NOTE ON THE MARINE MOLLUSCAN FAUNA FROM THE
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別言語のタイトル

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NOTE ON THE MARINE MOLLUSCAN FAUNA FROM THE
PLEISTOCENE KOGASHIRA FORMATION IN
KAGOSHIMA CITY, SOUTH KYUSHU, JAPAN

By
Shozo Hayasaka* and Kimihiko Ōki*

(Received Sept. 30, 1971)

Introduction and Acknowledgments

The Kogashira Formation (Ōki and Hayasaka, 1970, p. 77), one of the marine formations intercalated in the thick and complicated pyroclastic sequence originated from the Aira and Ata calderas, has long been known to yield molluscan fossils (Otuka, 1931). Although the detailed stratigraphic relation in the sequence and the general aspect of the associated fauna had been left uncertain, one of the species occurring most abundantly in the Kogashira Formation has been described as a new species named Mabellarca hiratai** by Dr. Tadashige Habe (1953) based upon the specimens collected by Prof. Kunio Hirata of the Kagoshima University.

In 1970, the writers (op. cit.) described the stratigraphy of the northern Kagoshima City area (Table 1) including the distribution of the Kogashira Formation in its northwestern part. Through the writers’ study, the stratigraphic relations of the present formation with the other stratigraphic units has been clarified and the molluscan fossils occurring there were discriminated specifically and listed up.

Though the number of species discriminated in the present collection is rather scarce, they seem to be worthy of a paleontological note for the following reasons. The faunal characteristics of the Kogashira Formation may be helpful to understand the ecology of the interesting extinct species Anadara (Scapharca) hiratai (Habe) on the one hand, and on the other, to compare it with the other faunas from the different horizons in the sequence concerned.

Here the writers thank Professor Kotora Hatai of the Institute of Geology and Paleontology, Tohoku University, for reviewing the manuscript. Particular appreciation is due to Dr. Nobuhiro Hatae, Professor Emeritus of the Kagoshima University, for his valuable suggestions which stimulated the present work. Thanks are also due to Professor Rikizo Imaizumi of the Tohoku University for his information on the crab fossils.

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** The generic position of this species has been revised by Noda (1966) to Anadara (Scapharca).
Table 1. Generalized stratigraphic sequence in the northern part of Kagoshima City (Öki and Hayasaka, 1970)

