

## **Bivalve Fauna from the Pre-Sotoizumi Group Developed to the North of Mt. Haidate, Oita Prefecture, Kyushu**

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(Received September 2, 1996)

### **Abstract**

In this paper, many Lower Cretaceous (Upper Barremian-Lower Albian) marine conditional bivalves, 38 species including 3 new species of 33 genera, are described from the Osaka Formation at Mie-machi and the Tamarimizu Formation at Notsu-machi, Oita Prefecture in Kyushu. Most specimens belong to already named species from the Kesado, Yatsushiro and Takahata Formations of the Pre-Sotoizumi Group, in Central Kyushu, the Miyako Group (Upper Aptian-Lower Albian) of Northeast Japan, the Nankai Group (Barremio-Aptian) and Shinjougawa Group in Shikoku, but their diagnostic characteristics became clearer owing to the excellent state of preservation.

The Osaka and Tamarimizu Formations are best comparable to the Pre-Sotoizumi Group, which is represented by the Kesado, Yatsushiro and Takahata Formations, from the faunal aspects and lithological characteristics, as well as from the geological situation.

**Key words :** Osaka and Tamarimizu Formations, Pre-Sotoizumi Group, Bivalves, Kyushu

### **Introduction**

The Lower Cretaceous bivalve faunas from the Chichibu Belt of the Outer Zone of Southwest Japan, are divided into the Tethyan faunas and the Northern-Tethyan faunas (TASHIRO, 1994a). The Northern-Tethyan faunas occur from the Monobegawa Group of the Monobe area, Kochi Prefecture (TASHIRO, 1993). On the other hand, the Tethyan faunas are known from the Nankai Group of the Hagino and Nakaizu areas and the Torinosu Group of the Sakawa area in Shikoku (TASHIRO, 1993). Moreover, the Tethyan fauna have been reported from the Pre-Sotoizumi Group in Kyushu, i. e. Kesado, Yatsushiro (TASHIRO, 1990), Takahata (TASHIRO and TANAKA, 1992) Formations, and the Shinjougawa Group (TASHIRO, 1994b) of the Shimanto Belt in Shikoku.

In the material of our collection from these formations, the bivalves, consisting of 33 genera and 38 species including 3 new species, are described in this paper, with their biostratigraphical implications. These fauna undoubtedly belong to the fauna of the Pre-Sotoizumi Group.

Incidentally, the bivalve fauna of the Sukubo Formation, which is represented by the late Albian formation of the Pre-Sotoizumi Group, Oita Prefecture, have already been described by TASHIRO et al. (1985).

In this study, H. TANAKA, T. MIYAMOTO and T. TAKAHASHI have engaged mainly to the

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geological survey and collection of fossils of the Osaka and Tamarimizu Formations. In the other hand, the paleontological description of fossils and collection of fossils have been achieved by M. TASHIRO and H. TANAKA.

Before going into our study, we wish to express our grateful thanks to Emer. Prof. TATSURO MATSUMOTO of Kyushu University, for his kind suggestions about the ammonites.

The specimen (KSGT) which are treated in this paper, are kept in the Faculty of Science, Kochi University.

### Geological Setting

The Osaka, Tamarimizu and Haidateyama areas are located in the eastern Kyushu (Text-fig. 1). The investigated area is underlain mainly by rocks ranging in age from Middle Carboniferous to Upper Cretaceous, with a partial covering of the Quaternary volcanic ejecta.

The Pre-Sotoizumi Group (TASHIRO, 1993) is underlain by the Osaka, Tamarimizu and Sukubo Formations. The first two locates at the north of Mt. Haidate, is overlain by the Upper Cretaceous Tano Group. The last is restricted in the distribution on the eastern slope of Mt. Haidate and overlies the Haidateyama Group.

On the basis of our recent research, the Lower Cretaceous stratigraphy and geological age of the Pre-Sotoizumi Group is summarized as follows.

#### Osaka Formation

The Osaka Formation is characterized by sandstone, often calcareous and sometimes conglomeratic, accompanied with alternating beds of sandstone and shale and sandy shale. Lenses and nodules of limestone are included. Shallow marine bivalves and other fossils are found at horizons.

**Distribution** : This formation and its correlatives are discontinuously distributed over Osaka and across Ishiba-dam to Tamarimizu in three areas separated by the exposure of basement rocks. As a whole, it forms an anticlinal structure with an axis trending ENE-WSW, modified by parallel faults. The base of the formation is in fault contact with the pre-Cretaceous rocks, while the top is unconformably overlain by the Upper Cretaceous Tano Group.

**Lithology and fossils** (Text-Figs 2 and 3) : The Osaka Formation is subdivided lithostratigraphically into two members, the lower and the upper. The lower member of this formation is composed of conglomeratic or pebbly sandstone, medium- to coarse-grained calcareous sandstone, alternating beds of sandstone and shale, and dark gray sandy shale in ascending orders. Each of the sandstone layers in alternating beds ranges in thickness from a few centimeters to 40cm, showing a graded bedding and parallel lamination. Small-scale slump structures are observable in a certain horizon. The upper member is mainly composed of fine-grained sandstone accompanied with conglomeratic sandstone and dark gray siltstone. Lenses of limestone are also included. The conglomeratic sandstone often contains subrounded granules and pebbles of chert, sandstone, shale and granitic rocks, yielding hippuritids (bivalve). The Osaka Formation contains abundant shallow marine fossils such as pelecypods (including hippuritids and rudistids), gastropods, corals, bryozoans and echinoids. Ammonites are also obtained from the Ishiba-dam (I104). Table 1 shows the list of identified bivalve species.

**Geological age** : The upper member of the Osaka Formation is characterized by the predominance of sandstone (often calcareous and sometimes conglomeratic), showing a shallow marine

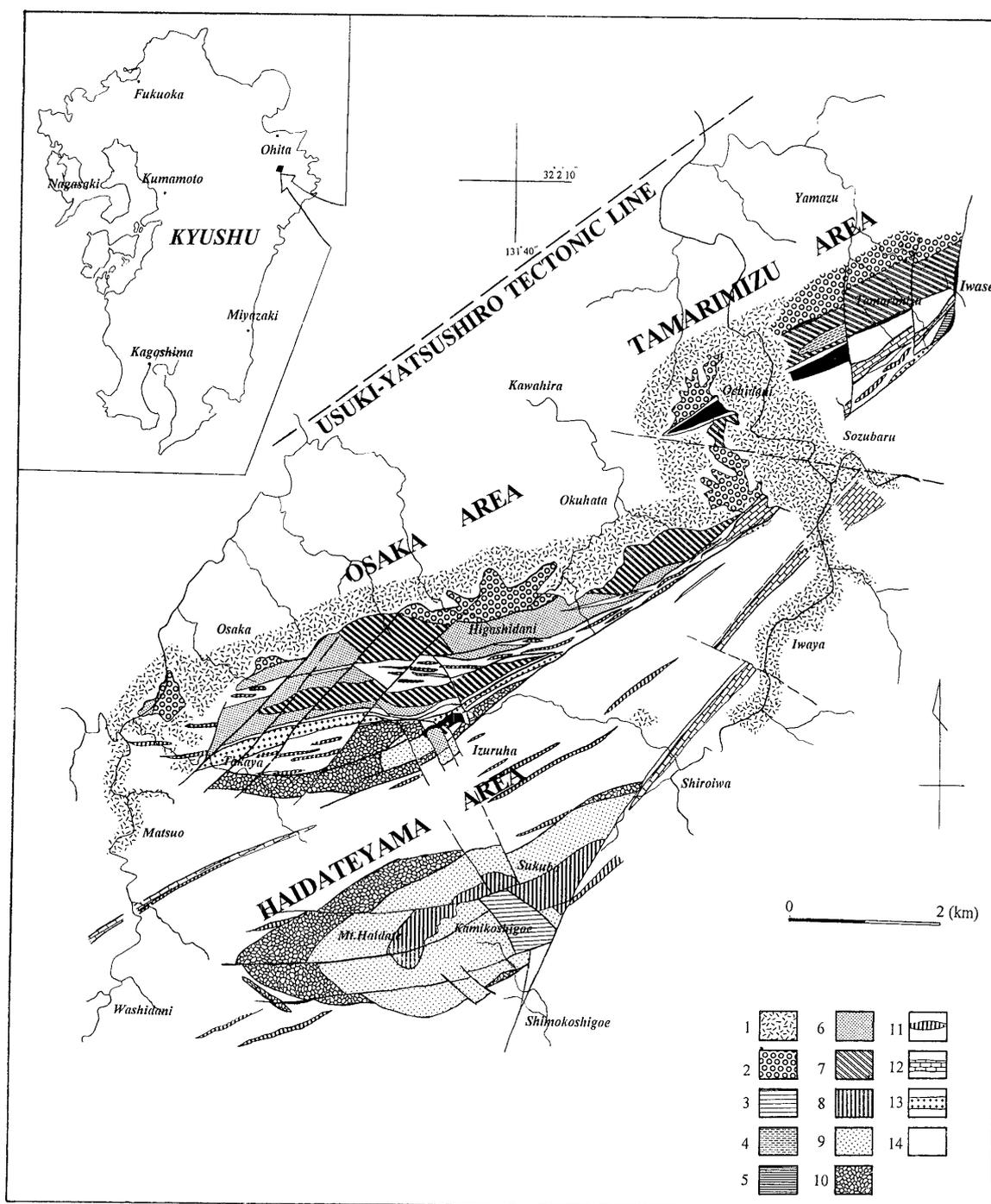


Fig. 1 Geological map of the Osaka, Tamarimizu and Haidateyama Areas.

1: Aso pyroclastic flow deposits, 2: Tano Group (Upper Cretaceous), 3: Sukubo Formation (Upper Albian), 4: A member of the Tamarimizu Formation (Barremian), 5: B member of the Tamarimizu Formation (Upper Aptian-Albian?), 6: Upper member of the Osaka Formation (Aptian-Lower Albian?), 7: Lower member of the Osaka Formation (Barremian-Aptian), 8: Haidateyama Formation (Barremian), 9: Upper member of the Koshigoe Formation (Upper Hauterivian-Lower Barremian?), 10: Lower member of the Koshigoe Formation (Lower Hauterivian), 11: Chert, 12: Limestone, 13: Granitic rocks, 14: Basement complex (Chichibu Super group)

TABLE 1. LIST OF THE BIVALVE FOSSILS FROM THE OSAKA FORMATION

<i>Gervillaria</i> sp. cf. <i>G. alaeformis</i> (SOWERBY)	OS03, OS06, OS07
<i>Gervillaria miyakoensis</i> (NAGAO)	OS06, OS07
<i>Gervilla forbesiana</i> d'ORBIGNY	OS06, OS07
<i>Isognomon choshiensis</i> HAYAMI	OS03, OS06
<i>Entolium ikedai</i> TASHIRO	OS02
<i>Neithea</i> ( <i>Neithea</i> ) <i>kochiensis</i> HAYAMI	OS01, OS02
<i>Astarte</i> ( <i>Asarte</i> ) <i>yatsushiroensis</i> TASHIRO and TANAKA	OS01, OS02, OS03 OS06, OS07
<i>Anthonya igenokiensis</i> TASHIRO and KOZAI	OS06
<i>Eriphyla pulchella</i> HAYAMI	OS02
<i>Opis haginoensis</i> AMANO	OS06
<i>Ptychomya densicostata</i> NAGAO	OS02, OS03
<i>Ptychomya hasei</i> TANAKA and TASHIRO	OS03
<i>Protocardia</i> ( <i>Protocardia</i> ) <i>amanoi</i> TASHIRO and MATSUDA	I104
<i>Nemocardium yatsushiroensis</i> HAYAMI	OS05, OS06
<i>Globocardium sphaeroideum</i> (FORBES)	I104
<i>Spondylus decoratus</i> NAGAO	OS02
<i>Limatula nagaoui</i> HAYAMI	OS07
<i>Amphidonte subhariotoidea</i> (NAGAO)	OS03
<i>Rastellum</i> ( <i>Arctostrea</i> ) <i>carinatum</i> LAMARCK	OS03, OS04
<i>Nipponitrigonia plicata</i> KOBAYASHI and NAKANO	OS04, OS06
<i>Pterotrigonia bungoensis</i> TASHIRO and TANAKA	OS02, OS04, OS07, OS08, OS09
<i>Xenocardita amanoi</i> (HAYAMI)	OS06
<i>Linearia</i> sp.	OS04
<i>Resatrix bungoensis</i> TASHIRO and TANAKA	OS02
<i>Pseudopisidium inflata</i> TASHIRO and KOZAI	OS06
<i>Caestocorbula</i> sp.	OS06
<i>Panopea</i> ( <i>Myopsis</i> ) sp. aff. <i>P. (M.) plicata</i> (SOWERBY)	OS06
<i>Pachytraga japonica</i> OKUBO and MATSUSHIMA	OS02, OS07, Hg01
<i>Pholadomya</i> sp.	OS06
<i>Plectomya</i> sp.	OS02
<i>Platymyoidea nipponica</i> TASHIRO and MATSUDA	OS02

facies. It contains ammonites and bivalves. The identified ammonites are *Chelonicerias* sp. and *Dufrenoyia* aff. *justinae* (HILL) (preliminary identification by MATSUMOTO). *Chelonicerias* has been known from the Upper Aptian strata of the Tethys province including the stratotype area in Japan, it occurs from the Kimigahama and Nagasakihama Formations of the Choshi area (OBATA et al., 1975), the Hoji Formation of Katsuuragawa area (NAKAI, 1956), the lower part of the Hibihara Formation and the Hagino Formation of the Monobegawa area (TASHIRO et al., 1980; MATSUMOTO et al., 1982) and the Hinagu Formation of the Yatsushiro area (OBATA and MATSUMOTO, 1977). *Dufrenoyia* aff. *justinae* has been recorded from the Upper Aptian of Texas (ADKINS, 1928) and Taiwan (MATSUMOTO et al., 1965). The bivalve fauna from the upper member resembles the faunas of the Kesado Formation of the Yatsushiro area (TASHIRO, 1990), the Kimigahama Formation of the Choshi area (HAYAMI and OJI, 1980), the Nankai Group in Shikoku (Sanbosan Terraine), the Doganaro Formation in Shikoku (Shimanto Terraine) and the Miyako



Group of Northeast Japan, containing Aptian type genera and species such as *Anthonya igenokiensis*, *Neithea kochiensis*, *Nipponitrigonia plicata*, *Pterotrigonia* aff. *pocilliformis*, *Limatula nagaoui*, *Caestocorbula* sp. and *Plectomya* sp.. From the evidence of fossils mentioned above, the upper member is roughly correlative with the Upper Aptian.

Although there is no reliable fossil, the lower member may roughly be correlated to the Upper Barremian (?) -Lower Aptian, judging from the following line.

1). The upper member, which is characterized by the occurrence of Upper Aptian ammonites, covers the top of the lower member.

2). The present member is comparable with the lower member of the Kesado Formation (TAKAHASHI et al., 1996) from its lithofacies represented by rhythmically alternating beds of sandstone and shale.

The correlation based on hippuritids (*Pachytraga* etc.) in West Europe by PAGUIER (1905) and KUTASSY (1934) may also suggest the age of the member in question. In Japan, the occurrence of hippuritids is rather limited, though pachyodont pelecypods, e. g., *Praecaprotina yaegashii* (YEHARA), *Toucasia carinata orientalis* NAGAO and *Pachytraga japonica* OKUBO were reported by YEHARA (1920), YABE et al. (1926), and NAGAO (1933) from the Miyako area of Kitakami and the Sorachi area of Hokkaido, and also by OKUBO and MATSUSHIMA (1959) from the Akaishi area of Central Japan.

#### **Tamarimizu Foration**

The Tamarimizu Formation is characterized by the predominance of fine-grained arenite sandstone. Nodules and lenses of limestone are included. Abundant shallow marine bivalves, and several ammonites are found.

