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495. OCCURRENCE OF *NIPPONONAIA RYOSEKIANA* FROM THE SANCHU AREA, JAPAN*

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山中地方から産出した *Nippononaia ryosekiana*: *Nippononaia* は近縁の *Trigonioides* とともに白亜紀に東亜で栄えた特徴的な非海棲二枚貝であるが，その模式種 *Unio* (*Nippononaia*) *ryosekianus* の原標本の産地・時代が不明のためとかく疑問の多い属であつた。最近群馬県中里村瀬林近傍の八幡沢において本種の標本多数が高鹹の堆積環境を示す *Protocyprina* sp. を伴つて産出したので報告する。これらは転石より得られたものであるが，同沢に広く分布する瀬林層（およそ宮古世）に由来することは間違いない。*Nippononaia* の標本中数個はほぼ完全で，原標本が不完全なため未知であつた部分の特徴を補い知ることができる。母岩の性質は出所不明の原標本とよく似ている。

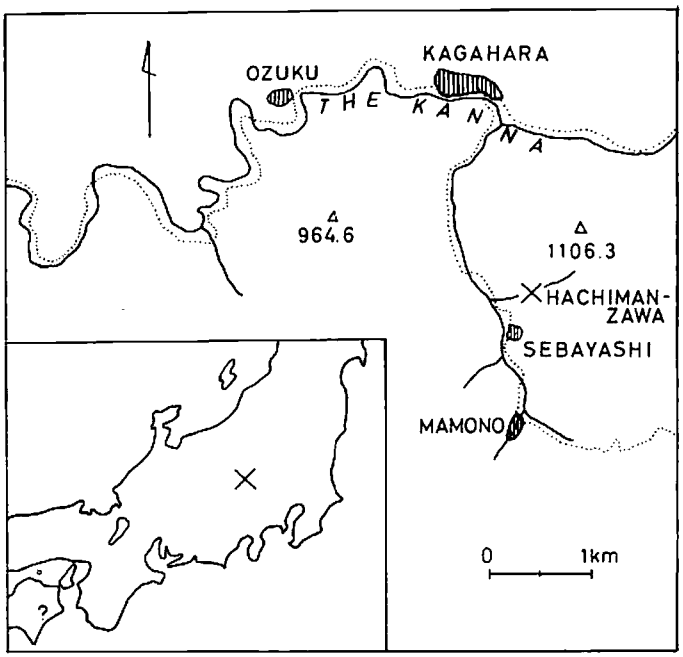
Nippononaia を含む Trigonioididae の分類上の位置，系統発生については異論の多いところで，今までの資料で結論を下すのは困難な点もある。しかし形態的にみて本科は Trigoniacea よりも Unionacea により深い関係を持つと考えられる。これまでに本科の蝶番構造を表現するために用いられた歯式はいずれも，異歯二枚貝の歯の相同関係を表わす BERNARD の歯式とは異質である。最後にこれまで不明確であつた Trigonioididae の特徴を定義した。

速水　格・市川健雄

Introduction

Nippononaia SUZUKI, 1941, is a characteristic and important pelecypod genus, which occurs mainly from the Lower Cretaceous non-marine formations of eastern Asia. It is well characterized by the combination of peculiar hinge and surface sculpture, although some different opinions have been presented as to its systematic position and phylogeny. There are, however, some uncertainties with regard to the type-species itself, i.e. *Unio* (*Nippononaia*) *ryosekianus*. SUZUKI (1941) established the species on the basis of two incomplete specimens, one of which was designated by himself as the holotype. The two specimens, which were once believed to have been destroyed during the World War II, are now actually preserved in the Geological Institute, University of Tokyo. But their actual localities are still unknown, as SUZUKI (1941, p. 413) noted originally that they had come from the "Ryoseki group; Komô, Hanoura-mati, Naka-gun, Tokushima Prefecture, or Santyû (=Sanchu)

* Received May 6, 1965; read September 25, 1965 at Nagasaki.



Text-fig. 1. Map showing the locality of *Nippononaia ryosekiana*.

graben in the Kwanto mountainland". No additional specimen of this species had been obtained from these two areas, but recently we found unexpectedly a boulder of black shale at Hachimanzawa in the eastern part of the Sanchu area, in which many individuals of *Nippononaia ryosekiana* were contained together with a few specimens of *Protocyprina* sp. No specimen *in situ* has been found, but the boulder in question was certainly derived from the Sebayashi formation of approximately an Aptian-Albian (Miyakoan) age. The geographic position is indicated in Text-fig. 1.

In this paper we described *Nippononaia ryosekiana* (SUZUKI) and *Protocyprina* sp. on the basis of the newly collected material. One of us (I. H.) gives some palaeontological remarks on the genus *Nippononaia*.

Before going into description, we express our sincere thanks to Prof. Tatsuro MATSUMOTO of the Kyushu University for his kind suggestion and reading of this manuscript. Acknowledgements are also due to Prof. Emeritus Teiichi KOBAYASHI of the University of Tokyo for his generous criticism, and to Prof. Toshio KIMURA of the University of Tokyo and Prof. Yoshihisa OTA of the Fukuoka Gakugei University for their kind encouragement and assistance in various ways.

Systematic description

Order Naiadida

COX (1960) distinguished the Anthracosiacea and Unionacea from the Order Schizodontida, and proposed a new order, Naiadida, for them. This procedure is here adopted.

Superfamily Unionacea

Family Trigonioididae*

Genus *Nippononaia* SUZUKI, 1941

Type-species:—*Unio* (*Nippononaia*) *ryosekianus* SUZUKI, 1941, Lower Cretaceous (probably Aptian-Albian), Japan (original designation).

Nippononaia ryosekiana (SUZUKI)

Pl 17, Figs. 1-8; Text-fig. 2

1941. *Unio* (*Nippononaia*) *ryosekiana* SUZUKI, *Jour. Geol. Soc. Japan*, Vol. 48, No. 575, p. 412, text-figs. 1-3 [*Trans. Palaeont. Soc. Japan*, No. 128, p. 60, text-figs. 1-3] [*sic*].

1943. *Plicatounio* (*Nippononaia*) *ryosekianus* SUZUKI, *Jour. Sigenkagaku Kenkyusyo*, Vol. 1, No. 2, p. 196, 211.

Material:—Eight specimens (GK. H6755—GK. H6762) from a boulder of black shale at Hachimanzawa (HAYAMI and ICHIKAWA coll.). The holotype and paratype preserved in the University of Tokyo are also concerned with the description below. A plaster cast of the holotype is preserved also in the Kyushu University (GK. H6765).

Description:—Shell of medium size, about 50-60 mm long in the adult stage, equivalve, inequilateral, transversely elongated, about twice or more as long as high, elongate-ovate in outline, rounded in front, tapering posteriorly, pointed at the extremity, moderately inflated; test moderate in thickness; antero-dorsal margin short, passing gradually into the anterior margin; postero-dorsal margin very long, slightly curving downwards; ventral margin gently and broadly arcuate but a little concave in its posterior part; umbo orthogyrous, not prominent, unusually broad, placed at about two-sevenths of shell length from the anterior extremity; a rounded carina extends from the umbo to the posterior extremity, delimiting a narrow postero-dorsal area; lunule and escutcheon absent; surface ornamented with numerous characteristic ribs, divided into four areas, i.e. antero-dorsal, anterior, posterior and postero-dorsal areas, by different mode of ornamentation; several ribs on the central part converge on the line just below the umbo and scribe acute Vs, the angle of which is approximately 20 degrees; anterior ribs about 25 in the adult stage, regularly spaced, nearly straight or a little sinuous; posterior ribs about 35 in the adult stage, subvertical, slightly sinuous, as broad as anterior ribs near the Vs but become much broader and more sparse on the posterior area; antero-dorsal and posterior dorsal peripheral areas ornamented with upward curving short riblets; whole surface marked also with numerous concentric growth-lines of irregular interval and prominence; hinge plate moderate in breadth, provided with opisthocline pseudocardinal teeth and posterior lateral teeth of unionoid type; right valve possesses one large and one minute pseudocardinal teeth, while left valve has two large pseudocardinal teeth; large pseudocardinal teeth subparallel to post-umbonal margin, roof-shaped, stout, faintly striated obliquely; posterior lateral teeth, one in the left valve and two in the right, comparatively short, parallel to the postero-dorsal margin, smooth without any crenulation, distinctly separated from the pseudocardinals; adductor scars subequal in size, situated close to the outer ends of the pseudocardinal and posterior lateral teeth; anterior one hemicircular, strongly impressed, accompanied with a minute

* See also page 153 for the diagnosis.

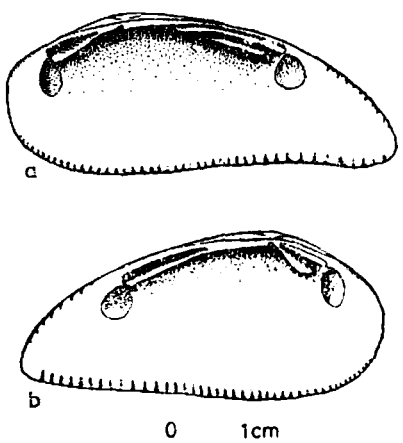
pedal scar; posterior one subcircular, not so strongly impressed; ventral, anterior and posterior margins crenulated internally in accordance with the external ribs; umbonal cavity very shallow.

Measurements in mm:—

Specimen	Length	Height	Thickness	L/H
Left valve (GK. H6755)	53.5	25.5	6.5	2.10
Right in. mould (GK. H6756)	35.5	16.5	4.0	2.15+
Left in. mould (GK. H6757)*	29.0+	14.0	8.0	2.07+
Right valve (GK. H6758)	49.0	21.0+	5.5	2.38−
Left valve (GK. H6759)*	50.0	19.5	7.0	2.56
Left valve (GK. H6760)*	57.5	18.0+	9.5	3.19−
Left valve (GK. H6761)*	36.0+	19.0	5.5	1.84+
Left valve (GK. H6762)*	30.5+	14.5	4.0	2.10+
Left in. mould (Holotype)	32.5+	16.0	5.0+	2.03+

Observations and comparisons:—The holotype of this species (SUZUKI, 1941, text-fig. 1; Pl. 17, Figs. 2a, b) is a left internal mould, revealing the hinge structure and muscle system. The pseudocardinal teeth are feebly crenulated, as mentioned by SUZUKI (1941, p. 413), but the posterior lateral teeth are quite smooth. The paratype (SUZUKI, 1941, text-figs. 2, 3; Pl. 17, Fig. 1) is a left external mould, exhibiting the characteristic surface sculpture on the antero-central part of the shell. The posterior parts of the two original specimens are broken away, so that the general outline is not recognized from them.

Eight specimens (GK. H6755—GK. H6762) and a few fragmentary ones in the present collection are specifically identical with the holotype and paratype of *Nippononaia ryosekiana* in view of the similar surface sculpture and hinge structure, although its test is slightly exfoliated in the posterior part, the remainining part is complete and shows the characteristic ornamentation. In another left valve (GK. H6759) the antero-dorsal peripheral area with upward curving riblets is slightly broader than in other specimens. The hinge structure exhibited in two internal moulds (GK. H6756, GK. H6757) agrees well with that of the holotype. They show similarly smooth posterior lateral teeth and faintly striated pseudocardinal teeth. The subumbonal pseudocardinals are undeveloped in all the moulds.



Text-fig. 2. Internal structure of *Nippononaia ryosekiana* (SUZUKI).
a: right valve restored mainly from the specimen GK. H6756, ×1
b: left valve restored mainly from the holotype, ×1

The present species is clearly distinguishable from *Nippononaia asinaria*

* Strongly deformed specimens.

REESIDE, 1957, from the Lower Cretaceous of Colorado, *Nippononaia tetoriensis* MAEDA, 1962, from the Upper Jurassic or Lower Cretaceous of central Honshu and *Nippononaia mekongensis* KOBAYASHI, 1963, from the (?) Lower Cretaceous of east Thailand, by the much more delicate ribs and more sharply pointed posterior extremity. *Trigonioides* (*Wakinoa*) *wakinoensis* (OTA, 1959) and *Trigonioides* (*Wakinoa*) *sengokuensis* (OTA, 1959) from the Lower Cretaceous of north Kyushu, which were originally described under the generic name of "*Nippononaia*", are somewhat similar to the present species in the surface sculpture, but they are at least subgenerically distinct from the present species, because the pseudocardinal and posterior lateral teeth are strongly crenulated in those species as precisely studied by OTA (1963). Moreover, the angle of Vs is distinctly smaller in the present species than in any other species of *Nippononaia* and *Trigonioides*.

Occurrence:—Probably Miyakoan (Aptian—Albian). The present material was collected from a boulder of carbonaceous black shale at the middle course (about 300 meters from the mouth) of a small valley Hachimanzawa, near Sebayashi, south of Kagahara, Nakazato Village, Tano County, Gumma Prefecture. It was about 1 meter long and certainly derived from the Sebayashi formation exposed along this valley in view of the similar lithology. It is interesting that the present species was accompanied by *Protocyprina* sp. and an indeterminable ostreid, since *Protocyprina* is generally regarded as a marine or brachyhaline water inhabitant. Some fossiliferous beds containing *Isognomon sanchuensis* (YABE and NAGAO) and "*Cyrena*" *radiatostriata* YABE and NAGAO are exposed in the valley, but they are distinct from the boulder in question in the lithology and fossil assemblage.

It is as yet undecided whether the type locality of the present species is in the Katsuuragawa basin or in the Sanchu area. SUZUKI's specimens, however, may have occurred also from the same formation as the present material, because the mother rock of his specimens is just comparable with that of these specimens, and because no additional specimen has been obtained from the Katsuuragawa basin. SUZUKI (1941, p. 413) noted that his specimens certainly came from the "Ryoseki group". The term of "Ryoseki group" at that time, however, may have been used not only for the true Ryoseki group of approximately Lower Neocomian but also for the brackish water deposits of Miyakoan (Aptian—Albian) series, as pointed out by MATSUMOTO (1947) and others. Furthermore, ARAI et al. (1958) and TAKEI (1963) clarified that the Sebayashi formation itself, which had long been assigned to the Kochian (Ryoseki) series, actually overlies the Ishido formation which bears some Upper Neocomian ammonites and other marine fossils. Therefore, it is highly probable that the life range of *Nippononaia ryosekiana* is confined to the Miyakoan (Aptian—Albian) age.

Order Heterodontida

Superfamily Arcticacea

Family Neomiodontidae

Genus *Protocyprina* VOKES, 1946

Type-species:—*Astarte libanotica* FRAAS, 1878, Aptian, Lebanon (original designation).

Protocyprina sp. indet.

Pl. 17, Figs. 9, 10

This species is at present represented by two specimens (GK. H6763, GK. H6764). One of them (GK. H6763) is bivalved and shows subovate outline and surface characters, although it is strongly compressed secondarily (both valves, 46.0 mm. long, 38.5 mm. high, 5.0+mm. thick). The other is an immature right valve (GK. H6764) and apparently undeformed (20.5 mm. long, 17.0 mm. high, 4.0 mm. thick). The two specimens show several clear concentric ribs on the umbonal surface and more or less conspicuous posterior carinae. From the external feature these specimens are referable to *Protocyprina* VOKES, 1946, which was recently redefined by HAYAMI and NAKAI (1965). The present species is apparently similar to the immature shells of *Protocyprina naumanni* (NEUMAYR, 1890) from the Neocomian Ryoseki group of Japan (YABE, NAGAO and SHIMIZU, 1926; HAYAMI and MATSUMOTO, 1963; HAYAMI and NAKAI, 1965), but differs from the species in having thinner test and more distinct umbonal concentric ribs. In this respect, the present species may be closer to *Protocyprina libanotica* (FRAAS, 1878) from the Aptian of Lebanon (VOKES, 1946). The posterior carina is probably stronger in the present species than in *P. naumanni* and *P. libanotica*. The specific denomination of these specimens is deferred until the hinge structure becomes clear, although they probably belong to a new species.

Occurrence:—The present specimens were obtained from the same boulder as the specimens of the preceding species at Hachimanzawa.

Some remarks on the genus *Nippononaia*

by Itaru HAYAMI

SUZUKI (1941) proposed *Nippononaia* as a subgenus of *Unio* RETZIUS, 1788, but subsequently he (1943) transferred it to *Plicatounio* KOBAYASHI and SUZUKI, 1936, regarding it as a subgenus of *Plicatounio*. In fact, the hinge structure of *Nippononaia ryosekiana* is somewhat similar to *Plicatounio* (*s. s.*). However, the right valve of *Nippononaia ryosekiana* possesses only one large pseudocardinal tooth, while two pseudocardinals are distinct in the right valve of *Plicatounio* (*Plicatounio*) *naktongensis* KOBAYASHI and SUZUKI, 1936, and probably also in other species of *Plicatounio*. *Nippononaia* is clearly distinguishable from *Trigonioides* KOBAYASHI and SUZUKI, 1936, by the larger ratio of length/height, the undeveloped subumbonal pseudocardinal teeth and the non-crenulated posterior lateral teeth.

