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Molluscan Fauna of the Mizunami Group in the Iwamura Basin

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Abstract

The molluscan fauna of the Mizunami group in the Iwamura basin, Gifu Prefecture is analysed and the faunal development is discussed. Thirteen new species and one new subspecies are described.

Introduction

The Mizunami group is a well-known stratigraphic unit among geologists and palaeontologists of this country, as it yields rich Miocene fauna and flora including *Vicarya* and *Desmostylus*. The stratigraphy has been intensely studied by the members of the research group of the Paleo-Setouchi supergroup.[1)2)7)] The present writer is investigating the Mizunami group which is the type of the First Paleo-Setouchi supergroup* (Ikebe, 1951) in the Iwamura basin and he has already reported on the stratigraphy.[6)] In this paper, the molluscan fauna is mentioned and analysed.

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Notes on the geology

The general outline of the stratigraphy in this basin is given in Fig. 1, and the lithology of each subdivision is as follows;

1. Agi Formation.....Yellowish and greenish gray, tuffaceous medium sandstones and siltstones intercalating lignite seams and arkose conglomerates.
2. Kubohara Sandstone.....Massive, tuffaceous, medium to fine sandstones containing many nodules.
3. Tsuruoka Mudstone.....Massive, dark and bluish gray, pumiceous mudstones.

* The Miocene strata deposited in the Setouchi inland sea region.

4. Higashihora Sandstone.....Massive, tuffaceous, medium to coarse sandstones with nodules.
5. Maki Siltstone.....Tuffaceous, hard, dark gray siltstones intercalating tuff, sandstone and hard shale.
6. Hachiyato Limestone.....Limestone with numerous fragmental mollusks.
7. Ryodenji Alternation.....Mainly massive, dark gray, pumiceous siltstones (2-5 m. in thickness) alternating with medium, laminated sandstones 2-0.1 m. thick.

These are the strata which deposited in the shallow Aegean sea* and represent a cycle of sedimentation. The geological structure is synclinal controlled by the faults with NE–WS trend.

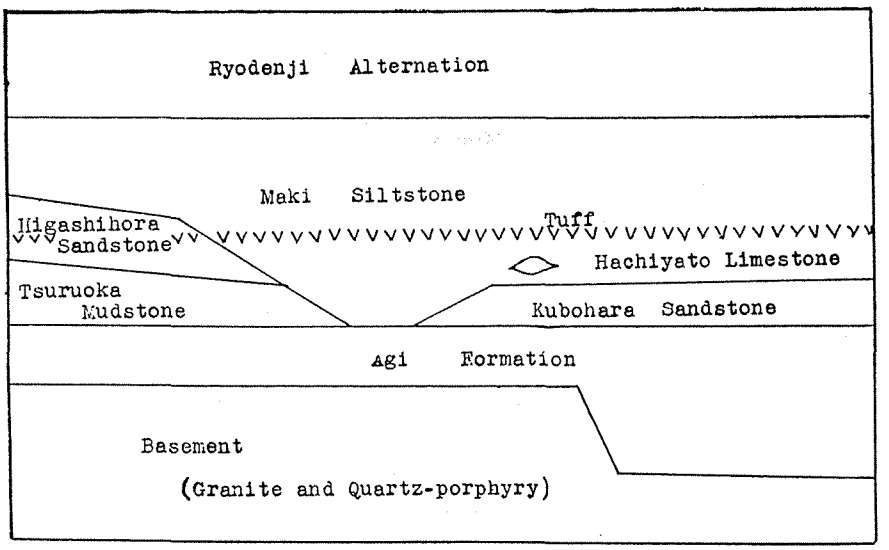


Fig. 1. Diagram to show the stratigraphy of the Mizunami Group in the Iwamura Basin

The faunal list

The following is the complete faunal list of species from the different horizons and assemblages.

Pelecypoda	57
Scaphopoda	2
Gastropoda	41
Total number	100
Number of the determined species and subspecies	66
Number of new species	14

Abbreviations

× : Occurrence of that species

✖ : Remarkable occurence of that species

* It is imagined the inlet or inland sea such as in the present Inland Sea.

Ks: Kubohara Sandstone
1: Whole occurrence
2: *Barbatia-Zirphaea-Cerithium* assemblage
3: *Glycymeris-Arca-Calyptraea* assemblage
4: *Cyclina-Vicaryella* assemblage
Tm: Tsuruoka Mudstone
Hs: Higashihora Sandstone
Ms: Maki Siltstone
1: *Lucinoma-Nuculana* assemblage (general type)
2: *Nipponomarcia-Venerupis* assemblage
Hl: Hachiyato Limestone
Ra: Ryodenji Alternation

		Ks				Tm	Hs	Ms		Hl	Ra
		1	2	3	4			1	2		
1.	*Acila submirabilis*	×	—	×	—	—	—	**×**	×	—	—
2.	*A.* sp. indet.	—	—	—	—	—	—	×	—	—	—
3.	*Nuculana pennula*	×	—	×	—	—	—	**×**	—	×	×
4.	*"Nuculana" inermis*	—	—	—	—	—	—	×	—	—	—
5.	*Saccella confusa*	×	—	×	—	—	—	—	×	—	—
6.	*Portlandia thraciaeformis*	×	—	×	—	—	—	**×**	—	—	—
7.	*Yoldia* cfr. *laudabilis*	—	—	—	—	—	—	—	—	—	×
8.	*Y.* cfr. *watasei*	—	—	—	—	—	—	×	—	—	×
9.	*Arca miyatensis*	×	—	**×**	—	—	—	—	—	**×**	—
10.	*Barbatia kubara*	×	**×**	—	—	—	—	—	—	×	—
11.	*Glycymeris minoensis*	×	—	**×**	—	—	—	—	—	×	—
12.	*G.* sp. indet.	×	—	×	—	—	×	—	—	—	—
13.	*Crenella fornicata*	×	—	**×**	—	—	—	—	—	×	—
14.	*Volsella* aff. *nipponica*	×	—	**×**	—	—	×	—	—	×	—
15.	*Septifer agiensis*	×	—	**×**	—	—	—	—	—	**×**	—
16.	*Musculus* sp.	×	—	×	—	—	—	—	—	—	—
17.	*Lithophaga rechifora*	×	**×**	—	—	—	—	—	—	—	—
18.	*Chlamys iwamurensis*	×	×	×	—	—	—	×	—	×	—
19.	*Ch. egregius*	×	—	×	—	—	—	**×**	—	—	—
20.	*Lima* sp.	—	—	—	—	—	—	—	—	×	—
21.	*Anomia lischkei*	×	**×**	×	—	—	—	—	—	—	—
22.	*Ostrea* sp. indet.	×	**×**	—	—	—	—	—	—	×	—
23.	*Venericardia siogamensis*	×	—	×	—	—	×	**×**	×	×	—
24.	*V.* sp. indet	×	—	×	—	—	—	—	—	—	—
25.	*Trapezium modiolaeforme*	—	—	—	×	—	—	×	—	—	—
26.	*Joannsiella* sp. indet.	×	×	×	—	—	—	—	—	—	—
27.	*Felaniella usta*	×	—	×	—	—	**×**	—	—	—	—
28.	*Lucinoma acutilineata*	×	×	×	—	—	×	**×**	×	—	—
29.	*Pillucina yokoyamai*	×	×	×	—	—	—	×	—	—	—
30.	*Wallucina habei*	×	—	**×**	—	—	—	—	—	—	—
31.	*Chama* sp.	×	**×**	—	—	—	—	—	—	—	—
32.	*Clinocardium shinjiense*	**×**	—	**×**	—	—	—	—	—	×	—
33.	*Callista* aff. *roscida*	×	—	×	—	—	—	—	—	—	—

