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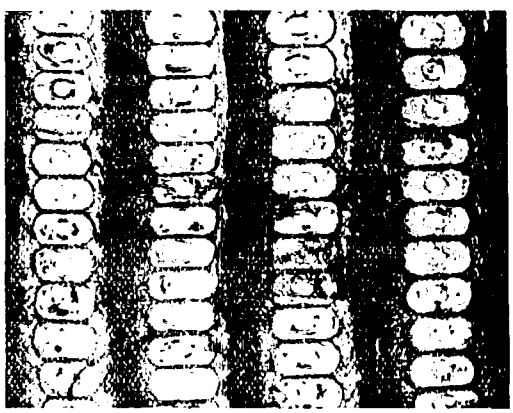

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CONTENTS

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401. PROBLEMATICAL MARKINGS ON THE UNDER-SURFACE OF A MIOCENE TUFFACEOUS SILTSTONE, YAMAGATA PREFECTURE, JAPAN*

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山形県中新統中の一生痕：中新世の地層下面に見出された markings を記載し，現生「にっぽんよこえび」の作る markings と比較し，該層の堆積環境を考察した。

畑井小虎・小高民夫

Introduction and Acknowledgements

It is well known to all who have studied the under-surface of sedimentary rocks that various kinds of problematical markings are generally well preserved there. These problematical markings range from minute to rather large sizes and show a wide variety of shapes, but usually are more or less horizontal in orientation parallel with the bedding plane of the strata in which they are preserved. Such markings have received various names as hieroglyphs, fucoids and others and have been ascribed to a wide variety of organisms and less commonly to physical origin.

Very fortunately the senior writer in cooperation with Dr. Yushi FUNAYAMA of the Tohoku University succeeded in obtaining some peculiar problematical markings from the under-surface of a siltstone exposed along the Sagae River below Mizusawa, Mazawa-machi, Nishi-Murayama-gun, in the western part of the Yamagata Basin, Yamagata Prefecture. This problematical marking is described in this article and compared with interesting markings found in the tidal zone of Nobiru beach, Mono-gun, Miyagi Prefecture, because they are similar to one another.

Here the writers thank Dr. Yushi FUNAYAMA of the Department of Geology, Faculty of Education of the Tohoku University for his guidance in the field and help in collecting the problematical markings. Particular thanks are due to Professor Isao MOTOMURA of the Institute of Biology of the Tohoku University for his kind information and suggestions on the markings in the tidal zone of Nobiru beach above mentioned. Thanks are also due to Messrs. Minoru SAITO of the Kagawa University and Hiroshi NODA of the Tohoku University for their cooperation in observations along the beach at Nobiru.

Description of the Fossil Sample

The fossil sample was found on the under-surface of a marine tuffaceous siltstone of Miocene age exposed on the right bank of the Sagae River below Mizusawa in the western part of Mazawa-machi, Nishi-Murayama-gun, Yamagata Prefecture. The markings are well preserved except for their slight deforma-

* Received Oct. 1, 1960; read at 76th meeting of the society at Matsue, Sept. 24, 1960.

tion by subsequent pressure of the overlying sediments and occur in a lamina of fine tuff at the base of the tuffaceous siltstone above mentioned and immediately above the underlying tuffaceous sediments.

The markings (Fig. 2) show a rather wide range in detail shapes of the more or less cyclindrical tubular or rod-like structures seen from below. These rod-like forms measure about from 0.5 to 1.5 millimeters in width and up to about 10 millimeters in maximum length. Some are apparently circular and others are more or less compressed circular in cross-sections; they were moulded in a cast of rounded section. They may be from almost straight to variously curved to the right or to the left. All are devoid of striations either of concentric or longitudinal or diagonal directions with regard to the longer axis of the rods, and the surface or more correctly their lower parts, appear to be quite smooth. However, at places these rod-like structures are at times broken as if by cracking at the time of consolidation or by subsequent pressure of the loading sediments. The rods show at places bulding, pinch-and-swell shapes, a gradual widening or narrowing along their lengths, and overlapping of one upon the other. Superficial branching structures are also apparent. Many of the short rod-like structures cross one another at various angles, overlap several times at the same position to form a thickened aspect, and where bulding or pinch-and-swell portions occur it is noticed that this is due to thickening by overlapping or crossing of one on the other.

Because the under-surface of this tuffaceous siltstone is not a straight or horizontal one, but provided with undulatory aspect, it is inferred that either deposition was rapid and unequal loading occurred and that this resulted in the deformation of the original structures. Also because the strata preserving the peculiar markings have been subjected to subsequent crustal disturbances, it may also be thought that the effect is reflected in the varied shapes of the rod-like structures particularly in their more or less deformed shapes.

Should the subsequent agencies which would have strong influence on the reshaping of the rod-like structures be brought into consideration and the preserved peculiar markings restored, it is inferred that their original shapes would have been straight to variously curved rod-like structures attaining no great length or width, and that the circular cross-sections may not have been the original. This inference results from that shallow but long and narrow excavations in muddy or soft sediments if fine grained may be subjected to filling to the original level of the sediments before they were excavated. Continued deposition of fine grained sediments causes filling of the excavations and further sedimentation results in their complete coverage and preservation. By such procedure the peculiar markings on the under-surface are negatives of the original markings made on the surface of the underlying sediments.

Markings in the Intertidal Zone of Nobiru Beach

Having had the opportunity to visit Nobiru beach, Mono-gun, Miyagi Prefecture at the time of low tide, various interesting markings were observed and photographed, among which one is described in the following lines.

The markings (Fig. 1) were found impressed or excavated in fine grained sands

near the strand line at lowest tide forming a kind of zone parallel with the beach and extending at least 500 meters in length and about two to five meters in width were measured. They were particularly well observed near the terminal portions of small rills flowing from the near the strand line seawards during low tide. At the time of observations these markings seem to have occupied areas slightly higher than the seaward adjacent area and lower than the landward adjoining area, although the difference in height was slight.

The markings consist of a variety of shapes, being from straight to curved in right or left directions, and all were noticed to represent shallow and narrow troughs or excavations with parallel-sided walls. In width they measured about 0.5 to nearly three millimeters and in length up to about 10 centimeters in maximum. The excavations or trails as they may be called were noticed to cross one another, appear as branching at places, have abrupt terminal parts or obscure ones, be partially filled with the sandy sediments, retain their original shapes and be developed in an enormous number as is forming clusters. Thus it is evident as also shown in the photograph (Fig. 1) that their shapes and sizes are quite varied.

Near the afore-mentioned rill-marks the development of the peculiar markings described above decrease in number and structure and there are found many small holes in the sand. Also some holes were recognized in areas where the trails were dense in arrangement. All of the trails seemed to be parallel or horizontal in position with the sandy deposits in which they are impressed and none suggested a different orientation. The holes were all found to have vertical positions in the sand beach.

These markings just described in the above are due to *Gammarus*, small crustaceans measuring about eight to 20 millimeters in length and whose species live in brackish and marine waters extending from the region of Northeast Japan southwards to Kyushu in geographical distribution, and generally live in shallow waters. One of its species *Gammarus* (*Rivulogammarus*) *lacustris* (G. O. Sars) is known to live in freshwater lakes of Manchuria and Mongolia. The one just stated to live in brackish and marine waters is *Gammarus* (*Rivulogammarus*) *nipponensis* Ueno, and the markings above described are due to this species. Here it should be stated that Professor Isao Motomuar of the Tohoku University provided the senior writer with information concerning the markings described above. The small crustacean can be caught in large numbers and is used for bait by the local fishermen.

Interpretation of the Fossil Markings

The fossil markings described in this article show rounded under-surface and since this is the negative, it may be inferred that they originally were moulded in long and narrow casts with rounded bottoms showing trail-like appearance. Although their shapes as now preserved can be considered to have been slightly deformed by subsequent compression by the pressure of the overlying sediments and probably also by crustal disturbance, their original forms are thought to have been analogous with the markings made by *Gammarus*.

If the fossil markings can be interpreted as made by some marine animal similar to or by *Gammarus* itself, then it may be possible to analyse the environment under which the sediments

preserving those structures were deposited. The environment would thus be interpreted to have been in the tidal zone or nearby, and since the beds preserving the structures are now truncated, evidence suggesting the ancient shoreline could not be found. However, it may be postulated that the tuffaceous siltstone was originally deposited on a broad and shallow area near to the shore, if the fossil markings can be accepted as analogous with those made by the Recent *Gammarus*.

Since other kinds of markings are also preserved on the under-surface of the sedimentary rocks (Miocene) of the terrain along the Sagae River in Yamagata Prefecture, the writers hope to study other structures before presenting any conclusion as to the paleo-environment of the rocks preserving the structures.

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Illustrated Encyclopedia of the Fauna of Japan (1949) : Hokuryu-kan Book Co., Tokyo, refer to pp. 827–282, fig. 2377.

YONGE, C. M. (1949) : The Sea Shore. Collins St. James's Place, London, refer to pp. 153, 253–264.

Text-figures. Markings on under-surface.

Fig. 1 : Markings of *Gammarus* (*Rivulogammarus*) *nipponensis* UÉNO in the intertidal zone at Nobiru beach, Mono-gun, Miyagi Prefecture.

Fig. 2 : Fossil markings on under-surface of Miocene tuffaceous siltstone on right bank of Sagae River below Mizusawa, Mazawa-machi, Nishi-Murayama-gun, Yamagata Prefecture. IGPS coll. cat. no. 78264.

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402. NOTE ON *HETEROTRIGONIA SUBOVALIS* (JIMBO)*

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Heterotrigonia subovalis (JIMBO) についての記載：北海道三笠市幾春別産の多数の標本について，古生物学的研究を行い，この種が成長に伴い，その表面装飾の変化が著しく，また *Trigonia saucatai* YEHARA と *Apiotrigonia jimboi* NAKANO はそれぞれ *H. subovalis* の幼形および成長形であることが判明した。 中野光雄

Introduction and Acknowledgements

Heterotrigonia COX is considered probably to be a genus of the subfamily Trigoniinae KOBAYASHI, and is well characterized by its outline and surface sculpture. This genus is characteristic in the Northern Pacific from the upper Albian (?) to the Santonian. *Trigonia subovalis* is a typical *Heterotrigonia*, and had been originally described by JIMBO (1894) from the "*Trigonia* Sandstone" (Cenomanian-Turonian) of Pombetsu in Ikushumbetsu, Mikasa-city, Central Hokkaido. Its occurrences were reported by some authors from the Cenomanian to the Santonian formations in the Yezo geosynclinal region including Hokkaido, Sachalin, and Kamtschatka. Recently, the writer had a good chance to visit to the Ikushumbetsu district and collected numerous specimens of *Heterotrigonia subovalis* from various places. As a result of this palaeontological study, it is recognized that *H. subovalis* presents remarkable change of characters in ontogenetic development and *Trigonia saucatai* and *Apiotrigonia jimboi* must be an immature and adult forms of *H. subovalis*, respectively.

The materials dealt with in this paper were collected by late Kotora JIMBO, Tatsuro MATSUMOTO, and the writer from the Ikushumbetsu district in Mikasa-city of Central Hokkaido and stored in the Geological Institutes of the University of Tokyo (GT), Kyushu University (GK), and Hiroshima University (GH).

The writer wishes to express his sincere thanks to Prof. Sotoji IMAMURA of the Hiroshima University, Prof. Teiichi KOBAYASHI of the University of Tokyo, and Prof. Tatsuro MATSUMOTO of the Kyushu University at Fukuoka for their kind guidance and continuing encouragement. The writer records here his cordial thanks to Messrs. Tomowo OSE and Ichiro HAYASHI of the Sumitomo Colliery Company for the facilities to survey the Ikushumbetsu district and to Mr. Yoshiro UEDA of the Geological Survey of Japan and Mr. Ikuwo OBATA of the Kyushu University for their assistances.

Subfamily **Trigoniinae** KOBAYASHI, 1954

Genus *Heterotrigonia* COX, 1952

* Received Oct. 14, 1960; read at the annual meeting of the society at Tokyo, Jan. 15, 1961.

Type species:—*Trigonia diversicostata* WHITEAVES, 1876. Haida formation (Up. Albian ?) of Queen Charlotte series; British Columbia.

Diagnosis:—Shell small to medium in size, pyriform to triangularly ovate, inequilateral, moderately inflated. Umbo narrow, rather prominent; beak opisthogyrous and antero-mesial. Marginal and escutcheon carinae visible only near umbo where the surface is tripartite distinctly and ornamented with several plain concentric costae and costellae. Escutcheon fairly broad, depressed, provided with transverse, plain or tuberculate costellae. Area narrow, with several, radial, plain or tuberculate costae which are sometimes bifurcated or evanescent later. Flank with two series of plain or tuberculate costae, except in the vicinity of umbo: anterior series of costae first subconcentric, but become oblique, sometimes undulated or obsolete, in the later stages; posterior series consists of radial or subvertical costae which are often bifurcated: some radial or vertical costae confluent with anterior subconcentric ones.

Growth-lines or concentric bands sometimes well developed on the whole surface.

List of Species:—

Heterotrigonia granosa NAKANO, 1957. Middle formation (Santonian) of Himenoura group; Amakusa, Kyushu, Japan.

Trigonia subovalis JIMBO, 1894. Cenomanian-Santonian; Central Hokkaido of Japan, South Sachalin and Kamtschatka.

Remarks:—This genus is closely similar to *Apiotrigonia* and *Iotrigonia* in outline and surface costation, but is easily distinguished by the presence of a small number of radial costae on the narrow area.

In the early stage of growth, the whole surface is sculptured with several, plain concentric costae and costellae and tripartite distinctly by a marginal and an escutcheon carina. It is sometimes recognized that in the umbonal region the concentric costae rapidly become L-shaped costae through V-shaped costae and radial costae on the area appeared suddenly. In the later stages, the characteristic L-shaped costae on the flank and the radial costae on the area are sometimes evanescent.

As already pointed out by the writer (1957), the shell outline is rather constant in this genus, but the ornamentation is somewhat variable. Costae in *granosa* are tuberculate, but plain in *diversicostata* and *subovalis*. *Diversicostata* has transverse and horizontal costae on the anterior part of the flank, and its area is provided with a few distinct radial costae in all stages. In *subovalis*, transverse and horizontal costae become gradually oblique, more or less undulate, and disappear in the later stages, but the concentric bands are well developed on the whole surface. Its area is sculptured with several radial costae, but they are not well recognized in the later stages. In the shell outline, *granosa* is trigonal-ovate and small-sized, but pyriform in *subovalis* and *diversicostata*. *Diversicostata* is medium-sized, while in *subovalis* the adult shell measures 45-60 mm. long and 35-43 mm. high. Escutcheon is well developed in *subovalis* and *granosa*, but absent in *diversicostata*.