**Distribution** : In the Tamarimizu district, the formation is distributed in two areas separated by the interposition of basement complex extending in ENE-WSW trend. A Member (southern area) of the formation is distributed only at a very limited area near Iwase, being interspaced between two parallel faults of NE-SW trend. B Member (northern area) of the formation is exposed only in a narrow area near Tamarimizu.

**Lithology and fossils** (Text-figs 2 and 3) : The Tamarimizu Formation is lithostratigraphical subdivided into A and B Members. A Member is characterized by fine-grained sandstone accompanied with conglomeratic sandstone and dark gray siltstone. Patches of limestone are frequently included in the massive sandstone. The sandstone contains abundant well-preserved marine bivalves, together with ammonites. B Member is composed mainly of weathered, fine-grained, brownish arenite sandstone, with interbeds of thin-bedded, dark grayish sandy shale. The identified species are listed on Table 2.

**Geological age** : A Member of the Tamarimizu Formation contains abundant bivalve shells and ammonites, e. g., *Shastrioceras* sp. and *Hypophylloceras* cf. *onoensis* (STANTON) (preliminary identification by MATSUMOTO) are obtained from the member (Loc. Ta502). *Shastrioceras*, which indicates Barremian in age, has been recorded from the Lower Horsetown Group in California (ANDERSON, 1938). In Japan, it occurs from the Ishido Formation of the Sanchu area (MATSUKAWA, 1983), the Idaira Formation near Lake Hamana (HAYASHI et al., 1981), the Arida Formation of the Aridagawa area (OBATA and OGAWA, 1976) and the Monobe Formation of the Monobegawa area (TASHIRO et al., 1980). *Hypophylloceras* is a long-lived genus ranging from Hauterivian to Maastrichtian. *H. onoensis* has been reported from the Aptian of California. Therefore, A Member in question can be correlated approximately with the Upper Barremian to

TABLE 2. LIST OF THE BIVALVE FOSSILS FROM THE TAMARIMIZU FORMATION

<i>Cucullaea (Idonearca) acuticarinata</i> NAGAO	Ta501
<i>Glycymeris (Hanaia) desillineata</i> NAGAO	Ta501
<i>Pinna</i> sp. cf. <i>p. robinaldina</i> d'ORBIGNY	Ta501
<i>Isognomon choshiensis</i> HAYAMI	Ta502
<i>Entolium ikedai</i> TASHIRO	Ta502
<i>Neithea syriaca amanoi</i> HAYAMI	Ta501
<i>Chlamys</i> sp. cf. <i>C. robinaldina</i> (d'ORBIGNY)	Ta501
<i>Limatula nagaoui</i> HAYAMI	Ta501
<i>Pterotrignonia yokoyamai</i> (YEHARA)	Ta502
<i>Xenocardita amanoi</i> (HAYAMI)	Ta501
<i>Astarte (Yabea) akatsui</i> HAYAMI	Ta502

## Lower Aptian.

The bivalve fauna of B Member is closely similar to that of the Kesado Formation (TASHIRO, 1990), and is comparable with the faunas of the Hagino and Ikuna Formations of the Nankai Group (TASHIRO, 1993), containing Albian type genera and species such as *Parvamussium*, *Cucullaea acuticarinata*, *Pterotrignonia hokkaidoana*. From the faunal aspects and lithological characters, as well as from the geological situation, B Member is assigned to the Lower Albian.

Description of bivalve fossils  
by MASAYUKI TASHIRO and HITOSHI TANAKA

## Class Bivalvia

## Subclass Pteriomorpha

## Family Cucullaeidae

Genus *Cucullaea* LAMARCK, 1801Subgenus *Idonearca* CONRAD, 1862*Cucullaea (Idonearca) acuticarinata* NAGAO

## Plate 1, Figs. 8, 9; Plate 3, Fig. 7

*Synonymy* : - (See, TASHIRO, 1990)

*Material* : - KSGT 0001 - KSGT 0002, external moulds of right and left valves ; KSGT 0003 - KSGT 0006, internal moulds of right and left valves ; all specimens from Ochidani of Nozu, Oita Prefecture.

*Measurements* : - (in mm)

specimen	Length	Height
KSGT 0003 r. int. mould.	19.5	13.3
KSGT 0004 r. int. mould.	31.9	22.5
KSGT 0005 l. int. mould.	31.9	21.0
KSGT 0006 l. int. mould.	28.0	20.0

*Remarks* : - Present specimens are all internal and external moulds. The specific characters of those specimens are, however, well preserved in each mould. The locality of the specimens are the same with the type locality of *Cucullaea (Idonearca) fujiii* HAYAMI (1965).

Recently, *C. (I.) fujiii* was classified into the same species with *Cucullaea (Idonearca) acuticarinata* Nagao (1934) from the Miyako Group (Aptio-Albian) in Northeastern Japan, by TASHIRO

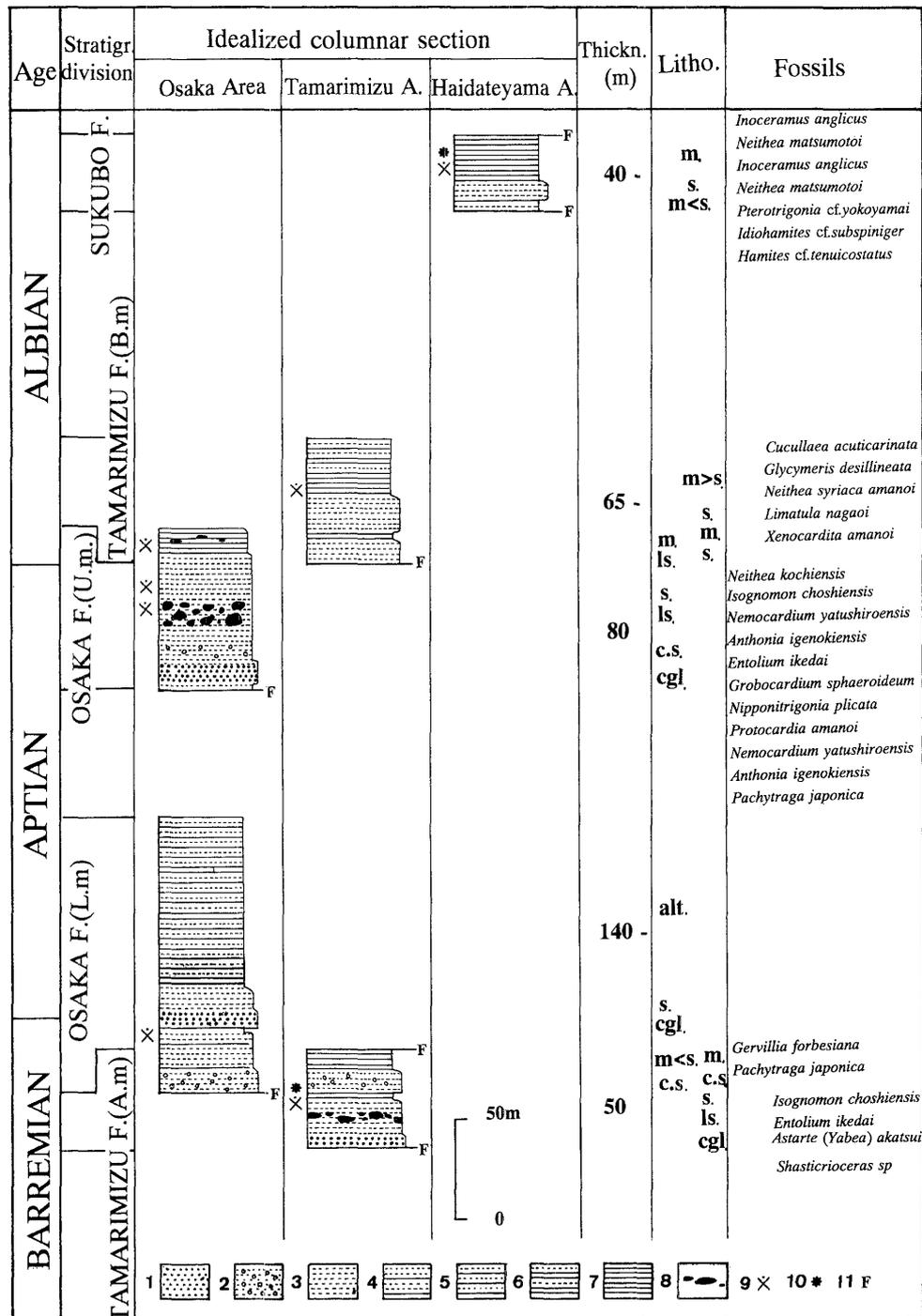


Fig. 3 Total lithological columnar sections of the correlatives of the Pre-Sotoizumi Group (Osaka, Tamarimizu and Sukubo Formations).

1: Conglomerate (cgl.), 2: Conglomeratic sandstone (c.s.), 3: Sandstone (s.), 4: Sandstone and shale in alternating (sandstone being predominant)(m>s.), 5: Sandstone and shale in alternation (both being approximately inequal amount)(alt.), 6: Sandstone and shale in alternation (shale being predominant)(m>s.), 7: Mudstone or sandy shale (m.), 8: Limestone (ls.), 9: Marine organisms, 10: Ammonites, 11: Fault (F).

(1990). This species, *C. (I.) acuticarinata*, is also known from the Ikuna Formation (Aptian; TASHIRO and KAWAJI, 1987) and Birafu Formation (Valanginian to Barremian; MORINO et al. 1989), both of the Nankai Group in Shikoku, and the Kesado Formation (Barremio?-Aptian; TASHIRO, 1990) of the Pre-Sotoizumi Group in Central Kyushu.

*Occurrence* : - Loc. Ta501

Family Glycymerididae

Genus *Glycymeris* DA COSAT, 1778

Subgenus *Hanaia* HAYAMI, 1965

*Glycymeris (Hanaia) desilineata* NAGAO

Plate 2, Fig. 4

*Synonymy* : - (See, TASHIRO, 1990)

*Material* : - KSGT 0007, internal mould of a left valve, from Ochidani of Nozu, Oita Prefecture.

*Remarks* : - Present specimen is measured, 12.8 mm in length and 13.9 mm in height. This specimen is undoubtedly referable to *Glycymeris (Hanaia) desilineata* NAGAO (1934), from the Miyako Group (Aptio-Albian) of Northeast Japan, as the same species, because of its very narrow brim of hinge plate under the dorsal margin, asymmetrical location of the hinge plate which was situated at horizontal on anterior and oblique on posterior, and about 25 in number of the inner marginal crenulations. Recently this species was described by TASHIRO (1990) from the Kesado Formation (Barremian ? to Aptian) of the Pre-Sotoizumi Group in Central Kyushu.

*Occurrence* : - Loc. Ta501

Superfamily Pinnacea

Genus *Pinna* LINNE, 1758

*Pinna* sp. cf. *P. robinaldina* D'ORBIGNY

Plate 5, Fig. 24

1957, *Pinna* sp. AMANO, *Kumamoto Jour. Sci.*, Ser. B, Sec. 1, Vol. 2, No. 2, p. 85, pl. 1, figs. 10-13

*Material* : - KSGT 0008, imperfect external and internal moulds of a left valve, from Ochidani of Nozu, Oita Prefecture.

*Remarks* : - Several fragmental specimens inclusive KSGT 0008 are at hand. The specimens, KSGT 0008, measured 20 mm in shell breadth, may be conspecific with *Pinna* sp. by AMANO (1957), from the Hagino Formation (Aptian) of the Nankai Group in Shikoku, judging from the surface ornamentation, moderately inflated posterior carina and elongated subtrigonal outline. This is also closely related to *Pinna* sp. cf. *P. robinaldina* D'ORBIGNY, from the Miyako Group (Aptio-Albian; NAGAO, 1934) and Kesado Formation (Barremio-Aptian; TASHIRO, 1990) of the Pre-Sotoizumi Group in Kyushu. *P.* sp. aff. *P. robinardina* D'ORBIGNY from the Monobe Formation (Barremian; TASHIRO and KOZAI, 1984) of the Monobegawa Group in Shikoku is discriminated from those specimens in their strong subradial ribs of the surface and less inflated posterior carina of the valve.

*Occurrence* : - Loc. Ta501

Order Pterioda  
 Suborder Pteriina  
 Superfamily Pteriacea  
 Family Bakevellidae  
 Genus *Gervillaria* COX, 1954  
*Gervillaria* sp. cf. *G. alaeformis* (SOWERBY)  
 Plate 2, Fig. 5; Plate 3, Fig. 11

*Synonymy* : - (See, TASHIRO, 1990)

*Material* : -KSGT 0009, external moulds of left valve (OS 107); KSGT 0010 -KSGT 0012, internal moulds of left valves; KSGT 0013, internal mould of right valve; all specimens from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Loc.
KSGT 0010, l. int. mould.	23.5	25.8	OS06
KSGT 0011, l. int. mould.	25.0	23.5	OS03
KSGT 0012, l. int. mould.	24.5	25.1	OS07
KSGT 0013, r. int. mould.	33.7	31.0	OS03

*Remarks* : - This species is closely similar to *Gervillaria haradae* (YOKOYAMA), from the Monobegawa Group of Southwest Japan (YABE et al. 1926 ; TASHIRO and KOZAI, 1986), in its outline, but differs in having its less numerous and weak radial ornamentations on the surface than those of *G. haradae*.

*Occurrence* : - Locs. OS03, OS06 and OS07

*Gervillaria miyakoensis* (NAGAO)  
 Plate 2, Figs. 6-7; Plate 6, Fig. 1

*Synonymy* : - (See, TASHIRO and TANAKA, 1992)

*Material* : - KSGT 0014 internal mould of left valve; KSGT 0015, external mould of left valve; KSGT 0016-KSGT 0019, internal and external moulds of left and right valves; all specimens, from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Loc.
KSGT 0014, r. int. mould.	106.8	88.5	OS06
KSGT 0019, l. int. mould.	52.5+	71.5	OS07

*Remarks* : - Abundant but imperfect specimens of this species are collected from the Osaka area. Each specimen is, however, well preserved in its specific feature. This species is characterized by large valve, more or less narrow posterior wing, and entirely smooth or miserable radial ribs on the external surface except for growth lines. The specimens from the Miyako Group (Aptio-Albian; HAYAMI, 1965) and Takahata Formation (Upper? Albian; TASHIRO and TANAKA, 1992) of the Pre-Sotoizumi Group in Central Kyushu, are shown nearly smooth external surface. In the present specimens from this Osaka area, weak but distinctly numerous radial ribs appear on the umbonal part about 5 cm in height from the beak towards the venter. Since the distinction between the specimens from this area and those from Miyako Group and Takahata Formation is shown the degrees of the preservation or the variational changes came from the pass of geological ages between them, it seems that the distinction between them is artificial. However, the younger stage or umbonal features of those specimens from this area resembles closely to *Gervillaria* cf. *alaeformis*.

*Occurrence* : - Loc. OS06 and Loc. OS07

Genus *Gervillia* DeFrance, 1820

*Gervillia forbesiana* d'Orbigny

Plate 6, Fig. 2

*Synonymy* : - (See, TASHIRO, TANAKA and SOGABE, 1993)

*Material* : - KSGT 0020, internal mould of left valve, from Ochidani of Nozu, Oita Prefecture. KSGT 0021 and KSGT 0022, internal and external moulds of left and right valves, from Osaka of Mie, Oita Prefecture.

*Remarks* : - Some specimens composed of the imperfect external and internal moulds except for two moulds, KSGT 0021 and KSGT 0022, are collected from the Osaka and Tamarimizu Formations. This species was one of well known and worldwide bivalves from Early Cretaceous Period. We think, you are recognizable to this species from every localities consisted with the Lower Cretaceous shallow marine conditional sediments in Japan. Present specimens of this species collected from this areas are nearly all of the fragmental internal and external moulds. An external mould of left valve is measured 90.0 mm in length and 23.5 mm in height.