		Ks				Tm	Hs	Ms		Hl	Ra
		1	2	3	4			1	2		
34.	*Saxiodomus* aff. *purpuratus*	×	—	×	—	—	—	—	—	—	—
35.	*Dosinia nomurai*	**×**	×	**×**	—	—	**×**	—	—	—	—
36.	*D. anguloides*	×	×	×	—	—	—	—	—	—	—
37.	*D. suketoensis*	×	—	×	—	—	—	—	×	—	—
38.	*D.* cfr. *akaisiana*	×	—	—	—	—	—	—	—	—	—
39.	*Cyclina japonica*	×	—	—	**×**	**×**	—	—	—	—	—
40.	*Mercenaria* sp. indet.	×	×	×	—	—	—	—	—	**×**	—
41.	*Liocyma* cfr. *minuta*	×	—	**×**	—	—	—	—	—	—	—
42.	*Nipponomarcia nakamurai*	**×**	×	×	—	—	×	—	**×**	×	—
43.	*Venerupis siratoriensis*	**×**	×	×	—	—	×	—	**×**	×	—
44.	*Paphia* sp.	×	—	×	—	—	—	—	—	—	—
45.	*Lutraria* aff. *arcuata*	×	×	×	—	—	—	—	—	—	—
46.	*Macoma tokyoensis*	×	—	×	—	—	—	**×**	×	—	—
47.	*M.* aff. *praetexta*	×	—	×	—	—	—	—	—	—	—
48.	*M.* sp.	×	—	×	—	—	—	—	—	—	×
49.	*Gari* (?) sp.	×	×	×	—	—	—	—	—	—	—
50.	*Sanguinolaria minoensis*	×	—	—	**×**	**×**	—	—	—	—	—
51.	*Phaxus izumoensis*	×	—	×	—	—	×	×	×	—	—
52.	*Solen* aff. *gouldi*	×	—	×	—	—	—	—	—	—	—
53.	*Anisocorbula venusta elongata*	×	—	**×**	—	—	—	—	—	×	—
54.	*Zirphaea subconstricta kotorai*	×	**×**	—	—	—	—	—	—	—	—
55.	*Teredo* sp.	×	—	—	—	—	×	—	—	—	—
56.	*Thracia* cfr. *hitosaoensis*	×	—	×	—	—	—	—	—	—	—
57.	*Cuspidaria* sp.	—	—	—	—	—	—	—	—	×	—
58.	*Dentalium* sp. 1	—	—	—	—	—	—	×	—	—	—
59.	*D.* sp. 2	×	—	×	—	—	—	—	—	—	—
60.	*Diodora humilis*	×	—	×	—	—	—	—	—	×	—
61.	*Patella* sp.	×	×	—	—	—	—	—	—	—	—
62.	"*Tectura*" sp. 1	×	—	×	—	—	—	—	—	**×**	—
63.	"*T.*" sp. 2	×	×	—	—	—	—	—	—	×	—
64.	*Protorotella depressa*	×	—	×	—	—	—	—	×	—	—
65.	*P. togariensis*	×	—	—	—	—	—	—	—	—	—
66.	*Leptothyra ena*	×	**×**	**×**	—	—	—	—	—	×	—
67.	*Lunella kurodai*	×	**×**	**×**	—	—	—	—	—	—	—
68.	*Nerita kamigiriensis*	×	×	—	—	—	—	—	—	—	—
69.	*Turritella s-hataii*	×	—	**×**	—	—	**×**	×	×	—	—
70.	*T. tanaguraensis*	×	—	×	—	—	—	—	×	—	—
71.	*Planaxis* sp.	×	—	×	—	—	—	—	—	—	—
72.	*Cerithidea sirakii*	×	×	**×**	—	—	—	—	—	—	—
73.	*Batillaria* cfr. *s-itoi*	×	×	—	—	—	—	—	—	—	—
74.	*Vicarya yokoyamai*	—	—	—	—	**×**	—	—	—	—	—
75.	*Vicaryella ishiiana*	×	×	—	**×**	**×**	—	—	—	—	—
76.	*Bittium* sp. indet.	×	×	—	—	—	—	—	—	—	—
77.	*Cerithium kaneharai*	×	**×**	**×**	—	×	—	—	—	—	—
78.	*Eulima* sp.	×	—	—	—	—	—	—	—	—	—

