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MOLLUSCAN FOSSILS FROM THE NEOGENE DEPOSITS SCATTERED ALONG THE WESTERN WING OF THE HIDAKA MOUNTAINS, HOKKAIDO

by

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(with 3 text-figures, 1 table and 4 plates)

Abstract

A marine molluscan fauna has been newly found in Tertiary deposits scattered along the western wing of the Hidaka Mountains. This fauna is composed of 40 and over molluscan species in company with some species of brachiopods and others, and is characterized by a considerable number of cold and shallow water elements. The geological age of this fauna is discussed from the stratigraphic viewpoint and the faunal assemblage. The writers come to the tentative conclusion that this fauna may be referable to the middle Miocene "Kawabata" Stage in the provincial Neogene molluscan succession of Hokkaido. In addition to the description of this fauna, the unique plicate species *Mytilus (Plicatomytilus) hidakensis*, one of the new species, is particularly discussed on its morphological features with relation to its allied species.

Introduction

Sakai, one of the present writers, has been engaged in the geological survey of the northern part of the Urakawa-Samani area, Hidaka Province during a few summers since 1976, and has mainly investigated Mesozoic deposits that are exposed along the western slope of the Hidaka Mountains, the backbone range of Hokkaido.

In 1978, Suzuki had a chance of carrying on the fieldwork together with him, and unexpectedly collected some molluscan fossils from a few outcrops of Tertiary deposits that are narrowly and sporadically distributed in this area. Sakai and Suzuki have continuously traced the distribution of Tertiary deposits and have collected many fossils at various localities in this area.

Sequentially, Suzuki and Uozumi have examined these fossils in detail, and now come to some tentative conclusion that this fauna is of middle Miocene age, but may be distinguishable from the well-known Miocene faunas of Hokkaido: the Asahi, Takinoue, Kawabata, Atsunai-Togeshita and Wakkanai faunas reported by Uozumi and Fujie (1958) and Uozumi (1962). Simultaneously, they attend with keen interest that an unique plicate species of mytilid is contained in this fauna. It seems that this new fauna, now in question, has the following geological and paleontological significance: 1) Examined this fauna, the historical change of the Miocene molluscan faunas of Hokkaido may be discussed more strictly; 2) settled the geological age of this fauna, it may be used to determine the date when the Hidaka metamorphic and pultonic masses were unroofed; 3) the unique plicate species of mytilid, *Mytilus hidakensis* seems to be closely related to *M. tichanovitchi*, Miocene species of Saghalin-Hokkaido and *M. middendorffi*, North American Miocene

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species. Their relations seem to involve an interesting phase of evolution or mutation. Also their geological and geographical distributions appear to suggest to migrate from one side to the other along the Northern Pacific Ocean.

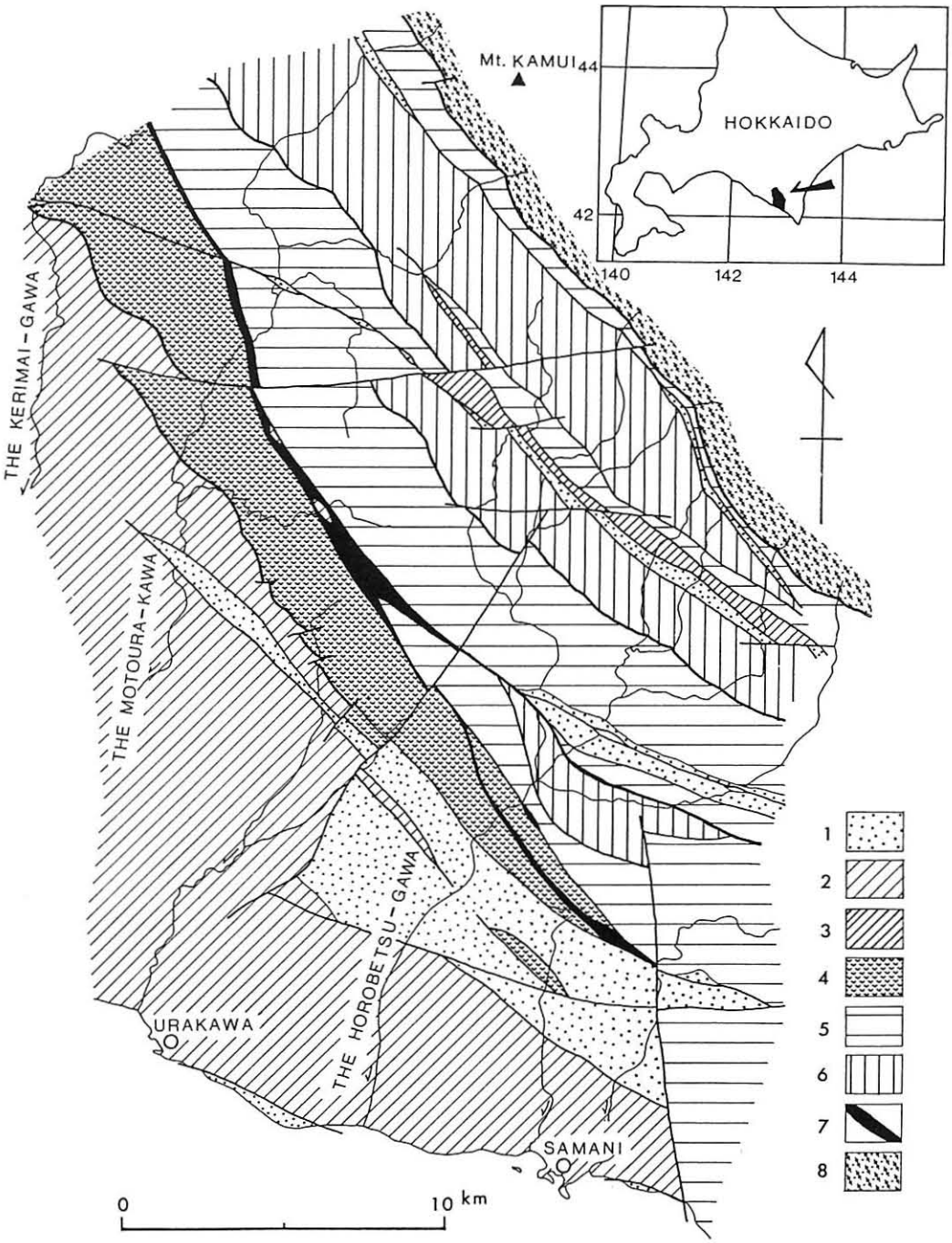
These three problems stated above will be respectively reported in detail in each separate paper on a future occasion. In this paper, the writers will describe only the occurrence of the interesting molluscan fauna associated with several new species.

Outline of geology

Generally speaking, the surveyed area is situated in the western side of the Hidaka metamorphic belt, Hidaka Province and is chiefly occupied by pre-Cretaceous deposits; the Kamui Group and Naizawa Formation, and Cretaceous deposits; the Menashuman Formation and Yezo Group. The Kamui Group, distributed in the eastern part of this area, consists of sandstone, slate, tuff, chert and phyllite, and is in fault contact with the Hidaka metamorphic belt on the east. The Naizawa Formation, distributed in the central, consists mainly of basic lava (pillow lava in part), hyaloclastite and chert, and is bordered by the Kamui Group with intrusion of the Hidaka western marginal greenstone belt on the east. The stratigraphic relationship between the Kamui Group and the Naizawa Formation is not yet clear only from field observations, but the latter seems to be Triassic in age from paleontological evidence (Sakai, 1976; Sakagami and Sakai, 1979). The Menashuman Formation is exposed together with Tertiary deposits in narrow distribution surrounded by the Kamui Group, and consists of sandstone, mudstone and acidic and/or siliceous tuff. The Yezo Group, distributed in the western, consists mainly of sandstone, shale and alternating beds of sandstone and mudstone, and is thrust over by the Naizawa Formation on the east. The stratigraphic relationship between the Menashuman Formation and the Yezo Group is not yet clear, but generally the former seems to be older than the latter from its lithological features.

Tertiary deposits containing molluscan fossils are found in narrow and sporadical distribution along the NW-SE trending faults, although three fault systems are recognized in this area: NNW-SSE, NW-SE and E-W trending faults (Sakai and Suzuki, 1980). From the geographic distribution, these deposits are separated into five zones, as shown in Text-figure 1. But they are regarded as some parts of a single formation from the lithological and biostratigraphical viewpoints. Here the present writers will propose a new name "the Kamikineusu Formation" for these deposits. The Kamikineusu Formation is in fault contact with the basement rocks in many cases, but in the C-zone, this formation is unconformablly underlain by the Kamui Group. This formation consists of basal conglomerate, dark green coarse-grained sandstone and gray siltstone in ascending order.