<table>
<thead>
<tr>
<th>Age</th>
<th>Formation Name</th>
<th>Thickness (m)</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger Volcanic Ash and Pumice Bed (新期火山灰および凝灰層)</td>
<td>5</td>
<td>yellowish brown volcanic ash bed, brown volcanic ash bed, thinly laminated volcanic ash and pumice bed, pumice fall bed</td>
<td></td>
</tr>
<tr>
<td>Sakamoto Pumice Flow (桜本凝灰層)</td>
<td>100+</td>
<td>grayish white, pumiceous breccia tuff</td>
<td></td>
</tr>
<tr>
<td>Nagada Pumice Flow (長田凝灰層)</td>
<td>50+</td>
<td>reddish orange, pumiceous tuff pumice bed (diameter 1cm+)</td>
<td></td>
</tr>
<tr>
<td>Kand Pumice Flow (寒戸凝灰層)</td>
<td>10</td>
<td>massive black tuff</td>
<td></td>
</tr>
<tr>
<td>Tattoo Formation (塩尾層)</td>
<td>25</td>
<td>pumiceous tuff, tuffaceous sand (very coarse - very fine grained) and tuffaceous silt</td>
<td></td>
</tr>
<tr>
<td>Shirayama Formation (白山層)</td>
<td>50+</td>
<td>siltstone, unconsolidated coarse grained sand and gravel (angular and cobble to boulder sized) tuffaceous sand (coarse - very fine grained) and tuffaceous silt, rounded pebble gravel</td>
<td></td>
</tr>
<tr>
<td>Iso Pumice Flow (白洲凝灰層)</td>
<td>40+</td>
<td>gray-colored welded tuff</td>
<td></td>
</tr>
<tr>
<td>Isumado Formation (小山部層)</td>
<td>40+</td>
<td>tuffaceous sand (very coarse - very fine grained) and tuffaceous silt, unconsolidated coarse grained sand, rounded pebble gravel</td>
<td></td>
</tr>
<tr>
<td>Kogashira Formation (江部層)</td>
<td>10+</td>
<td>dark gray coloured welded tuff</td>
<td></td>
</tr>
<tr>
<td>Torayama Basalt (鳥鶴層)</td>
<td>16+</td>
<td>bluish gray siltstone, tuffaceous sand (medium - very fine grained) and tuffaceous silt, rounded pebble-granule gravel</td>
<td></td>
</tr>
<tr>
<td>Yoshino Pumice Flow (吉野凝灰層)</td>
<td>80+</td>
<td>dark gray coloured olivine basalt</td>
<td></td>
</tr>
<tr>
<td>Isumado Tuffaceous Sand Member (石渡砂凝灰層)</td>
<td>50+</td>
<td>grayish brown coloured welded tuff</td>
<td></td>
</tr>
<tr>
<td>Keku Formation (ヶ呂層)</td>
<td>110</td>
<td>pumiceous breccia tuff, pumiceous breccia tuff (fine - very fine grained) and tuffaceous silt</td>
<td></td>
</tr>
<tr>
<td>Muragaka Andesite (村垣安山岩)</td>
<td>10+</td>
<td>dark gray coloured two-pyroxene andesite</td>
<td></td>
</tr>
<tr>
<td>Shikashima Basalt (白石層)</td>
<td>10+</td>
<td>dark grey coloured olivine basalt</td>
<td></td>
</tr>
<tr>
<td>Hiramatsu Basalt (平沢層)</td>
<td>20+</td>
<td>black coloured compact basalt</td>
<td></td>
</tr>
<tr>
<td>Minoda Formation (三田層)</td>
<td>20+</td>
<td>tuffaceous sand (very coarse - very fine grained) and tuffaceous silt, angular pebble gravel, pumiceous breccia tuff</td>
<td></td>
</tr>
<tr>
<td>Late Pliocene-Early Pleistocene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Million Pumice (千曜凝灰層)</td>
<td>20+</td>
<td>tuffaceous sand (very coarse - very fine grained) and tuffaceous silt, angular pebble gravel, pumiceous breccia tuff</td>
<td></td>
</tr>
<tr>
<td>Million Rhodolite (千野凝灰層)</td>
<td>10+</td>
<td>gray laminated tuff, obsidian, pumiceous breccia tuff, two-pyroxene andesite</td>
<td></td>
</tr>
</tbody>
</table>

Geologic Setting

As stated above, the geology of the northern part of Kagoshima City including the Kogashira Formation was studied by the present writers (Öki and Hayasaka, 1970).

The most remarkable feature of the Kogashira Formation is the extremely limited distribution (Text-fig. 1) in comparison with those of the other 19 stratigraphic units discriminated through the writers' study cited above (Table 1). As shown in Text-fig. 1, the Kogashira Formation crops out in the four limited areas in the northwestern border of the Kagoshima City area. Outside of this area, the Kogashira Formation has been unknown even from the subsurface geologic data (Hayasaka and Öki, 1971). Owing to this unfavourable situation, a few problems on the Kogashira Formation, such as paleogeography, sedimentary environment and so on, have still remained unsolved.
Molluscan Fauna from the Kogashira Formation

The fossil locality from where the specimens treated in the present article were collected, the type locality of the Kogashira Formation, is an about 16 meters high river side cliff, cut in its middle part for the national highway No. 3 (Text-fig. 2) and situated at about 1 km west of the Kogashira spa.

The vertical sequence of rock facies observed at the type locality is as shown in Text-fig. 2. The molluscan fossils are richly but rather sporadically contained in the massive siltstone bed. Most of the specimens preserve the original shell material and even their detailed sculptures. Many pelecypod specimens preserve their valves conjoined. The massive siltstone entombing these molluscan fossils may imply a calm shallow water condition during the deposition of the pyroclastic sediments.

