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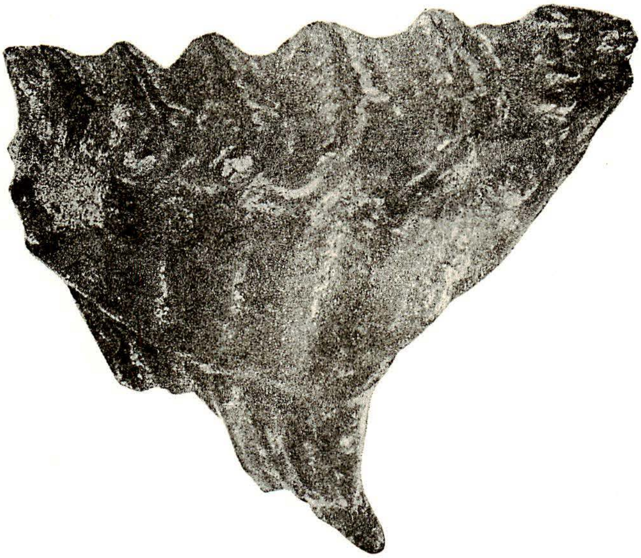

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601. TWO SMALL DESMOCERATID AMMONITES FROM HOKKAIDO

(STUDIES OF THE CRETACEOUS AMMONITES FROM HOKKAIDO AND SAGHALIEN—XXIV)*

TATSURO MATSUMOTO[1], TATSUO MURAMOTO[2]
and AKITOSHI INOMA[3]

北海道産デスモセラス科小型アンモナイト2種： その1は幾春別地方白亜系の下部セノマニアンの *Mantelliceras japonicum* 帯から産したもので，新属新種としてここに記載する。これは成体殻の径が2cm 足らずの小型で，四角い螺環断面をもち，螺旋曲線が少しずれている。殻表面には装飾がほとんどない。殻をはずすと弱いくびれが周期的に認められる。縫合線はかなり単純化しているが，個体発達的に辿るとデスモセラスの型である。幼殻はまるこい。このような特異形態を示す小型のものはアンモナイトの進化史上いろいろな科に正道からそれた小分枝として認められる。他例と同様その直接起源が正確に辿れず，見掛上不連続的に見いだされている。このものは普通のデスモセラス亜科のメンバーに比べて，あまり活発でない生活様式をもっていたのではないかと推察される。 松本達郎・村本辰雄

その2は羽幌地域のサントニアンから得られたもので，*Kitchinites* (*Neopuzosia*) の新種として記載する。プゾシア亜科には大型のものがよく知られているが，これは成体殻の直径が僅か3cm 程度であるとともに，その殻口縁に顕著な耳があることが特異である。その未成年殻は *K.* (*N.*) *ishikawai* のそれと酷似するが，耳の発達の前兆がすでに認められ，成体殻では明確に異なる。これに関連して，ジュラ紀アンモナイトで雌雄異形の実例と解釈されている場合との相似が気付かれるので，プゾシア亜科における雌雄異形の可能性につき一応検討したが，答はむしろ否定的である。本亜科のアンモナイトは，一定の型の縫合線をもっているが，大きさ，殻の装飾とくに住房の装飾，殻口の性質などにおいて，かなりの多様性を示す。本種はそうした分化発達の一端を示す実例とみなされる。

松本達郎・猪間明俊

Introduction

In this paper descriptions and remarks are given on two small, peculiar ammonite species which are assignable to the family Desmoceratidae. The authorship for one of them, belonging to the subfamily Desmoceratinae, is T. MATSUMOTO and T. MURAMOTO and that for the other, belonging to the subfamily Puzosiinae, is T. MATSUMOTO and A. INOMA.

Before going further we thank Dr. Itaru HAYAMI, Miss Yuko WADA and Miss Seiko HAYAKAWA in their kind assistance in preparing the plates and typescript. For the study of the second species we thank the Japan Petroleum Exploration Company and Professor Wataru HASHIMOTO for their kind support.

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Systematic description

Family Desmoceratidae

Subfamily Desmoceratinae*

Several years ago when we were concentrated in a field work to obtain fossils from the Cenomanian of the Ikushumbets area, central Hokkaido, one of us (T. MURAMOTO) was successful to find four small, peculiar ammonite specimens. They show very distinctive characters of one and the same species, which requires a new genus in the Desmoceratinae.

Genus ***Microdesmoceras*** MATSUMOTO and MURAMOTO, nov.

Type-species.—Microdesmoceras tetragonum sp. nov., to be described below.

Generic diagnosis.—A small desmoceratid, with somewhat simplified pattern of sutural elements, showing a broad and trifid lateral lobe (L) and somewhat phylloid terminals of saddles aligned on a descending line.

Coiling of moderate involution; slightly deviated from normal spire in the last whorl. The body-whorl and the preceding part of the late, septate whorl characterized by somewhat tetragonal outline in cross-section. The surface of the shell nearly smooth, only with flexuous weak lirae, which show a moderately projected curve on the venter and another on the middle part of the flank. Gently sigmoid, periodic constrictions marked on the internal mould of late whorls, but not accompanied with a perceptible elevation on the surface of the shell.

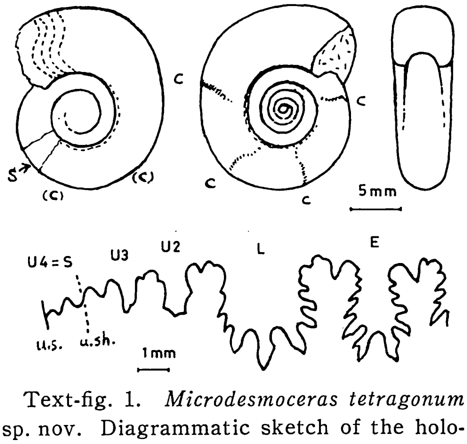
Remarks.—This genus is at present represented by only a single species from the Lower Cenomanian of Hokkaido. Its comparisons and affinities with other genera are to be given after the description of the species.

Microdesmoceras tetragonum MATSUMOTO and MURAMOTO, sp. nov.

Pl. 47, Figs. 1-4; Text-figs. 1-4

Material.—Holotype, GK. H5653, from loc. Ik 1101, Kami-Katsurazawa, Ikushumbets. Three paratypes, of which one from loc. Ik 1101 and another from Ik 1051b are preserved in the MURAMOTO Museum and the last from loc. Ik 1067bp is in Kyushu University (GK.) with register number H5650. The last one has been cut into two main parts and a few minute pieces (of the first whorl) to examine the characters of the inner whorls.

Specific characters.—The shell is small. The holotype, which is regarded as representing an adult stage, is 18 mm in



Text-fig. 1. *Microdesmoceras tetragonum* sp. nov. Diagrammatic sketch of the holotype in two lateral and an apertural views (above). A part of the lirate surface (left) and constriction on the internal mould (center) are shown. The external part of the second last suture (below) exposed at s. u.s. = umbilical seam; u.sh. = umbilical shoulder. (T. MAT. *delin.*)

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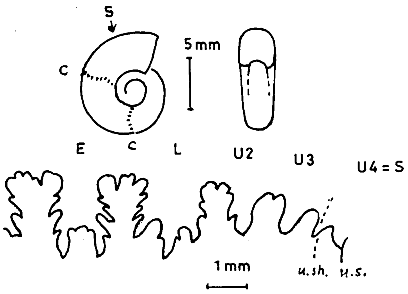
* The authorship of the description under subfamily Desmoceratinae is Tatsuro MATSUMOTO and Tatsuo MURAMOTO.

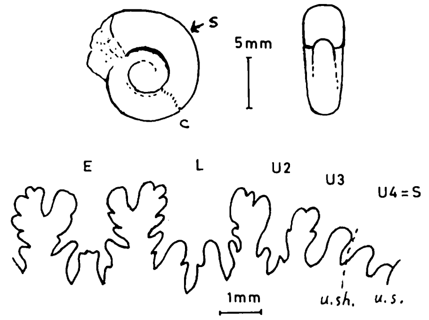


Text-fig. 2. *Microdesmoceras tetragonum* sp. nov. Diagrammatic sketch of a paratype, from loc. Ik 1101, in lateral and apertural views (above) and the suture exposed at s. (T. MAT. *delin.*)

diameter. The involution is moderate and the umbilicus is of moderate width, about 34(±1) percent of the shell diameter. The mode of coiling of the adult whorl, as seen in the holotype, is slightly deviated from the normal spire, i.e. slightly scaphitoid.

The body-whorl occupies about three quarters of the last volution. It is nearly as high as broad and approximately tetragonal in cross-section, having flat and parallel flanks, a broadly arched venter and vertical umbilical walls. The preceding septate part of at least a half volution has also flat and parallel flanks but is somewhat broader than high. Still inner whorls are much broader than high and rounded to reniform in cross-section. They are more evolute than the outer whorls. The above mentioned change of shell-form with growth may be illustrated by a cross-section (Text-fig. 4).

The surface of the shell looks nearly smooth, having only weak lirae. As far as the observed outer whorls (of 10 to 20 mm in diameter) are concerned, the lirae show a sigmoid curvature, running fairly strongly forward from the umbilical edge to the mid-flank, curved somewhat backward on the outer half of the flank and then recurved at the ventrolateral part passing to a moderate ventral projection. The lateral and the ventral projections are rounded. The outline of the apertural margin is not precisely known.



Text-fig. 3. *Microdesmoceras tetragonum* sp. nov. Diagrammatic sketch of a paratype, from loc. Ik 1051b, in lateral and apertural views (above) and the external part of the last suture exposed at s. (T. MAT. *delin.*)

There are three or four constrictions per whorl in the late growth-stages. They are roughly sigmoid on the flank but not so much projected as the lirae on the venter. They are impressed only on the internal mould and the corresponding elevations on the test are hardly discernible. The constrictions of the body-whorl is very faint on the flanks but better marked on the venter.

Generally speaking the suture is of desmoceratid type, but is particular in its more simple pattern as compared with those of the nearly contemporary *Desmoceras* (*Pseudouhligella*) and *Puzosia*. The external suture of the last whorl (at the whorl height of 4 or 5 mm) is characterized by a somewhat narrowed stem of the external lobe, asymmetrically divided first lateral saddle, broad and trifid first lateral lobe (L), which is situated on the ventrolateral shoulder, much

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5653	18.0(1)	6.2(.34)	6.0(.33)	6.0(.33)	1.0
Paratype from Ik 1101	9.8(1)	3.3(.33)	4.0(.41)	4.0(.41)	1.0
Paratype from Ik 1051b	11.2(1)	3.8(.34)	4.2(.37)	4.2(.37)	1.0
GK. H5650	12.5(1)	4.4(.35)	4.8(.38)	5.1(.41)	1.0

smaller and narrower second lateral lobe (U2) and gradually descending auxiliaries. Minor incisions are less numerous and shallower than in the typical *Desmoceras* or *Puzosia* and each of the saddles and folioles show a rather entire outline, resulting in a somewhat phylloid aspect in the sutural pattern.

The development of the suture with growth has not been completely traced, because of unfavourable state of preservation. So far as the observation on the available material is concerned, the formula is probably E, L, U_2, U_3, U_4=S, U_{1v}, U_{1d}, I, but could be interpreted otherwise. The saddle between E and L is bipartite in early stages (from a certain stage of the second whorl) and then modified in late stages, normally by subdivision of the larger dorsal branch.

The protoconch is comparatively large as in other examined examples of the desmoceratids.

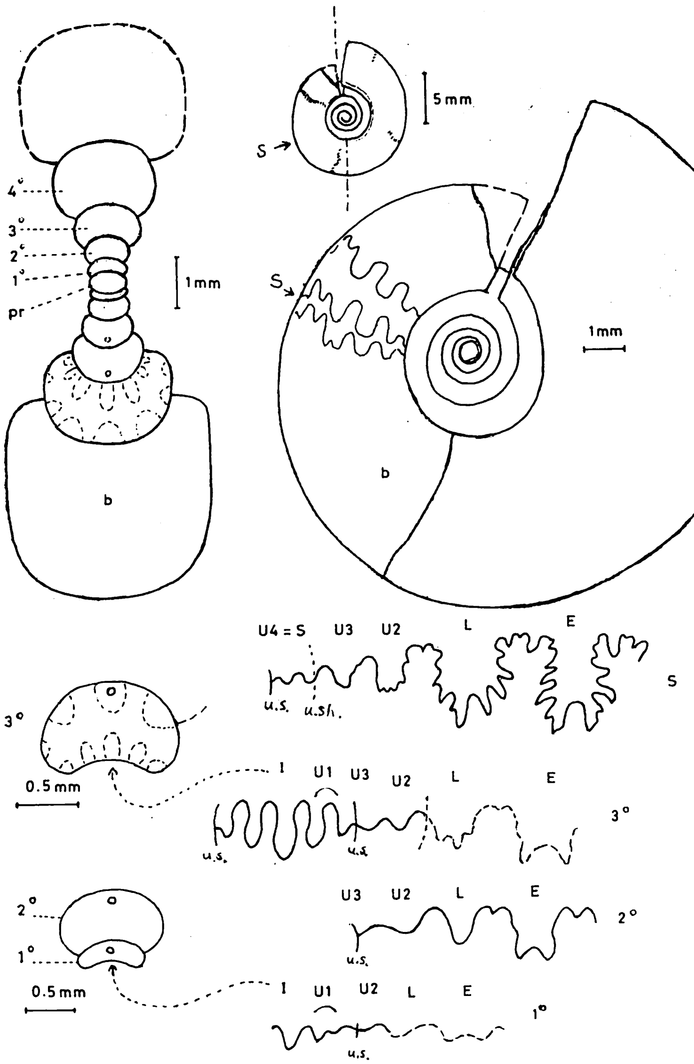
Remarks.—The holotype and the third paratype (GK. H5650) are regarded as representing an adult shell, because the last two septa are approximated and because the last whorl presents a particular shape as compared with earlier whorls.

The variation in shell-form between individuals seems to be little, as is indicated by the above measurements, but the number of the examined specimens is by no means enough to lead a conclusion. There is some extent of difference in the details of the suture, such as the mode of subdivision of the first lateral saddle, even among the four specimens, although the fundamental pattern of the suture is the same.

Comparison.—At first sight this species looks like a certain species of *Tetragonites* in shell-form, but it is not related with the Tetragonitidae, because its suture is fundamentally different from those of the Tetragonitidae. In the latter the first lateral saddle is tripartite, the lateral lobes [L and U_2] are bipartite and the internal lobe forms a septal lobe [Is].

In its simplicity of suture (or better to say simplified suture), small size and smooth shell the present species reminds us of such species as *Flickia simplex* PERVINQUIÈRE, 1907, but it differs from them by its rather desmoceratid basic pattern of sutures, different shell-form and the existence of constrictions. Certainly it has no affinity with the Flickiidae which, in turn, are apparently related to *Mojsisoviczia* or *Falloticeras* of the Brancoceratidae (see WRIGHT, 1957, p. L409), hence provisionally placed in the Acanthocerataceae.

On account of its phylloid aspect of sutures, smooth shell with sigmoid lirae and more or less evolute whorls, this species is apparently similar to certain early representatives of the Phyllocerataceae, such as *Eopsiloceras planorboides* (GÜMBEL) (see WIEDMANN, 1970) and *Wopfingites krystyni* WIEDMANN, 1970,



Text-fig. 4. *Microdesmoceras tetragonum* MATSUMOTO and MURAMOTO, sp. nov. Diagrammatic illustration of a paratype, GK. H5650, showing growth of whorls in cross-section and lateral view (above) and also that of sutures (below). pr=protoconch, 1°=the first whorl, 2°=the second whorl, 3°=the third whorl, 4°=the fourth whorl, b=early part of the body-whorl [living-chamber]. s=the last second suture. A concealed but presumed part of a suture is drawn with a broken line, with the aid of the observed feature in cross-section. (T. MAT. *delin.*)

from the Upper Triassic of Europe. The similarity is regarded again as homeomorphy, because it has no lituid internal lobe of the phylloceratacean type and because its geological age is much separated from them.

This species is somewhat allied to *Desmoceras* (*Pseudouhligella*) *japonicum*

YABE (see MATSUMOTO, 1954a), from the Cenomanian of the northern Pacific region, in the flattened flanks, perpendicular walls and sigmoidal constrictions of an adult shell, although the shell of the latter species is more compressed, much more involute and about six times as large as the former in diameter. The suture of the former resembles that of an immature shell of the latter (see MATSUMOTO, 1954, text-fig. 6 [52]), in the general pattern and probably also in the mode of development with growth, although much broader L and more simple, phylloid outline of the saddles are characteristic of the former. *D.* (*P.*) *japonicum* and other species of *Desmoceras* have more finely and deeply incised, complex sutures in late growth-stages.

The present species resembles certain species of *Puzosia* [e.g. *P. mayoriana* (D'ORBIGNY)] in the degree of involution, width of umbilicus and sigmoid constrictions. The suture of immature *Puzosia* or its allies (see SCHINDEWOLF, 1966, text-figs. 373-377) is fairly similar to that of the present species, but the former is more incised and the auxiliaries are strongly descending* even if the shells of the same size are compared. Species of *Puzosia* have generally more distinctly marked constriction and numerous ribs. They are evidently larger than the present species in the adult stage.

Occurrence.—The holotype and a paratype came from loc. Ik 1101 and another paratype from loc. Ik 1051b on the northern wall of the V-shaped valley of the Ikushumbets (see MATSUMOTO *et al.*, 1969, text-fig. 9). They were contained in calcareous nodules from the lower part of unit IIb, Mikasa Formation. The bed belongs to the zone of *Mantelliceras japonicum*, Lower Cenomanian. The third paratype was found in a rolled calcareous nodule collected at loc. Ik 1067bp, which was probably derived from the same zone exposed on the southern wall of the Shimo-ichino-sawa [locally called Tori-sawa], a tributary of the Ikushumbetsu near an electric power station, because *Zelandites inflatus*, *Hypoturilites* sp. and *Eogunnarites* sp., among many other mollusks, were found in the same nodule.

Discussions.—On the basis of the preceding description it can be concluded that the genus *Microdesmoceras*, as represented by *M. tetragonum*, should be ascribed to the family Desmoceratidae. *M. tetragonum* is, however, so peculiar that it is not directly connected with any known species of the Desmoceratidae. In other words the origin of the species is obscure.

Microdesmoceras is not so closely connected with main representatives of the Desmoceratinae or those of the Puzosiinae that it could possibly be accomodated in a new subfamily. However, we still hesitate to propose a new subfamily name, because we have not yet discovered any descendants or relatives which could be closely grouped with *Microdesmoceras* under the same subfamily. It is indeed a particular offshoot of the Desmoceratidae, in view of its small size, simplified suture, less prominent constrictions and tetragonal, smooth, slightly scaphitoid outer whorl. For the time being we have to assign it to either the subfamily Puzosiinae or to the subfamily Desmoceratinae. Someone might prefer the former assignement on account of its less involute coiling, but we are rather inclined to the latter assignement, though provisionally, on the grounds of the pattern of its suture.

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* This character is not well shown in SCHINDEWOLF's text-figs. See MATSUMOTO, 1954b, text-figs. 2-4 for this point.

It is interesting to see the appearance of peculiar micromorphic offshoots in the evolutional history of various branches of the Ammonoidea. The Upper Albian to Cenomanian Flickiidae, which are provisionally ascribed to the Acanthocerataceae (see WRIGHT, 1957, p. L409), are good examples. Lower Cenomanian genus *Neosaynoceras*, which is included at present in the family Acanthoceratidae may be another minor example which considerably deviates from the principal genera of the family in many characters. *Microdesmoceras* can be taken as another example of a special, dwarfish derivative which appeared in the course of the evolutional history of the Cretaceous great family Desmoceratidae.

Aside from the Cretaceous examples, *Cymbites* and *Paracymbites* in the Arietitidae, *Protocymbites* in the Psiloceratidae and *Metacymbites* in the Liparoceratidae, *Primelites* and *Diaphorites*, provisional members of the Eoderoceratidae, and *Oecoptychius* and *Protophites* in the Stephanocerataceae are examples of peculiar dwarfs or degenerated, simplified (or specialized) derivatives in several families or superfamilies of Jurassic ammonites (see ARKELL, 1957, p. L240, L248, L296).

The origin of this kind of ammonites is more or less obscure and they are often called cryptogenic. In other words the peculiar character appeared seemingly suddenly, with little evidence of intermediate forms. Why this is so is one of the problems of evolution in palaeontology. How were the habitats or ecological conditions of these ammonites may be another problem to be worked out in the future. We generally presume that they may have been less aggressive animals.

Subfamily Puzosiinae*

The subfamily Puzosiinae include many species which have a large shell. A giant example, which is more than a meter in shell-diameter, was reported by MILLER and YOUNGQUIST (1946) from the Senonian of Montana under the specific name of *Parapuzosia bradyi*. A specimen of *Pachydesmoceras denisoni* (STOLICZKA) (1865, pl. 66a), GSI. No. 208, which one of us (T.M.) examined in the Museum of the Geological Survey of India, Calcutta, is nearly as large as 100 cm in diameter at the middle of the coarsely ribbed body-whorl. The holotype of *Lytodiscoides conduciaensis* (CHOFFAT, 1903) and that of *L.* [=" *Achileoceras* "] *erasmusi* (VAN HOEPEN, 1951), which have magnificently ornate body-whorl, are likewise large.

In the Cretaceous deposits of Hokkaido and Saghalien large ammonites are not infrequently found at various stratigraphic levels. Some of them certainly belong to the subfamily Puzosiinae. Thus an example of *Mesopuzosia* sp., which came from the Upper Turonian (upper most part of the Mikasa Sandstone) of the Yubari area, now exhibited in the National Science Museum, and two other examples of *Pachydesmoceras* cf. *pachydiscoide* MATSUMOTO, from the Turonian Saku Formation of the Saku area, one of which was presented to the Akiyoshidai Science Museum (from T.M.) and the other in the possession of Kyushu University (T.M. Coll.), are about 70 to 80 cm in diameter. They are, however, nearly wholly septate and, accordingly must have exceeded a meter, if their body-whorls were completely preserved. Aside from these giant examples, we see more

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* The authorship of the description under the subfamily Puzosiinae is Tatsuro MATSUMOTO and Akitoshi INOMA.

frequently puzosiine ammonites of about 30 to 40 cm in diameter.

In contrast to the above mentioned large ammonites of the Puzosiinae there are very small specimens which represent a species of the same family. They were collected by one of us (A.I.) from the Upper Cretaceous of the Haboro area, northwest Hokkaido, preliminarily studied by A. INOMA, then sent to T. MATSUMOTO of Kyushu University for further study and now preserved in the Type-Specimen Room, Department of Geology, Kyushu University. They are assigned to a new species of *Kitchinites* described below, with some discussions.

Genus *Kitchinites* SPATH, 1922

Subgenus *Neopuzosia* MATSUMOTO, 1954

Type-species.—Kitchinites (*Neopuzosia*) *japonicus* SPATH, 1922.

Remarks.—Neopuzosia was proposed as an independent genus, because the distinction between the type-species of *Neopuzosia* and that of *Kitchinites* [*K. pondicherryanus*] was very clear. There are, however, certain species which show apparently intermediate or even mixed characters (see MATSUMOTO, 1954b, p. 89; HOWARTH, 1965, p. 387). At present we would agree with WRIGHT (1957) and HOWARTH (1965) in admitting *Neopuzosia* as a subgenus of *Kitchinites*.

Species of *Kitchinites*, including those of the subgenera *Neopuzosia* and *Kitchinites* (s.s.), have a shell of moderate to small size even at the mature stage, being generally smaller than many other species of the Puzosiinae. This point was mentioned by MATSUMOTO (1954b, p. 90) and has been ascertained by subsequent descriptions of HOWARTH (1965) and HENDERSON (1970). The species to be described below may exemplify the smallest form.

Kitchinites (*Neopuzosia*) *haboroensis* MATSUMOTO and INOMA, sp. nov.

Pl. 47, Figs. 5-6; Text-figs. 5-9

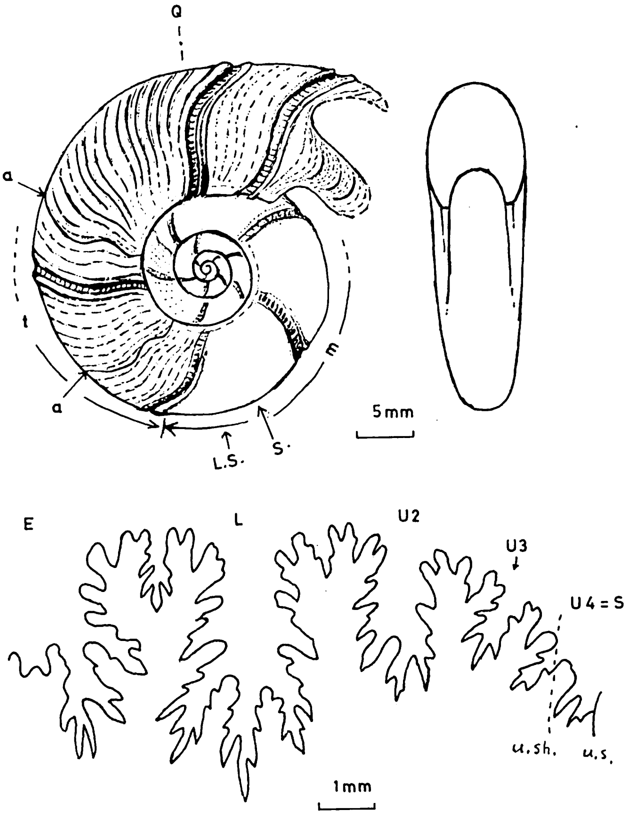
Material.—Holotype, GK. H5654, from loc. IA-1564. Paratypes, GK. H5655, from loc. IA-1562; GK. H5656; from loc. IA-1561; GK. H5657, from loc. IA-1599; GK. H5660, from loc. IA-1557; GK. H5661, from loc. IA-1570; GK. H5658, from loc. IA-1577, Haboro area. Probably referable specimens, GK. H5659, from loc. IA-1536, Haboro area; IGPS. 57746, Ikushumbets area.

Specific characters.—Shell is small, about or slightly less than 30 mm in diameter at the adult stage. It is moderately evolute, about a half of the inner whorl being embraced by the outer one. Its umbilicus is also fairly wide, occupying about 34-38 percent of a diameter in the holotype and measurable paratype. The umbilicus is shallow and encircled by a very low but nearly vertical or steeply inclined wall.

The outer whorl is compressed, showing about 0.7 to 0.8 in the proportion of breadth to height. Its flanks are, however, gently convex, passing to a rather narrowly arched venter. Its cross-section is, therefore, subelliptical. The inner whorls are less compressed and subrounded; the innermost one is depressed.

Constrictions are well marked (i.e. deep and moderately broad on the internal mould) and fairly frequent, about five to six per whorl. They are gently sigmoid on the flank and projected on the venter. On the body-whorl the linguiform ventral projection is remarkable, being accompanied with the notable elevation behind the constriction.

The inner whorls are nearly smoothish.

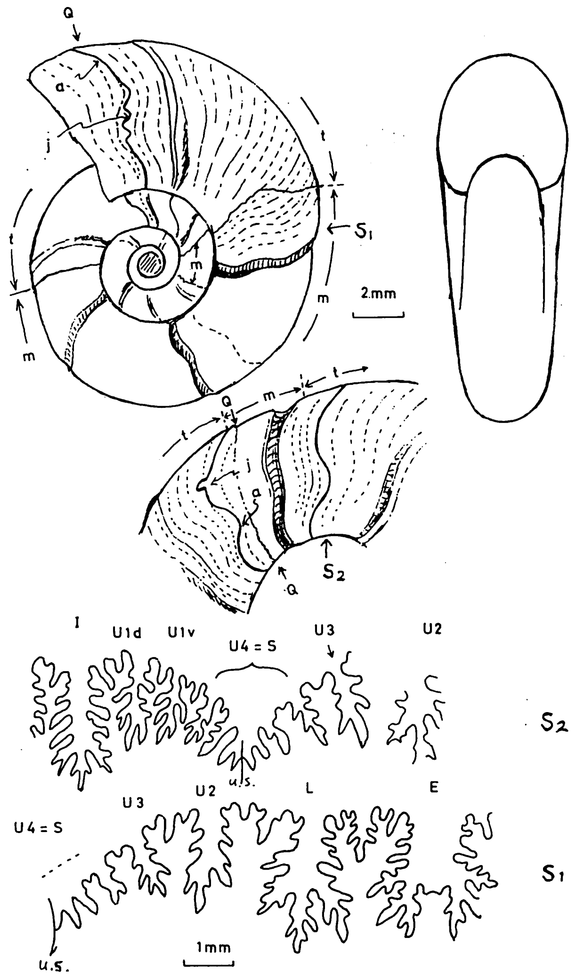


Text-fig. 5. *Kitchinites* (*Neopuzosia*) *haboroensis* MATSUMOTO and INOMA, sp. nov. Diagrammatic sketch of the holotype, GK. H5655, in lateral view and its front view, with body-whorl cut at Q (above); external part of the second last suture at S (below). m=internal mould; t=test preserved; a=line of demarcation showing the apertural margin at an earlier growth-stage; u.s.=umbilical seam, u.sh.= umbilical shoulder. (T. MAT. *delin.*)

The septate part of the outer whorl has fine and weak, sigmoidal ribs. The body-whorl has more distinct, but fairly fine and dense, ribs, which are more or less sigmoidal on the flank and projected on the venter. The ribs which are situated at some distance in front of the constriction are normally more sigmoid than the others, although there may be a variation in the details.

