusulinids of Fukuji, southern part of the Hida Massif, central Japan. *Sci. Tokyo Kyoiku Daigaku, Sec. C*, vol. 5, no. 47, p. 153-246, pls. 1-15.

—— (1960): *Yabeina* from the Omi Limestone, Niigata Prefecture, central Japan. *Sci. Rep. Tohoku Univ.*, vol. 2, Spec. vol. 4, p. 335-343, pl. 36.

—— and KOIKE, T. (1964): Carboniferous conodonts from the Omi Limestone, Niigata Prefecture, central Japan. *Trans. Proc. Palaeont. Soc. Japan*, N.S., no. 53, p. 179-193, pls. 27-28.

ISHII, K. (1934): Geological sheet map with explanatory text, "Shirouma", 1:75000, *Geol. Surv. Japan.*

KATO, T. and IISAKA, G. (1934): The Omi Limestone and Kurohime-Myojyo Tectonic Line. *Jour. Geol. Soc. Japan.*, vol. 41, p. 417-420 (in Japanese).

KAWADA, S. (1954): Stratigraphical and paleontological studies of the Omi Limestone in the Itagamine district, Niigata Prefecture. *Bull. Tokyo Univ., Education, Geol. & Min. Inst.*, no. 31, p. 15-27 (in Japanese).

OZAWA, Y. (1925): On the fusuline-limestone of Omi. *Jour. Geol. Soc. Japan.*, vol. 32, p. 27-35 (in Japanese).

RAUSER-CHERNOUSSOVA, et al. (1951): Middle Carboniferous fusulinids of the Russian Platform and adjoining regions. *Acad. Nauk. USSR.*, p. 1-380, pls. 1-58

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## Explanation of Plate 52

All ×20

Figs. 1-10. *Profusulinella omiensis* WATANABE, n. sp.
1. Axial section of the holotype; 2-8. Axial sections of paratypes; 9-10. Saggital sections of paratypes. Loc. ScI-G.

Figs. 11-16. *Profusulinella daiyamensis* HASEGAWA
11, 13a, 15. Axial sections; 12, 14, 16. Slightly oblique sections; 13. Saggital section. 11a, 12a and 13 ×30. Loc. ScI-18u.

Figs. 17-18. *Profusulinella* sp. A
17, 18. Axial sections. Loc. ScII-5.

Figs. 19-20. *Profusulinella pseudorhomboidea* PUTRJA
19, 20. Axial sections. Loc. ScI-14.

Figs. 21-24. *Profusulinella probiconica* WATANABE n. sp.
21. Axial section of the holotype; 22. Axial section of paratype; 23. Slightly tangential section of paratype; 24. Saggital section of paratype. Loc. ScI-5 and ScI-7.

Figs. 25-26. *Profusulinella* sp. B
25. Axial section; 26. Oblique section. Loc. ScI-2.

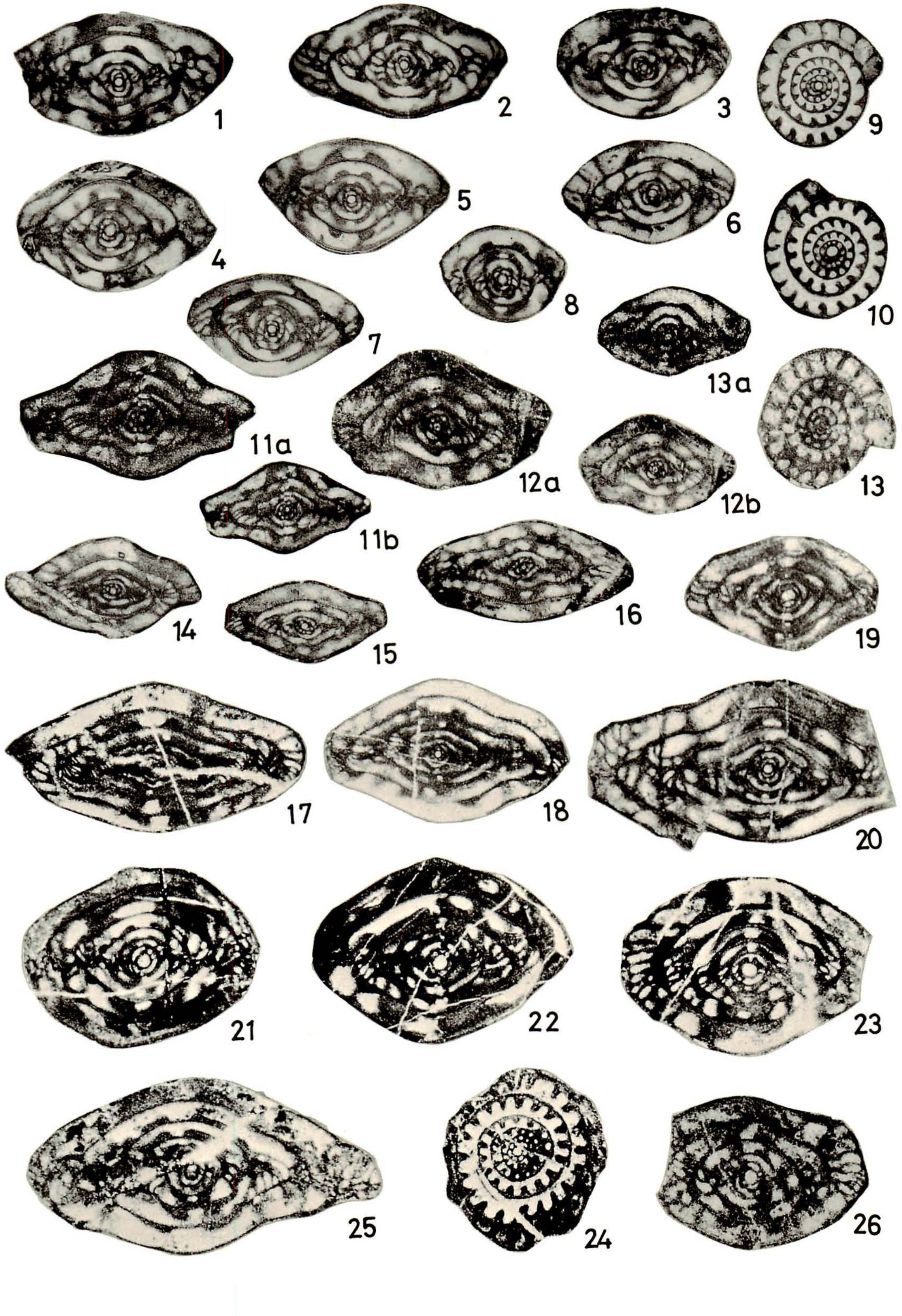
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Table 12. Measurements of *Fusulinella jamesensis* in mm.

| | | N | MEAN | SD | Fig. 15 | Fig. 16 | Fig. 17 |
|---|---|---|---|---|---|---|---|
| Length | | 4 | 2.09 | 0.37 | 2.44 | 1.68 | 1.88 |
| Width | | 4 | 1.09 | 0.17 | 1.25 | 1.00 | 0.90 |
| Form Ratio | | 3 | 1.91 | —— | 1.95 | 1.68 | 2.09 |
| Proloculus | | 4 | 0.08 | 0.02 | 0.08 | 0.08 | 0.10 |
| | Vol. | | | | | | |
| | 1 | 4 | 0.07 | —— | 0.08 | 0.08 | 0.08 |
| | 2 | 4 | 0.12 | —— | 0.13 | 0.12 | 0.13 |
| Radius | 3 | 4 | 0.19 | —— | 0.21 | 0.18 | 0.20 |
| Vector | 4 | 4 | 0.28 | —— | 0.33 | 0.25 | 0.33 |
| | 5 | 4 | 0.43 | —— | 0.50 | 0.40 | 0.49 |
| | 6 | 3 | 0.57 | —— | 0.68 | 0.55 | —— |
| | 1 | 3 | 0.05 | —— | —— | 0.08 | 0.09 |
| | 2 | 4 | 0.15 | —— | 0.13 | 0.13 | 0.18 |
| Half | 3 | 4 | 0.28 | —— | 0.28 | 0.25 | 0.35 |
| Length | 4 | 4 | 0.51 | —— | 0.50 | 0.45 | 0.65 |
| | 5 | 4 | 0.74 | —— | 0.78 | 0.73 | 0.88 |
| | 6 | 3 | 0.98 | —— | 1.08 | 0.88 | —— |
| | 1 | 3 | 1.57 | —— | —— | 1.00 | 1.20 |
| | 2 | 4 | 1.30 | —— | 1.00 | 1.09 | 1.35 |
| Form | 3 | 4 | 1.51 | —— | 1.31 | 1.43 | 1.75 |
| Ratio | 4 | 4 | 1.84 | —— | 1.54 | 1.80 | 2.00 |
| | 5 | 4 | 1.75 | —— | 1.55 | 1.81 | 1.77 |
| | 6 | 3 | 1.58 | —— | 1.59 | 1.59 | —— |
| | 1 | 3 | .009 | —— | .010 | .010 | .007 |
| Thickness | 2 | 3 | .019 | —— | .014 | .019 | .024 |
| of | 3 | 3 | .024 | —— | .024 | .024 | .024 |
| Spirotheca | 4 | 3 | .029 | —— | .029 | .031 | .026 |
| | 5 | 3 | .044 | —— | .041 | .048 | .043 |
| | 6 | — | —— | —— | —— | —— | —— |

(in Russian).

