790. THE BIVALVE FAUNA FROM THE MIYANOHARA FORMATION (LOWER CENOMANIAN) OF SAKAWA AREA, SHIKOKU*

TOMOKO MATSUDA

Doshimaru 2-12-232, Wakamatsu-ku, Kitakyushu, 808

Abstract. This paper deals mainly with the description of the bivalve species from the upper part of the Miyanohara Formation (Lower Cenomanian) of the Sakawa area, Shikoku. They are 19 species of 15 genera, including 4 new species. The occurrence of several trigoniids, Pterotrigonia (?Scabrotrigonia) pustulosa, P. (Ptilotrigonia) mifunensis and P. (Ptil.) amakusensis already described by Tashiro and Matsuda (1983b) suggests that the fauna is referable to the upper Lower Cenomanian. This conforms well with the previous age determination (K4a2) by ammonites (Matsumoto, 1977). This bivalve fauna is closely similar to that of the S-IV Formation (Tashiro and Matsuda, 1983a) of the Goshouroua Group in Shishi-jima island of Kyushu, that of the Middle part of the Nagase Formation (Tashiro et al., 1982) of Shikoku, and that of the Misakubo Formation of the Akaishi Mountains.

Introduction

The Upper Cretaceous Miyanohara Formation is very narrowly distributed in the neighbourhood of Miyanohara (Sakawa district) in Shikoku (Text-fig. 1). This formation is composed of the lower part and the upper part in the latter of which the described fossils occur. Several molluscan fossil localities are probably of the same horizon. The specimens were mainly collected at the easternmost locality (Text-fig. 1) where those of Hirata's and Katto's collection were also obtained. Although several bivalve fossils from the Miyanohara Formation were described by Amano (1956), more numerous bivalve specimens have recently been collected from the upper part of the formation. In the present paper I describe 19 species of 15 genera, including 4 new species, and discuss their biostratigraphical implications, including the correlation of the Miyanohara Formation with the Cenomanian strata of Kyushu, Akaishi and Hokkaido.

Repository.—The following abbreviations are used for the indication of the institutions where the described specimens are kept.

KSG: Department of Geology, Faculty of Science, Kochi University, Kochi

HPC: Hirata's Palaeontological Collections in the Makino Botanical Garden, Godaisan of Kochi

Before going further, I wish to express my sincere thanks to Prof. Masayuki Tashiro of Kochi University, for his continuous encouragement, valuable suggestions and kind supply of the specimens from Hokkaido and Kyushu and to Prof. Emeritus Tatsuro Matsumoto of Kyushu Univ., for his reading of the draft with instructive suggestions. Thanks are also due to Dr. Itaru Hayami of the Univ. of Tokyo, for his kind advice, to Prof. Jiro Katto of Kochi Univ., for

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Text-fig. 1. Map showing the fossil localities of the Miyanohara Formation at Miyanohara in Sakawa.
U: Upper member of the Miyanohara Formation; L: Lower member of the Miyanohara Formation; A: Alluvium.
Below is the index map showing also relevant localities.
S: Shishijima island; G: Goshonoura island; N: Nagase.

his supply of some specimens from the Miyanohara Formation, to the staff of the Hirata’s Palaeontological Collections in the Makino Botanical Garden, Godaisan of Kochi, for the inspection of several specimens which were collected by the late Mr. Motome Hirata from the Miyanohara and Nagase Formations.

Systematic description

Class Bivalvia
Subclass Palaeotaxodonta
Order Nuculoida

Superfamily Nuculacea Gray
Family Nuculidae Gray
Genus Nucula Lamarck, 1799
Subgenus Pectinuclea Quenstedt, 1930
Nucula (Pectinuclea) kochiensis
Tashiro et Matsuda
Plate 1, Figs. 1–8

790. Bivalve Fauna from Miyanozara Formation

Japan, n.s., no. 127, p. 396, pl. 62, figs. 7, 11–15, text-fig. 3.

Material: -- KSG 3361, external mould of right valve; KSG 3360 and KSG 3362--KSG 3364, internal mould of right and left valves; they are collected from Miyanozara of Sakawa. Another specimen, KSG 3365, external mould of right valve, from Yunokuchi at Shishijima.

Measurements (in mm):--

<table>
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<td>KSG 3362 L. in mould</td>
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<td>KSG 3363 R. in mould</td>
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<td></td>
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<td>KSG 3364 L. in mould</td>
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<tr>
<td>KSG 3365 R. ex. mould</td>
<td>18.5</td>
<td>15.0</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Remarks: -- These specimens are undoubtedly identified with Nucula (Pectinucula) kochiensis Tashiro et Matsuda (1982), from the Fukigoshi Formation of the Monobe area in Shikoku, judging from the radial ribs on the disk, trigonal outline and features of the hinge structure. As to Nucula sp. from the Miyanozara Formation Amano (1956) did not describe the ornamentation on the disk, but it is probably identical with this species in view of the hinge structure and shell outline.

Occurrence: -- Medium- and fine-grained sandstone of the Miyanozara Formation at Miyanozara in Sakawa area. This species is known from the siltstone of the S-I and S-III Formations of the Goshonoura Group at Hegushi and Yunokuchi of Shishijima.

Subclass Pteriomorpha
Order Arcoida
Superfamily Arcacea Lamarck
Family Cucullaeidae Stewart
Genus Cucullaea Lamarck, 1801
Subgenus Idonearca Conrad, 1862
Cucullaea (Idonearca) ezoensis ezoensis Yabe et Nagao
Plate 2, Figs. 11–16


Material: -- KSG 3368 -- KSG 3370, internal moulds of the right valves, from Miyanozara, Sakawa. KSG 3371, external mould of the right valve, from Kashiwaguri of Shishijima island.
Measurements (in mm):

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<td>32.0</td>
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<td>KSG 3370 R. in. mould</td>
<td>18.0</td>
<td>12.5</td>
<td>—</td>
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<tr>
<td>KSG 3371 R. ex. mould</td>
<td>18.5</td>
<td>16.5</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Remarks:—Many specimens from the Goshonoura Group of the Shishijima island and the Miyanohara Formation are before me. They are characterized by the subquadrate outline, and their postero-ventral corner are not much projected towards posterior. Although the specimens from the Goshonoura Group of the Shishijima island were identified with Cucullaea ezoensis var. amaxensis Matsumoto by Amano (1956), they are safely identified with Cucullaea (Idonearca) ezoensis ezoensis Yabe et Nagao, from the Middle Yezo Group in Hokkaido, because of their less projected postero-ventral corner. Likewise, the specimens from the Miyanohara Formation are undoubtedly identified with the same subspecies.