Near the apertural margin of the adult shell there are two approximated constrictions which show a very strong ventral projection. Aside from the elevations which are accompanied with the two constrictions, ribs are very faint, whereas fine, sigmoid lirae are discernible on the shell-surface of the interval between these two constrictions. In front of the last constriction there are elongated lappets which are situated at about the inner one third of the flank. The ventral part of the peristrome is moderately projected.

A distinct line of demarcation which probably marks the apertural margin of



Text-fig. 6. *Kitchinites* (*Neopuzosia*) *haboroensis* MATSUMOTO and INOMA, sp. nov. Diagrammatic sketch of an immature shell, paratype no. 5, GK. H5658, in lateral and frontal view (above) ; the other side, in part (center) ; internal suture, with adjacent portion of external suture, at S2; external suture at S1 (below). symbols m, t, a, and u.s. same as in Text-fig. 5, j=injured part of the apertural margin at an early growth-stage. (T. MAT. *delin.*)

the immature shell is sometimes preserved at some distance in front of the constriction, showing a moderate flexuosity on the flank and a ventral projection. Its convexity on the lower part of the flank is somewhat stronger than the ribs or lirae on the adjacent parts (Text-figs. 5-7).

Sutures are of *Puzosia* pattern. Those in the late part of the septate whorl have a somewhat asymmetrically tripartite first lateral lobe (L) which is deeper than the external lobe (E). The auxiliary elements beyond the second lateral lobe (U_2) are aligned on a strongly descending line.

Measurements.—

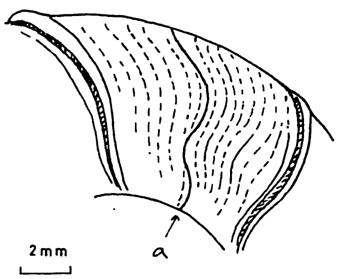
Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5654	29.0(1)	11.2(.38)	11.5(.40)	8.9(.31) (c) 8.7(.29) (ic)	.77
" (−180°)	——	——	7.2	6.2	.86
GK. H5655	28.0(1)	10.4(.37)	11.2(.40)	7.3(sec. compr.)	
GK. H5656	29.5(1)	10.2(.34)	12.2(.41)	8.7(.29)	.71
GK. H5658	14.3(1)	4.3(.30)	5.5(.38)	5.5(.38)	1.0

The saddles are bipartite and their stems tend to be narrowed by deep incision of the branches of the lobes. The sutural formula is probably E, L, U_2, U_3, U_4=S, U_{1v}, U_{1d}, I, but could be interpreted otherwise [E, L, U_2, U_3=S, U_1, I, as one of us (T.M., 1954b, text-fig. 3) thought so on *K.* (*N.*) *ishikawai*] (see also SCHINDEWOLF, 1966, text-fig. 377).

Remarks.—There is some extent of variation in the relative width of umbilicus and the proportion between breadth and height of the whorl, even if the shells of corresponding size are compared. The details in the rib curvature may also vary as shown in the illustration.

Comparison.—The shell of this species closely resembles the small immature one of *Kitchinites* (*Neopuzosia*) *ishikawai* (JIMBO, 1894) (see also MATSUMOTO, 1954b). In fact the two species are apparently indistinguishable up to the shell diameter of about 20 mm, if we ignore the minor variation. One point which may serve as a distinction even in this immature shell is that a remarkably sigmoidal line of demarcation, probably the peristome of the immature shell, is distinct at some distance ahead of the constriction on a well preserved shell of *K.* (*N.*) *haboroensis*. A similar line may be discernible in front of the constriction on some well preserved inner whorl of *K.* (*N.*) *ishikawai*, but its curvature seems to be more gentle, with a less pronounced lateral projection.

The distinction in the succeeding later whorls of the two species is unmistakable. The adult shell of *K.* (*N.*) *haboroensis* is much smaller and more widely umbilicate than that of *K.* (*N.*) *ishikawai* and ends at the peristome which is characterized by pronounced lateral lappets. The mode of curvature of the ribs on the body-whorl of *K.* (*N.*) *haboroensis* is more sigmoid than those of *K.* (*N.*) *ishikawai*. The ribs are remarkably strong on the ventral part of the adult body-whorl of *K.* (*N.*) *ishikawai*, except for the faintly ribbed apertural part. Such a sudden increase in the rib-intensity does not occur in *K.* (*N.*) *haboroensis*, although the ribs gradually become distinct on its outer whorl. The probably adult shell of *K.* (*N.*) *ishikawai* has at least two more whorls, attaining to about 120 or 130 mm in diameter, as represented by GK. H5663 (Y. UEDA Coll.) from the generally same Haboro-Chikubetsu area (UEDA *et al.*, 1962). Its very apertural margin is not completely preserved, but there are two, fairly approximated constrictions which are prorsiradiate and very gently sigmoid on the flank and strongly projected on the venter. The weak ribs and lirae on the interval of the two constrictions and immediately in front of the last one show a similar curvature. Although the very margin is not completely preserved, judging from the curvature of the lirae in the



Text-fig. 7. *Kitchinites (Neopuzosia) haboroensis* MATSUMOTO and INOMA, sp. nov. Diagrammatic sketch of a part of an immature shell, paratype no. 6, GK. H5661, in lateral view (test preserved).
(T. MAT. *delin.*)

preserved last part, it does not seem to have long lateral lappets.

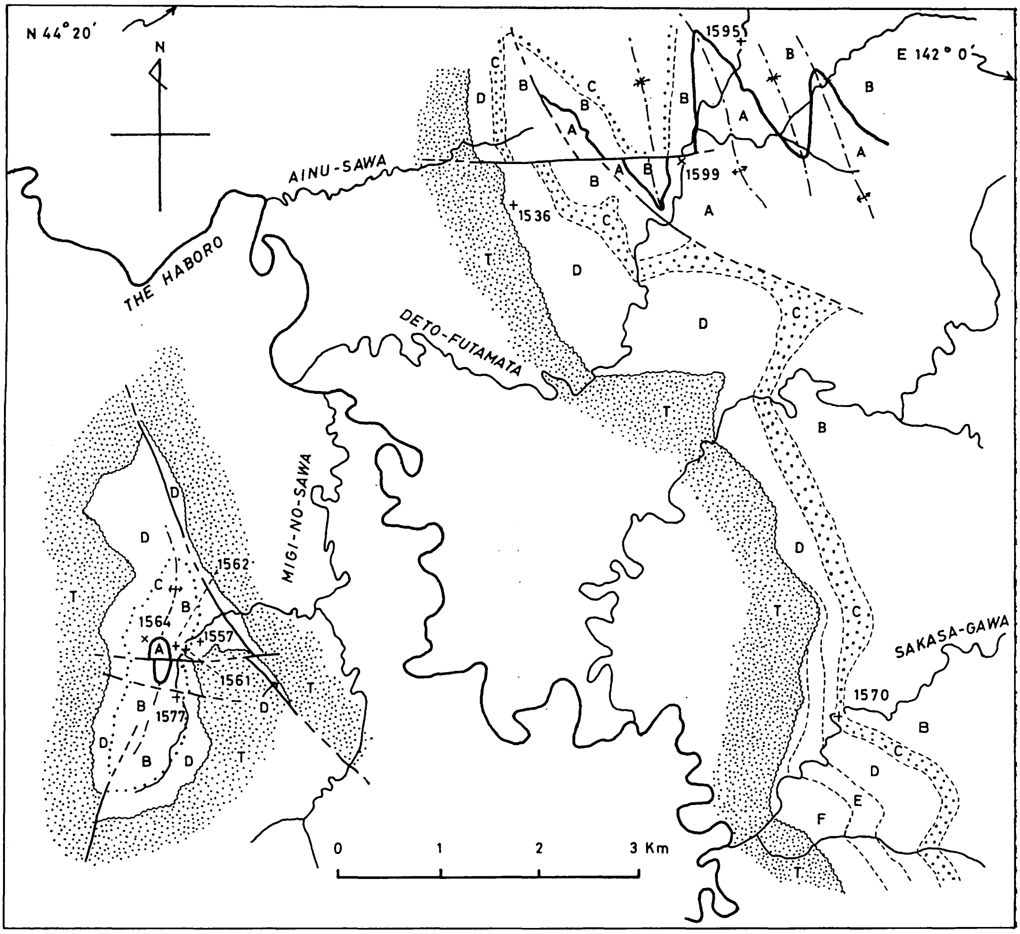
K. (*N.*) *haboroensis* is somewhat similar to *Yokoyamaoceras jimboi* MATSUMOTO (1955, pl. 9, figs. 4, 5; text-fig. 13) in the small size, presence of lateral lappets and other general appearance. The latter has ventrolateral tubercles on a limited part of the body-whorl and prorsiradiate constrictions which cut obliquely numerous ribs behind them. The suture of the former species is of puzosiine type, with remarkably descending auxiliaries, whereas that of the latter is of *Kossmaticeras* type.

Kitchinites (*Kitchinites*) *angolaensis* HOWARTH, 1965 (p. 386, pl. 11, figs. 4-6), from the Campanian of Angola, is considerably small. Its probably adult shell, as represented by the holotype, is 64 mm in diameter. Therefore it is twice as large as *K.* (*N.*) *haboroensis*. *K.* (*K.*) *angolaensis* has somewhat less flexuous ribs and more involute and more compressed whorls than *K.* (*N.*) *ishikawai* and *K.* (*N.*) *haboroensis*, if the shells are compared at corresponding size. Rather rapid strentghening of the ribs on the ventral part of the probably adult whorl is evident in *K.* (*K.*) *angolaensis*, whereas constrictions are stronger in *K.* (*N.*) *haboroensis*.

Unfortunately the peristome of the adult shell has not been clearly described in *K.* (*K.*) *angolaensis* nor in *K.* (*K.*) *pondicherryanus* (KOSSMAT), the type-species from India. The neotype of *K.* (*K.*) *angustus* (MARSHALL), proposed by HENDERSON (1970, p. 34, pl. 14, fig. 1), from the Campanian of New Zealand, shows dense lirae at the preserved last part (diameter about 130 mm), which show a very gently sinuous curvature on the flank and are considerably projected on the venter as in the above mentioned specimen of *K.* (*N.*) *ishikawai*. However, it is not certain whether or not the last part of that New Zealand species marks the very apertural margin.

In view of the gentle inflation of the flanks and the gradual strengthening of the ribs in the adult shell, this species could be referred to *Mesopuzosia*, but we are inclined to assign it to *Kitchinites* (*Neopuzosia*) because of its small size and its close resemblance to *K.* (*N.*) *ishikawai* in immature stages.

Occurrence.—The type-locality is loc. IA-1564, in unit B (siltstone) of the Santonian sequence exposed in the area of the Haboro dome, Rumoi district, Teshio provine, northwest Hokkaido. Paratypes came from loc. IA-1599, Deto-Futamata, a tributary of the Haboro, upper part of unit A (siltstone), and rolled or fallen nodules obtained at loc. IA-1557, IA-1561, IA-1562, IA-1577 (Haboro dome), IA-1570 (Sakasa-gawa), and IA-1536 (Ainu-sawa). The possible sources of the rolled or fallen nodules are from unit A to D within the Santonian sequence (zone of *Inoceramus naumanni*) of the Haboro area (Text-fig. 8). They are all from calcareous nodules in siltstone and often associated with *Inoceramus naumanni*. Thus in the Haboro area, which repre-



Text-fig. 8. Geological map of the upper reaches of the Haboro. A–F = Upper Cretaceous (Santonian) sequence in ascending order, A : dark grey siltstone, with tuffaceous sandstone at the top (indicated by black band), B : dark grey siltstone, C : glauconitic sandstone (coarsely dotted), D : dark grey siltstone, E : green sandstone, F : black mudstone. T = Tertiary (Miocene) conglomerate, sandstone, shale and tuff (finely dotted). × = Locality where the described ammonites were obtained (in situ) ; + *Ditto* (in fallen or rolled nodules). (Geol. Surv. by A. INOMA)

sents a northwestern part of the Yezo geosyncline and probably belongs to a less off-shore facies, the species seems to occur not uncommonly. In other areas the occurrence of the species has not been well ascertained, except for a rare occurrence of a probable example from the Santonian of Kikume-zawa, Ikushumbets area, central Hokkaido.

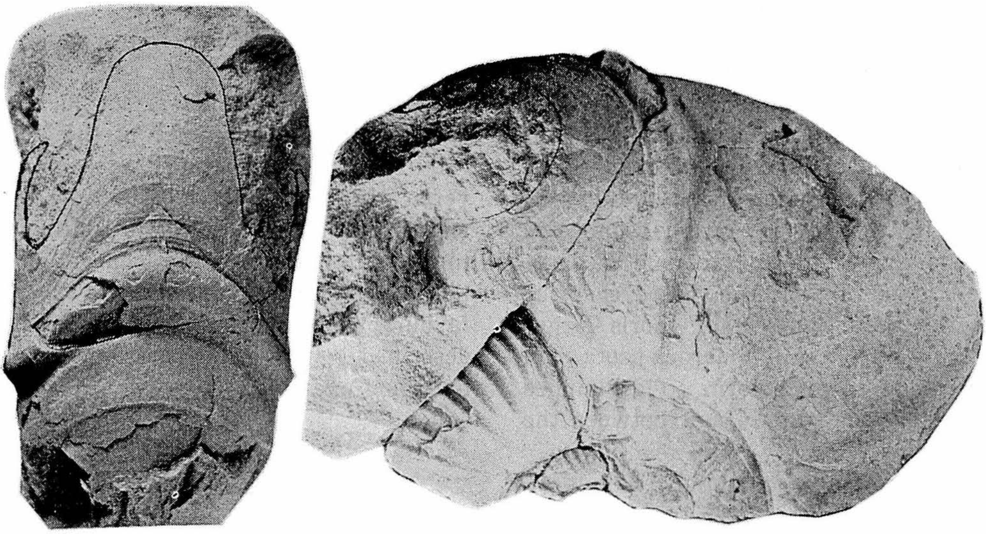
Discussions.—The fact that *Kitchinites* (*Neopuzosia*) *haboroensis* shows almost the same stratigraphical range as *K.* (*N.*) *ishikawai* (JIMBO) and that the former is closely similar to the latter in the immature stages but much smaller in the mature stage, having a particular type of peristome, recalls us of the possibility of sexual dimorphism between the two "nominal species". The situation apparently seems to be analogous with the cases in certain Jurassic ammonites as exemplified by *Cosmoceras spinosum* (SOWERBY) and *Quenstedtoceras mariae* (D'ORBIGNY), which were discussed by MAKOWSKI (1962), and by *Creniceras renggeri* (OPPEL), *Distichoceras bicostatum* (STAHL), and ? *Hecticoceras brightii* (PRATT), which were ontogenetically examined by PALFRAMAN (1966, 67, 69).

We do appreciate these and other authors who took into consideration the problem of sexual dimorphism in the study of ammonites, but it seems to us fairly difficult to present the necessary and sufficient evidence for concluding that A is the female and B is the male of one and the same species.

Aside from the Jurassic ammonites, with which we are not well acquainted, let us consider the problem in the case of the Puzosiinae. Although numerous species of the subfamily have been monographed by various authors, little has been mentioned about the peristome of mature shells. In our experience of field work we observe that the smoothish body-whorl of a large shell of *Puzosia*, *Mesopuzosia* or *Pachydesmoceras* is often squashed probably because of its weaker condition as compared with the septate whorls.

One of a few examples in which the apertural margin was described is a very large specimen of "*Ammonites planulatus*" in STOLICZKA (1865, p. 134, pl. 68). One of us (T.M.) fortunately had an opportunity to examine this specimen in the museum of the Geological Survey of India, Calcutta. There is a broad, deep, concave constriction near the preserved last part of the shell (about 805 mm in diameter). The body-whorl is smoothish and unusually inflated behind the last constriction, with the breadth of 225 mm (about 0.98 of the height). The shell in front of the last constriction is not completely preserved; the ventral linguiform projection is present but the presence or absence of lateral lappets is not know. If we assume that there were no lateral lappets, this specimen could possibly be regarded as representing a female form of *Puzosia* sp. by analogy with the cases of Jurassic ammonites. However, the evidence to conclude so is by no means sufficient and no corresponding male form (somewhat smaller one with lateral lappets) has been confirmed to occur in the same formation.

In the recent collection of one of us (T.M.) there is an interesting specimen, GK. H5665 (Text-fig. 9), from loc. T 1021p of the Turonian Saku formation, in which the peristome is almost completely preserved. Based on the general characters of the shell it is probably referable to *Mesopuzosia pacifica* MATSUMOTO, 1954. It is of moderate size, only somewhat larger than the holotype. On the last part of its body-whorl the ribs are much weakened between two, rather approximated, strong constrictions (elevations on the shell), which are very gently sigmoidal on the flank and projected on the venter. In front of the last constriction there is a remarkable ventral rostrum, which approximately continues the spiral line of coiling, and remarkable lateral lappets, which are as long as the rostrum but somewhat bent inward at their terminal portion. The lirae are gently sigmoidal on the part immediately in front of the last constriction but become more and more strongly flexuous so as to follow the outline of the very apertural margin. Whether every shell of *Mesopuzosia pacifica* has always



Text-fig. 9. *Mesopuzosia* sp. cfr. *M. pacifica* MATSUMOTO. GK. H5665, from loc. T1021p2, Saku Formation, ×0.9. Note the will preserved apertural margin and a marked contribution behind it. (I.H. *photos*)

this kind of peristome in the mature shell or not is not clear. One of the paratypes of this species, GK. H1571 (see MATSUMOTO, 1954b, pl. 15, fig. 2) has a larger outer whorl than the holotype and the above specimen (GK. H5665), but its outer whorl is so incompletely preserved that its apertural margin is not shown. Thus we cannot yet settle the problem of sexual dimorphism in this species.

Be that as it may, it is interesting to see a similarity between the well preserved peristome of the above mentioned *Mesopuzosia pacifica* and that of *Kitchinites (Neopuzosia) haboroensis*. On these grounds it can be stated that at least some, if not all, of the Puzosiinae have an apertural margin which is characterized by a rostrum and lateral lappets.

We would not completely deny the possibility that *Kitchinites (Neopuzosia) haboroensis* might represent the male form of *K. (N.) ishikawai*. So far as the available material is concerned, we should regard them as two different species, inasmuch as we observe a difference even in the immature stage (see description under the heading of comparison). The said difference, however, should be examined more precisely by treating more specimens with respect to ontogeny and variation.

Another point which is unfavorable for concluding the sexual dimorphism in this case is the occurrence. Although there would be some collection failure, the specimens of *K. (N.) haboroensis* have been known only in a limited area of a particular facies and are not always associated with *K. (N.) ishikawai*, which, in turn, is more widely distributed. We rather consider that smaller ammonites which possess lappets at the peristome of the shell should have particular habitats and mode of life which are different from larger ammonites without lappets. Presumably the former may have been less active and less rapidly locomotive than the latter and have taken different kinds of food. Too much difference in these respects between male and female seems to be unnatural, if not impossible. In other words, the difference in size and apertural character of the adult shell may not imply sexual dimorphism but may be concerned with taxonomic difference or morphological diversity in evolution, which in turn, is connected with diversity in habitats and mode of life. It is, furthermore, noted that the megaform is about two whorls larger and has much more numerous septa than the compared microform. This implies a considerable gap in age between the two forms.

In spite of a large number of specimens which have been monographed under the subfamily Puzosiinae, examples which have lappets are very few. Smaller shells with lappets should occur more frequently in association with numerous, larger shells, if such sexual dimorphism as analogous to that stated in Jurassic ammonites existed in the Puzosiinae. We would rather expect a different type of sexual dimorphism in the Puzosiinae, such as more inflation of the adult body-whorl or broader aperture and somewhat (but not extremely) larger size of the male shell than the female, as suggested by the living species of *Nautilus*, or difference in fineness or intensity of the ornamentation of the adult shell as suggested by REYMENT (1971) for dimorphic pairs of Cretaceous *Benueites* species.

To sum up, we have considered a possibility of sexual dimorphism in the Puzosiinae but are rather inclined to think that the available evidence is yet insufficient to support it, leaving the problem in the future. In this paper we describe *Kitchinites* (*Neopuzosia*) *haboroensis* as a new species of the Puzosiinae which is characterized by a very small size and a particular type of shell-aperture, stressing that the Puzosiinae include various species from a gigantic size to a very small one. It is noted that the Puzosiinae show a considerable diversity in the character of the adult body-whorl. There would be some diversity in the character of its apertural margin in the same subfamily, although the actual features have not yet been thoroughly known on account of the unfavourable preservation. The species described in this paper presents a rare but good example.

References cited

ARKELL, J.W. (1957) : *In* MOORE, R.C. (ed.) : *Treatise on Invertebrate Paleontology*, Part L (Mollusca 4, Cephalopoda, Ammonoidea) L1-L490, Geol. Soc. Amer. & Univ. Kansas Press.

CHOFFAT, P. (1903) : Contributions à la connaissance géol. des colonies portugaises d'Afrique. I. Le Cretacique de Conducia, pp. 1-29, 7 pls., 1 folded pl., *Commiss. Serv. Géol. Portugal.*

HENDERSON, R.A. (1970) : Ammonoidea from the Mata series (Santonian-Maastrichtian) of New Zealand. *Special Papers in Palaeontology*, (6), pp. 1-82, pls. 1-15.

HOEPEN, Ir. E.C.N. VAN (1951) : A remarkable desmoceratid from the South African Albian. *Paleont. Navor. Nas. Mus. Bloemfontein*, Dl. 1, St. 10, pp. 345-349.

HOWARTH, M.K. (1965) : Cretaceous ammonites and nautiloids from Angola. *Bull. Brit. Mus. (Nat. Hist.), Geol.*, Vol. 10, (no. 10), pp. 337-412, pls. 1-13.

KOSSMAT, Frantz (1895) : Untersuchungen über die Südindische Kreide-formation, I. *Beitr. Paläont. Geol. Osterr.-Ungarns u.d. Orients*, Bd. 9, pp. 97-203 [1-107], pls. 15-25 [1-11].

MAKOWSKI, Henryk (1962) : Problem of sexual dimorphism in ammonites. *Palaeontologia Polonica*, No. 12, 92p., 20 pls.

MATSUMOTO, Tatsuro (1954a) : Selected Cretaceous leading ammonites in Hokkaido and Saghalien. *In* MATSUMOTO, T. (ed.) : *The Cretaceous System in the Japanese Islands,* Appendix, pp. 243-313, pls. 17 [1]-36 [20].

—— (1954b) : Family Puzosiidae from Hokkaido and Saghalien. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.,* Vol. 5, No. 2, pp. 69-118, pls. 9-23.

—— (1955) : Family Kossmaticeratidae from Hokkaido and Saghalien. *Japan. Jour. Geol. Geogr.,* Vol. 26, nos. 1-2, pp. 115-164, pls. 8-10.

——, Tatsuo MURAMOTO and Takemi TAKAHASHI (1969) : Selected acanthoceratids from Hokkaido. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.,* Vol. 19, No. 2, pp. 251-296, pls. 25-38.

MILLER, A.K. and YOUNGQUIST, Walter (1946) : A giant ammonite from the Cretaceous of Montana. *Jour. Paleont.,* Vol. 20, no. 5, pp. 479-484, pls. 73-75.

PALFRAMAN, D.F.B. (1966) : Variation and ontogeny of some Oxfordian ammonites; *Taramelliceras richei* (DE LORIOL) and *Creniceras renggeri* (OPPEL), from Woodham, Buckinghamshire. *Palaeontology,* Vol. 9, pt. 2, pp. 290-311, pls. 48-52.

—— (1967) : Variation and ontogeny of some Oxford Clay ammonites: *Distichoceras bicostatum* (STAHL) and *Horioceras baugieri* (D'ORBIGNY), from England. *Ibid.,* Vol. 10, pt. 1, pp. 60-94, pls. 9-13.

—— (1969) : Taxonomy of sexual dimorphism in ammonites : morphogenetic evidence in *Hecticoceras brightii* (PRATT). *In* G.E.G. WESTERMANN (Ed.). Sexual dimorphism in fossil Metazoa and taxonomic implications. *Internat. Union Geol. Sci.,* Ser. A, No. 1, pp. 126-154, pls. 6-8.

PERVINQUIÈRE, L. (1907) : Etudes de paleontologie tunisienne. I. Cephalopodes des terrains secondaires. *Carte Geol. Tunisie,* 428p., 27 pls.

REYMENT, R.A. (1971) : Vermuteter Dimorphismus bei der Ammonitengattung *Benueites. Bull. Geol. Inst. Univ. Uppsala,* [N.S.], Vol. 3, art. 1, pp. 1-18, pls. 1-10.

SCHINDEWOLF, O.H. (1966) : Studien zur Stammesgeschichte der Ammoniten. V, *Akad. Wiss. Liter., Abh. Math.-Naturw. Kl.,* Jahr. 1966, No. 3, pp. 321-454.

STOLICZKA, Ferdinand (1863-66) : Ammonitidae, with revision of the Nautilidae, etc. *In* BLANFORD, M.F. and STOLICZKA, F., 1861-66. The fossil Cephalopoda of the Cretaceous rocks of southern India. *Mem. Geol. Surv. India, Palaeont. Indica,* Ser. 3, 216p., 95 pls. [pp. 41-56, pls. 26-31, 1863; pp. 57-106, pls. 32-54, 1864; pp. 107-154, pls. 55-80, pl. 66a, 1865; pp. 155-216, pls. 81-94, 1866].

UEDA, Yoshiro, Tatsuro MATSUMOTO and Ken AKATSU (1962) : The Cretaceous deposits in the Chikubetsu area, Hokkaido. *Sci. Rept. Dept. Geol. Kyushu Univ.,* Vol. 6, no. 1, pp. 15-32, with 3 folded chart and maps [in Japanese with English abstract].

WIEDMANN, Jost (1970) : Über den Ursprung der Neoammonoideen-Das Problem einer Typogenese. *Eclogae Geologicae Helvetiae,* Vol. 63, no. 3, pp. 923-1020, pls. 1-10.

WRIGHT, C.W. (1957) : *In* MOORE, R.C. [Editor] : *Treatise on Invertebrate Paleontology, Part L, Mollusca, Cephalopoda, Ammonoidea,* L1-L490, Geol. Soc. Amer. & Univ. Kansas Press.

Ainu-sawa	愛奴沢	Mikasa	三笠
Chikubetsu	築別	Rumoi	留萠
Deto-Futamata	デト二股	Sakasa-gawa	逆川
Ikushumbets	幾春別	Saku	佐久
Kikume-zawa	菊面沢	Shimo-ichino-sawa	下一の沢
Haboro	羽幌	Tori-sawa	鳥沢

Explanation of Plate 47

Figs. 1–4. *Microdesmoceras tetragonum* MATSUMOTO and MURAMOTO, sp. nov. ......Page 378

1. Holotype, GK. H5653, from loc. Ik 1101, zone of *Mantelliceras japonicum*, Ikushumbets area. Two lateral (a, b), apertural (c) and external (d) views, approximately ×2.
2. Paratype no. 2, immature specimen, from loc. Ik 1051b, MURAMOTO Museum coll. Lateral (a) and external (b) views, approximately ×2.
3. Paratype no. 1, immature specimen, from loc. Ik 1101, MURAMOTO Museum coll. Two lateral (a, b) and external (c) views, ×2.
4. A half of paratype no. 3, GK. H5650, from loc. Ik 1067bp. Two lateral (a, b) and sectional (c) views, ×2.

Figs. 5–6. *Kitchinites* (*Neopuzosia*) *haboroensis* MATSUMOTO and INOMA, sp. nov. ...Page 384

5. Holotype, GK. H5654, from loc. IA-1564, unit B of the Santonian sequence, Haboro area. Two lateral (a, b–c) and external (d) views, ×1.5. To show the ribbing and other features b and c are taken under the light of somewhat different orientation.
6. Paratype no. 1, GK. H5655, from loc. IA-1562. Two lateral view (a. b), ×1.5.

Kyushu University [I. HAYAMI] photos, with whitening.


