

Bivalve fossils from the type Monobegawa Group

(Part I)

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Introduction

The Lower Cretaceous Monobegawa Group is typically cropping out along the stream of the river of Monobe-gawa which runs across the Kami-gun country (Monobe area) of Shikoku. The western extension of the Monobegawa Group is widely distributed at north of Tosa-yamada (= Ryoseki area) and north of Kochi City (= Kochi area).

This study treats mainly the description of bivalve fossils from the Monobegawa Group at the various localities of Monobe, Ryoseki and Kochi areas. In this part 1, we try to explain about the stratigraphical reviews of the Monobegawa Group, and describe 27 species of 17 genera belonging to orders Nuculoida, Arcoida and Mytiloida.

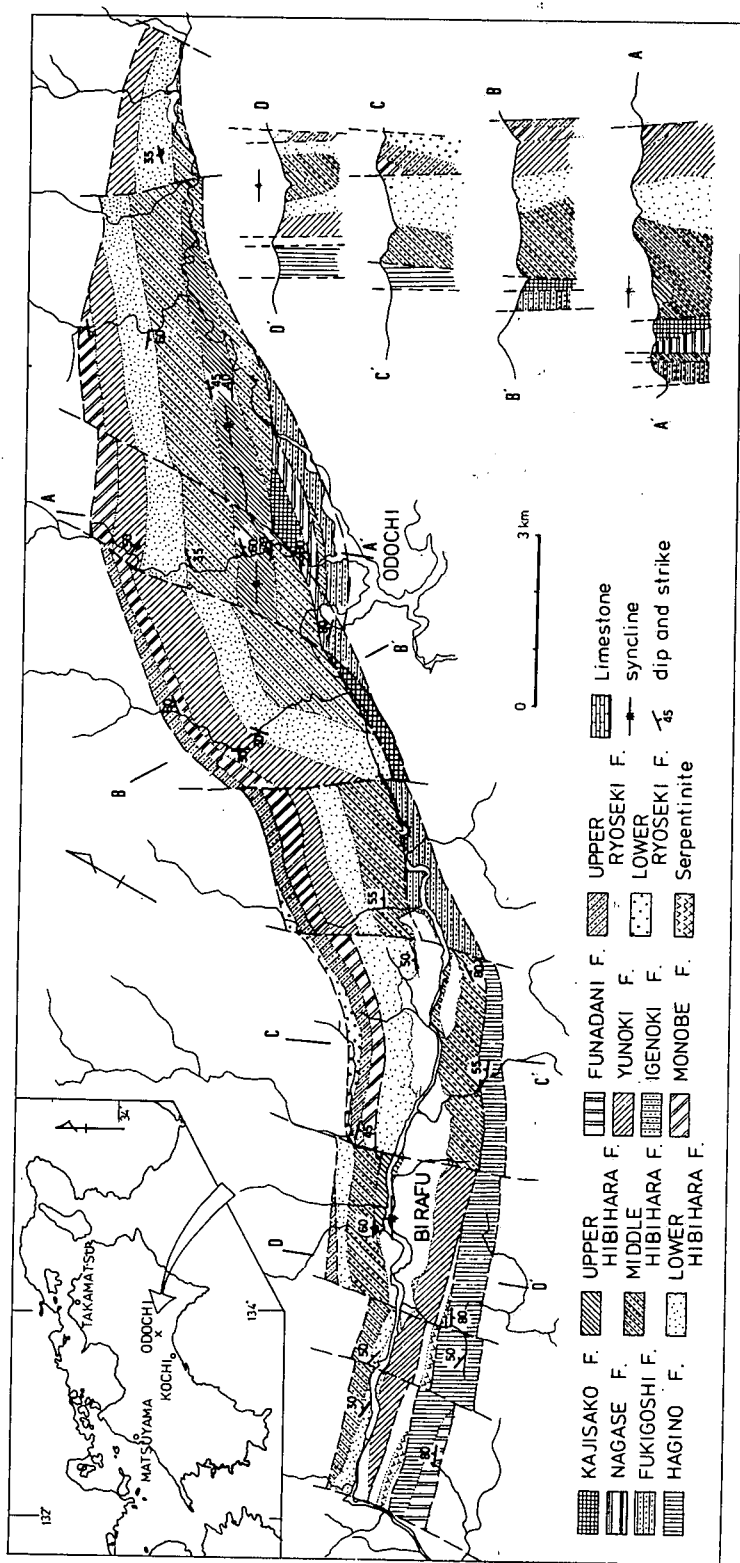
Before going into our study, we wish to express our sincere thanks to Emer. Prof. Tatsuro Matsumoto of Kyushu University, for his gratefull encouragements and kindly information of ammonites. We are also much indebted to Mr. Keiji Nakano of Osaka, Mis. Tomoko Matsuda of Fukuoka and Mis. Atsumi Hamamoto of Ehime., for their supplied us of many specimens of bivalves from the Monobegawa Group. We also wish to dedicate this paper to Prof. J. Katto in the commemoration of this retirement from Kochi University.

The materials described in this paper (KSG) are kept in the Faculty of Science, Kochi University, Kochi, 780.

Stratigraphical reviews of the Monobegawa Group

The Lower Cretaceous System (Monobegawa Group (s. l.)) of the Monobe area (inclusive with the Ryoseki and Kochi areas) was hitherto divided into three groups, i. e., Ryoseki, Lower Monobegawa and Upper Monobegawa Groups (Yabe, 1926; Hujita, 1943; Kobayashi, Hujita and Kimura, 1945; Matsumoto ed. 1954; Katto and Suyari, 1957).

The Monobegawa Group (s. l.) in this area is divided into the northern belt and the southern belt. The northern belt is distributed at the northern side to the so called Kurosegawa Tectonic Belt which extends narrowly from ENE to WSW. Another one, the southern belt, is distributed at the southern side of the tectonic



Text-fig. 1—A Map showing the geological outline of the Lower Cretaceous Monobegawa Group of Monobe area

belt, and contacted with so called Sanbosan (Sanposan) Belt on the southern side by the fault.

Recently the northern belt of the Cretaceous System was reinvestigated stratigraphically by Tashiro et al. (1980) and Tanaka et al. (1984, in this volume). According to the studies the Lower Cretaceous is divided into 4 formations, i. e., Ryoseki, Monobe, Yunoki and Hibihara (=Kaminiro) Formations.

The Ryoseki Formation is divided into lower and upper members. The former is characterized by conglomerate, and red-colored mudstone and sandstone which are presamable to the non-marine facies, contacted unconformably with so-called Paleozoic Chichibu Northern Belt. The latter is composed of conglomerate, sandstone and tuffaceous mudstone, overlaid conformably on the lower member. From the mudstone, so-called "Ryoseki Flora" and brackish "Ryoseki Fauna" were described classically by many authors.

The Monobe Formation which ranges conformably from the Ryoseki Formation is composed of sandy facies on lower part and muddy facies on upper part. Abundant subtidal or shallow marine bivalves usually occur from the lower part. And in the upper part, many important ammonites and bivalves are reported by Tashiro et al. (1980) and Matsumoto et al. (1982). The presamable geological age of this formation ranges from late Hauterivian to Early Barremian.

The Yunoki Formation is also composed of sandy facies on lower and middle parts but muddy facies on upper part, overlaid conformably on the Monobe Formation. This formation mainly characterized by the occurrence of brackish-water bivalves and plant fossils. But a few Barremian type ammonites and several marine bivalves are obtained from the mudstone of the upper part.

The Hibihara Formation is divided into four members, i. e., lower, middle, upper and upper-most members, nonconformably laid on the Yunoki Formation. The lower member is mainly composed of conglomerate and coarse grained sandstone. Several thin mudstone beds which characterized by the plant fossils or brackish bivalves are interbedded in the basal part. Shallow marine or subtidal molluscan faunas are usually developed in several horizons of the sandstone. A Lower Aptian ammonite, *Chelonicerias* sp., occurs from the sandstone. The middle member is composed of the alternations of sandstone and dark gray mudstone, be characterized by the occurrence of Aptian type ammonites. The upper member is mainly composed of dark gray massive siltstones. Many ammonites, echinoidea and planctonic or presamable to neretic bivalves, are commonly occur from the upper part of this member. The age of the fossiliferous siltstone is determinable to the Late Albian, judging from the ammonites and inoceramid. The upper-most member is characterized by the fine alternations of sandstone and dark-gray shale. Only fossil ever been found from this member.

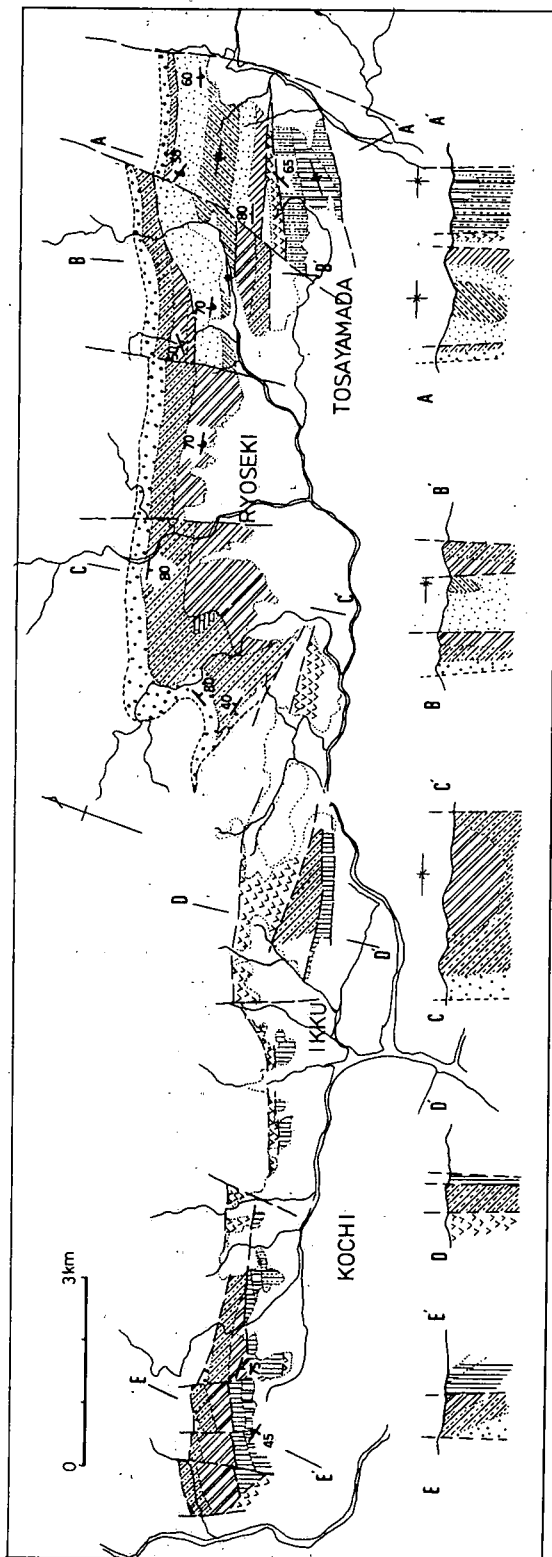
The southern belt of the Lower Cretaceous System is divided into the Igenoki (new name), Funadani, Hagino and Fukigoshi Formations.

The Igenoki Formation is distributed very narrowly with about 50 m in thickness,

at about 1500 m east of Tosayamada, take the strike of N 80° E in general and inclined towards northern side with about 70°, contacted with the Sanbosan Belt on southern (lower) side by a fault, and be covered conformably by the Funadani Formation on northern side.

The lower part of this formation is composed of fine grained massive arenite sandstone which is characterized by the occurrence of *Pinna* (*Pinna*) sp. and *Brachiodontes igenokiensis* sp. nov.. The upper part is consisting with gray greenish mudstone, Several thin acidic tuff beds intercalated in the lower division. Many bivalves and several ammonites abundantly occur from the mudstone. According to an information by Dr. T. Matsumoto, a species of ammonites, *Shastrioceras* sp., is suggested that the upper part of this formation is referable to the Late Barremian.

The Funadani Formation is composed mainly of conglomerate on lower part and of sandstone rich alternations of arenite sandstone and graygreenish mudstone on the main part. Thin carbonate beds are sometimes interbedded on the lower and middle parts of this formation. Although we could not obtain only certain species of bivalves except for *Eomiodon* sp. and *Ostrea* sp., several brackish-water bivalves were reported



Text-fig. 1—B Ryoseki and Kochi areas

by Katto and Suyari (1956) from the type area, Funadani of east of Tosayamada.

The Hagino Formation is mainly composed of massive arenite sandstone. Abundant marine bivalve fossils were described by Amano (1957) and Hayami (1965—1966).

An ammonite species, *Cheloniceras* sp., from this formation is suggested the fossiliferous sandstone to the Lower Aptian (Matsumoto et al. 1982).

The Fukigoshi Formation is characterized by dark gray massive siltstone on lower half part, and of the alternations of arenite sandstone and dark-gray siltstone on the upper half part. Many lower Lower Cenomanian bivalves were described from the upper part by Tashiro and Matsuda (1982). This Formation is contacted conformably with the Cenomanian Nagase Formation on the upper side and bounded by a fault from the Torinosu Group on the lower side. Although this is not connected with the Hagino Formation as the geographical distribution, this is closely concerned to the southern belt of the Lower Cretaceous System in its characteristic arenite sandstone and geo-structural position of the distribution in the southern side to the Kurosegawa Tectonic Belt.

