

## Lower Cretaceous Marine Pelecypods of Japan Part III

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## Lower Cretaceous Marine Pelecypods of Japan

### Part III

By

Itaru HAYAMI

### Abstract

This is a serial comprehensive study on the Lower Cretaceous pelecypods of Japan, except for the trioniids, the pachyodonts and the brackish- and fresh-water species. In the present part 19 species belonging to the Asthenodontida and the Eudesmodontida are described systematically on the basis of many specimens which were collected from various sedimentary areas by stratigraphers and palaeontologists including myself. 4 new species are proposed.

As the result of this study it is recognized that the Aritan ( $\div$  upper Neocomian) and the Miyakoan (except for the uppermost part) ( $\div$  Aptian—Albian) pelecypods are represented by about 50 and about 130 species respectively. Their stratigraphic occurrence are noted, and their faunal significance is discussed in some detail. The pelecypods of the two epochs are more or less clearly distinguishable from the Berriasian and earlier ones represented in Japan by the “Torinosu-type” fauna and also from the post-Albian ones which are well known in the uppermost Miyakoan and Gyliakian of Hokkaido and Kyushu. The faunal resemblance between the Japanese Aptian and the Lower Greensand of England is especially worthy of note.

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#### 4. Systematic Descriptions [continued from Part II]

Order Asthenodontida

Superfamily Hiatellacea

Family Hiatellidae

Genus *Panopea* MÉNARD DE LA GROYE, 1807

(=*Glycymeris* LAMARCK, 1799, non DA COSTA, 1778;

*Panopea* auct.; *Panopaea* auct.)

*Type-species*.—*Panopea aldrovandi* MÉNARD DE LA GROYE, 1807, Recent, Mediterranean Sea (monotypy).

Subgenus *Myopsis* AGASSIZ, 1840

*Type-species.*—*Mya mandibula* SOWERBY, 1813, Cretaceous, England (designated by COX, 1964).

*Remarks.*—*Myopsis* AGASSIZ, 1840, the type-species of which was recently designated by COX (1964), is applicable for a number of Cretaceous species of *Panopea*. *Myopsis* appears to be distinguishable from *Panopea* (s. s.) by the narrower, more prominent and more anteriorly placed umbo.

*Panopea (Myopsis) plicata* (SOWERBY)

## Plate 22, Figures 1–7

- 1823. *Mya plicata* SOWERBY, Min. Conch. Great Britain, Vol. 5, p. 20, pl. 419, fig. 3.
- 1835. *Panopaea plicata*, SOWERBY, *Ibid.*, Vol. 6, index, p. 241.
- 1852. *Panopaea plicata*, PICTET and ROUX, Moll. fossil. verts de Genève, p. 399, pl. 28, fig. 2.
- 1852. *Panopaea rhodani* PICTET and ROUX, *Ibid.*, p. 400, pl. 28, fig. 3.
- 1858. *Panopaea plicata*, PICTET and RENEVIER, Fossil. du terrain aptien, pp. 56, 175, pl. 6, figs. 1, 2.
- 1909. *Panopea gurgitis*, WOODS, Monogr. Cret. Lamell. England, Vol. 2, p. 222, pl. 35, figs. 9–14, pl. 36, figs. 1–8 (non Brongniart, 1822).
- 1926. *Panopea* sp. aff. *gurgites* (BRONGNIART), YABE, NAGAO and SHIMIZU, *Sci. Rep. Tohoku Imp. Univ.*, Ser. 2, Vol. 9, Pt. 3, p. 55, pl. 12, figs. 10, 15, 19, 20. (sic)
- 1934. *Panope* sp. aff. *gurgitis* (BRONGNIART), NAGAO, *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 231, pl. 31, figs. 10, 14.
- 1940. *Panope* cf. *gurgitis* (BRONGNIART), IMLAY, *Bull. Geol. Soc. America*, Vol. 51, p. 154, pl. 6, figs. 7, 8.
- 1954. *Panopea gurgitis*, COX, *Jour. Paleont.*, Vol. 28, No. 5, p. 634, pl. 67, fig. 9 (non BRONGNIART, 1822).
- 1957. *Panopea* (?) sp., AMANO, *Kumamoto Jour. Sci.*, Ser. B, Sec. 1, Vol. 2, No. 2, p. 106, pl. 2, fig. 12.

*Material.*—Ten specimens (GK. H6535–GK. H6540, GK. H6711–GK. H6714) from the Miyako area (HANAI and HAYAMI coll.) are concerned with the description below.

*Description.*—Shell small- or medium-sized for the genus, equivalve, very inequilateral, transversely elongated, oblong, strongly inflated; length slightly smaller than twice the height; test very thin; antero-dorsal margin short, faintly concave in front of the umbo, passing gradually into the anterior margin; postero-dorsal margin long, nearly straight, forming an obtuse angle at the junction with the siphonal margin; siphonal margin rounded, widely gaping; umbo comparatively narrow, incurved, rising a little above the dorsal margin, orthogyrous, placed at about one-third of shell-length from the anterior extremity; a blunt carina extending from the umbo to the antero-ventral margin, defining a steep anterior slope which is usually a little concave; postero-dorsal area somewhat flattened but not clearly delimited; surface marked with irregularly spaced concentric plications on the middle and posterior areas; numerous radial threads composed of serial microscopic granules, covering the whole surface,



although they are seen only in well preserved specimens; pallial sinus broadly rounded, fairly profound; adductor impressions obscure.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Left valve (GK. H6535)	49.5+	41.0	12.0	1.21+
Left valve (GK. H6536)	55.5	33.0	9.5	1.68
Right valve (GK. H6537)	53.0	29.5	9.0	1.79
Left valve (GK. H6538)	42.0	23.5	6.5	1.79
Left valve (GK. H6539)	37.0	20.0	6.0	1.85
Left valve (GK. H6540)	87.5	49.0	15.5	1.79
Right valve (GK. H6711)	47.5+	31.0	9.0	1.53+
Right valve (GK. H6712)	23.0	12.0	3.5	1.92
Right valve (GK. H6713)	37.5	22.0	6.0	1.70
Left valve (GK. H6714)	30.5+	21.0	5.5	1.40+

*Observations and comparisons.*—The outline and the position of umbo are rather constant, although the prominence of the anterior carina is somewhat variable. In some specimens the antero-dorsal area seems slightly concave, but it is nearly flat in others. The characteristic radial ornament is clearly observed in a broken left valve (GK. H6535) and some other specimens. In a left valve, the test of which is almost exfoliated, a deeply sinuated pallial line is traceable. The hinge structure is not observable in the present material. However, a small prosocline conical umbonal tooth at the bottom of a triangular depression and a well defined post-umbonal plate for the adherence of ligament are clearly seen in one of NAGAO's specimens (1934, pl. 31, fig. 10, GH. reg. no. 6810), which was described as *Panope* aff. *gurgitis* and evidently conspecific with the present specimens.

The present specimens are specifically indistinguishable from the Lower Greensand ones described by WOODS (1909) as *Panopea gurgitis* (BRONGNIART). The radial threads bearing numerous microscopic granules may or may not be preserved in the British and Japanese specimens, but are very similar between them. Although the outline may recall that of *Pleuromya* AGASSIZ, 1842, the hinge structure is of *Panopea*-type as was ascertained by WOODS and NAGAO.

*Mya plicata* SOWERBY, 1823, and *Pholadomya neocomiensis* LEYMERIE were synonymized with *Panopea gurgitis* by WOODS (1909) as a result of his comprehensive study of this group. However, BRONGNIART's holotype of *Lutraria guargitis* was refigured by COSSMANN (1911), and its outline is quite different from WOODS' specimens of *P. gurgitis* in the much shorter antero-dorsal margin and smaller ratio of length/height. They appear to be at least specifically different. COSSMANN (1911) is probably right in stating that WOODS' lumping of *M. plicata*, *L. gurgitis* and *P. neocomiensis* in a single species is erroneous. In fact, LEYMERIE's original figure of *Pholadomya neocomiensis*, though its photographic illustration is not available at present, shows more remarkably tapering posterior area and almost closed siphonal margin. WOODS (1909) described some specimens under the name of *Panopea gurgitis* var. *neocomiensis*,

but they are probably different from LEYMERIE's original specimens and may be conspecific with WOODS' specimens of "*P. gurgitis*". Some Argentine specimens of *Panopea neocomiensis* (WEAVER, 1931) show similar radial threads, but the outline is slightly narrower than the present specimens. COX (1954) supported WOODS' treatment of this group, referring a species from the Lower Cretaceous of Trinidad to *P. gurgitis*. That species appears to be conspecific with the present specimens.

Although the synonymies among various related species of *Panopea* (*Myopsis*) from the Lower Cretaceous should be further studied on the basis of their type specimens, the present specimens are provisionally referred to *P. plicata* owing to the close resemblance to the Lower Greensand specimens. The average size of the Japanese specimens appear slightly smaller than that of WOODS', and the concentric undulations appear to be less persistent on the postero-dorsal area. But the difference may not require a subspecific distinction. *Panopea* (?) sp. of AMANO (1957) is, if not conspecific with, closely related to the present species, because the external features are quite similar to the present specimens.

*Occurrence*.—Aritan to upper Miyakoan (upper Neocomian to Albian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0017, 0018, southern coast of Hiraiga, and at loc. Hn. 0155, northern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture. Grey sandy shale of the "*Orbitolina* sandstone" of the Miyako group at loc. Hn. 6203, northeast of Raga, the same village. Similar specimens from the Ishido formation at loc. Hy. 4002, Ichinosebashi, south of Kagahara, Nakazato village, Tano County, Gumma Prefecture (ICHIKAWA and HAYAMI coll.), and also from the Hagino formation at Hagino, Mirafu village, Kami County, Kochi Prefecture.

*Panopea (Myopsis) nagaii* sp. nov.

Plate 22, Figure 8

1954. *Pleuromya nagaii* MATSUMOTO, Cretaceous System, Japan. Islands, p. 115, *nom. nud.*

*Material*.—The holotype is a bivalved internal mould (GK. H6545) collected from the Yatsushiro formation at loc. Km. 3096, southwest of Kohara, Toyo village, Yatsushiro County, Kumamoto Prefecture (KANMERA coll.). Paratypes (GK. H6544, GK. H6546) from the type locality (KANMERA and HAYAMI coll.) and another paratype (GK. H6715) from the Yuasa area (MATSUMOTO coll.).

*Description*.—Shell small for the genus, highly inequilateral, *Pleuromya*-like in outline, much longer than high, strongly inflated; antero-dorsal margin obliquely sloping down into the rounded anterior margin; postero-dorsal margin much longer, nearly horizontal or slightly concave, forming a rounded obtuse angle with the obliquely truncated posterior margin; anterior area more or less flattened and probably gaping at the extremity; umbo placed anteriorly, orthogyrus, rising a little above the dorsal margin; surface marked with irregularly spaced strong concentric folds which diminish away from the postero-dorsal area; post-umbonal plate of *Panopea*-type well developed; musculature unknown.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Holotype (GK. H6545) right in. mould	37.0	20.5	8.0	1.80
Paratype (GK. H6544) both in. mould	31.5+	22.0	18.0	1.43+
Paratype (GK. H6546) left in. mould	22.5	11.5	5.0	1.96

*Observations and comparisons.*—The present specimens are rather poorly preserved and their tests are completely eroded away. Although the shell-convexity appear unusually strong, the material may be suffered from considerable secondary deformation. The concentric folds are irregular but very strong, and the umbonal plate, the trace of which is seen in the paratype (GK. H6544), suggests *Panopea* instead of *Pleuromya*. Moreover, the anteriorly placed umbo indicates that the present species belongs to the subgenus *Myopsis*.

The present species is distinguishable from *Panopea* (*Myopsis*) *plicata* (SOWERBY, 1823) from the Aptian-Albian of England, Japan and many other areas of the world by the more prominent concentric folds, slightly more anteriorly placed umbo, stronger convexity and smaller size. Radial threads are not observable in the present material, probably because of the unfavourable preservation.

*Occurrence.*—Aritan and upper Miyakoan (upper Neocomian to Albian). Fine grey sandstone and sandy shale of the Yatsushiro formation at loc. Km. 3097, southwest of Kohara, Toyo village, Yatsushiro County, Kumamoto Prefecture. Fine sandstone of the same formation at loc. Km. 1843, north of Shimofukami, Sakamoto town, the same county. Fine grey sandstone of the Arita formation at loc. Ys. 103, west of Kumai, Yuasa town, Arita County, Wakayama Prefecture.

## Superfamily Myacea

## Family Corbulidae

Genus *Pulsidis* OTA, 1964

*Type-species.*—*Pulsidis nagatoensis* OTA, 1964, Lower Neocomian, west Japan (original designation).

*Pulsidis higoensis* (MATSUMOTO)

1938. *Aloidis* (*Caryocorbula*) *higoensis* MATSUMOTO, *Jour. Geol. Soc. Japan*, Vol. 45, No. 532, p. 19, pl. 2, fig. 8, text-fig. 9.

1964. *Pulsidis higoensis*, OTA, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Vol. 15, No. 1, p. 153, pl. 21, figs. 13–17, text-fig. 3.

The present species is not represented in the present collection.

*Occurrence.*—Black fine sandstone and shale of the Yatsushiro formation (mainly Albian) at a locality 2 km south of Miyaji, Yatsushiro City, Kumamoto Prefecture. The present species was originally reported by MATSUMOTO (1938) from the medium to rather coarse-grained sandstone of the member of the Gosyonoura group (Albian-Turonian) at Gosyonoura island, Kumamoto Prefecture.

## Order Eudesmodontida

## Superfamily Pandoracea

## Family Pholadomyidae

Genus *Pholadomya* SOWERBY, 1823

(=*Procardia* MEEK, 1871; *Flabellomya* ROLLIER, 1913)

*Type-species*.—*Pholadomya candida* SOWERBY, 1823, Recent, West Indies (monotypy).

*Pholadomya miyamotoi* NAGAO

Plate 22, Figures 9–14; Plate 23, Figures 3–5

1943. *Pholadomya* (?) *miyamotoi* NAGAO, *Jour. Geol. Soc. Japan*, Vol. 50, p. 158, pl. 12, figs. 8, 9.

*Material*.—NAGAO (1943) established the present species on the basis of two specimens from the Hiraiga formation at Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture. The figure numbers of his plate were in part erroneously given. The figures 8a, 9 and 9b represent a left valve, which is designated here as the lectotype. The specimen in figs. 8, 9a is another example of this species. Six specimens (GK. H6547–GK. H6552) from the type area are also concerned with the description below (HANAI and HAYAMI coll.).

*Description*.—Shell small-sized for the genus, scarcely exceeding 30 mm. in length, equivalve, inequilateral, transversely ovate, not much elongated, about 1.2 times longer than high, strongly inflated; test very thin; antero-dorsal margin sloping down into the rounded anterior margin, while postero-dorsal margin is much longer and broadly concave; ventral margin broadly arcuate, not clearly delimited from the posterior margin; posterior area flattened, weakly auriculate; umbo orthogyrous, highly prominent, incurved, placed at about two-fifths of length from the anterior extremity; surface covered with radial and concentric plications which are strongly impressed on the internal surface; radials 18–24 in number, narrow but very sharp, roof-shaped, crowded on the antero-median area but becoming gradually more sparse and stronger towards the posterior, not distributed on the flattened posterior area and anterior peripheral area; sometimes weak radial ribs of secondary order inserted; concentric ribs confined to the antero-median area, somewhat sinuous, composed of numerous fine granulations at the intersections with the radial plications; growth-lines comparatively weak; hinge and musculature not observable.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Right valve (GK. H6547)	16.5	13.0	4.0	1.27
Right valve (GK. H6548)	21.0	18.0	6.0	1.18
Right valve (GK. H6549)	16.5	13.5	4.5	1.22
Left valve (GK. H6550)	15.0	12.0	4.0	1.25
Right valve (GK. H6551)	22.5	16.5+	7.5	1.36—
Right valve (GK. H6552)	22.0	18.0	6.5	1.22

*Observations and comparisons.*—The present material is generally well preserved, although the test is fragile and mostly exfoliated. NAGAO's type specimens are slightly larger than the present ones, but the outline and the characteristic ornamentation are quite identical. The number of radial plications varies to a great extent among individuals, ranging from 17 to 25.

*Pholadomya cornueliana* (D'ORBIGNY, 1844) from the Aptian of France and the Lower Greensand of England (WOODS, 1909) must be a closely allied species to the present one, and the latter might be actually a geographical subspecies of the former. Surface granulations are not clearly drawn in the figures of *P. cornueliana* in D'ORBIGNY's and MOESCH's monographs, but they are clearly shown in WOODS' (1909) description and illustration. *Pholadomya subdinnensis* (D'ORBIGNY, 1846), which was regarded by MOESCH as a synonym of *P. cornueliana*, is also very similar to the present species in the outline and ornamentation. However, the concentric ribs of typical European specimens of *P. cornueliana* are not sinuous and more persistent than in *P. miyamotoi*, and accordingly the ornamentation appears more regularly cancellate on the antero-median surface of *P. cornueliana*. The posterior flattened area is wider, and the distributed area of granulations is probably narrower than in that species.

*Pholadomya shattucki* BÖSE, 1910 (= *Pholadomya roemeri* SHATTUCK, 1902, non WHITFIELD, 1885) from the Cenomanian of Mexico and Texas (PERKINS, 1960) differs from the present species in the more equidistantly spaced radial plications and in the much larger size.

*Pholadomya* aff. *cornueliana* recorded by AMANO (1957) from the Hagino formation of Shikoku is probably related to the present species, but its posterior area is less pronouncedly auriculate and the surface seems to be covered with non-sinuous concentric plications than in the present specimens. *P. miyamotoi* is clearly distinguishable from *Pholadomya subpedelnalis* NAGAO, 1934, from the Miyako group, by the more numerous radial plications, although they are somewhat similar in the outline and dimensions.

*Occurrence.*—Lower Miyakoan (Aptian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0017, 0018, southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture.

#### *Pholadomya brevitesta* NAGAO

Plate 23, Figure 2

1943. *Pholadomya brevitesta* NAGAO, *Jour. Geol. Soc. Japan*, Vol. 50, No. 596, p. 157, pl. 13, fig. 3.

*Material.*—The holotype by monotypy is a bivalved specimen illustrated by NAGAO (1943, pl. 13, fig. 3, 3a, 3b). It was collected from the Tanohata formation at Koikorobe, Tanohata village, Shimohei County, Iwate Prefecture. A specimen (GK. H6554) from the type area (HANAI coll.) is also concerned with the description below.

*Description.*—Shell of medium size, equivalve, inequilateral, gibbose in outline, longer than high, moderately inflated; test thin; antero-dorsal margin

very short; postero-dorsal margin long, nearly straight, passing gradually into the rounded siphonal margin; ventral margin broadly arcuate; maximum convexity lying anteriorly from the center; umbo placed very anteriorly, incurved, slightly prosogyrous, rising a little above the dorsal margin; anterior peripheral area obscurely delimited from the remainder by a shallow sulcus which extends from the umbo to the antero-ventral area; posterior area slightly flattened, gaping at the extremity; surface ornamented with radial and concentric plications; radials about 17 in number, irregularly spaced, much narrower than their interspaces, confined to the antero-median surface; no radial rib on the anterior and posterior areas; concentric plications covering the whole surface, about 35 in number, rather regularly spaced, round-topped, much broader than their interspaces, forming a network with the radials; granules weakly developed at the intersections; musculature and hinge structure unknown. Specimen (G.K. H6554) both valves, 55.0 mm. long, 47.0 mm. high, 32.0 mm. thick.

*Observations and comparisons.*—A well preserved bivalved specimen at hand is probably conspecific with the holotype of *Pholadomya brevitesta* NAGAO, 1943, because the ornamentation and the mode of anterior sulcus are quite similar. The holotype is apparently shorter than the present one and nearly as high as long. The umbo seems to be more prominent in the holotype than in the present specimen. It is, however, possible that the differences are partly due to the secondary deformation of the holotype. At the localities of NAGAO's and the present specimens closed pelecypod shells are apt to be deformed owing to the soft matrices. Supposing the original outline is better preserved in the present specimen, the present species is not much apart from *Pholadomya collombi* COQUAND, 1866, from the Aptian-Cenomanian strata of western Europe (MOESCH, 1875), but the radial ornament is more crowded and more irregularly spaced than in that species. *Pholadomya esmarki* (NILSSON, 1827) (GOLDFUSS, 1836; MOESCH, 1875) from the upper Lower and Upper Cretaceous of Europe may be also allied to the present species in some respects, but the concentric ribs seem to be more prominent in *P. brevitesta*. *Pholadomya martini* FORBES, 1845, from the Lower Greensand of England and the Neocomian of Germany (WOLLEMANN, 1900; WOODS, 1909) resembles the present species in the outline, but the posterior unornamented area is narrower in the former than in the latter.

*Pholadomya japonica* AMANO, 1956, from the Gyliakian Miyanohara sandstone of southern Shikoku may be related to the present species, but the posterior flattened area is distinctly narrower than in the latter.

*Occurrence.*—Lower Miyakoan (Aptian). Black sandy shale of the Tanohata formation at loc. Hn. 0006, southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture. NAGAO's holotype came from the same formation at Koikorobe in the same village. A similar specimen was obtained from the Ishido formation at loc. Hy. 4001, Ichinose-bashi, south of Kagahara, Nakazato village, Tano County, Gumma Prefecture (HAYAMI coll.).

*Pholadomya subpedelnalis* NAGAO

Plate 23, Figure 1

1934. *Pholadomya subpedelnalis* NAGAO, *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 214, pl. 26, fig. 8.

*Material*.—The holotype by monotypy is a bivalved specimen (GH. reg. no. 6796) illustrated by NAGAO (1934, pl. 26, fig. 8). It was collected from the "Hiraiga sandstone" of Hideshima, Miyako City, Iwate Prefecture. A specimen (GK. H6558) newly collected from the type area is also concerned with the description below.

*Description*.—Shell very small, equivalve, very inequilateral, trigonally ovate, rostrated posteriorly, much longer than high, moderately inflated; antero-dorsal margin weakly concave, passing gradually into the anterior margin; anterior margin subvertical, slightly gaping; postero-dorsal margin broadly concave; siphonal margin well delimited but short; umbo placed slightly anteriorly from the mid-point of length; a sharp carina extending from the umbo to the postero-dorsal extremity, defining a deeply concave area corresponding to the escutcheon; surface ornamented with 10, widely spaced and subequidistant radial ribs and irregularly folded concentric ribs; small tubercles produced at their intersections; concentric ribs much weakened and radial ribs absent on the antero-dorsal and postero-dorsal areas; hinge structure and musculature unknown. Specimen, GK. H6558, closed internal mould, 17.5 mm. long, 14.0 mm. high, 8.5 mm thick.

*Observations and comparisons*.—The present specimen is a bivalved internal mould, the test of which is completely eroded away. The ornamentation is, however, well recognized on the internal surface. The present specimen is certainly conspecific with *Pholadomya subpedelnalis* NAGAO, 1934, from the Miyako group in view of the similar mode of surface ornamentation. The ratio of length/height of the present specimen is slightly larger than in NAGAO's holotype, but the difference may be attributed to the strong deformation of the latter specimen, because fossils are generally more or less strongly deformed at the type locality. *Pholadomya miyamotoi* NAGAO, 1943, resembles the present species in the posteriorly rostrate outline, but the radial ribs of *P. subpedelnalis* are distinctly fewer and more equidistantly spaced, the concentric ribs being more prominent and more widely spaced than in the present species.

*Occurrence*.—Lower and upper Miyakoan (Aptian to Albian). Grey sandy shale of the upper part of the "*Orbitolina* sandstone" of the Miyako group at loc. Hn. 6203, northeast of Raga, Tanohata village, Shimohei County, Iwate Prefecture. NAGAO's holotype came from the "Hiraiga sandstone" (probably the 2nd cycle sediments of the Miyako group) at Hideshima of Sakiyama, Miyako City, the same prefecture.

*Pholadomya tuberculata* sp. nov.

Plate 24, Figures 1–3

*Material*.—The holotype is a left valve (GK. H6555) collected from the

Hiraiga formation at loc. Hn. 0018, southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture (HAYAMI coll.). Paratypes (GK. H6556, GK. H6557) from the type locality (HAYAMI coll.).

*Description.*—Shell comparatively small-sized, scarcely 30 mm. in length, very inequilateral, transversely elongated, oblong, not rostrated, moderately inflated; test rather thick for the genus; antero-dorsal margin obliquely truncated, short; postero-dorsal margin nearly straight, very long; anterior and posterior margins smoothly rounded, probably gaping to a certain extent; ventral margin broadly arcuate; anterior sulcus absent; umbo rather improminent, broad, slightly prosogyrous, placed at about one-fourth of shell-length from the anterior extremity; a conspicuous ridge extending subhorizontally along the postero-dorsal margin, delimiting clearly a narrow area corresponding to escutcheon; surface ornamented with weak radial and concentric ribs; radial ribs about 8 in number, much narrower than their interspaces, distributed on the umbonal and median surface, becoming much weaker and soon disappeared towards anterior, posterior and ventral areas; concentric lamellae broad, fairly irregular in density and prominence, forming conspicuous tubercles at the intersections with the radial ribs; growth-lines comparatively weak; hinge and musculature unknown.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Holotype (GK. H6555) left valve	25.0	15.0	4.5	1.67
Paratype (GK. H6556) left valve	18.0+	14.5	5.0	1.24+
Paratype (GK. H6557) left valve	20.5+	15.5	5.0	1.32+

*Observations and comparisons.*—The present species is now represented only by three left valves. The holotype reveals a complete outline. The test is almost exfoliated in the holotype but well preserved in one of the paratypes (GK. H6556), the posterior part of which is broken off.

The present species is readily distinguishable from *Pholadomya miyamotoi* NAGAO, 1943, *Pholadomya brevitesta* NAGAO, 1943, and *Pholadomya subpedenalis* NAGAO, 1934, from the same sedimentary area by the smaller number of radial ribs, less prominent umbo, more transversely elongated and oblong outline and more persistent concentric lamellae. *Pholadomya ovula* AGASSIZ, 1842 (MORRIS and LYCETT, 1853; MOESCH, 1875) from the Great Oolite of England resembles the present species in some respects, but differs from it in the less concave postero-dorsal margin and the less tuberculate surface. *Pholadomya pedenalis* ROEMER, 1852 (MOESCH, 1875), from the Aptian of western Europe and Texas, and *Pholadomya trigeriana* COTTREAU, 1855 (MOESCH, 1875), from the Neocomian of Swiss and France, show much larger dimensions and more prominent umbones, although the surface ornamentation and some other characters are similar. *Pholadomya rogeri* FRENEIX, 1958, from the Senonian of New Caledonia has more densely spaced radial ribs and much larger dimensions. *Pholadomya connectans* FORBES, 1840 from the Valudayur group of southern India (STOLICZKA, 1871) resembles the present species in the outline and ornamentation, but a



conspicuous groove extends subvertically from the umbo to the ventral margin in that species.

*Occurrence*.—Lower Miyakoan (Aptian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0017, 0018, southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture.

*Pholadomya* sp. aff. *P. cornueliana* (D'ORBIGNY)

1957. *Pholadomya* aff. *cornueliana* (D'ORBIGNY), AMANO, *Kumamoto Jour. Sci.*, Ser. B, Sec. 1, Vol. 2, No. 2, p. 92, pl. 2, fig. 9.

*Remarks*.—The present species is not represented in this collection. As compared by AMANO, it seems to be close to *Pholadomya cornueliana* (D'ORBIGNY, 1844) from the Aptian of France and the Lower Greensand of England (WOODS, 1909) in view of the outline and ornamentation. It is likewise similar to *Pholadomya miyamotoi* NAGAO, 1943, from the Miyako group, but distinguishable from that species by the more persistent and non-sinuuous concentric ribs.

*Occurrence*.—Lower Miyakoan (Aptian). Weathered sandstone of the Hagino formation at Hagino, Mirafu village, Kami County, Kochi Prefecture (according to AMANO, 1957a).

*Pholadomya* sp. A indet.

Plate 24, Figure 4

This species is represented at present by an internal mould of left valve (GK. H6781, 43.0+ mm. long, 40.0 mm. high, 16.5 mm. thick). The test is completely eroded away and the posterior part is broken. In the shell-size it is comparable with *Pholadomya brevitesta* NAGAO, 1943, from the Miyako group, but the radial ribs are subequidistantly spaced and the concentric ribs are, if present, very weak in the present species. It resembles more closely *Pholadomya speetonensis* WOODS, 1909, from the Speeton Clay of England, in the general outline and surface sculpture, but the shell is more obliquely elongated in the present species.

*Occurrence*.—Lower Miyakoan (Aptian). Weathered sandstone of the Hagino formation at loc. Hy. 6011, Hagino, Mirafu village, Kami County, Kochi Prefecture (OGAWA coll.).

*Pholadomya* sp. B indet.

Plate 24, Figures 5–6

This species is represented by two specimens: one is a closed internal mould and the other is a left internal mould (GK. H6791, 37.5 mm. long, 22.5 mm. high, 16.0 mm. thick; GK. H6792, 24.5 mm. long, 16.0 mm. thick, 5.5 mm thick). It has similar concentric ribs to *Pholadomya brevitesta* NAGAO, 1943, from the Miyako group, but are distinguishable from that species by the more transversely elongated outline and weaker radial riblets. In the outline the present species is somewhat similar to *Pholadomya martini* FORBES, 1845, from the Lower

Greensand of England (WOODS, 1909), but the radial ornament may be much weaker in the former than in the latter.

*Occurrence*.—Aritan to upper Miyakoan (upper Neocomian to Albian). Dark grey sandy shale of the Hanoura formation at loc. Hy. 5002 (boulder), Hiroyasu, Katsuura town, Katsuura County, Tokushima Prefecture (HAYAMI coll.), and fine grey sandstone of the Yatsushiro formation at loc. Km. 1843, north of Shimofukami, Sakamoto town, Yatsushiro County, Kumamoto Prefecture (KANMERA coll.).

