

Mollusks from the Barremian Lower Hanoura Formation, Tokushima Prefecture

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1. Introduction

Bivalves from the Monobegawa Group (lower Cretaceous) of the Tokushima Prefecture (Eastern Shikoku, Japan) have been described by Yehara (1923, Yabe, Nagao and Shimizu (1926), Nagao (1934), Amano (1957), Hayami (1965a, 1965b, 1966), Tashiro and Kozai (1984, 1986, 1988, 1989, 1991).

Tashiro (1985, 1986, 1994, 2000) subdivided the Early Cretaceous bivalve faunas into so called Tethyan- and North Tethyan-types, suggesting origins 1000 km or more apart, the faunas subsequently having been brought together in their present position by a lateral fault.

Kozai and Ishida (2003), discovering a mixed brackish-water fauna in Kochi, central Shikoku, proposed that instead of distant origins, elements of both associations could have been mixed in a transitional, intermediate zone between the so-called Tethyan- and North Tethyan-types.

Matsukawa and Eto (1987) marine currents theory was based on the distribution of Barremian ammonites that would indicate the existence of boreal and equatorial currents at the time of the Hauterivian—Barremian transgression. But, if water temperature was the cause for the different populations, radiolarian assemblages should be different as well, which is not the case, since identical radiolarian assemblages are found in both areas (Ishida and Hashimoto, 1991).

As neither theory is supported by field evidence, the nature of the bivalve-fauna had to be reconsidered. It appeared that the so-called “Tethyan” -type specimens were all brackish, thus indicating higher salinity than the more continental “North Tethyan” type. The mixed brackish water fauna in central Shikoku indicates an environmental transition, essentially controlled by salinity (Kozai *et al.* 2005).

A large number of interesting marine bivalves, recently collected in the lower part of the Lower Hanoura Formation in Tokushima are describe in this paper, including 4 new species.

2. Geological Setting and Age

South of the Median Tectonic Line (MTL) that subdivides S-W Japan into Outer- and Inner zones, the Outer Zone comprises in Central and Eastern Shikoku the three different Early Cretaceous successions of the Monobegawa, Nankai and Takegatani groups (Fig.1).

The Monobegawa Group extends from the Monobe area to Tokushima, and consists of several depositional facies, each characterized by upward thinning successions. In the Tokushima area of eastern Shikoku, the Monobegawa Group is subdivided into Tatsukawa, Lower Hanoura, Upper Hanoura, Hoji and Fujikawa formations in ascending order (Ishida *et al.* 1992).

The Tatsukawa Formation unconformably overlies the Permian Accretionary Complex (PAC). Conglomerates dominate the lower part of the formation that contains the brackish and fresh water mollusks. It is overlain by the Barremian Lower Hanoura formations and can therefore be regarded as Hauterivian in age.

The Lower Hanoura formation consists of conglomerate, sandstone and mudstone, and contains abundant marine mollusks, ammonites and radiolarians of Barremian age (Ishida *et al.* 1992).

The Upper Hanoura Formation consists of conglomerates, sandstones and mudstones that in their lower

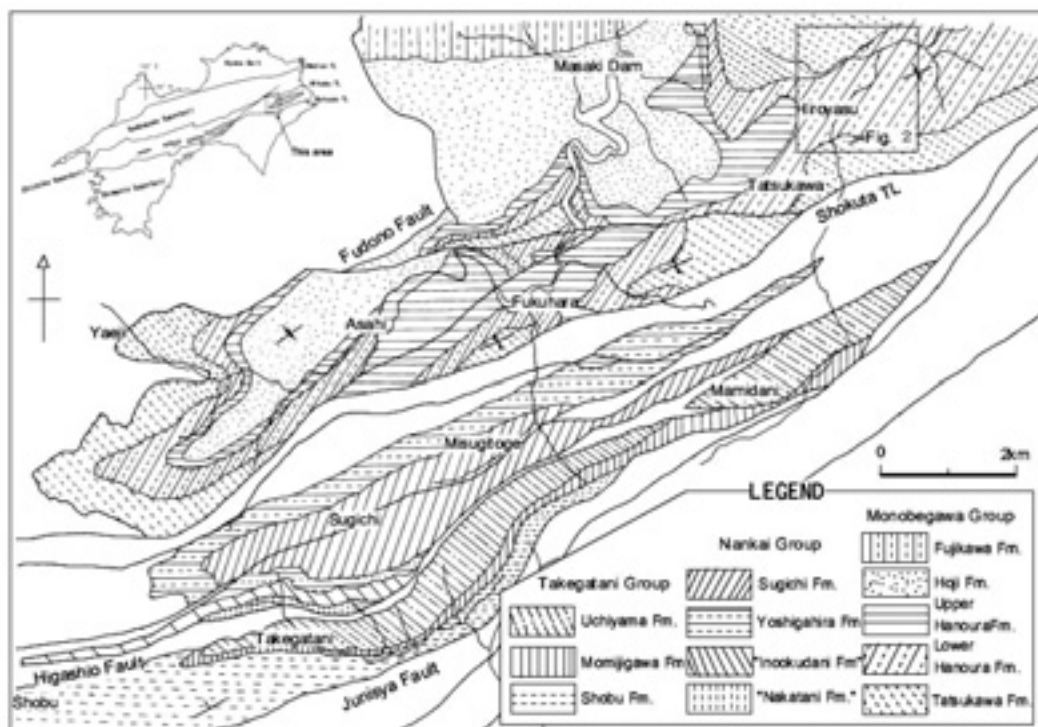


Fig.1. Geological outline map of the Lower Cretaceous in the west part of Tokushima.

parts contain abundant brackish water bivalves. Among the very rare macro-fossils in the black shale of the upper part occurs Aptian ammonites. Radiolarians indicate an Aptian age (Ishida *et al.* 1992).

The Hoji Formation consists of conglomerates, sandstones and some intercalated acidic tuff. The sandstone beds yield Middle Aptian ammonites.

The Fujikawa Formation encompasses thick black shales and alternations of sandstone and shale. Fossils are very rare. The radiolarian *Pseudodictyomitra pentacolaensis* Assemblage indicates a Late Albian age (Ishida and Hashimoto, 1991).

3. Sample localities

The Lower Hanoura Formation is about 300m thick. Along the Tatsukawagawa River, the lower part of the formation is well exposed and yields many bivalve fossils (Fig.2).

Loc.30109: Sandy mudstone along a small trail in the Agenotani valley, Katsuura town, Tokushima Prefecture.

Loc.30111: Calcareous fine sandstone along a small trail in the Agenotani valley, Katsuura town, Tokushima Prefecture.

Loc.30145: Calcareous fine sandstone at left side of the Tatsukawa River, Katsuura town, Tokushima Prefecture.

Loc.30146: Dark gray very fine sandstone, roadside exposure, North of Hiroyasu, Katsuura town, Tokushima Prefecture.

Loc.30147: Calcareous fine sandstone or sandy mudstone in withered valley, Tatsukawa, Katsuura town, Tokushima Prefecture.

Loc.30148: Dark gray very fine sandstone at withered valley, Tatsukawa, Katsuura town, Tokushima Prefecture.

Loc.30149: Dark gray very fine sandstone on left bank of Katsuura River, Nakagoya, Katsuura town, Tokushima Prefecture.

Loc.30150: Calcareous fine sandstone or sandy mudstone on left bank of the Tatsukawa River, Hiroyasu, Katsuura town, Tokushima Prefecture.

Loc.30151: Dark gray very fine sandstone, right bank of Tatsukawa River, Hiroyasu, Katsuura town, Tokushima Prefecture

Loc.30152: Calcareous fine sandstone cliff under small road, Hiroyasu, Katsuura town, Tokushima Prefecture.

Loc.30154: Calcareous fine sandstone or sandy mudstone, small trail, south of Katsuura River, Katsuura -town, Tokushima Prefecture.

Loc.30155: Very fine sandstone, small trail, south of Katsuura River, Katsuura-town, Tokushima Prefecture.

Loc.30156: Dark gray very fine sandstone, trail south of Katsuura River, Katsuura-town, Tokushima Prefecture.

Loc.30157: Calcareous fine sandstone, small trail, south of Katsuura River, Katsuura-town, Tokushima Prefecture.