International Scale	MONOBEGAWA GROUP		Japanese Scale		
	Northern belt	Southern belt			
CENOMANIAN		Nagase F.	K-4	a	
		Fukigoshi F.			
ALBIAN	Hibihara F. (=Kaminiro F.)		K-3	b	
APTIAN		Hagino F.			a
		Funadani F.			
BARREMIAN	Yunoki F.	Igenoki F.	K-2	b	
	Monobe F.				
HAUTERIVIAN	Ryoseki F.			a	

Text-fig. 2. Correlation of each formation of the Monobegawa Group

Systematic Description

Class Bivalvia

Subclass Palaeotaxodonta

Order Nuculoida

Superfamily Nuculaceae Gray

Family Nuculidae Gray

Genus *Nuculopsis* Girty, 1911Subgenus *Palaeonucula* Quenstedt, 1930*Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao)

Plate 1

Figs. 1, 2

1926. *Nucula ishidoensis* Yabe et Nagao; in Yabe, Nagao and Shimizu, *Sci. Rept. Tohoku Imp. Univ.*, ser. 2, vol. 11, no. 2, p. 41, pl. 13, figs. 46, 47.
1965. *Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao); Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 234.
1965. *Nuculopsis (Palaeonucula)* sp. cf. *N. (P.) ishidoensis* (Yabe et Nagao); Matsumoto, Hayami and Hashimoto, *Petrol. Geol. Taiwan*, no. 4, p. 8, pl. 1, fig. 8.
1972. *Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao); Shikama and Suzuki, *Sci. Rept. Yokohama Nat. Univ.*, ser. 2, vol. 19, pl. 4, figs. 5, 6.
1975. *Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao); Hayami, *Univ. Mus., Univ. Tokyo, Bull.* 10, p. 20.
1980. *Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao); Hayami, in Hayami and Oji, *Trans. Proc. Palaeont. Soc. Japan*, n. s., no. 120, p. 423, pl. 51, figs. 1 — 6.

Material. - KSG 3659-KSG 3662, internal moulds; KSG 3663, external mould; all the specimens were collected from Doiban, Monobe area.

Measurements: - (in mm.)

Specimen		Length	Height
KSG 3659,	r. int. mould	13.5	8.5
KSG 3660,	l. int. mould	12.8	9.2
KSG 3661,	r. int. mould	12.0	9.0

Remarks: - The outline of this species is variable from subtrigonal to elongate ovate. The posterior margin occupies about a half length of the anterior margin. The apical angle is about 100° or more in degrees. Although the specimens from Monobe area, are smaller than the type species of *Nuculopsis (Palaeonucula) ishidoensis* (Yabe et Nagao) (IGPS 7125), from the Ishido Formation of Sanchu, they are

undoubtedly conspecific with *N. (P.) ishidoensis*, in having its smooth inner margin and external surface, and relatively strong and thick denticles on the hinge plate.

Occurrence : - Sandstone of the lower member of the Hibihara Formation at Sasa of Doiban, Monobe area.

Genus *Nucula* Lamarck, 1799

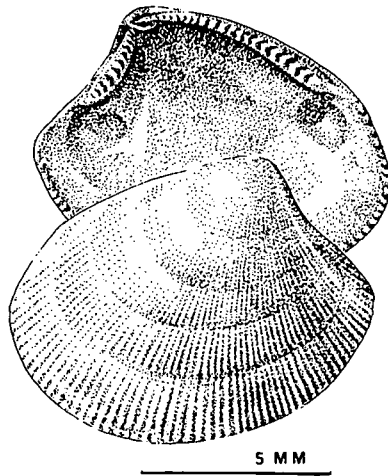
Subgenus *Pectinucula* Quenstedt, 1930

Nucula (Pectinucula) tosaensis, sp. nov.

Plate 1 Figs. 3-5, Text-fig. 3

Material : - KSG 3664 (holotype), left internal mould; KSG 3665-KSG 3666 (paratypes), internal moulds of left and right valves; KSG 3667-KSG 3668 (paratypes), left valves; all the specimens are collected from Sasa of Monobe area.

Diagnosis : - Shell small, trigonal ovate, longer than high, weakly inflated; umbo not prominent, opisthogyrous, pointed at about three fifths from front of the valve; apical angle about 90° ; anterior dorsal margin long, weakly arched; posterior dorsal



Text-fig. 3. *Nucula (Pectinucula) tosaensis*, sp. nov.

Measurements: - (in mm.)

Specimen	Length	Height	Thickness
KSG 3664, l. int. mould	11.2	9.5	—
KSG 3665, l. int, mould	9.5	7.4	—
KSG 3666, r. int, mould	9.1	7.2	—
KSG 3667, l. valve	9.0	7.4	1.0
KSG 3668, l. valve	6.5	5.0	0.8

margin nearly straight with about a half length of the anterior one; anterior margin well rounded; posterior margin short, nearly straight, obliquely truncated; ventral margin broadly arched; postero-ventral corner somewhat angulated; posterior carina nearly straight, extending from the umbo to the postero-ventral corner, forming an angulated ridge; surface ornamented with about 40 round-topped radial ribs; hinge plate strong with numerous taxodont teeth; anterior segment of the hinge plate occupied about twice length to the posterior one; an angle between anterior and posterior segments of the hinge plate is about 120° ; ligament resilifer very narrow, located under the beak, oblique to anterior with about 30° to the anterior segment of the hinge plate; both lateral adductor scars weakly impressed; inner ventral margin finely crenulated with about 30 in number; growth lines very weak.

Observation : - The radial ribs on the surface are strong and wider than their interspaces. The outline of the valve is rather uniform with trigonal ovate. The hinge denticles are generally countable about 10 in the anterior segment of the hinge plate and about 20 in the posterior ones.

Comparison : - This species is referable to the subgenus *Pectinucula* Quenstedt (1930), by its strong radial ribs on the surface. *Nucula* (*Pectinucula*) *pectinata* Sowerby (type species of *Pectinucula*; Woods, 1899; Quenstedt, 1930), from the Lower Greensand, of England, resembles closely this species in the distinct radial ribs, but differs in its more rounded outline and larger valve than those of this species. This also resembles *Nucula* (*Pectinucula*) *kochiensis* Tashiro et Matsuda (1982), from the Fukigoshi Formation (Lower Cenomanian) of the Monobe Area, in the radial ribs on the disk. This species is, however, characterized by less numerous and stronger radial ribs, and more angulated outline of the valve than those of *N.* (*P.*) *kochiensis*. *Nucula* (*pectinucula*) *radiatocostata* Nagao (1932), from the Upper Cretaceous of South Saghlin, is discriminated from this species by its elongately subovate outline and large valve. The distinctions between this species and *Nucula* (*Nucula*) *amanoi* Tashiro (1976), from the Himenoura Group (Santonian) in Kyushu, are shown by flat-topped ribs on the surface in the latter and by round-topped ribs on the surface in the former.

Occurrence : - Sandstone of the lower member of the Hibihara Formation at Sasa of Doiban, Odochi, Monobe area, Lower Aptian.

?*Nucula* (*Pectinucula*) sp.

Plate 1 Fig. 6

Material : -KSG 3652, right valve, from Hibihara, Odochi, Monobe area.

Description : - Shell medium to small, roundly ovate in outline, slightly taller than high, well inflated; umbo opisthogyrous, weakly prominent, located at a little posterior than the center of the valve; anterior dorsal margin weakly arched; anterior margin well rounded; ventral margin broadly convex; posterior margin nearly straight,

not demarcate from posterior dorsal margin; surface ornamented with numerous round-topped radial ribs; inner ventral margin finely crenulated.

Observation : -Several fragmental specimens and a right valve (KSG 3652) are in our hand. KSG 3652 is measured 10.1 mm length, 9.0 mm height and 1.8 mm thick. The radial ribs are countable about 40. Hinge structures of this species are invisible in detail.

Comparison : -This species is discriminated from *Nucula* (*Pectinucula*) *tosaensis* Tashiro et Kozai, from the lower member of the Hibihara Formation, in its taller and more rounded valve than that of *N. (P.) tosaensis*. Although this species resembles *Nucula* (*Pectinucula*) *kochiensis* Tashiro et Matsuda (1982), from the Fukigoshi Formation, in its round-topped radial ribs, this species differs from *N. (P.) kochiensis*, in its taller valve and more rounded outline.

Occurrence : -Dark-gray siltstone of the upper member of the Hibihara Formation at Minamiike of Hibihara, Monobe area : Upper Albian (*Inoceramus anglicus* Zone).

Superfamily Nuculanacea Adams et Adams

Family Nuculanidae Adams et Adams

Genus *Portlandia* Mörch, 1857

Portlandia sanchuensis (Yabe et Nagao)

Plate 1 Figs. 7-9

1926. *Nuculana sanchuensis* Yabe et Nagao; in Yabe, Nagao and Shimizu, *Sci. Rep. Tohoku Imp. Univ., ser. 2, vol. 11, no. 2, p. 42, pl. 12, figs. 21-23.*
1965. *Nuculana* (s. l.) *sanchuensis* Yabe et Nagao; Hayami, *Mem. Fac. Sci. Kyushu Univ., ser. D, vol. 15, no. 2, p. 235.*
1980. *Portlandia sanchuensis* (Yabe et Nagao); Hayami, in Hayami and Oji, *Trans. Proc. Palaeont. Soc. Japan, n. s., no. 120, p. 425, pl. 51, figs. 7-10.*

Material : - KSG 3669, internal mould, from north of Todoronotaki of Yunoki, Odochi, Monobe area. KSG 3670-KSG 3672, internal moulds, from Doiban, Sasa of Odochi, Monobe area.

Measurements : - (in mm.)

Specimen		Length	Height
KSG 3670,	r. int. mould	9.3	5.9
KSG 3671,	r. int. mould	9.2	6.1
KSG 3672,	l. int. mould	10.1	5.7

Remarks : - The outline of this species is variable. Recently Hayami (1980, in Hayami and Oji) had been described this species in detail based on the specimens from the Choshi Area in Central Japan. This species from the Monobe Area is undoubtedly conspecific with *Portlandia sanchuensis* (Yabe et Nagao) which was well defined by Hayami.

Occurrence : - Sandstone of the lower member of the Hibihara Formation at Sasa of Doiban, Monobe area : Lower Aptiam. Dark-gray siltstone of the Monobe Formation at the north of Todoronotaki, Monobe area.

Family Malletiidae Adams et Adams

Genus *Mesosaccella* Chavan, 1946

Mesosaccella choshiensis Hayami

Plate 1 Fig. 27

1980. *Mesosaccella choshiensis* Hayami ; in Hayami and Oji, *Trans. Proc. Palaeont. Soc. Japan*, n. s., no. 120, p. 426, pl. 51, fig. 11, 12

Material : - KSG 3600, left valve; KSG 3601, internal mould of right valve; all from north of Todoronotaki, Yunoki of Monobe area; KSG 3602, internal and external moulds of right valve.

Measurements : - (in mm)

Specimen	Length	Height	Thickness
KSG 3600, l. valve	11.0	5.3	2.0
KSG 3601, r. int. mould	10.6	6.0	—
KSG 3602, r. ext. mould	10.5	5.9	1.8

Remarks : - The specimens from the Hibihara Formation are safely conspecific with *Mesosaccella choshiensis*, by its same features of the valve.

Occurrence : - Dark gray siltstone of the Middle part of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Monobe area.

Mesosaccella insignis (Nagao)

Plate 1 Fig. 28

1934. *Nuculana insignis* Nagao, *Jour. Fac. Sci. Hokkaido Imp. Univ.*, ser. 4, vol. 2, no. 2, p. 189, pl. 29, figs. 10—12.

1965. *Mesosaccella insignis* (Nagao); Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 189, pl. 27, fig. 1.

1975. *Mesosaccella insignis* (Nagao); Hayami, *Univ. Mus., Univ. Tokyo, Bull.* 10, p. 24.

Material : - KSG 3603, internal mould of right valve; KSG 3604 and KSG 3605, left and right valve; the specimens from Yunoki of Odochi, Monobe area.

Measurements (in mm) : -

Specimen		Length	Height	Thickness
KSG 3603,	r. int. mould	7.0	4.1	—
KSG 3604,	r. valre	7.9	5.1	1.1
KSG 3605,	l. valre	9.2	4.6	1.2

Remarks : - The specimens from the Hibihara Formation are internal and external moulds. These specimens are undoubtedly conspecific with *Mesosaccella insignis* (Nagao) from the Miyako Group of N-E Japan (Nagao, 1934; Hayami, 1975), in its outline which is tapering to posterior, and numerous regular subconcentric grooves or striae on the main part of the surface.

Occurrence : - Dark gray shale of the Upper Member of the Hibihara Formation at Minamiike of Yunoki, Monobe area; Upper Albian.

Subclass Pteriomorphia

Order Arcoida

Superfamily Arcacea Lamarck

Family Parallelodontidae Dall

Subfamily Parallelodontinae Dall

Genus *Cosmetodon* Branson, 1942

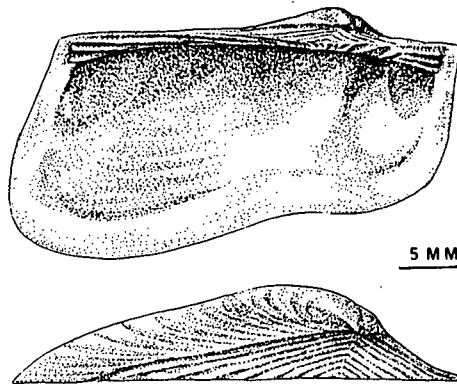
Cosmetodon monobensis, sp. nov.