Occurrence:—Rare in the medium-grained sandstone of the Miyanohara Formation at Miyanohara, Shikoku, and the siltstone of the S-I Formation at Hegushi of the Shishijima island; also rare in fine-grained sandstone of the S-V Formation of the Goshonoura Group at Yunokuchi of the Shishijima island; common in the medium-grained sandstone of the S-IV Formation at Hegushi; abundant in the medium-grained sandstone of the S-III Formation of the Goshonoura Group at Kashiwaguri of the Shishijima island.

Family Arcidae Lamarck
Genus Arca Linné, 1758
Subgenus Eonavicula Arkell, 1929
Arca (Eonavicula) tashiroi sp. nov.

Plate 2, Figs. 1–10; Text-fig. 2


Text-fig. 2. Arca (Eonavicula) tashiroi sp. nov.
A diagramatic sketch of the holotype. (T. Matsuda delin.)

Material:—Holotype, KSG 3372, external mould of right valve, from Enokuchi of Goshonoura island; paratypes, KSG 3374 and KSG 3375, external and internal moulds, from Miyanohara of Sakawa; the other paratypes, KSG 3373, KSG 3376 and KSG 3377, external and internal moulds from Kashigaguri of Shishijima and Enokuchi of Goshonoura.

Diagnosis:—Shell medium to large for the genus, elongately subquadrart, longer than high, very inflated; umbo prominent, orthogyrus, located at about one third from front of the valve; anterior margin a little convex, subvertical to the dorsal margin; ventral margin horizontal, nearly straight but slightly concave at the middle part; posterior margin nearly straight, obliquely truncated; dorsal margin nearly straight; a shallow radial sulcus extends from the umbo to center of the ventral margin; posterior carinal ridge not angulated but well elevated, especially near the umbo; dorsal carinal ridge weakly elevated; hinge line straight with about 40 small diverging teeth; ligament area wide, triangular, provided with five or more chevron-shaped ligament grooves; disk ornamented with abundant fine radial ribs and numerous laminated concentric ribs; median part of the disk near the radial sulcus somewhat reticulated by two sorts of the ribs; posterior area ornamented with two sorts of the ribs as like as the disk; the concentric ribs are usually waved near the
posterior margin; inner margin smooth; both lateral adductor scars weakly impressed.

Measurements (in mm):—

<table>
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<td>KSG 3373 R. in. mould</td>
<td>27.5</td>
<td>14.0</td>
<td>—</td>
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<tr>
<td>KSG 3374 R. ex. mould</td>
<td>21.5</td>
<td>9.0</td>
<td>5.5</td>
</tr>
<tr>
<td>KSG 3375 L. in. mould</td>
<td>24.0</td>
<td>12.5</td>
<td>—</td>
</tr>
<tr>
<td>KSG 3376 R. ex. mould</td>
<td>28.5</td>
<td>15.0</td>
<td>7.0</td>
</tr>
<tr>
<td>KSG 3377 L. in. mould</td>
<td>15.5</td>
<td>ca 7.0</td>
<td>—</td>
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</table>

Observation:—This species is very variable in the outline and the strength of the concentric ribs. In mature specimens the concentric laminae are more strongly marked than in the younger specimens, and the secondary radial ribs frequently appear on the ventral part of the disk.

Comparison:—This species is discriminated from Arca (Eoanaivula) prolata Amano (1957), from the Hagino Formation in Shikoku by the more numerous radial ribs and strongly laminated concentric ribs. Arca (Eoanaivula) shinanoensis Yabe et Nagao (in Yabe, Nagao and Shimizu, 1926), from the Shiroi Formation in Central Japan, is distinguishable from this species in its less inflated and smaller valve. This species resembles Arca sanctae-cruces Pictet et Campiche, from the Lower Greensand of England (Woods, 1899), in the numerous laminated concentric ribs on the surface, but differs in its distinct chevron-shaped ligament grooves and less rounded anterior margin. Arca carteroni d’Orbigny, from the Lower Greensand of England (Woods, 1899), is similar to this species in its numerous laminated concentric ribs on the surface and several ligament chevrons, but differs in its more elongated outline.

Occurrence:—Medium- to fine-grained sandstone of the Miyanoohara Formation at Miyanoohara, Sakawa; siltstone of the Fukigoshi Formation of Odochi, Monobe area (see, Tashiro and Matsuda, 1982); siltstone of the S-I Formation at Hegushi of Shishijima island. Fine-grained sandstone of the S-IV Formation at Kashiwaguri of the same island; medium-grained sandstone of the IIb Formation (Matsumoto, 1938), of the Goshonoura Group at Enokuchi of Goshonoura.

Family Glycymerididae Newton
Genus Glycymeris da Costa, 1778
Subgenus Hanaia Hayami, 1965

Glycymeris (Hanaia) goshonouraensis Matsukuma

Plate 1, Figs. 11—15


Material:—KSG 3379, internal mould of left valve, and KSG 3380, left valve, both from Miyanoohara of Sakawa; KSG 3378, KSG 3381 and KSG 3382, internal and external moulds, from Hegushi, Shishijima island.

