

Molluscan Fossils from the Niitsu, Higashiyama and Takezawa Oil-Fields, Niigata Prefecture, Japan

By

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Abstract

The neogenic molluscan fauna of the Niitsu, Higashiyama and Takezawa oil-fields in Niigata Prefecture, Japan, is described and analysed. Two new species and a new subspecies are described.

Introduction and Acknowledgements

The molluscan fossils collected from the neogenic rocks of the Niitsu, Higashiyama and Takezawa oil-fields during the recent five years are at the writer's disposition.

He is indebted to Prof. J. MAKIYAMA for his constant guidance in the course of the work, and to Dr. T. KURODA for informations on malacology. Thanks are also due to the members of the Oil Research Company for furnishing the opportunity of this research and allowing him to publish the results.

General geology

The general outline of stratigraphy in these oil-fields is given in Table 1.

The strata that yield molluscan fossils are Teradomari, Shiiya, Nishiyama, Haizume and Tsukayama formations. The general lithology of each subdivision is as follows:

1. Teradomari formation... Massive dark gray mudstones (so-called black shale)
2. Shiiya formation... Alternating sandstones, mudstones and conglomerates
3. Nishiyama formation... Massive bluish gray mudstones (so-called gray shale)
4. Haizume formation... Massive tuffaceous fine sandstones and siltstones (so-called sandy shale)
5. Tsukayama formation... Loose sandstones, gravels, and clays

Table 1. The Correlation of the Neogene Tertiary Formations in Niitsu, Higashiyama and Takezawa Oil-fields.

Age		Standard unit		Niitsu	Higashiyama	Takezawa
Plio-Pleist.	I	Uonuma Group	Oguni F.	Jingamine F.	Goyama F.	Inakura F.
			Tsukayama F.	Myogadani F.	Wanazu Sand F.	Wanazawa F.
Pliocene	H ₂	Chuetsu Group	Haizume F.	Hashida F.	Shiraiwa F.	Wanazu F. Ota F. Shioya F.
	H ₁		Nishiyama F.	Oguchi F. "Ôsawa-ishi"	Ushigakubi F.	Takezawa F.
			Shiia F.	Kanazu F.	Higashiyama F.	Kawaguchi F.
Miocene	G	Kubiki Group	Teradomari F.	Gomado Volcanics Tsuchikura F.	Araya F.	Araya F.
	F		Nanatani F.	Nanatani F.		

Molluscan fauna and environments

The abbreviations of the terms used in this paper as follows ;

- a) Bathymetric range
 N... Neritic, N₀... Intertidal, N₁... Enneritic, N₂... Mesoneritic, N₃... Subneritic, N₄... Bathynetric, B... Bathyal
- b) Bottom character
 R... Rock, G... Gravel, S... Sand, mS... muddy Sand, M... Mud, sM... sandy Mud, ses... sesile form
- c) Geographical distribution
 O... Oyashio type species (Living species habitat in Northern Japan)
 OJ... Oyashio-Japonic type species (Oyashio type species, but also distributed over the Japonic Province)
 J... Japonic type species (Living species, habitat restricted to the Japonic Province)
 JK... Japonic-Kuroshio type species (Japonic species, but also distributed in southern Japan to Formosa)
 pJ... past Japonic type species
 ×... Occurrence of that species
 ×... Remarkable occurrence of that species

1. Teradomari formation

The mollusks of this formation were obtained from the dark gray mudstones in Takezawa district.

1. *Solemya tokunagai* YOKOYAMA
2. *Nuculana (Thestyloda)* sp.
3. "*Yoldia*" sp.
4. *Limopsis* sp.

B

5. "*Propeamussium*" sp.
6. *Calyptogena nipponica* OINOMIKADO et KANEHARA
7. *Joannisiella* sp.
8. *Thyasira bisecta* (CONRAD) O B, N
9. *Serripes mahiyamai* (YOKOYAMA)
10. *Periploma* sp.
11. "*Nuculana*" sp.
12. *Neptunea eos* (KURODA) [N-B]

These species are found as autochthonous fossils in mudstone, indicating a deep neritic or bathyal muddy environment. *Solemya tokunagai* YOKOYAMA and *Calyptogena nipponica* OINOMIKADO et KANEHARA are the noticeable forms.

