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Author(s)	Uozumi, Satoru; Fujie, Tsutomu
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NEOGENE MOLLUSCAN FAUNA IN HOKKAIDO

Part II. Description of the Okushiri fauna associated
with *Vicarya*, from Okushiri Island, Southwest Hokkaido.

by

Satoru UOZUMI and Tsutomu FUJIE

Contribution from the Department of the Geology and Mineralogy,
Faculty of Science, Hokkaido University, Sapporo. No. 970

The purpose of the present article is to describe the occurrence of *Vicarya* and its associated fossils from Okushiri Island. Such an association of fossils was hitherto unknown from Hokkaido. These fossils were collected by the writers, and Y. FUJIWARA and T. TSUCHIYA, graduate students of our University, from the Neogene deposits developing in Okushiri Island, Southwest Hokkaido.

Okushiri Island is geographically situated in Japan Sea, about 30 km west off the Oshima Peninsula. This island was geologically investigated by Dr. J. SUZUKI and Mr. B. SONOKI in 1936–1937 but since then, no particular informations have been added in this field.

In summer of 1961, the present writers engaged in the geological survey in this island, together with our students and found some fossils to be described in this paper. At the present moment, the writers do not know much about the details in stratigraphical sequence and geologic structure of the Neogene Tertiary of this island, because our field trip was so short in term. Nevertheless, it is almost certain that *Vicarya* fauna was found from the Tsurikake formation which rests on the Aonaigawa formation. Further, the latter covers the Bushigawa formation. Thus, the stratigraphical sequence of the Neogene Tertiary in this island can be tabulated in the following in descending order:

Senzyo formation	So-called "Hard shale" intercalated thin tuff layers and abundance containing <i>Makiyama chitanii</i> .
conformity	
Tsurikake formation*	Tuff breccia or agglomeratic conglomerate, occasionally interbedded with tuffaceous coarse grained sandstone in the upper part.

* The Chatsu formation called by SUZUKI and SONOKI (1936) seems to us to be synchronous and heterofacies to the Tsurikake formation, although they once assigned the Chatsu formation in the younger horizon than the Tsurikake formation.

White-brown tuff, coarse-medium grained sandstone and gray shale in alternation; it contains two or three thin coal seams in the middle part.

Dark gray or gray fine grained sandstone, interbedded with the *Ostrea* beds in which marine fossils are found in the lower part.

unconformity	
Aonaigawa formation	Green coloured tuff and greenish gray sandstone are predominant, containing thin coal seams here and there.
?	
Bushigawa formation	White gray liparitic tuff.
unconformity	
Basements	Granitic rocks, in Mesozoic age.

The geologic sequence mentioned above can not be always observed everywhere of this island, because of rather frequent presence of unconformities between formations. Each formation is generally very limited in distribution. Furthermore, lithologic facies is considerably changeable at places. This may be resulted from the fact that the sedimentary basins of those days were separated with each other by certain reason.

In addition, the Neogene Tertiary of Okushiri Island seems to be tectonically separated into two units (north and south regions) by the NEE-SWW trend tectonic line linking small villages, Yaji and Muenjima, as is shown in Text-Figure 1. In short, the Bushigawa and Aonaigawa formations, the lower formations composed of the so-called green tuffs, are not well developed in the northern area, while the matter is different in the southern area. Namely, the green tuff formations are well developed in the south. To speak more in detail, the *Vicarya* and *Vicaryella* bearing Tsurikake formation typically develops in the northern area and directly covers the Mesozoic granitic rocks: the lower part of this formation mostly consists in sandstones and shales, containing rather thin coal seams and *Ostrea* beds. This fact may show that limnic or brackish condition was prevalent during the period. To the contrary the upper part of this formation is mainly represented by volcanic products. In the southern area, the stratigraphically equivalent formation with the Tsurikake formation exclusively consists in coarse grained sandstones which is very thin as a whole and overlies the Aonaigawa green tuff formation.

Secondly, the Aonaigawa formation, mainly represented by green coloured tuff, is developed only in the restricted area in the northern region and it is very thin as a whole. This gives also the marked contrast to that of the southern region, where the same formation reaches more than two hundred meters in thickness.

Thirdly, the Senzyo formation lying on the Tsurikake formation is represented by the so-called "hard shale", in which a special type of sponge called *Makiyama chitanii* is abundantly found. However, in the northern region, such a lithologic facies is rather rare and this formation is largely replaced by the volcanic facies composed of lava flows, agglomerates and tuff breccias.

Thus, the sedimentary condition may be concluded to have been quite different between north and south regions in Okushiri Island, throughout Miocene in age.

Further, the same type of contrast can be perceived from the viewpoint of palaeontology. For instance, *Vicarya* occurs only in the northern region, although the Tsurikake formation in which the other gastropods are found, is also well developed in the southern region along the coast of this island.

On the contrary, *Vicaryella* is widely found in both regions. A remarkable sponge fossil, *Aphlocallistes* is also rich in the Tsurikake formation developing in both regions. However, this fossil has never been found in association with *Vicarya* or *Vicaryella* at any locality. The writers are now in the opinion, *Aphlocallistes* may denote a little upper horizon than that of *Vicarya* and *Vicaryella*.

Fossils found from the Tsurikake formation may be listed in the following:

	1	2
<i>Barbatia uetsukiensis</i> HATAI and NISHIYAMA	F*	×
<i>Scapharca kakehataensis</i> (HATAI and NISHIYAMA)	A	×
<i>Mizuhopecten kimurai</i> (YOKOYAMA)	F	×
<i>Monia</i> sp.	F	×
<i>Ostrea gravitesta</i> YOKOYAMA	A	×
<i>Diplodonta ferruginata</i> (MAKIYAMA)	F	×
<i>Clinocardium okushirense</i> UOZUMI and FUJIE	R	×
<i>Dosinia nomurai</i> OTUKA	F	×
<i>Nipponomarcia nakamurai</i> (IKEBE)	F	×
<i>Venerupis</i> sp.	R	×
<i>Soletellina minoensis</i> (YOKOYAMA)	F	×
" <i>Tellina</i> " sp.	R	×
<i>Macoma</i> sp.	R	×
<i>Solen</i> cf. <i>gouldi</i> CONRAD	F	×
<i>Cultellus izumoensis</i> YOKOYAMA	F	×
<i>Calliostoma</i> sp.	R	×
<i>Vicarya yokoyamai</i> TAKEYAMA	R	×
<i>Vicaryella notoensis</i> MASUDA	F	×
<i>Cerithidea</i> cf. <i>tokunariensis</i> MASUDA	F	×
<i>Cerithidea</i> sp.	R	×
<i>Polinices</i> sp.	R	×

* Abbreviation: A: abundant; F: common; R: rare; Loc. 1: Cliff along the river, about 400m upper stream of the Miyatsu-gawa, Miyatsu, Okushiri Island; Loc. 2: Cliff of the middle stream of the Aonai-gawa, near Tomisato, Okushiri Island.

<i>Chicoreus asanoi</i> MASUDA	F	×	
<i>Murex</i> sp.	R	×	
<i>Babylonia kozaiensis</i> NOMURA	R	×	
<i>Aphlocallistes</i> sp.	A	×	×



Fig. 1

Showing the geographic positions of the localities where the fossils were found in Okushiri Island.

Among the fossils listed above, the combination of *Vicarya* and *Vicaryella notoensis* is somewhat noteworthy. As a matter of fact, such an association of fossils was first reported by Dr. K. MASUDA (1956) from the Higashi-Innai formation developing in the Noto Peninsula, Ishikawa Prefecture. Since then, the same occurrence of these two species in association was reported from the Kurosedani formation in Toyama Prefecture, the Orito formation in the Sado Island of Niigata Prefecture and the Kunimi formation in Fukui Prefecture, all in Central Honshu, facing the Japan Sea. Dr. Y. KAMADA (1960) also paid attention on the occurrence of *Vicarya* together with *Vicaryella notoensis* in Japan. He reported that such an association can be only observed in the Hokuriku district, Central Honshu. However, the same type of combination is now also found in far northern region like Okushiri Island. Thus, the *Vicarya* and *Vicaryella* fauna in Japan can be regarded to distribute along the coast line linking Noto Peninsula—Sado Island—Okushiri Island, which may have been roughly to be parallel to the inner side of the Honshu arc.