Trigonia sawatai YEHARA represented by a single specimen from the "*Trigonia* Sandstone" of Ikushumbetsu in Mikasa-city Central Hokkaido, is most probably an immature form of *Trigonia subovalis* JIMBO as can be judged from the shell form and the surface costation. In the early stage, *Apiotrigonia jimboi* NAKANO has radial costae on the area and is

similar to *subovalis* and *sawatai*. Accordingly, *jimboi* indicates probably an adult stage of *subovalis*.

It is observed that two topotype specimens of *Trigonia newcombei* PACKARD, from the Haida formation of the Queen Charlotte series in British Columbia, now stored in the Kyoto University are quite different from each other. The larger one (J. M. 10179) having radial costae on its broad area, may be a member of *Heterotrigonia*, but the other one (J. M. 10180) is probably a member of *Apiotrigonia* because of its narrow smooth area.

Distribution:—Upper Albian (?) to Santonian in the Northern Pacific.

Heterotrigonia subovalis (JIMBO)

Plate 9, Figures 1-14

1894. *Trigonia subovalis* JIMBO, *Pal. Abh., N. F., Bd. 2, Ht. 3*, pp. 188-189, pl. 8, figs. 5, 5a.

1923. *Trigonia sawatai* YEHARA, *Japan. Jour. Geol. Geogr., Vol. 2, No. 3*, p. 80, pl. 10, fig. 9.

1957. *Apiotrigonia jimboi* NAKANO, *Ibid., Vol. 28, Nos. 1-3*, pp. 115-116, pl. 8, figs. 5-7.

1957. *Heterotrigonia subovalis* NAKANO, *Ibid., Vol. 28, Nos. 1-3*, pp. 118-119, pl. 8, figs. 13-15.

1960. *Megatrigonia* (*Apiotrigonia*) *subovalis* LIWEROSKAJA, *Palaeont. Bull., 2, Leningrad*, pp. 251-252, pl. 5, figs. 1-3.

Material:—Older Collections in the University of Tokyo. Holotype, GT. Cr. 1285, from the "*Trigonia* Sandstone" at Pombetsu in Ikushumbetsu, Mikasa-city, Central Hokkaido (Coll. K. JIMBO); besides this in JIMBO's collection there are the following five specimens: GT. Cr. 908a and 908b from the same formation at Pombetsu in Ikushumbetsu and GT. Cr. 1284a, 1284b, and 1295 from the same formation at Katsurazawa in Ikushumbetsu.

In M. NAKANO's collection, there are about 70 fairly complete and incomplete specimens from the same formation in Ikushumbetsu of Mikasa-city. GH. NM. H. 101-118 and GH. NM. H. 120-124 were collected from the *Calycoceras* zone of the "*Trigonia* Sandstone" at Keirimbashi in Shimokatsurazawa of Ikushumbetsu and GH. NM. H. 119 was obtained from the *Inoceramus hobetsensis* zone of the upper member of the same formation at an old site of a quarry near the Katsurazawa dam-site in Kamikatsurazawa of Ikushumbetsu.

In T. MATSUMOTO's collection, GK. H. 6035-37 from the *Calycoceras* zone (?) of the same formation at T. MATSUMOTO's loc. IK-2021 along the Pombetsu river in Ikushumbetsu. Besides this MATSUMOTO's collection contains a number of unregistered specimens from the same formation in the same district.

Description:—Shell medium to fairly large in size, triangularly ovate to pyriform, moderately inflated, inequilateral, broader than high; antero-dorsal margin short and nearly straight or slightly convex; antero-ventral rounded; ventral broad and gently arcuated; siphonal rather broad and well rounded; postero-dorsal long and concave. Umbo small, rather prominent, sculptured with about 5 plain concentric costae; beak opisthogyrous, pointed at about a fourth to two-fifths from the front. Flank with two series of plain costae except for the umbonal region; anterior costae subconcentric but soon become oblique, more or less undulated, and disappear later; posterior radial or subvertical costae broadened, sometimes bifurcated and die out ventrally; about a third of posterior radial costae reach ventral periphery. Shallow ante-carinal depression some-

times well developed. Marginal and escutcheon carinae distinct only near umbo. Several radial costae on the area except for the umbonal region, first distinct but soon obsolete in the later stages. Median furrow shallow and indistinct. Escutcheon broad, depressed, provided with numerous plain transverse costellae which are first subconcentric and later oblique.

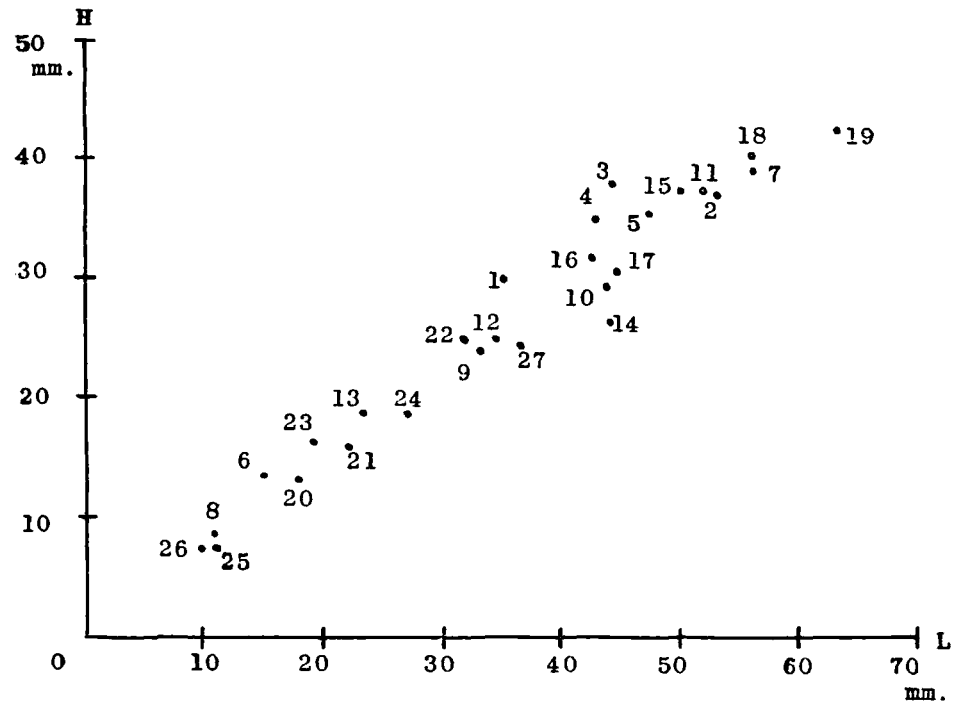
Growth-lines distinct in all stages, especially crowded in the area; in the adult stage concentric bands well developed on the whole surface. Internally, a radial ridge presents on the area, coincides approximately with the middle of the area; ventral periphery slightly plicated or sometimes smooth. Test rather thin.

Measurements in mm.

Specimen	Valve	Length	Height	L/H
*1. GT. Cr. 1285	Bivalved	35.0	30.0	1.17
2. GT. Cr. 1284a	Left	53.0	37.0	1.43
3. GT. Cr. 1284b	Left	44.3	38.0	1.27
4. GT. Cr. 1295	Right	43.0	35.0	1.23
5. GH. NM. H. 101	Left	47.5	35.5	1.34
6. GH. NM. H. 102	Right	14.8	13.5	1.10
7. GH. NM. H. 103	Left	56.0	39.1	1.43
8. GH. NM. H. 104	Left	11.0	8.0	1.38
9. GH. NM. H. 105	Left	33.0	24.0	1.38
10. GH. NM. H. 106	Left	44.0	29.2	1.50
11. GH. NM. H. 107	Left	52.0	37.5	1.39
12. GH. NM. H. 108	Right	34.5	25.0	1.38
13. GH. NM. H. 109	Right	23.3	18.5	1.26
14. GH. NM. H. 110	Left	44.2	31.5	1.40
15. GH. NM. H. 111	Right	50.0	37.5	1.33
16. GH. NM. H. 112	Left	42.5	31.7	1.30
17. GH. NM. H. 113	Left	44.6	35.6	1.25
18. GH. NM. H. 114	Left	56.0	40.5	1.38
19. GH. NM. H. 115	Right	63.0	42.5	1.41
20. GH. NM. H. 116	Left	17.8	13.0	1.45
21. GH. NM. H. 117	Left	22.0	16.0	1.37
22. GH. NM. H. 118	Left	32.0	25.0	1.28
23. GH. NM. H. 119	Right	19.2	16.2	1.20
24. GH. NM. H. 120	Right	27.0	18.5	1.45
25. GK. H. 6035	Left	11.0	8.2	1.34
26. GK. H. 6036	Left	9.8	7.5	1.31
27. GK. H. 6037	Left	36.7	24.1	1.52

* Numbers correspond to those in text-fig. 1.

Remarks:—In a recent paper, the writer (1957) noted that the area is smooth in *Apiotrigonia jimboi*, but radially costellate in *Trigonia subovalis* and *T. sawatai* the latter of which resembles *T. subovalis* in ornamentation and shell



Text-fig. 1. Proportion of height to length of *Heterotrigonia subovalis* (JIMBO)

form. The radial costation on the area are, however, well observed on some specimens (pl. 9, figs. 4a-b, fig. 13) of *Ap. jimboi* before hand. Because of the ill-preservation and the effacement of the costation through growth, in many cases the radial costation on the area and the characteristic L-shaped costation on the flank are not well observed.

Like many other trigoniids this species presents remarkable change of characters in ontogenetic development. The shell form is, however, rather constant through growth. The outline is trigonally ovate to pyriform, and the beak located at a fourth to two-fifths from the anterior end. The height-length proportion ranges 1 : 1.10 to 1 : 1.50, mostly 1 : 1.30 to 1 : 1.40.

Shell (about 1.5 mm. near beak) in the first stage of growth is recognized occasionally in some specimens (GH. NM. H. 104 and GK. H. 6035). In this stage, the whole surface is provided with about 5 plain concentric costae and costellae and distinct three carinae. Shell is similar to that of *Frenguelliella* because of the absence of the radial costation on its area.

In the next stage shell (about 3 mm. near beak) is tripartite distinctly and radial costae appear suddenly on its area. Succeeding about 3 concentric costae on the flank change gradually into L-shaped costae through V-costae.

In the succeeding stage, when the shell is about 10-25 mm. long and 8-20 mm. high, the flank is sculptured with 8 to 17 subconcentric costae and 4 to 10 radial or subvertical costae. Costae on

the area number 4 to 6. In the form in figs. 2a-b on pl. 9 (GH. NM. H. 119), costellae on the escutcheon number about 17 and they are connected with the coarse growth-lines on the area.

In the following stage, the shell is about 35 mm. long and some 30 mm. high and the costation near the umbo is usually uncertain. The main part of the flank is sculptured with 8 to 14 radial or subvertical costae and about 15 subconcentric costae. Radial or subvertical costae in this stage are sometimes bifurcated near the ventral periphery, and subconcentric costae on the anterior part of the flank are slightly oblique, more or less undulated, and sometimes obsolete in the antero-ventral margin. Radial costae on the area number 6 to 10, and often evanescent posteriorly. Costellae on the escutcheon number about 18 in some forms. Concentric bands are developed in the vicinity of the marginal part and growth-lines are crowded especially on the posterior part.

In the last stage, the shell is 45-60 mm. long and 35-43 mm. high and the surface costation in the earlier stages is commonly not well observed. There are, however, 10-15 radial costae and about 15 subconcentric to transverse costae on the flank. Subconcentric or transverse costae on the anterior part are usually undulated and oblique. Costation on the area is evanescent, and the escutcheon ornamented with numerous transverse costellae. Strong concentric bands are well developed on the whole surface.

As discussed above, the surface sculpture is quite variable through growth. YEHARA's *sawatai* resembles the early stage of the illustrated specimen (pl. 9, fig. 7) which is a typical form of JIMBO's *subovalis*. On the other hand, the early stage of *Apiotrigonia jimboi* is quite similar to *subovalis* as can be judged from the surface costation. Therefore, *sawatai* and *jimboi* must indicate as an immature and an adult form of *subovalis*, respectively.

Variation:—This species has a certain degree of the variation on its surface ornamentation. For example, the sculpture is not always equally even in specimens of similar size. Because of ill-preservation, the exact extent of the variation is uncertain. There are, however, a *Rutitrigonia*-like form (pl. 9, fig. 1) on which the typical L-shaped costation is obsolete and the concentric bands are well developed. On the other hand, a specimen on fig. 6 in pl. 9 has a typical L-shaped costation which is usually evanscent in the anterior part. In the early stage, concentric striae on the area are strong and crowded in the illustrated form (pl. 9, fig. 2), but they are weak in the other specimens (pl. 9, figs. 5 and 10). In the adult stage, the radial costation on the area is commonly not well observed, but well developed in the specimen on fig. 13 in pl. 9. In some unfigured specimens, the visible radial or subvertical costae on the posterior part of the flank all reach the ventral margin.

Comparison:—This species is characterized by the presence of the L-shaped costation on the flank and the radial ornament on the area.

This species resembles closely *Apiotrigonia minor* (YABE and NAGAO) and its allied forms from the Cenomanian to the Maestrichtian in Japan, but is easily distinguished from the latters by the presence of the radial sculpture on the narrow area. *Heterotrigonia diversicostata* (WHITEAVES) from the Haida formation of the Queen Charlotte series of British Columbia is closely allied to the early and middle stages of the present form, but differs by

the absence of the transversely costellae escutcheon. As compared with *Apiotrigonia newcombei* (PACKARD) from the Haida formation in British Columbia, this species is larger than the latter and its area is radially costellate. *Heterotrigonia granosa* NAKANO from the middle formation (probably Santonian) of the Himenoura group at Wadanohana in Ryugatake-mura, Amakusa-gun, Higo Prov., Kumamoto Pref., resembles this form, but differs in having the smaller shell and its costae are all tuberculate. *Apiotrigonia turcmenensis* (ARCHANGELSKY) from the Cenomanian of Turkestan is similar to the adult form of the present species, but differs by the absence of the radial sculpture on the area.