Remarks on the molluscan fossils

The molluscan fossils collected from the present locality and discriminated by the senior writer are shown in the following list (Table 2).
Table 2. List of molluscan fossils from the Kogashira formation.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbatia (Savigny arca) obtusoides (Nyst)</td>
<td>1</td>
</tr>
<tr>
<td>Barbatia (Savigny arca) virescens (Reeve)</td>
<td>1</td>
</tr>
<tr>
<td>Anadara (Scapharca) broughtonii (Schrenck)</td>
<td>1</td>
</tr>
<tr>
<td>Anadara (Scapharca) hiratai (Habe)</td>
<td>50+</td>
</tr>
<tr>
<td>Anadara (Tegillarca) sp.</td>
<td>1</td>
</tr>
<tr>
<td>Atrina sp.</td>
<td>1</td>
</tr>
<tr>
<td>Chlamys (Mimachlamys) nobilis (Reeve)</td>
<td>1</td>
</tr>
<tr>
<td>Pecten albicans (Schröter)</td>
<td>3</td>
</tr>
<tr>
<td>Ostrea (Ostrea) denselamellosa Lischke</td>
<td>5</td>
</tr>
<tr>
<td>Lucina stearnsiana Oyama</td>
<td>8</td>
</tr>
<tr>
<td>Fulvia bullata (Lin né)</td>
<td>3</td>
</tr>
<tr>
<td>Fulvia mutica (Reeve)</td>
<td>1</td>
</tr>
<tr>
<td>Cyclina orientalis (Sowerby)</td>
<td>3</td>
</tr>
<tr>
<td>Paphia euglypta (Philippi)</td>
<td>1</td>
</tr>
<tr>
<td>Lutraria sp.</td>
<td>2</td>
</tr>
<tr>
<td>Arcopagia (Merisca) subtruncata (Hanley)</td>
<td>1</td>
</tr>
<tr>
<td>Macoma (Psammacoma) awajiensis Sowerby</td>
<td>1</td>
</tr>
<tr>
<td>Macoma (Pseudometts) praerupta (Salisbury)</td>
<td>1</td>
</tr>
<tr>
<td>Moerella sp.</td>
<td>1</td>
</tr>
<tr>
<td>Barnea (Umitakea) japonica (Yokoyama)</td>
<td>1</td>
</tr>
<tr>
<td>Dentalium (Paradentalium) octangulatum hexagonum Gould</td>
<td>1</td>
</tr>
<tr>
<td>Lunella granulata (Gmelin)</td>
<td>2</td>
</tr>
<tr>
<td>Turritella (Kurosoia) fascialis Menke</td>
<td>37</td>
</tr>
<tr>
<td>Batillaria zonalis (Brugi ère)</td>
<td>2</td>
</tr>
<tr>
<td>Thoricium kobelti (Dunker)</td>
<td>1</td>
</tr>
<tr>
<td>Proclava pfefferi (Dunker)</td>
<td>1</td>
</tr>
<tr>
<td>Natica vitellus spadicea (Gmelin)</td>
<td>7</td>
</tr>
<tr>
<td>Rapana thomasiiana Crosse</td>
<td>1</td>
</tr>
<tr>
<td>Purpura (Mancilla) clavigera Küster</td>
<td>3</td>
</tr>
<tr>
<td>Coralliophila hatai Hayasaka</td>
<td>2</td>
</tr>
<tr>
<td>Siphonalia cassidariaformis (Reeve)</td>
<td>6</td>
</tr>
<tr>
<td>Hemifusus tuba (Gmelin)</td>
<td>1</td>
</tr>
<tr>
<td>Tritia (Reticunassa) acutidentata (Smith)</td>
<td>1</td>
</tr>
<tr>
<td>Nassarius (Zeuxis) kiensis Kira</td>
<td>3</td>
</tr>
<tr>
<td>Nassarius (Niotha) livecens (Philippi)</td>
<td>9</td>
</tr>
<tr>
<td>Mitrophiex collinsoni (A. Adams)</td>
<td>1</td>
</tr>
<tr>
<td>Adamnestia sp.</td>
<td>1</td>
</tr>
<tr>
<td>Ringicula doliaris Gould</td>
<td>1</td>
</tr>
</tbody>
</table>