2. Shiiya formation.

This formation is poor in fossil content. There are found *Chlamys* sp. and *Anomia lischkei* DAUTZENBERG et FISCHER in a few seams of granular conglomerates in the alternating beds. The depositional environment of the Shiiya formation is hardly to be estimated with such a poor material.

3. Nishiyama formation

This formation mainly consists of bluish gray mudstones, but is variable at places, containing conglomerates, sandstones, siltstones and alternations. The molluscan fauna is variable too. The Table 2 is the faunal list of species from the different lithofacies.

The muddy facies prevailing most widely contains the usual forms such as *Thyasira bisecta* (CONRAD), *Periploma* sp., *Acila* (*Truncacila*) *nakazimai* OTUKA. These forms occur either scattering sporadically or in calcareous nodules. In any case, almost all individuals are found in natural attitude both the valves conjoint, showing the autochthonous origin in deep neritic to bathyal muddy bottom.

The local facies are as follows ;

a) "Ôsawa-ishi" facies—fossil-fragmental coarse to medium-grained and fossiliferous fine-grained sandstone facies

This facies takes place in the Niitsu district. Two different types of this facies are recognized: the fossil-fragmental coarse to medium-grained sandstones and the fossiliferous fine sandstones, although they pass insensibly to each other. The main elements of mollusks are as follows ;

Limopsis tajimae SOWERBY, *Polynemamussium alaskense* (DALL), *Venericardia ferruginea* CLESSIN, *Nuculana sadoensis* (YOKOYAMA), *Chlamys iwakiana* (YOKOYAMA), *Astarte bennettii* DALL, *Chlamys heteroglypta* (YOKOYAMA), *Leptothyra amussitata* GOULD, *Laevicardium undatopictum* (PILSBRY). Besides there are several forms of Brachiopoda.

The representative mollusks from the typical fossil-fragmental sandstones indicate a past environment of neritic (N₁-N₂) sandy bottom. However, in addition to these, are some muddy bottom inhabitants such as *Acila*, *Nuculana* and *Crenella*. These

Table 2. (Continued)