Measurements (in mm):—

<table>
<thead>
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<tr>
<td>KSG 3379 L. in. mould</td>
<td>11.0</td>
<td>9.5</td>
<td>—</td>
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<td>KSG 3380 L. valve</td>
<td>16.5</td>
<td>15.0</td>
<td>6.0</td>
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<td>KSG 3381 R. in. mould</td>
<td>22.5</td>
<td>ca 16.0</td>
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<td>KSG 3382 R. in. mould</td>
<td>ca 20.0</td>
<td>ca 19.0</td>
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</table>

Remarks:—Several specimens have been obtained from the Miyanoohara Formation. On the other hand, many specimens occur from the S-IV Formation of the Goshonoura Group of the Shishijima island. They are characterized by its asymmetrical hinge structure in the immature stage, inflated valve, round-topped radial ribs on the surface and fine radial ridges on the internal
surface. In these characters they are identified
with *Glycymeris* (*Hanaia*) *solida* Nagao (Tashiro,
1971) from the Goshonoura Group of the
Goshonoura island.

**Occurrence:**—Rare in the medium- to
fine-grained sandstone of the Miyanozara Formation,
at Miyanozara, Sakawa; abundant in the fine-
gained sandstone of the S-I-V Formation of the
Goshonoura Group at Hegushi of Shishijima
island; common in the fine-grained sandstone of
the S-I Formation of the Goshonoura Group at
Yunokuchi of the same island.

Order Pterioida
Suborder Ostreina Ferussac
Superfamily Ostreacea Fafinesque
Family Ostreidae Rafinesque
Subfamily Ostreinae Rafinesque
Genus *Crassostrea* Sacco, 1897
*Crassostrea kawachiensis* Tamura

Plate 2, Fig. 18

Geol. Soc. Japan*, vol. 45, no. 532, p. 13,
text-figs. 1, 2.

sci., p. 114, pl. 2, figs. 1—5.


1982. *Crassostrea kawachiensis* Tamura;
Tashiro and Matsuda, *Trans. Proc. Palae-
63, figs. 8, 9, 11.

**Material:**—KSG 3387, internal mould of
the left valve, from Miyanozara of Sakawa.

**Remarks:**—Although some specimens occur
from the Miyanozara Foramition, they are
imperfect or fragmentary. KSG 3387 is measured
34.0 mm in length and 55.0 mm or more in
height. This is characterized by its tall and
inflated valve, and thick test. These specimens
are probably referable to *Crassostrea kawachi-
densis* Tamura (1977), originally described from
the Mifune Group of Central Kyushu.

**Occurrence:**—Common in the medium- to
coarse-grained sandstone of the Miyanozara
Formation at Miyanozara, Sakawa.

Order Trigonioida
Superfamily Trigoniacea Lamarck
Family Trigoniidae Lamarck
Subfamily Pterotrigniniinae van Hoepen
Genus *Pterotrignia* van Hoepen, 1929
Subgenus *Scabrotigrina* Dietrich, 1933
*Pterotrignia (?Scabrotigrina) pustulosa*
(Nagao)

**Synonymy, Material, Description and Occur-
25—27.

Subgenus *Ptilotrignia* van Hoepen, 1929
*Pterotrignia (Ptilotrignia) mifunensis*
(Tamura et Tashiro)

**Synonymy, Material, Description and Occur-
42—45.

*Pterotrignia (Ptilotrignia) amakusensis*
Tashiro et Matsuda

**Synonymy, Material, Description and Occur-
41—42.

*Pterotrignia (Ptilotrignia) miyanozaraensis*
Tashiro et Matsuda

**Material, Description and Occurrence:**—See
Tashiro and Matsuda, 1983b, pp. 45, 46.

Subclass Heterodonta
Order Veneroida
Superfamily Lucinacea Fleming
Family Lucinidae Fleming
Subfamily Myrteinae Chavan
Genus Myrtea Turton, 1822
Subgenus Myrtea Turton, 1822
Myrtea (Myrtea) amanoi sp. nov.
Plate 1, Figs. 16–21; Text-fig. 3


Material:—Holotype, KSG 3389, right valve, from the Fukigoshi Formation at Odochi of Monobe area (see Tashiro and Matsuda, 1982); paratype, KSG 3390, internal mould, from the same locality of the holotype; KSG 3391 and KSG 3392, external moulds, from Miyanohe, Sakawa; KSG 3393, external mould, from Enokuchi, Goshonoura island.

Diagnosis:—Shell small, subovate in outline, slightly longer than high, weakly inflated; umbo small, located at a little posterior than mid-length of the valve; anterior dorsal margin oblong, nearly straight but weakly concave near the umbo; posterior dorsal margin slightly convex; anterior margin weakly arched, truncated, forming an angle of about 120° with the dorsal margin; ventral margin broadly arched; posterior margin nearly straight or slightly convex, vertically truncated from the dorsal margin; apical angle about 120°; lunule narrow, elongated, distinctly separated from the disk by a narrowly angulated ridge, nearly smooth only with growth lines; escutcheon depressed very narrow, smooth; the concentric ribs on the surface roof-shaped, regularly spaced in general, narrower than their flat interspaces; posterior carina weakly extended from the umbo to the postero-ventral corner; hinge plate long; hinge formula is as follows:—

AIII 3a 3b/AIV AII 2 4b
2 subvertical or slightly oblique; 3a small nearly vertical; 3b strong, obliquely extended towards postero-ventral corner; 4b large, elongated, strongly oblique; lateral teeth elongated; anterior adductor scar oblong, weakly impressed; posterior adductor scar small; fine and numerous radial striae appear on the internal surface; inner margin smooth.

Measurements (in mm):—

<table>
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<td>KSG 3392 R. ex. mould</td>
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<td>14.5</td>
<td>13.5</td>
<td>3.0</td>
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Observation:—The concentric ribs number about 40, being more closely spaced near the umbo than on the ventral part in the adult specimens. Fine but distinct growth lines are discernible on the interspace of the ribs on the ventral part of the disk.