1a


1c


1b


1d


2a


2b


3a


3c


3b

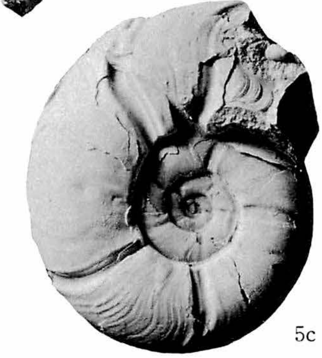

4a


4c

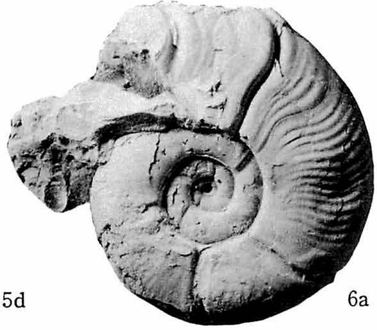

4b

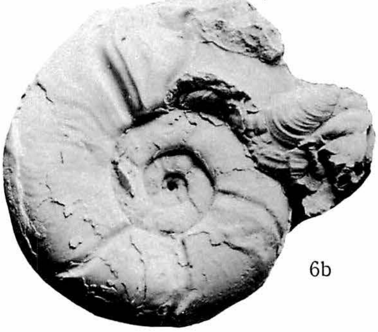

5a


5b


5c


5d


6a


6b

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 87, pp. 395-408, pls. 48, 49, September 30, 1972

602. *SWIFTOPECTEN* OF THE NORTHERN PACIFIC*

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北太平洋地域の *Swiftopecten*： *Swiftopecten* は，北日本から記載された現生の *Pecten swiftii* BERNARDI を模式種として，HERTLEIN (1935) によって提唱されたものである。筆者は以前，日本の化石および現生の *Pecten swiftii* について研究し，その地質学的意義について考察を行なった (MASUDA, 1959, 1960)。その際，筆者は北アメリカ西海岸の新生界から報告されている，いわゆる *Swiftopecten* と日本の *Swiftopecten* を比較検討する必要があることを指摘した。

今回，筆者は北アメリカ西海岸から報告されたすべての *Swiftopecten* について検討した結果，アラスカから記載された *Pecten* (*Chlamys*) *kindlei* DALL, *Chlamys* (*Swiftopecten*) *donmilleri* MACNEIL および，北カリフォルニアから ARNOLD (1906) が報告した *Pecten* (*Chlamys*) *parmeleei* DALL は，*swiftii* とシノニムであることが明らかになったほか，中部一南部カリフォルニアから知られている *parmeleei* は *swiftii* の亜種と考えるべきであることが明らかになった。しかし，西海岸におけるこれら以外のものは，*Swiftopecten* とは別のグループに入れられるべきであると考えられる。

この結果，*Swiftopecten* は東アジアから北樺太，カムチャッカを経てアラスカ，さらに西海岸に沿って南カリフォルニアまで分布していたことになる。日本では *swiftii* の最初の出現は Middle Miocene であるが，アラスカでは Late Miocene に出現し，Early Pliocene には北カリフォルニアまで分布した。後，北方に移って Middle Pleistocene に絶滅している。一方 *swiftii* から進化したと考えられる *parmeleei* は，Middle Pliocene に中一南部カリフォルニアに出現したが，その末期には絶滅してしまったと考えられる。

Swiftopecten のこのような地理的・地質学的分布は，北太平洋地域における古地理の変遷と密接な関係にあることは明らかである。

増田孝一郎

Introduction

Pecten swiftii, a common Recent scallop of Northern Japan, was first described by BERNARDI (1858), and subsequently it and its varieties were recorded from the seas of Northern Japan and also from the Neogene and Pleistocene deposits of Japan, the West Coast of North America and eastern Soviet Russia. In 1935 HERTLEIN proposed *Swiftopecten* for the present species as a subgenus of the genus *Pecten*.

Among the Northern Pacific Recent and fossil pectinids *Swiftopecten* is of interest because of its characters, extensive geographical distribution and rather short geological range, as discussed in the following pages.

From the study of the Tertiary Pectinidae of Japan the writer doubted whether *Swiftopecten* of the West Coast of North America is identical with the true *Swiftopecten* of Japan. To clarify this problem MASUDA (1959a, 1960) examined numerous fossil specimens of *Swiftopecten swiftii* (BERNARDI) collected from the Neogene and Pleistocene formations in Northern Japan and Recent specimens

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* Received January 22, 1972; read January 23, 1972 at Chiba.

from the Northern Pacific and Japan Sea. At that time he supposed that the North American *Pecten kindlei* DALL and *Pecten parmeleei* DALL might be descendants of *swiftii*, and that they migrated from East Asia to the West Coast of North America. MASUDA also pointed out that the interrelationship between the Japanese fossil and Recent *Swiftopecten* and the so-called North American *Swiftopecten* should be studied comparatively.

Many specimens of *Swiftopecten* from the West Coast of North America were studied in connection with the problems mentioned above. The specimens studied are now in the collections of the Department of Geology, Stanford University, U.S. Geological Survey in Menlo Park, Museum of Paleontology, University of California in Berkeley, California Academy of Sciences in San Francisco, Smithsonian Institution in Washington, D.C., and County Museum of Natural History in Los Angeles.

The examination of those specimens revealed that *Pecten kindlei* DALL from the Pleistocene of Alaska, some of *Pecten parmeleei* DALL from the Pliocene of northern California and *Chlamys* (*Swiftopecten*) *donmilleri* MACNEIL from the Miocene of Alaska are synonyms of *Swiftopecten swiftii* (BERNARDI), and that several western North American species or subspecies referred to *Swiftopecten* differ from the true *Swiftopecten*.

In the present article the morphological characters of *Swiftopecten* are described and the paleontological significances of the so-called *Swiftopecten* of the West Coast of North America are discussed.

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Historical review of *Swiftopecten*

In the West Coast of North America

the species or subspecies hitherto been referred to *Swiftopecten* or described as a variety of *swiftii* are: *Pecten* (*Chlamys*) *parmeleei* DALL, 1898, *Pecten etchegoini* ANDERSON, 1905, *Pecten* (*Chlamys*) *nutteri* ARNOLD, 1906, *Pecten* (*Chlamys*) *wattsi* ARNOLD, 1906, *Pecten* (*Chlamys*) *wattsi morani* ARNOLD, 1906, *Pecten* (*Chlamys*) *kindlei* DALL, 1920, *Chlamys* (*Swiftopecten*) *donmilleri* MACNEIL, 1967, *Chlamys* (*Swiftopecten*) sp., MACNEIL, (1967), *Swiftopecten* sp., ADEGOKE, (1967), *Swiftopecten adekunbiana* ADEGOKE, 1969 and *Chlamys* (*Swiftopecten*) *leohertleini* MACNEIL, 1970. However, no Recent species of *Swiftopecten* is known from the West Coast of North America.

Pecten (*Chlamys*) *parmeleei* first described by DALL (1898) from the Pliocene formation at San Diego, Southern California, was distinguished from *swiftii*. In 1906 ARNOLD illustrated *parmeleei* from the Pliocene formation at Pacific Beach near San Diego and also from the Pliocene formation at Crescent City in Northern California. ELDRIDGE and ARNOLD (1907) also reported the species from the Pliocene Fernando Formation at Elsemare Canyon, Southern California. Subsequently GRANT and GALE (1931) considered *parmeleei* a synonym of *swiftii* with the statement that the morphological characteristics pointed by DALL are the same as those of *swiftii*. WOODRING and BRAMLETTE (1950) illustrated *parmeleei* from the Pliocene Careaga Sandstone of the Santa Maria district, Southern California.

In 1920 DALL described *Pecten* (*Chlamys*) *kindlei* based upon the specimens from the Pleistocene deposits of Center Creek Mines near Nome, Alaska. GRANT and GALE (1931) included *kindlei*, *nutteri* and *etchegoini* into the variety of *swiftii* of the subgenus *Pallium*, and *wattsi*, *wattsi morani* and *cosibensis* were included into *etchegoini* and *heteroglyptus* into *nutteri*. Among the species treated by them both *Pecten cosibensis* YOKOYAMA, 1911 and *P. heteroglyptus* YOKOYAMA, 1926 had been described from the Pliocene formations in Japan.

MACNEIL (1943) described *Pecten kindlei* DALL under the subgenus *Manupecten* from the Intermediate Beach, Center Creek near Nome in Alaska, but subsequently from the same locality he (MACNEIL, 1967) recorded *kindlei* as a subspecies of *swiftii* under the subgenus *Swiftopecten*. At the same time he described *Chlamys* (*Swiftopecten*) *donmilleri*, n. sp. from the Miocene Yakataga Formation, Yakataga district, Alaska, and *Chlamys* (*Swiftopecten*) cf. *donmilleri* and *Chlamys* (*Swiftopecten*) sp. from the Unga Conglomerate at Alaska Peninsula. Furthermore, very lately he also described *Chlamys* (*Swiftopecten*) *leohertleini*, n. sp., from the Pliocene Tachilni Formation at the western end of Alaska Peninsula (MACNEIL, 1970).

In 1956 GLEN illustrated *Pecten* (*Pallium*) *swiftii* var. *etchegoini* and *swiftii* var. *nutteri* from the Pliocene " Merced " Formation near San Francisco, California. FAUSTMAN (1964) recorded *Pecten* (*Swiftopecten*) *etchegoini wattsi* and *Pecten* (*Swiftopecten*) sp. from the " Wildcat " Formation in Northern California.

Recently ADEGOKE (1967) described *Swiftopecten* sp. from the Miocene Santa Margarita Formation, California and discussed its paleontological significance, and he also (ADEGOKE, 1969) described from the same formation, *Swiftopecten adekunbiana*, n. sp. and *Swiftopecten* n. sp. and included *etchegoini*, *wattsi* and *nutteri* from the Pliocene Etchegoin and San Juaquin Formation, California, in the genus *Swiftopecten*.

On the other hand, in Soviet Russia, KHOMENKO (1934) recorded *swiftii* under the subgenus *Pallium* from the Pliocene formation of Schmidt Peninsula, Northern Sakhalin. Subsequently SLODKEWITSCH (1938) illustrated *Pecten* (*Pallium*) *swiftii* from the Pliocene Pomyr Series of Sakhalin and considered *nutteri*, *etchegoini*, *heteroglyptus* and *pilutukensis* as varieties of *swiftii*. Lately ILYINA (1963) figured *etchegoini* as a variety of *swiftii* under the genus *Swiftopecten* from the Pliocene of Kamchatka and KRISHTOFOVICH (1964) illustrated *swiftii*, *nutteri* and *pilutukensis* as varieties of *swiftii* under the subgenus *Swiftopecten* of the genus *Chlamys* from the Pliocene of Sakhalin.

Since the historical review of the *swiftii* group in Japan by the writer (MASUDA, 1959a, 1960, 1962a), SAWADA (1962), IWAI (1965) and UOZUMI, FUJIE and MATSUI (1966) figured *swiftii* under the genus *Swiftopecten* from the Pliocene formations in Northern Japan and also KASENO and MATSUURA (1965) figured *swiftii* under the genus *Chlamys* from the Pliocene of Ishikawa Prefecture.

As mentioned already HERTLEIN (1935) proposed *Swiftopecten* as a subgenus of the genus *Pecten* and designated *switii* BERNARDI as the type species, but gave no diagnosis of his new subgenus.

Although *swiftii* had been described under the genus *Pecten*, the genus or subgenus *Chlamys* or as the subgenus *Pallium*, HABE (1958) first used *Swiftopecten* as a subgenus of the genus *Chlamys* in Japan. The writer referred *swiftii* to the subgenus *Swiftopecten* of the genus *Chlamys* (MASUDA, 1959a). But because of its distinct morphological characters the writer raised *Swiftopecten* to generic rank (MASUDA, 1960).

On the other hand, on the West Coast of North America this species and its varieties had been referred to the subgenus *Pallium* or *Manupecten* of the genus *Pecten* (GRANT and GALE, 1931, MACNEIL, 1943) and to the subgenus *Swiftopecten* of the genus *Pecten*, but subsequently MACNEIL (1967) referred them to the subgenus *Swiftopecten* of the genus *Chlamys* and ADEGOKE (1967) raised *Swiftopecten* to generic rank. In eastern Soviet Russia *swiftii* and its varieties were referred to the subgenus *Pallium* of the genus *Pecten* (SLODKEWITSCH, 1938), but ILYINA (1963) raised *Swiftopecten* to generic rank and KRISHTOFOVICH (1964) considered *Swiftopecten* as a subgenus of the genus *Chlamys*.

From the remarks given above the *Swiftopecten* group is a confusing one in the Northern Pacific area. Therefore, to clarify the confusion the writer describes the type species from Japan and presents discussions concerning it.

Description

Family Pectinidae

Subfamily Chlamyinae V. TEPPNER, 1918

Genus *Swiftopecten* HERTLEIN, 1935

Swiftopecten HERTLEIN, 1935, p. 319.
Type-species :—*Pecten swiftii* BERNARDI, 1858. Recent, Northern Japan.

Geological and geographical distributions:—Middle Miocene to Recent. North Pacific.

Remarks:—As pointed out on the earlier lines the *Swiftopecten* group has been considered a subgenus *Pallium* or *Manupecten*. However, *Pallium* (SCHUMACHER, 1817, *fide* GRANT and GALE, 1931) is distinguishable from *Swiftopecten* by its small shell, nearly equal auricles and well-marked cardinal crura, and *Manupecten* (MONTEROSATO, 1889, *fide* COSSMAN and PEYROT, 1914) differs from *Swiftopecten* by its right valve being nearly equal to the left one in convexity, both valves having equal sculpture, radial ribs which are nearly equal to their interspaces in width, and by the left valve with no constricted radial ribs. *Manupecten* is considered to be closely related with *Swiftopecten* as pointed out by PHILIPPI (1900), GRANT and GALE (1931) and MACNEIL (1967). Therefore, further studies are necessary to settle the relationship between them.

Swiftopecten swiftii (BERNARDI, 1858)

Pl. 48, figs. 1-5, Pl. 49, figs. 1-5

1858. *Pecten swiftii* BERNARDI, *Jour. de Conch.*, Vol. 7, 2nd Ser. Tome 3, p. 90, pl. 1, fig. 1, pl. 2, fig. 2.
1867. *Pecten swiftii* BERNARDI: SCHRENCK, *Moll. Amurl. Nordjap. Meeres*, p. 487, pl. 21, figs. 1-3.
1882. *Pecten swiftii* BERNARDI: KOCHIBE, *Rika Kai-shi, Tokyo Univ. Press*, No. 4, p. 75, pl. 5, fig. 2.
1888. *Pecten swiftii* BERNARDI: KÜSTER und KOBELT in MARTINI und CHEMNITZ, *Syst. Conch. Cab.*, Vol. 7, pt. 2, p. 142, pl. 40, fig. 3.
1902. *Pecten swiftii* BERNARDI: YOSHIWARA, *Zool. Mag. Tokyo*, Vol. 14, no. 162, p. 144, pl. 2, figs. 6a-b.
1906. *Pecten (Chlamys) parmeleei* DALL: ARNOLD, *U.S. Geol. Surv. Prof. Paper* No. 47, p. 119, pl. 41, figs. 5, 5a.
1920. *Pecten (Chlamys) kindlei* DALL, *U.S. Geol. Surv. Prof. Paper* 125-C, p. 30, pl. 6, figs. 2, 7.
1925. *Pecten swiftii* BERNARDI: YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo*, Vol. 45, art. 5, p. 27, pl. 2, fig. 1.
1926. *Pecten swiftii* BERNARDI: YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo*, Vol. 1, pt. 8, p. 303, pl. 37, figs. 5, 6.
1931. *Pecten (Pallium) swiftii* BERNARDI: GRANT and GALE, *Mem. San Diego Soc. Nat. Hist.*, Vol. 1, p. 171, pl. 10, figs. 1a-b, 4a-b.
1931. *Pecten (Pallium) swiftii kindlei* DALL: GRANT and GALE, *Ibid.*, p. 174, pl. 10, fig. 7.
1934. *Chlamys swiftii* (BERNARDI): KINOSHITA and ISAHAYA, *Rept. Fish. Surv. Hokkaido Fish. Exp. Stat.*, No. 33, p. 14, pl. 10, fig. 74.
1934. *Pecten swiftii* BERNARDI: KHOMENKO, *Trans. Geol. Oil Inst.*, Ser. A, Fasc. 40, p. 31, pl. 2, figs. 3, 4, pl. 3, figs. 2, 3.
1935. *Pecten (Pallium) swiftii* BERNARDI: NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull.*, No. 6, p. 98, pl. 9, fig. 8, pl. 10, figs. 3, 4, pl. 11, fig. 8, pl. 13. fig. 3.
1938. *Pecten (Pallium) swiftii* BERNARDI: SLODKEWITSCH, *Acad. Sci. USSR, Paleont. Inst. Paleont. USSR*, Vol. 10, pt. 3, fasc. 18, p. 169, pl 22, fig. 2, pl. 23, figs. 1, 1a, 2, 3.
1943. *Pecten (Manupecten) kindlei* DALL: MACNEIL in MACNEIL, MERTIE and PILSBRY, *Jour. Paleont.*, Vol. 17, no. 1, p. 87, pl. 12, figs. 7, 8.
1950. *Chlamys islandicus* var. *swiftii* (BERNARDI): KUBOTA, *Cenozoic Res.*, No. 6, p. 12, pl. 9, figs. 66, 67.
1955. *Chlamys swifti* (BERNARDI): HABE, *Publ. Akkeshi Mar. Biol. Stat.*, No. 4, p. 6, pl. 2, fig. 7.
1958. *Chlamys (Swiftopecten) swifti* (BERNARDI): HABE, *Publ. Seto Mar. Biol. Lab.*, Vol. 6, no. 3, p. 263, pl. 12, fig. 18.
1958. *Chlamys (Swiftopecten) swifti* (BERNARDI): YAMAMOTO and HABE, *Mar. Biol. Stat. Asamushi, Tohoku Univ., Bull.*, No. 9, pt. 1, p. 15, pl. 3, fig. 4, pl. 5, figs. 4, 7.
1958. *Chlamys swiftii* (BERNARDI): TOMIZAWA in T. and K. YAGI, *Geol. Kami-Minochi*, p. 326, pl. 3, figs. 5a-b.
1958. *Chlamys swifti* (BERNARDI): FUJIE, *Cenozoic Res.*, No. 28, p. 668, pl. 27, figs. 29, 30.
1959. *Chlamys (Swiftopecten) swiftii* (BERNARDI): MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N.S.*, No. 34, p. 87, pl. 9, figs. 1-7.
1959. *Chlamys swiftii* (BERNARDI): OYAMA, *Sci. Photogr. Club, Tokyo*, II, *Chlamys* (5), figs. 6-8.

1960. *Swiftopecten swiftii* (BERNARDI) : MASUDA, *Sci. Rept., Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol.* No. 4, p. 380, pl. 39, figs. 9, 10.

1960. *Chlamys (Swiftopecten) swifti* (BERNARDI) : HABE, *Shirikishinai Mar. Biol. Inst., Hokkaido Gakugei Univ., Publ.*, No. 2, p. 4, pl. 1, fig. 16, pl. 5, figs. 7, 8.

1962. *Swiftopecten swiftii* (BERNARDI) : MASUDA, *Sci. Rept., Tohoku Univ., 2nd Ser. (Geol.)*, Vol. 33, no. 3, p. 196.

1962. *Swiftopecten swiftii* (BERNARDI) : SAWADA, *Mem. Muroran Inst. Technol.*, Vol. 4, no. 1, p. 73, pl. 1, fig. 3, pl. 2, fig. 3, pl. 3, fig. 4.

1964. *Chlamys (Swiftopecten) swiftii* (BERNARDI) : KRISHTOFOVICH, *Soviet Petrol. Sci.-Res. Geol., Expl. Inst.*, 232, p. 143, pl. 20, figs. 1, 2.

1965. *Swiftopecten swiftii* (BERNARDI) : IWAI, *Bull. Educ. Fac., Hirosaki Univ.*, No. 5, p. 29, pl. 15, figs. 9, 10.

1966. *Swiftopecten swiftii* (BERNARDI) : UOZUMI, FUJIE and MATSUI, *Jour. Fac. Sci., Hokkaido Univ., Ser. 4 (Geol. Mineral.)*, Vol. 13, no. 2, p. 175, pl. 14, fig. 2.

1967. *Chlamys (Swiftopecten) donmilleri* MACNEIL, *U.S. Geol. Surv. Prof. Paper* 553, p. 12, pl. 3, figs. 1, 4, 6.

1967. *Chlamys (Swiftopecten) swiftii kindlei* (DALL) : MACNEIL, *Ibid.*, p. 13, pl. 3, figs. 5, 7-9.

Remarks:—The original description is quoted below for the sake of persons to whom the original work is inaccessible.

"Testa maxima, utrinque convexa, solidiuscula, nitida, elongata, valva superore costis nodosis, majoribus 5, munita; nodis distantibus concentricè dispositis; interstiis longitudinaliter radiatis, minutissimè granularis, costis concentricis 5 graditim dispositis; valva inferiore vix nodosa, regulariter radiatum sulcata; auriculis valdè inaequilateralibus; suprà nodosis, infra sulcatis."

The present species is characterized by its large and thick, posteriorly contorted shell which forms an angle of about 70° at apex and is much higher than long, four prominent round-topped radial ribs with several, fine radial threads, two subordinate radial ribs near submargins, fine intercalary threads, rather conspicuous concentric constrictions, very large triangular anterior auricle and flat hinge plate in the right valve. The left valve is characterized by its five prominent, round-topped radial ribs which are usually nodose and by its young shell which is nearly flat or rarely a little concave upwards.

By the re-examination of the type specimen (U.S. Natl. Mus., No. 499058) and numerous topotype specimens, it is considered that *Pecten (Chlamys) kindlei* DALL is a synonym of *swiftii*, because the convexity of the valves, low radial ribs and concentric constrictions observed in *kindlei* are quite similar with those of *swiftii*. Similarly the hypotype specimen (U.S. Natl. Mus., No. 164842) and the specimens labelled as *parmeleei* (Dept. Geol., Stanford Univ., No. 4838) from the "Wildcat" Formation in the vicinity of Crescent City, Northern California, are synonyms of *swiftii*.

Chlamys (Swiftopecten) donmilleri was described by MACNEIL (1967) from the Miocene Yakataga Formation, Alaska, based upon rubber casts. The morphological characters of the type specimens (U.S. Natl. Mus., No. 644882, 644883, 644884) as observed by the writer coincide with those of *Swiftopecten swiftii*, therefore, MACNEIL's *donmilleri* is a synonym of *Swiftopecten swiftii*. But *Chlamys (Swiftopecten)* cf. *donmilleri* described by MACNEIL (1967) from the Miocene Unga Conglomerate, Alaska Peninsula can not be identified with *swiftii* but with *Chlamys cosibensis* (YOKOYAMA) which is known from the Miocene to Pliocene formations in Japan. For the *Chlamys cosibensis* group another paper is expected to be written.

Swiftopecten swiftii resembles *Chlamys cosibensis* (YOKOYAMA) and has been confused with it (MASUDA, 1959b). Also *Chlamys etchegoini* (ANDERSON), *Chlamys nutteri* (ARNOLD), *Chlamys wattsi* (ARNOLD) and *Chlamys wattsi morani* (ARNOLD) described from the Pliocene deposits of California resemble *swiftii*, which can be distinguished from those species and *cosibensis* by its large, higher, posteriorly contorted shell, smaller apical angle, triangular large anterior auricle and nearly flat left valve in younger stage.

Type locality:—Northern Japan. Recent.

Geographical distribution:—Living in Northern Japan, Sea of Okhotsk and along East Korea.

Geological distribution:—Middle Miocene to Recent in Japan, Pliocene to Recent in Sakhalin and Kamchatka, and Middle (?) to Late Miocene to Middle Pleistocene along the West Coast of North America.

Swiftopecten swiftii parmeleei (DALL, 1898)

Pl. 48, figs. 6, 7, Pl. 49, figs. 6–8.

1898. *Pecten (Chlamys) parmeleei* DALL, *Trans. Wagner Free Inst. Sci., Philadelphia*, Vol. 3, pt. 4, p. 708, pl. 37, figs. 14, a.

1906. *Pecten (Chlamys) parmeleei* DALL: ARNOLD, *U.S. Geol. Surv. Prof. Paper*, No. 47, p. 119, pl. 41, figs. 1, 1a.

1907. *Pecten (Chlamys) parmeleei* DALL: ELDRIDGE and ARNOLD, *U.S. Geol. Surv., Bull.*, No. 309, p. 25, pl. 36, fig. 7.

1959. *Pecten (Pallium) swiftii etchegoini* ANDERSON: GLEN, *Univ. Calif. Publ., Geol. Sci.*, Vol. 36, no. 2, p. 167, pl. 15, fig. 6.

1959. *Chlamys (Swiftopecten) swiftii parmeleei* (DALL): MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N.S.*, No. 34, p. 93.

Remarks:—The original description is "This species is close to *P. Swiftii* BERNARDI of Japan (J. de Conchyl., vii, plates 1 and 2, 1858) but smaller, and differs by the smooth top surface of the ribs, which in *P. Swiftii* are more or less striated or coarsely threaded, and by the not alternated radial riblets on the right posterior ear; also, especially, by the profuse coalescent microscopically checkered squamation, which makes a complete external coating to the valve. Alt. 45, lat. 38 mm".

Parmeleei is characterized by its small shell which is contorted posteriorly in the younger stage but tends to become rounded with growth, four prominent but rather low, round-topped radial ribs which are broader than their interspaces with several, fine radial threads, two subordinate radial ribs near submargins, rather conspicuous concentric constrictions, very large triangular auricle in the right valve, and by the left valve having five round-topped radial ribs.

Parmeleei differs from the closely related *Swiftopecten swiftii* in having smaller shell which tends to become rounded with growth and somewhat larger apical angle. Thus, morphologically, *parmeleei* may have descended from *swiftii* and is considered a subspecies of *swiftii*.

From *Chlamys cosibensis* (YOKOYAMA) *parmeleei* differs by its higher shell which is posteriorly contorted in the younger stage and triangular anterior auricle.

GRANT and GALE (1931) figured *parmeleei* from the Middle Pliocene deposits at Holser Canyon, Los Angeles, California, but their specimens should be identified probably with *Chlamys* species. In 1950 WOODRING and BRAMLETTE illustrated *Chlamys parmeleei* from the Pliocene Careaga Sandstone, Santa Maria district, California. However, according to the writer's study of the hypotype specimen (U.S. Natl. Mus., No. 560101) their *parmeleei* should be identified with *Chlamys etchegoini* (ANDERSON). GLEN (1959) described *Pecten* (*Pallium*) *swiftii etchegoini* from the "Merced" Formation, San Mateo, California, but the writer considers that GLEN's specimen (Mus. Paleont., Univ. Calif. Berkeley, No. 37614) should be identified with *parmeleei*. In 1966 STANTON recorded *parmeleei* from the Late Miocene Castaic Formation, Los Angeles, California, but STANTON's specimen has not been authenticated.

Type locality:—Pacific Beach, San Diego, California.

Distribution:—Middle to Southern California. Middle Pliocene.

Remarks

As already pointed several species or subspecies of the West Coast of North America have been referred to *Swiftopecten*. However, among those species the true *Swiftopecten* is represented only by the so-called *kindlei* and *donmilleri* from Alaska, some of the so-called *parmeleei* from northern California, and *parmeleei* from middle to southern California, whereas the other species hitherto referred to *Swiftopecten* should be referred to *Chlamys* or some other genera.

According to the writer's study of the type specimen (Mus. Paleont., Univ. Calif. Berkeley, No. 36639) of *Swiftopecten adekunbiana* ADEGOKE, 1969 which was first described as *Swiftopecten* sp. (ADEGOKE, 1967) and subsequently named *adekunbiana*, n. sp. from the Miocene Santa Margarita Formation, California is different from *Swiftopecten*, because its hinge area is characteristic to the genus *Lyropecten*.

Also several species have been described as the varieties of *swiftii* from the Pliocene deposits of Sakhalin and Kamchatka but considering from their descriptions and figures *Swiftopecten* in Sakhalin and Kamchatka is represented only by *swiftii* (s.s.).

As already pointed out (MASUDA, 1959a) some morphological differences such as concentric constrictions or natures of the radial ribs of the left valve are observed in the specimens living in the northern areas and those living in more southern areas. These morphological features may suggest that the specimens living in the northern areas are somewhat less influenced by the water temperature than those living in more southern areas. And, the morphological differences observed between the fossil specimens and Recent ones may be the reflection of the environmental conditions such as thermal conditions. Such inference may be interpreted that the so-called *kindlei* represents the northern type of *swiftii* and that some of the so-called *parmeleei* from northern California the rather southern type of *swiftii*. Also the so-called *donmilleri* may represent the southern type of *swiftii*.