No.					Niitsu					Higashi-yama			Take-zawa	
					1	2	3	4	5	6	7	8	9	10
46	<i>Venericardia (Megacardita) kiiensis</i> (SOWERBY)	S	J	N ₃₋₄		×								
47	<i>V. (Miodontiscus) prolongata nakamurai</i> YOKOYAMA		O	N ₂₋₄		×								
48	<i>Felaniella usta</i> (GOULD)	S	J	N ₁₋₂					×				×	×
49	<i>Thyasira bisecta</i> (CONRAD)		O	B, N	×		×			×	×	×	×	×
50	<i>Th. ozawai</i> YOKOYAMA		J	(N-B)			×					×		
51	<i>Lucinoma annulata</i> (REEVE)	sM	J	N ₁		×	×	×					×	×
52	<i>Laevicardium undatopictum</i> (PILSBRY)		J			×								
53	<i>Fulvia</i> sp.						×							
54	<i>Clinocardium ciliatum</i> (FABRICIUS)		O			×								
55	"Cardium" sp.									×		×		
56	<i>Callista (s.s.) brevisiphonata</i> (CARPENTER)		O	N ₁₋₄		×								
57	<i>C.</i> sp.													×
58	<i>Saxodomus purpuratus</i> (SOWERBY)	S	J	N ₀₋₁		×								
59	<i>Dosinia (Phacosoma) japonica</i> (REEVE)	mS	J	N ₁										×
60	<i>Mercenaria yokoyamai</i> MAKIYAMA		pJ			×								
61	<i>Piacamen tiara</i> (DILWYN)		JK	N ₁₋₃										×
62	<i>Macoma tokyoensis</i> MAKIYAMA	mS, sM	J	N ₁₋₂		×			×					
63	<i>Anisocorbula venusta</i> (GOULD)	S	J	N ₁₋₄		×								
64	<i>Mya (Arenomya) japonica</i> JAY	mS, sM	J	N ₀₋₁		×			×					
65	<i>Mvadora japonica</i> HABE	S	J	N ₁		×	×							
66	<i>Thracia kakumana</i> (YOKOYAMA)		pO	N			×							
67	<i>Periploma</i> sp.													
68	<i>Cuspidaria behringensis</i> (LACHE)	mS	O	N-B		×	×	×		×			×	
69	<i>Dentalium (Dentale) weinkauffi</i> DUNKER		J	N ₂₋₃		×	×							
70	<i>Siphonodenalium (Pulsellum) ozawai</i> YOKOYAMA		J	N ₁		×	×	×		×				
71	<i>Emarginula?</i> sp.		R, S											
72	<i>Puncturella (s.s.) nobilis</i> (A. ADAMS)		O	N ₁₋₄		×								
73	<i>P. (Cranopsis) pelex</i> (A. ADAMS)		J			×								
74	<i>Collisella</i> aff. <i>heroldi</i> (DUNKEK)		JK			×								
75	"Acmaea" sp. 1												×	
76	"A." sp. 2						×	×						
77	<i>Lepeta lima</i> DALL						×							
78	<i>Margarites vahliioides</i> (YOKOYAMA)	ses. M	O	N ₀		×						×		
79	<i>Calliostoma</i> sp.									×				
80	<i>Umbonium (Suchium) suchiense subsuchiense</i> MAKIYAMA		pJ	N ₀₋₂		×								×
81	<i>Umbonium</i> sp.						×		×					
82	<i>Starkeyna sobrina</i> (A. ADAMS)	(S)	J	(N ₁)			×							
83	<i>Leptothyra amussitata</i> GOULD	R, S	O	N ₁₋₃		×	×			×			×	
84	<i>Turbo cornutus</i> SOLANDER		JK	N ₀₋₁		×								
85	<i>T.</i> sp.	R											×	
86	<i>Rissoina</i> sp.													
87	<i>Tachyrhynchus yanamii</i> (YOKOYAMA)						×	×	×					
88	<i>Turritella (Neohaustator) saishuensis</i> YOKOYAMA		pJ							×				
89	<i>Bittium a-satowi</i> OINOMIKADO et IKEBE		pJ				×							
90	<i>B. aff. yokoyamai</i> OTUKA			N ₂₋₄				×						

were more prolific in the fossiliferous fine sandstones. They seem to have been swept by flowing water. It has been assumed that a submarine bank or an island existed in the sea which deposited the Nishiyama formation*. "Ôsawa-ishi" was deposited around this hypothetical island. The changing facies is understood that the fossil-fragmental sandstones were deposited near by the beach and fossiliferous fine sandstones under the waters away offshore. Farther outside was the site of the superfine sandstones where the mollusks such as *Nuculana onoyamai* OTUKA, *Acesta goliath* (SOWERBY), *Astarte* lived. The chief elements of this assemblage remind the Omma-Manganjian fauna**, though no positive criterion is disposed at present.

b) conglomerate facies

There are two types of the conglomerate facies. It is pebbly in the Niitsu and Takezawa districts, while granular in the Higashiyama district. In the former type, the fossil assemblage is the mixture of sandy inhabitants, for instance *Glycymeris yessoensis* (SOWERBY), *G. nipponica* (YOKOYAMA) and *Limopsis tajimae* SOWERBY and those of muddy bottom as *Acila insignis* (GOULD) and *Lucinoma annulata* (REEVE). In the latter, the majority is fragmental, so as the contents are indeterminate except for small shells *Bittium* which is abundant. In either case, the occurrence is allochthonous.