Comparison:—This species is discriminated from Myrtea (s. 1.) angularis Tashiro (1976), from the Himenoura Group in Kyushu, in its rounded outline and less numerous concentric ribs on the disk. This species differs from Myrtea ezoensis (Nagao) (1938), from the Upper Ezo Group of Hokkaido, in its rounded outline and
numerous concentric ribs. This species resembles *Caullucina esbedensis* Freneix (1976), from the Hassi Oum-Esbed of France, in the subovate outline, but differs in its small size and posterior location of the umbo. *Lucina mattriformis* Stephenson (1941), from the Nacatoch Sand of U.S.A., is discriminated from this species, by its rounded outline and angled posterior carina.

*Occurrence:*—Siltstone of the Fukigoshi Formation in Monobe area (see Tashiro and Matsuda, 1982): medium- to fine-grained sandstone of the Miyanoara Formation at Miyanoara of Sakawa.

**Family Mactromyidae Cox**

**Genus Thetis Sowerby, 1826**

*Thetis japonica* (Yabe et Nagao)

Plate 2, Fig. 17


**Material:**—KSG 3388, external mould of left valve, from Miyanoara of Sakawa.

**Remarks:**—A single specimen, (KSG 3388), 27.5 mm long, 25.0 mm height and 11.5 mm thick, was collected from the Miyanoara Formation. Although its hinge structure is not clear, other features are very well preserved. It is certainly referable to *Thetis japonica* (Yabe et Nagao), because of its well inflated valve, rounded outline and smooth surface except for fine growth line.

*Occurrence:*—Very rare at the medium-grained sandstone of the Miyanoara Formation of Sakawa.

**Superfamily Crassatellacea Ferussac**

**Family Crassatellidae Ferussac**

**Subfamily Crassatellinae Ferussac**

**Genus Pachythaerus Conrad, 1869**

*Pachythaerus nagaoi* (Matsumoto)

Plate 1, Figs. 22—24


**Material:**—KSG 3395 and KSG 3396, internal and external moulds, from Kashiwaguri of Shishijima Island; KSG 3394, internal mould of imperfect right valve, from Miyanoara of Sakawa.

**Measurements (in mm):**

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<td>24.5</td>
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<td>—</td>
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<tr>
<td>KSG 3396</td>
<td>10.5</td>
<td>9.5</td>
<td>3.0</td>
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</table>

**Remarks:**—Although a specimen, KSG 3394, from the Miyanoara Formation is an imperfect internal mould, it is referable to *Pachythaerus nagaoi* (Matsumoto), from the Goshonoura Group of Central Kyushu, by its characteristic hinge structure. The specimens from the Shishijima island are also referable to this species as
already discussed by Amano (1956).

Occurrence.—Very rare in the medium grained sandstone of the Miyanoohara Formation at Miyanohara, Sakawa; rare at the fine-grained sandstone of the S-III and S-V Formations at Hegushi and Yunokuchi of the Shishijima island; abundant in the fine-grained sandstone of the S-IV Formation at Kashiwaguri of the same island.

Genus *Anthonya* Gabb, 1864

*Anthonya apicalis* Nagao

Plate 1, Figs. 25–31


Material.—KSG 3397 — KSG 3400, internal and external moulds, from Miyanohara, Sakawa; KSG 3401 and KSG 3402, external moulds, from Kashiwaguri and Yunokuchi of Shishijima island; KSG 3403, internal mould, from Katsurazawa, Mikasa.

Measurements (in mm):—

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<td>KSG 3403</td>
<td>33.0</td>
<td>11.5</td>
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Remarks.—Amano (1956) distinguished the specimens from Shishijima island and Miyanohara from *Anthonya apicalis* Nagao (1938) from Hokkaido, as a subspecies, *Anthonya apicalis shishijimensis*. It was said by him that the shell is not so rapidly tapering in its posterior part, not so concave at the dorsal margin, and the anterior margin is more produced. As far as I have observed, several specimens in my hand from the Miyanohara Formation are tapering in the posterior part like the specimens of *A. apicalis* from Hokkaido (Nagao, 1938). Although the dorsal margin is nearly straight in the immature specimens from Miyanohara and Shishijima, it is usually concave in the adult specimens. Hayami (in Hayami and Kase, 1981) has noted that the specimens of *A. apicalis* from the sea bottom off the coast of Kuji have not so prominent umbo and not so regularly spaced ribs on the surface as those from Miyanohara and Shishijima. The adult specimens from the Miyanohara are, however, identical with *A. apicalis apicalis* in its surface ornamentation and the shape of umbo. To sum up, I am inclined to deny the subspecific distinction within *A. apicalis* between the forms from Hokkaido and Southwest Japan.

Occurrence.—Common in the medium-grained sandstone of the Miyanohara Formation at Miyanohara, Sakawa; rare at the fine-grained sandstone and siltstone of the S-IV and S-III Formations at Hegushi and Yunokuchi of Shishijima.

Superfamily Veneracea Rafinesque

Family Veneridae Rafinesque

Subfamily Pitarinae Stewart

Genus *Goshoria* Tamura, 1977

*Goshoria crenulata* (Matsumoto)

Plate 3, Figs. 1–3

1938. "*Callista" (Pseudamiantis) crenulatus Matsumoto, *Jour. Geol. Soc. Japan*, vol. 45, no. 532, p. 19, text-figs. 12, 13, pl. 1, fig. 5.


1982. Goshoraia crenulata (Matsumoto); Tashiro and Matsuda, Ibid., no. 127, pp. 410–411, pl. 65, figs. 12, 13.

**Material:**—KSG 3404 and KSG 3405, external and internal moulds, from Miyanoohara, Sakawa; KSG 3406, internal mould, from Hegushi of the Shishijima island.