Plate 1 Figs. 10—18; Plate 2 Figs. 17—18

Material : - Holotype, KSG 3606, internal mould of left valve, from north of Todoronotaki, Yunoki, Monobe area; paratypes, KSG 3607-KSG 3610, internal moulds of left and right valves; paratypes, KSG 3611-KSG 3612, external moulds of right and left valves; paratypes, KSG 3613 and KSG 3614; right and left valves; all paratypes, from the same locality with the holotype.

Diagnosis : - Shell medium in size, elongated subparallelogram in outline, well inflated; umbo prominent, nearly orthogyrous, pointed at about one fourth from front of the valve; anterior and posterior margins nearly straight, shorter in anterior with about a half length than in posterior; anterior margin obliquely truncated, nearly straight on upper part but weakly arched on lower part; ventral margin straight but weakly sinuated under the umbo; posterior margin nearly straight, obliquely truncated; postero-ventral part narrowly rounded; posterior carina indistinctly elevated, extending from the umbo to the postero-ventral coner; a radial depression extending from the umbo

to the centeal part of ventral margin; surface ornamented by fine numerous subinternal radial striae; concentric growth lines well developed on full surface of the valve, especially crowded and prominent on the ventral part; hinge plate elongated with numerous taxodont teeth; 4 teeth on anterior lateral part horizontal, elongated; 4 teeth on posterior side elongated, horizontally parallelated, occupied about a half length of the hinge plate in two of upper ones; 7 or more teeth under the umbo very small, divergent; all the teeth finely crenulated; ligament area broad, subtriangular with numerous chevron shaped ligament grooves; beaks of left and light valves fairly remote from in each; inner margin smooth; parial line somewhat deep; both lateral adductor scars weakly impressed.



Text-fig. 4. *Cosmetodon monobensis*, sp. nov.

Measurements (in mm.): -

Specimen	Length	Height	Thickness
KSG 3606, l. int. mould	36.0	20.4	—
KSG 3607, conj. int. mould	36.2+	14.3	—
KSG 3609, r. int. mould	26.7	9.9	—
KSG 3613, r. valre	38.0	18.2	4.8
KSG 3614, l. valve	33.2+	15.0	4.9
KSG 3611, r. ext. mould	23.9	9.8	3.0

Observation : - Abundant specimens are in our hand. The outline of the valve is somewhat variable in the posterior half part. The antero-dorsal coner is rather uniform with about 70° in degrees. The ligament grooves number about 8 in general in the mature specimens. The subinternal radial ribs are very fine, generally observable among the interspaces of prominent growth lines.

Comparison : - This species closely resembles *Cosmetodon nipponicus* (Nagao) from the Miyako Group in N-E Japan (Nagao, 1934; Hayami, 1965), in the elongated outline and features of surface ornamentation, but differs in its more anterior location of the umbo and wider ligament area with numerous chevron grooves. *Cosme-*

todon keyserlingii (d'Orbigny), the type species of this genus, from the Jurassic USSR (Newell, 1969), is nearly identical with this species in its outline and surface characters. The type species is distinguishable from this form by its oblique anterior lateral teeth. *Grammatodon* (*Cosmetodon*) *rataensis* Alencaster (1956), from the Aptian of Mexico, is discriminated from this species by its less elongated and more trapezoidal outlines. Several Jurassic *Cosmetodon* in Japan, e. g., *C. niranohamensis* (Hayami, 1958), *C. infraliassicus* (Hayami, 1959), *C. inflatus* (Tamura, 1959) and *C. koikensis* (Tamura, 1959), are discriminated easily from this species by the differences of the location of umbo and features of outline. Although Hayami (1965, 1975) listed the specimens from the Arida Formation, under *Cosmetodon nipponicus* (Nagao), the specimens are probably referables to this species, judging from the observation of our many collections from the Arida Formation.

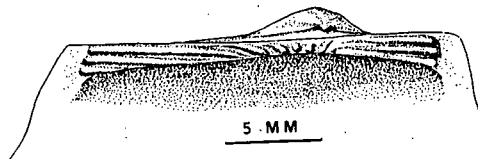
Occurrence : - Dark gray siltstone of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Monobe area ; Upper Hauterivian or lower Lower Barremian.

Cosmetodon nipponicus (Nagao)

Plate 2, Fig. 19; Plate 4, figs. 19-20, Text-fig. 5

1934. *Grammatodon nipponica* Nagao ; *Jour. Fac. Sci. Hokkaido Imp. Univ.*, ser. 4, vol. 2, no. 3, w. 190, pl. 28, fig. 3.
 1965. *Parallelodon nipponicus* (Nagao) ; Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 236, pl. 27, figs. 6, 7.
 1969. *Parallelodon nipponicus* (Nagao) ; Hatai, Kotaka and Noda, *Saito Ho-on Kai Museum, Res. Bull.* no. 38, p. 31.
 1975. *Parallelodon* (*Cosmetodon*) *nipponicus* (Nagao) ; Hayami, *Univ. Mus., Univ. Tokyo, Bull.* no. 10, p. 27.

Material : - KSG 3615, external mould of left valve, from north of Todorono taki, Yunoki, Monobe area ; KSG 3616, internal mould of left valve, from the same locality ; KSG 3617-KSG 3618, internal moulds of left valves, from Haidateyama, Minami-Amabe-gun, Oita (for comparison).



Text-fig. 5. *Cosmetodon nipponicus* (Nagao)

Measurements (in mm.): -

Specimen		Length	Height	Thickness
KSG 3615,	l. ext. mould	17.5	10.2	2.1
KSG 3616,	l. int. mould	16.9	9.5	—
KSG 3617,	l. int. mould	17.5	9.3	—
KSG 3618,	l. int. mould	19.0	10.0	—

Remarks : - This species is rather uniform in the shape of outline. This is clearly discriminated from *Cosmetodon monobensis* sp. nov., from the same locality, in its less inflated valve, very narrower ligament area and elongated anterior teeth.

Occurrence : - Very rare in the occurrence from dark-gray siltstone of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Monobe area.

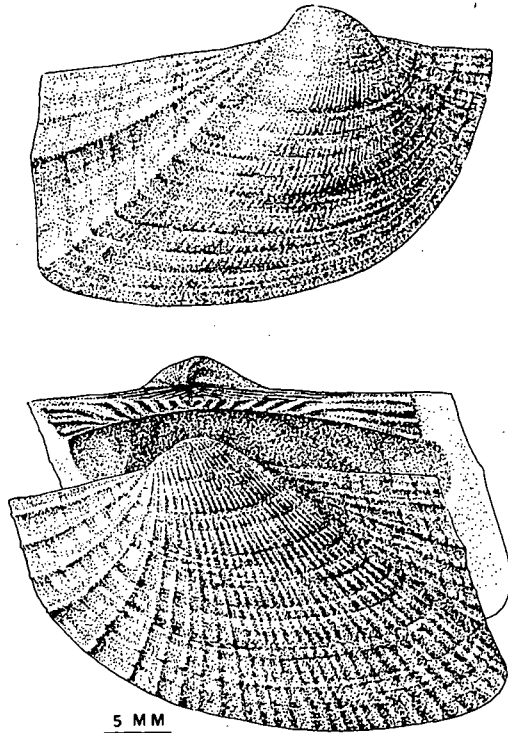
Genus *Nanonavis* Stewart, 1930*Nanonavis yokoyamai* (Yabe et Nagao)

Plate 2 Figs. 1—16 Text-fig. 6

1890. *Cucullaea* cf. *striatella* Michelin; Yokoyama, *Palaeontographica*, vol. 36, p. 199, pl. 25, fig. 13.
1926. *Grammatodon yokoyamai* Yabe et Nagao; in Yabe, Nagao and Shimizu, *Sci. Rept. Tohoku Imp. Univ.*, ser. 2, vol. 9, no. 2, p. 44, pl. 12, figs. 12, 13, 25.
1963. *Nanonavis yokoyamai* (Yabe et Nagao); Matsumoto, Hayami and Asano, *Palaeont. Soc. Japan, 25th Anniv. vol.*, p. 32, pl. 51, fig. 13.
1965. *Nanonavis* (*Nanonavis*) *yokoyamai* (Yabe et Nagao); Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 238, pl. 27, figs. 8—13.
1965. *Nanonavis* (*Nanonavis*) sp., cf. *N. (N.) yokoyamai* (Yabe et Nagao); Hayami, *Ibid.*, p. 241, pl. 27, fig. 14.
1972. *Nanonavis* (*Nanonavis*) *yokoyamai* (Yabe et Nagao); Shikama and Suzuki, *Sci. Rept. Yokohama Nat. Univ.*, ser. 2, vol. 19, pl. 4, fig. 7.
1975. *Grammatodon* (*Nanonavis*) *yokoyamai* Yabe et Nagao; Hayami, *Univ. Mus., Univ. Tokyo Bull.* 10, p. 29.
1980. *Grammatodon* (*Nanonavis*) *yokoyamai* Yabe et Nagao; Tashiro and Yamamoto, *Res. Rept. Kochi Univ.*, vol. 29, nat. sci., p. 3, pl. 1, fig. 3.
1980. *Nanonavis yokoyamai* (Yabe et Nagao); Tashiro, Kozai, Okamura and Katto, *Geol. Palaeont. Shimanto Belt, Taira, A. and Tashiro, M eds.*, pl. 10, fig. 10, pl. 11, fig. 4.
1980. *Grammatodon* (*Nanonavis*) *yokoyamai* Yabe et Nagao; in Hayami and Oji; *Trans. Proc. Palaeont. Soc. Japan, n. s.*, no. 120, p. 427, pl. 52, figs. 1—6.

Material : - KSG 3697-KSG 3699, external moulds of right and left valves; KSG 3700-KSG 3702, internal moulds of left and right valves; both from north of Todoronokaki, Yunoki, Monobe area; KSG 3703-KSG 3704, external moulds of left and right valves; KSG 3705-KSG 3707, internal moulds of left and right valves; both from-

Igenoki of Tosayamada, Ryoseko area; KSG 3078 - KSG3710, internal and external moulds of right valves, from Kasanokawa of Ryoseki, Ryoseki area.



Text-fig. 6. *Nanonavis yokoyamai* (Yabe et Nagao).

Measurements (in mm.): -

Specimen		Length	Height	Thickness
KSG 3697,	l. ext. mould	24.5	16.2	6.0
KSG 3698,	l. ext. mould	33.5	20.0	6.7
KSG 3700,	r. int. mould	23.9	15.0	—
KSG 3702,	r. int. mound	30.8	21.8	—

Remarks : - Abundant specimens, almost internal and external moulds, are in our hand. This species is one of the well known Lower Cretaceous bivalves from Japan. This species is characterized by the strongly inequi-ornaments on the surface of right and left valves. The surface of left valve is ornamented with strong radial ribs but of right valve with numerous radial striae. The feature of this species is one of most important factors for the comparison of this species with the other species of *Nanonavis*.

Occurrence : - Dark gray siltstone of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Monobe area. Dark gray shale of the Yunoki Formation

at Todoronotaki. Fine grained sandstone of the Monobe Formation at Tutui and Kasanokawa of Ryoseki, Ryoseki area. Gray greenish siltstone of the "Lower Monobegawa Group" by Hirata (1975) (= Igenoki Formation), at Igenoki of Tosayamada, Ryoseki area; Upper Hauterivian and Barremian.

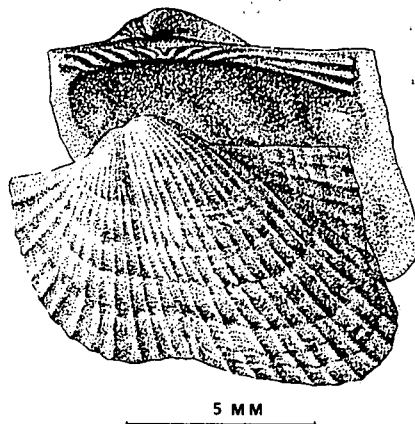
Genus *Nemodon* Conrad, 1869

Nemodon tosaensis, sp. nov.

Plate 1 Figs. 19, 21-26, Text-fig. 7

Material : - Holotype, KSG 3679, external and internal moulds of left valve, from Doiban, Odochi, Monobe area; paratypes, KSG 3680 - KSG 3681, external moulds of left valves; paratypes, KSG 3682 - KSG 3684, internal moulds of right and left valves; all the paratypes from the same locality with the holotype.

Diagnosis : - Shell very small, subquadrate or trapezoidal in outline, moderately inflated; umbo prominent, slightly prosogyrous, located at about one third from front of the valves; anterior and posterior dorsal margins nearly straight, horizontal except for umbonal elevation, longer in posterior with about twice length than in anterior; anterior and posterior margins obliquely truncated, nearly straight,



Text-fig. 7. *Nemodon tosaensis*, sp. nov.

Measurements (in mm.) : -

Specimen	Length	Height	Thickness
KSG 3679, l. int. mould	5.2	3.4	—
KSG 3680, l. ext. mould	7.5	3.9	1.1
KSG 3681, l. ext. mould	5.1	3.0	0.7
KSG 3682, r. int. mould	5.0	3.0	—
KSG 3684, l. int. mould	8.0	5.0	—

parallelated in each other; ventral margin elongated, shallowly sinuated on the central part but weakly convex on both anterior and posterior parts; a radial sulcus extending vertically from the umbo to the axis of the sinuation of ventral margin; posterior carinal ridge angulated, extending from the umbo to postero-ventral corner; dorsal or marginal carina distinctly angulated; flank ornamented by about 25 radial ribs which are narrower than their interspaces; posterior area behind the posterior carinal ridge ornamented with several ribs as same as the flank; hinge plate straight, horizontal, elongated with nearly same length of the valve; about 4 teeth on the anterior segment of the hinge plate obliquely situated; about 3 teeth on the posterior one elongated, nearly horizontal; several teeth under the umbo very small, divergent; inner margin smooth; anterior and posterior adductor scars indistinctly remarked; growth lines on the external surface generally weak but somewhat developed near the ventral margin.