c) sandstone facies

This facies is characterized by *Glycymeris yessoensis* (SOWERBY), *Glycymeris nipponica* (YOKOYAMA) and *Turritella saishuensis* YOKOYAMA. These representatives indicate a neritic (N₁-N₂) and sandy environment.

d) siltstone facies

The main components of the assemblage are:

Ennucula nipponica (SMITH), *Nuculana onoyamai* OTUKA, *Nuculana robai* KURODA, *Nuculana sadoensis* (YOKOYAMA), *Limopsis tajimae* SOWERBY, *Siphonodentalium ozawai* YOKOYAMA, *Natica clausa tugaruana* NOMURA et HATAI

It is evident that these forms inhabited in neritic waters of silty bottom.

e) alternations facies

Scarcely yield fossil; it is not certain which is predominant among the assemblage. Presences of *Thyasira bisecta* (CONRAD) and *Lucinoma annulata* (REEVE) suggest a close relation to the proper muddy facies. These forms inhabited in neritic waters of silty bottom.

The molluscan fauna of Nishiyama formation is a part of the ancient Japonic fauna including the remarkable Oyashio elements.

The constituents are as follow;

Kuroshio-Japonic	10%
Japonic	58%

* KANEHARA: Jour. Jap. Assoc. Petrol. Tech. 15, 1950

MAKIYAMA: Chubu-chiho, 1950

**OTUKA: Trans. Palaeont. Soc. Japan, 21, 1936

ONUYAMA: The Globe, 19, 1933

Oyashio-Japonic	5%
Oyashio	27%

4) Haizume formation

Tuffaceous fine sandstones and siltstones are main components of this formation. There are some fossil beds in several horizons. The molluscan species included in this formation are in Table 3.

a) siltstone facies

The followings are the remarkable fossil species.

Acila nakazimai OTUKA, *Nuculana yokoyamai* (KURODA), *Thyasira bisecta* (CONRAD), *Siphonodentalium ozawai* YOKOYAMA, *Volsella difficilis* KURODA et HABE, *Venericardia ferruginea* CLESSIN, *Macoma tokyoensis* MAKIYAMA, *Neptunea arthriticta* (BERNARDI)

They are found scattered solitarily in the rocks, but they may well indicate a neritic (N_1-N_4) environment of silty bottom.

b) fine sandstone facies

Nuculana yokoyamai (KURODA), *Volsella margaritacea* NOMURA et HATAI, *Turritella saishuensis* YOKOYAMA and *T. saishuensis etigoensis* IKEBE are the main components of the molluscan assemblage. Their occurrences are scatterings in general. *Turritella* is the most remarkable, forming the fossil zone in the sandstone. The zone is considered to be a good key marker. The neritic environment seems to have been predominant.

c) fossil beds

Three groups of fossil community are recognized:

i) *Turritella-Glycymeris* group in the Higashiyama and Takezawa districts.

Chief elements: *Glycymeris yessoensis* (SOWERBY), *G. nipponica* (YOKOYAMA), *Anadara trilineata amicula* (YOKOYAMA), *Patinopecten kurosawaensis* (YOKOYAMA), *Turritella saishuensis* YOKOYAMA

ii) *Spisula-Umbonium* group in the Takezawa district

Chief element: *Spisula voyi* GABB, *S. sachaliensis* (SCHRENCK), *Clinocardium nuttallii* (CONRAD), *Umbonium akitanum* SUZUKI, *Mercenaria yokoyamai* MAKIYAMA

iii) *Glycymeris-Limopsis* group in the Niitsu district

Chief elements: *Nuculana yokoyamai* (KURODA), *Glycymeris nipponica* (YOKOYAMA), *G. pilsbryi* (YOKOYAMA), *Limopsis tajimae* SOWERBY, *Venericardia myogadaniensis* n. sp.