The basal conglomerate is composed of rounded pebbles and subrounded cobbles in a matrix of coarse-grained sand, and contains occasionally a considerable number of large blocks of limestone, chert and alternating beds of sandstones and slate. These blocks are commonly exceeded several meters in diameter. The components of the pebbles and cobbles are occupied in 85 – 95 percent by sandstone, chert, slate and basalt (meta-basalt in part), which seem to be derived from the Kamui Group. The remainder is occupied in 5 – 15 percent by acidic and/or siliceous tuff, and in 1 percent by dacite, andesite and rhyolite. It is



Text-fig. 1 Geological map of the Urakawa-Samani area.
1: Kamikineusu Formation, 2: Yezo Group, 3: Menashuman Formation, 4: Naizawa Formation, 5 and 6: Kamui Group (5: Soematsuzawa Formation, 6: Nishuomanaizawa Formation), 7: Serpentinite, 8: Hidaka metamorphic rocks.

remarkable that the conglomerate, 30 meters in thickness, is wholly lacking in the materials derived from the Hidaka metamorphic belt. Molluscan fossils are rather rare in the conglomerate. The coarse-grained sandstone contains characteristically a large amount of glauconite and many fossil specimens of molluscs, brachiopods, echinoids and balanoids. Such sediments exceeds 300 meters in thickness, and also grades upward into the siltstone, which is occasionally interbedded with bluich gray fine-grained sandstone and alternating beds of sandstone and mudstone. The siltstone, spotted be pumice grains, contains calcareous nodules and some molluscan fossils, and is estimated to exceed 300 meters in thickness.

Until the present time, the Neogene deposits, similar to the Kamikineusu Formation in lithology, have been occasionally reported in adjacent areas by various authors: the Amemasuzawa Formation by Hasegawa and Sakou (1958), the Shintomi Formation by Suzuki, M. et al. (1959) and the Kashikoshioumanaizawa Formation by Suzuki, M. et al. (1961). But they are exposed sporadically in narrow distribution, and the stratigraphical relationship between them could not clearly be confirmed from field observations. Now the present writers will assume that the Kamikineusu Formation may be contemporaneous with these formations from the geographical distribution and lithofacies. Furthermore, the Kamikineusu Formation is lithologically similar to the Noya Formation (middle Miocene, "Takinoue" Stage) and the Azamizawa Formation (middle Miocene, "Kawabata" Stage), and it is less similar to the Shizunai Formation (middle to late Miocene, "Wakkanai" Stage). The latter three formations are typically exposed in the Shizunai-Mitsuishi area, west of the surveyed area. Regarding the components of conglomerates of the abovementioned four formations, the Kamikineusu Formation is very similar to the Noya and Azamizawa Formation, and is quite different from the Shizunai Formation. According to Miyasaka and Kikuchi (1978), conglomerates of the Noya and Azamizawa Formation do not or very rarely, if any, contain the pebbles which seem to be drived from the Hidaka metamorphic belt. On the other hand, conglomerate of the younger Shizunai Formation contains such pebbles to some extent. It is significant to determine the lithologic sequence of the pebbles and boulders, since they can be used to determine the age when the Hidaka Mountains were rapidly upheaval, when the Hidaka metamorphic and plutonic masses were unroofed, etc. Actually, the large differences recognized between the components of conglomerates of the Noya and Shizunai Formation are due probably to the differences of the stratigraphical position between these conglomerates produced by the upheaval and erosion of the Hidaka Mountains (Hidaka metamorphic and plutonic rocks). In other words, this evidence, if it really was so, may suggest that the Hidaka metamorphic belt was not exposed on the ground surface and was overlain by the Kamui Group and others during the depositional period of the Kamikineusu Formation, and then gradually upheaved along with the progress of the geological time, exposed on the ground surface and began to supply metamorphic and plutonic pebbles into the depositional basins of the Shizunai Formation and its equivalents. As to the last point, the evidence that the components of conglomerates belonging to late Miocene and Pliocene in the Hidaka area are considerably occupied by the pebbles of the Hidaka metamorphic and plutonic rocks may enforce the possibility.

Concerning to the geological age, the Kamikineusu Formation and its equivalents have

been roughly considered to be Miocene. But it seems that such assumption was not always supported by the stratigraphical and paleontological evidences and could not be defined to the presice stratigraphic position. This problem concerning the Kamikineusu Formation will be more discussed from the paleontological viewpoint in the next chapter.

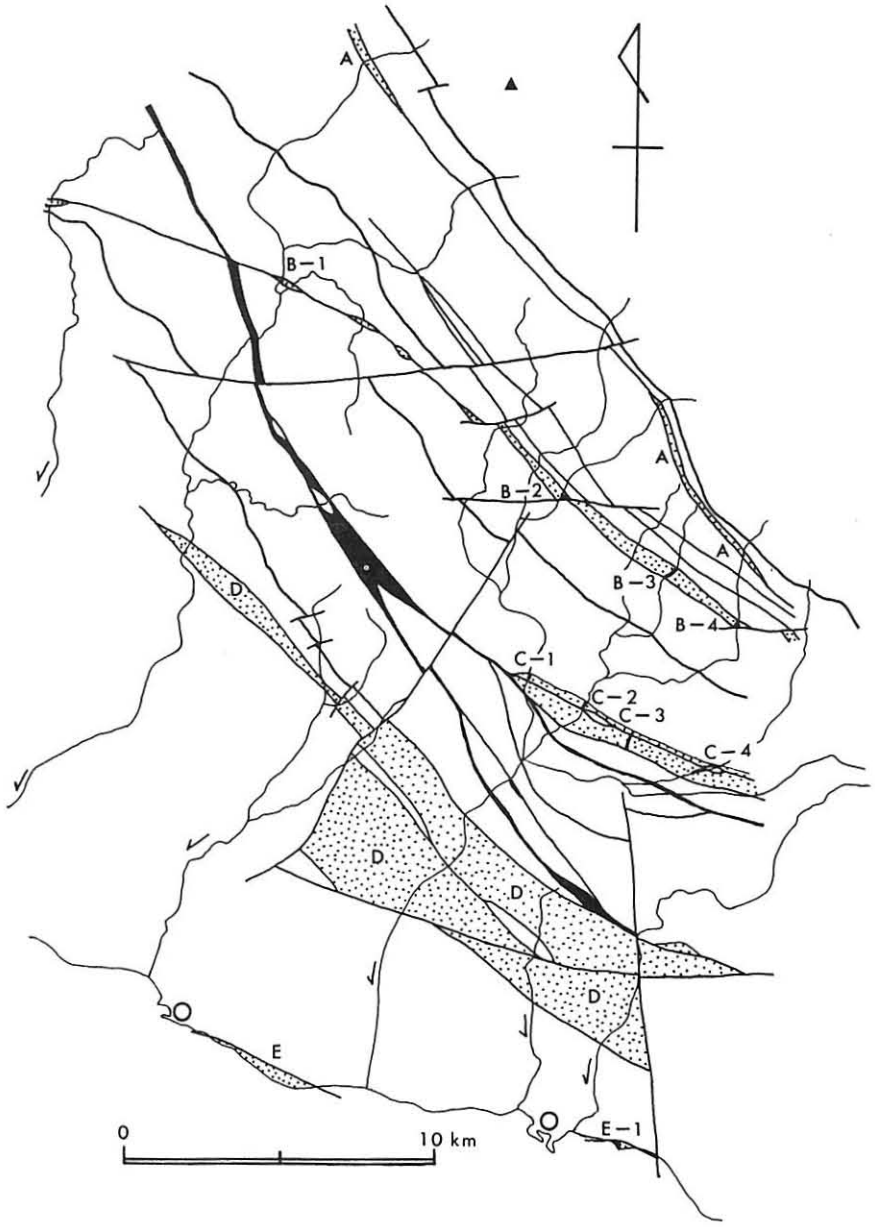
Fauna of the Kamikineusu Formation

The fossils, now in question, were collected at nine outcrops of the Kamikineusu Formation, which are distributed in B-, C- and E-zones, but not in A- and D-zones, as shown in Text-figure 2. In B-, C- and E-zones, fossil specimens are obtained from various lithologic facies, although many of them are usually from fine- to coarse-grained sandstone (Text-fig. 3). In futures there is a large possibility that some fossils will be found in A- and D-zones on careful observations. Fossil specimens have been more or less deformed within their bearing rocks, which were terribly disturbed by the upheaved movements of the Hidaka metamorphic belt. However, some specimens are rarely found in the good state of preservation: some specimens of *Mytilus hidakensis* are in complete preservation, and have left the periostracal metarials on shell surfaces.

The fauna of the Kamikineusu Formation is composed of 40 and over molluscan species in company with some species of brachiopods, echinoids and balanoids as shown in Table 1. Among them, *Mytilus hidakensis, M. shunbetsuensis* and *Chlamys sakaii* will be originally described herein by the present writers.