The surface sculpture of *Nippononaia* is quite different from that of *Plicatounio*, which is characterized by several broad radial plications on the posterior part instead of clear-cut V-shaped ribs. In this respect *Nippononaia* is much closer to *Trigonioides*. Although superficially similar V-shaped ornaments are seen also in some unrelated marine pelecypods such as *Goniomya* AGASSIZ, 1838, *Acila* H. and A. ADAMS, 1858, *Heteroglypta* VON MARTENS, 1880, *Vaugonia* CRICKMAY, 1930, *Glyptoleda* FLETCHER, 1945, *Undulomya* FLETCHER, 1946, and *Pentagrammysia* TSCHERNYSCHEW, 1950, the close resemblance of ornamentation indicates an intimate phylogenetical relationship between *Nippononaia* and *Trigonioides*.

Anyhow, *Nippononaia* should be regarded as a distinct genus of the Trigonioididae COX, 1952. The following species have been described under the generic name of *Nippononaia* besides the type-species.

1. *Nippononaia asinaria* REESIDE, 1957, Lower Cretaceous (probably Aptian), Burro Canyon formation, west Colorado.
2. *Nippononaia* sp. by REESIDE, 1957, Lower Cretaceous (probably Aptian), Burro Canyon formation, west Colorado.
3. "*Nippononaia*" *wakinoensis* OTA, 1959, Lower Cretaceous, Wakino subgroup of the Kwanmon group, north Kyushu.
4. "*Nippononaia*" *sengokuensis* OTA, 1959, Lower Cretaceous, Wakino subgroup of the Kwanmon group, north Kyushu.
5. "*Nippononaia*" *wakinoensis intermedia* HASE, 1960, Lower Cretaceous, Wakino subgroup of the Kwanmon group, north Kyushu.
6. "*Nippononaia*" (?) *obsoleta* HASE, 1960, Lower Cretaceous, Shimonoseki subgroup of the Kwanmon group, west Honshu.
7. *Nippononaia tetoriensis* MAEDA, 1962, Upper Jurassic or Lower Cretaceous, Itoshiro subgroup of the Tetori group, central Japan.
8. *Nippononaia mekongensis* KOBAYASHI, 1963, (?) Lower Cretaceous, upper (or middle) part of the Khorat series, east Thailand.

Of these species, the third (including the fifth subspecies) and fourth species were excluded by OTA (1963) from *Nippononaia* and considered to constitute *Wakinoa* OTA, 1963, a subgenus of *Trigonioides*. The sixth species may be also assignable to *Trigonioides* (*Wakinoa*). The hinge structure of the eighth species is imperfectly known, but it may belong also to *Wakinoa*, because the posterior lateral teeth were said to be crenulated (KOBAYASHI, 1963, p. 39).

There are some different opinions as to the systematic position and phylogeny of *Trigonioides* and *Nippononaia*. KOBAYASHI and SUZUKI (1936) and KOBAYASHI (1956, 1963) regarded *Trigonioides* as an aberrant and land-locked genus derived from a certain trigoniid. As noted above, SUZUKI (1941, 1943) assigned *Nippononaia* as a member of the Unionacea, suggesting that the resemblance between *Trigonioides* and *Nippononaia* might be superficial.

On the other hand, COX (1952, p. 45) introduced for *Trigonioides* and *Hoffetrigonia* a new family name Trigonioididae, which was considered by him to be more appropriately placed in the Unionacea than in the Trigoniacea. Although the family was once withdrawn by himself (1955, p. 348), it was revived by KOBAYASHI (1956) and subsequent investigators. COX (1955) emphasized again the resemblance of the hinge structure between "*Trigonioides*" and some groups of *Unio* and between *Hoffetrigonia* and *Castalia*, suggesting that "*Trigonioides*" and *Hoffetrigonia* bear no intimate relationship to the Trigoniidae. Unfortunately his specimen illustrated as "*Trigonioides kodairai*" (COX, 1955, text-fig. 1A; KOBAYASHI, 1956, pl. 5, fig. 3) is actually not a true *Trigonioides*, but probably belongs to *Plicatounio* (*Plicatounio*) *naktongensis*, as pointed out by KOBAYASHI (1956, p. 80). It has no strong subumbonal teeth which are characteristically developed in *Trigonioides* (*s. s.*). However, COX's opinion on the systematics of this pelecypod group was still clearly expressed in his treatment of *Hoffetrigonia* SUZUKI, 1940, which is now regarded as a subjective synonym of *Trigonioides*.

KOBAYASHI (1956) described the dentition of *Trigonioides* in detail, and expressed the disposition of hinge teeth by means of the following dentition formula:

$$\frac{5a\ \ 3a\ \ (1a+1b)\ \ 3b}{4a\ \ 2a\ \ 1'\ \ 2b}$$

or

$$\frac{5a\ \ 3a\ \ (1a+1b)\ \ 3b}{4a\ \ 2\ \ \ \ \ \ 4b}$$

He compared the dentition with that of the Trigoniidae*, suggesting again that *Trigonioides* was derived from the Trigoniidae. He interpreted the teeth 1a+1b and 1′ of *Trigonioides* (*s. s.*) to be terminal products which were added to the hinge of the Trigoniidae, and suggested that *Nippononaia* was possibly derived from *Trigonioides* by the broadening of the shell and by the effacement of the subumbonal pseudocardinal teeth.

Subsequently KOBAYASHI's notation on the hinge of *Trigonioides* was followed by OTA (1959) and MAEDA (1963) with slight modifications. OTA (1959a) described the dentition of *Wakinoa* (="*Nippononaia*" at that time), giving the following notation in correspondence with KOBAYASHI's denomination on the hinge of *Trigonioides*:

$$\frac{5a\ \ 3a\ \ \ \ \ \ \ \ \ \ 3b\ \ 5b}{(4a)\ \ 2a\ \ (1')\ \ 2b\ \ 4b}$$

MAEDA (1962) expressed the dentition of *Nippononaia tetoriensis* MAEDA by means of the following formula:

$$\frac{(5a)\ \ 3a\ \ \ \ \ \ 3b\ \ (5b)}{4a\ \ 2a\ \ 2b\ \ 4b}$$

OTA (1963), on the contrary, gave the posterior lateral teeth of *Plicatounio* and *Trigonioides* distinct letters from the pseudocardinal teeth as follows**:

Trigonioides (*s. s.*) .....

$$\frac{(5)\ \ 3\ \ 1a\ \ (1b)\ \ \ \ \ \ PI}{(4)\ \ 2\ \ 1'a\ \ (1'b)\ \ PII\ \ PIV}$$

Trigonioides (*Wakinoa*) .....

$$\frac{5\ \ 3\ \ (1)\ \ \ \ \ PI\ \ (PIII)}{(4)\ \ 2\ \ 1'\ \ PII\ \ PIV}$$

I agree with OTA (1963) in considering that some of the posterior lateral teeth may be actually homologous with those of heterodont pelecypods and not with the posterior cardinal teeth of trigoniids, because the posterior lateral teeth of the Trigonioididae are clearly separated from the pseudocardinals. It is, however, rather impossible to consider that the pseudocardinal teeth of the Unionidae and the Trigonioididae are essentially related to the cardinal teeth of heterodont pelecypods. As observed before (HAYAMI, 1962), the cardinal teeth of heterodont pelecypods are closely related to the anterior lateral teeth, but in the Trigonioididae there are no anterior lateral teeth. As deemed by COX (1955), BERNARD's notation of hinge teeth is not applicable for the Unionidae and the Trigonioididae. The letters, which have been individually given to the pseudocardinal teeth in the above cited dentition formulae of the Trigonioididae, should be interpreted to bear no relation to the notation on the cardinal and lateral teeth of heterodont pelecypods, although these formulae may express to a certain extent the general disposition of pseudocardinal and posterior lateral teeth in respective species.

I am of opinion that the teeth of the Trigonioididae are likewise independent of those of the Trigoniidae. The pseudocardinal teeth appear to be generally not so variable in the Trigonioididae as in the Unionidae. The pseudocardinal teeth of the Unionacea are, however,

* As shown by COX (1952, p. 47) and others, the notation, which has been customarily applied to the hinge of the Trigoniidae, is as follows: $\frac{(5a)\ \ 3a\ \ 3b}{4a\ \ 2\ \ \ (4b)}$

** "PI" and "PIII" in OTA's figures (1963, p. 501, figs. 2-6) should be interpreted as PIII and PV respectively. The parentheses for the teeth 4 are unnecessary.

not so fixed as the cardinal teeth of the Heterodontida and the Schizodontida and probably related to the "primitive lamellae" of Palaeozoic actinodont pelecypods.

OTA (1963) suggested a phylogenetical series, *Plicatounio* (*s. s.*) — *Plicatounio* (*Kwanmonia*)—*Trigonioides* (*Wakinoa*)—*Trigonioides* (*s. s.*) as the result of his study on the non-marine pelecypods from the Kwanmon group in north Kyushu. Because the surface ornamentation is quite different between *Plicatounio* (*s. s.* and *Kwanmonia*) and *Trigonioides* (*s. s.* and *Wakinoa*), the evolution from *Kwanmonia* to *Wakinoa* is not warranted here. However, I agree with him in considering that the peculiar dentition of *Trigonioides* (*s. s.*) may have derived from an unionoid hinge by the enlargement of the subumbonal pseudocardinal teeth. The hinge structure can be regarded as a rapidly evolving character in this case.

In the Kwanmon group, the first appearance of *Plicatounio* (*s. s.*), *Kwanmonia*, *Wakinoa* and *Trigonioides* (*s. s.*) are almost synchronous (OTA, 1963). In the Tetori group, *Nippononaia* appeared much earlier than *Trigonioides* (*s. s.*). To my regret, the correlation between non-marine formations of different areas is often very difficult owing to the scarcity of guide fossils. The order of stratigraphic occurrence of these genera and subgenera in one sedimentary basin may not always indicate their evolutional history. Nevertheless, it is certain that the maximum development of *Wakinoa* and *Nippononaia* seems to have taken place prior to that of *Trigonioides* (*s. s.*).

With regard to the hinge structure and other morphological characters *Trigonioides* (*Wakinoa*) appears to be transitional between *Trigonioides* (*s. s.*) and *Nippononaia*. In the type-species of *Wakinoa*, "*Nippononaia*" *wakinoensis* OTA, 1959, the pseudocardinal and posterior lateral teeth are strongly crenulated and the anterior pseudocardinal tooth of the right valve (5 in OTA's notation) is more clearly demarcated than in *Nippononaia ryosekiana*. They are, however, very similar in the general disposition of hinge teeth and the surface sculpture. In some respects it might be possible to consider that *Wakinoa* is a subgenus of *Nippononaia*. On the grounds of the morphological relationship and available stratigraphic evidence it is reasonable to presume alternatively that *Trigonioides* (*Wakinoa*) was a common ancestor of *Trigonioides* (*s. s.*) and *Nippononaia* or that *Trigonioides* (*s. s.*) was derived from *Nippononaia* through *Trigonioides* (*Wakinoa*). *Hoffetrigonia* SUZUKI, 1940 (type-species: *Trigonioides kobayashi* HOFFET) is, as pointed out by KOBAYASHI (1956), probably a synonym of *Trigonioides* (*s. s.*), but it might constitute an infrageneric group for some Senonian species with large dimensions and well developed subumbonal pseudocardinal teeth. The ancestry of the Trigonioididae is still an unsolved problem, but it should be sought in Upper Jurassic and earlier species of the Naiadida instead of the Schizodontida.

Trigonioididae COX, 1952, have been regarded as a distinct and valid family by KOBAYASHI (1954, p. 74; 1956, p. 89), OTA (1959, p. 100), MAEDA (1963, p. 80) and OTA (1963, p. 511), although the name was withdrawn by COX (1955). Unfortunately, COX (1952) and these subsequent authors failed to give any clear diagnosis of the Trigonioididae, although the relationship of this family to certain families of the Unionacea and Trigoniacea were discussed repeatedly by them. The diagnostic characters of the Trigonioididae in my conception can be sum-

marized as follows:

Shell commonly medium-sized, subtrigonal to elongate-ovate, longer than high; lunule and escutcheon not defined, though sometimes a week carina extends along the postero-dorsal margin; umbo low, orthogyrous; ligament opisthodetic, external; surface commonly ornamented with characteristic sculpture scribing Vs on the middle part; antero-dorsal and postero-dorsal peripheral areas commonly provided with upward curving short riblets; hinge of unionoid type, composed of several crenulated pseudocardinal teeth and posterior lateral teeth: posterior lateral teeth clearly separated from the pseudocardinal teeth, never forming an echelon as in some groups of the Unionidae; subumbonal pseudocardinal teeth may or may not developed; umbonal cavity shallow.

The Trigonioididae, as defined above, include *Nippononaia* besides *Trigonioides*. The distribution of this family seems to be confined almost to the Cretaceous non-marine formations of eastern Asia.

References

ARAI, Fusao, TAKEI, Kensaku, HOSOYA, Hisashi and TAKAHASHI, Kiyoshi (1958): Considerations concerning the ripple marks discovered in the Sanchu graben. *Earth Sci. (Chikyu Kagaku)*, (40), 1-12, pls. 1-4.

COX, Leslie R. (1952): Notes on the Trigoniidae, with outlines of a classification of the family. *Proc. Malacol. 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.

—— (1960): Thoughts on the classification of the Bivalvia. *Proc. Malacol. Soc. London*, 34, (2), 60-88.

HASE, Akira (1960): The Late Mesozoic formations and their Molluscan fossils in west Chugoku and north Kyushu.

Explanation of Plate 17

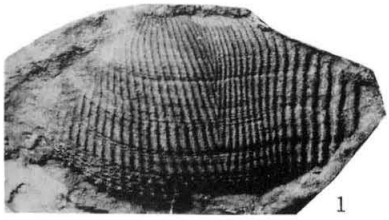
Figs. 1-8. *Nippononaia ryosekiana* (SUZUKI) ..... p. 147

1. Plaster cast from a left external mould (GT. paratype) ×1.5. Loc. uncertain.
2a. Left internal mould (GT. holotype) ×1.5. Loc. uncertain.
2b. Plaster cast from the same specimen (GK. H6765) ×1.5.
3a. Left valve (GK. H6755) ×1.5. Loc. middle course of Hachimanzawa, near Sebayashi, Nakazato village, Tano County, Gumma Prefecture.
3b. Upper view of the same specimen, ×1.5.
4. Deformed left valve (GK. H6760) ×1.5. Loc. ditto.
5. Deformed left valve (GK. H6759) ×1.5. Loc. ditto.
6. Deformed left valve (GK. H6762) ×1.5. Loc. ditto.
7. Deformed left valve (GK. H6761) ×1.5. Loc. ditto.
8. Deformed right valve (GK. H6758) ×1.5. Loc. ditto.

Figs. 9, 10. *Protocyprina* sp. indet. ..... p. 149

9. Immature right valve (GK. H6764) ×1.5. Loc. ditto.
10. Deformed bivalved specimen (GK. H6763) ×1. Loc. ditto. 10a: right view, 10b: left view.

The specimens in Figs. 1 and 2 are preserved in the Geological Institute, University of Tokyo, and those in Figs. 3-10 are kept in the Department of Geology, Kyushu University. Photos by ICHIKAWA (Figs. 1, 2) and by HAYAMI (Figs. 3-10).