Genus *Goniomya* AGASSIZ, 1838

(=*Lysianassa* MÜNSTER in GOLDFUSS, 1836, *non*  
MILNE-EDWARD, 1830)

*Type-species*.—*Mya angulifera* SOWERBY, 1819, Middle Jurassic, western Europe (designated by HERRMANNSEN, 1846).

*Remarks*.—*Goniomya* is a well characterized Mesozoic pelecypod genus having particular V- or U-shaped ornaments. Certain species of the Grammysiidae from the Carboniferous and Permian of U.S.S.R. have *Goniomya*-like V-shaped sculpture and have been grouped as *Pentagrammysia* TSCHERNYSHEW, 1950 (type-species: *P. altaica* TSCHERNYSHEW). However, it is open to question whether the resemblance of sculpture is only due to a homoeomorphism or actually indicates phylogenetical relationship. It is also noticeable that the ornamentation of *Undulomya* FLETCHER, 1946 (type-species: *U. pleiopleura* FLETCHER, 1946) resembles that of some species of *Goniomya*. The type-species is known from the Permian of Australia, and DICKINS (1956) transferred the genus from the Pholadomyidae to Arcomyidae on the basis of the presence of radiating rows of minute granules. Radially arranged punctations exist also in many species of *Goniomya*, and I maintain that *Goniomya* is phylogenetically intimate to *Undulomya*.

The classification of *Goniomya*, although it may be somewhat artificial, can be to a certain extent based on the development of the horizontal ribs of median set. In many species of *Goniomya*, median ribs are confined to the umbonal area, and the anterior and posterior ribs scribe Vs in the ventral area. But in some species from the Jurassic and Cretaceous, horizontal ribs are persistent throughout the growth. If the latter group was actually originated from the former, as presumed from the stratigraphic occurrence, the evolution may constitute a case of "neoteny".

*Goniomya subarchiaci* NAGAO

Plate 25, Figures 1-13

1934. *Goniomya subarchiaci* NAGAO, *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 215, pl. 29, figs. 2, 3.

*Material*.—The holotype is a bivalved specimen (GH. reg. no. 6786) illustrated by NAGAO (1934, pl. 29, fig. 3). It was collected from the Aketo formation at the northeast of Raga, Tanohata village, Shimohei County, Iwate Prefecture.

Another specimen of NAGAO (1934, pl. 29, fig. 2) is also an example of this species. 16 more specimens (GK. H6559-GK. H6566, GK. H6716-GK. H6723) from the type area (HANAI and HAYAMI coll.) are concerned with the description below.

*Description.*—Shell small- or medium-sized for the genus, equivalve, fairly inequilateral, elongate-elliptical, transversely elongated, moderately inflated; length smaller than twice the height; test very thin, translucent; antero-dorsal margin obliquely truncated; postero-dorsal margin slightly concave behind the umbo, much longer than the antero-dorsal; siphonal margin well delimited, forming an obtuse angle with the postero-dorsal margin; ventral margin broadly arcuate; umbo fairly prominent, orthogyrous, incurved, a little rising above the dorsal margin, placed at about one-third of shell-length from the anterior end; a weak carina extending from the umbo to the postero-ventral corner, defining obscurely a slightly concave and somewhat flattened postero-dorsal area; a pair of prominent ridges run subparallel to the antero- and postero-dorsal margins, delimiting narrow crescentic areas corresponding to the lunule and escutcheon; surface ornamented with characteristic U-shaped ribs of *Goniomya*-type, which are distributed on a triangular area covering the umbonal and central surface; umbonal angle of the triangle about 100 degrees, divided into three parts of about 40, 25 and 35 degrees from the anterior side; ribs of the anterior part about 14–16 in number, prosocline, prominent; ribs of the median part similar in number but more or less weakened towards the venter, nearly horizontal, forming an obtuse angle of about 140 degrees with the anterior set just below the umbo; ribs of the posterior part broad, smaller in number, opisthocline, meeting median horizontal ribs with obtuse angles of about 115 degrees; three sets of ribs generally continuous but sometimes median set truncated by posterior set; ribs never scribe Vs even in the adult stage; anterior, posterior and ventral areas of the shell nearly smooth except for faint growth-lines and many fine radial threads composed of numerous microscopic serial punctures; hinge and musculature unknown.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Left valve (GK. H6559)	32.0	17.5	5.5	1.83
Left valve (GK. H6560)	35.0	18.5	6.0	1.89
Left valve (GK. H6561)	31.0	16.5	5.0	1.88
Right valve (GK. H6562)	38.5	22.0	7.0	1.75
Left valve (GK. H6563)	16.0	10.5	3.0	1.52
Right valve (GK. H6564)	29.0+	17.0	5.5	1.71+
Left valve (GK. H6565)	29.0	17.0	5.5	1.71
Left valve (GK. H6566)	26.5	15.5	4.5	1.64
Left valve (GK. H6716)	33.0	18.5	6.0	1.78
Left valve (GK. H6717)	22.0	13.0	4.0	1.69
Right valve (GK. H6718)	34.5	19.0	6.5	1.82
Left valve (GK. H6719)	26.0+	17.0	5.5	1.53+
Left valve (GK. H6720)	29.0	18.0	5.5	1.61
Left valve (GK. H6721)	25.5	15.0	5.0	1.70
both valves (GK. H6722)	38.5	19.0	11.5	2.03
Right valve (GK. H6723)	36.5	22.5	7.0	1.62

*Observations and comparisons.*—This species is represented in the present collection by a large number of well preserved specimens. Closed valves are not rare at some localities but usually ill-preserved and suffered from secondary deformation. The fragile test is mostly exfoliated or eroded away in many specimens, but completely preserved in a left valve (GK. H6716), which shows numerous rows of microscopic punctations (Pl. 25, Figure 2b). The ornamented area in these specimens except for immature ones is comparatively narrow, and the ribs of the median set (horizontal ribs) are moderately long throughout the growth. Although the ratio of length/height is fairly variable and ranges from 1.60 to 1.90, all the specimens including NAGAO's type specimens show invariably U-shaped ornamentation.

*Goniomya nonvscripta* TAMURA, 1959, from the Upper Jurassic Soma group of Northeast Japan, has also well developed and persistent median horizontal ribs. The ornamented area is, however, distinctly narrower in the present species than in *G. nonvscripta* and also than in many other Jurassic species.

As noted by NAGAO (1934), the present species may be closely related to *Goniomya archiaci* (PICTET and RENEVIER, 1858), from the Aptian of France and the Lower Greensand of England (WOODS, 1909), but the former is distinguishable from the latter by the more anteriorly placed umbo, more rounded posterior margin and better differentiated ribs into three sets. The present species is somewhat similar to *Goniomya caudata* AGASSIZ, 1842 (= *Pholadomya agassizii* D'ORBIGNY, 1846), from the Neocomian of France, in the oblong outline, but the ornamented area is probably much narrower than in the European species, unless the illustrated specimens of *G. caudata* in AGASSIZ (1842) and D'ORBIGNY (1846) are immature. Moreover, the ribs of three sets are more sharply geniculated at the junctions in the present species.

*Occurrence.*—Lower and upper Miyakoan (Aptian to Albian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0016, 0017, 0018, southern coast of Hiraiga, grey sandy shale of the Tanohata formation at loc. Hn. 0220, northern coast of Hiraiga, grey sandy shale of the upper part of the "*Orbitolina* sandstone" at loc. Hn. 6202 and Hn. 6203, northeast of Raga, and grey sandy shale of the Aketo formation at loc. Hn. 6201, northeast of Raga, all in Tanohata village, Shimohei County, Iwate Prefecture. NAGAO (1934) noted that a similar specimen had occurred from the "Kawarazawa formation" of the Sanchu area.

*Goniomya* sp. indet.

Plate 24, Figure 7

This species is represented by two poorly preserved specimens: one is a left internal mould (GK. H6573, 15.5 mm. long, 9.0 mm. high, 3.5 mm. thick) and the other is a right internal mould (GK. H6572, 21.0+mm. long, 18.5 mm. high, 5.5 mm. thick).

Shell inequilateral, comparatively short, subtrigonal with nearly straight antero-dorsal and postero-dorsal margins; siphonal margin clearly demarcated; umbo narrow, pointed, orthogyrous, placed slightly anteriorly from the mid-point

of length; ornamentation composed of three sets of ribs on the umbonal area, although the middle set (horizontal ribs) is soon shortened and disappeared on the middle surface to form V-shaped sculpture in the adult stage; hinge and musculature unknown.

The present species is clearly distinguishable from *Goniomya subarchiaci* NAGAO, 1934, from the Miyako group by the shorter shell and less persistent horizontal ribs of the median set and more sharply pointed umbo.

*Occurrence*.—Aritan and upper Miyakoan (upper Neocomian to Albian). Dark grey sandy shale of the Ishido formation at loc. Hy. 4001, Ichinose-bashi, south of Kagahara, Tano County, Gumma Prefecture (ICHIKAWA and HAYAMI coll.), and dark grey sandy shale of the Yatsushiro formation at loc. Km. 3096, southwest of Kohara, Toyo village, Yatsushiro County, Kumamoto Prefecture (KANMERA coll.).

### Superfamily Laternulacea

#### Family Laternulidae

#### Genus *Cercomya* AGASSIZ, 1842

*Type-species*.—*Cercomya pinguis* AGASSIZ, 1842, Lower Jurassic, western Europe.

#### *Cercomya gurgitis* (PICTET and CAMPICHE)

##### Plate 24, Figures 8–10

- 1858. *Anatina robinaldina*, PICTET and RENEVIER, Matér. Pal. Suisse, sér. 1, p. 63, pl. 7, fig. 1 (non *A. robinaldina* D'ORBIGNY, 1845)
- 1865. *Anatina gurgitis* PICTET and CAMPICHE, *Ibid.*, Sér. 4, p. 105, pl. 107, figs. 6–8.
- 1909. *Anatina* (*Cercomya*) *gurgitis*, WOODS, Monogr. Cret. Lamell. England, Vol. 2, p. 238, pl. 39, figs. 2–4.
- 1934. *Anatina* (*Cercomya*) sp., NAGAO, *Jour. Fac. Sci., Hokkaido Imp. Univ.*, Ser. 4, Vol. 2, No. 3, p. 216, pl. 32, fig. 2.
- ? 1957. *Anatina* (*Cercomya*?) sp., AMANO, *Kumamoto Jour. Sci.*, Ser. B, Sec. 1, Vol. 2, No. 2, p. 93, pl. 2, figs. 10, 11.
- 1961. *Cercomya gurgitis*, CASEY, *Palaeontology*, Vol. 3, Pt. 4, p. 607, listed.

*Material*.—Three specimens (GK. H6574–GK. H6576) from the Miyako area (HANAI and HAYAMI coll.) are concerned with the description below.

*Description*.—Shell medium-sized, equivalve or subequivalve, very inequilateral, transversely elongated, remarkably rostrated and gradually tapering posteriorly, roundly truncated at the extremity, moderately inflated; test very thin; length attaining about three times the height; antero-dorsal margin nearly horizontal, gradually bending down to the rounded anterior margin; postero-dorsal margin much longer than the antero-dorsal, broadly concave to the caudal end; umbo not prominent, broad, opisthogyrous, placed almost centrally or a little anteriorly from the mid-point of length; two rounded carinae running from the umbonal area to the posterior extremity, delimiting a shallow sulcus and a somewhat steep postero-dorsal slope; a very inconspicuous depression passes

from the umbo obliquely forwards across the valve; anterior surface in front of the depression ornamented with irregularly spaced concentric ribs which are much narrower than their interspaces; concentrics much weakened on the posterior area; fine growth-lines covering the whole surface; antero-median surface provided with numerous faint radial rows which are composed of microscopic granules; valve margin apparently closed except for slightly gaped caudal end; hinge and musculature unknown.

*Measurement in mm.*

Specimen	Length	Height	Thickness	L/H
Both valves (GK. H6574)	39.5	13.0	6.0	3.04
Right in. mould (GK. H6575)	56.5	17.5	5.5	3.23
Left ex. mould (GK. H6576)	64.5+	23.5	7.5	2.74+

*Observations and comparisons.*—Three specimens in the present collection are specifically identical with the specimen from the same area, which was described by NAGAO (1934) as *Anatina* (*Cercomya*) sp. Although NAGAO's specimen is very incomplete, the outline and ornamentation of the anterior part are quite similar to those of the present specimens. The characteristic microscopic granules are clearly observable in one specimen (GK. H6574), but not seen in two other specimens owing to the unfavourable preservation.

In every essential character the present specimens agree well with *Anatina* (*Cercomya*) *gurgitis* PICTET and CAMPICHE, 1865, from the Aptian of France and the Lower Greensand of England (WOODS, 1909). The posterior rostrum, ornamentation and weak oblique sulcus are especially similar to those of the Lower Greensand specimens. *Anatina robinaldina* (D'ORBIGNY, 1845) from the Hauterivian of France differs from the present species in the shorter outline and deeper oblique sulcus. The present specimens are also similar in the outline to *Cercomya spatulata* AGASSIZ, 1842, from the "Portlandian" of France, but the concentric lamellae are more persistent on the posterior surface in the latter than in the former. *Anatina* (*Cercomya*?) sp. described by AMANO (1957) from the Hagino formation of southern Shikoku is probably conspecific with *C. gurgitis*, but its specific identity cannot be decided at present, because the posterior rostrum is lacked in that specimen.

Many authors have considered *Cercomya* to be a subgenus of *Anatina* (= *Laternula*), but, as suggested by CASEY (1961), it should be separated generically from *Laternula* by the rostrated posterior area.

*Occurrence.*—Lower and upper Miyakoan (Aptian and Albian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0018, southern coast of Hiraiga, and grey sandy shale of the "*Orbitolina* sandstone" at loc. Hn. 6202, northeast of Raga, Tanohata village, Shimohei County, Iwate Prefecture. NAGAO (1934) reported the present species also from the Hiraiga formation at Haibe and from the Aketo formation at Aketo in the same village. A similar specimen from the weathered sandstone of the Hagino formation at Hagino, Mirafu village, Kami County, Kochi Prefecture (according to AMANO, 1957).

Genus *Plectomya* DE LORIOL, 1868

*Type-species*.—*Tellina rugosa* RÖMER, Jurassic, western Europe (monotypy).

*Plectomya aritagawana* sp. nov.

Plate 25, Figures 14–15; Plate 26, Figure 2

1954. *Laternula aritagawana* MATSUMOTO, Cretaceous System, Japan. Islands, pp. 76, 113, listed (*nom. nud.*).

? 1957. *Laternula* sp., AMANO, *Kumamoto Jour. Sci.*, Ser. B, Sec. 1, Vol. 2, No. 2, p. 105, pl. 1, fig. 19.

*Material*.—The holotype is a bivalved specimen (GK. H6577) which is composed of internal and external moulds. It was collected from the Arita formation at loc. Ys. 53, north of the pass between Yuasa and Yoshikawa, Yuasa town, Arita County, Wakayama Prefecture (MATSUMOTO coll.). A paratype (GK. H6578) from the type locality, and two other paratypes (GK. H6579, GK. H6580) from the Yatsushiro area (KANMERA coll.).

*Description*.—Shell small- or medium-sized, apparently equivalve, transversely oblong, about twice as long as high, moderately inflated; test thin; antero-dorsal margin slightly convex, passing gradually into the anterior margin; postero-dorsal margin broadly concave; siphonal margin obliquely truncated, widely gaping; umbo a little opisthogyrous, placed subcentrally; a fairly sharp carina extending from the umbo to the postero-ventral area, delimiting a wide posterior area; central part of the flank weakly constricted; flank ornamented with widely spaced concentric plications in the anterior part, while it is entirely smooth except for growth-lines in the posterior part; posterior area behind the carina smooth; umbonal fissure not observed; hinge unknown but probably edentulous; musculature unknown.

*Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Holotype (GK. H6577) both valves	22.0	12.0	6.5	1.83
Paratype (GK. H6578) left in. mould	33.5	17.0	5.0	1.97
Paratype (GK. H6579) right in. mould	25.0	12.5	4.0	2.00

*Observations and comparisons*.—Four specimens and several fragments are available for the present study. Each shows a weak subvertical construction in the central part and widely spaced concentric plications in front of the constriction. All the external characters are well exhibited in the holotype, although its posterior carina may be emphasized by certain secondary deformation.

The present species has been known to some stratigraphers as *Laternula aritagawana* MATSUMOTO (MS). The presence of a distinct central constriction and characteristic anterior plications suggest that it belongs to *Plectomya*, although the posterior carination is more conspicuous than in any known species of this genus.

The present species is somewhat similar to *Anatina carteroni* D'ORBIGNY, 1843, *A. marullensis* D'ORBIGNY, 1843, and *A. cornueliana* D'ORBIGNY, 1843, from

the Lower Cretaceous of France, all of which are referable to *Plectomya*. The posterior carina is, however, almost absent or very weak in those European species.

*Occurrence*.—Aritan to upper Miyakoan (upper Neocomian to Albian). Dark grey sandy shale of the Arita formation at loc. Ys. 53, north of the pass between Yuasa and Yoshikawa, Yuasa town, Arita County, Wakayama Prefecture. Grey fine sandstone of the same formation at loc. Ys. 103, a rail-road cutting, west of Kumai, the same town. Grey sandstone of the Yatsushiro formation at loc. Km. 3113 ( $\div$  Km. 3096), southwest of Kohara, Toyo village, Yatsushiro County, Kumamoto Prefecture. In addition, a few fragmentary specimens, which may be conspecific with the present species, were collected from the black shale of the Hanoura formation at loc. Hy. 5003, Hiroyasu, Katsuura town, Katsuura County, Tokushima Prefecture (HAYAMI coll.).

*Plectomya* sp. aff. *P. anglica* WOODS

Plate 25, Figure 16

*Compare*.—

1909. *Plectomya anglica* WOODS, Monogr. Cret. Lamell. England, Vol. 2, p. 238, pl. 39, fig. 1.

A specimen composed of internal and external moulds of closed valves resembles the preceding species *Plectomya aritagawana* sp. nov., but differs from this species in the weaker construction, weaker posterior carina, narrower and less clearly delimited posterior area and the reappearance of concentric folds on the posterior part of the flank.

The last mentioned character is very similar to that of *Plectomya anglica* WOODS, 1909, from the Lower Greensand of England. The specific identification is, however, impossible at present, because the material is secondarily compressed. Specimen, internal mould of closed valves (GK. H6600), 31.0 mm. long, 19.0 mm. high, 6.0+mm. thick.

*Occurrence*.—Upper Miyakoan (Albian). Grey fine sandstone of the Yatsushiro formation at loc. Hy. 1016, west of Mt. Jôgûsan, Miyaji, Yatsushiro City, Kumamoto Prefecture (HAYAMI coll.).

Family Periplomatidae

Genus *Offadesma* IREDALE, 1930

*Type-species*.—*Periploma angasi* CROSSE and FISCHER, 1864 (original designation).

*Offadesma altissimum* sp. nov.

Plate 26, Figure 1

*Material*.—The holotype is a bivalved internal mould (GK. H6581) collected from the upper part of the "*Orbitolina* sandstone" of the Miyako group at loc. Hn. 6203, northeast of Raga, Tanohata village, Shimohei County, Iwate Prefecture.



*Description*.—Shell medium-sized for the genus, inequivalve, inequilateral, roundly rhomboidal in outline, tapering posteriorly, rostrated, subvertically truncated at the posterior extremity; test thin (holotype, GK. H6581, closed internal mould, 45.5 mm. long, 30.5 mm. high, 12.5 mm. thick); left valve weakly convex, while right valve is fairly strongly inflated; antero-dorsal margin nearly straight; postero-dorsal margin as long as the antero-dorsal, somewhat angularly concave behind the umbo; ventral margin forms an obtuse chevron, its curvature being strong in the middle part; posterior part of the ventral margin nearly straight or a little concave; siphonal margin well delimited, more or less gaping, forming obtuse angles with the postero-dorsal and postero-ventral margins; umbo slightly opisthogyrus, pointed, rising a little above the dorsal margin, placed near the mid-point of length; posterior rostrated part remarkably flattened; surface apparently smooth except for growth-lines; umbonal area of right valve provided with a trace of short subvertical fissure; musculature and other internal structures unknown.

*Observations and comparisons*.—The present species is represented at present by a well preserved specimen. It resembles closely some living species of *Offadesma* in the inequivalveness, outline and presence of an umbonal fissure, although the internal characters and surface granulations are not observable owing to the inadequate preservation. Several species from the Cretaceous have been referred to *Periploma* and other genera of the Periplomatidae, but their posterior rostrum is generally not so well developed as in the present species.

Some genera of the Thraciidae such as *Cyathodonta* Conrad, 1849, show similarly inequivalve and rostrated shell, but the presence of an umbonal fissure prevents me from referring it to that family. So far as I am aware, there is no comparable species of the Periplomatidae in the Cretaceous, and the present species may be the earliest representative of *Offadesma*.

*Occurrence*.—Upper Miyakoan (Albian). Grey sandy shale of the upper part of the "Orbitolina sandstone" of the Miyako group at loc. Hn. 6203, northeast of Raga, Tanohata village, Shimohei County, Iwate Prefecture (HAYAMI coll.).

#### Family Thraciidae

##### Genus *Thracia* BLAINVILLE, 1824

*Type-species*.—*Thracia corbuloidea* BLAINVILLE, 1824, Recent (designated by GRAY, 1847).

*Thracia* sp. indet.

Plate 26, Figure 3

This species is represented by a left valve. Shell small, inequilateral, sub-elliptical, not much elongated, weakly inflated (GK. H6583, 24.5 mm. long, 17.5 mm. high, 3.5 mm. thick); test very thin; anterior margin smoothly arcuate without any angulation; postero-dorsal margin slightly concave behind the umbo, slightly shorter than the antero-dorsal; posterior margin subvertically truncated, forming an obtuse angle with the postero-dorsal margin; posterior area not

rostrated but remarkably flattened; umbo comparatively narrow, slightly opisthogyrous, rising a little above the dorsal margin; surface smooth except for weak growth-lines; internal characters unknown.

The test of the present specimen is almost entirely exfoliated, but partly preserved on the postero-dorsal area. In the outline the present species resembles some species of *Periploma* SCHMACHER, 1817, and *Periplomya* CONRAD, 1870. It differs, however, from the former in the absence of umbonal fissure and chondrophore and from the latter in the absence of internal ridge. It is probably a member of *Thracia*. In many external characters the present specimen is similar to *Thracia* sp. of WOODS (1909, p. 243, pl. 40, figs. 7–9) from the Gault and Upper Greensand of England, although the dimensions of the present specimen are much smaller. *Thracia robinaldina* (D'ORBIGNY, 1845), from the Lower Greensand of England (WOODS, 1909), is also similar to the present species but shows more transversely elongated outline. CASEY (1961) referred the former species to *Periplomya*, but the latter, as noted above, is not a member of that genus.

*Occurrence*.—Lower Miyakoan (Aptian). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0017, southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture (HAYAMI coll.).

#### Genus *Corimya* AGASSIZ, 1842

*Type-species*.—*Corimya pinguis* AGASSIZ, 1842, Jurassic, Western Europe (designated by STOLICZKA, 1871).

#### *Corimya* (?) *tanohatensis* sp. nov.

Plate 26, Figures 4, 5

*Material*.—The holotype is a bivalved internal mould (GK. H6724) from the Tanohata formation at the southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture (HANAI and HAYAMI coll.). Paratype (GK. H6725) from the type locality (HANAI and HAYAMI coll.).

*Description*.—Shell small, inequilateral, subequivalve, rounded in front and subquadrate backwards, moderately inflated; test thin; antero-dorsal margin rounded, passing gradually into the anterior; postero-dorsal margin longer than the antero-dorsal, nearly straight, obliquely truncated by the well delimited siphonal margin; a very sharp carina extending from the umbo to the postero-ventral angle, delimiting clearly a posterior area, which is obtuse-triangular and remarkably flattened or even slightly concave; umbo rather broad, placed near the mid-point of length; surface of the main part ornamented with broadly plicated concentric ribs, which are weakened towards the anterior periphery and posterior carina; posterior area wholly marked with regular oblique riblets parallel to the posterior siphonal margin; internal characters unknown.

#### *Measurements in mm.*

Specimen	Length	Height	Thickness	L/H
Holotype (GK. H6724) both valves	21.5	16.0	5.0	1.34
Paratype (GK. H6725) both valves	20.0	13.5	8.0	1.47

*Observations and comparisons.*—The holotype is nearly complete but secondarily compressed. The paratype is incomplete but the original shell-convexity is better preserved. The test of the two specimens was replaced by carbonaceous substance, but the surface sculpture is well preserved. The posterior carina is similarly strong in the two valves of both specimens.

Posteriorly carinated species of the Thraciidae from the Jurassic and Cretaceous are generally referable to *Corimya* AGASSIZ, 1842, but the present species possesses a still sharper posterior carina than any species of typical *Corimya*. It seems to be congeneric with *Lutraria? carinifera* SOWERBY, 1826, from the Cenomanian–Turonian of England and France, in view of the similar sharp carina and surface sculpture. AGASSIZ (1842) included that species in *Corimya*, although D'ORBIGNY (1845) and some others referred it to *Lyonsia* and WOODS (1909) to *Thracia*. It is highly probable that *L? carinifera* and the present species belong to a certain unnamed genus of Eudesmodontida. But the systematic position of the two species cannot be decided at present, because their internal characters have not been clarified.

It is noteworthy that the present species is somewhat similar to the species of "*Cuspidaria*" from the Upper Triassic and Jurassic. As pointed out by COX (1960, p. 73), those species may not be early representatives of typical *Cuspidaria*. They show *Cuspidaria*-like rostrated outline, but a more or less sharp posterior carina, which is absent in Recent species of the Cuspidariidae, is well developed and defines sharply a flattened posterior area. It is possible that those species of "*Cuspidaria*" were rather ancestral to these Cretaceous species in question.

Specifically, the present species is distinguishable from *L? carinifera* by the more conspicuous concentric ornamentation on the flank and the narrower posterior area. It is also similar to *Lyonsia elegans* D'ORBIGNY, 1845, from the Cenomanian of France but differs from that species in the less elongated outline and stronger concentric ribs. It may be also congeneric with *Panopea rotundata* SOWERBY, 1836, from the Lower Greensand of England, which was referred to *Thracia* by WOODS (1909) and CASEY (1961, p. 607), but the latter has more globose shell and weaker concentric sculpture than the present species.

*Occurrence.*—Lower Miyakoan (Aptian). The present specimens were collected from a boulder of grey sandy shale at the southern coast of Hiraiga, Tanohata village, Shimohei County, Iwate Prefecture. Judging from the lithology, the boulder was certainly derived from the Tanohata formation exposed there.

#### Superfamily Pholadacea

#### Family Teredinidae

#### Genus *Teredo* LINNAEUS, 1758

*Type-species.*—*Teredo navalis* LINNAEUS, 1758, Recent (by ICZN, Opinion 94).

#### "*Teredo*" *matsushimaensis* HATAI

Plate 26, Figures 6–9

1951. *Teredo matsushimaensis* HATAI, *Inst. Geol. Palaeont. Sendai, Short Paper*, No. 3, p. 30, pl. 5, figs. 1-5.

*Remarks.*—HATAI (1951) established *Teredo matsushimaensis* on the basis of several calcified tubes and five isolated valves from the "Hiraiga sandstone" of the Miyako group at Matsushima islet of the Moshi area\*, Iwaizumi town, Iwate Prefecture. These specimens (IGPS reg. no. 73697) were collectively treated by him as "syntype". The illustrated bivalved specimen (HATAI, 1951, pl. 5, figs. 1, 3, 4), which was obtained from a certain tube in the petrified wood (pl. 5, fig. 5), is designated as the lectotype.

Numerous tubes were found in several pieces of drift wood at the type locality, and some of them are illustrated here. An ill preserved left valve (GK. H6777, 11.0+mm. long, 12.0 mm. high, 4.5 mm. thick) was obtained from the terminal part of a tube. This specimen shows a similar median constriction and other essential characters to the lectotype. A narrow tube (GK. H6776) was collected from a shell bed of Hiraiga. It is probably of the same species.

The up-to-date classification of the Teredinidae should be based mainly on the morphology of pallets, which are formed at the posterior end of the tube. Because the character is not observable in the specimens from the Miyako group, the taxonomic position of this species is difficult to be determined at present.

*Occurrence.*—Lower Miyakoan (Aptian). Drift woods in the calcareous sandstone of the 2nd cycle sediments of the Miyako group at loc. Hn. 4154, Matsushima, off the coast of Moshi, Iwaizumi town, Shimohei County, Iwate Prefecture (HANAI coll.). Calcareous sandstone of the Hiraiga formation at loc. Hn. 0017, southern coast of Hiraiga, Tanohata village, the same county (HAYAMI coll.).

## 5. Stratigraphic occurrence of Lower Cretaceous marine pelecypods in Japan

### 1) Kochian pelecypod faunas

The Kochian (approximately lower Neocomian) series of Japan is generally represented by widely distributed embayment, estuarine or deltaic sediments. It is probably due to an extensive emergence of this age, and the facies is in many respects comparable with that of the Wealden in Northwestern Europe. The series, however, forms commonly one sedimentary cycle in many areas of Southwest Japan. Pelecypods in this series are mostly brackish-water species. *Bakevella*, *Ostrea*, *Protocardia*, *Protocyprina*, *Eomiodon*, *Neomiodon*, *Isodomella* and *Tetoria* are very common in the Kochian sediments, forming frequently striking cyrenoid banks. Some of these genera are found also in certain purely marine sediments of other series, but the absence of cephalopods, corals, echinoids,

\* In the original description the locality was said to be "Matsushima, Taro-mura", but it is probably erroneous, because the Miyako group is distributed at Matsushima of Moshi and not at Matsushima of Taro.

crinoids and any other marine organisms suggests that these pelecypod faunas prospered under some conditions of unstable salinity such as a profound embayment and an estuary. The palaeontological study on these brackish-water faunas has been undertaken by many authors (NAUMANN and NEUMAYR, 1890; YABE, NAGAO and SHIMIZU, 1926; KOBAYASHI and SUZUKI, 1939; OTA, 1964; HAYAMI and NAKAI, 1965, etc.), and is still now in progress.

