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384. HETERODONT AND OTHER PELECYPODS FROM THE UPPER JURASSIC SOMA GROUP, JAPAN*

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福島県相馬の上部ジュラ系産の異歯目その他の斧足類：　相馬の中の沢層及び小山田層からの Heterodonta 及び *Exogyra, Corbula, Thracia* 計 13 種 (うち 3 新種) を記載する。又 *Arctica* (*Somarctica*) *abukumensis* TAMURA, n. sp. にもとづいて *Somarctica* 亜属を設定し，*Arctica* の進化系列について言及した。鳥巣二枚貝動物群の Heterodonta としては *Astarte* が種数・個体数ともに多く，この点はこゝでも確認され，四国九州方面のものとも共通種が多い。*Astarte subdepressa* BLAKE and HUDLESTON は英国の上部ジュラ系に産するが，中の沢層及び小山田層いづれからも産出する。　田　村　　実

Heterodonta in addition to an *Exogyra*, *Corbula* and *Thracia* from the Nakanosawa and Koyamada formations of the Soma Group total 13 species, 3 of which are new and 8 species were already described from the Torinosu Group in Sakawa Basin (KIMURA, 1956) or Sakamoto area (TAMURA, 1959a, b). Most of the Heterodonta belong to the Astartidae. One *Astarte* is identified with *A. subdepressa* from the Corallian of England (ARKELL, 1932). Further the lineage of *Arctica* is briefly discussed and *Somarctica* subgen. nov. is erected with *A.* (*S.*) *abukumensis* TAMURA, new species. The specific names and their ranges shown in the above table. For the geological notes and fossil localities, see the previous paper (TAMURA, 1959c).

Specific name	Nakanosawa formation				Koyamada form.	
	5th zone	6th zone	7th zone	8th zone	9th zone	10th zone
Exogyra kumensis TAMURA	—	—	—	×	—	—
Astarte ogawensis KIMURA	×	—	—	—	—	—
Astarte defecta TAMURA	×	—	—	—	—	—
Astarte sakamotoensis TAMURA	×	—	×	×	×	—
Astarte kambarensis KIMURA	×	—	—	—	×	×
Astarte subdepressa BLAKE and HUDLESTON	×	—	×	×	×	×
Astarte (*Coelastarte*) *somensis* TAMURA, new species	×	—	—	—	—	—
Opis (*Trigonopis*) *torinosuensis* KIMURA	×	—	×	×	—	—
Opis (*Coelopis*?) sp.	×	—	—	—	—	—
Arctica (*Somarctica*) *abukumensis* TAMURA, new species	×	—	—	—	—	—
Protocardia tosensis KIMURA	—	—	×	×	×	×
Corbula globosa TAMURA	—	—	—	×	—	×
Thracia fukushimensis TAMURA, new species	—	—	×	×	—	—

* Received Jan. 30, 1959; read at 72th meeting of the Society at Hiroshima, Feb. 14, 1959.

The writer wishes to acknowledge his indebtness to Prof. KOBAYASHI of the University of Tokyo for his kind guidance. Further KOBAYASHI gave him the opportunity of studing the fossils stored in his institute. Thanks are also due to Mr. K. MASATANI and others, collectors of these fossils.

Description of Fossils

Family Ostreidae

Genus *Exogyra* SAY, 1820

Exogyra kumensis TAMURA

1959a. *Exogyra kumensis*, TAMURA, p. 27, pl. 5, figs. 29-31.

Occurrence:—Rare in 8th zone at Loc. 14.

Family Astartidae

Genus *Astarte* J. SOWERBY, 1816

Astarte ogawensis KIMURA

1956. *Astarte ogawensis*, KIMURA, p. 86, pl. 1, fig. 9.
1959a. *Astarte ogawensis*, TAMURA, p. 29, pl. 5, figs. 8-10.

Occurrence:—Rare in 5th zone at Loc. 7 and 8.

Astarte defecta TAMURA

1959a. *Astarte defecta*, TAMURA, p. 29, pl. 5, figs. 4-7.