The *Turritella-Glycymeris* group takes places in the middle part in the Higashiyama and Takezawa districts; the *Spisula-Umbonium* group occurs in the upper part in the Takezawa district; the *Glycymeris-Limopsis* group in the lower part, in the Niitsu district. These fossil groups consist of reworked shells derived from biotopes elsewhere nearby. The species are the indicators of the environment of neritic sandy bottom. *Glycymeris-Limopsis* group resembles the fossil assemblage in the "Ôsawashi" of the Nishiyama formation, but it is distinguished from the latter in the following respects.

- 1) Absence of Brachiopoda and Family Turridae.
- 2) Meagerness of adhering forms, for instance Family Acmaeidae.
- 3) Differences in the components—decrease of the Oyashio type species.

	JK	J	OJ	O
“Ôsawa-ishi”	9	57	7	27
<i>Glycymeris-Limopsis</i> fossil bed	17	62	4	17 %

The fact conceives that the hypothetical submarine bank or island of the Nishiyama stage still survived, while circumstances of sea changed considerably.

The fauna belongs to the Omma-Manganjian fauna. It is closely related to those of the Omma formation near Kanazawa City and Sawane formation of Sado Island.

5) Wanazu formation

The uppermost part of the Haizume formation is distinguished as the Wanazu formation in the Takezawa district. This part consists of medium grained sandstones often yielding fossils listed below.

1. <i>Acila (Truncaila)</i> sp.				
2. <i>Anadara trilineata amricula</i> (YOKOYAMA)			pJ	N ₀₋₄
3. <i>Glycymeris yessoensis</i> (SOWERBY)		S	JO	N ₁₋₂
4. <i>Patinopecten yessoensis</i> (JAY)		G, S, (sM)	O	N ₁₋₄
5. <i>Felaniella usta</i> (GOULD)		S	J	N ₁₋₂
6. <i>Lucinoma annulata</i> (REEVE)		sM	J	N ₁
7. “ <i>Cardium</i> ” sp.				
8. <i>Dosinia japonica</i> (REEVE)		mS	J	N ₁
9. <i>Mercenaria</i> sp.				
10. <i>Leukoma marica</i> (LINNÉ)			KJ	
11. <i>Spisula sachaliensis</i> (SCHRENCK)		(mS)	J	N ₁₍₂₎
12. <i>Mya japonica</i> JAY		mS, sM	JO	N ₀₋₁
13. <i>Umbonium akitanum</i> SUZUKI			pJ	N ₀₋₂
14. <i>Natica clausa tugaruana</i> NOMURA et HATAI			OJ	
15. <i>Nassarius acutidentatus</i> (SMITH)		R, S	J	N ₀₋₃
16. <i>Antiplanes contraria</i> (YOKOYAMA)			O	
17. <i>Ophiodermella miyatensis</i> (YOKOYAMA)			O	

In these shells, *Glycymeris yessoensis* and *Umbonium akitanum* is remarkable. At many places mollusks are found scattered in the sandstones showing the autochthonous origin but at other places they are to make fossil-beds. Even in the latter case, there is reason that they have not been transported so far. They are properly situated in the matrix, without showing a little wearing of shell substance. Judging from the criteria known by the Recent shells, the fauna represents the Japonic-Oyashio shallow neritic (N₁-N₂) sandy bottom dwellers.

6) Tsukayama formation

In Takezawa district, this formation yields 3 species: *Ostrea* sp., *Corbicula* sp. and *Barnea japonica* (YOKOYAMA). These species indicate brackish waters in embayment. These characteristic species though small in number may well show the above statement.

7) Summary

Each formation has the own characteristic molluscan fauna. The Teradomari, Shiiya and Nishiyama faunas are of the deep neritic to bathyal type, while the Haizume and Wanazu faunas are neritic. The Tsukayama fauna is brackish inner bay type.

The stratigraphical sequences show that the transgression started in the early Miocene has continued until the Pliocene time. There the Teradomari to Tsukayama formations were deposited. The faunal analysis shows the same consequence as the strata. The faunal sequences represent a cycle, commencing from the bathyal type, then followed by the neritic type, came to the final brackish type. The Teradomari, Shiiya and Nishiyama faunas indicate the great transgression, but the latter faunas after Haizume show the regressive stage.