Loc.30158: Dark gray very fine sandstone, small trail, south of Katsuura River, Katsuura-town, Tokushima Prefecture.

Loc.30159: Calcareous fine sandstone, withered valley, south-west of Tatsukawa, Katsuura-town, Katsuura town, Tokushima Prefecture

Locs.30150-30152 are same localities as Hy 5001-5003 of Hayami (1966).



Fig.2. Fossil localities in the Katsuura area

4. Systematic paleontology

Class Bivalvia Linné, 1758
 Subclass Palaeotaxodonta Koroblov, 1954
 Order Nuculoida Dall, 1889
 Family Nuculidae Gray, 1824
 Genus *Nucula* Lamarck, 1799
Nucula sp.
 Pl.2, Fig.28

Material. — One specimen (NU36-0157), poorly preserved right internal mould 13.4mm long, 10.5mm high. The test is almost entirely eroded away, but the characteristic hinge structure is clearly impressed on the internal mould.

Occurrence. — Loc.30151.

Family Nuculacea Gray, 1824
 Genus *Nuculopsis* Girty, 1911
Nuculopsis shidoensis (Yabe and Nagao)
 Pl.2, Fig.29

Nucula shidoensis Yabe and Nagao. Yabe, Nagao and Shimizu 1926, p.41, pl.13, figs. 46, 47.

Nuculopsis shidoensis (Yabe and Nagao). Hayami 1965a, p.234; Shikama and Suzuki 1972, pl.4, figs.5, 6; Hayami 1975; Tashiro and Kozai 1984, pl.1, figs.1, 2.

Measurements. (in mm)

Specimen	Length	Height	
NU36-0027a	15.1	4.5	Right internal mould
NU36-0027b	15.1	4.5	Left internal mould
NU36-0028	17.4	10.1	Left internal mould

N U36-0027 and NU36-0027b are conjoined valves.

Occurrence. — Loc.30151

Family Nuculanidae Adams and Adams, 1858
 Genus *Portlandia* Mörch, 1857
Portlandia sanchuensis (Yabe and Nagao)
 Pl.3, Fig.15

Nuculana sanchuensis Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.42, pl.12, figs.21-23; Hayami 1965a, p.235.

Portlandia sanchuensis (Yabe and Nagao), Hayami and Oji 1980; Tashiro and Kozai 1984, pl.1, figs.7-9.

Measurements. (in mm)

Specimen	Length	Height	
NU36-0100	9.0	6.1	Right internal mould
NU36-0150a	11.1	7.1	Right internal mould
NU36-0150b	11.1	7.1	Left internal mould

NU36-0150 is butterflyed valves.

Occurrence. — Loc.30151

Family Mallettiidae Adams and Adams, 1858

Genus *Mesosaccella* Chavan, 1946

Mesosaccella choshiensis Hayami

Pl.2, Fig.21

Mesosaccella choshiensis Hayami, Hayami and Oji 1980, p.426, pl.51, figs.11, 12; Tashiro and Kozai 1984, pl.1, fig.27.

Measurements in mm.

Specimen	Length	Height	
NU36-0026	10.5	5.6	Right internal mould
NU36-0161	13.8	7.2	Right internal mould
NU36-0162	12.3	6.1	Right internal mould

Occurrence. — Loc.30151

Subclass Pteriomorpha Beurlen, 1944

Order Arcoida Stoliczka, 1871

Family Parallelodontidae Dall, 1898

Genus *Cosmetodon* Branson, 1942

Cosmetodon nipponicus (Nagao)

Pl.1, Figs.15-16

Grammatodon nipponica Nagao, Nagao 1934, p.190, pl.28, fig.3.

Parallerodon nipponicus (Nagao), Hayami 1965a, pl.27, figs.6, 7; Hatai, Kotaka and Noda 1969, p.31; Hayami 1975.

Cosmetodon nipponicus (Nagao), Tashiro and Kozai 1984, pl.2, fig.19, pl.4, figs 19-21.

Measurements in mm.

Specimen	Length	Height	
NU36-0140	19.0	8.2	Right external mould
NU36-0141	24.8	13.3	Right internal mould
NU36-0145	22.4	13.2	Left internal mould

Ocurrence. — Loc.30151

Family Cucullaeidae Stewart, 1930

Genus *Cucullaea* Lamarck, 1801

Cucullaea obliquata (Amano)

Pl.1, Figs.7-8

Trigoniarca obliquata Amano, Amano 1957, p.82, pl.1, figs.6-8; Hayami 1975. *Trigoniarca* sp. cf. *T. obliquata*, Hayami 1965a, pl.28, fig.17;

Cucullaea obliquata (Amano), Tashiro and Kozai 1984, p.24-25.

Measurements in mm.

Specimen	Length	Height	
NU36-0021	49.5	29.1	Left internal mould
NU36-0022	54.0	26.7	Left valve
NU36-0023	44.6+	26.1+	Left internal mould
NU36-0082	51.6	38.4	Left internal mould
NU36-0099	50.4	30.0	Right internal mould

Occurrence. — Loc.30152

Genus *Nanonavis* Stewart, 1930
Nanonavis yokoyamai (Yabe and Nagao)
 Pl.2, Fig.19

Grammatodon yokoyamai Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.44, pl.12, figs.12, 13, 15; Hayami 1975, p.29; Hayami and Oji 1980, pl.52, figs.1-6.

Nanonavis yokoyamai (Yabe and Nagao), Ichikawa and Maeda 1958, p.67; Hayami, Matsumoto and Asano 1963, pl.51, fig.13; Hayami 1965a, pl.27, figs.8-13; Shikama and Suzuki 1972, pl.4, fig.7; Tashiro and Kozai 1984, pl.2, figs.1-16.

Measurements in mm.

Specimen	Length	Height	
NU36-0076	28.1	20.7	Left valve
NU36-0077	26.2	17.8	Left internal mould
NU36-0123	24.2	16.3	Conjoined valve

Ocurrence. — Locs.30146, 30148, 30151

Family Arcidae, Lamarck, 1809
 Genus *Barbatia* Gray, 1842
Barbatia hiroyasensis sp. nov.
 Pl.1, Figs.9-12

cf. Barbatia hayamii Tashiro and Kozai, Tashiro and Kozai 1984.

Material. — The holotype is an internal mould of a left valve (NU-0153). Paratypes (NU36-0068, NU36-0069, NU36-0121, NU36-0151, NU36-0152), all from the type-locality.

Type locality.—Calcareous fine sandstone or sandy mudstone on left bank of the Tatsukawa River, Hiroyasu, Katsuura town, Tokushima Prefecture (Loc.30150).

Description. — The large to medium sized shell, compared to the genus, is elongate-oval, slightly expanded posteriorly, well inflated, longer than high; thin test; umbo slightly prominent, placed at about one third from front of the valve; antero-dorsal margin short, nearly straight; anterior margin well rounded, meeting dorsal margin in obtuse angle; postero-dorsal margin gently arcuate; ventral margin nearly straight or broadly arcuate; a blunt angular carina extends from umbo to postero-ventral region, defining a steep posterior slope; surface marked with irregularly spaced concentric plications, numerous radial threads covering the whole surface, although only visible in well preserved specimens.

Measurements in mm.

Specimen	Length	Height	
NU36-0068	23.3	12.4	Left internal mould
NU36-0069	26.9	12.4	Right internal mould
NU36-0120	17.6	11.1	Right valve
NU36-0121	20.5	10.0	Left internal mould
NU36-0151	27.2	12.2	Left internal mould
NU36-0152	27.2	12.2	Left external mould
NU36-0153	16.0	10.0	Left internal mould

Observation and comparisons. — The holotype reveals the complete outline and hinge structure, although the test is almost eroded away. Paratype NU36-0152 has a well preserved surface ornamentation. In para-

types NU36-0068 and-0069, numerous teeth remain clearly visible. In outline this species is similar to *Barbatia hayamii* Tashiro and Kozai from the Monobe Formation in Kochi, but differs in its shorter hinge plate. The surface ornamentation of this species is similar to *Barbatia kochiensis* Tashiro and Kozai from the Hibihara Formation in Kochi, but the umbo is located more anteriorly. The hinge plate is similar to that of *Barbatia marullensis* (d'Orbigny) from the Lower Greensand in England, but differs in its elongate-oval outline.