As known at present the oldest occurrence of *swiftii* is the Middle Miocene Otsutsumi Formation in the environs of Sendai, Northeast Honshu, Japan, where it is rather rare, and its associated molluscan fauna mainly consists of what we now call temperate water elements, such as *Miyagipecten matsumoriensis* MASUDA, *Chlamys kaneharai* (YOKOYAMA), *Dosinia kaneharai* YOKOYAMA, *Mercenaria chitaniana* (YOKOYAMA), *Spisula voyi* GABB, etc. But with the progress of geological age *swiftii* gradually increased its dominancy in association with the increase of cooler water molluscs, bryozoans, barnacles, foraminifers, etc. from the Miocene through Pliocene to Recent.

From the morphological differences observed between the Recent and fossil specimens it is inferred that *Swiftopecten swiftii* acquired its stability as a species during the Middle Miocene and survived to the Recent with little morphological variation (MASUDA, 1959a, 1960).

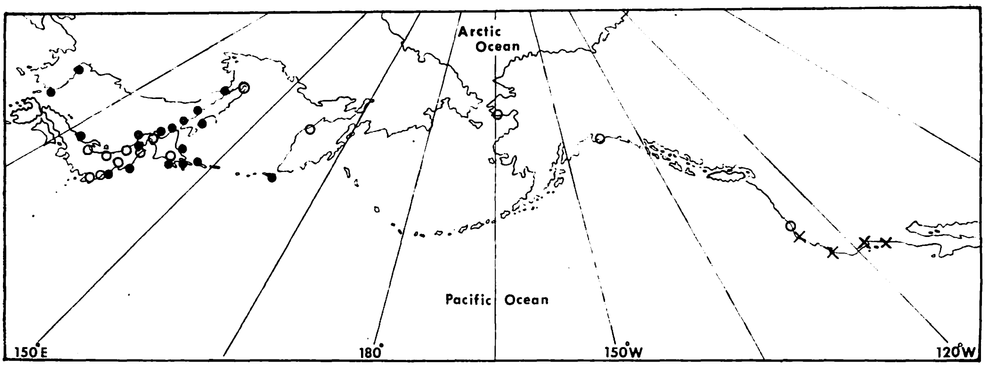
On the other hand, the first appearance of *Swiftopecten* along the West Coast of North America is the Miocene Yakataga Formation in Alaska, which yielded *donmilleri*; it is believed to be Middle to Late Miocene in American chronology (MACNEIL, 1967). As the morphological characteristics of *donmilleri* can be interpreted to represent the southern type of *swiftii* (MASUDA, 1959a), it is inferred that the Yakataga Formation may have been deposited under the influence of moderate to rather cool water environmental conditions. This view is also supported by the associated fauna (ADDICOTT *et al.*, 1971).

It is thought that the occurrence of *Swiftopecten* along the West Coast of North America is a result of its migration from East Asia to North America. Therefore, the writer considers that the Yakataga Formation is at least not older than the Ôtsutsumi Formation in Japan.

The changes of the environmental conditions from the Miocene to Recent (DURHAM, 1950, MASUDA, 1962b) probably have greatly influenced the marine fauna. As *swiftii* had acquired its stability as a species in the Middle Miocene (MASUDA, 1959a), it could survive to the Recent in the northwestern Pacific region but in the northeastern Pacific region it became extinct in the Middle Pleistocene. As the results of the gradual changing environmental conditions, it is inferred that *Swiftopecten parmeleei* branched off from the *Swiftopecten swiftii* stock as a result of its southward migration followed by localization and adaptation in the Middle Pliocene and it became extinct at the end of Middle Pliocene. On the other hand, *Swiftopecten swiftii* extended its distribution to northern California in the Early Pliocene but with the progress of geological age it retreated to Alaska and became extinct in the Middle Pleistocene. Therefore, it is expected that *swiftii* will be found from the Pliocene or Pleistocene formations of the northern part of the West Coast of North America and also from the Pliocene of Kamchatka. The geographical distribution of *swiftii* and *parmeleei* is shown in Text-fig. 1.

MACNEIL (1943, 1967) reported *Fortipecten* from Alaska and the writer and ADDICOTT (MASUDA and ADDICOTT, 1970) recorded *Yabepecten* from the Early Pliocene Montesano Formation in Washington, and from the same formation the writer described *Mizuhopecten warreni*, n. sp. (MASUDA, 1971). Therefore, the occurrences of *Swiftopecten*, *Fortipecten*, *Yabepecten* and *Mizuhopecten* in the West Coast of North America may be significant for interregional correlation between Asia and North America. Those genera are all known from the Cenozoic formation of Japan.

The occurrence of *Swiftopecten swiftii* from the Middle Miocene formation in Alaska suggests that the first Bering land bridge connecting North America and Asia was in the Middle Miocene. On the other hand, MACNEIL (1967) considered that the Unga Conglomerate yielding *Chlamys* (*Swiftopecten*) cf. *donmilleri* in the Alaska Peninsula represents the Middle Miocene in American chronology, but according to the writer's study MACNEIL's cf. *donmilleri* is a synonym of *Chlamys cosibensis* (YOKOYAMA) and is morphologically a Pliocene type of *cosibensis*. Therefore, the geological age of the Yakataga Formation is open to ques-



Text-fig. 1. Geographical distribution of Recent and fossil *Swiftopecten*.
●——*Swiftopecten swiftii* (BERNARDI) (Recent)
○——*Swiftopecten swiftii* (BERNARDI) (Fossil)
×——*Swiftopecten swiftii parmeleei* (DALL)

tion. Although further studies on the stratigraphy and paleontology of the Yakataga Formation are necessary to settle this problem, the writer is inclined to consider that a part of the formation with *donmilleri* may represent the Late Miocene or Early Pliocene. Considering from the occurrences of *Yabepecten, Mizuhopecten* and *Fortipecten* from the Early Pliocene formations of the northern West Coast of North America, it may be that the Bering strait was closed by a land bridge during the Late Miocene or very Early Pliocene.

References

ADEGOKE, O.S. (1967) : California Late Miocene records of *Swiftopecten* HERTLEIN, 1935. *Veliger*, Vol. 9, no. 3, pp. 337-339, pl. 47.

—— (1969) : Stratigraphy and paleontology of the marine Neogene formations of the Coalinga region, California. *Univ. Calif. Publ., Geol. Sci.*, Vol. 80, pp. 1-241, pls. 1-13, 6 text-figs., 3 maps.

ADDICOTT, W.O., KANNO, S., SAKAMOTO, K. and MILLER, D.J. (1971) : CLARK's Tertiary molluscan types from the Yakataga district, Gulf of Alaska. *U.S. Geol. Surv. Prof. Paper* 750-C, pp. C18-C33, figs. 1-6.

ANDERSON, F.M. (1905) : A stratigraphic study of the Mount Diablo Range of California. *Proc. Calif. Acad. Sci., Ser. 3*, Vol. 2, pp. 155-248, pls. 13-35.

ARNOLD, R. (1906) : Tertiary and Quaternary pectens of California. *U.S. Geol. Surv. Prof. Paper* 47, pp. 7-146, pls. 1-53.

BERNARDI, M. (1858) : Description d'especes nouvelles. *Jour. de Conch.*, Vol. 7, 2nd Ser., T. 3, pp. 90-94, pls. 1-2.

COSSMAN, M. and PEYROT, A. (1914) : Conchologie Neogenique de L'Aquitaine. Tome II, Pelecypodes. *Act. Soc. Linn. Bord.*, pp. 1-496, pls. 1-26.

DALL, W.H. (1898) : Contributions to the Tertiary fauna of Tampa and the Pliocene beds of the Caloosahahatchie River. *Trans. Wagner Free Inst. Sci., Philadelphia*, Vol. 3, pt. 4, pp. 571-947, pls. 26-37.

—— (1920) : Pliocene and Pleistocene fossils from the Arctic Coast of Alaska and the Auriferous Beaches of Nome, Norton Sound, Alaska. *U.S. Geol. Surv. Prof. Paper* 125-C, pp. 23-37, pls. 4-5.

DURHAM, J.W. (1950) : Cenozoic marine climate of the Pacific coast. *Bull. Geol. Soc. Amer.*, Vol. 61, pp. 1243-1264, 3 text-figs.

—— (1961) : Palaeogeographic conclusions in light of biological data. "Symposium, Pacific basin biogeography". *10th Pacific*

Congress, pp. 355-365, 4 text-figs.

—— and MacNeil, F.S. (1967) : Cenozoic migrations of marine invertebrates through the Bering Strait region, in Hopkins, D.M., *The Bering land bridge*, pp. 326-349, 4 tables, Stanford Univ. Press.

Eldridge, G.H. and Arnold, R. (1907) : The Santa Clara Valley, Puente Hills and Los Angeles Oil districts, southern California. *Bull. U.S. Geol. Surv.*, No. 309, pp. 1-266, pls. 1-41, 17 text-figs.

Faustman, W.F. (1964) : Paleontology of the Wildcat Group at Scotia and Centerville Beach, California. *Univ. Calif. Publ., Geol. Sci.*, Vol. 41, pp. 97-151, pls. 1-3, 7 text-figs.

Fujie, T. (1958) : Pleistocene molluscan fossils (Pelecypoda) from the Shikonai Formation, Hokkaido. *Cenozoic Res.*, No. 28, pp. 663-679, pls. 27-28.

Glen, W. (1959) : Pliocene and Lower Pleistocene of the western part of the San Francisco Peninsula. *Univ. Calif. Publ., Geol. Sci.*, Vol. 36, no. 2, pp. 147-198, pls. 15-17, 5 text-figs.

Grant, U.S., IV, and Gale, H. (1931) : Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. *Mem. San Diego Soc., Nat. Hist.*, Vol. 1, pp. 1-1036, pls. 1-32, 15 text-figs.

Habe, T. (1955) : Fauna of Akkeshi Bay, 21, Pelecypoda and Scaphopoda. *Publ. Akkeshi Mar. Biol. Stat.*, No. 4, pp. 1-31, pls. 1-7.

—— (1958) : Report on the Mollusca chiefly collected by the S.S. Soyo-maru of the Imperial Fisheries Experimental Station on the continental shelf bordering Japan during the years 1922-1930. Part 3. Lamellibranchia (1). *Publ. Seto Mar. Biol. Lab.*, Vol. 6, no. 3, pp. 241-279, pls. 11-13.

—— (1960) : Fauna of shell-bearing mollusks of the sea around Shirikishinai, Hokkaido. 1. Pelecypoda. Fauna and flora of the sea around the Shirikishinai Marine Station. *Shirikishinai Mar. Stat. Biol. Instr., Hokkaido Gakugei Univ.*, No. 4, pp. 1-10, pls. 1-5.

Hertlein, L.G. (1935) : The Templeton Crocker Expedition of the California Academy of Sciences, 1932. *Proc. Calif. Acad. Sci., Ser. 4*, Vol. 21, no. 25, pp. 301-328, pls. 18-19.

Ilyina, A.P. (1963) : Mollusks in the Neogene of Kamchatka. *Soviet Petrol. Sci.-Res. Geol. Expl. Inst.*, 202, pp. 1-242, pls. 1-54.

Iwai, T. (1965) : The geological and paleontological studies in the marginal area of the Tsugaru Basin, Aomori Prefecture, Japan. *Bull. Educ. Fac., Hirosaki Univ.*, No. 15, pp. 1-68, pls. 12-20, 3 text-figs., 10 tables.

Kaseno, Y. and Matsuura, N. (1965) : Pliocene shells from the Omma Formation around Kanazawa City, Japan. *Sci. Rept. Kanazawa Univ.*, Vol. 10, no. 1, pp. 27-62, pls. 1-20, 3 text-figs., 5 tables.

Keen, A.M. and Bentson, H. (1944) : Check list of California Tertiary marine Mollusca. *Geol. Soc. Amer., Spec. Paper*, No. 56, pp. 1-280, 4 text-figs.

Khomenko, I.P. (1934) : The stratigraphy of the Tertiary beds of the south-western coast of the Schmidt Peninsula (Northern Sakhalin). *Trans. Geol. Oil Inst., Ser. A*, Fasc. 40, pp. 12-86, pls. 1-19.

Kinoshita, T. and Isahaya, T. (1934) : Catalogue of marine Mollusca from Hokkaido. *Rept. Fish. Surv. Hokkaido Fish. Exp. Stat.*, No. 33, pp. 1-19, pls. 1-15.

Kochibe, T. (1882) : Jôhoku Chishitsu Hen (Geology of Northern Hitachi), *Rika Kaishi, Tokyo Univ. Press*, No. 4, pp. 1-153, pls. 1-9.

Krishtofovich, L.V. (1964) : Mollusks in the Tertiary sediments of Sakhalin. *Soviet Petrol. Sci.-Res. Geol. Expl. Inst.*, 232, pp. 1-343, pls. 1-55.

Kubota, K. (1950) : Explanation of Cenozoic fossils from northern Japan, 9. Fossil Pectinidae from the Setana Series. *Cenozoic Res.*, No. 6, pp. 12-18, pls. 8-9.

Küster, H.C. and Kobelt, W. (1882) : Die Gattungen *Spondylus* und *Pecten* in Martini und Chemnitz, *Syst. Conch. Cab.*, Vol. 7, pt. 2, pp. 1-296, 72 pls.

MacNeil, F.S. (1967) : Cenozoic pectinids of Alaska, Iceland and other northern regions. *U.S. Geol. Surv. Prof. Paper* 553, pp. 1-57, pls. 1-25.

—— (1970) : New Pliocene *Chlamys* (*Swiftopecten*) and *Beringius* from the Alaska Peninsula. *Nautilus*, Vol. 84, no. 2, pp. 69-74, 1 pl.

——, MERTIE, J.B. Jr. and PILSBRY, H.A. (1943) : Marine invertebrate faunas of the buried beaches near Nome, Alaska. *Jour. Paleont.*, Vol. 17, no. 1, pp. 69-96, pls. 10-16.

——, WOLFE, J.A., MILLER, D.J. and HOPKINS, D.M. (1961) : Correlation of Tertiary formations of Alaska. *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 45, no. 11, pp. 1801-1809, 2 text-figs.

MASUDA, K. (1959a) : On the Miocene Pectinidae from the environs of Sendai: Part 14, On *Pecten swiftii* BERNARDI. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, No. 34, pp. 101-111, pl. 9, 1 text-fig.

—— (1959b) : On the Miocene Pectinidae from the environs of Sendai: Part 15, *Pecten cosibensis* YOKOYAMA and its related species. *Ibid.*, No. 35, pp. 130-141, pl. 13, 1 text-fig.

—— (1960) : On morphogenesis of *Nanaochlamys*. *Sci. Rept., Tohoku Univ., 2nd Ser. (Geol.), Spec. Vol.* No. 4, pp. 371-383, pl. 39, 10 text-figs.

—— (1962a) : Tertiary Pectinidae of Japan. *Ibid.*, Vol. 33, no. 2, pp. 117-238, pls. 18-27, 11 text-figs.

—— (1962b) : Note on the Tertiary Pectinidae of Japan. *Ibid., Spec. Vol.* No. 5, pp. 159-193, 9 text-figs., 9 tables.

—— (1971a) : On some *Patinopecten* from North America. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, No. 83, pp. 166-178, pls. 19-21, 2 text-figs.

—— (1971b) : *Amussiopecten* from North America and northern South America. *Ibid.*, No. 84, pp. 205-223, pls. 25-26, 4 text-figs.

—— and ADDICOTT, W.O. (1970) : On *Pecten* (*Amusium*) *condoni* HERTLEIN from the West Coast of North America. *Veliger*, Vol. 13, no. 2, pp. 153-156, 1 pl.

NOMLAND, J.C. (1917) : The Etchegoin Pliocene of Middle California. *Univ. Calif. Publ., Geol. Sci.*, Vol. 10, no. 14, pp. 109-254, pls. 1-12, 2 text-figs.

Explanation of Plate 48

(Natural size)

Right valve

Figs. 1-5. *Swiftopecten swiftii* (BERNARDI).

1, Dept. Geol., Stanford Univ., No. 4846. Loc.: Intermediate Beach, Nome, Alaska. Middle Pleistocene.

2, IGPS*, coll. cat. no. 90593. Loc.: About 300 m NW of Kurosawa, Akita City, Akita Prefecture. Sasaoka Pliocene.

3, 4, Saito Ho-on Kai Mus., Reg. no. 21266. Loc.: Tayazawa, Wakimoto-machi, Oga City, Akita Prefecture. Shibikawa Pliocene.

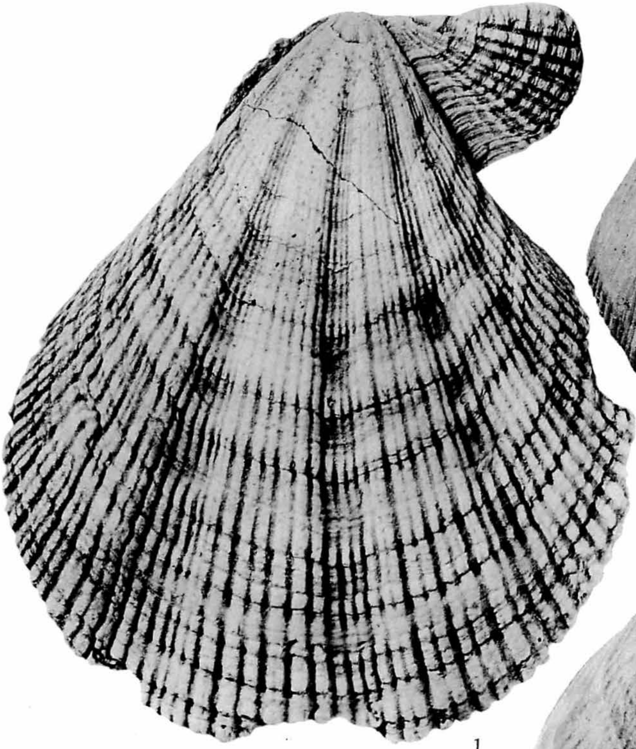
5, Dept. Geol. Stanford Univ., No. 4838. Loc.: Crescent City wharf, Del Monte County, California. "Wildcat" Pliocene.

Figs. 6, 7. *Swiftopecten swiftii parmeleei* (DALL).

6, Dept. Geol., Stanford Univ., No. 47210. Loc.: East of Capitola, Santa Cruz County, California. Purisima Pliocene.

7, Los Angeles County Museum. Loc.: South central part of San Diego County, California. San Diego Pliocene.

*—Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.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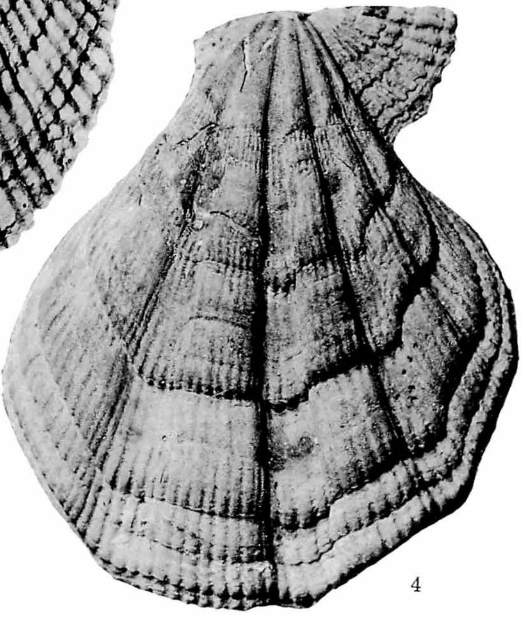
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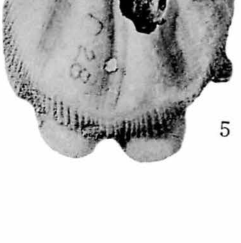
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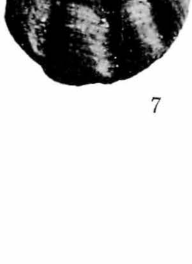

7

NOMURA, S. and HATAI, K. (1935) : Pliocene Mollusca from the Daishaka shell beds in the vicinity of Daishaka, Aomori-ken, Northeast Honshû, Japan. *Saito Ho-on Kai Mus., Res. Bull.*, No. 6, pp. 83-137, pls. 9-13.

OYAMA, K. (1959) : The molluscan shells, II, *Chlamys* (5). *Sci. Photogr. Club, Tokyo.*

PHILIPPI, H.A. (1900) : Beiträge zur Morphologie und Phylogenie der Lamellibranchier. II. Zur Stammesgeschichte der Pectiniden. *Zeit. Deutsch. Geol. Gesellsch.*, Bd. 52, pp. 64-117, 24 text-figs.

SAWADA, Y. (1962) : The geology and paleontology of the Setana and Kuromatsunai areas in southwest Hokkaido, Japan. *Mem. Muroran Inst. Technol.*, Vol. 4, no. 1, pp. 1-110, pls. 1-8, 9 text-figs., 13 tables.

SCHRENCK, L. (1867) : Mollusken des Amurlandes und des nordjapanischen Meeres. *Reisen und Forshung Amurlande in dem 1854-1856*. Vol. 2, pt. 3, pp. 259-976, pls. 12-28, 1 map.

SLODKEWITSCH, W.S. (1938) : Tertiary Pelecypoda from the Far East. Pts. 1 & 2. *USSR Acad. Sci., Paleont. Inst., Paleont. of USSR*, Vol. 10, pt. 2, fasc. 19, pp. 1-275, pls. 1-106.

STANTON, R.J. (1966) : Megafauna of the Upper Miocene Castaic Formation, Los Angeles County, California. *Jour. Paleont.*, Vol. 40, no. 1, pp. 21-40, pls. 5-7, 2 text-figs.

TOMIZAWA, T. (1958) : Studies on fossils from the Kami-Minochi district, Nagano Prefecture, in T. and K. YAGI, Geology of Kami-Minochi-gun, Nagano Prefecture. pp. 317-347, pls. 1-14, 5 text-figs., 2 tables.

UOZUMI, S., FUJIE, T. and MATSUI, M. (1966) : Neogene molluscan fauna in Hokkaido. Part 3, Description of the Ainonai fauna associated with *Desmostylus* cf. *minor* NAGAO, from Kitami district, East Hokkaido. *Jour. Fac. Sci., Hokkaido Univ., Ser. 4 (Geol. Mineral.)*, Vol. 13, no. 2, pp. 119-183, pls. 14-15, 3 text-figs.

WOODRING, W.P. and BRAMLETTE, M.N. (1950) : Geology and paleontology of the Santa Maria district, California. *U.S. Geol. Surv. Prof. Paper* 222, pp. 1-185, pls. 1-23, 9 text-figs.

YAMAMOTO, G. and HABE, T. (1959) : Fauna of shell-bearing mollusks in Mutsu Bay. Lamellibranchiata (1). *Mar. Biol. Station Asamushi, Tohoku Univ., Bull.*, Vol. 9, no. 1, pp. 1-20, pls. 1-5.

YOKOYAMA, M. (1911) : Pectens from Koshiba Neogene. *Geol. Soc. Tokyo, Jour.*, Vol. 18, no. 208, pp. 1-5, pl. 1.

—— (1926) : Fossil shells from Sado. *Jour. Fac. Sci., Imp. Univ. Tokyo*, Vol. 1, pt. 8, pp. 249-312, pls. 32-37.

YOSHIWARA, S. (1902) : Japanese shells. *Zool. Mag. Tokyo*, Vol. 14, no. 162, pp. 141-145, pls. 1-5.

Akita	秋田
Kaidateno-sawa	貝立沢
Kurosawa	黒沢
Oga	男鹿
Ôtsutsumi	大堤
Sado-gun	佐渡郡
Sasaoka	笹岡
Sawada-machi	佐和田町
Sawane	沢根
Shibikawa	鮪川
Tayazawa	田谷沢
Tomizawa	富沢
Wakimoto-machi	脇本町

Explanation of Plate 49

(Natural size)

Left valve

Figs. 1–5. *Swiftopecten swiftii* (BERNARDI).

1, Dept. Geol., Stanford Univ., No. 4846. Loc.: Intermediate Beach, Center Creek, Nome, Alaska.

2, Saito Ho-on Kai Mus., Reg. no. 16827. Loc.: Tomizawa, Wakimoto-machi, Oga City, Akita Prefecture. Shibikawa Pliocene.

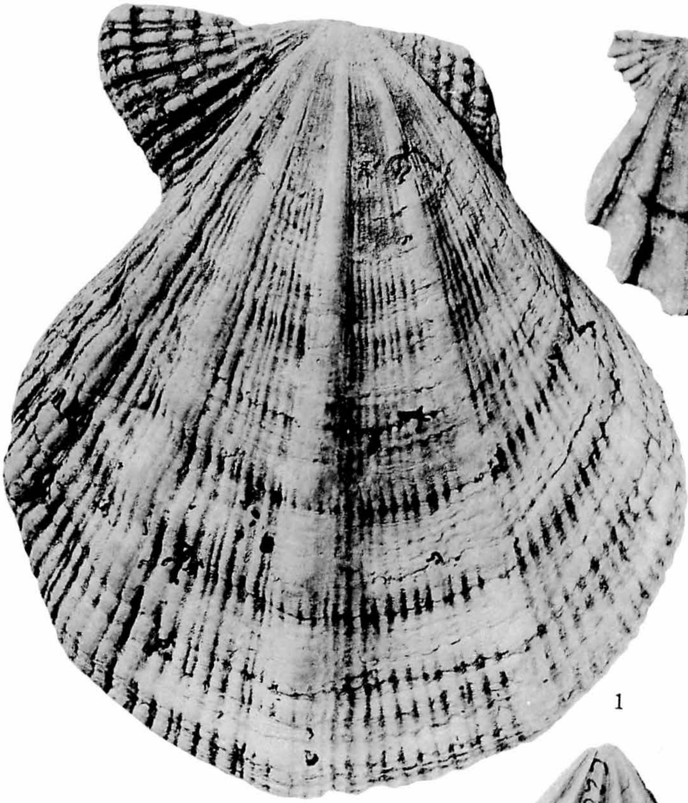
3, 4, Dept. Geol., Stanford Univ., No. 4838. Loc.: Crescent City wharf, Del Monte County, California. "Wildcat" Pliocene.

5, IGPS, coll. cat. no. 90597. Loc.: Kaidate-no-sawa, Sawada-machi, Sado-gun, Niigata Prefecture. Sawane Pliocene.

Figs. 6–8. *Swiftopecten swiftii parmeleei* (DALL).

6, 8, Los Angeles County Museum. Loc.: 305 A. South central part of San Diego County, California. San Diego Pliocene.

7, IGPS, coll. cat. no. 92043. Loc.: Tijuana River south western San Diego County, California. San Diego Pliocene.



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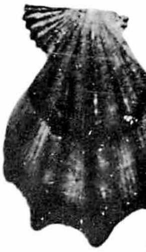

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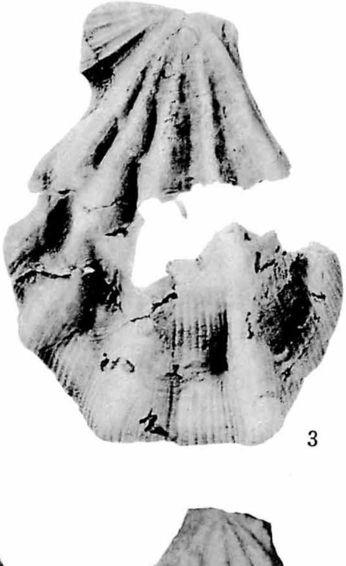

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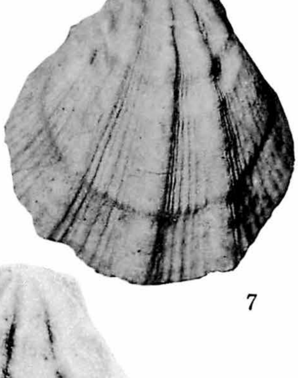

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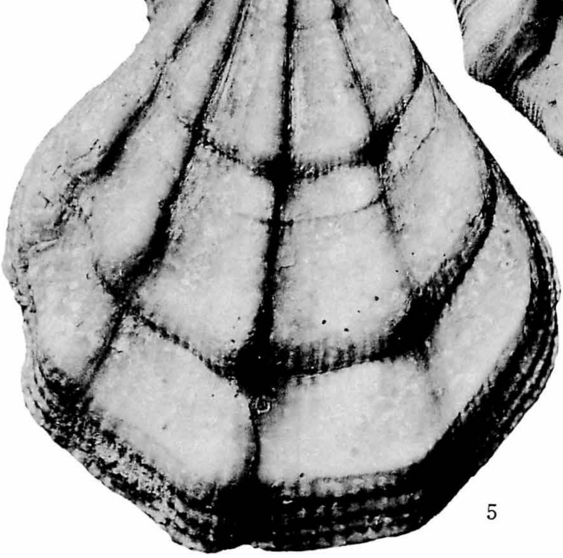

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 87, pp. 409-413, September 30, 1972

603. SCAPHOPODA-LIKE FOSSILS FROM THE UDO FORMATION (MIOCENE) OF MIYAZAKI PREFECTURE, JAPAN*

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宮崎県中新世鵜戸層産掘足貝様化石について：宮崎県に広く発達する宮崎層群の青島相（南部地域）最下部は SHUTO (1961) により鵜戸層の双石部層と命名されている。今回，双石部層のシルト岩より一見，掘足貝，特に *Dentalium* に類似する化石を多数採集し，これを検討した。

既知の *Dentalium*, *Terebrellina* あるいは，*Makiyama* 等を比較検討したが，これらとは，管状化石の殻質，サイズ，彎曲の程度，両端部の特徴，表面彫刻，色つや等で異なり，むしろ，*Ditrupa* に類似し，上述の特徴は双石部層産種が *Ditrupa* に属することを示すものである。しかし *Ditrupa* の既存種には双石部層産の様な特徴をもつものがなく，*Ditrupa miyazakiensis*, n. sp. として区別された。　畑井小虎・野田浩司・小笠原憲四郎

Introduction and acknowledgements

During the excursion for observations, discussions and collection of the invertebrate marine fossils of different stratigraphic units of Mizuho age distributed in Miyazaki Prefecture, Kyushu, Japan in the latter part of October, 1971, abundant scaphopod-like fossils were collected and brought back to the laboratory for study. These form the subject of the present article.