Among the species listed above, Anadara (Scapharca) hiratai (Habe) and Turritella (Kurosoia) fascialis Menke are most abundant in number of specimens. The subordinate species are Lucina stearnsiana Oyama, Natica vitellus spadicea (Gmelin), Siphonalia cassidariaformis (Reeve) and Nassarius (Niotha) livecens (Philippi); and the other 21 species are each represented by only a single specimen. Four species could not be determined specifically, because of their unfavorable state of preservation, caused by the original ill preservation of them and by the breaking at the time of collection.
Besides these molluscs, echinoid and crab fossils were also collected and the latter has been recognized to be new to science and tentatively named *Macrophthalmus kogashiraensis* n. sp. by Prof. Rikizo Imaizumi of the Tohoku University. Further, it has also been known that the formation contains abundant fossil foraminifers, of which paleontological note will be given at another opportunity.

**Barbatia (Savignyarca) obtusoides (Nyst)**

A single internal mold of the left valve is in the present collection. Dimensions (in mm) of the specimen are 42 in length and 30 in height. The present species ranges from the Pliocene to the Recent, and is now living in the euneritic fascia (Oyama, 1952) (between the lowest tide mark and the depth of about 20–30 m) chiefly of embayments on the Pacific and the Japan Sea sides of Honshu, Japan, and southwards to the equatorial region.

**Barbatia (Savignyarca) virescens (Reeve) [Pl. 1, fig. 1]**

A single, rather small right valve is in the collection. The present species resembles the preceding one in general outline, but differs in having more convex and elongate shell with much coarser arrangement of radials on the posterior dorsal surface. The present species lives in the euneritic fascia of the open sea condition on the Pacific and the Japan Sea sides of Honshu, Japan, and southwards to the Philippines.

**Anadara (Scapharca) broughtonii (Schrenck)**

An imperfect right valve was identified as the named species from its characteristic features such as the number of radial ribs (41) and rather narrow ligamental area provided with two ligamental grooves. The present species ranges from the Pliocene to the Recent, and lives in the euneritic and mesoneritic (between 20–30 and 50–60 m) in the Japanese waters (Southern Hokkaido, Honshu, Shikoku and Kyushu), Korea and North China.

**Anadara (Scapharca) hiratai HABE [Pl. 1, figs. 2a-d]**

Numerous, well-preserved specimens mostly conjoined are in the collection. The present species was originally described by Habe (1953) based upon the specimens collected from the present locality. The generic position of the present species originally referred to the genus *Mabellarca* has been revised by Noda (1966) to *Anadara (Scapharca)*. The morphological features of the present species are so peculiar that we can not point out any species allied to the present one among the species hitherto recorded from Japan. There have been no records of the present species, either fossil or living, other than the one from the present formation. This peculiar species is most abundant in occurrence and characterizes the present fauna. The common and
sporadic occurrence of the conjoined valves of the present species in the massive mudstone of the formation indicates the autochthonous origin of them.

*Anadara (Tegillarca)* sp.

Only a single, imperfect external mold of the right valve is referable to *Anadara (Tegillarca)* based on its narrowly elevated, nodal structure of the radial ribs which are 19 in number. Owing to its unfavorable state of preservation, specific identification is reserved.

*Atrina* sp.

Only a single, imperfect specimen is in the collection.

*Chlamys (Mimachlamys) nobilis* (Reeve)

An intact, average sized specimen retaining the minute sculpture on its surface was examined. The present species ranges from the Late Pliocene to the Recent and lives in the euneritic and mesoneritic fasciae of the Pacific (23°–35°N) and the Japan Sea (37°N).