Occurrence:—Rare in 5th zone at Loc. 7.

Astarte sakamotoensis TAMURA

Plate 33, Figures 1, 2.

1959a. *Astarte sakamotoensis*, TAMURA, p. 29, pl. 5, figs. 1-3.

Observation:—The Sakamoto specimens were more or less deformed. Many detached small valves in the Soma Jurassic, have nearly straight or slightly rounded dorsal margins whereas the margins are a little arcuate in the holotype specimen. The concentric folds on surface are 6-10 in number and become much wider ventrally.

Occurrence:—Rare in 5th zone at Loc. 2; abundant in 7th zone at Loc. 15 and in 8th zone at Loc. 14; rare in 9th zone at Loc. 12.

Astarte kambarensis KIMURA

Plate 33, Figures 14-18.

1956. *Astarte kambarensis*, KIMURA, p. 85, pl. 1, fig. 7.
1959a. *Astarte* sp., TAMURA, p. 30, pl. 5, fig. 13.

Description:—Shell medium to small for genus, convex, inequilateral, somewhat trigonal in shape and longer than high; umbo distinct, strongly prosogyrate, at a third of shell length from anterior; antero-dorsal margin concave; lunule shallow; postero-dorsal nearly straight; ventral well rounded; surface ornamented with fine concentric growth-lines; internal margin crenulated; umbonal cavity fairly deep; posterior adductor scar a little larger than the other; both scars deep: hinge composed of short 2, obliquely elongated 4b and an anterior lateral tooth in left valve and oblique 3a and 3b and a posterior lateral tooth in right valve.

Measurement:—

		Length	Height
Right	(MM 3302)	24.5mm	19.0mm
R.	(MM 3303)	24.0	19.5
Left	(MM 3304)	19.5	18.5
L.	(MM 3305)	12.5	12.0

Observation:—This species was based on a poor internal and external mould of which hinge is unknown. *Astarte* sp. from the Sakamoto formation, which is represented by an internal mould, was separated from the species in the previous paper (TAMURA, 1959a) by the different outline. Many Soma specimens identifiable with it reveal a wide range of variability in shape. Now the writer is convinced himself that the specimens from the three areas are conspecific. The Soma specimens show the hinge and other characters, as described above. The Koyamada specimens (Figs. 16, 17) are deformed. The Soma form, especially in sandstone, is large.

Occurrence:—Common in 5th zone at Loc. 8 and in 9th zone at Loc. 12; abundant in 10th zone at Loc. 11.

Astarte subdepressa BLAKE and HUDLESTON

Plate 33, Figures 19-22.

1850. *Astarte pasiopae* d'ORBIGNY, ARKELL, pl. 33, figs. 2, 2a.
1877. *Astarte subdepressa*, BLAKE and HUDLESTON, p. 393, pl. 14, fig. 10.
1877. *Astarte Duboisiana*, BLAKE and HUDLESTON, p. 393, pl. 15, fig. 3.
1932. *Astarte subdepressa*, ARKELL, p. 235, pl. 33, figs. 1-9.

Description:—Shell small to large, subequilateral, moderately depressed, nearly as high as long, circular in outline; umbo at about 1/3 from anterior, prosogyrate, compressed; anterior or antero-dorsal margin short, depressed to form a shallow lunule; postero-dorsal more or less rounded; ventral semi-circular; surface ornamented with about 50 concentric ribs which are distinct, fine and narrower than their interspaces; pallial margin finely crenulated internally; hinge unknown.

Measurement:—

		Length	Height
Left	(MM 3309)	19.0mm	19.5mm
Right	(MM 3310)	37.5	33.0
L.	(MM 3311)	19.0	18.0
R.	(MM 3312)	8.5	8.5
L.	(MM 3313)	24.5	24.5

Observation and Comparison:—The Soma form well agrees with the holotype by ARKELL (1932). The shell is variable in size. The largest attains 37 mm in length but the smallest is only 6.0 mm long. The large specimens were mostly obtained from sandstones of the 5th and 9th zone. Concentric lines become sometimes obscure in ventral part.