**Measurements** (in mm):—

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Length</th>
<th>Height</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSG 3404 R. ex. mould</td>
<td>ca 35.0</td>
<td>26.5</td>
<td>6.5</td>
</tr>
<tr>
<td>KSG 3405 R. in. mould</td>
<td>31.5</td>
<td>25.0</td>
<td>—</td>
</tr>
<tr>
<td>KSG 3406 L. in. mould</td>
<td>—</td>
<td>15.5</td>
<td>—</td>
</tr>
</tbody>
</table>

**Remarks:**—These specimens are undoubtedly conspecific with Goshoraia crenulata (Matsumoto), from the Goshonoura Group in Kyushu (Matsumoto, 1938; Tamura, 1977), because of its fine subinternal radial ribs and numerous irregular concentric striae on the disk, prominent and prosogyrate umbo, subovate outline, finely crenulated inner margin and the same features of the hinge structure.

**Occurrence:**—Common in the medium-grained sandstone of the Miyanoohara Formation at Miyanoohara, Sakawa; common in the medium-grained sandstone of the S-III Formation of the Goshonoura Group at Kashiwaguri of the Shishijima island; common in the fine-grained sandstone of the S-IV and S-V Formation of the same Group at Hegushi and Yunokuchi of the same island; common in the siltstone of the S-I Formation of the same group at Hegushi and Katasoba of the same island.

Subfamily Tapetinae Adams et Adams

Genus Legumen Conrad, 1858

?Legumen sp.

Plate 3, Fig. 7

**Compare:**—


**Material:**—KSG 3407, left internal mould, from Miyanoohara.

**Remarks:**—A specimen, KSG 3407, is measured 15.0 mm in length and 9.5 mm in height. This is similar to ?Legumen sp. (Tashiro and Matsuda, 1982) from the Fukigoshi Formation in Shikoku, in having the same features of the outline and hinge structure.

**Occurrence:**—Very rare in the fine-grained sandstone of the Miyanoohara Formation at Miyanoohara of Sakawa.

Subclass Anomalodesmata Dall

Order Pholadomyoida Newell

Superfamily Pholadomyacea Gray

Family Pholadomyidae Gray

Genus Pholadomya Sowerby, 1823

Subgenus Pholadomya Sowerby, 1823

Pholadomya (Pholadomya) japonica Amano

Plate 3, Figs. 4–6


**Material:**—KSG 3408, conjoined valves, from Miyanoohara; KSG 3409, imperfect, conjoined valves, from Yunokuchi of the Shishijima island.

**Measurements** (in mm):—

<table>
<thead>
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<th>Specimen</th>
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<th>Thickness</th>
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<td>45.0</td>
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<td>KSG 3409 valve</td>
<td>30.0</td>
<td>31.5</td>
<td>9.0</td>
</tr>
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</table>
Remarks:—This species was established by Amano (1956) on the specimen from the Miyanoara Formation. The outline of this species is variable from subquadrate to subovate.

Occurrence:—Rare in the medium-grained sandstone of the Miyanoara Formation at Miyanoara of Sakawa; very rare in the fine-grained sandstone of the S-V Formation of the Goshonoura Group at Yunokuchi of the Shishijima island.

Subgenus Bucardiomya Rollier, 1912
Pholadomya (Bucardiomya) hiratai sp. nov.

Plate 3, Figs. 8–13; Text-fig. 4

Material:—Holotype, KSG 3383, external mould of right valve, from Miyanoara of Sakawa; paratypes, KSG 3384 and KSG 3385, external moulds of right valves, from the same locality; another paratype, HPC 8517, external mould of right valve, from Nagase, Monobe area.

Diagnosis:—Shell medium in size, subtrapezoidal or subtriangular in outline, strongly expanded; umbo prominent, located at about two fifths from front of the valve; anterior margin nearly straight, obliquely truncated, forming an angle of about 120° with ventral margin; ventral margin broadly arched; posterior margin narrowly rounded; posterior dorsal margin elongated, weakly concave near the umbo; disk ornamented with about 20 strong concentric ribs on its anterior half, and with distinct radial ribs on its posterior half; the concentric ribs narrower than their interspaces; the radial ribs loosely spaced with about 10 on the posterior marginal part, but closely spaced on the central part of the disk; posterior area broad, nearly smooth without fine growth lines; lunular area smooth.

Measurements (in mm):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Length</th>
<th>Height</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSG 3383 R. ex. mould</td>
<td>37.0</td>
<td>ca 25.0</td>
<td>ca 9.0</td>
</tr>
<tr>
<td>KSG 3384 R. ex. mould</td>
<td>27.0</td>
<td>ca 21.0</td>
<td>ca 10.0</td>
</tr>
<tr>
<td>KSG 3385 R. ex. mould</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>HPC 8517 R. ex. mould</td>
<td>25.0</td>
<td>ca 25.0</td>
<td>—</td>
</tr>
</tbody>
</table>

Observation:—The outline of the valve is somewhat variable. The concentric ribs are sometimes weakened near the ventral margin.

Comparison:—This species resembles Pholadomya (Bucardiomya) miyamotoi Nago (1943), from the Aptian Hiraiga Formation of Northeast Japan, in its outline and radial ribs on the disk, but differs in the absence of granulations on radial ribs and stronger concentric ribs on the

Explanation of Plate 1

Nucula (Pectinucula) kochiensis Tashiro et Matsuda
Fig. 1. Lateral view of right valve, gum cast of external mould (KSG 3365), x 1.2, loc. Yunokuchi of Shishijima, Kagoshima Prefecture.
Fig. 2. Lateral view of the same specimen, x 1.2.
Fig. 3. Dorsal view of the same specimen, x 1.2.
Fig. 4. Lateral view of left valve, plaster cast of internal mould (KSG 3364), x 1.2, loc. Miyanoara of Sakawa, Kochi Prefecture.
Fig. 5. Lateral view of right valve, plaster cast of internal mould (KSG 3360), x 1.2, loc. ditto.
Fig. 6. Lateral view of right valve, plaster cast of external mould (KSG 3361), x 1.2, loc. ditto.
Fig. 7. Lateral view of left valve, plaster cast of internal mould (KSG 3362), x 1.2, loc. ditto.
Fig. 8. Lateral view of right valve, plaster cast of internal mould (KSG 3363), x 1.2, loc. ditto.