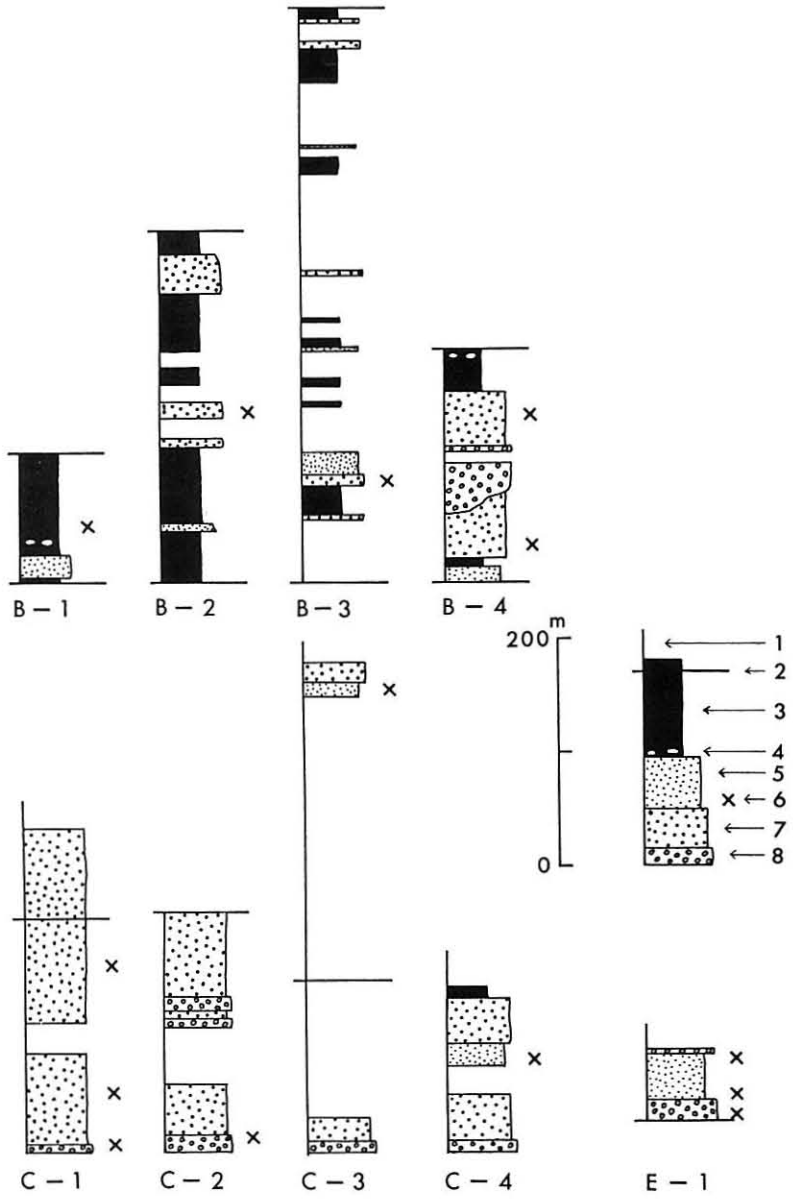
Analyzed this faunal composition in more detail, the fauna seems to be subdivided into two different fossil assemblages, which correspond to the facies of fossil bearing rocks: coarse-grained facies and fine-grained one. The fossils from coarse-grained deposits are typically found at Locs. C-1 and E-1 and its assemblage is mainly represented by *Yoldiia (Cnesterium) notabilis, Mytilus hidakensis, M. shunbetsuensis, Modiolus* sp., *Chlamys cosibensis hanzawae, Ch. sakaii, Monia macroschisma, Spisula onnechiuria, Mercenaria chitaniana* and *Nucella freycineti*. Among them, *Mytilus shunbetsuensis, Chlamys cosibensis hanzawae, Ch. sakaii* and *Monia macroschisma* were collected only from the conglomeratic deposits. The fossils from fine-grained deposits are also typically found at Locs. B-1, C-3, C-4 and E-1 (in part), and its assemblage is represented by *Acila (Truncacila)* cf. *gottschei, A. (T.) hidakensis, Nuculana* cf. *pernula, Acilana hayasakai var., Macoma optiva, M. tokyoensis, Panomya simotomensis* and *Periploma besshoensis*. Especially, *Macoma optiva* and *M. tokyoensis* are most aboundant and occasionally build up the "*Macoma* shell beds" at Loc. C-4. It may be considered that the difference between two fossil assemblages, stated above, reflects the changes of the sedimental environment. The basal coarse-grained materials were first deposited rapidly and boulders of the rocks incorporated in the basal part of the conglomerate. Then the depositional condition became stable and erosion of the land produced gradually finer-grained materials only. Thus the inhabitants might have been interchanged from the species favorable for coarse-grained sediments to the species for muddy ones. Nevertheless, this fauna is characterized by a considerable number of cold and shallow water elements, although a few temperate water elements belonging to *Anadara, Panomya, Fulgoraria,* etc. intermingle into this fauna.

On the geological age of this fauna, the following fossils should be worthy of attention.



Text-fig. 2 Map showing the distribution of the Kamikineusu Formation and fossil localities.

Firstly, this fauna contains nine species which have been only known from the Miocene deposits in Hokkaido: *Acila (Truncacila) hidakensis, Acilana hayasakai var., Glycymeris vestitoides, Chlamys cosibensis hanzawae, Spisula onnechiuria, Mercenaria chitaniana, Mya (Arenomya) fujiei, Panomya simotomensis* and *Neptunea modesta.* Also *Yoldia (Cnesterium) notabilis, Monia macroschisma, Macoma tokyoensis* and *Nucella freycineti* are well known as



Text-fig. 3 Stratigraphical columnar sections of the Kamikineusu Formation.
1: no exposure, 2: fault, 3: siltstone and shale, 4: calcareous nodule, 5: fine- to medium-grained sandstone, 6: fossils, 7: medium- to coarse-granined sandstone, 8: conglomerate.

the species which have widely ranged from Miocene to Recent. From the foregoing lines of the faunal assemblage, it may be said that this fauna indicates Miocene in age as a whole. Secondary, this fauna seems to be rather particular in the faunal composition as compared with the other Miocene faunas of Hokkaido, and does not contain the representative species which charactrize each well-known Miocene fauna as stated below. In the area along the

Table 1 List of molluscan fossils from the Kamikineusu Formation.

Loc.	B-1	B-2	B-3	B-4	C-1	C-2	C-3	C-4	E-1
PELECYPODA									
Acila (s.s.) sp.				X					
A. (Truncacils) cf. gottschei (Böhm)									X
A. (T.) hidakensis Nagao et Huzioka									X
Nuculana cf *pernula* (Yokoyama)				X					
Yoldia (s.s.) *akanensis* Uozumi		X							X
Y. (Cnesterium) notabilis Yokoyama			X		X			X	X
Acilana hayasakai (Uozumi) var.	X	X							
Anadara sp.									X
Glycymeris vestitoides Nomura	X								X
Mytilus (s.s.) cf. *edulis* Linnaeus					X				
M. (s.s.) *shunbetsuensis* Suzuki et Uozumi					X				
M. (Plicatomytilus) hidakensis Suzuki et Uozumi				X	X	X			X
Modiolus sp.					X				X
Chlamys cosibensis hanzawae Masuda					X				X
Ch. sakaii Suzuki et Uozumi					X				
Ch. spp.					X				
Monia macroschisma (Deshayes)					X				
Diplodonta sp.				X	X				
Cyclocardia sp.		X		X	X				X
Clinocardium sp.		X					X		X
Nemocardium ? sp.									X
Spisula onnechiuria (Otuka)					X				X
Peronidia sp.									X
Macoma optiva (Yokoyama)	X	X	X	X	X		X	X	X
M. tokyoensis Makiyama	X	X	X				X	X	
M. cf. *sejugata* (Yokoyama)	X	X	X						
Mercenaria chitaniana (Yokoyama)									X
Tapes ? sp.					X				
Liocyma sp.					X				
Mya (Arenomya) fujiei MacNeil									X
Panomya simotomensis (Otuka)		X		X	X				X
Periploma besshoensis (Yokoyama)									X
Thracia aff. *asahiensis* Uozumi									X
Cardiomya sp.			X						
GASTROPODA									
Turritella (Neohaustator) cf. *fortilirata chikubetsuensis* Kotaka			X	X					X
Tectonatica cf. *janthostoma* (Deshayes)	X			X	X		X	X	X
Nucella freycineti (Deshayes)					X				X
Helicofusus sp.			X	X	X				
Neptunea modesta (Kuroda)	X								X
N. sp.		X						X	X
Fulgoraria sp.									X
BRACHIOPODA									
Coptothyris grayi (Davidson)					X				
Terebratalia gouldi (Dall)					X				

western slope of the Hidaka Mountains, the Miocene molluscan faunal sequence has been established in ascending order as follows: the Asahi, Takinoue, Kawabata, Atsunai-Togeshita and/or Wakkanai fauna as described by Fujie and Uozumi (1957), Uozumi and Fujie (1958) and Uozumi (1962). The Asahi fauna is considered to be of early Miocene; the Takinoue and the Kawabata ones are of middle Miocene; and Wakkanai is probably of middle to late Miocene. The Atsunai-Togeshita fauna seems to be coeval with the Wakkanai one, or slightly