It is similar to *Lucina tsunoensis* KIMURA from the Sakamoto (TAMURA, 1959b) and Sakawa Basin (KIMURA, 1956) in outline and concentric ornament. The concentrics are, however, much finer and more regular in *tsunoensis*.

Occurrence:—Common in 5th zone at Loc. 7; abundant in 7th zone at Locs. 13 and 15; abundant in 8th zone at Loc. 14; common in 9th zone at Loc. 12; rare in 10th zone at Loc. 11.

Subgenus *Coelastarte* BOEHM, 1893

Astarte (Coelastarte) somensis TAMURA, new species

Plate 33, Figures 11-13.

Description:—Shell large for genus, very inequilateral, moderately convex, oblong, much longer than high; test thin; umbo strongly prosogyrate, situated in anterior quarter; anterior dorsal margin short and concave at a deep lunule; postero-dorsal long and nearly straight; anterior and posterior margins rounded and passing into rounded ventral one; surface with about 50 fine and distinct concentric lines; internal margin crenulated; umbonal cavity fairly deep; ligament fairly wide; anterior lateral short in left valve; two cardial teeth in each valve (3a and 3b oblique in right valve, oblique and strog 2b and oblique 4b in left); adductor scars relatively small but distinct; pedar scar distinctly impressed just behind anterior adductor scar.

Measurement:—

	Length	Height
Right (MM 3314)	51.5mm	38.5mm
Left (MM 3315)	44.0	35.0
Right (MM 3316)	43.5	31.0

Observation and *Comparison*:—Several specimens at hand show the hinge typical of *Astarte*. Although the lunule is incompletely preserved, its presence can be confirmed on the internal moulds (Figs. 12 and 13).

The most allied is *Coelastarte cardiniiformis* HAYAMI (1958) from the Liassic Shizukawa group. The chief differences are in the absence of marginal crenulation, much shallower umbonal cavity, indistinct concentric lines and in the much stronger 3b in *cardiniiformis*.

Occurrence:—Common in 5th zone at Locs. 7 and 8.

Genus *Opis* DEFRANCE, 1825

Subgenus *Trigonopis* MUNIER-CHALMAS, 1887

Opis (*Trigonopis*) *torinosuensis* KIMURA

Plate 33, Figures 5-7.

1956. *Opis* (*Trigonopis*) *torinosuensis*, KIMURA, p. 87, fig. 10.
1959b. *Opis* (*Trigonopis*) *torinosuensis*, TAMURA, p. 113, pl. 12, figs. 11-13.

Occurrence:—Common in 5th zone at Locs. 7 and 8, in 7th zone at Loc. 15 and in 8th zone at Loc. 14.

Subgenus *Coelopis* MUNIER-CHALMAS, 1887

Opis (*Coelopis*?) sp.

Plate 33, Figures 3, 4.

Description:—Shell medium for genus (24 mm long), moderately depressed, nearly as long as high, trigonal in shape; umbonal region unknown but umbo is submesial; anterior margin concave; posterior and ventral margins somewhat rounded; shell outline dilated anteriorly to form an acute angle and tripartated by strongly ridged anterior and posterior carinae; anterior and posterior parts strongly depressed; median part wide; internal margin crenulated; hinge unknown.

Observation:—An internal mould of a left valve is at hand whose umbonal part is broken off. Its characteristics are the wide median part and depressed shell. Surface ornament is unknown.

Occurrence:—5th zone at Loc. 7.

Family Arcticidae

Genus *Arctica* SCHUMACHER, 1817

Type-species:—*Venus islandica* LINNÉ.

Diagnosis:—Shell ovate and evenly inflated; umbo prosogyrous and fairly distinct; surface smooth; weak carina like angulation sometimes on posterior side. R. V.-1 tubercle-like, 3a often well developed but sometimes narrow and not stout, 3b wide and bifid, P_I fairly long in general. L. V.-2a sometimes distinct from 2b but sometimes fused, 2b triangular and massive, A_{II} usually separated from 2a.