*Pecten albicans* (Schröter)

This species is represented by an intact, juvenile specimen, an imperfect left valve and an internal mold of the left valve. The present species ranges from the Early Pliocene to the Recent, and is now living in areas with sandy bottom in the euneritic fascia in the Pacific (30°–42°N) and the Japan Sea (42°N).

*Ostrea (Ostrea) denselamellosa* Lischke

Fragments of a few large right valves and two small left valves are in the collection. The present species ranges from the Pliocene to the Recent, and lives on sandy, gravelly or rocky bottoms between one to ten meters below the low tide mark (euneritic fascia) in the waters of the Pacific coast of Japan (southern Hokkaido to Kyushu), Ryukyu Islands, Formosa, Korea and China.

*Lucina stearnsiana* Oyama [Pl. 1, fig. 3]

Seven, rather small intact specimens and an intact, internal mold specimen are in the collection. This species ranges from the Pleistocene to the Recent and is known to live in Honshu, Japan and southwards to the Ryukyu Islands. The present species inhabits the muddy bottom of the intertidal (between the highest tide and the lowest tide levels) and euneritic fasciae.

*Fulvia bullata* (Linne)

Two conjoined, but water-worn specimens and an external mold specimen were examined. The present species is now living in the euneritic fascia on the Pacific coast.
of central Honshu, Japan and southwards to the equatorial region.

_Fulvia mutica_ (REEVE)

An imperfect external mold of the right valve is in the collection. The present species ranges from the Pleistocene to the Recent, and is known to live in the eunetric fascia of northern (excluding Hokkaido), central and western Japan and the Philippine Islands.

_Cyclina (Cyclina) orientalis_ (Sowerby) [Pl. 1, fig. 4]

A well-preserved right valve, an internal mold of the left valve and an external mold of the left valve are in the collection. This species ranges from the Miocene to Recent and its geographic distribution is from Mutsu Bay, Aomori Prefecture, southwards along the Pacific coast to Kagoshima and Nagasaki Prefectures in Kyushu, and along the Japan Sea northwards to Mikata, Fukui Prefecture and also on the west coast of Korea (KAMADA, 1952). This species lives in the muddy bottoms of the intertidal and eunetric fasciae.

_Paphia euglypta_ (PHILIPPI)

Only a single internal mold specimen is in the present collection. The characteristic features of the surface ornamentation and general outline are identical with those of the named species. The present species lives in the water below the lower tide line (eunetric fascia) both in the Pacific (31°–39°N) and the Japan Sea (40°N).

_Lutraria_ sp.

An imperfect right valve and an imperfect internal mold of the left valve are referable to _Lutraria_.

_Arcopagia (Merisca) subtruncata_ (HANLEY)

An internal mold specimen of the right valve is in the collection. The present species ranges from the Pleistocene to the Recent and is known to live on the Pacific side of northern (excluding Hokkaido), central and western Japan, Formosa and the Philippines. This species inhabits a fine-grained sandy bottom and bathymetrically ranges from 10 to 300 meters (eunetric to bathyal fascia).

_Macoma (Psammacoma) awajiensis_ Sowerby [Pl. 1, fig. 5]

A single left valve is at hand. This species lives below the lowest tide line (eunetric fascia) both in the Pacific (33°–35°N) and the Japan Sea (37°N).

_Macoma (Pseudometis) praerupta_ (SALISBURY) [Pl. 1, fig. 6]

A rather well-preserved right valve is in the collection. The present species ranges
from the Pleistocene to the Recent, and lives on the muddy bottom of the shallow inland sea or embayment ranging from 10 to 50 meters in depth. The geographic distribution of this species is from Kii Peninsula in western Japan to the Philippine Islands.

**Moerella** sp.

Only a single, imperfect left valve is in the collection.

**Barnea (Umitakea) japonica (Yokoyama) [Pl. 1, fig. 7]**

An intact specimen with a little fractured periphery is in the collection. The present species, ranging from the Pliocene to the Recent, is known to live along the Kii Peninsula on the Pacific and Wakasa Bay on the Japan Sea side and southwards to Kyushu, Japan.