earlier than the latter. The fauna of the Kamikineusu Formation is quite different from the Wakkanai fauna, and does not wholly contain the representative species of the latter, such as *Yoldia sagittaria, Portlandis kakimii, Glycymeris idensis, Periplima yokoyamai* and *Neptuned eos*. Also this fauna does not resemble the Atsunai-Togeshita fauna, that is characterized by intermingling some Pliocene species in addition to the middle Miocene species such as *Anadara ogawai, Laevicardium shiobarense, Kaneharaia kaneharai mirabilis, Pitar okadana* and so on. From the different paleontological standpoints, it is noteworthy that the Kamikineusu Formation yields many specimens of *Spisula onnechiuria*, which has not been reported from the deposits belonging to the "Wakkanai" and the "Atsunai-Togeshita" Stages. This species is commonly found in the deposits belonging to the "Asahi", "Takinoue" and "Kawabata" Stages. Taking this evidence into consideration, the Kamikineusu fauna may be older than the Wakkanai and Atsunai-Togeshita faunas. More detailed paleontological correlation may be not only based on the faunal assemblage or on any well-known index species, but based, if possible, on the paleontological evidence of evolution or mutation of some species. 1) The varietal from of *Acilana hayasakai* is rather common in this fauna, now in question. Until the present time, this varietal form of *Acilana* has been only known from the deposits of the "Wakkanai" Stage, whereas the typical form of *Acilana hayasakai* is widely found in the deposits of the "Asahi" to the "Wakkanai" Stage, as described in the next chapter. 2) From the observation on a large number of the specimens of *Mercenaria chitaniana*, they are rather lower in height of shell than the typical form, reported by Hayasaka and Uozumi (1954). According to them, the ratio of height to length has a certain relation with the range of their vertical distribution in the Neogene sequence in Hokkaido, the older the geological age, the larger the value of Height/Length of shell and also the younger the bed, the longer the shell. From this standpoint, the fauna containing such form of *Mercenaria chitaniana* may be regarded as younger than the Chikubetsu fauna ("Takinoue" Stage) which is oldest fauna containing the typical form of this species. 3) *Mya (Arenomya) fujiei* has been described from the middle Miocene Takinoue Formation in Hokkaido and from the late Miocene Briones Sandstone in California. On careful examination, the present writers have recognized some slight differences between the Hokkaido's specimens in shell outline, as stated in the next chapter. The specimens, now in hand, are rather similar to the American specimens, without regards on the geographic distribution. If it really was so, this fact may suggest that the Kamikineusu fauna is younger than the Takinoue fauna. 4) *Mytilus hidakensis* may be intermediate in morphological form between *M. tichanovitchi* and *M. middendorffi*, as stated in detail in the next chapter. This fact seems to indicate some phase of the phylogenetic trend or mutation from the former to the latter, and so the fauna associated with *M. hidakensis* may be younger than the Asahi fauna associated with *M. tichanovitchi*. Furthermore, the present writers have been comparatively examined in detail the specimens of *Mytilus* from the middle Miocene Furanui Formation of the "Takinoue" Stage. These specimens, now in hand, may be recognized as a new undescribed form, although the Furanui *Mytilus, M. hidakensis* and *M. tichanovichi* have previously been lumped under *M. tichanovitchi* Makiyama. This new form may be intermediate form between *M. tichanovitchi* and *M. hidakensis*. The present writers are strongly inclined to regard that the slight differenced

existing between these three species represent the changes resulted during the lapse of time. This problem will be described in a separate paper in near future.

From the foregoing lines concerning the paleonological evidences, the present writers can try only a tentative conclusion. The fauna, now in question, is of the "Kawabata" Stage in the sense of the provincial Miocene faunal sequence of Hokkaido: younger than the Takinoue fauna and older than the Wakkanai one. The fossils hitherto collected from the Kawabata Formation are poorly known in number of species, so that we cannot discuss the detail comparison between the Kawabata and the Kamikineusu fauna. At the present stage of our knowledge, the Kamikineusu fauna may be considered as a standard fauna representing the "Kawabata" Stage in the provincial molluscan faunal sequence of Hokkaido.

Acknowledgements

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Systematic description

Genus *Acila* H. et A. Adams, 1858

Subgenus *Truncacila* Grant et Gale, 1931

Acila (Truncacila) cf. *gottschei* (Böhm)

Pl. 1, figs. 7, 8

1916. *Nucula (Acila) gottschei* Böhm, Jahrb. kön. preuss. geol. Landesanst., Berlin, vol. 36, pt. 1, pp. 554-555, pl. 29, figs. 5-7, 13.

1936. *Acila (Truncacila) gottschei* (Böhm). Schenck, Geol. Soc. Am., Special papers, no. 4, p. 88.

1941. *Acila (Truncacila) gottschei* (Böhm). Nagao et Huzioka, Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. 4, vol. 6, no. 2, pp. 121-123, pl. 29, figs. 10-15.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	Umbonal Angle	Angle of Bifurication	
30527	19.2	11.6	6.1	98	60	L.v.
30529a	19.4	11.5	8.5	105		Both
30529b	20.7	11.5	7.4	95		Both

Remarks: This species was described by Nagao and Huzioka (1941) from the Neogene deposits at various places in Hokkaido and Saghalin. The present specimens are rather variable in external features, and are more obliquely elongate in general than the typical form.

Occurrence: Loc. E-1 (fine-grained sandstone).

Acila (Truncacila) hidakensis Nagao et Huzioka

pl. 1, figs. 4-6

1941. *Acila (Truncacila) hidakensis* Nagao et Huzioka, Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. 4, vol. 6, no. 2, p. 124, pl. 29, figs, 20, 20a

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	Umbonal Angle	Angle of Bifurcation	
30524	17.2	15.8	8.6	108	64	Both
30525	19 ±	17.1	8.2	102		Both
30526	18.5	18.0	4.5	110		L.v.

Remarks: This species was originally reported by Nagao and Huzioka (1941) based on two imperfect specimens which were collected from the Kawabata Formation (middle Miocene) in Anetya, Hidaka Province, Hokkaido. They have established this species in comparison with *Acila (Truncacila) gottschei* (Böhm) as follows: "Which (this species) are closely similar to *A. gottschei* (Böhm) in general. They differ from the typical specimens of the latter in having a more distinctly excavated escutcheonal area, narrower radial ribs and broader and deeper interspaces, reminding one of the sculpture of *A. divaricata* (Hinds) var. *submirabilis* Makiyama. Moreover, the area of obsolete radial ribbing is not developed and secondary bifurcation is observable only in the ventral portion. The primary line of bifurcation is situated posterior to central, though this is probably owing to deformation. More material may prove that this form is a varietal one of *A. (T.) gottschei.*" Judging from their figures, the posterior margin of this species is much longer than that of *A. (T.) gottschei.*

The present specimens are characterized by subtriangular outline in having the relatively long posterior margin, the area of obsolete radial ribbing not developed, secondary bifurcation observable on the central to ventral part of shell and the primary birurcation line situated central to anterior. The last feature of them distinctly differes from that of the typical form described by Nagao and Huzioka (1941), and rather similar to that of *A. (T.) gottschei.* However, the posterior situation of the primary bifurcation line in the typical form may be the result of deformation of shell, as already noted out by the original authors. The other features of the shell may not be sufficient to distinguish this form from *A. (T.) hidakensis.*

Occurrence: Loc. E-1 (fine-grained sandstone).

Genus *Acilana* Khomenko, 1937

Acilana hayasakai (Uozumi) var.

Pl. 2, figs. 1-4

1937. *Yoldia tokunagai* Yokoyama. Kanehara, Jour. Geol. Soc. Jap., vol. 14, no. 527, pp. 793-794, pl. 25, figs. 6,7. (non Yokoyama, 1925).

1957. *Portlandia (Portlandella) tokunagai* var. *hayasakai* Uozumi, Jour. Fac. Sci., Hokkaido Univ., Ser. 4, vol. 9, no. 4, pp. 570-572, pl. 2, figs. 6-9, 15, 15a.

1966. *Portlandia (Hataiyoldia) hayasakai* Uozumi, Ibid., vol. 13, no. 2, p. 128, pl. 10, figs. 8-10.

1972. *Yoldia (Portlandella) karaginskiensis* Gladenkov, Trans. Publishing Office "Nauka", Moscow, Moscow, vol. 214, pp. 221-223, pl. 5, figs. 1-6, pl. 6, figs. 1-4, pl. 8, figs. 13, 14.

Dimensions (in mm):

U. H Reg. No.	Length	Height	Thickness	
30530	33.6	17.3	8.5	L.v.
30531	33.0	16.5	8.0	L.v.
30532	31.0	16.5	8.4	L.v.

Remarks: This species was established by Uozumi (1957) based on the specimens obtained from the early Miocene Asahi Formation in Hokkaido, and then reported from many localities of provincial Miocene deposits in Hokkaido. Judging from examination of many Hokkaido's specimens, the present writers consider that some specimens should be recognized as a varietal form of *A. hayasakai* that the surface sculpture is considerablly different from the typical one. In the varietal form, the minite divaricated sculpture is somewhat impressed near the ventral margin and tends to become almost obsolete towards the central part of shell. Forthermore, it is noticed that the varietal form occurs only in a horizon higher than of this species (s.s): the former occurs in the deposits of the "Wakkanai" Stage, and the latter in the deposits of the "Asahi" Stage to the "Wakkanai" Stage in the Neogene sequence of Hokkaido (Uozumi, 1957, 1962).

Yoldia karaginskiensis was reported from the middle Miocene deposits in Kamchatka by Gladenkov (1972) and is very similar to the present varietal form of *Acilana hayasakai* in surface sculpture. Gladenkov has considered that Kamchatka's species might be conspecific with the varietal form of *Acilana hayasakai.* Also he has noticed that *Yoldia karaginskiensis* in Kamchatka occurs in a horizon higher than that of typical form of *Acilana hayasakai* (personal communication in 1980).

