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CONTENTS

TRANSACTIONS

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365. SOME PELECYPODS FROM THE UPPER JURASSIC SAKAMOTO FORMATION IN CENTRAL KYUSHU, JAPAN*

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坂本層産の二枚貝化石：上部ジュラ系坂本層産の二枚貝化石のうち，未記載の Heterodonta 及び Myacid 等に属するものを 13 種（うち 8 新種）記載した。Myacid に属するものは一般に保存不良で同定困難なものが多い。以上の記載種は外国に近似種がなく，又本邦のジュラ系からも，四国の鳥の巣層群からの 2 種を除いては未記載のものである。

田 村 実

This is the third report of studies on the pelecypods of the Sakamoto formation. The following 13 species of pelecypods including 8 new ones are described on this occasion:

Opis (*Trigonopis*) *torinosuensis* KIMURA
Opis (*Trigonopis*) *trigonalis* TAMURA, new species
Opis (*Coelopis*) *tanourensis* TAMURA, new species
Corbula globosa TAMURA, new species
Lucina tsunoensis KIMURA
Eomiodon kumamotoensis TAMURA, new species
"*Eocallista*" *regularis* TAMURA, new species
Anisocardia sp.
Tancredia rostrata TAMURA, new species
Pleuromya ? *punctostriae* TAMURA, new species
Pholadomya ? *ashikitensis* TAMURA, new species
Arcomya ? sp.
Goniomya sp.

For stratigraphical notes the reader is referred to the first report (1959-1).

The writer wishes his hearty thanks to Prof. T. KOBAYASHI of the Univ. of Tokyo for his untiring guidance and to Mr. I. HAYAMI of the Univ. for his assistances in laboratory works.

* Received Sept. 24, 1958; read Dec. 7, 1958.

Family Astartidae

Genus *Opis* DEFRANCE, 1825

Subgenus *Trigonopis* MUNIER-CHALMAS, 1887

Opis (*Trigonopis*) *torinosuensis* KIMURA

Plate 12, Figures. 11-13.

1956. *Opis* (*Trigonopis*) *torinosuensis*, KIMURA, p. 87, pl. 1, fig. 10.

Several well preserved specimens, though partly deformed, are allied to this species. The Sakamoto form is longer relative to height and is larger and wider than the Torinosu form. Umbonal inflation is distinct in the Sakamoto form.

Measurements:—

	L	H	Th
R. (MM. 3087)	15.0mm	20.0mm	8.0mm
R. (MM. 3088)	20.0	17.0	8.0
L. (MM. 3089)	20.0	19.0	8.0
R. (MM. 3090)	11.5	11.0	4.5

Occurrence:—Locs. 1, 4, 6, 8.

Opis (*Trigonopis*) *trigonalis* TAMURA, new species

Plate 12, Figures 14-16.

Description:—Shell small in size, probably subequivalve, very inequilateral, prominently convex, much longer than high; postero-ventral margin obliquely elongated; umbo at about 1/4 from anterior end, prosogyrate and a little incurved; posterior and ventral margins long and nearly straight or slightly rounded; anterior margin short and arcuate; lunule short but distinct; surface ornamented with fine and numerous concentric striae; cardinal tooth strong and fang-like in right valve; probably two cardinals in left valve; flat belt along ventral margin narrow; internal margin denticulate; adductor impressions clearly impressed on flat belt of margin; posterior one twice as large as anterior.

Measurements:—

	L	H	Th	H/L	Th/L
L. (MM. 3098)	15mm	10mm	4mm	0.67	0.27
L. (MM. 3099)	14	8	5	0.57	0.36
L. (MM. 3100)	15	9	5	0.60	0.33
L. (MM. 3101)	12	6	3	0.50	0.25

Observation:—There are several specimens of internal and external moulds. The elongate trigonal form is unusual. The hinge area can not well seen because of the inflated umbo in the internal mould.

Comparison:—Some deformed specimens of *Corbula globosa* are similar to this species but more globose and have distinct rostrum. The internal marginal denticulation is absent in *globosa*. This species is distinct from *Opis* (*Trigonopis*) *torinosuensis* by its low shape of the shell.

Occurrence:—Locs. 1, 4, 6.

Opis (*Coelopis*) *tanourensis* TAMURA, new species

Plate 12, Figures 5-7.

Description:—Shell small (L: 5.5 mm, H: 6.0 mm in holotype), trigonal, inflated, slightly longer than high or as long as high; posterior margin straight; anterior margin concave; ventral margin rounded; umbo sub-median or slightly anterior, prosogyrate and strongly incurved; lunule deeply excavated, cordate, bounded by angulation, divided by median groove, smooth; escutcheon defined by angulation, small and indistinct; surface ornamented by about 30 elevated concentric ribs which are regularly disposed and much narrower than their interspaces; internal margin not crenulate. A steep tooth below umbo in right valve.

Observation and Comparison:—Several specimens of internal and external moulds at hand. The lunule and escutcheon are strongly depressed and bounded by two carina-like angulations. The angulations become steep ridges but not carina. The absence of carina, bisected lunule and lanceolate escutcheon are distinct specific characters.

This resembles *Opis* (*Trigonopis*) *corallina* DAMON (ARKELL, 1932) at a glance in surface ornaments. It is distinguished from that species by its distinct deep lunule and lack of distinct carina.

Occurrence:—Locs. 4, 11.

Family Erodonidae

Genus *Corbula* BRUGUIÈRE, 1797

Corbula globosa TAMURA, new species

Plate 12, Figures 1-4.

Description:—Shell small for genus,

prominently inflated, globose, inequilateral, nearly equivalve, trigonally ovate in outline; anterior margin short, nearly straight or a little arcuate; posterior margin long and rostrate; ventral margin a little rounded or nearly straight; umbo at about anterior 1/4, slightly incurved, prosogyrate and indistinct; sharp carina bounding depressed posterior area; surface with fine, fairly regular concentric ridges distinct on antero-ventral side but obscure in other part; a strong fang-like cardinal tooth in right valve and a socket in left valve; marginal flat belt distinct, nearly parallel to shell margin; adductor scars strongly impressed on flat belt in which posterior one is much stronger than anterior.

Measurements:—

	L	H	Th	H/l	Th/L
	mm	mm	mm		
R. (MM. 3093)	9.0	6.0	2.5	0.67	0.28
L. (MM. 3094)	7.0	4.5	3.0	0.64	0.43
L. (MM. 3095)	9.0	6.0	2.5	0.67	0.28
L. (MM. 3096)	3.5	3.5	1.5	1.0	0.43
L. (MM. 3097)	3.0	3.0	1.5	1.0	0.43

Observation:—Many external and internal moulds of both valves are variable in shape, although some are more or less deformed. It is note-worthy that the H/L and Th/L ratios are larger in small forms than in large form. This means that the shell becomes less inflated and rostrum is more distinct in large form (probably adult form) than in the small form (probably young form).

Comparison:—The internal wide belt along the shell margin and the rostrum are characteristics of this species. *Corbula islipensis* Lyc. (Mor. and Lyc. 1853, pl. 37, fig. 7) is closely related to this species but the umbo is more anterior in the latter than in the former. Another similar species is *Corbula borneensis* Vogel from Borneo (Vogel, 1896), but in *borneensis* the position of umbo is nearly mesial or slightly anterior and the flat belt is not so wide as in *globosa*. *Corbula daghaniensis* Cox from Callovian of Somaliland (Cox, 1935) is closely alike to this species but in the latter the rostrum is more developed and the umbo not so elevated.

Occurrence:—Locs. 4, 5, 11, 12.

Family Lucinidae

Genus *Lucina* Bruguière, 1797

Lucina tsunoensis Kimura

Plate 12, Figures 21, 22.

1956. *Lucina tsunoensis*, Kimura, p. 87, pl. 1, figs. 11-13.

Fine concentric ridges are fairly regularly disposed and about 18 in number. Some specimen from Tsurubami is large (20 mm long and 14 mm high) for the species and shows elongate outline. *Lucina* s. str. in recent taxonomy has no teeth but *Lucina* s. l. in this paper includes the one having teeth.

Occurrence:—Locs. 6, 11.

Family Neomiodontidae

Genus *Eomiodon* Cox, 1935

Eomiodon kumamotoensis Tamura, new species

Plate 12, Figures 17, 18.

Description:—Shell medium to small for genus, fairly convex, inequilateral, somewhat quadrate and higher than long; umbo distinct, a little prosogyrate and placed at a little anterior to center; postero-dorsal margin a little rounded; antero-dorsal slightly concave; ventral rounded; lunule depressed and distinct; posterior surface bounded by obtuse

carina-like angulation, a little depressed; surface covered by 9 concentric regularly disposed ridges; 2 diverging cardinal teeth and an anterior short lateral tooth seen in left valve.

Measurements:—

	L	H
R. (MM 3105)	13.5 mm	15.0 mm
L. (MM 3104)	9.5	9.5

Observation:—There are a few internal and external moulds of both valves, but the hinge area is poorly preserved and any precise observation is difficult. The posterior cardinal tooth is much stronger than anterior one in left valve. The posterior depression on surface happen to be impressed on an internal mould (Fig. 13) and the carina is distinct.

Comparison:—This is closely allied to *Astarte altissima* COX (1935) from Somaliland Jurassic in external characters, but in the latter the internal margin is denticulate as in many *Astarte*. *Eomiodon vulgaris* HAYAMI (1958) from the Liassic Kuruma group is somewhat similar to this but the concentric ribs of this are more regular, smaller in number. The shell of *vulgaris* is more elongated than this.

Occurrence:—Locs. 4, 6.

Genus *Eocallista* DOUVILLÉ, 1912

"*Eocallista*" *regularis* TAMURA, new species

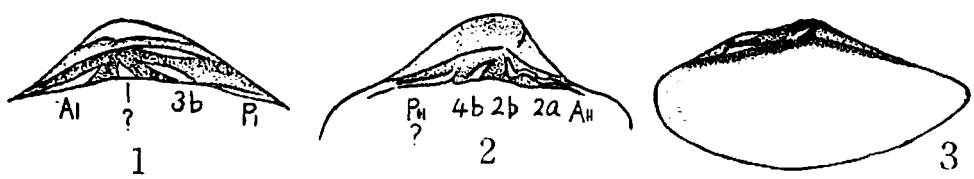
Plate 12, Figures 8-10.

Description:—Shell of medium size (L: 26 mm, H: 20 mm), inequilateral, moderately convex, ovate and longer than high; umbonal region slightly inflated; umbo a little anterior to center, prosogyrate, a little projected above hinge margin; postero-dorsal outline rounded; posterior portion expanded and postero-dorsal outline sloping down to rounded postero-ventral margin; ventral margin slightly rounded; anterior margin ronuded and convex, its most anterior part at about the mid-height; antero-dorsal margin excavated; surface ornamented with about 40 fairly regular fine grooves; in right valve 1 well developed, 3b long and not bifid, AI and PI present (See Text-fig. 1).

Observation:—The holotype left valve is represented by an internal and external mould. Its hinge structure belongs to the Cyprinidae and is similar to one of *Eocallista*. In *Eocallista*, however, 1 is not apart from AI (COX, 1947). This is more developed in hinge than *Eocallista* but 3a is invisible.

Comparison:—An undifferentiated tooth of 1 and fairly regular concentric fine grooves are characteristic of the species. *Eomiodon kumamotoensis* TAMURA and *Lucina tsunoensis* KIMURA have fine, concentric, regularly disposed ridges. These ornaments are somewhat similar to those of this species, but they are different in other characters.

Occurrence:—Loc. 5.



Text-Figures 1, 2, 3.

Fig. 1. Hinge structure of a right valve of "*Eocallista*" *regularis* TAMURA, new species.
Fig. 2. Hinge structure of a left valve of *Anisocardia* sp.
Fig. 3. Hinge structure of a right valve of *Tancredia elongata* TAMURA, new species.

Genus *Anisocardia* MUNIER-CHALMAS, 1863

Anisocardia sp.

Plate 12, Figures 19, 20.

Description:—Shell small to medium for genus, moderately inflated, slightly inequilateral, elongately subrectangular in outline; dorsal margin nearly straight, almost parallel to ventral margin, anterior and posterior margins slightly rounded and posterior one longer than anterior; umbo fairly elevated, a little projected beyond hinge margin, prosogyrate and slightly incurved, situated nearly mesial; lunule fairly deep but small; carina from umbo to postero-ventral margin sharp and distinct; surface ornaments unknown.

Measurements:—

	L	H
L. (MM 3108)	15 mm	13 mm
L. (MM 3109)	18	14

Observation:—Represented by two internal moulds of left valves having Anisocardian hinge (see Text-fig. 21). It somewhat resembles *Anisocardia elegans* MUNIER-CHALMAS in hinge structure (COX, 1947), but more or less deviates from the latter. The specimens are more or less deformed and the carina in Fig. 15 is strengthened by deformation. The external characters are unknown.

Comparison:—The fairly long and straight dorsal margin is characteristic of this species. *Anisocardia williamsoni* COX from Scarborough Limestone in England (COX, 1947) resembles this species in general form but the umbo is more elevated in the former.

Occurrence:—Loc. 4.

Family Tancrediidae

Genus *Tancredia* LYCETT, 1850

Tancredia rostrata TAMURA,

Plate 12, Figure 23.

Description:—Shell medium for genus (28 mm long, 14 mm high), slightly convex, highly inequilateral, ovately subtrigonal and much longer than high; umbo central, slightly prosogyrate, contiguous; antero-dorsal margin a little arcuate, somewhat acutely tapering; anterior extremity forming an angle of about 50° and a little higher from the midheight; postero-dorsal margin slightly rounded but angulate in middle part and shouldered; posterior extremity somewhat angulate at junction with ventral margin, at a little above midheight; ventral margin rounded; surface smooth except for fine growth-lines; a cardinal tooth below umbo in each valve oblique; lateral tooth in left valve short; probably two laterals on right valve.

Comparison:—The outline and hinge structure in Infra-Liassic species of *Hettangia* by TERQUEM which are now included in *Tancredia* has angular outline and shouldered posterior-dorsal margin (TERQUEM, 1855). In outline, this species is very elongate and acutely tapering anteriorly. The positions of both shell extermities are at a little higher than the midheight. These are distinction of this species from other species of *Tancredia*.

Occurrence:—These specimens from Locs. 6, 12.

Family Pleuromyidae

Genus *Pleuromya* AGASSIZ, 1843

Pleuromya ? *punctostriae* TAMURA,

new species

Plate 12, Figures 29-32.

Description:—Shell medium to small for genus (Holotype: 34 mm long, 25 mm high), depressed, inequilateral, somewhat rectangular or ovate in outline and gaping posteriorly; umbo at about anterior 1/4, not distinct, orthogyrate; posterior dorsal margin truncated or slightly rounded; posterior margin rounded and a little produced; ventral nearly parallel to dorsal margins and rounded; wrinkles on surface fairly regular and concentric; radial rows of minute granules very numerous on surface; hinge unknown.

Observation:—Several internal and external moulds of both valves are suffered from deformation. Figs. 29-31 are depressed laterally and Fig. 32 vertically. The posterior gape and the distinct carina of Fig. 32 are strongly exaggerated by deformation. As the hinge structure is invisible from the specimens at hand, it is difficult to say whether this belongs to *Pleuromya* or to *Homomya*. Judging from the modification of granulated surface of the Myacids (MORRIS and LYCETT, 1853), this belongs rather to *Pleuromya* than *Homomya*.

Comparison:—*Homomya hortulana* AG. from the Portlandian of Porrentruy (AGASSIZ, 1840) resembles this species in concentric wrinkles on surface and general outline. But in the strong inflation of the shell this is difference from the depressed form of *P.* ? *punctostriae*.

Occurrence:—Loc. 4.

Family Pholadomyidae

Genus *Pholadomya* G. B. SOWERBY, 1825

Pholadomya ? *ashikitensis* TAMURA, new species

Plate 12, Figures 26, 27.

Description:—Shell small for genus, fairly convex, equivalve, inequilateral, trigonal in outline; umbo situated nearly posterior end, nearly orthogyrate, not inflated; postero-dorsal margin a little arcuate and long; anterior margin slightly rounded; ventral margin rounded; posterior area depressed; surface ornamented with about 12 discontinuous radial ribs or rows of tubercles but absent on anterior side; growth-lines coarse on ventral side; hinge unknown; test thick.

Measurements:—

	L	H
R. (MM 3119)	35 mm	32 mm
R. (MM 3120)	22	20

Observation:—This species resembles the *Trigoniae* in its trigonal form and its thick test (2 mm in the holotype specimen). The posterior margin is absent and the postero-dorsal margin directly joins with the ventral one. The hinge structure is invisible but probably not of the *Trigoniae*. The fine radial ribs or radial rows of tubercles are very similar to those of *Pholadomya*. So the writer includes this species in *Pholadomya*. On the ventral side, tubercles are more distinct than in other part, especially at junction with concentric lines of growth.

Comparison:—This is distinctly different from other Jurassic species by its trigonal shape and its discontinuous radial ribs, judging from the materials available for the writer.