		Ks				Tm	Hs	Ms		Hl	Ra
		1	2	3	4			1	2		
79.	*"Hipponix"* sp.	×	**×**	—	—	—	—	—	—	×	—
80.	*Calyptraea tubura*	×	**×**	**×**	—	—	—	—	—	**×**	—
81.	*Crepidula jimboana*	×	**×**	×	—	—	×	—	×	×	—
82.	*Euspira meisensis*	×	×	×	—	—	**×**	—	×	×	—
83.	*Cymatium* (?) sp.	×	—	—	—	—	—	—	—	—	—
84.	*Ancistrolepis togariensis*	×	—	×	—	—	—	×	—	—	—
85.	*Siphonalia makiyamai*	×	×	×	—	—	—	—	—	—	—
86.	*S. minuta*	×	—	—	—	—	—	—	—	—	—
87.	*S.* sp. indet.	×	—	×	—	—	—	—	—	—	—
88.	*Hemifusus* sp.	×	—	—	—	—	—	—	—	—	—
89.	*Nassarius simizui*	**×**	×	×	—	—	—	—	**×**	—	—
90.	*N. hongoensis*	×	—	**×**	—	—	×	—	—	×	—
91.	*Olivella* (?) sp.	×	×	—	—	—	—	—	—	—	—
92.	*Fulgoraria striata*	×	—	×	—	—	—	×	—	—	—
93.	*Turricula* sp. indet.	×	—	×	—	—	—	—	—	—	—
94.	*Conus* sp.	×	—	×	—	—	—	—	—	—	—
95.	*Syrnola* sp. indet.	×	×	—	—	—	—	×	—	—	—
96.	*"Pyramidella"* sp.	×	×	×	—	—	—	—	—	—	—
97.	*Acteocyna* sp.	×	×	×	—	—	—	—	—	×	—
98.	*Adamnestia* sp.	—	—	—	—	—	—	—	**×**	—	—
99.	*Cylichna corpulenta*	×	—	×	—	—	—	—	—	—	—
100.	*C.* sp.	×	—	×	—	—	—	—	—	—	—
	Linthia nipponica	—	—	—	—	—	—	×	—	—	—
	Echinoidea	—	—	—	—	—	—	—	—	×	—
	Decapoda	—	—	—	—	—	×	—	—	—	×
	Brachiopoda	×	—	—	—	—	—	—	—	×	—
	Balanus	×	×	—	—	—	—	—	—	—	—
	Polychita	×	—	×	—	—	—	—	—	—	—
	Bryozoa	—	—	—	—	—	—	—	—	×	—

Faunal analysis of molluscan assemblage

1. Agi Formation

This formation has only floral fossils. It is certain that the sediment was deposited under a fresh water environment that was prevailed prior to the transgression, inasmuch as it contains the lignite seams but no marine mollusks. The general light-colored aspect of the rock may also due to the fresh water origin. The floral fossils are as follows;

Comptonyphyllum naumanni NATHORST, *Styrax obassia* SIEBOLD et ZUCCARNAI, *S. arakiana* KOIZUMI, *Alnus firma* SIEBOLD et ZUCCARNAI, *Carpinus tokonosky* MAXIMOWICH, *Quercus myrsinaefolia* BLUME, *Q. serrata* THUMBERG, *Parabenzoin praecox* NAKAI etc.

2. Kubohara Sandstone

The fauna of this member is represented by *Dosinia-Nipponomarcia* assemblage which is mainly consisting of *Dosinia nomurai* OTUKA with a few other species of the same genus, *Nipponomarcia nakamurai* IKEBE, *Venerupis siratoriensis* (OTUKA), *Euspira meisensis* MAKIYAMA and *Nassarius simizui* OTUKA. These species are found as autochthonous fossils, indicating a neritic and sandy environment. Besides, there are three other special assemblages confined to this sandstone.

a) *Barbatia-Zirphaea-Cerithium* Assemblage

The main elements are as follows;

Barbatia kubara n. sp., *Lithophaga rechifora* n. sp., *Anomia lischkei* DAUTZENBERG et FISCHER, *Ostrea* sp. indet., *Chama* sp., *Zirphaea subconstricta kotorai* OTUKA, *Leptothyra ena* n. sp., *Lunella kurodai* n. sp., *Cerithium kaneharai* FUJITA et OGOSE, *Calyptraea tubura* OTUKA, "*Hipponix*" sp. etc.

These forms are those inhabited in brackish waters and those adhered or bored in the shore-waters. The fossil enclosures are found in conglomeratic facies near the basements. Seeing the boring shells in the pebbles and the other special life modes closely related to the sedimentation, it is concluded that this assemblage is of an autochthonous origin and that the environment was the rocky or gravelly margin of the basin.

b) *Glycymeris-Arca-Calyptraea* Assemblage

The main components are:

Arca miyatensis OYAMA, *Glycymeris minoensis* n. sp., *Crenella fornicata* YOKOYAMA, *Volsella* aff. *nipponica* OYAMA, *Septifer agiensis* n. sp., *Wallucina habei* n. sp., *Clinocardium shinjiense* (YOKOYAMA), *Dosinia nomurai* OTUKA, *Liocyma* cfr. *minuta* NOMURA et ZINBO, *Anisocorbula venusta elongata* n. subsp., *Leptothyra ena* n. sp., *Lunella kurodai* n. sp., *Turritella s-hataii* NOMURA, *Cerithidea sirakii* MAKIYAMA, *Cerithium kaneharai* FUJITA et OGOSE, *Calyptraea tubura* OTUKA, *Crepidula jimboana* YOKOYAMA, *Nassarius hongoensis* n. sp. etc.

The subjects of this assemblage are *Glycymeris*, *Arca*, *Dosinia* and *Clinocardium* etc. that are representing a neritic environment, but other elements in addition are including some adhering forms such as *Calyptraea*, *Crepidula*, *Volsella*, *Septifer*, *Leptothyra* and *Lunella*, and some brackish forms such as *Cerithidea* and *Cerithium*. It is evident that this assemblage is a mixture of the proper biotope of the Kubohara sandstone and the *Barbatia-Zirphaea* assemblage. This is also proved by the nodulous occurrence of the assemblage. It is contained in the horizon slightly upper than the preceding assemblages.

c) *Cyclina-Vicaryella* Assemblage

The followings are the main elements.

Cyclina japonica KAMADA, *Sanguinolaria minoensis* (YOKOYAMA), *Vicaryella ishiiana* (YOKOYAMA)

This assemblage is limitted to the special localities and presents the facts to show the autochthonous origin in the sandstone. The environment was a brackish bay or estuary.