*Portlandia* (s.l.) *nagaseana* Tashiro et Matsuda
Fig. 9. Lateral view of left valve, plaster cast of internal mould (KSG 3367), x 1.2, loc. Miyano-
hara.
Fig. 10. Lateral view of left valve, plaster cast of internal mould (KSG 3366), x 1.2, loc. ditto.

*Glycymeris* (*Hanaia*) *goshonouraensis* Matsukuma
Fig. 11. Internal view of left valve, gum cast of internal mould (KSG 3379), x 1.5, loc. Miyano-
hara.
Fig. 12. Internal view of right valve, gum cast of internal mould (KSG 3382), x 1.2, loc. Hegushi of Shishijima.
Fig. 13. Lateral view of left valve, gum cast of external mould (KSG 3380), x 1.2, loc. Miyano-
hara.
Fig. 14. Internal view of right valve, gum cast of internal mould (KSG 3381), x 1.5, loc. Hegushi.
Fig. 15. Lateral view of right valve, gum cast of external mould (KSG 3378), x 1.2, loc. Yunokuchi of Shishijima.

*Myrtea* (*Myrtea*) *amanoi* sp. nov.
Fig. 16. Lateral view of right valve, plaster cast of external mould (KSG 3392), x 1.2, loc. Miyano-
hara.
Fig. 17. Internal view of right valve, gum cast of internal mould (KSG 3390), x 1.5, loc. Fuki-
goshi of Monobe area, Kochi Prefecture.
Fig. 18. Lateral view of left valve, gum cast of external mould (KSG 3391), x 1, loc. Miyano-
hara.
Fig. 19. Lateral view of right valve, gum cast of external mould (KSG 3393), x 1.5, loc. Enokuchi of Goshourajima, Kumamoto Prefecture.
Fig. 20. Lateral view of right valve, gum cast of external mould (KSG 3389), x 1.5, loc. Fuki-
goshi.
Fig. 21. Lateral view of right internal mould (same specimen with KSG 3389), x 1.5.

*Pachythaerus nagaoi* (Matsumoto)
Fig. 22. Lateral view of right valve, gum cast of external mould (KSG 3396), x 1.7, loc. Kashiwa-
guri, Shishijima.
Fig. 23. Internal view of right valve, gum cast of internal mould (KSG 3394), x 1, loc. Miyano-
hara.
Fig. 24. Internal view of right valve, gum cast of internal mould (KSG 3395), x 1.2, loc. Kashiwa-
guri of Shishijima.

*Anthonya apicalis* Nagao
Fig. 25. Lateral view of left valve, gum cast of external mould (KSG 3401), x 1.2, loc. Kushizaki, Shishijima.
Fig. 26. Lateral view of left valve, plaster cast of external mould (KSG 3398), x 1.2, loc. Miyano-
hara.
Fig. 27. Internal view of imperfect left valve, gum cast of internal mould (KSG 3399), x 1, loc. Miyano-
hara.
Fig. 28. Lateral view of left valve, gum cast of internal mould (KSG 3403), x 1.2, loc. Katsura-
zawa of Mikasa area, Hokkaido.
Fig. 29. Lateral view of right valve, gum cast of external mould (KSG 3402), x 1.2, loc. Yunokuchi.
Fig. 30. Lateral view of left valve, gum cast of external mould (KSG 3397), x 1.2, loc. Miyano-
hara, collected by Late Mr. Hirata.
Fig. 31. Lateral view of right valve, gum cast of external mould (KSG 3400), x 1.2, loc. ditto.
disk. It is distinguished from *P. (B.) subpedelnalis* Nagao (1943), from the Hiraiga Formation in that the latter has a trigonal outline. It is similar to *P. decussata* (Mantell), from the Chalk Marl of England (Woods, 1909), in its ornament on the disk, but differs in its elongated outline.

**Occurrence:**—Very rare in the medium-grained sandstone of the Miyanobara Formation at Miyanobara of Sakawa area; rare in the medium-grained sandstone of the Nagase Formation of the Monobe area.

Superfamily Pandoracea Rafinesque  
Family Laternulidae Hedley  
Genus *Periplomya* Conrad, 1870  
*Periplomya japonica* sp. nov.  
**Plate 3, Figs. 14—17**

**Material:**—Holotype, KSG 3410, conjoined valves, from Hegushi of Shishiji; paratype, KSG 3411, conjoined valves from the same locality; the other paratypes, KSG 3412 and KSG 3413, external moulds of the left and right valves, from Miyanobara, Sakawa.

**Diagnosis:**—Shell medium in size, elongatedly ovate, weakly inflated; test very thin; umbo a little prominent, nearly orthopygous, pointed at a little posterior than mid-length of the valves; anterior dorsal margin oblique, nearly straight; anterior and posterior margins well rounded; ventral margin broadly arched; posterior dorsal margin nearly straight and horizontal, apical angle about 120°; surface with irregular growth striae; two narrow inner buttresses extend radially from the umbo to the venter, of which the anterior one, observable subvertically under the umbo, short with about a ninth of the valve height; the other posterior one stronger and more elongated than the anterior, extended towards but not reaches the postero-ventral corner.

**Measurements (in mm):**—

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Length</th>
<th>Height</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>KSG 3410 valve</td>
<td>41.0</td>
<td>25.0</td>
<td>4.0</td>
</tr>
<tr>
<td>KSG 3411 valve</td>
<td>32.5</td>
<td>24.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

KSG 3412 R. ex. mould 22.0 13.0 4.0  
KSG 3413 L. ex. mould 21.0 14.0 2.5

**Observation:**—The H/L ratio of this species is variable from 0.75 to 0.59. The growth striae on the surface are very fine but well marked.