Subgenus *Somarctica* subgen. nov.

Type-species:—*Arctica* (*Somarctica*) *abukumensis*, new species.

Diagnosis:—Externally similar to *Arctica*. R. V.-1 tuberculiform and short, 3a a little distinct, 3b trigonal, wide and furrowed by a groove, P_I short. L. V.- 2a indistinct but a ridge elongated from A_{II}, 4 obliquely arcurte, narrow but prolonged, A_{II} elongate and inseparable from 2a-like ridge.

Remarks:—*Arctica* as a genus comprises *Arctica* s. str., *Venilicardia Stoliczka* and *Somarctica* subgen. nov. which are indistinguishable externally. The characteristics of these subgenera of *Arctica* in addition to *Eocallista* are tabulated below (Table 1).

Unfortunately the writer could actually examine no specimen of *Venilicardia*. Its hinge is, however, shown by STOLICZKA (1871), ZITTEL (1881-1885), WOODS (1904) and COX (1947). The specimens of recent *islandica* in the Geological Institute of the University of Tokyo were examined. 3a is more developed in *Arctica* s. str. than *Somarctica*; 3b furrowed by a groove in middle part and both sides are elevated and become fairly distinct denticles in *Arctica* s. str., but the groove is shallow and both denticles indistinct in *Somarctica*. *Somarctica* and *Venilicardia* chiefly differ in 3b which is not so wide in *Venilicardia*. It is separated into two denticles in *Arctica* (*Venilicardia*) *cordiformis* d'ORBIGNY (ZITTEL, 1881-85) and *Veniella* (*Venilicardia*) *obtruncata* STOL., but not in *Somarctica*. Moreover 2a is sometimes divergent from umbo and fused with 2b in *Venilicardia*, although 2a is indistinct and shown by an elongated ridge from A_{II} in *A.* (*Somarctica*) *abukumensis*, new species. The writer thinks that *Somarctica* was derived from *Eocallista* or its near kindred. The evolutional lineage of *Arctica* may be as shown in Fig. 1.

Table 1. Characteristics of *Arctica* and *Eocallista*

	Eocallista	*Arctica*		
		Somarctica	*Venilicardia*	*Arctica* s. str.
2a, 2b & A	divergent from umbo; 2a and A_{II} connected to form obtuse angle	2b triangular, stout; 2a indistinct and inseparable from A_{II}.	2b stout; 2a sometimes distinct from or fused with 2b; A_{II} separated from 2a.	2a absent: 2b stout, trigonal; A_{II} tubercular.
3a	small	small	fairly large but norrow	large
3b	narrow, not bifid.	wide and furrowed but not separated into two denticles.	bifid and separated into two denticles	wide and mesially furrow but not separated into two denticles.

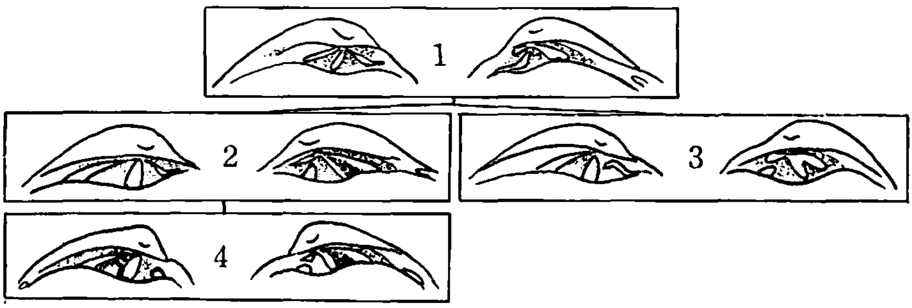

Fig. 1. Lineage of *Arctica*.
1—*Eocallista* 2—*Somarctica* 3—*Venilicardia* 4—*Arctica* s. str.

Arctica (Somarctica) abukumensis TAMURA, new species

Plate 33, Figures 25-28.