3. Tsuruoka Mudstone

Vicarya-Cyclina assemblage stands for this member. It consists of *Vicarya yokoyamai* TAKEYAMA, *Vicaryella ishiiana* (YOKOYAMA), *Cyclina japonica* KAMADA, *Sanguinolaria minoensis* (YOKOYAMA), *Cerithium kaneharai* FUJITA et OGOSE.

The occurrence of these mollusks showing a brackish environment, is an autochthon. It may be admitted that a possible westward invasion of the sea made the inlet where the mudstone was deposited.

4. Higashihora Sandstone

Dosinia-Felaniella assemblage represents this member. It consists of the following species.

Dosinia nomurai OTUKA, *Felaniella usta* (GOULD), *Turritella s-hataii* NOMURA, *Euspira meisensis* MAKIYAMA

These species occur not only in nodules but also in the sandstone matrix suggesting that the transportation of the dead shells seems to have been not very active. Generally speaking, this assemblage is not quite different from the typical assemblage of the Kubohara sandstone. Therefore, the physical conditions of both the times were much similar.

5. Maki Siltstone

Lucinoma-Nuculana assemblage is general in this member. Its main elements are as follows;

Acila submirabilis MAKIYAMA, *Nuculana pennula* (YOKOYAMA), *Portlandia thraciaeformis* (STÖRER), *Chlamys egregius* n. sp., *Venericardia siogamensis* NOMURA, *Lucinoma acutilineata* (CONRAD), *Macoma tokyoensis* MAKIYAMA

Both valves of these species are as attached showing the autochthonous origin in the muddy inland sea bottom. In addition to this assemblage, the fol'owing assemblages were also recognized.

a) *Nipponomarcia-Venerupis* Assemblage

The followings are main elements:

Nipponomarcia nakamurai IKEBE, *Venerupis siratoriensis* (OTUKA), *Nassarius simizui* OTUKA, *Adamnestia* sp.

Inasmuch as the heaped fossils are fragmental, the work transportation have been tolerably active. There are some more species follow in the special locality.

Dosinia suketoensis OTUKA, *Protorotella depressa* MAKIYAMA, *Turritella s-hataii* NOMURA, *Crepidula jimboana* YOKOYAMA, *Euspira meisensis* MAKIYAMA

These species are common to the assemblage of Kubohara sandstone, but as this assemblage is allochthonous, they are derived from another nearly biotope. The situation is very near to the basal horizon of this member. The distribution

is limitted in the environs of Agi-mura and Kubohara, Yamaoka-cho.

b) Assemblage of the Hachiyato Limestone

Septifer-Arca assemblage is remarkable. The main elements are as follows ; *Arca miyatensis* OYAMA, *Septifer agiensis* n. sp., *Mercenaria* sp. indet., "*Tectura*" sp. 1., *Calyptraea tubura* OTUKA

Naturally, this assemblage is allochthonous and consists of the species derived from various modes and conditions of life.

6. Ryodenji Alternation

Scarcely yielding fossil, no remarkable assemblage is discovered. However, though the data are poor, it may be assumed that *Nuculana-Yoldia* assemblage represents this member. Besides, *Decapoda* and "*Lebensspuren*" are found frequently. Considering the lithofacies, this member exhibits the regressive phase as a result of decreasing rate of subsidence.

7. Summary

The analysed assemblages are in a succession as follows (ascending order) ;

1. Floral assemblage	Agi Formation
2. *Dosinia-Nipponomarcia* assemblage (with *Barbatia* and *Cyclina* assemblages)	Kubohara sandstone
3. *Vicaya-Cyclina* assemblage	Tsuruoka mudstone
4. *Dosinia-Felaniella* assemblage	Higashihora sandstone
5. *Lucinoma-Nuculana* assemblage	Maki siltstone
6. *Nuculana-Yoldia* assemblage	Ryodenji alternation

The faunal development may be synthesized from the analysed series in relation to the stratigraphical criteria. In the beginning of the transgression, the fresh water assemblage showed only by the absence of marine mollusca, has taken place. Soon after that the neritic *Dosinia* assemblage consists of abundant and various species accompanying *Barbatia* and *Cyclina* ones appeared. *Vicarya-Cyclina* and *Dosinia-Felaniella* assemblages are found in the western area showing the ingression of the sea to that direction. The next *Lucinoma-Nuculana* assemblage indicates the deeper and wider inland sea of muddy bottom and expresses the faunal acme including fixed and confined species. Finally, scanty and destructive *Nuculana-Yoldia* assemblage occurs suggesting the probable regressive environment. The faunal development closely relates to the development of the basin which appears in the strata a cyclic sedimentatson, i. e. fresh water sediments, sandstone, mudstone and alternations.

Both the Oyasio (cold current) or Kurosio (warm current) types are fonnd a little in this fauna, but their rôles are not very important. It is not certain which is predominant. In the case of an inland sea, the fauna is neither Kurosio nor Oyasio type as the currents were not free to enter bodily. The fauna is evidently a part of the Japonic type. In general, however, there is a tendency to change from the warm sea type below to the cold sea ones above. In this connection, the deepening tendency of the basin must be considered.

Comparison and age

This fauna resembles the faunas of the Mizunami in the Mizunami basin, Ayukawa and Tsuzuki groups, but a precise comparison is unable at present. Those Miocene groups in different basins of west-central Japan grouped together into the First Paleo-Setouchi supergroup, the fauna of which are inland sea type, unlike those of another series of the Miocene groups (Shidara, Isshi, Awa and Murô groups) be the open sea type. The investigation on the relationship of these groups is premature.

The age is conceived to be the Miocene (F_2–F_3), for the existence of the index fossils such as *Vicarya yokoyamai* TAKEYAMA, *Nipponomarcia nakamurai* IKEBE, *Venerupis siratoriensis* OTUKA etc.

Conclusion

1. The fauna contains 100 species of mollusca and 14 species are new to science.
2. Each member has remarkable assemblages respectively and the change in these assemblages indicates the faunal development parallel to that of the basin.
3. This fauna is closely allied to the faunas of the typical Mizunami, Ayukawa and Tsuzuki groups.
4. The geologic age is the middle Miocene (F_2–F_3).

Description of the species

Acila (Truncacila) sp. indet.