**Comparison:**—“Periploma sp.” from the Misa-kubo Formation of the Akaishi Mountains (Matsushima and Kitamura, 1981) are probably conspecific with this species in showing the same features of the valve. This species is similar to *Periplomya grandis* Ichikawa et Maeda (1958), from the Izumi Group, in the outline, but differs in its smaller valve and weaker and narrower buttresses. It is discriminated from *P. nagaoi brevis* Ichikawa et Maeda (1958), from the Izumi Group, in that the latter has a more rounded outline. It is similar to “*Thracia* robindina” (d’Orbigny), from the Lower Greensand of England (Woods, 1909), in its elongated outline, but is characterized by less inflated valve than that of “*T.* robindina”.

**Occurrence:**—Common in the siltstone of the S-I Formation of the Goshonoura Group at Hegushi of Shishiji, and of the S-III Formation of the same group at Yunokuchi of the same island; very rare in the medium grained sandstone of the Miyanobara Formation at Miyanobara of Sakawa.

**Concluding remarks**

According to a biostratigraphic study of the Cretaceous pterotrionials in Japan by Tashiro and Matsuda (1983a), the geological age of the fossiliferous bed of the Miyanobara Formation was determined to be as upper Lower Cenomanian. This is supported by an ammonite, *Sharpeiceras* sp., which suggests the substage K4a2, i.e. upper Lower Cenomanian (Matsumoto, 1977, fig. 3; Matsumoto et al., 1982, fig. 2).

The middle part of the Nagase Formation (Tashiro et al., 1982), which is characterized by the occurrence of *Mantellliceras japonicum* Matsumoto, Muramoto et Takahashi, an indicator of the upper Lower Cenomanian (K4a2), is undoubtedly correlated with the fossiliferous
bed of the Miyanohara Formation. This is evidenced by the occurrence of some common bivalve species, i.e., *Pholadomya (Bucardiomya) hiratai*, *Pterotrignia (?Scabrotignia) pustulosa* (B form) and *Cucullaea (Idonearca) ezoensis ezoensis*.

The bivalve fauna of the Misakubo Formation (Matsushima and Kitamura, 1981) is closely similar to this Miyanohara fauna, but *Neithia* sp., *Linotrignia* sp. and *P. (?S.) monoboeana* are unknown in the latter.

Many species of the Miyanohara fauna, i.e., *Cucullaea (Idonearca) ezoensis ezoensis*, *Arca (Eonavicula) tashiroi*, *Glycymers (Hanaia) solidia*, *P. (?S.) pustulosa*, *P. (Ptil.) mifunensis*, *Pachythaerus nagoai*, *Anthonya apicalis* and *Goshonoura crenulata* are known from S-IV Formation (Tashiro and Matsuda, 1983a) of the Goshonoura Group in Shishijima. In my opinion, the Miyanohara fauna is safely correlated with the fauna of the S-IV Formation.

It can be said that the Miyanohara fauna represents an intervening substage between the fauna of the Members IIb and Ile or S-I Formation of the Goshonoura Group (Uppermost Albian to lower Lower Cenomanian on the evidence of associated ammonites) and that of the Lower Formation of the Mifune Group or the upper part of the Nagase Formation (Middle Cenomanian). It is devoid of *P. (Ptil.) ogawai*, *P. (Ptil.) dilapsa*, *P. (?S.) pustulosa* (A form), *Nipponitrignia* spp., *Cucullaea (Idonearca)*

### Explanation of Plate 2

**Arca (Eonavicula) tashiroi** sp. nov.

Fig. 1. Internal view of right valve, gum cast of internal mould (KSG 3373), x 2, loc. Enokuchi of Goshonourajima, Kumamoto Prefecture.

Fig. 2. Dorsal view of the same specimen, x 1.8.

Fig. 3. Lateral view of right valve, gum cast of external mould (KSG 3372), x 1.5, loc. ditto.

Fig. 4. Internal view of left valve, gum cast of internal mould (KSG 3377), x 1.5, loc. Kashiwaguri of Shishijima, Kagoshima Prefecture.

Fig. 5. Lateral view of right valve, plaster cast of external mould (KSG 3374), x 1.2, loc. Miyanohara of Sakawa area, Kochi Prefecture.

Fig. 6. Lateral view of imperfect left valve, gum cast of external mould, x 1.5, loc. Enokuchi.

Fig. 7. Lateral view of imperfect right valve, gum cast of external mould, x 1.5, loc. ditto.

Fig. 8. Lateral view of right valve, gum cast of external mould (KSG 3376), x 1.5, loc. Kashiwaguri.

Fig. 9. Dorsal view of internal mould (KSG 3375), x 1.5, loc. Miyanohara.

Fig. 10. Lateral view of the same specimen, x 1.5.

**Cucullaea (Idonearca) ezoensis ezoensis** Yabe et Nagao

Fig. 11. Lateral view of right internal mould (KSG 3370), x 1.5, loc. Miyanohara.

Fig. 12. Dorsal view of the same specimen, x 1.5.

Fig. 13. Internal view of right valve, gum cast of internal mould (KSG 3369), x 1, loc. ditto.

Fig. 14. Internal view of left valve, gum cast of internal mould (KSG 3368), x 1, loc. ditto.

Fig. 15. Lateral view of right valve, gum cast of external mould, x 1.2, loc. ditto, collected by Late Mr. Hirata.

Fig. 16. Lateral view of right valve, gum cast of external mould (KSG 3371), x 1.2, loc. Kashiwaguri.

**Thetis japonica** (Yabe et Nagao)

Fig. 17. Lateral view of left valve, plaster cast of external mould (KSG 3388), x 1, loc. Miyanohara.