The Kawaguchi formation of the Kuma area, the Ryoseki formation of the Kochi, Monobegawa and Sakawa area, the Tatsukawa formation of the Katsuura-gawa area, the Yuasa formation of the Yuasa-Aritagawa area, the Shiroy formation of the Sanchu area and the Yoshimo formation of the Shimonoseki area have been regarded as the member of the Kochian series in view of their stratigraphic position. *Bakevella shinanoensis*, *Ostrea ryosekiana*, *Protocyprina naumanni*, *Eomiodon sakawanus*, *Neomiodon otsukai*, *Isodomella shiroiensis* and *Tetoria* (*Paracorbicula*) *sanchuensis* are widely distributed and predominant pelecypods in the cyrenoid beds of these formations. They have been collectively called "Ryoseki fauna", but similar specific assemblages are known also in Aritan and Miyakoan brackish-water faunas. Only *Protocyprina naumanni* (NEUMAYR) is apparently confined in occurrence to this series. In Northeast Japan, some of these species including *P. naumanni* are known to occur from the Ayukawa formation of the Ojika area and also (?) from the Omoto formation of the Miyako area. As described before (HAYAMI, 1960), the brackish-water fauna of the Jusanhama formation of the Hashiura area of South Kitakami mountains may be Lower Cretaceous in age, but lacks any element of the "Ryoseki fauna".

On the other hand, marine pelecypods are rather rare in the Lower Neocomian of Japan. Only small marine pelecypod faunas of a Berriasian age are known to occur in the Kesennuma area of the south Kitakami mountains and in the Soma area of the north Abukuma mountains. They are accompanied by *Thurmanniceras*, *Berriasella*, *Spiticeras*, "*Olcostephanus*", *Kilianella* and some other ammonites in the former area and by *Thurmanniceras*, *Berriasella* and *Parakilianella* in the latter area (SATO, 1958, 1961).

From the Isokusa formation at Isokusa and Nagasaki of the Kesennuma area the following pelecypods have been described (KOBAYASHI and TAMURA, 1955; HAYAMI, SUGITA and NAGUMO, 1960):

*Parallelodon* (*Torinosucatella*) *kobayashii* (TAMURA)

*Grammatodon takiensis* KIMURA

*Grammatodon* sp.

*Variamussium* sp. cf. *V. habunokawense* (KIMURA)

*Limatula akiyamae* HAYAMI

*Myophorella* (*Promyophorella*) *obsoleta* KOBAYASHI and TAMURA

*Astarte* (*Astarte*) sp. cf. *A. (A.) spitiensis* STOLICZKA

*Astarte* (*Astarte*) sp.

*Pleuromya* sp.

Some of these species are common with the fauna of the upper part of the Kogoshio formation, which bears *Substeuerocheras* and a few other ammonites of an

upper Tithonian age.

The Koyamada formation of the Soma area, which covers conformably the Tithonian strata of the main part of the Soma group, bears the following pelecypods (KOBAYASHI and TAMURA, 1955; TAMURA, 1959-1960):

*Parallelodon* sp. aff. *P. inflatus* TAMURA

*Grammatodon takiensis* KIMURA

*Entolium kimurai* TAMURA

*Myophorella* (*Promyophorella*) *orientalis* KOBAYASHI and TAMURA

*Astarte kambarensis* KIMURA

*Eriphyla* (*Miyakoella*) *subdepressa* (BLAKE and HUDLESTON)

*Protocardia tosenensis* KIMURA

*Corbula* (?) *globosa* TAMURA

All the species of the Koyamada formation are the elements of the Torinosu fauna, which are widely distributed in the Upper Jurassic of the Outer Zone of Southwest Japan and Northeast Japan.

A trigoniid faunule found in the Yamanokami sandstone of the Sakawa area of Shikoku has been considered to be Kochian by many geologists. At Yamanokami, i.e. the southern slope of Mt. Ohira of the Sakawa area, the sandstone apparently covers the Upper Jurassic Torinosu group, but their stratigraphic relationship cannot be determined owing to the poor exposure. The faunule is composed of *Nipponitrigonia kikuchiana*, *N. naumanni*, *Rutitrigonia yeharai*, *Pterotrigonia pocilliformis* "var. *yamanokamiensis*" and some other undescribed pelecypods (KOBAYASHI, 1957; KOBAYASHI and NAKANO, 1958). The specific assemblage is similar to that of the Aritan fauna and not to the Upper Jurassic and Berriasian ones, and the age of this faunule is presumed to be Valanginian or later. Some marine pelecypod beds exist in the Ryoseki group of the Kaisekiyama belt of the Sakawa area (KOBAYASHI, 1939). Although the fauna is not yet observed, the assemblage has been said to be similar to that of the Aritan fauna.

The Uminoura formation in the Kuma area of Kyushu, which passes gradually from the *Aulacosphinctes*- and *Himalayaites*-bearing Tithonian strata of the Sakamoto formation (TAMURA, 1961; TAKAI et al., 1963 ed.), bears some marine pelecypods. It may be a marine representative of the Kochian series, as TAMURA compared it with the Yamanokami sandstone of the Sakawa area. However, no determinable pelecypod has been described.

## 2) Aritan pelecypod faunas

The Aritan (approximately upper Neocomian) series constitutes as a whole the second sedimentary cycle of the Japanese Cretaceous. It is mainly composed of marine sediments, although some brackish-water shells are found in the lower part of the sequence in some areas. It is probably because of an extensive transgression and a continuing inundation of this age. Marine pelecypods are fairly common in various areas of Northeast Japan and the Outer Zone of Southwest Japan.

Table 1. Stratigraphic position of Lower Cretaceous marine pelecypod-bearing formations in Japan (Hayami, 1966)

series	symbol	NORTHEAST JAPAN					SOUTHWEST JAPAN							standard		
		N. KITAKAMI	S. KITAKAMI	ABUKUMA	CHOSHI	SANCHU	AKAISHI	YUASA	KATSUURA	MONOBE	SAKAWA	USUKI	YATSU-SHIRO			
MIYAKOAN	K3 $\gamma$					SANYAMA	MISAKUBO						TOMOCHI	LOWER CENOMANIAN		
	K3 $\beta$	MIYAKO GROUP 4TH CYCLE 3RD CYCLE 2ND CYCLE 1ST CYCLE RAGA							FUJIKAWA				YATSUSHIRO	ALBIAN		
	K3 $\alpha$															
ARITAN	K2	MATSUMAEZAWA ? TAKINOSHIRISAWA ?	OFUNATO GROUP KANAE-GAURA OSHIMA			ISHIDO		ARITA	HANOURA	MAMIDANI	LOW. MONOBEGAWA (FUNADANI)	LOW. MONOBEGAWA	not identified	HACHIRYUZAN	BARREMIAN	
																HAUTERIVIAN
KOCHIAN	K1	HARACHIYAMA ? OMOTO ? ?	KANEKUSA ISOKUSA			SHIROI		YUASA	TATSUKAWA	SHOBU	RYOSEKI	RYOSEKI	YAMANOKAMI	"RYOSEKI"	UMINOURA KAWAGUCHI	NEOCOMIAN
UPPER JURASSIC		IWAIZUMI	KOGOSHIO	TOMISAWA		ONOSAWA		TORINOSU GROUP							TITHONIAN	

The correlation is tentative.

○ marine pelecypod-bearing formation

● brackish- or fresh-water pelecypod-bearing formation

Aritan pelecypods are well represented by the fauna of the Ishido formation of the Sanchu area in the frontier region of Nagano, Gumma and Saitama Prefectures. YOKOYAMA (1890) and YABE, NAGAO and SHIMIZU (1926) described 16 pelecypods from this formation at Ishido, south of Kagahara and some other localities. *Pulchellia ishidoensis*, *Leptoceras asiaticum*, *Crioceratites yagii* and a few other ammonites occur at Ishido in the western part of this area (YABE, NAGAO and SHIMIZU, 1926), indicating an upper Neocomian age at least for a part of this formation. The Ishido formation is widely distributed also in the eastern part of the Sanchu area, and bears many marine pelecypods at the south of Kagahara, the southern slope of Mt. Kanozan and some other localities. As recently pointed out by TAKEI (1963), the fossil localities of the "Kawarazawa formation" in YABE, NAGAO and SHIMIZU's index map (1926) belong at least in part to the Ishido formation of the present usage. The following species have been already described from the Ishido formation or are distinguishable in the present collection (locality number in brackets) :

- Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO)\*  
*Nuculana* (s. l.) *sanchuensis* YABE and NAGAO [Hy. 4001, 4002]  
*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Hy. 4001, 4002, 4003, 4011, 4013]  
*Trigonarca obsoleta* YABE and NAGAO\*  
*Amygdalum ishidoense* (YABE and NAGAO) [Hy. 4011]  
*Gervillaria haradae* (YOKOYAMA) [Hy. 4001, 4008, 4011]  
*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY [Hy. 4001, 4011]  
*Isognomon* (*Melina*) *ichikawai* sp. nov. [Hy. 4011]  
*Pinna* sp. cf. *P. robinaldina* D'ORBIGNY [Hy. 4011]  
*Neithea* (*Neithea*) *kanmerai* sp. nov. [Hy. 4011]  
*Neithea* (*Neithea*) sp.  
*Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER) [Hy. 4011]  
*Entolium sanchuense* sp. nov. [Hy. 4001]  
*Limatula ishidoensis* (YABE and NAGAO) [Hy. 4011]  
*Lopha* (*Arctostrea*) *carinata* (LAMARCK) [Hy. 4001, 4011]  
*Nipponitrigonia plicata* KOBAYASHI and NAKANO (?=*Nipponitrigonia sanchuensis* MAEDA) [Hy. 4011]  
*Nipponitrigonia kikuchiana* (YOKOYAMA)\*  
*Pterotrigonia yokoyamai* (YEHARA) [Hy. 4011]  
*Pterotrigonia pocilliformis* (YOKOYAMA) [Hy. 4001, 4002, 4003, 4008, 4011, 4013]  
*Rutitrigonia sanchuensis* (NAKANO) [Hy. 4011]  
*Rutitrigonia yeharai* KOBAYASHI\*  
*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [Hy. 4001, 4002, 4003, 4008, 4011]  
*Astarte* (*Astarte*) *costata* YABE and NAGAO [Hy. 4003]  
*Astarte* (*Yabea*) *shinanoensis* YABE and NAGAO [Hy. 4003]

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\* Species not represented in the present collection.



*Eriphyla* (*Eriphyla*) *minima* sp. nov. [Hy. 4003]  
*Pachythaerus kagaharensis* (YOKOYAMA) [Hy. 4001]  
*Anthonya* sp. aff. *A. subcantiana* NAGAO [Hy. 4001]  
*Laevicardium* (?) *ishidoense* (YABE and NAGAO)\*  
*Ptychomya densicostata* NAGAO [Hy. 4001]  
*Panopea* (*Myopsis*) *plicata* (SOWERBY) [Hy. 4002]  
*Pholadomya brevitesta* NAGAO [Hy. 4001]  
*Goniomya* sp. [Hy. 4001]

The Arita formation in the Yuasa-Aritagawa area of Wakayama Prefecture contains also marine pelecypods and ammonites of an upper Neocomian age. *Phyllopachyceras* sp. cf. *P. infundibulum*, *Australiceras asiaticum*, *Shasticiroceras nipponicum*, *Hamulina* sp. cf. *H. subcylindrica* and a few other ammonites have been reported (MATSUMOTO, 1947). The following pelecypods are here identified:

*Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO) [Ys. 105]  
*Nuculana* (s. l.) *sanchuensis* YABE and NAGAO [Ys. 3, 8]  
*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Ys. 8, 53, 105]  
*Modiolus falcatus* AMANO [Ys. 103]  
*Modiolus* sp. aff. *M. subsimplex* D'ORBIGNY [Ys. 103]  
*Pterinella shinoharai* sp. nov. [Ys. 329a]  
*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY [Ys. 329a]  
*Neithea* (*Neithea*) *kanmerai* sp. nov. [Ys. 103]  
*Variamussium kimurai* sp. nov. [Ys. 8]  
*Plicatula kuiensis* sp. nov. [Ys. 103]  
*Lopha* (*Arctostrea*) *carinata* (LAMARCK)\*  
*Nipponitrigonia kikuchiana* (YOKOYAMA)\*  
*Nipponitrigonia naumanni* (YEHARA)\*  
*Pterotrigonia pocilliformis* (YOKOYAMA) [Ys. 8, 103]  
*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [Ys. 103]  
*Lucinoma* (?) sp. [Ys. 8]  
*Ptychomya densicostata* NAGAO [Ys. 103]  
*Panopea* (*Myopsis*) *nagaoi* sp. nov. [Ys. 103]  
*Plectomya aritagawana* sp. nov. [Ys. 53, 103]

In the Katsuuragawa basin of Tokushima Prefecture, the Aritan series seems to be represented by the Hanoura formation, although its upper part may be referable to lower Aptian\*\*. *Phyllopachyceras infundibulum*, *Barremites pseudo-difficilis*, *Silesites* sp. cf. *S. seranonis*, *Hamulina* sp. cf. *H. subcylindrica*, *Pseudothurmannia hanourensis* and *Pulchellia* sp. cf. *P. ishidoensis* have been reported from this formation (YABE, 1927; YABE and SHIMIZU, 1931; etc.), although this fauna has not been fully described. The following pelecypods have been known or collected mainly from the middle and upper parts of this formation:

\*\* The ammonites of the Hanoura formation need a further careful study, because their identifications will serve fundamentals for the international correlation of the Aritan series. The biostratigraphy of the Katsuuragawa basin is now studied by Mr. I. NAKAI. See also the postscript II of this paper.

*Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO) [Hy. 5002, 5011]

*Nuculana* (s. l.) *sanchuensis* YABE and NAGAO [Hy. 5010]

*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Hy. 5002]

*Pterinella shinoharai* sp. nov. [Hy. 5002, 5004]

? *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY [Hy. 5002]

*Neithea* (*Neithea*) *kanmerai* sp. nov. [Hy. 5004]

*Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER) [Hy. 5002]

*Lopha* (*Arctostrea*) *carinata* (LAMARCK)\*

*Pterotrigonia pocilliformis* (YOKOYAMA) [Hy. 5001]

*Pterotrigonia* sp. cf. *P. yokoyamai* (YEHARA) [Hy. 5002]

*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [Hy. 5004, 5012, 5015]

*Scittilla japonica* sp. nov. [Hy. 5003]

*Scittilla* sp. [Hy. 5001]

*Astarte* (*Yabea*) sp. aff. *A. (Y.) shinanoensis* YABE and NAGAO [Hy. 5002]

? *Panopea* (*Myopsis*) *plicata* (SOWERBY) [Hy. 5004]

*Plectomya aritagawana* sp. nov. [Hy. 5003]

Furthermore, HIRAYAMA et al. (1956) listed *Cucullaea* aff. *acuticarinata*, *Spondylus* cf. *decoratus*, *Gervillaria* cf. *haradae*, *Laevicardium* (?) *ishidoense* and *Ptychomya* aff. *densicostata* from the Hanoura formation.

The Mamidani formation, which is distributed in a narrow area to the south of the Katsuuragawa basin, is probably also a representative of the Aritan series. HIRAYAMA et al. (1956) listed "*Propeamussium cowperi* var. *yubarensis*", *Limatula ishidoensis*, *Gervillia* aff. *forbesiana*, *Pterotrigonia pocilliformis*, *Astarte* (*Astarte*) *subsenecta*, *Anthonya* sp. and some other marine pelecypods, although I have not as yet observed the fauna of this formation.

In the Monobegawa basin of Kochi Prefecture the Aritan series is represented by the Lower Monobegawa subgroup called Funadani or Yunoki formation, although the biostratigraphic data are still insufficient to yield definite evidence as to the chronology. *Lopha* (*Arctostrea*) *carinata*, *Nipponitrigonia kikuchiana* and *Pterotrigonia pocilliformis* have been reported to occur in this part (KATTO et al., 1961, etc.). In addition, the following species occur in this subgroup at the mouth of a valley, Okunominotani, northwest of this basin:

*Barbatia* sp. [Hy. 6002]

*Chlamys shikokuensis* AMANO [Hy. 6002]

*Variamussium kimurai* sp. nov. [Hy. 6002]

*Astarte* (*Astarte*) sp. [Hy. 6002]

Pelecypods are also comparatively rare in the Lower Monobegawa subgroup of the Sakawa-Ochi area of Kochi Prefecture. Only *Pterotrigonia pocilliformis* and *Astarte* (*Astarte*) *subsenecta* have been reported from the environs of Ochi (HUKUTI, 1941).

The Hachiryuzan formation in the Yatsushiro (or Kuma) area of Kumamoto Prefecture is generally regarded as a representative of the Aritan series. It bears *Nipponitrigonia plicata* and *Pterotrigonia hokkaidoana* in addition to *Toxoceras* sp., *Leptoceras* sp. and *Crioceratites* sp. ex gr. *C. duvali* (MATSUMOTO,

1954; KOBAYASHI and NAKANO, 1959).

In the Kitakami mountains, Aritan marine pelecypods are found in the middle-upper part of the Oshima formation (=Yokonuma formation) at Oshima island, Kesenuma City, Miyagi Prefecture, and in the middle-upper part of the Ofunato group in the environs of Ofunato City, Iwate Prefecture.

The Oshima formation, which is probably Hauterivian-Barremian as indicated by the occurrence of *Paracrioceras ishiwarai* from the upper part, contains the following pelecypods:

- Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Hy. 0004, 0009]
- Gervillaria haradae* (YOKOYAMA) [Hy. 0002]
- Gervillia* (*Gervillia*) *forbesiana* (D'ORBIGNY)\*
- Lopha* (*Arctostrea*) *carinata* (LAMARCK) [Hy. 0003]
- Gryphaea* (s. l.) *oshimensis* sp. nov. [Hy. 0009]
- Pterotrigonia pocilliformis* (YOKOYAMA) [Hy. 0002, 0003]
- Astarte* (*Astarte*) sp. cf. *A. (A.) subsenecta* YABE and NAGAO [Hy. 0012]
- Astarte* (*Astarte*) sp. [Hy. 0012]

The Ofunato group including the Massaki group probably ranges from Kochian to Aritan, although index fossils have been scarcely found. According to SEKI and IMAIZUMI (1941) and ONUKI and MORI (1961), many marine and brackish-water pelecypods occur in the Funagawara, Hijiochi and Takonoura formations of this group. Although my survey on the fauna is not yet completed, the following species have been identified in the collections of the University of Tokyo and the Tohoku University or are represented in the present collection:

[Funagawara formation]

- Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO)\*
- Eonavicula shinanoensis* (YABE and NAGAO)\*
- Gervillia* (*Gervillia*) *forbesiana* (D'ORBIGNY)\*
- Pterotrigonia pocilliformis* (YOKOYAMA)\*
- Astarte* (*Astarte*) *subsenecta* YABE and NAGAO\*
- Pachythaerus* sp. cf. *P. kagaharensis* (YOKOYAMA)\*
- Costocyrena radiatostriata* (YABE and NAGAO) [Hy. 0051]
- Eomiodon sakawanus* (KOBAYASHI and SUZUKI) [Hy. 0054]
- Neomiodon* sp. cf. *N. otsukai* (YABE and NAGAO) [Hy. 0054]
- Paracorbicula sanchuensis* (YABE and NAGAO) [Hy. 0054]
- Panopea* (*Myopsis*) *plicata* (SOWERBY)\*

[Hijiochi formation]

- Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO)\*
- Plicatula* sp.\*
- Lopha* (*Arctostrea*) *carinata* (LAMARCK)\*
- Pterotrigonia pocilliformis* (YOKOYAMA)\*
- Nipponitrigonia kikuchiana* (YOKOYAMA)\*
- Ptychomya densicostata* NAGAO [Hy. 0053]
- Veniella* sp.\* [Hy. 0053]

In the northern Kitakami mountains the Kochian and Aritan series seem to

be represented by the thick strata of the Rikuchu group, i.e. the Omoto, Hara-chiyama, Takinoshirisawa and Matsumaezawa formations in ascending order (ONUKI, HASE and SUZUKI, 1960). The brackish-water pelecypods of the Omoto formation recall me to the Kochian fauna, as noted before. A marine faunule including *Pterotrignia hokkaidoana* was reported to occur from the Takinoshirisawa formation near Omoto of the Miyako area. The age of this faunule must be Aritan or thereabout in view of the stratigraphic position, though I have had no chance to observe the specimens.

Recently NAKAZAWA (1965) reported preliminarily the occurrence of a characteristic molluscan fauna including *Bakevella*, *Isognomon*, *Protocardia*, *Costocyrena* and *Filosina* from the folded complex near the Ominé mine, northwest of Kamaishi, Iwate Prefecture. The age, as was suggested by him, is presumably Aritan if not Kochian\*\*.

### 3) Miyakoan pelecypod faunas

Miyakoan pelecypod fossils are generally better preserved and more abundant as regards both numbers of species and individuals than Aritan ones. The Aritan deposits are mostly marine, while the Miyakoan (especially Upper Miyakoan) faunas comprise a considerable number of brackish-water species which occur commonly in some members of many sedimentary areas of Southwest Japan. The lower Miyakoan ( $K3\alpha$ ) roughly corresponds to the European Aptian, the upper Miyakoan ( $K3\beta$ ) to the Albian, and the uppermost Miyakoan ( $K3\gamma$ ) or Infra-Gylikian to the lowest Cenomanian (MATSUMOTO, 1954, 1959, 1963). By the reason stated before (Part I, p. 228), the pelecypod faunas of the uppermost Miyakoan are not discussed here.

The "Kawarazawa formation" of the Sanchu area in the Kwanto mountains was generally regarded as Miyakoan. As suggested by ARAI et al. (1958) and TAKEI (1963), however, this formation, especially the fossiliferous part, seems to be correlative to the Aritan Ishido formation. In fact, all the pelecypods hitherto known from the "Kawarazawa formation" are identical with the species from the Ishido formation.

On the other hand the brackish-water molluscan beds of the "Shiroi formation" at Hachimanzawa and some other localities, which were formerly assigned to the Kochian series, are evidently younger than the marine fossil beds of the Ishido formation. The stratigraphy of the eastern part of this area was recently clarified to some extent by TAKEI (1963), who named the brackish-water beds the Sebayashi formation. Although at present there is no definite palaeontological evidence concerning the age, I provisionally regard the Sebayashi formation as a representative of the Miyakoan series, because similar brackish-water beds with the species of *Costocyrena* are also common in the Miyakoan series of the Outer Zone of Southwest Japan. The following pelecypods were collected from the brackish-water beds at Hachimanzawa, south of Kagahara, Nakazato village,

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\*\* See also Postscript IV.

Gumma Prefecture. The same formation exposes also at the southeast of Koya in the western part of the Sanchu area, Nagano Prefecture.

*Isognomon* (*Isognomon*) *sanchuensis* (YABE and NAGAO) [Hy. 4005]

*Liostrea* sp. [Hy. 4006]

*Nippononaia ryosekiana* (SUZUKI) [Hy. 4006]\*\*

*Protocyprina* sp. [Hy. 4006]

*Costocyrena radiatostriata* (YABE and NAGAO) [Hy. 4005]

The overlying Sanyama formation bears some marine pelecypods and cephalopods. Although TAKEI (1963) regarded it as a representative of the Gyliaikian series, the fauna from the lower part of this formation recalls me to the Miyakoan one. As to the palaeontology and biostratigraphy of the Sanyama formation, much should be done in future.

In the Outer Zone of Southwest Japan, Miyakoan deposits are widely distributed in many sedimentary areas generally in close connection with the Aritan ones.

The Todai formation of the Akaishi mountains is considered to be Aritan or Miyakoan in age, since it bears *Nipponitrigonia naumanni* (YEHARA), *Pterotrigonia pocilliformis* (YOKOYAMA) and some other marine pelecypods (WAKIMIZU, 1899; YEHARA, 1923; MAEDA, 1962, 1964). A pachyodont pelecypod, *Pachytraga japonica* OKUBO was reported from the Shirane belt of the mountains (OKUBO and MATSUSHIMA, 1959), but its age cannot be determined with precision.

The Nishihiro and Izeki formations of the Yuasa-Aritagawa area of Wakayama Prefecture are approximately Miyakoan, as recognized from the stratigraphic sequence. It is noteworthy that the Nishihiro formation contains some brackish-water pelecypods which appear at first sight similar to those of the Kochian fauna, as pointed out by MATSUMOTO (1947).

*Bakevella shinanoensis* (YABE and NAGAO)

*Liostrea* sp. cf. *L. ryosekiana* (KOBAYASHI and SUZUKI)

*Isodomella* sp. cf. *I. shiroiensis* (YABE and NAGAO)

Besides the brackish-water species mentioned above, *Nipponitrigonia kikuchiana*, *Pterotrigonia pocilliformis* and *Pterotrigonia hokkaidoana* were reported from different beds of the same formation.

The Izeki formation, which probably passes laterally into the Nishihiro formation, bears the following pelecypods:

*Bakevella shinanoensis* (YABE and NAGAO) [Ys. 1020]

*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY\*

*Costocyrena* sp. aff. *C. radiatostriata* (YABE and NAGAO) [Ys. 1020, Hy. 9006]

*Tetoria* (*Paracorbicula*) sp. [Hy. 9006]

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\*\* SUZUKI (1941) described *Unio* (*Nippononaia*) *ryosekiana* from the "Ryoseki series of the Sanchu area or the Katsuuragawa basin". The new discovery of specifically identical specimens in a large float of black carbonaceous shale at loc. Hy. 4006, Hachimanzawa, suggests that SUZUKI's original specimens were possibly collected also from the Sebayashi formation. These specimens were recently described in a separate paper (HAYAMI and ICHIKAWA, 1965, *Trans. Proc. Pal. Soc. Japan*, N. S., No. 60, 145-155, pl. 17).

In the Katsuuragawa basin of Tokushima Prefecture, the Miyakoan is represented by the Hoji (=Boji) formation and probably also by the main part of the Fujikawa formation. The Hoji formation is said to contain *Chelonicer* sp. and *Ancyloceras giganteum*, but unfortunately these ammonites have not been allocated in the stratigraphic columns. Marine pelecypods, especially trigoniids, occur abundantly in the lower and upper parts of this formation at various localities such as Hoji, south of Fujikawa, south of Sakamoto and Mt. Kaseyama, and some cyrenoids are common in a brackish-water member at Hiura and Ochiai, which is embedded in the middle part of this formation together with some coal seams and plant-beds.

*Nuculopsis (Palaeonucula) ishidoensis* (YABE and NAGAO) [Hy. 5017]

*Gervillia (Gervillia) forbesiana* D'ORBIGNY [Hy. 5017]

*Liostrea* spp. [Hy. 5037]

*Nipponitrigonia kikuchiana* (YOKOYAMA) [Hy. 5019]

*Nipponitrigonia plicata* KOBAYASHI and NAKANO [Hy. 5019]

*Nipponitrigonia naumanni* (YEHARA)\* [?= *Nipponitrigonia sakamotoensis* (YEHARA)]

*Pterotrigonia pocilliformis* (YOKOYAMA) [Hy. 5017, 5021, 5022, 5023]

*Eomiodon sakawanus* (KOBAYASHI and SUZUKI) [Hy. 5027, 5031]

*Tetoria (Paracorbicula)* sp. [Hy. 5027, 5031]

*Isocyprina aliquantula* (AMANO) [Hy. 5019]

Pelecypods are very rare in the overlying Fujikawa formation except for the basal part where *Pterotrigonia pocilliformis* forms a fossil bank. Although some species of *Inoceramus* have been reported from the "Fujikawa formation" in the eastern part of this basin (HIRAYAMA et al., 1956), it is questionable whether the fossil bed is correlative to the Fujikawa formation proper or belong to a certain younger sedimentary cycle. "*Beudanticeras*" *shikokuense*, which was reported from the main part of this formation by YABE (1927), and "*Desmoceras kossmati*", which was listed by NAKANO (1960), closely resemble *Desmoceras (Pseudouhligella) dawsoni* and may indicate an Upper Albian age instead of a Cenomanian age.\*\*

AMANO (1957a) described many marine pelecypods from the upper part of the Monobegawa group or the Hagino formation at Hagino in the Monobegawa area of Kochi Prefecture, which is at least in part referable to the lower Miyakoan.\*\*\* The fauna is composed of the following species (specific names revised on the basis of AMANO's and the present specimens):

*Eonavicula prolata* (AMANO) [Hy. 6011]

*Nemodon* (?) sp. [Hy. 6011]

\*\* According to Mr. I. NAKAI's oral communication and presentation at the 91st Meeting of the Palaeontological Society of Japan at Nagasaki, 25th of September, 1965.

\*\*\* The ammonites of the Hagino formatin are not yet described, but some specimens, which were collected by Mr. OGAWA and are preserved in the Kyushu University, indicate an Aptian age (Prof. T. MATSUMOTO's oral communication).