ROWETT, C. L. and MINATO, M. (1969): Corals from the Omi Limestone, central Honshu, Japan. *Jour. Fac. Sci., Hokkaido Univ., Ser. 4*, vol. 14, no. 1, p. 7-35, pls. 1-9.

SADA, K. (1964): Carboniferous and Lower Permian fusulines of the Atetsu Limestone in West Japan. *Jour. Sci. Hiroshima Univ., Sec. C*, vol. 3, p. 225-269, pls. 21-28.

—— (1965): *Profusulinella* of Atetsu Limestone. *Ibid.*, vol. 4, no. 1, p. 95-116, pls. 9-10.

—— (1972): Fusulinids of *Profusulinella* Zone of the Taishaku Limestone. *Trans. Proc. Palaeont. Soc. Japan.*, N. S., No. 87, p. 436-446, pls. 52-53.

SAKAGAMI, S. (1962-63): Lower Carboniferous Bryozoa from Omi Limestone, Japan. Pts. 1 and 2, *Ibid.*, no. 48, p. 321-330, pls. 49-50; no. 49, p. 25-34, pls. 3-4.

SHENG, J.C. (1958): Fusulinids from the Penchi Series of the Taitzeho Valley, Liaoning. *Paleont. Sinica. N.S.B.*, no. 7, p. 59-110, pls. 1-16.

THOMPSON, M.L. (1965): Pennsylvanian and Early Permian fusulinids from Fort. St. James area, British Columbia, Canada. *Jour. Paleont.*, vol. 39, no. 2, p. 224-234, pls. 33-35.

——, PITRAT C.W. and SANDERSON, G.A. (1953): Primitive Cache Creek fusulinids from central British Columbia. *Ibid.*, vol. 27, no. 4, p. 545-552, pls. 57-58.

TORIYAMA, R. (1953): New peculier fusulinids genus from the Akiyoshi Limestone of southern Japan. *Ibid.*, vol. 27, no. 2, p. 251-256, pls. 35-36.

—— (1958): Geology of Akiyoshi. Pt. 3: Fusulinids. *Mem. Fac. Sci. Kyushu Univ.*, *Ser. D*, vol. 7, p. 1-254, pls. 1-48.

| | | | |
|---|---|---|---|
| Omi | 青海 | Ichinotani | 一の谷 |
| Itagamine | 板ケ峰 | Fukuji | 福地 |
| Kurohime | 黒姫 | Uta | 歌 |
| Akiyoshi | 秋吉 | Nishiyama | 西山 |
| Atetsu | 阿哲 | Gongen-yama | 権現山 |
| Taishaku | 帝釈 | | |

## Explanation of Plate 53

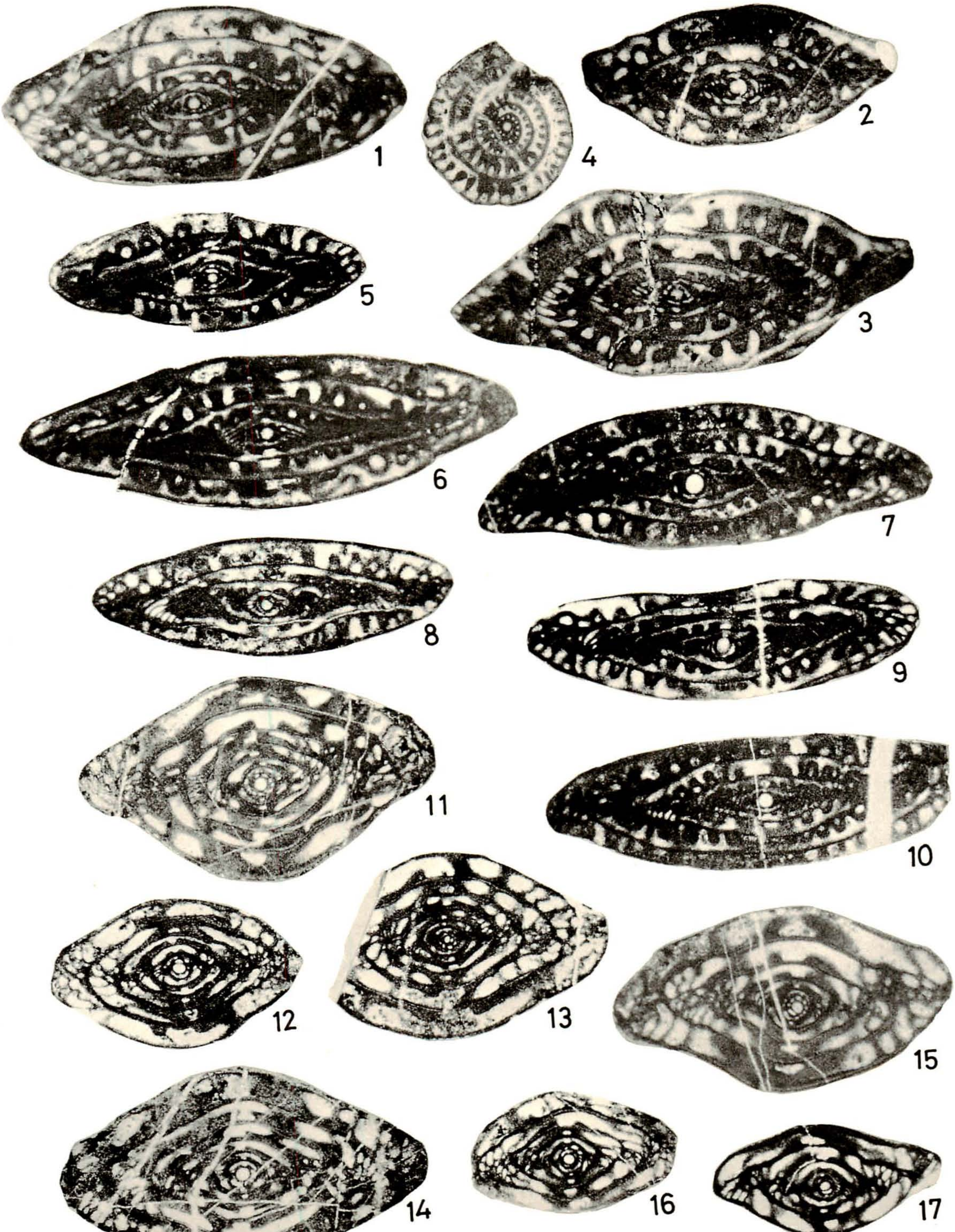
All ×20

Figs. 1-4. *Akiyoshiella ozawai* TORIYAMA
1, 2. Axial sections; 3. Oblique section; 4. Saggital section. Loc. ScI-5 and ScI-7.

Figs. 5-10. *Akiyoshiella toriyamai* THOMPSON, PITRAT & SANDERSON
5-10. Axial sections. Loc. IT-3, ScI-14 and G-1.

Figs. 11-14. *Fusulinella hayasakai* WATANABE, n. sp.
11-13. Axial sections of paratypes; 14. Axial section of the holotype. Loc. ScI-5, UT-1.

Figs. 15-17. *Fusulinella jamesensis* THOMPSON, PITRAT & SANDERSON
15-17. Axial sections. Loc. UT-1.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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 95, pp. 395-408, pls. 54, 55, September 20, 1974

# 638. NOTE ON THE GENUS *TRIGONIOIDES* (BIVALVIA)*

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Department of Geology, Kyushu University, Fukuoka 812**

*Trigonioides* 属について： *Trigonioides kodairai* の模式地である韓国慶尚南道河東郡金南面水門洞から採集した標本を再記載した。さらにこの模式地標本の内部構造を詳細に再検討し，*Trigonioides* (s. s.) についての新知見を加えた。また，これと日本や東南アジアの標本と比較検討した結果，いままで *Trigonioides* として記載された日本の *T. matsumotoi, T. suzukii, T. tetoriensis, T. mifunensis* を新亜属 *T.* (*Kumamotoa*) として新たに定義する。 梁　承　栄

## Introduction

*Trigonioides* is one of the most interesting and important non-marine pelecypod genera distributed in Mesozoic Asia. Since the genus was erected by KOBAYASHI and SUZUKI (1936) based on *Trigonioides kodairai* from Korea, it has been reported to occur at many localities; in southwestern and central Japan (MATSUMOTO, 1938, OTA, 1959 and 1963, HASE, 1960, MAEDA, 1963, and TAMURA, 1970), in southeast Asia (HOFFET, 1937, and KOBAYASHI, 1963 and 1969), in China (KOBAYASHI and SUZUKI, 1942, and KU, 1962), and in U.S.S.R. (MARTINSON, 1965).