In addition, among *Vicarya* and *Vicaryella* species, *Vicarya japonica* and *Vicaryella notoensis* are observed to have been distributed in rather inner side of Honshu of those days, while *Vicarya yokoyamai* and other species of *Vicaryella*, such as *ishiana* and *tyosenica*, seem to have been inhabited in the outer side of Honshu, as shown in Text-Figure 4.

In conclusion, the present writers are now of opinion that the difference observed in distribution of the species belonging to the genera *Vicarya* and *Vicaryella* could be resulted from the different migrating routes of those species.

In this regard the distribution of *Scapharca kakehataensis* and its allied species may support the conclusion: they are quite characteristic elements of the *Vicarya* fauna in general, but they are only distributed along the inner side of Honshu arc.

As a whole, the assemblage of the fauna to be described in this paper seems to be closely resembled the Miocene *Vicarya* fauna reported from the Higashi-Innai formation in Noto Peninsula and may indicate the Early Miocene in age. Further, the Tsurikake formation may be corresponding to the Oanzaigawa formation in stratigraphical position, the latter of which is developing in the environs of Kaminokuni-Mura, western coast of the Oshima Peninsula in Hokkaido. The latter may be remarkable formation because of containing the characteristic Miocene foraminifera, *Miogypsina* and *Operculina*. Further, this formation is also worth while noted to indicate the northern limit in distribution of the foraminifera above mentioned in Japan.

However, in respect to the assemblage of megafossils, there seems to be not any intimate relation existed between the Tsurikake and Oanzaigawa formations, in spite of that the both formations representing nearly equal stratigraphical position with each other. This may suggest us the different environmental condition to have been prevalent between these two formations, during the time of deposition: the

former may have represented more or less brackish condition, or an enclosed sea condition, while the latter, marine and open sea condition.

In closing the introductory remark, the present writers wish to thank to Professor Dr. Masao MINATO of Hokkaido University for constant encouragement and for kindly reading the present paper in manuscript. They are also much indebted to Dr. M. KATO for his kind help in various ways during the course of the present study. Thanks are also due to Messrs. Y. FUJIWARA and T. TSUCHIYA for the free use of their private collections.

Systematic Description

Family ARCIDAE

Genus *Barbatia* GRAY, 1847

Barbatia (Barbatia) uetsukiensis HATAI and NISHIYAMA

Pl. 11, Figs. 2, 3.

1949. *Barbatia (Barbatia) uetsukiensis* HATAI and NISHIYAMA, Jour. Palaeont., Vol. 23, no. 1, p. 89, pl. 23, figs. 6, 7.

HATAI and NISHIYAMA established this species based on the specimens of rather imperfect state of preservation, which were collected from the Uetsuki formation (Miocene), Okayama Prefecture: the specimen designated by them as the holotype is a left valve, the test of which seems for us somewhat to have been exfoliated.

The specimens which may be conspecific to the present species are frequently found in the Tsurikake formation, but most of them are unfortunately fragmentary and tests are perfectly exfoliated except for a few well preserved specimens, which are illustrated in the Plate 11.

The shells of this species newly found in Hokkaido may be slightly different in ornamentation in comparison with the holotype of the present species, so far as the original description is concerned.

In the Hokkaido specimens, surface of the shell is ornamented by radially lineated irregular riblets and incremental lines; similar radial riblets cover the entire surface excepting for the anterior and posterior slope, where the riblets become indistinct, and incremental lines are rugosed near the ventral margin in some specimens and are not wrinkled in some others.

Dimensions (inmm) :

Length	Height	Thickness
18.6	11.2	6.4
19.8	11.5	6.3
18.5	11.2	5.7
22.5	13.2	8.5

Repository: U.H. Reg. No. 13724.

Genus *Scapharca* GRAY, 1847*Scapharca kakehataensis* (HATAI and NISHIYAMA)

Pl. 11, Figs. 1, 4–8.

1949. *Anadara* (s.s.) *kakehataensis* HATAI and NISHIYAMA, Jour. Palaeont., Vol. 23, no. 1, pp. 88–89, pl. 23, figs. 8–10.
1949. *Anadara* (s.s.) *kurosedaniensis* HATAI and NISHIYAMA. *ibid.*, p. 89, pl. 23, figs. 11, 12.
1955. *Anadara* (s.s.) *kakehataensis*, MASUDA, Trans. Proc. Palaeont. Soc. Japan, N.S. No. 20, p. 123, pl. 19, figs. 2a-b.
1955. *Anadara* (s.s.) *kurosedaniensis*, MASUDA, *ibid.*, p. 123, pl. 19, fig. 3.
1956. *Anadara* (s.s.) *kakehataensis*, KASENO, Illust. Catal. Fossils from Fukui Pref. No. 1, p. 5, pl. 1, fig. 2.
1956. *Anadara* (s.s.) *kurosedaniensis*, KASENO, *ibid.*, p. 5, pl. 1, figs. 3a-b.
1960. *Anadara* (s.s.) *kakehataensis*, IWAI, Trans. Proc. Palaeont. Soc. Japan, N.S. No. 37, p. 204, pl. 24, figs. 3a-b, 4.
1960. *Anadara* (s.s.) *kurosedaniensis*, IWAI, *ibid.*, pp. 204–205, pl. 24, figs. 5a-b.
1961. *Anadara* (*Scapharca*) *kakehataensis*, FUJII, Venus, Vol. 21, no. 4, pp. 496–497, pl. 27, figs. 1–3.

It was K. HATAI and S. NISHIYAMA (1949) who first established this species based on a single specimen which was collected from the Susahara formation in Toyama Prefecture. Their description was as follows: "Shell heavy, moderate in size, quadrate, posterior side straight; equivalve, inequilateral, ventral border squarely rounded; umbonal region swollen, beak rather strongly incurved anteriorly; posterior slope more defined than anterior and diverging from the lateral slope at the 17th–19th radial riblet; area broad, arcuately trigonal in profile; surface with radial riblets and concentric lines, the former about 25 in number squarely rounded, weakly granulated, about equal to flattened interspaces in width; radial riblets somewhat corrugated ventrally by the crossing of the concentric lines. Length of holotype, 49.5 mm, height 44.8 mm, thickness of intact shells 46.0 mm."

In the same paper, they proposed to establish the another new species under the name of *Anadara kurosedaniensis*, based on the specimens collected from the same formation above stated in association with the present species. Since then,

these two species were reported from various localities in Japan. However these two have been regarded to be synonymous with each other by many palaeontologists, although certain scientists are now still in the opinion that there two are specifically distinct.

S. FUJII (1961) examined the topotype specimens of the present species, together with the numerous specimens collected from the various formations being stratigraphically equivalent to the Susahara formation. Further, he reviewed many allied species to the present one, and he finally claimed the synonymity between *Scapharca kakehataensis* and *kurosedaniensis*.