- Cucullaea fujii* sp. nov. [Hy. 6011]  
*Trigonarca obliquata* AMANO [Hy. 6011]  
*Modiolus falcatus* AMANO [Hy. 6011]  
*Gervillaria* sp. cf. *G. haradae* (YOKOYAMA) [Hy. 6011]  
*Neithea* (*Neithea*) *amanoi* sp. nov. [Hy. 6011]  
*Chlamys shikokuensis* AMANO [Hy. 6011]  
*Acanthotrignonia moriana* (YEHARA) [Hy. 6011]  
*Nipponitrignonia naumanni* (YEHARA)\*  
*Pseudocardia amanoi* sp. nov. [Hy. 6011]  
*Eriphyla* (*Miyakoella*) sp. cf. *E. (M.) miyakoensis* (NAGAO) [Hy. 6011]  
*Opis* (*Opis*) *haginoensis* AMANO [Hy. 6011]  
*Pachythaerus* sp. cf. *P. kagaharensis* (YOKOYAMA) [Hy. 6011]  
*Protocardia* sp. [Hy. 6011]  
*Laevicardium* (?) *corpulentum* (AMANO) [Hy. 6011]  
*Scittila* sp. cf. *S. japonica* HAYAMI [Hy. 6011]  
*Isocyprina aliquantula* (AMANO) [Hy. 6011]  
*Panopea* (*Myopsis*) sp. cf. *P. (M.) plicata* (SOWERBY) [Hy. 6011]  
*Pholadomya* sp. aff. *P. cornueliana* D'ORBIGNY [Hy. 6011]  
*Pholadomya* sp. [Hy. 6011]  
*Plectomya* sp. [Hy. 6011]

In addition, the following species were reported to occur from the Upper Monobegawa subgroup of this area, although I have not yet ascertain the specific identification: *Glycymeris* sp., *Bakevellia pseudorostrata* (NAGAO), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Spondylus* sp. aff. *S. decoratus* NAGAO, *Lopha* (*Arctostrea*) *carinata* (LAMARCK), "*Exogyra*" sp., *Nipponitrignonia kikuchiana* (YOKOYAMA) and *Pterotrignonia pocilliformis* (YOKOYAMA).

The Upper Monobegawa subgroup of the Sakawa basin of Kochi Prefecture contains *Pterotrignonia pocilliformis* (YOKOYAMA) and some other pelecypods, but reliable analysis of the fauna has not been achieved.

The Kikunotani formation in the Kurosegawa area of Ehime Prefecture contains *Nipponitrignonia kikuchiana* (YOKOYAMA), *Nipponitrignonia naumanni* (YEHARA) and *Pterotrignonia pocilliformis* (YOKOYAMA), but I have not yet been able to observe the associated pelecypods.

As listed by NAGAI and NAKANO (1961), the Nigyu formation in the Mikame area of the same prefecture bears *Glycymeris densilineata* NAGAO, *Nipponitrignonia kikuchiana* (YOKOYAMA), *Pterotrignonia hokkaidoana* (YEHARA), *Astarte* (*Astarte*) sp. cf. *A. (A.) subsenecta* YABE and NAGAO and some other pelecypods, although the material is too poorly preserved to be described. The age of these formations cannot be determined in detail, but is certainly Miyakoan if not Aritan.

As reported by FUJII (1954), the Haidateyama formation and its comparable strata in the western area of Usuki, Oita Prefecture, contains some marine pelecypods as listed below:

- Parallelodon nipponicus* (NAGAO) [U. 1005]

*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [U. 1005]

*Cucullaea fujii* sp. nov. [U. 1005]

*Pinna* sp. [U. 1005]

*Neithea* (*Neithea*) *matsumotoi* sp. nov. [U. 1005]

*Pterotrigonia pocilliformis* (YOKOYAMA) [U. 1005, Hy. 3003]

*Pterotrigonia datemasamunei* (YEHARA)\*

*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [U. 3095]

*Veniella* (?) sp.

There is no known index fossil in the Haidateyama formation, but the age is at least in part upper Miyakoan, because this formation closely resembles the Yatsushiro formation in the general aspect of the lithology and fauna.

In the Kuma mountains of Kumamoto Prefecture, the lower part of the Miyakoan series is well represented by the Hinagu formation and the upper part by the Yatsushiro formation. Pelecypods are common in the two formations and have been listed by MATSUMOTO and KANMERA (1952) and MATSUMOTO (1954). Some species of *Parahoplites*, *Acanthoplites*, *Colombiceras* and *Deshayesites* were reported to occur in the lower part of the Hinagu formation, and *Engonoceras* sp. aff. *E. stolleyi*, *Hoplites* sp. cf. *H. dentatus* and *Hamiticeras* sp. aff. *H. æquicostatum* are said to occur in the Yatsushiro formation. The assemblages seem to indicate an Aptian age for the former and an Albian age for the latter. In the lowest part of the Hinagu formation a brackish-water member with some pelecypods occurs, and the middle part bears many marine pelecypods, as listed below:

*Nuculana* (s. l.) *sachuensis* YABE and NAGAO [Km. 1832]

*Parallelodon* sp. cf. *P. nipponicus* (NAGAO) [Km. 3134]

*Pinna* sp. cf. *P. robinaldina* D'ORBIGNY [Km. 1832]

*Neithea* (*Neithea*) *kanmerai* sp. nov. [Km. 3085c]

*Plicatula kiiensis* sp. nov. [Km. 3085c]

*Nipponitrigonia kikuchiana* (YOKOYAMA) [Km. 3134]

*Pterotrigonia hokkaidoana* (YEHARA) [Km. 3085a, 3134]

*Pterotrigonia* (*Rinetrigonia*) sp. [Km. 3134]

*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [Km. 3085c]

*Costocyrena* sp. cf. *C. matsumotoi* HAYAMI [Km. 1639b]

"*Nakamuranaia chingshanensis*" (GRABAU) [Km. 1639b]

The Yatsushiro formation is distributed along two belts in the Kuma mountains. It is mostly marine, but some brackish-water sediments are inserted in the middle part. The following pelecypods were collected from various horizons at Miyaji, south of Kohara, north of Shimofukami, south of Bisho and north of Nekodani:

*Mesosaccella* sp. [Km. 3096]

*Malletia* (*Neilo*?) *higoensis* sp. nov. [Km. 3096]

*Nuculana* (s. l.) *sanchuensis* YABE and NAGAO [Km. 3096]

*Parallelodon nipponicus* (NAGAO) [Km. 1843]

*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Km. 3096, 3037,



Hy. 1016]

*Nanonavis* (*Nanonavis*) sp. cf. *N. (N.) yokoyamai* (YABE and NAGAO)

[Hy. 1007]

*Trigonarca* sp. cf. *T. obliquata* AMANO

*Pterinella shinoharai* sp. nov. [Km. 3037, 1843, Hy. 1012]

*Gervillaria haradae* (YOKOYAMA) [Hy. 1021, At. 828A]

*Bakevellia pseudorostrata* (NAGAO) [Km. 1843]

*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY [Km. 3096, 3097, At. 828A]

*Neithea* (*Neithea*) *matsumotoi* sp. nov. [Km. 3037, Hy. 1001]

*Entolium* (?) *yatsushiroense* sp. nov. [Km. 1843]

*Limatula* sp. cf. *L. nagaoi* HAYAMI [Km. 1843]

*Lopha* (*Arctostrea*) *carinata* (LAMARCK) [Km. 1843, Hy. 1012]

*Monia* sp. cf. *M. pseudotruncata* (YABE and NAGAO) [Km. 3035]

*Nipponitrigonia plicata* KOBAYASHI and NAKANO [Km. 1843]

*Rutitrigonia sanchuensis* (NAKANO) [Km. 1843]

*Pterotrigonia pocilliformis* (YOKOYAMA) [Km. 1843, 3036, 3037, 3096, 3097, Hy. 1007, 1012, 1021]

*Acanthotrigonia* sp. cf. *A. dilapsa* (YEHARA) [Km. 1843, 3096, 3097]

*Pseudocardia* sp.

*Astarte* (*Astarte*) *subsenecta* YABE and NAGAO [Km. 3037, At. 328]

*Astarte* (*Freiastarte*) sp. cf. *A. (F.) subomalioides* NAGAO [Km. 3037]

*Astarte* (*Yabea*) *akatsui* sp. nov. [At. 328]

*Eriphyla* (*Eriphyla*) *minima* sp. nov. [At. 328]

*Anthonya* sp. [Km. 1843]

*Fimbria* sp. [Km. 1843]

*Nemocardium yatsushiroense* sp. nov. [Km. 3037, Hy. 1012]

*Laevicardium* (?) *ishidoense* (YABE and NAGAO) [Km. 1843, At. 828A]

*Veniella* sp. aff. *V. japonica* NAGAO [Km. 3151]

*Costocyrena matsumotoi* sp. nov. [Km. 3035, Hy. 1017]

*Tetoria* (*Paracorbicula*) sp. [Hy. 1017]

*Ptychomya densicostata* NAGAO [Km. 1843]

*Panopea* (*Myopsis*) *nagaoi* sp. nov. [Km. 1843, 3097]

*Pulsidis higoensis* (MATSUMOTO)\*

*Pholadomya* sp. indet. [Km. 1843]

*Goniomya* sp. indet. [Km. 3096]

*Plectomya aritagawana* sp. nov. [Km. 3113]

*Plectomya* sp. aff. *P. anglica* WOODS [Hy. 1016]

In the north Kitakami mountains the Miyakoan series is typified by the Miyako group. It is distributed at several narrow places bordering the coast between Miyako and Tanohata, Iwate Prefecture. Severe diastrophisms of the "Oshima phase", which were accompanied by folding and granitic intrusions, took place in upper Neocomian and/or lower Aptian times, and the Apto-Albian Miyako group abuts against the Aritan and earlier rocks of the Rikuchu group and also granitic rocks with a conspicuous unconformity. The Miyako group is

mainly composed of calcareous sandstone and sandy shale, containing abundant and well-preserved neritic pelecypods at numerous localities and horizons (YEHARA, 1915; YABE and NAGAO, 1926; NAGAO, 1932, 1934, 1943; HATAI, 1951). A detailed study on the sediments and fossils of this group is now being undertaken by HANAI, and the rich ammonites contained are also being investigated by OBATA\*\*.

In the type section at Hiraiga of the Tanohata area and its northern coast, the Miyako group is composed of the following four sedimentary cycles:

- 4th cycle Aketo formation (=Akito sandstone)
- 3rd cycle unnamed formation (=“*Orbitolina* sandstone”)
- 2nd cycle Hiraiga formation (=Hiraiga sandstone)
- 1st cycle Tanohata formation (=Moshi sandstone + Tanohata shale)
- disconformity —————
- Raga conglomerate formation
- unconformity —————

#### Basement complex

The 1st and 2nd cycles carry the following ammonites (Shimizu, 1931; specific names revised by Matsumoto, 1954, 1959): *Holcophylloceras caucasicum* (SAYN), *Melchiorites* (?) *matsushimensis* (SHIMIZU), *Melchiorites yabei* (SHIMIZU), *Pseudohaploceras nipponicum* SHIMIZU, *Diadococeras nodosocostatifforme* SHIMIZU, *Cheloniceris subcornuerianum* (SHIMIZU) and *Parahoplites yaegashii* SHIMIZU. These ammonites indicate an Aptian (probably upper Lower and lower Upper Aptian) age for the fossiliferous part of the two formations. In the Moshi and Miyako (Sakiyama) areas ammonites show also an Aptian age, and numerous fossil localities belonging to the “Moshi sandstone” and the “Hideshima sandstone” are correlative with the 1st and 2nd cycles of the type area.

The Tanohata and Hiraiga formations (and their equivalents) in the Tanohata, Moshi and Miyako areas, which are regarded as lower Miyakoan, contain the following pelecypods:

- Mesosaccella insignis* (NAGAO) [Hn. 4053, 4151]
- Parallelodon nipponicus* (NAGAO) [Hn. 0017]
- Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) [Hn. 0012]
- Cucullaea acuticarinata* NAGAO [Hn. 0017, 0018, 0912, 0914, 0916]
- Cucullaea transversa* NAGAO [Hn. 0017, 0018]
- Glycymeris* (*Hanaia*) *densilineata* NAGAO [Hn. 0010, 0017, 0018, 0914, 0916, 1903, 2065, 4053, etc.]
- Glycymeris* (*Glycymerita*?) *haipensis* sp. nov. [Hn. 0914, 4051]
- Modiolus falcatus* AMANO [Hn. 0220]

\*\* I have been entrusted with the study of the Miyako pelecypods by Dr. T. HANAI, who kindly put his collection at my disposal. In this paper some of his unpublished results of his field survey are cited through his courtesy. The locality numbers and formation names cited are in agreement with those which will be used in his forthcoming publication. I have been informed by Dr. I. OBATA about the chronological relations of the Miyako group. My sincere thanks are due to these two persons for their kindness.

- Amygdalum ishidoense* (YABE and NAGAO) [Hn. 0017, 0018]  
*Lecompteus* sp. cf. *L. guerangeri* (D'ORBIGNY) [Hn. 4053]  
*Mytilus* (?) sp.  
*Gervillaria haradae* (YOKOYAMA) [Hn. 0017]  
*Gervillaria miyakoensis* (NAGAO) [Hn. 0017, 0920]  
*Bakevellia pseudorostrata* (NAGAO) [Hn. 0017, 0018]  
*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY [Hn. 0017, 0018]  
*Isognomon* (*Mytiloperna*) sp. [Hn. 0017, 0803]  
*Pinna* sp. [Hn. 0018]  
*Atrina heiensis* sp. nov. [Hn. 0018, 0220, etc.]  
*Neithea* (*Neithea*) *ficahoi* (CHOFFAT) [Hn. 0017, 0018, 0220, 0299, 0914, etc.]  
*Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER) [Hn. 0013, 0299]  
*Chlamys robinaldina* (D'ORBIGNY) [Hn. 0017, 0103]  
*Prohinnites* sp. cf. *P. favrinus* (PICTET and ROUX)  
*Pectinella miyakoensis* (NAGAO) [Hn. 0017, 0018]  
*Plicatula hanaii* sp. nov. [Hn. 0017, 0803]  
*Spondylus decoratus* NAGAO [Hn. 2065, etc.]  
*Plagiostoma* (*Plagiostoma*) *sanrikuense* sp. nov. [Hn. 0017]  
*Plagiostoma* (*Acesta*) *goliathiforme* sp. nov. [Hn. 0017, etc.]  
*Antiquilima ultima* sp. nov. [Hn. 4053]  
*Ctenoides subrapa* (NAGAO)  
*Limatula nagaoi* sp. nov. [Hn. 0017, 0018, 0220]  
*Monia aptiana* sp. nov. [Hn. 0017]  
*Liostraea* sp. ex gr. *L. cunabula* (SEELEY) [Hn. 0803, ?4051]  
*Lopha* (*Lopha*) *nagaoi* sp. nov. [Hn. 0017, 0802, 0803, 4024, etc.]  
*Lopha* (*Arctostrea*) *carinata* (LAMARCK) [Hn. 0017, 0480, etc.]  
*Amphidonte* (*Amphidonte*) *subhalioidea* (NAGAO) [Hn. 0017, 0023, 0310, 0802, 2058]  
*Amphidonte* (*Ceratostreon*) *yabei* (NAGAO) [Hn. 0017, 0018, 0802, 0803, 0920, etc.]  
*Gryphaeostrea* sp. ex gr. *G. vesicularis* (LAMARCK) [Hn. 0017]  
*Nipponitrigonia kikuchiana* (YOKOYAMA) [Hn. 0802, 0803, 0905, 4051, 4053, etc.]  
*Pterotrigonia hokkaidoana* (YEHARA) [Hn. 0010, 0017, 0018, 0220, 0299, 0802, 0803, 0914, 0916, 0920, 1903, etc.]  
*Pterotrigonia yokoyamai* (YEHARA) [Hn. 0017, 0018, etc.]  
*Pterotrigonia datemasamunei* (YEHARA)\*  
*Pterotrigonia kotoi* (YEHARA)\*  
*Myoconcha modesta* sp. nov. [Hn. 0803]  
*Pseudocardia* sp. cf. *P. tenuicosta* (SOWERBY) [Hn. 2058]  
*"Cardita"* (?) sp. [Hn. 2058]  
*Astarte* (*Astarte*) *semicostata* NAGAO [Hn. 0017, 0018, 0914, 0916, 0920, etc.]  
*Astarte* (*Freiastarte*) *subomalioides* NAGAO [Hn. 0017, 0018, 0916, 4101,

4051, etc.]

*Astarte (Nicanella) minor* NAGAO [Hn. 0017, 0018, 0914, 0916]

*Eriphyla (Miyakoella) miyakoensis* (NAGAO) [Hn. 0010, 0017, 0018, 0802, 0803, 0911, 0914, 4051, etc.]

*Opis (Opis) nakanoi* sp. nov.

*Anthonya subcantiana* NAGAO [Hn. 0017, 0018, 0220, etc.]

*Lucinoma (?) kotoi* (NAGAO) [Hn. 0017, 0018]

*Protocardia (Globocardium) sphaeroidea* (FORBES) [Hn. 0001, 0017, 0220]

*Protocardia hiraigensis* sp. nov. [Hn. 0017]

*Agapella (?) koikorobensis* sp. nov. [Hn. 0803]

*Nagaoella corrugata* (NAGAO) [Hn. 0017, 0018, 1904, 2065, 4051, 0914, 0916]

*Nagaoella* sp. aff. *N. corrugata* (NAGAO) [Hn. 0914, 0916]

*Panopea (Myopsis) plicata* (SOWERBY) [Hn. 0017, 0018, 0155, etc.]

*Pholadomya miyamotoi* NAGAO [Hn. 0017, 0018]

*Pholadomya brevitesta* NAGAO [Hn. 0006]

*Pholadomya subpedelnalis* NAGAO\*

*Pholadomya tuberculata* sp. nov. [Hn. 0017, 0018]

*Goniomya subarchiaci* NAGAO [Hn. 0016, 0017, 0018, 0220, 1903, etc.]

*Cercomya gurgitis* (PICTET and CAMPICHE) [Hn. 0018]

*Thracia* sp. [Hn. 0017]

*Corimya (?) tanohatensis* sp. nov.

"*Teredo*" *matsushimaensis* HATAI [Hn. 4154, 0017]

*Praecaprotina yaegashii* (YEHARA) [Hn. 0802, 0803, 4101, etc.]

The sediments belonging to the 3rd and 4th cycles of the Miyako group expose only in the type area. *Hoplites* sp. aff. *H. dentatus*, *Desmoceras* sp. and a few other ammonites occur from the upper part of the "Orbitolina sandstone" and the lower part of the Aketo formation, indicating a middle Albian age for the beds. The 3rd and 4th cycles are therefore treated as the upper Miyakoan. The following pelecypods were collected or have been reported from the "Orbitolina sandstone" and the Aketo formation at the northeast of Raga, Tanohata village:

*Nanonavis (Nanonavis) yokoyamai* (YABE and NAGAO) [Hn. 6203]

*Cucullaea acuticarinata* NAGAO\*

*Cucullaea transversa* NAGAO\*

*Glycymeris (Hanaia) densilineata* NAGAO [Hn. 6201, 6203]

*Amygdalum ishidoense* (YABE and NAGAO)\*

*Gervillaria miyakoensis* (NAGAO) [Hn. 6203]

*Gervillia (Gervillia) forbesiana* D'ORBIGNY [Hn. 6203]

*Pinna* sp.\*

*Atrina heiensis* sp. nov. [Hn. 6203]

*Neithea (Neithea) nipponica* sp. nov. [Hn. 0671, 6201, 6203]

*Neithea (Neithea) ficalhoi* (CHOFFAT) [Hn. 6203]

*Neithea* (s. l.) *aketoensis* sp. nov. [Hn. 6201]

*Chlamys* sp. cf. *C. subacuta* (LAMARCK) [Hn. 6201]

- Pectinella miyakoensis* (NAGAO)\*  
*Ctenoides subrapa* (NAGAO) [Hn. 6201]  
*Limatula nagaoi* sp. nov.\*  
*Lopha* (*Arctostrea*) *carinata* (LAMARCK) [Hn. 6203]  
*Amphidonte* (*Ceratostreon*) *yabei* (NAGAO)\*  
*Amphidonte* (*Amphidonte*) *subhaliotoidea* (NAGAO)\*  
*Pterotrigonia pocilliformis* (YOKOYAMA) [Hn. 6203]  
*Pterotrigonia datemasamunei* (YEHARA)\*  
*Astarte* (*Freiastarte*) *subomalioides* NAGAO  
*Astarte* (*Nicaniella*) *minor* NAGAO\*  
*Eriphyla* (*Eriphyla*) *pulchella* sp. nov. [Hn. 6201, 6202, 6203]  
*Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO) [Hn. 0671, 6201]  
*Anthonya subcantiana* NAGAO [Hn. 6203]  
*Lucinoma* (?) *kotoi* (NAGAO) [Hn. 6203]  
*Ptychomya densicostata* NAGAO\*  
*Nagaoella corrugata* (NAGAO) [Hn. 6201, 6203]  
*Panopea* (*Myopsis*) *plicata* (SOWERBY) [Hn. 6203]  
*Pholadomya subpedelnalis* NAGAO [Hn. 6203]  
*Goniomya subarchiaci* NAGAO [Hn. 6201, 6202, 6203]  
*Cercomya gurgitis* (PICHET and CAMPICHE) [Hn. 6202]  
*Offadesma altissimum* sp. nov. [Hn. 6203]

The Choshi formation in the Choshi area of Chiba Prefecture is referable to the Miyakoan series, since it bears *Hypophylloceras* aff. *H. onoense*, *Ancyloceras choshiense* and some other cephalopods. The following pelecypods have been reported previously or newly collected at Ashikajima and some other localities in this area:

- Cucullaea* sp. cf. *C. acuticarinata* NAGAO [Hy. 2003]  
*Isognomon* (*Isognomon*) *choshiensis* sp. nov. [Hy. 2003]  
*Nipponitrigonia choshiensis* MAEDA\*  
*Pterotrigonia pocilliformis* (YOKOYAMA)\*  
*Astarte* (*Astarte*) *costata* YABE and NAGAO [Hy. 2001]  
*Panopea* (*Myopsis*) sp. cf. *P. (M.) plicata* (SOWERBY)\*

In addition, the "Orbitolina sandstone" of the Lower Yezo group of Hokkaido contains two pachyodonts, *Toucasia carinata orientalis* and *Praeacprotina yae-gashii* (YEHARA). It may be also Miyakoan in age, but no other pelecypod has been reported to occur in the group.

As reported by MATSUMOTO and HARADA (1964), some pelecypods are known from the lower part of the Middle Yezo group in the Yubari area of Hokkaido. *Desmoceras* sp. cf. *D. (Pseudouhligella) dawsoni*, *Mortonicerias* (*Cantabrigites*) *imaii* (YABE and SHIMIZU), *Anagaudryceras sacya* (FORBES) and some other ammonites indicate an Albian age for this part as well as *Inoceramus anglicus* WOODS and *Inoceramus concentricus subsulcatus* WILTSHIRE. The associated pelecypods, as listed by MATSUMOTO and HARADA (1964), are apparently more closely related to the uppermost Miyakoan and Gyliakian faunas than to the

lower and upper Miyakoan faunas of Honshu. More precise study on the pelecypod fauna will be carried out on another occasion.

In the southern subzone of the Outer Zone of Southwest Japan, the Shimantogawa group is extensively distributed. In Shikoku it ranges actually from the Miyakoan to the Hetonaian. The Doganaro formation or the lowest part of this group is regarded as Miyakoan, as was interpreted by KATTO (1961). Although KOBAYASHI (1956) reported the occurrence of an Upper Jurassic trioniid and KATTO (1961) listed some pelecypods of Gyliakian type, a marine faunule including *Neithea* spp., which was recently collected by Mr. K. Kawasawa and others from this formation at Kakureyashiki of Susaki City, indicates undoubtedly a Miyakoan age.

## 6. Some remarks on the faunal characters

### 1) Faunal changes in the Lower Cretaceous of Japan

About 50 species of pelecypods are distinguishable in the Aritan and about 130 species in the Lower and Upper Miyakoan formations of Japan, as listed in Table 2. About 30 species of the Aritan pelecypods range up into Miyakoan. Moreover, some of the Kochian brackish-water species are actually found in certain Miyakoan deposits such as the Nishihiro, Hoji, Yatsushiro and Sebayashi formations. This fact indicates that the life range of some "elements of the Ryoseki fauna" are much longer than formerly supposed. The stratigraphic distribution of those brackish-water pelecypods was probably much influenced by sedimentary conditions.

Berriasian marine pelecypods are not rare in Northeast Japan, and most of them range up from the Tithonian or earlier. No striking extinction took place at the end of the Upper Jurassic. The Aritan pelecypods of Japan are, however, quite different from the Berriasian and Upper Jurassic ones as regards the specific assemblage. *Grammatodon* and *Myophorella* became extinct, and *Nanonavis*, *Trigonarca*, *Amygdalum*, *Pterinella*, *Gervillaria*, *Neithea*, *Rutitrigonia*, *Pterotrigonia*, *Pachythaerus*, *Anthonya*, *Costocyrena*, *Ptychomya*, *Scittila*, *Panopea* and some other important genera seem to have appeared suddenly after the Kochian. No Valanginian index fossil has been found in Japan. The formations corresponding to this stage are mainly composed of brackish-water deposits of the Kochian series, probably because of an extensive regression of the sea. In Argentina and western Europe the extinction of pelecypod fauna was also not significant at the end of Jurassic, and a certain post-Berriasian extinction is expected in some areas, although it is not very clear whether the extinction was world-wide or not.

No marked difference is observed between the specific assemblages of the Aritan and Miyakoan (proper) pelecypod faunas. A great number of species appear to have started since the Lower Miyakoan, but they do not indicate the presence of a post-Neocomian extinction, because the Aritan fauna is much poorer than the Miyakoan one. In western Europe the Aptian pelecypod faunas are

also closely related to the upper Neocomian ones.

On the other hand, the uppermost Miyakoan ( $\doteq$  lowest Cenomanian) pelecypods appear almost entirely different from those of the Miyakoan proper. The uppermost Miyakoan (or Infra-Gyliakian) is defined by the zone of *Desmoceras kossmati* and also by the occurrence of *Graysonites lozoi* (MATSUMOTO, 1959). The pelecypods from the lower part of the Gosyonoura group in west Kyushu and from the Middle Yezo group of Hokkaido differ almost completely from the upper Miyakoan species. Only a few species allied to Infra-Gyliakian and Gyliakian pelecypods are found in the Yatsushiro formation. As noted before, the pelecypod fauna of the lower part of the Middle Yezo group in the Yubari area is regarded as upper Albian (MATSUMOTO and HARADA, 1964). The fauna bearing some species of *Inoceramus* is apparently more similar to the Infra-Gyliakian faunas than to the upper Miyakoan faunas of Honshu. Therefore, an extinction is expected during the upper Albian, although the migration and geographic separation of the faunas should be further examined.

One of the most striking phenomena in the faunal change of this stage was the sudden reappearance of *Inoceramus*. In Japan, the Inoceramidae were already flourishing in the Jurassic (HAYAMI, 1960a), but in the Lower Cretaceous they seem very rare. The apparent extinction of *Parallelodon*, *Pterinella*, *Neithea*, *Costocyrena*, *Ptychomya* and *Goniomya* is also noticeable. *Astarte* (s. l.) also declined after this stage. Upper Albian or post-Albian extinction presumably occurred also in western Europe, Gulf Coast and many other regions. The faunal changes, however, must have been much influenced also by the change of geographic and local sedimentary conditions, and it should be further investigated how closely they were connected with the evolution of pelecypods on a world-wide scale.

## 2) Foreign elements in the Lower Cretaceous pelecypods of Japan

As reflected in the specific identifications of Japanese Lower Cretaceous pelecypods made by many authors and myself, there are a number of elements in common with foreign countries, especially those of western Europe. In Jurassic times the pelecypods, which were surveyed by HAYAMI (1961), include many European and Tethyan affinities in addition to western Pacific endemic species. Cosmopolitan species are known mainly in the neritic facies of the Outer Zone of Southwest Japan and Abukuma and Kitakami mountains. A similar tendency is known as to the Lower Cretaceous pelecypod fauna.

DIETRICH (1936, p. 400) pointed out the presence of cosmopolitan species among the Miyakoan pelecypods described by NAGAO (1934), if the following emendations of specific identifications were accepted (emended names by DIETRICH in parentheses): *Exogyra yabei* NAGAO ( $=E. \text{minos}$  COQUAND), *Gervillia miyakoensis* NAGAO ( $=Gervilleia \text{aliformis}$  SOWERBY var.), *Neithea morrissi* (PICTET and RENEVIER), *Protocardia* sp. in NAGAO ( $=Cardium$  (*Tendagurium*) *sphaeroideum* FORBES), *Ptychomya densicostata* NAGAO ( $=P. \text{robinaldina}$  D'ORBIGNY), *Panopea* cf. *gurgitis* (BRONGNIART). Although I cannot always accept his emendation,

the Aritan and Miyakoan pelecypods of Japan contain still many species which are identical with or hardly indistinguishable from typical forms of Europe, west Africa and some other countries.

So far as I can see, after comparing Japanese specimens with the illustrations of European specimens published by many authors and also with the collections of foreign fossils preserved in the Geological Institute, University of Tokyo and in the Department of Geology, Kyushu University, no marked difference is recognized as to the following species.

*Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) is similar to *Nanonavis securis* (LEYMERIE) from the Neocomian of France, England and (?) Argentina, and also to *Nanonavis* (*Nanonavis*) *carinata* (SOWERBY) from the Lower Greensand of England and the Aptian of France.

*Modiolus* sp. aff. *M. subsimplex* D'ORBIGNY resembles the typical form from the upper Neocomian of France.

*Lecompteus* sp. cf. *L. guerangeri* D'ORBIGNY is almost identical with the typical form from the Upper Greensand of England and the Albian and Cenomanian of France.

*Amigdalum ishidoense* (YABE and NAGAO) is probably related to *Modiolus rector* WOLLEMAN, from the Neocomian of Germany.

*Pectinella shinoharai* sp. nov. is probably intimate to *Pterinella petersi* TOULA from the Neocomian of Balkan, though specifically distinct.

*Gervillaria haradae* (YOKOYAMA) is somewhat similar to *Gervillaria alaeformis* (SOWERBY) from the Lower Greensand of England and the Aptian of France. Similar species occur also from the Lower Cretaceous of Argentina, Mexico, Colombia S. A. and Nigeria.

*Bakevella pseudorostrata* (NAGAO) resembles *Bakevella rostrata* (SOWERBY) from the Upper Greensand of England and the Cenomanian of France.

*Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY is identical with the specimens from the Lower Greensand of England and the Aptian of France.