A new family Trigonioididae was proposed by COX (1952) for this genus. Although it was withdrawn by COX (1955) himself, it has been now considered as a valid family by most of authors. As to the natural classification and the phylogeny of the trigonioidids there has been dispute among authors. Unfortunately, internal structure of the type-species of *Trigonioides*, *T. kodairai*, was not sufficiently known and the type-specimens are now missing.

I have recently collected a number of good specimens from the type-locality and had opportunities to observe most of the trigonioidid specimens described by Japanese authors at the University of Tokyo, Kumamoto University, and Fukuoka University of Education.

In this paper I primarily report a result of my study on *Trigonioides kodairai* with special stress on the hinge structure and discuss the classification of the genus by comparison between relevant species.

This study has been undertaken with the aid of grants from the Ministry of Education, Japan. I express my sincere gratitude to Professor Tatsuro MATSUMOTO of Kyushu University for his pertinent guidance and arrangement and also critical reading of the first draft of this paper. I am also indebted to Associate Professor Kametoshi KANMERA for his kind advice and encouragement, Dr. Tomowo OZAWA for his invaluable help in field working, and Messrs.

* Received Jan. 21, 1974; read Jan. 12, 1974, at Fukuoka.

** On leave from Department of Earth-Science, College of Education, Kyungpook National University, Daegu, Korea.

Hiromichi HIRANO and Kazushige TANABE and Miss Mutsuko HAYASHIDA of Kyushu University for their friendly helps in various ways. My sincere gratitude is extended to Professor Yoshihisa OTA of Fukuoka University of Education who gave me instructive suggestions, generously let me study his specimens and, in addition, kindly guided me to a fossil locality in Kyushu, to Associate Professor Itaru HAYAMI and Emeritus Professor Teiichi KOBAYASHI of the University of Tokyo, and Professor Minoru TAMURA of Kumamoto University, who kindly showed me their collections with warmful encouragements. Dr. Itaru HAYAMI furthermore read the typescript with kind suggestions.

## Systematic Description

### Superfamily Unionacea

### Family Trigonioididae

Genus *Trigonioides* KOBAYASHI and SUZUKI, 1936

*Generic diagnosis:* — Shell generally medium in size, equivalve aud subeqilateral; outline variably suboval, subtrapezoidal or subtrigonal; umbo prominent, slightly prosogyrous or orthogyrous. Surface ornamented with characteristic V-shape ribs in the median part and the reversed V-shape ribs on both anterior and posterior sides; the angles of the median V-sculptures very acute from about 10° to 20° and those of the reversed V on both sides larger than 30°. Hinge plate moderate or large in breadth, provided with opisthocline submedian teeth and posterior lateral teeth; the number of submedian teeth variable from two to five in right valve, three or four in left valve, and the number of posterior lateral teeth also variable, one or two in both valves. All of the hinge teeth crenulated on one or both sides; the submedian teeth originated a short distance anterior to the umbo. Two adductor scars situated close to the outer ventral ends of the submedian and posterior lateral teeth, anterior one accompanied by a minute pedal scar. Shell margin crenulated internally.

*Remark:*—I divide the genus *Trigonioides* into subgenera *Trigonioides* and *Kumamotoa* (n. subgen.) based on the difference of hinge structures as described below.

### Subgenus *Trigonioides*

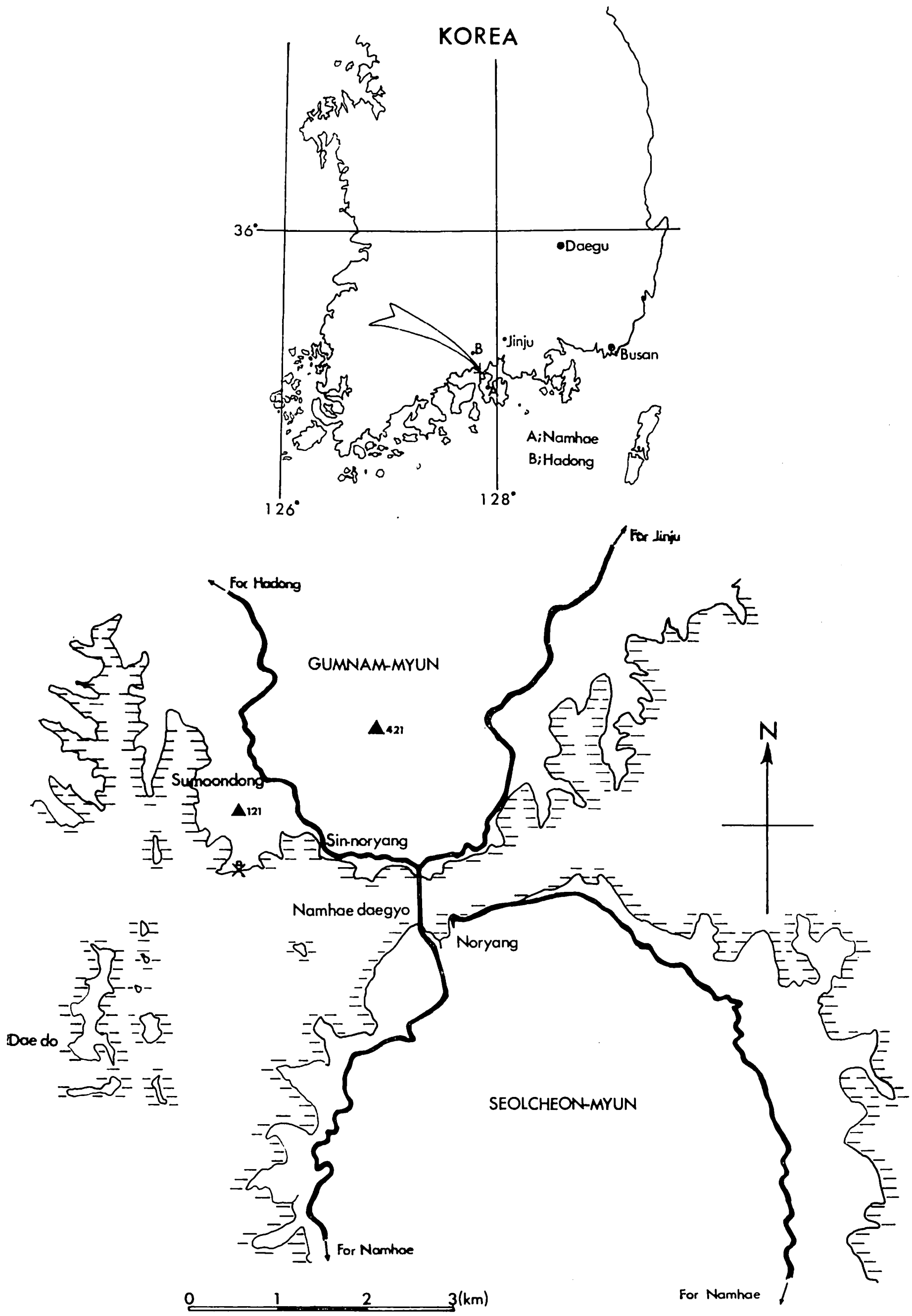
*Type-species:*—*Trigonioides kodairai* KOBAYASHI & SUZUKI, 1936.

*Subgeneric diagnosis:*—Shell medium in size, suboval in outline with rounded anterior and posterior margins and broadly arcuate ventral margin, moderately inflated, equivalve and subequilateral, with more or less prosogyrous or orthogyrous umbo, placed slightly anterior from the middle point. Surface ornaments generally the same as described in generic diagnosis. Hinge plate moderate in breadth, provided with opisthocline submedian teeth and posterior lateral teeth; three submedian and two posterior lateral teeth in right valve and two or three submedian and one posterior lateral teeth in the left; forming the following dental formula:

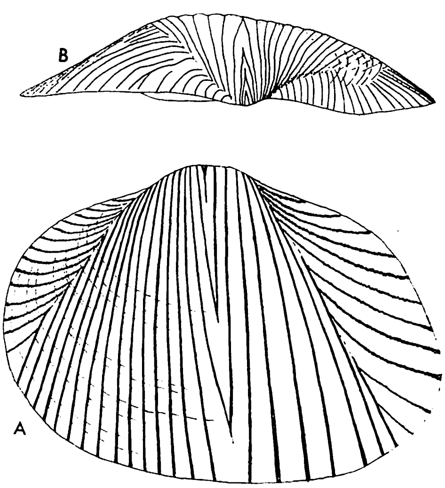
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | | 3 | | 1 | | PI | | PIII |
| | 4 | | 2 | | (1′) | | PII | |

*Trigonioides* (*Trigonioides*) *kodairai* KOBAYASHI & SUZUKI, 1936

Pl. 54, figs. 1-11, Pl. 55, figs. 1-4, Text-figs. 2, 4.




Text-fig. 1. Index and locality map of *Trigonioides* (s. s.) *kodairai*.




Text-fig. 2. Surface-ornamentation of the *T.* (s. s.) *kodairai*. A : side view of the left valve, B : upper view of the left valve.

1936. *Trigonioides kodairai* KOBAYASHI & SUZUKI, *Japan. Jour. Geol. Geogr.*, vol. 13, nos. 3-4, p. 248-250, pl. 27, figs. 1-4.