*Occurrence* : - Loc. OS06 and Loc. OS07

Family Isognomonidae

Genus *Isognomon* LIGHTFOOT, 1786

*Isognomon choshiensis* HAYAMI

Plate 2, Figs. 8, 9

*Synonymy* : - (See, TASHIRO and KOZAI, 1986)

*Material* : - KSGT 0023, internal mould of right valve; KSGT 0024, internal mould of left valve; both of external moulds of left valves, from Osaka of Mie, Oita Prefecture. A specimens, KSGT 0025, internal mould of right valve, from Tamarimizu of Nozu, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Loc.
KSGT 0023, r. int. mould	81.0	75.0	OS06
KSGT 0024, l. int. mould	49.0	52.0+	OS03
KSGT 0025, r. int. mould	27.0	22.0+	Ta502

*Remarks* : - Three specimens from this area are all imperfect moulds. The specific morphological characters which were safely referable to the same species with *Isognomon choshiensis* HAYAMI (1965) from the Choshi Group in Central Japan, are, however, well preserved. This species differs from *Isognomon sanchuensis* (YABE et al., 1926) from the Ishido Formation of the Monobegawa Group, in its more numerous and narrow ligament pits.

*Occurrence* : - Loc. OS06, Loc. OS03 and Loc. Ta502

Superfamily Pectinacea

Family Entoliidae

Genus *Entolium* MEEK, 1865

*Entolium ikedai* TASHIRO

Plate 1, Fig. 7

1990, *Entolium ikedai* TASHIRO; *Mem. Fac. Sci. Kochi Univ.*, Vol. 11, p. 8, pl. 2, figs. 1-5, text-fig.

1992, *Entolium ikedai* TASHIRO ; TASHIRO and TANAKA ; *Res. Rep. Kochi Univ.*, Vol. 41, p. 145, pl. 3, figs. 14-15

*Material* : -KSGT 0026, external and internal moulds of the same specimen of right ? valve, from Tamarimizu of Nozu, Oita Prefecture ; KSGT0027, internal mould of right valve, from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Loc.
KSGT 0026, r?. ext. mould.	63.0	76.5	Ta502
KSGT 0027, r. int. mould.	54.0	63.2	OS02

*Remarks* : - Although two present specimens are very wrong in the preservation, the specimens are shown the oblong outline of the valve, and very fine and numerous concentric riblets on the disk, each of which was one of important specific features classified into *Entolium ikedai* TASHIRO, from the Kesado Formation (Aptian) of the Pre-Sotoizumi Group in Central Kyushu. This species was also known from the Takahata Formation of the Kuraoka area in Central Kyushu (TASHIRO and TANAKA, 1992).

*Occurrence* : - Locs. Ta502 and OS02.

Family Pectinidae

Subfamily Pectininae

Genus *Neithea* DROUET, 1825

*Neithea syriaca amanoi* HAYAMI

Plate 1, Figs. 5, 6

*Synonymy* : - (See, TASHIRO and MATSUDA, 1986)

*Material* : - KSGT 0028, internal mould of right valve ; KSGT 0029-KSGT 0030, internal and external moulds of imperfect right valves ; KSGT0031, external mould of left valve ; all specimens from Ochidani of Nozu, Oita Prefecture.

*Remarks* : - An internal mould of right valve, KSGT 0028, is measured 26.6mm in length, 29.0mm in height and 10.5mm in thickness. The specimens from this locality is undoubtedly conspecific with *Neithea syriaca amanoi* HAYAMI (1965), from the Aptian Hagino Formation of the Nankai Group in Shikoku, because of the two secondary radial riblets on each interspace of the primary ribs on the disk. This species was described from the Aptian part of the Doganaro Formation of the Shimanto Belt in Shikoku (TASHIRO and KOZAI, 1986), the Aptian formations of Bunjo and Nakaizu of the Nankai Group in Shikoku (TASHIRO and MATSUDA, 1986), and Choshi Group at Nagasakibana of Central Japan (SHIKAMA and SUZUKI, 1972).

*Occurrence* : - Loc. Ta501

*Neithea (Neithea) kochiensis* HAYAMI

Plate 1, Figs. 1-4

*Synonymy* : - (See, *Neithea (Neithea)* sp. aff. *N. (N.) atava* (ROEMER) in TASHIRO, 1990)

*Material* : - KSGT 0032 and KSGT 0033, external mould of right valves ; KSGT 0034 and KSGT 0035, internal moulds of right valves ; KSGT 0036, external mould of left valve ; all specimens from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness	Loc.
KSGT 0032, r. ext. mould	106.5	106.5	32.8	OS02

KSGT 0033, r. ext. mould	51.5	84.2	14.5	OS02
KSGT 0034, r. int. mould	76.1	75.0+	-	OS01
KSGT 0036, l. ext. mould	103.8	105.5+	-	OS02

*Remarks* : - Present specimens from this area, Osaka of Oita, are very well in the preservation. The specimens are characterized by very large valve, rather thick of the test for the *Neithea* and 6 strong secondary radial ribs on the interspaces of 6 primary ribs on the external surface but nearly absence of the secondary ribs on the internal surface.

The specimens are undoubtedly conspecific with *Neithea* (*Neithea*) aff. *atava* (ROEMER) by TASHIRO (1990), from the Kesado Formation of the Pre-Sotoizumi Group in Central Kyushu, by their entirely the same specific features. HAYAMI (in HAYAMI and KAWASAWA, 1967) established *Neithea* (*Neithea*) *kochiensis* HAYAMI, based on a specimen, an internal mould of right valve, from the Doganaro Formation of the Shimantogawa Group in Shikoku. The specimens by Hayami, from the Doganaro Formation, an internal mould of right valves, is entirely the same with that of the same internal mould, KSGT 0034, from this area, with its conspecific feature, such as the less developed secondary radial ribs on the inner surface.

*Occurrence* : - Loc. OS02 and Loc. OS01

Genus *Limatula* WOOD, 1839

*Limatula nagaoui* HAYAMI

*Synonymy* : - (See, TASHIRO, 1990)

*Material* : - KSGT 0046, right external mould, from Ochidani of Nozu, Oita Prefecture.

*Remarks* : - A specimen, KSGT 0046, measured 19.3mm in length, 22.5mm in height and 2.8mm in thickness, was presented for this study. This is safely conspecific with *Limatula nagaoui* HAYAMI (1965), from the Miyako Group in Northeast Japan, because of its nearly the same features which had been described in detail by Hayami. This species is known from the Kesado Formation of the Pre-Sotoizumi Group in Central Kyushu (TASHIRO, 1990), and the Choshi Group of Central Japan (SHIKAMA and SUZUKI, 1972). Several fragmental specimens are collected from another locality, Loc. OS07.

*Occurrence* : - Loc. Ta501 and Loc. OS07

Genus *Chlamys* RODING, 1798

*Chlamys* sp. cf. *C. robinaldina* (D'ORBIGNY)

Plate 2, Figs. 1-3

1965, *Chlamys robinaldina* (D'ORBIGNY); HAYAMI, *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, Vol. 15, No. 2, p. 310, pl. 44, figs. 5-7

*Material* : - KSGT 0037 and KSGT 0038, internal moulds of right valves; KSGT 0039 and KSGT 0040, internal moulds of left valves; KSGT 0041-KSGT 0043, external moulds of left and right valves; all specimens, from Ochidani of Nozu, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height
KSGT 0037, r. int. mould.	24.5	23.5
KSGT 0039, l. int. mould.	16.3	18.3
KSGT 0040, l. int. mould.	24.0	26.5
KSGT 0038, r. int. moult.	29.0	-

*Remarks* : - Many specimens have been collected from this area. Although they are undoubtedly-

ly conspecific with *Chlamys robinaldina* (D'ORBIGNY) by HAYAMI (1965), from the Miyako Group in Northeast Japan, it is question that the Japanese specimens of this form were classified into the same species with *Chlamys robinaldina* (D'ORBIGNY) (i. e. WOODS, 1902), from Europe. In our observation, the Japanese specimens are characterized by numerous and flexible radial ribs on the external surface comparing with those of the European specimens.

*Occurrence* : - Loc. Ta501

Family Spondylidae

Genus *Spondylus* LINNE, 1758

*Spondylus decoratus* NAGAO

1934, *Spondylus decoratus* NAGAO; *Jour. Fac. Sci. Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 210, pl. 27, figs. 2, 5-7

1965, *Spondylus decoratus* NAGAO; HAYAMI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Vol. 15, No. 2, p. 324, pl. 47, figs. 4-9, pl. 52, fig. 6

*Material* : - KSGT 0044, external mould of right valve; KSGT 0045, internal mould of right valve; from Osaka of Mie, Oita Prefecture.

*Remarks* : - Two fragmental specimens, KSGT 0044 and KSGT 0045, are at hand. KSGT0044 is measured 40.0mm in the length of hinge plate. KSGT 0045 is probably higher than 35.0mm in the shell height. The hinge and ligamental structures of this species is presented on KSGT 0045. The external features are also shown in detail on KSGT 0045. Although the shell outline of those specimens are unknown, those two specimens are probably referable to *Spondylus decoratus* NAGAO (1934), from the Miyako Group in Northeast Japan with their the same hinge structure and external ornamentaion.

*Occurrence* : - Loc, OS02

Suborder Ostreina

Superfamily Ostreacea

Family Ostreidae

Subfamily Exogyrinae

Genus *Amphidonte* FISCHER DEWALDHEIM, 1829

*Amphidonte subhaliotoidea* (NAGAO)

Plate 6, Fig. 3

1934, *Exogyra subhaliotoidea* NAGAO; *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 203, pl. 30, figs. 1-4

1965, *Amphidonta (Amphidonta) subhaliotoidea* (NAGAO); HAYAMI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Vol. 15, No. 2, p. 343, pl. 50, figs. 6-9; pl. 51, figs. 1-2

1967, *Amphidonta (Amphidonta) subhaliotoidea* (NAGAO); HAYAMI and KAWASAWA. *Trans. Proc. Palaeont. Soc. Japan*, N. S., No. 66, p. 78, pl. 9, fig. 5

1972, *Amphidonta (Amphidonta) subhaliotoidea* (NAGAO); SHIKAMA and SUZUKI, *Sci. Rep. Yokohama Nat. Univ.*, Ser. 2, Vol. 19, pl. 1, figs. 10-14

1992, *Amphidonta (Amphidonta) subhaliotoidea* (NAGAO); TASHIRO and TANAKA, *Res. Rep. Kochi Univ.*, Vol. 41, p. 146, pl. 1, figs. 13-15

*Material* : - KSGT 0047- KSGT 0048, internal moulds of right and left valves; ; KSGT 0049, external mould of left valve; all specimens from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

specimen	Length	Height
KSGT 0047, l. int. mould	33.8	31.5
KSGT 0048, l. int. mould	46.0	35.5
KSGT 0049, l. ext. molud	28.5	40.0

*Remarks* : - This species is one of well known Eary Cretaceous oysters in Japan. Hitherto, this was described or reported from the Miyako Group in Northeast Japan (NAGAO, 1934), Doganaro Formation of the Shimantogawa Group in Shikoku (HAYAMI and KAWASAWA, 1967), Choshi Group in Central Japan (SHIKAMA and SUZUKI, 1972), Hagino and Bunjo Formations of the Nankai Group in Shikoku.

*Occurrence* : - Loc. OS03.

Genus *Rastellum* Fanjas-Saint-Fond, 1799  
 Subgenus *Arctostrea* PERVINQUIERE, 1910  
*Rastellum (Arctostrea) carinatum* (LAMARCK)  
 Plate 3, Figs. 8, 9

*Synonymy* : - (See, TASHIRO and TANAKA, 1992)

*Material* : - KSGT 0050 - 0052, external moulds of left and right valves ; KSGT 0053, internal mould of left valve ; all from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height
KSGT 0050, r. ext. mould	32.0	48.6
KSGT 0051, l. ext. mould	22.5	60.0
KSGT 0053, l. int. mould	25.0	48,5

*Remarks* : - The specimens had been classified into *Rastellum (Arctostrea) carinatum* (LAMARCK), from the Lower Cretaceous of Japan, are divided into two forms. One of them, the Monobegawa Form, occurring from the Huterivian to Barremian parts of the Monobegawa Group. The other form, the Nankai Form, from the Barremian to Albian parts of the Nankai, Miyako, Shimantogawa and Pre-Sotoizumi Groups. The Monobegawa Form is discriminated from the Nankai Form, in its wider shell-breadth and broadly situated chevron-shaped ribs on the surface, more than those of the latter. The specimens from this area are offerable to the Nankai Form.

*Occurrence* : - Loc. OS03 and Loc. OS04.

Subclass Palaeoheterodonta  
 Order Trigonioida  
 Superfamily Trigoniacea  
 Family Trigoniidae  
 Subfamily Trigoniinae  
 Genus *Nipponitrigonia* COX, 1952  
*Nipponitrigonia plicata* KOBAYASHI and NAKANO  
 Plate 5, Figs. 11, 12, 13 and 14

*Synonymy* : - (See, Tashiro, 1990)

*Material* : - KSGT 0054 and KSGT 0055 ; internal moulds of right valves ; KSGT 0056 and KSGT 0057, internal moulds of left valves ; KSGT 0058 and KSGT 0059 ; external moulds of left valves ; all from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0054, r. int. mould.	42.5	37.8	-
KSGT 0055, r. int. mould.	27.5	19.0	-
KSGT 0056, l. int. mould.	45.0	40.0	-
KSGT 0057, l. int. mould.	21.5	18.5	-
KSGT 0058, l. ext. mould.	41.5	36.1+	12.0
KSGT 0059, l. ext. mould.	22.0	19.0	5.8

*Remarks* : - This species is characterized with one or two inner radial ridges which extended straight from front of postero-ventral margin towards umbo. On some specimens, the ridge is one in number, and is generally not reached the inner beak. The concentric costae on the disk are distinct on umbonal area in about 5. The costae except for umbonal ones are variable in numbers and stoutness, appeared in general on the anterior half of the disk. If the inner radial ridge of this species is not able to recognize, this species is difficult to discriminate from *Nipponitrigonia sakamotoensis* YEHARA (1923) from the Barremio-Aptian sediments of the Monobegawa Group of Southwest Japan. Because of this species is characterized by nearly the same external features of the valve with *N. sakamotoensis*.

*Occurrence* : - Locs. OS04 and OS06.

#### Subfamily Pterotrigoniinae

Genus *Pterotrigonia* van HOEPEN, 1929

*Pterotrigonia yokoyamai* (YEHARA)

Plate 3, Fig. 10

1915, *Trigonia yokoyamai* YEHARA ; *Sci. Rep. Tohoku Imp. Univ.*, Ser. 2, Vol. 2, No. 2, p. 41, pl. 2, figs. 15-17

1934, *Trigonia yokoyamai* YEHARA ; NAGAO, *Jour. Fac. Sci. Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 2, p. 205

1954, *Pterotrigonia yokoyamai* (YEHARA) ; KOBAYASHI, *Japan. Jour. Geol. Geogr.*, Vol. 25, Nos. 1-2, p. 77

1977, *Pterotrigonia (Pterotrigonia) yokoyamai* (YEHARA) ; HAYAMI, *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 118

*Material* : - KSGT 0061 and KSGT 0062, right valves, from Tamarimizu of Nozu, Oita Prefecture.

*Remarks* : - Present specimen, KSGT 0061, is an imperfect right valve, brokened a little part on the syphonal margine, measured 28.0+ mm in length, 27.0mm in height and 7.0mm in thickness. The specific features of this specimen, referable to *Pterotrigonia yokoyamai* (YEHARA, 1915) from the Miyako Group (Aptio-Albian) in Northeast Japan, are well preserved. This species is characterized by smooth and less numerous subradial costae on the disk, and smooth and narrow posterior area, than those of the other several Aptio-Albian species of *Pterotrigonia* s. s. in Japan, such as *P. hokkaidoana* (YEHARA), *P. pocilliformis* (YOKOYAMA), *P. datemasamunei* (YEHARA) etc. .

*Occurrence* : - Loc. Ta502.