**Dentalium (Paradentalium) octangulatum hexagonum Gould**

An imperfect specimen is in the collection. The present species ranges from the Pliocene to the Recent and is known to live below low tide line in Honshu, Shikoku and Kyushu, Japan to China, the Philippine Islands and Singapore.

**Lunella granulata (Gmelin) [Pl. 1, figs. 8a, b]**

Two specimens of which apertures are slightly fractured were examined. The present species resembles the common Japanese species *L. coronata coreensis* (Récluz) in general outline, but differs from the latter in having the spirals with stronger tubercles and deep umbilicus. The geographic distribution of the present species is Amami-Oshima, Kagoshima Prefecture and southwards. The present species lives on gravelly and rocky bottoms in the intertidal fascia.

**Turritella (Kurosioia) fascialis Menke [Pl. 1, fig. 9]**

Thirty seven, well-preserved specimens of various sizes were examined. The specimens are rather small in size, and the dimensions (in mm) of the largest specimen are about 13 in height and about 3 in maximum diameter. The present species is now living in areas with sandy to sandy mud bottom bathymetrically ranging from 50 to 150 meters (subneritic to bathyneritic fasciae) on the Pacific and the Japan Sea sides of Honshu and in Shikoku and Kyushu. According to Kotaka (1959), the optimum temperature of the present species is from 10° to 20°C. and the bathymetric range in which the present species occurs commonly is between 70 and 80 meters.

**Batillaria zonalis Bruguière [Pl. 1, figs. 10a, b]**

A rather well-preserved and an imperfect specimens are in the collection. The present species ranges from the Pliocene to the Recent, and its geographic distribution is from Australia (type locality), the Philippines, China, Formosa to northern Honshu,
Molluscan Fauna from the Kogashira Formation

Japan. This is one of the common, widely ranging species in Japan, and usually inhabits the mudflats within the intertidal zone or estuaries of rivers.

Thericium kobelti (Dunker) [Pl. 1, figs. 11a, b]

A rather well-preserved specimen is in the collection. The present species lives below the lowest tide line in the Pacific (26°–35°N) and the Japan Sea (41°N).

Proclava pfefferi (Dunker) [Pl. 1, figs. 12a, b]

A single, water-worn specimen was examined. The present species lives on sandy mud bottom in the euneritic fascia of embayments, and its geographic distribution is from central Honshu, Japan and southwards to the equatorial region and in Japan Sea (37°N).

Natica vitellus spadicea (Gmelin) [Pl. 1, figs. 13a, b]

Seven, well-preserved specimens of rather small sizes. The present subspecies is discriminated from the species by its larger ratio of D/H due to increasingly developed body whorl (Kira, 1959). The present form is known to live in sandy mud in the euneritic fascia.

Rapana thomasiana Crosse

An imperfect specimen is in the collection. The present species lives in the euneritic fascia of the Pacific (southern Hokkaido to Kyushu) and ranges from the Pleistocene to the Recent.

Purpura (Mancinella) clavigera Köster [Pl. 1, figs. 14a, b]

Three specimens are at hand. The present species lives in the intertidal fascia and immediately below the lowest tide line in the Pacific (25°–41°N) and the Japan Sea (41°N).

Coralliophila hataii Hayasaka [Pl. 1, figs. 15a, b, 16a,b.]

Two, large and small specimens were examined. The present species was originally described by the senior writer (1961) from the Pleistocene Toyohashi Group in Atsumi Peninsula, Aichi Prefecture, Japan. There are no subsequent records of the present species, and therefore, this is the second one. It is interesting that the second occurrence of the present species is known also from the Pleistocene formation on the Pacific side of southwest Japan where it had been under the influence of the warm water Kuroshio current at the time of its deposition.

Siphonalia cassidariaeformis (Reeve) [Pl. 1, figs. 17a, b]

Six, well-preserved specimens of various sizes are in the collection. This species is now living in central and western Japan (Pacific, 31°–35°N; Japan Sea, 41°N), and ranges from the Pleistocene to the Recent.
Hemifusus tuba (Gmelin)

An imperfect, rather small specimen is in the collection. This species lives in the euneritic fascia in the central Honshu, Japan and southwards to the Philippines.