*Material:*—The holotype and paratypes designated by the original authors are now missing, and probably were lost during the World War II. All of the present specimens were collected from the type-locality (see Text-figure 1).

The specimens numbered with prefix KPE are preserved in the Department of Earth-Science, College of Education, Kyungpook National University, Daegu, Korea. Three plaster casts of the above specimens (KPE 1001, 1002, 1003) are kept in the Department of Geology, Faculty of Science, Kyushu University, Fukuoka, Japan.

*Description:*—Shell medium in size, commonly about 30 mm in length, occasionally larger than 40 mm; anterior and posterior margins well rounded, ventral margin gently and broadly arcuate, generally suboval or subelliptical in outline; subequilateral and equivalve; ratio of length to height about 0.75; moderately inflated; test moderate in thickness; umbo slightly prosogyrous placed at about 0.42-0.48 of the shell length from the anterior extremity, projected slightly above the hinge line; escutcheon and lunule both present. Surface ornamented with characteristic V-shape ribs in the median part and the reversed V-ornaments in both anterior and posterior parts. The angles of the median V-sculptures ontogenetically decreased, i. e. near the beak commonly larger than 20°, becoming smaller toward the ventral side down to about 10°, and the angles of the reversed V-ornaments on both sides generally larger than 30°. The radial ribs on the anterior side finer and weaker but denser in contrast with those on the posterior side. Ribs gradually effaced toward anterior and ventral margin, especially so in adult specimens. The median ribs number 10 in the posterior half and 18 in the anterior half; the ribs sloping obliquely toward outer dorsal sides, more than 11 on the posterior side and 15 on the anterior: the whole surface ornamented also with numerous concentric growth-lines of irregular interval and prominence.

Hinge plate and teeth generally the same as described in subgeneric diagnosis; in more detail as follows:

5: narrow and elongated, with regular transverse crenulations on posterior side only, parallel to the antero-dorsal margin

3: most prominent in the right valve, elongated and crenulated on both sides, subparallel to the antero-dorsal margin

1: low and short, crenulated on anterior side only

4: stout and highest in the left valve,

crenulated on both sides, subparallel to antero-dorsal margin

2: moderate and elongated, sloping obliquely toward anteroventral side, crenulated wholly on anterior side, in upper part only on posterior side

1′: not so distinct, immediately below the umbo, a shallow elongated recess the nature of which is doubtful

All of the submedian teeth are originated from a point a little anterior to the umbo.

PI: quite narrow and not so prominent, but elongated, with regular transverse crenulations on dorsal side, subparallel to postero-dorsal margin

PIII: moderately prominent and elongated, with regular transverse crenulations on ventral side, parallel to postero-dorsal margin

PII: prominent and elongated, with regular transverse crenulations on both sides, parallel to and extending through whole length of the postero-dorsal margin

Adductor scars subequal in size and form, situated close to the outer ventral ends of the submedian and the posterior lateral teeth; anterior one subcircular, strongly impressed, accompanied with a distinct minute pedal scar which is subtriangular in shape; posterior one also subcircular but not so distinct; shell margin crenulated internally, umbonal cavity moderately deep.

*Measurements* (in mm):—

| Specimens | Height | Length | D. | Infla. | H/L | D/L |
|---|---|---|---|---|---|---|
| KPE 1001(RV) | 34.1 | 43.0 | 20.6 | 7.0×2 | 0.793 | 0.479 |
| KPE 1002(LV) | 21.3 | 28.6 | 12.9 | 5.5×2 | 0.745 | 0.451 |
| KPE 1003(BV) | 31.2 | 42.2 | 17.5 | ? | 0.739 | 0.415 |
| KPE 1004(LV) | 21.7 | 29.3 | 13.8 | 5.3×2 | 0.740 | 0.471 |
| KPE 1005(RV) | 20.9 | 29.2 | 12.9 | 6.4×2 | 0.716 | 0.442 |
| KPE 1010(BV) | 25.1 | 33.3 | 16.0 | ? | 0.754 | 0.480 |
| KPE 1011(BV)* | 26.0 | 30.5+ | 14.3 | ? | 0.852 | 0.468 |
| KPE 1012(BV)* | 20.1+ | 30.1 | 16.4 | ? | 0.668 | 0.545 |
| KPE 1013(BV)* | 22.0 | 30.8 | 11.4 | ? | 0.714 | 0.370 |
| KPE 1014(RV)* | 25.5 | 31.3+ | 13.3 | 6.8×2 | 0.814 | 0.425 |
| KPE 1015(BV)* | 2?.1 | 31.3 | 13.7 | ? | 0.706 | 0.438 |
| KPE 1016(BV)* | 23.6+ | 30.6 | 16.5 | ? | 0.771 | 0.539 |
| KPE 1017(BV)* | 22.3 | 28.1+ | ? | ? | 0.794 | ? |

(RV), (LV), and (BV): right valve, left valve and bivalve respectively. ( )*: strongly deformed specimens. D: distance between umbo and anterior extremity.

*Observations*:—The specimen (KPE 1001) is a well preserved right valve and the largest among the present material. It shows essentially the same outline and the same pattern of ornament as the original figure of the holotype (KOBAYASHI & SUZUKI, 1936, pl. 27, fig. 1). About half of the specimens are bivalved and all possess well preserved test. The internal structures have been observed on the four specimens (KPE 1006–1009) from which the tests were dissolved out by hydrochloric acid. The internal structures examined on the four show constant characters without noticeable variation.

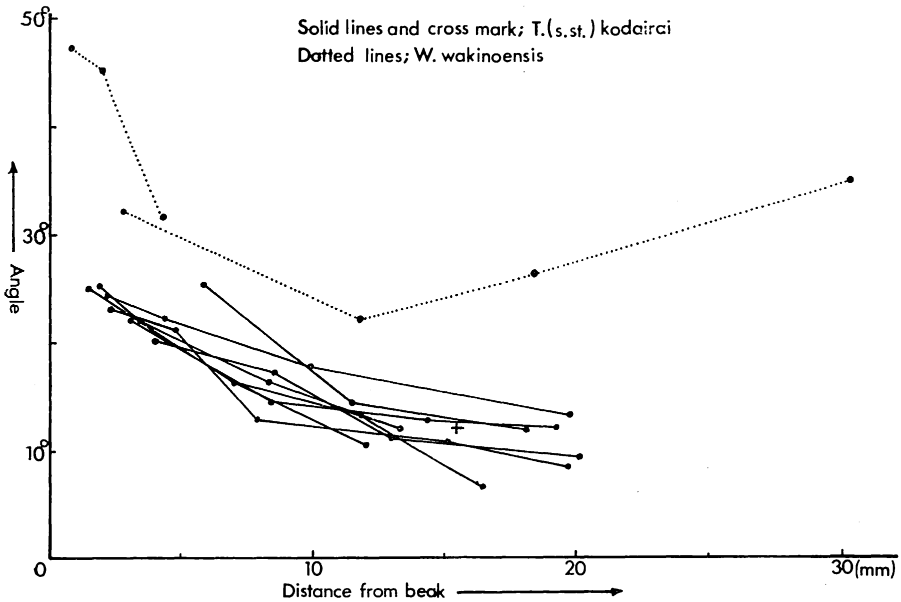
*Occurrence:*—The specimens described here were collected from the light green siltstone and claystone of Hasandong Formation at Sumoondong, Gumnam-myun, Hadong-gun, Gyeongsang-nam-do, Korea (see Text-figure 1).

It is interesting to note that the symmetrical planes of the bivalved fossils are posed vertically and the antero-posterior axes inclined to a bedding plane, while the single valves were commonly parallel to stratification.

I have not completed the stratigraphic investigation of the present area. According to LEE (1972), who surveyed the area in the vicinity of the fossil locality, the subdivision of the Nagdong Subgroup at Daegu-Waegwan Section can be generally extended to the studied area and it is undoubtedly assigned to the middle part of the Hasandong Formation, Nagdong Subgroup. The Nagdong Subgroup at Daegu-Waegwan Section was divided by TATEIWA (1929) and CHANG (1966) into the following formations in descending order:

Silla Subgroup
............Disconformity............
Nagdong Subgroup {
- Chilgok Formation
- Dongmyeong Formation (Jinju Formation)
- Hasandong Formation
- Yeonwhadong Formation (Nagdong Formation)

............Nonconformity............
Pre-Gyeongsang Group (granite or granitic gneiss)




Text-fig. 3. Ontogenetic change of the angle of V-sculptures due to the distance from beak.

## Discussion

*On the surface ornamentation:*—All of the trigonioidid species have characteristic V-shape ornaments on the median part and both of anterior and posterior sides are ornamented with the reversed V-shape ribs. The angles of V-shape ribs on the median part deserve consideration. The ontogenetic change of them can certainly be observed as shown in Text-figure 3. There is a decreasing trend from beak toward the ventral side. The Japanese specimens are unfortunately so often deformed that I cannot precisely compare the change.