Only a cast is under examination. The shell is roundly ovate, inflated, and has no rostration. It is obvious that this specimen belongs to a form of the Subgenus *Truncacila* with its special features. *Acila (Truncacila) insignis* (GOULD) (1861) may be an allied species of the present form, but distinguished from the latter by the obliquely elongate form.

Barbatia (Savignyarca) kubara n. sp. (Pl. V, figs. 1,2)

Shell medium, elongately ovate, depressed, longer than high, wider toward posterior end; dorsal margin nearly straight, ventrals undulated; postero-dorsal oblique, descending to a broadly rounded posterior margin; antero-dorsal short, abruptly turned to arcuate anterior margin; beak small, swallen, situated at the anterior three-fourth; surface triparte with two ridges, one running from beak to postero-dorsal and the other to two-third back of dorsal margin; sculpture consisting of radials and concentrics; radial ribs usually fine, numerous, as wide as interspaces, irregular on front surface; ribs of the middle part broad, coarse, strong with narrow interspace, each with 5 fine riblets; ribs on the back surface fine

granulated; concentric lines undulated, fine, crossing the radials, cancellated.

Dimensions: Height, 22 mm.; length, 52.5 mm.

Holotype: JC 1300084, Paratype: JC 1300085. (from 446, Nakanishi)

Occurrence: Nakanishi (446), Kamigiri (110).....Kubohara sandstone

This species obviously belongs to the Subgenus *Savignyarca*, but apparently no recent and fossil species is related to this species. *Barbatia (Savignyarca) obtusoides* NYST (1844) is more or less resembling to present new species, but the latter is distinguished by its strongly radiating ribs, and well defined radiating ridges.

Glycymeris minoensis n. sp. (Pl. V, figs. 3,4)

Shell medium in size, suborbicular, somewhat longer than high, convex, subequilateral; beak small, pointed, turned inwards, not touching, placed almost at the centre of dorsal border; anterior end rounded, posterior end broadly rounded with subtruncated and descending dorsal margin; ventral margin regularly arcuate; surface with many distinct radiating striae crossed by concentric incremental lines; the ligamental area small, triangular, equilateral, with distinct diverging grooves; hinge-teeth about 13 in number on each side, oblique on both sides, vertical in the middle; interior unknown, but basal margin crenulate.

Dimensions: Height, 24 mm.; length, 26 mm.; thickness of left valve 7.6 mm.

Holotype: JC 1300001. (from 113, Kamigiri)

Occurrence: Kamigiri (111, 112, 113).....Kubohara sandstone

This shell resembles *Glycymeris oinouyei* NOMURA (1935), *G. nakosoensis* HATAI et NISIYAMA (1949) and *G. totomiensis* MAKIYAMA (1927), but it is distinguished from these species by the small size of the adult shell and the details of the outline.

Glycymeris sp. indet.

This form is probably representing a new species. It is identical to the specimens from the Shukubora Sandstone, Mizunami basin. It has suborbicular, flattened shell with narrow impressed radial lines and fine radial threads.

Occurrence: Kamigiri (112).....Kubohara sandstone; Higashihora (457)..
....Higashihora sandstone.

Septifer (Mytilisepta) agiensis n. sp. (Pl. V, fig. 13)

Shell small, ovately trigonal, flattened, longer than high; dorsal margin slightly convex, short, postero-dorsal margin round, gradually descending to posterior margin; ventral margin nearly straight, its connection with postero-dorsal margin narrowly rounded; anterior prominent; beak situated anterior end, small, curved inwards; surface with radial and concentric scluptures; radials coarse, divaricate, wider than interspaces, 9–11 in number at posterior margin; concentric lines fine, incremental; inner margin not denticulate.

Dimensions : Height, 3.5 mm. ; length, 6.3 mm.

Holotype : JC 1300157 (from 600, Hachiyato)

Occurrence : Hachiyato (600, 162)……Hachiyato limestone; Kamigiri (111, 112, 113)……Kubohara sandstone

Septifer (*Mytilisepta*) *virgatus* (WIEGMANN) (1883) is more or less related to this new species, but the latter is distinguished form the former by its smaller and shorter shell.

Lithophaga (Leiosolenus) rechifora n. sp. (Pl. V, fig. 12)

Shell small in size, cylindrical; anterior end abruptly truncated, posterior end angulated; dorsal margin straight, long, gradually descending oblique postero-dorsal border; ventral margin broadly arched; blunt ridge runs from beak to posterior end of shell; surface with concentric growth lines.

Dimensions : Height anteriorly, 5 mm. ; height posteriorly, 6.7 mm. ; length, 16.5 mm. ; thickness of intact valves, 6.4 mm.

Holotype : JC 1300092 (from 446, Nakanishi)

Occurrence : Nakanishi (446), Kamigiri (110)……Kubohara sandstone

This shell is distinguishable from *L. otukai* NOMURA et HATAI (1936), only one described species in Japanese Miocene, in having the straight dorsal margin, the more elongate, flattened shell and no foliate growth line. *L. curta* LISCHKE (1874), a common species of the Recent seas, is another allied species, but it has larger shell, shorter dorsal margin and well-marked ridge.

Chlamys (Chlamys) iwamurensis n. sp. (Pl. V, figs. 5,6)

Shell medium in thickness, suborbicular, slightly convex, about 50 mm. in height, higher than long, subequivalve, equilateral except for ears; apical angle about 95°; sides gently concave, posterior being longer than the length of the anterior sides; ventral margin regularly rounded; left valve sculptured by numerous unequal narrow scaly ribs, also furnished with occasional riblets in some interspaces; incremental line fine, not imbricated; ears very unequal; anterior ear being longer than posterior, trigonal, sculptured by concentric imbricating lines and 11 radiating riblets; posterior small, trigonal sculptured as well as anterior; right valve similar to left except for ears, with byssal notch.

Dimensions : Height, about 52 mm. ; length, 49 mm. ; thickness, unknown.