Observation : - Although the hinge structure of this species is similar to those of *Nanonavis*, *Grammatodon* and *Cosmetodon*, this is characterized by distinct radial sulcus, strong radial ribs which occupied same arrangements on each right and left valve. The ligament area of this species is very narrowly along the hinge margin. The ligament grooves are nearly indistinct because of too narrow ligament area.

Comparison : - Several species of the Upper Cretaceous *Nemodon*, e. g., *N. enfalensis* Gabb (Conrad, 1869) and *N. simillina* (Whiteaves, 1879), both from North America, are discriminated from this species in their less developed central teeth on the mature stage and elongated outlines. According to an ontogenical study of the species of *Nemodon* by Speden (1970), divergent small central teeth distinctly present on the immature stage, and are gradually obscure through the growth. This is akin to the immature stage of *Nemodon sulcatus* (Evans et Shumard) by Speden (1970), from N. America.

Occurrence : - Medium to fine grained sandstone of the Lower Member of the Hibihara Formation at Sasa of Doiban, Odochi, Monobe area; Lower Aptian.

Nemodon sp.

1957. ? *Nemodon* sp.; Amano; *Kumamoto Jour. Sic. ser. B*, sec. 1, vol. 2, no. 2, p. 84, pl. 1, fig. 9.

Remarks : - Two fragmental specimens, internal mould of left valve and external mould of right valve, undoubtedly belong to *Nemodon* sp. by Amano (1957), are collected from the Hagino Formation at Hagino, Monobe Area. This species is discriminated from *Nemodon tosaensis* sp. nov., from the Hibihara Formation, in its elongated outline and more horizontal ventral margin. The hinge structures of this species is, however, nearly identical with *Nemodon tosaensis*. If we will get several well preserved specimens of this species, a new specific taxon is provided certainly for this species.

Occurrence : - Fine grained gray sandstone of the Hagino Formation at Hagino, Kami-gun, Monobe area; Lower Aptian.

Family Arcidae Lamarck

Subfamily Arcinae Lamarck

Genus *Arca* Linné, 1758Subgenus *Eonavicula* Arkell, 1929*Arca* (*Eonavicula*) sp. aff. *A. (E.) shinanoensis* Yabe et Nagao

Plate 3 Fig. 11; Plate 4 Figs. 17, 18

Compare: -

1926. *Arca shinanoensis* Yabe et Nagao; in Yabe, Nagao and Shimizu, *Sci. Rept. Tohoku Imp. Univ.*, ser. 2, vol. 9, no. 2, p. 42, pl. 13, figs. 33—35.
1975. *Arca* (*Eonavicula*) *shinanoensis* Yabe et Nagao; Hayami, *Univ. Mus., Univ. Tokyo Bull.* 10, p. 32.

Material: - KSG 3643, internal mould of right valve; KSG 3644 and KSG 3645, external moulds of right and left valves; all from Minamiike of Hibihara, Monobe area.

Measurements (in mm.): -

Specimen	Length	Height	Thickness
KSG 3643, r. int. mould	7.3	4.0	—
KSG 3644, l. ext. mould	9.2	5.0	1.5
KSG 3645, r. ext. mould	5.5	3.2	0.6

Remarks: - The radial ribs on the surface are distinctly impressed but very fine. They are narrower than their interspaces, number about 60 or more on the disk, abundantly closed. The growth line on the surface are strongly remarked, slightly laminated on the ventral part of the disk. The anterior segment of the hinge plate is shorter than posterior one with about a fourth in length.

This species is closely similar to *Arca* (*Eonavicula*) *shinanoensis* Yabe et Nagao (1926), from the Shiroy Formation of Sanchu, in its feature of outline, but differs in its somewhat distinct radial ribs on the surface and more anterior location of the umbo than those of *A. (E.) shinanoensis*.

Occurrence: - Gray greenish siltstone of the basal part of the Hibihara Formation at Minamiike of Hibihara, Monobe area.

Arca (*Eonavicula*) *prolata* Amano

1957. *Arca prolata* Amano; *Kumamoto Jour. Sci.*, ser. B, sec. 1, vol. 2, no. 2, p. 80, pl. 1, fig. 1—3.

1975. *Arca* (*Eonavicula*) *prolato* Amano ; Hayami, *Univ. Mus., Univ. Tokyo Bull.* 10, p. 32.

Remarks : - Several fragmental specimens are obtained from the Hagino Formation. Regarding to this species, Amano (1957) had been described in detail.

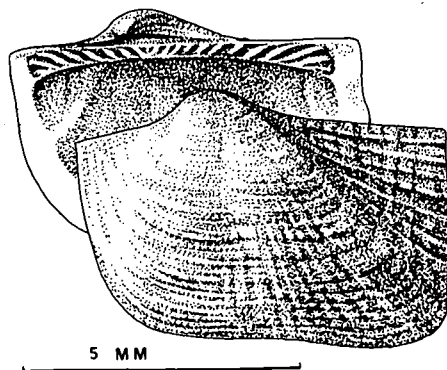
Occurrence : - Fine grained sandstone of the Hagino Formation at Hagino of Birafu, Kami-gun, Monobe area; Lower Aptian.

Arca (*Eonavicula*) *minima*, sp. nov.

Plate 1 fig. 20; Plate 3 Figs. 2, 3; Plate 4 Figs. 21 Text-fig. 8

Material : - KSG 3694, (holotype), internal and external moulds of left valve; paratype, KSG 3695, external mould of right valve; another paratype, KSG 3696, internal mould of left valves; all from Sasa of Doiban, Monobe area.

Diagnosis : - Shell very small, elongatedly subquadrate in outline, moderately inflated; umbo more or less prosogyrate, prominent, located at about two fifths from front of the valve; anterior and posterior dorsal margins straight, nearly horizontal, shorter in anterior than in posterior; anterior margin nearly straight, obliquely truncated; ventral margin straight but weakly sinuated on the central part of the margin, nearly parallelated with the dorsal margin; posterior margin straight, subvertically truncated; posterior carinal ridge distinctly angulated, extending nearly straight from the umbo to postero-ventral corner; dorsal carina distinct; disk ornamented with week radial ribs which are round-topped, partialated on posterior half of the disk; posterior slope behind the posterior carina depressed with several radial ribs; hinge plate elongated, nearly straight with numerous divergent taxodont teeth; ligament area very narrow; inner margin smooth; growth lines on the surface strongly remarked, somewhat laminated on the ventral part.



Text-fig. 8. *Arca* (*Eonavicula*) *minima*, sp. nov.

Measurements (in mm.): -

Specimen		Length	Height	Thickness
KSG 3694,	left valve	5.1	3.9	ca 1.0
KSG 3695,	r. ext. mould	5.0	3.5	0.8
KSG 3696,	l. int. mould	7.2	5.2	—

Observation : - The radial sulcus extending from the umbo to the venter is very shallow, observable as a line of weak depression. The radial ribs on the posterior slope number about 6. Hinge teeth are countable about 20 in total on the hinge plate. 4 or more teeth on the anterior segment are oblique. 4 or so posterior ones are elongated and inclined to anterior. The other teeth on central part of the plate are small and divergently situated.

Comparison : - This species is discriminated from *Arca* (*Eonavicula*) *prolata* Amano (1957) from the Hagino Formation, and *Arca* (*Eonavicula*) *tashiroi* Matsuda (1984MS) from the Cenomanian strata of S-W Japan, in having its strong posterior carina, and less numerous and stout radial ribs on the surface. Although this is similar to *Arca* (*Eonavicula*) *shinanoensis* Yabe et Nagao (1926) from the Ishido Formation of Sanchu, in the distinct carina, this is characterized by smaller size of the shell and more angulated outline than those of *A. (E.) shinanoensis*. *Arca* (*Eonavicula*) *whitfieldi* Vokes (1946), from the Aptian strata of Lebanon is well similar to this species in its angulated posterior carina and subquadrate outline, but differs from this species in its large valve and more or less elongated outline.

Occurrence : - Sandstone of the lower part of the Hibihara Formation at Sasa of Doiban, Monobe area; Lower Aptian.

Genus *Barbatia* Gray, 1842

Subgenus *Barbatia* Gray, 1842

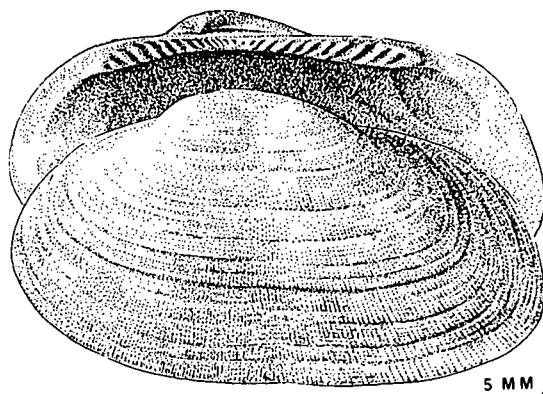
Barbatia (*Barbatia*) *kochiensis*, sp. nov.

Plate 3 Figs. 13, 14 Text-fig. 9

Material : - Holotype, KSG 3654, external mould of right valve; paratype, KSG 3655, internal mould of right valve; both from Sasa of Doiban, Odochi, Monobe area.

Diagnosis : - Shell medium to small, elongatedly ovate, well inflated; umbo large, nearly orthogyrous, well prominent, located at about two fifths from front of the valve; anterior dorsal margin straight; anterior margin truncated vertically but broadly arched; ventral margin very weakly convex; posterior margin well arched, obliquely subtruncated from weakly arched posterior dorsal margin; posterior carinal ridge indistinct with a blunt elevation; hinge plate narrow in breadth but long in length with about two thirds of the valve; hinge teeth occupied divergently on anterior and posterior segments of the plate, with about 7 in each, but nearly

vertical on central part; the central teeth numerous, weaker than the teeth of anterior and posterior segments; ligament area very narrow under the umbo; ventral margin smooth; flank ornamented by very fine radial ribs or striae; concentric growth lines distinct especially on the ventral part.



Text-fig. 9. *Barbatia (Barbatia) kochiensis*, sp. nov.

Measurements (in mm.): -

Specimen	Length	Height	Thickness
KSG 3654, r. ext. mould	29.0	19.5	4.9
KSG 3655, l. int. mould	—	15.0	—

Observation : - The radial striae on the surface are countable about 16 in the distance of 3 mm on the ventral part of the holotype. A shallow depressed area is broadly extending from umbo to venter. Ligament grooves are not observable.

Remarks : - This species is undoubtedly referable to genus *Barbatia* because of its less angulated posterior carinal ridge, elongately ovate outline, fine radial ribs on the surface and features of the arrangements of dentition. The species of *Eonavicula*, e. g., *Arca (Eonavicula) prolata* Amano (1975), *Arca (Eonavicula) tashiroi* Matsuda (1984MS) and *Arca (Eonavicula) whitfieldi* Vokes (1946), are similar to this species in their arrangements of dentition, but they are distinguishable from this species in the distinct posterior carinal ridge and quadrangular outline.

Comparison : - This is similar to *Barbatia syrmica* (Petho), from the Lower Cretaceous of Cebepo Boctoka, USSR. (Pojarkova, 1976), in the ovate outline, but differs in its less anterior location of the umbo and weaker hinge teeth than those of *B. syrmica*. *Barbatia decola* Stoliczka (1871) from the Arrialoor Group of India, is also discriminated from this species in its more stronger and less numerous radial ribs on the surface.

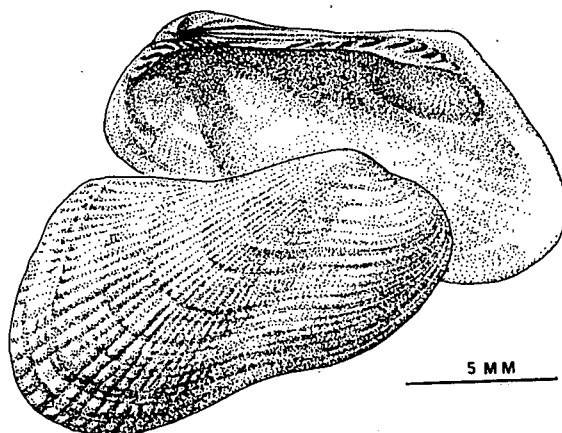
Occurrence : - Medium grained sandstone of the Middle Member of the Hibihara Formation at Sasa of Doiban, Monobe area; Lower Aptian.

Barbatia (Barbatia) hibiharensis, sp. nov.

Plate 3 Figs. 10 and 12 Text-fig. 10

Material : - Holotype, KSG 3646, internal mould of right valve; paratype, KSG 3647, from external mould of right valve; paratype, KSG 3648, internal mould of right valve; all from Hibihara, Monobe area.