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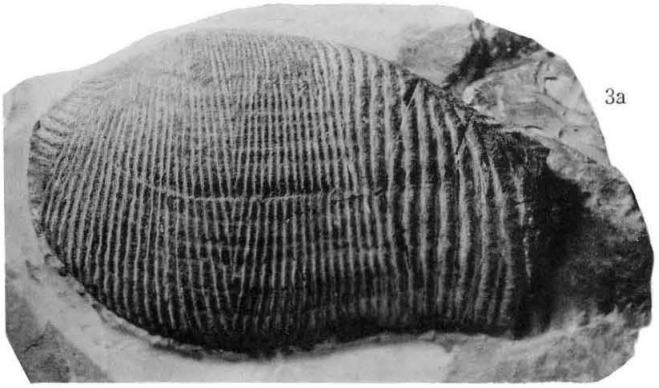
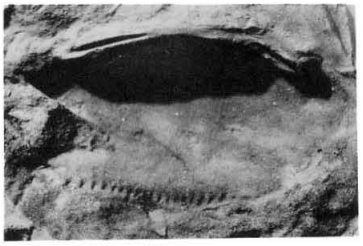
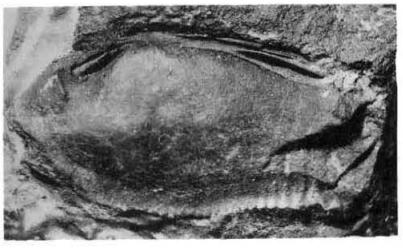


3a



2b

3b



2a

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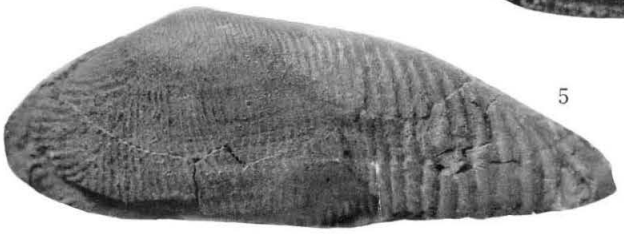

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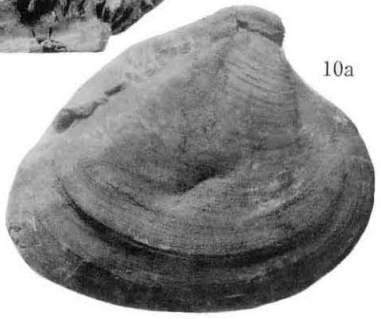
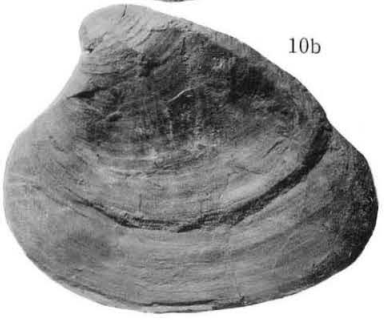


10a



10b

Jour. Sci., Hiroshima Univ., [C], 3, (2), 281-342, pls. 31-39.

HAYAMI, Itaru (1962): On the dentition formulae of heterodont pelecypods. *Fossils (Kaseki)*, (4), 67-78. (in Japanese)

HAYAMI, Itaru and NAKAI, Isao (1965): On a Lower Cretaceous pelecypod, "*Cyrena*" *naumanni*, from Japan. *Trans. Proc. Pal. Soc. Japan*, N.S., (59), 114-125, pls. 13, 14.

KOBAYASHI, Teiichi (1954): Studies on the Jurassic trigonians in Japan. Part 1. Preliminary notes. *Japan. Jour. Geol. Geogr.*, 25, (1-2), 61-80.

—— (1956): On the dentition of *Trigonioides* and its relation to similar pelecypod genera. *Ibid.*, 27, (1), 79-92, 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.

KOBAYASHI, Teiichi and SUZUKI, Kôiti (1936): Non-marine shells of the Naktong-Wakino series. *Ibid.*, 13, (3-4), 234-257, pls. 27-29.

MAEDA, Shiro (1962): On the occurrence of *Nippononaia* in the Late Mesozoic Tetori group. *Trans. Proc. Palaeont. Soc. Japan*, N.S., (46), 243-248, pl. 38.

—— (1963): *Trigonioides* from the Late Mesozoic Tetori group, central Japan. *Ibid.*, N.S., (51), 79-85, pl. 12.

MATSUMOTO, Tatsuro (1947): The geologic research of the Aritagawa valley, Wakayama Prefecture—A contribution to the tectonic history of the Outer Zone of Southwest Japan. *Sci. Rept., Fac. Sci. Kyushu University, Geol.*, 2, (1), 1-12 (in Japanese)

—— (1963, ed.): A survey of fossils from Japan illustrated in classical monographs. 57 pp., 68 pls. Palaeont. Soc. Japan, 25th Anniversary Volume.

NAUMANN, E. and NEUMAYR, M. (1890): Zur Geologie und Paläontologie von Japan. *Denkschr. Math.-Naturw. Cl., Kaiserl. Akad. Wiss.*, 57, 1-41, pls. 1-5.

OTA, Yoshihisa (1959): *Trigonioides* and its classification. *Trans. Proc. Palaeont. Soc. Japan*, N.S., (34), 97-104, pl. 10.

—— (1959a): On the "*Nippononaia*" from the Lower Cretaceous Wakino subgroup, north Kyushu, Japan. *Ibid.*, N.S. (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.

REESIDE, John B. (1957): Non-marine pelecypod (*Nippononaia asinaria*) from the Lower Cretaceous of Colorado. *Jour. Paleontology*, 31, (3), 651-653.

SUZUKI, Kôiti (1941): A new naiad, *Unio* (*Nippononaia*) *ryosekiana*, n. subgen. and n. sp., from the Lower Cretaceous of Japan. *Jour. Geol. Soc. Japan*, 48, (575), 410-413 (*Trans. Palaeont. Soc. Japan*, (128), 58-61)

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

TAKEI, Kensaku (1963): Stratigraphy and geological structure of the Cretaceous System in the eastern part of the Sanchû graben, Kwanto mountainland. *Jour. Geol. Soc. Japan*, 69, (810), 130-146.

VOKES, Harold Ernest (1946): Contributions to the paleontology of the Lebanon mountains, Republic of Lebanon. Part 3. The pelecypod fauna of the "Olive locality" (Aptian) at Abeih. *Bull. American Museum Nat. Hist.*, 87, (3), 143-215, pls. 1-10.

YABE, Hisakatsu, NAGAO, Takumi and SHIMIZU, Saburo (1926): Cretaceous Mollusca from the Sanchu graben in the Kwanto mountainland, Japan. *Sci. Rept. Tohoku Imp. Univ.* [2], 9, (2), 33-76, pls. 12-17.

Locality guide

Hachimanzawa, near Sebayashi, south of Kagahara, Nakazato village, Tano County, Gumma Prefecture (138°55′E, 36°01′N) 群馬県多野郡中里村神ヶ原南方瀬林八幡沢

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 60, pp. 156–165, pls. 18, 19, Dec. 20, 1965

496. SHELL STRUCTURE OF JAPANESE SMALLER FORAMINIFERA PART 1. *AMMONIA TOCHIGIENSIS* (UCHIO, 1951)*

HIROSHI UJIIÉ

Department of Paleontology, National Science Museum, Tokyo

日本産小型有孔虫類の殻構造；その1. *Ammonia tochigiensis* (Uchio, 1951)：この一連の研究は，日本とその近海原産の化石および現生有孔虫を主な材料として，それらの殻の微細構造を調べて記載すると共に，有孔虫の自然分類体系確立の一助にしようとするものである。はじめに *Rotalia tochigiensis* Uchio を調べて再記載し，それが *Ammonia* 属であること，また従来の同属の定義を少し拡張せねばならないことなどを明らかにした。なお，同種が本邦中下部中新統の特徴種であることを明示し，その原産地では，死殻堆積時に淘汰作用をうけた可能性のある点を指摘した。 氏家 宏

Introduction

Many authors, especially in Japan, have identified the smaller Foraminifera based upon the superficial observations of the external characters. However, on the other hand, a few authors have investigated the details of construction of the Foraminiferal test and incorporated such structure in the classifications and this procedure is being progressed in the last several years. Among them, the most recent and synthetic system was published by LOEBLICH *et al.* (1964), who referred to the investigations published up to 1960. As the result, the systematics incorporating the internal structure may somewhat different from the current taxonomy. The new system, however, is considerably complicate and contains room for re-examination in some parts. Therefore, a more assignment of a taxonomic name used in the new system to any old taxon would result in error and in providing more confusion in further research.

Under this situation, it is necessary that the Japanese micropaleontologists should examine the details of the Japanese Foraminiferal tests. The writer has paid attention to the detailed construction of the Foraminifera, since he published a short note on the internal structure of Elphidiidae in 1956. For the stated reasons, the writer deems it important to study the shell structure of the Japanese Foraminifera as a serial work.

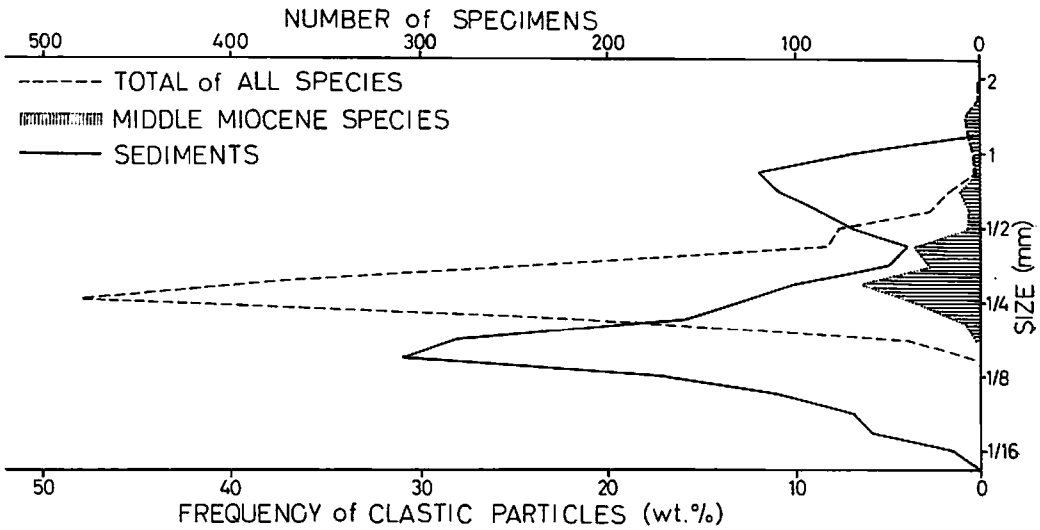
At the beginning of this serial work, the writer wishes to state that he welcomes the suggestions of all micropaleontologists and would also desire the cooperation of those persons interested in the project.

Material

Rotalia tochigiensis re-examined here was described from the Momiyama Sandstone Member of the Kanuma Formation

* Received May 11, 1965; read January 24, 1965 at Tokyo.

at 600 m northwest of Momiyama Station of the Tôbu Line in Tochigi Prefecture by UCHIO (1951), who reported its occurrence to be common in a population picked up from the rock-residues on a sieve of 100 mesh. In another population obtained from the residues on the 200 mesh screen by the writer from the same locality as that of UCHIO, relatively few specimens of this species were found in association with those of *Gaudrynella tsuchidai*, *Vaginulina otukai*, *Nonion boueanum* var. *multilobum*, *Elphidiella momiyamensis*, *Bolivina asanoi*, and *Eponides tanaii*. They have been recognized to be characteristic species in the Japanese Middle Miocene. The cause of the difference between composition of the two faunal populations mentioned above may be understood from Text-fig. 1, where there is shown the size-frequency distribution of the foraminiferal tests in the population obtained by the writer. The frequency



Text-fig. 1.

curve is bimodal with a minimum at about 0.9 mm in shell-diameter. It is interesting that a component of the larger sized shells is mostly composed of the Middle Miocene species mentioned above, while another one consisting of the smaller shells comprises a few Miocene species and many "Recent species" which yet survive in the Recent sea. Mechanical analysis of the sediments, in which the foraminiferal tests were found, also shows a bimodal size-frequency distribution which is quite comparable with that of the foraminiferal tests. According to HJULSTRÖM's experiment (1939) using spheric particles of quartz, the particles with a diameter exceeding 0.5 mm show greater erosion velocity with the increase in their size; the erosion velocity also increases in the particles smaller than 0.5 mm. Such a critical size as 0.5 mm might correspond to the shell-diameter (ca. 0.9 mm) of the minimum in Text-fig. 1, because the empty shell of the Foraminifera must have lighter weight than specific gravity of quartz. Therefore, the writer cannot easily decide whether the larger shells

composed of the "Miocene species" are endemic in this locality and the smaller shells mainly composed of the "Recent species" are exotic being derived from an adjacent area or whether the reverse case is true. In any case, the large specimens of these Miocene species were damaged or abraded at least in parts and the specimens of their young forms are so rare that their ontogenetic development may be difficult to be clarified.

Fortunately, the writer found abundant specimens of these "Miocene species" in the Tate Conglomerate and Sandstone Member of the Kadonosawa Formation at about 500 m south of the village of Shiratori, Fukuoka-machi, Ninohe-gun, Iwate Prefecture. Shells ranging from juvenile to full-growth of *Rotalia tochigiensis* were common in occurrence. Thereby, the writer used these materials for his investigation on the shell construction.

Short Notes on the Distribution

Since *Rotalia tochigiensis* was described in 1951, it has been reported from the undermentioned localities in Japan (see Text-fig. 2 also):

1: The siltstone of the Wakkauenbetsu Formation, in the Shintotsugawa area, Kabato-gun, Hokkaidô (ASANO, 1953b).

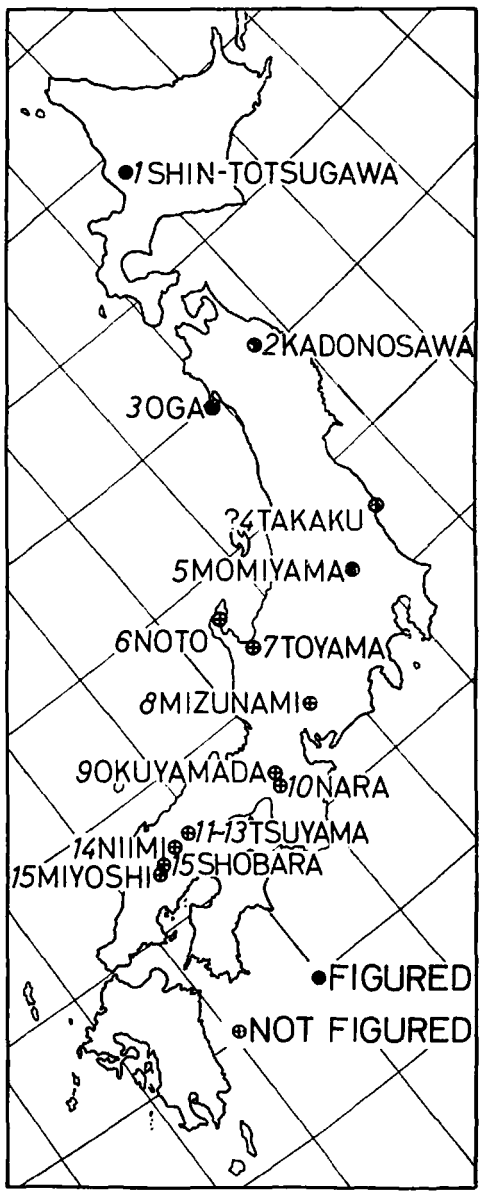
2: The Tate Member of the Kadonosawa Formation, where there is found the co-occurrence of very small sized *Miogypsina* cf. *kotoi* HANZAWA.

3: The Nishikurosawa Formation in the Oga Peninsula, Akita Prefecture (MATSUNAGA, 1963).

*4: The Numanouchi Formation of the Takaku Group in Taira City (FUKUTA, 1955).

5: The Momiyama Sandstone Member of the Kanuma Formation (type locality), with rare *Miogypsina*.

*6: The Higashi-innai Formation in Yanagida-mura, Fugeshi-gun, in the Noto Peninsula (ASANO, 1953a).



Text-fig. 2.

*7: The Tochitsu and Sunagosaka Alternations and the Nakanami Member at several places in Toyama Prefecture (CHIJI, 1961). The former two formations are in the *Nonion-Rotalia* Zone of CHIJI (1961), who correlated it with the so-called *Miogypsina-Operculina* horizon or zone, whereas the Nakanami Member occurs just above this zone.

*8: The Shukunohora Formation and the lowermost part of the Oidawara Formation in the Mizunami Group in Mizunami City (TAI, 1958). The former formation contains *Miogypsina kotoi* very abundantly at different localities.

*9: The Shiodani Sandstone Member of the Yuantani Formation of the Tsuzuki Group in the area of Okuyamada, Kyôto Prefecture (TAI, 1959).

*10: The Toyoda Formation of the Fujiwara Group in Nara City (TAI, 1957).

*11-13: The Katsuta Formation in the Tsuyama Basin, Okayama Prefecture (TAI, 1954 and 1959).

*14: The Lower sandstone of the Bihoku Group south of Niimi City (TAI, 1957).

*15: The Lower sandstone of the Bihoku Group in the Shôbara Basin, Hiroshima Prefecture (TAI, 1953).

*16: The Lower sandstone of the Bihoku Group in the Miyoshi Basin, Hiroshima Prefecture (TAI, 1957).

Rotalia tochigiensis was only listed from the localities marked with asterisk and, therefore, there is room to ascertain its true occurrence. All of the strata with it are nearly restricted within the so-called *Miogypsina kotoi—Operculina complanata japonica* Zone; a typical Middle Miocene zone of Japan. According to SAITO's comprehensive work (1963) on the planktonic Foraminifera in the Japanese Miocene, this zone corresponds to the *Globorotalia fohsi barisanensis* Zone. Standing on the present age-consideration, the rare occurrence of it in the Takaku Group may be doubtful.