Conclusions

1. The fauna of each formation represents a phase of the faunal development.
2. The *pari passu* development of faunas and epirogenesis forms a complete cycle.
3. The faunas are the Japonic-Oyashio type.
4. The Haizume fauna is a part of the Omma-Manganjian fauna.

Description of species

Bentharca echigoensis n. sp. (Pl. I, fig. 4)

Shell small, subtrapezoidal, inflated; dorsal margin straight, ventrals slightly arched, with a weak byssal notch in the middle; antero-dorsal margin short, abruptly turned to short anterior margin; postero-dorsal oblique, descending to a rounded posterior margin; beak small, situated at the anterior two-third; surface with numerous distinct radiating threads crossing irregular and concentric growth lines, decussate; ligamental area narrow, triangular, inequilateral; hinge line straight; posterior teeth ca. 12 in number, oblique, nearly parallel to hinge line at the posterior end; teeth 5 in anterior, oblique, terminal one parallel to hinge line.

Dimensions:— Length, 15.7 mm, height, 8.6 mm, thickness of left valve, 3.8 mm.

Holotype:— JC600101

Remarks:— Only two specimens are under examination. This species is distinguishable from *Bentharca xenophoricora* (KURODA, 1930) and *B. rubrotincta* KURODA (MS) in having trapezoidal shape with a weak byssal notch.

Type Locality:— Km 55, Small valley about 1 km E of Myogadani, Kamo City, Niigata Prefecture

Astarte (Trinodonta) bennettii DALL (Pl. II, fig. 6)

1903. *Astarte bennettii* DALL, Proc. U. S. Nat. Mus., vol. 26, p. 946, pl. 63, fig. 6.

Numerous specimens were obtained from various localities (Km 55, Km 4, Sg 3, Hs 10, Hs 14 in Niitsu district). This species may aptly be mistaken for immature

A. borealis (SCHUMACHER, 1817). All the specimens at hand fall into the named species having the small and high shell.

Venericardia (Cyclocardia) myogadaniensis n. sp. (Pl. I, fig. 7)

Shell medium, orbicular, thick, as long as high, moderately convex; beak small, pointed; antero-dorsal margin short, slightly concave, gradually descending to rounded anterior margin; postero-dorsal arched, connected with rounded posterior side; ventral margin regularly rounded; sculpture consisting of radials and concentrics; radiating ribs 24–26, broad, nearly flat-topped with narrow striaelike interspaces; concentrics fine, dense; lunule small, cordate, well-marked; teeth of the right valve consisting of 2 cardinals; inner margin crenulated.

Dimensions: – Height, 20.7 mm, length, 20.5 mm, thickness of right valve, 5.4 mm
Holotype: – JC600102

Remarks: – This shell is similar to *Venericardia (Cyclocardia) ferruginea* CLESSIN, 1888, but the former has the orbicularly higher shell and a more number of flat-topped ribs. *V. (C.) crebricostata* (KRAUSE, 1885) is another allied species, but contrasted with its triangular and elongate shell, the present new species is orbicularly rounded.

Type Locality: – Km 55, Small valley about 1 km E of Myogadani, Kamo City, Niigata Prefecture

Geological occurrence: – Nishiyama formation and Haizume formation, Chuetsu group

Serripes makiyamai (YOKOYAMA) (Pl. I, fig. 11)

1928. *Maetra? makiyamai* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, sec. 2, vol. 2, pt. 7, p. 360, pl. 69, fig. 3.

1935. *Serripes notabilis*, OTUKA, Jour. Geol. Soc. Japan, vol. 42, no. 504, p. 602.

Only a cast specimen is at hand (Loc. NT32, Araya, Kawaguchi-mura, Kita-unuma-gun). This species was originally described by YOKOYAMA based upon the specimen from Hanzogane, Higashiyama oil-field. OTUKA considered this species is synonymous with *Serripes notabilis* (SOWERBY), but the named species has a more elongate and flattened shell.