Diagnosis : - Shell small, elongate ovate, broadened to posterior, highly inequilateral, moderately inflated; umbo broad, prominent but not so tall, weakly prosogyrous, located subterminally at about one fifth from front of the valve; anterior dorsal margin very short, weakly arched, not demarkated clearly from well arched anterior margin; ventral margin nearly straight but weakly sinuated on the central part; posterior margin broadly convex, expanded to posterior; posterior dorsal margin elongated, nearly straight, occupied with about a half length of the valve; postero-ventral part rounded; a shallow radial depression obliquely extending from the umbo to the central part of ventral margin; posterior carinal part not angulated only swollen radial ridge; surface ornamented with round-topped radial ribs which are strong and less numerous on the posterior half part of the flank but forming delicate reticulations together with concentric growth lines on the anterior half part of the flank; hinge plate elongated with one fifth length of the valve, occupied numerous taxodont teeth; two teeth of anterior segment of the plate small, horizontally parallelated in each; 5 teeth of posterior segment elongated, subhorizontally parallelated; central part of the plate nearly smooth or rarely visible to several small dentational pustulations; ligament area elongatedly and asymmetrically trigonal in outline with 3 or so chevron shaped ligament grooves; anterior and posterior adductor scars very weakly impressed; inner margin smooth.

Text-fig. 10. *Barbatia (Barbatia) hibiharensis*, sp. nov.

Measurements (in mm.): -

Specimen		Length	Height	Thickness
KSG 3646,	r. int. mould	12.2+	6.9	—
KSG 3647,	r. ext. mould	7.3	3.8	1.4
KSG 3648,	r. int. mould	8.2	5.0	—

Observation : - The outline of this species is somewhat variable, and resembles the outline of species of *Brachidontes* or *Musculus*, but this species is shown its *Barbatia* type hinge structure and ligamental area and grooves. The radial ribs on the posterior part behind the radial depression are fairly stronger than on anterior ones, broader than their interspaces, and are developed mainly near the posterior carinal elevation.

Comparison : - This species differs from *Barbatia* (*Barbatia*) *hayamii*, sp. nov. and *Barbatia* (*Barbatia*) *kochiensis*, sp. nov., in its strong radial ribs on the surface and less numerous and parallelated teeth of dentition.

Occurrence : - Dark gray siltstone of the basal part of the Hibihara Formation at the dam site of Hibihara, Monobe area; Upper-most Barremian or Lowest Aptian.

Barbatia (*Barbatia*) *hayamii*, sp. nov.

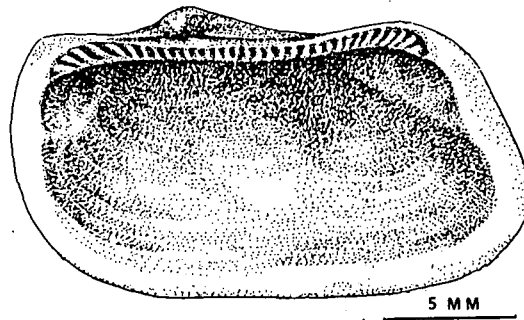
Plate 3 Figs. 1, 8, 9. Text-fig. 11

?1956. *Barbatia* sp. indet., Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D. *Geol.* vol. 15, no. 2, p. 249, pl. 28, fig. 16.

Material : - KSG 3649, internal mould of right valve; all from north of Todoronotaki, Yunoki, Monobe area.

Diagnosis : - Shell medium to small, elongately subtrapezoidal, well inflated; umbo prominent, somewhat large, slightly prosogyrous, pointed at about one third or two fifths from front of the valve; anterior dorsal margin short, nearly horizontal; anterior margin subvertically truncated, nearly straight on upper side but broadly rounded on lower side; ventral margin elongated, nearly straight; posterior dorsal margin elongated with about twice length to the anterior one, nearly straight; postero-ventral margin well rounded posterior carina not angulated only rounded elevation; surface nearly smooth; hinge line straight, occupied about two thirds of the valve length; hinge plate narrow but elongated with small numerous taxodont teeth; the teeth subvertical on posterior and central parts, oblique on anterior part, number about 25 in total; inner margin smooth; adductor scars very weakly impressed.

Observation : - A very shallow radial sulcus is extending from the umbo to venter, but soon changing into indistinct depression on the ventral part. The growth lines on the flank are weakly remarked on the ventral part but nearly indistinct on the other parts. Although the ligamental features not observable in detail, the ligament area is very narrow, scarcely visible under the beak.

Text-fig. 11. *Barbatia (Barbatia) hayamii* sp. nov.*Measurements* (in mm.) :-

Specimen	Length	Height	Thickness
KSG 3649, r. int. mould	10.0	5.0	—
KSG 3651, r. ext. mould	9.1	4.9	2.0

Comparison :- This species resembles *Barbatia diatreta* Stolicka (1871) from the Trichinopoly Group of India, in its elongated ovate outline, but differs in its smooth surface.

Occurrence :- Dark gray siltstone of the lower part of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Monobe area.

Family Cucullaeidae Stewart

Genus *Cucullaea* Lamarck, 1801Subgenus *Cucullaea* Lamarck, 1801*Cucullaea (Cucullaea) obliquata* (Amano)

1957. *Trigonarca* (?) *obliquata* Amano, *Kumamoto Jour. Sci.*, ser. B, sec. 1, vol. 2, no. 2, p. 82, pl. 1, figs. 6—8.
1965. *Trigonarca* sp. cf. *T. obliquata* Amano; Hayami, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 248, pl. 28, fig. 17.
1975. *Trigonarca?* *obliquata* Amano; Hayami, *Univ. Mus., Univ. Tokyo, Bull.* 10, p. 35.
1975. *Trigonarca?* *obliquata* Amano; Matsukuma, *Venus (Japanese Maroc.)*, vol. 38, p. 120.

Description :- Shell medium to small in size, warped elliptical in outline, strongly tapering to anterior, longer than high, well inflated; umbo orthogyrous, prominent but rather small, located at about two fifths from front of the valve; dorsal margin straight with about a half length of the valve, somewhat longer in

posterior than in anterior; anterior margin moderately convex, gradually changing into very weakly arched ventral margin; antero-dorsal corner bluntly angulated with about 120° ; posterior margin nearly straight or weakly concave, obliquely truncated; postero-ventral corner narrowly rounded, expanded to posterior; posterior carinal ridge distinctly angulated for *Cucullaea*; posterior dorsal carina narrow but distinct; posterior half of the disk and posterior area (slope) ornamented by very fine numerous radial ribs; growth line on the surface weak; ligament area very narrow with a few chevron shaped grooves; hinge plate narrow but elongated; 3 or so teeth on anterior segment of the plate elongated, nearly subhorizontal, parallelated in each other; 6 or more on posterior elongated but not so long as the anterior ones, nearly subhorizontal, parallel with one another; about 16 teeth on central part of the plate very small, nearly vertical but somewhat oblique on anterior side; inner margin smooth; posterior adductor scars strongly impressed but the anterior one very weak; inner posterior ridge remarkably developed; fine numerous radial striae observable over the shallow parial line.

Remarks: - Two imperfect external and internal moulds are obtained from the Hagino Formation of the Monobe Area. Although this species is classified a member of genus *Trigonarca* by Amano (1957) and Hayami (1975) in some indeseition, this is referable to *Cucullaea* s. s..

Occurrence: - Fine grained sandstone of the Hagino Formation at Hagino, Kamigun, Monobe area.

Family Glycymerididae Newton, 1922

Genus *Glycymeris* da Costa, 1778

Subgenus *Hanaia* Hayami, 1965

Glycymeris (Hanaia) matsumotoi Tashiro

Plate 3 Figs. 15—20

1971. *Glycymeris (Hanaia) matsumotoi* Tashiro, *Trans. Proc. Palaeont. Soc. Japan*, n. s., no. 84, p. 223, pl. 28, text-fig. 5-d, figs. 17—21.
1975. *Glycymeris (Glycymerita) matsumotoi* Tashiro; Hayami, *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 34.
1978. *Glycymeris matsumotoi* Tashiro; Matsukuma, *Venus (Japanese Maroc.)*, vol. 38, p. 119.

Material: - KSG 3673-KSG 3676, internal moulds; KSG 3677-KSG 3678, external moulds; they are collected from Sasa of Doiban, Odochi, Monobe area.

Measurements: - (in mm.)

Specimen		Length	Height
KSG 3673,	l. int. mould	7.6	6.3
KSG 3674,	r. int. mould	8.3	7.9
KSG 3675,	l. int. mould	6.7	5.5
KSG 3676,	l. int. mould	8.7	8.1

Remarks: - This species is characterized by its asymmetrically bended hinge plate (horizontal in the anterior segment and oblique in the posterior one), subtrapezoidal outline of the valve, round-topped radial ribs each of which composed of the bundle of radial striae.

The holotype (KE 1870) of this species was described from the? Upper Albian Miyaji Formation of Central Kyushu. An internal mould which is undoubtedly referable to this species, is also known from the "Kaisekiyama" Formation of the Sakawa area.

Occurrence: - Sandstone of the lower member of the Hibihara Formation at Sasa of Doiban, Odochi, Monobe area; Lower Aptian.

Subfamily Arcullaeinae Newell

Genus *Monobearca* Tashiro, nov.

Type species. - *Monobearca cuculoides* Tashiro et Kozai, sp. nov., Shikoku, Southwest Japan; Lower Aptian.

Diagnosis: - Shell small, subquadrate in outline; umbo orthogyrous, prominent, located central or slightly anterior to the mid-point of the valve length; disk smooth with a very fine subinternal radial striae; posterior carina distinct; inner margin smooth; hinge plate horizontally elongated with numerous convergent taxodont teeth.

Remarks: - Newell (1954) had been established glycymerid subfamily Arcullaeinae. According to Newell, this subfamily (group) is externally similar to Cucullidae from which is probably was derived but the hinge more closely resembles Glycymerididae. This new genus, *Monobearca*, is akin to *Cucullaea* in its internal and external features of the valve except for its hinge structure. And the hinge structure of this new genus resembles *Barbatia* and *Glycymeris* in its horizontally elongated hinge plate, and convergent and somewhat hooked denticles on both lateral segments of the hinge plate. This subgenus is discriminated clearly from *Glycymeris* in its smooth surface and less crenulated inner ventral margin. *Barbatia* is also discriminated from this new genus in its radial ribs on the surface and stronger radial sulcus on the disk. This resembles *Arcullaea* Vokes (1946) in its features of the hinge structure, but differs in its smooth surface. *Peruarca* Olsson (1944) and *Pellersia* Nicol (1953) resembles this new genus in their smooth surface and *Cucullaea*-like outline, but they differ from this *Monobearca* in their arched hinge plate and numerous and short teeth. In the comparison between this new genus and

Trigonarca Conrad (1862), this is easily discriminated from *Trigonarca*, in its subquadrate outline, horizontal hinge plate and nearly orthogyrate umbo. This is akin to *Eonavicula* Stewart (1930), in its subhorizontal hinge plate and convergent taxodont teeth. This genus is, however, characterized smooth surface and less angulated posterior carina than that of *Eonavicula*.

Distribution: - Monobe area, Southwest Japan; Lower Aptian.

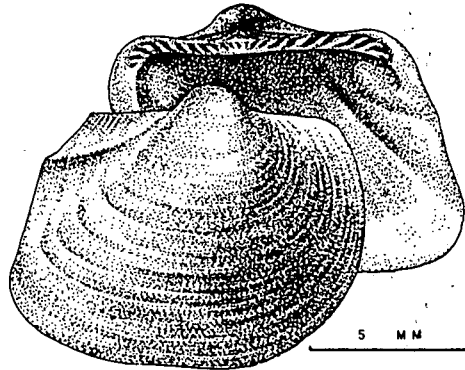
Monobearca cuculoides Tashiro et Kozai, sp. nov.

Plate 3 Figs. 4-7 Text-fig. 12

Material: - KSG 3685 (holotype), internal mould of right valve; KSG 3686-KSG 3689 (paratypes), internal moulds; KSG 3690-KSG 3693 (paratypes), external moulds; all of them, from Sasa of Doiban, Monobe area.

Diagnosis: - Shell very small, subtrapezoidal or subquadrate in outline, longer than high, well inflated; umbo orthogyrous, large, moderately prominent, located at nearly central or slightly anterior to the mid-point of the valves; dorsal margin long, nearly straight, a little longer in posterior part than in anterior part; anterior margin nearly straight on upper part but weakly arched on lower part, vertically truncated from the anterior dorsal margin; ventral margin broadly arched; posterior margin nearly straight, obliquely truncated from the posterior dorsal margin; postero-dorsal corner angulated with about 100° ; postero-ventral part bluntly angulated; surface smooth except for very fine growth lines and numerous subinternal radial striae; posterior carina not so angulated but observable as a well elevated rounded ridge; posterior area strongly depressed; a very narrow radial ridge extends from the umbo to nearly mid-point of the posterior margin; ligament area very narrow with few reverse v-shape ligament grooves; hinge plate nearly as long as the dorsal margin, occupied with numerous taxodont teeth; 4 or more teeth of the anterior part elongated, obliquely situated; 3 or more teeth on the posterior part also elongated, somewhat horizontal; 8 or so teeth on the central part small, convergent; inner surface smooth; anterior and posterior adductor scars small, nearly equal in size, weakly impressed; inner margin smooth.