The present writers have also examined several specimens referable to the present species, collected by themselves from the Yatsuo formation, Toyama Prefecture and they compared directly the Yatsuo specimens to those from the Tsurikake formation, Okushiri Island, Hokkaido. As a result, the present writers reached the same conclusion as FUJII in concern to the synonymity between *S.*

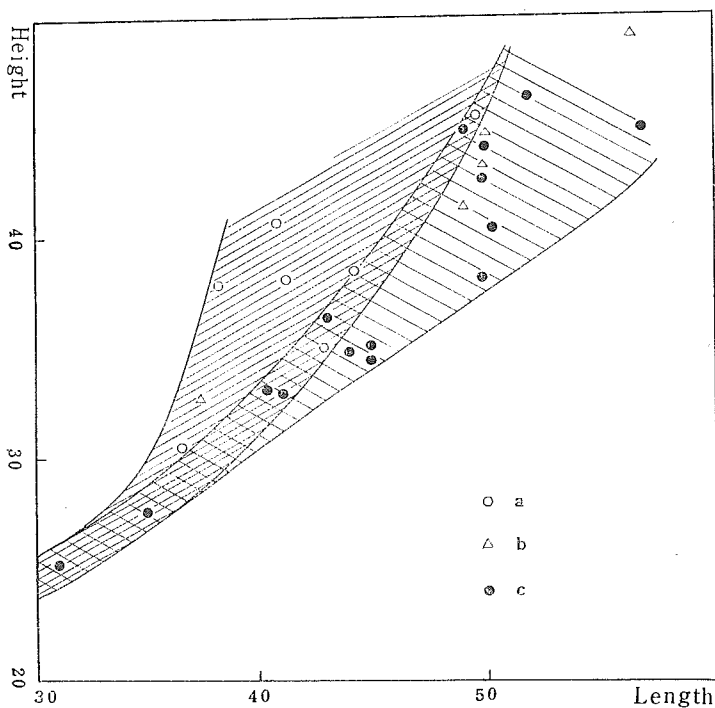


Fig. 2

Diagram showing the proportions of Height and Length of *Scapharca kakehataensis* HATAI and NISHIYAMA.

Two populations can be recognized in this concern.

- a: Yatsuo specimens, b: Tokunari specimens,
- c: Okushiri specimens.

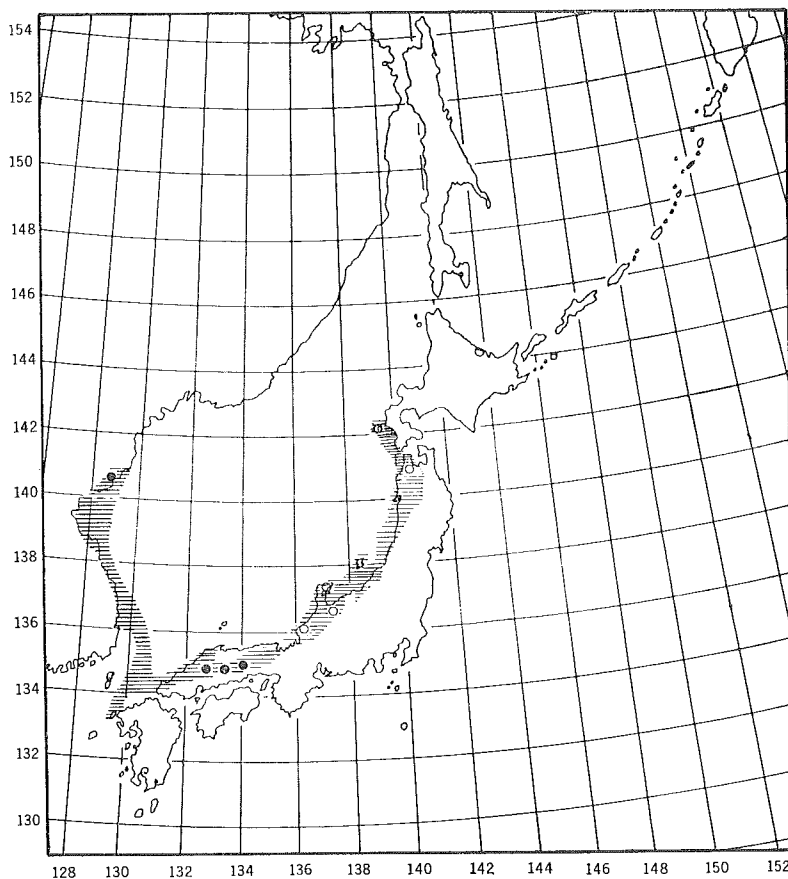
kurosedaniensis and *kakehataensis*.

The present now believe that the present species shows very characteristic nature in many respects: ornamentation, convexity and posterior slope. However, the proportion of height/length of shell shows the rather wide range of variation as shown in Text-Figure 2.

Description of the specimens from Hokkaido will be given below: shell heavy in test, quadrate; posterior margin rather truncate; surface of shell is ornamented by strong radial ribs and concentric incremental lines which are densely arranged near the ventral margin; radial ribs are rather variable in number, ranging from 24 to 29, 26 to 27 may be most common case; ribs somewhat granulated in anterior part and less distinct in posterior one; a distinct ridge extends from the beaks toward the basal portion of the posterior truncation; this ridge runs subparallel along 19th–21th radial ribs; the depressional space between the posterior margin and the ridge is very strong. The proportion between height and length of specimens is illustrated in Text-Figure 2. In general, the shells of Hokkaido specimens seem to be somewhat longer than the holotype described by HATAI and NISHIYAMA, and the specimens of the Yatsuo formation by FUJII and the specimens collected by the present authors from the same formation. In this respect, Hokkaido specimens are observed to be similar to the specimens from Tokunari, but do not like the Yatsuo ones. More in detail, the Yatsuo specimens show rather wide range of variation in general and are comparatively high in form of shell, especially in larger specimens which are about 40 mm in length. The Hokkaido and Tokunari specimens also are variable in form, especially in such larger form whose length is about 50 mm. To the contrary the smaller shells are rather stable in shell form. These evidences may suggest that *Scapharca kakehataensis* have usually rather wide range of variation especially in the proportion between height and length as commonly seen in shells of the shallow water habitants with heavy test. Also it is quite true that a variation can be usually observed recognized in the adult stage, than the younger one. Moreover, the facts that the Hokkaido specimens are more resemble in general the Tokunari specimens in respect to form and size than the Yatsuo ones, may show the environmental condition to have been nearly the same with each other. In all probability, the Hokkaido and Tokunari districts may have been in more suitable condition for this animal, than that of the Yatsuo district. If it really was so, the variation of forms observed in this species may be concluded to have been merely resulted from the difference of the environmental condition. Therefore it may be not taxonomically important.

Dimensions (in mm):

	Length	Height	Thickness	Number of ribs
Left Valve	57.0	45.0	23.9	27(8)*
„	49.8	37.9	18.6	25(7)
„	30.5	27.7	17.9	25(7)
„	44.1	34.9	15.7	25(6)
„	42.8	36.6	18.6	27(6)
„	50.5	40.4	18.0	24(6)
„	40.5	33.2	16.6	27(7)
„	45.3	35.0	18.0	27(7)
„	50.0	43.0	22.2	26(6)

**Fig. 3**

Showing the distribution of two species of *Scapharca*.

White circle: *Scapharca kakehataensis*; Black circle: *S. daitokudoensis*.

* a parenthesized number showing the number of ribs in posterior slope.

Right Valve	42.6	34.0	19.2	26(7)
„	48.6	24.0	24.0	27(8)
„	50.0	44.0	20.5	28(8)
„	52.4	46.4	22.5	28(8)
„	41.0	33.5	16.0	26(7)
„	30.5	25.4	12.0	26(7)

Repository: U.H. Reg. No. 13722, 13723.

This species and its allied species, *S. daitokudoensis* are restricted in the geological distribution, viz. they denote the Miocene age. Geographically they are distributed in the deposits developing in the regions along the coast of the inner side of Honshu arc and also along the eastern coast of Korea of the present day (Text-Figure 3). This fact may suggest that these species group migrated northward from somewhere in the south, together with the fauna including *Vicarya japonica*. And *S. kakehataensis* may have extended to Southwest Hokkaido far beyond the northern limit of distribution of *Vicarya japonica*.

Family PECTINIDAE

Genus *Mizuhopecten* MASUDA, 1965

Mizuhopecten kimurai (YOKOYAMA)

Pl. 12, Fig. 13.