Here the writers express their deep appreciation to the undermentioned persons for their kind cooperation in the field and talks during the evening, namely ; Professors Tokio SHIKAMA, Yokohama National University, Koichiro MASUDA, Miyagi College of Education, and Shozo HAYASAKA, Kagoshima University ; Associate Professors Takehiko IWAI, Hirosaki University, Taisuke TAKAYASU, Akita University, Tamio KOTAKA, Tohoku University, Saburo KANNO, Tokyo University of Education, Hiroyuki OTSUKA, Kagoshima University ; Junji ITOIGAWA, Nagoya University, Kiyotaka CHINZEI, Tokyo University, and Sakae OHARA, Chiba University, Drs. Yasuhide IWASAKI, Tokyo University, Kazuo OKAMOTO, Hiroshima University, and Mr. Kimihiko OKI, Kagoshima University.

Fossil locality and stratigraphic position

The abundant scaphopod or *Dentalium*-like specimens were collected from a siltstone of a road cliff south of Uzutsumi near the Kagamisu-toge (pass) on the road leading from Nagayama to Kogochi, south of Kiyotake, Kiyotake-cho,

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* Received Jan. 23, 1972 ; read June 3, 1972 at Utsunomiya.

Miyazaki-gun, Miyazaki Prefecture. The siltstone is a part of the Boroishi Member of the Udo Formation (Miocene) and also of the Aoshima facies of the Miyazaki Group of SHUTO (1961).

The fossil locality of the scaphopod or *Dentalium*-like fossils nearly corresponds to locality no. 12 or 13 of SHUTO (1961). SHUTO (op. cit.) recorded from the locality (no. 12 and no. 13) such fossil molluscs as, *Acila* (*Acila*) *submirabilis* MAKIYAMA, *Saccella confusa kongiensis* OTUKA, *Yoldia* (*Tepidoleda*) *naganumana* (OTUKA), n. subsp., *Paliolum* (*Delectopecten*) *peckhami* (GABB), *Amussiopecten iitomiensis* (OTUKA), *Joanisiella cumingii* (HANLEY), *Laevicardium pigmaea* SHUTO, *Vepricardium kyushuense* SHUTO, *Ventricoloidea foveolata miyazakiensis* (SHUTO), *Pitar* sp., *Paphia* (*Paphia*) *exilis takaokaensis* SHUTO, *Clementia* (*Clementia*) *papyracea* (GRAY).

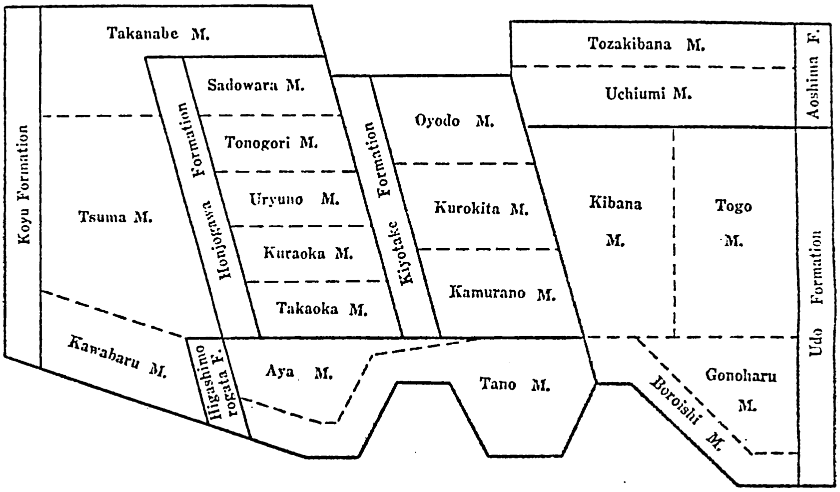
These fossils, all marine in origin, were considered to be Miocene in age by SHUTO (op. cit.) and to characterize the Boroishi Member, the lowest part of the Udo Formation. The scaphopod-like fossils, although from most probably the same cliff from where SHUTO recorded the fossil molluscs mentioned above, did not occur in association with the molluscs. Although from the same lithofacies as the molluscs, the scaphopod-like fossils were found forming a close assemblage separated from the nearest molluscan fossil both vertically and laterally by a distance of more than several ten centimeters.

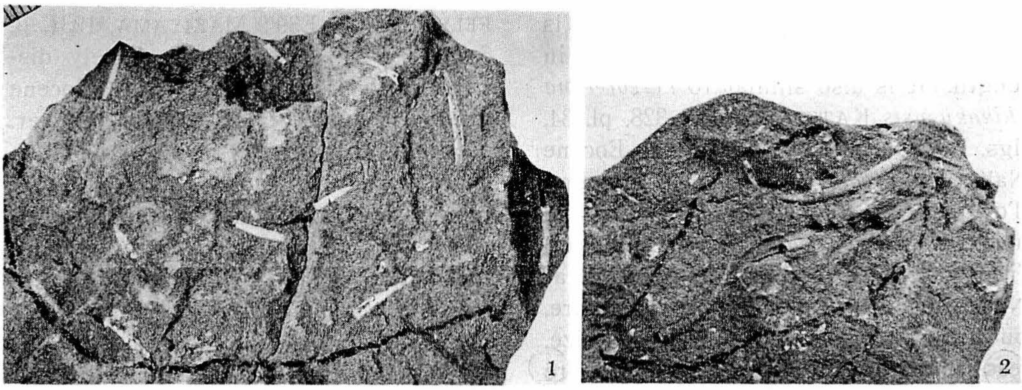
The stratigraphic subdivision of the Miyazaki Group according to SHUTO (1961) is reproduced in Table 1, for the sake of the readers.

The scaphopod-like fossils

The scaphopod-like fossils were found in the siltstone facies of the Boroishi Member of the Udo Formation. The tubular fossils were found in a position almost parallel with the bedding plane of the stratum preserving them. None of the calcareous tubular structures were found to be either vertical or oblique to the bedding plane at least where they

Table 1. Stratigraphic subdivision of the Miyazaki Group according to SHUTO (1961).





Text-figs. 1, 2. *Ditrupa miyazakiensis* HATAI, NODA and OGASAHARA. Natural size. Text-fig. 1—weathered specimens. Text-fig. 2—well preserved specimen showing annular growth, other showing irregular growth.

could be determined as buried in their original position, which is parallel with the sea bottom on which they lived, and on which they crawled over. In this respect they may be of value in determination of the inclination and top or bottom of the strata in which they occur. The non-association of the scaphopod-like or annelid tubes with other kinds of invertebrate fossils may be due to that the larvae of molluscs, foraminifers and other kinds of marine life form a part of their food chain.

The tubular specimens showed random orientation of their shells, but all that could be observed were preserved horizontally throughout a thickness of about ten to fifteen centimeters of siltstone, the state of preservation was different according to whether exposed or embedded, none were seen lying across one another although many were in close position, none so far as observed exceeded 25 mm in length, andn one were found in association with fossils of bivalves, gastropods or scaphopods or other invertebrates. All of the tubular structures are short, measuring up to about 20-25 mm in length and about 1-1.3 mm in diameter, gently curved, both ends open, the surface rather smooth, irregulary wrinkled or more or less annular, all brownish colored, consisting of calcium carbonate, and none were found to be straight or entirely smooth throughout their length. In general curvature the present specimens resemble *Dentalium* (*Laevidentalium*) *coruscum* PILSBRY, described and illustrated by KURODA and KIKUCHI (1933, p. 10, pl. 1, fig. 1) from Toyama Bay, Toyama Prefecture, but the curvature is stronger and the shell is more strongly polished in *coruscum* compared with the present fossil. The fossil also resembles *Dentalium* (*Laevidentalium*) *toyamense* KURODA and KIKUCHI (1933, p. 11, pl. 1, figs. 5, 6) from Toyama Bay, but the shell is smaller, more strongly curved and the growth is more irregular than the Recent species of KURODA and KIKUCHI.

In general size and shape, the present fossil resembles *Dentalium ophiodon* DALL (HENDERSON, 1920, p. 84, pl. 14, fig. 2) but differs in having stronger and less oblique annulations on the shell.

The Miyazaki specimen also resembles the worm tube from Proctor Creek, Snohomish County, Washington, illustrated by DANNER (1955, fig. 3), but is more strongly curved and shorter in length. It is also similar to *Terebrellina shikokuensis* KATTO (1960, p. 328, pl. 34, figs. 1, 3, pl. 35, fig. 7) from the Eocene Naharigawa Formation at Kannoura, Toyo-cho, Aki-gun, Kochi Prefecture, and also the same species (KATTO, op. cit.) from the Eocene Muroto Formation at Nabae, Muroto City, Kochi Prefecture, but differs from them in the smaller size, less curvature of the tube and more prominent external sculpture of the shell.

Hyalinoecia tubicola illustrated by HERSEY (1967, p. 239, figs. 22-23, p. 240, figs. 22-24) from Dalaware Bay in 450 m depth (former) and from Chesapeak Bay in 365 m depth (latter), also resembles the present fossil specimens but the Recent species is longer and straighter than the fossil one.

The genus *Ditrupa* BERKELEY, 1835, figured by HOWELL (1962, p. W156, fig. 97-4) is very closely similar to the present fossil, which has stronger concentric wrinkles or annulations on the surface. The type species of *Ditrupa, D. cornea* (LINNÉ) is stated to come from the Pliocene of Italy (HOWELL, op. cit.) and to contain *Dentalium corneaum* LINNÉ and *Dentalium subulatum* DESHAYES as its synonyms. The characters distinguishing the present fossil from *Ditrupa cornea* (LINNÉ) illustrated by HOWELL (op. cit.) are considered sufficient for the proposal of a news pecies, which is here named *miyazakiensis*, after the geographic name of its occurrence. *Miyazakiensis* can be distinguished from the different kinds of fossils mentioned above which show resemblance with it by the features already mentioned. There seems to be little chance for the present fossils being mistaken from detached parts of the sponge known as *Makiyama chitanii* (MAKIYAMA) (=*Sagarites*) (DELAUBENFELS, 1955, p. E39; MAKIYAMA, 1931, p. 5, figs. 1, 2). *Makiyama* is widely distributed in the Miocene and Pliocene marine deposits of Japan, and wherever, it occurs, it is always found as isolated, sporadic rods with squarely rounded terminals, generally more or less flattened and often creased longitudinally along its middle part. The terminal parts of the *Makiyama* short rods never taper towards one end, never consist of calcareous material, and usually do not occur in clusters, although the rods are usually found in a position parallel with the bedding plane of the strata in which they occur. Under the microscope *Makiyama* is spiculate. The just mentioned characters serve to easily distinguish *Ditrupa miyazakiensis* from *Makiyama chitanii*. Also since the genus *Dentalium* or *Siphonodentalium* consists of shells made of aragonite (SHROCK and TWENHOFEL, 1953, p. 362), they will not be misidentified for the shells of an annelid tube, which consist of calcium carbonate.

References cited

DANNER, W.R. (1955) : Some fossil worm tubes of western Washington. *Rocks and Minerals*, pp. 451-457, 7 figs.

DELAUBENFELS, M. W. (1955) : Treatise on invertebrate paleontology, *Edited by* R.C. MOORE, *Geol. Soc. America and Univ. Kansas Press*, Part E, Archaeocyatha and Porifera, pp. 1-122, 89 figs.

HENDERSON, J.B. (1920) : A monograph of the East American scaphopod mollusks. *U.S. Nat. Mus., Bull.*, no. 111, pp. 1-177, pls. 1-20.

HERSEY, J.B. (1967) : Deep sea photography. *Johns Hopkins Press*, 310 pp.

HOWELL, B.F. (1962) : Treatise on invertebrate paleontology, *Edited by* R.C. MOORE, *Geol. Soc. America and Univ. Kansas Press*, Part W, Worms, pp. 144-177, figs. 85-108.

KATTO, J. (1960) : Some Problematica from the so-called unknown Mesozoic strata of the southern part of Shikoku, Japan. *Sci. Repts., Tohoku Univ., 2nd Ser., Geol., Spec. Vol.*, no. 4, pp. 323-334, pls. 34-35.

KURODA, T. and KIKUCHI, K. (1933) : Studies on the molluscan fauna of Toyama Bay (1). *Venus (Japan. Jour. Malac.)*, vol. 4, no. 1, pp. 1-14, pl. 1. (*in* Japanese with English Résumé).

MAKIYAMA, J. (1931) : Stratigraphy of the Kakegawa Pliocene in Totomi. *Mem., Coll. Sci., Kyoto Imp. Univ., Ser. B*, vol. 1, art. 1, pp. 1-53, pls. 1-3, figs. 1-4.

SHROCK, R.R. and TWENHOFEL, W.H. (1953) : Principles of invertebrate paleontology. *MacGraw-Hill Book. Co. Inc.*, New York, Toronto, London, pp. 1-816.

SHUTO, T. (1961) : Palaeontological study of the Miyazaki Group—A general account of the faunas—. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, vol. 10, no. 2, pp. 73-206, figs. 1-23, tabs. 1-5, pls. 11-13.

Aki-gun	安芸郡	Muroto	室戸
Aoshima	青島	Nabae	菜生
Boroishi	双石	Nagayama	永山
Kannoura	甲浦	Naharigawa	奈半利川
Kagamisu-toge	鏡洲峠	Toyo-cho	東洋町
Kiyotake	清武	Udo	鵜戸
Kogochi	小河内		

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 87, pp. 414-428, pls. 50, 51, September 30, 1972

604. PERMO-CARBONIFEROUS ENDOTHYRACEANS FROM JAPAN*

PART 1. BISERIAMMINIDAE

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本邦産 Endothyraceans の研究： Endothyracean foraminifera は 11 科からなり，古生代後期の重要な示準化石とされているが，いまだに本邦におけるその意義はほとんど知られていない。本邦からの biseriamminids の報告ははじめてであり，この科の全記載種を総括して化石層序学的意義を再確認した。主として中国地方の主要石灰岩層（阿哲・帝釈・秋吉）から，*Globivalvulina* に属する（他の2属 *Biseriammina, Olympina* は未発見）7種；*G. kamensis, G. granulosa compressa, G. mosquensis, G.* sp. cf. *G. kantharensis, G.* sp. cf. *G. gracea, G. regularis* n. sp., *G.* sp. A, *G.* sp. B を記載して，本邦の上・下部石炭系の境界，ことに上部石炭系下部における化石層序学的な意義を明らかにした。また，産出層準および石灰岩の岩質と産出頻度についても研究した。 沖村雄二

Introduction

It is well known that some of the endothyracean foraminifera have been accepted valuable index fossil in the late Paleozoic. According to *Treatise on Invertebrate Paleontology* (Edit. MOORE, 1964, pp. 329-358), the superfamily Endothyracea is organized by eleven families; Nodosinellidae, Colaniellidae, Ptychocladiidae, Palaeotextulariidae, Semitestulariidae, Tetrataxidae, Biseriamminidae, Tournayellidae, Endothyridae, Archaediscidae and Lasiodiscidae. Among them, the biostratigraphical significance of Endothyridae and Palaeotextulariidae has been passably established on the basis of their paleontological study. However, the study of the other families may be said to be insufficient, especially in Japan.

This report is the first description of the Biseriamminidae from Japan treating mainly the Carboniferous specimens from the thick limestones of Taishaku, Akiyoshi, Atetsu and Koyama of the Chugoku Region, the Kakisako formation of the Kuma Massif, Kyushu Region, and the Nagaiwa formation of the Kitakami Massif, Tohoku Region. The Permian specimens are also examined from the Taishaku and Atetsu limestones in order to compare with Carboniferous ones morphologically and to make clear the stratigraphic distribution.

All the specimens from the above limestones belong to *Globivalvulina*, a genus of the Biseriamminidae. As is shown by RAUSER-CHERNOUSSOVA and REITLINGER (1957), *Globivalvulina* appears in the upper Lower Carboniferous and becomes extinct in the Upper Permian, thriving extremely in the lower Upper Carboniferous. Accordingly the frequency of globivalvulinid foraminifera may offer some important data to the boundary problem between the Lower and Upper Carboni-

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* Received Jan. 24, 1972; read Jan. 23, 1972 at Chiba.

ferous of Japan.

Acknowledgements:—The writer wishes to express his sincere thanks to Professor Akira HASE of Hiroshima University who constructively advised him and kindly revised the manuscript. Thanks are due to the research members of stratigraphy and paleontology of the same university for their helpful discussions. Financial aids for this study were partly granted by the Ministry of Education.

Repository:—All the specimens described and figured in this paper are kept in the Institute of Geology and Mineralogy, Hiroshima University, Japan. Their register numbers are indicated within the brackets in the explanation of plates.

Paleontological and biostratigraphical notes on the family Biseriamminidae and the genus *Globivalvulina*

The family Biseriamminidae was first proposed by CHERNYSHEVA (1941) with the type-genus *Globivalvulina*, but his classification is not always followed after that. For instance, PLUMMER (1948) studied in detail the morphology of *Globivalvulina*, and said that it would be placed in the family Cassiduliniidae by the nature of a biserial arrangement of chambers in a planispiral coiling, even though the aperture of this Paleozoic form is not harmonious with those of the rest of the family. CUSHMAN and JONES (1950) followed BRADY's classification (1876) which placed this genus in the Trochamminidae characterized with a trochospiral coiling. REITLINGER (1950) newly established the subfamily Globivalvulinae, and included it in the family Tetrataxidae by the characteristics of biserial chamber arrangement, trochospiral shell and two-layered wall. According to Osnovy Paleontologii (Edit. RAUSER-CHERNOUSSOVA and FURSENKO, 1959) *Globivalvulina* is again attached to the Biseriamminidae.

Such confusion on the taxonomy of *Globivalvulina* is chiefly caused by some difference of worker's subjective view with regard to the coiling form and wall structure; that is to say, it is a question whether the test is planispiral or trochospiral, and whether the wall is agglutinate or undifferentiated microgranular or layered. In this paper the writer follows the classification of *Treatise on Invertebrate Paleontology*. According to it, the diagnosis of Biseriamminidae (synonymous with Globivalvulinae REITLINGER, 1950; and Globivalvulininae POKORNY, 1958) is as follows: Test enrolled planispirally to slightly trochospirally, chambers biserially arranged, involute, aperture opens at inner border of septal face.

The family Biseriamminidae consists of three genera; *Biseriammina* from the middle Tournaisian of South Ural (CHERNYSHEVA, 1941), *Olympina* from the Permian of Cyprus (REICHEL, 1945) and the type-genus *Globivalvulina*. The first and the second are monotypic, and there is nothing to be mentioned on their biostratigraphical significance.

SCHUBERT (1921) proposed *Globivalvulina* for the "*Globigerina*-like" Paleozoic foraminifera, designating briefly *Valvulina bulloides* BRADY as the type-species, but he did not defined it in detail. According to the emended definition of *Treatise on Invertebrate Paleontology*, the basic characters of the genus are summarized as follows: Subglobular to hemispherical test, planispirally to slightly trochospirally coiled; biserially arranged chambers; microgranular calcareous wall with some inner fibrous layers; aperture

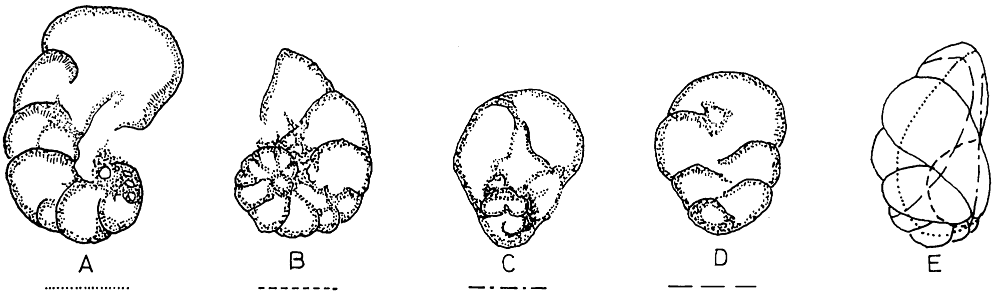
Table 1. Stratigraphic distribution of the species of *Globivalvulina* previously described.

	Low Carb.	Up. Carbon.			Perm.
		low.	mid.	up.	
G. biserialis Cush. & Waters				×	
G. bristolensis Reitlinger	×				
G. bulloides (Brady)	×?	×	×	×	×?
* *G. cora* Harlton			×		
G. cyprica Reichel					×
G. donbassica Potievskaya					×
G. eogranulosa Reitlinger		×	×		
* *G. gaptankensis* Harlton			×		
G. gracea Reichel					×
G. granulosa Reitlinger			×		
G. granulosa complicata Reit.			×		
G. granulosa compressa Reit.		×			
G. granulosa multiseptata Reit.			×		
G. kamensis Reitlinger		×			
G. kantharensis Reichel					×
G. minima Reitlinger		×			
G. moderata Reitlinger		×	×		
G. mosquensis Reitlinger			×		
*° *G. ovaia* Cushman & Waters				×	
G. parva Chernysheva	×				
G. pulchra Reitlinger			×		
G. rauserae Reitlinger				×	
G. scaphoides Morozova		×	×		
+*G. shikhanensis* Morozova				×	
+*G. spiralis* Morozova				×	
G. syzranica Reitlinger			×		
G. vonderschmitti Reichel					×
+*G. vulgaris* Morozova				×	×?

* Described only by the external characters of free specimens; + described by line drawing without microphotograph; ° identified with *G. biserialis* by thin section study.

interiomarginal, opens into vestibule near middle of apertural face.

Twenty-eight species of *Globivalvulina* have been previously described; two from the upper Lower Carboniferous, twenty-one from the Upper Carboniferous and five from the Permian (see Table 1). Generally the species from the Lower



Text-fig. 1. Various sections of *Globivalvulina* (partly figured after REICHEL, 1964). A, sagittal section; B, nearly sagittal section; C, apertural section; D, parallel section; E, external view. Lines under capital letters A, B, C and D correspond sectional lines shown in E.

Carboniferous are small in size (0.25 mm more or less in maximum length of sagittal section) and subspherical in shape, while the Permian species are characterized with larger size (more than 0.6 mm) and rapidly expanding chambers in adult stage. The Upper Carboniferous species are commonly 0.3 mm to 0.6 mm in size and intermediate in shell shape between the Lower Carboniferous and Permian types.

The re-examination is required with three species which have been only studied by the external appearance without taking notice of the inner microstructure by thin section. St. JEAN (1957, p. 36) regards both species of *Globivalvulina biserialis* and *G. ovata* as the same one from the common characteristics of the inner structure. Three species which were defined with the vague figures by line drawing are also insufficient in order to compare exactly with other species.

With regard to the orientation of thin section in this genus, the terms of transverse and longitudinal sections have hitherto been mainly used, but there is such disorder that REITLINGER's transverse section (1950) is the same as St. JEAN's longitudinal one (1957). In any case, it admits of no doubt that the section carrying the helicoid axis of biseriality (in other words perpendicular to the coiling axis) and passing through the proloculus best reveals internal features of the shell, as is known from the morphological study of REICHEL (1946, text-figure 36) and PLUMMER (1948). The present writer makes use of the term of sagittal section to this orientation. The apertural section, which is sliced with the face of lobata opening, is indispensable for the purpose of observing the feature of aperture, for it can not be seen in sagittal section. Such others as axial, parallel and nearly saggital sections are also necessary to investigate in detail the characteristics of test (Text-fig. 1).

Systematic description

Family Biseriamminidae
CHERNYSHEVA, 1941

Genus *Globivalvulina* SCHUBERT, 1921

Type-species:—Valvulina bulloides BRADY, 1876, *Palaeont. Soc., London, Monograph*, vol. 30, p. 89, pl. 4, figs. 12-15.

It was reported from the upper Pennsylvanian of Iowa, U.S.A., but according to PLUMMER (1948, p. 169), the exact geographic position of the type-locality for the species is questionable.

Diagnosis:—Test small, subglobular to hemispherical, planispirally to slightly trochospirally coiled, comprises a biserial succession of chambers arranged along an axis of biseriality that draws an open helicoid curve. Apertural face (ventral side) more or less concave. Wall calcareous, microgranular, may have an inner fibrous or porous layer particularly well developed along septa. Aperture single, lobate, and opens into near the center of a little flattened part of somewhat concave apertural face, with a valvular projection.

Remarks:—This genus is clearly distinguished from the others of Endothyracea by a lobate aperture and chambers biserially arranged along the helicoid axis of biseriality. In parallel section, the chamber arrangement closely resembles that of palaeotextulariids seen in 0/∞/∞ section, but the shell of *Globivalvulina* is not tapering, being obtuse-triangular in shape. The apertural character can be defined in detail only by the external observation of isolated specimens, though examined partly in apertural section.

Geological age:—The upper Lower Carboniferous to the upper Permian; mainly the lower Upper Carboniferous. Occurrences of the upper Lower Carboniferous and Permian species are geographically restricted. That is to say, only two Visean species have been recorded from the central part of Bashkiria, U.S.S.R., and Permian ones, except *G. donbassica* from Donbass region, from Chatzimanoli, Ile de Chio, Greece and Cyprus. All the other species occur from the Pennsylvanian of the U.S.A. and European Russia.

Globivalvulina kamensis REITLINGER

Pl. 50, figs. 1-8

1950. *Globivalvulina kamensis* REITLINGER, *Akad. Nauk. USSR, Inst. Geol. Nauk, Trudy, Moscow, fasc.* 126 *(Geol. Ser.* no. 47), p. 78, pl. 16, figs. 5-6.

1962. *G. kamensis*: BOGUSH and JUFEREV, *Akad. Nauk, USSR, Dep. Siberian Inst. Geol. Geogr.*, p. 197, pl. 8, fig. 14.

Types:—So far as the type-specimens photomicrographed by REITLINGER are concerned, they are not good enough to describe the species definitely, because the one is a nearly apertural section (fig. 5) and the other (holotype) a nearly sagittal, slightly oblique section (fig. 6). They were obtained from the Kashira formation (lower Moscovian), southern part of the region around the Timan Upland, Komi, U.S.S.R.

Material:—Five sections almost perpendicular to the coiling axis, three parallel to the plane of ventral side of test, and seven others were examined. The majority came from the *Millerella* sp. A∼*Pseudostaffella antiqua* zones of the Akiyoshi and Taishaku limestone groups.

Description:—Test moderate in size, hemi-ellipsoid, slightly trochospiral with a very weakly curved helicoid axis of biseriality, consisting usually of one to one and a half volutions with biserial chambers. Chambers six to seven in number in each row, fairly overlapped; the last two rapidly expanding, occupying about two-thirds of the total outer whorl, and especially the last chamber highly inflated; inner half of the whorl consists of small chambers tightly coiled. The last chamber has a valvular projection on the floor, which takes about a half of the chamber height and generally parallels the "antetheca of

Fusulinacea". Wall relatively thin, calcareous and microgranular, partially with inner fibrous layer. Aperture lobate, opening at the central part of somewhat flattened apertural face; its true character is indistinct, though observed as dark part in Pl. 50, fig. 8 (nearly apertural section).

Dimensions:—The longest diameter 0.34 mm in the figured sagittal section (Pl. 50, fig. 1), and the maximum width 0.25 mm in the figured parallel section with apertural face (Pl. 50, fig. 7).