Occurrence:—Abundant in the *Mantelliceras* (?) zone (lower Cenomanian) to the *Inoceramus hobetsensis* zone (middle Turonian) in the Ikushumbetsu district, Mikasa-city, Central Hokkaido. Comparable specimens were reported from the Upper Yezo group in South Sachalin and the Gyliakian formation (Cenomanian-Turonian) of Kamtschatka.

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Explanation of Plate 9

All natural size except for figs. 5 and 10.

Heterotrigonia subovalis (JIMBO) ..... p. 57

Fig. 1. Lateral view of an adult right valve specimen (GH. NM. H. 115), showing *Rutitrigonia*-like ornament on the flank; *Calycoceras* zone of the lower member of the "*Trigonia* Sandstone" at Keirimbashi in Shimokatsurazawa, Ikushumbetsu, Mikasa-city, Central Hokkaido.

Figs. 2a-b. Lateral and posterior views of a modeling cast of an immature right valve (GH. NM. H. 119); *Inoceramus hobetsensis* zone of the upper member of the "*Trigonia* Sandstone" at an old site of a quarry near Katsurazawa-dam, Kamikatsurazawa, Ikushumbetsu, Mikasa-city, Central Hokkaido.

Fig. 3. Lateral view of an adult left valve specimen (GH. NM. H. 107).

Figs. 4a-b. Lateral and posterior views of an adult left valve (GH. NM. H. 103).

Fig. 5. Lateral view of an immature left valve (GH. NM. H. 104). ×2.

Fig. 6. Lateral view of an adult left valve (GH. NM. H. 101), showing L-shaped costation on the flank.
Calycoceras zone of the "*Trigonia* Sandstone" at Keirimbashi in Ikushumbetsu, Mikasa-city.

Fig. 7. Lateral view of a modeling cast of a typical form (middle stage) of a left valve (GK. H. 6037) (Coll. T. MATSUMOTO); *Calycoceras* zone (?) of the upper member of the same formation at T. MATSUMOTO's loc. IK-2021 along the Pombetsu river in Ikushumbetsu, Mikasa-city.

Fig. 8. Postero-lateral view of an external cast (GH. NM. H. 124) of a right valve in the middle stage.

Figs. 9a-b. Lateral and posterior views of a right valve specimen (GH. NM. H. 122) in the middle stage.

Fig. 10. Lateral view of an immature right valve (GH. NM. H. 102). ×2.

Fig. 11. Lateral view of a left valve (GH. NM. H. 105) in the middle stage.

Figs. 12a-b. Lateral and posterior views of an early adult stage of a left valve specimen (GH. NM. H. 106).

Fig. 13. Postero-lateral view of an external cast of an imperfect right valve specimen (GH. NM. H. 121) in the adult stage, showing the obsoletion of the radial sculpture on the area.

Fig. 14. Postero-lateral view of an external cast of an imperfect left valve specimen (GH. NM. H. 123) in the middle stage, showing the obsoletion of the radial costation on the area.
Calycoceras zone of the lower member of the "*Trigonia* Sandstone" at Keirimbashi, Shimokatsurazawa in Ikushumbetsu, Central Hokkaido.


1


2a


2b

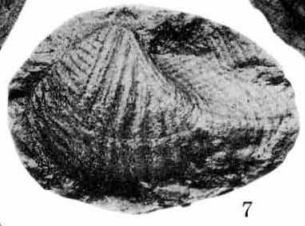

3


4a


4b


5


6


7


8


9b


9a

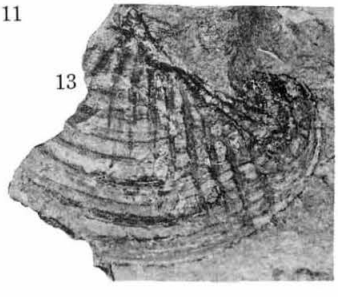

10


12a


11


12b


14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Trans. Proc. Palaeont. Soc. Japan, N. S. No. 42, pp. 63-67, June 10, 1961

403. A FOSSIL *RHINOCEROS* FROM KUZUÛ, TOCHIGI PREFECTURE, JAPAN*

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葛生産化石犀の一種：本化石は栃木県葛生の大叶石灰岩のさけめから 1947 年に発見されたもので第二前臼歯は武蔵野郷土館所蔵他は野間達郎氏所有品である。標本は右側上顎前臼歯および大臼歯をそなえているが，歯冠部は第二前臼歯と第四前臼歯を除いては一部分欠損したり又は全部欠損している。歯の形態からみると，中国の周口店によく出る *Rhinoceros mercki* JÄGER によく似ているので同一種かあるいはこれに近い種と考えられるが，今後なを多くの資料の追加提供されるのを待って種名を決定したい。さしあたり *R.* sp. として報告する。

永 沢 譲 次

The specimen dealt here was given to the present writer for studying through the kindness of Mr. Tatuo NOMA and the writer had reported it as *Rhinoceros* referable to *R. mercki* of Choukoutien in China at the 60th annual meeting of the Japanese Geological Society, spring, 1953, in Tokyo.

This paper is the first description about the above mentioned specimen. My cordial thanks are due to Prof. SAKAZUME of Dôshisha University, to Mr. KUSAKA and Dr. OZAKI of the National Science Museum (Tokyo) as regards literature.

Description of species

Order Ungulata

Sub-order Perissodactyla

Family Rhinocerotidae

Genus *Rhinoceros*

Rhinoceros sp.

Text-figs. 1, 2, 3.

* Received Nov. 15, 1960; read at 78th meeting of the society at Akita, May 13, 1961.

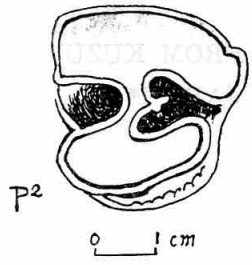
Material:—A fragment of right upper jaw with P^3-M^2 in situ, the rests of broken P^2, M^3, and a detached right P^2 belonging to the Musashino Kyodo-Kan at Koganei, Tokyo.

Locality:—A limestone fissure of Yosizawa quarry, Ôgano at Kuzuû, Tochigi Prefecture, Japan. The specimen was collected in December 1947.

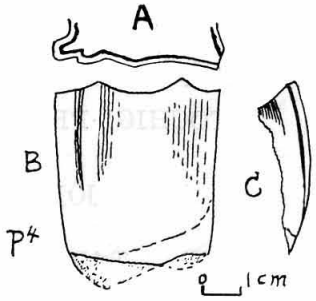
Horizon:—Precise horizon unknown (Pleistocene).

Description:—P^2 much worn. The external wall of the crown with a distinctive parastyle almost smooth and gently convex. Deep-seated crochet crenated or doubled on P^2. Protocone and hypocone fused at the base, and the inner side of inner cones rounded. The anterior fossette has a narrow open inlet at the anterior side of the crown. The crown is bordered lingually and anteriorly by a low basal cingulum. Length of the outer side of the crown is larger than that of the inner side of the crown.

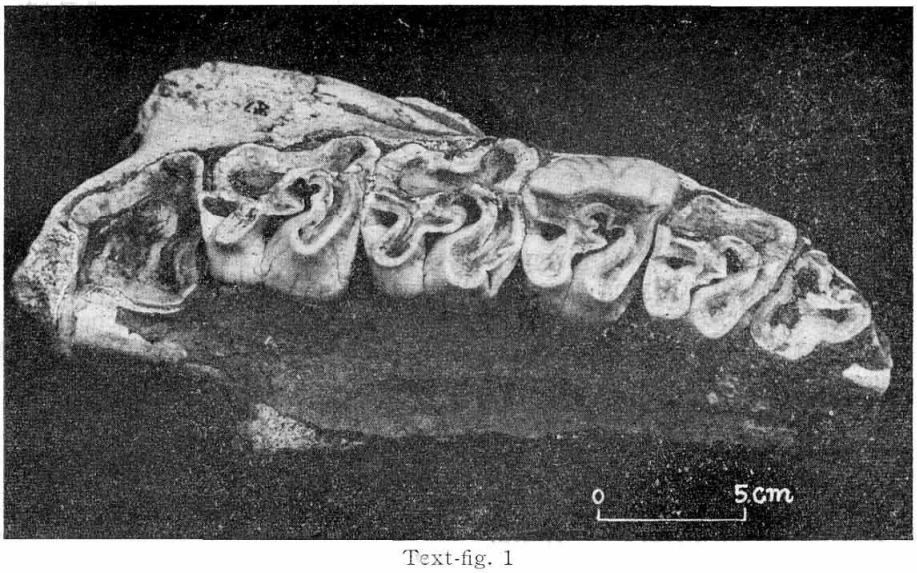
P^3: Crown moderately worn. The inner half part of the crown preserved. Length of the outer side of the crown is larger than that of the inner side of



Text-fig. 2



Text-fig. 3



Text-fig. 1

Text-fig. 1. *Rhinoceros* sp. Right upper premolars and molars, crown-view.
Text-fig. 2. *R.* sp. Right upper second premolar, crown-view.
Text-fig. 3. *R.* sp. Right upper fourth premolar: A, upper view; B, external view; C, anterior view.

the crown. Postfossette present. Crochet prominent, with a small spur at its inner portion. Crista rudimentary. No antecrochet. The half part of the anterior side of the crown is bordered by a low basal cingulum. Protocone and hypocone fused at the base, presenting somewhat convex wall.

P^4: A complete crown moderately worn. Length of the outer side of the crown is larger than that of the inner side of the crown. Posterior fossette present. Crochet prominent, with a spur at its outer portion and another smaller spur at its inner portion. Crista more or less distinct. No antecrochet. Protocone and hypocone fused at the base. The surface of the external wall of the crown comparatively smooth and gently convex, with a single fold (paracone-fold) set much forward, very close to the parastyle. Paracone-fold attains not to the crown base. No posterior fold on the external wall of the crown.

M^1: The inner half part of the crown is preserved. Length of the

outer side of the crown is larger than that of the inner side of the crown.

Anterior and posterior lophes separated by a broad valley, not bordered lingually by a cingulum. But, the half part of the anterior side of the crown bordered by a cingulum forming an oblique ridge. Protocone has a enamel sinus near the corner of the anterior-inner side of the crown. Posterior fossette present. Crochet prominent. No crista. No antecrochet. A feeble cusp presents at a posterior part of the protocone.

M^2: The inner half of the crown is preserved. Length of the outer side of the crown is larger than that of the inner side of the crown. Crochet prominent. A feeble crista which will disappear when more worn, presents.

There is no true antecrochet on the protoloph, but a small fold projects into the median valley from its outer portion, that is, external to the crochet (whereas the antecrochet always appears internal to the crochet). We can see the same fold or spur on M^1 of the Choukoutien *R. mercki* (Teilhard, 1936, fig. 11) and M^1, M^2 of *R. mercki* Kaup from Les Grottes de Grimaldi (Boule and others, 1906-1919, figs. 2, 5).

The half part of the anterior side of the crown is bordered by a cingulum forming an oblique ridge. Two small cusps present at posterior part of the protocone.

The teeth measure as follows:

	Maximum length	Maximum breadth	Height of crown at outer side	Height of crown at inner side
P^2	33 mm	35 mm	—	—
P^3	39 mm	50 mm	—	22 mm
P^4	45 mm	50 mm	47 mm	25 mm
M^1	50 mm	59 mm	—	20 mm
M^2	51 mm	62 mm	—	25 mm
M^3	46 mm (at base of crown)	54 mm (at base of crown)	—	—

Thickness of enamel layers: 1~2.5 mm
Length of a root of M^3....30 mm (measured directly)
Length of a root of P^3....30 mm (approximately)

From the above mentioned measurements, it is known that crowns are moderately hypsodont (perhaps a little shorter than in *R. mercki* of Choukoutien).

Comparisons:—The character of the teeth above mentioned bears a striking resemblance to that of the Choukoutien *R. mercki*, but the size of teeth is somewhat smaller than in *mercki*. We have known three species of *Rhinoceros* in Pleistocene deposits of China: *R. mercki* Jäger, *R. sinensis* Owen, and *R. tichorhinus* Cuv. (*Coelodonta antiquitatis* Blum.). The specimen described here is easily distinguished from *R. tichorhinus* Cuv. by its smooth outer wall of crown with lophes sub-transvers.

The Chinese form of *R. mercki* was first described as *R.* sp. by Zdansky (1928) and next by Wang (1931) as a new species: *R. choukoutiensis*, but in 1936 Teilhard de Chardin, refered it to *R. mercki* of Europe. This form is two-horned, with a complete nasal septum and hypsodont upper and lower teeth,

and presents no vestigial upper and lower incisors, occurring widely in Pleistocene deposits (from Villafranchian to Loessic times) of China.

NAORA (1954, p. 16) distinguished the present specimen from *R. mercki* owing to the unaccordance of the shape of P^2. But, as compared P^2, a detached tooth belonging to the Musashino Kyodo-Kan at Koganei, Tokyo, with MERCK's P^2 figured by ZDANSKY (1928, pl. 5, fig. 82, pl. 6, fig. 2), the writer could not recognize any morphological or specific differences between both P^2. *Dicerorhinus* (?) sp. which is represented by an isolated tooth, probably M_1 or M_2 reported by SHIKAMA (1949, p. 74) from a fissure deposits of Ôgano limestone at Kuzuû, Tochigi Prefect. is brachyodont (short crowned tooth), so it cannot belong to the same species (*R. mercki*).

According to the descriptions of PEI (1958, p. 32) and TEILHARD de CHARDIN (1936, p. 28), the distinction between *R. mercki* and *R. sinensis* OWEN from Szechuan in China is uneasy as long as the molars only are known in either species. In *R. sinensis*, however, external wall of the upper molariform teeth (especially the two last premolars) is not so even as in *mercki*, but presenting two distinct folds corresponding to the two internal lophes (MATH. and GRANGER, 1923).

As external wall of P^4 of the present specimen is almost smooth, so in this point, the difference is noticeable between this form and *R. sinensis* OWEN.