1925. *Pecten kimurai* YOKOYAMA, Jour. Coll. Sci., Imp. Univ., Tokyo, Vol. 45, art. 5, p. 27, pl. 2, fig. 4; pl. 4, figs. 1-6.
1957. *Patinopecten kimurai*, FUJIE and UOZUMI, Cenozoic Res., No. 23, p. 34, pl. 24, fig. 10.
1960. *Patinopecten kimurai*, MASUDA, Trans. Proc. Palaeont. Soc., Japan, N.S. No. 38, pp. 250-252, pl. 29, fig. 1; pl. 30, fig. 6.
1962. *Patinopecten kimurai kimurai* MASUDA, Sci. Rep., Tohoku Univ., 2nd Ser., Vol. 33, no. 2, p. 205, pl. 24, fig. 6.
1962. *Patinopecten kimurai*, KAMADA, Palaeont. Soc., Japan, Spec. Paper, No. 8, pp. 64-65, pl. 5, figs. 5-6.
1965. *Mizuhopecten kimurai*, MASUDA, Trans. Proc. Palaeont. Soc., Japan, N.S. No. 52, p. 149.

The specimens referable to the present species are rather rare in the Tsurikake formation. Further, they are mostly rather in ill-preservation. Nevertheless, their identity to the species *kimurai* is almost doubtless.

Dimensions (in mm):

Length	Height
57.3+	79.1

Repository: U.H. Reg. No. 13741.

Family UNGULINIDAE

Genus *Diplodonta* BROWN, 1831*Diplodonta ferruginata* MAKIYAMA

Pl. 6, Figs. 8, 9.

1926. *Diplodonta ferruginata* MAKIYAMA, Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, Vol. 2, no. 3, pp. 157–158, pl. 12, figs. 12, 13.
 1934. *Taras ferruginata*, OTUKA, Bull. Earthq. Res. Inst., Vol. 12, pt. 3, p. 616, pl. 45, figs. 29, 40.

Several specimens of the present authors' collection may be conspecific with the MAKIYAMA's species *ferruginata* because of the shell showing a straight and nearly horizontal posterior dorsal margin and roughly quadrangular outline.

Dimensions (in mm):

	Length	Height	Thickness
Left Valve	16.7	14.8	3.6
„	24.2	21.4	7.0
Right Valve	20.9	18.0	6.7
„	20.0	17.7	5.5
„	18.0	16.5	4.8

Repository: U.H. Reg. No. 13731.

Family CARDIIDAE

Genus *Clinocardium* KEEN, 1936*Clinocardium okushirense* UOZUMI and FUJIE n.sp.

Pl. 12, Figs. 4–6.

Shell medium in size, thin, semi-quadrate in outline; rather equilateral in form; length slightly exceeding than the height; moderately convex; umbo small, centrally located, slightly prosogyrous; anterior dorsal margin slightly convex and sloping downwards; posterior dorsal margin almost straight, merging into the steeply sloping sub-truncate posterior end; ventral margin broadly arcuate with an inconspicuous posterior umbonal ridge; surface with sculpture of about 45–50 distinct radial ribs separated by flat-bottomed interspaces about equal to the width of the ribs; the ribs on the anterior and middle parts of shell are narrow and rounded; the interspaces narrower compared to those on the posterior part, and they are flatter and wider, with the interspaces widely channeled; all the ribs are crossed by very fine concentric incremental lines but these are not emphasized on the disk. Interior features unknown.

Dimensions (in mm) :

	Length	Height	Thickness
Right Valve	28.6	26.5	8.6
Left Valve	22.0	19.2	7.0

Repository: U.H. Reg. No. 13732 (Holotype); 13733 (Paratype).

This species is characterized by the large number of ribs which are separated by flat-bottomed interspaces, subequal to the width of the ribs.

The present species somewhat resembles *Clinocardium fastosum* in having a good many ribs, the latter of which was reported by YOKOYAMA (pl. 48, fig. 5, 1927) from the Pliocene Onma formation typically developed in Ishikawa Prefecture. It also resembles *C. asagaiensis arakawae* described by KAMADA (pl. 10, figs. 15–17, 1962) from the Jo-ban Coal field. However the present species is distinct from both of them in having wide, flat-bottomed interspaces between ribs. Further, the present species is easily distinguishable from the many other species having been described under the generic name of “*Cardium*” from the Japanese Neogene deposits by the characters described in the foregoing lines.

Family VENERIDAE

Genus *Dosinia* SCOPOLI, 1777

Dosinia nomurai OTUKA

Pl. 12, Figs. 3, 10, 11.

- 1934. *Dosinia japonica nomurai* OTUKA, Bull. Earthq. Res. Inst. Imp. Univ., Tokyo, Vol. 12, pt. 3, p. 518, pl. 38, fig. 54.
- 1934. *Dosinia nagaii* OTUKA, *ibid.*, p. 48, Pl. 38, fig. 55.
- 1937. *Dosinia japonica nomurai*, OTUKA, Japan. Jour. Geol. Geogr., Vol. 14, nos. 1–2, p. 29, pl. 3, figs. 3, 4.
- 1956. *Dosinia chikuzenensis* HIRAYAMA, Sci. Rep., Tokyo Kyoiku Daigaku, Sec. C, Vol. 5, no. 45, p. 109, pl. 7, figs. 14, 15, (non. pl. 7, figs. 1–13.)
- 1962. *Dosinia nomurai*, MASUDA, Saito Ho-on Kai Mus., Res. Bull., No. 31, pp. 30–32, pl. 1, figs. 1–9.

Dosinia nomurai was first described and illustrated by OTUKA from the Kadonosawa formation in Iwate Prefecture. At the same time, OTUKA proposed to establish the another new species under the name of *Dosinia nagaii* based on the specimens collected from the same formation in association with the present species.

Recently K. MASUDA (1962) examined many specimens of the present species now in concern, including the holotype, topotype and hypotype specimens. As a result he concluded that *Dosinia nagaii* OTUKA is a synonym with *Dosinia nomurai* OTUKA, although a considerable individual variations can be perceived in *D. nomurai*

in respect to the outline of shell.

Certain specimens, now in problem, show strongly similar outline of shell to that of the holotype specimen of *Dosinia nomurai*, illustrated by OTUKA. In spite of it, certain other specimens show some resemblance to the so-called "*D. nagaii*" in shell form now in question. But the difference in shell form can be anyhow regarded with certainty to be only within individual variations. MASUDA's view should be accordingly accepted in the writers' opinion.

Dimensions (in mm) :

	Length	Height	Thickness
Left Valve	57.4	51.6	12.4

Repository : U.H. Reg. No. 13734.

Genus *Nipponomarcia* IKEBE, 1941

Nipponomarcia nakamurai (IKEBE)

Pl. 12, Figs. 1, 2.

1931. *Pitar*(?) sp. KURODA, In HOMMA's Geol. Central Shinano, pt. 4, p. 57, text-fig. 5.
 1941. *Katelsia* (*Nipponomarcia*) *nakamurai* IKEBE, Venus, Vol. 11, nos. 2-3, p. 50, pl. 2, figs. 1-8.
 1956. *Nipponomarcia nakamurai*, ITOIGAWA, Mem. Coll. Sci., Univ. Kyoto, Ser. B, Vol. 23, no. 2, p. 182, pl. 1, figs. 4, 5.
 1962. *Nipponomarcia nakamurai*, KAMADA, Palaeont. Soc., Japan, Spec. Paper, No. 8, pp. 118-119, pl. 13, figs. 11, 12.

Nipponomarcia is characteristic in small and thick shell, having truncated posterior margin and quadrate short pallial sinus. The present species shows some similarity to the Miocene species *Katelsia endoi* HATAI and KOTAKA, but the shell of the latter is more unequilateral, and has angulation of the anterior and posterior margin.