Remarks:—The last chamber of this species is more inflated than in any other species of *Globivalvulina.* It also differs from others except for *G. gracea* REICHEL in its long valvular projection. This projection is apparently short in the photomicrograph of the holotype, for it is a slightly oblique section. *G. kamensis* closely resembles *G. granulosa* REITLINGER including its three subspecies, but the former is distinguished from the latter in its plane or very slightly arcuate apertural face.

Horizon:—The present species was obtained from the *Millerella* sp. A∼ *Pseudostaffella antiqua* zones of the Akiyoshi limestone, the *Millerella* sp. A zone of the Taishaku and the Koyama limestone, and the upper part of the Kakisako formation (*Millerella* zone) of the Kuma Massif.

Globivalvulina mosquensis REITLINGER

Pl. 50, figs. 9-12

1950. *Globivalvulina mosquensis* REITLINGER, *Akad. Nauk, USSR, Inst. Geol. Nauk, Trudy, Moscow,* fasc. 126 (*Geol. Ser.* no. 47), p. 79, pl. 16, figs. 1-4.

Types:—This species was first found from the middle Upper Carboniferous Podolsk formation in the eastern part of the Moscow Basin, U.S.S.R. The holotype (fig. 1) is described as transverse section, but it may be a slightly oblique, nearly sagittal section, and the paratype (fig. 2) is a parallel one. Therefore, the apertural feature and the valvular projection are unable to be seen in detail in these figures.

Material:—The writer obtained fourteen specimens in all, but there is no precisely sagittal section. Three nearly sagittal sections slightly oblique to the coiling axis, two sections parallel to the apertural face, and nine other were examined. The occurrence is limited to the *Profusulinella*∼*Fusulinella* zones of the Akiyoshi and Atetsu limestones and the Nagaiwa formation (*Profusulinella* zone) of the Kitakami Massif.

Description:—Test moderate in size, subglobular, slightly trochospiral, and slightly compressed laterally; apertural face very weakly concave. Number of whorls not more than one and a half. Chambers increasing gradually in size, especially slowly in juvenile stage, biseriality that describes an open helicoid curve, but the last chamber swerves from the axis; seven chambers in each row interlocked very shallowly. The valvular projection may be present on the floor of the last chamber, as shown in Pl. 50, fig. 10 (slightly oblique, nearly sagittal section); the identical hook-shaped projection is also recognized on floors of the last three chambers in the figure of the holotype. Wall relatively thin, microgranular, calcareous, with inner fibrous layer partially. Aperture probably lobate, opening on some what concave apertural face; but its precise character obscure because of a lack of apertural section.

Dimension:—The longest diameter 0.38 mm in the nearly sagittal section (Pl. 50, fig. 10), and the maximum width 0.35

mm in the parallel section with apertural face (Pl. 50, fig. 12).

Remarks:—Such characters as low spire and inner fibrous layer described on the type-specimens are not always special ones of this species. The present species resembles more closely *G. bulloides* (BRADY) than any other species, but differs in its small size and regularly expanding chambers through the growth stage. It is also distinguished from *G. kamensis* REITLINGER in its more deeply concave apertural face.

Horizon:—Although this species was originally recorded from the upper Moscovian, it may range down to the lower Moscovian or Bashkirian by reason of occurring from the *Profusulinella beppensis* zone of the Akiyoshi limestone and its equivalents.

Globivalvulina granulosa compressa REITLINGER

Pl. 51, figs. 1-6

1950. *Globivalvulina granulosa* REITLINGER var. *compressa* REITLINGER, *Akad. Nauk, USSR, Inst. Geol. Nauk, Trudy, Moscow,* fasc. 126 (*Geol. Ser.* no. 47), p. 81, pl. 16, figs. 10-11.

Types:—The holotype specimen (fig. 10) is not a transverse section but a nearly sagittal one, and also the paratype specimen (fig. 11) is a nearly apertural section (not a longitudinal one). They were described from the lowermost Moscovian Vereia formation, southern part of the region around the Timan Upland, Komi, U.S.S.R.

Material:—Nine specimens were examined. They consists of four nearly sagittal, a just apertural and four other sections from the *Millerella* sp. A∼*Pseudostaffella antiqua* zone of the Akiyoshi limestone and the *Millerella*∼*Profusulinella* zones of the Taishaku limestone. There is no section precisely perpendicular to the coiling axis and passing through the proloculus.

Description:—Test moderate in size, hemispherical, fairly concave in apertural face, composed of one to one and a quarter whorls with six or seven chambers biserially arranged, almost planispiral, but its helicoid axis weakly curved in later stage. Chambers deeply overlapped, rapidly expanding except those in juvenile stage which are tightly coiled; the last chamber relatively inflated, slightly swerving from the helicoid axis of biseriality. Valvular projection indistinct owing to a lack of sagittal section, but a small hook-shaped projection may be present on the floor of the last chamber. Wall thin, microgranular, calcareous, inner fibrous layer poorly developed. Aperture lobate, fairly large, opening at the central part of concave apertural face; there are five lobations, among which one is acute and the rest are obtuse.

Dimension:—The longest diameter 0.39 mm and the maximum width 0.26 mm in the nearly sagittal section (Pl. 51, fig. 2). The length along the axis of biseriality 0.34 mm and the maximum width 0.32 mm in the apertural section (Pl. 51, fig. 5).

Remarks:—The present species is allied to *G. mosquensis* REITLINGER in respect that the last chamber swerves from the helicoid axis of biseriality, but the former is clearly distinguished from the latter by its strongly concave apertural face. This species closely resembles *G. bulloides* (BRADY), but it differs in its apertural feature with five lobations and curved helicoid axis of biseriality.

Horizon:—Although the type-species of this species were originally described from the lowermost Moscovian, its range should be set down to the Bashkirian owing to the occurrence from the *Millerella* zone.

Globivalvulina sp. cf. *G. kantharensis* Reichel

Pl. 50, figs. 13-14

Compare :

1946. *Globivalvulina kantharensis* Reichel, *Eclogae Geol. Helv., Lausanne*, vol. 38, no. 2, pp. 554-555, text-figs. 40a-d.

Types:—*G. kantharensis* was described from the lower Permian of Cyprus. The holotype (text-fig. 40b) is a sagittal sectiion and the paratype ? (text-fig. 40c) is a section nearly parallel to the coiling axis and apertural face. Other two specimens are oblique. Therefore, the apertural feature is unknown even throughout all figured specimens.

Material:—Two nearly sagittal sections from the lower part of the *Pseudoschwagerina* zone of the Taishaku limestone.

Description:—Test small, subglobular, comprising a compact biserial succession of gradually enlarging chambers, almost planispirally coiled with an axis of biseriality that describes an open helicoid curve. Apertural side strongly concaved. Valvular projection is present on the floor of the last chamber, fairly long, hook-shaped; Its length attains to half of the chamber height. In sagittal section, a single aperture is recognized as a low slit-like opening. Wall thin, microgranular, calcareous; inner fibrous layer very poorly developed.

Dimension:—The maximum length 0.32 mm and the maximum width 0.23 mm in the nearly sagittal section figured with Pl. 50, fig. 13.

Comparison:—In many important characters the material here dealt with is comparable with *G. kantharensis* Reichel, though the writer avoids the exact identification owing to insufficiency of the material. The species is closely allied to *G. bulloides* (Brady) and *G. granulosa compressa* Reitlinger, but it can be distinguished in its strongly depressed ventral side and gradually expanded chambers.

Horizon:—In Cyprus *G. kantharensis* was accompanied by *Pseudoschwagerina* sp., and in Taishaku, too, occurred only from the lower *Pseudoschwagerina* zone. Very recently, Mr. Takeda, who is engaging in studying the geology of the southwestern Atetsu limestone plateau, found three specimens belonging to this species from the *Pseudoschwagerina* zone. Therefore, the species may be effective as a horizon marker.

Globivalvulina sp. cf. *G. gracea* Reichel

Pl. 51, figs. 7-10

Compare

1946. *Globivalvulina gracea* Reichel, *Eclogae Geol. Helv., Lausanne*, vol. 38, no. 2, p. 550, pl. 19, figs. 15-17, text-figs. 36A-F and 38a-f.
1970. *Globivalvulina gracea* : Kochansky-Devide, *Geol. Razpr. Por.*, vol. 38, p. 185, pl. 9, fig. 6, pl. 18, figs. 1-2.

Types:—Reichel established *G. gracea* from the Permian of Chio Island, Greece. The holotype photomicrographed with pl. 19, fig. 15 is a nearly sagittal section. The test-figs. 36A-F given as "cotype" (paratype ?) are the most important figures requisite for thin section study of the genus *Globivalvulina*.

Material:—Three nearly sagittal, a parallel and two oblique specimens were examined from the *Fusulinella* and *Para-*

fusulina zones of the Taishaku limestone.

Description:—Test relatively large, subglobular, weakly depressed on apertural side, consisting of one and a half whorls with eight chambers biserially arranged through the growth stage. Chambers gradually enlarging, but the last and penultimate ones fairly inflated. A valvular projection is present on the floor of the last chamber, long, tapering, and parallels the " antetheca of Fusulinacea ". Wall relatively thick, composed of outer microgranular and inner fibrous layers. In sagittal section the aperture is recognized as a slit-like opening.

Dimension:—The maximum length 0.59 mm and the maximum width 0.39 mm in the sagittal section (Pl. 51, fig. 9). The length along the axis of biserity 0.52 mm and the maximum width 0.39 mm in the parallel section (Pl. 51, fig. 10).

Comparison:—Almost all characters stated above are comparable with those of *G. gracea*, though the apertural nature is indistinct because of lack of apertural section. This species and *G. kantharensis* REICHEL are closely alike in their subglobular shell, but the former is distinguished from the latter in its larger size and more depressed ventral side. The species is also distinguished from *G. mosquensis* REITLINGER by that the last chamber of the latter swerves out of the axis of biseriality.

Horizon:—According to the original description of *G. gracea* from Chio Island, the species coexists with such Permian foraminifers as *Agathammina pusilla* (GEINITZ), *Hemigordius* aff. *schlunbergi* (SCHUBERT) and *Geinitzina postcarbonica* SPANDEL, but there is no evidence on the precise age. The specimens dealt with in this paper occurred from the Moscovian and Middle Permian parts of the Taishaku limestone.

Globivalvulina regularis sp. nov.

Pl. 50, figs. 15-19

Material:—A sagittal section (holotype, YONG6-15), a nearly apertural section (paratype, YONG6-14), two parallel sections with apertural face, two nearly sagittal sections and others were examined. The majority came from the Nagaiwa formation of the Kitakami Massif.

Description:—Test relatively large, subglobular, planispiral, weakly depressed on both lateral sides of the boundary between the juvenile and the adult, consisting of one volution with seven chambers of adult stage fairly inflated as compared with four small, gradually enlarging and tightly coiled chambers of the juvenile. On each floor of the adult chambers there is a hook-shaped projection, while the axial part of early stage filled with calcareous microgranular secondary deposits. Wall composed of outer thick microgranular and inner thin defective fibrous layers. Aperture lobate, with five shallow lobations, opening on the concave apertural side.

Dimension:—The maximum length 0.48 mm and the maximum width 0.38 mm in the holotype (sagittal section) figured with Pl. 50, fig. 19. The maximum length 0.42 mm and the maximum width 0.41 mm in the paratype (apertural section) figured with Pl. 51, fig. 18.

Remarks:—This new species can be distinguished from other species of *Globivalvulina* in its depression on both lateral sides of test that is caused by abrupt expanding of chambers in adult stage.

Horizon:—Almost all specimens were obtained from the Ng-6 horizon (ONUKI, 1955) of the Nagaiwa formation (*Profusulinella* zone), Kitakami Massif. A few came from the *Millerella* sp. A zone of the Akiyoshi limestone and from the same zone of the Kobatake limestone, Jinseki-gun, to the south of Taishaku district, Hiroshima Prefecture.

Globivalvulina sp. A

Pl. 50, figs. 20-22

Material:—Six specimens were examined; a nearly sagittal, a parallel, a nearly apertural and other sections from the lower Upper Carboniferous part of the Akiyoshi and Taishaku limestones.

Description:—Test moderate in size, subglobular, very slightly trochospiral. Number of whorls not over one and a half. Commonly seven chambers biserially arranged; chambers of an inner half whorl small and tightly coiled, while those of later stage increase in size rapidly but not uniformly, and the last chamber fairly swerves from the helicoid axis of biseriality. Secondary deposits remarkably developed on floors of the chambers. Wall relatively thin, consisting of outer microgranular and inner fibrous layers. Aperture lobate, with two or more acuate lobations, opening at the central part of apertural face.

Dimensions:—The maximum length 0.27 mm and the maximum width 0.21 mm in the sagittal section (Pl. 50, fig. 22). The length along the axis of biseriality 0.31 mm and the maximum width 0.33 mm in the nearly apertural section (Pl. 50, fig. 21).

Remarks:—This species is remarkably characterized with secondary deposits, inflated chambers of the adult stage, and a considerable swerve of the last chamber. Accordingly, it may be a new species, but the writer hesitates to conclude so, because there is no sagittal section enough to designate as the type-specimen.

Horizon:—The occurrence of the present species is limited to the *Millerella* sp. A zone of the Akiyoshi limestone. Some specimens comparable with this species were found from the same zone of the Taishaku limestone.

Globivalvulina sp. B

Pl. 51, figs. 11-13

Material:—Two nearly sagittal and other oblique sections were examined from the Upper Permian of Taishaku.

Descriptive remarks:—Test large, hemiellipsoid, planispiral, composed of one and a half whorls with nine or ten chambers biserially arranged along the helicoid axis of biseriality. The helicoid axis becomes very loosely coiled or uncoiled in later stage, and this is the most important character of the species. Chambers deeply overlapped as those of palaeotextulariids. The characters of valvular projection and aperture are indistinct because of an absence of availably oriented section. Owing to the insufficiency of the material, the definite designation is postponed.

Dimension:—The maximum length 0.57 mm and the maximum width 0.33 mm in the sagittal section figured with Pl. 51, fig. 11.

Horizon:—All the specimens referable to this species were obtained only from the locality TKSH-1, *Yabeina* zone of the Taishaku limestone.

Notes on the occurrence of *Globivalvulina*

In this chapter, the biostratigraphical significance of *Globivalvulina* is noted, and the frequency of it is related with the petrographical character of limestone. The writer (1966) has already divided the Carboniferous limestones of the Chugoku Region into the following zones in descending order.

Fusulinella imamurai—F. biconica zone
Profusulinella toriyamai—P. beppensis zone
Pseudostaffella antiqua zone
Eostaffella sp. A—*Millerella* sp. A zone
——— Disconformity ———
Mediocris sp. A—*M. mediocris* zone
Endostaffella delicata zone
Endothyra sp. A zone

The upper four zones are characterized with primitive fusulinaceans, while the lower three with smaller foraminifers. The writer (1963, 1966) also emphasized that *Globivalvulina* is one of the characteristic genera in the *Millerella* zone.

Table 2 shows the biostratigraphic distribution of *Globivalvulina* in the Taishaku, Atetsu and Akiyoshi limestones. Among 239 specimens in 64 thin sections (a section 30×20 mm in area) examined, 151 one (about 67.3%) were obtained from the *Eostaffella* sp. A-*Millerella* sp. A zone, where the genus is occassionally greater than fusulinaceans in frequency. Especially speaking, the occurrence of three species of *G. kamensis* REITLINGER, *G. granulosa compressa* REITLINGER and *G.* sp. A is limited to this zone. Moreover, the writer did not find any species of *Globivalvulina* from the underlying zones.

Such being the case, it may be concluded that *Globivalvulina* is an important faunal element of the *Eostaffella* sp. A-*Millerella* sp. A zone of the Chugoku Region, and that the frequency of it offers an available datum to the problem concerning the boundary between the Lower and Upper Carboniferous in Japan. RAUSER-CHERNOUSSOVA and REITLINGER (1957, p. 113) has already stated that the age of prosperity of the genus is in the lower Upper Carboniferous.

Table 3 shows the distribution of *Globivalvulina* with regard to the lithologic types of limestone. As understood from this table, globivalvulinid foraminifera occur more abundantly from micritic limestones, especially such limestones as foraminiferal or crinoidal biomicrite, than from sparitic ones. Such occurrence may be related to the paleoecology of the

Table 2. Frequency of *Globivalvulina* with relation to the divisions of the Permo-Carboniferous limestones in Chugoku Region. Numerals in and out of brackets indicate the number of thin sections containing *Globivalvulina* and that of specimens of the genus respectively.

	Taishaku l.s.	Atetsu l.s.	Akiyoshi l.s.	Total
Yabeina zone	20 (2)	14 (7)	not exam.	34 (9)
Pseudoschwagerina zone	19 (3)	13 (2)		32 (5)
Fusulinella zone	4 (3)	0	2 (1)	6 (4)
Profusulinella zone	1 (1)	7 (2)	1 (1)	9 (4)
Pseudostaffella antiqua zone	0	3 (1)	4 (1)	7 (2)
Eostaffella sp. A—*Millerella* sp. A zone	41 (18)	43 (9)	67 (13)	151 (40)
Total	85 (27)	80 (21)	74 (16)	239 (64)

Table 3. Frequency of *Globivalvulina* with relation to the petrographical divisions of limestones. Numerals show the number of thin sections containing *Globivalvulina*. In each box the number of the Carboniferous sections is set below and that of the Permian ones above.

	Taishaku l.s.	Atetsu l.s.	Akiyoshi l.s.	Total
Sparite	4 1	5 3	2	15
Sparudite	0 0	0 5	1	6
Micrite	1 17	4 0	2	24
Micrudite	0 1	0 4	10	15
Biolithite	0 3	0 0	1	4
Total	5 22	9 12	16	64

genus. However, it is difficult to make clear the paleoecological environment, because what factors influence the frequency of Paleozoic smaller foraminifera is not well known.

In this respect, the study of CRONEIS and TOOMEY (1965) is worth appending, which reported the composition of the foraminiferal population on four thin sections (a section 30×30 mm. in area) from the Gunsight limestones (Virgilian). According to it, 200 specimens of globivalvulinids on an average are counted from the foraminiferal-brachiopodal biomicrudite (coral horizon) accompanied with a few sessile foraminifera, while only 3 specimens from the algal-foraminiferal biomicrudite in which the remains of calcareous algae and sessile foraminifera are the dominant faunal elements. It was supposed by them that the depositional environment of the former was under normal marine, clear, shallow water, and that of the latter under very shallow, marine, quiet water.

References

BOGUSH, O.I. and JUFEREV, O.V. (1962) : Foraminifers and stratigraphy of the Carboniferous deposits in Karatau and Talasskii Alatau. *Akad. Nauk, USSR, Rept. Siberian Inst.G eol. Geograph.*, p. 1-234, pls. 9 (in Russian).

BRADY, H.B. (1876) : A monograph of Carboniferous and Permian Foraminifera (the genus *Fusulina* excepted). *Pal. Soc. London, Monograph*, no. 30, p. 1-166, pls. 12.

CHERNYSHEVA, N.E. (1941) : A new genus of Foraminifera from the Tournaisian deposits of the Urals. *Akad. Nauk, USSR, Doklady*, vol. 32, no. 1, p. 69-70.

—— (1948) : Some new species of Foraminifera from the Visean of the Makarov district (South Urals). *Akad. Nauk, USSR, Inst. Geol. Nauk, Trudy*, no. 62 (*Geol. Ser.* no. 19), p. 246-250, pl. 1 (in Russian).

CRONEIS, C. and TOOMEY, D.F. (1965) : Gunsight (Virgilian) Wewokellid sponges and their depositional environment. *Jour. Paleont.*, vol. 39, no. 1, p. 1-16, pls. 7.

CUSHMAN, J.A. and WATERS, J.A. (1928) : Additional Cisco Foraminifera from Texas.

Contrib. Cushman Lab. Foram. Research, vol. 4, no. 3, p. 1-16, pls. 8.

—— and —— (1930) : Foraminifera of the Cisco group of Texas. *Univ. Texas Bull.*, no. 3016, p. 22-81, pls. 11.

GALLOWAY, J.J. and RYNIKER, C. (1930) : Foraminifera from the Atoka Formation of Oklahoma. *Oklahoma Geol. Survey, Circ.*, no. 21, p. 1-27, pls. 5.

HARLTON, B.H. (1928) : Pennsylvanian Foraminifera of Oklahoma and Texas. *Jour. Paleont.*, vol. 1, p. 305-310, pls. 2.

KOCHANSKY-DEVIDE, V. (1970) : Permski Mikrofosili Zahodnih Karavank. *Geol. Razpr.*

Explanation of Plate 50

(All figures ×100)

Globivalvulina kamensis REITLINGER

Figs. 1 and 3. Nearly sagittal section (1, YOTM40; 3, YOTM109) from the *Mediocris mediocris* zone of the Taishaku limestone.

Fig. 2. Tangential section (YOAD17) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 4. Nearly sagittal section (YOAD13-2) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 5. Nearly sagittal section (YOA3-1) from the lower part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 6. Nearly sagittal section (YOAD26-2) from the *Pseudostaffella antiqua* zone of the Akiyoshi limestone.

Fig. 7. Parallel section (YOAD24-1) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 8. Nearly apertural section (YOTM109-2) from the *Mediocris mediocris* zone of the Taishaku limestone.

Globivalvulina mosquensis REITLINGER

Figs. 9-11. Nearly sagittal sections (9, YOAD11-1; 10, YOAD24-2; 11, YOAD24-3) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 12. Parallel section (YOAKJ2-1) from the lower part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Globivalvulina sp. cf. *G. kantharensis* REICHEL

Figs. 13 and 14. Nearly sagittal section (13, YOTUYM18-1; 14, YOTUYM18-2) from the *Pseudoschwagerina* zone of the Taishaku limestone.

Globivalvulina regularis sp. nov.

All specimens from the Nagaiwa formation (*Profusulinella* zone) of the Kitakami Massif.

Figs. 15 and 16. Nearly sagittal sections (15, YONG6-11; 16, YONG6-12).

Fig. 17. Parallel section (YONG6-13).

Fig. 18. Neaaly apertural section (YONG6-14), Paratype.

Fig. 19. Sagittal section (YONG6-15), Holotype.

Globivalvulina sp. A

Fig. 20. Parallel section (YOAD28-2) from the *Profusulinella beppensis* zone of the Akiyoshi limestone.

Fig. 21. Nearly apertural section (YOAD3) from the lower part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 22. Nearly sagittal section (YOAD14) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.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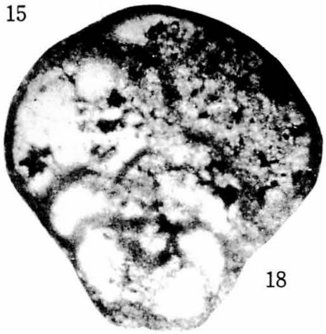
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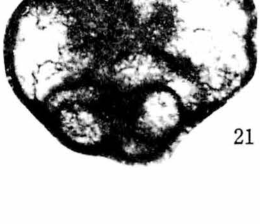
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Por., vol. 13, p. 175–250, pls. 26 (in Jugoslavian).

Liebus, A. (1932) : Die Foraminiferen In: Die Fauna des Deutschen Unterkarbons. Pt. 3. *Preuss. Geol. Landesanst., Bah., n.s.*, no. 141, p. 133–175, pls. 2 (in German).

Moore, R.C., edit. (1964) : *Treatise on Invertebrate Paleontology*. Geol. Soc. Amer. and Univ. Kansas Press.

Morozova, V.G. (1949) : Representatives of the Families Lituolidae and Textulariidae from the Upper Carboniferous and Artinskian Deposits of the Bashkiria, Pre-Ural. *Akad. Nauk, USSR, Inst. Geol. Nauk, Trudy*, no. 105 (*Geol. Ser.* no. 35), p. 244–275, pls. 5 (in Russian).

Okimura, Y. (1963) : Characteristics of the Smaller Foraminiferal Assemblage from the Carboniferous limestone of the Chugoku Province. *Kaseki (Fossils)*, no. 6, p. 1–6 (in Japanese).

—— (1966) : Microbiostratigraphical Studies on the Foraminiferal Faunas of the Lower Carboniferous Formations of the Chugoku Region, Southwest Japan. *Geol. Rep. Hiroshima Univ.*, no. 15, p. 1–46, pl. 1 (in Japanese).

Plummer, H.J. (1948) : Morphology of *Globivalvulina*. *Amer. Mid. Naturalist*, vol. 39, p. 166–173.

Potievskaya, P.D. (1962) : Representatives of certain Families of small Foraminifera. *Akad. USSR, Kiev, Inst. Geol. Sci., Trudy*, Ser. Strati, and Paleont., no. 44, p. 49–94, pls. 8 (in Russian).

Rauser-Chernoussova, D.M. and Reitlinger, E.A. (1957) : Phylogeny of Paleozoic Foraminifera and its stratigraphical significance. *Izvest. Akad. Nauk, USSR, Ser. Geol.*, vol. 11, p. 103–124 (in Russian).

—— and Fulsenko, A.B., edit. (1959) : *Osnovy Paleontologii*. Izdat. Akad. Nauk, USSR, Moskva (in Russian).

Reichel, M. (1946) : Sur Queleques Foraminiferes nouveaux du Permien Mediterranean. *Eclog. Geol. Helvetiae*, vol. 38, p. 524–560, pls. 19.

Reitlinger, E.A. (1950) : Foraminifera of the Middle Carboniferous Formations of the Central part of the Russian Platform (Exclusive of the family Fusulinidae). *Akad. Nauk, USSR, Inst. Geol. Nauk, Trudy*, no. 126 (*Geol. Ser.* no. 47), p. 1–127, pls. 22 (in Russian).

Schubert, R. (1921) : Paleontologische Daten zur Stammesgeschichte der Protozoen. *Pal. Zeitschr., Berlin*, vol. 3, no. 2, 1–153.

St. Jean, J. (1957) : A Middle Pennsylvanian Fauna from Dubois County, Indiana. *Indiana Geol. Survey, Bull.*, no. 10, p. 1–66, pls. 5.

Warthin, A.S. (1930) : Micropaleontology of the Wetumka, Wewoka, and Holdenville Formations. *Oklahoma Geol. Survey, Bull.*, no. 53, p. 1–95, pls. 7.

Akiyoshi	秋吉	Kobatake	小畠
Atetsu	阿哲	Koyama	高山
Jinseki-gun	神石郡	Kuma	球磨
Kakisako	柿迫	Nagaiwa	長岩
Kitakami	北上	Taishaku	帝釈

Explanation of Plate 51

(All figures ×100)

Globivalvulina granulosa compressa REITLINGER

Fig. 1. Nearly apertural section (YOAD22-1) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Figs. 2 and 3. Nearly sagittal sections (2, YOAKJ4; 3, YOAKJ2-2) from the lower part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 4. Sagittal section (YOAD11-2) from the upper part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Fig. 5. Apertural section (YOAD22-2) from the same horizon as the above.

Fig. 6. Parallel section (YOA3-2) from the lower part of the *Millerella* sp. A zone of the Akiyoshi limestone.

Globivalvulina sp. cf. *G. gracea* REICHEL

Fig. 7. Nearly sagittal section (YOTUYM51) from the *Parafusulina* zone of the Taishaku limestone.

Fig. 8. Nearly sagittal section (YOTNDA4) from the *Pseudoschwagerina* zone of the Taishaku limestone.

Fig. 9. Sagittal section (YOTUYM18-3) from the *Pseudoschwagerina* zone of the Taishaku limestone.

Fig. 10. Parallel section (YOTG27) from the *Fusulinella* zone of the Taishaku limestone.

Globivalvulina sp. B

All specimens from the *Yabeina* zone of the Taishaku limestone.

Fig. 11. Sagittal section (YOTKSH1).

Fig. 12. Nearly sagittal section (YOTKSH2).

Fig. 13. Tangentially oblique section (YOTKSH3).


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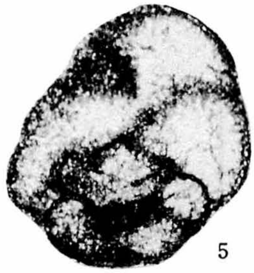
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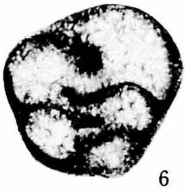
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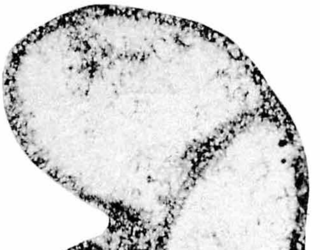
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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 87, pp. 429-435, September 30, 1972

605. A NOTE ON THE DISTRIBUTION OF *BRAARUDOSPHAERA BIGELOWI* (GRAN AND BRAARUD) DEFLANDRE IN THE BOTTOM SEDIMENTS OF SENDAI BAY, JAPAN*

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仙台湾底質中の *Braarudosphaera bigelowi* (GRAN and BRAARUD) DEFLANDRE について：仙台湾より採集した18個の底質試料中の石灰質ナンノプランクトン群集について検討し，次の結果を得た。*Braarudosphaera bigelowi* は水深 24 m 以浅の堆積物中に豊富に見出されるのに反し，*Cyclococcolithus leptoporus* はその外側のより深い堆積物中に多産する。両種の分布の関係は，MARTINI (1967) がペルシア湾において考察した結果と一致する。

高山俊昭

Introduction:—The living calcareous nannoplankton species *Braarudosphaera bigelowi* (GRAN and BRAARUD) DEFLANDRE has twelve regular pentagonal calcareous skeletal elements around the cell which make a dodecahedral form (Text-fig. 1-a). Each pentagonal skeletal element consists of five segments of crystallographic units which are joined along straight sutures that radiate from the center of the plate (Text-fig. 1-b). This species was first described by GRAN and BRAARUD in 1935 as *Pontosphaera bigelowi* and since then it has been reported from the sediments of the Jurassic to the Recent by many investigators from many parts of the world.