R. sinensis OWEN reported by MATSUMOTO (1915) is distinguished from this form by distinct folds on the protoloph and the hypocone. M^1 of *R. mercki* illustrated by TEILHARD (1936, fig. 11), M^1 and M^2 of the same species by ZDANSKY (1928, pl. 6, fig. 4, pl. 8, fig. 2) and one isolated specimen, M^2 refered to *R. mercki* by CHIA and CHAI (1957, pl. 2, fig. 1) present a weak enamel sinus or groove at the posterior wall of the protocone, making a feeble antecrochet. But, it is not recognized on M^1 and M^2 of the present specimen, M^1 and M^2 of *R. mercki* illustrated by YOUNG (1933, fig. 18) and M^1 and M^2 of *R. mercki* KAUP from Les Grottes de Grimaldi (BOULE and others, 1906-1919, figs. 3, 5). About the upper teeth of the Choukoutien *R. mercki*, TEILHARD (1936, p. 24) wrote: "Antecrochet and crista small, deep-seated, sometimes vestigial, but rarely entirely absent."

From the above description, it seems, the presence of such a enamel sinus or feeble antecrochet cannot be a constant character in *R. mercki* JÄGER.

But, it is safe to say that if the Chinese forms have constantly more or less recognizable antecrochet in the molars, the present specimen will be distinguished from the Chinese forms by the lacking of antecrochet and small dimensions of teeth.

The present teeth are smaller than those of *R. sinensis* OWEN from Szechuan (MATH. and GRANGER, 1923).

As above mentioned descriptions, the present form seems to belong to MERCK's *Rhinoceros* or species closely allied to it. But, the writer wishes to preserve the precise specific name of this specimen till farther evidences are provided.

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 42, pp. 68-72, pl. 10, June 10, 1961

404. A NEW SPECIES OF *APHELASTER* FROM THE LOWER CRETACEOUS OF JAPAN*

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Geological Survey of Japan

and

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Kyobashi Upper Secondary Chemical Schoo.

本邦下部白堊系産 *Aphelaster* の1新種：Toxasteridae 科の *Aphelaster* には，これまでに南フランスおよびマジョルカの下部白堊系 Hauterivian 階から産出する模式種 *Aphelaster integer* (GAUTHIER) だけが知られていた。本邦では，*Aphelaster* に属する種が，Hauterivio-Barremian 階の下部物部川亜層群に相当する湯浅地方の有田層・山中地溝帯の石堂層・勝浦川盆地の羽ノ浦層および八代地方の八龍山層から産出する。したがって，本邦での層序的産出範囲から，*Aphelaster* の生存期間は Barremian にまで延長されることがわかった。日本産の種は，前歩帯・対歩帯の特徴によって明らかに模式種と区別される。したがって，本邦産の種を新種とみとめ，*Aphelaster serotinus* と命名する。さらに，*Aphelaster* を由来せしめた *Toxaster* (*Eotoxaster*)，Hauterivian 期の *Aphelaster*，Barremian 期の *Aphelaster* の系列における形態的変化から，日本産の種は，より進んだ特徴を具えていると考えられる。

田中啓策・柴田松太郎

Introduction and Acknowledgements

Although Cretaceous echinoids are often used in zoning of the standard areas of Europe and America, they are found in very small numbers in Japan. The writers have studied some toxasterid echinoids from the Lower Cretaceous in Southwest Japan for several years. As a result, it became clear that some of them are characteristic species not hitherto known from the Lower Cretaceous of Japan. They can be identified to a new species of the genus *Aphelaster* for which the specific name of *Aphelaster serotinus* is offered. The present specimens were collected from the Lower Monobegawa subgroup developed in the following areas: (1) the "Sanchu graben" in the Kwanto massif, (2) the Yuasa district in the western part of the Kii Peninsula, (3) the Katsuragawa basin in the eastern part of Shikoku, and (4) the Yatsushiro district in Middle Kyushu. The Lower Monobegawa subgroup is referred to the Hauterivio-Barremian stage. The subgroup called Arita formation in the Yuasa area, especially its fossiliferous part is undoubtedly Barremian in age because of the occurrence of ammonites such as *Phyllopachyceras infundibulum* (D'ORBIGNY), *Shasticrioceras nipponicum* MATSUMOTO, *Heteroceras* sp., *Hamulina* cf. *subcylindrica* D'ORBIGNY, etc. According to the present data, the

* Received Jan. 9, 1961; read at 75th meeting of the society at Urawa, May 21, 1960.

genus *Aphelaster* occurs only from the Hauterivian in South Europe, and yet it contains no species except for *A. integer* (GAUTHIER), the type species of the genus *Aphelaster*. Therefore, it should be pointed out that the stratigraphic occurrence of *Aphelaster* ranges up to the Barremian stage. Judging from the morphological change in *Aphelaster*, it may be furthermore suggested that the Japanese Barremian species is morphologically advanced as may be expected of a later representative of this genus.

Thanks are due to Prof. Tatsuro MATSUMOTO of the Department of Geology, Kyushu University, Mr. Noboru YAMASHITA of the Geological Institute, University of Tokyo and to Mr. Yukio YABE of the Japan Information Center of Science and Technology for the offer of the materials; to Mr. Masahiro OKUBO of the Geological Institute, University of Tokyo for photographing; to Dr. Haruyoshi FUJIMOTO of Yamagata University, Prof. Wataru HASHIMOTO of the Geological and Mineralogical Institute, Tokyo University of Education and Prof. Syozo NISIYAMA of the Geological Institute, Shimane University for advice. Furthermore, indebtedness is expressed to Prof. Henri TERMIER, Laboratorie de Géologie, Faculté des Sciences à la Sorbonne, Mr. André DEVRIÈS, Faculté des Sciences, Universite d'Alger and Prof. Wyatt DURHAM of the Department of Paleontology, University of California for responses to inquiries and reprints of literatures.

Description of Species

Family Toxasteridae LAMBERT, 1920

Genus *Aphelaster* LAMBERT, 1920

Type species: *Toxaster integer* GAUTHIER

The genus *Aphelaster* originally designated by J. LAMBERT (1920a) was later regarded as no more than a subgenus or section under *Toxaster* rather than a separate genus by itself (1933). This genus is, however, essentially different from any other genus included in the family Toxasteridae in the following points: (1) the test circular in outline, (2) the frontal depression as well as the anterior notch, if any, very indistinct, (3) the petals all alike, long, continuing to the ambitus, (4) the paired petals somewhat flexuous, (5) the poriferous zones all equal, and (6) the genitals 3 and 4 separated by the ocular IV. Of these characters, the primitive feature of the apical system as mentioned above is noteworthy. Such is pointed out also in some primitive forms of *Toxaster* represented by *T. africanus* (COQUAND) and other allied species, for which LAMBERT (1933) proposed a section named *Eotoxaster*. But, *Aphelaster* is distinguished from *Eotoxaster* by its general features of the test such as the shape, the features of the petals and so forth. Such being the circumstances, the writers would like to regard *Aphelaster* as a distinct genus, supporting MORTENSEN's opinion. Then attaching great importance to the primitive feature of the apical system, *Aphelaster* is thought to be closely related to *Eotoxaster* which should be thought of at least as a subgenus under *Toxaster*.

The species belonging to the genus *Aphelaster* had been only the two: the type species and *Toxaster tosaensis* DE LORIOL. As to the latter, MORTENSEN (1951) states that *T. tosaensis* was referred to *Aphelaster* in consideration of all petals resemblance. However, he says that this species tolerably differs from *Aphelaster integer* although the structure of the apical system is unknown. In

such circumstances, MORTENSEN persists that it is too soon to include *Toxaster tosaensis* in *Aphelaster* as LAMBERT and THIÉRY (1924) do. However, NISIYAMA (1954) who disagrees with the thought of LAMBERT and THIÉRY believes that *T. tosaensis* is a very primitive form and then proposes a new genus to be named *Allotoxaster* (MS) for it. The present writers also think that *T. tosaensis* should be removed from *Aphelaster* approving of MORTENSEN'S and NISIYAMA'S opinions.

Aphelaster has been represented by only the type species which occurs from the Hauterivian in South Europe. However, discovery of a new species identified to *Aphelaster* in Japan makes the stratigraphic occurrence of this genus range up to the Barremian.

Aphelaster serotinus TANAKA and SHIBATA, new species

Plate 10, Figures 1-6;
Text-figures 1-2

Type specimens:—Holotype, GSJ. 6092; Paratypes, GSJ. 6010, 6038

Description:—Test of moderate size, subcircular, rather wider than long, widest slightly in front of the center; anterior sulcus so very shallow as to disappear near the ambitus from which it extends to the peristome as a very shallow depression; anterior indentation, if any, very indistinct. Adapical surface somewhat inflated, highest at the apical system, not truncated posteriorly; actinal surface flattened. Apical system about central; genital pores four in number; ocular IV meeting the madreporite, thus separating the genitals 3 and 4. Ambulacra all alike, petaloid; petals reaching to the ambitus. Anterior ambulacrum located in the anterior sulcus which is very shallow, straight, somewhat narrower than the paired ambulacra. Paired ambulacra superficial, slightly flexuous; anterior paired ambulacra much less flexuous or nearly straight, diverging at a larger angle as compared with that of the posterior paired ambulacra which are shortest; anterior poriferous zones more flexuous than the posterior, the two zones nearly equal in width. In all petals poriferous zones somewhat wider than the interporiferous; pore paires composed of inner short and outer elongate pores. The ratio of the length of the outer pore, interval between the outer and inner pores and the length of the inner pore is 2 : 1 : 1. Paired pores similar, not conjugate; the outer pore wider and rounded at its two ends, while narrower in the middle part; the inner pore uniform in width, its inner end bent towards the ambitus in the middle part of the petal, but not so near the apical system. In the proximal and distal parts of the petal, the pores decrease in length; near the ambitus the pores similar, minute, nearly circular, close together, set obliquely, situated near the anterior outer corner of the ambulacral plate. Interporiferous zones covered with irregularly arranged granules.

Peristome subcircular, rather subpentagonal, shallow, about one-fourth of the length from the front, with a slightly emarginate labrum; plastron amphisternous. Periproct just a little above the posterior margin of the test, longitudinal oval in outline. Tubercles small, perforate, not crenulate, scattered uniformly; interporiferous zones of the paired ambulacra dotted with uniserial tubercles, about nine in number; tubercles comparatively small in the interporiferous zones of the anterior ambulacrum. No fascioles.

Text-figure 1. *Aphelaster serotinus* TANAKA and SHIBATA. Apical system of GSJ. 6092; magnified.

Text-figure 2. *Aphelaster serotinus* TANAKA and SHIBATA. Pore pairs in the anterior ambulacrum of GSJ. 6038; magnified.

Measurements (in mm.):—

Specimen reg. no.	GSJ. 6010
Length	36.8
Width	40.8
Height	10.6
Length of the ambulacra	
I	13.4
II	16.0
III	ca 14.3
IV	15.3
Width of the ambulacra	
I	5.2
II	5.2
III	4.5
IV	5.2
Number of the pore pairs	
I	31
II	35(+)
III	18(+)
IV	31(+)
Distance of apex from the anterior end	15.0

Remarks:—The present species resembles *Aphelaster integer* (GAUTHIER), the type species of *Aphelaster* in many points, but it is distinguishable from the latter by the following points. In the species described here, all the ambulacra of which the paired ambulacra are less flexuous or nearly straight are more petaloid as compared with the case of the type species; then the paired pores are peculiar in shape. It may be also a character for discriminating this species from *Aphelaster integer* that tubercles in the interporiferous zones are smaller in the anterior ambulacrum than in the paired ambulacra. Furthermore, it is pointed out by LAMBERT (1933) that *Aphelaster* is closely related to *Toxaster* (*Eotoxaster*) and that the former was derived from the latter. The present writers who agree with LAMBERT's opinion can indicate some morphological changes in the lineage from *Toxaster* (*Eotoxaster*) *africanus* (COQUAND), the representative of this subgenus through Hauterivian *Aphelaster integer* to Barremian *Aphelaster serotinus* as noted below. That is, the paired ambulacra are less flexuous in the second species than in the first and then become nearly straight in the Barremian species of *Aphelaster* of this country. Further, all of the ambulacra are more petaloid in *Aphelaster serotinus* than in *A. integer* and *Toxaster* (*Eotoxaster*) *africanus*. Besides, the anterior sulcus and anterior notch are shallow in *Toxaster* (*Eotoxaster*), while they become very indistinct or non-existing in *Aphelaster*. Still, all the specimens were obtained from muddy facies. That fact may indicate that *Aphelaster serotinus* lived in muddy layers on the sea-floor.

Occurrence:—(1a) About 800 m. southeast of Yoshikawa, Tasukawa-mura, Arita-gun, Wakayama Prefecture (Yuasa district); Arita formation; sandy siltstone (GSJ. 6010; coll. by TANAKA). (1b) Suhara Pass, north of Yuasa-machi, Arita-gun, Wakayama Prefecture; Arita

formation: sandy siltstone (GSJ. 6038: coll. by TANAKA), (2) north of a hill called Hachiryuzan, Takata-mura, Yatsushiro-gun, Kumamoto Prefecture: Hachiryuzan formation; shale (coll. by MATSUMOTO and KAMMERA),* (3) Tatsukawa, Katsura-machi, Katsura-gun, Tokushima Prefecture: Hanoura formation (coll. by YAMASHITA), and (4) Ishido, Ohinata-mura, Minamisaku-gun, Nagano Prefecture (Sanchu graben): Ishido formation: siltstone (GSJ. 6092 and 6093: coll. by YABE). Aritan epoch in the Japanese province, approximately Hauterivio-Barremian age (Arita formation: Barremian in age).

* The specimen is probably identical with the present species, although the features of the ambulacral pores can not be fully ascertained due to its ill-preservation.

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Explanation of Plate 10

Aphelaster serotinus TANAKA and SHIBATA, new species

Figs. 1a-b. 1a, Adapical surface, ×1.2. 1b, Actinal surface, ×1.2. Ishido formation. (Holotype, GSJ. 6092).

Figs. 2a-b. 2a, Adapical surface, ×1.2. 2b, Actinal surface, ×1.2. Arita formation. (Paratype, GSJ. 6010).

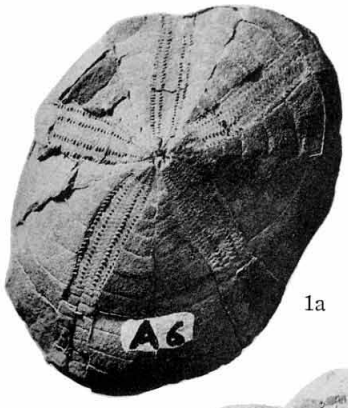
Figs. 3a-b. 3a, Adapical surface, ×1.5. 3b, Adapical surface, ×3. (External mould). Arita formation. (Paratype, GSJ. 6038).