Remarks: - Although the specimen are almost external and internal moulds, the specific characters are well preserved in each specimen. The outline of the valve is somewhat variable from trapezoidal to subquadrate. The hinge teeth are also variable in number. This species resembles some species of *Trigonarca*, e. g., *Trigonarca lecointrei* Freneix (1972) from Tarfaya, *Trigonarca passyana* (d'Orbigny) (Woods, 1899) from England and USSR (Pojarkova, 1976) and *Trigoarca tumida* Whiteaves (1876), from Queen Charlotte Islands, in the features of dentition and outline, but clearly differs in its distinct subinternal radial striae on the flank. *Trigonarca obsoleta* Yabe et Nagao (1926) from the Ishido Formation of N-E Japan, is discriminated from this species in its trigonal outline.

Text-fig. 12. *Monobearca cuculloides*, sp. nov.*Measurements* (in mm.): -

Specimen		Length	Height	Thickness
KSG 3685,	l. int. mould	10.0	8.0	—
KSG 3687,	r. int. mould	10.5	8.4	—
KSG 3688,	l. int. mould	6.5	5.1	—
KSG 3689,	r. int. mould	7.3	5.4	—
KSG 3693,	r. ext. mould	7.0+	5.1	1.7

Occurrence : - Medium grained sandstone of the lower part of the Hibihara Formation at Sasanokawa of Doiban, Odochi, Monobe area ; Lower Aptian.

Order Mytiloida

Superfamily Mytilacea Rafinesque

Family Mytilidae Rafinesque

Subfamily Mytilinae Rafinesque

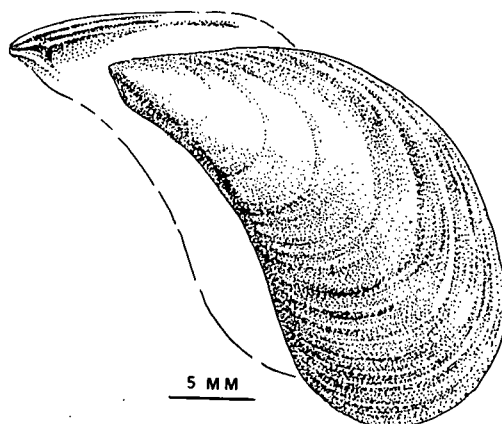
Genus *Lycettia* Cox, 1927*?Lycettia kochiensis*, sp. nov.

Plate 3 Figs. 27, 28, Text-fig. 13

Material : - Holotype, KSG 3655, left valve ; paratypes ; KSG 3656 and KSG 3657, left valves ; another paratype, KSG 3658, right valve ; both from Sasa of Doiban, Odochi, Monobe area.

Diagnosis : - Shell mytiliform, longer than high, moderately inflated ; umbo terminal, sharply angulated with about 45° in degrees, protruded to anterior ; dorsal

margin straight near the umbo but weakly arched on posterior; posterior margin broadly arched on upper part but rounded rapidly on lower part; ventral margin oblique, nearly straight or slightly concave; anterior margin nearly indistinct; an angulate carina extending from the umbo to postero-ventral extremity; surface nearly smooth.



Text-fig. 13. ?*Lycettia kochiensis*, sp. nov.

Measurements (in mm): -

Specimen		Length	Height	Thickness
KSG 3655,	l. valve	18.6	12.3	4.8
KSG 3656,	l. valve	13.2	10.2	2.2
KSG 3657,	l. valve	20.1	14.0	4.5
KSG 3658,	r. valve	19.0	14.0	9.3

Remarks : - The hinge structures of this species are unknown in detail. A narrow radial tooth is parallelated with the narrow ligamental nymph which extends along from the umbo to the dorsal margin.

This species is discriminated from the type species of *Lycettia*, *L. lunularis* (Lycett) (Cox, 1937), in its shorter dorsal margin. *Lycettia tippana* (Conrad) (Stephenson, 1941) from N-America, is characterized by more concaved ventral margin and higher valve than those of this species. This differs from *Dreissensia* cf. *lanceolata* (Sowerby), from the Goshonoura Group of Kyushu (Amano and Furuzawa, 1958), in its sharply angulated umbo.

Occurrence : - Medium grained sandstone of the Hibihara Formation at Sasa near Doiban, Odochi, Monobe area; Lower Aptian.

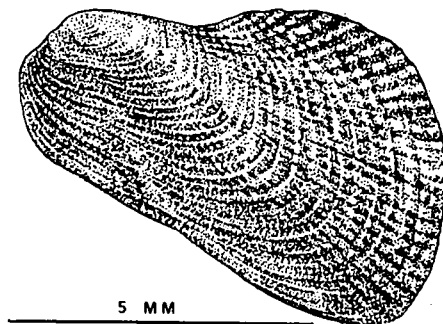
Genus *Brachidontes* Swainson, 1840

Brachidontes igenokiensis, sp. nov.

Plate 4 Figs. 9—16, Text-fig. 14

Material : - Holotype, KSG 3626, external mould of right valve; paratypes, KSG 3627—KSG 3630, external moulds of right and left valves; paratypes, KSG 3631-KSG 3635, internal moulds of right and left valves; all specimens from Igenoki of Tosayamada, Kami-gun, Ryoseki area.

Diagnosis : - Shell very small, subtrigonal in outline, slightly longer than high, well inflated; umbo large, prominent, subterminally pointed at about one fifth from front of the valve; dorsal margin nearly straight, horizontal with about a half or more length of the valve; posterior margin nearly straight but weakly arched on lower part, subvertically truncated from the dorsal margin; ventral margin obliquely elongated, weakly sinuated on middle part of the margin; anterior margin narrowly rounded; posterior carinal ridge not angulated but well inflated, extending from umbo to postero-ventral part; surface ornamented with numerous radial ribs and concentric lines; the radial ribs number about 20 in total on the venter, strong on posterior half of the surface, bi- or triferated in general, but narrow and weakened on the anterior half; concentric lines well developed, forming fine reticulations together with the radial ribs on the anterior part to the posterior carinal elevation.



Text-fig. 14. *Brachidontes igenokiensis*, sp. nov.

Measurements (in mm.) : -

Specimen		Length	Height	Thickness
KSG 3626,	r. ext. mould	7.0	4.0	0.8
KSG 3628,	l. ext. mould	7.9	4.1	1.0
KSG 3631,	r. int. mould	7.5	5.2	—
KSG 3632,	r. int. mould	7.3	5.5	—
KSG 3633,	r. int. mould	7.3	4.3	—

Observation : - Many specimen, almost internal and external moulds, are in our hand. This species is characterized by its subtrigonal outline, well shouldered posterior dorsal part and strong radial ribs and concentric lines. A radial depression extends indistinctly from umbo to venter in subvertical, and divides the surface into the strongly costated posterior and the narrowly and closely costated anterior.

Comparison : - This is discriminated clearly from *Brachidontes nankoi* Ichikawa et Maeda (1958), from the Izumi Group and Himenoura Group (Tashiro, 1976) of S-W Japan, in its small and less elongated valve. This species is closely similar to *Brachidontes vectiensis* (Woods) from England (Woods, 1899) in its small valve and strong radial ribs on the posterior part of the surface. *Brachidontes vectiensis* is, however, characterized by more rounded and elongated outline than that of this species.

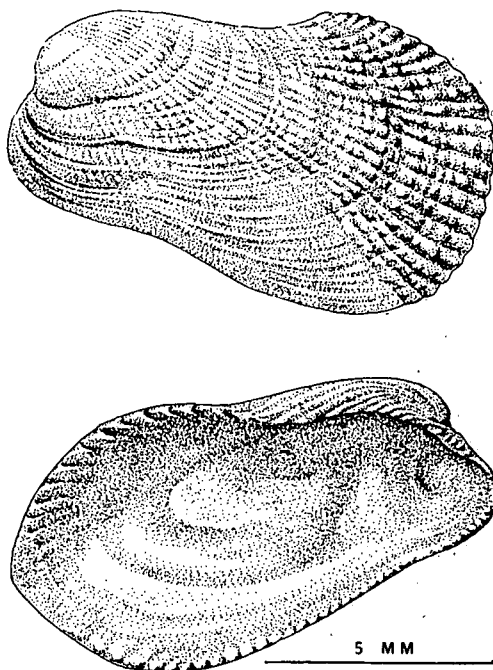
Occurrence : - Gray greenish siltstone of the Igenoki Formation, at Sano of Tosayamada, Kami-gun, Ryoseki area; Upper Barremian.

Brachidontes pyriformis, sp. nov.

Plate 3 Figs. 21—26 Text-fig. 15

Material ; - Holotype, KSG 3636, internal mould of left valve ; paratypes ; KSG 3637-KSG 3641, external moulds of left and right valves ; the other paratypes, KSG 3641-KSG 3642, internal and external moulds of left and right valves ; all specimens from Yunoki, Odochi, Monobe area.

Diagnosis : - Shell small, elongated pyriform, moderately inflated ; umbo prominent but not so large, strongly prosogyrous, subterminally located at about one seventh from front of the valve ; anterior dorsal margin short weakly concave ; posterior dorsal margin elongated, nearly straight but very often bended to upwards on the posterior part against to the horizontal anterior part ; anterior margin well rounded, expanded to anterior ; ventral margin very long, nearly straight but weakly sinuated on the medium part of the margin ; posterior margin very long, moderately rounded and expanded to posterior, obliquely subtruncated from the posterior dorsal margin ; posterior carinal ridge nearly indistinct except for near the umbo ; a strong elevated ridge extends from the umbo to antero-ventral margin ; a shallow radial sulcus extends from the umbo to an axis of ventral sinuation, parallelated with the anterior elevation ; lunuler and escutcheonal areas strongly depressed ; surface of the valve ornamented by numerous radial ribs which are strongly remarkated on the posterior half but weak or very often effaced on anterior half ; concentric growth lines strong, irregularly developed ; hinge plate narrow, situated along the anterior margin with about 5 small oblique taxodont-like teeth ; inner margin crenulated ; anterior adductor scar small, subovate, strongly impressed ; posterior adductor scar indistinctly remarked ; inner surface smooth.

Text-fig. 15. *Brachidontes pyriformis*, sp. nov.*Measurements* (in mm.): -

Specimen	Length	Height	Thickness
KSG 3636, l. int. mould	7.9	5.2	—
KSG 3637, l. ext. mould	8.2	5.6	1.2
KSG 3638, l. ext. mould	8.5	4.2	1.1
KSG 3639, l. ext. mould	5.7	3.8	1.0
KSG 3640, r. ext. mould	7.0	5.8	0.9
KSG 3641, l. int. mould	11.9	8.4	—

Observation : - The radial ribs on the posterior area behind the posterior elevation, are generally bifercated, number about 22 on the area; The radials on the anterior part of the disk are very fine and slender, be countable 20 or more in number, usually appear distinctly near the radial sulcus, but nearly effaced, on the ventral part. The radial elements of the sarface are roundtopped, broader than their interspaces on the posterior part but narrower than those on the anterior part.

Comparison : - This differs from *Brachidontes igenokiensis*, sp. nov., from Ryoseki area, in having its weaker concentric lines and radial ribs on the anterior part of the flank, and numerous distinct dysodont teeth.

Occurrence : - Fine grained sandstone of the basal part of the Hibihara Formation at Hibihara of Yunoki, Odochi, Monobe area; Lowest Aptian.

Subfamily Modiolinae Keen

Genus *Modiolus* Lamarck, 1799*Modiolus* sp. aff. *M. subsimplex* d'Orbigny

Plate 4 Figs. 3, 4

1965. *Modiolus* sp. aff. *M. subsimplex* d'Orbigny; Hayami, *Mem. Fac. Sci., Kyushu Univ., ser. D. Geol.*, vol. 15, no. 2, p. 256, pl. 30, fig. 3.

Compare: -

1899. *Modiola subsimplex* (d'Orbigny); Woods, *Monograph of the Cretaceous Lamellibranchia of England*, p. 97, pl. 16, figs. 7-10.

Material: - KSG 3642-KSG 3643, external and internal moulds of left and right valves, from Doiban of Odochi, Monobe area.

Measurements: - (in mm.): -

Specimen	Length	Height	Thickness
KSG 3642, r. ext. mould	25.5	12.8	4.3
KSG 3643, l. ext. mould	25.0	14.9	4.5

Remarks: - This species is characterized by the very elongated outline for genus *Modiolus*. This is undoubtedly conspecific with *Modiolus* sp., aff. *M. subsimplex* d'Orbigny (Hayami, 1965), from the Arida Formation of Kishu, in the elongated outline, but somewhat differs from *Modiolus subsimplex* d'Orbigny from the Lower Greensand of England (Woods, 1889), in its location of posterior carina which is extending from umbo to postero-ventral margin, partialated to more ventral side than that of *M. subsimplex*.

Modiolus falcatus Amano

1957. *Modiolus falcatus* Amano, *Kumamoto Jor. Sci. Ser. B, Sec. 1*, vol. 2, no. 2, p. 91, pl. 2, figs. 3-8.

1965. *Modiolus falcatus* Amano; Hayami, *Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol.*, vol. 15, no. 2, p. 255, pl. 30, figs. 1, 2.

1975. *Modiolus falcatus* Amano; Hayami, *Univ. Mus., Univ. Tokyo, Bull.* 10, p. 38

Remarks: - Several specimens, KSG 3624-KSG 3625, are collected from the Hagino Formation of the Monobe area. This is discriminated from *Modiolus* sp., aff. *M. subsimplex* d'Orbigny, from the Hibihara Formation in its less elongated outline and broader posterior marginal part.

Occurrence: - Fine grained sandstone of the Hagino Formation at Hagino,

Kamigun, Monobe area; Lower Aptian.