#### *Pterotrigonia bungoensis* TASHIRO and TANAKA, n. sp.

Plate 3, Figs. 1-6

*Material* : - Holotype, KSGT 0063, right valve ; paratype, KSGT 0064, internal mould of right

valve; paratype, KSGT 0065, external mould of right valve; the other paratypes, KSGT0066 and KSGT 0067, external moulds of left valves; all typical specimens, from Osaka of Mie, Oita Prefecture.

*Diagnosis* : - Shell medium in size; umbo strongly prominent, situated subterminally at one side of crescentric outline of the shell; disk ornamented with about 16 strong pterotrigonian-type costae; area narrowly but elongatedly expands to posterior, nearly smooth on the adult stage except for growth lines.

*Description* : - Shell medium in size, longer than high, crescent in outline, moderately inflated; umbo opisthogyrous, shapely prominent; located at about one fifth or more from front of the valve; anterior margin convex; ventral margin long, weakly arched on anterior but nearly straight on posterior; syphonal margin narrowly rounded; escutcheon margin deeply concave; escutcheon moderate in size, ornamented with about 12 tuberculated costellae; the costellae subvertically situated of umbonal half of the escutchen, but slanting to horizontal on posterior half of the escutchen; area narrow, ornamented with numerous concentric riblets on umbonal half of the area, but nearly smooth except for irregularly spaced growth lines on posterior half of the area; median fallow of the area distinct; posterior carina indistinct except for umbonal region; disk elongated triangle in outline, ornamented with about 16 tuberculated strong costae; several umbonal costae subconcentric, about 5 costae on anterior half part of the disk subradial, about 7 costae on posterior half subvertical.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0063, l. valve	54.0	40.2	20.6
KSGT 0064, r. int. mould.	57.5	40.0	-
KSGT 0065, r. ext. mould.	72.0	55.0	22.0
KSGT 0066, l. ext. mould.	58.9	33.0+	14.9

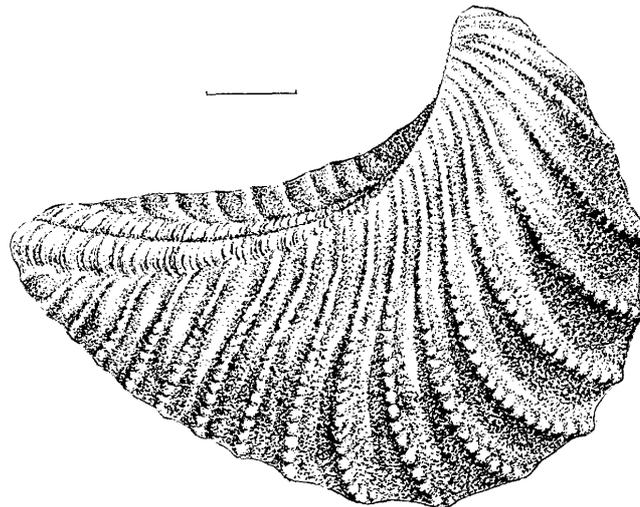


Fig. 4 *Pterotrigonia bungoensis* Tashiro and Tanaka (scale 10 mm)

*Observation* : - Abundant specimens on the various growth stages of this species have been collected from this area. Although the outline of this species is somewhat variable, the prominent umbo, expanded area and elongated outline of this species are uniform in general.

*Comparison* : - This species resembles *Pterotrigonia takahatensis* TASHIRO and TANAKA (1992), from the Takahata Formation (?Upper Albian) of the Pre-Sotoizumi Group, in its prominent umbo, and narrowly expanded and smoothed area, but differs from this species in its elongated outline of the valve, strongly prominent and tuberculated costae on the disk, and distinctly remained umbonal costellae on the area. This new species is probably concerned with *P. takahatensis* as the same lineage trigonian which was situated at one of the ancestors of *P. takahatensis*.

*Occurrence* : - Locs. OS02, OS04, OS07, OS08 and OS09.

Subclass Heterodonta  
Order Veneroida  
Superfamily Carditacea  
Subfamily Carditesinae  
Genus *Xenocardita* VOKES, 1946  
*Xenocardita amanoi* (HAYAMI)  
Plate 5, Figs. 19, 20 and 21

*Synonymy* : - (See, TASHIRO, 1990)

*Material* : - KSGT 0068, internal and external moulds of the same specimen of left valve, from Ochidani of Nozu, Oita Prefecture.

*Remarks* : - A specimen, KSGT 0068, measured 10.5mm in length, 11.0mm in height and 5.0mm in thickness, is undoubtedly conspecific with *Xenocardita amanoi* (HAYAMI, 1966), from the Hagino Formation of the Nankai Group of Shikoku, in its tuberculated radial ribs and well inflated valve, as already defined in detail by HAYAMI (1966). This species was described or reported from the Hagino and Bunjo Formations of the Nankai Group of the Sanbouzan Terrain in Shikoku (TASHIRO and MATSUDA, 1986; TASHIRO and KOZAI, 1988), Lower Cretaceous formation of Nagasakibana of Choshi of the Chichibu Terrain in Central Japan (SHIKAMA and SUZUKI, 1972), Doganaro Formation of the Shimantogawa Group of Shimanto Terrain in Shikoku (TASHIRO and KOZAI, 1988), and Kesado Formation of the Pre-Sotoizumi Group of Yatsushiro area in Kyushu.

*Occurrence* : - Locs. Ta501 and OS06.

Superfamily Crassatellacea  
Family Astartidae  
Subfamily Astartinae  
Genus *Astarte* SOWERBY, 1816  
Subgenus *Astarte* SOWERBY, 1816  
*Astarte (Astarte) yatsushiroensis* TASHIRO and TANAKA  
Plate 4, Figs. 10-14

1992, *Astarte (Astarte) yatsushiroensis* TASHIRO and TANAKA; *Res. Rep. Kochi Univ.*, Vol. 41, p. 150, pl. 2, figs. 1-7, 10-12

*Material* : - KSGT 0069, right external mould; KSGT 0070 and 0071, left valves, KSGT 0072, right valve; KSGT 0073-KSGT 0076, internal moulds of left and right valves; all type specimens from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness	Loc.
KSGT 0069, r. ext. mould.	23.8	24.0	4.9	OS03
KSGT 0070, l. valve	21.5	22.6	5.6	OS07

KSGT 0071, l. valve	19.0	17.5	4.2	OS07
KSGT 0072, r. valve	17.2	17.0	4.4	OS07
KSGT 0074, r. int. mould.	22.0	18.4	-	OS06
KSGT 0075, l. int. mould.	22.2	21.3	-	OS07

*Remarks* : - Abundant specimens of this species are presented for this study. The specimens are undoubtedly conspecific with *Astarte (Astarte) yatsushiroensis* TASHIRO and TANAKA (1992) from the Takahata and Yatsushiro Formations of the Pre-Sotoizumi Group in Central Kyushu. The present specimens from this locality are very well for the preservation comparing with the type species from the Takahata Formation.

*Occurrence* : - Locs. OS03, OS07, OS02 and OS06.

Subgenus *Yabea* HAYAMI, 1965

*Astarte (Yabea) akatsui* HAYAMI

Plate 5, Figs. 5, 6

1965. *Astarte (Yabea) akatsui* HAYAMI; *Mem. Fac. Sci. Kyushu Univ.* Ser. D, Geol. Vol. 17, No. 2, p. 95, pl. 9, figs. 2-5, pl. 14, figs. 10, 11

1975. *Astarte (Yabea) akatsui* HAYAMI; HAYAMI. *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 127

1985. *Astarte (Yabea) akatsui* HAYAMI; TASHIRO and MATSUDA in TASHIRO, MATSUDA and TANAKA, *Mem. Fac. Sci., Kochi Univ.* Ser. E, Vols. 5-6; p. 10, pl. 2, figs. 13-15

*Material* : - KSGT 0077 and KSG 0078, internal moulds of left valves, from Tamarimizu of Nozu, Oita Prefecture. KSGT 0079, right valve; KSGT 0080, left internal mould, from Tamarimizu of Nozu, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0077, l. int. mould	17.5	16.3	-
KSGT 0078, l. int. mould	18.6	18.0	-
KSGT 0080, l. int. mould	27.0	25.6	-
KSGT 0079, r. valve	25.0	25.1	5.8

*Remarks* : - Typical specimen of this species was described from the Middle Albian Yatsushiro Formation of the Pre-Sotoizumi Group in Southwestern Kyushu by Hayami (1965). Present specimens from Oita Prefecture are undoubtedly conspecific with *Astarte (Yabea) akatsui* HAYAMI, in having its the same features which had been described in detail by HAYAMI (1965).

*Occurrence* : - Loc. Ta502.

Genus *Anthonya* GABB, 1864

*Anthonya igenokiensis* TASHIRO and KOZAI

Plate 4, Fig. 15

1988, *Anthonya igenokiensis* TASHIRO and KOZAI; *Res. Rep. Kochi Univ.*, Vol. 37, p. 48, pl. 3, Figs. 9-13, Text-fig. 5

*Material* : - KSGT 0081, internal and external moulds of the same left valve, from Osaka of Mie, Oita Prefecture.

*Remarks* : - Present specimen is measured 27.0mm in length and 10.9mm in height. This specimen is not so well for the preservation, it is, however, the specific characters of *Anthonya igenokiensis* TASHIRO and KOZAI (1988), from the Nankai Group in Shikoku, are remained as the same *Astarte*-like hinge structures, and the same concentric ornamentation and less prominent

posterior carina on the external mould.

*Occurrence* : - Loc. OS06.

Subfamily Eriphyliinae

Genus *Eriphyla* GABB, 1864

*Eriphyla pulchella* HAYAMI

1965. *Eriphyla pulchella* HAYAMI; *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Vol. 17, No. 2, p. 98, pl. 9, figs. 6-12; pl. 14, fig. 6

1975. *Eriphyla pulchella* HAYAMI; HAYAMI, *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 128,

*Material* : - KSGT 0082, left valve; KSGT 0083 and KSGT 0084, internal moulds of right-valves; from Tamarimizu of Nozu, Oita Prefecture. KSGT 0085 and KSGT 0086, internal moulds of right valves, from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0082, l. valve	29.5	25.4	5.2
KSGT 0083, r. int. mould.	22.1	19.0	-
KSGT 0084, r. int. mould.	18.0	17.0	-
KSGT 0085, r. int. mould.	23.0	20.2	-
KSGT 0086, r. int. mould.	22.5	21.0	-

*Remarks*.- The outline of the valve and locational point of the umbo of the present specimens are variable in each specimen. Although the present specimen are probably referable to *Eriphyla pulchella* HAYAMI (1965), from the Aptio-Albian Miyako Group in Northeast Japan, in having the same diagnostic features as already mentioned in detail by HAYAMI (1965). However, a few minor distinctions in artificial level between the typical specimen and present specimens, such as, in the present specimens, the valves are larger in size than in typical specimen, and the concentric ribs of the disk are effaced on the ventral part.

*Occurrence* : - Loc. OS02.

Subfamily Opinae

Genus *Opis* DEFRANCE, 1887

*Opis haginoensis* AMANO

1957. *Opis (Trigonopsis) haginoensis* AMANO; *Kumamoto Jour. Sci.* Ser. B, Sec. 1, Vol. 2, No. 2, p. 97, pl. 2, figs. 25-26

*Material* : - KSGT 0087 and KSGT 0088, internal moulds of right and left valve, from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height
KSGT 0087, l. int. mould.	10.0	13.0
KSGT 0088, r. int. mould.	22.0	29.5

*Remarks* : - Since two specimens from this area, are nearly identical with *Opis (Trigonopsis) haginoensis* AMANO (1957), from the Hagino Formation of the Nankai Group, in its subtrigonal outline, we tentatively offer these specimens to *O. (T.) haginoensis* AMANO as the same species.

*Occurrence* : - Loc. OS06.

Subfamily Ptychomyiinae  
 Genus *Ptychomya* AGASSIZ, 1842  
*Ptychomya densicostata* NAGAO

Plate 4, Figs. 1-4

1934, *Ptychomya densicostata* NAGAO; *Jour. Sci. Rep. Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 224, pl. 28, fig. 4

1990, *Ptychomya densicostata* NAGAO; TASHIRO, *Mem. Fac. Sci. Kochi Univ.*, Ser. E, Vol. ii, p. 14, pl. 2, figs. 12-15

*Material* : - KSGT 0089 and KSGT 0090, internal moulds of left valves; KSGT 0091 and KSGT 0092, external moulds of right and left valves; from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0089, l. int. mould.	77.5+	48.0	-
KSGT 0091, r. ext. mould.	79.0	47.8	8.0
KSGT 0092, l. ext. mould.	80.0	50.0	10.0

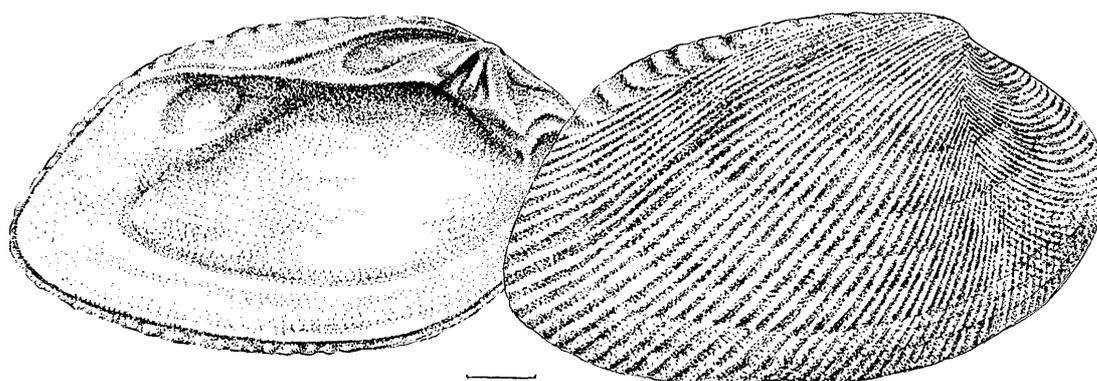


Fig. 5 *Ptychomya densicostata* Nagao (scale 10 mm)

*Remarks* : - Numerous well preserved specimens were collected from this Osaka area. The specimens are safely classified into *Ptychomya densicostata* NAGAO, from the Miyako Group in Northeast Japan, as the same species, because of its nearly the same external ornamentations and outline of the valve, as mentioned in detail by NAGAO (1934), and the same hinge and ligamental structure, also mentioned by TASHIRO (1990), based on the specimens from the Kesado Formation of the Pre-Sotoizumi Group in Central Kyushu.

*Occurrence* : - Loc. OS02 and OS03.

*Ptychomya hasei* TANAKA and TASHIRO, n. sp.

Plate 4, Figs. 5-9.

*Material* : - Holotype, KSGT 0093, internal mould of right valve; paratype, KSGT 0094, internal mould of left valve; another paratype, KSGT 0095, external mould of right valve; all the specimens from Osaka of Mie, Oita Prefecture.

*Diagnosis* : - Shell elliptical, medium in size; external surface with fine zigzag pattern ribbings; lunule deeply depressed; escutchen smoothly widened, folding back strongly to inner side; hinge formula shown as follows : - (AII) 4a 2 4b / 3a 3b, subinternal margin very finely crenulated.