It seems to the writer that the correlation of the Tertiary rocks within the Japanese Islands is quite possible should such a benthonic smaller Foraminifera with complicate shell structure be used. Further, the neritic habitat of *Rotalia tochigiensis*, which is known only from an inner neritic environment judging from the associated fossils and from the lithofacies (sandstone to sandy siltstone) may serve as an important paleoecological indicator.

Generic Position from View-point of Shell Structure

Many species hitherto considered to belong to the so-called *Rotalia* should be transfered to other genera, *e.g. Ammonia, Pseudorotalia, Pararotalia, Asterorotalia, Cuvillierina, Notorotalia*, etc., because the type species of *Rotalia*, *i.e. Rotalites trochidaeformis* LAMARCK, has several special and rather unique characters in comparison with other "*Rotalia*" as shown already by DAVIES (1932), SMOUT (1954), REISS and MERLING (1958), and others. The most common species of "*Rotalia*", namely *Nautilus beccarii* LINNÉ including its allies, had been placed by authors frequently under the generic name of *Streblus* FISCHER DE WALDHEIM, 1817. That genus was, however, preoccupied and suppressed by *Ammonia* BRÜNNICH, 1772, with the same type species (*N. beccarii*) as *Stre-*

blus, as discussed in detail by FRIZZELL and KEEN (1949).

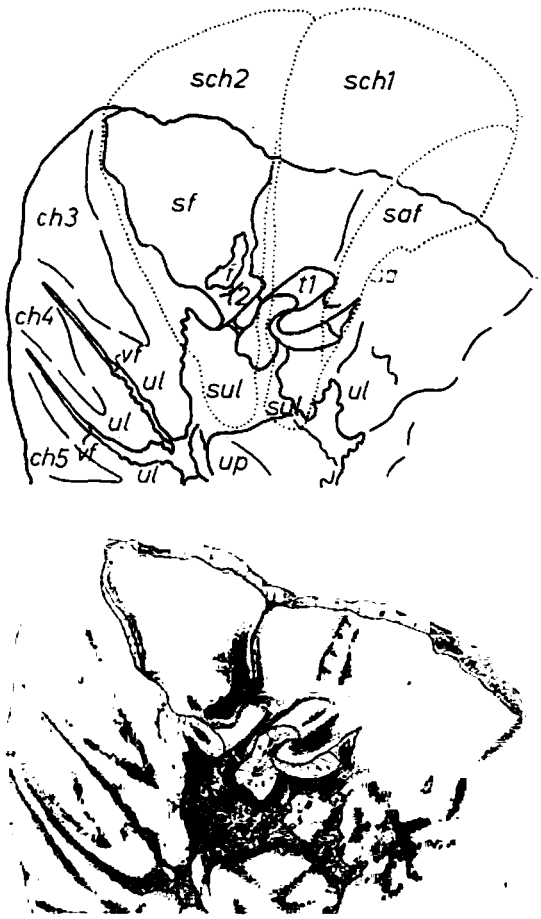
Rotalia tochigiensis UCHIO, 1951, was stated in the original work resemble *Ammonia beccarii* (LINNÉ) in morphological features and therefore both species were considered as congeneric. As supplemental to the original description, however, it should be added that the internal structure of "*Rotalia*" *tochigiensis* shows a tendency to lean towards that of *Pseudorotalia* REISS and MERLING, 1958.

In the type species of *Pseudorotalia*, namely *Rotalia schroeteriana* CARPENTER, PARKER and JONES, 1862, REISS and MERLING (1958) found that the tooth plate at its most distal and free end forms a backwards directed fold and it and other features show also some other distinctions from other species of "*Rotalia*". The characteristic features of *Pseudorotalia* were clearly shown by REISS (1963) as being the sutural canals in both spiral and umbilical cavities. On the other hand, *Ammonia* has persistently open fissures around the umbilical plug and along the ventral sutures. HOFKER (1951) already regarded the present ventral fissures (his sunken ventral sutures) as the beginning of the sutural canals, probably, plus the umbilical cavities (his umbilical canal system). Supporting this view, the insufficiently closed septal spaces and umbilical cavities were recognized in *Turbinulina gaimardii* FORNASINI, 1906 (=*Rotalia papillosa* BRADY, 1884), a species which belongs to the genus *Pseudorotalia* according to the writer's observation of its shell structure (1963). And it and "*Rotalia*" *tochigiensis* show rather wide septal space comparable to that of *Pseudorotalia* on the umbilical side. "*R.*" *tochigiensis* also shows strong torsion of the tooth plate in a manner very similar to those of *Pseudorotalia schroeteriana* and *P. gaimardii* differing from the weak one of *Ammonia beccarii*. The shape of the intercameral foramen is very similar between "*R.*" *tochigiensis*, *P. schroeteriana*, and *P. gaimardii*, forming an interiomarginal and elongate opening, the umbilical half of which is apart from the base of the septum because of the well development of the tooth plate. The intercameral foramen of *A. beccarii* is a rather simple comma-shape (for example, see the "aperture on the penultimate chamber" of ISHIZAKI, 1943, and also HOFKER, 1950).

In a text-book published recently, LOEBLICH and TAPPAN (1964) described that *Pseudorotalia* differs from *Ammonia*, *Rotalia*, and *Lockhartia* in having sutural canals and in lacking umbilical aperture, which is also absent in *Ammonia* as shown by REISS and MERLING (1958) and in "*Rotalia*" *tochigiensis*. Besides, there are several discrepancies between LOEBLICH and TAPPAN's description of *Pseudorotalia* and its original one, which is also different somewhat from the writer's observation (1963) on *Pseudorotalia gaimardii* especially concerning the umbilical cavity or the ventral chamberlet. These problems, however, shall be clarified in another work on the shell structure of other "*Rotalia*" in the near future. The diagnosis of *Ammonia* by LOEBLICH and TAPPAN also includes several questionable points as follows: "—septa primarily double; wall calcareous, finely perforate, radial in structure; umbilical surface with irregular granules along suture and over umbilical region; umbilicus with open umbilical fissures and plug in young forms, which is broken up into numerous fused pillars and bosses in adult specimens. —; aperture interiomarginal". Truly, however, the

septa is secondarily double as in *Pseudorotalia* and the statement on the aperture is simple too. The conditions of the wall-perforation, of the ornamentation of the umbilical surface, and of the umbilical plug shown by both authors appear to be seen only in *Ammonia beccarii* (see Remarks). These features may be less important as generic characters.

Thus, it may be concluded that "*Rotalia*" *tochigiensis* should be included into the limits of *Ammonia* (*sensu lato*) but shows a slight tendency in its structural features to lean towards its allied genus, *Pseudorotalia*.



Text-figs. 3a, b.

sch 1 and *sch 2*:—supposed last and penultimate chambers, *ch 3* to *ch 5*:—ante-penultimate and preceding chambers in the last volution, *sul*:—supposed "umbilical lip", *ul*:—"umbilical lip", *vf*:—ventral fissure, *up*:—umbilical plug, *saf*:—supposed apertural face, *sa*:—supposed aperture, *sf*:—septal face, *f*:—septal foramen between the penultimate and the ante-penultimate chambers, *t'*:—incomplete tooth plate dividing the last sector into chamber lumen and umbilical space under the "umbilical lip", *t 1*:—complete but broken tooth plate, *t 2*:—protruded part of the ante-penultimate tooth plate, into the penultimate chamber from the penultimate septal face (*sf* of this figure).

Description

Family Rotaliidae EHRENBERG, 1838

Genus *Ammonia* BRÜNNICH, 1772

Ammonia tochigiensis (UCHIO, 1951)

Text-figs. 3a, b; Pl. 18, figs. 1-7; Pl. 19, figs. 1-5

Rotalia tochigiensis UCHIO, 1951, pp. 374-376, pl. 5, figs. 1a-c.—ASANO, 1951, text-figs. 17a, b.

Cf. *Rotalia tochigiensis* MATSUNAGA, 1963 (not UCHIO), pl. 52, figs. 9a-c.

Description:—Test free, biconvex to plano-convex, low trochospiral coil of three or four volutions, periphery round; spiral sutures not limbated but depressed; chambers numerous, increase up to 16 per one volution with shell-growth; interiomarginal sutures not limbated, considerably raised on spiral side owing to deposition of clear and imperforate shell substance, deeply depressed on umbilical side, forming

open ventral fissures; intercameral septa imperforate, secondarily double, leaving open space on umbilical side but perfectly closed and then boundary of two lamellae indistinct on spiral side; wall coarsely perforate, of radially fibrous calcite; spiral and umbilical surfaces rather smooth, without distinct ornamentation; umbilicus with open umbilical-ventral fissures and a large central plug throughout, umbilical plug extending inward to proloculus, forming a single clear pillar of shell substance without canal; aperture interiomarginal-basal narrow slit on umbilical side, its umbilical end continuing to slit beneath "umbilical lip"; interiomarginal foramen converted from aperture, probably by partial resorption of apertural face slightly before addition of new chamber, elongate opening, umbilical part of which is apart from base, becomes discontinuous to slit under "umbilical lip" within same sector and, after formation of new chamber, strongly torted free margin added, extending forward first and then folding backward quickly; "umbilical lip" imperforate, clear, extending from chamber-wall within same sector, covering a part of umbilicus, leaving posterior and anterior slits (="labial aperture") but no umbilical one.

Hypotypes:—Reg. Nos. (Department of Paleontology, National Science Museum) 5580 to 5596, from the Tate Member of the Kadonosawa Formation at about 500 m south of the village of Shiratori, Fukuoka-machi, Ninohe-gun, Iwate Prefecture. All specimens figured in this paper are from this locality. Reg. Nos. 5597 to 5599, from the Momiyama Sandstone Member of the Kanuma Formation

Explanation of Plate 18

(Figs. 1–4: ×40; figs. 5–7: ×100)

Figs. 1–4. External views showing shell growth. The characters are rather constant in every point except for the increasing of the number of chambers per one volution. a: spiral side, b: umbilical side, c: apertural side.

Fig. 1. Full-grown specimen with obscure aperture owing to the adhersion of rock matrix; Reg. No. 5580.

Fig. 2. Adult with aperture of an interiomarginal-basal slit, whose umbilical end continues to the slit under the "umbilical lip": Reg. No. 5581.

Fig. 3. Specimen with a doubtful aperture, because it has the shape of an intercameral foramen; Reg. No. 5582.

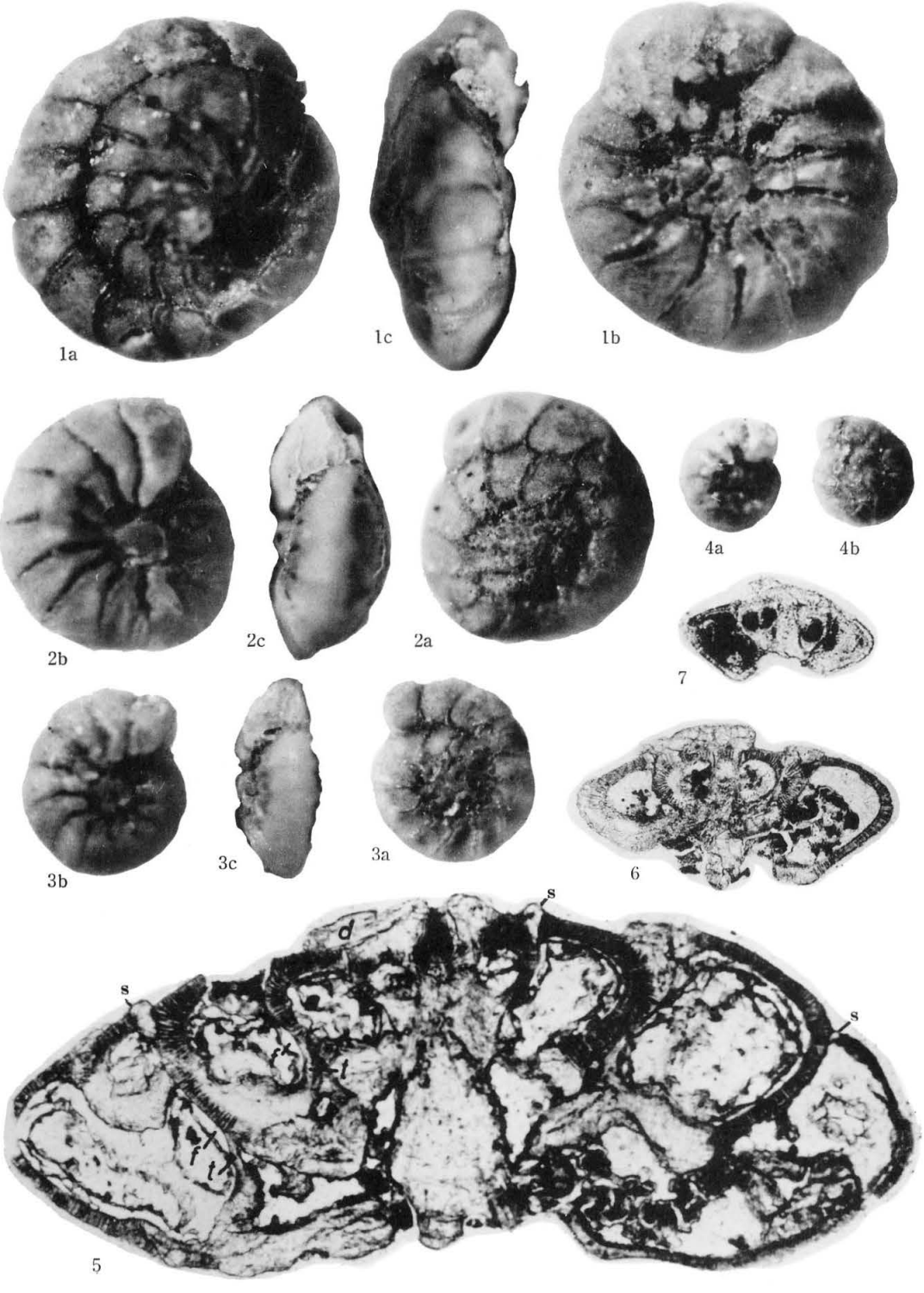
Fig. 4. Young specimen with an aperture of interiomarginal-basal slit; Reg. No. 5583.

Figs. 5–7. Vertical sections showing shell growth.

Fig. 5. Full-grown adult with coarsely perforate spirothecal wall, imperforate and clear septal wall and "umbilical lip", which covers the umbilical cavity, and a single but large transparent umbilical plug. At some junctions of the spirothecal wall upon the previous volution on the spiral side, there are often inserted small masses of clear shell substance (*s* in fig.); that is probably a part of the septal wall (*f*: intercameral foramen, *t*: tooth plate, *d*: secondary deposition of shell substance). Reg. No. 5586.

Fig. 6. Young specimen with the shell construction essentially similar to the full-grown one; Reg. No. 5588.

Fig. 7. Very young specimen with thin spirothecal wall and lacking the umbilical plug due to the deconstruction in preparation of the section; Reg. No. 5589.


1a
1c
1b
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2a
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4b
7
3b
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l
5

at 600 m northwest of Momiyama Station of the Tôbu Line in Tochigi Prefecture (Type locality). They are reposited in the National Science Museum, Tokyo, Japan.

Remarks:—Comparing this species with the figures of the topotypes of *Ammonia beccarii* (LINNÉ, 1758) illustrated by CUSHMAN (1928) of many different stages of the shell growth, UCHIO (1951) correctly pointed out that "—both young and adult tests of *R. tochigiensis* have a umbilical plugs, smooth surfaces and the sutures on the ventral side without ornamentation, while *R. beccarii* (L.) has smooth surfaces and no umbilical plug in young form, —, in the mature stage, the ventral plug is broken into several large bosses: —". Besides, he stated that the intercameral septa of the latter species are double because of the presence of depression on their sutures, from the simple limbate sutures of the former species. This procedure may be in need of reconsideration because of the misinterpretation of the true meaning of the "double septa" and of the "limbate sutures".

In addition to the difference of ornamentation, probably of specific level, the writer noticed that *Ammonia tochigiensis* has coarse perforation, whereas *Ammonia beccarii* has fine perforation. This difference in perforation has been often considered as worthy of generic distinction in Foraminiferal toxonomy. In the Rotaliidae, REISS and MERLING (1958) and REISS (1963) also regarded such kind of perforation to be worthy and described that the perforation of *Ammonia* is fine, and subsequently LOEBLICH and TAPPAN (1964) adopted this feature in their diagnosis of the genus *Ammonia*. However, the writer thinks that this criterion is not of generic value but is of specific level at least in this family. The perforation consists of protopores in both species.