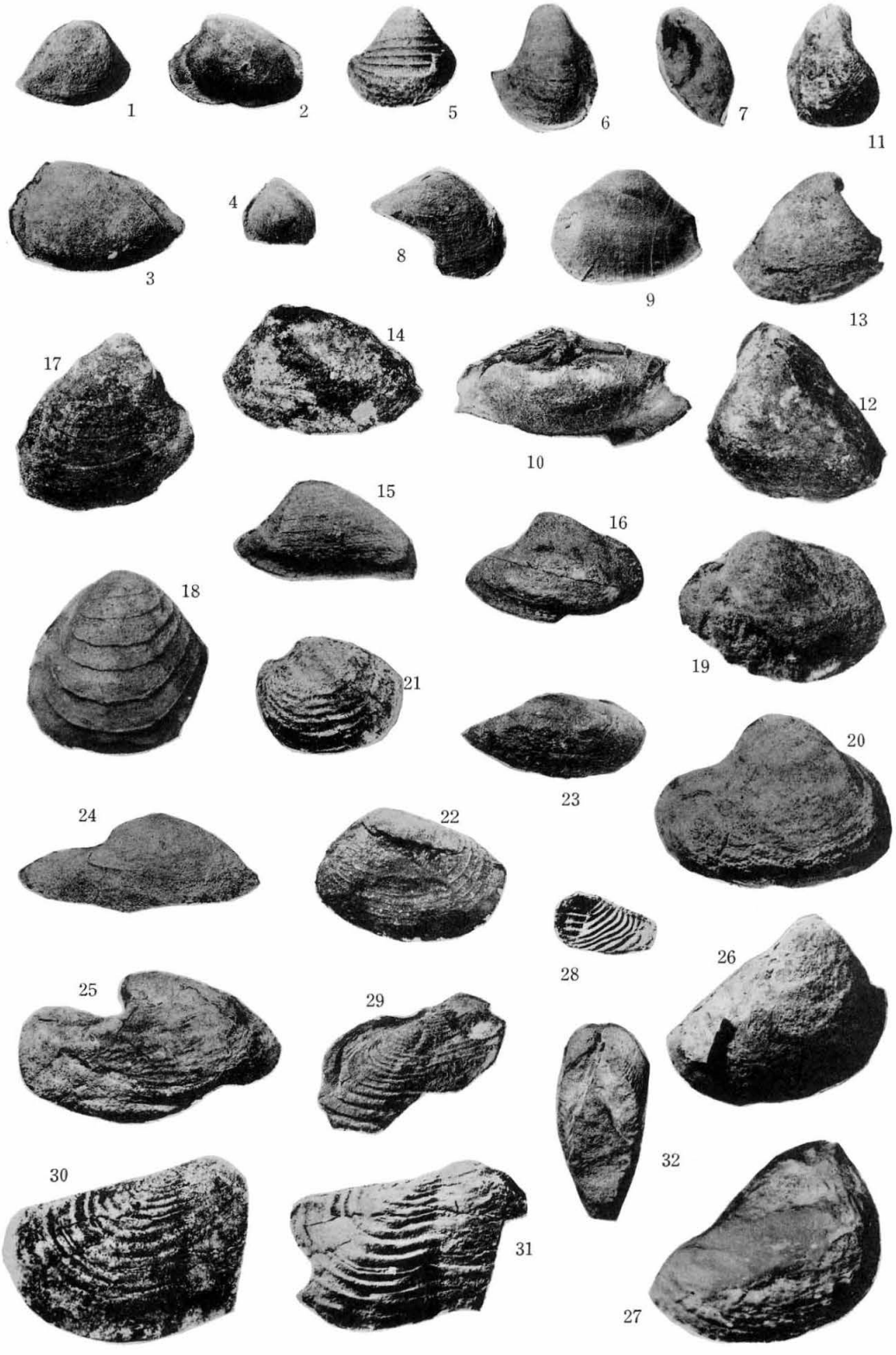
Occurrence:—Loc. 12.

Genus *Arcomya* AGASSIZ, 1843

Arcomya ? sp.

Plate 12, Figures 24, 25.

Two deformed internal moulds of left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Explanation of Plate 12

Corbula globosa TAMURA, new species

Fig. 1. Plaster cast of the external mould of the holotype right valve; Loc. 4. ×2. (MM 3093)

Figs. 2, 3. Internal moulds of left valves; Loc. 5. ×3. (MM 3094, 95).

Fig. 4. Internal mould of a left valve; Loc. 12. ×3. (MM 3097).

Opis (*Coelopis*) *tanourensis* TAMURA, new species

Fig. 5. Clay cast of the external mould of the holotype left valve; Loc. 12. ×3. (MM 3091).

Figs. 6, 7. Internal moulds of the holotype left valve: side view (Fig. 6) and anterior view (Fig. 7); Loc. 11. ×3. (MM 3091).

"*Eocallista*" *regularis* TAMURA, new species

Figs. 8, 9. Clay cast of the external mould and internal mould of the broken holotype left valve; Loc. 5. ×1. (MM 3107).

Fig. 10. Internal mould of the holotype left valve: ×1.5.

Opis (*Trigonopis*) *torinosuensis* KIMURA

Fig. 11. Right valve; Loc. 6. ×1. (MM 3087).

Fig. 12. Internal mould of a left valve; Loc. 6. ×1.5. (MM 3089).

Fig. 13. Internal mould of a right valve; Loc. 6. ×1. (MM 3088).

Opis (*Trigonopis*) *trigonalis* TAMURA, new species

Fig. 14. Left valve; Loc. 6. ×2. (MM 3098).

Fig. 15. Internal mould of the holotype left valve; Loc. 4. ×2. (MM 3099).

Fig. 16. Internal mould of a left valve; Loc. 4. ×2. (MM 3100).

Eomiodon kumamotoensis TAMURA, new species

Fig. 17. Internal mould of a right valve; Loc. 4. ×3. (MM 3104).

Fig. 18. Plaster cast of the external mould of the holotype left valve; Loc. 6. ×2. (MM 3105).

Anisocardia sp.

Figs. 19, 20. Internal moulds of left valves; Loc. 4. ×2. (MM 3109, 08).

Tancredia rostrata TAMURA, new species

Fig. 23. Internal mould of the holotype left valve; Loc. 6. ×1. (MM 3110).

Lucina tsunoensis KIMURA

Fig. 21. Clay cast of the external of a left valve; Loc. 11. ×3. (MM 3402).

Fig. 22. Left valve; Loc. 6. ×1. 5. (MM 3103).

Arcomya ? sp.

Figs. 24, 25. Internal moulds of left valves; Locs. 11 (Fig. 24), 4 (Fig. 25). ×2. (MM 3121, 22).

Pholadomya ? *ashikitensis* TAMURA, new species

Figs. 26, 27. Internal mould and the modeling cast of the external mould of the holotype right valve; Loc. 12. ×1. (MM 3119).

Goniomya sp.

Fig. 28. External mould of the fragment of a right valve?; Loc. 4. ×1. (MM 3123).

Pleuromya ? *punctostriae* TAMURA, new species

Fig. 29. Internal mould of a right valve; Loc. 4. ×1. (MM 3112).

Figs. 30, 31. Plaster cast of a external mould and internal mould of the holotype right valve; Loc. 4. ×1. (MM 3113).

Fig. 32. Internal mould of a bivalved shell; posterior view; Loc. 4. ×1.5. (MM 3114).

All specimens here described are stored in the Geol. Inst., Univ. of Tokyo.

valves at hand are probably included into *Arcomya* due to its general resemblance to *Arcomya* and the lack of tooth.

Shell small, inequilateral, a little convex, elongately ovate in outline: umbo a little anterior to middle, incurved and prosogyrate; posterior and ventral margins rounded but posterior produced posteriorly; anterior dorsal margin excavated; anterior margin truncated.

Occurrence:—Locs. 4, 12.

Genus *Goniomya* AGASSIZ, 1838

Goniomya sp.

Plate 12, Figure 28.

Two fragments showing characteristic V-shaped ornament of *Goniomya* are at hand.

Occurrence:—Loc. 4.

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See also ARKELL (1927-37), COX (1935), KIMURA (1956), MOR. and LYC. (1854), TAMURA (1959-1, -2) in Bibliography of *Trans. Proc. Palaeont. Soc. Japan, N. S. Nos. 33, 34* of this study.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 35, pp. 121-132, pl. 13, Sept. 15, 1959

366. ON THE MIOCENE PECTINIDAE FROM THE ENVIRONS OF SENDAI: PART 15. *PECTEN COSIBENSIS* YOKOYAMA AND ITS RELATED SPECIES*

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仙台附近中新統産 Pectinidae: その 15, *Pecten cosibensis* YOKOYAMA 及びその関係種について: *Pecten cosibensis* YOKOYAMA は最初神奈川県の小柴層から記載され, 後各地から多くの産出が報告された。併しその原記載が不充分であつたために非常に多くの混乱が生じていた。筆者は *cosibensis* 及びこれに似た多数の標本について再検討し, *cosibensis* のグループを次の4つの亜種に区別した。それらは夫々 *Chlamys cosibensis cosibensis* (YOKOYAMA), *Ch. cosibensis hanzawae* MASUDA, n. subsp., *Ch. cosibensis turpicula* (YOKOYAMA), *Ch. cosibensis heteroglypta* (YOKOYAMA) である。これらの間には *cosibensis hanzawae* → *cosibensis* (s. s.) → *cosibensis turpicula* → *cosibensis heteroglypta* の進化系列が考えられる。

増田孝一郎

Introduction and Acknowledgements

The type specimens of *Pecten cosibensis* YOKOYAMA (1911) from the Pliocene Koshiba formation at Koshiba, Yokohama City, Kanagawa Prefecture consist of two unfavorably preserved shells. The one described as a left valve is a right valve. His *Pecten tigerrinus* MÜLLER from the same locality are the left valves of *cosibensis*, and his *Pecten swiftii* (YOKOYAMA, 1920) from the same locality is a right valve of *cosibensis*. *Cosibensis* also occurs from the Pliocene of Saishu Island (YOKOYAMA, 1923). The Shigarami Miocene at Shimosoyama, Shigaramimura, Kami-Minochi-gun, Nagano Prefecture, yielded him an imperfect right valve of *Pecten turpiculus*; it is close to *cosibensis*. He described (1926) *Pecten heteroglyptus* from the Sawane Pliocene at Kaidate, Sawada-machi, Sado-gun, Niigata Prefecture and stated that his previously described *Pecten cosibensis* is a synonym of *P. heteroglyptus*. But as pointed out by KURODA (1932) and NOMURA and HATAI (1936), such procedure is not favorable. GRANT and GALE (1931) regarded YOKOYAMA's *cosibensis* and *tigerrinus* to be synonym of *Pecten* (*Pallium*) *swiftii* var. *etchegoini* ANDERSON and YOKOYAMA's *heteroglyptus* to be *Pecten swiftii* var. *nutteri* ARNOLD. The writer (MS) holds the Japanese species as distinct. NOMURA and HATAI (1935) described and discussed *P. cosibensis* and *P. heteroglyptus* from the Pliocene Daishaka formation near Daishaka, Namioka-machi, Minami-Tsugaru-gun, Aomori Prefecture, but confusion still remains concerning them and their related species.

Numerous specimens of *P. cosibensis* were studied and the results show that the *cosibensis* group includes four subspecies, *Chlamys cosibensis* (s. s.), *Ch. cosibensis hanzawae* MASUDA, n. subsp., *Ch.*

* Received Oct. 14, 1958; read at the 71st. meeting of the Society at Kyoto, Sept. 27, 1958.

cosibensis turpicula and *Ch. cosibensis heteroglypta*.

Acknowledgements are due to Dr. Kotora HATAI of the Department of Geology, Faculty of Education, Tohoku University, for his supervision. Thanks are due to Messrs. Yutaka SAITÔ of the Department of Geology, Faculty of Education, Shinshu University, Shin-ichi HONMA of the Kanazawa High School at Kanai-mura, Sado-gun, Niigata Prefecture and Jun KATAOKA of the Institute of Geology and Paleontology, Faculty of Science, Tohoku University, for their assistance in the collecting specimens.

Description

Family Pectinidae

Subfamily Pectininae

Genus *Chlamys* (BOLTEN) RÖDING, 1798

Chlamys cosibensis (YOKOYAMA), 1911

Plate 13, Figures 1-9.

1911. *Pecten cosibensis* YOKOYAMA, *Jour. Geol. Soc. Tokyo, Vol. 18, No. 208*, p. 4, pl. 1, figs. 3, 4.
1911. *Pecten tigerrimus* MÜLLER, YOKOYAMA, *Ibid.*, p. 3, pl. 1, figs. 11, 12. (non MÜLLER, 1776).
1920. *Pecten cosibensis* YOKOYAMA, *Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. 39, Art. 6*, p. 156, pl. 13, figs. 7, 8.
1920. *Pecten swiftii* BERNARDI, YOKOYAMA, *Ibid.*, p. 154, pl. 14, fig. 11. (non BERNARDI, 1858).
1920. *Pecten tigerrimus* MÜLLER, YOKOYAMA, *Ibid.*, p. 155, pl. 14, figs. 5, 6. (non MÜLLER, 1776).
1923. *Pecten cosibensis* YOKOYAMA, *Ibid.*, *Vol. 44, Art. 7*, p. 7, pl. 1, fig. 5.
1926. *Pecten heteroglyptus* var. *cosibensis* YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 8*, p. 304, pl. 33, figs. 6, 7.
1930. *Chlamys cosibensis* YOKOYAMA, KURODA in HONMA, *Geol. Cent. Shinano, Pt. 4*, p. 36, pl. 3, fig. 12.
1935. *Chlamys swiftii etchegoini* (ANDERSON), OTUKA, *Bull. Earthq. Res. Inst., Vol. 13, Pt. 4*, p. 886, pl. 55, fig. 140. (non ANDERSON, 1905).
1935. *Pecten (Pallium) cosibensis* YOKOYAMA, NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull., No. 6*, p. 97, pl. 12, figs. 5, 8, 9; pl. 13, figs. 4-7.
1953. *Pecten (Pallium) heteroglyptus* YOKOYAMA, NOMURA and HATAI, *Ibid.*, p. 99, pl. 11, fig. 7. (non YOKOYAMA, 1926).
1950. *Chlamys islandica* var. *swiftii* form *etchegoini* (ANDERSON), KUBOTA, *Cenozoic Research, No. 6*, p. 15, pl. 8, fig. 54; pl. 9, fig. 68. (non ANDERSON, 1905).
1950. *Chlamys islandica* var. *cosibensis* YOKOYAMA, KUBOTA, *Ibid.*, p. 15, pl. 8, fig. 55.

Shell moderate in size, thickness and convexity, higher than long, equilateral except for auricles; left valve more convex than right; ventral margin somewhat uneven corresponding to external sculpture; both valves radiately ribbed and forming an angle of less than 90° at apex.

Right valve with more than 20, round-topped, unequal radial ribs, fine intercalary threads and concentric growth lines, with rather distinct fine network; radial ribs in central part of disc usually gathered into four, rather elevated, rounded, stout fascicular bundles separated by more or less deep valleys, usually divided into two parts by a shallow longitudinal furrow near beak and sometimes again near ventral margin, but sometimes valleys so shallow that fascicular bundles become rather inconspicuous; two fascicular bundles in central part of disc much more distinct than others, usually consist of four to five or rarely more, subequal radial ribs more or less broader than interspaces, and sometimes with an intercalary thread

between them, but bundles near submargins usually rather inconspicuous and with a few intercalary threads between radial ribs; submargins with several, subordinate, fine radial threads; valleys usually rather deep, narrower than bundles themselves and with unequal intercalary threads which are two to three or rarely more in number; primary intercalation usually appears on upper half of disc, nearly equal to divided threads in strength at ventral margin; secondary and tertiary intercalations appear on lower half of disc, and somewhat fainter and finer than other radials; concentric constrictions rather distinct; anterior auricle much larger and longer than posterior one, furnished with deep byssal notch and rather narrow byssal area, and sculptured with several, distinct, somewhat imbricated radial threads, fine intercalary threads and concentric lines; posterior auricle similar to anterior, though radial threads of posterior one more numerous and less distinct than anteriors; hinge with distinct cardinal crura, rather wide and shallow resilial pit provided with distinct lateral ridges widely open towards lower, and with distinct ctenolium. Left valve with five, prominent, rather stout radial ribs separated by rather deep and wide valleys, rather low, fine radial ribs in valleys, fine intercalary threads and concentric growth lines, with rather distinct fine network; ribs prominent, two near submargins sometimes inconspicuous, nearly equal to others in strength near beak but tend to become stout and elevated towards ventral margin, divided into three or more, finely scaled, fine radial threads by shallow longitudinal furrows; other radials unequal in strength, finely scaled, and rarely divided into two finely scaled radial threads by a shallow longitudinal furrow; intercalary threads between radial ribs finely scaled, usually appear on upper half of disc, and sometime secondary ones between radial ribs and intercalary threads appear near ventral margin; concentric constrictions usually more distinct than those of right valve, and sometimes radial ribs appear somewhat nodose; anterior auricle sculptured with a few finely imbricated, fine radial threads and concentric lines, posterior one similar to anterior, though radial threads more numerous and finer than anteriors. Interior surface of valves gently folded corresponding to external sculpture; characteristic fine serration at ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—*Chlamys* (*Swiftopecten*) *swiftii* (BERNARDI) is distinguished from the present one by its large, posteriorly contorted shell which is much higher than long, smaller apical angle, triangular anterior auricle, rather simple cardinal crura and rather flat hinge plate sculptured with fine striae parallel to the hinge line, and nearly flat left valve in young shell. *Chlamys wattsi* (ARNOLD) (ARNOLD, 1906) from the Pliocene of Fresno County and *Chlamys wattsi morani* (ARNOLD) (ARNOLD, 1906) from the Pliocene of Monterey County, both in California, resemble the present species; the former differs from *cosibensis* by its right valve having convexity nearly equal with the left valve, radial ribs, less prominent byssal notch and obsolete posterior auricle, and from the latter by its radial ribs with five to seven, strong, squarish, elevated radial threads, slightly developed byssal notch, short posterior auricle and less distinct concentric constrictions. *Chlamys etchegoini* (ANDERSON) (NOMLAND, 1917) from the Pliocene of Fresno County, California, resembles this species, but differs

Table 1. Measurements on the selected specimens of *cosibensis* group (in mm.)