Occurrence. — Locs.30150, 30152

Family Glycymeridae Newton, 1922

Genus *Glycymeris* da Costa, 1778

Glycymeris matsumotoi Tashiro

Pl., Fig.9

Glycymeris matsumotoi Tashiro, Tashiro 1971, p.223, pl.28, figs.17-21; Hayami, 1975, p.34; Matsukuma 1979, p.119; Tashiro and Kozai 1984, pl.3, figs.15-20.

Measurements in mm.

Specimen	Length	Height	
NU36-0067	5.1	5.0	Right internal mould
NU36-0119	6.8	5.4	Right internal mould

Occurrence. — Loc.30150

Order Mytiloida Férussac, 1822

Family Mitilidae Rafinesque, 1815

Genus *Modiolus* Lamarck, 1799

Modiolus obatus sp. nov.

Pl.2, Figs.15-18

Material. — The holotype is a left valve (NU-0146).

Type locality.-Calcareous fine sandstone or sandy mudstone in withered valley, Tatsukawa, Katsuura town, Tokushima Prefecture (Loc.30147).

Paratypes.- (NU36-0080, NU36-0124, NU36-0125, NU36-0146, NU36-0154) from the Calcareous fine sandstone or sandy mudstone, small trail, south of Katsuura River, Katsuura-town, Tokushima Prefecture (Loc.30154)

Description. — Shell small, elongate-oval, slightly expanded posteriorly, well inflated, longer than high; test thin; umbo large, prominent, located at about one sixth from the front of the valve; antero-dorsal margin short, nearly straight; anterior margin well rounded; postero-dorsal margin gently arcuate; ventral margin obliquely elongated, weakly sinuated on posterior part of margin; a blunt angular carina extends from umbo to postero-ventral region; surface marked with regularly spaced concentric ribs, covering the whole surface.

Measurements in mm.

Specimen	Length	Height	
NU36-0080	9.4	6.2	Left valve
NU36-0124	5.1	7.7	Left valve
NU36-0125	16.2+	7.4	Left valve
NU36-0126	19.0	9.1	Right valve
NU36-0146	18.8	7.8	Left valve
NU36-0154	14.1	8.0	Right external mould

Observation and comparisons. — The holotype reveals the complete outline and surface ornamentation, but the hinge structure cannot be observed.

In outline, this species is similar to *Modiolus sestuniae* Hayami from the Toarcian in Vietnam, but the blunt angular carina of this species lies more posteriorly.

Modiolus falcatus that Amano (1957) described from the Hagino Formation of the Monobegawa Group in Kochi clearly differs from the new species in its subtrigonal outline.

Occurrence. — Locs.30147, 30150, 30154

Genus *Amygdalum* Megerle von Mühlfeld, 1811

Amygdalum ishidoense (Yabe and Nagao)

Pl.1, Fig.4

Modiola ishidoensis Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.63, pl.13, fig.42; *Gervillia* ? sp., Nagao 1934, pl.24, fig.2; *Amygdalum ishidoense* (Yabe and Nagao), Hayami 1965a, pl.30, figs.4-10; Hayami 1975, p.39; Tashiro and Kozai 1984, pl.4, figs.1, 2.

Measurements in mm.

Specimen	Length	Height	
NU36-0118	26.7	9.5	Conjoined valve
NU36-0065	36.2	18.7	Left internal mould

Occurrence. — Locs.30148, 30151

Family Pinnidae Leach, 1819

Genus *Pinna* Linné, 1758

Pinna sp. cf. *P. robinaldia* d'Orbigny

Pl.2, Fig.1

Pinna sp. cf. *P. robinaldia* d'Orbigny, Amano 1957, pl.1, figs.10-13; Hayami 1965a, pl.39, fig.2, 3; Hayami 1975, p.40; Tashiro and Kozai 1984, pl.4, figs.5-8.

Measurements in mm.

Specimen	Length	Height
NU36-038	26.7+	57.4+
NU36-040	74.5	98.6+
NU36-158	11.8+	27.3+

Occurrence. — Loc.30151

Order Pterioida Newell, 1965

Family Pteriinae, Gray 1847

Genus *Pterinella* Toula, 1882

Pterinella shinoharai Hayami

Pl.3, Figs.9-10

Pterinella shinoharai Hayami, Hayami 1965a, p.265-268, pl.10, figs.1-3, pl.32, figs.1-6, pl.33, figs.1-2, pl.34, figs.1-2, pl.34, figs.1-2, pl.35, figs.1-2; Hayami 1975, pl.2, fig.1; Tashiro and Kozai 1986, pl.1, figs 15, 16; pl.8, 1-5; .

Measurements in mm.

Specimen	Length	Height
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NU36-0049	34.6	49.9	Right valve
NU36-0050	42.1	54.2	Left valve
NU36-0051	54.1	45.0	Right external mould
NU36-0052	93.5+	71.3+	Left external mould

Occurrence. — Locs.30151, 30155, 30158

Family Bakevellidae King, 1850

Genus *Gervillia* Defrance, 1820

Gervillia forbesiana d'Orbigny

Pl.2, Fig.1

Gervillia forbesiana d'Orbigny, Woods 1899, p.58, pl.12, figs, 1-5; Yabe, Nagao and Shimizu 1926; Yabe 1927. Pl.12, fig.1-2; Shinohara 1951, pl.11, fig.2; Hayami 1965a, pl.37, figs.1-8.; Shikama and Suzuki 1972, pl.4, fig.13; Hayami 1975, 47; Tashiro, Kozai, Okamura, and Katto 1980, pl.10 pl.10, fig.1; Tashiro and Kozai 1986, pl.1, figs.1-9.

Measurements in mm.

Specimen	Length	Height	
NU36-0066	45.3	11.3	Left internal mould

Occurrence. — Loc.30150

Genus *Isognomon* Lightfoot, 1786

Isognomon ichikawai Hayami

Pl.2, Figs.12-13

Isognomon ichikawai Hayami, Hayami 1965a, p.280, pl.38, figs.8, 9; Hayami 1975, p.49.

Measurements in mm.

Specimen	Length	Height	
NU36-0020	68.0+	75.1	Left internal mould
NU36-0097	31.2	33.3	Right internal mould
NU36.0098	55.2	31.8+	Right internal mould

Occurrence. — Loc.30150

Family Entoliidae Korobkov, 1960

Genus *Entolium* Meek, 1865

Entolium sanchuense Hayami

Pl.1, Fig.17

Entolium sanchuense Hayami, Hayami 1965a, p.315, pl.45, figs.12, 13, pl.52, fig.5; Hayami 1975, p.72-73.

Measurements in mm.

Specimen	Length	Height	Apical angle
NU36-0018	23.4	21.3	115° Left valve
NU36-0019	23.8	20.0	116° Right internal mould
NU36-0093	21.1	18.8	106° Right valve
NU36-0094	30.0	27.4	115° Left internal mould
NU36-0095	31.0	31.2	120° Right internal mould
NU36-0096	38.0	34.5	113° Right internal mould

Occurrence. — Locs.30150, 30152

Entolium ikedai Tashiro

Pl.1, Fig.18

Entolium ikedai Tashiro, Tashiro 1990, p.8, pl.2, figs.1-5.

Measurements in mm.

Specimen	Length	Height	Apical angle
NU36-0014	21.4	34.4	90° Right valve
NU36-0015	13.4	18.0	83° Left valve
NU36-0090	61.6	81.6	95° Right valve
NU36-0091	13.1	18.8	81° Right valve
NU36-0147	34.3	41.4	94° Right external mould

Occurrence. — Locs.30150, 30152

Entolium nishikawai sp. nov.

Pl.1, Figs.19-20

Material. — The holotype is a left valve (NU36-0009). Paratype (NU36-0159) is from the same locality as the holotype.

Type locality. — Calcareous fine sandstone cliff under small road, Hiroyasu, Katsuura town, Tokushima Prefecture (Loc.30152).