Holotype : JC 1300046 (from 111, Kamigiri), Paratype : JC 1300039 (from 21, Kamigiri), JC 1300047 (from 111, Kamigiri)

Occurrence : Kamigiri (111, 112, 113, 21, 93), Nakanishi (446)……Kubohara sandstone, Hikage (246–1)……Maki siltstone

This shell is closely allied to *Ch. irregularis* (SOWERBY) (1847) but former has the more orbicular shell with the finer scaly ribs. *Ch. harimensis* MAKIYAMA 1923) is another allied species but it is distinguished from the present new species in having the inflated shell with the stout, coarse and a little imbricated ribs.

Chlamys egregius n. sp. (Pl. V, figs. 7–9)

Shell moderate in size, suborbicular, higher than long, nearly equilateral, compressed, with indistinct concentric growth lines and radial sculpture; beak small sharply pointed; apical angle about 90°; anterior side slightly convex, posterior gently concave in the middle; ventral margin rounded; right valve with about 16–12 primary ribs and a few splitted subsidiary ones; ribs broad, rounded, unequal, not high with a few longitudinal striae on the back, separated by shallow smooth-bottomed valleys of narrower breadth; rib on the left valve also usually 16–12 in number, narrower than interspaces, flat-topped, unequal; interspace with fine reticulated sculpture; anterior ear of left valve with 5 weak scaly radial riblets, that of the right valve subdivided into 4 irregular radial riblets on the upper area; the lower byssal area furnished with flexuous, lamellated, horizontal, incremental lines; byssal notch distinct, byssal comb well maked; incremental lines very fine, not imbricated; interior obscurely radially grooved, ventral margin crenulated.

Dimensions: Height, 29 mm.; length, 26 mm.; thickness of the right valve 4 mm.

Holotype: JC 1300018, Paratype: JC 1300019, JC 1300020 (from 112–2, Kamigiri)

Occurrence: Kamigiri (111, 112–2, 113), Nakanishi (245)……Kubohara sandstone; Hachiyato (1–1, 185), Maki (267)……Maki siltstone

No allied species is known among the Recent and fossil species. Apparently this species is similar to *Patinopecten kimurai* (YOKOYAMA) (1925), a well known Miocene scallap, but the new species having well marked byssal comb obviously belongs to the Genus *Chlamys*. The ribs are variable in number 12 to 16. The individuals with few ribs have left valves with fine and ridged ribs. Therefore, it may be subdivided into some subspecific groups in future when a sufficient material is supplied.

Ostrea (Crassostrea) sp. indet. (Pl. V, figs. 10, 11)

It differs from *O. gravitesta* YOKOYAMA (1926) and *O. gigas* THUNBERG (1869) as it has small and thin shell. The Genus *Ostrea* is variable in form, it is difficult to classify the fossil species.

Venericardia (Cyclocardia) siogamensis NOMURA

1926. *Venericardia tokunagai*, YOKOYAMA, Jour. Fac. Sci. Univ. Tokyo, sec. 2, Vol. I, p. 223, pl. 28, figs. 17, 18.

YOKOYAMA correlated this fossils to his species *Venericardia tokunagai*, which is originally a fossil form from the Asagai formation. However, the *Venericardia* from this area is not *V. tokunagai* but is referable to *V. siogamensis* NOMURA. *V. tokunagai* has a greater number of ribs and shell is more trigonal.

Venericardia (Cyclocardia) sp. indet. (Pl. V, fig. 15)

Shell small, trigonal, thick, inflated, sculptured with 14 radiating ribs and concentric growth line crossing each other.

This shell is similar to *V. ferruginea* CLESSEN (1888), but distinguished in having smaller shell and a smaller number of radiating ribs. *V. orbicularis* YOKOYAMA (1923) is another allied species, but differs in its high and round shell form.

With poor ill-preserved specimens no more detail is given at present.

Joannisiella sp. indet.

Shell orbicular, moderately inflated; surface smooth except the feeble growth line; weak ridge runs from beak to postero-ventral margin; teeth unknown.

Only cast specimens are at hand.

Wallucina habei n. sp. (Pl. VI, figs. 1, 2)

Shell small, ovately suborbicular, thick, convex, roundly produced towards antero-ventral side; antero-dorsal side short, slightly concave; postero-dorsal margin gently convex, gradually descending to posterior margin; anterior margin broadly rounded; ventral side well rounded; beak small, prominent, approximate, situated about at centre of the dorsal border; the surface shows a distinct keel running from the beak to the postero-ventral end; scluptured with irregular, slightly lamellated, concentric lines and obscure radiating striae; lunule distinct, cordate; ligamental area wide, stout, with 2 cardinal teeth; anterior one of left valve trigonal; lateral teeth developed only on the right valve, strong, well marked; inner margin denticulated; inner side with fine radiating striae; muscular scar obvious.

Dimensions: Height and length, 4 mm.; thickness of left valve; 1.5 mm.

Holotype: JC 1300051, Paratype: JC 1300052 (from 111, Kamigiri)

Occurrence: Kamigiri (111, 113)

Wallucina lamyi CHAVAN (1938) is like the present species, but the latter has a more orbicular, thin and compressed shell. The ridge running from the beak to the postero-ventral end is the most remarkable feature of this new species.

Mercenaria sp. indet.

Shell small, ornamented with strong concentric lamella.

It differs from *M. yokoyamai* (MAKIYAMA) (1927) in its smaller, longer and compressed shell.

Anisocorbula venusta elongata n. sub. sp. (Pl. VI, fig. 7)

This shell is closely allied to *Anisocorbula venusta* (GOULD) (1861) but differs in its long shell and the direction of the ridge running from the beak to the postero-ventral margin.

Dimensions: Height, 5 mm.; length, 8 mm.; thickness, 3.2mm.

Holotype: JC 1300060 (from 111, Kamigiri)
Occurrence: Kamigiri (111, 112, 113).....Kubohara sandstone

Leptothyra ena n. sp. (Pl. VI, fig. 8)

Shell small, globose-conic, solid, higher than diameter; suture deeply impressed; whorls 6, convex, spirally sculptured; threads fine, numerous, narrower than interspace, intercalated by finer, but well-marked ones; last whorl descending anteriorly; aperture suborbicular, oblique; columella nearly smooth.

Dimensions: Height, 9 mm.; diameter, 8 mm.
Holotype: JC 1300033 (from 112, Kamigiri)
Occurrence: Kamigiri (111, 112, 113).....Kubohara sandstone

This species is closely allied to *L. amussitata* (GOULD) (1861), a Recent species but differs from the latter in having the fine spiral threads.