Description:—Shell large for genus, very inequilateral, moderately convex, ovate and longer than high; umbo at about anterior 1/3, slightly incurved, strongly prosogyrate; antero-dorsal margin concave and shouldered at the extremity; postero-dorsal a little rounded; ventral margin well rounded; umbonal part most tumid; concentric lines of growth fine; umbonal cavity deep. In right valve 1 below beak stout and tubercular; 3a close to hinge-margin, narrow and not well developed; 3b unusually wide, diagonally elongate and bifid but lateral sides forming no denticles; P_I short. In left valve 2b well developed and stout; 4b stout and obliquely elongated; A_{II} tubercular, extending into 2a-like ridge.

Measurement:—

		Length	Height
Left	(MM 3319)	74.0mm	66.5mm
L.	(MM 3320)	69.0	62.0
Right	(MM 3321)	76.0	65.0
R.	(MM 3322)	41.0	39.0

Observation and *Comparison*:—Like *Lima (Plagiostoma) enormicosta* TAMURA, *Pteria masatanii* TAMURA and *Neoburmesia iwakiensis* YABE and SATO, this is one of the largest pelecypods in the Soma Jurassic. Whether the extension of A_{II} towards umbo corresponds to 2a or not is a question, but nevertheless a ridge-like tooth is clearly observable.

It is easily distinguished from "*Eocallista*" *regularis* TAMURA from the Sakamoto formation (1959b) by the surface ornaments and hinge character.

Occurrence:—Common in 5th zone at Locs. 7 and 8.

Family Cardiidae

Genus *Protocardia* BEYRICH, 1845

Protocardia tosensis KIMURA

Plate 33, Figures 23, 24.

1956. *Protocardia tosensis*, KIMURA, p. 88, pl. 1, fig. 14.

1959a. *Protocardia tosensis*, TAMURA, p. 28, pl. 5, figs. 33-37.

This is one of the most abundant species in the Soma Jurassic. Its external characters are distinct. The Soma form is generally more inflated than the Torinosu (holotype) and Sakamoto form. The largest of Soma measures 48 mm in length and 46 mm in height, while the holotype (20.5mm long and 18.3mm high) and the Sakamoto form are less than 26 mm in length. Radial ribs in posterior are countable 20 or more in these specimens.

Occurrence:—7th zone at Locs. 3, 13, and 15, 8th zone at Loc. 14, 9th zone at Loc. 12 and 10th zone at Loc. 11.

Family Corbulidae

Genus *Corbula* BRUGUIÈRE, 1797

Corbula globosa TAMURA

1959b. *Corbula globosa*, TAMURA, p. 114, pl. 12, figs. 1-4.

Occurrence:—Abundant in 10th zone at Locs. 9 and 11, rare in 8th zone at Loc. 14.

Family Thraciidae

Genus *Thracia* LEACH, 1823

Thracia fukushimensis TAMURA, new species

Plate 33, Figures 8-10.

Description:—Shell small to medium for genus, moderately depressed, nearly equivalve, inequilateral, trigonally ovate; umbo nearly mesial or a little posterior, indistinct and opisthogyrous; antero-dorsal margin nearly straight, but curving down and passing into rounded ventral margin; posterior margin truncated more or less obliquely; umbonal carina feeble but distinct; post-carinal part a little depressed; surface with fine irregular concentric ribs and growth-lines; hinge unknown; test thin.

Measurement:—

		Length	Height
Left	(MM 3225)	23.5mm	15.5mm
L.	(MM 3326)	23.0	14.5
L.	(MM 3327)	20.0	16.0
Right	(MM 3328)	22.0	14.5

Observation:—Attached valves are densely crowded at Loc. 14. The position of the umbo is variable to a small extent, but the umbo is usually located a little posterior to the median point. Concentric undulations or folds are distinct on surface.

The species is near to *Thracia weedi* STANTON from the Jurassic of Yellowstone National Park (STANTON, 1899), but the umbo in the latter is more angulate than in the former.