Specific name	Locality	Height	Length	Hinge-length	Depth	Apical angle	Valve
cosibensis (s. s.)	A	24	21.5	10.5	6	80°	R
	B	48.8	45	19.4	10	85°	〃
		35	31.7	15.5	7	80°	〃
		26.1	23.7	12.7	5.1	85°	〃
		25	22.2	12	4	85°	〃
		24.6	21.5	11.5	4.3	80°	〃
		37.8	34	16	8.5	85°	L
		31.9	28.1	14	6	85°	〃
		31.2	27.4	14	5.4	85°	〃
		27.5	24	12	5	85°	〃
		25.2	22.3	12.5	4.7	80°	〃
	C	56.5	54.3	24.3	8.9	85°	R
		55.8	51.3	22	11.2	80°	〃
		53.1	46.8	20.5	9.5	80°	〃
		47	43	19	10.8	80°	〃
		34.4	31	13	8	85°	〃
		58	52.5	—	14	80°	L
		51.3	44	20	16	85°	〃
		39	35	15	10	80°	〃
		28.8	24.7	12.5	6	80°	〃
		26	22	11.8	6.7	85°	〃
	D	66.2	58.4	26	15.5	85°	R
		41.6	38.2	19	10.7	85°	〃
		74.2	70.4	30	19.2	90°	L
		58.8	51	22.7	14.6	85°	〃
	E	37	—	14.7	8.8	80°	R
	F	31	29.8	11.5	8	90°	R
		26.4	24.5	10.8	6.4	90°	〃
		23.7	21.3	9.5	5	90°	〃
		21	19.5	9.6	5	90°	〃
c. hanzawai	F	19.5	18.8	10.2	5	90°	R
		17.7	16.5	8	4	90°	〃
		26.2	24.5	10.8	5.3	90°	L
		24.2	22	10.2	6.3	90°	〃
		22	20.5	10.5	4.3	90°	〃
		20.2	18	9.2	4.1	90°	〃
		18.1	16.4	9.5	4	90°	〃
	G	28	26	11	6.5	90°	R
		14.8	13.7	—	2.5	90°	L
	H	32	30.4	—	8	90°	R
c. turpiculata	E	46	42.5	17.5	12.5	90°	R
		39.7	34.3	16.4	7.5	85°	〃+
		39.7	34.3	16.4	7.8	85°	L+
	I	37.4	34	—	7	85°	R
		35.5	31	14	6.5	85°	〃
		44.3	38.2	16.3	8.2	85°	L
c. heteroglypta	C	60	55	23	10.3	90°	R
		55	50.9	22	8.6	90°	〃
		49	46	19	9	90°	〃
		28	25.7	12.4	4.8	90°	〃
		57	52.2	21	13.4	90°	L
		56.5	51	22	11	90°	〃
		53.5	48.6	21.5	12	90°	〃
		36	31.7	14.4	6.5	90°	〃
	D	74.2	71.5	29.8	15.2	90°	R
		62.5	59.5	28	13	90°	〃
		74	69	—	18.8	90°	L
		66.5	64.7	29	19.5	90°	〃
	B	34	30	15.6	6.1	85°	R+
		34	30	15.6	7.2	85°	L+

+……intact valve. A……Koshiba formation, Kanagawa Prefecture. B……Hamada formation, Aomori Prefecture. C……Sawane formation, Niigata Prefecture. D……Daishaka formation, Aomori Prefecture. E……Shigarami formation, Nagano Prefecture. F……Sugota formation, Akita Prefecture. G……Moniwa formation, Miyagi Prefecture. H……Ôtsutsumi formation, Miyagi Prefecture. I……Suenomatsuyama formation, Iwate Prefecture.

by the radial ribs and the obsolete posterior auricle.

Remarks:—This species which is characterized as above described are from the localities mentioned below.

Described specimens:—River cliff of the Chikagawa stream, about 200 m. from the sea shore at Chikagawa, Tanabu-machi, Shimokita-gun, Aomori Prefecture. Silty fine-grained sandstone of the Hamada formation (Pliocene). DGS, Reg. No. 3686, IGPS, coll. cat. no. 72556.

Occurrence:—Aoso, Nanakita and Utsuno formations in Miyagi Prefecture, Ginzan formation in Yamagata Prefecture, Suenomatsuyama formation in Iwate Prefecture, Shigarami formation in Nagano Prefecture, Sawane and Shiraiwa formations in Niigata Prefecture, Sasaoka formation in Akita Prefecture, Koshiba formation in Kanagawa Prefecture, Hamada and Daishaka formations in Aomori Prefecture and Setana formation in Hokkaido: Late Early Miocene to Pliocene in age.

Chlamys cosibensis hanzawae

MASUDA, n. subsp.

Plate 13, Figures 10-15.

1925. *Pecten swiftii* BERNARDI. YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 3*, p. 123, pl. 15, fig. 3. (non BERNARDI, 1858).

1936. *Pecten* (*Manupecten*) *cosibensis* YOKOYAMA, NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull., No. 10*, p. 163, pl. 18, figs. 5, 39-42.

1937. *Pecten* (*Swiftopecten*) *swiftii* BERNARDI, NOMURA and HATAI, *Ibid., No. 13*, p. 129, pl. 18, fig. 6. (non BERNARDI, 1858).

Shell small, inflated, suborbicular, equilateral except for auricles; right valve more convex than left; both valves radiately ribbed and forming an angle of about 90° at apex.

Right valve with about 20, close-set, rather distinct, round-topped, fine radial ribs, finely scaled, fine intercalary threads and concentric growth lines, with distinct fine network: radial ribs in central part of disc usually gathered into four, round-topped, rather elevated, stout fascicular bundles separated by rather deep valleys, usually divided into two parts by a shallow longitudinal furrow towards ventral margin; bundles of four to six, subequal radial ribs broader than their interspaces and sometimes finely scaled, sometimes with a fine intercalary thread between radial ribs; submargins sculptured with several, subordinate, faint, fine radial threads; valleys usually rather deep, narrower than bundles themselves, with unequal intercalary threads which are one to three or rarely more in number, sometimes valleys very shallows and narrow; primary intercalary threads usually appear on upper half of disc, nearly equal to divided radial threads in strength at ventral margin, secondary and tertiary intercalaries somewhat fainter and finer than other radials appear on lower half of disc; when of inconspicuous bundles intercalary threads are one to three in number, and fainter and finer than radial threads; more or less distinct concentric constrictions sometimes present near ventral margin; anterior auricle much larger and longer than posterior one, with narrow and deep byssal notch and rather narrow byssal area, sculptured with several, distinct, more or less imbricated, fine radial threads and concentric lines; posterior auricle similar to anterior, though radial threads somewhat fainter and finer than those of anterior; hinge with very conspicuous cardinal crura, rather wide and shallow resilial pit with distinct, fine

lateral ridges widely open towards lower, and with distinct ctenolium. Left valve with about 20, fine radial ribs, three in central part of disc prominent, intercalary threads and concentric growth lines, with rather distinct fine network; three prominent radial ribs rather sharp near beak, subequel to other radials, usually tend to become elevated, stout and rounded towards ventral margin, and divided into three to four or rarely a little more, finely scaled radial threads by shallow longitudinal furrows; other radials finely scaled, rarely divided into two, finely scaled radials by a shallow longitudinal furrow, and nearly equal to or a little less than divided radial threads of prominent radials in strength at ventral margin; intercalary threads finely scaled, primary ones usually appear on about half of disc, and secondary ones appear near ventral margin; submargins sculptured with several, faint, fine radial threads; anterior auricle with several, finely imbricated, fine radial threads and concentric lines, and posterior auricle similar to anterior in sculpture, though radial threads fainter and finer than those of anterior. Interior surface of valves gently folded corresponding to external sculpture; characteristic fine serration at ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This species is distinguishable from *cosibensis* (s. s.) by its small, suborbicular shell, the more inflated right valve, somewhat larger apical angle, rather distinct, fine radial ribs and indistinct concentric constrictions. *Chlamys* (*Swiftopecten*) *swiftii* (BERNARDI) differs from the present one by its large, posteriorly contorted shell, smaller apical angle, radial ribs and very large triangular anterior auricle.

Remarks:—The subspecific name is dedicated to Dr. Shōshirō HANZAWA, Professor of the Tohoku University in recognition of his contribution to the paleontology of Japan.

Type locality, Geological formation and Age:—Ukibuta, Higashi-Yuri-mura, Yuri-gun, Akita Prefecture. Lat. 39°18′05″N., long. 140°20′05″E. Conglomeratic coarse-grained sandstone of the Sugota formation. Early Miocene.

Occurrence:—Sugota formation in Akita Prefecture, Moniwa, Tsunaki, Ôtsutsumi and Oido formations in Miyagi Prefecture, Nanao formation in Ishikawa Prefecture, Suenomatsuyama formation in Iwate Prefecture, and Obashira, Chichibu City, Saitama Prefecture: Early to Late Miocene in age.

Depository:—Holotype, DGS. Reg. No. 3690. Paratypes, DGS. Reg. No. 3691 and SM. Reg. No. 7360.

Chlamys cosibensis turpicula (YOKOYAMA), 1926

Plate 13, Figures 16a, b.

1926. *Pecten turpiculus* YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 1*, p. 18, pl. 2, fig. 4.
1931. *Chlamys swiftii turpiculus* (YOKOYAMA). KURODA in HONMA, *Geol. Cent. Shinano, Pt. 4*, p. 36, pl. 3, fig. 13.

Shell moderate in size and convexity, higher than long, equilateral except for auricles, subequivalve; both valves radiately ribbed and forming an angle of about 85° at apex.

Right valve with more than 20, unequal, round-topped radial ribs, fine intercalary threads and concentric growth lines, with rather distinct fine network; radial ribs in central part of disc usually gathered into about ten, more or less elevated, round-topped fascicular bundles separated by somewhat deep and

narrow valleys, divided into two or three parts by shallow longitudinal furrows near half of disc towards ventral margin, other radials near submargins rather low, divided into two parts near ventral margin or remain undivided; fascicular bundles usually of two unequal radial ribs, separated by rather narrow and shallow interspaces with or without an intercalary thread; submargins sculptured with several, subordinate, faint, fine radial threads: valleys rather deep, narrower than bundles, with unequal fine intercalary threads, one to three in number: primary intercalary threads appear on upper half of disc, nearly equal to divided radial threads in strength at ventral margin, secondary and tertiary ones appear on lower half of disc; concentric constrictions rather distinct: anterior auricle much larger than posterior, with deep byssal notch and narrow byssal area, sculptured with several, distinct, fine radial threads and concentric lines, appearing more or less imbricated; posterior one similar to anterior; hinge with distinct cardinal crura, distinct ctenolium, rather wide and deep resilial pit with rather distinct lateral ridges. Left valve with prominent, round-topped, unequal radial ribs separated by rather deep and wide valleys, rather low radial ribs in valleys and near submargins, fine intercalary threads and concentric growth lines, ornamented by distinct fine network; prominent radial ribs nearly equal to other radials in strength near beak, but tend to become unequally elevated and rounded towards ventral margin, and usually divided into three to four or rarely more, fine radial threads by shallow longitudinal furrows, sometimes radial ribs smooth and their divisions obscure; other radials rather low, usually alternate with prominent radials, and divided into two parts or remain undivided; submargins sculptured with several, subordinate, fine radial threads: valleys usually deep or sometimes shallow, somewhat broader than radial ribs: intercalary threads unequal in strength, usually one to three or rarely more in number; primary intercalaries usually appear on upper half of disc, secondary ones on about half of disc; concentric constrictions rather conspicuous; anterior auricle sculptured with several, more or less imbricated, distinct radial threads, somewhat less distinct intercalary threads and concentric lines, and posterior one similar to anterior, though posterior radial threads much fainter and finer. Interior surface of valves gently folded and with characteristic fine serration at ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This differs from *cosibensis* (s. s.) by its subequivalved shell, about 20, unequal, round-topped radial ribs which are usually gathered into about ten, more or less elevated fascicular bundles in the right valve, and the left valve with rather prominent, rounded, unequal radial ribs which are alternated with the less prominent radial ribs. It becomes difficult to distinguish the present one from *cosibensis* (s. s.), when the latter has the radial ribs separated by rather wide and deep interspaces with one or two intercalary threads. *Chlamys nutteri* (ARNOLD) (ARNOLD, 1906) from the Pliocene of San Mateo County, California, is distinguished from *turpicula* by its larger shell, smaller number of and more prominent radial ribs and stronger intercalary threads.

Described specimens:—Left river cliff, Shimoniregi, Shimosoyama, Shigaramimura, Kami-Minochi-gun, Nagano Pre-

fecture. Fine-grained sandstone of the Shigarami formation (Late Miocene). Topotype, DGS, Reg. No. 3698.

Occurrence:—Shigarami formation in Nagano Prefecture, Suenomatsuyama formation in Iwate Prefecture, Sawane and Shiraiwa formations in Niigata Prefecture, and Daishaka and Hamada formations in Aomori Prefecture: Late Miocene to Pliocene in age.

Chlamys cosibensis heteroglypta (YOKOYAMA), 1926

Plate 13, Figures 17a-c, 18a-b.

1926. *Pecten heteroglyptus* YOKOYAMA, *Jour. Fac. Sci., Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 8*. p. 304, pl. 33, figs. 1-5, 8.
1936. *Pecten (Pallium) heteroglyptus* YOKOYAMA, NOMURA and HATAI, *Saito Ho-on Kai Mus., Res. Bull., No. 6*, p. 99, pl. 10, figs. 5, 6; pl. 11, figs. 1, 2.

Shell moderate in size, rather thick, suborbicular, equilateral except for auricles; left valve somewhat more convex than right; both valves radiately ribbed and forming an angle of about 90° at apex.

Right valve with about 25, round-topped, smooth, nearly equal radial ribs, unequal fine intercalary threads and concentric growth lines, with rather distinct fine network: radial ribs broader than their interspaces and divided into two or rarely three parts by shallow longitudinal furrows on lower half of disc; interspaces unequal; submargins sculptured with several, subordinate, faint, fine radial threads; intercalary threads usually one in number, but two or three when interspaces widen, in which primary intercalary thread appears on upper half of disc, and secondary or tertiary ones near ventral margin; concentric constrictions sometimes more or less distinct; anterior auricle much larger than posterior, with narrow and deep byssal notch, rather narrow byssal area, and with several, distinct radial threads, fine intercalary threads and concentric lines, giving imbricated appearance; posterior auricle similar to anterior, posterior radial threads somewhat less distinct and more numerous than anteriors; hinge with conspicuous cardinal crura, rather deep resilial pit with distinct lateral ridges and distinct ctenolium. Left valve with round-topped, unequal radial ribs, fine intercalary threads and concentric growth lines, with fine network; radial ribs usually divided into two or rarely three, fine radial threads by shallow longitudinal furrows towards ventral margin, some remain undivided; intercalary threads usually one or rarely three in number, in which primary intercalary thread appears on upper half of disc, and secondary or tertiary ones appear near ventral margin; concentric constrictions indistinct; anterior auricle larger than posterior, and with several, fine radial threads, faint intercalary threads and concentric lines, giving imbricated aspect; posterior auricle similar to anterior in sculpture, radial threads a more numerous and fainter than anteriors. Interior surface of valves gently folded and with fine serration at ventral margin.

Dimensions:—Shown in Table 1.

Comparison and Affinity:—This subspecies is distinguished from *cosibensis* (s. s.) by its suborbicular shell, round-topped, smooth, subequal radial ribs which are not gathered into fascicular bundles, indistinct concentric constrictions in the right valve and by the left valve having unequal, round-topped radial ribs and indistinct concentric constrictions. *Chlamys cosibensis turpi-*

cula differs from the present one by its subequivalved shell, about ten, more or less elevated fascicular bundles consisting of about two, round-topped radial ribs separated by rather deep valleys, conspicuous concentric constrictions in the right valve, and by the left valve having rather elevated, round-topped, unequal radial ribs separated by more or less deep valleys and conspicuous concentric constrictions.

It becomes difficult to distinguish the present species from *cosibensis* (s. s.) and *cosibensis turpicula*, when the valleys between the fascicular bundles are shallow and the concentric constrictions are more or less indistinct in them.

Chlamys erythrocomata (DALL) (DALL, 1907), a Recent Northern Pacific scallop, is distinguished from the present one by its rather large, thick, orbicular, inflated shell, more radial ribs which are more or less squarish in form and gathered obscurely into fascicular bundles and the inconspicuous cardinal crura.

Described specimens:—Right river cliff, northwest of Daishaka, Namioka-machi, Minami-Tsugaru-gun, Aomori Prefecture. Conglomeratic calcareous coarse-grained sandstone of the Daishaka formation (Pliocene). DGS, Reg. No. 3688.