Genus *Amygdalum* Megerle von Mühlfeld

Amygdalum ishidoense (Yabe et Nagao)

Plate 4 Figs. 1, 2

1926. *Modiola* (?) *ishidoensis* Yabe et Nagao; in Yabe, Nagao and Shimizu, *Sci. Rep. Tohoku Imp. Univ.*, sec 2, vol. 9, no. 2, p. 63, pl. 13, fig. 42.
 1934. *Gervillia*? sp., Nagao, *Jour. Fac. Sci. Hokkaido Imp. Univ.*, ser 4, vol. 2, no. 3, p. 201, pl. 24, fig. 2.
 1965. *Amygdalum ishidoense* (Yabe et Nagao); Hayami, *Mem. Fac. Sci. Kyushu Univ. ser. D, geol.* vol. 15, no. 2, p. 257, pl. 30, figs. 4—10.
 1975. *Amygdalum ishidoense* (Yabe et Nagao); Hayami, *Univ. Mus., Univ. Tokyo, Bull.* 10, p. 39.

Material : - KSG 3619, external moulds of left and right valves; KSG 3620, internal moulds of conjoined valves; both specimens collected from north of Todoronotaki of Yunoki, Odochi, Monobe area.

Measurements (in mm.) : -

Specimen		Length	Height	Thickness
KSG 3619,	conj. ext. moulds	38.5+	20.0+	9.8
KSG 3620,	conj. int. moulds	41.3	21.0+	—

Remarks : - Many specimens which are well preserved internal and external moulds, are in our hand. This is safely identical with *Amygdalum ishidoense* (Yabe et Nagao), from the Ishido Formation of Sanchu (Yabe, Nagao and Shimizu, 1926; Hayami, 1965), in its characteristic features which were well designated by Hayami,

Occurrence : - Dark gray siltstone of the lower part of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Odochi, Monobe, area; Upper Hauterivian or Lower Barremian.

Superfamily Pinnacea Reach

Family Pinnidae Leach

Genus *Pinna* Linné, 1758

Subgenus *Pinna* Linné, 1758

Pinna (Pinna) sp., cf. *P. (P.) robinaldina* d'Orbigny

Plate 4 Figs. 5, 6, 7, 8

1957. *Pinna* sp.; Amano, *Kumamoto Jour. Sci.*, ser. B, sec. 1, vol. 2, no. 2,

p. 85, pl. 1, figs. 10 — 13.

1965. *Pinna* sp., cf. *P. robinaldina* d'Orbigny ; Hayami, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, vol. 15, no. 2, p. 281, pl. 39, figs. 2, 3.
 1975. *Pinna* (*Pinna*) sp., cf. *P. (P.) robinaldina* d'Orbigny ; Hayami, *Univ. Mus. Univ. Tokyo, Bull.* 10, p. 40.

Compare: -

- 1905—1906. *Pinna robinaldina* d'Orbigny ; Woods, *Monogr. Cret. Lamell. England*, vol. 2, p. 96, pl. 12, figs. 11—15, pl. 13, fig. 1.

Material: - KSG 3621, external and internal moulds of left valve, from Hagino, Monobe area; KSG 3622, internal mould of left valve, from Sasa near Doiban of Odochi, Monobe area; KSG 3623, internal and external moulds of right valve, from Igenoki of Tosayamada, Ryoseki area.

Measurements (in mm.): -

Specimen		Length	Height	Thickness
KSG 3621,	l. ext. mould	74.0	22.0	5.6
KSG 3622,	l. int. mould	35.0	11.5	—
KSG 3623,	r. ext. mould	83.0+	34.0	10.0

Remarks: - Although abundant materials are collected from several localities of Monobe and Ryoseki areas, they are almost imperfect or fragmental internal and external moulds. This species had already been described from this Monobe area by Amano (1957) and Hayami (1965).

Occurrence: - Fine grained sandstone of the lower part of the Hibihara Formation at Sasa of Doiban, Odochi, Monobe area; Lower Aptian. Fine grained sandstone of the Hagino Formation at Hagino, Kamigun, Monobe area; Lower Aptian. Fine grained sandstone and dark gray siltstone of the Igenoki Formation at Igenoki of Tosayamada, Ryoseki area; Upper Barremian. Dark gray siltstone of the middle part of the Monobe Formation at about 1000 m east of Kasanokawa, Ryoseki, Ryoseki area; Lower Barremian. Dark gray siltstone of the lower part of the Monobe Formation at about 300 m north of Todoronotaki, Yunoki, Odochi, Monobe area; Lower Barremian. (to be continued)

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PLATES 1 ~ 4

Explanation of Plate 1

Nuculopsis (Palaeonucula) ishidoensis (Yabe et Nagao)

- Fig. 1. inner view of left valve, gum cast of internal mould, KSG 3659, x 1.5; loc. Sasa of Doiban, Monobe area.
Fig. 2. lateral view of right valve, gum cast of external mould, KSG 3663, x 2; loc. ditto.

Nucula (Pectinucula) tosaensis, sp. nov.

- Fig. 3. lateral view of left valve, KSG 3668, x 2.5; loc. Sasa of Doiban.
Fig. 4. inner view of left valve, gum cast of internal mould, KSG 3665, x 2.5; loc. ditto.
Fig. 5. ditto, ditto, KSG 3664, x 2.5; loc. ditto.

Nucula (Pectinucula) sp.

- Fig. 6. lateral view of right valve, KSG 3652, x 2; loc. Minaminoike of Hibihara, Monobe area.

Portlandia sanchuensis (Yabe et Nagao)

- Fig. 7. inner view of left valve, gum cast of internal mould, KSG 3672, x 1.5; loc. Sasa of Doiban, Monobe area.
Fig. 8. lateral view of right internal mould, KSG 3670, x 1.5; loc. ditto.
Fig. 9. lateral view of left internal mould, KSG 3669, x 2; loc. north of Todoronotaki, Monobe area.

Cosmetodon monobensis, sp. nov.

- Fig. 10. lateral view of left internal mould in conjoined valves, KSG 3608, x 1.2; loc. north of Todoronotaki, Monobe area.
Fig. 11. dorsal view of conjoined internal mould, KSG 3067, x 1; loc. ditto.
Fig. 12. inner view of imperfect left valve, gum cast of internal mould, x 1.2; loc. ditto.
Fig. 13. dorsal view of the same specimen, x 1.2.
Fig. 14. lateral view of left valve, gum cast of external mould, x 1; loc. ditto.
Fig. 15. lateral view of right valve, gum cast of external mould, KSG 3611, x 1.2; loc. ditto.
Fig. 16. inner view of conjoined valves, the same species with KSG 3608; x 1.2.
Fig. 17. ligamental view of imperfect right valve, gum cast of internal mould, KSG 3610, x 1.2; loc. ditto.
Fig. 18. inner view of the same specimen with KSG 3610, x 1.2.

Nemodon tosaensis, sp. nov.

- Fig. 19. lateral view of left valve, gum cast of external mould, KSG 1681, x 5; loc. Sasa of Doiban, Monobe area.
Fig. 21. lateral view of left valve, gum cast of external mould, KSG 1679, x 5; loc. ditto.
Fig. 22. ditto, ditto, KSG 1680, x 5; loc. ditto.
Fig. 23. inner view of right valve, gum cast of internal mould, KSG 1683, x 3; loc. ditto.
Fig. 24. lateral view of right internal mould, KSG 1683, x 5; loc. ditto.
Fig. 25. lateral view of left internal mould, KSG 1679, x 5; loc. ditto.
Fig. 26. ditto, ditto, KSG 1684, x 3.5; loc. ditto.

Arca (Eonavicula) minima, sp. nov.

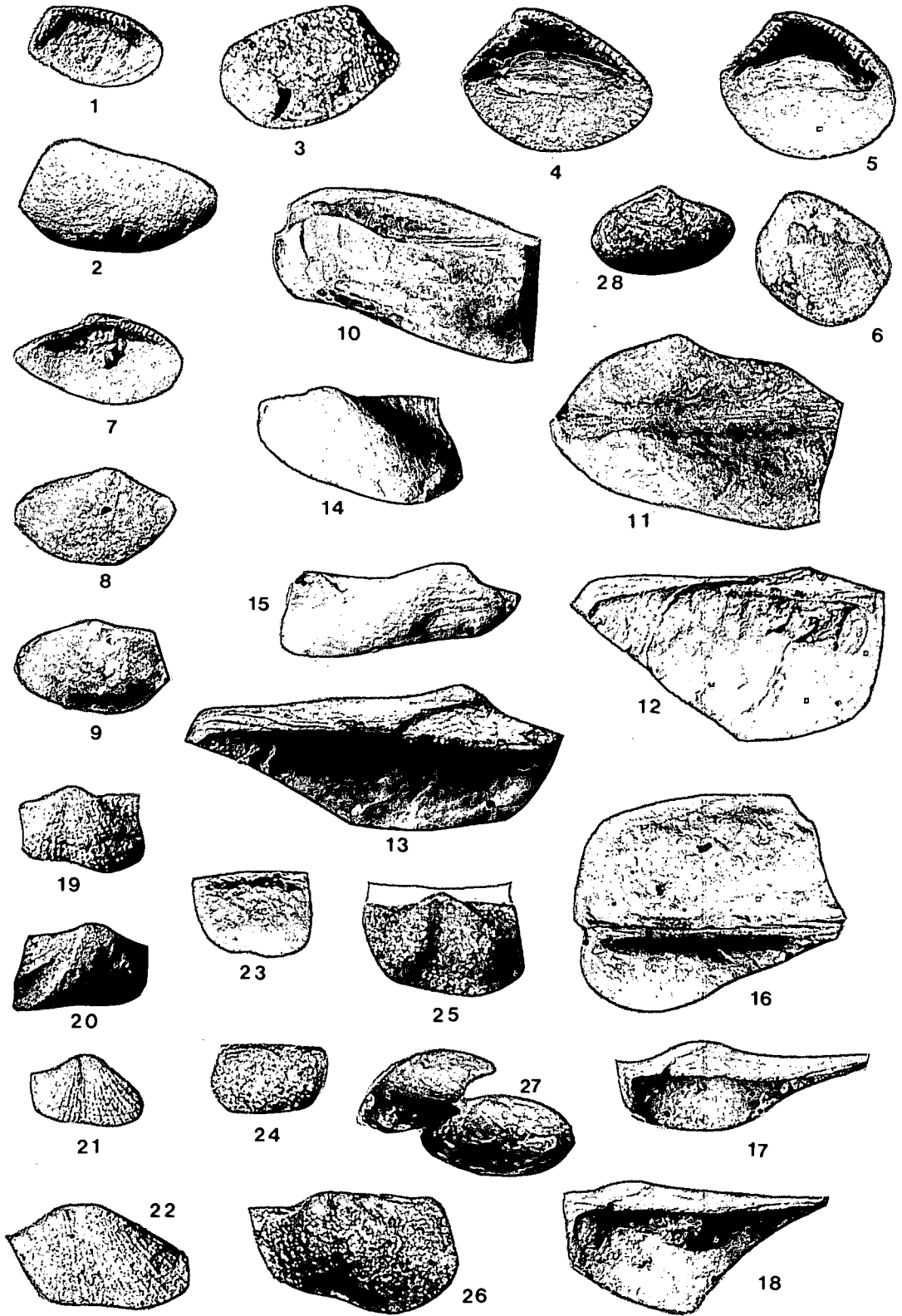
- Fig. 20. lateral view of right valve, gum cast of external mould, KSG 3694, x 5; loc. Sasa of Doiban, Monobe area.

Mesosaccella choshiensis Hayami

- Fig. 27. lateral view of left valve, KSG 3600; x 2; loc. north of Todoronotaki, Monobe area.

Mesosaccella insingnis (Nagao)

- Fig. 28. lateral view of right valve, KSG 3064, x 2; loc. Minamiike of Yunoki, Monobe area.



Explanation of plate 2

Nanonavis yokoyamai (Yabe et Nagao)

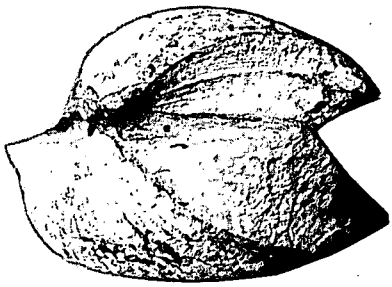
- Fig. 1. dorsal view of conjoined valves, gum cast of external mould, KSG 3698, x 1.5; loc. north of Todoronotaki, Monobe area.
- Fig. 2. lateral view of left valve, x 1.5; loc. ditto.
- Fig. 3. dorsal view of conjoined valves, x 1.5; loc. ditto.
- Fig. 4. lateral view of right valve, x 1.5; loc. ditto.
- Fig. 5. lateral view of left internal mould; x 1.5; loc. Sasa of Aridagawa, Wakayama Prefecture (for comparison).
- Fig. 6. lateral view of left valve, gum cast of external mould, KSG 3697, x 1; loc. north of Todoronotaki, Monobe area.
- Fig. 7. ditto, ditto, x 1.5; loc. ditto.
- Fig. 8. posterior view of right valve, gum cast of external mould, x 1.5; loc. ditto.
- Fig. 9. dorsal view of right valve, gum cast of external mould, x 1.5; loc. ditto.
- Fig. 10. lateral view of imperfect left valve, gum cast of external mould, x 1.5; loc. ditto.
- Fig. 11. inner view of right valve, gum cast of internal mould, KSG 3701, x 1.5; loc. ditto.
- Fig. 12. inner view of imperfect left valve, gum cast of internal mould, x 1.5; loc. ditto.
- Fig. 13. lateral view of right valve, gum cast of external mould, KSG 3699, x 1.5; loc. ditto.
- Fig. 14. lateral view of right internal mould, x 1.5; loc. ditto.
- Fig. 15. lateral view of right valve, gum cast of external mould, x 3; loc. ditto.
- Fig. 16. same specimen with Fig. 15, x 2.