Acknowledgements

The writer wishes to express his hearty thanks to Professor Kotora HATAI of the Tôhôku University and to Dr. Hiroshi OZAKI of the National Science Museum for their kind reviewing the manuscript. Thanks are also due to Dr. Shigeru AOKI of the Institution of Civil Engineering of the Tokyo Metropolitan Government for his kind gift of rock sample from the Kadonosawa Formation.

References

ASANO, K. (1953a): Miocene Foraminifera from the Shintotsugawa area, Kabato-gun, Hokkaidô. *Trans. Proc. Palaeont. Soc. Japan, N. S., no. 10*, pp. 45-54.

—— (1953): Miocene Foraminifera from the Noto Peninsula, Ishikawa Prefecture. *Short Paper Inst. Geol. Paleont., Tôhôku Univ., no. 5*, pp. 1-21, pls. 1-3.

CHIJI, M. (1961): Neogene biostratigraphy of the Toyama sedimentary basin, Japan Sea coast. *Bull. Osaka Mus. Nat. Hist., no. 14*, 88 pp., pl. 1.

CUSHMAN, J. A. (1928): On *Rotalia beccarii* (LINNÉ). *Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4*, pp. 103-107, pl. 15.

DAVIES, L. M. (1932): The Genera *Dictyoconoides* NUTTALL, *Lockhartia* nov., and *Rotalia* LAMARCK: their type species, generic differences, and fundamental distinction from the *Dictyoconus* group of forms. *Trans. Royal Soc. Edinburgh, vol. 57, pt. 2*, pp. 397-428, pl. 1-4.

FRIZZELL, D. L. and A. M. KEEN (1949): On the nomenclature and generic position of *Nautilus beccarii* LINNÉ (Foraminifera, "Rotaliidae"). *Jour. Paleont., vol. 23, no. 1*, pp. 106-108.

FUKUTA, O. (1955): On the Takaku Group in view of the micropaleontological

standpoint. *Bull. Geol. Surv. Japan, vol. 6, no. 11*, pp. 23-30 (in Japanese with English abstract).

HJULSTRÖM, F. (1939): Transportation of detritus by moving water, in TRASK's "Recent marine sediments". Publ. Soc. Econ. Paleont. Miner. pp. 5-31.

HOFKER, J. (1950): Wonderful animals of the sea, Foraminifera. *Amsterdam Naturalist, vol. 1, no. 3*, pp. 1-20.

—— (1951): The Foraminifera of the Siboga Expedition. Siboga Expeditie, Mon. IV, (c), Pt. 3, 513 pp.

ISHIZAKI, K. (1943): On the aperture of the Foraminiferal genus *Streblus*. *Trans. Nat. Hist. Soc. Taiwan, vol. 33, no. 235*, pp. 90-95 (in Japanese).

LEOBLICH, A. R. JR. and H. TAPPAN (1964): Sarcodina, chiefly "Thecamoebians" and Foraminiferida, in MOORE's "Treatise on invertebrate paleontology", pt. C, vol. 2. Publ. Geol. Soc. America and Kansas Univ. Press. pp. 513-900.

MATSUNAGA, T. (1963): Benthonic smaller Foraminifera from the oil fields of northern Japan. *Sci. Rep. Tôhôku Univ., 2nd ser., vol. 35, no. 2*, pp. 67-122, pls. 24-52.

REISS, Z. (1963): Reclassification of perforate Foraminifera. *Bull. Israel Geol. Surv., no. 35*, 111 pp., 8 pls.

—— and P. MERLING (1958): Structure of some Rotaliidae. *Ibid., no. 21*, 19 pp., 5 pls.

SAITO, T. (1963): Miocene planktonic Foraminifera from Honshû, Japan. *Sci. Rep. Tôhôku Univ., 2nd ser., vol. 35, no. 2*, pp. 123-209, pls. 53-56.

SMOUT, A. H. (1954): Lower Tertiary For-

Explanation of Plate 19

(×100)

Figs. 1-4. Horizontal sections showing shell growth. The most remarkable feature may be the gradual thickening of the septal wall and, especially, of the spirothecal wall in the inner volutions of the larger shells. This may be due to the accumulation of lamellae following shell growth as stated by SMOUT (1955) concerning the lamellar structure of his "rotaliid septa".

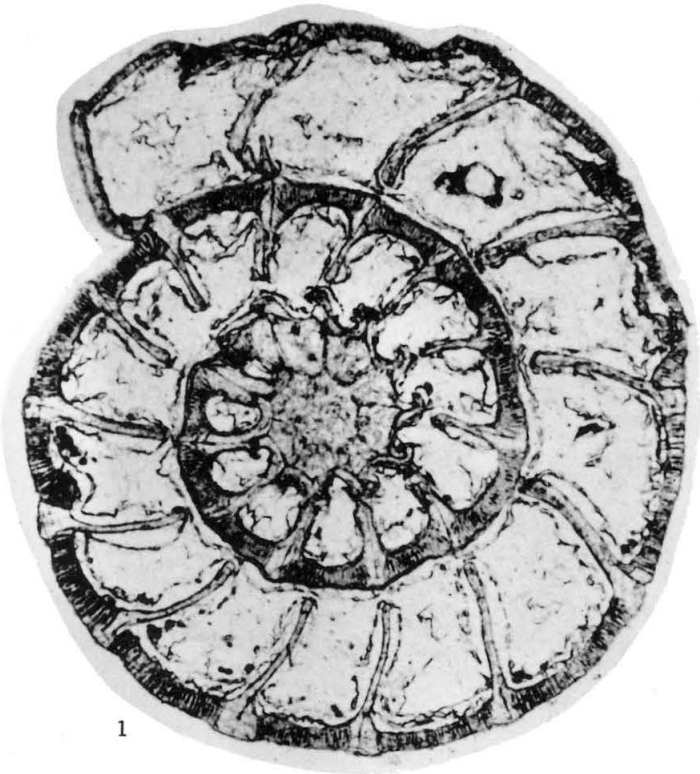
Fig. 1. Adult with coarsely perforate spirothecal wall and with constractingly imperforate walls of intercameral septum, of tooth plate, and of "umbilical lip", and of umbilical plug. There is recognized a simple passage of the intercameral foramen at the base of septal wall (namely, its proximal side) in the outer volution; the passage becomes apart from the base by the insertion of the torted tooth plate in the inner volution. This continuous change is due to that the plane of the section cuts more the umbilical side of the inner volution and, at the same time, the more spiral side of the outer volution of nearly biconvex test like this species. Another remarkable feature is that the apertural wall consists of one lamella but the intercameral septa consist of two lamellae leaving the closed septal space. As seen in the central part of this figure, there is hardly no open space in the umbilical-ventral fissure also. Reg. No. 5590.

Fig. 2. Adult cut at the more umbilical side than Fig. 1, showing considerably open spaces in septal walls and in umbilical-ventral fissures; Reg. No. 5592.

Fig. 3. Young specimen with shell construction very similar to that of the adult, especially, having torted tooth plate in the inner volutions; Reg. No. 5593.

Fig. 4. Very young specimen showing perforate spirothecal wall and imperforate septal wall; Reg. No. 5594.

Fig. 5. Vertical section of an adult showing shell construction very similar to Fig. 5 of Plate 18, but with considerably concealed umbilical cavities; Reg. No. 5587.



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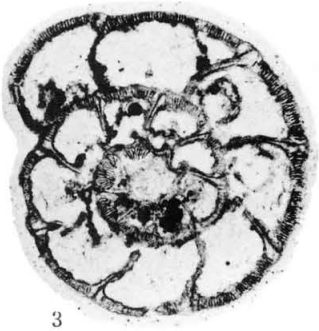
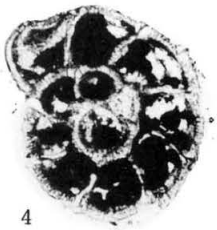


3



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2

5

aminifera of the Qater Peninsula. British Mus. (Nat. Hist.), London, 96 pp., 15 pls.

—— (1955): Reclassification of the Rotaliidae (Foraminifera) and two new Cretaceous forms resembling *Elphidium*. *Jour. Washington Acad. Sci., vol. 45, no. 7*, pp. 201–210.

TAI, Y. (1953): Miocene Foraminifera from the Shôbara Basin, Hiroshima Prefecture. *Jour. Sci. Hiroshima Univ., ser. C, vol. 1, no. 3*, pp. 1–9.

—— (1954): Miocene Foraminifera from the Tsuyama Basin, Okayama Prefecture, Japan. *Ibid., no. 4*, pp. 1–24, pl. 1.

—— (1957): Microbiostratigraphical study of the Cenozoic strata of the western Setouchi Province, Japan. *Geol. Rep. Hiroshima Univ., no. 5*, pp. 1–58 (in Japanese with English abstract).

—— (1958): On the "Togarian Stage"—Miocene microbiostratigraphy of the Setouchi geologic province. *Jour. Geol. Soc. Japan, vol. 64, no. 757*, pp. 516–525 (in Japanese with English abstract).

—— (1959): Miocene microbiostratigraphy of west Honshû, Japan. *Jour. Sci. Hiroshima Univ., sec. C, vol. 2, no. 4*, pp. 265–395, pls. 39–43.

UCHIO, T. (1950): Tertiary fossil fauna from Tochigi Prefecture (1). *Jour. Geol. Soc. Japan, vol. 56, no. 661*, pp. 455–458 (in Japanese with English abstract).

—— (1951): New species of Foraminifera of the Miocene age in Tochigi Prefecture, Japan. *Ibid., vol. 57, no. 671*, pp. 369–377, pl. 5.

UJIIÉ, H. (1963): Foraminifera from the Yûrakuchô Formation (Holocene), Tokyo City. *Sci. Rep. Tokyo Kyoiku Daigaku, sec. C, vol. 8, no. 79*, pp. 229–243, pls. 1–3.

Fugeshi-gun	鳳至郡
Fukuoka-machi	福岡町
Kabato-gun	樺戸郡
Miyoshi Basin	三次盆地
Momiyama Station	樅山駅
Ninohe-gun	二戸郡
Noto Peninsula	能登半島
Oga Peninsula	男鹿半島
Okuyamada	奥山田
Shintotsugawa	新十津川
Shiratori	白鳥
Shobara Basin	庄原盆地
Tôbu Line	東武線
Tsuyama Basin	津山盆地
Yanagida-mura	柳田村

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 60, pp. 166-171, pl. 20, Dec. 20, 1965

497. *ASANONELLA SHOJII* N. GEN., N. SP. (FAM. DISCORBIDAE) FROM TOKUNOSHIMA, KAGOSHIMA PREFECTURE, JAPAN*

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徳之島産化石有孔虫の一新属・新種：鹿児島県大島郡徳之島町亀津の亀津層より底棲有孔虫の新属・新種が発見されたので，*Asanonella shojii* と命名し，その記載並びに層位的，地理的分布とこれと共存する浮游性・底棲有孔虫化石群を報告する。　　黄　敦友

Introduction

While studying rock samples from the Kametsu Formation of Tokunoshima at the request of by Dr. Rikii SHOJI of the Department of Mining Engineering, Faculty of Engineering, Tohoku University the writer found a new genus and new species of Foraminifera. The same genus and species was also found by the writer in the samples from the Sanhsien-chi section of eastern Taiwan (1964) and from a Pliocene formation in southern Taiwan. Previously the writer referred the specimens here described as *Epistominella tubulifera* (HERON-ALLEN and EARLAND) (HUANG, 1964, pl. 3, figs. 1-2). However, from the present study it was found that in the thin section and dissected specimens of the species, the apertural characters and suture opening were arranged in special form. That is, the tooth of transparent shell material protrude from the previous spiral wall of the inner margin of the aperture. This structure, and other details which are described in this article indicate that the specimens are not related to the genus *Epistominella*, *Truncatulina* and *Eponides*, and should be described as new to science.

The many specimens of this interesting foraminifer remained unnoticed as to its precise taxonomic position because at first sight the structure of its test closely recalls certain other Rotaliid genera (*Epistominella*, *Eponides*, and *Truncatulina* etc.).

Based on the microstructure, lamellar characters and internal structures, this new genus should be placed in the family Discorbidae, Ehrenberg, 1838.

* Received May 21, 1965; read June 20, 1965 at Kanazawa.

Acknowledgements

The writer expresses his sincere gratitute to Professor Kiyoshi ASANO of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University for his kind guidance and advice on the taxonomy of the Foraminifera. Thanks are also due to Professor Kotora HATAI of the same Institute for the reading the manuscript and for his encouragement. He also thanks Dr. Yokichi TAKAYANAGI of the same Institute for his valuable discussions and encouragement. Special thanks are due to Assistant Pro-

fessor Rikii SHOJI of the Department of Mining Engineering, Faculty of Engineering, Tohoku University for kindly submitting his collection to the writer for study and for his kind information on the geology of Tokunoshima Island.

Acknowledgement is also made of the partial financial support of this investigation through a grant from the Japan Society for the Promotion of Science as part of the Japan—U.S. Cooperative Science Program.

Systematic Paleontology

Phyllum Protozoa

Class Sarcodina

Order Foraminiferida EICHWALD, 1830

Superfamily Discorbacea EHRENBERG, 1838

Family Discorbidae EHRENBERG, 1838

Subfamily Discorbinae EHRENBERG, 1838

Genus Asanonella HUANG, new genus

Genotype:—*Asanonella shojii* HUANG, n. sp.

Description:—Test free, trochospiral, lenticular to unequally biconvex, periphery subacute; chambers numerous, all chambers visible, sutures strongly oblique on dorsal side, generally radial on umbilical side; only final whorl visible; wall calcareous, perforate, with monolamellar character and radial structure; aperture elongate at interiomarginal part, margins round, extending from near umbilicus to near periphery, with poreless tooth protruding from previous spiral wall; supplementary sutural openings at ventral side of last few chambers.

Remarks:—The genus is named in honour of Professor ASANO, an eminent foraminiferalogist under whose direction the present work was accomplished.

This monotypic genus has the general outer form and wall structure similar to the genus *Discorbis*, but has a characteristic aperture with poreless apertural tooth. The morphological character, micro-structure and lamellar character observed in dissected specimens and thin section, indicate that this form belongs to the Discorbidae. The aperture is similar to the genus *Discorbis* established by LAMARCK in 1804, but the new genus shows different shape of the aperture which has a tooth of transparent shell material on the interiomarginal portion (pl. 20, figs. 1-2), and with round periphery of aperture.

Geologic and geographic distribution:—Mentioned under the new species described below.

Asanonella shojii, new species

Pl. 20, figs. 1-9

Holotype:—IGPS coll. cat. no. 86381 from locality No. 28, lat. 27°43′37″N., long. 129°1′13″E., a small cliff near the grounds of the Kametsu High School, Tokunoshima-chô (Figure 1), Kagoshima Prefecture, Kyushu, Japan. Kametsu Formation, Pleistocene.

Paratype:—IGSP coll. cat. nos. 86382-86385 from the same sample of the same locality as of the holotype.

Thin section:—Horizontal section (IGPS coll. cat. no. 86391) from the same sample and same locality of the holotype.

Description:—Test free, biconvex, slightly more elevated dorsally than ventrally, composed of about 2½ whorls all visible on dorsal side, only last-formed whorl visible on ventral side, early chambers obscured by ornamentation,

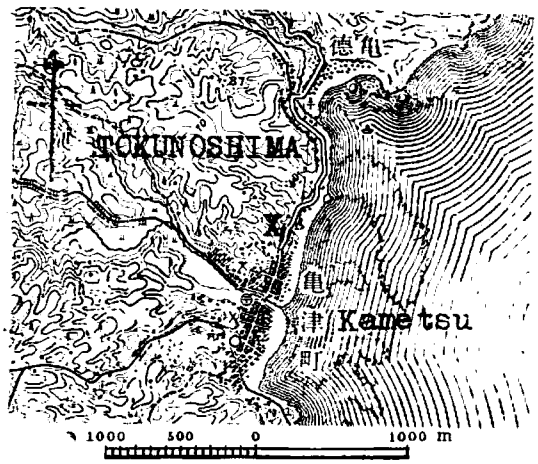


Fig. 1. Map of Kametsu coast of Tokunoshima showing location of the sample locality. X mark is the type locality of *Asanonella shojii* HUANG, new species.

six to seven chambers in last-formed whorl; wall calcareous, coarsely perforate, radial and monolamellar in structure. Dorsal suture thickened but not raised, almost tangential; dorsal surface, walls of chambers between sutural lines coarsely perforate with limbate margin, in large specimens, occasionally flaring and well separated at periphery, limbation may coalesce to form small protuberant cups, with excavated centers. Tubular outgrowths especially marked on dorsal surface, in large specimens, often toward peripheral edges and at times wanting on ventral surface. Ventral surface smooth, polished; sutures nearly radiate, more or less depressed. Aperture interiomarginal, elongate on inner margin of final chamber, periphery round, extending from near umbilicus to near periphery, with tooth of transparent shell material, protrude from previous spiral wall at periphery of aperture; supplementary sutural opening at ventral side of last few chambers.