Description. — Shell large compared to the genus, elliptical, about 1.3 times longer than high, slightly inflated; test thin; short antero-dorsal margin nearly straight, postero-dorsal margin nearly straight, forming obtuse angle with the obliquely truncated siphonal margin; ventral margin gently arcuated; apical angle about 135 degrees; auricles subequal in size; anterior auricle sub-vertically truncated; posterior auricle diagonally attached to the postero-dorsal margin; surface ornamentation consists of numerous, about 3-4 per mm, very fine concentric striae.

Measurements in mm.

Specimen	Length	Height	Apical angle
NU36-0009	71.8	55.0	134° Left external mould
NU36-0159	75.6	68.9	140° Left internal mould

Observation and comparisons. — The present species is represented by two specimens (NU36-0009 and NU36-0159). The holotype reveals the complete outline and surface ornamentation. In outline, this species is similar to *Entolium sanchuensis* Hayami from the Barremian Ishido Formation, but the angle is different. The apical angle of 135 degrees in the new species is larger than the approximately 100 degrees in *E. sanchuensis* Hayami and only about 90 degrees in *Entolium ikedai* Tashiro.

Occurrence. — 30152

Family Pectinidae Rafinesque, 1815

Genus *Neithea* Drouet, 1825

Neithea hanourensis Tashiro and Kozai

Pl.2, Fig.20

Neithea hanourensis Tashiro and Kozai, Tashiro and Kozai 1986, p.36, pl.4, figs.11-13.

Measurements in mm.

Specimen	Length	Height	
NU36-0071	10.5	8.6	Right valve

Occurrence. — Loc.30148

Neithea atava (Römer)

Pl.2, Fig.27

Pecten atavus Römer, Römer 1839, p.29, pl.18, fig.21. *Neithea atava* (Römer) Cox, 1954, pl.64, figs.1, 4; Fujii 1954, p.418; Alencaster 1956; Druschiza and Kudrjavnseva 1956, pl.2, figs.5-7; Dhondt 1973, pl.1, figs.2a, b; Hayami 1975, p.74; Hayami and Noda 1977, pl.5, figs.4, 5, pl.6, figs.1, 2; Tashiro, Kozai, Okamura and Katto 1980, pl.11, fig.6; Tashiro and Kozai 1986, pl.9, figs.1-4, pl.10, figs.1, 2. *Neithea kammerai* Hayami, Hayami 1965a, pl.43, figs 1-5, pl.52, fig.3.

Measurements in mm.

Specimen	Length	Height	
NU36-0057	48.1+	55.5+	Right valve
NU36-0058	74.5+	47.6+	Left external mould
NU36-0109	45.8	34.5	Right external mould
NU36-0110	41.2	32.4	Left external mould

Occurrence. — Locs.30109, 30146, 30148

Family Propeamussiidae Abbot, 1954

Genus *Parvamussium* Sacco, 1897

Parvamussium kimurai (Hayami)

Pl.2, Fig.30

Variamussium kimurai Hayami, Hayami 1965a, p.210, pl.46, figs.1-4.

Parvamussium kimurai (Hayami), Hayami 1975, p.83; Tashiro and Kozai 1986, pl.3, figs.23, 24, pl.6, fig.18.

Measurements in mm.

Specimen	Length	Height	
NU36-0044	15.1	11.9	Left external mould

Occurrence. — Loc.30151

Family Plicatulidae Watson, 1930

Genus *Plicatula* Lamarck, 1801

Plicatula monobensis Tashiro and Kozai

Pl.3, Fig.6

Plicatula monobensis Tashiro and Kozai, Tashiro and Kozai 1986, p.43, pl.2, fig.21, pl.3, figs.8, 9, 11, pl.4, figs.14-16.

Measurements in mm.

Specimen	Length	Height	
NU36-0045	108	14.5	Right internal mould

Occurrence. — Loc.30152

Plicatula kiiensis Hayami

Pl.3, Figs.2-3

Plicatula kiiensis Hayami, Hayami 1965a, p.323, pl.46, figs.6-8; Hayami 1975, p.84; Tashiro and Kozai 1986, pl.3, figs.1-7, 10, 12.

Measurements in mm.

Specimen	Length	Height	
NU36-0042	31.5	26.8	Right internal mould
NU36-0132	14.5	15.8	Right external mould
NU36-0133	16.8	10.4	Left external mould
NU36-0134	21.4	21.6	Right internal mould

Occurrence. — Loc.30150

Family Limidae Rafinesque, 1815

Genus *Limatula* Wood, 1839

Limatula nagaoi Hayami

Pl.2, Fig.14

Lima ishidoensis Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.213, pl.27, figs.9-10; *Limatula ishidoensis* (Yabe and Nagao), Hayami 1965a, p.49, figs.1-4; Hayami 1975, p.89; Tashiro and Kozai 1986, pl.6, fig.19.

Measurements in mm.

Specimen	Length	Height	
NU36-0078	6.2	10.8	Left valve
NU36-0079	3.7	8.6	Right valve

Occurrence. — Loc.30150

Family Ostreidae Rafinesque, 1815

Genus *Amphidonte* Fischer de Waldheim, 1829

Amphidonte sp. cf. *A. subhaliotoidea* (Nagao)

Pl.1, Fig.4

Cf. *Exogyra subhaliotoidea* Nagao, Nagao 1934, pl.30, figs.1-4;

Amphidonte subhaliotoidea (Nagao), Hayami 1965a, pl.50, figs.6-9, pl.51, figs.1-2; Hayami and Kawasaki 1967, pl.9, fig.5; Shikama and Suzuki 1972, p.10-14; Hayami 1975, pl.4, fig.2; Tashiro and Kozai 1986, pl.8, fig.2.

Measurements in mm.

Specimen	Length	Height	
NU36-0041	25.7	30.1	Right internal mould
NU36-0104	27.8	38.5	Left valve
NU36-0105	16.7	21.8	Left valve
NU36-0106	16.5	16.4	Left internal mould

Occurrence. — Locs.30109, 30151

Genus *Lopha* Röding, 1798

Lopha nagaoui Hayami

Pl.2, Fig.26

Lopha nagaoui Hayami, Hayami 1965a, p.338, pl.49, figs.8-11, pl.50, figs.1-2; Shikama and Suzuki 1972, pl.5, fig.8; Hayami 1975, p.91.

Measurements in mm.

Specimen	Length	Height	
NU36-0139	13.5	7.6	Right valve
NU36-0083	17.7	11.3	Right valve

Occurrence. — Loc.30151

Rastellium carinatum (Lamarck)

Pl.3, Fig.24

Ostrea carinata Lamarck, Lamarck 1871, Stoliczka, p.468, pl.48, fig.5, pl.49, figs.1-2; *Ostrea diluviana* Linné, Yabe, Nagao and Shimizu 1926, pl.13, figs.4-6; Yabe 1927, pl.15, fig.4; Nagao 1934, p.201; *Lopha-carinata* (Lamarck), Hayami 1965a pl.49, fig.13; Shikama and Suzuki 1972, pl.5, fig.5; *Rastellium carinatum* (Lamarck), Hayami 1975, p.91; Tashiro and Kozai 1986, pl.8, fig.3, pl.9, fig.5.

Measurements in mm.

Specimen	Length	Height	
NU36-0016	60.1+	21.5+	Right internal mould
NU36-0017	38.6+	30.8+	Right internal mould

Occurrence. — Loc.30151

Subclass Palaeoheterodonta Newell, 1865

Order Trigonioidea Dall, 1889

Family Trigoniidae Lamarck, 1819

Genus *Rutitrigonia* van Hoepen, 1929

Rutitrigonia yeharai Kobayashi

Pl.3, Figs.18-19

Trigonia neumayri Yehara, Yehara 1923, p.82, pl.9, figs.1-3; *Rutitrigonia yeharai* Kobayashi, Kobayashi 1957, p.59, pl.10, fig.1; Kobayashi and Nakano 1958, pl.12, figs.9, 10; Hayami 1975, p.106.

Measurements in mm.

Specimen	Length	Height	
NU36-0081	48.7+	44.5+	Right valve
NU36-0128	74.8+	47.8+	Left external mould

Occurrence. — Locs.30152, 30159

Genus *Pterotrigonia* van Hoepen, 1929

Pterotrigonia pocilliformis (Yokoyama)

Pl.3, Fig.16

Trigonia pocilliformis Yokoyama, Yokoyama 1891, p.361, pl.40, figs.1-3; Yehara 1923, pl.9, figs 8-10,

pl.10, figs.4-6; Yabe, Nagao and Shimizu 1926, p.45; Yabe 1927 pl.4, fig.3.