However, it can be one of the criteria to distinguish *Trigonioides* from *Wakinoa*. The angle in the early growth-stage is commonly larger than 20° and it becomes smaller with growth down to about 10° in the case of the former, but in the latter the angle near the beak is larger than 40° and even in the ventral part it is larger than 30°.

In view of the dissimilar pattern of ornament, the specimen from Wakino which was identified with *T. kodairai* by KOBAYASHI and SUZUKI (1936, pl. 29, fig. 13) is undoubtedly different from true *T. kodairai* but probably referable to *Wakinoa wakinoensis*. Even in the subsequent collections from the Wakino Formation no specimen is referable to *T. kodairai*.

OTA (1959) proposed the classification based upon the reversed V-ornamentations, the so-called Kodairai type, Suzukii type, and Matsumotoi type. However, the ornamentation of *T. kodairai* as seen in the present topotypes considerably differs from the figure of "Kodairai type" by OTA (1959, p. 100, text-fig. 3). His figure of "Suzukii type" seems to have drawn on the basis of a deformed specimens, the ornamentation of which is essentially similar to that of *T. kodairai*. "Matsumotoi type" ornament is not also constantly maintained, but for a single specimen (OTA 1959; pl. 10, fig. 12). As OTA pointed out, there is a considerable variation in ornamentation, that is in the number of the radial ribs and the set of the V-sculptures, i.e., double, tripple or multiple types as found by TAMURA (1970).

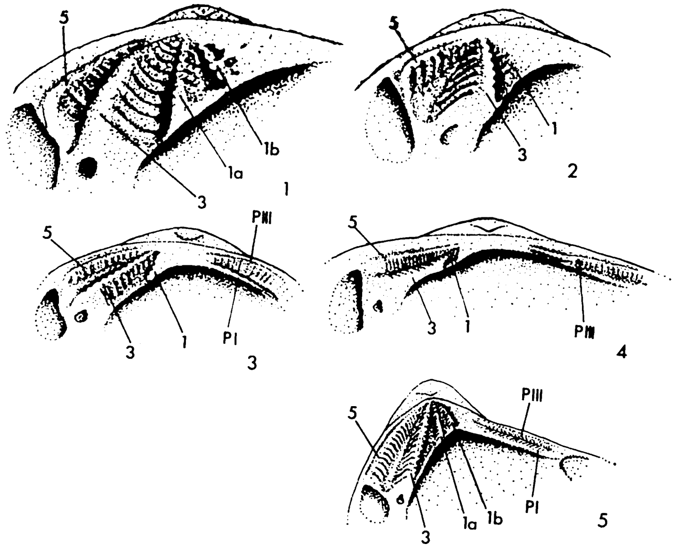
*On the hinge teeth:*—

1) *T. matsumotoi* and *T. mifunensis:* According to TAMURA (1970), the dental formula of these species is as follows:

$$\frac{\quad 5 \quad 3 \quad 1a \quad 1b \qquad (PIII)}{(6) \quad 4 \quad 2 \quad 1'a \quad 1'b \;\; PII \qquad PIV}$$

Although there is an intraspecific variation in the hinge teeth 6 and 1′b as pointed out by previous authors (OTA, 1959; TAMURA, 1970), 1a, 1′a and 1b are constant and prominent in these species, but they are not so distinct in *T. kodairai*. The hinge plate of these Japanese species is much wider than that of *T. kodairai*, and 5, 4, 3, 2, and 1a are distinctly higher compared with those in *T. kodairai*, respectively. Furthermore, the relative ratio of the length between them is quite different from each other as seen in Text-figure 5. That is, the value of 1a/3 is much smaller in *T. kodairai* (0.25) than in *T. matsumotoi* and *T. mifunensis* (larger than 0.6 in both). The posterior lateral teeth of these group cannot be certainly observed in OTA and TAMURA's specimens.

2) *T. suzukii:* I observed all of the specimens of *T. suzukii* stored in the Fukuoka University of Education in which holotype is included, but I cannot find 1b and 1′b, and it is also very difficult to ascertain posterior lateral teeth. As shown in Text-figure 4, the submedian teeth are similar to those of



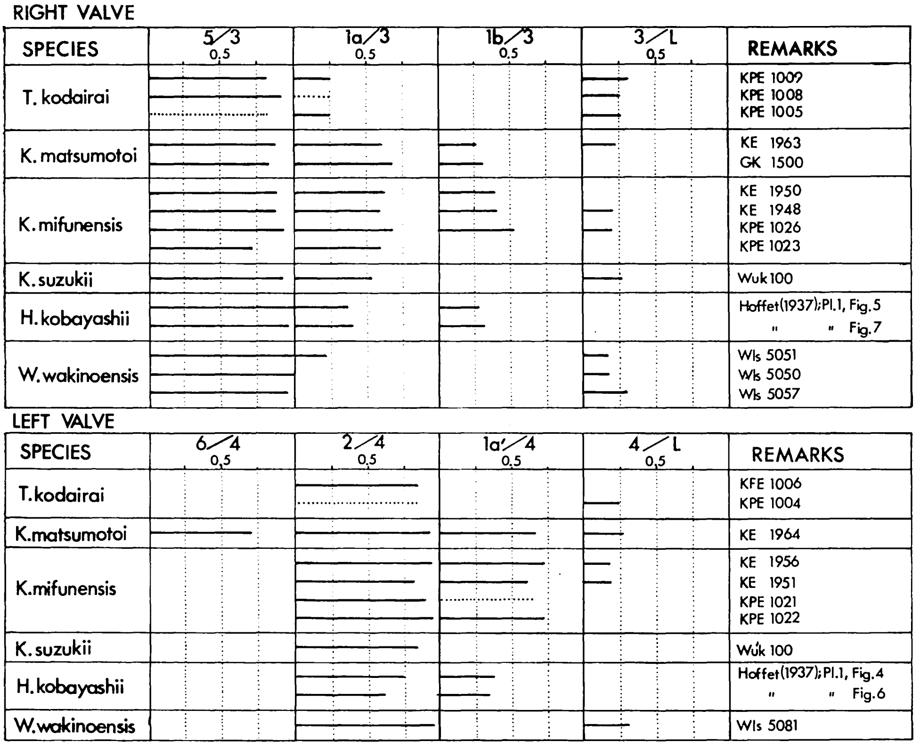

Text-fig. 4. Hinge structure of *T.* (s. s.), *T.* (*Kumamotoa*), *Wakinoa* and *Hoffetrigonia*. 1. *T.* (*Kumamotoa*) *matsumotoi* and *mifunensis*, 2. *T.* (*Kumamotoa*) *suzukii*, 3. *T.* (s. s.) *kodairai*, 4. *Wakinoa wakinoensis*, 5. *Hoffetrigonia kobayashii*.

*T. kodairai*, but not exactly the same. The hinge plate of *T. suzukii* is much wider just like those of *T. matsumotoi* and *T. mifunensis* the submedian teeth of *T. suzukii* much stronger than those of *T. kodairai*. In addition, the value of 1a/3 is also nearer to those of *T. matsumotoi* and *T. mifunensis* than to that of *T. kodairai*.

In conclusion, it seems reasonable and natural to exclude the above three Japanese species from *Trigonioides* (s. s.) and place them under a new subgenus, *Kumamotoa*.

3) *Wakinoa*: *Wakinoa* was established by OTA (1963) as a subgenus of *Trigonioides* based on the type-species "*Nippononaia*" *wakinoensis* OTA, 1959, and its allied species. As illustrated in Text-figure 4 and has been pointed out already by previous authors, the hinge structure of this group is distinctly different from that of *Trigonioides*. The hinge plate is narrow and the features of crenulations are irregular and dense and the submedian teeth 1 and 1′ are variable in contrast with any other species of *Trigonioides*. Moreover, there is some difference in surface ornamentation as mentioned above. Therefore it seems also reasonable to exclude this group from the genus *Trigonioides* and separate it as an independent genus.

4) *Hoffetrigonia*: This genus was proposed by SUZUKI (1940) as a new genus based on *Trigonioides kobayashii* (HOFFET, 1937) from Indochina (Viet Nam) by the reason that its outline and hinge teeth differ from those of the Korean and Japanese species. After that, KOBAYASHI (1956) regarded *Hoffetrigonia* as synonymous with *Trigonioides* because there is no remarkable difference between them. And OTA (1959) agreed




Text-fig. 5. Relative ratio of the length of submedian teeth in Trigonioididae. 6, 5, 4, 3, 2, 1a, 1'a and 1b: symbols of dentitions, L: length of the specimen, Prefix KE: specimens of the Earth-Science Department, Kumamoto University, Prefix GK, Wuk, and Wls: specimens of the Earth-Science Department, Fukuoka University of Education.

with him. Subsequently, on account of the presence of a small escutcheon distinguishable from *Trigonioides* s. str., KOBAYASHI (1968) placed the *Hoffetrigonia* as a subgenus of *Trigonioides* in which *T.* (*H*) *kobayashii* only was contained. As KOBAYASHI pointed out, the Indochinese trigonioidid species has submedian teeth 5, 3, 1a, and 1b in right valve like *T. matsumotoi* and *T. mifunensis* from Japan. Therefore, there is no difference in dental formula between them, but the dentition of Indochinese species shows unique features as illustrated in the plates (HOFFET, 1937, pl. 1, fig. 4-7, and KOBAYASHI, 1968, pl. 23, figs. 1a and 1b) and the Text-figure 4 presented here. In all of the Korean and Japanese species of *Trigonioides* the submedian teeth are originated at a short distance anterior to the umbo, while in the Indochinese species they are originated immediately below the umbo. And the crenulations in the latter are distinctly denser than in the former, except for *Wakinoa*. Moreover, the value of 1a/3 of *Hoffetrigonia* is also characteristically intermediate between the Korean and Japanese species as illustrated in Text-figure 5. *Hoffetrigonia* is apparently more similar to Trigoniidae in hinge structures than any other Korean and

Japanese trigonioidids, although there may be no genetic connection.