In younger form, umbilical area very small, marked by a transparent solid mass of shell material, which flush with surface, and does not project as a stud; in adult form, ventral view of last chamber nearly twice as large as previous chambers and more or less inflated.

Dimensions:—

Type (IGPS coll. cat. no.)	Maximum diameter (in mm)	Minimum diameter (in mm)	Height (in mm)
Holotype (86381)	0.23	0.19	0.13
Paratype A (86384)	0.36	0.32	0.2
Paratype B (86383)	0.28	0.22	0.15
Paratype C (86382)	0.31	0.27	0.18
Paratype D (86385)	0.26	0.22	0.14
Topotype A (86386)	0.36	0.28	0.2
Topotype B (86387)	0.25	0.21	0.16
Topotype C (86388)	0.3	0.25	0.17
Topotype D (86389)	0.39	0.37	0.23
Topotype E (86390)	0.3	0.25	0.2

Depository:—The holotype, paratype, and thin section are deposited in the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, Sendai, Japan.

Comparisons:—This new species closely resembles *Truncatulina tubulifera* HERON-ALLEN and EARLAND, 1915 and of CUSHMAN, 1924; *Epistominella tubulifera* (HERON-ALLEN and EARLAND) of TODD, 1957, and *Eponides tubulifera* (HERON-ALLEN and EARLAND) var. *canimareinsis* PALMER and BERMUDEZ, 1936. Although, the present new species has a test form and surface ornamentation in the raised tubes, coarse perforation on the dorsal surface and smooth surface on the ventral side similar to the species mentioned above, it is quite different from those species in the apertural character and supplementary suture opening on the ventral side. The apertural character of the above mentioned species all show an elongate slit on the inner margin of the final chamber and no supplementary suture opening on the ventral side. The apertural character is an important character for the classification of the Foraminifera therefore, the apertural character is believed to be an important criteria for the newly proposed genus.

Geologic and geographic distribution:—This species occurs from the Pliocene formations of the Sanhsieng-chi section in eastern Taiwan and the Pleistocene Kametsu Formation at the type locality and locality No. 124, Nishiagon, Isen-chô in Tokunoshima. This geographic species range of this is the Taiwan—Tokunoshima region and its chronological distribution is the Plio-Pleistocene in age.

Remarks:—This species is named in honor of Assistant Professor Rikii SHOJI of the Department of Mining Engineering, Faculty of Engineering, Tohoku University, who collected the material.

This species is found in the loose, fossiliferous, calcareous sandy part of the Kametsu Formation.

According to Dr. Rikii SHOJI (personal communications), the sand facies of the Kametsu Formation corresponds sedimentologically to the 2nd cycle of deposition studied by him. This facies has yielded such smaller Forminifera;

I. Planktonic poulation
Globgerina foliata BOLLI
Globigerinoides conglobatus (BRADY)
Globigerinoides ruber (D'ORBIGNY)
Globigerinoides quadrilobatus sacculifer (BRADY)
Globigerinoides trilobus (REUSS)
Globoquadrina dutertrei (D'ORBIGNY)
Globorotalia crassaformis (GALLOWAY and WISSLER)
Globorotalis menardii (D'ORBIGNY)
Globorotalia truncatulinoides (D'ORBIGNY)
Hastgerina siphonifera (D'ORBIGNY)
Orbulina universa D'ORBIGNY
Pulleniatina obliquiloculata (PARKER and JONES)

II. Benthonic population
A. Dominant species
Amphistegina madagascariensis D'ORBIGNY
Amphistegina radiata (FICHTEL and MOLL)
Baculogypsina sphaerulata (PARKER and JONES)
Calcarina hispida BRADY
Calcarina spengleri (GMELIN)
Cibicides lobatulus (WALKER and JACOB)
Cibicides praecinctus (KARRER)
Cibicides pseudoungerianus (CUSHMAN)
Elphidium fax barbarense NICOL
B. Rare species
Ammonia beccarii (LINNAEUS)

Ammonia nipponica (ASANO)
Anomalina collingera CUSHMAN and PARR
Bolivina schwagerina BRADY
Bolivina semicostata CUSHMAN
Cancris auriculus (FICHTEL and MOLL)
Cassidulina asanoi UCHIO
Cassidulina californica CUSHMAN and HUGHES
Cibicides refulgens (MONTFORT)
Cymbaloporetta bradyi (CUSHMAN)
Dentalina mucronata NEWGEBOREN
Discorbis patelliformis (BRADY)
Discorbis tuberocapitata (CUSHMAN)
Discopulvinulina bradyi CUSHMAN
Elphidium jenseni (CUSHMAN)
Epistominella elegans (D'ORBIGNY)
Eponides orientalis ASANO
Eponides subornatus (CUSHMAN)
Fissurina catenulata (WILLIAMSON)
Guttulina orientalis CUSHMAN and OZAWA
Hanzawaia nipponica ASANO
Lenticulina abensis (ASANO)
Lenticulina calcar (LINNAEUS)
Lenticulina iotus (CUSHMAN)
Loxostomum amygdalaeforme (BRADY)
Loxostomum limbatum var. *costulatum* (CUSHMANN)
Loxostomum pacificum LEROY
Mississippina concentrica (PARKER and JONES)
Neouvigerina porrecta (BRADY)
Patellinella inconspicus (BRADY)
Patellinella jugosa (BRADY)
Poroeponides cribrorepandus ASANO and UCHIO
Pseudorotalia gaimardii (D'ORBIGNY)
Quinqueloculina spp.
Rectobolivina bifrons (BRADY)
Rectobolivina bifrons striatula (CUSHMAN)
Reusella simplex (CUSHMAN)
Sigmoidella kagaensis CUSHMAN and OZAWA
Siphogenerina raphana (PARKER and JONES)
Siphonina australis CUSHMAN
Siphoninoides glabra (HERON-ALLEN and EARLAND)
Textularia conica D'ORBIGNY

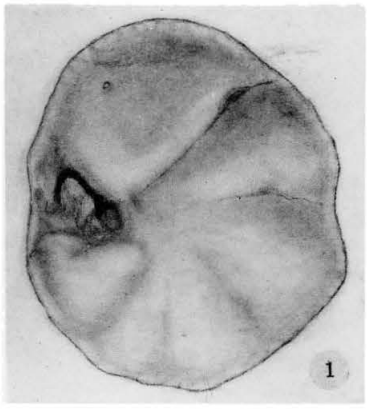
References

CUSHMAN, J. A. (1924): Somoan Foraminifera. *Dept. Mar. Biol., Carnegie Inst. Washington, vol. 21*. pp. 38-39, pl. 11, fig. 8.

CUSHMAN, J. A., TODD, Ruth and POST, R. J.

Explanation of Plate 20

Figs. 1-3. *Asanonella shojii* HUANG, n. sp., Holotype (IGPS coll. cat. no. 86381). ×320
Figs. 4-6. *Asanonella shojii* HUANG, n. sp., Paratype (IGPS coll. cat. no. 86383, Fig. 4; 86384, Fig. 5; 86385, Fig. 6). ×320
Each figure shows the apertural character.
Fig. 7. *Asanonella shojii* HUANG, n. sp., Paratype (IGPS coll. cat. no. 86382). ×320
Internal structure of dissected chamber, showing the intraseptal aperture, intraseptal aperature tooth and aperature tooth.
Fig. 8. *Asanonella shojii* HUANG, n. sp., Paratype (IGPS coll. cat. no. 86382). ×320
Ventral view showing the sutural opening and small tubular opening on ventral surface.
Fig. 9. *Asanonella shojii* HUANG, n. sp. (IGPS coll. cat. no. 36391). ×100
Horizontal section, showing radial and monolamella structure.
The specimen is from the type locality.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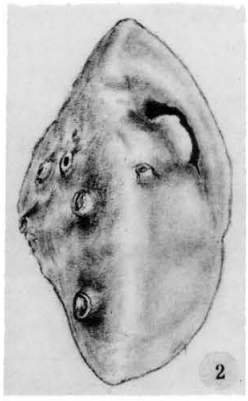
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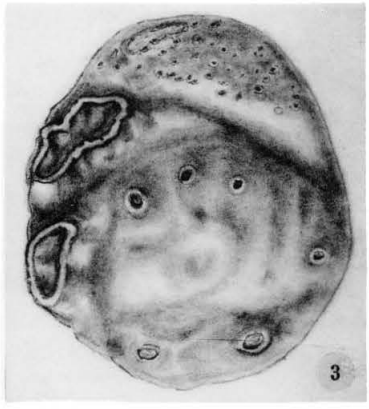
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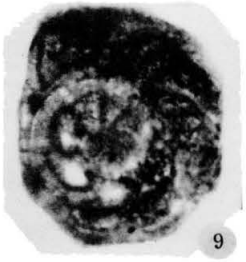
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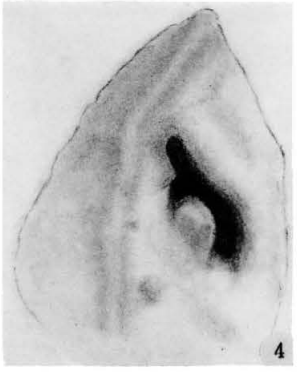
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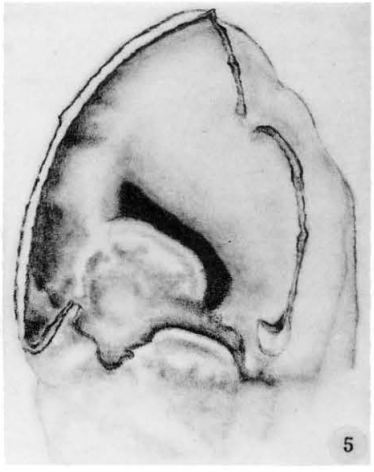
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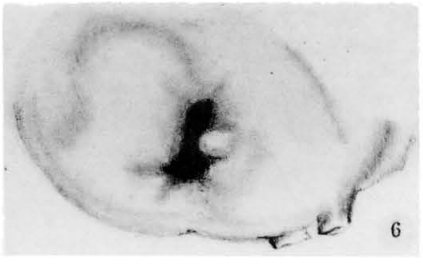
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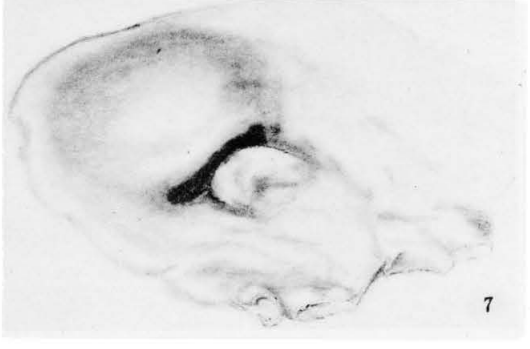
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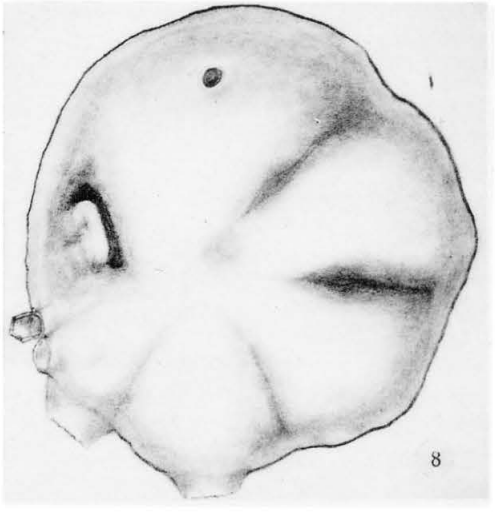
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(1954) : Recent Foraminifera of the Marshall Islands, Bikini and nearby atolls ; pt. 2, Oceanography (Biol.) : *U. S. Geol. Surv., Prof. Paper* 260-H, pp. 319-384, pls. 82-93.

ELLIS, B. F. and MESSINA, A. R. (1940 et seq.) : Catalogue of Foraminifera. *Amer. Mus. Nat. Hist., New York*, 45 vols., and supplement-vols.

GRAHAM, J. J. and MILITANTE, P. J. (1959) : Recent Foraminifera from the Puerto-Galera area, northern Mindoro, Philippin. *Standford Univ. Publ., Geol. Sci., vol. 6, no. 2*, pp. 1-134.

HATAE, N., et al. (1964) : Report of the water source survey on the southern Tokunoshima (in Japanese). *Kagoshima Chigaku Chosa Kenkyukai*, pp. 1-12.

HUANG, Tunyow (1964) : Smaller Foraminifera from the Sanhsien-chi, Taitung, eastern Taiwan. *Geol. Soc. China, Proc. no. 7*, pp. 63-72.

LOEBLICH, Alfred R. Jr. and TAPPAN, Helen (1964) : Treatise on Invertebrate Paleontology, pt. C, Protista 2, Sarcodina ; *Geol. Soc. America and Univ. Kansas.*

PALMER, D. K. and BERMUDEZ, P. J. (1936) : Late Tertiary Foraminifera from the Matanzas Bay Region, Cuba. *Soc. Cubana Hist. Nat., Mem., vol. 9, no. 4*, pp. 251, pl. 20, figs. 8-10 (*fide* ELLIS and MESSINA, 1940 et seq.).

REISS, Z. (1958) : Classification of lamellar Foraminifera. *Micropaleontology, vol. 4, no. 1*, p. 51-70.

SHOJI, Rikii (1965) : Personal communications.

TODD, Ruth (1957) : Smaller Foraminifera (in Geology of Saipan, Marianes Islands, pt. 3, Paleontology). *U. S. Geol. Surv. Prof. Paper* 280-H, pp. 265-320.

TODD, Ruth (1965) : The Foraminifera of the tropical Pacific collections of the "Albatross", 1889-1900 ; pt. 4, Rotaliform families and Planktonic families. *U. S. Nat. Mus., Bull.* 161.

WOOD, A. (1949) : The structure of the wall of the test in the Foraminifera. *Quart. Jour. Geol. Soc. London, vol. 104*, pp. 229-255.

Isen-chô 伊仙町
Kagoshima 鹿児島
Kametsu 亀津
Nishiagon 西阿権
Sanhsien-chi 三仙溪
Tokunoshima 徳之島

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 60, pp. 172-177, 3 figs., Dec. 20, 1965

498. TWO FOSSIL SPECIES OF *DISCINISCA* (BRACHIOPODA) FROM NORTH HONSHU, JAPAN*

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東北日本産 *Discinisca* (腕足類) の化石二種について：従来、本邦産現棲種としては 3 種，化石種としては僅か 1 種しか知られていなかつた *Discinisca* 属の 2 新種を記載した。何れも宮城県内の鮮新統（竜の口層及び小牛田層）より産したものである。

畑井小虎・早坂祥三

Introduction

The Neotremata (Brachiopoda : Gastrocaulia) comprise two superfamilies and five genera, among which only two genera, *Discinisca* and *Craniscus*, have been recorded from the Japanese Islands. The former genus comprises four species and the latter one species, and among them only one of the former and one of the latter have been reported to occur as fossil (HATAI, 1940, 1954). These are :

Family Discinidae GRAY
  Genus *Discinisca* DALL
    Discinisca kamikatetuensis YABE and HATAI. Pleistocene
    D. (?) *rikuzenensis* HATAI. Recent
    D. sparselineata DALL. Recent
    D. stella (GOULD). Recent

Family Craniidae KING
  Genus *Craniscus* DALL
    Craniscus japonicus (A. ADAMS). Fossil and Recent

The discovery of two fossil species of *Discinisca*, both of which are believed to be new to science, brings the number of species of the genus known from Japan to six in total.

The genus *Discinisca* occurs as fossil from the Cretaceous of North America, the Eocene of the United States of America, the Oligocene of Holland, Miocene of Poland and Italy according to THOMSON (1927), the Pliocene of Japan (two new species described in this article), and from the Pleistocene of the Ryukyu Islands (HATAI, 1940). Thus there is a continuous record of the genus from Cretaceous to Recent. As Recent, the genus is distributed along the Atlantic and Pacific coasts of South America, the Pacific side of North America and in the seas of China, Japan, Philippine Islands, Ceylon and India according to DALL (1920), THOMSON (1927), and HATAI (1940).