*Description* - Shell ovate, longer than high, weakly inflated, umbo less prominent, prosogyrous, located at about one fifth from front of the valve, anterior dorsal margin weakly concave, anterior margin rounded in semicircular, ventral margin broadly arched, posterior dorsal margin weakly arched, posterior margin obliquely subtruncated, disk ornamented with four sorts of narrow but distinct riblets about 25 antero-dorsal marginal riblets subhorizontal, 15 or so posterior dorsal riblets widely spaced and obliquely situated, 20 or more riblets on the disk subradial, formed reverse V-shaped pattern with the antero-ventral riblets, 10 or less riblets appeared on posterior areal part subradial, formed sharp chevrons on a line extending from the umbo to postero-ventral, with the riblets of the disk, and formed asymmetrical reverse V-trend pattern with the posterior dorsal riblets, posterior carina indistinct, lunule deeply depressed, escutcheon area smooth, folding back to inner side of the valve, internal margin divided into inner submargin and outer margin, the submargin very finely crenulated, outer margin crenulated with the numbers which were concerned with the riblets on the disk, hinge plate wide with crenulated cardinal teeth, hinge formula is as follows - (AII) 4a 2 4b / 3a 3b, cardinal 2 and 3b very large situated subvertical 4a and 3a narrow, 4b long but weak, distinctly separated by a socket-like sulcus from nymph, ligament pit large, alongs beneath posterior dorsal shell margin, lateral adductor scars strongly impressed, small elliptic muscular pit located on a buttress of anterior hinge plate

*Measurements* - (in mm)

Specimen	Length	Height	Thickness
KSGT 0093, r int mould	44.0	39.5	-
KSGT 0094, l int mould	64.9	57.5	-
KSGT 0095, r ext mould	34.5	29.8	3.5

*Observation* - Three specimens, well preserved external and internal moulds, are collected from

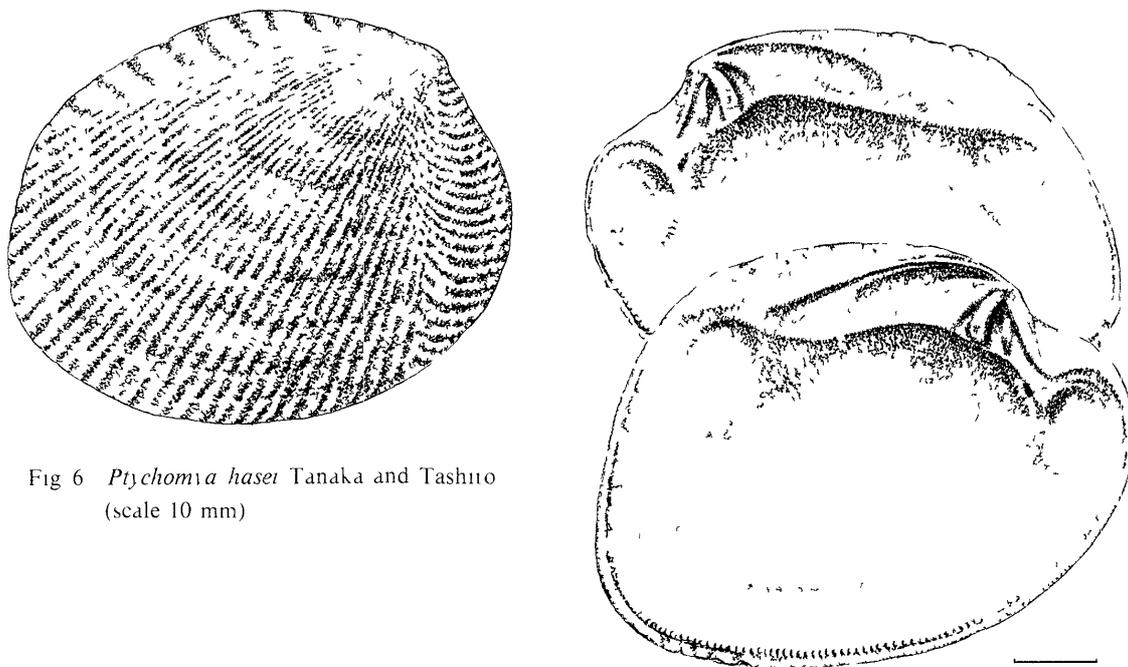


Fig 6 *Ptychomya hassei* Tanaka and Tashiro  
(scale 10 mm)

the Osaka Formation. We can recognise the specimens belonging to two species of *Ptychomya*, *P. densicostata* and this species, in a very same block of sandstone. One of most characteristic features of this species is shown by an appearance of cardinal tooth, 4a.

*Comparison* : - This species resembles closely to *Ptychomya hayamii* TASHIRO and KOZAI (1989), from Monobe and Ishido Formations of the Monobegawa Group of Southwest Japan, in its ovate outline and external ornamentations of the valve. On the other hand, *Ptychomya densicostata* NAGAO (1934) from the Miyako Group in Northeast Japan, Kesado Formation of the Pre-Sotoizumi Group in Central Kyushu (TASHIRO, 1990) and this Osaka Formation, is also similar to this species in having its stout hinge structure. This species is, however, clearly discriminated from two Japanese species of *Ptychomya*, *P. densicostata* and *P. hayamii* in its appearance of the cardinal 4a and imperfect but observable lateral AII.

*Occurrence* : - Loc. OS03

Superfamily Cardiacea

Family Cardidae

Subfamily Protocardinae

Genus *Protocardia* von BEYRICH, 1845

Subgenus *Protocardia* von BEYRICH, 1845

*Protocardia (Protocardia) amanoi* TASHIRO and MATSUDA

Plate 5, Figs. 15, 16

*Synonymy* : - (See TASHIRO and MATSUDA 1986)

*Material* : - KSGT 0126 and KSGT 0127, external moulds of left valves, from west of Ishiba-dum, Mie of Ono, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0126, l. ext. mould	18.0	20.0	4.0
KSGT 0127, l. ext. mould	20.3	14.5	5.2

*Remarks* : - Two specimens from this area are safely referable to *Protocardia (Protocardia) amanoi* TASHIRO and MATSUDA (1986), from the Hagino and Bunjou Formations of the Nankai Group in Shikoku, because of their smooth disk and 10 or more radial ribs on the posterior area. This species was reported from the Doganaro Formation of the Shimantogawa Group in Shikoku (TASHIRO, 1994).

*Occurrence* : - Loc. I104

Genus *Nemocardium* MEEK, 1876

*Nemocardium yatsushiroense* HAYAMI

Plate 5, Fig. 18

1965. *Nemocardium yatsushiroense* HAYAMI; *Mem. Fac. Sci. Kyushu Univ.* Ser. D, Vol. 17, No. 2, p. 120, pl. 17, figs. 1-7

?1972. *Nemocardium yatsushiroense* HAYAMI; SHIKAMA and SUZUKI, *Sci. Rep. Yokohama Nat. Univ.*, pl. 6, fig. 9

1975. *Nemocardium (Nemocardium) yatsushiroense* HAYAMI; HAYAMI, *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 133

1978. *Nemocardium ishidoense* YABE and NAGAO; KATTO and TASHIRO, *Res. Rep. Kochi Univ.*, Vol. 27, pl. 1, figs. 12-15

*Material* : - KSGT 0096, internal mould of left valve ; KSGT 0097, imperfect external mould of left valve ; from Osaka of Mie, Oita Prefecture.

*Remarks* : - An internal mould of left valve, KSGT 0096, is measured 35.3mm long and 46.3mm height. Very narrow and numerous but distinct radial ribs on the surface of the valve characterized one of important specific features of this species are clearly shown on the specimen, imperfect external mould of left valve, KSGT 0097. Typical specimen of this species was described from the Middle Albian Yatsushiro Formation in southwestern Kyushu. The specimens listed as *Laevicardium(?) ishidoense* (YABE and NAGAO) by KATTO and TASHIRO (1978), collected from the Doganaro Formation of the Shimanto Terrain of Shikoku, is probably referable to this species, because of its numerous radial ribs and less taller and more angulated valve than those of *N. ishidoense*, from the Monobegawa Group of Southwest Japan.

*Occurrence* : - Locs. OS05, OS02 and OS06.

Genus *Globocardium* HAYAMI, 1965  
*Globocardium sphaeroideum* (FORBES)  
 Plate 5, Fig. 17

*Synonymy* : - (See, TASHIRO and TANAKA, 1992)

*Material* : - KSGT 0098, internal and external moulds of the same right valve, from West of Ishiba-dum, Mie of Ono, Oita Prefecture.

*Remarks* : - Present specimens, KSGT 0098, measured 37.0mm in length, is very wrong in the preservation. The specific characters of *Globocardium sphaeroideum*, such as widely spaced and flat toroid concentric ribs of the external surface, and well inflated valve, are recognizable in the specimens. This species had been described or listed from the Miyako Group of Northeast Japan (HAYAMI, 1965), Choshi Group of Central Japan (SHIKAMA and SUZUKI, 1972), and the Yatsushiro, Kesado and Takahata Formations of the Pre-Sotoizumi Group of Central Kyushu (TASHIRO and IKEDA, 1987 ; TASHIRO, 1990 ; TASHIRO and TANAKA, 1992).

*Occurrence* : - Loc. I104

Superfamily Tellinacea  
 Family Tellinidae  
 Subfamily Tellininae  
 Genus *Linearia* CONRAD, 1860  
*Linearia* sp.

Plate 6, Fig. 11

*Material* : - KSGT 0100, single specimen, external mould of left valve conjoined with imperfect external mould of the right valve, from Osaka of Mie, Oita Prefecture.

*Description* : - Shall elongated ovate with about twice length to the valve height, weakly inflated ; umbo orthogyrus, less prominent, located at a little anterior than the mid point of the valve length ; surface nearly smooth except for very fine growth lines ; posterior carina indistinct.

*Remarks* : Single specimen, external mould of left valve, measured 55.0mm long, 22.0mm+ and 3.8mm thick, is at hand. Specific features of this specimen are not clear. This is, however, probably referable to a member of the Cretaceous tellinid genus *Linearia*, in having its elongated outline, less prominent umbo and less inflated valve.

*Occurrence* : - Loc. OS04.

## Superfamily Veneracea

## Family Veneridae

## Subfamily Pitarinae

Genus *Resatrix* CASEY, 1952*Resatrix bungoensis* TASHIRO and TANAKA, n. sp.

Plate 5, Figs. 1-4; Plate 6, Fig. 7

**Material** : - Holotype, KSGT 0101, internal mould of left valve ; paratypes, KSGT 0102-KSGT 0104, internal moulds of left and right valves ; the other paratypes, KSGT 0105 and KSGT 0106, external moulds of left and right valves; all typical specimens from Osaka of Mie, Oita Prefecture.

**Diagnosis** : - Shell roundly ovate ; prosogyrate umbo pointed anteriorly ; hinge with three cardinal teeth and elongated lateral teeth on each valve ; cardinal 3a conected with lateral AIII ; cardinal 3b strongly bifid ; inner margin smooth ; parial sinus deep ; top of the sinus sharply angulated ; external surface smooth ; escutcheon and posterior carina indistinct.

**Description** : - Shell roundly ovate, slightly longer than high, weakly inflated ; umbo small, prosogyrous, weakly prominent, pointed at about one thirds from front of valve ; anterior dorsal margin narrowly concave, with about a half length of the posterior one ; anterior margin well rounded with semicircular ; ventral margin broadly arquated ; posterior margin narrowly rounded between broadly arquated ventral margin and weakly arched dorsal margin ; lunuler area moderately depressed but not demarkated clearly from broaded disk ; escutcheon and posterior carina indistinct ; surface of valve nearly smooth except for growth lines ; hinge plate moderate in size with distinct cardinal and elongated lateral teeth ; hinge formula is as follows : - AIII AI 3a 1 3b PI / AII 2a 2b 4b (PII) ; 3a continued with AIII ; I narrow, situated subvertical ; 3b large, distinctly bifid ; 2a and 2b stlong ; 4b long but narrow ; PII substituted with posterior dorsal margin ; ligament external, situated elongatedly but narrowly behind beak ; inner surface smooth ; inner margin smooth ; parial line rather deep ; parial sinus deep ; top of the sinus angulated with about 40 in degrees, pointed at about nearly center of the inner surface ; anterior and posterior adductor scars weakly impressed.

**Measurements** : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0102, r. int. mould.	26.0	18.5	-
KSGT 0103, r. int. mould.	35.5	29.0	-
KSGT 0101, l. int. mould.	23.0	21.4	-
KSGT 0106, r. ext. mould.	31.5	27.6	7.8
KSGT 0104, l. int. mould.	24.9	20.4	-

**Observation** : - Many specimens of this species are collected from several localities of Osaka Area. The specimens are obtained as nearly external and internal moulds. This species characterized by the corbuculoid-like elongated anterior lateral teeth, and the same of deeply located and acutely angled top of the parial sinus. This species is referable to a new species belonging to the genus *Resatrix*, judjing from its anterior lateral tooth continued with cardinal tooth of right valve, distinctly bifid cardinal 3b, indistinct escutcheon and posterior carina, and elongated but not complete posterior lateral teeth.

**Comparison** : - This species is safely discriminated from *Resatrix (Vectorbis) japonica* TASHIRO and KOZAI (1989) from the Hibihara Formation (Apian) of the Monobegawa Group in Shikoku, in its smooth surface and angulated top of the parial sinus. *Resatrix suzukii* HAYAMI (1983) from the Choshi Group (Barremian) in Central Japan resembles this species with its smooth surface and

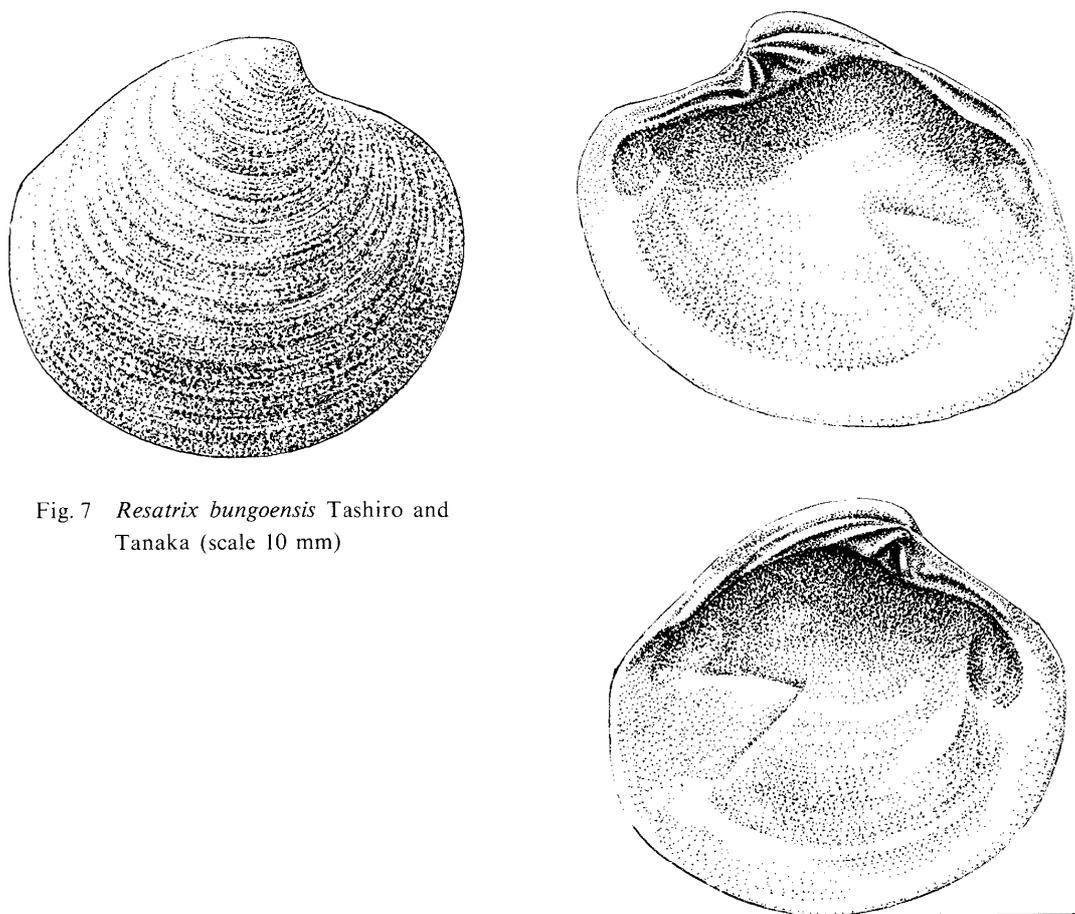


Fig. 7 *Resatrix bungoensis* Tashiro and Tanaka (scale 10 mm)

rounded outline of the valve, but *R. suzukii* differs from this species in having its smaller and more rounded valve, and more anterior location of the umbo. *Resatrix (Vectorbis) miyazakiensis* TASHIRO and TANAKA (1992), from the Takahata Formation of the Pre-Sotoizumi Group, is easily discriminated from this new species in its narrow hinge plate.