Abundant occurrences of fossil *Braarudosphaera bigelowi* have been reported from various stratigraphic horizons: the Danian of south-west France (MARTINI, 1961), the Lower Eocene Lodo Formation in California (BRAMLETTE and SULLIVAN, 1961), the Middle Oligocene "Rupelton" of the Mainz Basin (MARTINI, 1960) and the Sarmatian of the Vienna Basin (STRADNER, 1960). MAXWELL *et al.* (1970) studied the deep sea cores taken from the South Atlantic Ocean and found several layers of *Braarudosphaera* chalk of the kind that occur most frequently in the Oligocene. According to them these layers of chalk consist almost exclusively of *Braarudosphaera rosa* and are distributed widely in the South Atlantic. They considered that these chalk layers originated at bathyal depths on the basis of the floral and faunal evidences associated with *Braarudosphaera rosa* and they proposed two hypotheses to explain the origin, *i.e.* either unusual oceanographic conditions such as the so-called "red-tide" bloom must have prevailed in this region for a short interval of geologic time or currents carried these shallow water deposits into deep water.

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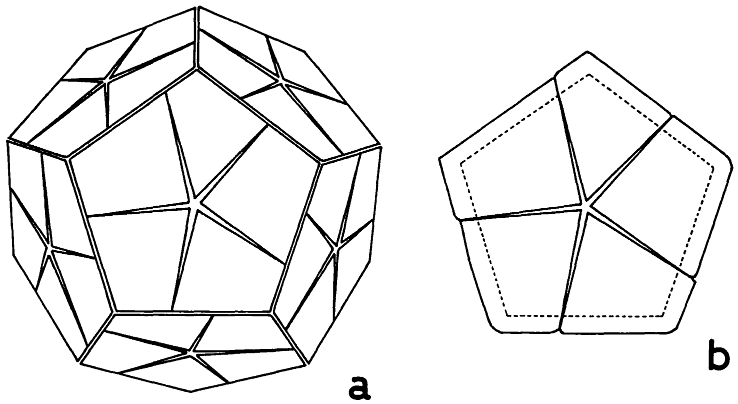


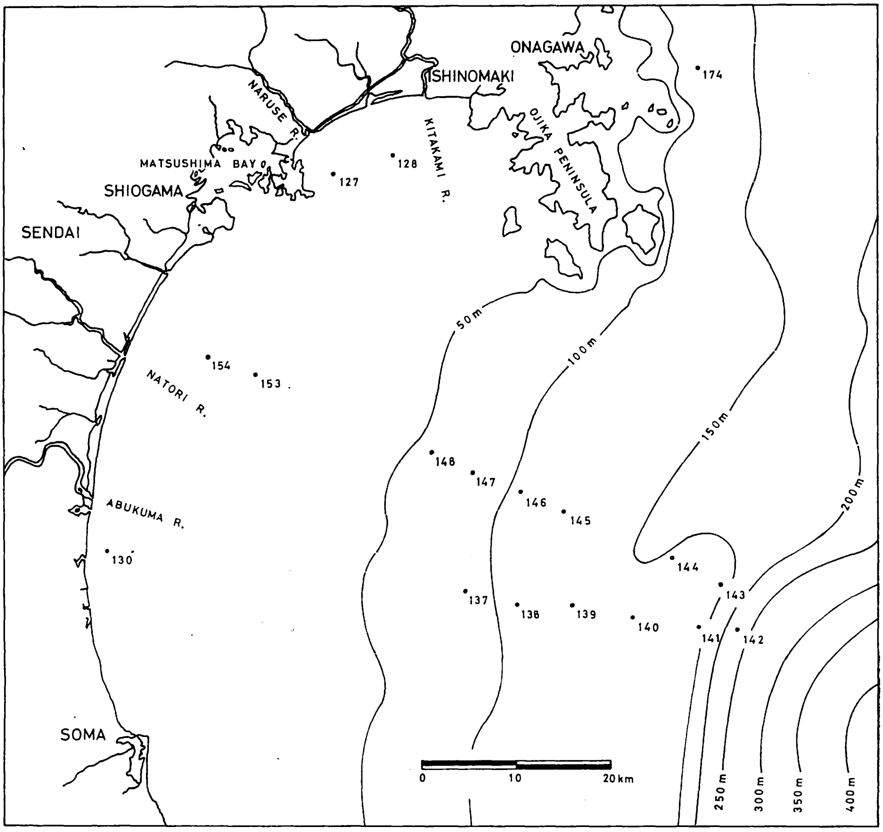
Text-fig. 1. *Braarudosphaera bigelowi* (GRAN and BRAARUD) DEFLANDRE; coccosphere (a) and its single plate (b).

It is generally accepted that modern *Braarudosphaera bigelowi* occurs in abundance only from the near shore water and that it is very rare or absent in the typical pelagic sediments despite a few exceptions (GRAN and BRAARUD, 1935; GAARDER, 1954). MARTINI (1967) investigated the distribution pattern of *Braarudosphaera bigelowi* and *Cyclococcolithus leptoporus* in the recent sediments of the Persian Gulf, the Gulf of Oman and the northern part of the Arabian Sea and reported as follows; *Braarudosphaera bigelowi* which is fairly abundant in the Persian Gulf drastically reduces its number at the Strait of Hormz, becomes few in the northwestern part of the Gulf of Oman and almost absent in the greater part of the Gulf of Oman and northern Arabian Sea; on the other hand the number of specimens of *Cyclococcolithus leptoporus* which is abundant in all samples from the Gulf of Oman, decreases abruptly at the Strait of Hormz, becomes rare in the eastern part of the Persian Gulf and almost absent in the central part of the same Gulf.

As the calcareous nannoplankton uses the energy of sunlight for photosynthesis like other plants, they are mainly concentrated in the upper layers of the ocean within the reach of sunlight. Therefore it seems probable that such factors as salinity and the temperature of the surface water are more significant in the control of their distribution, than the depth of water. Their distribution patterns are considered to be closely related to the present current systems. Nevertheless, *Braarudosphaera bigelowi* is assumed as a species that inhabits coastal waters and through its life-history the free-swimming generation appears to alternate with filamentous or other sessile forms that colonize on rocks or other solid foundations.

It is considered that the detailed studies of the modern *Braarudosphaera bigelowi* may afford some solution to the origin of the spectacular burst of fossil *Braarudosphaera* at these stratigraphical horizons. However, these data are still incomplete and fragmentary, and the origin is still a mystery. With this view in mind the present writer contributes some data on the distribution pattern of *Braarudosphaera bigelowi* in the bottom sediments of Sendai Bay.

Materials:—Sendai Bay is located on the eastern side of Miyagi Prefecture; approximately at 38°30′ to 37°50′N. Lat. and 141°00′ to 142°20′E. Long. and is surrounded by the Ojika Peninsula at the north and by a gentle concave coast line at the west (Text-fig. 2). The coast line between Ishinomaki and Soma Cities is interrupted by the recently submerged Matsushima Bay. On the land area surrounding Sendai Bay, the Miyagino coastal plain is headed at the north by the southern part of the Paleozoic and Mesozoic systems of the Kitakami Massif. The main drainages into Sendai Bay are the Kitakami, Naruse, Nanakita, Natori and the Abukuma rivers. A total of 18 samples were taken from the bottom of Sendai Bay in November, 1966, extending from shallow water (19 m) to the upper part of the continental slope (203 m). The sampling localities are shown in Text-fig. 2. The samples were taken by the Phleger sampler (PHLEGER, 1951, 1960) and the uppermost one centimeter in thickness, comprising approximately 10 cc of wet sediment, was cut off from each core and examined for the present study. At the time of sampling, measurements were made of the depth of water and the surface and bottom water temperatures. The bottom water temperature was measured on board the ship from the water obtained by the



Text-fig. 2. Chart of Sendai Bay, showing locations of the samples.

Phleger sampler before removing the sediment. These data are as follows:

Site No.	Water depth (m)	Temperature °C Surface	Bottom
127	19	15.8	12.5
128	22	16.1	14.0
130	24	16.4	14.5
137	87	17.9	15.5
138	109	17.8	15.5
139	130	17.8	14.0
140	143	17.6	14.0
141	142	17.7	12.5
142	203	17.9	12.4
143	144	17.9	13.5
144	147	18.7	13.5
145	126	19.3	14.8
146	103	19.5	15.1
147	76	19.7	16.0
148	55	19.7	16.0
153	34	18.9	15.5
154	28	18.9	15.5
174	130	18.5	14.5

The present materials were processed and examined according to the following methods outlined by STRADNER and PAPP (1961). Disintegration of a very small quantity of the samples was placed in a small glass. Water was added until a depth of 3-4 cm was obtained. The glass was placed in a ultrasonic equipment at moderate vibration level. After settling of the heavier particles, a few drops were sucked from the upper layer of the suspension with a drinking straw and settled out on a microscopic cover glass and dried on an electric hot-plate carefully. Caedax (n=1.55) was then spread over it, dried and a large deck glass was pressed on it. This was examined under a Nikon binocular polarizing microscope with phase contrast equipment. A magnification of 1,500X with oil-immersion objective lens was necessary.

Distribution pattern:—In each sample two hundred specimens of coccoliths were counted. The relative frequencies of the species obtained are listed in Table 1. Under the light microscope nearly half of the total specimens were too small (less than 3μ) for precise identification, though they were considered to belong to *Emiliania huxleyi*, "*Coccolithus doronicoides*" and broken specimens of *Gephyrocapsa oceanica*. Therefore they are lumped together under miscellaneous in Table 1. Among the remaining ones the fairly dominant species is *Gephyrocapsa oceanica*. In addition, *Coccolithus pelagicus*, *Braarudosphaera bigelowi*, *Helicopontosphaera kamptneri*, *Cyclococcolithus leptoporus*, *Rhabdosphaera clavigera* and *Syracosphaera pulchra* were found, though rare and sporadic in occurrence. Of the distribution patterns the following are recognized: 1) *Braarudosphaera bigelowi*

Table 1. Abundance in counted specimen; 200 in each sample.

Species / Sample	127	128	130	154	153	148	147	137	146	138	145	139	174	141	140	143	144	142
Braarudosphaera bigelowi	4	8	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0
Coccolithus pelagicus	8	3	3	2	2	2	3	2	7	2	3	2	9	1	3	9	7	6
Cyclococcolithus leptoporus	0	0	0	2	0	0	2	0	3	2	6	3	5	1	7	8	5	3
Gephyrocapsa oceanica	85	42	62	100	109	28	50	90	47	28	30	25	88	33	58	43	31	57
Helicopontosphaera kamptneri	1	1	3	0	0	0	0	1	1	0	0	0	3	0	0	1	0	1
Rhabdosphaera clavigera	1	1	1	1	0	1	1	0	0	0	0	3	0	0	0	0	2	0
Syracosphaera pulchra	3	2	0	0	1	3	2	3	0	1	0	4	0	0	0	0	0	0
Miscellaneous	98	143	129	95	86	165	142	103	142	167	161	163	95	165	132	139	155	133
Total	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Depth(m)	19	22	24	28	34	55	76	87	103	109	126	130	130	142	143	144	147	203

Table 2. Abundance in counted specimen; 200 in each sample (*Gephyrocapsa oceanica* and miscellaneous excluded).

Species \ Sample	127	128	130	154	153	148	147	137	146	138	145	139	174	141	140	143	144	142
Braarudosphaera bigelowi	90	99	82	–	–	17	–	8	15	7	3	3	4	1	2	5	6	0
Coccolithus pelagicus	54	28	45	–	–	48	–	53	76	66	63	52	64	75	86	59	61	93
Cyclococcolithus leptoporus	4	5	10	–	–	52	–	41	90	77	118	86	64	89	101	107	100	95
Helicopontosphaera kamptneri	7	2	7	–	–	21	–	10	8	8	3	15	6	15	2	24	9	7
Oolithotus antillarum	0	0	0	–	–	0	–	0	1	0	1	3	1	4	0	2	2	1
Rhabdosphaera clavigera	4	8	8	–	–	17	–	14	2	8	3	10	20	3	0	2	15	0
Syracosphaera pulchra	41	58	48	–	–	45	–	74	8	34	9	31	41	13	9	1	7	4
Total	200	200	200	–	–	200	–	200	200	200	200	200	200	200	200	200	200	200
Depth(m)	19	22	24	28	34	55	76	87	103	109	126	130	130	142	143	144	147	203

is found only from the sediments less than 87 m in water depth and it is the characteristic species of the inner part of the bay; 2) *Cyclococcolithus leptoporus* is rare or almost absent in the near shore sediments; 3) *Syracosphaera pulchra* occurs from the sediments less than 130 m in water depth.

To reveal the distribution patterns of these species more clearly, in each sample 200 coccoliths specimens except *Gephyrocapsa oceanica* and miscellaneous specimens were counted at random again and identified. The relative frequencies of the species obtained are listed in Table 2. On this occasion station nos. 147, 153 and 154 were excluded because only a small number of minute specimens of coccoliths were found from these samples. During the cruise several boring were made in the area between station nos. 130 and 137 and between 148 and 152, but no cores could be taken because of the distribution of bedrocks. HATTORI (1967) studied the bottom sediments of Sendai Bay and divided them into three units on the basis of texture, composition, minor structures of the sediments and their presumed historical ages, *i.e.* Younger Suites, Older Sands A and Older Sands B. Sample nos. 147, 153 and 154 were obtained from the area of his Older Sands B, which were considered by him to be in the non-depositional area. This may be the reason why only a small number of specimens were found from these cores and also in some part of the sea floor of this area bed-rocks are exposed. Table 2 shows that the near shore sediments shallower than 24 m are characterized by the abundant occurrence of *Braarudosphaera bigelowi* comprising nearly 50 percent of the assemblage. On the contrary *Cyclococcolithus leptoporus* is almost absent in this area. The distribution patterns of these two species, which are substantially the same as MARTINI's (1967), are shown in Text-fig. 3 and Text-fig. 4. Judging from the present data, the distribution of *Braarudosphaera bigelowi* is apparently controlled only by the depth of water. To obtain a clear understanding of the real factors involved, it is also necessary to assume other factors such as fresh water and nutrients provided by the drainages like the Kitakami River. At present no data concerning these factors are available, and there is room for further investigation.

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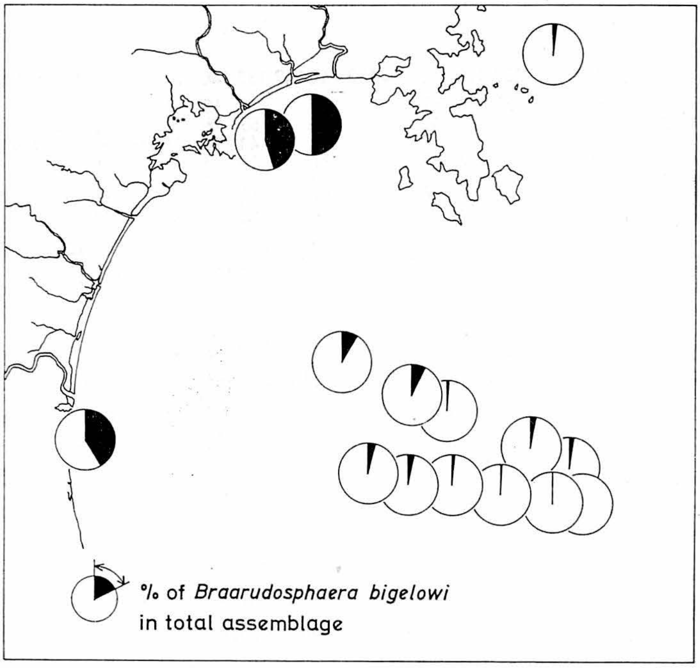
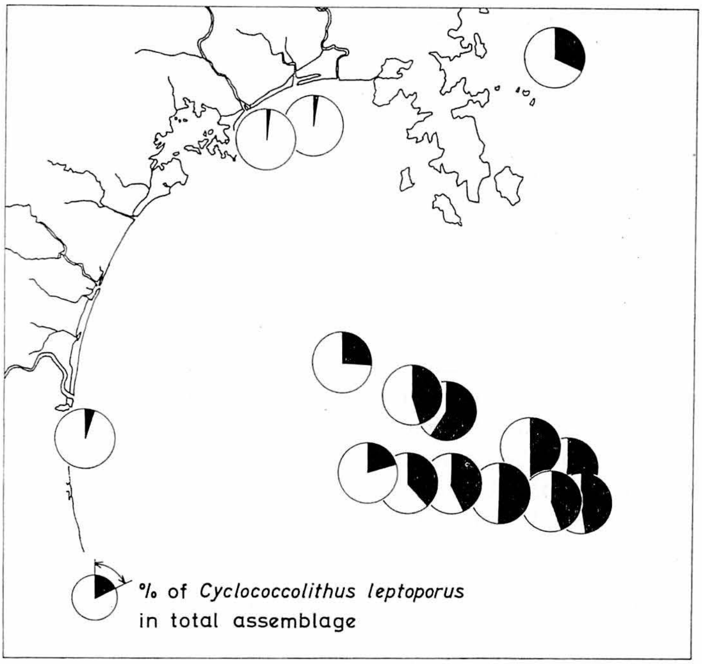


Text-fig. 3. Percentage distribution map of *Braarudosphaera bigelowi.*



Text-fig. 4. Percentage distribution map of *Cyclococcolithus leptoporus.*

gy, Tohoku University for their critical reading of the manuscript. The bottom sediments were obtained by the research vessel Tansei-maru of the Oceanographic Institute, University of Tokyo; acknowledgements are expressed to the crew of this ship for their kind assistance in collecting the samples.

References

BRAMLETTE, M.N. & SULLIVAN, F.R. (1961) : Coccolithophorids and related nannoplankton of the early Tertiary in California. *Micropaleontology*, vol. 7, no. 2, pp. 129-188, 14 pls.

GAARDER, K.R. (1954) : Coccolithineae, Silicoflagellatae, Pterospermataceae and other forms from the "Michael Sars" North Atlantic Deep Sea Expedition 1910. *Rep. Sars N. Atl. Deep Sea Exped. 1910*, vol. 2, no. 4, pp. 1-20.

GRAN, H.H. & BRAARUD, T. (1935) : A quantitative study of the phytoplankton in the Bay of Fundy and the Gulf of Maine. *Jour. Biol. Board Canada*, vol. 1, pp. 279-467.

HATTORI, M. (1967) : Recent sediments of Sendai Bay, Miyagi Prefecture, Japan. *Sci. Rept. Tohoku Univ., 2nd Ser. (Geol.)*, vol. 39, no. 1, pp. 1-61.

MARTINI, E. (1960) : Braarudosphaeriden, Discoasteriden und verwandte Formen aus dem Rupelton des Mainzer Beckens. *Notizbl. hess. L.-Amt Bodenforsch.*, vol. 88, pp. 65-87, pls. 8-11.

—— (1961) : Ein Kalkflagellat in den Meeren der Gegenwart und Vorzeit. *Natur u. Volk*, vol. 91, no. 9, pp. 335-339.

—— (1967) : Nannoplankton und Umlagerungserscheinungen im Persischen Golf und im nördlichen ArabischenM eer. *Neus Jahrb. Geol. Paläont. Monatsh.*, vol. 10, pp. 597-607.

MAXWELL, A.E., HERZEN, R.P. von, HSÜ, K.J., ANDREWS, J.E., SAITO, T., PERCIVAL, S.F., MILOW, E.D., Jr. & BOYCE, R.E. (1970) : Deep sea drilling in the South Atlantic. *Science*, vol. 168, no. 3935, pp. 1047-1059.

PHLEGER, F.B. (1951) : Ecology of Foraminifera, northwest Gulf of Mexico, Pt. I., Foraminifera distribution. *Geol. Soc. Amer., Mem.*, 46, pp. 1-88, pls. 1, 2.

—— (1960) : Ecology and distribution of Recent Foraminifera. *The John Hopkins Press, Baltimore*, viii+297p, pls. 1-11.

STRADNER, H. (1960) : Über Nannoplankton-Invasionen im Sarmat des Wiener Beckens. *Erdoelzeitschr.* vol. 76, no. 12, pp. 430-432.

—— & PAPP, A. (1961) : Tertiäre Discoasteriden aus Österreich und deren stratigraphische Bedeutung mit Hinweisen auf Mexico, Rumänien und Italien. *Jahrb. Geol. Bundesanst.* [*Wien*], *Sonderband*, vol. 7, pp. 1-159, pls. 1-42.

Abukuma	阿武隈	Nanakita	七北田
Ishinomaki	石巻	Naruse	鳴瀬
Kitakami	北上	Natori	名取
Matsushima	松島	Ojika	牡鹿
Miyagi	宮城	Sendai	仙台
Miyagino	宮城野	Soma	相馬

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 87, pp. 436-445, pls. 52, 53, September 30, 1972

606. FUSULINIDS OF THE *PROFUSULINELLA* ZONE OF THE TAISHAKU LIMESTONE (STUDIES OF THE STRATIGRAPHY AND THE MICROFOSSIL FAUNAS OF THE CARBONIFEROUS AND PERMIAN TAISHAKU LIMESTONE IN WEST JAPAN, NO. 2)[*]

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帝釈石灰岩の *Profusulinella* 帯の紡錘虫（石炭・二畳紀帝釈石灰岩の層序と微化石動物群についての研究, No. 2)：筆者は帝釈石灰岩の *Profusulinella* 帯（佐田, 1967）についての研究から 2 種の *Profusulinella* と 4 種の共存種を識別したので，ここに記載・報告する。記載された種は *Profusulinella fusiformis* Sada, sp. nov., *P. toriyamai* Sada, *Millerella* sp. B, *Pseudostaffella taishakuensis* Sada, sp. nov., *Nankinella yokoyamai* Sada, sp. nov., *Staffella akagoensis* Toriyama である。これらの紡錘虫によって特徴づけられる帝釈石灰岩の *Profusulinella* 帯は，阿哲石灰岩の *Profusulinella toriyamai* 帯（佐田, 1961, 1964, 1965）; 秋吉石灰岩の *Profusulinella beppensis* 帯（鳥山, 1954, 1958), 福地の *Profusulinella fukujiensis* 帯（猪郷, 1957）に対比され，さらに，北米の Early Atokan の *Profusulinella* 化石動物群に比較される。 佐田公好

Introduction

Having a very short stratigraphic range, the genus *Profusulinella* Rauser-Chernoussova and Beljaev is regarded as being one of the best index fossils in the lower part of the Middle Pennsylvanian. The *Profusulinella* zones in Japan have been reported from several areas since the first discovery of this zone (Toriyama, 1954) in the Akiyoshi Limestone in Yamaguchi Prefecture but the *Profusulinella* zones whose zone fossils had been described and illustrated are very few. As far as our knowledge goes, they are only three zones, that is to say, the *Profusulinella beppensis* zone (Toriyama, 1958) of the Akiyoshi Limestone, the *Profusulinella fukujiensis* zone (Igo, 1957) of the Ichinotani formation in Gifu Prefecture and *Profusulinella toriyamai* zone (Sada, 1961) of the Atetsu Limestone in Okayama Prefecture. And these zones are mostly characterized by such genera as *Profusulinella*, *Pseudostaffella*, *Millerella*, *Nankinella*, *Staffella*, *Eoschubertella* and *Akiyoshiella*, all rather primitive genera except for the last one. Recently, the Atetsuan was proposed by Toriyama (1967) for the time stratigraphic unit equivalent to the zone of *Profusulinella* in Japan based on the *Profusulinella toriyamai* zone in the middle part of the Kodani formation of the Atetsu Limestone (Sada, 1961).

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[*] Received May 17, 1972; read Jan. 21, 1967 at Tokyo.

The Carboniferous and Permian Taishaku Limestone about 30 km to the west of the Atetsu Limestone, having been studied by me since 1965, comprizes in its lower part the *Profusulinella* zone designated in my preceding paper (1967). The *Profusulinella* zone in this area, as I described before, conformably overlies the Lower Pennsylvanian *Millerella* zone and also is covered by the *Fusulinella* zone, while the species identified from the zone are *Profusulinella toriyamai* SADA, *P. fusiformis* SADA, sp. nov., *Millerella* sp. B, *Pseudostaffella taishakuensis* SADA, sp. nov., *Nankinella yokoyamai* SADA, sp. nov. and *Staffella akagoensis* TORIYAMA. The present fauna consisting of them closely resembles in specific or generic composition the *Profusulinella toriyamai* fauna of the Atetsu Limestone. For example, *Profusulinella toriyamai* SADA is a representative species in both *Profusulinella* faunas of the Taishaku and the Atetsu Limestone. *Pseudostaffella taishakuensis* SADA, sp. nov. is similar to *P. kanumai* IGO from the Ichinotani formation and the Atetsu Limestone in some respects and they are almost of the same stage in the evolutional development of the shell. Accordingly, the paleontological similarities between these two faunas indicate that the *Profusulinella* fauna of the Taishaku Limestone is, to be sure, of the Atetsuan age. And also the present fauna may be considered to be of the equivalent age to the *Profusulinella* faunas in the lower part of the Middle Pennsylvanian in North America. In this paper are given six species of fusulinids cited above from the *Profusulinella* zone of the Taishaku Limestone.

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Systematic Paleontology

Family Ozawainellidae THOMPSON & FOSTER, 1937

Genus *Millerella* THOMPSON, 1942

Type species.—*Millerella marblensis* THOMPSON, 1942.

Millerella sp. B

Pl. 53, figs. 13–14

Descriptive remarks.—The present specimens are poorly preserved but the shell shape and some internal characters suggest that the present forms are ascribable to genus *Millerella*. The shell of the present species is small and discoidal in shape. The periphery of the outer volution is broadly rounded to subangular and the shell has a short axis of coiling, possessing the umbilicate poles. The specimen illustrated as fig. 14 on Pl. 53 is 188μ long and 566μ wide. Its form ratio is 0.3.

The present species resembles somewhat *Millerella* ? sp. A (SADA, 1969, p. 120, pl. 12, figs. 20–21) from the Chesterian *Eostaffella* zone of the lower part of the Taishaku Limestone. The former species, however, can be distinguished from the latter one in having a longer axis of coiling, a larger form ratio and an incomplete evolute form in the outer volutions.

Table 1. Measurements of *Millerella* sp. B.

Specimen	A12801D2e	A12801D10g
Pl. fig.	53–13	53–14
Length	0. 226	0. 188
Width	0. 660	0. 566
Form ratio	0. 3	0. 3

(Measurements in mm)

Occurrence.—Rare in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Profusulinella toriyamai* SADA, *P. fusiformis* SADA, sp. nov., *Pseudostaffella taishakuensis* SADA, sp. nov., *Nankinella yokoyamai* SADA, sp. nov. and *Staffella akagoensis* TORIYAMA. Type locality is Loc. No. A12801D.

Family Fusulinidae VON MÖLLER, 1878

Subfamily Fusulininae VON MÖLLER, 1878

Genus *Profusulinella* RAUSER-CHERNOUSSOVA and BELJAEV, 1936

Type species.—*Profusulinella aljutovica* RAUSER-CHERNOUSSOVA, 1938.

Profusulinella toriyamai SADA

Pl. 52, figs. 1-4

1958. *Profusulinella* sp. A, TORIYAMA. *Mem. Fac. Sci. Kyushu Univ., Ser. D, Geol.*, vol. 7, pp. 35-36, pl. 1, figs. 20-21.
1961. *Profusulinella toriyamai* SADA. *Jour. Sci. Hiroshima Univ., Ser. C,* vol. 4, no. 1, pp. 97-99, pl. 9, figs. 1-13.

Description.—The shell is small and ellipsoidal in shape. The mature specimen of five volutions illustrated as fig. 1 on Pl. 52 is 1151μ long and 944μ wide, having a form ratio of 1.2. The lateral slopes are straight to convex. The ratios of the half length to the radius vector of the 1st to the 5th volution are 1.0, 0.8, 1.5, 1.4 and 1.2, respectively.