Occurrence: Locs. B-1 and B-2 (siltstone, especially in nodules).

Genus *Mytilus* Linnaeus, 1958

Subgenus *Mytilus*

Mytilus (Mytilus) shunbetsuensis Suzuki et Uozumi, n. sp.

Pl. 2, figs. 6, 7.

Description: Shell medium in size, rather thin in test, very long lanceolate in outline and rather inflated; postero-dorsal margin straight to slightly arcuate and gradually merging into a narrow regularly rounded posterior margin; ventral margin slightly concave near its central portion. Beak low, pointed and produced. A blunt umbonal ridge extends from the beak to the posterior extremity through the central area of shell, and nearly straight to somewhat convexed toward the postero-dorsal area of shell. Surface sloping steeply toward the ventral margin, especially near the middle of the ventral area of shell and gradually toward the posterior extremity; ornamented with concentric and periodic coarse undulations and fine growth lines.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	
30534	79.0	23.5	13.7	L.v.
30535	55.3	19.9	13.5	R.v.

Holotype: U.H. Reg. No. 30534

Type locality: Loc. C-1

Remarks: Five specimens of the present species in hand are more or less imperfect and slightly deformed. The present species is primarily characterized by very elongate outline, and seemingly resembles *Mytilus hannibali* Clark and Arnold (1923) from the Sooke Formation developing in Vancouver Island, Canada. But the former is much elongate in form as compared with the latter.

Occurrence: Loc. C-1 (conglomerate).

Subgenus *Plicatomytilus* Allison et Addicott, 1976

Mytilus (Plicatomytilus) hidakensis Suzuki et Uozumi, n. sp.

Pl. 1, figs. 1, 10; Pl. 2, fig. 8; Pl. 3, figs. 1-3.

Description: Shell elongate, ventricose, rather large in size and moderately thick in test; dorsal margin arcuate with a pronounced angle; ventral margin nearly straight. Beak low, slightly prosogyrate. A umbonal ridge extends from the beak to the posterior extremity through the postero-dorsal area of shell, the behind of it being strongly depressed; posterior slope of the ridge overhanging. The depressed dorsal area narrow and elongate along the postero-dorsal margin, and forming a wing. Surface is ornamented by concentric, periodic coarse undulations and fine growth lines. In addition to these sculptures, three radiated rugose ribs develop on the surface of the postero-ventral area of adult shell and produce undulatory deflections of the plane of commissure. The rugose ribs usually low, flattly round-topped, subequal to the interspaces and variable in strength: posterior two much stronger than anterior one that is sometimes invisible. Hinge plate with two dysodont teeth, located at just under the beak. Ligament groove long, deep and heavy.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	
30521	84.0	41.3	24.0	L.v.
30538	78.8	47.3	20.5	L.v.
30520	83.2	44.0	24.5	L.v.
30539	74 ±	39.4	27.6	R.v.
30540	70.1	40.2	15.2	R.v.
30536	109 ±	55.4	53.2	Both

Holotype: U.H. Reg. No. 30520

Type locality: Loc. C-1.

Remarks: Many specimens of the present species are obtained. They are very well in preservation, and some of them have left the periostracal materials on their shell surfaces.

The present species is very similar to *Mytilus (Plicatomytilus) middendorffi* Grewingk from the middle Miocene deposits of North America (Addicott, 1974; Allison and Addicott, 1976). They are characterized by radial ribs on the postero-ventral surface of shell. But the present species is not ornamented by finner radial ribs that branch off of the main broad dorsal rib in the postero-dorsal area of shell. The other two species belonging to the subgenus *Plicatomytilus* are reported by Allison and Addicott (1976): *M. (P.) gratacapi* is from the middle to late Miocene deposits of Alaska and M. (P.) sp. from the middle Miocene deposits of Kamchatka. *M. (P.) gratacapi* differs markedly from the present species by having the prominently ribbed lunule and the strong arching and twisting of the umbonal ridge. The Kamchatkan *Plicatomytilus* species is more or less similar to the present species, but differs by being less inflated and by the weak deflection of the plane of commissure. The present species is easily distinguished from all other Japanese mytilids by its unique form and rugose radial ribbing sculpture. *Mytilus tichanovitchi* Makiyama is very inflated species of early Miocene age in Hokkaido and Saghalin (Makiyama, 1937; Uozumi, 1966), and somewhat resembles the present species, but is readily distinguishable by no rugose radial ribs.

The immature shells of the abovementioned five species are reasonably different from

the respective adult one. They are rather flat in common and are characterized by the projecting antero-ventral margin looking like that of *Modiolus* shell. And the shells in early growth stages of these species are rather difficult to be distinguished from each other. The shells of them resemble that of *Mytilus edulis* Linnaeus in internal features of shell, as already noted by Addicott (1974), but it seems that they are rather readily distinguished from the latter by the projecting antero-ventral margin, as stated above. These facts may suggest that the *Plicatomytilus* species: *M. (P.) hidakensis, M. (P.) moddendorfii, M. (P.) gratacapi* and *M. (P.)* species of Kamchatka, differenciated from a non-plicate ancestral species like *M. tichanovitchi* which is not directly related to *M. edulis*. This problem will be discussed in a separate paper in near future.

Occurrence: Locs. B-4 and C-1 (coarse-grained sandstone), Locs. C-2 and E-1 (conglomerte).

Genus *Chlamys* Röding, 1798

Chlamys sakaii Suzuki et Uozumi, n. sp.

Pl. 5, figs. 5a, b.

Description: Shell moderate to large in size and thick, much higher than long, moderately inflated, nearly equilateral excepting for auricles; valve radiately ribbed, apical angle about 80°. Valve ornamented with about 18 strongly elevated, round-topped and imbricated radial ribs, intercalary threads and concentric growth lines; radial ribs separated from each other by subequal round-bottomed interspaces, which average about as wide as or slightly narrower than the ribs. Interspaces on the lower half part of disc usually furnished with or sometimes without the imbricated intercalary threads. Auricle moderate in size, more or less truncated behind at about right angle, and ornamented with several, weakly imbricated radial threads and concentric lines; anterior auricle slightly large than posterior one, furnished with conspicuous cylindrical bysal gape, which located along the anterior margin of the auricle and openned at the anterior end of hinge line. Hinge with rather simple cardinal crura, deep and wide resilial pit with indistinct lateral ridges. Interior surface of valve unknown.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	Hinge Line	Apical Angle	
30541	81.3	112.9	20.8	52.8	82	L.v.

Holotype: U.H. Reg. No. 30541

Type locality: Loc. C-1.

Remarks: The description of the present species is based on a imperfect left valve specimen. Therefore the characters of the right valve and the interior features are not well known. The present species can be readily distinguished from the other Japanese pectinids by the slender form and the cylindrical byssal gape which are located along the anterior margin of auricle.

Chlamys matsunoi and *Ch. kotakae* Masuda (1962) have features somewhat resembling the present species in the slender shell-form and strongly elevated radial ribs, but they are apparently distinguishable from the present one by a large number of radial ribs and by lacking the intercalary threads appearing on the lower half part of disc.

The present species was collected from the conglomerate of the middle Miocene "Kawabata" Stage in the Hidaka Province, Hokkaido. *Chlamys matsunoi* and *Ch. kotakae*

were also from the similar lithological deposits of the middle Miocene "Takinoue" Stage in the same area. The characteristic slender shell-form of three species, stated above, seems to have been affected by the special condition of their living environments.

The present species is named after Mr. Akira Sakai, one of the present writers, who collected the specimen during field work.

Occurrence: Loc. C-1. (conglomerate).

Genus *Mercenaria* Schumacher, 1817

Mercenaria chitaniana (Yokoyama)

Pl. 4, figs. 5-8.