*Occurrence* : - Loc. OS02

Genus *Pseudopisidium* TASHIRO and KOZAI, 1989

*Pseudopisidium inflata* TASHIRO and KOZAI

Plate 5, Figs. 7-10

1989, *Pseudopisidium inflata* TASHIRO and KOZAI, *Res. Rep. Kochi Univ.*, Vol. 38, p. 142, pl. 5, figs. 17-20

*Material* : - KSGT 0121-KSGT 0123, internal moulds of left and right valves ; KSGT0124-0125, external moulds of left and right valves ; all from Osaka of Mie-machi, Oita Prefecture.

*Measurements* : -(in mm)

Specimen	Length	Height	Thickness
KSGT 0121, l. int. mould.	14.5	11.5	-
KSGT 0122, r. int. mould.	12.5	12.0	-
KSGT 0123, l. valve.	17.0	16.5	-
KSGT 0124, r. ext. mould.	19.5	16.0	-

*Remarks* : - Numerous specimens consisted of the internal and external moulds, are collected from Osaka Area. The specimens are safely referable to *Pseudopisidium inflata* TASHIRO and KOZAI (1989), from the Aptian Hagino Formation of the Nankai Group in Shikoku, in their very inflated valves and narrow hinge plates.

*Occurrence* : - OS06

Order Myoida  
Suborder Myina  
Superfamily Myacea  
Family Corbulidae  
Subfamily Caestocorbulinae  
Genus *Caestocorbula* VINCENT, 1910  
*Caestocorbula* sp.

Plate 5, Figs. 22, 23; Plate 6, Fig. 8

*Material* : - KSGT 0107-KSGT 0109, internal moulds of left and right valves ; KSGT 0110-KSGT 0111, external moulds of left and right valves ; all from Osaka of Mie-machi, Oita Prefecture.

*Remarks* : - Many specimens, measured 10mm or less in length, classified into the genus *Caestocorbula*, are collected from the Osaka Formation. Since they are wrong for the preservation, the specific position of the specimens was not able to determined in this study.

*Occurrence* : - Loc. OS06

Superfamily Hiatellacea  
Family Hiatellidae  
Genus *Panopea* MENARD, 1807  
Subgenus *Myopsis* AGASSIZ, 1840  
*Panopea (Myopsis)* sp. aff. *P. (M.) plicata* (SOWERBY)  
Plate 6, Figs. 9,10.

*Material* : - KSGT 0112 and KSGT 0113, internal mould of right valves, from Osaka of Mie-machi, Ono-gun, Oita Prefecture.

*Remarks* : - A specimen, KSGT 0112, measured 32.0mm in length and 16.6mm in height. Another specimen, KSGT 0113, is imperfect for to measured. This specimen safely classified into the same species with *Panopea (Myopsis)* aff. *plicata* (SOWERBY), from the Miyako Group in Northeast Japan (HAYAMI, 1966) and the Nankai Group in Shikoku (TASHIRO and KOZAI, 1991), in its the same features already mentioned in detail by HAYAMI (1966 ; also see, TASHIRO and KOZAI, 1991).

*Occurrence* : - Loc. OS06

Order Hippuritoida  
Superfamily Hippuritacea  
Family Caprotinidae  
Genus *Pachytraga* PAQUIER, 1900  
*Pachytraga japonica* OKUBO and MATSUSHIMA  
Plate 6, Figs. 4,5

1959, *Pachytraga japonica* OKUBO and MATSUSHIMA *Chikyu-kagaku*, No. 42, p. 2, text-figs. 1-7  
1975, *Pachytraga japonica* OKUBO and MATSUSHIMA ; HAYAMI, *Univ. Mus. Univ. Tokyo, Bull.* 10,

p. 148

*Material* : - KSGT 0114 - KSGT 0113, internal moulds of upper valves ; from Osaka of Mie, Oita Prefecture.

*Measurements* ; -

Specimen	Length	Height
KSGT 0114, int. mould	83.8	53.4
KSGT 0115, int. mould	91.5	74.6
KSGT 0116, int. mould	52.0+	53.2

*Remarks* : - Abundant specimens had been collected by one of us, TANAKA (1989). The specimens are composed of a colonial assemblage bed in the calcareous sandstone. The specimens probably conspecific with *Pachytraga japonica* OKUBO and MATSUSHIMA (1959), from the Shimanto Belt of the Akaishi Mountains in Central Japan, in its complicated shell structures.

*Occurrence* : - Locs. OS07, OS02 and Hg01

Subclass Anomalodesnata  
Order Pholadomyoidea  
Superfamily Pholadomyacea  
Family Pholadomyidae  
Genus *Pholadomya* SOWERBY, 1823  
*Pholadomya* (s. l.) sp.  
Plate 6, Fig. 6

1966, *Pholadomya* sp. B indet ; HAYAMI, *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, Vol. 17, no. 3, p. 162, pl. 24, figs. 5-6

*Material* : - KSGT 0117 and KSGT 0118, conjoined valves, from Osaka of Mie, Oita Prefecture.

*Measurements* : - (in mm)

Specimen	Length	Height	Thickness
KSGT 0117, conj. valves	39.0	24.0	20.1/2
KSGT 0118, r. valve	35.0	22.0	8.9

*Remarks* : - From the Yatsushiro Formation of the Pre-Sotoizumi Group, one of us, Tashiro, had been collected several specimens which were undoubtedly offerable to the specimens from this Osaka Formation as the same species (TASHIRO and IKEDA, 1987). The specimens from Yatsushiro and Osaka Formations are identical with *Pholadomya* sp. of which was already described from the Yatsushiro Formation, by HAYAMI (1966). The generic and specific positions of the specimens are uncertain, because of the inner features of the specimens not observable.

*Occurrence* : - Loc. OS06

Superfamily Pandoracea  
Family Laternulidae  
Genus *Plectomya* DE LORIOL, 1868  
*Plectomya* sp.

*Material* : - KSGT 0119, external mould of right valve ; from Osaka of Mie, Oita Prefecture.

*Remarks* : - Single specimen, KSGT 0119, 14.0mm high and longer than 16.0mm in length, was present for this study. This is offerable to a member of genus *Plectomya*, because of its elliptical outline and concentric ribs on the surface.

*Occurrence* : - Loc. OS02

Genus *Platymyoidea* COX, 1964

*Platymyoidea nipponica* TASHIRO and MATSUDA

Plate 6, Figs. 12

1985, *Platymyoidea nipponica* TASHIRO and MATSUDA ; in TASHIRO, MATSUDA and TANAKA ;  
*Mem. Fac. Sci. Kochi Univ.*, Ser. E, Vols. 5-6, p. 17, pl. 3, figs. 24-25

*Material* : - KSGT 0120, internal mould of left valve, from Osaka of Mie, Oita Prefecture.

*Remarks* : - Present specimens, KSGT 0120, 35.0mm in length and 18.0mm in height, is safely offerable to *Platymyoidea nipponica* TASHIRO and MATSUDA (1985), from the Sukubo Formation (TANAKA, 1989) of the Pre-Sotoizumi Group in Oita Prefecture, in its the same specific features which were already mentioned in detail by TASHIRO and MATSUDA (1985).

*Occurrence* : - Loc. OS02

### Concluding remarks on the bivalve fauna of the Pre-Sotoizumi Group

When one of us (TANAKA, 1989) summarized the Mesozoic Formations and their molluscan faunas in the Haidateyama Area, the characters of the Osaka and Tamarimizu faunas could hardly be made clear, because described species were poor in those day. In this present study, the occurrence of 38 bivalve species are confirmed in these formations, and it becomes possible for us to compare the specific assemblage with nearly contemporaneous (Barremian-Lower Albian) faunas of these regions. The distribution of bivalve species of the Osaka and Tamarimizu faunas, is illustrated in Table 3.

Many common species, 15 species of 14 genera, are known between Osaka-Tamarimizu fauna and Kesado fauna of the Pre-Sotoizumi Group of the Southwest Japan. The numbers of the common species between faunas of the Osaka-Tamarimizu and Kesado, occupies about three-eighth of all described species from Osaka-Tamarimizu fauna.

The bivalve fauna of the Osaka and Tamarimizu Formations closely resembles to that of the Nankai Group at the Sanbosan Belt of Chichibu Terrain in southwest Japan, which defined by TASHIRO (1993). There are, by count, 15 common species between them.

The fauna from the Miyako Group distributed in Northeast Japan, resembles Osaka-Tamarimizu fauna in its many common species, 12 in numbers, in spite of the former apart from the latter in about 1100 or more kilometers in the geographic distance, and of the difference of the geological ages shown mainly Latest Aptian to Albian in the former but considerable to Late Barremian to Early Albian in latter.

The Osaka-Tamarimizu fauna is also concerned with the Doganaro fauna of the Northern-Shimantogawa Group in the Shimanto Terrain, because of the occurrence of common species in each, such as *Gervillia forbesiana* (FORBES), *Neithea kochiensis* HAYAMI, *Protocardia (Protocardia) amanoi* TASHIRO and MATSUDA, *Pterotrignia (Pterotrignia) aff. pocilliformis* (YOKOYAMA) and *Xenocardita amanoi* HAYAMI.

Another resemble faunas with the Osaka-Tamarimizu fauna, are cropping out several localities forming very narrow distributions, such as the so-called Ishido Formation at Ohinata area in Sanchu, Central Japan and the so-called Choshi Group at south of Inubozaki, in Chiba Prefecture, Central Japan, the Sukubo Formation at Haidateyama area, Eastern Kyushu, the Takahata Formation at Kuraoka area, Central Kyushu, the Yatsushiro Formation at Yatsushiro area, Western Kyushu.

TABLE 3. DISTRIBUTION OF THE BIVALVE SPECIES OF THE OSAKA AND TAMARIMIZU FAUNAS

Species of Kesado and Tamarimizu Faunas	K	Y	S	M	N	T	D	I	Mo
<i>Cucullaea (Ideonearca) acuticarinata</i>	○			○	○				
<i>Glycymeris (Hanaia) desillineata</i>	○			○	○				
<i>Pinna</i> sp. <i>P. robinaldina</i>			○					○	○
<i>Gervillaria</i> sp. cf. <i>Galaeformis</i>	○			○	○		○		
<i>Gervillaria miyakoensis</i>				○		○			
<i>Gervillia forbesiana</i>	○	○		○	○		○		○
<i>Isognomon choshiensis</i>								○	
<i>Entolium ikedai</i>	○					○			
<i>Neithea syriaca amanoi</i>	○				○		○	○	
<i>Neithea (Neithea) kochiensis</i>	○						○		
<i>Astarte (Astarte) yatsushiroensis</i>		○				○			
<i>Astarte (Yabea) akatui</i>		○	○						
<i>Anthonya igenokiensis</i>					○				
<i>Eriphyla pulchella</i>				○					
<i>Opis haginoensis</i>					○				
<i>Ptychomya densicostata</i>	○			○					
<i>Ptychomya hasei</i>									
<i>Protocardia (Protocardia) amanoi</i>					○		○		
<i>Nemocardium yatsushiroensis</i>		○							
<i>Globocardium sphaeroideum</i>	○			○		○		○	
<i>Spondylus decoratus</i>				○					
<i>Limatula nagaai</i>	○	○		○				○	
<i>Chlamys</i> sp. cf. <i>C. robinaldina</i>				○					
<i>Amphidonte subhariotoidea</i>						○			
<i>Rastellum (Arctostrea) carinatum</i>						○			
<i>Nipponitrigonia plicata</i>	○								
<i>Pterotrigonia</i> (s. s.) aff. <i>pocilliformis</i>	○				○		○	○	
<i>Pterotrigonia yokoyamai</i>			○		○				
<i>Pterotrigonia bungoensis</i>									
<i>Xenocardita amanoi</i>	○				○		○	○	
<i>Linearia</i> ap	○				○ ?				
<i>Resatrix bungoensis</i>									
<i>Pseudopisidium inflata</i>					○				
<i>Caestocorbula</i> sp.					○ ?	○			
<i>Panopea (Myopsis) sp. aff. P. (M.) plicata</i>				○	○				
<i>Pachytraga japonica</i>	○ ?								
<i>Pholadomya</i> sp.		○							
<i>Plectomya</i> sp.			○ ?						
<i>Platymyoidea nipponica</i>			○						

K : Kesado Formation, Y : Yatsushiro Formation, S : Sukubo Formation, M : Miyako Formation, N : Nankai Group, T : Takahata Formation, D : Doganaro Formation, I : Ishido Formation and Choshi Group, Mo : Monobegawa Group

The Haidateyama Formation which probably correlated with the Monobe Formation of the Monobegawa Group, is distributed in the Haidateyama area, separates from the Osaka Formation with only about 3 km in the geographical distance. The geological ages of the Haidateyama and Monobe Formations are very closed or nearly the same with the age of the lower member of the Osaka Formation, considerable from Late Barremian to Early Aptian. However, Monobegawa fauna (Haidateyama fauna : see Table 3), entirely differs from Osaka-Tamarimizu fauna, except for and *Gervillia forbesiana* D'ORBIGNY, which were well known as the cosmopolitan species, in point off specific order. On the other hand, Monobegawa fauna is akin to Osaka-Tamarimizu fauna in the compositions of the generic order of bivalves, except several genera, such as *Cucullaea*, *Globocardium*, *Xenocardita* and *Plectomya*, which were known in general as the lower latitude livelihoods. It seems Monobegawa fauna was developed in the basin which was a great deal of distance apart in latitude from the basin of Osaka-Tamarimizu fauna. It is suggested that the different paleobiogeographical areas was existed between them.

Furthermore, the Osaka fauna contains *Pachytraga* sp. (hippuritids), *Archimedeia* cf. *rigida* (gastropods) and *Pygurus* (*P.*) *posteroexpansus* (echinoids) together with hexacorals and bryozoans. These fossils, as well as the lithologic characters, may suggest that the Osaka Formation has some resemblance to the Urganian facies of Warm subtropical shallow-sea condition. The authers beleive that they are great valve for interpretation off paleogeography and correlation.

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#### Explanation of Plate 1

##### *Neithea kochiensis* HAYAMI

- Fig. 1: Lateral view of right valve, gum cast of external mould, KSGT 0033, x 1; Loc. OS01
- Fig. 2: Lateral view of right internal mould, KSGT 0034, x 1; Loc. Ditto.
- Fig. 3: Lateral view of left external mould, KSGT 0036, x 1; Loc. Ditto.
- Fig. 4: Lateral view of right valve, gum cast of external mould, KSGT 0032, x 0.8; Loc. Ditto.

##### *Neithea syriaca amanoi* HAYAMI

- Fig. 5: Lateral view of left valve, gum cast of external mould, KSGT 0031, x 1.5; Loc. Ta501
- Fig. 6: Lateral view of right valve, gum cast of external mould, KSGT 0029, x 1.5; Loc. Ditto.