This species was established by IKEBE based on the specimens collected from the Miocene Ayugawa formation developing in Shiga Prefecture. Since then the same species has been described from various formations such as the Ayugawa, Tsuzuki, Awa and Togari formations mainly developed in the Setouchi Province in Southwest Japan. Further, KAMADA found the present species from the Miocene deposits developed in the Jo-ban Coal field in Northeast Honshu.

The shells described by KURODA under the name of *Pitar*(?) sp. from the Tertiary deposits of the Shinano province, Central Honshu seem to be conspecific with the species now in problem. Consequently the new finding of this species in Okushiri Island extends its geographical distribution further north. Besides this, it may be somewhat important to trace the route of migration of the so-called *Vicarya* fauna from south to Hokkaido. Perhaps the present species together with

Vicarya yokoyamai, may have migrated along the during the Miocene age, instead of taking the Japan Sea route.

Dimensions (in mm) :

	Length	Height	Thickness
Both Valve	19.4	12.6	9.9
	13.9	10.5	6.8
	13.8	9.4	6.2
Right Valve	20.1	13.8	5.6
	14.5	10.0	4.8
Left Valve	17.4	11.5	5.0

Repository : U.H. Reg. No. 13735, 13736.

Family SOLENIDAE

Genus *Cultellus* SCHUMACHER, 1817

Cultellus izumoensis YOKOYAMA

Pl. 12, Fig. 7.

1923. *Cultellus izumoensis* YOKOYAMA, Japanese Jour. Geol. Geogr., Vol. 2, no. 1, p. 5, pl. 2, fig. 1.
 1941. *Cultellus izumoensis*, OTUKA, Japanese Jour. Geol. Geogr., Vol. 18, nos. 1-2, pp. 23-24, Text-fig. 4.
 1956. *Cultellus izumoensis*, KANNO, Sci. Rep., Tokyo Kyoiku Daigaku, Sec. C, Vol. 4, no. 34, pp. 213-214, pl. 5, fig. 8.

KANNO recently distinguished three species and one subspecies among the Japanese fossil *Cultellus*: *C. izumoensis* YOKOYAMA, *C. izumoensis jobanicus* KANNO, *C. rectangulus* KANNO and *C. otukai* OGASAWARA and TANAI.

The specimens now at the writers' disposal for study are apparently conspecific with *izumoensis*, because they do not have concave ventral margin which was recognized by Kanno as the characteristic feature in the subspecies "*jobanicus*".

Dimensions (in mm) :

Length	Height	Posterior/Anterior
52.	16.2	3.72

Repository : U.H. Reg. No. 13725.

Family POTAMIDIDAE

Genus *Vicarya* D'ARCHIAC and HAIME, 1854*Vicarya* (*Vicarya*) *yokoyamai* TAKEYAMA

Pl. 13, Figs. 4, 5, 10.

1925. *Cerithium* sp. YOKOYAMA, Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. 45, art. 5, p. 12, pl. 2, fig. 5.
1926. *Vicarya baculum* YOKOYAMA, Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1, pt. 7, p. 219, pl. 28, figs. 4-6 (non *Cerithium baculum* YOKOYAMA 1924 and 1925).
1933. *Vicarya verneuili yokoyamai* TAKEYAMA, Japanese Jour. Geol. Geogr., Vol. 10, nos. 3-4, pp. 134-137, pl. 13, fig. 4.
1938. *Vicarya callosa yokoyamai*, YABE and HATAI, Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Vol. 19, no. 2, pp. 157-159, pl. 21, figs. 25, 27, 32, 37,
1938. *Vicarya callosa martini* SAGA (MS), YABE and HATAI, *ibid.*, p. 159, pl. 21, fig. 29.
1939. *Vicarya verneuili yokoyamai*, IKEBE, Jour. Geol. Soc., Japan, Vol. 64, no. 553, pp. 542-545, Text-figs. 3-7.
1944. *Vicarya yokoyamai*, OYAMA and SAKA, Bull. Sigenkagaku Kenkyusyo, Vol. 1, no. 2, pp. 138-139, pl. 14, figs. 2a-c, 3a-c.
1960. *Vicarya yokoyamai*, KAMADA, Sci. Rep., Tohoku Univ., 2nd Ser., Spec. Vol., No. 4, p. 283, pl. 30, figs. 3a-3b; pl. 31, figs. 6, 7, 10.
1962. *Vicarya* (*Vicarya*) *yokoyamai*, KAMADA, Palaeont. Soc., Japan, Spec. Paper, No. 8, p. 151, pl. 18, figs. 13, 14.

It has been well known that there are two types of *Vicarya* in the Miocene deposits widely developing in various places in Japan: one is the so-called "Tsuyama type", *Vicarya callosa japonica* YABE and HATAI, and other one is "Tsukiyoshi type", *Vicarya yokoyamai* TAKEYAMA.

So far as the writers are aware, no specimens belonging to the genus *Vicarya* have been previously known from Hokkaido, although the Miocene deposits are widely developed in Hokkaido. Therefore, the new finding of this genus in Okushiri Island may be interesting in consideration of palaeozoogeography and palaeogeography.

Until the recent discovery of this genus in Hokkaido *Vicarya* has been considered to have been mainly distributed in the southern parts of Honshu in Japan. As a matter of fact, among Japanese *Vicarya*, the species "*japonica*" however shows to be rather restricted in geographic distribution, viz, it has been only found from the deposits developing along the Japan Sea coast, while *V. yokoyamai* has been rather known from the Pacific side. It is only the Hokuriku district, Central Japan facing the Japan Sea where these two species are found together. This may suggest us that *V. japonica* migrated northward along the coast of Japan Sea from the south in those days, and it finally reached north Korea and Central Japan, while *V.*

yokoyamai migrated along the coast of the Pacific of those days and reached Hokkaido through the northeastern part of Honshu. And these two species mentioned above intermingled in the Hokuriku district, Central Honshu. As to this point, the following facts may strengthen the possibility of migration above mentioned: *Scapharca kakehataensis* and *Vicaryella notoensis* are mainly found together with *Vicarya japonica* and to be confined to the Miocene deposits distributed around the coast of Japan Sea but not found around the opposite side, as shown in Text-Figures 3 and 4.

Specimens from Okushiri Island will be described below: A few, somewhat imperfect specimens at hand show more or less variable nature with each other

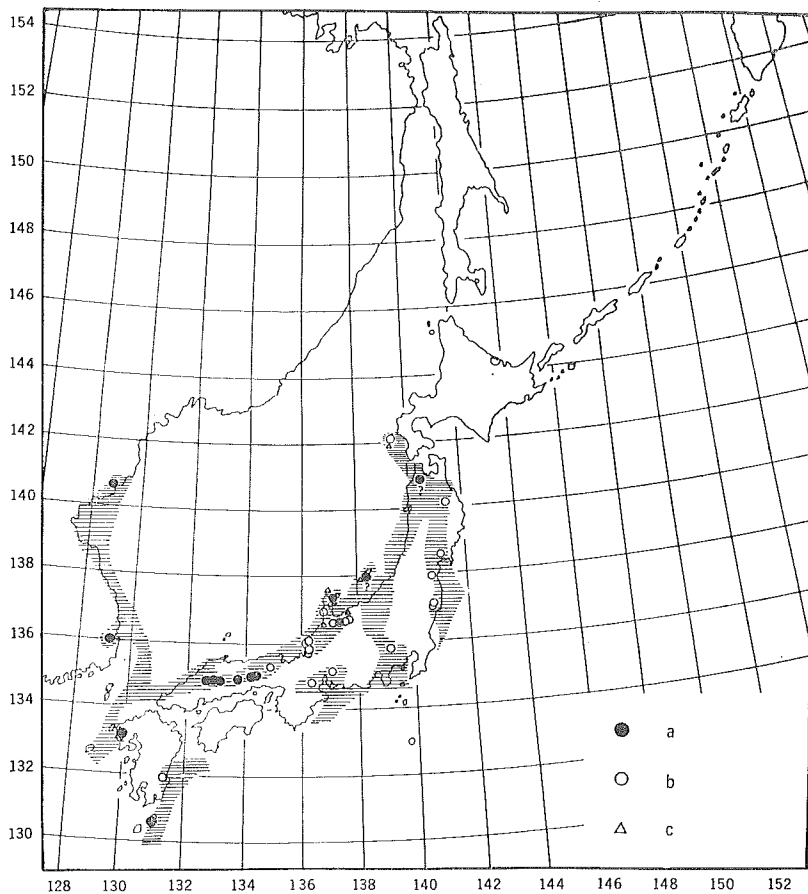


Fig. 4

Showing the distribution of Miocene *Vicarya* and *Vicaryella*.