The genus *Craniscus* has a more restricted geographical distribution and a shorter geological range than *Discinisca*, being known to range from the Oligocene to Miocene of Australia, the Miocene of Japan, and is distributed geographically from the seas of central to southwest Japan southwards to the Philippine Islands, Borneo and the Cele-

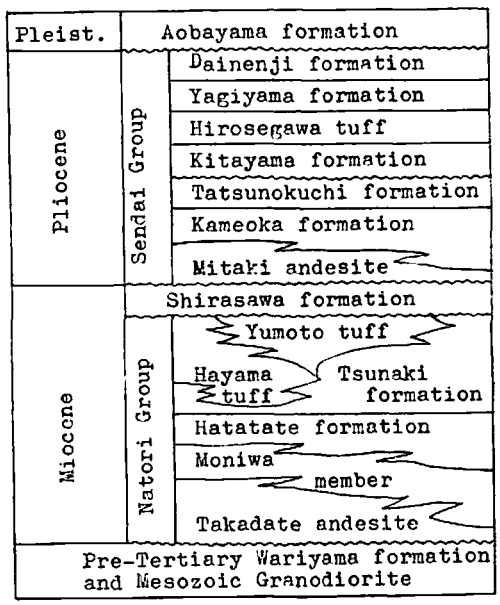
* Received June 20, 1965 ; read June 30, 1965 at Kanazawa.

bes. Since it is not represented in the present collection, further remarks will be reserved for another opportunity.

The scarcity of records of the fossil *Discinisca* in Japan may be due in part to the fragile character of their thin chitinous tests. Also it may be probable that some of the fossil discinisids were described or considered as gastropods from their resemblance to certain species of the family Patellidae of the order Aspidobranchia (KEEN, 1958).

Fortunately the writers had an opportunity to study several specimens of the genus *Discinisca* from the Tatsunokuchi Formation distributed in Sendai City and its correlative the Kogota Formation in Kogota Town, both in Miyagi Prefecture. Through the detailed examination, they could be classified into two different species both being new to science.

Table 1. Stratigraphical sequence of the Tertiary sediments in Sendai and its environs (after SHIBATA, 1962).



Remarks on the Fossil Locality and Geological Age of the Formation

The stratigraphic position of the Tatsunokuchi Formation is shown in Table 1. It occupies the lower part of the Sendai Group, which is of marine origin in its lower and upper parts. The Sendai Group lies upon different parts of the Miocene System and older rocks and the boundary between them is a structural unconformity. The group is succeeded upwards by but separated from the Aobayama Formation with erosional unconformity.

The fossil locality of the *Discinisca* species from the Tatsunokuchi Formation is the railway cutting at Dainohara along the Senzan Railway, where the silty to rather coarse sandy facies of the middle part is exposed. This facies is distributed both southwards and northwards of the fossil locality, but brachiopods have been found only at the locality mentioned above. The other locality is a road cut in the west of Kogota Town north of Sendai City, where the silty facies of the Kogota Formation is well exposed. At this brachiopod locality and in the vicinity there occur fossil pelecypods characteristic of the Tatsunokuchi Formation at its type locality [*Anadara tatunokutiensis* NOMURA and HATAI, *Dosinia tatunokutiensis* NOMURA, *Fortipecten takahashii* (YOKOYAMA), etc. (NOMURA, 1938)].

The stratigraphic position in the geologic column of the separated localities, lithologic characteristics, and faunal assemblages of the Tatsunokuchi Formation at the type locality and of the Kogota Formation in the environs of Kogota Town are good evidence for the contemporaneity of the two stratigraphic units.

The geological age of the Tatsuno-

kuchi Formation is generally accepted as belonging to the Pliocene, but to what part it really belongs remains unsettled and whether it is entirely Pliocene or includes a part of the Miocene is also an unsolved problem. For this reason the senior author (HATAI, 1962) once proposed a new classification of the upper Tertiary System based upon the stratigraphy and paleontology of Northeast Honshu, Japan. According to him (op. cit.) the strata in North Honshu hitherto considered as more or less equivalent to the standard Pliocene of Europe may be known as the Miyagian. However, whether the Miyagian can be correlated with the standard Pliocene strictly remains to be solved.

By the procedure he explains that the known stratigraphic boundaries, lithological features and faunal characteristics are well known for the Miyagian, which is developed and distributed in Japan, but not for those of the standard Pliocene of Europe. Consequently, it is clear that the Tatsunokuchi Formation occupies the lower part of the Miyagian and is, therefore, early Miyagian in geological age. If, it be necessary to adhere to usage of the European term though even without sufficient evidence for its usage in Japan, the Tatsunokuchi Formation and its correlative the Kogota Formation may correspond to early Pliocene.

Descriptions of the Brachiopod Species

Superfamily Discinacea WAAGEN, 1885

Family Discinidae GRAY, 1840

Genus *Discinisca* DALL, 1871

Type species:—*Orbicula lamellosa* BRODERIP, 1833.

Type locality:—Iquiqui, Bay of Ancou, Peru (fide DALL, 1920).

Diagnosis:—" Valves unequally convex, dorsal conical, ventral flatter, concave to depressed; outline oval to squarish; apices subcentral; test more or less horny, concentrically lamellose or with radial sculpture which may become papillose; ventral valve with longitudinal septum centrally, anterior adductor scars nearly central, in ventral valve on each side of septum, larger than posterior adductors, which are near posterior margin and separated by scars of posterior protractors." (HATAI, 1940)

Remarks:—The features of the genus can not be examined in detail in the specimens of the present collection which comprises only dorsal valves. However, the specimens at hand are referable to the genus *Discinisca* in having more or less horny conical test with the surface concentrically lamellose or with somewhat papillose radial sculpture.

Discinisca sendaiensis HATAI and HAYASAKA, n. sp.

Figs. 1a-c

Description:—Test medium in size; dorsal valve conical, highly elevated; test rather solid and horny in texture, black in color; beak subposterior and bluntly pointed; outline of margin as indicated by growth-lines on the upper part of outer surface subcircular in nepionic and neanic stages, and subrhombic in latter stages because of irregular growth; posterior margin nearly straight. Sculpture consisting of rather broad concentric lamellae with fine and irregular concentric lines and of faint and short radial ribs only on young part of shell surface. Inner margin of dorsal valve smooth; two muscle scars, ellipti-

cal in outline, situated near posterior margin of inner surface. Ventral valve unknown.

Dimensions (in mm):—Length 20.8, width 19.4, height 8.8, distance from apex of beak to posterior margin 9.4, and to anterior margin 18.6, beadth of concentric lamella 1.5 to nearly 2, long axis of muscle scar 3.8 and short axis 2.5.

Repository:—IGPS* coll. cat. no. 86421 (Holotype), no. 86422 (Paratype).

Occurrence:—Railway cutting at Dainohara, along the Senzan Line, Sendai City. Tatsunokuchi Formation (Sendai Group), Pliocene.

Remarks:—According to DALL (1920) "the Disciniscas are naturally divided into three groups as follows:

A) large, lamellose, flexible, without radiating sculptures.
Examples: *Discinisca lamellosa*, *D. laevis*.

B) large, less lamellose, with feeble irregular radiation, more solid.
Examples: *Discinisca strigata*, *D. cumingi*.

C) small, with regular radiating sculpture, not lamellose, solid.
Examples: *Discinisca stella*, *D. antillarum*."

The present new species is referable to DALL's group B by several morphological features. The eastern Pacific Recent species *strigata* BRODERIP (DAVIDSON, 1888, p. 239, pl. 26, fig. 26; DALL, 1920, p. 276; OLDROYD, 1924, p. 222, pl. 49, fig. 5; THOMSON, 1927, p. 132; HERTLEIN and GRANT, 1944, p. 36, pl. 2, fig. 10, pl. 16, fig. 17, pl. 18, fig. 6) most resembles the present species, but the latter has more elevated dorsal valve and shows anomalous growth. Three dorsal valves of different sizes and three imperfect dorsal valves are in the collection. All of them show irregularity in development of the concentric lines and lamellae and poor development of radial ribs, which are the characteristics of the present species.

* Abbreviation for the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Discinisca miyagiensis HATAI and HAYASAKA, n. sp.

Figs. 2a–b, 3a–b

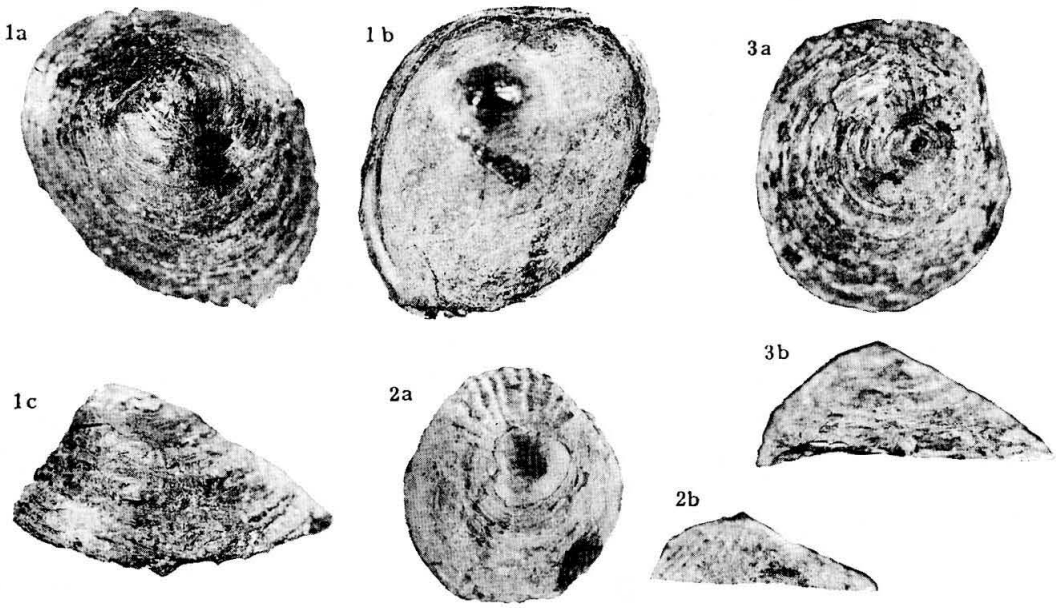
Description:—Test small in size, somewhat calcareous in texture and solid, roughly orbicular in outline, posterior margin rounded. Dorsal valve not so elevated, with apex bluntly pointed and situated posteriorly; gently sloping anterior surface straight or a little concave in profile and ornamented with concentric growth lines and faint radiating rib-like foldings near margin, posterior surface strongly convex in profile and with strong and continuous radial ribs narrower than interspaces. Ventral valve unknown.

Dimensions (in mm):—Length 10.7, width 9.9, height 4.5, distance from beak to posterior margin 5.8 and to anterior margin 7.9 (smaller specimen): length 13.8, width 12.8, height 6.2, distance from beak to posterior margin 7.2 and to anterior margin 10.7 (larger specimen).

Repository:—IGPS coll. cat. no. 86423 (smaller: Holotype); no. 86424 (larger: Paratype).

Occurrence:—Road cut west of Kogota Town, Miyagi Prefecture. Kogota Formation, Pliocene.

Remarks:—Two somewhat worn dorsal valves are in the collection. Several features of these small and rather solid shells suggest their close relation to *D.*



Figs. 1a-c. *Discinisca sendaiensis* HATAI and HAYASAKA, n. sp.
External (a), internal (b) and lateral (c) views of dorsal valve (Holotype). ×2
Figs. 2a-b, 3a-b. *Discinisca miyagiensis* HATAI and HAYASAKA, n. sp.
Apical (2a, 3a) and lateral (2b, 3b) views of dorsal valves. 2: Holotype. 3: Paratype. ×3

stella GOULD (REEVE, 1862, *Orbicula*, pl. 1, fig. 1; DAVIDSON, 1888, p. 204, pl. 26, figs. 27, 27a; DALL, 1920, p. 278; THOMSON, 1927, p. 132; HATAI, 1940, p. 186), a living species which is common in the seas of Japan and China. But the present specimens are distinguishable from *stella* in having much stronger radial ribs on the posterior surface. They also resemble *D. cumingii* BRODERIP (SOWERBY, 1847, p. 360, pl. 73, fig. 6; REEVE, 1862, *Orbicula*, pl. 1, fig. 6; DAVIDSON, 1888, p. 202, pl. 26, figs. 23-25; DALL, 1920, p. 277; HERTLEIN and GRANT, 1944, p. 27, pl. 2, figs. 8, 9, 11, pl. 6, figs. 1-4, text-fig. 3) recorded from the Pliocene of California and now living in the eastern Pacific. The subspecies *hannibali* HERTLEIN and GRANT (1944, p. 29, pl. 16, figs. 7, 8, 11) discriminated from the typical *cumingi* by stronger and more continuous radial ribs seems to have close relation to the present species. The present species, however, differs from the foregoing species and subspecies in the partial development of the radial ribs, coarser concentric lines and smaller size.

References

DALL, W. H. (1920): Annotated list of the Recent Brachiopoda in the collection of the United States National Museum, with descriptions of thirty-three new forms. *Proc. U. S. Nat. Mus., Vol. 57*, pp. 261-377.

DAVIDSON, T. (1886-1888): A monograph of

Recent Brachiopoda. *Trans. Linnean Soc., 2, Vol. 4, Zool., Pt. 1*, pp. 1–73, pls. 1–13, 1886; *Pt. 2*, pp. 75–182, pls. 14–25, 1887; *Pt. 3*, pp. 183–248, pls. 26–30, 1888.

HATAI, K. M. (1940): The Cenozoic Brachiopoda of Japan. *Sci. Rep. Tohoku Imp. Univ., Ser. 2 (Geol.), Vol. 20*, pp. 1–113, 26 text-figs., 7 tables., 12 pls.

HATAI, K. (1954): Check list of Japanese Tertiary and Pleistocene Brachiopoda. *Sci. Rep. Tokyo Kyoiku Daigaku, Section C, Vol 3*, pp. 99–139.

HATAI, K. (1962): Mizuho To. *Sci. Rep. Tohoku Univ., Ser. 2 (Geol.), Spec. Vol., No. 5*, pp. 329–348.

HERTLEIN, L. G. and GRANT, U. S. (1944): The Cenozoic Brachiopoda of Western North America. *Univ. Calif., Math. Phys. Sci., Vol. 3*, 326 pp., 21 pls., 34 text-figs.

KEEN, A. M. (1958): Sea shells of Tropical West America. *Stanford Univ.*, pp. viii +624.

NOMURA, S. (1938): Molluscan fossils from the Tatunokuti shell bed exposed at Gôroku cliff in the western border of Sendai. *Sci. Rep. Tohoku Imp. Univ., Ser. 2 (Geol.), Vol. 19, No. 2*, pp. 235–275, pls. 33–36.

OLDROYD, I. S. (1924): The marine shells of the west coast of North America. Vol. I. *Stanford Univ., Publications, Univ. Ser., Geol. Sci., Vol. I, N.o 1*, pp. 1–247, 57 pls.

REEVE, L. A. (1862): Conchologia Iconica, *Vol. 13*.

SHIBATA, T. (1962): Geology of the Sendai and Nanakita-Sanbongi Areas, Miyagi Prefecture. *Sci. Rep. Tohoku Univ., Ser. 2 (Geol.), Vol. 34, No. 4*, pp. 239–301, 4 tables, 6 text-figs., pls. 17–26 (with bibliography on the geology and paleontology).

SOWERBY, G. B. (1847): Thesaurus conchyliorum, *Vol. 1*.

THOMSON, J. A. (1927): Brachiopod morphology and genera (Tertiary and Recent). *N. Z. Board Sci. Man. No. 7*, pp. 1–383, 2 pls., 103 text-figs.

Dainohara 台の原　　Kogota 小牛田　　Senzan Railway 仙山線

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 60, pp. 178-181, pl. 21, Dec. 20, 1965

499. ON THE SOME NEW SPECIES OF FOSSIL FORAMINIFERA FROM THE BORING CORES IN THE GAS FIELD IN CHIBA PREFECTURE, JAPAN*

YU HIGUCHI

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千葉県ガス田地域における化石有孔虫の新種について：千葉県ガス田地域に掘削された天然ガス探掘井のボーリング・コアーの試料より検出された有孔虫化石の内四つの新種について記載した。これらはいずれも同ガス田のガス貯留層を構成する上総層群中のもので，比較的普遍的な産出がみられ，とくに *Gyroidina kazusaense* HIGUCHI, n. sp. は，ボーリング・コアーの試料の範囲内では，最下部上総層群に特徴的な種である。　　樋口　雄

Introduction

The gas field in Chiba Prefecture occupies the main part of the gas-producing area of the southern Kanto region, and is one of the largest gas fields in Japan.

Stratigraphically the majority of the gas-producing strata in the area are restricted to the marine Kazusa group which consists of 10 formations. These formations are mainly composed of alternation of sandstone and siltstone, and were deposited in a large sedimentary basin of Pliocene to early Pleistocene age.

The writer has studied the Kazusa group from the view point of microbiostratigraphy for several years examining many cores collected from the gas wells in the field.

The detailed result of the above-mentioned studies was reported in 1964 by the writer[2].