1923. *Venus stimpsoni* Yokoyama, Jap. Jour. Geol. Geogr., vol. 2, p. 6, pl. 1, fig. 5.
1926. *Chione chitaniana* Yokoyama, Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, vol. 1, pt. 9, pp. 352-353, pl. 39, fig. 13.
1927. *Venus yokoyamai* Makiyama, Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, vol. 3, pp. 46-47, pl. 2, fig. 8.
1927. *Chione chitaniana* Yokoyama, Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, vol. 2, pt. 4, p. 201, pl. 51, figs. 3, 4.
1931. *Mercenaria yokoyamai* (Makiyama). Kuroda, In Homma's "Shinano-Chyubu Chisitsusi" (Geology of Central Shinano), p. 58, pl. 6, fig. 39.
1936. *Mercenaria yokoyamai* (Makiyama). Otuka, Jour. Geol. Soc. Japan, Vol. 43, pp. 731-732, pl. 13, figs 6a, 6b.
1936. *Venus (Chione) yokayamai* (Makiyama). Nomura et Hatai, Saito H-on Kai Mus. Res. Bull., no. 10 p. 126, pl. 14, figs. 3, 4.
1938. *Venus (Mercenaria)* yokoyamai (Makiyama). Oinomikado, Jour. Geol. Soc. Japan, no. 45, p. 672.
1939. *Venus (Chione) yokoyamai* (Makiyama). Nomura et Hatai, Jap. Jour. Geol. Geogr., vol. 16, nos. 1-2, pp. 5 and 55.
1940. *Mercenaria chitaniana* (Yokoyama). Otuka, Jap. Jour. Geol. Geogr., vol. 17, nos. 1-2, pp. 95-95, pl. 11, figs. 9-12.
1940. *Mercinaria chitaniana* (Yokoyama). Nomura, Sci. Rep. Tohoku Imp. Univ., vol. 21, no. 1, pp. 260-261, pl. 33, fig. 17.
1954. *Mercenaria chitaniana* (Yokoyama). Hayasaka et Uozumi, Trans. Proc. Palaeont. Soc. Japan, N.S., no. 15, pp. 166-168, pl. 22, figs. 2, 5.
1960. *Mercenaria chitaniana* (Yokoyama). Shuto, Mem. Fac. Sci., Kyushu Univ., Ser. D, vol. 19, no. 2, pp. 145-146, pl. 13, fig. 7.
1970. *Mercenaria chitaniana* (Yokoyama). Iwasaki, Jour. Fac. Sci., Univ. Tokyo, Sec. 2, vol. 17, pp. 408-409, pl. 5, fig. 2, pl. 7, figs. 5-7.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	
50549	62.0	46.0	16 ±	L.v.
50550	57 ±	44.7	17.9	L.v.
50551a	35.3	27.6	8.6	L.v.
50551b	50.5	42.5	15.6	R.v.
50552a	49 ±	44.3	23.0	Both.
50552b	56.2	46.7	11.5	L.v.
50552c	22.8	18.8	5.2	L.v.

Remarks: In 1954, Hayasaka and Uozumi re-examined fossil specimens of Genus *Mercenaria* from Tertiary deposits in Hokkaido. In their paper, the following discussions are of particular interest: "the above-mentioned three species *(M. y-iizukai, M. chitaniana* and *M. stimpsoni)* are very close to one another in general aspects, but in regard to the proportion

of Height/Length of shell, variations rather conspicuous according to geological horizons: the older the geological age, the larger the value of Height/Length, and also the younger the bed, the longer the shell. *M. chitaniana* (Miocene-Pliocene) is intermediate in form." They stated further that the specimens of *M. chitaniana* from Hokkaido are strongly variable in form.

Judging from the morphological features, the present specimens are regarded to be conspecific with the so-calledd "*M. chitaniana*", but are very variable in form. They show a wider range in the ratio of height to length of shell than that of *M. chitaniana* reported by Hayasaka and Uozumi (1954). Especially, it is noteworthy that the value of Height/Length of some specimens, now in hand, reach into the range of that of *M. stimpsoni.* Such tendency may be not always possible to explain as the results of deformation of the fossils, though some specimens in question are truely deformed.

In connection of such appearance, Iwasaki (1970) has reported that the specimens from the Higashi-Tanakura area, Fukushima Prefecture, show a wide range in proportion of Height/Length, which covers all-over the range in *M. chitaniana* and *M. y-iizukai.* This problem must be discussed again when many specimens of "*M. chitaniana*" are collected in future.

Occurrence: Loc. E-1 (coarse-grained sandstone).

Genus *Mya* Linnaeus, 1758
Subgenus *Arenomya* Winckworth, 1930
Mya (Arenomya) fujiei MacNeil

Pl. 4, figs. 1-3.

1915. *Mya dickersoni* Clark, Publ. in Geology, California Univ., vol. 8, no. 22, p. 478, (in part), pl 63, fig. 4.
1957. *Mya japonica oonogai* Fujie, Jour. Fac. Sci., Hokkaido Univ., Ser. 4, vol. 9, no. 4, p. 403 (in part), pl. 2, figs. la, b and 2.
1965. *Mya (Arenomya) fujiei* MacNeil, U.S. Geol. Surv. Prof. Paper, no. 483-G, p. 30, pl. 5, fig. 1.

Dimensions (in mm):

U. H. Reg. No.	Length	Height	Thickness	Anterior Length	Posterior Length	
30545	24.7	12.6	3.8	11.6	13.1	L.v.
30546	31.8	15.6	5.0	14.8	17.0	R.v.
30547	32.1	16.3	5.5	14.0	18.1	L.v.

Explanation of Plate 1

(All figures in natural size)

Figs. 1, 10. *Mytilus (Plicatomytilus) hidakensis* Suzuki et Uozumi, n. sp. 1: U.H. Reg. No. 30520 (Holotype) left valve, Loc. C-1. 10: U.H. Reg. No. 30521, left valve, Loc. C-1.

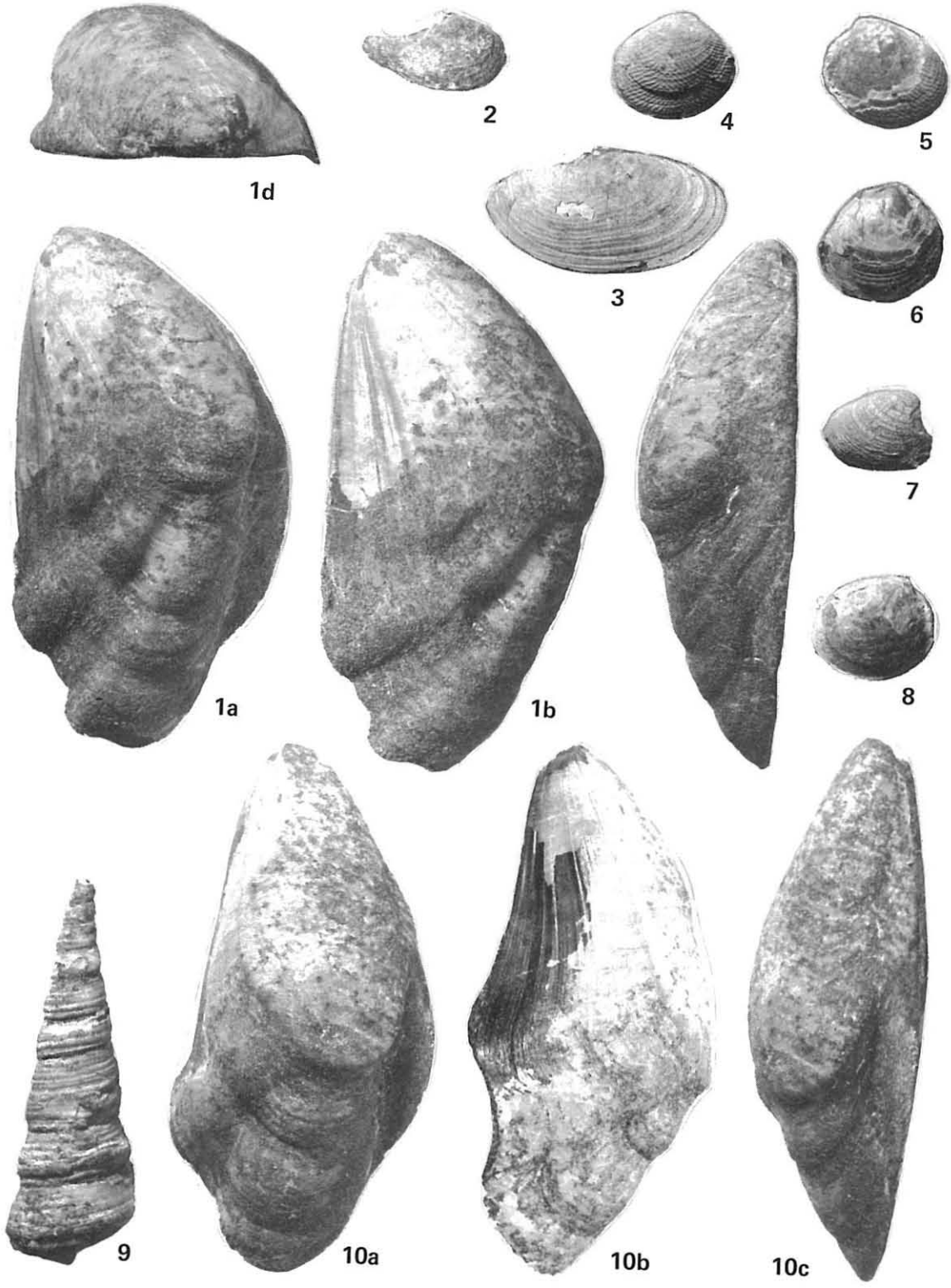
Fig. 2 *Nuculana* cf. *pernula* (Yokoyama). U.H. Reg. No. 30522, right valve, Loc. B-4.

Fig. 3. *Yoldia (Cnesterium) notabilis* Yokoyama. U.H. Reg. No. 30523, right valve, Loc. B-3.

Figs. 4-6. Acila (Truncacila) hidakensis Nagao et Huzioka. 4: U.H. Reg. No. 30524, left valve, Loc. E-1. 5: U.H. Reg. No. 30535, right valve, Loc. E-1. 6: U.H. Reg. No. 30526, left valve, Loc. E-1.

Figs. 7, 8. *Acila (Truncacila)* cf. *gottschei* (Bohm). 7: U.H. Reg. No. 30527, left valve, Loc. E-1. 8: U.H. Reg. No. 30529, left valve, Loc. E-1.