Occurrence:—Sawane and Shiraiwa formations in Niigata Prefecture and Daishaka and Hamada formations in Aomori Prefecture:—Pliocene in age.

Remarks on *Chlamys cosibensis* and its subspecies

As mentioned in earlier pages, *Chlamys cosibensis* and its subspecies are closely related to each other. Their sequence in appearance is *cosibensis hanzawae* from the early Miocene, *cosibensis* (s. s.) from the late early Miocene, *cosibensis turpicula* from the late Miocene and *cosibensis heteroglypta* from the Pliocene.

Some specimens of *cosibensis hanzawae* from the Moniwa formation at Kita-Akaishi, Sendai City, occur associated with *Lepidocyclina japonica* YABE, pectinids as *Chlamys arakawai* (NOMURA), *Chlamys nisataiensis* OTUKA, *Nanaochlamys notoensis* (YOKOYAMA), *Placopecten akihoensis* (MATSUMOTO) etc, other pelecypods, gastropods, corals, echinoids, brachiopods, balanids, bryozoan-fragments and shark's teeth. The Moniwa fauna indicates a warm water condition. The specimens of *cosibensis hanzawae* from the early Miocene Sugota formation may be a little younger than the Moniwa formation were found at Ukibuta, Higashi-Yuri-mura, Yuri-gun, Akita Prefecture, associated with such as *Chlamys akitana* (YOKOYAMA), *Chlamys* cf. *ingeniosa* (YOKOYAMA), *Placopecten akihoensis* (MATSUMOTO), *Patinopecten yamasakii iwasakiensis* (NOMURA), and *Patinopecten kimurai ugoensis* (HATAI and NISIYAMA), other molluscs, brachiopods, echinoids, balanids, foraminifers and bryozoans. The Sugota formation indicates a warm thermal condition. A few specimens from late early Miocene formations as Otsutsumi, Tsunaki, Utsuno, Ginzan and their correlatives were found, associated with such as *Chlamys miyatokoensis* (NOMURA and HATAI), *Chlamys kaneharai* (YOKOYAMA), *Chlamys* (*Swiftopecten*) *swiftii* (BERNARDI), *Chlamys cosibensis* (s. s), *Patinopecten paraplebejus* (NOMURA and HATAI), and *Miyagipecten matsumorienesis* MASUDA and other fossils. This fauna mainly comprises warm water animals. The late Miocene Suenomatsuyama formation yielded specimens at Anaushi, Fukuoka-machi, Ninohe-gun, Iwate Prefecture, associated with such as *Chlamys* (*Swiftopecten*) *swiftii*, *Chlamys cosibensis* (s. s.), *Chlamys cosibensis turpicula*, *Patinopecten kimurai* (YOKOYAMA), *Patinopecten*

yamasakii ninohensis MASUDA and other pelecypods, gastropods, echinoids balanids and bryozoans. This fauna is characterized by cold water assemblage. It may be noticed that the specimens referable to *cosibensis hanzawae* from the Suenomatsuyama formation are usually somewhat larger in size and more convex than those of the early Miocene, and the radial ribs of the former are more distinct. These facts may support the view of NOMURA and HATAI (1935, 1936) who concluded that with regard to *Chlamys cosibensis* the older the geological age is, the smaller is the size of shells.

The deposition of the early Miocene formations as the Moniwa and Sugota proceeded under the influence of warm thermal conditions, while the Tsunaki, Otsutsumi, Utsuno, Ginzan seas and their correlatives were influenced by rather cool thermal conditions, and the late Miocene Suenomatsuyama sea was influenced by cold water. Thus, *Chlamys cosibensis hanzawae* was originally a warm water inhabitant in the early Miocene time, but became adapted to diverse environmental conditions of the late early Miocene, and by the influence of rather cold water conditions in the late Miocene it became extinct.

The specimens of *cosibensis* (s. s.) from the Miocene formations are usually rather few and the size of the shell is somewhat smaller than those from the Pliocene formations, while in the Pliocene they became abundant and the size of shell larger than those of the Miocene.

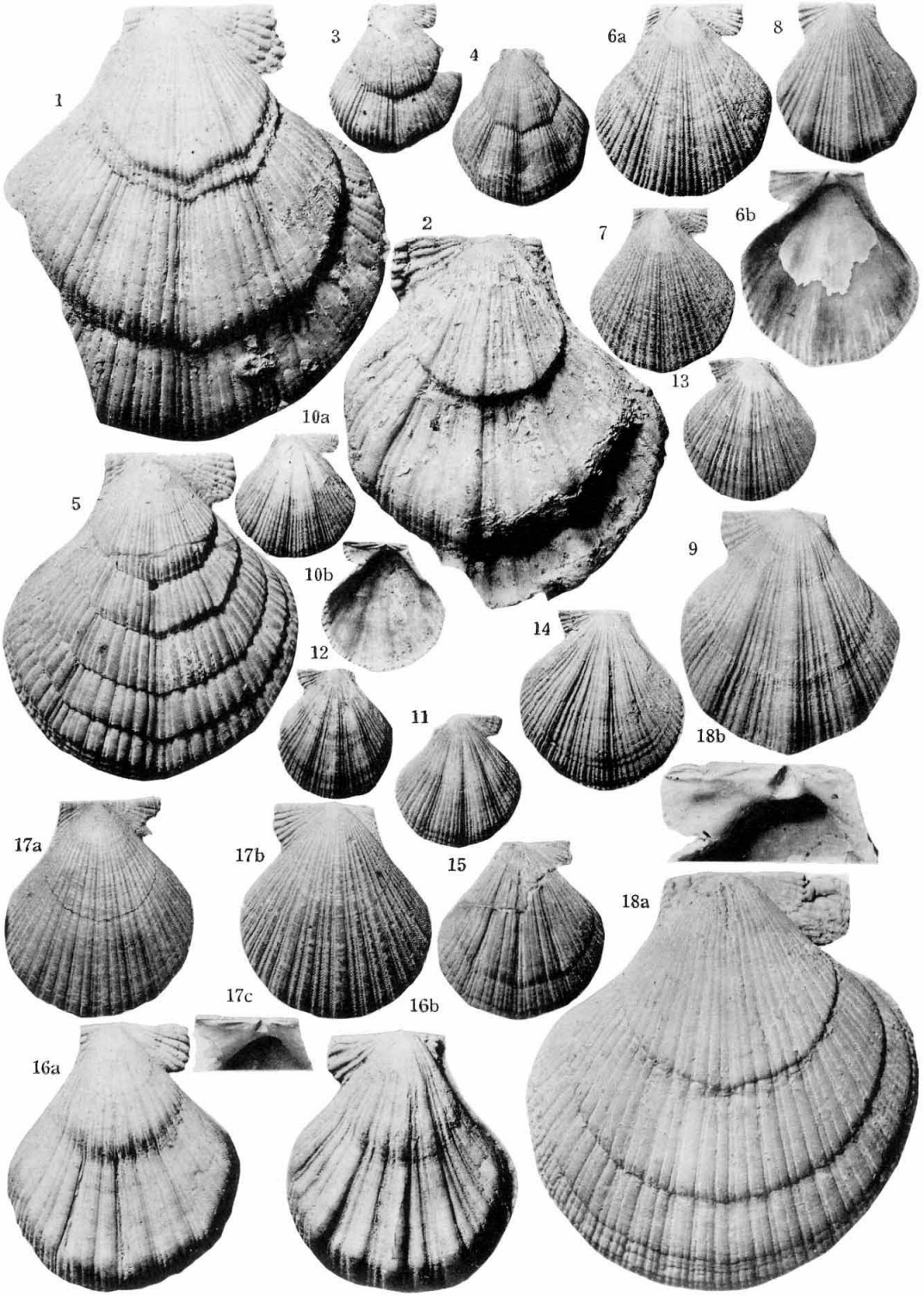
Chlamys cosibensis turpicula occurs from the late Miocene Shigarami and Suenomatsuyama formations but its number is rather few. In the Pliocene they become common and exhibit somewhat less distinct concentric constrictions.

Abundant specimens of *cosibensis heteroglypta* were found from the Pliocene Sawane, Shiraiwa, Daishaka, Hamada and Setana formations.

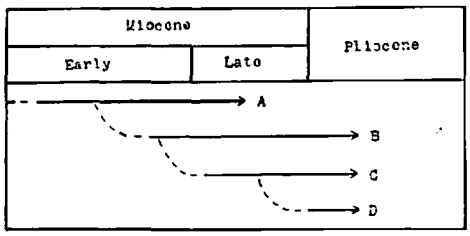
The view of NOMURA and HATAI concerning the relation between the geological age and the size of shell is also supported in the case of *cosibensis* (s. s.), *cosibensis turpicula* as well as in the case of *cosibensis hanzawae*. Their occurrence and geological ranges are shown in Table 2 and the text-figure.

Table 2. Occurrence of *Chlamys cosibensis* group

Geological age	Early Miocene										Late Mio.	Pliocene							
Formation name / Subspecific name	Moniwa	Oido	Sugota	Nanao	Otsutsumi	Tsunaki	Utsuno	Ginzan	Aoso	Nanakita	Suenomatsuyama	Shigarami	Koshiba	Sawane	Shiraiwa	Sasaoka	Daishaka	Hamada	Setana
cosibensis							+	+	+	+	+	+	+	+	+	+	+	+	+
hanzawae	+	+	+	+	+	+	+				+								
turpicula											+	+		+			+	+	
heteroglypta														+	+		+	+	+



MASUDA photo.



Text-fig.
Showing the geological ranges and the lines of evolution of *Chlamys cosibensis* group.
A—*Chlamys cosibensis hanzawae* MASUDA
B—*Chlamys cosibensis cosibensis* (YOKOYAMA)
C—*Chlamys cosibensis turpicula* (YOKOYAMA)
D—*Chlamys cosibensis heteroglypta* (YOKOYAMA)

From the above it is thought that *cosibensis* (s. s.) branched off from *cosibensis hanzawae* in the late early Miocene, and reached its maximum flourishing in the Pliocene where it became extinct. It is inferred that *cosibensis turpicula* branched off from *cosibensis* (s. s.), and *cosibensis heteroglypta* from *cosibensis turpicula*, and that they represent parallel forms of slight subspecific distinction. The Californian *Chlamys wattsi*, *Chamys wattsi morani*, *Chlamys nutteri* and *Chlamys etchegoini* are considered to be species closely related to the Japanese ones, but with regard to their interspecific relationship future study may

Explanation of Plate 13

(Natural size)

Figs. 1-9. *Chlamys cosibensis* (YOKOYAMA)
1. Right valve. SM. Reg. No. 6161. Loc. Right stream cliff, northwest of Daishaka, Namioka-machi, Minami-Tsugaru-gun, Aomori Prefecture. Daishaka formation.
2. Left valve. DGS, Reg. No. 3685. Loc. Same as above.
3. Right valve. Topotype, IGPS, coll. cat. no. 13315. Loc. Koshiba, Yokohama City, Kanagawa Prefecture. Koshiba formation.
4. Right valve. DGS, Reg. No. 3686. Loc. River cliff of the Chikagawa stream, about 200 m. from the sea shore at Chikagawa, Tanabu-machi, Shimokita-gun, Aomori Prefecture. Hamada formation.
5. Right valve. IGPS, coll. cat. no. 72556. Loc. Same as above.
6a, b. a, Right valve. b, Interior view. DGS, Reg. No. 3687. Loc. Same as above.
7. Right valve. DGS, Reg. No. 3686. Loc. Same as above.
8, 9. Left valve. DGS, Reg. No. 3686. Loc. Same as above.

Figs. 10-15. *Chlamys cosibensis hanzawae* MASUDA, n. subsp.
10a, b. a, Right valve. b, Interior view. Holotype. DGS, Reg. No. 3690. Loc. Ukibuta, Higashi-Yuri-mura, Yuri-gun, Akita Prefecture. Sugota formation.
11. Right valve. DGS, Reg. No. 2691. Loc. Same as above.
12-14. Left valve. DGS, Reg. No. 3691. Loc. Same as above.
15. Right valve. IGPS, coll. cat. no. 16084. Loc. Kita-Akaishi, Sendai City, Miyagi Prefecture. Moniwa formation.

Figs. 16a, b. *Chlamys cosibensis turpicula* (YOKOYAMA)
a, Right valve. b, Left valve. Topotype, DGS, Reg. No. 3698. Loc. Left river cliff of the Susobana-gawa at Shimoniregi, Shigaremi-mura, Kami-Minochi-gun, Nagano Prefecture. Shigarami formation.

Figs. 17, 18. *Chlamys cosibensis heteroglypta* (YOKOYAMA)
17a-c. a, Right valve. b, Left valve. c, Hinge area. DGS, Reg. No. 3687. Loc. Same as Fig. 4.
18a, b. a, Right valve. b, Hinge area. DGS, Reg. No. 3688. Loc. Same as Fig. 1.

settle the problem.

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367. SOME PELECYPODS FROM THE TSUKINOURA FORMATION IN MIYAGI PREFECTURE*

(Studies on the Dogger Pelecypods in Japan, 2)

ITARU HAYAMI

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月ノ浦層産ドッガー斧足類数種：牡鹿半島頸部の小鯛島東岸とその対岸に露出する月ノ浦砂礫層には二枚の著しい化石層が認められるが，この上部層より *Chlamys*, *Ctenostreon* の新種と未記載の *Lopha* 2 種を識別したので記載する。　　速水　格

The Tsukinoura formation, mainly composed of coarse sandstones and conglomerates, is distributed at the eastern half of Kodaijima island and southern coast of Tsukinoura in the neck of Ojika peninsula, Miyagi Prefecture. It bears several fossil beds on the coasts along the Kodaijima channel, two of which are most striking. The lower bed is composed of bituminous sandstone and shale, containing shell-banks of *Bakevellia* sp. and *Eomiodon vulgaris* HAYAMI (1958). The latter species has been known from similar facies of the Lias of this country. Its range is now known to extend into the lower Dogger. The upper bed is a ferruginous granular conglomerate. Because of the coarse-grained matrix, the detail of fossils and minute specimens can be hardly observed, but the following species with relatively large size are distinguishable in my collection.

Chlamys kobayashii HAYAMI, new species
Ctenostreon ojikense HAYAMI, new species
Lopha a sp. indet.
Lopha b sp. indet.

Because of the absence of any guide fossils, the age of this formation cannot be determined, but it is presumed to be Bajocian or slightly later, for the underlying Kodaijima formation can be correlated to the Aratozaki formation of Shizukawa area by the common occurrence of *Trigonia sumiyagura* KOBAYASHI and KASENO, 1947 (KOBAYASHI and MORI, 1954) and some other pelecypods. Some authors correlated the Tsukinoura to the Aratozaki formation, but I could find no common species between the two faunas.

I express my sincere thanks to Prof. Teiichi KOBAYASHI of the University of Tokyo for his kind guidance and supervision of this manuscript.

Description of Species

Family **Pectinidae** LAMARCK

Genus *Chlamys* RÖDING, 1798

Chlamys kobayashii HAYAMI, new species

Plate 14, Figures 1-2.

Description:—Shell medium to large for genus, inequivalve, subequilateral

* Received Sept. 19, 1958; read Dec. 7, 1958.

exclusive of auricles, nearly acline, not strongly inflated, much higher than long; antero-dorsal margin of main body slightly sinuated, more or less gaped, while postero-dorsal margin of main body is slightly convex, passing gradually into venter; auricles of *Chlamys*-type, well defined, very unequal; byssal auricle linguiform, supported by an auricular sulcus, excavated below by a profound byssal notch; posterior auricle of each valve truncated subrectangularly, cancellate with about 10 radial riblets and numerous concentric lines; left anterior one also netted, but its posterior margin fairly concave in lower half; surface ornamented with 36–40 radial ribs, some of which are bifurcated towards ventral periphery in right valve and insert secondaries in left valve; radials angular, roof-shaped in transverse section; intervals nearly as wide as ribs, marked with numerous concentric fila; ctenolium probably present; umbo slightly prosogyrous, submesial; apical angle about 75 degrees or slightly larger.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3124) right ex. mould	41.5	62.0	7.0
Paratype (MM 3125) right ex. mould	44.0+	46.5+	?

Observation and comparison:—Seven specimens were procured. The holotype (Fig. 1), though fairly compressed antero-posteriorly, shows the nearly complete outline, byssal area and radial ornamentation on the main body and both auricles. The radial ribs increase their number by bifurcation in right valve and by insertion in left valve. The mode is commonly seen in normal species of *Chlamys*. This is somewhat similar to *Chlamys mojsisovicsi* KOBAYASHI and ICHIKAWA (1949; NAKAZAWA, 1952; ICHIKAWA, 1954) from the Carnic and *C. kurumensis* KOBAYASHI and HAYAMI (HAYAMI, 1957) from the Lias of this country. But it is distinguishable from the two in the large dimensions, more prominent concentric markings and stronger and less flat-topped radial ribs. Radial riblets on posterior auricles are more in number than in *mojsisovicsi* and *kurumensis*. As to foreign species, *Chlamys textorius* SCHLOTHEIM (GOLDFUSS, 1836; DUMORTIER, 1867; DECHASEAUX, 1936, etc.) from the Lias and *C. ambigua* (MÜNSTER) (GOLDFUSS, 1836; GREPPIN, 1899; DECHASEAUX, 1936; COX, 1952, etc.) from the Dogger are two allied species to this. In the number of radials on main body this is intermediate between the two species, which are considered by STAESCHE (1926) and DECHASEAUX (1936) to have been connected phylogenetically. But further close comparison proves that this is distinct from them in the more roof-shaped less scaly radials, and smaller apical angle. In the radial ribbing and their number, this may be closer to *Chlamys subtextoria* (MÜNSTER) (GOLDFUSS, 1836; STAESCHE, 1926; DECHASEAUX, 1936; COX, 1952, etc.) from the Callovian and later of Europe and India, but the shell is larger and posterior auricle more vertically truncated at the postero-dorsal corner than that species.