The purpose of this paper is to describe some new species of fossil foraminifera collected from boring cores of the gas field.

The writer is extremely grateful to Professor K. ASANO and Dr. Y. TAKAYANAGI of the Institute of Geology and Paleontology of the Tohoku University for his valuable advices and encouragement in many ways. He is also indebted to Dr. Y. ISHIWADA and Dr. O. FUKUTA of the Geological Survey of Japan; Dr. Y. KUWANO, Research Institute for Natural Resources, and Dr. Y. KIKUCHI, North Smatra Oil Development Cooperation Co. Ltd., for valuable informations on the stratigraphy of the field. Thanks are due to the Kanto Natural Gas Development Co. Ltd., for permission to issue this paper, and to the Asahi Glass Co. Ltd., for an offer of valuable data.

General review of stratigraphy and biostratigraphy of Kazusa group

The Kazusa group is widely distributed on the surface and subsurface in the southern half of the Kanto district, consisting of marine sandstone and siltstone. The maximum thickness of the

* Received July 1, 1965; read Sept. 25, 1965 at Nagasaki.

group attains to more than 2500 meters in the eastern part of Boso Peninsula. It is overlain by the Quaternary Narita group which consists mostly of loose sand, and overlies the Miocene series which consist of alternation of sandstone and siltstone and yield *Globorotalia fohsi barisanensis*, *Globorotalia fohsi fohsi*, and *Orbulina universa* etc. According to T. MITSUCHI (1937), the group can be divided into 10 formations as shows in Table 1. The formations above the middle part

Table 1. Geological sequence of the Kazusa group.

Formation	Thickness (m)	Lithology
Kasamori	250	silty sandstone
Chonan	140-180	alt. of sandst. & siltst.
Kakinokidai	100	sandy siltst. with sand layers
Kokumoto	250	siltst., alt. of sandst. & siltst.
Umegase	350	sand rich alt. of sandst. & siltst.
Otadai	250	alt. of sandst. & siltst.
Kiwada	800	siltstone
Ohara	150	alt. of sandst. & siltst.
Namihana	250	silt rich alt. of sandst. & siltst.
Katsu-ura	300	sand rich alt. of sandst. & siltst.

of the Umegase are probably assigned to Quaternary age, because of the first marked occurrence of cold water planktonic foraminifera.

The writer has classified the group into 11 benthonic foraminiferal zonules from the view point of biostratigraphy, and established the correlation of the group within the southern Kanto region.

The lithologic characters of the group in the Chiba gas field change laterally in the exploited area. But the biofacies of the foraminifera in the east side area of Chiba City are stable, and correlation of the wells by means of the foraminiferal zonules is easy.

From the foraminiferal fauna of these zonules, it is evident that a relatively shallow water fauna is mixed with deep water

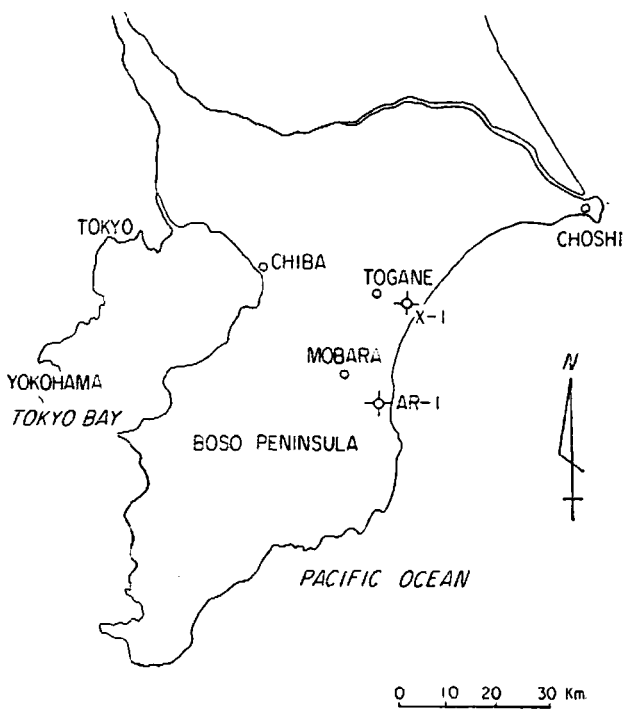


Fig. 1. Map showing well locations.

ones in the lowermost part of the group, and a deep water fauna is abundant in the lower and middle part, and a shallow water fauna is characterized in the upper part. From the above-mentioned foraminiferal faunas, upper formations of Kazusa group may be of inner to middle neritic deposition. Formations from Umegase to Kiwada may be of bathyal deposition, and formations from Ohara to Katsuura may be of inner to outer neritic deposition.

The locations of gas wells from which the writer has collected the boring cores are shown in Fig. 1.

Description of new species

Family Textulariidae

Spiloplectammia kujukuriense HIGUCHI, n. sp.

Pl. 21, figs. 1a, b

Description:—Test compressed, rather elongate, about 2 or 3 times as high as broad, subrhomboidal in apertural view, thickest in central portion, periphery subacute: early portion planispiral, consisting of 7 or 8 chambers, later biserial, low and broad: suture distinct, slightly depressed, earlier ones radial, later ones oblique: wall finely arenaceous: aperture a narrow opening at the inner margin of the last formed chamber: Length up to 0.5 mm.

Holotype:—From 860 m depth of the boring well at Kujukuri-machi, Sanbu-gun, Chiba Pref., Kiwada formation, Pliocene.

Occurrence:—Rare, but found throughout the upper Kiwada formation in the Kujukuri coastal plain.

Remarks:—This species characterised by the relatively short and tapered biserial part of the test.

Family Lagenidae

Fissulina matobai HIGUCHI, n. sp.

Pl. 21, figs. 2a, b

Description:—Test subglobular, broadly ovate in front view, slightly longer than broad, broadest at base, basal end truncated and ornamented with broad basal flange, bluntly pointed at apertural end: wall smooth, transparent: aperture entosolenian. Length up to 0.3 mm.

Holotype:—From 480 m depth of the boring well at Kujukuri-machi, Sanbu-gun, Chiba Pref., Otadai formation, Pliocene.

Occurrence:—Few, but found throughout the upper Pliocene formations of Chiba gas field.

According to Mr. MATOBA's verbal information, it also occurs in the Pliocene Iioka formation, Choshi City, Chiba Pref.

Remarks:—The character of the test distinguish this species from the allied ones of the genus.

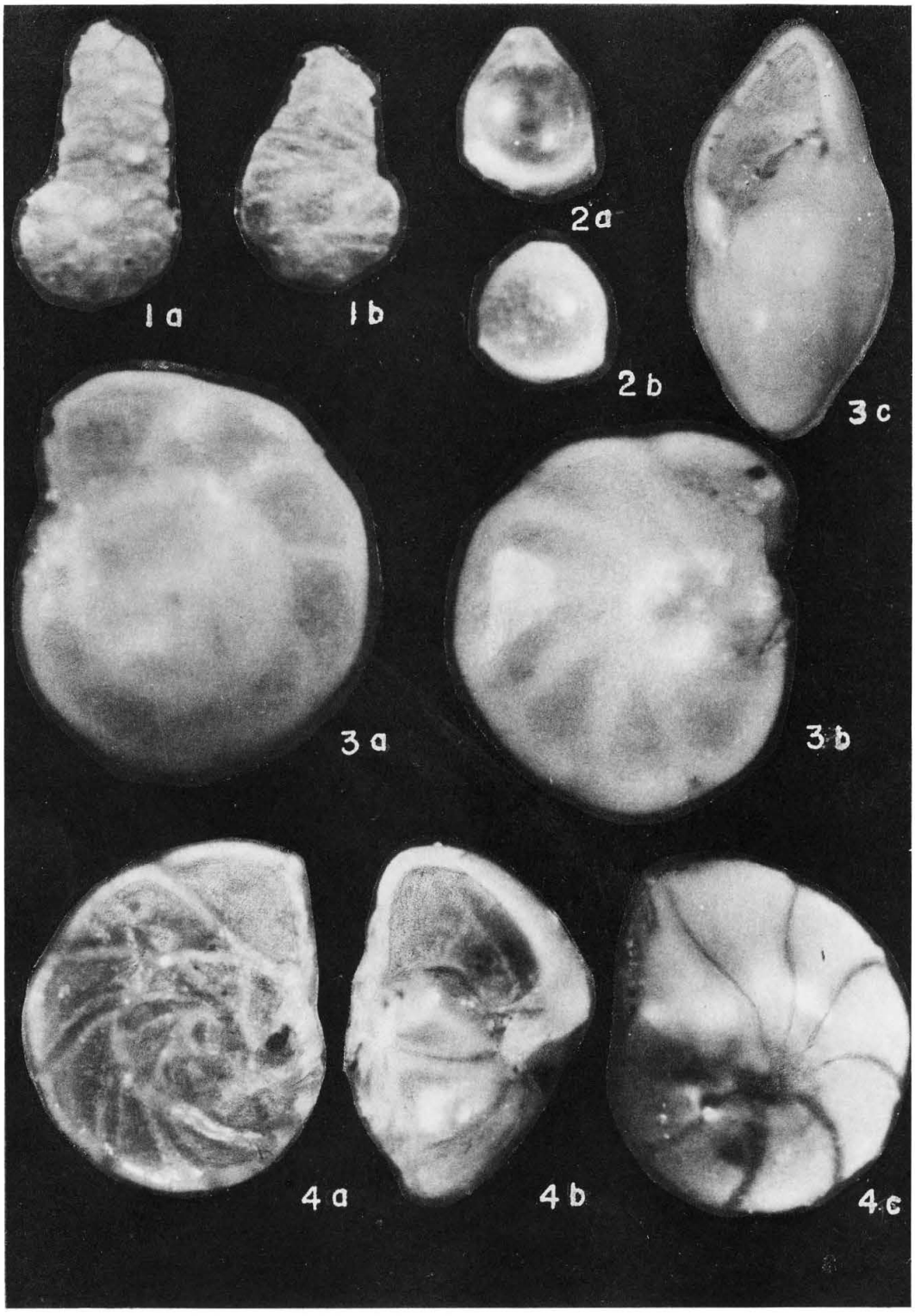
Family Rotaliidae

Eponides asanoi HIGUCHI, n. sp.

Pl. 21, figs. 3a, b, c

Explanation of Plate 21

Figs. 1a, b. *Spiloplectammina kujukuriense* HIGUCHI, n. sp. ×70
Figs. 2a, b. *Fissulina motobai* HIGUCHI, n. sp. ×70
Figs. 3a, b, c. *Eponides asanoi* HIGUCHI, n. sp. ×70
Figs. 4a, b, c. *Gyroidina kazusaense* HIGUCHI, n. sp. ×70


1a
1b
2a
2b
3c
3a
3b
4a
4b
4c

Description:—Test subcircular in outline, biconvex, periphery subrounded, 2 or 3 whorls visible on dorsal side, completely involute in ventral side, slightly depressed in umbilical region: about 8 or 9 chambers in the last whorl: sutures indistinct, somewhat limbated, slightly oblique on dorsal side, slightly curved on ventral side: wall smooth, finely perforated: aperture a short opening at ventral border of the last chamber. Length up to 1 mm.

Holotype:—From 1060 m depth of the boring well at Kujukuri-machi, Sanbu-gun, Chiba Pref., Ohara formation, Pliocene.

Occurrence:—Few, but found throughout the lower Pliocene formations of Chiba gas field.

Remarks:—This species resembles *Eponides haidingerii* (D'ORBIGNY), but is distinguished by the subrounded periphery and indistinct sutures.

Gyroidina kazusaense HIGUCHI, n. sp.

Pl. 21, figs. 4a, b, c

Description:—Test plano-convex, dorsal side flat or even slightly convex, ventral side much convex, 2 or 3 whorls visible on dorsal side, umbilicus deeply excavated, periphery not broadly rounded: chambers distinct, 8 or 9 chambers in last whorl: sutures distinct, limbated, oblique and slightly curved and raised on dorsal side, slightly curved on ventral side: wall thick, smooth: aperture an elongate slit at ventral border of last chamber. Diameter up to 1 mm.

Holotype:—From 1420 m depth of the boring well at Arakuma, Ichinomiya-machi, Chosei-gun, Chiba Pref., Katsuura formation, Pliocene.

Occurrence:—Rare, but found throughout the lowermost Pliocene formation of Kujukuri coastal plain.

Remarks:—This species closely related to *Gyroidina soldanii* D'ORBIGNY, but differs by the form of periphery, and by the limbated and raised sutures.

References

ASANO, K. (1956): The Foraminifera from the adjacent sea of Japan. collected by the S. S. Soyo-maru, 1922-1930, Part 1. Nodosariidae. *Sci. Rep. Tohoku Univ., 2nd ser. (Geology)*, Vol. 27, pp. 1-55, text-figs. 1-5, pls. 1-6.

HIGUCHI, Y. (1964): Microbiostratigraphical studies of the gas field in Chiba Prefecture, Japan. *Contr. Inst. Geol. Paleont. Tohoku Univ.*, No. 61 (in Japanese), pp. 1-48, text-figs. 1-24, tables 1-7.

ISHIWADA, Y. (1964): Benthonic Foraminifera off the Pacific coast of Japan referred to biostratigraphy of the Kazusa group. *Rep. Geol. Sur. Japan*, No. 205, pp. 1-45, text-figs. 1-14, pls. 1-8.

KIKUCHI, Y. (1964): Biostratigraphy of the Neogene and Quaternary deposits based upon the smaller foraminifera in the Southern Kanto region. *Contr. Inst. Geol. Paleont. Tohoku Univ.*, No. 59 (in Japanese), pp. 1-36, text-figs. 1-8, tables 1-3, pls. 1-8.

LOEBLICH, A. R. and TAPPAN, H. (1964): Treatise on Invertebrate Paleontology, Part C, Protista 2, Sarcodian, chiefly "Thecamoebians" and Foraminifera. Geol. Soc. America and Univ. Kansas Press, pp. 1-900, text-figs. 1-653.

MITSUCHI, T. (1937): Geological sheet map "Mobara" 1/75,000. Geol. Sur. Japan.

Arakuma 新熊
Chosei-gun 長生郡
Ichinomiya-machi 一の宮町
Kujukuri-machi 九十九里町
Sanbu-gun 山武郡

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第91回例会および「化石群集と堆積相」についての討論会は1965年9月25日(土)長崎大学教養部地学教室において開催された(参加者54名)。

個人講演

On some new species of fossil Foraminifera from the boring cores in the gas field in Chiba Prefecture (代読) .....Yu HIGUCHI

Permian Brachiopods from Tham Nam Maholan, Thailand .....Juichi YANAGIDA

四国, 登層からの貝化石について (代読).....

Classification of the Neomiodontidae from Japan .....Itaru HAYAMI

Occurrence of *Nippononaia ryosekiana* from the Sanchu area, Japan .....

.....Itaru HAYAMI and Takeo ICHIKAWA

御所浦層群産 Corbiculidae その他について ..

天野昌久

On a desmoceratid Ammonite from the Fujikawa Formation, Katsuragawa Valley, Japan.....Isao NAKAI

Discovery of Aptian Ammonites from the Shimanto Terrain, Western Shikoku ....

.....Isao NAKAI and Shigeki HADA

白亜紀アンモナイト Peroniceratinae の分類について .....松本達郎

Bulimina sculptilis-jacksonensis Group の形態的層位学的考察 .....内尾高保

討論会「化石群集と堆積相」

石炭系有孔虫化石群集と堆積相 .....沖村雄二

坂本沢層の堆積相と化石群 .....

..... 勘米良亀齢・三上貴彦

鳥巣統における貝化石群集と堆積相 ....田村 実

本邦古第三系における有孔虫化石群集と岩相 ..

..... 内尾高保

北海道新生代における貝類化石群集と岩相について .....菅野三郎

北陸地方第三系における化石群集と岩相 .....

..... 津田禾粒

能登半島東院内層の貝類化石群集と堆積相 ....

..... 増田孝一郎

中国地方新第三系における有孔虫化石群集と堆積相 .....多井義郎

海肌化石と岩相との関係について .....森下 晶

生物遺骸群集と堆積相 (予報).....鎌田泰彦

例会通知

	開催地	開催日	講演申込締切日
1966年総会・年会	東北大学	1966年1月24,25日	1965年10月20日
第93回例会	東京	1966年6月（予定）	1966年5月（予定）

会告

日本古生物学会論文賞設定

日本古生物学会では，評議員会の決定により，本年度から，論文賞を設定することになりました。毎年，過去2年間の日本古生物学会報告記事上に発表された論文につき賞の委員会で審議し，評議員会の承認を経て優秀と認められる論文に対し，日本古生物学会より賞状およびメダルをおくります。発表は毎年度の年会で行なわれます。

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(Jan. 15, 1963)

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