Pterotrigonia pocilliformis (Yokoyama), Kobayashi 1954, p.77; Kobayashi and Nakano 1957, pl.16, figs.1-3; Kobayashi and Nakano 1958, pl.11, fig.12; Matoba 1964, pl.37, figs.6, 7; Maeda and Kawabe 1967, pl.1, figs.1-3; Katto and Tashiro 1978, pl.1, figs.7-9; Tashiro, Kozai, Okamura and Katto 1980, pl.10, fig.14; Hayami and Oji 1980, pl.52, fig.7; Tashiro and Matsuda 1982, pl.8, figs.6-11; Tashiro and Matsuda 1986, pl.1, figs.6-11; Tashiro, Yanagisawa and Kitamura 1986, pl.1, figs.11, 12; Tashiro and Kozai 1986, pl.5, figs.1, 2, 6, pl.7. Figs.1-11.

Measurements in mm.

Specimen	Length	Height	
NU36-0059	36.0	30.1	Left external mould
NU36-0060	36.6	23.4	Right internal mould
NU36-0111	17.5+	19.6	Conjoined valve
NU36-0112	35.5	24.8	Conjoined valve

Occurrence. — Locs.30150, 30152, 30156, 30158

Subclass Heterodonta Neumayr, 1884
Order Veneroida Adams and Adams, 1856
Family Astartidae d'Orbigny, 1844
Genus *Astarte* Sowerby, 1816
Astarte subsenecta Yabe and Nagao
Pl.3, Figs.11-12

Astarte subsenecta Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.47, pl.13, figs.14-16, pl.14, fig.11; Hayami 1965b, pl.7, figs.10-18, figs.1-5; Shikama and Suzuki 1972, pl.6, fig.4; Hayami 1975, pl.6, figs.3-5; Hayami and Oji 1980, pl.53, figs.1-6; Tashiro, Kozai, Okamura and Katto 1980, p.75; Tashiro, Matsuda and Tanaka 1985, pl.10, fig.16, pl.3, figs.1-3; Tashiro and Matsuda 1986, pl.75, fig.14, pl.77, figs.17-19, 25, 26; Tashiro and Kozai 1988, pl.1, figs.1, 2.

Measurements in mm.

Specimen	Length	Height	
NU36-0030	10.0	9.5	Right valve
NU36-0031	16.0	13.3	Right valve
NU36-0032	16.1	16.0	Right valve
NU36-0033	18.6	18.9	Left internal mould
NU36-0034	18.6+	17.1	Left internal mould

Occurrence. — Locs.30151, 30109

Genus *Yabea* Hayami, 1965
Yabea shinanoensis (Yabe and Nagao)
Pl.3, Figs.25-26

Astarte shinanoensis Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.47, pl.13, figs.29-30; *Astarte (Yabea) shinanoensis* Yabe and Nagao, Hayami 1965b, pl.8, figs.25-26. Pl.14, figs.7-8; Hayami 1975, p.126; *Yabea shinanoensis* (Yabe and Nagao), Tashiro and Kozai 1988, pl.2, figs.17, 25.

Measurements in mm.

Specimen	Length	Height	
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NU36-0043	21.5	21.2	Right internal mould
NU36-0155	26.1	21.7	Left internal mould

Occurrence. — Loc.30149

Yabea sp. aff. *Y. shinanoensis* (Yabe and Nagao)
Pl.3, Figs.22-23

Astarte (Yabea) sp. aff. *A. (Y.) shinanoensis* Yabe and Nagao, Hayami 1965b, pl.9, fig.1, pl.14, fig.9.

Measurements in mm.

Specimen	Length	Height	
NU36-0035	26.4	20.2	Left internal mould
NU36-0036	19.4	18.2	Right internal mould
NU36-0037	22.3	20.8	Right internal mould

Observation: — Hayami (1965b), only one specimen from the Hanoura Formation, the surface ornament was not preserved. Also our newly collected similar specimens from same locality, are unfortunately internal moulds that in transversal outline differ from *Yabea shinanoensis* (Yabe and Nagao).

Occurrence. — Loc.30151

Genus *Eriphyla* Gabb, 1864
Eriphyla sp. aff. *E. oblonga* Freneix
Pl.1, Figs.13-14

Measurements in mm.

Specimen	Length	Height	
NU36-0070	18.2	12.8	Right internal mould
NU36-0073	18.1	17.1	Left internal mould
NU36-0074	25.1+	26.3	Left valve
NU36-0122	18.3	13.5	Right valve
NU36-0130	16.8	13.9	Right internal mould
NU36-0131	17.0	15.0	Left internal mould

Observation: — *Eriphyla minima* Hayami from the Miyako Group shows similar smooth inner ventral margin and small size for the genus. *E. minima* Hayami resembles *Eriphyla oblonga* Freneix, from the Cretaceous of New Caledonia, but is smaller in size and has a more rectangular outline.

Occurrence. — Loc.30151

Family Crassatellidae Férussac, 1822
Genus *Anthonya* Gabb, 1864
Anthonya elongata sp. nov.
Pl.1, Figs.1-3

Material. — The holotype is a left valve (NU36-0075). Paratypes (NU36-0083a and NU36-0083b)

Type locality. — Dark gray very fine sandstone on left bank of Katsuura River, Nakagoya, Katsuura town, Tokushima Prefecture (Loc.30149).

Paratypes originate from the dark gray very fine sandstone, right bank of Tatsukawa River, Hiroyasu,

Katsuura town, Tokushima Prefecture (Loc.30151).

Description. — Rectangular shell elongate, highly in-equilateral, much longer than high, nearly flat; anteriorly located ortho-gyrous umbo is subterminal; umbonal angle about 120 degrees; antero-dorsal margin very long, nearly straight, or slightly convex; posterior dorsal margin straight. Ventral margin nearly straight, parallel with posterior dorsal margin; much longer than the anterior margin, the posterior one is sub-vertically truncated; a blunt carina extends from the umbo to the postero-ventral angle; escutcheon indistinct; lunule not clear; surface smooth; hinge plate wide, sub-triangular; hinge formula shown as follows: 3a 3b P III/A II 2 4b P II; cardinal 2 and 4b strong, elongated; cardinal 3a strong, triangular; 3b narrow.

Measurements in mm.

Specimen	Length	Height	
NU36-0075	31.0	9.7	Right internal mould
NU36-0083a	14.2	6.8	Right internal mould
NU36-0083b	14.2	6.8	Right external mould

Observation and comparisons. — The holotype reveals the complete internal feature and hinge structure. The outline of the species is rectangular and flat. This new species resembles *Anthonya subcantiana* Nagao, from the Upper Aptian Miyako Group of NE Japan, but shows a bigger length/height ratio than *A. subcantiana*. In its outline the present new species is similar to *Anthonya igenokiensis* Tashiro and Kozai, from the Aptian Igenoki Formation in Shikoku, but its surface is covered with distinct concentric ribs. Hayami (1965a) described *Anthonya* aff. *subcantiana* Nagao from the Barremian Ishido Formation in the Sanchu area, thought *A. elongate* n.sp. has a more rectangle outline.

Occurrence. — Loc.30149

Family Cardiidae Lamarck, 1809
Genus *Globocardium* Hayami, 1965
Globocardium sphaeroideum (Forbes)
Pl.2, Figs.5-6

Cardium sphaeroideum Forbes, Forbes 1845, p.243, pl.2, fig.8. *Protocardia sphaeroidea* (Forbes), Woods 1908, pl.31, figs.2, 3; Hayami 1965b, pl.16, figs.1-6. *Globocardium sphaeroideum* (Forbes), Hayami 1975, p.133.

Measurements in mm.

Specimen	Length	Height	
NU36-0136	28.2+	41.0	Left valve
NU36-0137	41.8+	34.3	Right valve
NU36-0138	47.8	35.4	Right valve

Occurrence. — Loc.30149

Genus *Granocardium* Lamarck, 1809
Granocardium brevis Tashiro and Kozai
Pl.2, Fig.2

Granocardium brevis Tashiro and Kozai, Tashiro and Kozai 1988, pl.4, figs.1-13.