Figs. 4a-b. 4a, Adapical surface, ×1.2. 4b, Actinal surface, ×1.2. Ishido formation. (GSJ. 6093).

Fig. 5. Adapical surface, ×1. Hanoura formation.

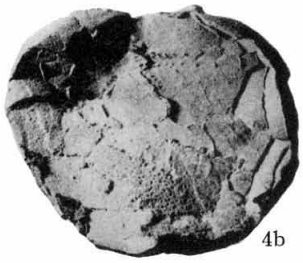
Fig. 6. Adapical surface, ×1. Hachiryuzan formation.

All specimens here illustrated are internal moulds unless otherwise stated.

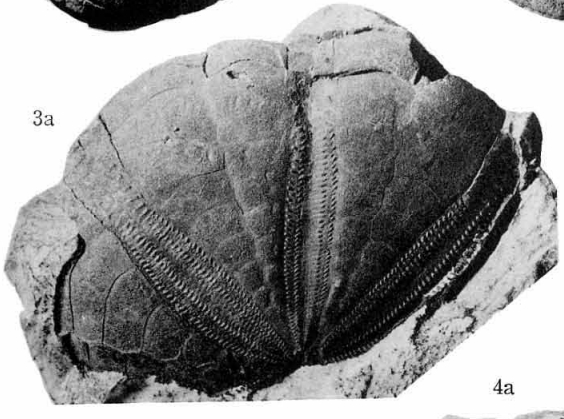


1a

1b



4b

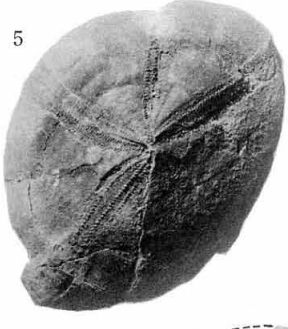


3a

2a

2b

4a



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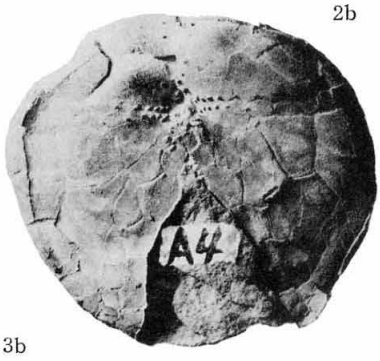

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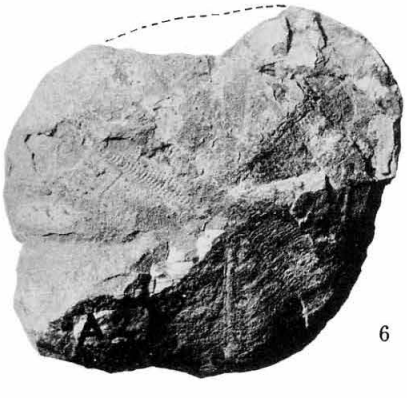

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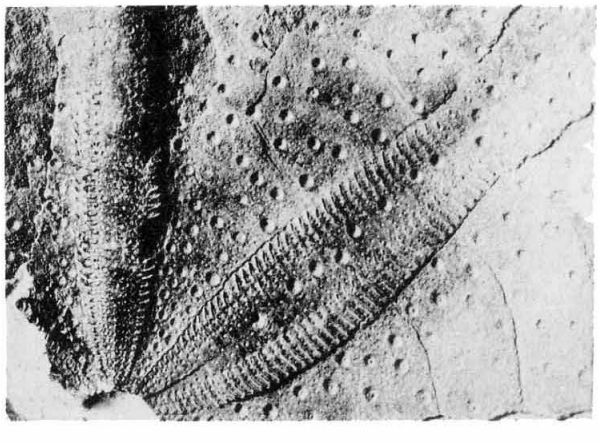

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405. ON SOME CONSIDERATION OF THE MOLLUSCAN FAUNA FROM THE ASAGAI FORMATION*

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浅貝層産貝化石群についての一考察：これまでの研究によると浅貝動物群は北方系に属し，寒冷な気候を示すものとされてきた。しかるにこの度四倉駅北方の八日十日トンネルの複線化工事の際に採集された貝化石の中には，保存の良好な *Pitar* (*Pitarina*) *matsumotoi* (NAGAO) ならびに *Soletellina* (s. s.) *kobiyamae* KANNO, n. sp. などの南方系の貝化石を豊富に含んでいることがわかった。これらの事実から浅貝動物群の示す古気候は決して寒冷なものではなかったことを指摘した。　菅野三郎

Introduction

The molluscan fossils collected by Mr. H. KOBIYAMA from the Yakatoka tunnel (八日十日トンネル) which is now being constructed along for the Joban line about 500 meters north of the Yotsukura station (四倉駅), were sent to the writer for examination. The fossils were determined to comprise *Yoldia asagaiensis* MAKIYAMA, *Venericardia* (*Cyclocardia*) *tokunagai* YOKOYAMA, *Pitar* (*Pitarina*) *matsumotoi* (NAGAO), *Papyridea harrimani* DALL, *Soletellina kobiyamae* KANNO, n. sp., *Mya* (*Arenomya*) *grewingki* MAKIYAMA, *Periploma besshoense* (YOKOYAMA), *Crepidula auricula* YOKOYAMA, *Ampulina asagaiensis* MAKIYAMA, and *Colus asagaiensis* MAKIYAMA.

It is noteworthy that the present fauna includes *Pitar* (*Pitarina*) *matsumotoi* and *Soletellina kobiyamae* KANNO, n. sp., which are recorded for the first time from the Asagai formation. Moreover, *Pitar* (*Pitarina*) *matsumotoi* is originally recorded from the Ashiya formation of north Kyushu and subsequently known to occur from the Wakkanabe formation of Hokkaido.

The writer here expresses his thanks to Prof. Wataru HASHIMOTO of our Institute, and Prof. Kotora HATAI, Institute of Geology and Paleontology, Tohoku University, for their continued encouragement. Thanks are also due to Mr. Hajime KOBIYAMA for kindly offering his collection to the writer for study and for his kind collaboration in the field. The writer extends his thanks to Mr. Atsuyuki MIZUNO, Geological Survey of Japan, for his permission to examine the molluscan fossils collected from the Paleogene formations of north Kyushu now preserved in the Survey.

Geology of the Vicinity of the Yakatoka Tunnel

The present molluscan fauna was collected from about 10 meters above the base of the Asagai formation at about 100 meters north of the southern entrance of the Yakatoka tunnel. Here the Asagai is superposed on the Iwaki formation with conformity. The Iwaki comprises

* Received Feb. 23, 1961 ; read at the annual meeting of the society at Tokyô, Jan. 15, 1961.

sandstone and conglomeratic sandstone and its uppermost has coaly shale or a nearly one meter thick coal seam.

The Asagai formation preserves abundant molluscan fossils whereas the coal seam of the uppermost part of the Iwaki yields some plant fossils as *Musophyllum* sp., *Sabalites* sp. and others.

Among the molluscan fossils, almost all of the pelecypods were found in natural position (INOMATA and HIGUCHI, 1955, p. 29), especially, *Mya* (*Arenomya*) *grewingki* occurs parallel to the bedding plane and in natural position.

Characteristics of the Asagai Fauna

The geological age of the Asagai formation has been discussed by many workers such as TICHANOWITSCH (1909), YOKOYAMA (1924), MAKIYAMA (1934), HATAI and NISIYAMA (1949), HATAI and KAMADA (1950), and HIRAYAMA (1955) from the stand-point of the molluscan fossils, while ASANO (1949) stated his view on the basis of the foraminiferal fauna. Many of them conclude that the Asagai belongs to the upper Oligocene or Aquitanian (MAKIYAMA; HIRAYAMA), middle Oligocene or Rupelian (HATAI and KAMADA) or Oligocene (ASANO; HATAI and NISIYAMA).

Moreover, all workers have expressed the view that the thermal condition of the Asagai fauna is a typically boreal or cold water type based upon the molluscan and the foraminiferal genera in the Asagai fauna. The molluscan genera as *Cyclocardia*, *Liocyma*, *Thyasira*, *Ancistrolepis*, *Buccinum*, *Aulacofusus* and *Margarites* range in the northern Pacific, namely, north of Hokkaido, and extend along the west coast of North America down to Oregon and California. ASANO (1949) noticed that the Asagai assemblage is of cold water judging from *Elphidium asagaiense* ASANO, and *E. yumotoense* ASANO, which resemble some species widely distributed in the Arctic seas.

The marine Eocene fauna of Kyushu comprises such foraminifers as *Nummulites* and *Discocyclina*, and such molluscs as *Orthaulax* and *Athleta*, all of which are inhabitants of the tropical regions. The Eocene flora of the Ishikari group contains such genera as *Sabalites* and *Musophyllum* which resemble some genera now widely distributed in the tropical to subtropical regions.

The marine Oligocene faunas of Japan excepting for the Asagai comprise tropical to subtropical elements, namely, *Arca*, *Crassatellites*, *Pitar*, *Callista*, *Turritella*, *Phalium*, *Cypraea*, *Conus*, and nautiloids. These molluscan genera seems to be inhabitants of rather warm temperate condition.

The Miocene marine fauna includes larger foraminifers as *Lepidocyclina* and *Miogypsina* as well as molluscs which are characteristic and widely distributed in the tropical to the subtropical areas in the world. Moreover, the so-called Kadonosawa fauna of middle Miocene age in Japan shows features characteristic of the subtropical type. However, the Kadonosawa fauna is replaced by the Yama fauna (OTUKA, 1943) and the Tôgeshita fauna (HASHIMOTO, 1950) which are characterized by the mixture of inhabitants of cool and warm waters.

In the Pliocene the marine fauna is characterized by rather cool inhabitants.

Shortly speaking, during the Eocene to Oligocene, the marine climate of the Pacific coast of Japan estimated from the marine fauna and flora was rather warm and shows tropical or subtropical characteristics excepting for the Asagai fauna. Such conditions seem to continue to the middle Miocene of Japan. While

it had started to shift south of that warm climate and replaced by rather frigophilic (cold limited) fauna during the upper Miocene to Pliocene. Accordingly, the discordance arises among the characteristics of the Asagai and the other Oligocene faunas in Japan. From the abovementioned reasons, the Asagai fauna should be re-examined from the view-point of the thermal condition. The new occurrence of *Pitar* (*Pitarina*) *matsumotoi* and *Soletellina kobiyamae* may serve to interpret these inharmonious phenomena.

Pitar (*Pitarina*) *matsumotoi* is known to occur from the Yamaga and the Sakamizu formations (Oligocene) of the Ashiya group in northern Kyushu. The Yamaga and the Sakamizu faunas comprise the inhabitants of rather warm waters. In addition, the recent species of the genus *Pitar* is distributed from the equator to N. lat. 36° along the Pacific coast of Japan.

Fourty molluscan genera have been reported from the Asagai formation, of which 11 genera are distributed in the area ranging from the equator to north of N. lat. 70° along the Pacific coast of Japan, namely;

Glycymeris	0°-39°	*Tellina*	0°-72°
Lima	0°-40°	*Soletellina*	0° 51°
Laevicardium	0°-33°	*Calyptraea*	0°-35°
Papyridea	0°-25°	*Turritella*	0°-35°
Dosinia	0°-42°	*Epitonium*	0°-39°
Mactra	0°-46°		

The Asagai fauna, indeed, comprises abundant molluscs such as *Conchocele*, *Liocyma*, *Venericardia*, *Mya*, *Margarites*, *Aulacofusus*, and *Buccinum*, all of which distribute rather in the northern Pacific. However, the presence of tropical or subtropical elements should be considered to interpret the paleoclimate estimated by the fossil fauna. Durham (1960, p. 4) stated "the presence of thermophilic organisms seems to be much more important than the presence of *cool water elements*, but their significance must be supported by evidence (such as growth stages) that they lived (in the sense of completing a life cycle) where found", and "within the marine environment frigophilic organisms can usually find suitable temperatures in deeper water within the same region, and they are thus not significant in terms of the regional climate". For instance, as cited by Durham (1950), the gastropod *Fusitriton oregonensis* which is common in intertidal area from Puget Sound to Alaska is found only in deeper water off southern California. The same case was pointed out by Naruse (1952) and the writer (1960, p. 152) based upon the distribution of the genus *Ancistrolepis* along the Pacific coast of Japan, namely, *Ancistrolepis okhotensis* Dall which had been collected from off Sakhalin (N. lat. 48°) from 109 fathoms and *A. trochoideus* (Dall) from off Yokohama (N. lat. 33°) from 600 fathoms.

On the other hand, paleoclimatic studies along the Pacific coast of North America are being progressed by many workers as Durham (1950, 1960), Chaney (1940), Dorf (1955), and Barghoorn (1953), based upon the distribution of the marine fauna and flora. Floras and faunas of a "subtropical" type extended much further poleward in the northern hemisphere during the early Tertiary than at present. However, they gradually retreated towards the tropics during the later Tertiary.

The climatic changes during the early to late Tertiary agree with one another on both Pacific coasts of Japan and Northwest America. The conclusion on the basis of the new occurrence of *Pitar* and *Soletellina* leads us to the opinion

that the Asagai fauna is not a boreal fauna but a subtropical to temperate one.

Description

Family Carditidae

Genus *Venericardia* LAMARCK, 1801

Subgenus *Cyclocardia* CONRAD, 1867

Venericardia (Cyclocardia) tokunagai YOKOYAMA, 1924

Pl. 11, Figs. 1-3

1924. *Venericardia tokunagai* YOKOYAMA, YOKOYAMA: *Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 45, art. 3*, p. 18, pl. 3, figs. 10-12.

1955. *Venericardia (Cyclocardia) tokunagai* YOKOYAMA, HIRAYAMA: *Sci. Rep. Tokyo Univ. Education, sec. C, vol. 4, no. 29*, p. 89, pl. 2, figs. 17, 19, 20.

1960. *Venericardia (Cyclocardia) tokunagai* YOKOYAMA, OYAMA, MIZUNO and SAKAMOTO: *Ill. Handb. Jap., Paleog. Moll.*, p. 151, pl. 44, figs. 7a-c.