Fig. 9. *Turritella (Neohaustator)* cf. *fortilirata chikubetsuensis* Kotaka. U.H. Reg. No. 30528, Loc. B-4.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1b
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10a
10b
10c

Remarks: Several specimens at hand are characterized by transversely elongate outline, obliquely truncate posterior margin and the condrophore without anterior subumbonal groove. And the pallial sinus is rather large and deep, and its anterior extremity is regularly rounded. These characters may suggest that the present specimens appear to be conspecific with *Mya (Arenomya) fujiei,* which was established by MacNeil (1965) on the basis of some Japanese specimens described as *M. japonica oonogai* by Fujie (1957) and a American one reported firstly under the name of *M. dickersoni* by Clark (1915, Pl. 63, fig. 4). Speaking in more detail, the present specimens are rather similar to the American one than to the Japanese ones. That is to say, the present specimens and American one, stated above, are elongate subrectangular in outline with squarely truncate posterior end with obtuse subangulate junction with the dorsal margin. Whereas in the Japanese forms figured by Fujie (1957), the posterior margin makes a acute angle with the dorsal margin.

MacNeil (1965) has additionally noted in his paper that one specimen of *Mya dickersoni* figured by Clark (1915, Pl. 63, fig. 4) may be conspecific with this species or intermediate form between *Mya fujiei* and *M. areneria.* Concerning this problem, the present writers feel it necessary to extend their examinations for both Japanese and American specimens before they can draw any definite conclusion on a future occasion. In any case, it may be noticed that the specimens of this species, except for the present ones, have yielded from the middle Miocene Takinoue Formation in Hokkaido and from the late Miocene Briones Sandstone in California.

Occurrence: Loc. E-1 (coarse-grained sandstone).

Genus *Thracia* Sowerby, 1823

Thracia aff. *asahiensis* Uozumi

Pl. 4, fig. 11.

Dimensions: (in mm):

U. H. Reg. No.	Length	Height	Thickness	
50555	36 ±	29.8	12.4	Both.

Remarks: An imperfect specimens, now in hand, is characterized by the quadrate equilateral outline with prominent and sharply pointed beak, obliquely truncate posterior margin and strongly concave margin just in front of umbones.

The present specimen more or less resembles *Thracia asahiensis* Uozumi (1966) from the

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Explanation of Plate 2

(All figures in natural size, unless otherwise denoted)

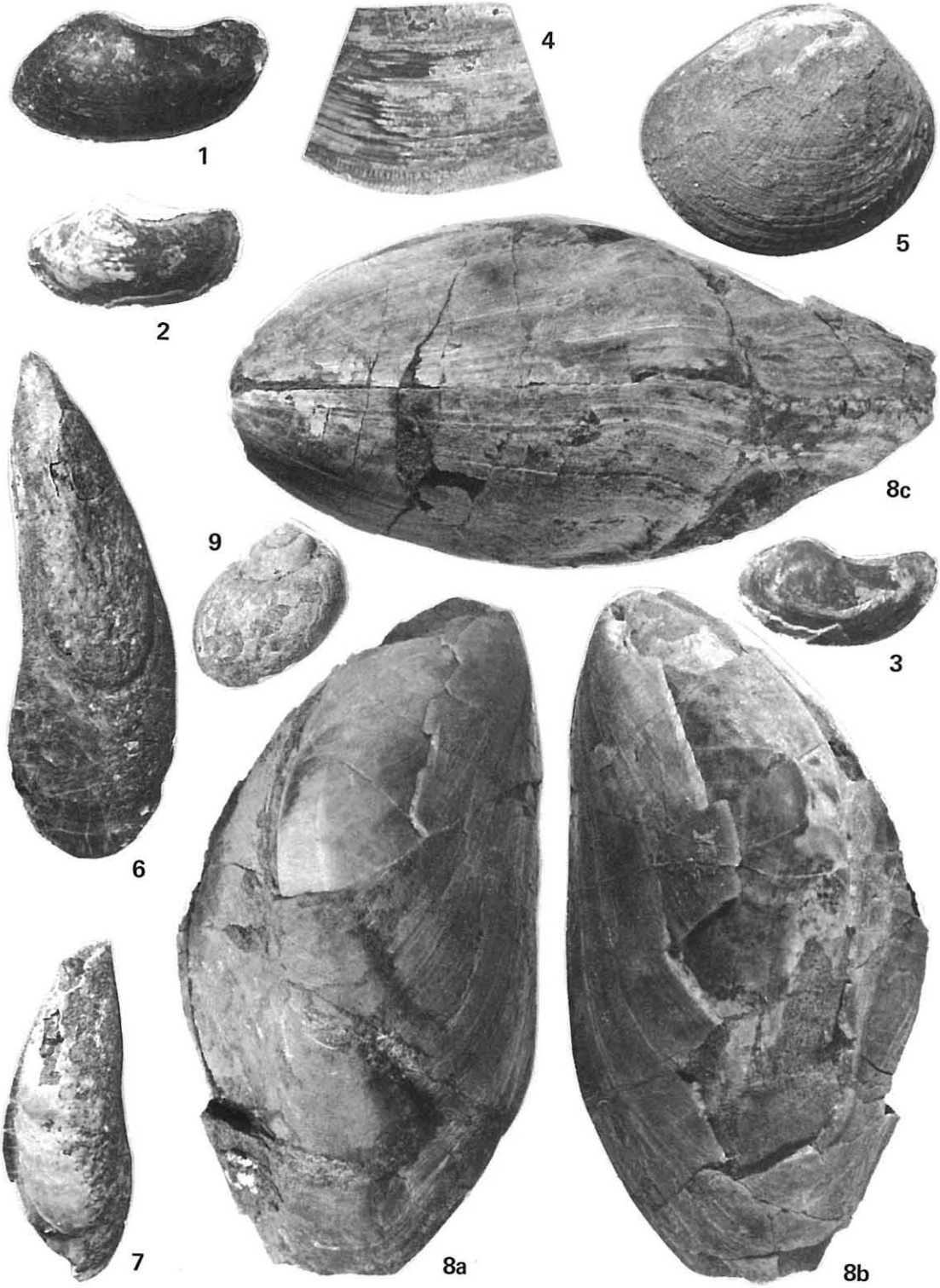
Figs. 1-4. *Acilana hayasakai* (Uozumi) var. 1: U.H. Reg. No. 30530, left valve (X1.2), Loc. B-2. 2: U.H. Reg. No. 30531, left valve, Loc. B-2. 3: U.H. Reg. No. 30532, left valve, Loc. B-2. 4: A higher magnification of surface sculpture (X 5).

Fig. 5. *Glycymeris vestitoides* Nomura. U.H. Reg. No. 30533, right valve, Loc. E-1

Figs. 6, 7. *Mytilus* (s.s.) *shunbetsuensis* Suzuki et Uozumi, n.sp. 6: U.H. Reg. No. 30534 (Holotype), left valve, Loc. C-1. 7: U.H. Reg. No. 30535, right valve, Loc. C-1.

Fig. 8. *Mytilus (Plicatomytilus) hidakensis* Suzuki et Uozumi, n. sp. U.H. Reg. No. 30536, Loc. E-1. 8a: right valve; 8b: left valve; 8c: ventral view.

Fig. 9. *Tectonatica* cf. *janthostoma* (Deshayes). U.H. Reg. No. 30537, dorsal view, Loc. B-4.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early Miocene Asahi Formation in Ishikari Province, central Hokkaido, but differs from the latter by its obliquely truncate posterior margin and widely rounded pallial sinus. *Thracia hataii* Kamada (1955), *T. kamayashikiensis* Hatai (1940) and *T. pertrapezoidea* Nomura (1935) reported from the Neogene deposits in Japan, are respectively characterized by the obliquely truncate posterior margin, but they are transversely more elongate in outline in comparison with the present form.

The present form may be perhaps a new species, but a specific name can not be proposed until more well-preserved specimens are examined.

Occurrence: Loc. E-1 (coarse-grained sandstone).

Genus *Turritella* Lamark, 1799

Subgenus *Neohaustator* Ida, 1952

Turritella (Neohaustator) cf. *fortilirata chikubetsuensis* Kotaka

Pl. 1, fig. 9

1959. *Turritella (Neohaustator) fortilirata chikubetsuensis* Kotaka, Sci. Rep. Tohoku Univ., Ser. 2, vol. 31, no. 2, p. 73, pl. 10, figs. 18-21.

Repository: U.H. Reg. No. 30528

Remarks: The specimens, now in hand, are characterized by rather broad and flat-topped spirals, and seem to be conspecific with *T. (N.) fortilirata chikubetsuensis*, reported by Kotaka (1959) from the middle Miocene deposits in the central part of Hokkaido.

Occurrence: Locs. B-3, B-4 and E-1 (coarse- to medium-grained sandstone).

Fossil localities

Loc. B-1: Riverside cliff along the upper stream of the Motoura-kawa near the meeting point of the Motoura-kawa and its eastern branch, the Shorokanbetsu-zawa. Urakawa-cho, Hokkaido.