Measurements in mm.

Specimen	Length	Height
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NU36-0142	12.0	10.8	Right valve
NU36-0143	6.9	6.5	Left internal mould
NU36-0144	6.9	6.5	Left external mould

Occurrence. — Loc.30149

Granocardium ishidoense (Yabe and Nagao)

Pl.2, Figs.3-4

Cardium ishidoensis Yabe and Nagao, Yabe, Nagao and Shimizu 1926, p.48, pl.12, figs.9, 16, 18. *Laevicardium* (?) *ishidoensis* (Yabe and Nagao), Hayami 1965b, pl.17, figs.8-10; Hayami 1975, p.134; Katto and Tashiro 1978, pl.1, figs.12-15; Tashiro and Matsuda 1986, pl.77, figs.8, 9. *Granocardium ishidoense* (Yabe and Nagao), Tashiro and Kozai 1988, p.59-60.

Measurements in mm.

Specimen	Length	Height	
NU36-0061	25.7	50.0	Left valve
NU36-0062	26.2+	36.4	Left valve
NU36-0114	9.4	10.5	Left valve

Occurrence. — Loc.30149

Family Cultellidae Davies, 1935

Genus *Leptosolen* Conrad, 1865

Leptosolen amabilis Tashiro and Kozai

Pl.2, Fig.10-11

Leptosolen amabilis Tashiro and Kozai, Tashiro and Kozai 1988, p.51, pl.2, figs.18-24.

Measurements in mm.

Specimen	Length	Height	
NU36-0129	14.5	4.8	Right internal mould
NU36-0149	14.5	4.8	Left internal mould
NU36-0150	14.5	6.5	Left internal mould

Occurrence. — Loc.30151

Family Arctiidae Newton, 1891

Genus *Ptychomya* Agassiz, 1842

Ptychomya densicostata Nagao

Pl.3, Figs.13-14

Ptychomya densicostata Nagao, Nagao 1934, p.224, pl.28, fig.4; Hayami 1965b, pl.21, figs.1-4; Hayami 1975, p.137.

Measurements in mm.

Specimen	Length	Height	
NU36-0024	60.5	28.6	Right external mould
NU36-0025	64.3	31.6	Left internal mould

Occurrence. — Locs.30152, 30111

Family Icanotiidae Casey, 1916

Genus *Scittila* Casey, 1961

Scittila japonica Hayami

Pl.3, Fig.17

Scittila japonica Hayami, Hayami 1965b, p.126, pl.18, fig.1; Hayami 1975, p.136.

Measurements in mm.

Specimen	Length	Height	
NU36-0010	52.5	19.5	Right internal mould

Occurrence. — Locs.30152, 30111

Scitilla dericatostriata Tashiro and Kozai

Pl.3, Figs.20-21

Scitilla dericatostriata Tashiro and Kozai, Tashiro and Kozai 1988, p.63, pl.3, figs.17, 18.

Measurements in mm.

Specimen	Length	Height	
NU36-0011	44.8	19.4	Right internal mould
NU36-0084	31.8	19.0	Left internal mould
NU36-0086	29.0	16.8	Left internal mould
NU36-0087	29.4	16.9	Right internal mould

Occurrence. — Locs.30152, 30111

Order Myoida Stliczka, 1870

Family Corbulidae Lamarck, 1818

Genus *Caestocorbula* Vincent, 1910

Caestocorbula shikamai Hayami

Pl.1, Fig.6

Caestocorbula shikamai Hayami, Hayami and Oji 1980, p.436, pl.53, figs.8-12; Kozai 1987, figs.4-1-9. Tashiro and Kozai 1991, pl.1, fig.7.

Measurements in mm.

Specimen	Length	Height	
NU36-0156	20.4	17.0	Right internal mould

Occurrence. — Loc.30149

Family Hiattellidae Gray, 1824

Genus *Panopea* Menard, 1807

Panopea plicata (Sowerby)

Pl.2, Fig.22-24; Pl.3, Fig.1

Mya plicata Sowerby and Sowerby, 1823, p.20, pl.419, fig.3; *Panopea plicata* Sowerby and Sowerby 1835, p.241; Hayami 1966, pl.22, figs.1-7; Hayami 1975, p.146.

Measurements in mm.

Specimen	Length	Height	
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NU36-0029	40.4	21.5	Right valve
NU36-0054	31.3	17.1	Left valve
NU36-0053	18.5	11.4	Right valve
NU36-0055	29.1	17.7	Left valve
NU36-0056	26.5	18.4	Right valve
NU36-0072	50.1	29.7	Left valve
NU36-0101	32.5	20.2	Right valve
NU36-0117	26.4	18.4	Left valve

Occurrence. — Locs.30155, 30152

Subclass Anomalodesmata Dall, 1889

Order Pholadomyoidea Newel, 1965

Family Pholadomyacea Gray, 1847

Genus *Pholadomya* Sowerby, 1823

Pholadomya miyamotoi Nagao

Pl.3, Fig.7

Pholadomya miyamotoi Nagao, Nagao 1943, p.158, pl.12, figs.8, 9; Hayami 1966, pl.22, figs.9-14, pl.23, figs.3-5; Hayami 1975, p.149.

Measurements in mm.

Specimen	Length	Height	
NU360012	19.0	18.1	Right valve

Occurrence. — Locs.30146, 30152

Genus *Goniomya* Agassiz, 1841

Goniomya subarchiaci Nagao

Pl.2, Fig.8

Goniomya subarchiaci Nagao, Nagao 1934, p.215, pl.29, figs.2, 3; Hayami 1966, pl.25, figs.1-13; Hayami 1975, p.150.

Measurements in mm.

Specimen	Length	Height	
NU36-0047	21.4	12.1	Left valve
NU36-0048	27.6	17.0	Right valve
NU36-0107	14.5	9.1	Right valve
NU36-0108	30.7	13.7+	Right valve

Occurrence. — Locs.30149, 30152

Goniomya hayamii Tashiro and Kozai

Pl.2, Fig.7

Goniomya hayamii Tashiro and Kozai, Tashiro and Kozai 1991, p.198, pl.2, figs.1-6.

Measurements in mm.

Specimen	Length	Height	
NU36-0135	11.5	11.2	Right valve

Occurrence. — Loc.30151

Family Laternulidae Hedley, 1918
Genus *Plectomya* de Loriol, 1868
Plectomya concentrica Tashiro and Kozai

Pl.3, Fig.8

Plectomya concentrica Tashiro and Kozai, Tashiro and Kozai 1991, p.201, pl.2, figs.8-10.

Measurements in mm.

Specimen	Length	Height	
NU36-0115	22.4	9.8	Left valve
NU36-0116	17.6+	11.4	Left valve

Occurrence. — Loc.30152

Plectomya aritagawana Hayami

Pl.3, Fig.4

Plectomya aritagawana Hayami, Hayami 1966, p.168, pl.25, figs.14, 15, pl.26, fig.2; Hayami 1975; Tashiro and Kozai 1991, pl.2, figs.18-23.

Measurements in mm.