Tritia (Reticunassa) acutidentata (Smith)

A single, well-preserved specimen is in the collection. The present species lives below the lowest tide line (euneritic fascia) of the Pacific (28°-43°N) and the Japan Sea (43°N).

Nassarius (Zeuxis) kiiensis Kira [Pl. 1, fig. 18]

Two, well-preserved and an imperfect specimens are in the collection. This species is now living in the euneritic fascia on the Pacific side of the central Honshu, Japan.

Nassarius (Niotha) livescens (Philippi) [Pl. 1, figs. 19a, b]

The present species, represented by nine, well-preserved specimens in the collection, is now living from the lowest tide line to the depth of about 10 meters in the Pacific (0°-41°N) and in the Japan Sea (41°N).

Mitropifex collinsoni (A. Adams) [Pl. 1, figs. 20a, b]

A single specimen lacking the basal extremity of the shell was identified as the named species. The present species inhabits muddy sand bottom ranging from 5 to 30 meters in depth in the central Honshu, Shikoku and Kyushu, Japan.

Adamnestia sp.

Four juvenile specimens are referable to Adamnestia.

Ringicula (Ringiculina) doliaris Gould

Only a single, but well-preserved specimen is in the collection. The present species has been regarded as one of the elements of the "Asiatic Continental Fauna" (Miyadi et al., 1954). This lives on the muddy bottom of embayments on the coasts of northern, central and southwestern Japan and of the Chinese Continent.

Concluding Remarks

From the foregoing remarks on each species included in the present collection, the general biotic aspect of the fauna can be summarized as follows.

All the species determined specifically are known to live in the south Kyushu region except Lunella granulata (Gmelin), which is known as living in the south of the Amami Islands, about 300 km south of the present area. No cold current elements are included in the present fauna. Based on the geographic distribution of each species, the following four species-groups can be recognized in the present fauna.
1) The species living in central Japan (both Pacific and Japan Sea sides) and southwards, being under the influence of the warm current. This group includes most of the species identified.

2) The species of which living distribution seems to be restricted to around the Japanese Islands, such as Pecten albicans (Schröter), Rapana thomaisiana Crosse, Siphonalia cassidariaformis (Reeve), Nassarius (Zeuxis) kiiensis Kira and Mitropifex collinsoni (A. Adams). Among these, the first named two species are now living in Hokkaido, Honshu, Shikoku and Kyushu irrespective of the current system and the latter three live in central and western Japan.

3) The species having their northern limits of distribution in the cold current area, such as, Anadara (Scapharca) broughtonii (Schrenck), Ostrea (Ostrea) denselamellosa (Lischke), Batillaria zonalis (Bruguière), Purpura (Mancinella) clavigera (Küster), Tritia (Reticulassa) acutidentata (Smith) and Nassarius (Niotha) livescens (Philippi).

4) The elements of the “Asiatic Continental Fauna (Miyadi 197, 1954) living in the embayments on the coasts of Japan and the Chinese Continent, such as, Barnea (Umitahe) japonica (Yokoyama) and Ringicula (Ringiculina) doliaris Gould.

It is noticeable that the present fauna comprises two Pleistocene species, Anadara (Scapharca) hiratai (Habe) and Coralliophila hataii Hayasaka, which are not known to be living at present. The species in the present collection other than the foregoing two are all living ones. Of these species, the geologic ranges are summarized as follows.

Number of the species

- ranging from the Miocene to the Recent ...............2
- ranging from the Pliocene to the Recent .............6
- ranging from the Pleistocene to the Recent ..........12
- known only from the Pleistocene .....................2

The remaining species have not been known as fossil.