Occurrence:—Common at the Kodaijima strait. A left valve collected by KOBAYASHI and FUKADA from the upper part of the Kosaba sandstone formation at Shibitachi of Karakuwa area, northern

Miyagi Pref. This species is presumed to be a characteristic element of the Tsukinoura and upper Kosaba faunules which are slightly younger than the *Trigonia sumiyagura*-faunules in the lower Aratozaki, lower Kosaba and Kodaijima formation.

Family **Limidae** D'ORBIGNY

Genus *Ctenostreon* D'EICHWALD, 1862

Ctenostreon ojikense HAYAMI, new species

Plate 14, Figures 3a-b.

Description:—Shell large for limids, equivalve, inequilateral, inflated, somewhat irregular in outline but usually subovate, fairly inequilateral with a slightly opisthocline main body and unequal auricles, nearly as long as high; test moderate in thickness; antero-dorsal margin of main body long, straight; postero-dorsal short, slightly convex; dorsal margin roof-shaped in external view, but hinge-line straight; anterior auricle well defined, inflated to form a widely gaped anterior margin; posterior auricle large, ill defined from main body, more or less obtusely truncated; surface ornamented with 7 or 8 stout, roof-shaped radial plications which bear several tubercles; concentric lamellae considerably weak for genus but fairly prominent on anterior auricle; umbo slightly prosogyrous, submesially placed, not rising above dorsal margin; ligament area not very wide, provided with a large, slightly prosocline, triangular ligament pit below beak; apical angle exclusive of auricles about 105 degrees.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3126) left in. and ex. moulds	65.0	60.0	11.0
Paratype (MM 3127) left internal mould	53.5+	60.2	12.0

Observation and comparison:—Represented by five specimens. They are somewhat variable in outline, but all show similarly strong convexity and regular number of radials. The holotype specimen (Figs. 3a-b) may be slightly compressed in dorso-ventral direction but its outline is nearly complete. Judging from the radial ribbing and ligament structure, this is a limid and referable to *Ctenostreon*. The radial plications are 7 or 8 in this species and it is small in comparison with most species of the genus. The concentric lamellae are much weaker than normal *Ctenostreon*. In the mode of ornamentation only *Ctenostreon paucicostatum* LEANZA (1942) from the Lias of Neuquen resembles this but the shell is probably much taller and thicker with a broader ligament area and the apical angle smaller than this species. This is obviously different from *Ctenostreon* sp. from the Aratozaki formation of Shizukawa area (HAYAMI, 1959, MS) in the more roof-shaped radials of smaller number.

Occurrence:—Common at the Kodaijima strait.

Family **Ostreidae** LAMARCK

Genus *Lopha* BOLTEN, 1798

(=*Alectryonia* FISCHER DE WALDHEIM, 1807)

Lopha a sp. indet.

Plate 14, Figure 4.

Represented by a solitary right ex-

ternal mould (MM 3128, 19.0 mm. long; 36.0 mm. high). Shell small, subequilateral, ovate, not strongly inflated, bearing nine radial angular plications which are very irregularly spaced, increase their number mainly by irregular insertion and probably interlock at valve-margin with those of counter valve; median parting not strong; concentric laminae prominent. This may belong to the group of *Lopha marshii* (SOWERBY) (1814; COX, 1952) from the Aalenian to Kimmeridgian of Europe and India, but the dimensions are much smaller and the outline more ovate than that species.

Occurrence:—Rare at the Kodaijima strait.

Lopha b sp. indet.

Plate 14, Figure 5.

Another right valve represented by internal and external moulds (MM 3129, 22.0 mm. long; 55.5 mm. high) disagrees with the preceding form in the more vertically elongated outline, absence of median parting and more delicate plications which are restricted near ventral periphery.

Occurrence:—Rare at the Kodaijima strait.

Explanation of Plate 14

Figs. 1-5. Pelecypods from the Tsukinoura Formation at Kodaijima strait, south of Tsukinoura, Ishinomaki City, Miyagi Pref.

Chlamys kobayashii HAYAMI, new species ..... p. 133

Fig. 1. Gypsum cast of right external mould, holotype (MM 3124), ×1.

Fig. 2a. Right internal mould, paratype (MM 3125), ×1.

Fig. 2b. Clay cast of the same specimen, ×1.

Ctenostreon ojikense HAYAMI, new species ..... p. 135

Fig. 3a. Left internal mould, holotype (MM 3126), ×1.

Fig. 3b. Gypsum cast of the same specimen, ×1.

Lopha a sp. ..... p. 135

Fig. 4. Right external mould (MM 3128), ×1.

Lopha b sp. ..... p. 136

Fig. 5. Right external mould (MM 3129), ×1.

Figs. 6-13. Pelecypods from the upper Aratozaki Formation at the east of Shizuhama, Shizukawa-machi, Miyagi Pref.

Kobayashites hemicylindricus HAYAMI, new species ..... p. 139

Fig. 6a. Left internal mould, holotype (MM 3130), ×2.

Fig. 6b. Clay cast of the external mould of the same specimen, ×2.

Fig. 7. Right internal mould, paratype (MM 3131), ×2.

Fig. 8. Left internal mould (MM 3132), ×2.

Fig. 9. Clay cast of left external mould (MM 3133), ×2.

Fig. 10. Left internal mould (MM 3134), ×2.

Protocardia inaii HAYAMI, new species ..... p. 140

Fig. 11. Clay cast of right external mould, holotype (MM 3135), ×1.

Fig. 12. Right internal mould, paratype (MM 3136), ×2.

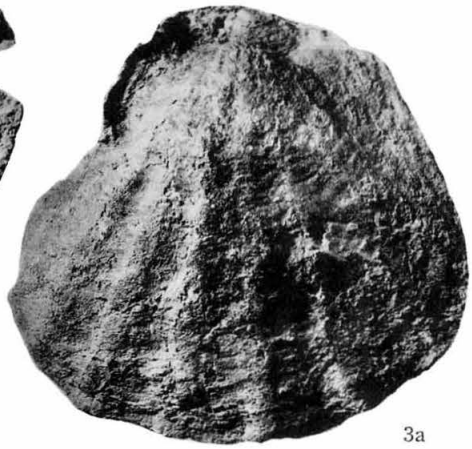
Fig. 13. Clay cast of left external mould, paratype (MM 3137), ×2.

All specimens illustrated here are kept in the Geological Institute, University of Tokyo.

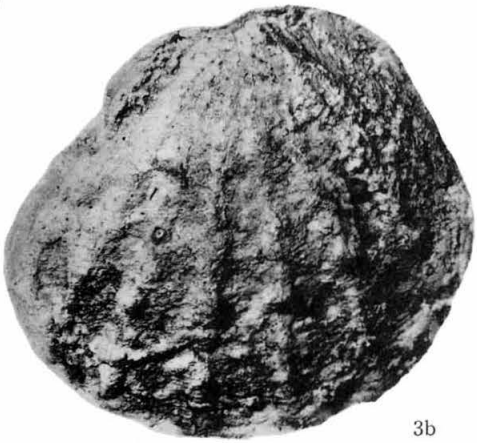
1

2a

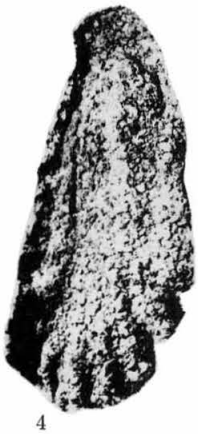
2b



3a



3b



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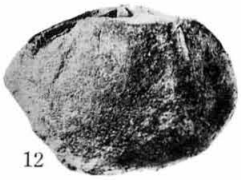

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6b

13

10

6a

9

8

7

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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 35, pp. 138-141, pl. 14, Sept. 15, 1959.

368. SOME PELECYPODS FROM THE UPPER ARATOZAKI FORMATION INCLUDING A NEW GENUS *KOBAYASHITES**

(Studies on the Dogger Pelecypods in Japan, 3)

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荒砥崎上部層産ドッガー斧足類数種：志津川地方の荒砥崎上部層は化石が稀だが，細浦—沼水浜間の海岸に *Isognomon*, *Protocardia* の他に特異な gervilliid を含む凝灰質砂岩層がある。この gervilliid はジュラー白亜紀の *Gervillia* と三畳紀の *Hoernesia* にやや似ているが，いづれとも明瞭に異るので *Kobayashites* (新属) として記載する。　速水　格

As noted before (HAYAMI, 1959), the upper part of the Aratozaki formation in Shizukawa area is composed of conglomerates and ferruginous coarse sandstones. Fossils are very rare, but a thin layer of pelecypod-bearing black bituminous sandstone is exposed on the shore between Hosoura and Shizuhama. The following species collected therefrom are described in this paper.

Kobayashites hemicylindricus HAYAMI, new genus and new species
Isognomon sp. ex gr. *rikuzenicus* (YOKOYAMA)
Protocardia inaii HAYAMI, new species

The first species is undoubtedly a gervilliid but the shell is unusally inequivalve and the hinge-line very long for *Gervillia* (s. s.) and *Cultriopsis*. On this account I propose a new generic name, *Kobayashites*, for it. The last species seem more or less intimate to some Western Dogger forms.

Previously INAI (1939) reported "*Perna* sp." from this locality and included the the bed in the Arato formation. Diverge opinions were expressed on the relationship of the formation with the underlying Aratozaki by several other authors. So far as I can see in this area, however, the two formations are always in contact with each other with strike faults, and it is indecisive directly from field observation whether the relation is disconformable or conformable. The fossil bed in question is located near the fault zone, but seemingly lies conformably on the conglomeratic sandstone of the Aratozaki formation. As similar bituminous beds are occasionally inserted in the upper part of the formation at some other localities, I am inclined to consider that such beds imply temporal lagoonal conditions in the upper Aratozaki stage. The age is presumed to be somewhere in Bajocian.

* Received Sept 19, 1958; read Dec. 7, 1958

Description of species

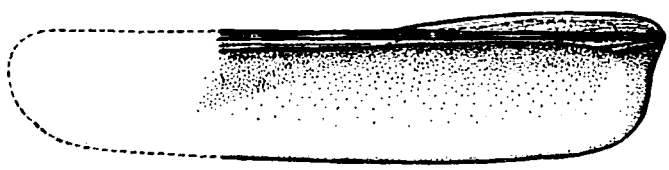
Family **Bakevelliidae** KING, 1850,
em. COX, 1954

Genus *Kobayashites* HAYAMI, new genus

Type species:—*Kobayashites hemicylindricus* HAYAMI, new species, Bajocian, Northeast Japan.

Diagnosis:—Shell small for family, elongated posteriorly, soleniform, very inequivalve, neither strongly curved, nor alate; left valve hemicylindrical, provided with a wide byssal gape and a septum-like thickening below umbo, but right valve nearly flat; hinge-line unusually long; posterior margin short; subterminal; hinge and ligament structures of *Bakevellia*-type.

Remarks:—This genus is characterized by the hemicylindrical inequivalve shell and unusual length of hinge-line. It may be an offshoot from *Gervillia* judging from similarly wide gape, subterminal umbo and elongated outline. But Jurasso-Cretaceous *Gervillia* DEFRANCE (1820), Jurassic *Cultriopsis* COSSMANN (1904) and Triassic *Angustella* WAAGEN (1907) have equivalve or subequivalve shell, more or less alate posteriorly and strongly curved with much shorter hinge-line. In these respects this is somewhat similar to *Hoernesia* LAUBE (1865) chiefly from the Triassic of Europe. Such a septum-like thickening below umbo is also seen in *Hoernesia joannis austriae* KLIPSTEIN, type of that genus (BITTNER, 1895). But if compared with the type form and *H. socialies* SCHLOTHEIM, the shell of the Aratozaki form is less inequivalve, less contorted and much more elongated horizontally. Moreover, such a wide byssal gape is probably unknown in *Hoernesia*.



Text-fig. 1. Interior of *Kobayashites hemicylindricus* HAYAMI, n. sp. (restored)

Kobayashites hemicylindricus HAYAMI, new species

Plate 14, Figures 6-10 and Text-fig. 1

Description:—Shell small for gervillids, highly inequivalve, slender, nearly straight, soleniform in outline, more than 3.5 times as long as high; test thin; hinge-line very long, occupying most of shell-length; posterior margin short; ventral margin straight, subparallel to hinge; umbo subterminal, more or less prosogyrous; both wings undeveloped, not discriminated from main body; left valve moderately inflated with protruded umbonal area above hinge, but right valve much flatter with scarcely salient umbo, slightly contorted in anterior area; byssal gape wide, occupying most of anterior margin of left valve, crescentic in anterior but indiscernible in right valve; ligament area narrow, faintly striated horizontally, provided with four or more small, subequidistant, subquadrate ligament pits; their interspaces about 3-4 times as long as pits; ligament area subparallel to valve-margin in left valve but very oblique in right; cardinal teeth one or two in each valve, slightly oblique, directed to the anterior end of hinge-margin; hinge-plate supported by a septum-like thickening below umbo; laternal tooth on each valve weak but very long, running parallel and very close to dorsal margin; surface smooth but for fine concentric growth-lines.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3130) left in. mould	30.5+	8.5	4.0
Paratype (MM 3131) right in. mould	15.0+	6.5	1.5
Paratype (MM 3132) left ex. mould	30.0	8.0	3.5

Observation and comparison:—Four left internal moulds, though not complete, show characteristic internal features, long hinge-line and wide byssal gape. The right valve is represented only by one internal mould (Fig. 7), but the inequivalveness is obvious. Its general outline is known in a left external mould (Fig. 9). The outline and inequivalveness are quite different from those of hitherto described species of *Gervillia* and allied genera. I could find no comparable species with this in foreign literature.

Occurrence:—Procured on the coast east of Shizuhama in Shizukawa-machi, Miyagi Prefecture (Province of Rikuzen).

Family **Isognomonidae** DALL

Genus *Isognomon* SOLANDER, 1786

Isognomon sp. ex gr. *rikuzenicus* (YOKOYAMA)

Several internal moulds of a large isognomonid are at hand. As to the ligament and byssal structures I could find no diagnostic character to distinguish it from *Isognomon rikuzenicus* (YOKOYAMA) (1904), (HAYAMI, 1957) from the Lias of this area.

Occurrence:—The same as the preceding.

Family **Cardiidae** LAMARCK

Genus *Protocardia* BEYRICH, 1845

(=*Protocardium*, auct.)

Protocardia inaii HAYAMI, new species

Plate 14, Figures 11-13

Description:—Shell medium, equivalve, subequilateral, round, strongly inflated, more or less longer than high, noncarinated; umbo slightly prosogyrous, rising above hinge, submesial; lunule and escutcheon not impressed; posterior radial ribs about 22 in number, regular in strength, distributed in about a fourth of whole surface from posterior end; remaining part marked with numerous faint radial threads; concentric ribs absent; growth-lamellae somewhat irregular in strength and interval; musculature weakly impressed; right valve having a conical cardinal 3b and small 3a, deep subvertical socket 2′ and a pair of remote lateral teeth.

Measurement in mm.	Length	Height	Thickness
Holotype (MM 3135) right ex. mould	28.5	24.0	7.5
Paratype (MM 3136) right in. mould	14.5	11.5	4.0
Paratype (MM 3137) left ex. mould	10.5	9.0	4.5

Observation and comparison:—Represented by four specimens. The posterior radial ornaments of *Protocardia* are seen in the holotype and other external moulds. The holotype shows numerous faint radial threads on its main surface, but is more or less compressed in antero-ventral to postero-dorsal direction. The original outline is presumed to be more globose and better represented by other illustrated specimens. This may be an ally to *Protocardia buckmani* (MORRIS and LYCETT, 1853) (=*Cardium consobrium* TERQUEM and JOURDY, 1871) from the Inferior and Great Oolite, but the umbo is not so salient above hinge as that species. In this respect this is more similar to *Protocardia* sp. in BENECKE (1905, p. 231, pl. 17, figs. 7–8), but the general outline is more round and equilateral.

Occurrence:— The same as the preceding.

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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 35, p. 142, Sept. 15, 1959

SHORT NOTES

5. IDENTITY OF ALGAL *TUBIPHYTES* MASLOV, 1956, AND HYDROZOAN GENUS *NIGRIPORELLA* RIGBY, 1958

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Permo-Pennsylvanian stratigraphers and paleontologists have observed a peculiar organism frequently in carbonate rocks, which sometimes is a very significant limestone-builder.

To the author's knowledge, NEWELL, RIGBY, FISCHER, WHITEMAN, HICKOX and BRADLEY (1953; e. g. pl. 17, fig. 3, pl. 18; p. 112) are the first who illustrated clearly the organism and called it as "hydrocoralline (?)". NEWELL illustrated the same organism later (1955) again as "hydrocoralline (?)". The exactly identical fossil has been found from the Lower and Upper Permian rocks (Zone of *Parafusulina* to Zone of *Yabeina*) in the Japanese Islands while the author has sought for calcareous algae.