*Pinna* sp. cf. *P. robinaldina* D'ORBIGNY is almost indistinguishable from the typical form from the upper Neocomian and Aptian of France and the Lower Greensand of England.

*Neithea* (*Neithea*) *nipponica* sp. nov. resembles *Neithea* (*Neithea*) *quinque-costata* (SOWERBY) from the Lower Greensand and Upper Greensand of England, the Albian of France and some other areas of western Europe, north Africa, the Near East and (?) Peru, although it is specifically separable.

*Neithea* (*Neithea*) *amanoi* sp. nov. resembles *Neithea* (*Neithea*) *morrisi* (PICTET and RENEVIER) from the Lower Greensand of England and the Aptian of France and also *Neithea* (*Neithea*) *syriaca* (CONRAD) from the Aptian of the Near East.

*Neithea* (*Neithea*) *ficahoi* (CHOFFAT) is indistinguishable from the specimens from the Albian of Angola.

*Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER) is very close to the



- specimens of *N. atava* from the Lower Greensand of England, although there are some different opinions as to the concept of this species.
- Chlamys robinaldina* (D'ORBIGNY) is indistinguishable from the specimens from the Lower Greensand of England and the Aptian of France.
- Chlamys* sp. cf. *C. subacuta* (LAMARCK) is similar to the typical specimens from the Upper Greensand of England.
- Prohinnites* sp. cf. *P. favrinus* (PICTET and ROUX) resembles the typical specimens from the Aptian of France and the Lower Greensand of England.
- Liostrongya* sp. ex gr. *L. cunabula* (SEELEY) resembles the typical specimens from the Lower Greensand of England.
- Lopha* (*Arctostrea*) *carinata* (LAMARCK) seems to be a cosmopolitan species. It occurs also from the Lower Cretaceous of western Europe, north Africa, Gulf Coast, Mexico, Trinidad and Argentina.
- Amphidonte subhalioidea* (NAGAO) is similar to "*Exogyra*" *halioidea*, especially to the specimens from the Ootatoor group of southern India.
- Amphidonte* (*Ceratostreon*) *yabei* (NAGAO) is probably related to "*Exogyra minos*" from the Lower Cretaceous of western Europe and South America.
- Gryphaea* sp. ex gr. *G. vesicularis* (LAMARCK) is probably related to the typical form from the Aptian to Senonian of western Europe.
- Pseudocardia* sp. cf. *P. tenuicosta* (SOWERBY) resembles the typical specimens from the Lower Greensand of England.
- Astarte* (*Astarte*) *semicostata* NAGAO is closely related to *Astarte cantabrigiensis* WOODS, 1906, from the Lower Greensand of England.
- Astarte* (*Yabea*) *shinanoensis* YABE and NAGAO is fairly similar to *Astarte bodei* WOLLEMAN from the Upper Neocomian of Germany.
- Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO) is probably intimate to *Eriphyla* (*Miyakoella*) *upwarensis* (WOODS) from the Lower Greensand of England.
- Opis* (*Opis*) *nakanoi* sp. nov. is somewhat similar to *Opis haldonensis* WOODS from the Upper Greensand and *Opis neocomiensis* D'ORBIGNY from the Lower Greensand of England.
- Anthonya subcantiana* NAGAO is similar to *Anthonya cantiana* WOODS from the Lower Greensand of England.
- Protocardia sphaeroidea* (FORBES) is in every way identical with the specimens from the Lower Greensand of England and the Aptian of France.
- Scitilla japonica* sp. nov. and *Scitilla* sp. in the present paper are probably allied to *Scitilla nasuta* CASEY (= *Tellina carteroni* in WOODS) from the Lower Greensand of England.
- Panopea* (*Myopsis*) *plicata* (SOWERBY) is identical with the typical specimens from the Lower Greensand of England (= *Panopea gurgitis* in WOODS). Similar species are known from the Lower Cretaceous of Argentina, Trinidad and Gulf Coast region.

*Pholadomya miyamotoi* NAGAO and *Pholadomya* sp. aff. *P. cornueliana* (D'ORBIGNY) are closely allied to *Pholadomya cornueliana* D'ORBIGNY from the Aptian of France and the Lower Greensand of England.

*Cercomya gurgitis* (PICTET and CAMPICHE) is identical with the typical specimens from the Aptian of France and the Lower Greensand of England.

*Plectomya* sp. aff. *P. anglica* WOODS is fairly similar to the typical specimen of *P. anglica* from the Lower Greensand of England.

It is noticeable that the Aritan and Lower Miyakoan pelecypods of Japan include a considerable number of species identical with or closely allied to those of the upper Neocomian and Aptian faunas of western Europe. The Aptian pelecypods of the Miyako group are especially similar to the Lower Greensand fauna of England. The stratigraphic occurrence of the Lower Greensand fossils has recently been clarified by CASEY (1961) and further precise comparison will be possible zone by zone, when the stratigraphy and the index fossils of the Miyako group are described in detail.

It has been said that the biotope of the Lower Miyakoan including pachyodont pelecypods, nerinean gastropods, hermatypic corals, larger foraminifera, calcareous algae, etc., resembles that of the Urgonian, which represents the marginal facies of the ancient Mediterranean, but the similarity is mainly due to the similar physico-chemical conditions of sedimentary environment and not to synchronism. The specific assemblage of the lower Miyakoan pelecypods and gastropods is, in fact, more similar to that of the Lower Greensand than of the Urgonian.

Some Miyakoan pelecypods are closely related to those from the contemporary strata of Angola, Morocco, east Africa, Crimea, Caucasus, Syria, Lebanon, Attock and South India, if not identical with them. In order to justify the assumption of faunal communication between Japan and Europe (or between Japan and Indo-African province), it is necessary to investigate further the assemblages constituting the contemporaneous faunas in southeastern Asia. Our knowledge of this subject is, however, very insufficient at present.

Another faunal relation can be expected to have existed between Japan and the Pacific coast of Mexico and U. S. A. in Aptian-Albian times. As described by ALLISON (1955), the gastropods of the Alisitos formation of Baja California include many species in common with or allied to those of the Miyako group, which were described by NAGAO (1934). Similar resemblance can be expected among the associated pelecypods of that formation\*.

There are a large number of contributions on the Lower Cretaceous pelecypods of the Gulf Coast region and South American cordillera. Although more precise comparison will depend upon the further integration of descriptions, the faunas of those regions are seemingly almost unrelated to those of the Japanese

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\* The pelecypods of the Alisitos formation remain undescribed, but the presence of some common or allied species was suggested in a list, which was kindly sent me by Prof. Edwin C. ALLISON of the San Diego State College.

Table 2. List of Lower Cretaceous marine pelecypods from Japan

		Northeast Japan					Southwest Japan					Range													
		Hokkaido	Kita-kami		Kwan-to	Akaishi	Yuasa	Shikoku		Kyushu															
			Miyako	Ofunato				Oshima	Katsu-uragawa	Monobe-gawa	Sakawa		Nozu	Yatsu-shiro											
K1: Kochian (≡ Berriasian+Valanginian) K2: Aritan (≡ Hauterivian+Barremian+? Lower Aptian) K3: Miyakoan (≡ Aptian+Albian+Lowest Cenomanian)  K3α: Lower Miyakoan (≡ Aptian) K3β: Upper Miyakoan (≡ Albian) K3γ: Uppermost Miyakoan (≡ Lowest Cenomanian)  Some species from K3γ, which are not treated in the present study, are omitted from this list.  ○: present collection △: other collection ?: doubtful occurrence (only listed previously)		1. Lower Yezo group (K3)	2. Lower Miyako group (K3α)	3. Upper Miyako group (K3β)	4. Ofunato group (K2)	5. Oshima formation (K2)	6. Berriasian formations in Oshima & Soma	7. Choshi formation (K3α)	8. Ishido formation (K2)	9. Sebayashi formation (K3)	10. Todai formation (K3)	11. Arita formation (K2)	12. Nishihiro-Izeki f. (K3)	13. Hanoura formation (K2)	14. Hoji formation (K3)	15. Lower Monobegawa g. (K2)	16. Upper Monobegawa g. (K3)	17. Lower Monobegawa g. (K2)	18. Upper Monobegawa g. (K3)	19. Haidateyama f. (K3β)	20. Hachiryuzan f. (K2)	21. Hinagu formation (K3α)	22. Yatsushiro formation (K3β)		
Malletiidae	1. <i>Mesosaccella insignis</i> (NAGAO)	○	△																					K3α-K3β	
	2. <i>Mesosaccella</i> sp.																					○		K3β	
	3. <i>Malletia</i> ( <i>Neilo</i> ?) <i>higoensis</i> sp. nov.																					○		K3β	
Nuculidae	4. <i>Nuculopsis</i> ( <i>Palaeonucula</i> ) <i>ishidoensis</i> (YABE and NAGAO)							○					○	△											K2-K3
Nuculanidae	5. <i>Nuculana</i> ( <i>s. l.</i> ) <i>sanchuensis</i> YABE and NAGAO							○		?	○											○			K2-K3β
Parallelo-dontidae	6. <i>Parallelodon nipponicus</i> (NAGAO)	○	○								○										○		○		K2-K3β
	7. <i>Parallelodon</i> ( <i>Torinosucatella</i> ) <i>kobayashii</i> (TAMURA)					△																			K1

[illegible]

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range
Pteriidae	27. <i>Pterinella shinoharai</i> sp. nov.											○	○									○		K2-K3 $\beta$
Bakevelliidae	28. <i>Gervillaria haradae</i> (YOKOYAMA)	○			?			○									?					○		K2-K3 $\beta$
	29. <i>Gervillaria miyakoensis</i> (NAGAO)	○	○																					K3 $\alpha$ -K3 $\beta$
	30. <i>Bakevella shinanoensis</i> (YABE and NAGAO)											○												K1-K3
	31. <i>Bakevella pseudorostrata</i> (NAGAO)	○																				○		K3 $\alpha$ -K3 $\beta$
	32. <i>Bakevella iwatensis</i> sp. nov.	○																						K3 $\alpha$
	33. <i>Gervillia</i> ( <i>Gervillia</i> ) <i>forbesiana</i> D'ORBIGNY	○	○	?	○			○			○	○	?									○		K2-K3 $\gamma$
Isognomonidae	34. <i>Isognomon</i> ( <i>Isognomon</i> ) <i>choshiensis</i> sp. nov.							○																K3 $\alpha$
	35. <i>Isognomon</i> ( <i>Isognomon</i> ) <i>sanchuensis</i> (YABE and NAGAO)									○														K3
	36. <i>Isognomon</i> ( <i>Mytiloperma</i> ) sp.	○																						K3 $\alpha$
	37. <i>Isognomon</i> ( <i>Melina</i> ) <i>ichikawai</i> sp. nov.							○																K2
Pinnidae	38. <i>Pinna</i> sp. cf. <i>P. robinaldina</i> D'ORBIGNY							○									?					○		K2-K3 $\alpha$
	39. <i>Pinna</i> sp.	○	△																					K3 $\alpha$ -K3 $\beta$
	40. <i>Atrina heiensis</i> sp. nov.	○	○																					K3 $\alpha$ -K3 $\beta$
Pectinidae	41. <i>Neithea</i> ( <i>Neithea</i> ) <i>nipponica</i> sp. nov.	?	○																					? K3 $\alpha$ -K3 $\beta$
	42. <i>Neithea</i> ( <i>Neithea</i> ) <i>matsumotoi</i> sp. nov.																			○		○		K3 $\beta$
	43. <i>Neithea</i> ( <i>Neithea</i> ) <i>amanoi</i> sp. nov.																○							K3 $\alpha$
	44. <i>Neithea</i> ( <i>Neithea</i> ) <i>ficahoi</i> (CHOFFAT)	○	○																					K3 $\alpha$ -K3 $\beta$
	45. <i>Neithea</i> ( <i>Neithea</i> ) <i>kanmerai</i> sp. nov.										○											○		K2-K3 $\alpha$

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range	
Pectinidae	46. <i>Neithea</i> ( <i>Neithea</i> ) sp.								○																K2
	47. <i>Neithea</i> ( <i>Neithella</i> ) sp. cf. <i>N.</i> ( <i>N.</i> ) <i>atava</i> (RÖMER)	○							○																K2-K3 $\alpha$
	48. <i>Neithea</i> (s. l.) <i>aketoensis</i> sp. nov.		○																						K3 $\beta$
	49. <i>Chlamys robinaldina</i> (D'ORBIGNY)	○																							K3 $\alpha$
	50. <i>Chlamys</i> sp. cf. <i>C. subacuta</i> (LAMARCK)		○																						K3 $\beta$
	51. <i>Chlamys</i> (?) <i>shikokuensis</i> AMANO																○	△							K2-K3 $\alpha$
	52. <i>Prohinnites</i> sp. cf. <i>P. favrinus</i> (PICTET and ROUX)	○																							K3 $\alpha$
Amusiidae	53. <i>Entolium kimurai</i> TAMURA						○																		K1
	54. <i>Entolium sanchuense</i> sp. nov.								○																K2
	55. <i>Entolium yatsushiroense</i> sp. nov.																					○		K3 $\beta$	
	56. <i>Pectinella miyakoensis</i> (NAGAO)	○	△																						K3 $\alpha$ -K3 $\beta$
	57. <i>Variamussium</i> sp. cf. <i>V. habunokawense</i> (KIMURA)						○																		K1
	58. <i>Variamussium kimurai</i> sp. nov.																○								K2
Plicatulidae	59. <i>Plicatula hanaii</i> sp. nov.	○																							K3 $\alpha$
	60. <i>Plicatula kiiensis</i> sp. nov.										○					?						○		K2-K3 $\alpha$	
Spondylidae	61. <i>Spondylus decoratus</i> NAGAO	○																							K3 $\alpha$
Limidae	62. <i>Plagiostoma</i> ( <i>Plagiostoma</i> ) <i>sanrikuense</i> sp. nov.	○																							K3 $\alpha$
	63. <i>Plagiostoma</i> ( <i>Acesta</i> ) <i>goliathiforme</i> sp. nov.	○																							K3 $\alpha$
	64. <i>Antiquilima ultima</i> sp. nov.	○																							K3 $\alpha$



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range
Trigoniidae	84. <i>Nipponitrigonia quadrata</i> KOBAYASHI and NAKANO																						△	K3 $\beta$
	85. <i>Nipponitrigonia sakamotoensis</i> (YEHARA)														△									K3
	86. <i>Rutitrigonia yeharai</i> KOBAYASHI																	△						K2
	87. <i>Rutitrigonia sanchuensis</i> (NAKANO)								○														○	K2-K3 $\beta$
	88. <i>Myophorella</i> ( <i>Promyophorella</i> ) <i>obsoleta</i> KOBAYASHI and TAMURA						○																	K1
	89. <i>Myophorella</i> ( <i>Promyophorella</i> ) <i>orientalis</i> KOBAYASHI and TAMURA						○																	K1
	90. <i>Pterotrigonia datemasamunei</i> (YEHARA)		△																	△				K3 $\alpha$ -K3 $\beta$
	91. <i>Pterotrigonia pocilliformis</i> (YOKOYAMA)			?	?	○	○		○	○		○		○	△		△		?		○	○		K2-K3 $\beta$
	92. <i>Pterotrigonia hokkaidoana</i> (YEHARA)		○	○				○						?			○				○	○		K2-K3 $\gamma$
	93. <i>Pterotrigonia yokoyamai</i> (YEHARA)		○					○					○											K2-K3 $\alpha$
	94. <i>Pterotrigonia kotoi</i> (YEHARA)		△																					K3 $\alpha$
	95. <i>Pterotrigonia</i> ( <i>Rinetrigonia</i> ) sp.																					△		K3 $\alpha$
	96. <i>Scabrotrigonia imanishii</i> NAKANO	△																						K3
	97. <i>Acanthotrigonia moriana</i> YEHARA																○							K3 $\alpha$
Myoconchidae	98. <i>Myoconcha modesta</i> sp. nov.		○																					K3 $\alpha$
Carditidae	99. <i>Pseudocardia</i> sp. cf. <i>P. tenuicosta</i> (SOWERBY)		○																					K3 $\alpha$
	100. <i>Pseudocardia amanoi</i> sp. nov.																○							K3 $\alpha$
	101. “ <i>Cardita</i> ” ? sp.		○																					K3 $\alpha$
Astartidae	102. <i>Astarte</i> ( <i>Astarte</i> ) <i>subsenecta</i> YABE and NAGAO			○				○		○		○	○	?	△		△		○			○		K2-K3 $\beta$



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range
Astartidae	103. <i>Astarte</i> ( <i>Astarte</i> ) sp. cf. <i>A. (A.) subsenecta</i> YABE and NAGAO		○																					K2
	104. <i>Astarte</i> ( <i>Astarte</i> ) <i>costata</i> YABE and NAGAO								○	○														K2-K3 $\alpha$
	105. <i>Astarte</i> ( <i>Astarte</i> ) <i>semicostata</i> NAGAO		○																					K3 $\alpha$
	106. <i>Astarte</i> ( <i>Astarte</i> ?) sp.				○																			K2
	107. <i>Astarte</i> ( <i>Freiastarte</i> ) <i>subomalioides</i> NAGAO		○	○																				K3 $\alpha$ -K3 $\beta$
	108. <i>Astarte</i> ( <i>Freiastarte</i> ) sp. cf. <i>A. (F.) subomalioides</i> NAGAO																					○		K3 $\beta$
	109. <i>Astarte</i> ( <i>Nicaniella</i> ) <i>minor</i> NAGAO		○	△																				K3 $\alpha$ -K3 $\beta$
	110. <i>Astarte</i> ( <i>Yabea</i> ) <i>shinanoensis</i> YABE and NAGAO								○															K2
	111. <i>Astarte</i> ( <i>Yabea</i> ) sp. aff. <i>A. (Y.) shinanoensis</i> YABE and NAGAO												○											K2
	112. <i>Astarte</i> ( <i>Yabea</i> ) <i>akatsui</i> sp. nov.																					○		K3 $\beta$
	113. <i>Eriphyla</i> ( <i>Eriphyla</i> ) <i>pulchella</i> sp. nov.			○																				K3 $\beta$
	114. <i>Eriphyla</i> ( <i>Eriphyla</i> ) <i>minima</i> sp. nov.								○													○		K2-K3 $\beta$
	115. <i>Eriphyla</i> ( <i>Miyakoella</i> ) <i>miyakoensis</i> (NAGAO)		○	○																				K3 $\alpha$ -K3 $\beta$
	116. <i>Eriphyla</i> ( <i>Miyakoella</i> ) sp. cf. <i>E. (M.) miyakoensis</i> (NAGAO)																△							K3 $\alpha$
	117. <i>Opis</i> ( <i>Opis</i> ) <i>nakanoi</i> sp. nov.		○																					K3 $\alpha$
	118. <i>Opis</i> ( <i>Opis</i> ) <i>haginoensis</i> AMANO																△							K3 $\alpha$
	119. <i>Opis</i> ( <i>Opis</i> ) sp.		○																					K3 $\alpha$
Crassa-tellidae	120. <i>Pachythaerus kagaharensis</i> (YOKOYAMA)				△				○															K2
	121. <i>Anthonya subcantiana</i> NAGAO		○											?										?K2-K3 $\alpha$

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range
Crassatellidae	122. <i>Anthonya</i> sp. aff. <i>A. subcantiana</i> NAGAO								○															K2
Lucinidae	123. <i>Lucinoma</i> (?) <i>kotoi</i> (NAGAO)		○	○																				K3 $\alpha$ -K3 $\beta$
	124. <i>Lucinoma</i> (?) sp.											○												K2
Fimbriidae	125. <i>Fimbria</i> sp.																					○		K3 $\beta$
Cardiidae	126. <i>Protocardia</i> ( <i>Globocardia</i> ) <i>sphaeroidea</i> (FORBES)		○																					K3 $\alpha$
	127. <i>Protocardia hiraigensis</i> sp. nov.		○																					K3 $\alpha$
	128. <i>Nemocardium yatsushiroense</i> sp. nov.																					○		K3 $\beta$
	129. <i>Laevicardium</i> (?) <i>ishidoense</i> (YABE and NAGAO)									△												○		K2-K3 $\beta$
	130. <i>Laevicardium</i> (?) <i>corpulentum</i> (AMANO)																○							K3 $\alpha$
Icanotiidae	131. <i>Scittila japonica</i> sp. nov.													○		△								K2-K3 $\alpha$
	132. <i>Scittila</i> sp.													○										K2
Neomiodontidae	133. <i>Costocyrena matsumotoi</i> sp. nov.																				?	○		? K3 $\alpha$ -K3 $\beta$
	134. <i>Costocyrena radiatostriata</i> (YABE and NAGAO)			○					○															K2-K3
	135. <i>Costocyrena</i> sp. aff. <i>C. radiatostriata</i> (YABE and NAGAO)												○											K3
	136. <i>Eomiodon sakawanus</i> (KOBAYASHI and SUZUKI)			○											○									K1-K3
	137. <i>Protocyprina naumanni</i> (NEUMAYR)													?		○								K1-? K2
	138. <i>Protocyprina</i> sp.								○															K3
	139. <i>Neomiodon otsukai</i> (YABE and NAGAO)			○																				K1-K2
Arcticidae	140. <i>Isocyprina aliquantula</i> (AMANO)							?					?		○									K3 $\alpha$



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	range
Pholadomy- idae	160. <i>Pholadomya</i> sp. B													○									○	K2-K3 $\beta$
	161. <i>Goniomya subarchiaci</i> NAGAO		○	○																				K3 $\alpha$ -K3 $\beta$
	162. <i>Goniomya</i> sp.								○														○	K2-K3 $\beta$
Laternulidae	163. <i>Cercomya gurgitis</i> (PICTET and CAMPICHE)		○	○													?							K3 $\alpha$ -K3 $\beta$
	164. <i>Plectomya aritagawana</i> sp. nov.											○		○									○	K2-K3 $\beta$
	165. <i>Plectomya</i> sp. aff. <i>P. anglica</i> WOODS																						○	K3 $\beta$
Periplomat- idae	166. <i>Offadesma altissimum</i> sp. nov.			○																				K3 $\beta$
Thraciidae	167. <i>Thracia</i> sp.		○																					K3 $\alpha$
	168. <i>Corimya</i> (?) <i>tanohatensis</i> sp. nov.		○																					K3 $\alpha$
Teredinidae	169. “ <i>Teredo</i> ” <i>matsushimaensis</i> HATAI		○																					K3 $\alpha$
Hippuritidae	170. <i>Praecaprotina yaegashii</i> (YEHARA)		○																					K3 $\alpha$
	171. <i>Toucasia carinata orientalis</i> NAGAO	○																						K3
	172. <i>Pachytraga japonica</i> OKUBO																							?K3

Aritan and Miyakoan except for a few cosmopolitan species.

In Alaska and British Columbia and along the Pacific coast of United States, *Buchia*- (= *Aucella*-) and *Aucellina*-bearing faunas prospered in early Cretaceous times and suggested an intimate connection with the Arctic province. Arctic elements cannot be found in the Aritan and Miyakoan pelecypods here discussed, but "*Aucella*" spp., recently discovered by TERAOKA et al. (1962) from the Saroma group of a Late Jurassic or early Cretaceous age in northeast Hokkaido may be an exception.

### Locality Guide

In this article main registered localities of Lower Cretaceous pelecypods concerning the present study are listed. The geographic and stratigraphic positions, age, lithology, fossil assemblage and collector(s) are briefly mentioned.

1. Tanohata area, Shimohei County, Iwate Prefecture (岩手県下閉伊郡田野畑村)  
141°57'E, 39°56'N (Fig. 1)

#### Hn. 0001

Location: Tokuzo (トクゾウ), southern coast of Hiraiga (平井賀) inlet

Str. position: middle part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Protocardia* (*Globocardium*) *sphaeroidea* (FORBES)

Collector: HANAI

#### Hn. 0006

Location: west of Tokuzo, southern coast of Hiraiga inlet

Str. position: upper part of the Tanohata formation (lower Miyakoan)

Lithology: grey sandy shale

Fossils: *Pholadomya brevitestis* NAGAO, *Corimya* (?) *tanohatensis* sp. nov. [boulder]

Collectors: HANAI and HAYAMI

#### Hn. 0010

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Pterotrigonina hokkaidoana* (YEHARA), *Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO)

Collectors: HANAI and HAYAMI

#### Hn. 0012

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: grey sandy shale

Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO)

Collector: HAYAMI

#### Hn. 0013

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine dirty calcareous sandstone

Fossils: *Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER)

Collector: HAYAMI

#### Hn. 0016

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

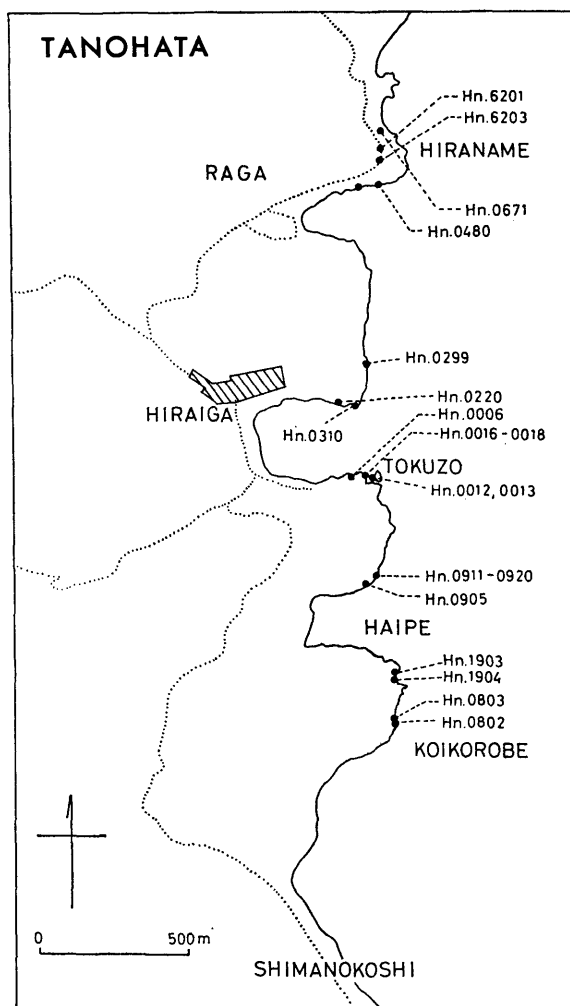


Fig. 1. Map showing the fossil localities in the Tanohata area.

Lithology: grey sandy shale

Fossils: *Pectinella miyakoensis* (NAGAO), *Limatula nagaoui* sp. nov.

Collector: HAYAMI

Hn. 0017

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Parallelodon nipponicus* (NAGAO), *Cucullaea acuticarinata* NAGAO, *Cucullaea transversa* NAGAO, *Glycymeris (Hanaia) densilineata* NAGAO, *Amygdalum ishidoense* (YABE and NAGAO), *Gervillaria haradae* (YOKOYAMA), *Gervillaria miyakoensis* (NAGAO), *Bakevella pseudorostrata* (NAGAO), *Bakevella iwatensis* sp. nov., *Gervillia (Gervillia) forbesiana* D'ORBIGNY, *Isognomon (Mytiloperna)* sp., *Neithea (Neithea) ficalhoi* (CHOFFAT), *Chlamys robinaldina* (D'ORBIGNY), *Pectinella miyakoensis* (NAGAO), *Plicatula hanaï* sp. nov., *Plagiostoma* (Plagio-

*stoma*) *sanrikuense* sp. nov., *Plagiostoma* (*Acesta*) *goliathiforme* sp. nov., *Limatula* *nagaoi* sp. nov., *Monia* *aptiana* sp. nov., *Lopha* (*Lopha*) *nagaoi* sp. nov., *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Amphidonte* (*Amphidonte*) *subhaliotoidea* (NAGAO), *Amphidonte* (*Ceratostreon*) *yabei* (NAGAO), *Gryphaeostrea* sp. ex gr. *G. vesicularis* (LAMARCK), *Pterotrigonia* *hokkaidoana* (YEHARA), *Pterotrigonia* *yokoyamai* (YEHARA), *Astarte* (*Astarte*) *semicostata* NAGAO, *Astarte* (*Freiastarte*) *subomalioides* NAGAO, *Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO), *Astarte* (*Nicaniella*) *minor* NAGAO, *Anthonya* *subcantiana* NAGAO, *Lucinoma* (?) *kotoi* (NAGAO), *Protocardia* *hiraigensis* sp. nov., *Protocardia* (*Globocardium*) *sphaeroidea* (FORBES), *Nagaoella* *corrugata* (NAGAO), *Panopea* (*Myopsis*) *plicata* (SOWERBY), *Pholadomya* *miyamotoi* NAGAO, *Pholadomya* *tuberculata* sp. nov., *Goniomya* *subarchiaci* NAGAO, *Theracia* sp., "*Teredo*" *matsushimensis* HATAI, *Opis* (*Opis*) sp.