Remarks:—The present species was originally reported by YOKOYAMA from the Asagai formation distributed in Hirono-mura, Futaba-gun, Fukushima Prefecture. However, the type specimens are so meager that some confusion arises as to specific determination. The supplementary note is given as follow: The outline of the shell exhibits considerable variation, namely, one is obliquely trigonal and the other shows rather rounded shell, and intermediate forms between them exist. Surface ornamented with about 25 radial ribs which are slightly elevated, round-topped and separated with round-bottomed, shallow grooves. When the outer layer is missing, the ribs show distinctly angular, flat-topped radials. Growth lines sinuate on the ventral border.

Reg. no. 6116.

Family Veneridae

Genus *Pitar* RÖMER, 1857

Subgenus *Pitarina* JUKES-BROWN, 1913

Pitar (Pitarina) matsumotoi (NAGAO), 1928

Pl. 11, Figs. 4-8

1928. *Pitaria matsumotoi* NAGAO, NAGAO: *Sci. Rep., Tohoku Imp. Univ., ser. 2, vol. 12, no. 1*, p. 73, pl. 11, fig. 17; pl. 13, figs. 4-6.

1940. *Pitar* sp. KUROSE: *Mem. Fac. Sci. Eng., Waseda Univ., no. 13*, pl.-fig. 5 (no description).

1952. *Pitar* (s. s.) *matsumotoi* (NAGAO), MIZUNO: *Trans. Proc. Palaeont. Soc. Japan, N. S., no. 6*, p. 192 (no. fig.).

1955. *Pitar* cf. *matsumotoi* (NAGAO), UOZUMI: *Ditto., no. 19*, pp. 78-79, pl. 12, figs. 1, 4.

1956. *Pitar matsumotoi* (NAGAO), HIRAYAMA: *Sci. Rep. Tokyo Univ. Education, sec. C, vol. 5, no. 45*, p. 114, pl. 4, fig. 15.

1960. *Pitar matsumotoi* (NAGAO), OYAMA, MIZUNO, and SAKAMOTO: *Ill. Handb. Jap. Paleog. Moll.*, p. 184-185, pl. 57, figs. 1a-c.

Remarks:—The present species was originally described by NAGAO from the Yamaga formation of the Ashiya group in northern Kyushu. The specimens at hand are similar in outline to the holotype of the named species and are characterized by having transversely quadrate-ovate shell, evenly convex postero-ventral end, slightly concave antero-dorsal margin, faintly arched postero-dorsal border, and nearly horizontal, short, and triangular pallial sinus.

According to NAGAO's original description, there is a faint groove-like depression extending into the shell at a distance of one-third of the length of the shell.

However, the present specimens have hardly no groove-like depression and deeper pallial sinus, and thicker shell. These differences seem to depend upon the state of fossil preservation.

The present specimens are so well preserved that their hinge structure can be observed as follow: Hinge teeth consisting in the right valve of a strong middle cardinal, a rather strong posterior cardinal, a thin anterior one which are connected with one another making an arch and an anterior socket, and in the left valve of a large posterior cardinal, a thinner cardinal in front and an elongate anterior lateral.

The present species has been reported from the Yamaga formation (upper Oligocene) of the Ashiya group and its correlative in northern Kyushu and the Wakkanabe Eocene in Yubari City in Hokkaido (Uozumi, 1955). However, the latter specimens seem to be not conspecific with the named species because they have rather straight postero-dorsal margin, more rounded ventral border, more pointed narrow pallial sinus, and weak hinge teeth.

Reg. No. 6117.

Family Asaphidae

Genus *Soletellina* Blainville, 1824

Subgenus *Soletellina* s. s.

Soletellina (s. s.) *kobiyamae* Kanno, n. sp.

Pl. 11, Figs. 9-12

Shell moderate in size, equivalved, inequilateral, compressed, ovate-rectangular in outline; beaks rather inconspicuous, anterior to the middle; antero-dorsal margin short, gently convex, turned into broadly rounded anterior end; posterior dorsal margin long, nearly straight; ventral border rather straight merging into widely arched or somewhat truncated posterior margin, making blunt angle between the postero- and postero-dorsal margins. Surface of shell covered by fine, irregular lines of growth. Nymph plate missing. Hinge teeth consisting in the left valve of a small, but distinct anterior cardinal and thin and week posterior one; the anterior cardinal more or less bifid; hinge plate of a right valve inaccessible. Pallial sinus deep and wide. Anterior muscle scar rather rounded, the posterior somewhat narrow and elongated.

Measurements:—ca. 65 mm in length; 45 mm in height; 14 mm in thickness of intact valves (holotype).

Comparison:—*Soletellina* (*Nuttalia*) *ezonis* Kuroda et Habe (1955, p. 17, pl. 1, figs. 12-13), a Recent species of the Pacific coast of eastern Hokkaido, is more or less akin to the present one, but differs therefrom by having equivalved shells, widely rounded ventral margin and sloping postero-dorsal border, and narrowly rounded posterior margin. *Soletellina minoensis* Yokoyama (1926, p. 221, pl. 28, fig. 14) from the Tsukiyoshi Miocene of Gifu Prefecture somewhat resembles the present species, but the former differs from the latter by having more elongate, thick and lower shell.

Remarks:—The genus *Soletellina* Blainville, 1824, has been reported from the Miocene in Japan, thus the present occurrence seems to be the oldest in our country.

Reg. Nos. 6118 (holotype); 6119 (paratype).

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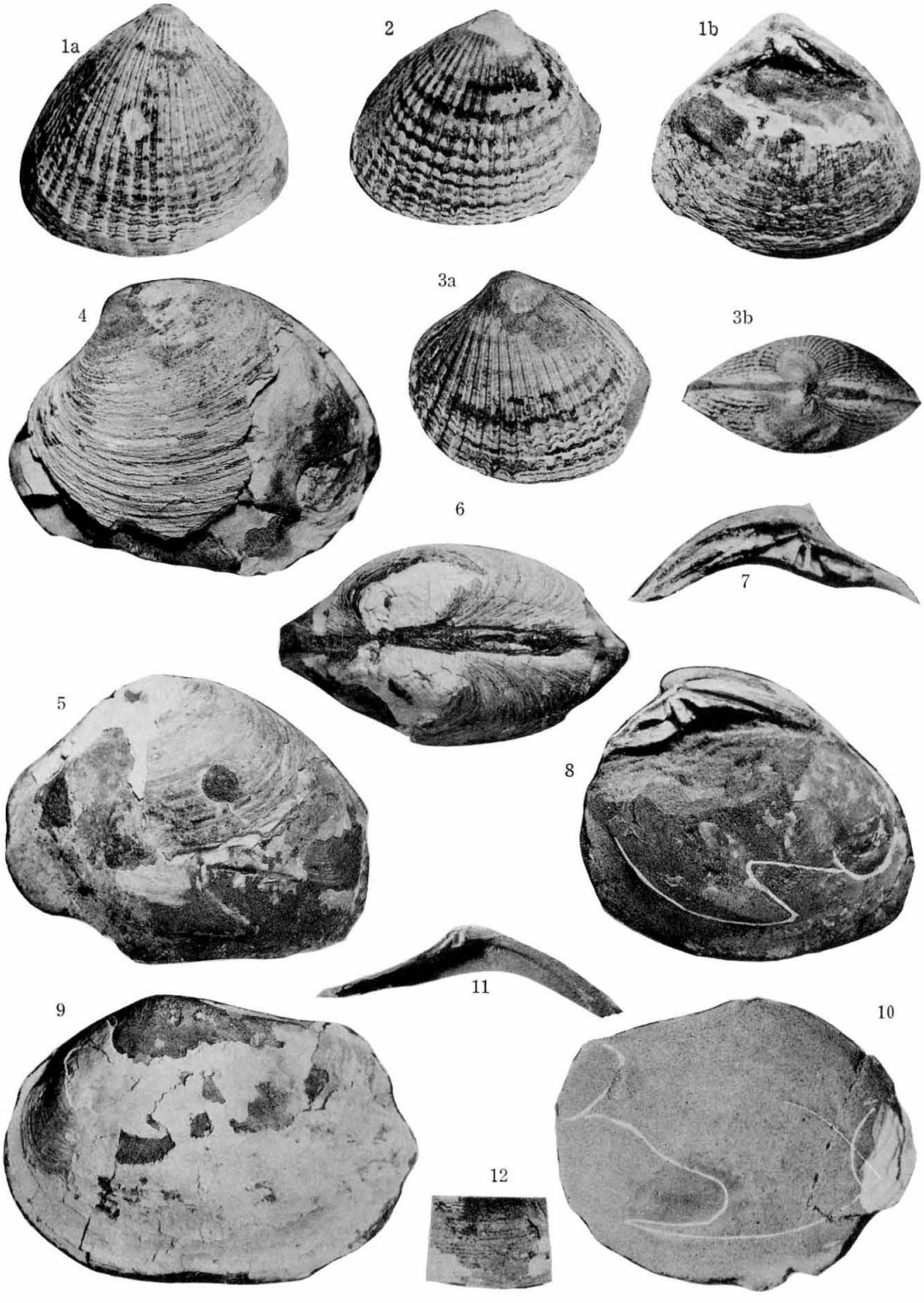
Explanation of Plate 11

(All figures in natural size)

Figs. 1-3. *Venericardia* (*Cyclocardia*) *tokunagai* YOKOYAMA
- Fig. 1b. Showing the cardinal teeth of fig. 1a.
- Fig. 3b. Showing the apical view of fig. 3a.

Figs. 4-8. *Pitar* (*Pitarina*) *matsumotoi* (NAGAO)
- Figs. 7-8. Showing the cardinal teeth of left and right valves.

Figs. 9-12. *Soletellina* (s. s.) *kobiyamae* KANNO, n. sp.
- Fig. 9. Holotype.
- Fig. 10. Paratype.
- Fig. 11. Showing the hinge teeth of a left valve.
- Fig. 12. Showing the outer surface of shell.



S. AOKI photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 42, pp. 79-87, pl. 12, June 10, 1961

406. A FIND OF *MONOTIS (ENTOMONOTIS)* FROM EASTERN YAMAGUCHI PREFECTURE, JAPAN*

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Institute of Geology and Mineralogy, Faculty of Science,
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山口県東部より *Monotis* (*Entomonotis*) の発見：山口県玖珂郡美和町向畑の北方約1kmの地点からあらたに産出した *Monotis* (*Entomonotis*) の2種を記載し，あわせてその地質時代と付近の地質について略述する。 長谷 晃

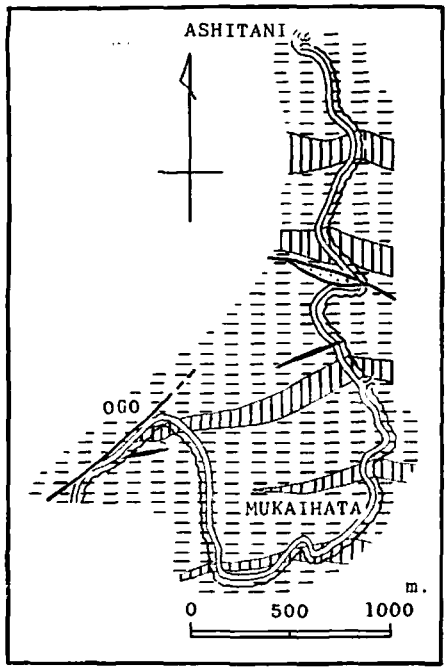
Introduction and Acknowledgements

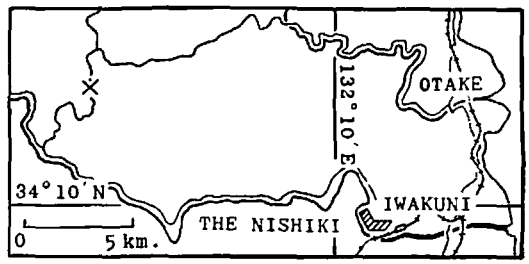
The Upper Triassic (Norian) *Monotis* (*Entomonotis*) was recently discovered from the siltstone exposed at a new wayside cutting, about 1 km. north of Mukaihata, Miwa-cho, Kuga-gun, Yamaguchi Prefecture (see Text-fig. 1). Several fossil specimens were at first sent me by Mr. Makoto SHIMAOKA of Miwa Middle School. Subsequently, many well-preserved specimens were collected and the geology was investigated by myself assisted by some members of Hiroshima University. The area around the locality is mainly occupied by the late Paleozoic strata named the Kuga group, and is situated between the two metamorphic zones in the Inner Zone of Southwest Japan, the Sangun and the Ryoké (KOJIMA & OKAMURA, 1952; KOJIMA, 1953; NUREKI, 1960). Therefore, the discovery of *Monotis* (*Entomonotis*) seems to be of significance for the analysis of the geologic history of this district. In this paper I describe two species of the genus from the above-mentioned locality; one is identical to the Siberian species, *Monotis* (*Entomonotis*) *typica* (KIPARISOVA), and the other represents a new species. Brief notes on geology are also given.

I wish to express my sincere thanks to Professor Tatsuro MATSUMOTO of Kyushu University and Professor Sotoji IMAMURA of Hiroshima University for their advice, encouragement and kindness of reading the typescript. Many thanks are also due to Dr. Koichiro ICHIKAWA of Osaka City University for his valuable suggestion, to Professor Teiichi KOBAYASHI and Dr. Itaru HAYAMI of Tokyo University for their help, to Professor George KOJIMA, Mr. Kei HIDE, Dr. Mitsuo NAKANO and Dr. Terukazu NUREKI of Hiroshima University for their help and criticism, and to Messrs. Kazuo OKAMOTO and Tsuruo YOKOYAMA of the same university for their assistance in collecting fossil specimens. Finally, particular thanks are due to Mr. Makoto SHIMAOKA of Miwa Middle School, who showed me the fossil locality.

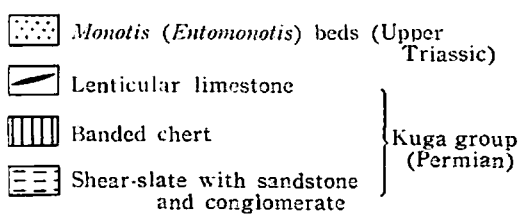
Repository: All the specimens described in this paper are kept in the Institute of Geology and Mineralogy, Faculty of Science, Hiroshima University, Hiroshima, Japan.