The proloculus is minute and its outside diameter is 37μ. The expansion of the shell is slow. The radius vectors of the 1st to the 5th volution in a specimen are 56, 113, 188, 302 and 510μ, respectively. The spirotheca is thin and consists of a tectum and inner and outer tectoria in all volutions. The thickness of the spirotheca of the 1st to the 5th volution at the central part of the shell is 23, 23, 23, 39 and 50 μ, respectively. The septa are unfluted throughout the length of the shell. The tunnel is low and broad. The chomata are massive in the outer volutions.

Remarks.—In the shell shape, the internal character and the measured values, the present species agrees closely with *Profusulinella toriyamai* SADA (1961, pp. 97-99, pl. 9, figs. 1-13) from the Atetsu Limestone in Okayama Prefecture, West

Table 2. Measurements of *Profusulinella toriyamai* SADA
Specimen A12801D2a: Pl. 52, fig. 1.

Length	Width	Form ratio	Prol.
1.151	0.944	1.2	0.037

Radius vector Vol.		Ratio of Hl. to Rv. Vol.		Thickness of spirotheca Vol.	
				0	0.009
1	0.056	1	1.0	1	0.023
2	0.113	2	0.8	2	0.023
3	0.188	3	1.5	3	0.023
4	0.302	4	1.4	4	0.039
5	0.510	5	1.2	5	0.050

(Measurements in mm)

Japan.

Occurrence.—Abundant in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Millerella* sp. B, *Profusulinella fusiformis* SADA, sp. nov., *Pseudostaffella taishakuensis* SADA, sp. nov., *Nankinella yokoyamai* SADA, sp. nov. and *Staffella akagoensis* TORIYAMA. Type locality is Loc. No. A12801D.

Profusulinella fusiformis SADA, sp. nov.

Pl. 52, figs. 5-12

Description.—The shell is small and fusiform in shape, having a straight axis of coiling and bluntly pointed poles. The lateral slopes are slightly concave. The holotype of four volutions (Rg. No. A12801D13b) illustrated as fig. 8 on Pl. 52 is 1227μ long and 528μ wide, giving a form ratio of 2.3. The fully grown specimen of five volutions (Rg. No. A12801D13a) (Pl. 52, fig. 5) is 1567μ long and 755μ wide and its form ratio is 2.1. The inner two volutions are tightly coiled and spherical to ellipsoidal, and beyond the 3rd volution the shell attains its mature shape. The ratios of the half length to the radius vector in the 1st to the 5th volution of four specimens are 1.0-1.7, 1.0-3.0, 1.6-2.9, 1.9-2.2 and 2.3, respectively.

The proloculus is small. The outside diameter of the holotype is 75μ. The radius vectors of the 1st to the 5th

Table 3. Measurements of *Profusulinella fusiformis* SADA, sp. nov.

Specimen		A12801D13a	A12801D14b	A12801D13b	A12801D8d
Pl. fig.		52-5	52-6	52-8	52-10
Length		1.567	1.511	1.227	1.038
Width		0.755	0.736	0.528	0.547
Form ratio		2.1	2.0	2·3	1.9
Prol.		0.037	0.056	0.075	0.056
	Vol.				
Radius vector	1	0.056	0.056	0.056	0.075
	2	0.094	0.094	0.094	0.113
	3	0.151	0.188	0.151	0.188
	4	0.264	0.321	0.283	0.302
	5	0.377			
Ratio of Hl. to Rv.	1	1.7	1.7	1.7	1.0
	2	2.0	2.4	3.0	1.0
	3	2.4	2.6	2.9	1.6
	4	2.2	2.2	2.1	1.9
	5	2.3			
Thickness of spirotheca	0	0.013	0.011	0.018	0.016
	1	0.016	0.021	0.011	0.025
	2	0.016	0.021	0.009	0.016
	3	0.023	0.018	0.018	0.021
	4	0.025	0.032	0.027	0.011
	5	0.039			

(Measurements in mm)

volution of four specimens are 56-75, 94-113, 151-188, 264-321 and 377μ, respectively. The spirotheca is thin and composed of a tectum and inner and outer tectoria. The spirothecal thickness of the 1st to the 5th volution of four specimens is 11-25, 9-21, 18-23, 11-32 and 39μ, respectively. The septa are almost plane and closely spaced. The septal counts of the 1st to the 6th volution of a specimen illustrated as fig. 12 on Pl. 52 are 5, 11, 13, 15, 15 and 20, respectively. The chomata are well developed and massive in the outer volutions. The tunnel path is almost straight. The tunnel angle of the 3rd volution of the holotype is 32°.

Remarks.—In the shell size, the shell shape, the number of volutions, the rate of expansion, the spirothecal structure, and the mould of chomata, *Profusulinella fusiformis* SADA, sp. nov. is closely allied to *Profusulinella* sp. B described by SADA (1961, pp. 105-107, pl. 10, figs. 4-8) from the *Profusulinella* zone in the middle part of the Kodani formation of the Atetsu Limestone. The striking similarities between these two species indicate that they are indubitably conspecific each other. The present species differs from *Profusulinella toriyamai* SADA (1961, pp. 97-99, pl. 9, figs. 1-13 and figs. 1-4 on Pl. 52 in this paper) from the Atetsu Limestone and the Taishaku Limestone in that the former species is fusiform in the shell shape and has the larger form ratio and the slower expansion of the shell. *Profusulinella fusiformis* SADA, sp. nov. somewhat resembles *P. beppensis* TORIYAMA (1958, pp. 31-33, pl. 2, figs. 1-6) from the Akiyoshi Limestone. However, *P. fusiformis* can be easily distinguished from *P. beppensis* by its shape of the shell, its longer axis of coiling, its slower expansion, its larger form ratio and its larger proloculus.

Occurrence.—Commonly found in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Millerella* sp. B, *Profusulinella toriyamai* SADA, *Pseudostaffella taishakuensis* SADA, sp. nov., *Nankinella yokoyamai* SADA, sp. nov. and *Staffella akagoensis* TORIYAMA. Type locality is Loc. No. A12801D.

Genus *Pseudostaffella* THOMPSON, 1942

Type species.—*Pseudostaffella needhami* THOMPSON, 1942.

Pseudostaffella taishakuensis SADA, sp. nov.

Pl. 52, figs. 13-21; Pl. 53, fig. 12

Description.—The shell of the present species is small and spherical to subspherical in shape. The specimens of five volutions are 679 to 830μ in length and 660μ in width, giving the form ratio of 1.0 to 1.3. The shells of four volutions are 528 to 660μ long and 528 to 622μ wide, having form ratio of 0.9 to 1.3. The inner one to two volutions are tightly coiled and they show commonly endothyroid coiling.

The outside diameter of the proloculus is 75μ in the illustrated specimens. The radius vectors of the 1st to the 5th volution of four specimens are 75, 94-132, 170-188, 207-321 and 358-396μ, respectively. The spirotheca is thin and consists of a tectum and inner and outer tectoria. The thickness of the spirotheca of the 1st to the 5th volution is 16-27, 16-23, 13-27, 23-29 and 25-34μ, respectively. The chomata are well developed and massive and asymmetrical in the outer volutions.

Remarks.—*Pseudostaffella taishakuensis* SADA, sp. nov. is somewhat similar to

Table 4. Measurements of *Pseudostaffella taishakuensis* SADA, sp. nov.

Specimen		A12801D5b	A12801D10c	A12801D7c	A12801D4d
Pl. fig.		52-13	53-12	52-21	52-20
Length		0. 660	0. 528	0. 830	0. 679
Width		0. 528	0. 622	0. 660	0. 660
Form ratia		1. 3	0. 9	1. 3	1. 0
Prol.		0. 075	0. 075	0. 075	——
	Vol.				
Radius vector	1	0. 075	0. 075	——	——
	2	0. 113	0. 132	0. 094	0. 094
	3	0. 170	0. 188	0. 188	0. 188
	4	0. 207	0. 321	0. 283	0. 245
	5			0. 396	0. 358
Thickness of spirotheca	0	0. 034	0. 013	——	——
	1	0. 027	0. 016	0. 018	0. 023
	2	0. 021	0. 016	0. 021	0. 023
	3	0. 021	0. 013	0. 016	0. 027
	4	0. 025	0. 029	0. 025	0. 023
	5			0. 025	0. 034

(Measurements in mm)

Pseudostaffella kanumai IGO (1957, pp. 194-196, pl. 4, fig. 26, pl. 5, figs. 1-5) and *P. kanumai pauciseptata* IGO (1957, pp. 196-197, pl. 5, figs. 6-8) from the Ichinotani formation in the Fukuji area, Gifu Prefecture, Central Japan. The former, however, can be distinguished from the latter two by its smaller shell, rather larger form ratio and larger proloculus. *Pseudostaffella taishakuensis*, sp. nov. can be recognized from *P. rotunda* DOUGLASS (1971, pp. 6-9, pl. 2, figs. 4-21), which was described from Peratovich Island near Prince of Wales Island, Southeastern Alaska, by its smaller size of the shell, the smaller chomata and the narrower tunnel angles. *Pseudostaffella taishakuensis*, sp. nov. differs from *P. sandersoni* THOMPSON (1965, p. 227, pl. 33, figs. 10-18) from British Columbia in having a larger shell and thicker spirotheca.

Occurrence.—Common in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Millerella* sp. B, *Profusulinella toriyamai* SADA, *P. fusiformis* SADA, sp. nov., *Nankinella yokoyamai* SADA, sp. nov., *Staffella akagoensis* TORIYAMA. The type locality is Loc. No. A12801D.

Family Staffellidae MIKLUKHO-MAKLAY, 1949

Genus *Nankinella* LEE, 1931

Type species.—*Staffella discoides* LEE, 1931.

Nankinella yokoyamai SADA, sp. nov.

Pl. 52, fig. 22; Pl. 53, figs. 1-2, 4-11

Description.—The shell of *Nankinella yokoyamai* SADA, sp. nov. is discoidal and planispiral throughout growth and has umbilicate to partial umbilicate poles and angular periphery in general. The axial length and median width of the

Table 5. Measurements of *Nankinella yokoyamai* SADA, sp. nov.

Specimen		A53112704	A12801D4c	A12801D6c	A12801D6d	A12801D15b	A12801D14c
Pl. fig.		53-1	53-9	53-10	53-11	53-4	53-6
Length		0. 453	0. 377	0. 415	0. 245	0. 510	0. 340
Width		1. 473	0. 849	0. 849	0. 698	1. 208	1. 085
Form ratio		0. 3	0. 4	0. 5	0. 4	0. 4	0. 3
Prol.		0. 075	0. 056	0. 075	0. 075	0. 037	0. 056
	Vol.						
Radius vector	1	0. 075	0. 075	0. 075	0. 056	0. 094	0. 056
	2	0. 132	0. 132	0. 132	0. 113	0. 188	0. 113
	3	0. 207	0. 188	0. 188	0. 170	0. 283	0. 188
	4	0. 283	0. 283	0. 321	0. 264	0. 415	0. 283
	5	0. 396	0. 472	0. 472	0. 396	0. 566	0. 415
	6	0. 566					0. 603
	7	0. 755					
Thickness of spirotheca	0	0. 025	0. 034	0. 011	0. 018	0. 011	0. 018
	1	——	0. 018	0. 011	0. 025	0. 032	0. 018
	2	——	0. 018	0. 013	0. 018	0. 023	0. 013
	3	——	0. 018	0. 011	0. 023	0. 023	0. 021
	4	0. 013	0. 025	0. 016	0. 023	0. 021	0. 021
	5	0. 025	0. 023	0. 023	0. 021	0. 025	0. 023
	6	0. 046					0. 029
	7	0. 023					

(Measurements in mm)

Explanation of Plate 52

Figs. 1-4. *Profusulinella toriyamai* SADA
1-2. Axial sections: Rg. No. A12801D2a (x22) and A12801D10a (x22), respectively.
3-4. Sagittal sections: Rg. No. A12801D6a (x22) and A12801D8f (x22), respectively.
Figs. 5-12. *Profusulinella fusiformis* SADA, sp. nov.
8. Axial section of the holotype: Rg. No. A12801D13b (x22).
9. Enlarged figure of Fig. 8 (x50).
5-6, 10-11. Axial sections of paratypes: Rg. No. A12801D13a (x22), A12801D14b (x22), A12801D8d (x22) and A12801D2b (x22), respectively.
7, 12. Sagittal sections of paratypes: Rg. No. A12801D8c (x22) and A12801D10a (x22), respectively.
Figs. 13-21. *Pseudostaffella taishakuensis* SADA, sp. nov.
20. Axial section of the holotype: Rg. No. A12801D4d (x63).
13-17, 21. Axial sections of paratypes: Rg. No. A12801D5b (x63), A12801D1a (x63), A12801D4b (x63), A12801D1b (x63), A12801D4e (x63) and A12801D7c (x63), respectively.
18-19. Sagittal sections of paratypes: Rg. No. A12801D9c (x63) and A12801D5a (x63).
Fig. 22. *Nankinella yokoyamai* SADA, sp. nov.
22. Sagittal section of a paratype: Rg. No. A12801D6b (x63).

holotype of the species (A53112704) illustrated as fig. 1 on Pl. 53, are 453 and 1473μ, respectively. Its form ratio is 0.3. The specimens of five to six volutions are 245 to 510μ long and 698 to 1208μ wide. Their form ratios range from 0.3 to 0.5.

The proloculus has the outside diameter of 37 to 75μ in six specimens. The radius vectors of the 1st to the 7th volution are 56-94, 113-188, 170-283, 264-415, 396-566, 566-603 and 755μ, respectively. The spirotheca is partly replaced by the secondary mineralization and it seems to be composed of three layers in the inner volutions and four layers consisting of a tectum, diaphanotheca and inner and outer tectoria in the outer two volutions. The septa are unfluted and extend forward slightly. The septal counts of the specimen illustrated as fig. 7 on Pl. 53 are 7, 9, 11 and 15, respectively, for the 1st to the 4th volution. The chomata are low. The tunnel angles of the 3rd to 5th volutions of the holotype are 14, 14 and 12 degrees, respectively.

Remarks.—*Nankinella yokoyamai* SADA, sp. nov. resembles in some respects *Nankinella plummeri* THOMPSON (1947, pp. 155-157, pl. 32, figs. 11-16, pl. 33, figs. 10-11) from the Pennsylvanian rocks of the Llano Uplift in Texas. However, the mature form of the former species has a longer axis of coiling, generally larger proloculus and fairly thicker spirotheca. *Nankinella yokoyamai* SADA, sp. nov. is similar to *Nankinella* sp. A by KOCHANSKY-DEVIDÉ (1965, p. 118, pl. 2, figs. 14-18). The former species, however, can be distinguished from the latter one by the larger shell, the larger proloculus and the umbilicate form of the former species. The species name is dedicated to Dr. Tsuruo YOKOYAMA who formerly carried on the study of the stratigraphy of the Taishaku Limestone.

Occurrence.—Commonly found in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Millerella* sp. B, *Profusulinella toriyamai* SADA, *P. fusiformis* SADA, sp. nov., and *Staffella akagoensis* TORIYAMA. The type locality is Loc. No. A12801D.

Genus *Staffella* OZAWA, 1925

Type species.—*Staffella sphaerica* VON MÖLLER, 1878.

Staffella akagoensis TORIYAMA

Pl. 53, fig. 3

1958. *Staffella akagoensis* TORIYAMA. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, vol. 7, pp. 22-24, pl. 1, figs. 6-8.

Description.—The shell of *Staffella akagoensis* TORIYAMA is small, subspherical and planispiral, having a broadly rounded periphery. The specimen of six volution (Pl. 53, fig. 3) is 566μ long and 1000μ wide, possessing a form ratio of 0.5.

The proloculus is small and its outside diameter is 56μ. The radius vectors of the 1st to the 6th volution of a specimen are 56, 94, 188, 283, 377 and 528μ, respectively. The spirotheca is thin and seems to consist of four layers such as a tectum, a lighter layer seemingly like a diaphanotheca and inner and outer tectoria. The thickness of the spirotheca of the outer three volutions of a specimen is 18 to 25μ. The chomata are low and asymmetrical.

Remarks.—The present species resembles closely *Staffella akagoensis* TORIYAMA (TORIYAMA, 1958) from the *Profusulinella* zone of the Akiyoshi Limestone in all respects except for the length of the shell and the form ratio. The pre-

Table 6. Measurements of *Staffella akagoensis* TORIYAMA.
Specimen A53112704Jb: Pl. 53, fig. 3.

Length	Width	Form ratio	Prol.
0. 566	1. 000	0. 5	0. 056

Radius vector Vol.		Thickness of spirotheca Vol.	
1	0. 056	0	——
2	0. 094	1	——
3	0. 188	2	——
4	0. 283	3	——
5	0. 377	4	0. 018
6	0. 528	5	0. 018
		6	0. 025

(Measurements in mm)

sent form has the slightly shorter length of the shell and the smaller form ratio. However, it seems that such a difference between these two forms falls within the specific variation of *Staffella akagoensis* TORIYAMA.

Occurrence.—Abundant in the *Profusulinella* zone of the Taishaku Limestone. Associated fusulinids are *Millerella* sp. B, *Profusulinella toriyamai* SADA, *P. fusiformis* SADA, sp. nov., *Pseudostaffella taishakuensis* SADA, sp. nov. and *Nankinella yokoyamai* SADA, sp. nov. Type locality is Loc. No. A12801D.

References

[See also the references cited in the preceding papers by SADA (1967, 1969 and 1970)]

DOUGLASS, R.C. (1971): Pennsylvanian Fusulinids from Southeastern Alaska. *Geol. Surv. Prof. Paper* 706, pp. 1-20, pls. 1-7.

KOCHANSKY-DEVIDÉ, V. (1965): Die Fusuliniden Foraminiferen aus dem Karbon und Perm im Velebit und in der Lika (Kroatien) Mittleres und Oberes Perm. *Jugoslavenska Akademija znanosti i Umjetnosti Odjel za Prirodne Nauke, Acta geologica v*, str. pp. 101-150, pls. 1-13.

SADA, K. (1961): *Profusulinella* of Atetsu Limestone. *Jour. Sci. Hiroshima Univ., Ser. C*, vol. 4, no. 1, pp. 95-116, pls. 9-10.

—— (1964): Carboniferous and Lower Permian Fusulines of the Atetsu Limestone in West. Japan. *Ibid.*, vol. 4, no. 3, pp. 225-269, pls. 21-28.

—— (1965): Carboniferous and Permian Stratigraphy of the Atetsu Limestone in West Japan. *Ibid.*, vol. 5, no. 1, pp. 21-80.

—— (1967): Fusulinids of the *Millerella* Zone of the Taishaku Limestone (Studies of the Stratigraphy and the Microfossil Faunas of the Carboniferous and Permian Taishaku Limestone in West Japan, No. 1). *Trans. Proc. Palaeont. Soc. Japan, N.S.* no. 67, pp. 139-147, pls. 12-13.

—— (1969): Microfossils of the Lowest Part

Explanation of Plate 53

Figs. 1-2, 4-11. *Nankinella yokoyamai* SADA, sp. nov.
1. Axial section of the holotype: Rg. No. A53112704 (x55).
2, 4-6, 9-11. Axial sections of paratypes: Rg. No. A12801D7a (x60), A12801D15b (x60), A12801D13c (x60), A12801D14c (x60), A12801D4c (x65), A12801D6c (x60) and A12801D6d (x60), respectively.
7-8. Sagittal sections of paratypes: Rg. No. A53112704Ja (x60) and A12801D8a (x60), respectively.

Fig. 3. *Staffera akagoensis* TORIYAMA
3. Axial section: Reg. No. A53112704Jb (x60).

Fig. 12. *Pseudostaffella taishakuensis* SADA, sp. nov.
12. Axial section of a paratype: Rg. No. A12801D10c (x60).

Figs. 13-14. *Millerella* sp. B
13-14. Axial sections: Rg. No. A12801D2e (x91) and A12801D10g (x100).


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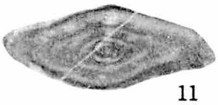
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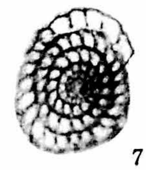
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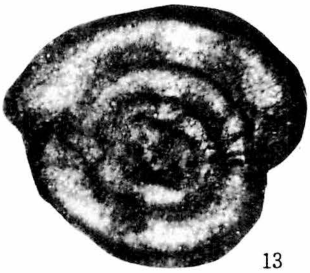
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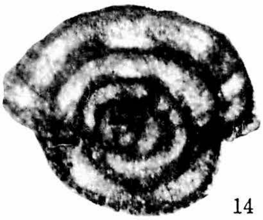
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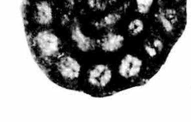
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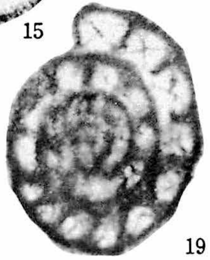
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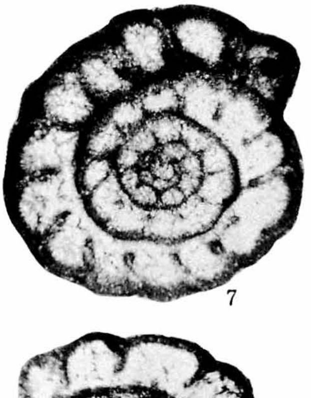
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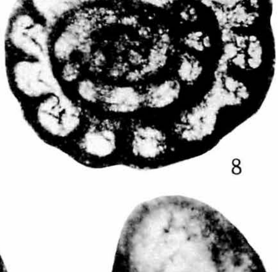
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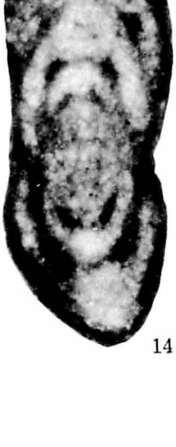
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of the Taishaku Limestone (Ditto, No. 4). *Ibid.*, no. 75, pp. 119-129, pls. 12-13.

—— & Yokoyama, T. (1970): Fusulinids of *Fusulinella* Zone of the Taishaku Limestone (Ditto, No. 3). *Mem. Fac. General Educ. Hiroshima Univ. III*, vol. 4, pp. 45-54, pl. 1.

Thompson, M.L. (1947): Stratigraphy and Fusulinids of Pre-Desmoinesian Pennsylvanian Rocks, Llano Uplift, Texas. *Jour. Paleont.*, vol. 21, no. 2, pp. 147-164, pls. 31-33.

—— (1965): Pennsylvanian and Early Permian Fusulinids from Fort St. James Area, British Columbia, Canada. *Ibid.*, vol. 39, no. 2, pp. 224-234, pls. 33-35.

Toriyama, R. (1954): Geology of Akiyoshi. Pt. 1. Study of the Akiyoshi Limestone Group. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, vol. 4, no. 1, pp. 40-97.

—— (1967): The Fusulinacean Zones of Japan. *Ibid.*, vol. 18, no. 1, pp. 35-260.

Akiyoshi Limestone	秋吉石灰岩	Ichinotani	一ノ谷
Atetsu Limestone	阿哲石灰岩	Kodani	小谷
Fukuji	福地	Taishaku Limestone	帝釈石灰岩

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第109回例会は，1972年6月3日宇都宮大学教養部において開催された。(参加者70名) また翌6月4日には，栃木県益子町，茨城県岩瀬町周辺の巡検が行われた。(案内者 鈴木陽雄)

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掛川層群の微化石層位学的研究 ……..加藤道雄

掛川貝化石群とその変遷—*Suchium giganteum* について……………………土 隆一

台湾北部産 *Amussiopecten* と共産する貝類化石群について……………菅野三郎・張 麗旭

瀬又上層の *Pecten tokyoensis* 殼表面に認められるイワフジツボ (*Chthamalus challengeri*) について……………………福田芳生

Chlamys cosibensis (YOKOYAMA) of Northern Pacific ……………..MASUDA, K.

A fossil worm trail from the Upper Cretaceous Nakaminato Formation, Ibaraki Prefecture……..HATAI, K. & NODA, H.

Scaphopoda-like fossils from the Udo Formation (Miocene) of Miyazaki Prefecture, Japan ……………………… HATAI, K., NODA, H. & OGASAHARA, K.

Some fossil Pteropoda from Miyazaki and Okinawa Prefectures, Japan….NODA, H.

ドレッジ・サンプルおよび打上げ標本からみたタマキガイ属2枚貝のサイズ構成，補食者…………………………………松隈明彦

アカフジツボとオオアカフジツボの種間関係 ………………………………山口寿之

長野県中新統産甲殼十脚目異尾類 Eumunida. (中間報告)……………………今泉力蔵

カニ類化石の甲殻の微細構造 (中間報告)…………………………………今泉力蔵

下関植物化石群 ……….藤岡一男・高橋英太郎

The Tertiary floras of Korea ..HUZIOKA, K.

秋田県宮田化石植物群・秋田県三途川化石植物群…………………藤岡一男・植村和彦

Ctenis species from the Itoshiro Sub-group, the Tetori Group, Central Honshu, Japan. ……………..KIMURA, T. & SEKIDO, S.

New ferns from the Japanese Mesozoic, Part 2……………………KIMURA, T.

Some bellerophontids from the Permo-Trias of Kashmir……………..MURATA, M.

Permian fusulines from Wat Kirinakratanarum, Central Thailand….TORIYAMA, R., KANMERA, K. & PITAKPAIVAN, K.

Lower Carboniferous Visean faunas discovered from Mitsusawa, southeastern part of the Kwanto massif, Japan, Part 1. Gastropoda ……………SAKAGAMI, S.

四国佐川盆地山姥石灰岩産の二畳紀腕足類 …………………………………柳田寿一

秋吉石灰岩層群最下部層より産出した腕足類 *Marginatia* 属………………柳田寿一

Upper Triassic ammonites from Okinawa, Part 3…………………ISHIBASHI, T.

A new gaudryceratine ammonite from the Cenomanian of Hokkaido….MATSUMOTO, T., MURAMOTO, T. & TAKAHASHI, T.

九州山部層産アンモナイトとその地質時代 (代読) ………………………………野田雅之

Spongosaturnalids (Radiolaria) の走査電子顕微鏡による2,3の知見..市川浩一郎・八尾 昭

沖縄本島南部2,3の鹿化石の産状について …………………………………野原朝秀

例会通知

	開催地	開催日	講演申込締切日
110回例会	愛媛大学	1972年10月28·29日	1972年9月20日
1973年総会·年会	東北大学	1973年1月16·17日	1972年11月20日*
111回例会	新潟大学	1973年6月23·24日（予定）	1973年4月20日*

* **申込締切日**は，プログラム印刷の都合で今後とも開催の**約2ケ月前**にいたします。御諒承下さい。

○ 第110回例会・野外巡検（10月29日）―中央構造線，久万層群，二名層など―（案内者 永井浩三）

学会記事

◎ 1972年6月よりの入会者（1972年6月2日の評議員会で承認）は普通会員8名 在外会員1名（順不同，敬称略）。上西敏郎，金杉洋美，西脇二一，伊藤 真，西川廉行，岡村 真，松永二三郎，佐藤二郎，尹　銑。

◎ 1972年6月2日の評議員会において，次の諸君の退会が認められた（敬称略）。岩佐三郎，宇野博子，尾又利一，紿野義夫，鈴木たけお，春城清之助，満岡 孝。

◎ 1972年5月現在登録会員は合計473名。

◎ 前記評議員会において古生物学研究連絡委員会委員の候補が選出された（順不同，敬称略）。浅野 清（学術会議），大森昌衛（学術会議），波部忠重（動物学会），前川文夫（植物学会），松本達郎，鹿間時夫，花井哲郎，小高民夫，高柳洋吉，鎮西清高，浜田隆士，高井冬二，市川浩一郎。

◎ 前記評議員会において科研費配分委員会委員の候補が次のように選出された。高柳洋吉，首藤次男，佐藤 正（次点 氏家 宏）。

NEWS

◎ 1972年8月11日に第9期古生物学研究連絡委員会の第1回会合が開かれ，委員長に浅野 清，幹事に大森昌衛，小高民夫，花井哲郎，浜田隆士，松本達郎の5君が選出された。

◎ 上記連絡委員会において，次のように各種委員が選出された（順不同，敬称略）。地球化学・宇宙化学連合小委員会（小西健二），国際地球観測特別委員会（奈須紀幸），太平洋学術研究連絡委員会（松本達郎），動物学名小委員会（鹿間時夫，小畠郁生，浜田隆士），地質学地理学輯報編集委員会（木村敏雄，市川浩一郎，浜田隆士，首藤次男，棚井敏雅），古生物学研究所小委員会（鹿間時夫，小西健二，鳥山隆三，橋本 亘，花井哲郎，氏家 宏，前川文夫，大森昌衛，高柳洋吉）。

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CONTENTS

TRANSACTIONS