Cosmetodon monobensis, sp. nov.

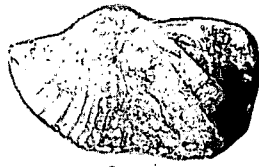
- Fig. 17. inner view of left valve, gum cast of internal mould, KSG 3606, x 1.2; loc. north of Todoronotaki, Monobe area.
- Fig. 18. lateral view of imperfect right valve, gum cast of external mould, x 1.2; loc. ditto.

Cosmetodon nipponicus (Nagao)

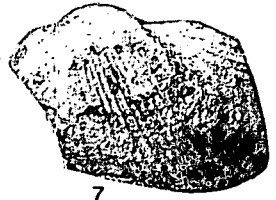
- Fig. 19. lateral view of left internal mould, KSG 3617, x 2; loc. Haidateyama, Minami-Amabe-gun, Oita Prefecture (for comparison).



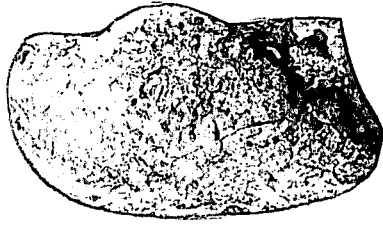
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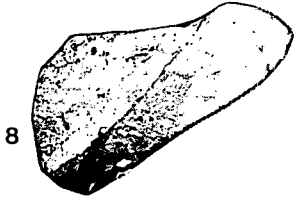
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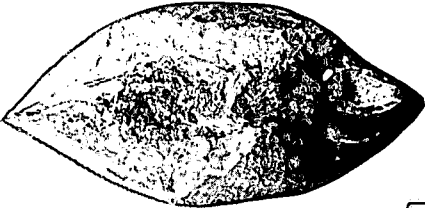
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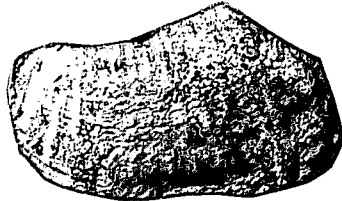
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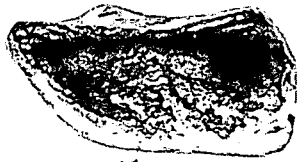
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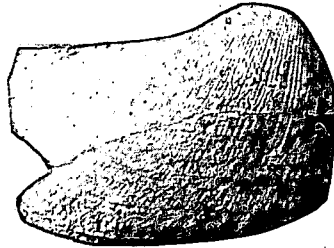
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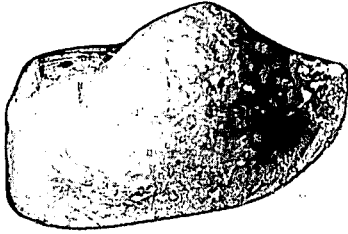
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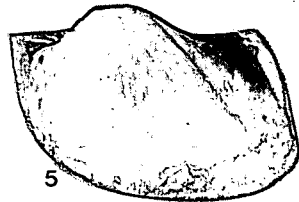
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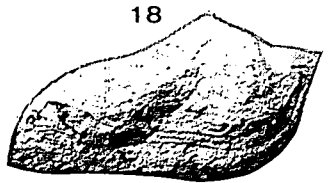
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5



18

Explanation of plate 3

Barbatia (Barbatia) hayamii, sp. nov.

Fig. 1. inner view of left valve, gum cast of internal mould, KSG 3650, x 2.5; loc. north of Todoronotaki, Monobe area.

Fig. 8. lateral view of right valve, gum cast of external mould, KSG 3651, x 3; loc. ditto.

Fig. 9. inner view of right valve, gum cast of internal mould, KSG 3649, x 3; loc. ditto.

Arca (Eonavicula) minima, sp. nov.

Fig. 2. inner view of left valve, gum, cast of internal mould, KSG 3696; x 3; loc. Sasa of Doiban, Monobe area.

Fig. 3. lateral view of left valve, gum cast of external mould, KSG 3691; x; loc. ditto.

Monobearca cuculloides, gen. et sp. nov.

Fig. 4. lateral view of left internal mould, KSG 3685, x 3; loc. Sasa of Doiban, Monobe area

Fig. 5. lateral view of left valve, gum cast of external mould, KSG 3692, x; loc. ditto.

Fig. 6. lateral view of left valve, gum cast of external mould x 3; loc. ditto.

Fig. 7. lateral view of imperfect right valve, gum cast of external mould, KSG 3693, x 4; loc. ditto.

Barbatia (Barbatia) hibiharensis, sp. nov.

Fig. 10. inner view of right valve, gum cast of internal mould, KSG 3646, x 3; loc. dam site of Yunoki, Monobe area.

Fig. 12. lateral view of right valve, gum cast of external mould, KSG 3647, x 3; loc. ditto.

Arca (Eonavicula) sp. aff. A. (E.) shinanoensis Yabe et Nagao

Fig. 11. inner view of right valve, gum cast of internal mould, KSG 3643, x 3; loc. dam site of Yunoki, Monobe area.

Barbatia (Barbatia) kochiensis, sp. nov.

Fig. 13. lateral view of right valve, gum cast of external mould, KSG 3654, x 1.5; loc. Sasa of Doiban, Monobe area.

Fig. 14. umbonal view of right valve, showing hinge structure, gum cast of internal mould, KSG 3655, x 2.

Glycymeris (Hanaia) matsumotoi Tashiro

Fig. 15. inner view of right valve, gum cast of internal mould, x 2.5; loc. Sasa of Doiban, Monobe area.

Fig. 16. same with fig. 15, x 5

Fig. 17. lateral view of left internal mould, KSG 3676, x 4; loc. ditto.

Fig. 18. inner view of left valve, same with KSG 3676, x 4.

Fig. 19. lateral view of left valve, gum cast of external mould, KSG 3678, x 4; loc. ditto.

Fig. 20. inner view of left valve, gum cast of internal mould, KSG 3675, x 3; loc. ditto.

Brachidontes pyriformis, sp. nov.

Fig. 21. lateral view of left valve, gum cast of external mould, KSG 3637, x 3; loc. dam site of Yunoki, Monobe area.

Fig. 22. ditto, ditto, KSG 3638, x 3; loc. ditto.

Fig. 23. lateral view of right valve, gum cast of external mould, KSG 3640, x 3; loc. ditto.

Fig. 24. inner view of left valve, gum cast of internal mould, KSG 3636, x 3; loc. ditto.

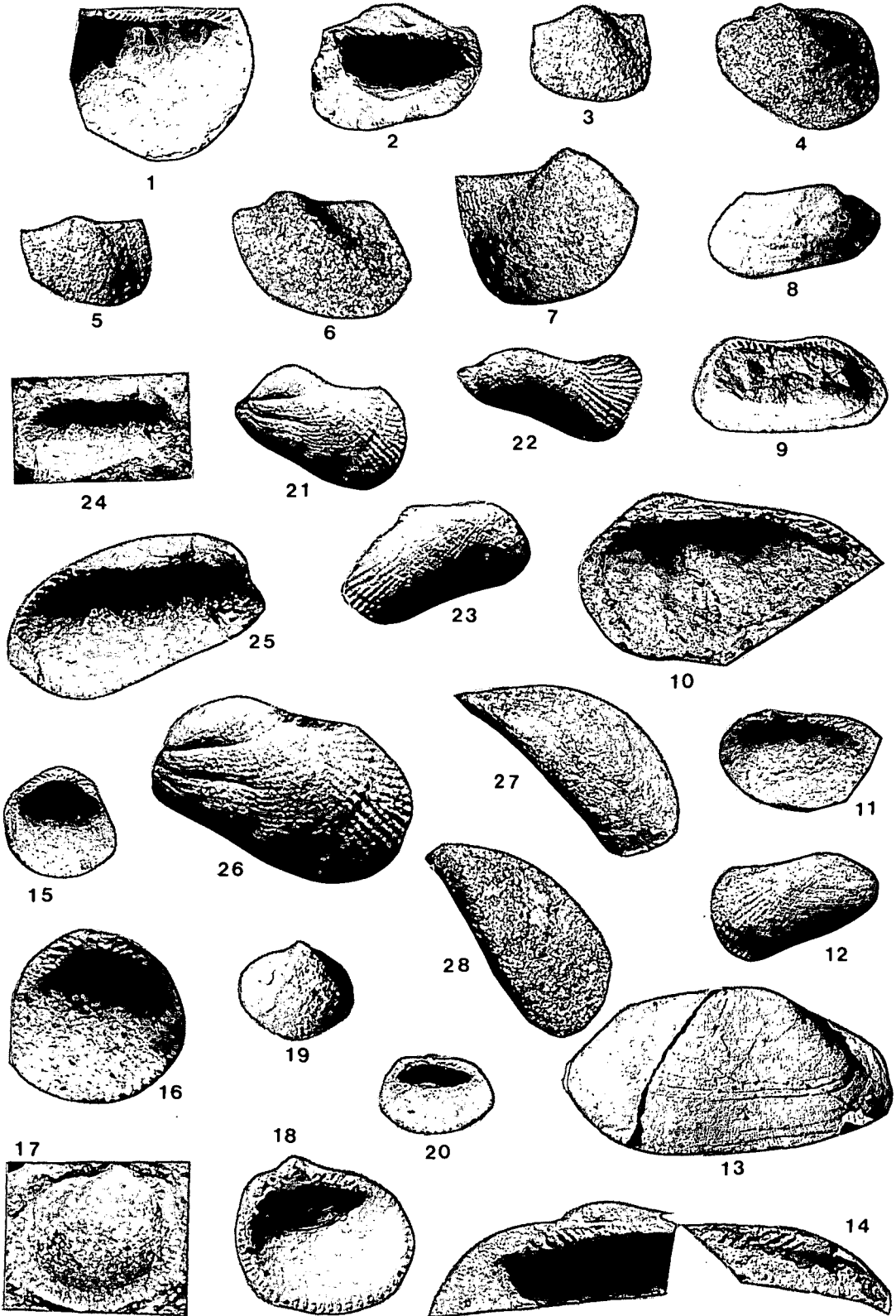
Fig. 25. same with KSG 3636, x 5.

Fin. 26. same with KSG 3637, x 5.

?*Lycettia kochiensis*, sp. nov.

Fig. 27. lateral view of left valve, KSG, x 2; loc. Sasa of Doiban, Monobe area.

Fig. 28. ditto, KSG 3657, x 2; loc. ditto.



Explanation of plate 4

Amygdalum ishidoense (Yabe et Nagao)

Fig. 1. lateral view of left internal mould, KSG 3620, x 1.2; loc. north of Todoronotaki, Monobe area.

Fig. 2. dorsal view of conjoined internal mould, x 1.2; loc. ditto.

Modiolus sp. aff. *M. subsimplex* d'Orbigny

Fig. 3. lateral view of right valve, gum cast of external mould, KSG 3642, x 1.5; loc. Sasa of Doiban, Monobe area.

Fig. 4. lateral view of left valve, gum cast of external mould, KSG 3643, x 1.5; loc. ditto.

Pinna (*Pinna*) sp. cf. *P. (P.) robinaldina* d'Orbigny

Fig. 5. lateral view of left external mould, KSG 3621, x 1; loc. Hagino Monobe area.

Fig. 6. lateral view of left internal mould, KSG 3621, x 1; loc. ditto.

Fig. 7. lateral view of right valve, gum cast of external mould, KSG 3622, x 2; loc. north of Todoronotaki, Monobe area.

Fig. 8. lateral view of right valve, KSG 3623, x 1; loc. Igenoki of Tosayamada, Ryoseki area.

Brachidontes igenokiensis, sp. nov.

Fig. 9. lateral view of right internal mould, KSG 3632, x 3; loc. Igenoki of Tosayamada, Ryoseki area.

Fig. 10. lateral view of left valve, gum cast of external mould, KSG 3627, x 3; loc. ditto.

Fig. 11. ditto, ditto, KSG 3628, x 3; loc. ditto.

Fig. 12. lateral view of right valve, gum cast of external mould, KSG 3626, x 3; loc. ditto.

Fig. 13. lateral view of right internal mould, KSG 3629, x 3; loc. ditto.

Fig. 14. ditto, ditto, KSG 3633, x 3; loc. ditto.

Fig. 15. lateral view of left valve, gum cast of external mould. KSG 3629, x 3; loc. ditto.

Fig. 16. lateral view of left (under) and right (upper) valves; gum cast of external moulds. KSG 3630, x 3; loc. ditto.

Arca (*Eonavicula*) sp. aff. *A. (E.) shinanoensis* Yabe et Nagao

Fig. 17. lateral view of left valve, gum cast of external mould, KSG 3644, x 3; loc. dam site of Yunoki, Monobe area.

Fig. 18. lateral view of right valve, gum cast of external mould, KSG 3645, x 3; loc. ditto.

Cosmetodon nipponicus (Nagao)

Fig. 19. lateral view of left valve. gum cast of external mould, KSG 3615, x 2; loc. north of Todoronotaki, Monobe area.

Fig. 20. lateral view of left internal mould, KSG 3616, x 2; loc. ditto.

Arca (*Eonavicula*) *minima*, sp. nov.

Fig. 21. lateral view of internal mould, KSG 3694, x 4.