* Received Mar. 3, 1961; read at 72nd meeting of the society at Hiroshima, Feb. 14, 1959.





Text-fig. 1. Index map of the locality of *Monotis* (*Entomonotis*).



Text-fig. 2. Geological map of the Mukaihata area.

Paleontological Descriptions

Class Pelecypoda

Family Monotidae

Genus *Monotis* BRONN, 1830

Type-species:—*Pectinites salinarius* SCHLOTHEIM, 1820, by subsequent designation by HERRMANNSEN (1852).

Subgenus *Entomonotis* MARWICK, 1935

Type-species (of the subgenus):—*Monotis richmondiana* ZITTEL, 1864, by original designation.

Monotis (*Entomonotis*) *typica* (KIPARISOVA)

Pl. 12, figs. 1a, b, 2-11

1932. *Pseudomonotis scutiformis* TELLER, KIPARISOVA, *Trans. Geol. Prosp. Serv., U. S. S. R., fasc. 111*, p. 21, pl. 1, figs. 14-18.

1936. *Pseudomonotis scutiformis* var. *typica* KIPARISOVA, *Trans. Arctic Inst., vol. 30*, p. 118, pl. 1, figs. 6, 7, 9, 10.

1954. *Pseudomonotis* (*Entomonotis*) *scutiformis* var. *typica*, KIPARISOVA, *Field atlas of the fauna and flora of the Triassic formations in Primorskij Kraj*, p. 38, pl. 29, figs. 7-9.

1958. *Monotis* (*Entomonotis*) *typica*, ICHIKAWA, *Palaeontographica, vol. 111, pt. A, fasc. 5-6*, p. 180.

Types:—*Pseudomonotis scutiformis* var. *typica* was established by KIPARISOVA (1936) on syntypes, of which four were illustrated (pl. 1, figs. 6, 7, 9, 10). I have not seen the actual specimens.

Material:—Among a hundred and more specimens collected by K. HIDE, T.

Nureki, K. Okamoto, T. Yokoyama and myself, the comparatively well preserved ones are IGSH-HA 321A-C, 322A, B, 323, 324A-C, 325A, B, 326-336, 337A, B, 338A, B, 339, 340, 341A-C and 342A-D (right valves, 321-332, 341B, C, 342B, C, D; left ones, 333-340, 341A, 342A).

Diagnosis:—Shell of moderate size, oblique-oval in outline, but sometimes nearly circular, somewhat longer than high or almost as high as long, inequivalve, somewhat inequilateral, rounded in front, slightly or considerably produced postero-ventrally. Left valve moderately inflated, most convex near the center of the valve; right valve weekly convex or almost flat except the umbonal area.

Hinge-line about 2/5 as long as the shell-length. Postero-dorsal margin fairly long, straight, forming an obtuse angle with the posterior margin; posterior wing rather well developed but ill-defined, triangular, flattened or slightly concave; posterior margin long, nearly straight or sometimes slightly concave, forming a rounded angle with the ventral margin, which is long, arched and passing insensibly into the well rounded anterior margin; anterior wing small, rounded, not well defined. Byssal ear small but distinctly projected obliquely upwards from the umbo of the right valve, with a slit-like byssal notch beneath.

Umbo of the left valve rather large, prominent, strongly incurved, prosogyrous, projected considerably beyond the hinge-margin, situated at about 2/5 to 1/3 the length of the shell from the anterior end; umbo of the right valve smaller and less elevated than that of the left, pointed, slightly projected above the hinge-margin. A ridge extending from the umbo towards the postero-ventral corner, at first distinct and then gradually flattened.

Surface-ornament similar in the two valves, consisting of numerous radial ribs of two orders (rarely three orders), besides the concentric growth-lines and undulations. Radial ribs almost straight, but in the anterior part curved upwards, as broad as or somewhat narrower than the nearly flat interspaces, well defined, moderately prominent, round-topped, narrower and more closely set on both the anterior and posterior sides than on the median area, having a tendency to be weakened towards the posterior, but still distinct on the posterior wing; ribs of the second order, which appear usually in the middle growth-stage, becoming almost as strong as the primaries in the later stage; fine and short ribs of the third order infrequently inserted near the periphery; the total number of the ribs, inclusive of those on the posterior wing, about 40 to 55, predominantly about 45 to 50. Radial ribs crossed by fine, rather regular, crowded concentric growth-lines and several irregularly developed concentric wrinkles or folds.

Measurements:—The specimens at hand are often too much deformed for the precise measurement. The following dimensions are mostly based on less deformed specimens.

Specimen: IGSH-HA	Length (mm.)	Height (mm.)
321A (right valve)	26	21
321B (do.)	21.5	22
322A (do.)	22	17.5
323 (do.)	31.5	34
326 (do.)	32	38.5

331	(do.)	25	21
332	(do.)	24	22.5
333	(left valve)	27.5	19.5
334	(do.)	26	20
335	(left valve, immature)	14	13
341B	(right valve, immature)	17	13

Remarks:—From the above-described characters, the specimens before me are identified to *Monotis* (*Entomonotis*) *typica* (KIPARISOVA), which has been reported from the Upper Triassic of East Transbaikalia, Werchojansk, the Kolyma-Indigirka Land and the Maritime Province, all in East Siberia.

The secondary deformation prevents me from examining the variation of the shell-outline and the inflation. In IGSH-HA 321A (Pl. 12, fig. 1a, b) and HA 321B (Pl. 12, fig. 2), both of which seem to be scarcely deformed, the ratios of the length to the height are 1.24 and 0.98 respectively.

The intercalation of the ribs of the second order is generally not so conspicuous as in the syntypes of KIPARISOVA (1936, pl. 1, figs. 6, 7, 9, 10). In the immature specimens and even in some of the adult ones [e.g. IGSH-HA 337B (Pl. 12, fig. 6)], the radial sculpture consists of the primary ribs only, with the secondary ribs infrequently inserted near the periphery. In certain other examples [e.g. IGSH-HA 339 (Pl. 12, fig. 7), HA 341A (Pl. 12, fig. 9), HA 341C (Pl. 12, fig. 8)] a secondary rib appears in every interspace between the primaries, and thus they are quite similar to the Siberian form. All the specimens at hand were collected from one and the same locality and are intimately connected in one morphic series. It is, accordingly, unwarrantable to divide them specifically or subspecifically.

Judging from the internal moulds, the inner surface of the shell reflects the radial ribs and concentric folds of the outer surface. The inner surface of the posterior wing is almost smooth. The byssal ear is well observable in IGSH-HA 329 (Pl. 12, fig. 11).

"*Pseudomonotis*" *scutiformis* var. *typica* KIPARISOVA (1936, p. 118) has been ranked by ICHIKAWA (1950, p. 19; 1958, p. 180) as an independent species. As KIPARISOVA stated, this is clearly distinguished from *Monotis* (*Entomonotis*) *scutiformis* (TELLER) (1886, p. 125, pl. 19, fig. 3a, b) by its more oblique-oval outline, more weakly differentiated radial sculpture and ribbed posterior wing. None of the Mukaihata specimens approaches that species. Therefore, I agree with ICHIKAWA in separating the two forms specifically. This species differs also from "*Pseudomonotis*" *scutiformis* var. *kolymica* KIPARISOVA (1936, p. 120, pl. 1, figs. 8, 11-14) in number and arrangement of the ribs.

In the shell-outline and the radial sculpture of two orders which covers the whole surface inclusive of the posterior wing, *Monotis* (*Entomonotis*) *typica* is closely allied to *M.* (*E.*) *jakutica* (TELLER) (1886, p. 124, pl. 17, figs. 16a, b, 17, 18; KIPARISOVA, 1954, p. 46, pl. 35, fig. 6) from Werchojansk and other areas of East Siberia, but the ribs are finer and more numerous in the former than in the latter. *M.* (*E.*) *ochotica densistriata* (TELLER) (1886, p. 119, pl. 17, figs. 7, 8, 13a, b, 14; pl. 18, figs. 9, 10; KOBAYASHI & ICHIKAWA, 1949, p. 253, pl. 9, fig. 15), a well-known Norian subspecies distributed in Japan and Siberia, resembles

the present species in the number of the radial ribs, but has a larger shell and a nearly smooth posterior wing which is rather well defined from the main part of the shell. Moreover, the ribs of that subspecies are of three orders. *M. (E.) multistriata* (Kobayashi and Ichikawa) (1949, p. 255, pl. 9, figs. 11, 12 ?, 14) from the Norian in the Sakawa basin in Shikoku, Japan, is another resembling species, but has less numerous and less differentiated ribs.

M. (E.) typica differs from *M. (E.) subcycloidea* (Kobayashi) (1935, p. 29, pl. 7, fig. 1) from the Kamosho formation in the western part of Yamaguchi Prefecture in outline of the shell, which suggests that the latter might be conspecific with *M. (E.) scutiformis*.

Occurrence:—About 1 km. north of Mukaihata, Miwa-cho, Kuga-gun, Yamaguchi Prefecture. This species is widely distributed in the Norian of East Siberia, and has been reported (but not fully described) also from the Kitakami Massif, Northeast Japan.

Monotis (Entomonotis) mukaihatensis Hase n. sp.

Pl. 12, figs. 12a, b, 13a, b, 14-16, 17a-c, 18

Material:—Holotype, IGSH-HA 311, a left valve (Pl. 12, fig. 12a, b). Paratypes, IGSH-HA 312, a left valve (Pl. 12, fig. 13a, b); IGSH-HA 313, a left valve (Pl. 12, fig. 14); IGSH-HA 314, a left valve (Pl. 12, fig. 15); IGSH-HA 315, a left valve (Pl. 12, fig. 16); IGSH-HA 316, conjoined valves of immature stage (Pl. 12, fig. 17a-c). Several other comparable specimens are also available to me. All were collected by K. Hide, T. Nureki, K. Okamoto, T. Yokoyama and myself.

Diagnosis:—Shell of moderate size, oblique-oval in outline, longer than high, somewhat inequivalve, highly inequilateral, short and rounded in front, prolonged postero-ventrally.

Left valve considerably inflated, most convex near the center of the valve; hinge-line about 1/3 to 1/4 as long as the shell-length; postero-dorsal margin short, nearly straight, forming an obtuse angle with the posterior margin; posterior wing small, triangular, not well defined; posterior margin long, weakly curved, gently descending and then bent forwards into the ventral margin, describing a semicircle; ventral margin long, arched, passing insensibly into the well rounded anterior margin; umbo of moderate size, strongly convex and incurved, projected considerably beyond the hinge-margin, situated at about 1/4 to 1/5 the length of the shell from the anterior end; beak prosogyrous; a ridge extending from the umbo towards the postero-ventral corner, at first distinct and then becoming obsolete.

Right valve similar to the left in outline, but less inflated, provided with a small spiniform byssal ear which is projected obliquely upwards from the umbo; antero-dorsal margin excavated beneath the ear to form a deep sinus; umbo smaller and less elevated than that of the left, projected a little above the hinge-margin.

Surface-ornament consisting of several irregularly spaced concentric wrinkles or folds of unequal strength and faint traces of radial ribs, the latter of which are entirely obsolete on the umbonal area.

Measurements:—Owing to the secondary deformation, the precise measurement is difficult. Some specimens measure approximately as follows.

Specimen IGSH-IIA	Length (mm.)	Height (mm.)	Thickness (mm.)
311 (left valve)	36.5	26	8
313 (do.)	29.5	23.5	7
316 (conjoined valves, immature)	16	14	3.5+2.5

Remarks:—The holotype specimen, which seems to be scarcely deformed, is about 1.4 times longer than high. About 15 radial ribs are countable on its antero-ventral area, which are low but rather distinct, closely set, uniform in strength and almost as broad as the interspaces. There are about 10 indistinct traces of ribs on rather broad area of the posterior half. The radial sculpture on the rest of the surface is almost effaced. In IGSH-IIA 316 (a paratype, immature) about 25 ribs are countable along the antero- and postero-ventral margins of the right valve. While the concentric undulations are distinct on both the external and internal moulds, the radial sculpture is very obscure on the latter.

The present shell can undoubtedly be referred to *Monotis* (*Entomonotis*) by its outline, inequivalve shell and distinctly projected byssal ear with a deep byssal notch beneath, the last of which is well observable on the right valve of IGSH-IIA 316 (Pl. 12, fig. 17a-c).

Among the species of *Monotis* (*Entomonotis*) hitherto described from the Upper Triassic in Japan and East Siberia, *M.* (*E.*) *zabaikalica* (KIPARISOVA) (1932, p. 30, pl. 2, figs. 12, 13; 1936, p. 80, pl. 1, fig. 5; KOBAYASHI & ICHIKAWA, 1949, p. 257, pl. 10, figs. 12-20; synonym: *Entomotis kurosawai* SAKAGUCHI, 1939, p. 229, pl. 15, figs. 1-6) has the closest resemblance to *M.* (*E.*) *mukaihatensis* in the oblique-oval outline, the strongly convex left valve and the retrogressive radial sculpture. In *M.* (*E.*) *zabaikalica* *zabaikalica*, however, the effacement of radial sculpture is more evident than in this species; the whole surface is almost smooth except for the concentric undulations. In *M.* (*E.*) *zabaikalica semiradiata* ICHIKAWA, 1958 (=*E. zabaikalica* var. *intermedia* KOBAYASHI & ICHIKAWA, 1949, p. 258, pl. 10, figs. 19, 20), the distinct ribs are on the umbonal area, while near the periphery they are obsolete. The reverse is the case in the species in question. In this respect the present species is very similar to *M.* (*E.*) *sublaevis* (TELLER) (1886, p. 125, pl. 19, fig. 2a, b) from Werchojansk, but is distinguished by its smaller posterior wing and shorter hinge-margin. "*Pseudomonotis*" sp. nov. described by KIPARISOVA (1936, p. 117, pl. 1, figs. 1-3) from the Kolyma-Indigirka Land also resembles this in surface-ornament, but the radial ribs are more obsolete and the posterior wing is larger in the former than in the latter.

Monotis routhieri AVIAS (1953, p. 113, pl. 25, fig. 4) from the Upper Norian or the Rhaetian in New Caledonia and *M. calvata* MARWICK (1953, p. 58, pl. 6, figs. 21, 22, 26) from the strata of the same age in New Zealand are also characterized by the retrogression of the radial ribs. *M.* (*E.*) *mukaihatensis* is easily distinguished from the former by its smaller size and much more conspicuous concentric folds, and from the latter by its narrower and more numerous traces of ribs on the peripheral area.