##### *Entolium ikedai* TASHIRO

- Fig. 7: Inner view of left(?) valve, gum cast of internal mould, KSGT 0027, x 1; Loc. OS02

##### *Cuculaea (Idonearca) acticarinata* NAGAO

- Fig. 8: Lateral view of right valve, gum cast of external mould, KSGT 0001, x 1; Loc. Ta501
- Fig. 9: Dorsal view of the same specimen with KSGT 0001, x 1

#### Explanation of Plate 2

##### *Chlamys* sp. aff. *C. robinardina* D'ORBIGNY

- Figs. 1-3: Lateral views of left valves, gum casts of external moulds, KSGT 0041 (Fig. 1), KSGT 0042 (Fig2), KSGT 0043(Fig. 3), x 1.2; Loc. Ta501

##### *Glycymeris (Hanaia) densicostata* NAGAO

- Fig. 4: Internal mould of left valve, KSGT 0007, x 2; Loc. Ta501 *Gervillaria* sp. cf. *G. alaeformis* d'Orbigny
- Fig. 5: Lateral view of view of left valve, gum cast of external mould, KSGT0009, x 1.2; Loc. OS07

##### *Gervillaria miyakoensis* NAGAO

- Fig. 6: internal mould of left valve, KSGT 0014, x 0.8; Loc. OS06
- Fig. 7: internal mould of right valve, KSGT 0019, x 1; Loc. OS07

##### *Isognomon choshiensis* HAYAMI

- Fig. 8: Internal mould of right valve, KSGT 0024, x 1.2; Loc. OS08

Fig. 9 : Internal mould of left valve, KSGT 0023, x 0.8 ; Loc. OS06

### Explanation of Plate 3

*Pterotrignia bungoensis* TASHIRO and TANAKA, n. sp.

Fig. 1 : Lateral view of right valve, gum cast of external mould, x 1 ; Loc. OS04

Fig. 2 : Lateral view of left valve, the same specimen with fig. 1, x 1

Fig. 3 : Dorsal view of the same specimen with fig. 1, x 1

Fig. 4 : Dorsal view of left valve, gum cast of external mould, KSGT 0066, x 1.2 ; Loc. OS02

Fig. 5 : Lateral view of the same specimen with KSGT 0066, x 1

Fig. 6 : Internal mould of right valve, KSGT 0064, x 1 ; Loc. OS04

*Cucullaea (Idonearca) acticarinata* NAGAO

Fig. 7 : Internal mould of left valve, KSGT 0006, x 1 ; Loc. Ta501

*Rastellum (Arctostrea)* sp., aff. *R. (A.) carinatum* (LAMARCK)

Figs. 8 and 9 : Lateral views of right(?) valves, KSGT 0050 (Fig. 8), KSGT 0052 (Fig. 9), x 1.2 ; Loc. OS03

*Pterotrignia yokoyamai* (YEHARA)

Fig. 10 : Lateral view of right valve, KSGT 0061, x 1 : Loc. Ta502

*Gervillaia* sp. aff. *G. alaeaformis* D'ORBIGNY

Fig. 11 : Internal mould of left valve, KSGT 0010, x 1 : OS03

### Explanation of Plate 4

*Ptycomya densicostata* NAGAO

Figs. 1 and, 2 : Lateral views of right valves, gum casts of external moulds, x 1, ; Loc. OS02

Fig. 3 : Inner view of left valve, gum cast of internal mould, KSGT 0089, x 1 ; Loc. Ditto

Fig. 4 : Lateral view of right valve, gum cast of external mould, KSGT 0091, x 1 ; Loc. OS03

*Ptycomya hasei* TANAKA and TASHIRO, n. sp.

Fig. 5 : Inner view of right valve, gum cast of internal mould, KSGT 0093, x 1 ; Loc. OS03

Fig. 6 : Lateral view of right valve, gum cast of external mould, KSGT 0095, x 1 ; Loc. Ditto

Fig. 7 : Inner view of left valve, gum cast of internal mould, KSGT 0094, x 1 ; Loc. Ditto

Fig. 8 : inner view of left valve, gum cast of internal mould, x 1 ; Loc. Ditto

Fig. 9 : Lateral view of right valve, gum cast of external mould, x 1 ; Loc. Ditto

*Astarte (Astarte) yatsushiroensis* TASHIRO

Fig. 10 ; Lateral view of right valve, gum cast of external mould, KSGT 0069, x 1.2 ; Loc. OS06

Fig. 11 : Dorsal view of conjoined valves, gum cast of external mould, KSGT , x 1.2 ; Loc. Ditto

Fig. 12 : Inner view of left valve, gum cast of internal mould, KSGT 0075, x 1 ; Loc. Ditto

Fig. 13 : Inner view of right valve, gum cast of internal mould, KSGT 0074, x 1 ; Loc. Ditto

Fig. 14 : Lateral view of left valve, gum cast of external mould, KSGT 0071, x 1 : Loc. Ditto

*Anthonya igenokiensis* TASHIRO and KOZAI

Fig. 15 : Internal mould of left valve, KSGT 0081, x 1 : Loc. OS06

### Explanation of Plate 5

*Resatrix bungoensis* TASHIRO and TANAKA, n. sp.

Fig. 1 : Lateral view of right valve, gum cast of external mould, KSGT 0106, x 1.2 ; Loc. OS

Fig. 2 : Inner view of right valve, gum cast of internal mould, KSGT 0102, x 1.2 ; Loc. Ditto

Fig. 3 : Inner view of left valve, gum cast of internal mould, KSGT 0101, x 1.2 ; Loc. Ditto

Fig. 4 : Lateral view of right valve, gum cast of external mould, x 1 ; Loc. Ditto

*Astarte (Yabea) akatsui* HAYAMI

Fig. 5: Lateral view of right valve, KSGT 0079, x 1.2; Loc. Ta502

Fig. 6: Inner view of left valve, gum cast of internal mould, KSGT 0080, x 1.2; Loc. Ditto

*Pseudopisidium inflata* TASHIRO and KOZAI

Fig. 7: Inner view of right valve, gum cast of internal mould, KSGT 0121, x 2; Loc. OS06

Fig. 8: Inner view of left valve, gum cast of internal mould, KSGT 0122, x 2; Loc. Ditto

Fig. 9: Internal mould of left valve, KSGT 0123, x 1; Loc. Ditto

Fig. 10: Lateral view of right valve, gum cast of external mould, KSGT 0124, x 1; Loc. Ditto

*Niponitrigonia plicata* KOBAYASHI and NAKANO

Figs. 11, 12: Internal moulds of left valves, KSGT 0056 (Fig. 11), KSGT 0057 (Fig. 12), x 1; Loc. OS04

Fig. 13: Immature stage of left valve, gum cast of external mould, x1; Loc. Ditto

Fig. 14: Lateral view of right valve, gum cast of external mould, KSGT 0058, x 1; Loc. Ditto

*Protocardia amanoi* TASHIRO and MATSUDA

Fig. 15: Lateral view of right valve, gum cast of external mould, KSGT 0126, x 1.2, Loc. I104

Fig. 16: Lateral view of right valve, gum cast of external mould, KSGT 0127, x 1.2; Loc. Ditto

*Globocardium sphaeroideum* (FORBES)

Fig. 17: Lateral view of left valve, gum cast of external mould, KSGT 0098, x 1; Loc. I104

*Nemocardium yatsushiroense* HAYAMI

Fig. 18: Lateral view of imperfect left valve, gum cast of external mould, KSGT 0096, x 1; Loc. OS05

*Xenocardita amanoi* (HAYAMI)

Figs. 19 and 21: Lateral views of left valves, x 1.2; Loc. Ta501

Fig. 20: Lateral view of left valve, gum cast of external mould, KSGT 0068, x 1.2; Loc. OS06

*Caestocorbula* sp.

Figs. 22 and 23: Lateral views of right valves, gum casts of external moulds, KSGT 0110 (Fig. 22) and KSGT 0111 (Fig. 23), x 3; Loc. OS06

### Explanation of Plate 6

*Gervillaria miyakoensis* (NAGAO)

Fig. 1: Lateral view of imperfect left valve, gum cast of external mould, x 1; Loc. OS06

*Gervillia forbesiana* D'ORBIGNY

Fig. 2: Lateral view of left valve, KSGT 0021, x 1; Loc. OS06

*Amphiodonte subhariotoidea* (NAGAO)

Fig. 3: Inner view of left (?) valve, gum cast of internal mould, KSGT 0049, x 1; Loc. OS03

*Pachytraga japonica* OKUBO and MATSUSHIMA

Fig. 4: Internal mould of the lid-valve of shell, KSGT 0114, x 0.7; Loc. OS07

Fig. 5: Internal mould of the lid-valve of shell, KSGT 0116, x 0.9; Loc. OS02

*Pholadomya* (s. l.) sp.

Fig. 6: Lateral view of left valve, KSGT 0118, x 1; Loc. OS06

*Resatrix bungoensis* TASHIRO and TANAKA, n. sp.

Fig. 7: Internal mould of left valve, KSGT 0104, x 2; Loc. OS02

*Caestocorbula* sp.

Fig. 8: External mould of left valve, KSGT 0110, x 2; Loc. OS06

*Nopea (Myopsis)* sp. aff. *P. (M.) plicata* (SOWERBY)

Fig. 9: Internal mould of right valve, KGST 0113, x 1.5; Loc. OS06

Fig. 10: Internal mould of right valve, KGST 0112, x 2; Loc. Ditto

*Linearia* sp.