Specimen	Length	Height	
NU36-0063	16.1	8.3	Left valve
NU36-0064	19.8	10.2	Right valve

Occurrence. — Locs.30152, 30157

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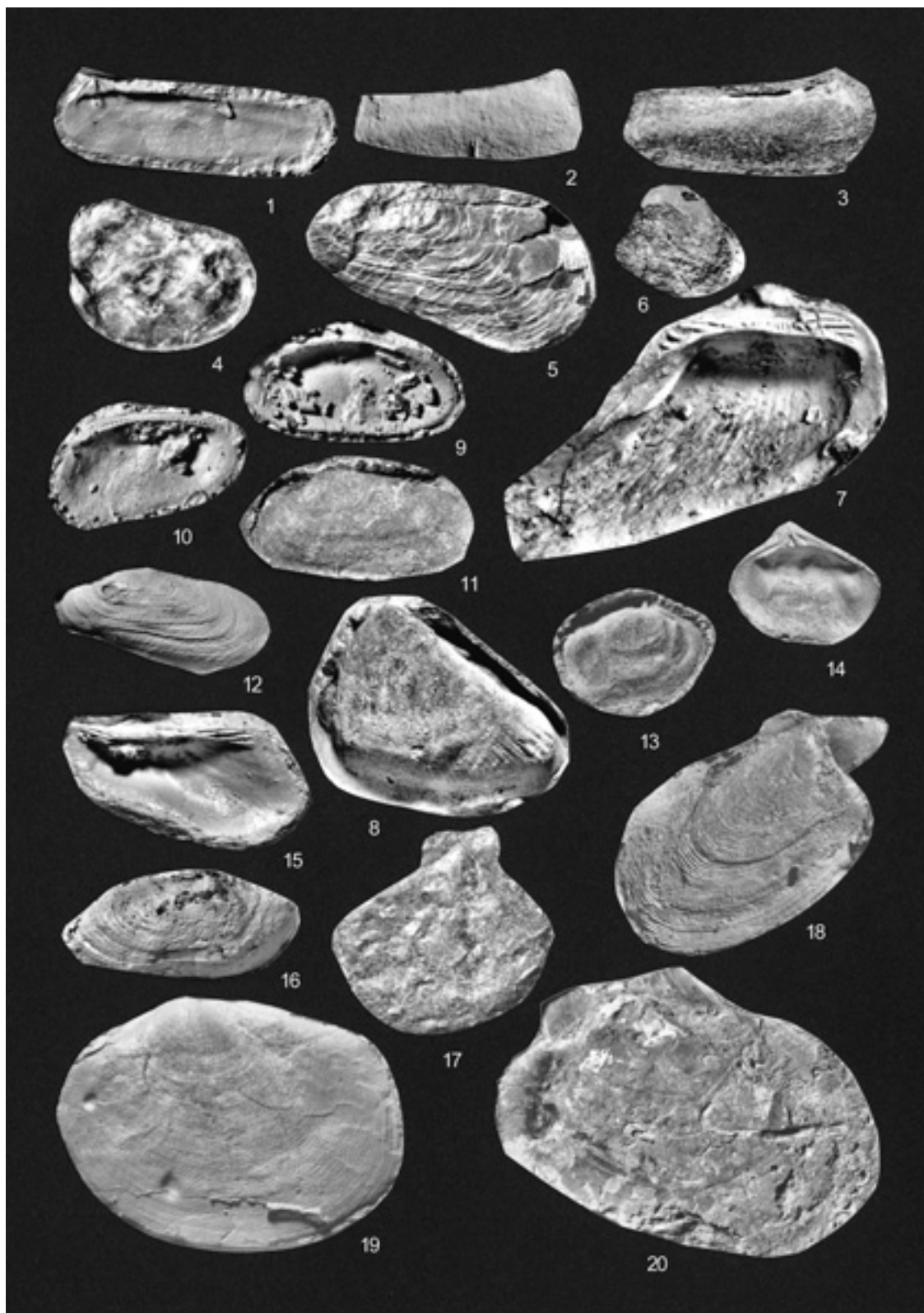
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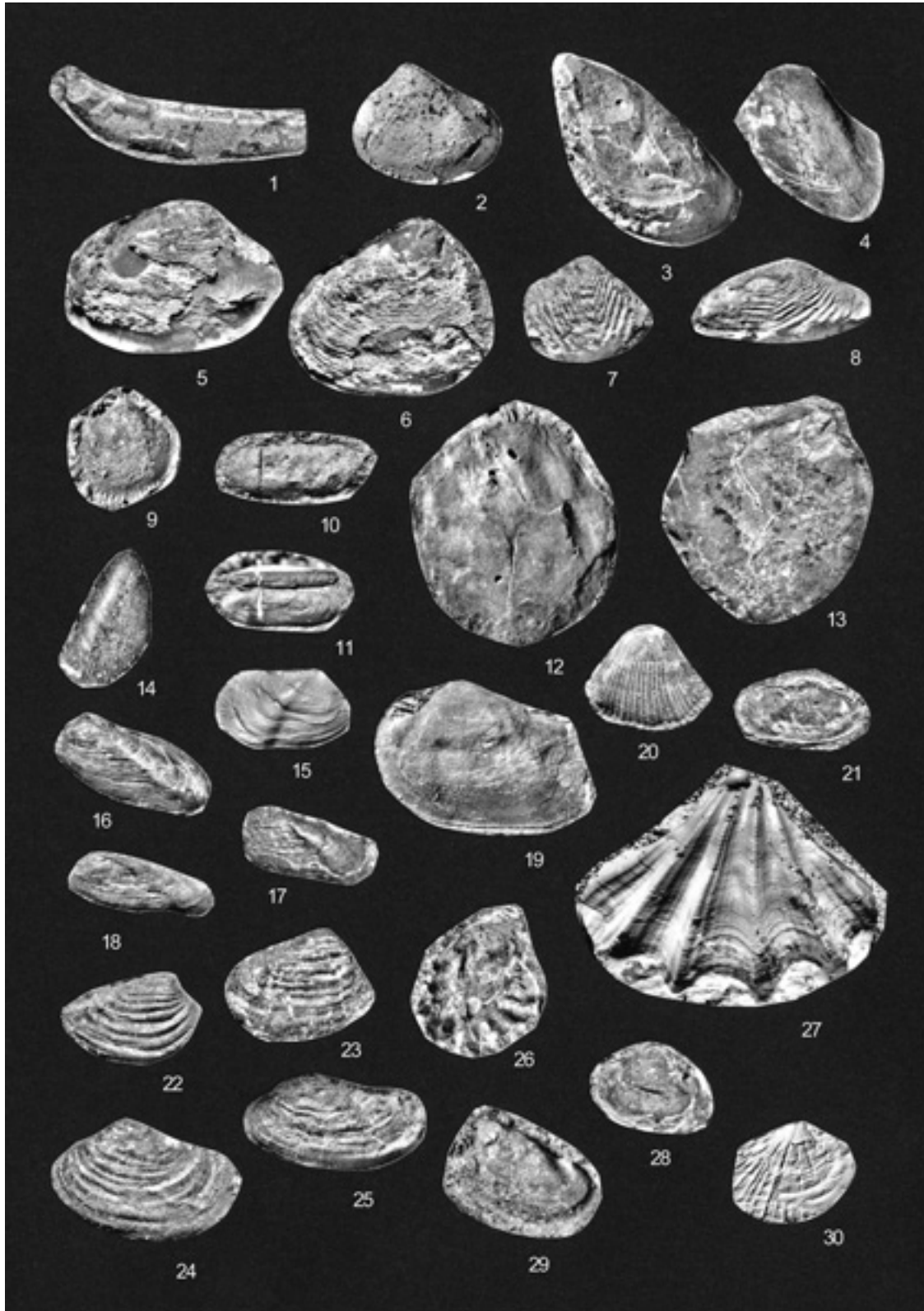
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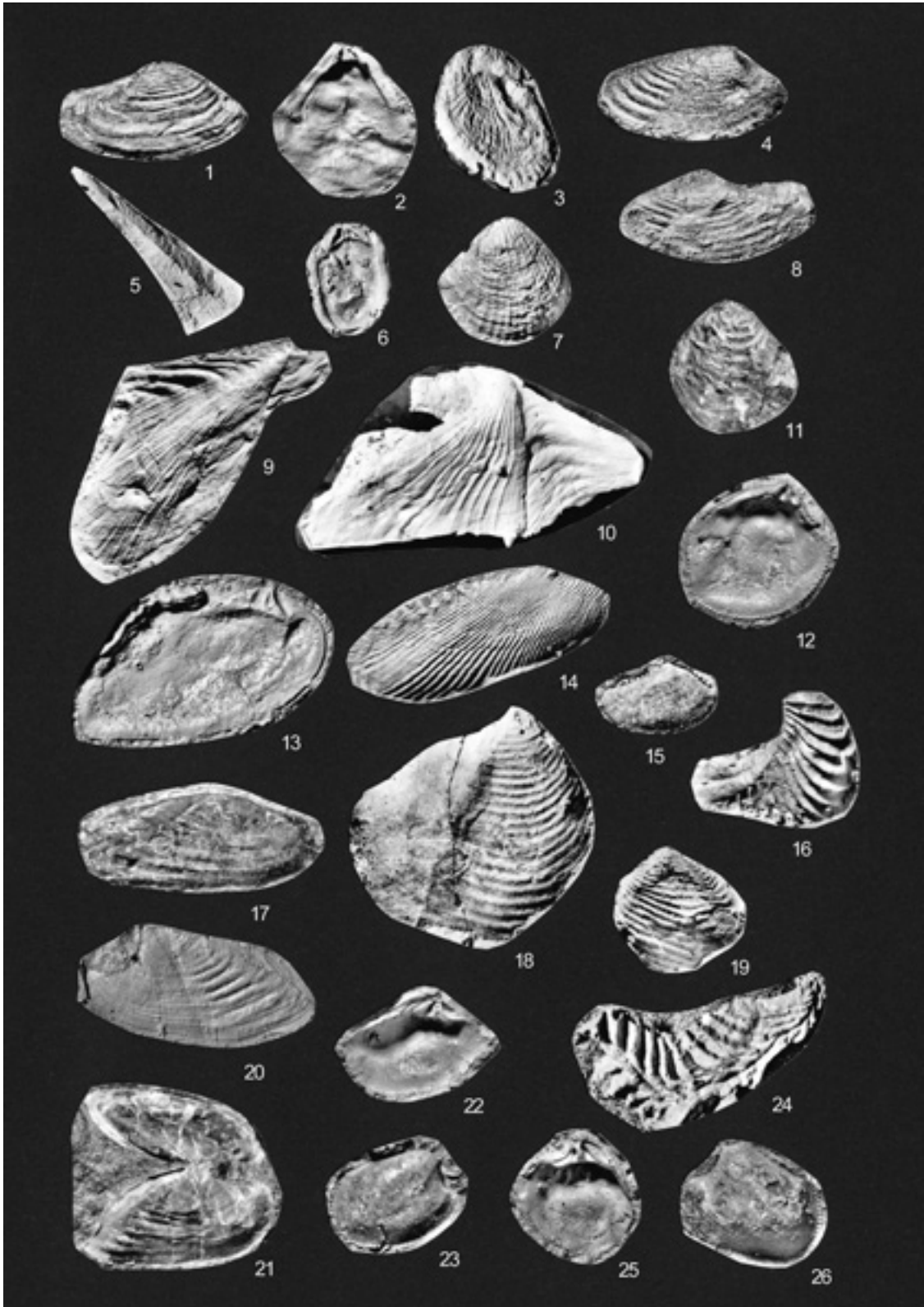
Explanation of Pl.1