Collectors: HANAI, OBATA, NAKANO and HAYAMI

Hn. 0018

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Cucullaea* *acuticarinata* NAGAO, *Cucullaea* *transversa* NAGAO, *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Amygdalum* *ishidoense* (YABE and NAGAO), *Bakevella* *pseudorostrata* (NAGAO), *Bakevella* *iwatensis* sp. nov., *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Atrina* *heiensis* sp. nov., *Pinna* sp., *Neithea* (*Neithea*) *ficahoi* (CHOFFAT), *Pectinella* *miyakoensis* (NAGAO), *Limatula* *nagaoi* sp. nov., *Amphidonte* (*Ceratostreon*) *yabei* (NAGAO), *Pterotrigonia* *hokkaidoana* (YEHARA), *Pterotrigonia* *yokoyamai* (YEHARA), *Astarte* (*Astarte*) *semicostata* NAGAO, *Astarte* (*Freiastarte*) *subomalioides* NAGAO, *Astarte* (*Nicaniella*?) *minor* NAGAO, *Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO), *Anthonya* *subcantiana* NAGAO, *Lucinoma* (?) *kotoi* (NAGAO), *Nagaoella* *corrugata* (NAGAO), *Panopea* (*Myopsis*) *plicata* (SOWERBY), *Pholadomya* *miyamotoi* NAGAO, *Pholadomya* *tuberculata* sp. nov., *Goniomya* *subarchiaci* NAGAO, *Cercomya* *gurgitis* (PICTET and CAMPICHE)

Collectors: HANAI, OBATA and HAYAMI

Hn. 0023

Location: Tokuzo, southern coast of Hiraiga inlet

Str. position: upper part of the Hiraiga formation (lower Miyakoan)

Lithology: grey sandy shale

Fossils: *Amphidonte* (*Amphidonte*) *subhaliotoidea* (NAGAO)

Collector: HANAI

Hn. 0103

Location: northern coast of Hiraiga

Str. position: Hiraiga formation (lower Miyakoan)

Lithology: medium grey calcareous sandstone

Fossils: *Chlamys* *robinaldina* (D'ORBIGNY)

Collector: HANAI

Hn. 0220

Location: northern coast of Hiraiga inlet

Str. position: upper part of the Tanohata formation (lower Miyakoan)

Lithology: dark grey sandy shale

Fossils: *Modiolus* *falcatus* AMANO, *Atrina* *heiensis* sp. nov., *Neithea* (*Neithea*) *ficahoi* (CHOFFAT), *Limatula* *nagaoi* sp. nov., *Pterotrigonia* *hokkaidoana* (YEHARA), *Pterotrigonia* sp. cf. *P. pocilliformis* (YOKOYAMA), *Anthonya* *subcantiana* NAGAO, *Pterotrigonia* (*Globocardium*) *sphaeroidea* (FORBES), *Protocardia* sp., *Goniomya* *subarchiaci* NAGAO

Collectors: HANAI, OBATA and HAYAMI

Hn. 0299

Location: coast between Hiraiga and Raga (羅賀)

Str. position: upper part of the Hiraiga formation (Lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Glycymeris (Hanaia) densilineata* NAGAO, *Neithea (Neithea) ficalhoi* (CHOFFAT), *Neithea (Neithella) sp. cf. N. (N.) atava* (RÖMER), *Pterotrigonia hokkaidoana* (YEHARA)

Collectors: HANAI, OBATA and HAYAMI

Hn. 0310

Location: northern coast of Hiraiga inlet

Str. position: upper part of the Hiraiga formation (lower Miyakoan)

Lithology: grey sandy shale

Fossils: *Amphidonte (Amphidonte) subhaliotoidea* (NAGAO)

Collector: HANAI

Hn. 0480\*

Location: northern coast of Raga inlet

Str. position: "Orbitolina sandstone" (exactly indeterminable) (upper Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Lopha (Arctostrea) carinata* (LAMARCK)

Collector: HANAI

Hn. 0671

Location: coast of Hiraname (平波目), northeast of Raga

Str. position: upper part of the "Orbitolina sandstone" of the Miyako group (upper Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Glycymeris (Hanaia) densilineata* NAGAO, *Neithea (Neithea) nipponica* sp. nov., *Pterotrigonia hokkaidoana* (YEHARA), *Pterotrigonia* sp. cf. *P. date-masamunei* (YEHARA), *Eriphyla (Miyakoella) miyakoensis* (NAGAO), *Nagaoella corrugata* (NAGAO)

Collector: HAYAMI

Hn. 0802

Location: coast of Koikorobe (コイコロベ), north of Shimanokoshi (島越)

Str. position: basal part of the Tanohata formation (lower Miyakoan)

Lithology: fine to medium grey sandstone

Fossils: *Lopha (Lopha) nagaoi* sp. nov., *Amphidonte (Amphidonte) subhaliotoidea* (NAGAO), *Nipponitrigonia kikuchiana* (YOKOYAMA), *Pterotrigonia hokkaidoana* (YEHARA), *Eriphyla (Miyakoella) miyakoensis* (NAGAO), *Praeaprotina yaegashii* (YEHARA)

Collectors: HANAI, OBATA and HAYAMI

Hn. 0803

Location: coast of Koikorobe, north of Shimanokoshi

Str. position: basal part of the Tanohata formation (lower Miyakoan)

Lithology: medium grey conglomeratic sandstone

Fossils: *Isognomon (Mytiloperna) sp.*, *Plicatula hanaii* sp. nov., *Liostrea* sp. cf. *L. cunabula* (SEELEY), *Lopha (Lopha) nagaoi* sp. nov., *Amphidonte (Cerato-streon) yabei* (NAGAO), *Nipponitrigonia kikuchiana* (YOKOYAMA), *Myoconcha modesta* sp. nov., *Eriphyla (Miyakoella) miyakoensis* (NAGAO), *Agapella (?) koikorobensis* sp. nov., *Praeaprotina yaegashii* (YEHARA)

\* This locality was erroneously recorded as "Hiraiga formation at the southern coast of Raga" in the Part I of this study (*Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Vol. 15, No. 2, p. 341, explanation of Plate 49).



Collectors: HANAI, OBATA and HAYAMI

Hn. 0905

Location: northern coast of Haibe (ハイベ) inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Tanohata formation (lower Miyakoan)

Lithology: fine to medium grey sandstone

Fossils: *Nipponitrigonia kikuchiana* (YOKOYAMA), *Praecaprotina yaegashii* (YEHARA)

Collector: HANAI and HAYAMI

Hn. 0911 ( $\cong$  Hn. 0912)

Location: northern coast of Haibe inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Cucullaea acuticarinata* NAGAO, *Glycymeris (Hanaia) densilineata* NAGAO, *Eriphyla (Miyakoella) miyakoensis* (NAGAO)

Collectors: HANAI, OBATA and HAYAMI

Hn. 0914

Location: northern coast of Haibe inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Cucullaea acuticarinata* NAGAO, *Glycymeris (Hanaia) densilineata* NAGAO, *Pterotrigonia hokkaidoana* (YEHARA), *Astarte (Astarte) semicostata* NAGAO, *Astarte (Freiastarte) subomalioides* NAGAO, *Astarte (Nicanella) minor* NAGAO, *Nagaoella corrugata* (NAGAO), *Nagaoella* sp. cf. *N. corrugata* (NAGAO), *Glycymeris (Glycymerita?) haipensis* sp. nov.

Collector: HANAI, OBATA and HAYAMI

Hn. 0916

Location: northern coast of Haibe inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Cucullaea acuticarinata* NAGAO, *Glycymeris (Hanaia) densilineata* NAGAO, *Pterotrigonia hokkaidoana* (YEHARA), *Astarte (Astarte) semicostata* NAGAO, *Astarte (Astarte) semicostata* NAGAO, *Astarte (Freiastarte) subomalioides* NAGAO, *Astarte (Nicanella?) minor* NAGAO, *Nagaoella corrugata* (NAGAO), *Nagaoella* sp. cf. *N. corrugata* (NAGAO)

Collectors: HANAI, OBATA and HAYAMI

Hn. 0920

Location: northern coast of Haibe inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Gervillaria miyakoensis* (NAGAO)

Collector: HANAI and HAYAMI

Hn. 1903 ( $\cong$  Hn. 1904)

Location: southern coast of Haibe inlet, between Hiraiga and Shimanokoshi

Str. position: lower part of the Hiraiga formation (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Glycymeris (Hanaia) densilineata* NAGAO, *Nagaoella corrugata* (NAGAO), *Pterotrigonia hokkaidoana* (YEHARA), *Anthonya subcantiana* NAGAO, *Goniomya subarchiaci* NAGAO, etc.

Collectors: HANAI, OBATA and HAYAMI

Hn. 6201

Location: coast (road-cut) of Hiraname, northeast of Raga

Str. position: lower part of the Aketo formation (upper Miyakoan)

Lithology: grey sandy shale

Fossils: *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Neithea* (*Neithea*) *nipponica* sp. nov., *Neithea* (s. l.) *aketoensis* sp. nov., *Chlamys* sp. cf. *C. subacuta* (LAMARCK), *Ctenoides subrapa* (NAGAO), *Eriphyla* (*Eriphyla*) *pulchella* sp. nov., *Nagaoella corrugata* (NAGAO), *Goniomya subarchiaci* NAGAO

Collectors: HANAI, OBATA and HAYAMI

Hn. 6203 ( $\cong$  Hn. 6202)

Location: southern coast of Hiraname (road-cut), northeast of Raga

Str. position: uppermost part of the "Orbitolina sandstone" of the Miyako group (upper Miyakoan)

Lithology: grey sandy shale

Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Gervillaria miyakoensis* (NAGAO), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Atrina heiensis* sp. nov., *Neithea* (*Neithea*) *ficahoi* (CHOFFAT), *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Pterotrigonia pocilliformis* (YOKOYAMA), *Pterotrigonia hokkaidoana* (YEHARA), *Pterotrigonia* sp. cf. *P. datemasamunei* (YEHARA), *Eriphyla* (*Eriphyla*) *pulchella* sp. nov., *Anthonya subcantiana* NAGAO, *Lucinoma* (?) *kotoi* (NAGAO), *Nagaoella corrugata* (NAGAO), *Panopea* (*Myopsis*) *plicata* (SOWERBY), *Pholadomya subpedelnalis* NAGAO,

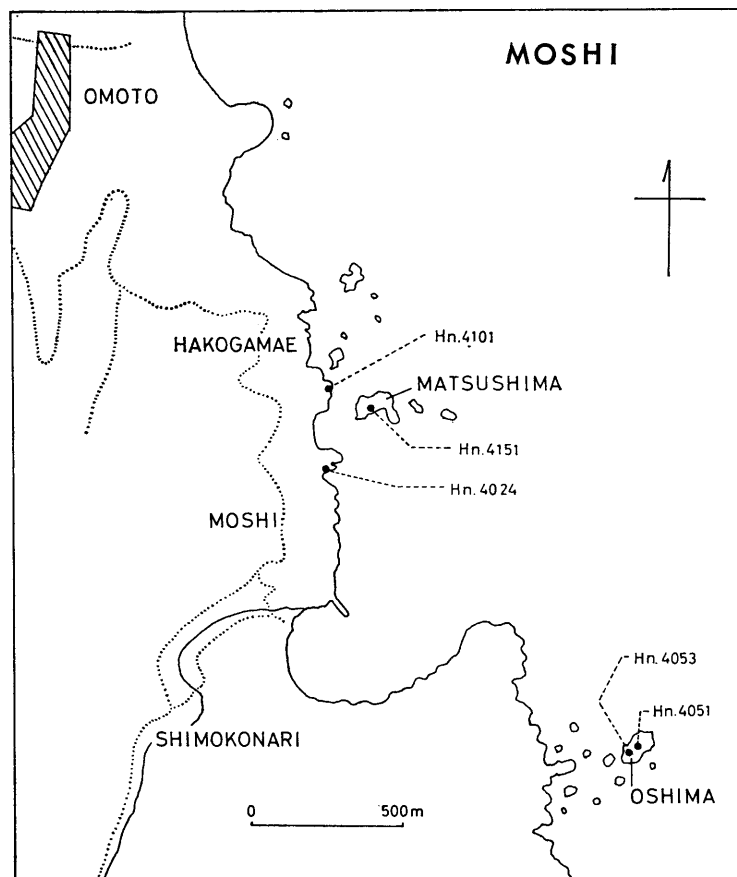


Fig. 2. Map showing the fossil localities in the Moshi area.

*Goniomya subarchiaci* NAGAO, *Cercomya gurgitis* (PICTET and CAMPICHE), *Offadesma altissimum* sp. nov.

Collectors: HANAI, OBATA and HAYAMI

2. Moshi area, Iwaizumi town, Shimohei County, Iwate Prefecture (岩手県下閉伊郡岩泉町茂師) 141°58'E, 39°50'N (Fig. 2)

Hn. 4024 (≡ Hn. 4026)

Location: coast of Mannenmon, northeast of Moshi

Str. position: upper part of the 1st cycle sediments of the Miyako group (lower Miyakoan)

Lithology: medium grey calcareous sandstone

Fossils: *Nipponitriconia kikuchiana* (YOKOYAMA), *Praecaprotina yaegashii* (YEHARA)

Collectors: HANAI and HAYAMI

Hn. 4051

Location: Oshima islet (大島), off the southeastern coast of Moshi

Str. position: 2nd cycle sediments of the Miyako group (lower Miyakoan)

Lithology: medium to fine grey sandstone

Fossils: *Glycymeris* (*Glycymerita*?) *haipensis* sp. nov., *Liostrea* sp. ex. gr. *L. cunabula* (SEELEY), *Nipponitriconia kikuchiana* (YOKOYAMA), *Astarte* (*Freiastarte*) *subomalioides* NAGAO, *Eriphyla* (*Miyakoella*) *miyakoensis* (NAGAO), *Nagaoella corrugata* (NAGAO)

Collectors: HANAI, OBATA and HAYAMI

Hn. 4053

Location: Oshima islet, off the southeastern coast of Moshi

Str. position: 2nd cycle sediments of the Miyako group (lower Miyakoan)

Lithology: medium grey calcareous sandstone

Fossils: *Mesosaccella insignis* (NAGAO), *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Lecompteus* sp. cf. *L. guerangeri* (D'ORBIGNY), *Mytilus* sp., *Antiquilima ultima* sp. nov., *Nipponitriconia kikuchiana* (YOKOYAMA)

Collectors: HANAI, OBATA and HAYAMI

Hn. 4101

Location: coast of Hakogamae, northeast of Moshi

Str. position: 1st cycle sediments of the Miyako group (lower Miyakoan)

Lithology: medium to fine grey sandstone

Fossils: *Nipponitriconia kikuchiana* (YOKOYAMA), *Astarte* (*Freiastarte*) *subomalioides* NAGAO, *Praecaprotina yaegashii* (YEHARA)

Collectors: HANAI and HAYAMI

Hn. 4151

Location: Matsushima islet (松島) of Hakogamae, northeast of Moshi

Str. position: 2nd cycle sediments of the Miyako group (lower Miyakoan)

Lithology: fine grey noduliferous sandstone

Fossils: *Mesosaccella insignis* (NAGAO), *Astarte* (*Astarte*) *semicostata* NAGAO, *Astarte* (*Freiastarte*) *subomalioides* NAGAO, *Nagaoella corrugata* (NAGAO)

Collectors: HANAI, OBATA and HAYAMI

Hn. 4154

Location: Matsushima islet of Hakogamae, northeast of Moshi

Str. position: 2nd cycle sediments of the Miyako group (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Teredo matsushimaensis* HATAI

Collector: HANAI

3. Sakiyama area, Miyako City, Iwate Prefecture (岩手県宮古市崎山地方) 141°58'E,

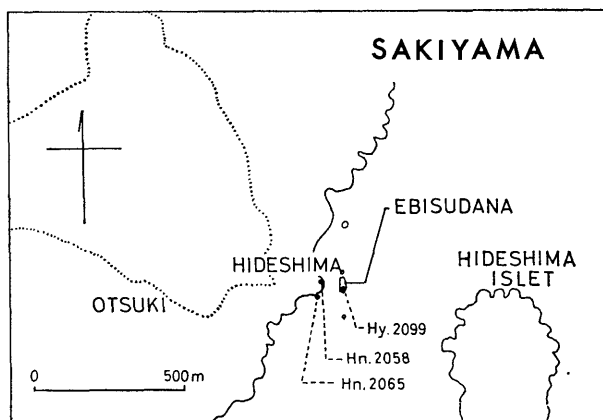


Fig. 3. Map showing the fossil localities in the Sakiyama area.

39°40'N (Fig. 3)

Hn. 2058

Location: coast of Hideshima (日出島), Sakiyama

Str. position: upper part of the 1st cycle sediments of the Miyako group (lower Miyakoan)

Lithology: dark grey mudstone

Fossils: *Amphidonte* (*Amphidonte*) *subhaliotoidea* (NAGAO), *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Pseudocardia* sp. cf. *P. tenuicosta* (SOWERBY), *Opis* (*Opis*) *nakanoi*

Collectors: HANAI, NAKANO and HAYAMI

Hn. 2065

Location: coast of Hideshima, Sakiyama

Str. position: upper part of the 1st cycle sediments of the Miyako group (lower Miyakoan)

Lithology: dark grey mudstone

Fossils: *Spondylus decoratus* NAGAO

Collectors: HANAI and HAYAMI

Hy. 2099 (≡ Hn. 2051)

Location: Ebisudana (戎棚), off the coast of Hideshima, Sakiyama

Str. position: lower part of the 2nd cycle sediments of the Miyako group (lower Miyakoan)

Lithology: fine grey calcareous sandstone

Fossils: *Glycymeris* (*Hanaia*) *densilineata* NAGAO, *Neithea* (*Neithea*) *ficahoi* (CHOFFAT), *Pterotrignia hokkaidoana* (YEHARA)

Collector: HAYAMI

4. Ofunato area, Ofunato City, Iwate Prefecture (岩手県大船渡地方) 141°41'E, 39°02'N  
Hy. 0054

Location: road-cut near Umagoé (馬越), west of the central part of Ofunato City

Str. position: Funagawara formation (? Aritan)

Lithology: black carbonaceous shale

Fossils: *Liostrrea* sp., *Eomiodon sakawanus* (KOBAYASHI and SUZUKI), *Neomiodon* sp. cf. *N. otsukai* (YABE and NAGAO), *Tetoria* (*Paracorbicula*) *sanchuensis* (YABE and NAGAO)

Collector: HAYAMI

5. Massaki area, Ofunato City, Iwate Prefecture (岩手県大船渡市末崎地方) 141°45'E, 38°59'N

Hy. 0051

Location: western coast of Goishi (基石), Massaki

Str. position: Funagawara formation (? Aritan)

Lithology: fine grey sandstone

Fossils: *Costocyrena radiatostriata* (YABE and NAGAO), *Tetoria* (*Paracorbicula*) *sanchuensis* (YABE and NAGAO)

Collectors: OBATA, TOKUYAMA and HAYAMI

Hy. 0053

Location: coast facing Kinchakuwa (巾着岩), north of Goishi, Massaki

Str. position: Hijiochi formation (? Aritan)

Lithology: black sandy shale and fine grey sandstone

Fossils: *Pterotrigonia pocilliformis* (YOKOYAMA), *Veniella* sp., *Ptychomya densicostata* NAGAO

Collectors: OBATA, TOKUYAMA and HAYAMI

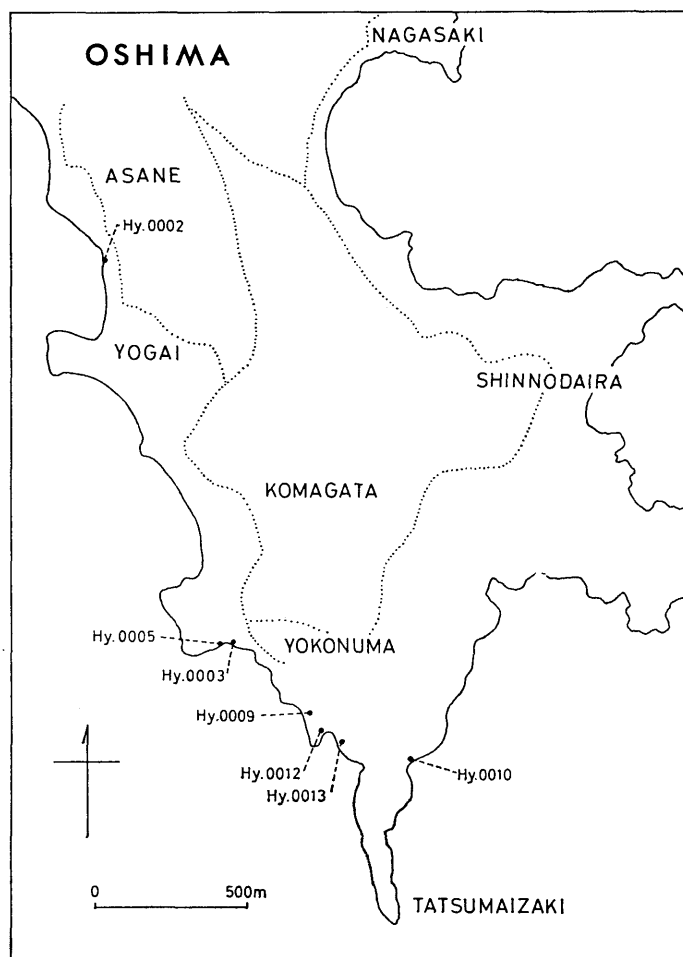


Fig. 4. Map showing the fossil localities in the Oshima area.

6. Oshima area, Kesennuma City, Miyagi Prefecture (宮城県気仙沼市大島地方) 141°37'E, 38°50'N (Fig. 4)

## Hy. 0002

Location: southern coast of Asane (浅根), Oshima island  
 Str. position: middle part of the Oshima formation (Aritan)  
 Lithology: fine grey calcareous sandstone  
 Fossils: *Gervillaria haradae* (YOKOYAMA), *Pterotrignia pocilliformis* (YOKOYAMA)  
 Collectors: SUGITA, NAGUMO and HAYAMI

## Hy. 0003

Location: northern coast of Yokonuma (横沼), Oshima island  
 Str. position: upper part of the Oshima formation (Aritan)  
 Lithology: dark grey shale  
 Fossils: *Lopha (Arctostrea) carinata* (LAMARCK), *Pterotrignia pocilliformis* (YOKOYAMA)  
 Collectors: OBATA and HAYAMI

## Hy. 0009

Location: coast of Yokonuma, Oshima island  
 Str. position: upper part of the Oshima formation (Aritan)  
 Lithology: black shale  
 Fossils: *Gryphaea* (s. l.) *oshimensis* sp. nov., *Astarte* sp.  
 Collectors: OBATA and HAYAMI

## Hy. 0010

Location: coast of Shiraito-hama (白糸浜), southeast of Yokonuma, Oshima island  
 Str. position: upper part of the Oshima formation (Aritan)  
 Lithology: black sandy shale  
 Fossils: *Nanonavis (Nanonavis) yokoyamai* (YABE and NAGAO), ? *Gervillaria haradae* (YOKOYAMA), *Gervillia (Gervillia) forbesiana* D'ORBIGNY, *Lopha (Arctostrea) carinata* (LAMARCK), *Pterotrignia pocilliformis* (YOKOYAMA), *Astarte (Astarte)* sp.  
 Collectors: SUGITA, NAGUMO and HAYAMI

## Hy. 0012

Location: southern coast of Yokonuma, Oshima island  
 Str. position: upper part of the Oshima formation (Aritan)  
 Lithology: black sandy shale  
 Fossils: *Astarte (Astarte)* sp. cf. *A. (A.) subsenecta* (YABE and NAGAO), *Astarte (Astarte)* sp.  
 Collectors: OBATA and HAYAMI

7. Choshi area, Chiba Prefecture (千葉県銚子地方) 140°52'E, 35°43'N

## Hy. 2001

Location: coast of Ashikajima (海鹿島), east of the central part of Choshi City  
 Str. position: Choshi formation (lower Miyakoan)  
 Lithology: fine grey sandstone  
 Fossils: *Astarte (Astarte) costata* YABE and NAGAO  
 Collector: HAYAMI

## Hy. 2003

Location: quarry near Ashikajima, east of the central part of Choshi City  
 Str. position: Choshi formation (lower Miyakoan)  
 Lithology: fine grey sandstone  
 Fossils: *Cucullaea* sp. cf. *C. acuticarinata* NAGAO, *Isognomon (Isognomon) choshiensis* sp. nov., *Pterotrignia* sp. cf. *P. pocilliformis* (YOKOYAMA), *Panopea* sp.  
 Collectors: HANAI and HAYAMI

8. Nakazato area, Tano County, Gumma Prefecture (群馬県多野郡中里村) 138°55'E,

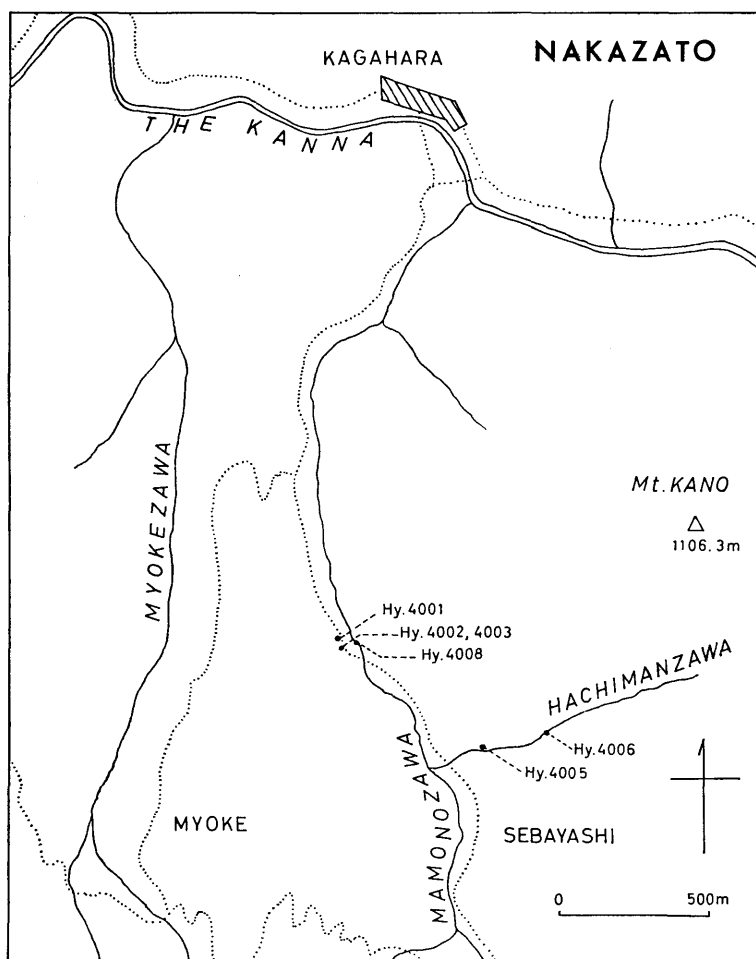


Fig. 5. Map showing the fossil localities in the Nakazato area.

36°00'N (Fig. 5)

#### Hy. 4001

Location: Ichinose-bashi (一ノ瀬橋) of Sebayashi, south of Kagahara (神ヶ原)

Str. position: middle part of the Ishido formation (Aritan)

Lithology: fine grey sandstone

Fossils: *Nuculana* (s. l.) *sanchuensis* YABE and NAGAO, *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Gervillaria haradae* (YOKOYAMA), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Neithea* (*Neithea*) *kanmerai* sp. nov., *Neithea* (*Neithea*) sp., *Entolium sanchuense* sp. nov., *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Pterotrigonia pocilliformis* (YOKOYAMA), *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Pachythaerus kagaharensis* (YOKOYAMA), *Anthonya* sp., *Ptychomya densicostata* NAGAO, *Pholadomya brevitesta* NAGAO, *Goniomya* sp., *Thracia* sp.

Collectors: ICHIKAWA, SUGITA and HAYAMI

#### Hy. 4002 (≡ Hy. 4003)

Location: Ichinose-bashi of Sebayashi (瀬林), south of Kagahara

Str. position: middle part of the Ishido formation

Lithology: dark grey sandy shale

Fossils: *Nuculana* (s. l.) *sanchuensis* YABE and NAGAO, *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) *Pterotrignia pocilliformis* (YOKOYAMA), *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Astarte* (*Astarte*) *costata* YABE and NAGAO, *Astarte* (*Yabea*) *shinanoensis* YABE and NAGAO, *Eriphyla* (*Eriphyla*) *minima* sp. nov., *Panopea* (*Myopsis*) *plicata* (SOWERBY)

Collectors: ICHIKAWA, SUGITA and HAYAMI

Hy. 4005

Location: lower valley of Hachimanzawa (八幡沢), near Sebayashi, south of Kagahara

Str. position: lower part of the Sebayashi formation (Miyakoan)

Lithology: black carbonaceous mudstone

Fossils: *Isognomon* (*Isognomon*) *sanchuensis* (YABE and NAGAO), *Costocyrena radiatostriata* (YABE and NAGAO)

Collector: HAYAMI

Hy. 4006

Location: middle valley of Hachimanzawa, northeast of Sebayashi (exactly unknown)

Str. position: Sebayashi formation (Miyakoan)

Lithology: black carbonaceous shale

Fossils: *Liostrea* sp., *Nippononaia ryosekiana* (SUZUKI), *Protocyprina* sp.

Collectors: ICHIKAWA and HAYAMI

Hy. 4008

Location: river floor near Ichinose-bashi, south of Kagahara

Str. position: middle part of the Ishido formation (Aritan)

Lithology: fine bluish grey sandstone

Fossils: *Gervillaria haradae* (YOKOYAMA), *Pterotrignia pocilliformis* (YOKOYAMA)

Collectors: ICHIKAWA and HAYAMI

9. Ohinata area, Minamisaku County, Nagano Prefecture (長野県南佐久郡大日尚地方)  
138°42'E, 36°08'N (Fig. 6)

Hy. 4011

Location: road-cut near Ishido (石堂), east of Koya (古谷)

Str. position: lower part of the Ishido formation (Aritan)

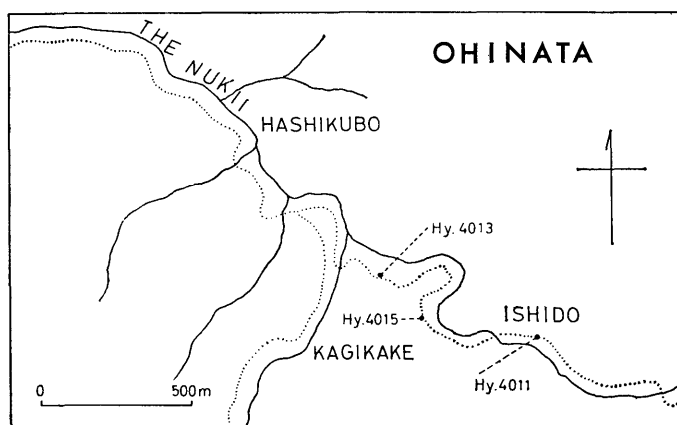


Fig. 6. Map showing the fossil localities in the Ohinata area.



Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Amygdalum ishidoense* (YABE and NAGAO), *Gervillaria haradae* (YOKOYAMA), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Isognomon* (*Melina*) *ichikawai* sp. nov., *Pinna* sp. cf. *P. robinaldina* D'ORBIGNY, *Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER), *Limatula ishidoensis* (YABE and NAGAO), *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Nipponitrigonia plicata* KOBAYASHI and NAKANO, *Rutitrigonia sanchuensis* (NAKANO), *Pterotrigonia pocilliformis* (YOKOYAMA), *Pterotrigonia yokoyamai* (YEHARA), *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Isocyprina* sp.

Collectors: ICHIKAWA and HAYAMI

Hy. 4013

Location: road-cut, west of Ishido

Str. position: middle part of the Ishido formation (Aritan)

Lithology: black shale

Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Pinna* sp., *Pterotrigonia* sp.

Collector: HAYAMI

10. Yuasa area, Arita County, Wakayama Prefecture (和歌山県有田郡湯浅地方)  
135°10'E±, 34°03'N± (Fig. 7)

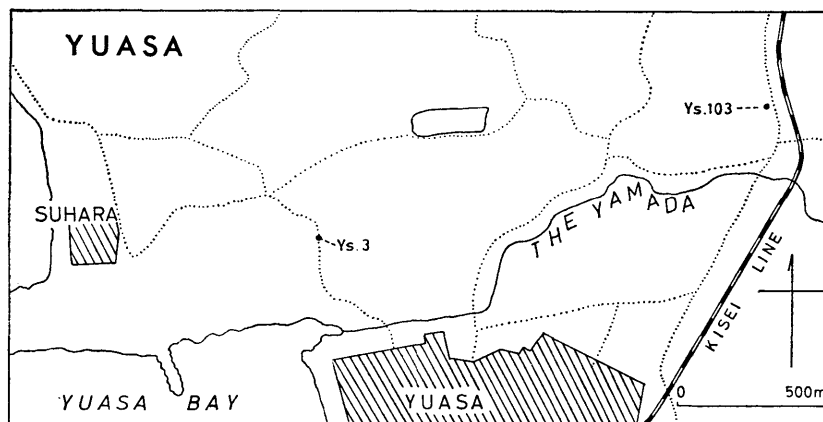


Fig. 7. Map showing the fossil localities in the Yuasa area.

Ys. 3

Location: near Suhara (栖原), north of the central part of Yuasa town

Str. position: lower part of the Arita formation (Aritan)

Lithology: black shale

Fossils: *Nuculana* (s. l.) *sanchuensis* YABE and NAGAO

Collector: MATSUMOTO

Ys. 8 (=Hy. 3003)

Location: north of a pass between Yuasa and Yoshikawa (吉川)

Str. position: lower part of the Arita formation (Aritan)

Lithology: dark grey sandy shale

Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Plectomya arita-gawana* sp. nov.

Collector: MATSUMOTO

Ys. 103 (=Hy. 3006)

Location: a rail-road cut, west of Kumai (熊井)

Str. position: middle part of the Arita formation (Aritan)

Lithology: fine grey sandstone and dark grey sandy shale

Fossils: *Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO), *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Modiolus falcatus* AMANO, *Modiolus* sp. aff. *M. subsimplex* D'ORBIGNY, *Neithea* (*Neithea*) *kanmerai* sp. nov., *Plicatula kiiensis* sp. nov., *Pterotriconia pocilliformis* (YOKOYAMA) *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Ptychomya densicostata* NAGAO, *Panopea* (*Myopsis*) *nagaoi* sp. nov., *Plectomya aritagawana* sp. nov.

Collectors: MATSUMOTO et al. and HAYAMI

Ys. 329a

Location: north of Oura (大浦), Minamihiro village (南広村)

Str. position: Arita formation (Aritan)

Lithology: grey sandy shale

Fossils: *Pterinella shinoharai* sp. nov., *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY

Collector: MATSUMOTO

Ys. 1020

Location: Yoshihara (吉原) of Ishigaki (石垣), Kanaya town (金谷町)

Str. position: lower part of the Izeki formation (Miyakoan)

Lithology: fine weathered sandstone

Fossils: *Bakevella shinanoensis* (YABE and NAGAO), *Liostrea* sp., *Costocyrena* sp. aff. *C. radiatostriata* (YABE and NAGAO), *Tetoria* (*Paracorbicula*) sp.

Collector: MATSUMOTO

11. Katsuura area, Katsuura County, Tokushima Prefecture (徳島県勝浦郡勝浦地方)

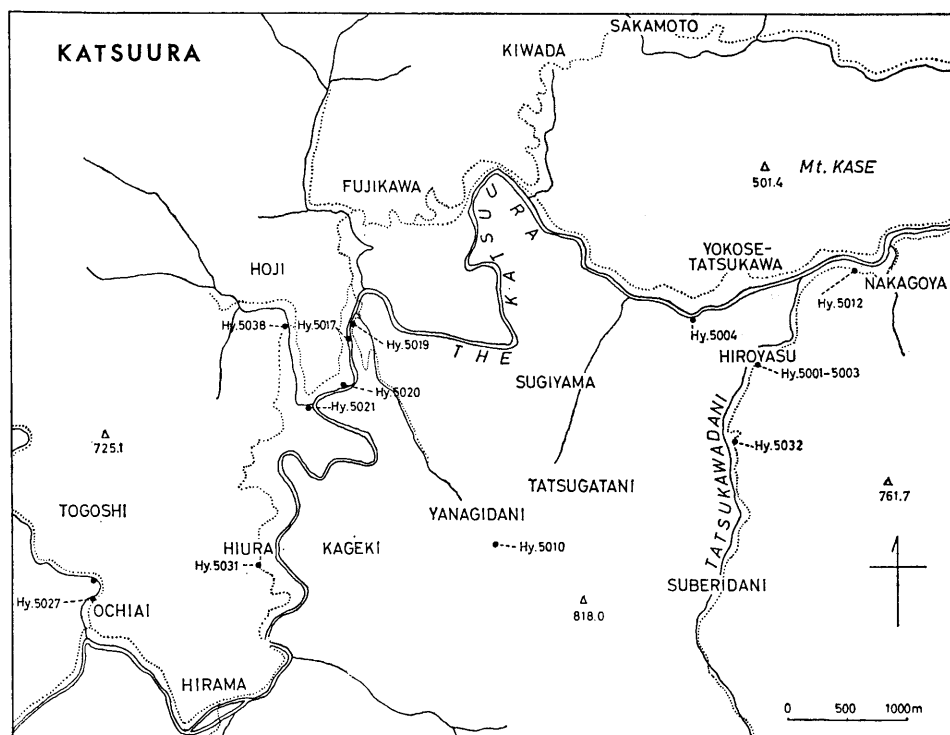


Fig. 8. Map showing the fossil localities in the Katsuura area.

134°26'E±, 33°54'N± (Fig. 8)

Hy 5002 (≡ Hy. 5001, Hy. 5003)

Location: road-cut at the opposite side of Hiroyasu (広安), Katsuura town (勝浦町)

Str. position: upper part of the Hanoura formation (Aritan)

Lithology: fine grey sandstone and dark grey sandy shale

Fossils: *Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO), *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO) *Pterinella shinoharai* sp. nov., *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Neithea* (*Neithella*) sp. cf. *N. (N.) atava* (RÖMER), *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Pterotrigonia* sp. cf. *P. yokoyamai* (YEHARA), *Pterotrigonia pocilliformis* (YOKOYAMA), *Scittila japonica* sp. nov., *Scittila* sp., *Pholadomya* sp., *Plectomya aritagawana* sp. nov.

Collectors: MATSUMOTO, NAKAI and HAYAMI

Hy. 5004

Location: southern bank of Katsuura river, northwest of Hiroyasu, Katsuura town

Str. position: upper part of the Hanoura formation (Aritan)

Lithology: grey calcareous sandy shale

Fossils: *Pterinella shinoharai* sp. nov., *Neithea* (*Neithea*) *kanmerai* sp. nov., *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Panoepa* (*Myopsis*) sp. cf. *P. (M.) plicata* (SOWERBY)

Collectors: NAKAI and HAYAMI

Hy. 5010 (≡ Hy. 5011)

Location: road-cut at the east of Nakagoya (中小屋), Katsuura town

Str. position: lower part of the Hanoura formation (Aritan)

Lithology: dark grey shale

Fossils: *Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO), *Nuculana* (s. l.) *sanchuensis* YABE and NAGAO

Collectors: NAKAI and HAYAMI

Hy. 5012 (≡ Hy. 5015)

Location: road-cut at the west of Nakagoya, Katsuura town

Str. position: lower part of the Hanoura formation (Aritan)

Lithology: dark grey shale

Fossils: *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO

Collectors: NAKAI and HAYAMI

Hy. 5017

Location: western bank of Katsuura river near Katsuura coal mine, south of Fujikawa (藤川), Kamikatsu town

Str. position: upper part of the Hoji formation (Miyakoan)

Lithology: fine grey sandstone

Fossils: *Nuculopsis* (*Palaeonucula*) *ishidoensis* (YABE and NAGAO), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Nipponitrigonia* sp., *Pterotrigonia pocilliformis* (YOKOYAMA)

Collectors: NUMANO, NAKAI and HAYAMI

Hy. 5019

Location: road-cut at the opposite side of Katsuura coal mine, south of Fujikawa

Str. position: upper part of the Hoji formation (Miyakoan)

Lithology: fine grey sandstone

Fossils: *Nipponitrigonia kikuchiana* (YOKOYAMA), *Nipponitrigonia plicata* KOBAYASHI and NAKANO, *Isocyprina aliquantula* AMANO

Collectors: NAKAI and HAYAMI

Hy. 5021 (≡ Hy. 5022)

Location: western bank of the Katsuura river, near the mouth of the valley of Hoji (傍示), Kamikatsu town

Str. position: lower part of the Hoji formation (Miyakoan)

Lithology: fine grey sandstone

Fossils: *Pterotrignia pocilliformis* (YOKOYAMA), *Lopha* sp.

Collectors: NAKAI and HAYAMI

Hy. 5027 ( $\div$  Hy. 5028)

Location: river floor at the northwest of the primary school, Ochiai (落合), Kamikatsu town

Str. position: middle part of the Hoji formation (Miyakoan)

Lithology: fine grey carbonaceous sandstone and black shale

Fossils: *Eomiodon sakawanus* (KOBAYASHI and SUZUKI), *Tetoria* (*Paracorbicula*) sp., ? *Lopha* sp.

Collectors: MATSUMOTO, NAKAI and HAYAMI

Hy. 5031

Location: road-cut at the north of Hiura (日浦), Kamikatsu town

Str. position: middle part of the Hoji formation (Miyakoan)

Lithology: black carbonaceous sandy shale

Fossils: *Eomiodon sakawanus* (KOBAYASHI and SUZUKI), *Tetoria* (*Paracorbicula*) sp.

Collectors: NAKAI and HAYAMI

12. Monobegawa area, Kami County, Kochi Prefecture (高知県賀美郡物部川地方)  
133°43'E, 33°37'N (Fig. 9)

Hy. 6011

Location: south of Hagino (萩野), Mirafu village (美良布村)

Str. position: upper part of the Monobegawa group or Hagino formation (lower Miyakoan)

Lithology: fine bluish grey (yellowish if weathered) sandstone

Fossils: *Eonavicula prolata* (AMANO), *Nemodon* (?) sp., *Cucullaea fujii* sp. nov., *Trigonarca obliquata* AMANO, *Gervillaria* sp. cf. *G. haradae* (YOKOYAMA), *Modiolus falcatus* AMANO, *Chlamys shikokuensis* AMANO, *Neithea* (*Neithea*) *amanoi* sp. nov., *Eriphyla* (*Miyakoella*) sp. cf. *E. (M.) miyakoensis* (NAGAO), *Opis* (*Opis*) *haginoensis* AMANO, *Pachythaerus* sp. cf. *P. kagaharensis* (YOKOYAMA), *Protocardia* sp., *Laevicardium* (?) *corpulentum* (AMANO), *Isocyprina aliquid*

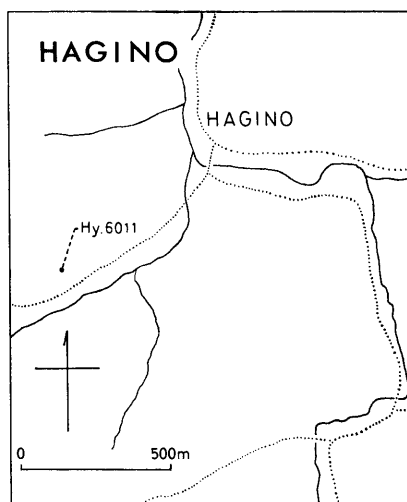


Fig. 9. Map showing the fossil localities in the Hagino area.

*antula* (AMANO), *Scittila* sp. cf. *S. japonica* HAYAMI, *Panopea* (*Myopsis*) sp. cf. *P. (M.) plicata* (SOWERBY), *Pholadomya* sp. aff. *P. cornueliana* D'ORBIGNY, *Plectomya* sp. cf. *P. aritagawana* HAYAMI

Collectors: AMANO, NAKANO, OGAWA and HAYAMI

13. Ryoseki area, Nangoku City, Kochi Prefecture (高知県南国市領石地方) 133°37'E, 33°37'N (Fig. 10)

Hy. 6002

Location: road-cut near the mouth of the valley of Okunominotani (奥簷谷), southwest of Ryoseki (領石)

Str. position: lower part of the Monobegawa group or Funadani formation (Aritan)

Lithology: dark grey shale

Fossils: *Chlamys* (?) *shikokuensis* AMANO, *Variamussium kimurai* sp. nov., *Astarte* sp.

Collectors: KIMURA and HAYAMI

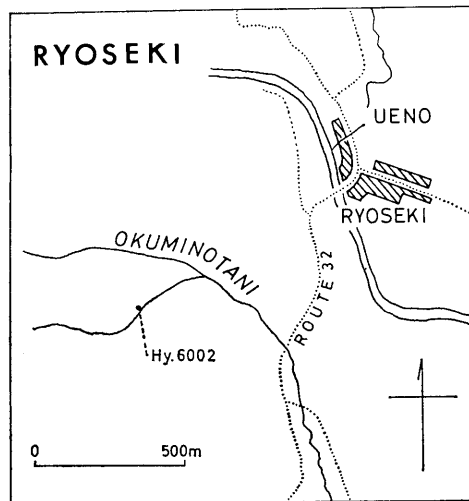


Fig. 10. Map showing the fossil localities in the Ryoseki area.

14. Haidateyama area, Ono County, Oita Prefecture (大分県大野郡楓楯山地方) 131°43'E, 33°02'N

U. 1005

Location: roadside between Tamarimizu (溜水) and Ochiai (落合), Nozu town (野津町)

Str. position: comparable strata with the Haidateyama formation (Miyakoan)

Lithology: fine weathered brownish sandstone

Fossils: *Parallelodon nipponicus* (NAGAO), *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Cucullaea fujii* sp. nov., *Neithea* (*Neithea*) *matsumotoi* sp. nov., *Pterotriconia pocilliformis* (YOKOYAMA), *Veniella* (?) sp.

Collectors: KANMERA and FUJII

U. 3095

Location: Yamaguchi-no-tani (山口ノ谷), Mie town (三重町)

Str. position: Haidateyama formation (Miyakoan)

Lithology: dark grey sandy shale

Fossils: *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO

Collector: FUJII

Hy. 8002

Location: road-cut at the north of Kamikoshigoe (上腰越), Honjo village (本庄村), Minamiamabe County (南海部郡)

Str. position: Haidateyama formation (Miyakoan)

Lithology: dark grey sandy shale and fine grey sandstone

Fossils: *Neithea* (*Neithea*) sp., *Pterotrigonia pocilliformis* (YOKOYAMA), *Pterotrigonia* sp. cf. *P. datemasamunei* (YEHARA)

Collector: HAYAMI

15. Yatsushiro area, Kumamoto Prefecture (熊本県八代地方) 130°40'E± 32°30'N± (Fig. 11)

At. 328

Location: south of Bisho (美生), Toyo village (東陽村), Yatsushiro County

Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: fine grey sandstone

Fossils: *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Astarte* (*Yabea*) *akatsui* sp. nov., *Eriphyla* (*Eriphyla*) *minima* sp. nov.

Collector: AKATSU

At 828A (≡ Hy. 1021)

Location: road-side at the south of Bisho, Toyo village

Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: fine grey sandstone

Fossils: *Gervillaria haradae* (YOKOYAMA), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Pterotrigonia pocilliformis* (YOKOYAMA), *Laevicardium* (?) *ishidoense* (YABE and NAGAO)

Collectors: AKATSU and HAYAMI

Hy. 1007

Location: a small valley at the southwest of Kohara (小原), Toyo village

Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: dark grey sandy shale

Fossils: *Nanonavis* (*Nanonavis*) sp. cf. *N. (N.) yokoyamai* (YABE and NAGAO), *Pterotrigonia pocilliformis* (YOKOYAMA)

Collector: HAYAMI

Hy. 1012

Location: road-cut at the north of Nekodani (猫谷), Yatsushiro City

Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Pterinella shinoharai* sp. nov., *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Pterotrigonia pocilliformis* (YOKOYAMA), *Nemocardium yatsushiroense* sp. nov., *Panopea* sp., *Astarte* sp.

Collectors: AMANO, TAMURA and HAYAMI

Km. 1639b

Location: left bank of the Kuma river, Takada (高田), northwest of Harameki (原女木), Yatsushiro City

Str. position: lower part of the Hinagu formation (lower Miyakoan)

Lithology: fine grey sandstone

Fossils: *Costocyrena* sp. cf. *C. matsumotoi* HAYAMI, "*Nakamuranaia*" *chingshanensis* (GRABAU)

Collector: KANMERA

Km. 1832

Location: road-side at the northeast of Tsuzura (九折), Sakamoto town (坂本町)

Str. position: Hinagu formation (lower Miyakoan)

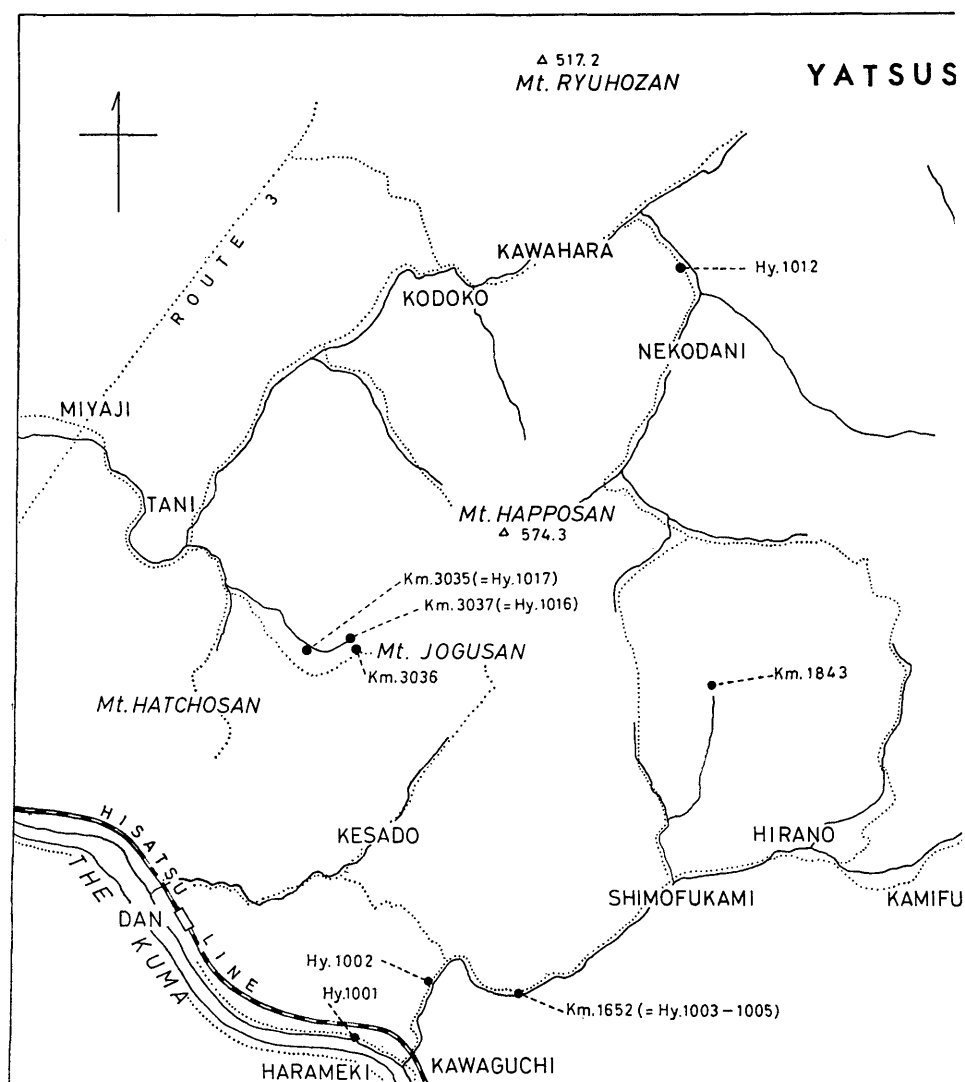


Fig. 11. Map showing the fossil

Lithology: dark grey sandy shale

Fossils: *Nuculana* (s. l.) *sanchuensis* YABE and NAGAO, *Pinna* sp. cf. *P. robinaldina* D'ORBIGNY

Collector: KANMERA

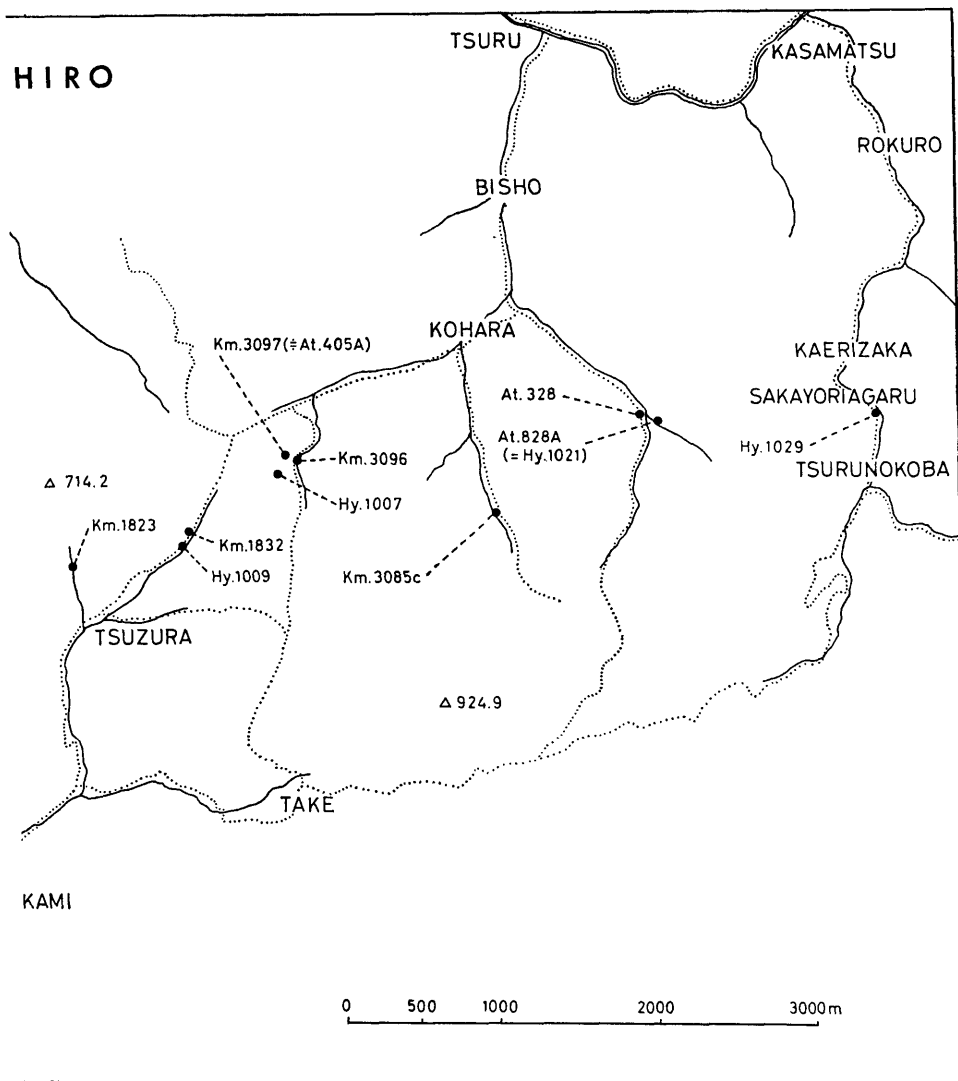
Km. 1843 (≠ Hy. 1001)

Location: north of Shimofukami (下深水), Sakamoto town

Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: grey fine sandstone

Fossils: *Parallelodon nipponicus* (NAGAO), *Pterinella shinoharai* sp. nov., *Bakewellia pseudorostrata* (NAGAO), *Neitheia* (*Neitheia*) *matsumotoi* sp. nov., *Entolium* (?) *yatsushiroense* sp. nov., *Limatula* sp. cf. *L. nagaoi* HAYAMI, *Lopha* (*Arctostrea*) *carinata* (LAMARCK), *Nipponitrigonia plicata* KOBAYASHI and NAKANO,



localities in the Yatsushiro area.

*Rutitrigonia sanchuensis* (NAKANO), *Pterotrigonia pocilliformis* (YOKOYAMA), *Acanthotrigonia* sp. cf. *A. dilapsa* (YEHARA), *Anthonya* sp., *Fimbria* sp., *Laevicardium* (?) *ishidoense* (YABE and NAGAO), *Ptychomya densicostata* NAGAO, *Panopea* (*Myopsis*) *nagaoi* sp. nov., *Goniomya* sp., *Pholadomya* sp.

Collectors: KANMERA and HAYAMI

Km. 3035 (≡ Hy. 1017)

Location: western slope of Mt. Jogusan (上宮山), Miyaji (宮地), Yatsushiro City  
Str. position: Yatsushiro formation (upper Miyakoan)

Lithology: fine grey sandstone and dark grey sandy shale

Fossils: *Monia* sp. cf. *M. pseudotruncata* (YABE and NAGAO), *Costocyrena matsu-motoi* sp. nov., *Tetoria* (*Paracorbicula*) sp.

Collectors: KANMERA and HAYAMI



## Km. 3036

Location: western slope of Mt. Jogusan, Miyaji, Yatsushiro City  
 Str. position: Yatsushiro formation (upper Miyakoan)  
 Lithology: grey sandy shale  
 Fossils: *Pterotrigonina pocilliformis* (YOKOYAMA)  
 Collector: KANMERA

Km. 3037 ( $\doteq$  Hy. 1016)

Location: western slope of Mt. Jogusan, Miyaji, Yatsushiro City  
 Str. position: grey sandy shale  
 Fossils: *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Pterinella shinoharai* sp. nov., *Neithea* (*Neithea*) *matsumotoi* sp. nov., *Pterotrigonina pocilliformis* (YOKOYAMA), *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO, *Astarte* (*Freiastarte*) sp. cf. *A. (F.) subomalioides* NAGAO, *Nemocardium yatsushiroense* sp. nov., *Plectomya* sp. cf. *P. aritagawana* HAYAMI  
 Collectors: KANMERA, FUJII and HAYAMI

## Km. 3085c

Location: south of Kohara, Toyo village  
 Str. position: Hinagu formation (lower Miyakoan)  
 Lithology: medium grey conglomeratic sandstone  
 Fossils: *Neithea* (*Neithea*) *kanmerai* sp. nov., *Plicatula kiiensis* sp. nov., *Astarte* (*Astarte*) *subsenecta* YABE and NAGAO  
 Collector: KANMERA

Km. 3096 ( $\doteq$  Km. 3097)

Location: a small valley, southwest of Kohara, Toyo village  
 Str. position: Yatsushiro formation (upper Miyakoan)  
 Lithology: dark grey sandy shale  
 Fossils: *Mesosaccella* sp., *Nuculana* (s. l.) *sanchuensis* (YABE and NAGAO), *Nanonavis* (*Nanonavis*) *yokoyamai* (YABE and NAGAO), *Gervillia* (*Gervillia*) *forbesiana* D'ORBIGNY, *Pterotrigonina pocilliformis* (YOKOYAMA), *Acanthotrigonia* sp. cf. *A. dilapsa* (YEHARA), *Panopea* (*Myopsis*) *nagaoi* sp. nov., *Goniomya* sp.  
 Collectors: KANMERA and HAYAMI

## Km. 3134

Location: northwestern slope of the peak of 251 m, Kongo (金剛), Yatsushiro City  
 Str. position: Hinagu formation (lower Miyakoan)  
 Lithology: fine grey sandstone  
 Fossils: *Parallelodon nipponicus* (NAGAO), *Nipponitrigonia kikuchiana* (YOKOYAMA), *Pterotrigonina hokkaidoana* (YEHARA), *Pterotrigonina* (*Rinetrigonia*) sp.  
 Collector: KANMERA

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## Index of Genera and Species

Names of genera, subgenera and species described (in italic type) or discussed (in roman type) in Part I (*Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., Vol. 15, No. 2, pp. 221–349, pls. 27–52, 1965), Part II (*Ibid.*, Ser. D, Geol., Vol. 17, No. 2, pp. 73–150, pls. 7–21, 1965) and Part III (this part) are alphabetically listed below. Plates are indicated by italic type with figure-number(s) in parentheses.