a: *Vicarya callosa japonica*; b: *Vicarya yokoyamai*;

c: *Vicaryella notoensis*.

in form: they may be roughly divided into two forms: one is resembled the specimens reported under the name of *Vicarya callosa martini* from the Tsukiyoshi formation by YABE and HATAI and the others seem to be common form, *Vicarya yokoyamai*, illustrated and reported by many scientists from various places in Japan.

Vicarya callosa martini YABE and HATAI was considered by IKEBE (1939) and OYAMA and SAKA (1944) to be mere variation of *V. yokoyamai* and the present writers are now of the same opinion in this regard.

The following description is based on the specimens which show some resemblance to the specimen called by YABE and HATAI as *V. yokoyamai martini*.

Shell rather large; apical angle show rather wide range of variation, about 15° in *martini* type and about 25° in common *yokoyamai* type, elongate and conical with many whorls, of which about the lower 12 are preserved. Whorls rather flat, commonly ornamented by four spiral cords, separated by nearly equal, distant interspaces. In about 8 upper whorls, the uppermost cord gradually becomes stronger on the later whorls and finely beaded. The lowest cord is the strongest of all and faintly granulated. The two other cords are weaker, of them the second one is the weakest: except for the first one, cords become gradually stronger from the second to fourth cord. The beads on the first cord are gradually stronger and less in number on the fourth whorl from the last one, but are not seen to be tubercular; they change into small tubercles on the last whorl; tubercles extend horizontally from the axis of shell, their top rather flat, but sloping below. Aperture unknown.

Dimensions (in mm):

Height	Diameter
84.4	29.6

Repository: U.H. Reg. No. 13727 b.

The other several specimens from Okushiri, referable to *Vicarya yokoyamai* were directly compared with the topotype specimens collected by the writers from the Tsukiyoshi formation. They are slightly distinct from the so-called *martini* type, above described. Accordingly it would be better to describe here the second type of specimens. Description is as follow:

Shell large, elongate and conical with many whorls, apical angle is about 25° and much larger in general than the *martini* type. Whorls flattish and ornamented by four spiral cords and one or two supplementary threads. In the younger stage, the sculpture of whorls is similar to the abovementioned *martini* type, but in the adult the sculpture becomes dissimilar: the beads on the uppermost cord changes into large tubercles and less in number from the fourth whorl to the last one; the uppermost cord is provided with 9-10 tubercles produced horizontally from the axis of shell, the second cord is as weak as in the younger whorls and the two other

cords are almost equally strong and faintly granulated. In addition, the other very faintly elevated threads are observable in the interspace between the second and third cords, and between the third and fourth cords.

Dimensions (in mm):

Height	Diameter
60.0+	29.8
80.0+	39.6

Repository: U.H. Reg. No. 13726, 13727 a.

Genus *Vicaryella* YABE and HATAI, 1938

Vicaryella notoensis MASUDA

Pl. 13, Figs. 3, 6.

1956. *Vicaryella notoensis* MASUDA, Trans. Proc. Palaeont. Soc., Japan, N.S., No. 21, pp. 161-162, pl. 26, figs. 2-4.
 1956. *Vicaryella notoensis*, KASENO, Illust. Foss. from Fukui, pt. 1, p. 7, pl. 4, figs. 19a-b.
 1960. *Vicaryella notoensis*, KAMADA, Sci. Rep., Tohoku Univ., 2nd Ser., Spec. Vol. No. 4, p. 291, pl. 31, figs. 5a-b.

The specimens which may be conspecific with the present species are rather richly found in the Tsurikake formation. Certain specimens of them are preserved as mere casts or moulds, besides they are mostly imperfect in preservation. However, all of them can be observed to have three beaded and elevated spiral cords. Further, beads can be counted as many as 25 on each cord and supplementary spiral threads appear in the interspace.

These features prove the Hokkaido specimens to be doubtlessly referable to *Vicaryella notoensis*, established by MASUDA on the basis of the specimens collected from the Higashi-Innai formation, Noto Peninsula.

Vicaryella ishiana (YOKOYAMA) (1926) is somewhat resembled the species now in question, but the former is distinguishable from the latter by more simple ornamentation of shell and less numerous tubercles, which may be generally counted as many as 15 on the spiral cords as described by MASUDA (1956) and subsequently by KAMADA (1960).

Dimensions (in mm):

Height	Diameter
35.3+	14.5

Repository: U.H. Reg. No. 13728, 13729.

Family POTAMIDIDAE

Genus *Cerithidea* SWAINSON, 1840*Cerithidea* cf. *tokunariensis* MASUDA

Pl. 13, Fig. 8.

1956. *Cerithidea tokunariensis* MASUDA, Trans. Proc. Palaeont. Soc., Japan, N.S., No. 21, p. 162, pl. 26, figs. 6, 7.

Several fragmental specimens at the writers' disposal are apparently similar to *Cerithidea tokunariensis*, described by MASUDA from the Miocene deposits in the Noto Peninsula, but the writers hesitate their specimens to identify to MASUDA's species, until more numerous and well preserved specimens will be found in future.

In spite of it, all the specimens now in consideration keep the surface sculpture composed of distinct longitudinal ribs and spiral cords, in which ribs are subvertical, round-topped, separated by wide interspaces. The ribs can be counted as many as fifteen to sixteen on the penultimate whorls. Cords are about three on each whorl, rather flat-topped, much narrower than their interspace but more distinct.

Cerithidea yatsuoensis reported by TSUDA (1959) from the Kurosedani formation in Toyama Prefecture somewhat resembles the present species now in problem, but the former is ornamented by much strong spiral cords.

Family MURICIDAE

Genus *Chicoreus* MONTFORT, 1810*Chicoreus asanoi* MASUDA

Pl. 13, Figs. 1, 2.

1950. *Chicoreus* (*Rhizophorimurex*) *tiganouranus*, OYAMA, Rep. Geol. Surv., Japan, No. 132, p. 11, pl. 1, figs. 5a-b, 6a-b. (non *tiganouranus* NOMURA 1935)
1956. *Chicoreus asanoi* MASUDA, Trans. Proc. Palaeont. Soc., Japan, N.S., No. 21, p. 163, pl. 26, figs. 10-11.
1956. *Chicoreus asanoi*, KASENO, Illust. Fossil. from Fukui, pt. 1, p. 7, pl. 4, figs. 23, 24.

Several specimens are now available for study. Description follows:

Shell moderate in size, ovate with seven whorls, rapidly enlarging and separated by rather indistinct suture. Apical angle about 60°-65°. One nuchlear whorl smooth; next one is decorated by longitudinal ribs which can only be seen under high magnification. Succeeding whorls ornamented with strong longitudinal ribs, faint growth lines and spiral cords; longitudinal ribs are about 9-11 in number;

spiral cords about 8 in number on the young whorls, distinct separated by wide interspaces, which are provided with three subordinate spiral threads; middle subordinate thread is the strongest among them and elevated; other two threads are nearly equally strong with each other and every weak. Cannal rather long, curved and opened.