**Crassostrea hawauchidensis** Tamura

Fig. 18. Lateral view of left internal mould (KSG 3387), x 1.2, loc. ditto.
790. Bivalve Fauna from Miyanoohara Formation

Table 1. List of bivalves from the Miyanoohara Formation and their known distribution in their parts of Japan

<table>
<thead>
<tr>
<th>Bivalves from the Miyanoohara F.</th>
<th>Kyushu</th>
<th>Shikoku</th>
<th>A</th>
<th>K</th>
<th>Mk</th>
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<tbody>
<tr>
<td>Nucula (Pectinula) kochiensis</td>
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<td>〇</td>
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<td>〇</td>
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<td>Portlandia (s. l.) nagaseana</td>
<td>△</td>
<td></td>
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<tr>
<td>Cucullaea (Idonearcia) ezoensis ezoensis</td>
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<tr>
<td>Arca (Eonavicula) tashiroi</td>
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<td>Glycymeris (Hanaia) goshonourensis</td>
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<tr>
<td>Crassostrea kawauchiensis</td>
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<td>Pterotrigonia (?Scabrotrigonia) pustulosa</td>
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<td>Gashoraia crenulata</td>
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<tr>
<td>?Legumen sp.</td>
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<tr>
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<tr>
<td>Pholadomya (Bucardiomya) hiratai</td>
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Geological age

<table>
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<th>LLC</th>
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<th>PMC</th>
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ezoensis amaxensis and Anthonya japonica, characteristic elements of the former (i.e. Uppermost Albain to lowest Cenomanian). On the other hand, P. (Ptil.) higoensis, Cymbophora okadakensis, Glycymeris (Hanaia) hokkaidoana and Anthonya mifunensis which are characteristic species of the latter (i.e. Middle Cenomanian), have not yet been found in the Miyanoohara fauna. In addition to these facts, the Miyanoohara fauna contains many species which are common with the faunas of the Lower and Middle Cenomanian strata in various areas of Japan as shown in Text-fig. 5.

Through this study the detailed change of the bivalve fauna from the late Albain to the Cenomanian has been made clear. This would be a foundation for further careful comparison between various areas within the Japanese province.
References


Matsukuma, A. (1979): Glycymerid bivalves from Japan and adjacent areas, part 1.

Explanation of Plate 3

Goshoria crenulata (Matsumoto)
Fig. 1. Dorsal view of internal mould (KSG 3406), x 1.2, loc. Hegushi of Shishijima, Kagoshima Prefecture.

Fig. 2. Lateral view of right valve, gum cast of external mould (KSG 3404), x 1, loc. Miyano-hara of Sakawa area, Kochi Prefecture.

Fig. 3. Internal view of right valve, gum cast of internal mould (KSG 3405), x 1, loc. ditto.

Pholadomya (Pholadomya) japonica Amano
Fig. 4. Lateral view of right valve, plaster cast of external mould, x 1, loc. Miyano-hara, collected by Mr. Hirata.

Fig. 5. Lateral view of left external mould (KSG 3409), x 1, loc. Hegushi.

Fig. 6. Lateral view of left external mould (KSG 3408), x 1, loc. Miyano-hara.

?Legumen sp.

Fig. 7. Internal view of left valve, gum cast of internal mould (KSG 3407), x 1, loc. ditto.

Pholadomya (Bucardiomya) hiratai sp. nov.

Fig. 8. Lateral view of imperfect right valve, plaster cast of external mould (KSG 3384), x 1, loc. ditto, collected by Prof. Katto.

Fig. 9. Lateral view of imperfect right valve, plaster cast of external mould (KSG 3385), x 1, loc. ditto, collected by Prof. Katto.

Fig. 10. Lateral view of imperfect right valve, plaster cast of external mould (HPC 8517), x 1, loc. Nagase, Monobe area, Kochi Prefecture, collected by Mr. Hirata.

Fig. 11. Lateral view of imperfect right valve, plaster cast of holotype (external mould) (KSG 3383), x 1, loc. Miyano-hara, collected by Mr. Hirata.

Fig. 12. Lateral view of the same specimen, x 1.

Fig. 13. Dorsal view of the same specimen, x 1.

Periplomys japonica sp. nov.

Fig. 14. Lateral view of left valve, plaster cast of external mould (KSG 3413), x 1.8, loc. Miyano-hara.

Fig. 15. Lateral view of right valve, plaster cast of external mould (KSG 3412), x 1.2, loc. ditto.

Fig. 16. Lateral view of right external mould (KSG 3411), x 1, loc. Hegushi.

Fig. 17. Lateral view of left external mould (KSG 3410), x 1, loc. ditto.


Tomoko MATSUDA

Akaishi 赤石, Enokuchi 江ノ口, Fukigoshi 吹越, Godaisan 五台山, Goshonoura 御所浦, Hagino 萩野, Hegushi 幽舟, Himenoura 妻ノ浦, Hiraiga 平井賀, Izumi 和泉, Kashiwaguri 柿栗, Kata- soba 片側, Katsurazawa 桂沢, Kochi 高知, Hokkaido 北海道, Kyusyu 九州, Mifune 御船, Mi- kasa 三笠, Misakubo 水窪, Miyano-hara 宮ノ原, Monobe 物部, Nagase 永瀬, Odochi 大栃, Sakawa 佐川, Shikoku 四国, Shiroi 白井, Shishijima 獅子島, Ezo エゾ, Yunokuchi 湯ノ口

四国高知県・佐川地域の宮ノ原層（Lower Cenomanian）から産する二枚貝化石については、Amano (1956) により数種が記載されているが、今回新種を含む多くの二枚貝化石を採集できたので、あらためて記載する。

本化石ファウナは、三角貝 Pterotrignia (?Scabrotrignia) pustulosa, P. (Ptilotrignia) mifunensis, P. (Ptil.) amakusensis, ならびにアンモナイト Shapeiceras sp. の産出から upper Lower Cenomanian と思われる。

また、本化石ファウナは、九州の御所浦層群、四国の永瀬層、赤石地域の水窪層、北海道の三笠層など日本における各地の Lower Cenomanian の地層の化石ファウナと類似しており、特に九州獅子島の御所浦層群、S-IV層の化石ファウナとはよく一致する。

松田智子