To sum up, I agree with SUZUKI's opinion that the *Hoffetrigonia* is an independent genus.

5) Other species: I had no chance to observe the specimens of *T. tetoriensis* and *T. kitadaniensis* described by MAEDA (1963). However, according to his description and illustration, *T. kitadaniensis* is hardly distinguished from *T. tetoriensis* as TAMURA (1970) mentioned. MAEDA (1963, p. 82) described the dental formula of *T. tetoriensis* as follows:

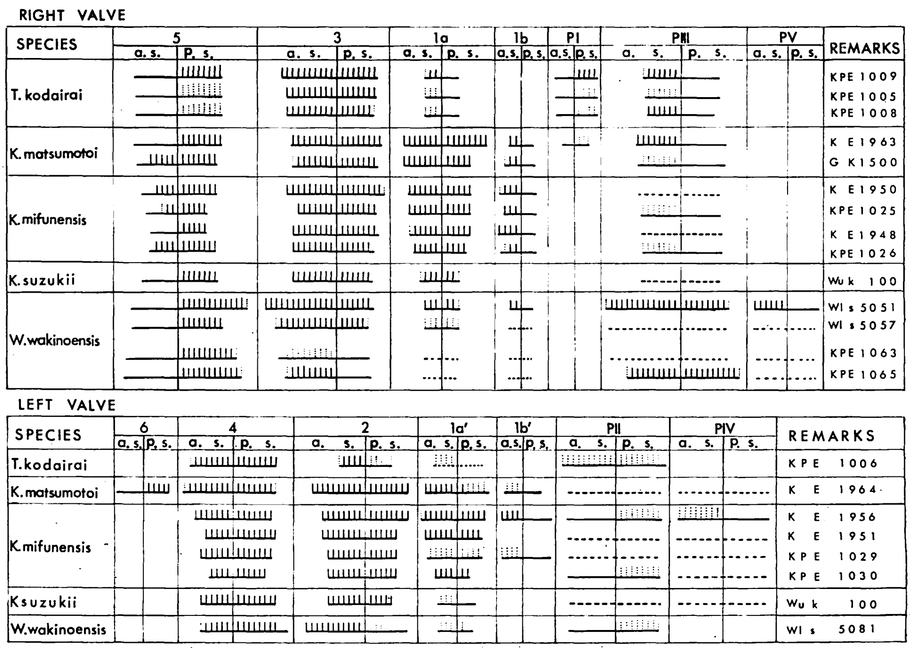
(5a) 3a 1a 1b 3b
/ 4a 2a 1′ 2b 4b

It is difficult to correlate the above dental formula with TAMURA's (1970), because homology does not maintained. Especially it is questionable whether or not the teeth 1′, 1b, and 2b in the former are equivalent to the 1′a, 1b and 1′b in the latter, respectively. Nevertheless it is important to consider that 1′ is crenulated on both sides. If so, 1b may be assigned to 1b in TAMURA's formula. And 2b is also crenulated on both sides, in which there must be another tooth between 1′ and 2b in right valve in addition to 1b. After all, the the above formula may be presented as follows:

(5) 3 1a 1b (PI) PIII
/ 4 2 1′a (1′b) PII PIV

In conclusion, *T. tetoriensis* (=*T. kitadaniensis*) undoubtedly belongs to the same group as *T. matsumotoi*, *T. suzukii* and *T. mifunensis*.

I examined the specimens of *T. kodairai paucisulcatus* SUZUKI kept at the University of Tokyo, but the internal structures could not be clearly seen.




Text-fig. 6. Number of the crenulations of the hinge teeth.
a. s.: anterior side, p. s.: posterior side.

However, as stated by SUZUKI (1940), it seems quite similar to *T. kodairai* in outline, size and the general disposition of the hinge teeth.

*Distribution and Phylogeny:*—KOBAYASHI and SUZUKI (1936) originally described the fossils from Sumoondong and Wakino under the name of *Trigonioides kodairai*. Through this study I come to the conclusion that the so-called *T. kodairai* from Wakino is not true *T. kodairai*, but referable to *Wakinoa wakinoensis*. Therefore, the correlation between Nagdong and Wakino Subgroup based on the occurrence of *T. kodairai* and others is left as a problem for future study.

The problem on the phylogeny of the *Trigonioides* has been frequently discussed, and the previous opinions may be divided into two; one is that the crenulations and the submedian teeth 1a, 1b, 1′a and 1′b became phylogenetically effaced from the Trigoniacea through *Trigonioides* to *Nippononaia* (KOBAYASHI, 1956) and the other that they became contrarily prominent from *Nippononaia* or *Plicatounio* through *Wakinoa* to *Trigonioides* (OTA, 1963, and HAYAMI in HAYAMI and ICHIKAWA, 1965). In the present state of knowledge, I cannot participate in the discussion, but my opinion is inclined to the latter. Anyhow, the *Trigonioides* (s. s.) may apparently take the position between *Wakinoa* and *T.* (*Kumamotoa*) in evolutionary trend.

## Proposal of subgenus *Kumamotoa*

Genus *Trigonioides* KOBAYASHI & SUZUKI, 1936

Subgenus *Kumamotoa* YANG, n. subgen.

*Type-species:*—*Trigonioides mifunensis* TAMURA, 1970.

*Included species:*—*Trigonioides matsumotoi* KOBAYASHI & SUZUKI, 1940. *Trigonioides suzukii* OTA, 1959. *Trigonioides tetoriensis* MAEDA, 1963. *Trigonioides mifunensis* TAMURA, 1970.

*Subgeneric diagnosis:*—Shell relatively large in the genus; subtrapezoidal, subelliptical, or subtrigonal in outline with rounded anterior margin and subelongated posterior margin; umbo prominent, slightly prosogyrous or orthogyrous; equivalve and subequilateral. Surface marked with the characteristic ornamentation of the genus. Hinge plate large in breadth, provided with most well developed hinge teeth in the genus; the dental formula as follows:

$$\frac{\quad 5 \quad 3 \quad 1a \quad 1b \qquad PIII}{(6) \quad 4 \quad 2 \quad 1'a \quad (1'b)\ PII \quad PIV}$$

where the teeth in parentheses are variable and sometimes absent. Most of the hinge regularly crenulated on one or both sides; the value of 1a/3 generally larger than 0.6.

## References


CHANG, K. H. (1966): Stratigraphy and sedimentation of Nagdong Subgroup (Lower Cretaceous), Gyeongsang Province, South Korea. *Jour. Geol. Soc. Korea*, 2, (1), 17-51, figs. 1-7, pls. 1-3.

COX, L. R. (1952): Notes on the Trigoniidae with outline of a classification of the family. *Proc. Malac. Soc. London*, 29, (2-3), 45-70, pls. 3-4.

—— (1955): On the affinities of the Cretaceous lamellibranch genera *Trigonioides* and *Hoffetrigonia*. *Geol. Mag.*, 92, (4), 345-349.

HASE, A. (1960): The late Mesozoic formations and their molluscan fossils in west Chugoku and north Kyushu. *Jour. Sci., Hiroshima Univ.*, (C), 3, (2), 281–

342, pls. 31-39.

HAYAMI, I. and ICHIKAWA, T. (1965): Occurrence of *Nipponoraia ryosekiana* from the Sanchu area, Japan. *Trans. Proc. Pal. Soc. Japan, N. S.*, (60), 145-155, pl. 17.

HOFFET, J. H. (1937): Les Lamellibranchis saumatres du Sénonien de Muong Phalane (Bas-Laos). *Bull. Serv. géol. l'Indochine*, 24, (2), 4-25, pls. 1-5.

KOBAYASHI, T. (1956): On the dentition of *Trigonioides* and its relation to similar pelecypod genera. *Japan. Jour. Geol. Geogr.*, 27, (1), 79-94, pl. 5.

—— (1963): On the Cretaceous Ban Na Yo fauna of East Thailand with a note on the distribution of *Nippononaia, Trigonioides*, and *Plicatounio*. *Ibid.*, 34, (1), 35-43, pl. 3.

—— (1968): The Cretaceous non-marine pelecypods from the Nam Phung Dam site in the northern part of the Khorat Plateau, Thailand with a note on the Trigonioididae. *Geol. Palaeont. SE Asia*, 4, 109-138, pls. 20-23.