Occurrence:—Abundant in 7th zone at Loc. 15 and 8th zone at Loc. 14.

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See also ARKELL, W. J. (1929-37), COX, L. R. (1935), KIMURA, T. (1956), SOWERBY, J. (1812-23), TAMURA, M. (1959a, b, c) and WOODS, H. (1904-13) in *Trans. Proc. Palaeont. Soc. Japan. N. S. nos. 33, 35, 36, 37 of this study.*

Explanation of Plate 33

Astarte sakamotoensis TAMURA
- Fig. 1. Left valve; ×1.5; Loc. 15. (MM 3300).
- Fig. 2. Right valve; ×1.5; Loc. 15. (MM 3301).

Opis (*Coelopis*?) sp.
- Figs. 3, 4. Internal mould of a left valve showing dorsal side (Fig. 3) and anterior side (Fig. 4); ×1; Loc. 7. (MM 3318).

Opis (*Trigonopis*) *torinosuensis* KIMURA
- Figs. 5-7. Plaster cast (Fig. 6) of external mould and internal mould (Fig. 5) and its anterior view (Fig. 7) of a right valve; ×1.5; Loc. 8. (MM 3317).

Thracia fukushimensis TAMURA, new species
- Figs. 8, 9. Left valves; ×1; Loc. 14. (MM 3327, 3326-holotype).
- Fig. 10. Right valve; ×1; Loc. 14. (MM 3328).

Astarte (*Coelastarte*) *somensis* TAMURA, new species
- Fig. 11. Plaster cast of an external mould of a right valve; ×1; Loc. 7. (MM 3316).
- Fig. 12. Internal mould of a left valve; ×1; Loc. (MM 3315).
- Fig. 13. Internal mould of the holotype right valve; ×1; Loc. 8. (MM 3314).

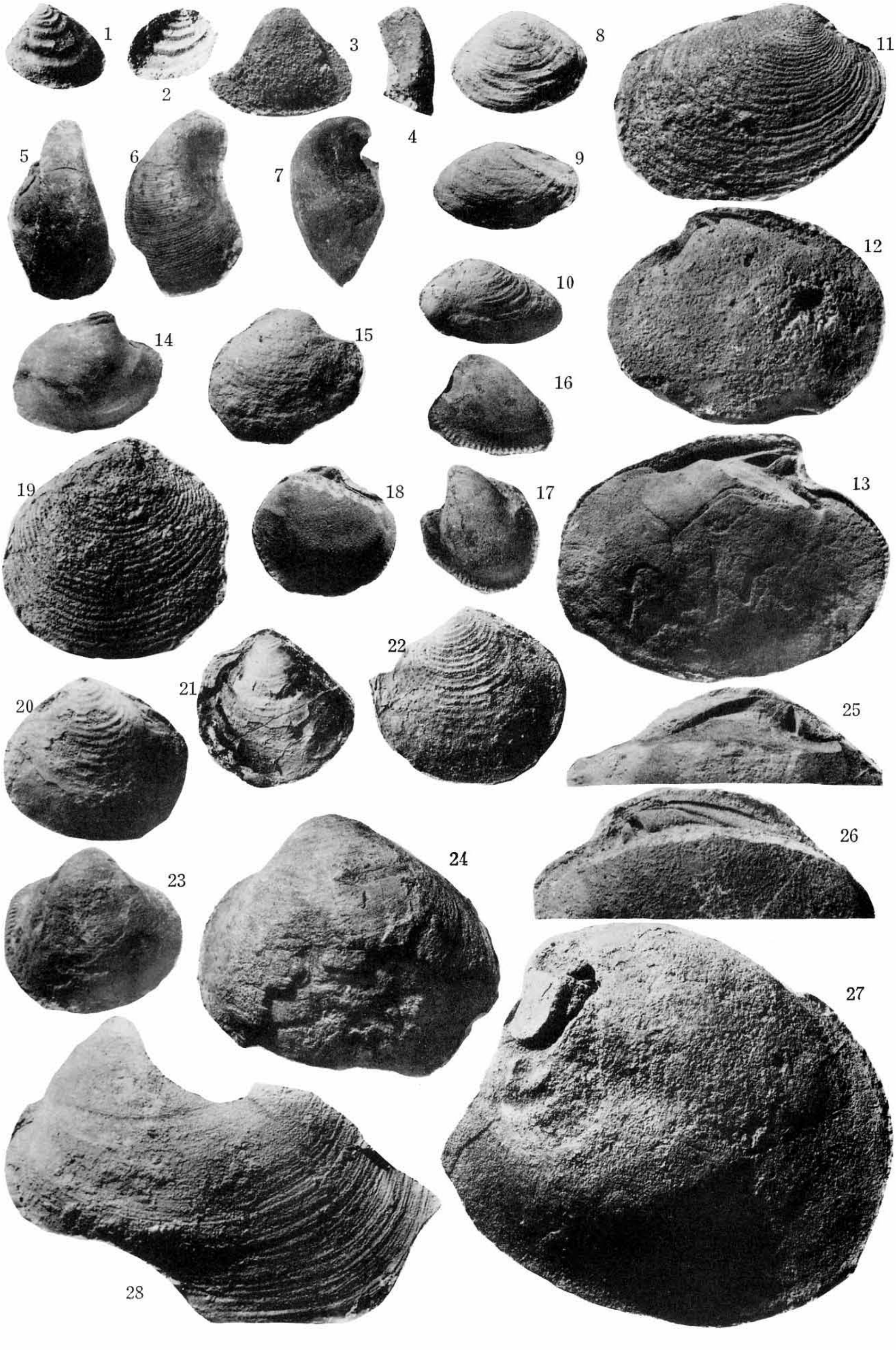
Astarte kambarensis KIMURA
- Figs. 14, 15. Internal mould and a clay cast of an external mould of a right valve; ×1; Loc. 7. (MM 3302).
- Figs. 16, 17. Internal moulds of left valves; ×1.5; Loc. 11. (MM 3306, 3307).
- Fig. 18. Internal mould of a right valve; ×1; Loc. 8. (MM 3308).