Loc. B-2: Riverside cliff along the downstream of the Sogabetsu-ichino-sawa, a branch of the Horobetsu-gawa. Urakawa-cho, Hokkaido.

Loc. B-3: Riverside cliff along the middle stream of the Shinnoshike-shuman-zawa, a branch of the Horobetsu-gawa. Urakawa-cho, Hokkaido.

Loc. B-4: Riverside cliff along the middle stream of the Menashuman-zawa, a branch of the Horobetsu-gawa. Urakawa-cho, Hokkaido.

Loc. C-1: Riverside cliff along the middle stream of the Horobetsu-gawa. Urakawa-cho, Hokkaido.

Loc. C-2: Roadside cutting along a wood-land path "Shuman-rindo". Urakawa-cho, Hokkaido.

Loc. C-3: Hill-side exposure, west of the Urakawa Seismic Station of Hokkaido University. Urakawa-cho, Hokkaido.

Explanation of Plate 3

(All figures innatural size)

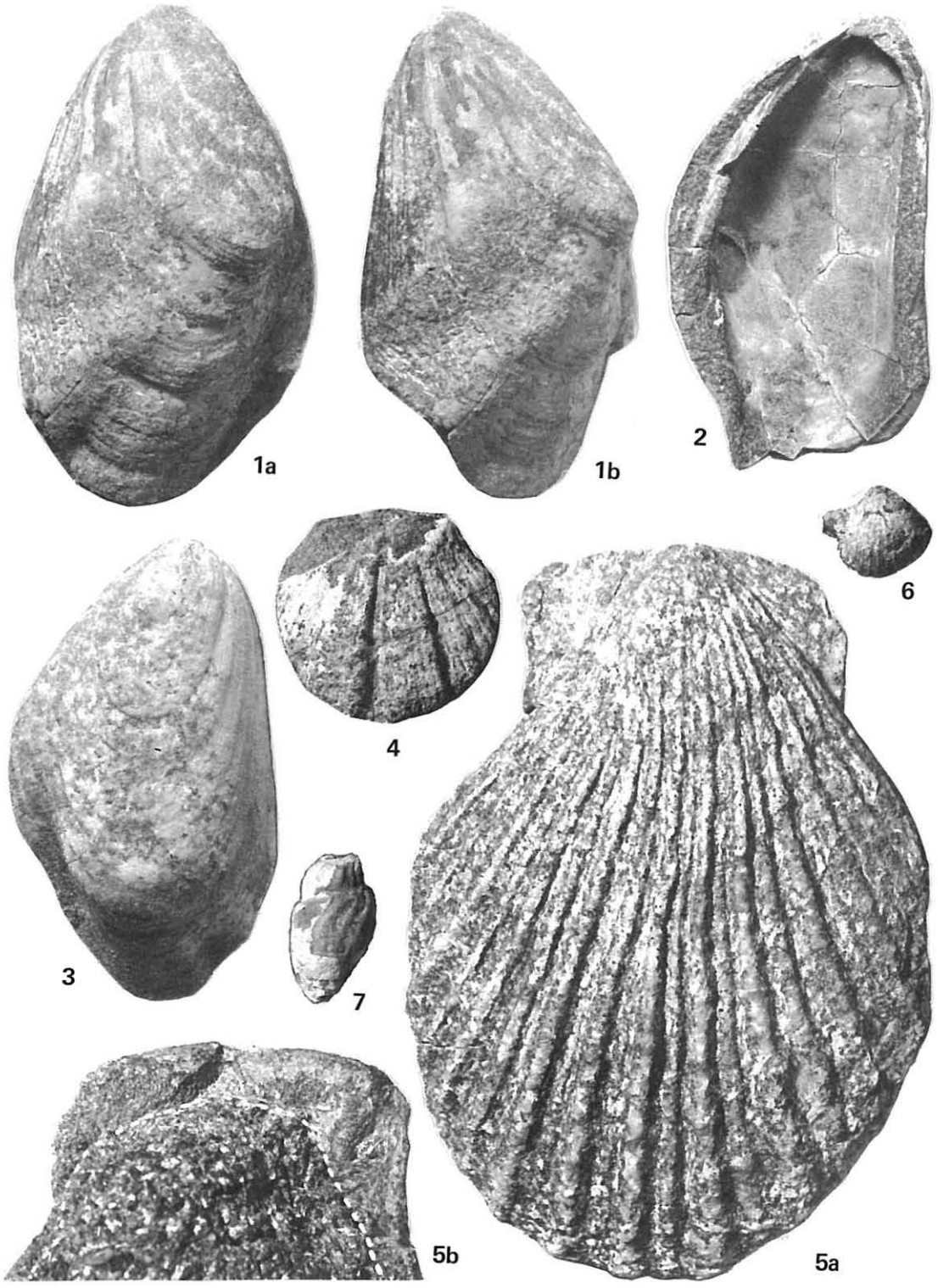
Figs. 1-3. *Mytilus (Plicatomytilus) hidakensis* Suzuki et Uozumi, n. sp. 1: U.H. Reg. No. 30538, left valve, Loc. C-1. 2: U.H. Reg. No. 30539, left valve, interior view, Loc. C-1. 3: U.H. Reg. No. 30540, right valve, Loc. C-1.

Fig. 4. *Chlamys cosibensis hanzawae* Masuda. U.H. Reg. No. 30542, right valve, Loc. C-1.

Fig. 5. *Chlamys sakaii* Suzuki et Uozumi, n. sp. U.H. Reg. No. 30541 (Holotype). 5a: left valve; 5b: interior view of hinge area, Loc. C-1.

Fig. 6. *Cardiomya* sp. U.H. Reg. No. 30543, right valve, Loc. B-3.

Fig. 7. *Fulgoraria* sp. U.H. Reg. No. 30544, dorsal view, Loc. E-1.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5b

Loc. C-4: Riverside cliff along the middle stream of the Menashunbetsu-gawa, a branch of the Horobetsu-gawa. Urakawa-cho, Hokkaido.

Loc. E-1: Roadside cliff along a national road "Route 236" near the seashore, east of the town of Samani. Samani-cho, Hokkaido.

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Explanation of Plate 4

(All figures in natural size)

Figs. 1-3. *Mya (Arenomya) fujiei* MacNeil. 1a; U.H. Reg. No. 30545, left valve; 1b: dorsal view, Loc. E-1. 2: U.H. Reg. No. 30546, right valve, Loc. E-1. 3: U.H. Reg. No. 30547, left valve, Loc. E-1.

Fig. 4. *Panomya simotomensis* (Otuka). U.H. Reg. No. 30548, left valve, Loc. C-1

Fig. 5-8. *Mercenaria chitaniana* (Yokoyama). 5: U.H. Reg. No. 50549, left valve (deformed), Loc. E-1. 6: U.H. Reg. No. 50550, left valve, Loc. E-1. 7: U.H. Reg. No. 50551, left valve, Loc. E-1. 8: U.H. Reg. No. 50552, right valve, Loc. E-1.

Figs. 9. 10. *Spisula onnechiuria* (Otuka). 9: U.H. Reg. No. 50553, left valve, Loc. C-1. 10: U.H. Reg. No. 50554, left valve, Loc. E-1.

Fig. 11. *Thracia* aff. *asahiensis* Uozumi. U.H. Reg. No. 50555, left valve, Loc. E-1.

Fig. 12. *Periploma besshoensis* (Yokoyama). U.H. Reg. No. 50556, left valve, Loc. E-1.

Fig. 13. *Neptunea modesta* (Kuroda). U.H. Reg. No. 50557, dorsal view, Loc. B-1.

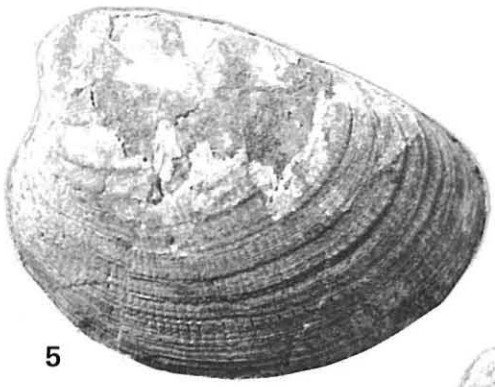

1a


1b


2


3


4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9


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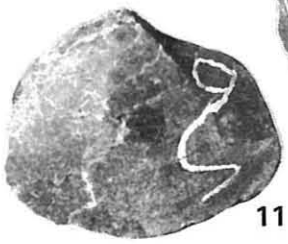
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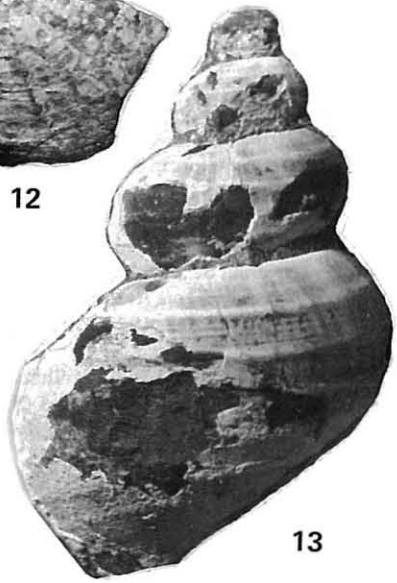
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