Lately, MASLOW (1956, p. 82-84, 91, 204, 233, etc., pl. 25, figs. 1-3, pl. 26, pl. 27, figs. 1-3, text-fig. 22) described the organism from the Upper Carboniferous (C_3) and Permian of the Ural Mountains* in the belief of its possible Schizophycean nature and named it *Tubiphytes*, a monotypic genus based on *T. obscurus* n. sp.

RIGBY (1958) proposed a new genus *Nigriporella* for the same fossil and reaffirmed its hydrozoan nature. According to him, the genus even ranges from the Lower Carboniferous (Mississippian) to Upper Permian, and consists of two species, *N. magna* RIGBY (type species) and *N. minima* RIGBY.

The present author would have a difficulty in supporting its algal nature and its inclined to agree with the other alternative, that is probably a hydrozoan. From his recent studies, he would say that *Nigriporella* is not uncommon in the Permian rocks in such widely scattered areas as Mexico, Guatemala, the Carnic Alps, Afghanistan, Burma, and South China, besides the Japanese Islands and North America.

Text-figures 1. *Nigriporella* sp. Lower Permian Nabeyama formation, Kurakakeyama, Kuzu, Tochigi Prefecture, Honshu. Coll. KK54051003. ×25.

* MASLOV (*ibid.*, p. 91) indicates its occurrence in the Upper Devonian on the table. However, this should be understood as a misprint.

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Trans. Proc. Palaeont. Soc. Japan, N. S., No. 35, pp. 143-146, pl. 15, Sept. 15, 1959

369. *SPINOMARGINIFERA* FOUND IN JAPANESE PERMIAN

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本邦二畳系より発見された *Spinomarginifera*：北上山地叶倉統より産した *Spinomarginifera* 属に属する二種を記載した。即ち *Spinomarginifera kueichowensis* HUANG と *Sp. huangi* NAKAMURA n. sp. である。いずれも南支の二畳系より産するが，後者は従来前者の mutation と見做されていた。しかし今回ほぼ完全な標本を採集し研究の結果，種々の相異点を見出したのでむしろ新種とすべきであろう。 中村耕二

Genus *Spinomarginifera* was established by T. K. HUANG, 1932, *S. kueichowensis* HUANG as genotype. The genus is especially characteristic in having shell with distinct marginal ridge, a feature which strongly reminds the writer of the genus *Marginifera* as well as *Eomarginifera*. The former is yet distinguishabe from the latter two, in possessing shell ornamented by different sculpture. The shell of the former is rather smooth except for weakly developing plicae and very sparsely distributed tubercles or pustules, while the shells of the latter two genera possess rather strong radial and concentric plicae, especially at the apical region. So far as the writer is now concerned, no species being assignable into the genus *Spinomarginifera* seem to have ever been reported outside South China. But the presence of two species which should be surely assigned into the genus *Spinomarginifera* has been known in the collections of brachiopods made by the staff of the Department of Geology and Mineralogy, Hokkaido University from the Permian of the Kitakami Mountains, N. E. Japan. One of them is conspecific with the genotype of this genus, and the other may be new to science. The writer wishes here to describe them briefly.

* Received Nov. 5, 1958; read June 20, 1956.

Before going into description, the writer wishes to offer his cordial thanks to Professor Masao MINATO for his kind guidance throughout this study. Thanks are also due to Mr. S. KUMANO for taking photographs, and to Messrs. H. TAKEDA, T. MAEKAWA and M. HARADA, Hokkaido Univ. who placed many excellent specimens at the writer's disposition for study.

Description of species

Genus *Spinomarginifera* HUANG, 1932

Spinomarginifera kueichowensis HUANG

Plate 15, Figures 1-4.

1932. *Spinomarginifera kueichowensis* HUANG: *Palaeontologia Sinica, Ser. B, Vol. 9, Fasc. 1*, p. 56, pl. V, figs. 1-11.

Shell small to medium in size. Hinge-line straight which is the greatest width of the shell. Ventral valve more or less strongly convex and shows rather remarkable geniculation at a distance of 13 mm. from the beak. Beak rather large, prominent and very much inclined to turn over the hinge-line. Median sinus very broad and shallow and begins

to appear clearly from the point of geniculation. Ears moderately broad and flatly convex. Cardinal area never observable. Surface sculpture varies with age. In general, the shell of the early stages is ornamented by widely spaced, fine spines which are disposed quincuncially. They generally become plump tubercles as the shell becomes older, and finally, those tubercles become changed into more or less complete plicae. However, there is to be found such a specimen whose shell is ornamented only by tubercles, instead of plicae, although it may show the mature stage from the viewpoint of size. The visceral disk of the dorsal valve is half-moon in shape, highly concave at apical region and then flattened until its anterior extremity, where it is strongly geniculated to form a straight and rather long trail. The more its geniculation approaches towards the hinge-line, the less the angle of geniculation becomes. Ears moderately broad and rather convex. Median fold almost absent, but in some specimens very faint gibbosity can be perceived especially in the anterior part beyond the geniculation. Surface sculpture consists of numerous spine bases which are irregularly scattered. They are especially coarse on the auricles. Further there are indistinct, irregular, sinuous, concentric markings which are hardly observable in the trail. Besides, small and shallow pits are faintly developed over the entire surface of the shell. Radial striae are absent at the visceral disk, although rather coarse striae are faintly traceable in the trail. Interior of the dorsal valve can be observed in some well preserved specimens. At first, the presence of a median septum must be noted. It begins just below the beak and occupies about three-fourths or two-thirds of the visceral portion in length. Next, the internal marginal ridges must be taken into consideration; they characterize the present species.

HUANG once said that marginal ridges of this genus are made up of three parts; a median diaphragm and two lateral ridges. The first named part is situated nearly at the point of geniculation; it projects inward being parallel to the visceral disk. Namely the marginal ridge makes 90° to the trail. The weak lateral ridges are separated into two segments by a median septum; they extend to become parallel to the hinge-line and stand perpendicular to the visceral part. Thirdly, one pair of long and slender adductor muscle scars is observable at both sides of the posterior position of the median septum, while a few erect internal spines are crowded between the median septum and brachial ridges in the anterior portion of the shell.

Remarks:—The specimens now at hand very much resemble the holotype of this species, except for the fact that the Japanese specimens are a little more transverse than the Chinese. According to HUANG, however, this species is very variable both in size and in shape. Accordingly the Japanese specimens may be identified with the latter. This is easily distinguishable from the allied species by the presence of a median sinus in the ventral valve.

In South China, this species is believed to be found only from the Loping series in association with *Lyttonia* fauna.

Hor.: Lower Kanokura series. *Coll.*: T. MAEKAWA. *Reg. No.*: 11554, 12368, 12441, 12585. *Loc.*: Kamiyasse, Niitsuki-machi, Kesennuma city, Miyagi Pref. *Coll.*: K. NAKAMURA. *Reg. No.*: 12584, 12374, 12586. *Loc.*: Kamiyasse, Niitsuki-

machi, Kesennuma city, Miyagi Pref. *Coll.*: H. TAKEDA, M. HARADA and K. NAKAMURA. *Reg. No.*: 12440, 12642, 12374. *Loc.*: Imo, Yahagi-machi, Rikuzentakada city, Iwate Pref.

Spinomarginifera huangi NAKAMURA, n. sp.

Plate 15, Figures 5-7.

1932. *Spinomarginifera kueichowensis* mut. α HUANG: *Palaeont. Sinica, ser. B, Vol. 9, Fasc. 1*, p. 60, pl. V, figs. 12-13.

Shell medium in size, usually subrectangular in outline except ears. Hinge-line straight, nearly equal to the greatest width. Visceral cavity comparatively thick. Ventral valve very strongly convex but does not show any geniculation.

The visceral part is, however, clearly distinguished from the auricles which are rather flat. Auricle expansions rather broad and convex. Median sinus narrow but rather deep throughout its length. The surface ornamentation of the ventral valve cannot be observed in detail, owing to the bad state of preservation, except for a few coarse spine-bases irregularly and sparsely scattered. Internal surface of the same valve is ornamented by very fine longitudinal striae. There is recognizable a pair of adductor muscle scars of elongate form at the apical region. Dorsal valve is strongly geniculate at the anterior end, from where the very long trail begins to grow. Visceral part is slightly concave, which may be the most important bio-character of this species. Auricles rather broad. Surface sculpture is composed of irregular growth-lines and shallow grooves instead of the spine-bases of the opposite valve. Median fold constantly present. More or less well preserved specimens show the interior of the same valve. The marginal ridge is composed of three parts: two lateral ridges and diaphragm, which connect with each other. Diaphragm is standing just on the point of geniculation. The more sharply the diaphragm may be situated in the central portion, the less it may appear towards the lateral portion. Cardinal process, which is trifid at the top, projects slightly above the hinge-line and unites anteriorly with a median septum which is as low as the septum of *Productus* proper. One pair of adductor muscle scars are elongately trigonal in shape, measures about 6.2 mm. in length and 2.8 mm. in width. They are situated near by on both sides of median septum. Besides, a pair of brachial impressions is impressed at the antero-lateral margin of the adductors. Internal surface of the visceral part can not be well observed, while at anterior margin, coarse spine-bases are to be seen, which are regularly arranged in two rows along the concentric bands. Also in the portion of trail rather coarse spine-bases are perceived.

Remarks:—The specimen figured by HUANG under the name of *Spinomarginifera kueichowensis* mut. α is hardly distinguishable from the present specimens now in concern. HUANG considered that his specimen may be only a mutation of the preceding species. According to HUANG, *S. kueichowensis* HUANG may be distinguishable from his so-called mutation α in the following three points: the latter is usually larger than the former, does not show any marked geniculation in ventral valve, and possesses pustules rather sparsely arranged. Besides, the less transverse shell form of the so-called mutation α and the presence of median fold, though it may be sometimes indistinct, must

be worthy of note. All those points above stated must be taken into consideration in specific distinction. The writer is now of the opinion that all those points justly considering those two forms specifically distinguishable from each other.

The specific name, *huangi*, is given in honour of Prof. T. K. HUANG who first established the present genus.

Hor.: Lower Kanokura series. *Loc.*: Kamiyasse, Niitsuki-machi, Kesennuma city, Miyagi Pref. *Reg. No.*: 12370. *Coll.*: H. TAKEDA and K. NAKAMURA. *Reg. No.*: 12369. *Coll.*: T. MAEKAWA. *Loc.*: Imo, Yahagi-machi, Rikuzentakada city, Iwate Pref. *Reg. No.*: 12372, 12371. *Coll.*: H. TAKEDA, M. HARADA and K. NAKAMURA.

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Explanation of Plate 15

(All figures in natural size.)

Figs. 1, 2, 3 and 4. *Spinomarginifera kueichowensis* HUANG .....p. 143
1a. Internal mould of the dorsal valve together with the internal mould of the apical region of ventral valve. 1b. Internal mould of ventral valve. 1c. External mould of ventral valve. 1d. Lateral view of the "Steinkern". 2. External mould of dorsal valve. 3. Internal mould of ventral valve. 4. Internal mould of dorsal valve showing the rather strong marginal ridge.
Fig. 1: reg. no.: 12642; fig. 4: 12374. Imo, Yahagi-machi, Rikuzentakada city, Iwate Pref. Fig. 2; reg. no.: 11554; fig. 3: 12585. Kamiyasse, Niitsuki-machi, Kesennuma city, Miyagi Pref.

Figs. 5, 6 and 7. *Spinomarginifera huangi* NAKAMURA, n. sp. .....p. 145
5. External mould of dorsal valve. 6a. External mould of dorsal valve. 6b. Internal mould of dorsal valve. 6c. Lateral view of the "Steinkern". 6d. Internal mould of ventral valve. 7a. Lateral view of the external mould of dorsal valve. 7b. External mould of dorsal valve. 7c. Internal mould of dorsal valve clearly showing the prominent marginal ridge, the muscle scars and the brachial ridges.
Fig. 5: reg. no.: 12369; fig. 6: 12370. Kamiyasse, Niitsuki-machi, Kesennuma city, Miyagi Pref. Fig. 7: reg. no.: 12371. Imo, Yahagi-machi, Rikuzentakada city, Iwate Pref.

1a

1b

3

2

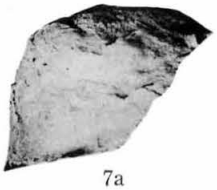
1c

1d

4

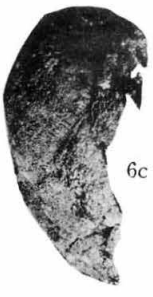
1e

5

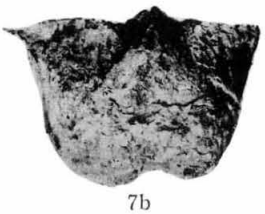


7a

6a



6c



7b

6b

6d

7c

KUMANO and NAKAMOTO photo.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 35, pp. 147-155, pl. 16, Sept. 15, 1959

370. "*BAKEVELLIA*" AND "*EDENTULA*" FROM THE LATE TRIASSIC MINE SERIES IN WEST JAPAN*

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美祢統産の "*Bakevellia*" と "*Edentula*": 美祢統から多産する "*Gervillia*" *hekiensis* 及び "*Edentula*" *triangularis* に就き特に其の棲息環境及び生長変化を考察した。前者は腐泥質内湾相に多産し、後者は公海的浅海相に多産し、各々異つた化石群集を構成している。*hekiensis* の各生長段階での蝶番・靱帯の性質から考えて、此種は *Bakevellia* とは別属にすべきものなので新属 *Bakevelloides* を提唱する。又 *triangularis* の生長変化、特に側歯外形の変化により、WAAGEN の *Edentula* (NITZCH に名前を先取されている) と COX の *Cuneigervillia* (*Edentula* の代属として提唱されたが両属の模式種は異る) とは系統的に違う事が判つたので、この機会に *Edentula* の代名 *Waagenoperna* を提唱する。　　徳山　明

"*Gervillia*" *hekiensis* KOBAYASHI & ICHIKAWA and "*Edentula*" *triangularis* KOBAYASHI & ICHIKAWA are two of abundant species in the Mine series. The former is found in the bituminous near-shore facies of the Hirabara stage or the lower Mine series, while the latter occurs in the neritic open-sea facies of the Aso stage or the upper Mine series. Several immature shells of the two species enabled the writer to study their ontogeny. Therefore their phyletic relations are briefly discussed here. "*Gervillia*" *hekiensis* is included in a new genus *Bakevelloides* or *Aguileria*-section which bears pseudotaxodont denticles and distributes from Middle Trias to Cretaceous. So far as the writer can see in his collection the Bakevelliidae are not monophyletic, because this section differs from the *Bakevellia*-section in the dentition already in the immature stage in spite of superficial resemblances. "*Edentula*" WAAGEN is an Upper Triassic genus hitherto known from the South Alps and Japan. From the ontogenetical observation it is noted that "*Edentula*" is more closely related to *Isognomon* than *Bakevellia*. According to COX (1954) *Cuneigervillia* which is a subjective synonym of *Edentula* WAAGEN grows through "*Bakevellia*-stage" and therefore he referred it to the Bakevelliidae. On the other hand, "*Edentula*" *triangularis* does not grow through this stage. Its immature form bears an opisthocline tooth in the anterior extremity and bears no lateral teeth in posterior. A further difference between the two species is in the ligament groove. More precisely, in "*Gervillia*" *hekiensis* a new ligament pit which is triangular or semiconical and prosocline, is inserted on the posterior side of the area; later, it is shifted forward till it becomes a complete groove which is hemicylindrical and forms a right angle with the hinge line. In "*Edentula*" *triangularis* the ligament pit, which is narrow and lies at the anterior angle of the area, becomes a wide and deep groove in posterior. Here the writer proposed a new name *Waagenoperna* for the sub-

* Received Nov. 12, 1958; read at the Annual Meeting of the Society at Tokyo, Dec. 7, 1958.

stitute of *Edentula* WAAGEN, 1907, (non NITSCH, 1820) and he refers it to the Isognomonidae.

The writer's thanks are due to Prof. T. KOBAYASHI for his kind guidance and encouragement throughout this work.

Family **Bakevelliidae** KING

Aguileria Section

"*Gervillia*" *hekiensis* and its allies are very common in the Upper Triassic formations in the inner zone of Southwest Japan. Namely, "*G.*" *hekiensis* is known from Heki (KOBAYASHI & ICHIKAWA, 1952), Nabae (NAKAZAWA, 1954) and Kyowa (NAKANO, 1957) and *Bakevellia subhekiensis* from Nabae. They are fairly convex and almost equivalved and have pseudotaxodont denticles, fairly wide, depressed triangular ligament area and a few but stout ligament pits. In these characteristics they match with Cretaceous *Aguileria* WHITE which is considered a subgenus of *Bakevellia* by Cox (1940). Some authors are of opinion that these Triassic forms were derived from the *Bakevellia*-stock (NAKAZAWA, etc.) at one time and *Aguileria* itself was also derived from the same stock (COX, etc.). In other words, the Triassic and Cretaceous forms indicate two independent branches. HAYAMI (1957) and NAKANO (1957) are of opinion that the two forms are on the same lineage from the stock of Permian *Bakevellia* s. str. Some immature forms of the Mine series, the writer collected recently, have pseudotaxodont dentition already in the very immature stage, while the "*Bakevellia*-stage" having two prosocline teeth at the anterior angle cannot be seen in this form. Therefore the writer thinks that the Bakevelliidae include at least two branches, the *Bakevellia*- and the *Aguileria*-branch, which were independently derived from the *Pteria*-stock and that the latter branch is not a direct off-shoot from the former branch. Therefore the writer establishes a new genus *Bakevelloides* for the Triassic and Jurassic forms and *Aguileria* represents probably a terminal branch of this section.