Fig. 11: External mould of left valve, KGST 0100, x 0.5; Loc. OS04

*Platmyoidea nipponica* TASHIRO and MATSUDA

Fig. 12: Internal mould of left valve, KGST 0120, x 1.8; Loc. OS02

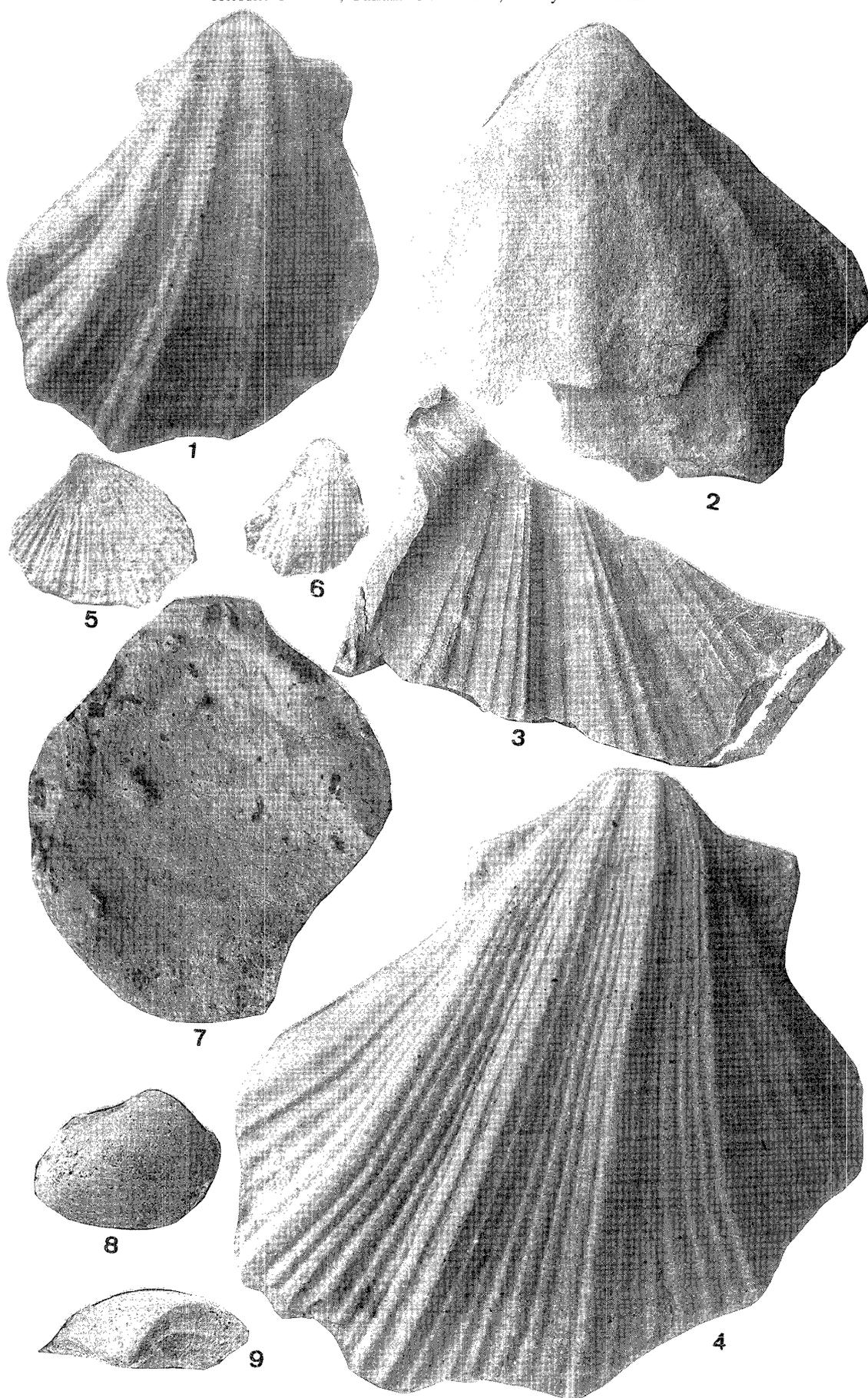


Plate 1

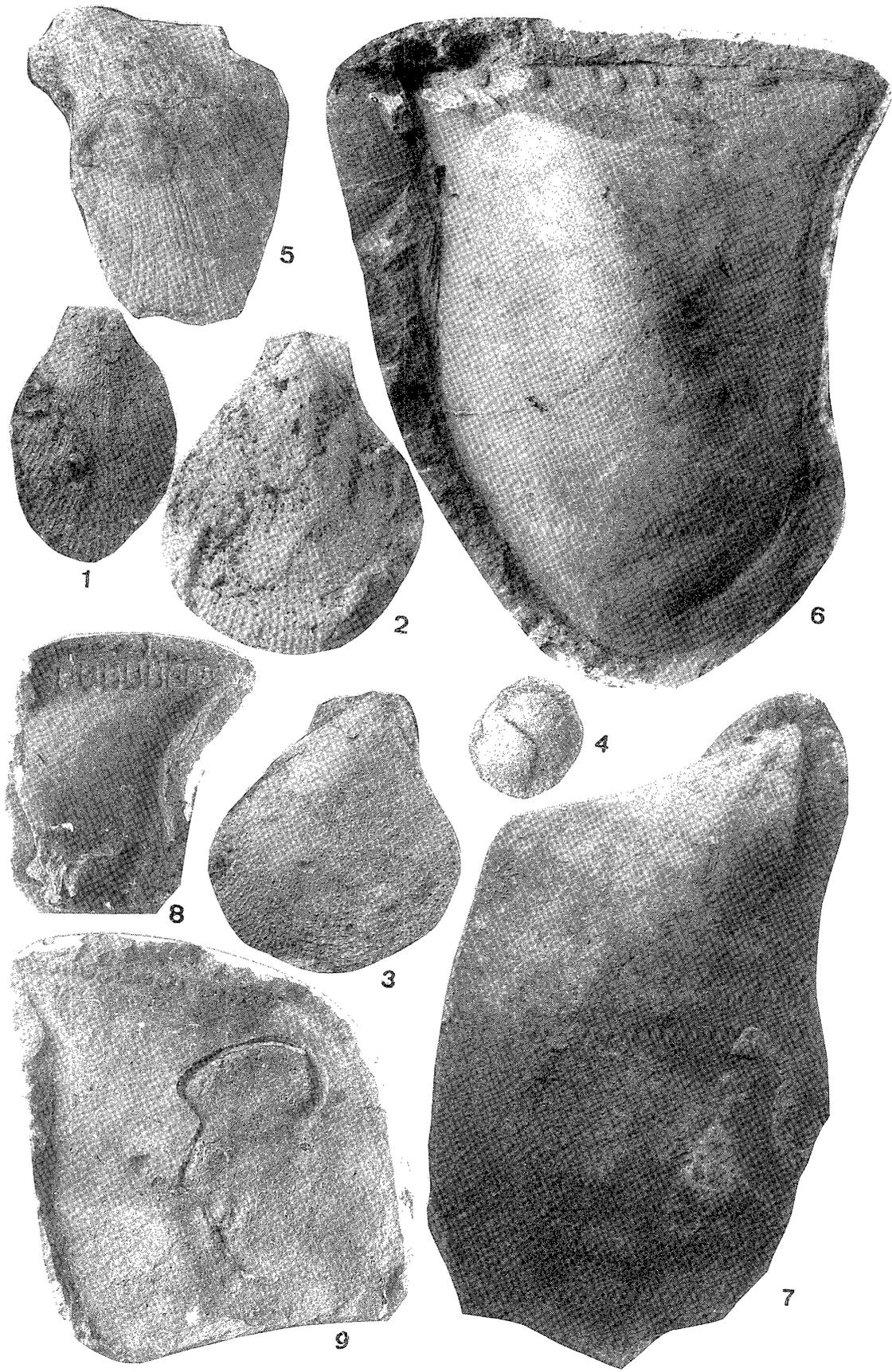


Plate 2

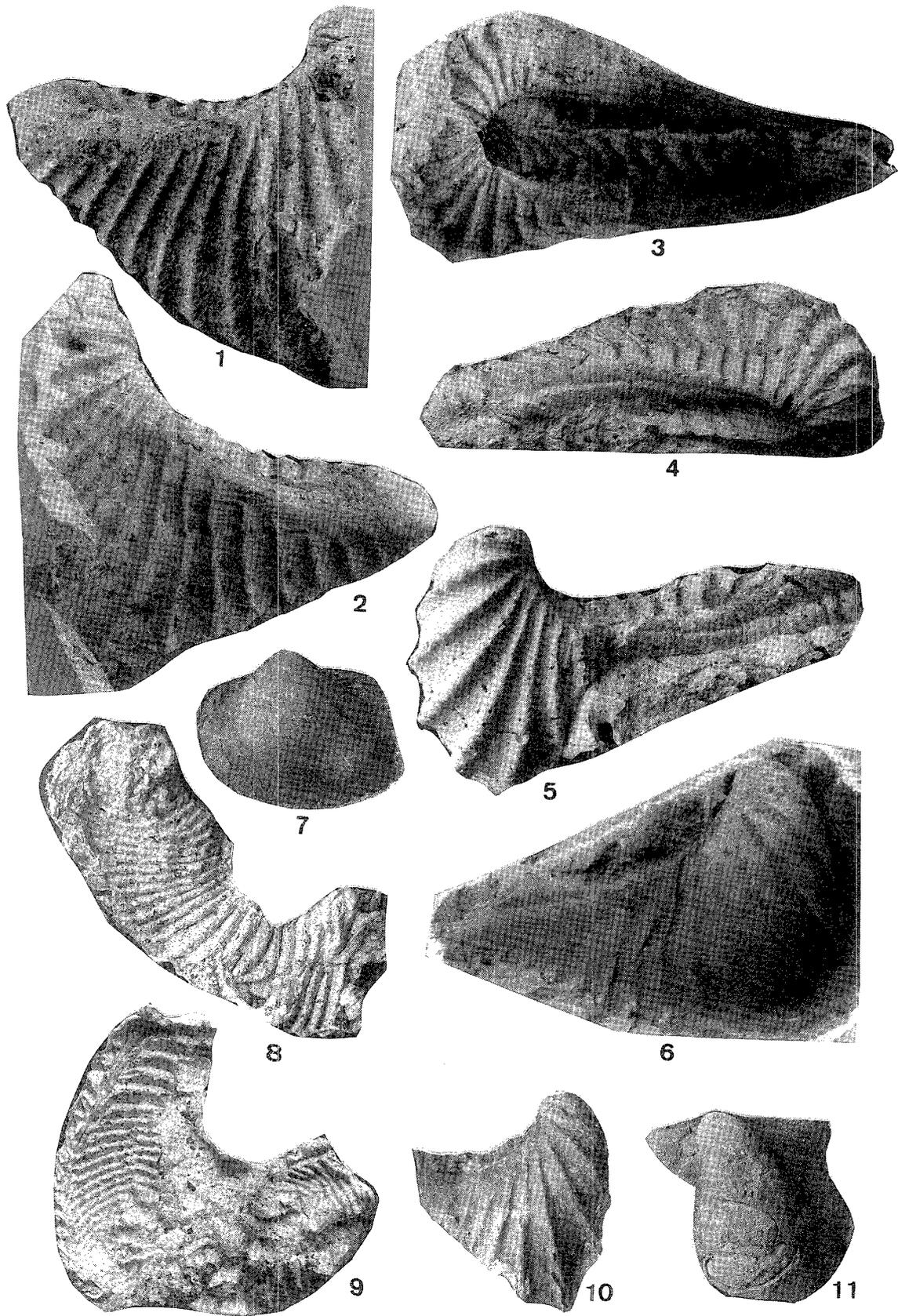


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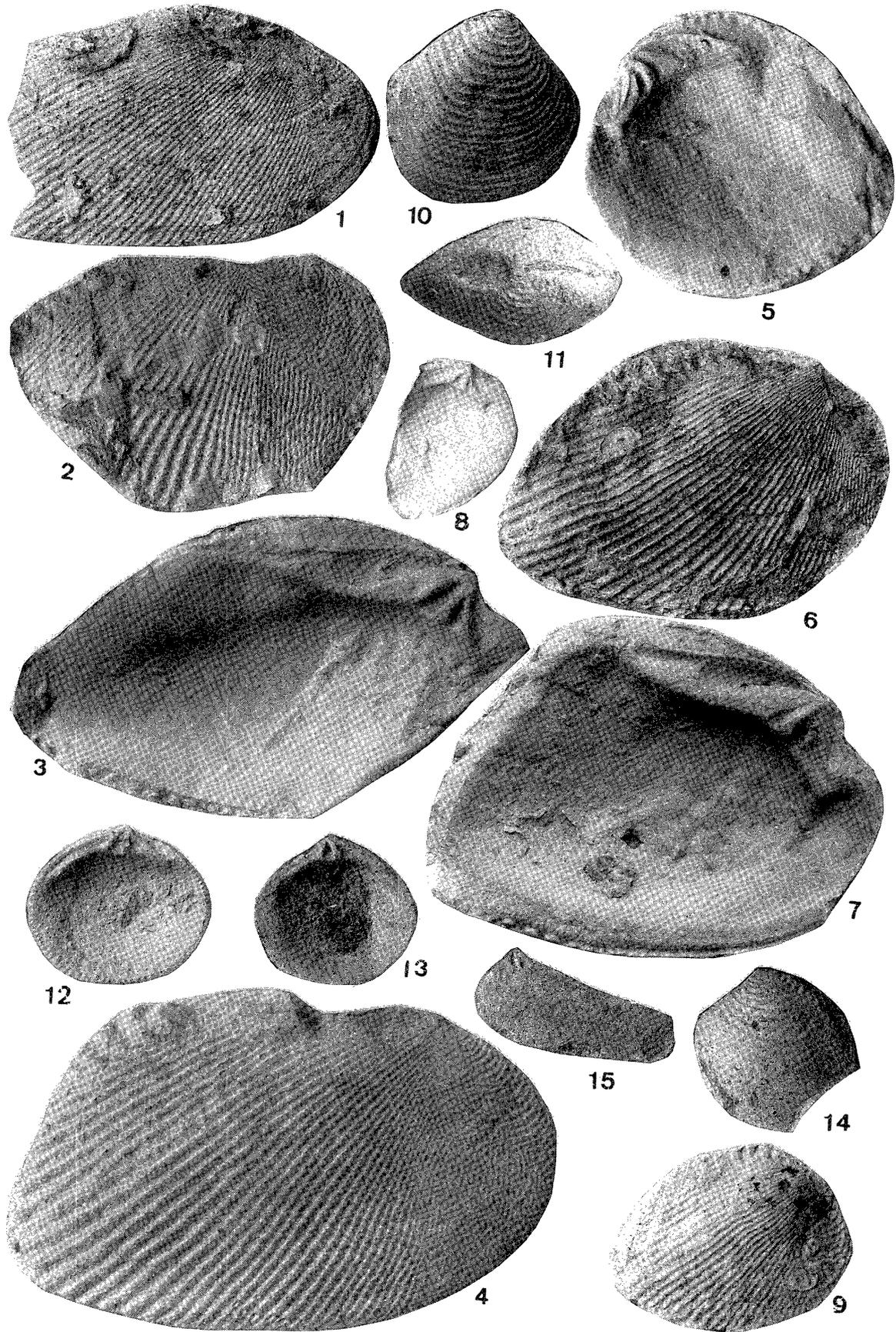


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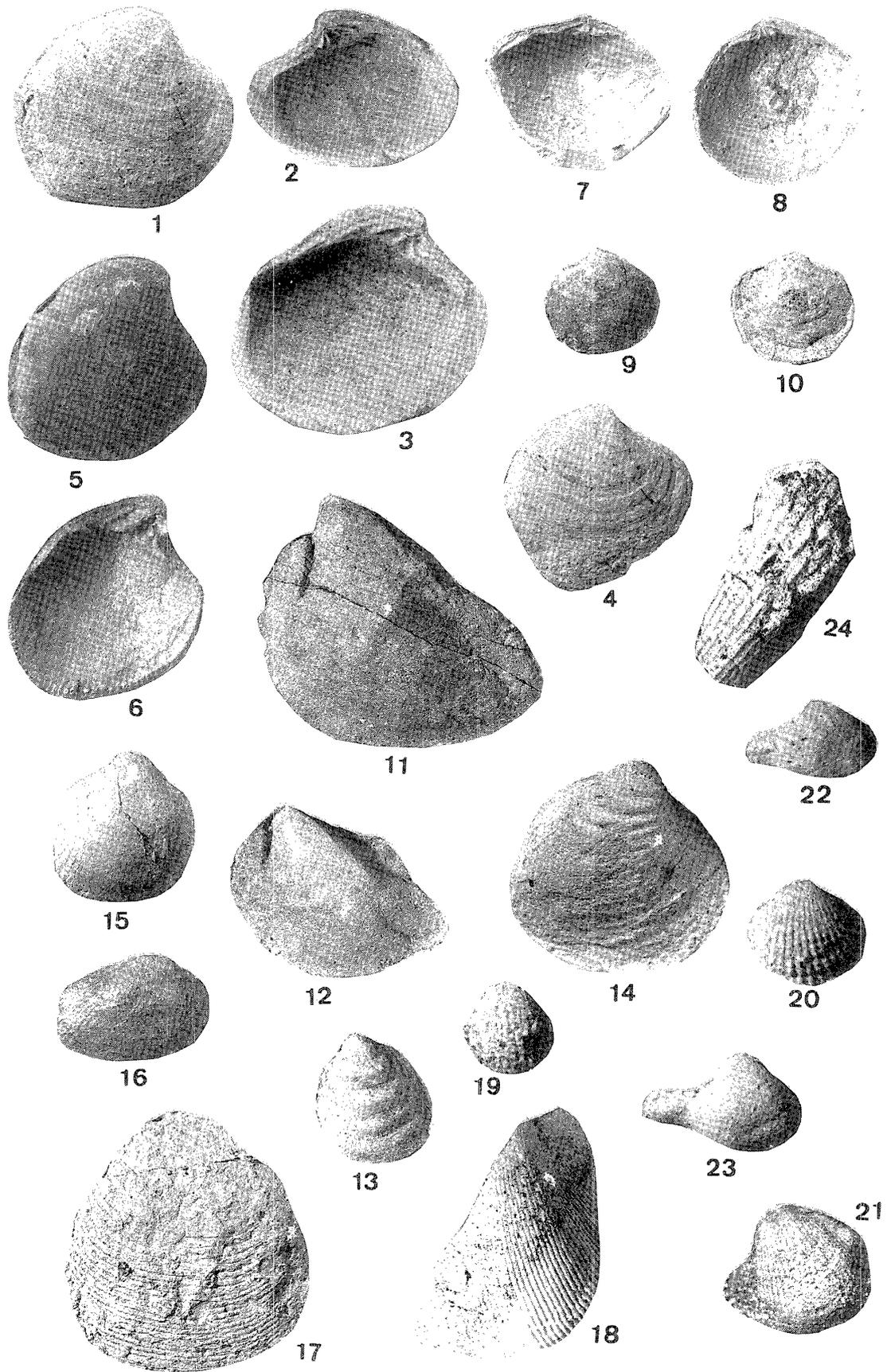


Plate 5

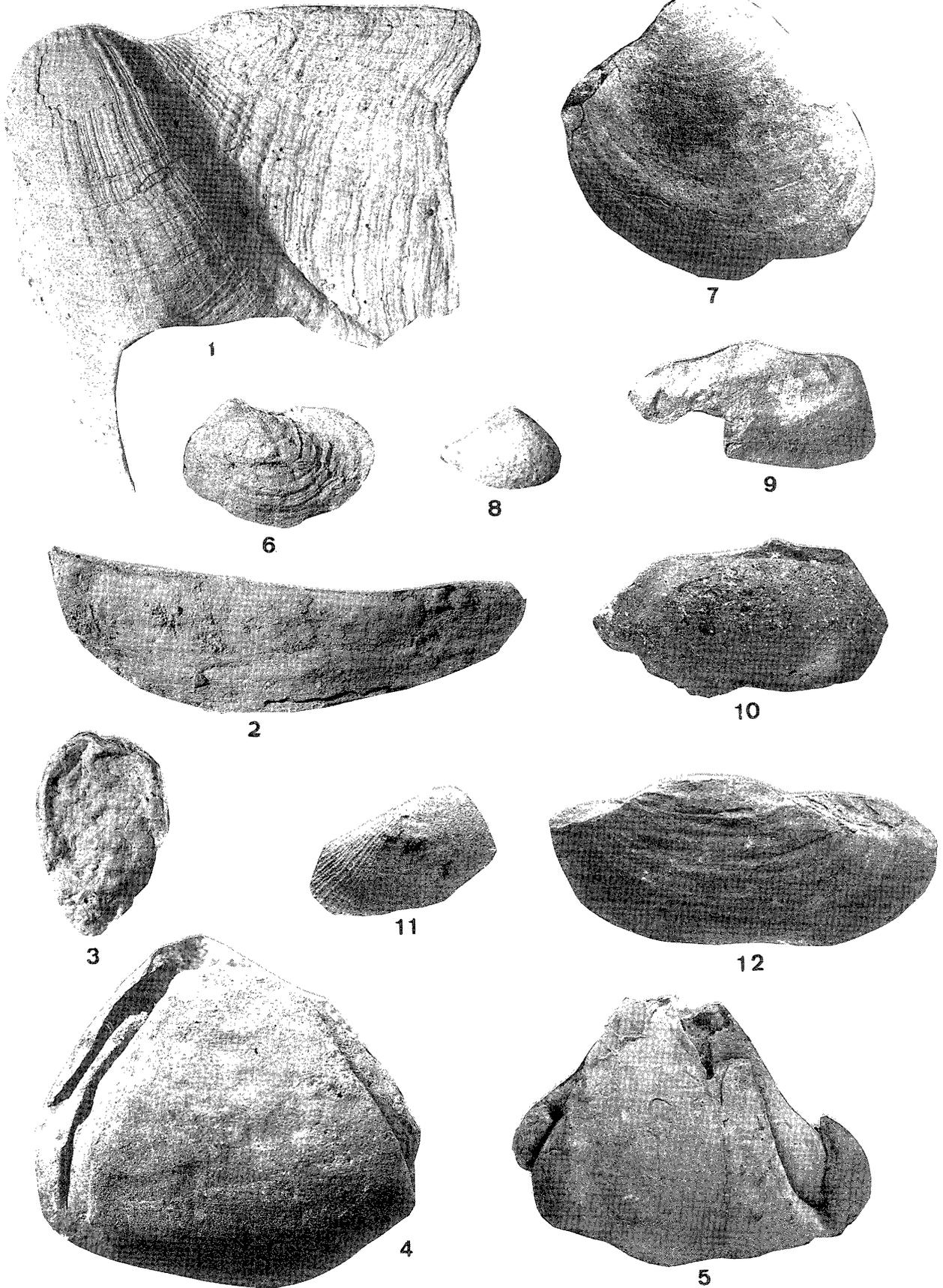


Plate 6