Lunella kurodai n. sp. (Pl. VI, figs. 9–13)

Shell medium, turbinate, solid, with inner pearly layer; suture well-marked; whorls 5, ornamented by spiral beaded cords 5 in younger whorl, 6 in body whorl; upper subsutural cord strong, slightly granulated; growth line finely marked; basal sculpture similar to that of whorls; aperture roundly rhombic.

Dimensions: Height, 13.5 mm.; diameter, 17.5 mm.
Holotype: JC 1300069 (from 111, Kamigiri)
Occurrence: Kamigiri (21, 111, 112), Nakanishi (446).....Kubohara sandstone

Lunella coreensis (RECLUZ) (1853) seems to be related to the present species, but is distinguished in having the weak granulated cords and the shouldered whorls.

The opercula from the same locality may belong to this new species. They are small, round, inflated and finely tuberculated. *Lunella ozawai* OTUKA (1938) was based on the operculum, but the opercula referred to this new species have the coarser ornamentation of the outer surface and their spiral sutures are more densely coiled.

Nerita kamigiriensis n. sp. (Pl. VI, figs. 14,15)

Shell moderate in size, solid, height equal to diameter, globular; spire very small, depressed with flattened apex, surface with only oblique, fine growth-lines; suture indistinct; body whorl extremely large and inflated; aperture large and ovately rounded; columella area flattened, wide with several small, irregular granules, crenulated along the straight margin; outer lip sharp, inner margin denticulated.

Dimensions: Height, 16 mm.; diameter, 16.4 mm.
Holotype: JC 1300083
Occurrence: Kamigiri (110)

Only one specimen examined at hand. This shell resembles *N. ocellata* GRILL (1889), but the apex of this new species is not eroded, and aperture is more round and not produced horizontally.

Bittium sp. indet.

Ill-preserved imperfect specimens only. The nuclear whorls are unknown, the later whorls have 8 spiral cords. The spiral cords are flat-topped, wider than the interspaces, the third from the top is weak. This species is different from *B. onoyamai* OINOMIKADO et IKEBE (1939) in the following respects; the third weak spiral cord from the top and low turreted shell.

Cerithium kaneharai FUJITA et OGOSE (Pl. VI, fig. 20)

1936. *Cerithium* sp., KANEHARA, Jap. Jour. Geol. Geogr. vol. 13, nos. 1–2, pl. 10, fig. 7
1950. *Cerithium kaneharai*, FUJITA et OGOSE, Jour. Geol. Soc. Japan, vol. 56, no. 666, p. 488

Well-preserved many specimens were obtained. This shell belongs to the Genus *Cerithium* having a well-marked short canal.

Siphonalia makiyamai n. sp. (Pl. VI, figs. 16, 17)

Shell medium, thick, fusiform, with axial nodes and spirals; spire narrowly conical, slightly higher than the aperture; protoconch unknown; whorls 5, convex, shouldered; axial nodes 11 in number, nearly vertical, blunt; spiral cords 6, catagenetic, strong, narrower than interspaces, running over the axials; a few finer threads between strong cords on the penultimate and body whorls; suture well-marked, undulated; growth lines distinct all over the surface, flexuous; aperture oblique ovate, other details unknown; canal narrow, short and recurved.

Dimensions: Height, ca. 23.5mm.; diameter, 13.5 mm.

Holotype: JC 1300099, Paratype: JC 1300100 (from 446, Nakanishi)

Occurrence: Kamigiri (110, 112), Nakanishi (446).....Kubohara sandstone

It is easy to distinguish this new species from *S. cassidariaeformis* (REEVE) (1846) by having small, narrowly fusiform shape, fewer spirals. *S. sikokuana* NOMURA (1937) is closely related to this species, but the former has a large and high shell with many fine intercalating threads.

Siphonalia minuta n. sp. (Pl. VI, figs. 21, 22)

Shell small, solid, fusiform, ornamented by axial plicae and spiral striae; spire sharply conical, nearly equal to the aperture; protoconch 2; remaining whorls 5, angular convex, shouldered; plicae 13 in number running from the upper suture to the lower, slightly oblique, rounded; spirals 3 in the younger whorl on the lower half of the surface, 4 in next whorl intercalating fine threads on the lower part; upper part also with fine threads; penultimate whorl with 5 strong cords and numerous fine threads; all spirals running over the axials; suture thick, slightly granulated, undulated; fine growth lines flexuous; aperture

oval, inner margin unknown; canal moderate in width, short, slightly recurved.

Dimensions: Height, 10 mm.; diameter, 5 mm.

Holotype: JC 1300113, Paratype: JC 1300114

Occurrence: Nakanishi (246).....Kubohara sandstone

This species has a remarkably small shell, slightly related to *S. sikokuana* NOMURA (1937) which has a larger shell with a great number of spirals.

Siphonalia sp. indet. (Pl. VI, fig. 18)

Shell medium, fusiform, with 11 axial nodes and fine numerous spiral threads.

Only a few fragmental specimens were obtained. It has peculiar form and ornamentation; but owing to the imperfection of specimens, specific determination is postpond.

Nassarius hongoensis n. sp. (Pl. VI, fig. 19)

Shell small, elongate ovate, solid, cancellated; spire turreted, higher than the aperture, outline slightly convex; protoconch of 3 smooth, convex whorls; whorls 5, slightly convex, sculptured with spiral striae and axial ribs; spirals fine, 8 in number, wider than interspace, the subsutural ones broad and granulose; axial ribs suboblique, 25 on the penultimate whorl, their interspaces nearly equal to them; body whorl convex, contracted below, with 14–15 spiral cords; fasciole defined with a spiral shallow groove, with 2 distinct grooves on the surface; aperture ovate, suboblique, slightly channeled above and with a short deep reflected canal below; columella long and concave, with a distinct basal fold; inner margin unknown.

Dimensions: Height, 11 mm.; diameter, 5 mm.