Genus *Bakevelloides* TOKUYAMA, new genus

Type species:—"*Gervillia*" *hekiensis* KOBAYASHI & ICHIKAWA from Carnic Heki formation in Japan.

Diagnosis:—Sheli almost equivalve, fairly convex and roundly triangular; a very shallow sulcus separates the anterior part from main body in left valve. Ligament area wide, depressed-trigonal or trapezoidal, with a few, stout ligament pits which are radiating from umbo. Hinge area narrow, with pseudotaxodont denticles, divergent from umbo: posterior one or two denticles sometimes become lateral teeth. Pallial line marked by a series of pallial muscle scars in anterior part.

List of species:—*Gervillia mytiloides* SCHLOTHEIM by CREDNER (1851) from the lower Muschelkalk. *Gervillia lata* PHILLIPS by KEYSERLING (1846) from the Jurassic of Petchora district.

Remarks:—In the outline, ligament and hinge apparatus Cretaceous *Aguileria* WHITE is the closest ally to this, although WHITE's is distinguishable from the writer's by the more obliquely elongated outline and more profound sulcus in the former than the latter. Moreover, the posterior lateral teeth are not separable from the pseudotaxodont denticles or a series of "transverse crenulations" in *Aguileria*, while they

are fairly stout and well specialized from the denticles in this genus. Therefore *Aguileria* is more widely apart from *Pteria* than *Bakevelloides* or more specialized than *Bakevelloides*, if *Bakevelloides* and *Aguileria* are in the same evolutional lineage, although ignorance of the growth change of *Aguileria* is a defect to determine the true relation. In spite of the superficial resemblances this differs from *Bakevellia* in the hinge development. According to Cox "In a few forms (subgenus *Aguileria*) the greater part of hinge line is bordered by a series of narrow transverse crenulations". In *Bakevelloides*, however, these actinodont denticles are already recognized in the very immature stage as will be related later. Therefore they reveal the true dentition instead of mere crenulation. From the ontogenetical stand point the denticles are essential for this branch. Its immature form closely resembles *Pteria*, *P. okubatensis* for example, in outline and in the ligament pit. Therefore this may have been derived separately from a pteriid branch rather than from *Bakevellia*. Finally, the writer opines that the Bakevelliidae are not monophyletic but include at least the two branches.

Bakevelloides hekiensis (Kobayashi and Ichikawa)

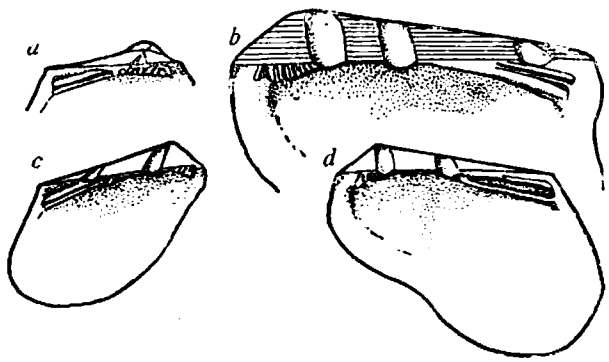
Plate 16, Figures 1-7; Text-figure

1926. *Gervillia* sp., Ozawa, *J. Geol. Soc. Tokyo, vol. 33*, p. 208 (listed).
1938. *Gervillia* sp., Katayama, *Ibid., vol. 46*, p. 138, pl. 8, fig. 11 (no description).
1952. "*Gervillia*" *hekiensis* Kobayashi & Ichikawa, *J. J. G. G., vol. 22*, pp. 76-78, pl. 2, figs. 4-6.
1954. *Bakevellia hekiensis*, Nakazawa, *Mem. Col. Sci., Univ. Kyoto, ser. B, vol. 21*, pp. 218-219, pl. 5, figs. 3-8; pl. 6, figs. 1-3.
1954. *Bakevellia subhekiensis* Nakazawa, *ibid, vol. 21*, pp. 219-220, pl. 6, figs. 4-7.
1957. "*Aguileria*" *hekiensis*, Nakano, *J. Sci. Hiroshima Univ., ser. C, vol. 8*, p. 64, pl. 9, fig. 4.

Description:—Shell fairly thick, roundly and obliquely trigonal, transversely elongated and more or less inequivalve, with left valve more inflated; umbo prosogyrous, large, rounded and protruded above hinge line; anterior margin rounded; antero-ventral almost straight with or without a weak ventral sinus at 2/5 from the anterior extremity; this sinuation more distinct in left valve than in right; posterior and postero-dorsal margin moderately convex, oblique to dorsal margin. Both anterior and posterior auricles indistinct; posterior one slant and a little convex. Surface marked with weak and somewhat regular concentric growth lines. Adductors anisomyarian; posterior adductor impression large and subelliptical, while anterior one is subrounded; pedal retractor scar deep and distinct under umbo; pallial line distinctly marked by a series of pallial muscular impression in anterior part. Ligament area fairly wide, low triangular to trapezoidal, striated horizontally; ligament grooves 4 to 5, large, deep and longer than wide. Hinge area narrow, provided with pseudotaxodont denticles, divergent from umbo. Posterior one (left valve) or two (right) form stout and oblique lateral teeth.

Measurement in mm.	Length	Height
One-pit stage (fig. 7)	12+	10+
Two-pit stage (fig. 6)	18.7	14.6
Two-pit stage (fig. 5)	23.4	10.9
Three-pit stage (fig. 3)	35.5	32.0
Three-pit stage (fig. 2)	49.5	36.7
Adult (five-pit) stage (fig. 1)	57.3	43+

Observation:—Many specimens in the Mine collection are fairly well preserved. Their outline, ligament and others vary so widely that the writer thinks that *hekiensis* and *subhekiensis* (NAKAZAWA, p. 220) belong to a species where *subhekiensis* represents a primitive stage. The growth changes observed in the Mine collection are:



Text-figure: *Bakevelloides hekiensis*: transformation of hinge and ligament grooves in 4 ontogenetical stages; a: one-pit stage, ×2; c: early two-pit stage, ×2; d: later two-pit stage, ×2; b: three-pit stage, ×1.

1) One-pit stage:—A ligament pit under the beak is prosocline, triangular and like that of *Pteria*. Several small teeth distinct in the hinge area are arranged in "actinodont-type" dentition.

2) Two-pit stage:—The first pit, just below the beak is prosocline and subtrapezoidal; the second pit added in the posterior part of the ligament area; no remarkable change is seen in dentition, although the denticles become somewhat obsolete in the middle part. Later the shell is elongated obliquely; pallial line and antero-ventral sinus are more distinct; second pit is shifted to the middle.

3) Three-pit stage:—The third pit inserted in the posterior part of the ligament area is triangular and prosocline, while the first and second are parallel to each other and rectangular to the hinge; the interspace between the first and second is narrower than that between the second and third. Ligament area is striated transversely. The lateral teeth are clearly separated into two series by the non-denticulate median part, although denticles sometimes form a continuous series.

4) Adult stage:—Ligament area depressed, slightly incurved, striated transversely and forms an obtuse angle (about 120°) with the plane of commissure; pits number 4 or 5. Dentition composed of several anterior denticles and 1 or 2 oblique posterior teeth.

Its immature form closely resembles *Pteria* such as *okubatensis* from the lower Mine series, in outline and ligament pit. Its newly inserted pit is very similar to that of *Pteria* in the shape and prosocline state. Seeing that some primitive *Pteriae* are similar to this (ex. *Cyrtodonta declivis*) in dentition, this species grows through the "*Pteria*-stage" (BERNARD's *Avicula*-stage) rather than the "*Bakevellia*-stage" (FRECH, 1902). Therefore the group of *Bakevelloides* may have been derived separately from the pteriid stock rather than from the *Bakevellia*-stock. Accordingly this group should be distinguished from the group of the strict sense at least in the generic rank.

Comparison:—In comparison with the typical form from Heki, the Mine specimens are commonly more convex

and more obliquely elongated. From any other specimens hitherto described from 3 places in West Japan, the Mine form is distinguishable by the convex outline and more "primitive" features: namely, anterior and posterior adductor scars are simple and large. Such differences, however, bear no specific value if considered the wide variability in outline, hingement, dentition and interior among the Mine specimens.

This species resembles *Bakevellia antiqua* (MÜNSTER) by KING in outline and interior, but the resemblance may be superficial, because their hinges are quite different from each other already in the immature stage. "*Gervilleia*" *mytiloides* SCHOLTHEIM in CREDNER from the Muschelkalk may belong to *Bakevelloides*, although that species is more obliquely elongated and less distinct in auriculation. Jurassic *Gervillia lata* PHILLIPS by KEYSERLING from Petchora district may be the closest ally. It is almost indistinguishable from the type specimen of *hekiensis* except for the deeper posterior muscular impression and more rounded anterior angle in the latter. Generally speaking, however, the Jurassic form differs from this in the more equivalved shell and more rounded outline, less distinct ventral sinus and better defined posterior auricles. Finally, *Aguileria cumminsi* WHITE (in STEPHENSON, 1952; type species of *Aguileria*) is intimately related to this in dentition, hinge, pallial line and muscular impressions, but WHITE's is more obliquely elongated and has a distinct byssal sinus. Because the byssal character which may be essential for classification, is widely apart between this and *Aguileria*, the writer refrains from identifying them to the same genus. Their true relation is indeterminable until the growth change of *cumminsi* is well known.

Occurrence:—Common in the upper part of the Kumanokura or the middle Atsu stage at West Shirogawara and very common in the middle and upper part of the Hirabara or the lower Mine series at Shiraiwa, Mugikawa, Hirabara and Okubata (from N to S). At Shiraiwa this species forms a shell bank with large *Palaeopharus*, "*Gryphaea*", *Schafhäutlia* and other near-shore pelecypods in bituminous sandstone facies. At Mugikawa it forms a shell bank by itself in more or less bituminous sandstone. At Hirabara it occurs in a shall bank with *Palaeopharus* and *Minetrigonia* in shallow-sea sandstone. At Okubata it is somewhat scattered in shallow-sea sandstone. Here this species is restricted to the northern or inner half of the "Hirabara-bay" (TOKUYAMA, 1958). The mode of occurrence suggests that this species is characteristic of the bituminous or near-shore shallow-sea facies. In Heki, Nabae and Kyowa this is often associated with *Palaeopharus*, *Minetrigonia* and *Cardinia* and sometimes with *Lima* or *Oxytoma*.

Family **Isognomonidae** DALL

Genus *Waagenoperna* TOKUYAMA, new name

=*Edentula* WAAGEN, 1907
(non NITZSCH, 1820)

Type species:—*Edentula lateplanata* WAAGEN from Carnic Pachycardientuff of Seiser Alm.

Diagnosis:—Shell fairly large, flattened and almost equivalve; anterior wing small and posterior one broad and scarcely defined. Byssal opening distinct below beak. Cardinal and lateral teeth absent already in immature stage. Ligament area shorter than dorsal margin,

striated transversely and provided with several ligament grooves, mostly wider than high, small and narrowly spaced near anterior angle, tending to be larger and more broadly spaced posteriorly. Posterior muscular impression at the end of ligament area, large but weak, while anterior one is small and distinct. Surface covered with concentric lines of growth; no radial markings.

List of species:—*Gervilleia planata* BROILI, Carnic, South Alps: *Edentula ozawai* KOBAYASHI, Ladino-Carnic, Japan: *Edentula triangularis* KOBAYASHI & ICHIKAWA, Carno-Noric, Japan.

Remarks:—The genus *Edentula* was established by WAAGEN for 2 Carnic species. Subsequently 2 species were added from Japan. As the generic name *Edentula* WAAGEN is preoccupied by NITZSCH in 1820, COX established a new genus *Cuneigervillia* for its substitute, selecting *Gervillia hagenowi* as the type species. COX's, however, bears a larger and more distinctly defined posterior wing and a less distinct anterior wing than WAAGEN's. In the Liassic form "the hinge in the earlier growth-stage with two teeth in the anterior angle and an elongated tooth on the interior of the posterior wing". Thus *Cuneigervillia* grows through the "*Bakevellia*-stage". Hence COX assigned it to the Bakevelliidae. On this occasion WAAGEN's two *Edentulae* were referred to this genus beside 3 Liassic species.

A study on the growth of hinge teeth casts a question whether *Edentula* is really identical with *Cuneigervillia* or not. More precisely, the writer's "*Edentula*" collection shows that hinge teeth, especially posterior laterals, are absent already in the very early stage. Its outline changes from cuneiform (immature) to *Isognomon*-shape (mature). So far as the writer can be seen in the Mine collection, *triangularis* does not grow through the *Bakevellia*-stage. If does, it should be called "*Pteria*-stage" rather than "*Bakevellia*-stage". Moreover, ligament apparatus suggest wide difference between the Triassic and Jurassic form. *Triangularis* is widely apart from *Cuneigervillia hagenowi*, while it is congeneric with *lateplanta* and *planata** in the above mentioned characteristics, they are more closely related to *Isognomon* rather than *Bakevellia*. Because the writer has no opportunity to make a close study on *Cuneigervillia*, it is a question for him whether or not all of the Jurassic *Cuneigervilliae* differ from "*Edentula*" in the generic rank. Nevertheless it is certain that *Edentula lateplanata* cannot be maintained in *Cuneigervillia*. Therefore the writer proposes a new name *Waagenoperna* for the substitute of *Edentula* WAAGEN.

As for its phyletic relation, WAAGEN suggested the lineage of *Myalina* (or *Promyalina*)—*Edentula*—*Isognomon*. According to him the embryonic hinge development of *Isognomon* is also suggestive of *Myalina* as the ancestor. On the other hand COX took *Cuneigervillia* for a derivative of *Bakevellia*. With the Mine collection, it is found that immature hinges of *Waagenoperna* and *Bakevelloides* are quite different. Namely, the posterior lateral is absent in *triangularis*, while it is very stout and distinct in *hekiensis*: ligament area shorter than margin in *Waagenoperna*, while it is as long as the margin in *Bakevelloides*. An anterior tooth is opisthocline in *Edentula*,

* The writer could observe the replica of BROILI's type specimens which were reproduced by Prof. T. KOBAYASHI at the Institut für Paläontologie und historischen Geologie der Ludwig-Maximilans-Universität zu München through the courtesy of the late Prof. F. BROILI.

whereas 2 cardinal teeth are prosocline in *Bakevelloides*. The arrangement of these hinge teeth, commonly prosocline, must be essential for phylogeny. This is the reason why *Waagenoperna* is placed in the Isognomonidae.

Distribution:—Upper Triassic: South Alps and Japan.

Waagenoperna triangularis (Kobayashi & Ichikawa)

Plate 16, Figures 8-15.

1952. *Edentula* (?) *triangularis*, Kobayashi & Ichikawa, *J.J.G.G., vol. 21*, pp. 268-270, text-figures 1, 2.

Description:—Shell almost equivalve, flattened, broadly inflated, depressed trigonal to cuneiform, wider than high and widest at a little below hinge line; umbo a little protruded above hinge line. Anterior auricle small, distinctly defined in left valve and less distinctly in right; posterior wing broad and ill-defined. Byssal sinus more or less distinct. Antero-ventral margin almost straight except for byssal sinus; postero-ventral one broadly rounded. Ligament area short and narrow in immature, becoming longer and wider; ligament grooves widely spaced, wider than long, shallow outside and deep inside, small and narrowly spaced in the anterior angle, becoming larger, wider and more widely spaced posteriorly. Hinge with an oblique prosocline tooth in anterior angle of immature shell, but later it becomes suddenly obsolete. Posterior lateral absent from very young stage. Posterior muscle scar large and sub-rounded. Surface marked with concentric lines of growth.

Measurement in mm.	Length	Height
Immature stage (fig. 16)	10.3	6.5
Immature stage (fig. 15)	16.5	10.0
Middle-grown stage (fig. 13)	26.9	17.5
Mature stage (fig. 9)	65.5	52.0

Observation:—The Mine specimens include several growth stages but no nepionic stage; their growth changes are:

1) Very immature stage:—Outline is *Pteria*-like; anterior tooth exists in anterior angle, but posterior lateral tooth is absent; ligament area very narrow; ligament groove unknown.

2) Immature stage:—Trace of an anterior tooth is opisthocline in anterior angle; ligament area narrow and short, about half as long as dorsal margin; ligament grooves 3 or 4, widely spaced in posterior; most anterior groove short, narrow and a little oblique; all of them wider than long, arch-shaped, deep in inside and shallow in outside of hinge margin.

3) Mature stage:-Outline a little higher and more rounded; hinge area fairly broad, as long as anterior margin; ligament grooves 5; each wider than long and narrower than interspace; ligament area becomes wider and longer through growth; ligament pits small, narrow and narrowly spaced in anterior angle, becoming larger, wider and more widely spaced in posterior part.