Natica (Tectonatica) claussa tugaruana NOMURA et HATAI (Pl. II, fig. 5)

1935. *Natica tugaruana* NOMURA et HATAI, Saito Ho-on Kai Mus. Res. Bull. no. 6, p. 128, pl. 9, fig. 9.

1939. *Natica (Cryptonatica) claussa tugaruana*, OTUKA, Jour. Geol. Soc. Japan, vol. 46, no. 544, p. 30, pl. 2, Text. figs. a-d.

Many well-preserved specimens were obtained. This subspecies differs from the species in its high shell with a large umbilical plug.

Beringius? hanzoganensis YOKOYAMA

1928. *Beringius? hanzoganensis* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, ser. 2, vol. 2, pt. 7, p. 358, pl. 68, fig. 6.

A few ill-preserved specimens are under examination. Unfortunately the generic name of this form is not decisive at present.

Siphonalia declivis YOKOYAMA (Pl. II, fig. 12)

1923. *Siphonalia cassidariaeformis*, YOKOYAMA, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 45, art. 2, p. 9, pl. 1, figs. 13-15.

1926. *Siphonalia declivis* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, sec. 2, vol. 1, p. 337, pl. 38, figs. 19-21.

1927. *Siphonalia cassidariaeformis declivis*, MAKIYAMA, Mem. Coll. Sci. Kyoto Imp. Univ., ser. B, vol. 3, no. 1, p. 117.

1941. *Siphonalia declivis*, MAKIYAMA, Mem. Coll. Sci. Kyoto Imp. Univ., ser. B, vol. 16, no. 2, p. 83, pl. 5, fig. 19, 22, 26, pl. 6, fig. 30.

Only a specimen is at hand. MAKIYAMA recognized the Dainiti and Hōnohashi forms, the former from the lower levels and the latter from the upper in the Dainiti sands. Inasmuch as the Niitsu specimen has a high cone with flat sloping shoulders, falls into the Hōnohashi form.

Clavus (Cymatosyrinx) sp. indet. (Pl. II, fig. 20)

Shell small, subfusiform with high-turreted spire; whorls 8, protoconch two, smooth; remaining whorls sculptured by the axials; axial nodes 16 in number, oblique, obsolete on the upper one-third of whorl, separated by interspaces of a nearly equal breadth; aperture unknown.

Only a specimen was obtained from Hs14, Hashida, Gosen City.

Granotoma dissoluta gosenensis n. subsp. (Pl. II, figs. 16, 17)

cf. 1926. *Bela dissoluta* YOKOYAMA, Jour. Fac. Sci. Imp. Univ. Tokyo, sec. 2, vol. 1, pt. 7, p. 263, pl. 32, fig. 13

This subspecies differs from the species in having 40-42 longitudinal plicae (28-30 in species). Other characters agree very well with those of the species.

Dimensions: - Length, 7.8 mm, diameter, 3.7 mm.

Holotype: - JC600103

Type Locality: - Sg 1, Valley about 800 m E of the large pond, S of Hashida, Gosen City, Niigata Prefecture.

Geological occurrence: - Nishiyama formation, Chuetsu group

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Explanation of Plate I

1. *Nuculana (Thestyloda) yokoyamai* (KURODA), ×2, Loc. Hs10.
2. *N. (s. s.) onoyamai* OTUKA, ×2, Loc. Sg 1.
3. *Polynemamussium alaskense* (DALL), Loc. Sg 3.
4. *Bentharca echigoensis* n. sp. (Holotype), ×2, Loc. Sg 13.
5. *Bentharca xenophoricola* (KURODA), ×2, Recent specimen from Tosa.
6. *Limopsis (s. s.) tajimae* SOWERBY, Loc. Sg 3.
7. *Venericardia (Cyclocardia) myogadaniensis* n. sp. (Holotype), Loc. Km 55.
8. *Patinopecten (s. s.) kurosawaensis* (YOKOYAMA), Loc. Km 55.
9. *P. (s. s.) kurosawaensis* (YOKOYAMA), Loc. Km 55.
10. *Volsella (s. s.) difficilis* KURODA et HABE, ×½, Loc. NT 20.
11. *Serripes makiyamai* (YOKOYAMA), ×½, Loc. NT 32.
12. *Chlamys iwakiana* (YOKOYAMA), Loc. Km 55.