Dimensions (in mm) :

Height	Diameter
39.4+	26.1
41.0+	28.0
34.0+	18.8

Repository : U.H. Reg. No. 13730.

From the description in the foregoing lines, the present specimens can be regarded to be entirely identical with the MASUDA's species described from the Noto Peninsula.

Murex tiganouranus NOMURA (1935) seems to be also closely resembled the present species. However, the former is distinct from the latter in having flattened form of whorl, with flattened shoulder area, less number of whorl, more prominent spiral cords and ornamentation with obsolete varices on the upper slope of shoulder. Further, the present species is also similar to *Chicoreus capuchinus* LAMARCK in certain points, but the latter has strong varices and high spires, as pointed by OYAMA (1950).

Genus *Murex* LINNE, 1758

Murex sp. indet.

Pl. 13, Fig. 9.

Shell rather small, thick and spinous: spire short and small; body whorl rapidly enlarged. Whorls probably five or six in number, of which the lower three are preserved, spire whorls angulated and tangent to the preceding whorl at suture; surface ornamented by three varices which are provided with spines at the edge of shoulder, and numerous spiral threads. Between varices there are two knobby ribs. Body whorl angulated by the upper and lower blunt angles; between them surface is flat and ornamented by several spiral threads; on the upper angle the surface is flat and forms nearly right angle with the surface of the central part of whorl. Surface below the lower angle is slightly concave and sloping downwards to cannal, which is nearly straight and long, ornamented with spines arranged in a few rows. Body whorl similarly ornamented by varices and knobby ribs as seen in spire. Aperture unknown.

	Height	Diameter
<i>Dimensions</i> (in mm):	23.6	10.2
<i>Repository</i> :	U.H. Reg. No. 13737.	

A single, somewhat imperfect specimen embedded in the mother rock was found in the collection from the Tsurikake formation. Although the test is largely exfoliated, the specimen is apparently belonging to the genus *Murex*. Further it resembles *Murex trapa*, very common recent species in Formosa. But the latter is still distinguishable from the former by its rounded whorl and more numerous knobby ribs between vaices. Anyhow, correct specific identification of this specimen, at the writers' disposal, seems to be difficult unless more better material can be obtained in future.

Family BUCCINIDAE

Genus *Babylonia* SCHLUTER, 1838

Babylonia kozaiensis NOMURA

P1. 13, Figs. 7a,b.

1939. *Babylonia kozaiensis* NOMURA, Jour. Geol. Soc., Japan, Vol. 46, no. 548, p. 256, pl. 13, figs. 8a-b.
 1940. *Babylonia kozaiensis*, NOMURA and ONISHI, Japanese Jour. Geol. Geogr., Vol. 17, nos. 3-4, p. 192, pl. 19, figs. 1a-b.

The present writers do not know much about the fossils belonging to genus *Babylonia* from the Neogene deposits in Japan.

The present species was established by NOMURA as new Miocene species from the deposits in Miyagi Prefecture. NOMURA's description of this species was as follows: "Shell rather small, ovate. Whorls about six(?), convex, roundly shouldered above with distinct, but not canaliculate sutures. Last whorl narrowed downward, and not so inflated as in *B. japonica* (REEVE) and somewhat constricted around middle. Aperture narrowly ovate. Umbilical region fractured. Surface smooth except for growth-lines. Height ca. 45, diameter 27 mm,"

Now, two somewhat deformed specimens from Okushiri became the problem whether they are really conspecific to the NOMURA's species. They are rather small in size, and characterized by less inflated whorls, numbering six and narrower aperture. Accordingly they are certainly distinct from the recent species, *Babylonia japonica*. *Babylonia elata*, described and illustrated by YOKOYAMA (1923) from the Pliocene deposits at Dainichi, Shizuoka Prefecture differs from *B. kozaiensis* in showing more distinct shoulders and in having a larger shell. At any case, the writers' material may be most nearly ally to the NOMURA's species.

Dimensions (in mm):

Height	Diameter
34.1	22.0+

Repository: U.H. Reg. No. 13738.

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(Manuscript received Sept. 15, 1965)

Explanation of Plate 11

Explanation of Plate 11

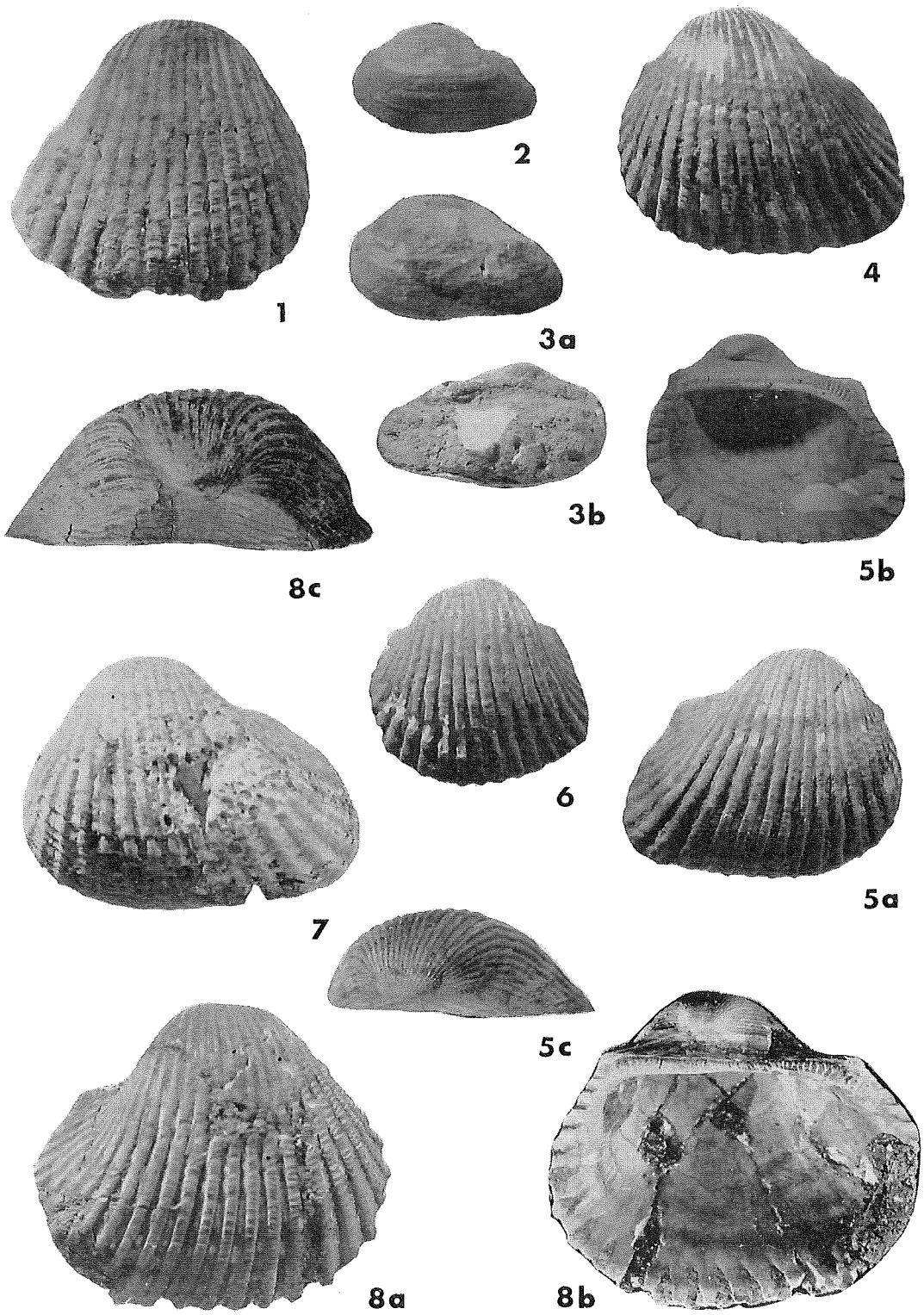
(All figures natural size)

Figs. 1, 4-8. *Scapharca kakehataensis* (HATAI and NISHIYAMA): U.H. Reg. No. 13722. 1 : Side view of right valve ; 4 : Side view of left valve ; 5 : Side view of right valve ; 5a : Side view of right valve ; 5b : Internal view of the same ; 5c : Dorsal view of the same ; 6 : Side view of left valve ; 7 : Side view of left valve ; 8a : Side view of right valve ; 8b : Internal view of the same ; 8c : Dorsal view of the same.