Comparison:—*Gervilleia planata* Broili is very close to this species. Its middle stage of growth is almost indistinguishable from the illustrated species by Broili; they are all cuneiform in outline, narrow and more or less short ligament area and similar ligament grooves. In the full maturity it is, however, higher and more broadly rounded in this than in *planata*; anterior auricle smaller than in *planata*. *Edentula lateplanata* Waagen agrees with this in ligament and outline but Waagen's is more broad-

ly inflated and more rostrated anteriorly. *Edentula ozawai* KOBAYASHI (1935) is distinguishable from this by the protruded posterior wing and higher outline in the former than the latter. Skytic *Edentula castelli* v. WITTENBURG (1908) is widely apart from this in the longer and more oblique outline in the former than this. Its generic designation for *Edentula* is questionable. *Cuneigervillia hagenowi* is distinguishable from this in the more strongly defined posterior wing and less distinct anterior auricle. The Jurassic form takes the aspect of *Bakevellia* in the immature stage, but this is quite distinct from that genus already in immature stages, notably in the hinge development and ligament characters.

Occurrence:—Common in the middle part of the Aso or upper Mine series (upper Carnic to Carno-Noric) at Aso, Kami-yuguchi, Higaeribara, Sonose and Ichinose, all in the Mine area in Nagato. At Aso and Kami-yuguchi it occurs with *Eumorphotis*, *Lima*, *Entolium*, *Chlamys*, *Cardinia*, "*Gryphaea*" and other pelecypods in very coarse sandstone of littoral neritic facies. At Higaeribara it forms a shell bank with "*Pentacrinus*", *Eumorphotis*, *Plagiostoma*, *Chlamys*, *Tosapecten*, *Plicatula*, "*Gryphaea*" and other pelecypods in medium grained sandstone of open-sea facies. At Sonose and Ichinose it occurs rather scattered in very coarse sandstone, like at Aso, with *Anodontophora*, *Tosapecten*, "*Gryphaea*" and other pelecypods. The mode of occurrence suggests that this species is characteristic in the shallow open-sea facies and more off-shore in comparison with the *Bakevelloides*-facies.

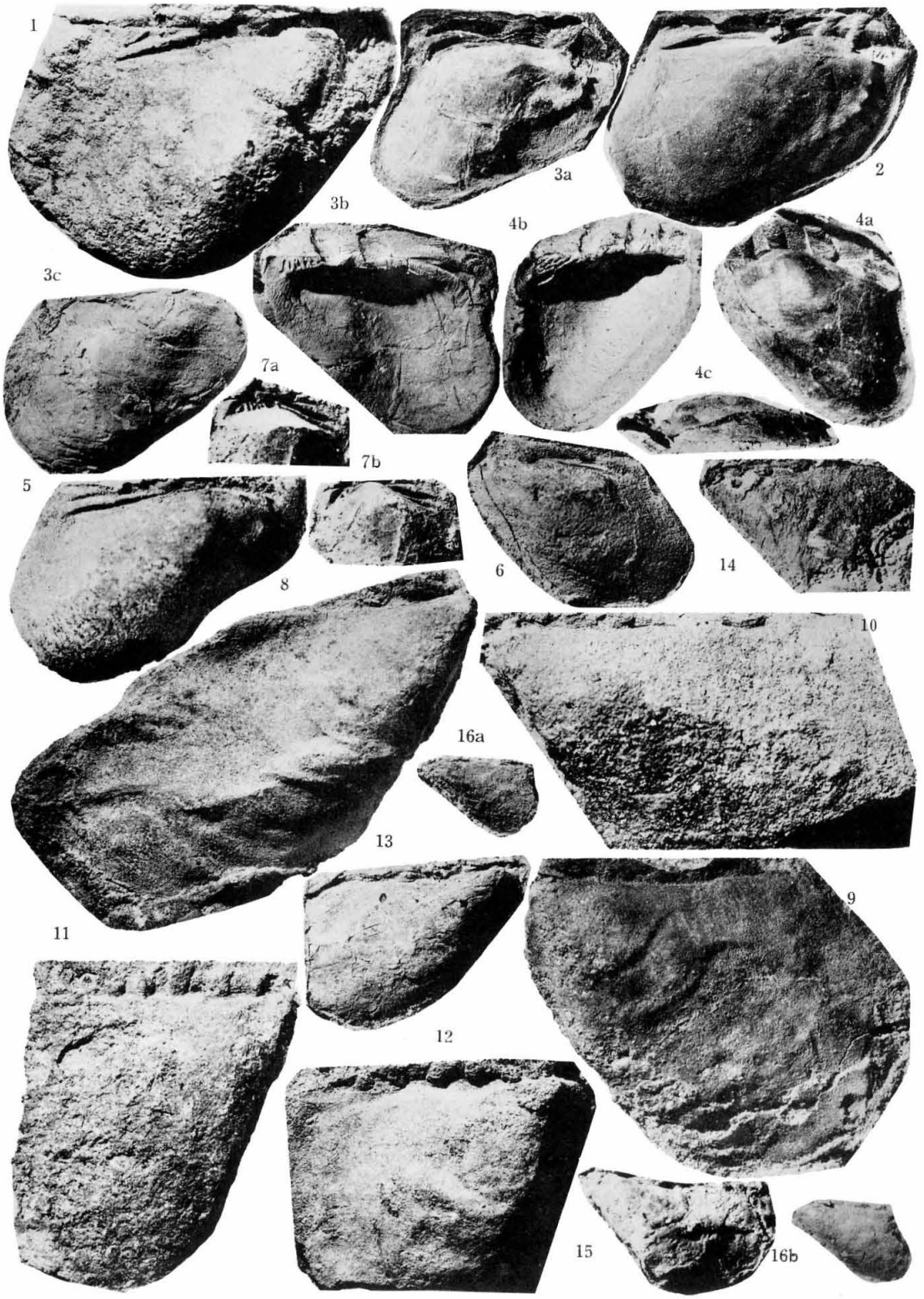
As KOBAYASHI described, *Edentula ozawai* is very common at a locality west of Shirogawara in the upper Atsu series (Ladino-Carnic or lower Carnic). It is interesting that *Waagenoperna* is absent in the Hirabara stage (lower Mine series; lower Carnic) notwithstanding the fact that the Hirabara stage yields many neritic pelecypods and brachiopods.

It is important that this is an only species occurring in common between the Mine and Nariwa districts. In the Nariwa district (KOBAYASHI & ICHIKAWA 1952 b) it is associated with *Cardinia misawensis* and "*Gervillia*" *saekii*. This represents a marine band inserted a little lower than the *Entomonotis*-bed. Its age is Noric, while in the Mine area this species occurs in the upper Carnic to Carno-Noric Aso stage. Therefore the range of this species is from upper Carnic to Noric.

Explanation of Plate 16

Figs. 1-7: *Bakevelloides hekiensis* (KOBAYASHI & ICHIKAWA).....p. 149
1-2: Right internal mould of an adult shell, ×1; 3a, b: right internal mould (3a) and its clay cast (b, c) of 3-pit stage, ×1; 4a-c: Left internal mould (lateral (a) and anterior view (c)) and its gypsum cast (c), ×1; 5: later state of two-pit stage, ×2; 6: earlier state of two-pit stage, ×2; 7a, b: one-pit stage, ×3. Loc.: 1: Hirabara, 2, 5, 7: North of Omine station; 3, 4: Shirawa; 6: Okubata; all in the Mine city, Nagato.

Figs. 8-16: *Waagenoperna triangularis* (KOBAYASHI & ICHIKAWA).....p. 153
8-12: Adult internal moulds, ×1; 13, 14: middle-grown stage, ×2; 15, 16a, b: immature left internal moulds and an external clay cast of a left valve (b), ×3. Loc.: 8, 9, 12: Mishime, near Aso; 10, 11: near Sonose; 13-16: Higaeribara; all in Aso, Mine city in the upper Carnic Aso stage.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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

「日本古生物学会第72回例会」1959年2月14日広島大学理学部地質学鉱物学教室において開催した。(参会者32名)。例会における講演者並びに講演題目は次の通りである。

Fusulinids from the Aratani Conglomerate in the Northeastern Part of Yamaguchi City ..... Michihiro KAWANO

Echigoella, a new Permian fusulinid genus from the Upper Part of the Omi limestone, Niigata Prefecture, Japan (代読) ..... Hisayoshi IGO

天草下島北岸に於ける坂瀬川層群中の有孔虫(代読) ..... 村田茂雄

Some Miocene Foraminifera from Okayama, Hyôgo and Kyôto Prefectures, West Japan ..... Yoshiro TAI

Smaller Foraminifera from the Tanabe Miocene Formations, Wakayama Prefecture ..... Yoshiro TAI

Permian Corals from the Taishaku District, Hiroshima Prefecture, Japan..... ..... Tsuruo YOKOYAMA

千葉県千葉郡八千代町柏井産出の鮮虫類につい

て（成田層）（代読）……高橋直二
Bemerkungen über den Brachiopodenfazies der Torinosuserie Südwestjapans（代読）……Akira TOKUYAMA
On Some Ordovician Fossils from Northern Malaya and her Adjacence……Teiichi KOBAYASHI
山口県東部（岩国市西方）より *Monotis* (*Entomonotis*) の新産出……長谷 晃
Marine Jurassic Pelecypods of the Tetori Group in Makito Area of Northern Gifu Prefecture, Central Japan（代読）……Itaru HAYAMI
Taxodonta and Isodonta from the Upper Jurassic Soma Group in Japan（代読）……Minoru TAMURA
Upper Jurassic Pteriacea from the Soma Group in Japan（代読）……Minoru TAMURA
A Note on *Neoburmesia*, peculiar Shape of Upper Jurassic Pelecypods, with Description of Mytilids and Myacids from the Jurassic Soma Group in Japan（代読）……Minoru TAMURA
Heterodonta and a *Ostrea* from the Upper Jurassic Soma Group, Japan（代読）……Minoru TAMURA
富山県桐谷産の三角介化石の二・三種について……中野光雄
A New Locality of the *Vicarya* Fauna from Aomori Prefecture（代読）..Takehiko IWAI
On *Fortipecten kenyoshiensis* SUDA & SHIBATA (MS) from the Pliocene of Aomori Prefecture, Japan（代読）..Kiyotaka CHINZEI
化石カイエビ類の種の限界について ….楠見 久
On the Fossil Beech Leaves from the Ningyô-tôge area in the Chugoku district, Japan（代読）……Toshimasa TANAI
On a Cycadean Trunk from the Uryu district, Hokkaido, Japan（代読）……Toshimasa TANAI

日本古生物学会第 73 回例会は 1959 年 5 月 23 日九州大学理学部地質学教室で開催した。（参会者 25 名）

特 別 講 演

古生代・中生代石灰藻の系統発生 ……遠藤隆次

例 会 講 演

On the Upper Permian fusulinids from the Ogamata formation, Northwestern Part of the Kwanto Massif（代読）……Atushi ISHII
New Species of Paleogene foraminifera from Kumamoto Prefecture ……Shigeo MURATA and M. SUGAHARA
A Gotlandian Coral newly found in the Hôei Mine, Oita Prefecture, Japan……Mitsuo NODA
Note on the Gotlandian Tetracorals from the Fukuji Formation. Part 1.（代読）……Hisayoshi IGÔ
On the taxonomic Position of *Favosites hidensis* and its Devonian Age.（代読）……Takashi HAMADA
Upper Paleozoic Corals from Fukuji, Southeastern Part of the Hida Massif. Part 3.（代読）……Hisayoshi IGÔ
富山県氷見郡宮川層の蘚虫類化石について（代読）……高橋直二
On the Discovery of Goniatitic Ammonite from the Upper Visean Hongo formation, Hida Massif.（代読）……Hisayoshi IGÔ
New occurrence of *Solenoceras* in the Sanuki Mountain-range, Shikoku, Japan. ……Mitsuo NAKANO and K. NUMANO
菊石 Desmoceratidae 科に見られる相対成長……小畠郁生
Upper Cretaceous Ammonites of California. Part 2. ……Tatsuro MATSUMOTO
Daonella in Japan.（代読）……..Teiichi KOBAYASHI and A. TOKUYAMA
The Halobiidae from Thailand.（代読）……..Teiichi KOBAYASHI and A. TOKUYAMA
Upper Jurassic Pelecypods from the Torinosu Group in Shikoku, Japan……Minoru TAMURA
The Bearing of the Trigoniids on the Jurassic Stratigraphy of Japan (Studies on the Jurassic Trigonians in Japan. Part 8.)……Teiichi KOBAYASHI, K. MORI and M. TAMURA
築別化石動物群について（代読）……菅野三郎・松野久也
宮崎層群産 Pectinidae について……首藤次男
宮崎層群産 Veneridae について……首藤次男
宮崎層群産 Buccinidae について……首藤次男
横浜の中里層産の貝化石について（代読）……青木直昭
Younger Mesozoic Estherids from the Wakino Group in Northern Kyushu, Japan……Hisashi KUSUMI
Two New Species of *Kewia* from Japan.（代読）……Matsutaro SHIBATA
Notes on Microfossils from a calcareous Sandstone (probably Pleistocene) at Kiribenohara, Yuya-machi, Yamaguchi Prefecture ……Kazuo OKAMOTO and Wataru ISHIJIMA

Article 18. The Society shall hold regularly one General Meeting a year. The President shall be Chairman and preside over the administrative affairs. The program for the General Meeting shall be decided by the Council. The President may call a special meeting when he deems it necessary. The General Meeting requires the attendance of more than one-tenth of the members. The President shall call a Special Meeting at the written request of more than one-third of the members. The request shall be granted only if the written statement fully explains the reasons for assembly and items for discussion.

Article 19. Members unable to attend the General Meeting may give an attending member a written statement signed by himself trusting the bearer with the decision of business matters. Only one attending member may represent one absentee.

Article 20. The decision of the General Meeting shall be by majority vote. When the number of votes is equal, the President shall cast the deciding vote.

Article 21. The President and Councillors shall compose the Council. The dicision of the General Meeting concerning administration shall be considered and implemented by the Council.

Article 22. The Executive Council shall carry out the decisions of the Council.

Article 23. The fiscal year of the Society shall begin on the first of January each year and end on the thirtyfirst of December of the same year.

Article 24. The amendments to the Constitution of the Society shall be decided at the General Meeting and must be approved by more than two-thirds of those members who are in attendance.

Addendum 1) Voting in the Council shall be by unsigned ballot.

(1959, 12, 6)

学　会　紀　事

常務委員会は評議員会にはかり，次の事を決定した。

1. 本会創立 25 周年を記念して記念事業準備委員会を発足することとした。
2. 日本学術会議第 5 期会員（第 4 部 地質学 全国区）候補者として，本会会員遠藤隆次君を推薦することとした。
3. 毎日学術奨励金に会員西山省三君の研究 "The Echinoid fauna of Japan and adjacent region" を推薦することとした。
4. 偕成学術奨励金に会員前田四郎君の研究 "中生代手取統の層位学的古生物学的研究" を推薦することとした。

例　会　通　知

	開　催　地	開　催　日	講演申込締切日
第 74 回 例 会	京 都 大 学	1959 年 11 月 21 日	1959 年 10 月 15 日

講読御希望の方は本会宛御申込下さい

1959 年 9 月 10 日　印　刷
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CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

Article 1. The Society shall be known as the Palaeontological Society of Japan.

Article 2. The object of the Society is to promote the study and popularization of palaeontology and related sciences.

Article 3. The Society, to execute Article 2, shall undertake the following business:

1. Issue the Society journal and other publications.
2. Hold or sponsor scientific lectures and meetings.
3. Popularize the science by field trips, scientific lectures and other projects.

Article 4. To attain the object of the Society, the Society may, by decision of the General Meeting, establish within it research committees.

Article 5. The Society shall be composed of members who are active or interested in palaeontology or related sciences.

Article 6. The members shall be known as Regular Members, Fellows, Patrons and Honorary Members.

Article 7. Persons desiring membership in the Society are requested to fill out the necessary application forms and receive the approval of the Council.

Article 8. Fellows are persons who have held Regular Membership in the Society for more than ten years, have contributed to the science of palaeontology, have been nominated by five Fellows and approved by the Council.

Article 9. Patrons are organizations supporting Article 2 and recommended by the Council.

Article 10. Honorary Members are persons of distinguished achievement in palaeontology. They shall be recommended by the Council and approved by the General Meeting.

Article 11. The members of the Society shall be obliged to pay the annual dues stated in Article 12. Members shall enjoy the privilege of receiving the Society journal and participating in the activities stated under Article 3.

Article 12. The rates for annual dues shall be decided by the General Meeting. Rates for annual dues are: Regular Members, Yen 600; Fellows, Yen 1,000; and Foreign Members, $3.00, for which they will receive special publications in addition to the Society journal; Patrons are organizations donating more than Yen 10,000 annually; Honorary Members are free from obligations.

Article 13. The budget of the Society shall be from membership dues, donations and bestowals.

Article 14. The Society, by decision of the Council, may expel from membership persons who have failed to pay the annual dues or those who have disgraced the Society.

Article 15. The officers of the Society shall be composed of one President and fifteen Councillors, among whom several shall be Executive Councillors. The term of office is two years and they may be eligible for re-election without limitation. The President may appoint several persons who shall be Secretaries and Assistant Secretaries. An Executive Council shall be nominated and approved by the Council. Councillors shall be elected from Fellows by vote of returned mail unsigned ballot.

Article 16. The President shall be a Fellow nominated and approved by the Council. The President shall represent the Society and supervise the business affairs. The President may appoint a Vice-President when he is unable to perform his duties.

Article 17. The Society may have the honorary president. The honorary President shall be recommended by the council and approved by the General Meeting. The honorary president may participate in the Council.