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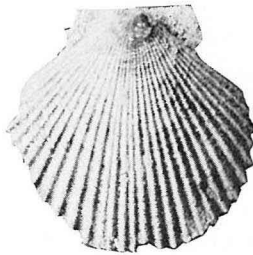
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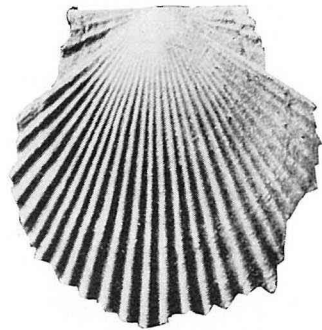
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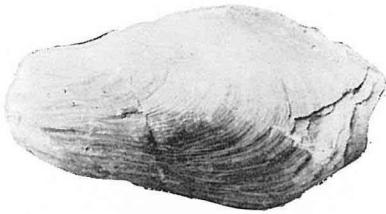
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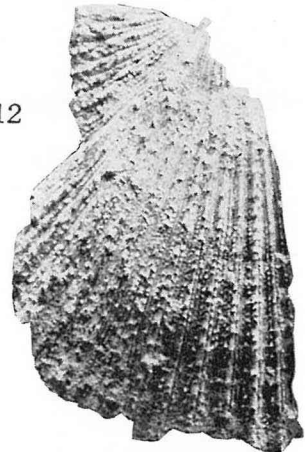
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Junji ITOIGAWA

Explanation of Plate II

1. *Venericardia (Megacardita) kiiensis* (SOWERBY), Loc. Km 55.
2. *Astarte (Tridonta) alaskensis* DALL, Loc. Sg 21.
3. *Macoma (s. s.) tokyoensis* MAKIYAMA, Loc. Km 11.
4. *Thracia kakumana* (YOKOYAMA), Loc. Km 55.
5. *Natica (Tectonatica) clausa tugaruana* NOMURA et HATAI, Loc. Km 55.
6. *Astarte (Tridonta) bennettii* DALL, Loc. Km 55.
7. *Venericardia (Miodontiscus) prolongata nakamurai* YOKOYAMA, ×2, Loc, Hs 11.
8. *Bittium a-satowi* OINOMIKADO et IKEBE, Loc. Km. 11.
9. *B. aff. yokoyamai* OTUKA, Loc. Sg 3.
10. *Trophonopsis (Boreotrophon) candelabrum* (REEVE), Loc. Km 55.
11. *Nassarius caelatus* (A. ADAMS), Loc. Hs 11.
12. *Siphonalia declivis* YOKOYAMA, Loc. Km 55.
13. *Tachyrhynchus yanamii* (YOKOYAMA), Loc. Hs 14.
14. *Ophiodermella nipponensis* (ONOYAMA), ×2, Loc. Km 55.
15. *Antiplanes contraria* (YOKOYAMA), Loc. Sg 11.
16. *Granotoma dissoluta gosenensis* n. subsp. (Holotype), ×2, Loc. Sg 1.
17. *G. dissoluta gosenensis* n. subsp. ×2, Loc. Sg 1.
18. *Suavodrilgia declivis* (MARTENS), ×2, Loc. Km 26.
19. *Propebela turricula candida* (YOKOYAMA), ×2, Loc. Sg 1.
20. *Clavus (Cymatosyrinx) sp. indet.*, ×2, Loc. Hs 14.
21. *Ophiodermella miyatensis* (YOKOYAMA), Loc. Km 26.



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