Holotype: JC 1300072, Paratype: JC 1300073 (from 111, Kamigiri)

Occurrence: Kamigiri (111, 112).....Kubohara sandstone, Higashihora (457) .....Higashihora sandstone

Nassarius japonicus (A. ADAMS) (1852), a Recent shell of Japan, similar to this new species but the former has a shorter canal and a well-marked finely beaded ornamentation. This species is distinguishable from *N. demissus* (YOKOYAMA) (1923) with its high spire and surface ornamentation and from *N. simizui* OTUKA (1934) with its fewer axial ribs and slightly lower shell.

Turricula sp. indet. (Pl. VI, fig. 24)

Shell longly fusiform, solid, medium in size; spire turreted, higher than the aperture including canal; protoconch unknown, remaining whorls 4, concave above the shoulder nodes, contracted below; axial nodes 11 in number, catagenetic, oblique, obsolete on the upper half of the whorl, and nearly equal to interspace in breadth on the body whorl; the spiral fine threads seen on the body whorl; aperture long, oval, with a notch close to the suture, shallow, gradually widening

outward; siphon elongate, narrow.

Only 3 fragmental specimens are obtained. This is a unique species, it will be worked out with a better material in future.

Syrnola sp. indet. (Pl. VI, fig. 23)

The shell is regularly elongate-conic; the outline is straight; the post-nuclear whorls are about 8, feebly shouldered at summit, contracted at suture; the surface is sculptured with faint growth-lines and an impressed line revolving below the suture; the columella is short, provided with a weak fold.

This species belongs to the Genus *Syrnola* on account of a fold but there is no allied species among the fossil and living shells.

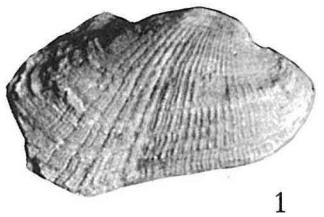
Bibliography

1) Fujita, K. and Ogose, S. (1950, 1951): Lithologic Classification of the Cenozoic Strata in the Northern Area of Mizunami-machi, Toki-gun, Gifu Prefecture, Japan. Jour. Geol. Soc. Japan, **56,** 481-492, **57,** 99-110.
2) Hayashi, T. (1954): Geology of the Izumi-machi District, Gifu Prefecture, Japan. ——Mainly on the Tertiary Strata of the District—— Studies from the Geol. & Mineral. Inst. Tokyo Univ. Educ., **3,** 135-142.
3) Ida, K. (1944): Tertiary Formations in the Environs of Iwamura-cho, Ena-gun, Gifu Prefecture, Gakujutsu Hokoku **3,** 1-17.
4) Ikebe, N. (1934): Miocene Strata of the eastern Part of Koga-gun, Omi. The Globe, **22,** 110-123.
5) Ishida, S. and the others. (1954): Cenozoic Formation in Okuyamada, Kyoto Prefecture. Jour. Geol. Soc. Japan, **60,** 160-166.
6) Itoigawa, J. (1955): The Cenozoic Strata in the Iwamura Basin, Gifu Prefecture, Japan. ibid. **61,** 511-517.
7) Ogose, S. (1952): On the Mode of Occurrence of Fossils in the Mizunami Group in the Eastern Mino, Japan. ibid. **58,** 477-486.

Plate V

Explanation of Plate V

1. *Barbatia* (*Savignyarca*) *kubara* n. sp. (Holotype)
2. *Barbatia* (*Savignyarca*) *kubara* n. sp. (Paratype)
3. *Glycymeris minoensis* n. sp.
4. Same specimen as fig. 3.
5. *Chlamys iwamurensis* n. sp. (Holotype)
6. *Chlamys iwamurensis* n. sp. (Paratype)
7. *Chlamys egregius* n. sp. (Holotype)
8. *Chlamys egregius* n. sp. (Paratype)
9. *Chlamys egregius* n. sp. (Paratype)
10. *Ostrea* (*Crassostrea*) sp. indet.
11. Same specimen as fig. 10.
12. *Lithophaga rechifora* n. sp.
13. *Septifer* (*Mytilisepta*) *agiensis* n. sp. ×2
14. *Nuculana pennula* (YOKOYAMA)
15. *Venericardia* (*Cyclocardia*) sp. indet.



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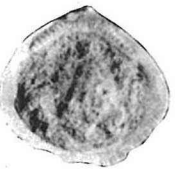

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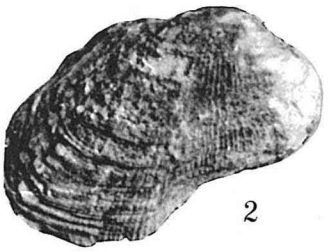

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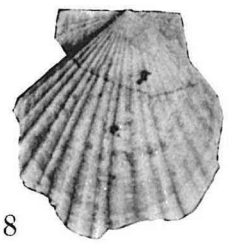

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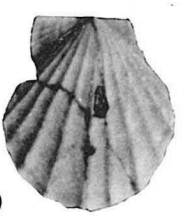

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Plate VI

Explanation of Plate VI

1. *Wallucina habei* n. sp. ×2
2. Same specimen as fig. 1. ×2
3. *Pillucina* (*Sydlorina*) *yokoyamai* (OTUKA) ×2
4. *Lucinoma acutilineata* (CONRAD)
5. *Venerupis* (*Siratoria*) *siratoriensis* (OTUKA)
6. *Nipponomarcia nakamurai* IKEBE
7. *Anisocorbula venusta elongata* n. subsp.
8. *Leptothyra ena* n. sp.
9. *Lunella* sp. (Operculum) ×2
10. *Lunella kurodai* n. sp. (Holotype)
11. Same specimen as fig. 10.
12. Same specimen as fig. 9. ×2
13. Same specimen as fig. 9. ×2
14. *Nerita kamigiriensis* n. sp.
15. Same specimen as fig. 14.
16. *Siphonalia makiyamai* n. sp. (Holotype)
17. *Siphonalia makiyamai* n. sp. (Paratype)
18. *Siphonalia* sp. indet.
19. *Nassarius hongoensis* n. sp. ×2
20. *Cerithium kaneharai* FUJITA and OGOSE
21. *Siphonalia minuta* n. sp. ×2
22. Same specimen as fig. 21. ×2
23. *Syrnola* sp. indet.
24. *Turricula* sp. indet.


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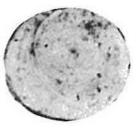
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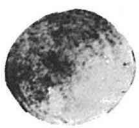
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