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## Postscript I

After a part of the manuscript of this serial study was completed, NEWELL (1965) presented a new scheme of pelecypod classification designed for the forthcoming "*Treatise on Invertebrate Paleontology, Part N*". His grouping and taxobasis are essentially similar to those of COX (1960), which I adopted in the present descriptions, but quite different in the name of subclasses, orders and suborders. I have felt that the ordinal names hitherto proposed by many authors including COX are somewhat troublesome and sometimes confusable, because they were derived from various taxonomic characters such as gill structures, hinge types, ligament characters, musculature and other morphological features. In this respect, the ordinal names, which are based on the names of typical representative genera and were adopted by NEWELL, would be accepted not only by palaeontologists but also by neontologists. Because the International Code

of Zoological Nomenclature is concerned only with the names of the family-, genus- and species-groups, the adoption of ordinal and subordinal names may not necessarily adhere to the principle of priority.

Hereafter, I intend to change the ordinal and subordinal names, which were cited in the present study, as follows:

Order Palaeotaxodontida	Order Nuculida	
Order Eutaxodontida	Order Arcida	
Order Isofilibranchida	Order Mytilida	
Order Pteronchida	Suborder Pteriina	} Order Pteriida
Order Colloconchida	Suborder Ostreina	
Order Heterodontida	Order Venerida	
Suborder Astartodontina	Suborder Astartina	
Suborder Oligodontina	Suborder Venerina [=Arcticina in NEWELL]	

#### Postscript II

In the present study, the Kochian, Aritan and Miyakoan series, which appear to represent three major sedimentary cycles of the Lower Cretaceous in Japan, were conventionally assigned to Lower Neocomian, Upper Neocomian and Aptian-Albian-Lowest Cenomanian respectively, as had been treated by many stratigraphers. It is, however, probable that the Aritan formations of the Outer Zone of Southwest Japan are partly correlated to the Lower Aptian, judging from some undescribed ammonites recently collected from the Katsuura area. There is much room for further investigation and improvement as to the correlation and chronology of the Japanese Lower Cretaceous. Dr. I. OBATA of the National Science Museum and Mr. I. NAKAI of the Kyushu University are now carrying out the biostratigraphy and ammonite palaeontology concerning to the Aritan and Miyakoan series. Taking their results into consideration in future, I might be able to determine the range of each pelecypod species on a more reliable basis, and to discuss the transition of pelecypod faunas of this period, which was only provisionally summarized in a separate paper (HAYAMI, 1965).

#### Postscript III (Nomenclatural correction)

Read *Amphidonte* for *Amphidonta* in the 1st part of this study (pp. 224, 343-347, pls. 49-51). The latter is an invalid emendation of the former and should be rejected, as pointed out by STENZEL (1947).

#### Postscript IV

After the manuscript of this serial study was completed, a full description of the molluscan fauna from the folded complex near the Ominé mine, northwest of Kamaishi, Iwate Prefecture was published (NAKAZAWA and MURATA, 1966). The fauna includes the following pelecypods: *Modiolus* sp., *Bakevellia* (*Neobakevellia*) *ominensis* NAKAZAWA and MURATA, *B. (N?) tadai* NAKAZAWA and MURATA, *Cuneigervillia quadrata* NAKAZAWA and MURATA, *Waagenoperna elon-*

*gata* NAKAZAWA and MURATA, *Isognomon* sp., *Pseudoptera* n. sp. aff. *P. viana* STEPHENSON, *Liostrea* sp., *Lopha* sp., *Protocardia ibukii* NAKAZAWA and MURATA, "*Eomiodon*" *ominensis* NAKAZAWA and MURATA, *Filosina* sp. aff. *F. jusanhamensis* HAYAMI, *Venilicardia*? sp., *Pleuromya* sp.

They are mostly brackish-water species. Only *Venilicardia*? sp., which occurs together with *Nerinea* sp., is considered to be a marine inhabitant. The age is, as noted by the authors, probably Neocomian, but it is rather curious that the assemblage is quite distinct from that of the Kochian and Aritan pelecypod faunas of other areas. As suggested by the authors, "*Eomiodon*" *ominensis* belongs to *Costocyrena* HAYAMI, 1965, and may be specifically distinct from *Costocyrena radiatostriata* and *C. matsumotoi*.

#### Postscript V

After the 1st part of this study was published, Dr. Vladimir L. SHOPOV and Dr. Ekim BONCEV of Bulgaria kindly gave me instructive information about the genus *Pterinella*, enclosing some copies of their papers and English translation of some other Bulgarian publications on the Lower Cretaceous mollusks of Balkan, which I had overlooked. According to PETKOVIC (1923) and some others, the fossil bed of *Pterinella petersi*, which TOULA assigned originally to the Neocomian, is now considered to be Aptian. BONCEV (1938) discussed the systematic position of the genus *Pterinella* and came to the conclusion that the genus was more closely related to the Pernidae [Isognomonidae plus Bakevelliidae in the present usage] than to the Aviculidae [=Pteriidae s. l.] especially in the adult stage. Although the presence of anterior supplementary ligament pits is not as yet ascertained in *Pterinella petersi*, i.e. the type-species of the genus, it is clear that *Pterinella shinoharai* HAYAMI from Japan is closely related to *P. petersi* in view of all the other essential characters. Although the palaeontological data are still insufficient to determine the systematic position of this peculiar pelecypod genus, I maintain the aforementioned thought of phylogeny that *Pterinella* was not directly related to the Bakevelliidae or other multivincular pterioids but was probably derived from *Pteroperna* or its allied genera of the Pteriidae.

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Itaru HAYAMI

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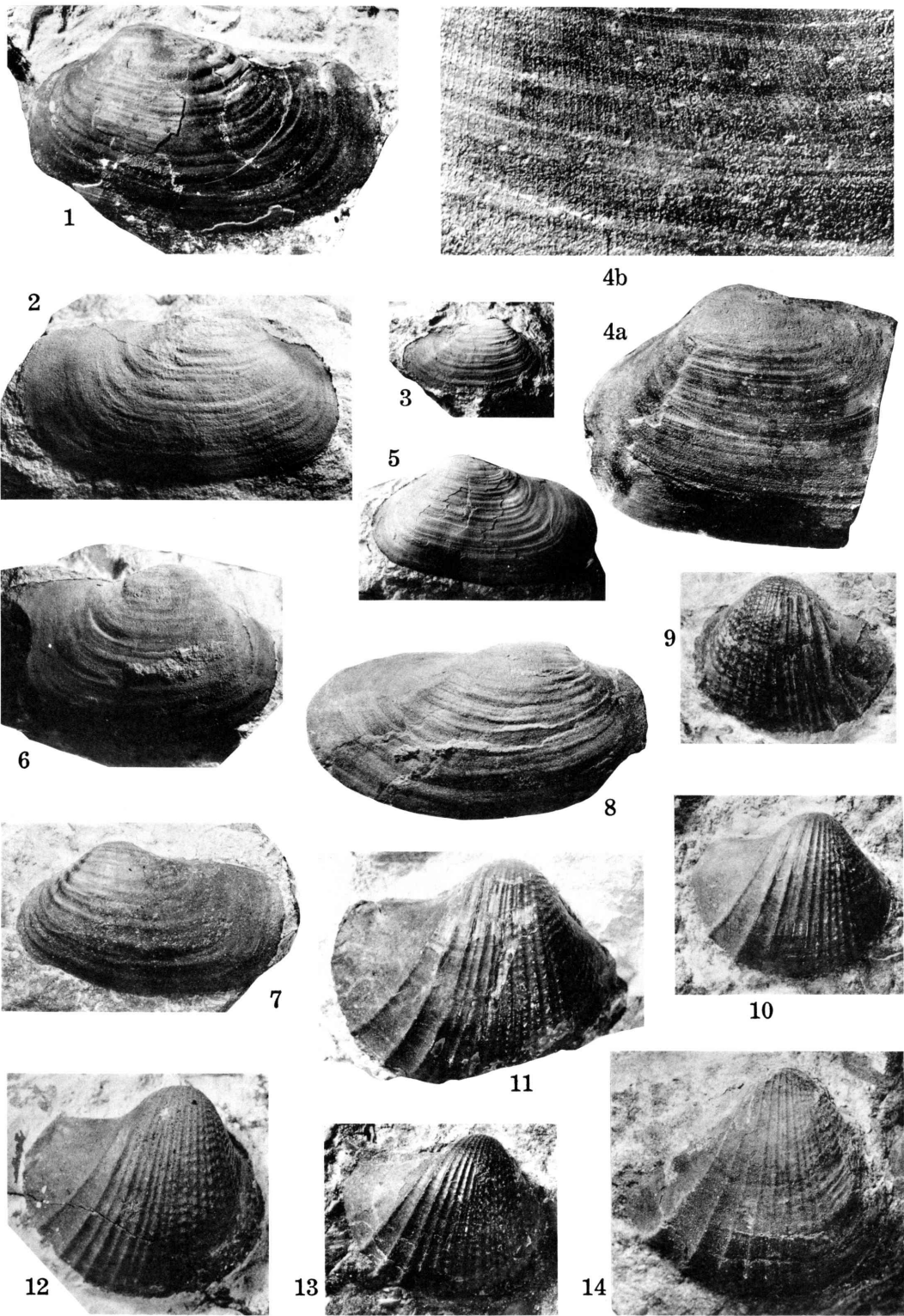
Part III

Plates 22~26

## Plate 22

## Explanation of Plate 22

- Figs. 1-7. *Panopea (Myopsis) plicata* (SOWERBY) .....Page 153**
1. Left valve (GK. H6536)  $\times 1$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, Tanohata village, Iwate Pref. (HANAI and HAYAMI coll.)
  2. Right internal mould (GK. H6537)  $\times 1$ . Loc. Hiraiga formation (boulder) at the south of Hiraiga, the same village. (HAYAMI coll.)
  3. Right valve (GK. H6712)  $\times 1$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, the same village (HANAI and HAYAMI coll.)
  4. Left valve (GK. H6535). Loc. ditto. (HANAI and HAYAMI coll.) 4a: lateral view ( $\times 1$ ); 4b: ornamentation on the central part of the same specimen ( $\times 4$ ).
  5. Left valve (GK. H6539)  $\times 1$ . Loc. ditto. (HAYAMI coll.)
  6. Right valve (GK. H6711)  $\times 1$ . Loc. ditto. (HANAI and HAYAMI coll.)
  7. Left valve (GK. H6538)  $\times 1$ . Loc. ditto. (HANAI and HAYAMI coll.)
- Fig. 8. *Panopea (Myopsis) nagaoi* sp. nov. ....Page 155**
8. Right internal mould (GK. H6545)  $\times 1.5$ . Holotype. Loc. Yatsushiro formation at Km. 3096, southwest of Kohara, Toyo village, Kumamoto Pref. (KANMERA coll.)
- Figs. 9-14. *Pholadomya miyamotoi* NAGAO .....Page 157**
9. Left valve (GK. H6550)  $\times 2$ . Loc. Hiraiga formation at Hn. 0018, south of Hiraiga, Tanohata village, Iwate Pref. (HANAI and (HAYAMI coll.)
  10. Right valve (GK. H6547)  $\times 2$ . Loc. ditto. (HAYAMI coll.)
  11. Right valve (GK. H6551)  $\times 2$ . Loc. ditto. (HAYAMI coll.)
  12. Right valve (GK. H6548)  $\times 2$ . Loc. ditto. (HANAI and HAYAMI coll.)
  13. Right valve (GK. H6802)  $\times 2$ . Loc. Hiraiga formation (boulder) at the south of Hiraiga, the same village. (HAYAMI coll.)
  14. Right valve (GK. H6553)  $\times 2$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, the same village. (HANAI and (HAYAMI coll.)
- All specimens illustrated are kept in the Department of Geology, Kyushu University.

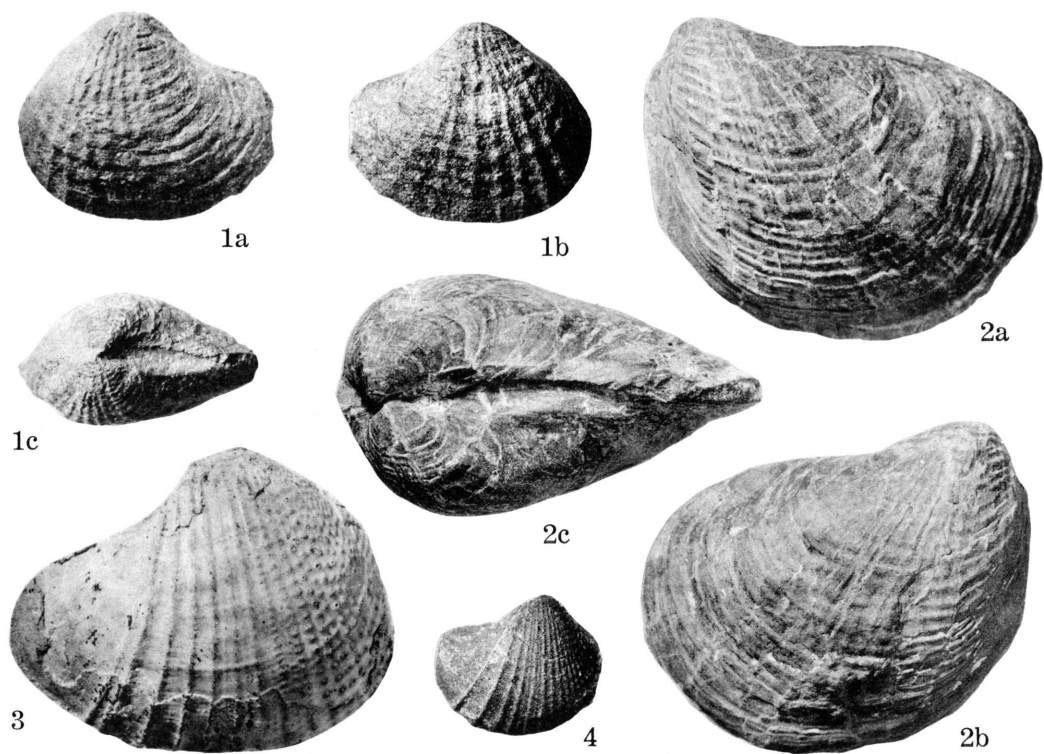


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## Plate 23

## Explanation of Plate 23

- Fig. 1. *Pholadomya subpedelnalis* NAGAO .....Page 160
1. Internal mould of closed valves (GK. H6558)  $\times 2$ . Loc. "Orbitolina sandstone" of the Miyako group at Hn. 6203, northeast of Raga, Tanohata village, Iwate Pref. (HAYAMI coll.) 1a: left valve; 1b: right valve.
- Fig. 2. *Pholadomya brevitesta* NAGAO .....Page 158
2. Both valves (GK. H6554)  $\times 1$ . Loc. Tanohata formation at Hn. 0006, south of Hiraiga, the same village. (HANAI coll.) 2a: left valve; 2b: right valve; 2c: upper view.
- Figs. 3, 4. *Pholadomya miyamotoi* NAGAO .....Page 157
3. Rubber cast from a right external mould (GK. H6801)  $\times 2$ . Loc. Hiraiga formation (boulder) at the south of Hiraiga, the same village. (HANAI coll.)
  4. Right internal mould (GK. H6549)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
- Fig. 5. Part of a slab with *Pholadomya miyamotoi* NAGAO (5a), *Panopea (Myopsis) plicata* (SOWERBY) (5b) and *Goniomya subarchiaci* NAGAO (5c, 5d)  $\times 1$ .
- 5a. Right valve (GK. H6802)  $\times 1$ . Loc. Hiraiga formation (boulder) at the south of Hiraiga, the same village (HAYAMI coll.)
- All specimens illustrated are kept in the Department of Geology, Kyushu University.



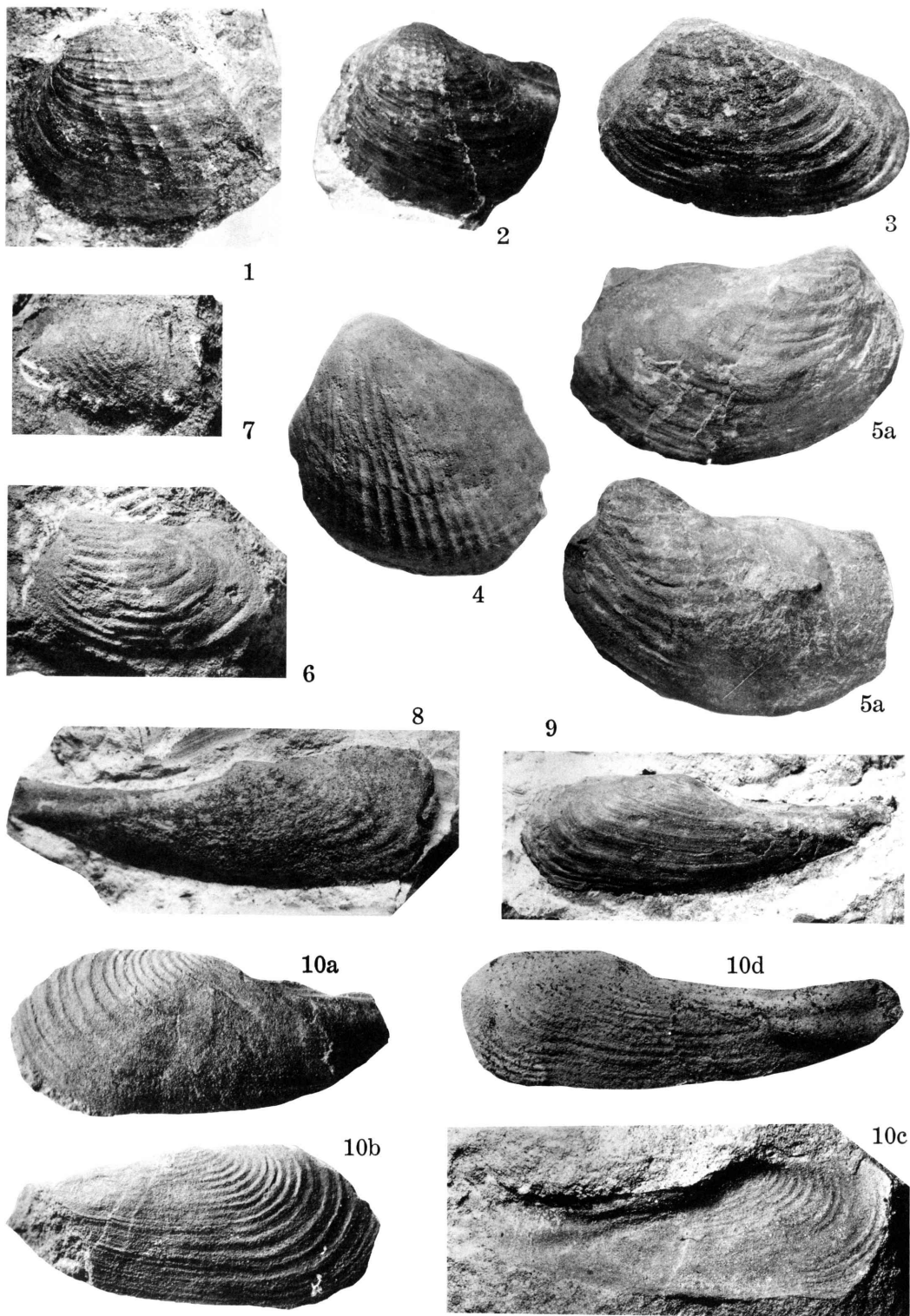
## Plate 24



## Explanation of Plate 24

- Figs. 1-3. *Pholadomya tuberculata* sp. nov. ....Page 160
1. Left valve (GK. H6556)  $\times 2$ . Paratype. Loc. Hiraiga formation at Hn. 0018, south of Hiraiga, Tanohata village, Iwate Pref. (HANAI and HAYAMI coll.)
  2. Left valve (GK. H6577)  $\times 2$ . Paratype. Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, the same village. (HANAI and HAYAMI coll.)
  3. Left valve (GK. H6555)  $\times 2$ . Holotype. Loc. Hiraiga formation at Hn. 0018, south of Hiraiga, the same village. (HANAI and HAYAMI coll.)
- Fig. 4. *Pholadomya* sp. A indet. ....Page 162
4. Left internal mould (GK. H6781)  $\times 1$ . Loc. Hagino formation at Hy. 6011, Hagino, Mirafu village, Kochi Pref. (OGAWA coll.)
- Figs. 5, 6. *Pholadomya* sp. B indet. ....Page 162
5. Internal mould of closed valves (GK. H6791)  $\times 1.5$ . Loc. Hanoura formation (boulder) at Hiroyasu, Katsuura town, Tokushima Pref. (HAYAMI coll.) 5a: right valve; 5b: left valve.
  6. Left internal mould (GK. H6792)  $\times 1.5$ . Loc. Yatsushiro formation at Km. 1843, north of Shimofukami, Sakamoto town, Kumamoto Pref. (KAN-MERA coll.)
- Fig. 7. *Goniomya* sp. indet. ....Page 165
7. Left internal mould (GK. H6573)  $\times 1.5$ . Loc. Ishido formation at Hy. 4001, Ichinose-bashi, Nakazato village, Gunma Pref. (ICHIKAWA and HAYAMI coll.)
- Figs. 8-10. *Cercomya gurgitis* (PICTET and CAMPICHE) ....Page 166
8. Right internal mould (GK. H6575)  $\times 1.2$ . Loc. Hiraiga formation at Hn. 0018, south of Hiraiga, Tanohata village, Iwate Pref. (HANAI and HAYAMI coll.)
  9. Left valve (GK. H6574)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.)
  10. Internal and external moulds of closed valves (GK. H6576)  $\times 1$ . Loc. "Orbitolina sandstone" of the Miyako group at Hn. 6202, northeast of Raga, the same village. (HANAI and HAYAMI coll.) 10a: left internal mould; 10b: right internal mould; 10c: left external mould; 10d: its rubber cast.

All specimens illustrated are kept in the Department of Geology, Kyushu University.

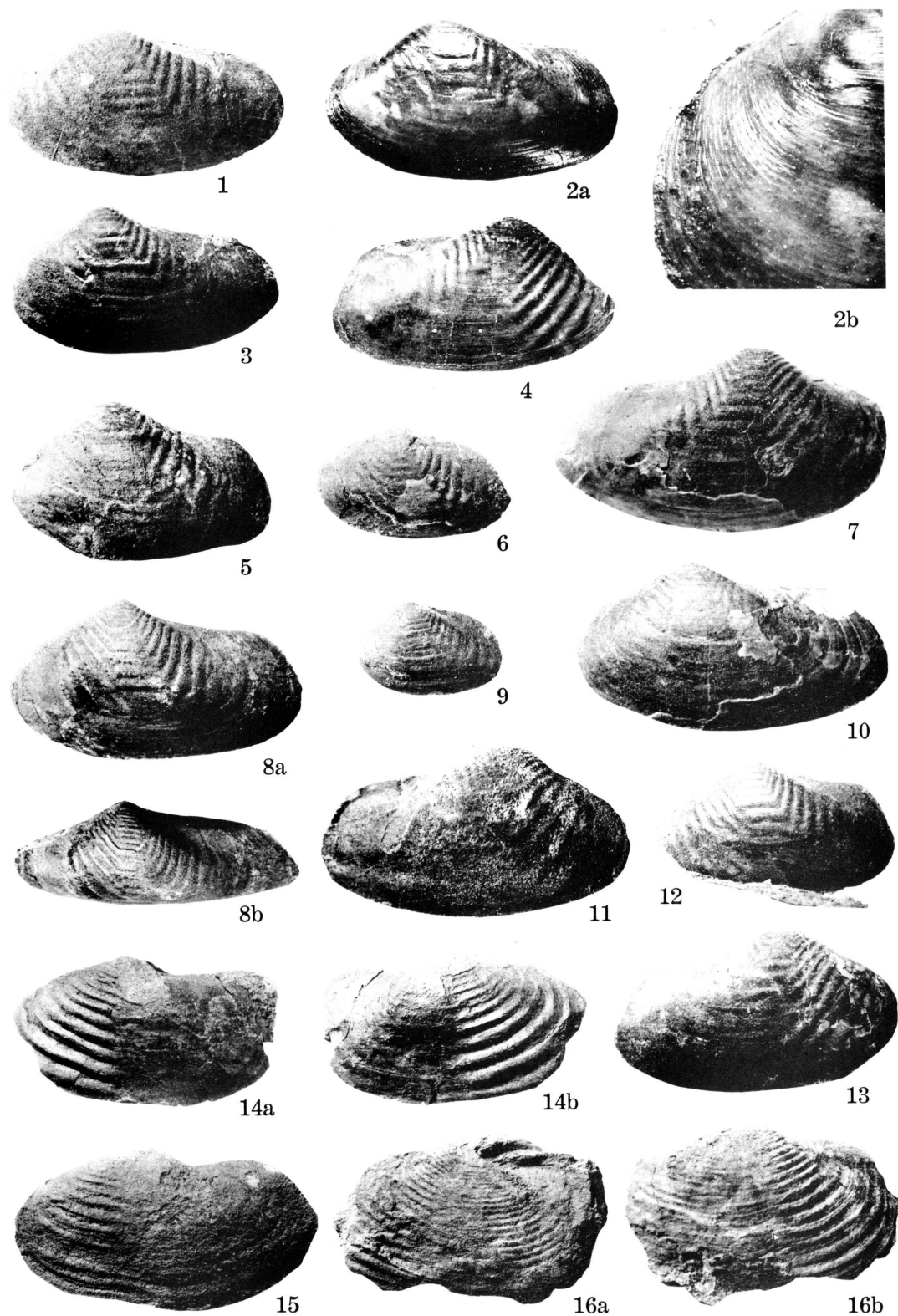


## Plate 25

## Explanation of Plate 25

- Figs. 1-13. *Goniomya subarchiaci* NAGAO .....Page 163
1. Left valve (GK. H6561)  $\times 1.5$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, Tanohata village, Iwate Pref. (HANAI and HAYAMI coll.)
  2. Left valve (GK. H6716). Loc. ditto. (HAYAMI coll.) 2a: lateral view ( $\times 1.5$ ); 2b: ornamentation on the anterior part ( $\times 5$ ).
  3. Left valve (GK. H6565)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.)
  4. Right valve (GK. H6564)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.)
  5. Left valve (GK. H6720)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.)
  6. Left valve (GK. H6717)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
  7. Right valve (GK. H6562)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
  8. Left valve (GK. H6559)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.) 8a: lateral view; 8b: upper oblique view.
  9. Left valve (GK. H6563)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
  10. Left valve (GK. H6560)  $\times 1.5$ . Loc. ditto. (HAYAMI coll.)
  11. Right valve (GK. H6718)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
  12. Left valve (GK. H6566)  $\times 1.5$ . Loc. Hiraiga formation at Hn. 0016, south of Hiraiga, the same village (HANAI and HAYAMI coll.)
  13. Right valve (GK. H6802)  $\times 1.5$ . Loc. Hiraiga formation at Hn. 0018, south of Hiraiga, the same village. (HANAI coll.)
- Figs. 14, 15. *Plectomya aritagawana* sp. nov. ....Page 168
14. Internal mould of closed valves (GK. H6577)  $\times 2$ . Holotype. Loc. Arita formation at Ys. 53, between Yuasa and Yoshikawa, Yuasa town, Wakayama Pref. (MATSUMOTO coll.) 14a: left valve; 14b: right valve.
  15. Left internal mould (GK. H6578)  $\times 1.5$ . Paratype. Loc. Arita formation at Ys. 103, west of Kumai, the same town. (MATSUMOTO coll.)
- Fig. 16. *Plectomya* sp. aff. *P. anglica* WOODS .....Page 169
16. Internal mould of closed valves (GK. H6600)  $\times 1.5$ . Loc. Yatsushiro formation at Hy. 1016, south of Miyaji, Yatsushiro City. (HAYAMI coll.) 16a: left valve; 16b: right valve.

All specimens illustrated are kept in the Department of Geology, Kyushu University.



## Plate 26

## Explanation of Plate 26

- Fig. 1. *Offadesma altissimum* sp. nov. ....Page 169
1. Internal mould of closed valves (GK. H6581)  $\times 1.5$ . Holotype. Loc. "Orbitolina sandstone" of the Miyako group at Hn. 6203, northeast of Raga, Tanohata village, Iwate Pref. (HANAI and HAYAMI coll.) 1a: left internal mould; 1b: right internal mould.
- Fig. 2. *Plectomya aritagawana* sp. nov. ....Page 168
2. Right internal mould (GK. H6579)  $\times 1.5$ . Paratype. Loc. Yatsushiro formation at Km. 3113, Miyaji, Yatsushiro City. (KANMERA coll.)
- Fig. 3. *Thracia* sp. indet. ....Page 170
3. Left valve (GK. H6583)  $\times 1.5$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, Tanohata village, Iwate Pref. (HAYAMI coll.)
- Figs. 4, 5. *Corimya* (?) *tanohatensis* sp. nov. ....Page 171
4. Internal and external moulds of closed valves (GK. H6724)  $\times 1.5$ . Holotype. Loc. Tanohata formation (boulder) at the south of Hiraiga, the same village. (HANAI and HAYAMI coll.) 4a: left internal mould; 4b: right internal mould.
  5. left internal mould (GK. H6725)  $\times 1.5$ . Loc. ditto. (HANAI and HAYAMI coll.)
- Figs. 6-9. "*Teredo*" *matsushimaensis* HATAI ....Page 172
6. Part of a slab (drift wood) with many calcareous tubes (GK. H6803)  $\times 1$ . Loc. 2nd cycle sediments of the Miyako group at Hn. 4154, Matsushima, Moshi, Iwaizumi town, Iwate Pref. (HANAI coll.)
  7. Tube taken from a drift wood (GK. H6804)  $\times 1$ . Loc. ditto. (HANAI coll.)
  8. Tube taken from a drift wood (GK. H6776)  $\times 1.5$ . Loc. Hiraiga formation at Hn. 0017, south of Hiraiga, Tanohata village, Iwate Pref. (HAYAMI coll.)
  9. Fragmentary right valve taken from the terminal part of a tube (GK. H6777)  $\times 3$ . Loc. 2nd cycle sediments of the Miyako group at Hn. 4154, Matsushima, Moshi, Iwaizumi town, Iwate Pref. (HANAI coll.)
- All specimens illustrated are kept in the Department of Geology, Kyushu University.