1-3: *Anthonyaelongata* sp. nov.; 4: *Amphydonte* sp. cf. *A. subhaliotoidea* (Nagao); 5: *Amygdalum ishidoense* (Yabe and Nagao); 6: *Caestocorbula shikamai* Hayami; 7-8: *Cucullaea obliquata* (Amano); 9-12: *Barbatia hiroyasensis* sp. nov.; 13-14: *Eriphyla* sp. aff. *E. oblonga* Freneix; 15-16: *Cosmetodon nipponicus* (Nagao); 17: *Entolium san-chuense* Hayami; 18: *Entolium ikedai* Tashiro; 19-20: *Entolium nishikawai*, sp. nov.



Explanation of Pl.2

1: *Gervillia forbesiana* d'Orbigny; 2: *Granocardium brevis* Tashiro and Kozai; 3-4: *Granocardium ishidoense* (Yabe and Nagao); 5-6: *Globocardium sphaeroideum* (Forbes); 7: *Goniomya hayamii* Tashiro and Kozai; 8: *Goniomya subarchiaci* Nagao; 9: *Glycymeris matsumotoi* Tashiro; 10-11: *Leptosolen amabilis* Tashiro and Kozai; 12-13: *Isognomon ichikawai* Hayami; 14: *Limatula Nagaoi* Hayami; 15-18: *Modiolus obatus* sp. nov.; 19: *Nanonavis yokoyamai* (Yabe and Nagao); 20: *Neithea hanourensensis* Tashiro and Kozai; 21: *Mesosaccella choshiensis* Hayami; 22-24: *Panopea plicata* (Sowerby); 26: *Lopha nagaoi* Hayami; 27: *Neithea atava* (Römer); 28: *Nucula* sp.; 29: *Nuculopsis shidoensis* (Yabe and Nagao); 30: *Parvamussium kimurai* (Hayami)



Explanation of Pl.3

1: *Panopea plicata* (Sowerby); 2-3: *Plicatula küiensis* Hayami; 4: *Plectomya aritagawana* Hayami; 5: *Pinna* sp. cf. *P. robinaldia* d'Orbigny; 6: *Plicatula monobensis* Tashiro and Kozai; 7: *Pholadomya miyamotoi* Nagao; 8: *Plectomya concentrica* Tashiro and Kozai; 9-10: *Pterinella shinoharai* Hayami; 11-12: *Astarte subsenecta* Yabe and Nagao; 13-14: *Ptychomya densicostata* Nagao; 15: *Portlandia sanchuensis* (Yabe and Nagao); 16: *Pterotrignia pocilliformis* (Yokoyama); 17: *Scitilla japonica* Hayami; 18-19: *Rutitrigonia yeharai* Kobayashi; 20-21: *Scitilla dericatostriata* Tashiro and Kozai; 22-23: *Yabea* sp. aff. *Y. shinanoensis* (Yabe and Nagao); 24: *Rastellium carinatum* (Lamarck); 25-26: *Yabea shinanoensis* (Yabe and Nagao)

Mollusks from the Barremian Lower Hanoura Formation, Tokushima Prefecture

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Abstract

Early Cretaceous Bivalves from the Lower Hanoura Formation of the Monobegawa Group in Tokushima, East Shikoku, are described. Forty eight species of thirty seven genera, including four new species, are dealt with. The species are as follows: -

Nucula sp., *Nuculopsis shidoensis* (Yabe and Nagao), *Portlandia sanchuensis* (Yabe and Nagao), *Mesosacella choshiensis* Hayami, *Cosmetodon nipponicus* (Nagao), *Cucullaea obliquata* (Amano), *Nanonavis yokoyamai* (Yabe and Nagao), *Barbatia hiroyasensis* sp. nov., *Glycymeris matsumotoi* Tashiro, *Modiolus obatus* sp. nov., *Amygdalum ishidoense* (Yabe and Nagao), *Pinna* sp. cf. *P. robinaldia* d'Orbigny, *Pterinella shinoharai* Hayami, *Gervillia forbesiana* d'Orbigny, *Isognomon ichikawai* Hayami, *Entolium sanchuense* Hayami, *Entolium ikedai* Tashiro, *Entolium nishikawai*, sp. nov., *Neithea hanourensis* Tashiro and Kozai, *Neithea atava* (Römer), *Parvamussium kimurai* (Hayami), *Plicatula monobensis* Tashiro and Kozai, *Plicatula kiiensis* Hayami, *Limatula Nagaoi* Hayami, *Amphydonte* sp. cf. *A. subhaliotoidea* (Nagao), *Lopha nagaoi* Hayami, *Rastellium carinatum* (Lamarck), *Rutitrigonia yeharai* Kobayashi, *Pterotrigonia pocilliformis* (Yokoyama), *Astarte subsenecta* Yabe and Nagao, *Yabea shinanoensis* (Yabe and Nagao), *Yabea* sp. aff. *Y. shinanoensis* (Yabe and Nagao), *Eriphyla* sp. aff. *E. oblonga* Freneix, *Anthonyaelongata* sp. nov., *Globocardium sphaeroideum* (Forbes), *Granocardium brevis* Tashiro and Kozai, *Granocardium ishidoense* (Yabe and Nagao), *Leptosolen amabilis* Tashiro and Kozai, *Ptychomya densicostata* Nagao, *Scitilla japonica* Hayami, *Scitilla dericatosriata* Tashiro and Kozai, *Caestocorbla shikamai* Hayami, *Panopea plicata* (Sowerby), *Pholadomya miyamotoi* Nagao, *Gonyomya subarchiaci* Nagao, *Goniomya hayamii* Tashiro and Kozai, *Plectomya concentrica* Tashiro and Kozai, *Plectomya aritagawana* Hayami