Locality : Miyatsu, Okushiri Island, Southwest Hokkaido.

Figs. 2, 3. *Barbatia uetsukiensis* HATAI and NISHIYAMA : U.H. Reg. No. 13724. 2 : Side view of left valve ; 3a : Side view of left valve ; 3b : Internal view of the same. Locality : same as above.

Plate 11



Explanation of Plate 12

Explanation of Plate 12

(All figures natural size)

Figs. 1, 2. *Nipponomarcia nakamurai* (IKEBE) : U. H. Reg. No. 13735. 1 : Side view of right valve ; 2 : Side view of left valve.

Locality : Miyatsu, Okushiri Island, Southwest Hokkaido.

Figs. 3, 10, 11. *Dosinia nomurai* OTUKA : U. H. Reg. No. 13734. 3 : Internal view of right valve ; 10 : Side view of left valve showing *Dosinia nagaii* of OTUKA ; 11 : Side view of right valve.

Locality : same as above.

Figs. 4-6. *Clinocardium okushiriense* UOZUMI and FUJII n. sp. U. H. Reg. No. 13732 (Holotype), 13733 (Paratype). 4 : Side view of right valve of holotype specimen ; 5-6 : Side view of left valve of paratype specimens.

Locality : same as above.

Fig. 7. *Cultellus izumoensis* YOKOYAMA : U. H. Reg. No. 13725. Side view of right valve.

Locality : same as above.

Figs. 8, 9. *Diplodonta ferruginata* MAKIYAMA : U. H. Reg. No. 13731. 8 : Side view of right valve ; 9 : Side view of left valve.

Locality : same as above.

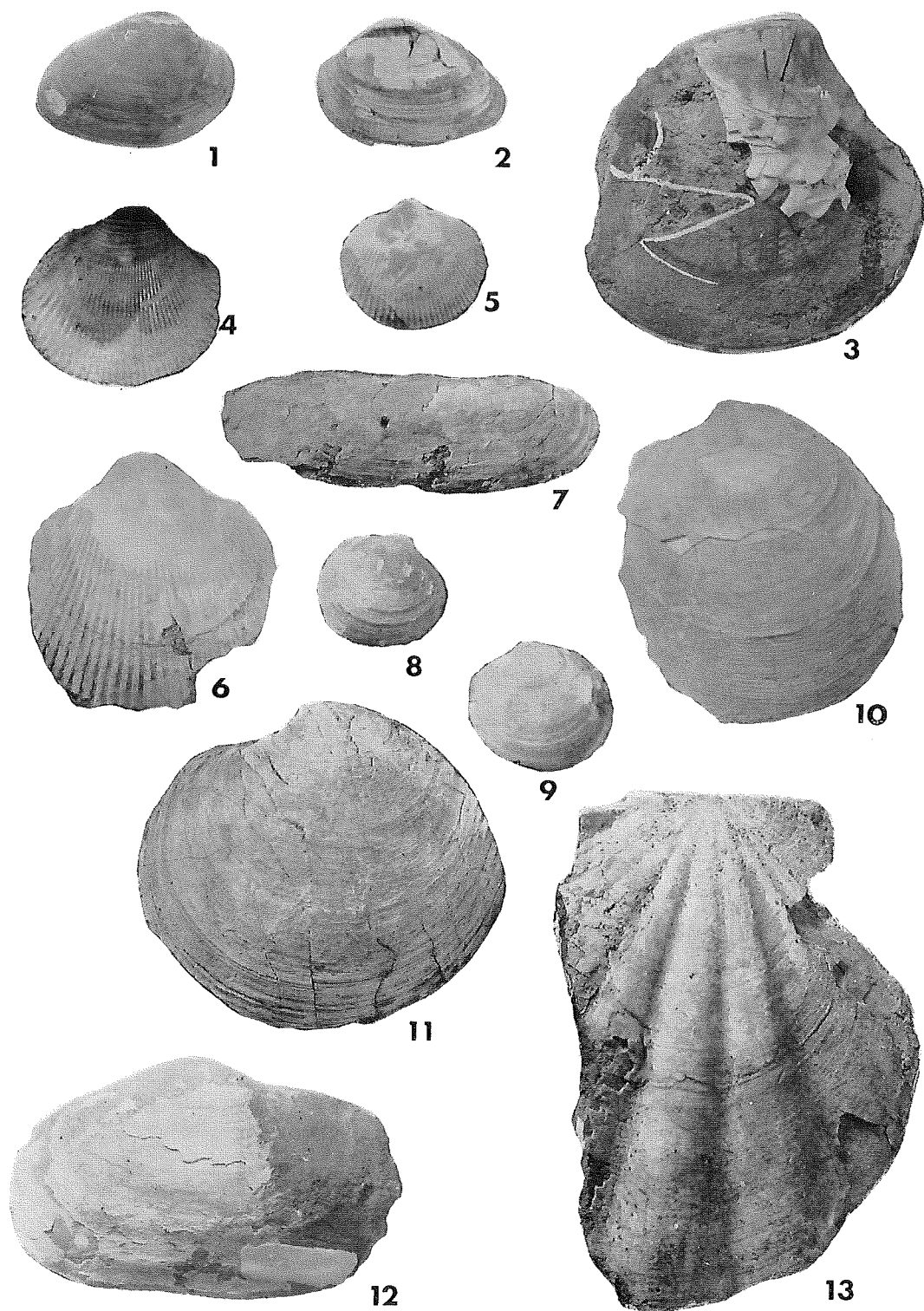
Fig. 12. *Soletellina minoensis* (YOKOYAMA) : U. H. Reg. No. 13740. Side view of left valve.

Locality : same as above.

Fig. 13. *Mizuhopecten kimurai* (YOKOYAMA) : U. H. Reg. No. 13741. Side view of right valve.

Locality : same as above.

Plate 12



Explanation of Plate 13

Explanation of Plate 13

Figs. 1, 2. *Chicoreus asanoi* MASUDA : U. H. Reg. No. 13730a, b. 1a : Apertural view ; 1b : Dorsal view ; 1c : Apical view ; 2 : Dorsal view. (All figures natural size)

Locality : Miyatsu, Okushiri Island, Southwest Hokkaido.

Figs. 3, 6. *Vicaryella notoensis* MASUDA. 3 : U. H. Reg. No. 13728, apertural view ; 6 : U. H. Reg. No. 13729, magnified figure showing the ornamentation, $\times 2\frac{1}{2}$.

Locality : same as above.

Figs. 4, 5, 10. *Vicarya yokoyamai* TAKEYAMA. 4 : U. H. Reg. 13726, dorsal view ; 5 : U. H. Reg. No. 13727a, plastic cast showing *V. martini* YABE and HATAI type ; 10 : U. H. Reg. No. 13727b, plastic cast. (All figures natural size).

Locality : same as above.

Fig. 7. *Babylonia kozaiensis* NOMURA : U. H. Reg. No. 13738. a : Dorsal view ; b : Apertural view. (All figures natural size).

Locality : same as above.

Fig. 8. *Cerithidea* cf. *tokunariensis* MASUDA : U. H. Reg. No. 13739. Magnified figure, $\times 2\frac{1}{2}$.

Locality : same as above.

Fig. 9. *Murex* sp. U. H. Reg. No. 13737. Dorsal view. (Natural size).

Locality : same as above.

Plate 13