The present fauna consists entirely of the normal marine water species including the four embayment species such as Barbatia (Savignyarca) obtusoides (Nyst), Macoma (Pseudometis) praerupta (Salisbury), Proclava pfefferi (Dunker) and Ringicula (Ringiculina) doliaris Gould. Most of the species in the collection live in the euneritic fascia (between the lowest tide and 20–30 m), and some of them extend their living ranges into the intertidal fascia [Lucina stearnsiana Oyama, Paphia euglypta (Philippi) and Purpura (Mancinella) clavigera Küster]. Further, there are two intertidal species in the present collection, namely, Lunella granulata (Gmelin) and Batillaria zonalis (Bruguière). On the other hand, the species inhabiting the deeper bottom are Anadara (Scapharca) broughtonii (Schrenck) (20–60 m: euneritic and mesoneritic fasciae), Chlamys (Mimachlamys) nobilis (Reeve) (euneritic and mesoneritic fasciae), Arcopagia (Merisa) subtruncata (Hanley) 10–300 m: euneritic to bathyal fascia) and Turritella (Kurosoia) fascialis Menke (50–150 m: subneritic and bathyneritic fasciae).
As already stated, the most abundant species in the collection are *Anadara (Scapharca) hiratai* (HABE) and *Turritella (Kurosovia) fascialis* MENKE, of which the former has not been known as living and the latter is the species having the deepest habitat among the present fauna. The depth ranges of the four subordinate species, *Lucina stearnsiana* OYAMA, *Natica vitellus spadicea* (Gmelin), *Stiphonalia cassidariaeformis* (REEVE) and *Nassarius (Niotha) livescens* (PHILIPPI) are in the intertidal and the euneritic fasciae, and many other species are also known to live in the euneritic fascia.

Judging from the good state of preservation of the specimens in the present collection, it may be reasonable to say that it is difficult to infer that they had been transported for a great distance before deposition. As a whole, the environmental condition under which the present fauna lived is inferred to be of the deeper part of the euneritic or the shallower part of the mesoneritic fascia along the open sea coast neighbouring an embayment. The sea water temperature assumed from the living distribution of each species of the present fauna is nearly the same as that of this area at present.

The mode of occurrence of *Anadara (Scapharca) hiratai* (HABE) which is represented mostly by well-preserved conjoined shells in the present collection, indicates their autochthonous origin, and therefore, it is reasonable to consider that the environmental condition stated above is nothing but the ecological condition for this extinct species.

The fact that the present fauna has only six species common to the rich molluscan fauna of the Shiroyama Formation in this area (Table 1) suggests considerable difference in faunal characters between them. However, the detailed comparison between the two is reserved until the study on the fauna of the Shiroyama Formation will be accomplished.

References


Molluscan Fauna from the Kogashira Formation


Explanation of Plate 1
(Natural size unless otherwise stated)

Fig. 1. Barbatia (Savignyarca) virescens (REEVE)
Fig. 2a-d. Anadara (Scapharca) hiratai (HABE)
Fig. 3. Lucina stearnsiana OYAMA. Two specimens showing external and dorsal surfaces respectively.
Fig. 4. Cyclina (Cyclina) orientalis (SOWERBY)
Fig. 5. Macoma (Psammacoma) awajiensis SOWERBY
Fig. 6. Macoma (Pseudometis) praerupta (SALISBURY)
Fig. 7. Barnea (Umitakea) japonica (YOKOYAMA). Dorsal view of conjoined valves

Figs. 8a, b. Lunella granulate (Gmelin)
Fig. 9. Turritella (Kurosoioia) fascialis MENKE. ×2.5
Figs. 10a, b. Batillaria zonalis BRUGUIÈRE
Figs. 11a, b. Thericium kobelti (Dunker)
Figs. 12a, b. Proclava pfefferi (Dunker)
Figs. 13a, b. Natica vitellus spadacea (Gmelin)
Figs. 14a, b. purpura (Mancinella) clavigera KüSTER
Figs. 15a, b. 16a, b. Coralliophila hataii Hayasaka
Figs. 17a, b. Siphonalia cassidariaeformis (REEVE)
Fig. 18. Nassarius (Zeuxis) kiensis KIRA
Figs. 19a, b. Nassarius (Niotha) livescens (PHILIPPI)
Figs. 20a, b. Mitropifex collinsoni (A. ADAMS)