Occurrence:—About 1 km. north of Mukaihata, Miwa-cho, Kuga-gun, Yama-

guchi Prefecture. Here, the present species coexists with but is much less abundant than *Monotis (Entomonotis) typica*.

Geological Notes

Both the late Paleozoic strata and the *Monotis (Entomonotis)* beds distributed in this area take the general trend of E-W and incline apparently monoclinally to the north with variable angles, but the structure is by no means simple (see Text-fig. 2). The Triassic strata seem to be inserted in the Paleozoic shear-rocks as a small "Schuppe". The thrust faults which cut off the former from the latter run in a direction of N60°±W, dipping to the NNE with an angle of 50-60°.

The Triassic strata are composed exclusively of siltstone. The siltstone is black to dark grey in color, massive to thickly stratified and sometimes sandy, with laminae of fine sandstone. Microscopically, the silt grains in clay matrix are usually subangular, with abundant quartz and minor amount of feldspar. Sericite flakes are also abundant. In some cases the siltstone is calcareous. The thickness of the outcropping strata is 10 m. or less.

The Paleozoic formation, that is a part of the Kuga group, is composed of "shear-slate" with subordinate sandstone and banded chert. Layers of conglomerate and lenses and nodules of limestone occur at horizons. The shear-slate is black in color, often containing teared blocks of sandstone, which are fusiform and are arranged along the shear-plane. It is cut obliquely by innumerable slaty cleavages. The sandstone is also sheared to some degree. The chert is milky to dark grey and thinly stratified. The complicated intraformational folds are common in it. The pebbles of the conglomerate are chiefly those of sandstone and subordinately those of chert, limestone and rhyolitic rock. Angular fragments of slate are also often contained. By the occurrence of *Yabeina* sp.* from a limestone lens near Naguwa, about 5 km. west of Mukaihata, the Kuga group of this area is assigned to the Permian, as suggested by Kojima and Okamura (1952) and Kojima (1953).

The Triassic rocks have also suffered from the shearing; the sandstone-laminae are teared in some degree and are cut by oblique cleavages. But the shearing is not so strong as in the Paleozoic slate.

The stratigraphic distribution of the species of *Monotis (Entomonotis)* has been well studied in the southern Kitakami Massif in Northeast Japan. According to Ichikawa (1950, 51, 54, 58) and Onuki and Bando (1958), *M. (E.) typica* occurs from the basal member of the upper Saragai formation, which is referred to the Lower Saragaian substage. Kiparisova (1932, 36, 54) regarded the age of this species in East Siberia as Upper Carnian, while Nakazawa (1958) and Ichikawa (1958) considered it to be Lower Norian.

M. (E.) mukaihatensis n. sp. is closely allied to *M. (E.) zabaikalica*. Kiparisova considered that the age of the latter species in Siberia is younger than that of *M. (E.) typica*. Similar relation has been observed in the Kitakami Massif, where *M. (E.) zabaikalica* occurs from the uppermost Saragai formation, that is the Upper Saragaian substage. In New Zealand and New Caledonia, the species with retrogressive radial sculp-

* The material was collected by Mr. Masatora Kawai of the Geological Survey of Japan. For the determination I am indebted to Mr. Kimiyoshi Sada of Hiroshima University.

ture (*Monotis calvata* MARWICK, 1953; *M. routhieri* AVIAS, 1953) have been reported from the Rhaetian and (or) the uppermost Norian (the strata above the *M.* (*E.*) *richmondiana* beds).

Such being the case, it is an interesting fact that the smooth species *M.* (*E.*) *mukaihatensis* coexists with the multiple-ribbed species *M.* (*E.*) *typica*. Recently, TUTSCHKOV (1955, after *Zentralblatt f. Geologie u. Paläontologie, Teil 2*, 1956, p. 160) has offered an opinion that the lower part of the Norian in Northeast Siberia is characterized by *M.* (*E.*) *scutiformis*, *M.* (*E.*) *typica* and *M.* (*E.*) *zabaikalica*. As *M.* (*E.*) *typica* predominates over *M.* (*E.*) *mukaihatensis*, the *Monotis* (*Entomonotis*) beds of Mukaihata are more probably assigned to the Lower Saragaian (Lower Norian) than to the Upper Saragaian (Upper Norian), and are possibly correlated to the Kamosho formation in the western part of Yamaguchi Prefecture.

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Explanation of Plate 12

(Figures of natural size, unless otherwise stated)

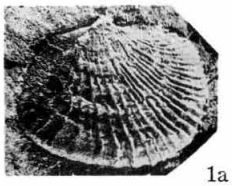
Monotis (*Entomonotis*) *typica* (KIPARISOVA) ..... p. 80

Fig. 1. Internal (1a) and external (1b) moulds of a right valve. IGSH-HA 321A.
Fig. 2. Internal mould of a right valve. IGSH-HA 321B.
Fig. 3. Left valve. IGSH-HA 333.
Fig. 4. Right valves. IGSH-HA 322A and B.
Fig. 5. Internal moulds of right valves of immature stage. IGSH-HA 324A, B and C.
Fig. 6. Internal mould of a left valve. IGSH-HA 337B.
Fig. 7. Internal mould of a left valve. IGSH-HA 339.
Fig. 8. Internal mould of a right valve. IGSH-HA 341C.
Fig. 9. Internal mould of a left valve. IGSH-HA 341A.
Fig. 10. Internal mould of a right valve. IGSH-HA 323.
Fig. 11. Internal mould of a right valve, showing the byssal ear, ×5. IGSH-HA 329.

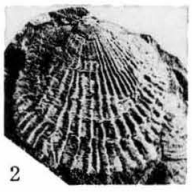
Monotis (*Entomonotis*) *mukaihatensis* HASE n. sp. ..... p. 83

Fig. 12. Internal (12a) and external (12b) moulds of a left valve. Holotype, IGSH-HA 311.
Fig. 13. Internal (13a) and external (13b) moulds of a left valve. Paratype, IGSH-HA 312.
Fig. 14. Internal mould of a left valve. Paratype, IGSH-HA 313.
Fig. 15. Internal mould of a left valve. Paratype, IGSH-HA 314.
Fig. 16. Internal mould of a left valve. Paratype, IGSH-HA 315.
Fig. 17. Internal (17a, b) and external (17c) moulds of conjoined valves of immature stage. 17b, showing the byssal ear of the right valve, ×5. Paratype, IGSH-HA 316.
Fig. 18. Internal mould of a left valve of immature stage. IGSH-HA 317.

All specimens came from a wayside cutting, about 1 km. north of Mukaihata, Miwa-cho, Kuga-gun, Yamaguchi Prefecture (Coll. K. HIDE, T. NUREKI, K. OKAMOTO, T. YOKOYAMA & A. HASE).


1a


1b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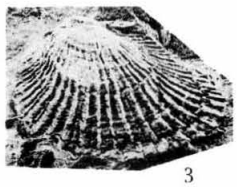
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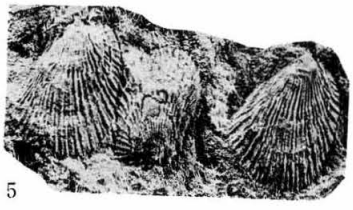
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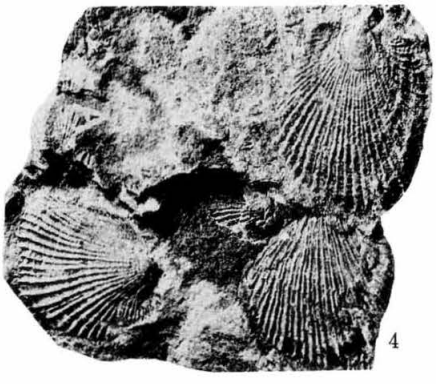
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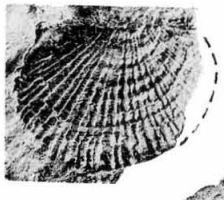
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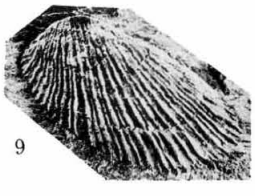
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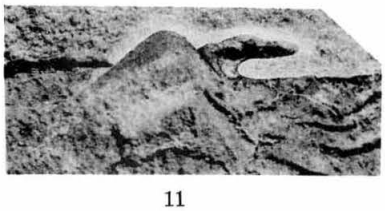
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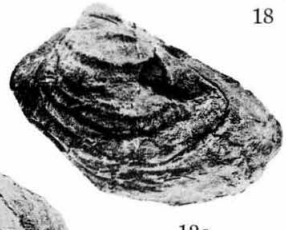
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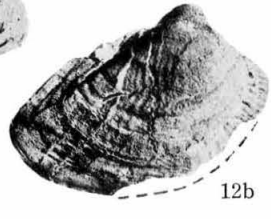

12b

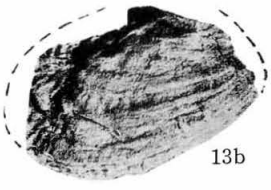

13a


14


17a


17c


16


13b


15


17b

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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第 78 回例会は，1961 年 5 月 13, 14 両日秋田大学鉱山学部において開催された。(参会者 31 名)

個 人 講 演 (5 月 13 日)

Fossil *Ailanthus* from Miocene flora of Hokkaido.....
....Toshimasa TANAI & Nobuo SUZUKI

Pollenformen aus den cozänen Kohlenflözen von Ishizuchi (代読) .....
..... Kiyoshi TAKAHASHI

On the evolution of the Osmundaceae ....
.....Seido ENDO

A new species of the genus *Clisiophyllum* from the Upper Carboniferous of the Ehime Prefecture, Southwest Japan (代読) ..Kenichi ISHII & Nobuo YAMAGIWA

Lower Permian Bryzoa from Miharano of the Taishaku limestone plateau, southwestern part of Japan (代読).....
.....Sumio SAKAGAMI & Saburo AKAGI

Gigantic Aturia from the Karatsu Coal-field in North Kyushu.....
.....Teiichi KOBAYASHI & Eiji INOUE

Notes on *Steinmannella* (*Yeharella*) *ainuana* (Yabe & Nagao) (代読)..Mitsuo NAKANO

On some new gastropods from the Kishima Group, North Kyushu (代読).....
..... Tugio SHUTO & Yoshio UEDA

Turrid gastropods from the Moeshima formation in Kagoshima Prefecture (代読)
..... Tugio SHUTO & Yoshio UEDA

A Fossil *Rhinoceros* from Kuzuû, Tochigi Prefecture, Japan (代読)..Joji NAGASAWA

秋田市北方豆腐岩付近の動物化石群について ..
..... 高安泰助

唐ノ浜層・登層の貝化石群について.....土 隆一

山形県尾花市銀山層産カニ化石 .....今泉力蔵

Tertiary Pectinidae of Japan.....
..... Koichiro MASUDA

油 田 古 生 物 討 論 会

裏日本の油田における古生物調査とその応用について。

新潟地域 .....新保久弥
山形地域 .....猪俣虎彦
秋田地域 .....松岡 寛

Colloquium on Miocene Flora of Japan (5 月 14 日)

I. 各 論

Miocene Flora of Southwestern Hokkaido, Japan .....
....Toshimasa TANAI & Nobuo SUZUKI

青森県西目屋山地の第三紀含植物化石層の層序とその植物群 .....藤岡一男

秋田県阿仁合炭田の打当植物群 .....藤岡一男

秋田県由利山地の第三紀含植物化石層の層序とその植物群 .....藤岡一男

Miocene Flora of Sendai Area, I. Akyu Flora .....Haruo OKUTSU

宮城県丸森町南部の大内植物群 .....
.....棚井敏雅・尾上 亨

能登半島能登中島町付近産の中新世植物化石 ..
..... 松尾勇邦・津田禾粒

能登半島北部の中新世植物群 (予報) ....石田志朗

濃尾地方の中村植物群と平牧植物群 ....藤岡一男

美濃亜炭田の平牧・中村両累層の植物化石群 ..
.....徳永重元・尾上 亨

II. 綜 合 討 論

本邦における中新世植物群の変遷と古地理 ....
.....棚井敏雅 (話題提供)

例　会　通　知

	開　催　地	開　催　日	講演申込締切日
第 79 回 例 会	金 沢 大 学	1961 年 9 月 23, 24 日	1961 年 8 月 31 日
第 80 回 例 会	九 州 大 学	1961 年 11 月 18 日	1961 年 10 月 25 日
1961 年総会年会	東 北 大 学	1962 年 1 月	1961 年 12 月 10 日

会　員　消　息

会員高井冬二・鎮西清高両君は東大西アジア調査隊に参加し，本年 6 月上旬イスラエルへ出発した。ヨーロッパ諸国を視察の上本年 10 月頃帰国の予定である。

会員加藤誠君はイギリス British Museum (Natural History) に留学中であったが，本年 2 月帰国した。

News

○ 9 月 23, 24 日の金沢における例会では通常の学術講演の他 23 日（土）に微古植物学（珪藻・石灰藻其の他）に関する討論会を，又 24 日（日）には金沢市南方湯涌方面の実地見学が予定されている。（連絡先　市川　渡）

○ 11 月 18 日の福岡における例会には，個人講演（午前）と「夾炭層に関する古生物学的研究」についてのコロキューム（午後）とを企画しています。（連絡先　松本達郎・島山隆三）

○ 横山又次郎先生（1860-1942）の生誕 100 年を記念して横山先生の研究を中心とした化石展が 7 月中旬より約 1 ヶ月間上野科学博物館で開催される。

○ 本会邦文特別出版物「化石」No. 2 がこの程出版される。これには上部白堊紀第三紀三層大型有孔虫（半沢正四郎），古脊椎動物の研究（鹿間時夫），動物学名法解説（1）（埴山次郎）其の他がおさめられている。（定価 一部 200 円）

○ International Union of Geological Sciences の創立総会が 3 月 9, 10 両日にわたり Paris で開催され会則・役員其の他が決定された。日本からは本会小林貞一会長が副会長の一人として役員に参加することになった。

購読御希望の方は本会宛御申込下さい

1961 年 6 月 1 日　印　刷
1961 年 6 月 10 日　発　行

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日本古生物学会報告紀事出版規定

(1961年1月15日改正)

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