—— and SUZUKI, K. (1936): Non-marine shells of the Naktong-Wakino series. *Japan. Jour. Geol. Geogr.*, 13, (3-4), 243-257, pls. 27-29.

—— and —— (1941): On the occurrence of *Trigonioides* in south-eastern Manchuria. *Bull. Geol. Inst. Manch.*, (101), 77-81.

KU, C. W. (1962): Note on the occurrence of some late Cretaceous fresh-water lamellibranches in the Chusing district of Central Yunnan with a brief review of the continental Cretaceous of Yunnan. *Acta Pal. Sinica*, 10, (3), 287-307, pls. 1-2.

LEE, Y. K. (1970): Sedimentological petrology of Nagdong Group in Jinju-Namhae area, South Gyeongsang Province, Korea. (M. S.) Dept. Geol. Kyungpook Natl. Univ.

MAEDA, S. (1963): *Trigonioides* from the late Mesozoic Tetori group, Central Japan. *Trans. Proc. Pal. Soc. Japan*, N.S., (51), 79-85, pl. 12.

MARTINSON, W. B. (1965): Cretaceous Lamellibranches of the family Trigonioididae and their classification. *Pal. Jour.*, 1965, (4), Acad. Sci. U. S. S. R.

MATSUMOTO, T. (1938): Geology of the Goshonoura Island, Amakusa, with special reference to the Cretaceous stratigraphy. *Jour., Geol. Soc. Japan*, 45, (532) 1-46, pls. 1-2 (in Japanese).

OTA, Y. (1959): *Trigonioides* and its classification. *Trans. Proc. Pal. Soc. Japan*,

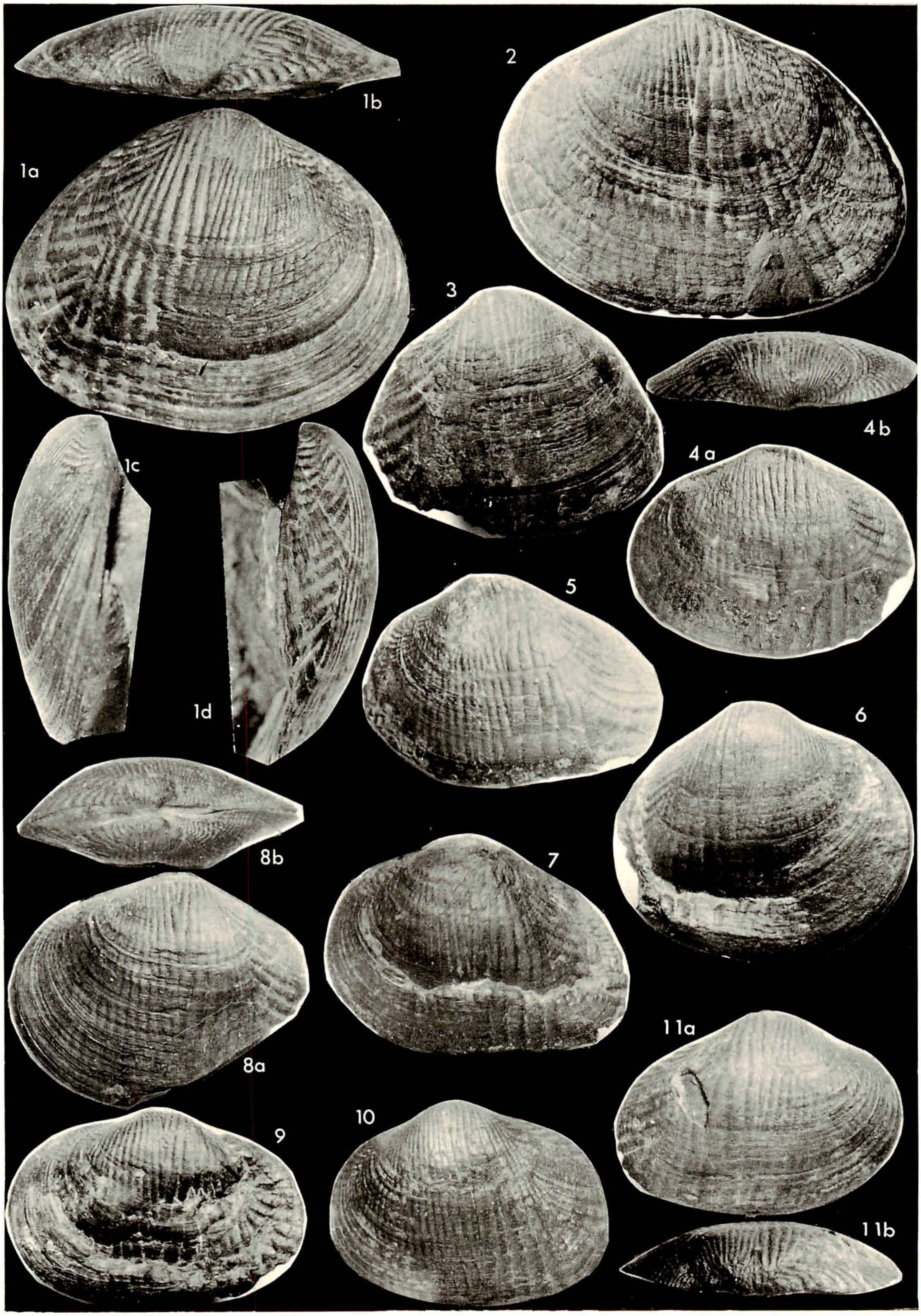
## Explanation of Plate 54

Figs. 1-11. *Trigonioides* (s. s.) *kodairai* KOBAYASHI & SUZUKI.

1. Right valve (KPE 1001) ×1.5, 1a; side view, 1b; upper view, 1c; anterior view, 1d; posterior view.
2. Bivalved (KPE 1003) ×1.5, Left valve side view.
3. Left valve (KPE 1014) ×1.5.
4. Left valve (KPE 1004) ×1.5, 1a; side view, 1b; upper view.
5. Bivalved (KPE 1013) ×1.5, Left valve side view.
6. Bivalved (KPE 1011) ×1.5, Right valve side view.
7. Bivalved (KPE 1015) ×1.5, Left valve side view.
8. Bivalved (KPE 1010) ×1.5, 8a; Left valve side view, 8b; upper view.
9. Bivalved (KPE 1012) ×1.5, Left valve side view.
10. Left valve (KPE 1002) ×1.5.
11. Right valve (KPE 1005) ×1.5, 11a; side view, 11b; upper view.

Loc.; Sumoondong, Gumnam-myun, Hadong-gun, Gyeongsang-nam-do, Korea.

All of the specimens illustrated are kept in the Department of Earth-Science, College of Education, Kyungpook National University, Daegu, Korea. Three plaster casts (KPE 1001, 1002, 1003) of the above specimens are preserved in the Department of Geology, Faculty of Science, Kyushu University, Fukuoka, Japan.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*N. S.*, (34), 97–104, pl. 10.

—— (1959): On the "Nippononaia" from the lower Cretaceous Wakino subgroup, north Kyushu, Japan. *Ibid.*, (34), 105–110, pl. 11.

—— (1963): Notes on the relationship of *Trigonioides* and *Plicatounio*, non-marine Mesozoic Bivalvia from eastern Asia. *Geol. Rept. Hiroshima Univ.*, (12), 503–512.

SUZUKI, K. (1940): Non-marine molluscan faunule of the Siragi series in South Tyosen. *Japan. Jour. Geol. Geogr.*, 17, (3–4), pls. 22–24.

—— (1943): Restudy on the non-marine molluscan fauna of the Rakuto series in Keisyo-do, Tyosen. *Jour. Sigenkagaku Kenkyusho*, 1, (2), 189–219 pls. 14–19.

TAMURA, M. (1970): The hinge structure of *Trigonioides*, with description of *Trigonioides mifunensis*, sp. nov. from upper Cretaceous Mifune group, Kumamoto Pref., Japan. *Mem. Fac. Educ., Kumamoto Univ.*, (18), Sec. 1, 38–52, pls. 1–2.

TATEIWA, I. (1929): Geological atlas of Chosen, no. 10; Gyeongju, Yeongcheon, Daegu and Waegwan sheets, Geol. Surv. Korea.

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| Daegu | 大邱 | Noryang | 露梁 |
| Dongmyeong | 東明 | Silla | 新羅 |
| Gyeongsang-nam-do | 慶尚南道 | Seolcheon-myun | 雪川面 |
| Gumnam-myun | 金南面 | Sinnoryang | 新露梁 |
| Hadong-gun | 河東郡 | Sumoondong | 水門洞 |
| Hasandong | 霞山洞 | Waegwan | 倭館 |
| Jinju | 晋州 | Wakino | 脇野 |
| Kumamoto | 熊本 | Yeonwhadong | 蓮花洞 |
| Nagdong | 洛東 | | |

## Explanation of Plate 55

Figs. 1-4. *Trigonioides* (s. s.) *kodairai* KOBAYASHI and SUZUKI.

1. Right valve. 1a; rubber cast of right internal mould (1b) ×2.5. 1b; internal mould of right valve (KPE 1007) ×1.5. Loc. Sumoon-dong.
2. Internal mould of right valve (KPE 1008) ×2.5. Loc. ditto.
3. Right valve, internal view (KPE 1005) ×2.5. Loc. ditto.
4. Left valve, internal view (KPE 1006) ×1.5. Loc. ditto.

Figs. 5-6. *Trigonioides* (*Kumamotoa*) *mifunensis* TAMURA.

5. Internal view of right valve, rubber cast of (KPE 1026) ×1. Loc. 500 m S. E. of Tashiro (see TAMURA, 1970 for precise locality).
6. Hinge structure of right valve, rubber cast of (KPE 1023) ×1. Loc. ditto.

Fig. 7. *Trigonioides* (*Kumamotoa*) *matsumotoi* KOBAYASHI and SUZUKI.

Showing the hinge structure of right valve, rubber cast of (GK 1500) ×1. Loc. Gosyonoura Island (see OTA, 1959 for precise locality).

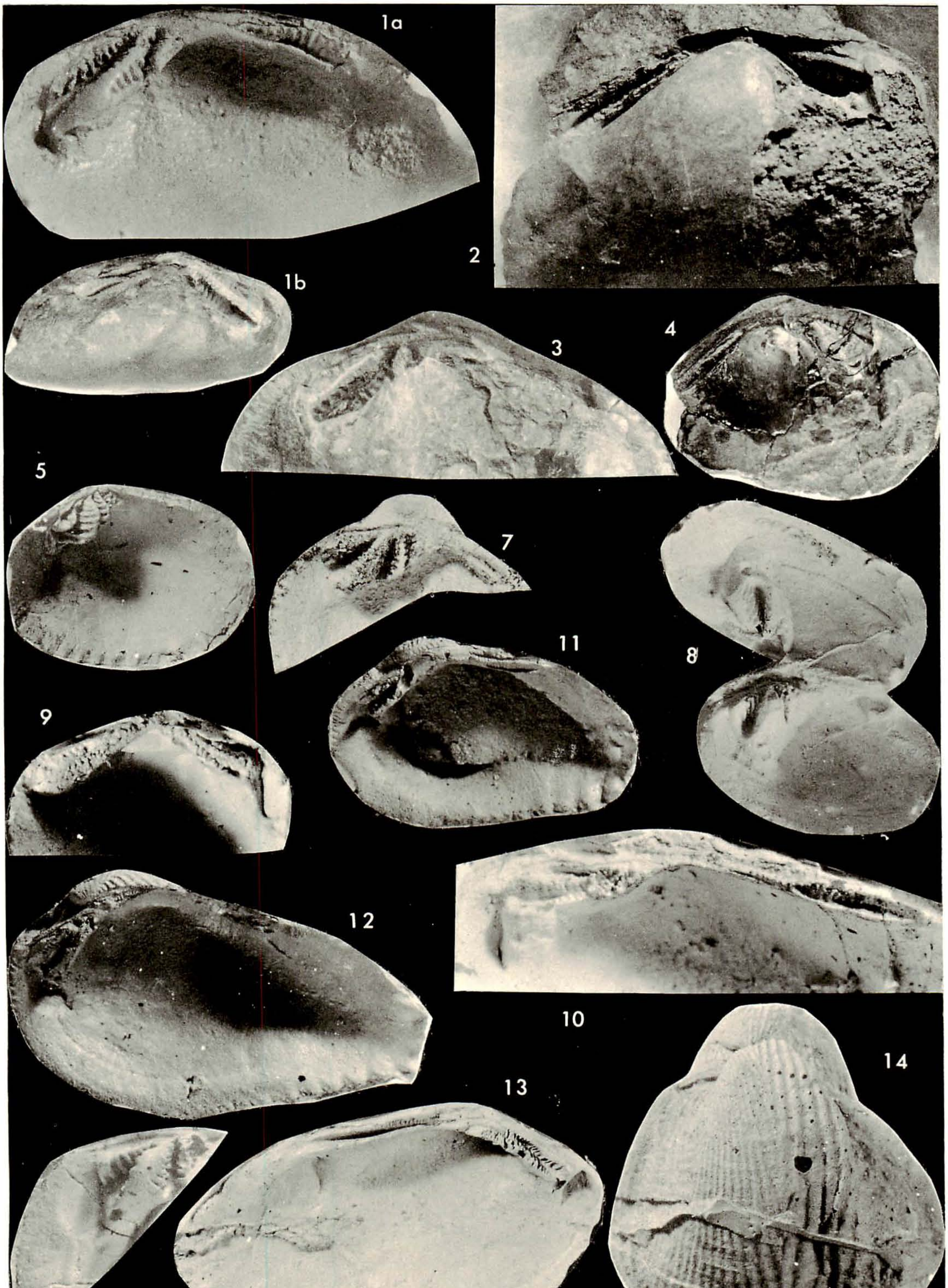
Fig. 8. *Trigonioides* (*Kumamotoa*) *suzukii* OTA.

Showing the hinge structure of the bivalved, rubber cast of (Wuk 100) ×1. Loc. Hata (see OTA, 1959 for precise locality).

Figs. 9-14. *Wakinoa wakinoensis* (OTA).

9. Rubber cast of left internal mould (Wls 5081) ×2.5. Showing the hinge structure. Loc. Rikimaru. (see OTA, 1959 for precise locality).
10. Rubber cast of right internal mould (Wls 5051) ×2.5. Showing the hinge structure. Loc. ditto.
11. Rubber cast of right internal mould (KPE 1065) ×1.5. Showing the hinge structure. Rikimaru, Miyata-machi, Kurate-gun, Fukuoka Pref.
12. Rubber cast of right internal mould (KPE 1063) ×1.5. Showing the hinge structure. Loc. ditto.
13. Rubber cast of left internal mould (KPE 1072) ×1. Showing the hinge structure. Loc. ditto.
14. Rubber cast of bivalved external mould (KPE 1067) ×1. Strongly deformed on posterior part. Loc. ditto.

The specimens of *T.* (s. s.) *kodairai* (KPE 1005, 1006, 1007, 1008), *T.* (*K.*) *mifunensis* (KPE 1026, 1023) and *W. wakinoensis* (KPE 1063, 1065, 1067, 1072) are kept in the Department of Earth-Science, College of Education, Kyungpook National University, Daegu, Korea. The specimens of *T.* (*K.*) *matsumotoi* (GK 1500), *T.* (*K.*) *suzukii* (WuK 100) and *W. wakinoensis* (Wls 5081, 5051) are kept in the Department of Earth-Science, Fukuoka University of Education, Fukuoka, Japan.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## “化石”のお知らせ

本学会発行の和文誌“化石”は，1960年の発刊以来ヴァラエティーに富んだ古生物学上のトピックを扱って，最新の研究成果を盛りこんだ密度の高い内容を誇るとともに，各種の国際ニュースを紹介する，ユニークな雑誌である。この存在は和文誌という性格にもかかわらず，国外においても注目されはじめているが，かえって国内では周知されないうらみがあります。そこで，現在バックナンバーとして在庫するものの主要内容を紹介いたします。

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# PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第113回例会は1974年6月15・16日に大阪市立自然史博物館において開催された(参加者70名)。

## 個人講演

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## 学　会　記　事

1974年6月14日大阪市立自然史博物館において開かれた評議会で次のことが決定承認された。

◎ 会則第23条にしたがい，本会の会計監査に特別会員・佐藤　正君（筑波大学）を選出し，2年間，監査を依頼することになった。

◎ 横山賞の選考基準が次のように定められた。
「国際的に最高水準の古生物学的研究を行ない，その評価が十分に定着した人に授与する」

◎ 本会報告・記事100号記念事業を行なうことになり，そのための小委員会（委員長・松本達郎）が発足した。

◎ 本学会特別会員・三木　茂君が逝去された。謹んで哀悼の意を捧げる。

◎ 次の諸君の入会が承認された（ABC順）。
浅賀正義，池田　正，間舎美幸，小村精一，黒沢利衛，Hsin Yin LING，村本喜久雄，長田敏明，佐俣哲郎，Reinhard SCHMIDT-EFFING。

◎ 会員・大嶋一精君の退会が認められた。

## 例 会 等 の 通 知

| | 開　催　地 | 開　催　日 | 講演申込締切 |
|---|---|---|---|
| 114回　例　会 | 名古屋大学 | 1974年10月19-20日 | 1974年8月20日 |
| 1975年　総会・年会 | 国立科学博物館 | 1975年1月25-26日 | 1974年11月30日 |
| 115回　例　会 | 岩手大学 | 1975年6月 | 未　定 |

◎ 114回例会では，20日に瑞浪地方巡検（ガイド・森下　晶）が予定されている。

◎ 1975年総会・年会ではシンポジウム「古生物学と走査型電子顕微鏡」（世話人・岩崎泰穎）が予定されている。

## お　知　ら　せ

◎ 日本地質学地理学輯報の原稿募集： JJGG は本49年度（Vol. 46）も出版されることになりました。従来通りの投稿規約にしたがって，なるべく早めに御投稿下さい。（JJGG 編集委員　浜田）

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