Astarte subdepressa BLAKE and HUDLESTON
- Fig. 19. Plaster cast of an external mould of a right valve; ×1; Loc. 7. (MM 3310).
- Fig. 20. Internal mould of a left valve; ×1.5; Loc. 15. (MM 3311).
- Fig. 21. Internal mould of a left valve; ×1; Loc. 15. (MM 3313).
- Fig. 22. Bivalved shell showing the left half; ×1.5; Loc. 15. (MM 3309).

Protocardia tosensis KIMURA
- Fig. 23. Right valve; ×1.5; Loc. 15. (MM 3330).
- Fig. 24. Left valve; ×1; Loc. 13. (MM 3331).

Arctica (*Somarctica*) *abukumensis* TAMURA, new species
- Figs. 25, 26. Internal moulds of right and left valves showing hinge structure; ×1; Loc. 8. (MM 3321, 3320).
- Figs. 27, 28. Internal mould and a clay cast of a broken external mould of the holotype left valve; ×1; Loc. 8. (MM 3319).

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



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385. ON THE MIOCENE PECTINIDAE FROM THE ENVIRONS OF SENDAI: PART 17, SUMMARY*

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仙台附近中新統産 Pectinidae: その 17, 総括: 筆者は 1952 年以来, 仙台附近中新統産 Pectinidae について報告して来たが, この間 8 属 24 種(又は亜種)及びこれらと関係の深い仙台附近以外からのもの 10 種(又は亜種)を記載した。これらの中, 2 新属, 10 新種(又は新亜種)を認めた。仙台附近産のものは, Table 2 にその各々の分布及び時代を示した。

増田孝一郎

Introduction

The Fossil Pectinidae from the Neogene Tertiary of Japan are important both stratigraphically and chronologically, because of their abundant species and individuals, wide distribution, more or less restricted geological ranges, generally good preservation and intimate relation with lithofacies.

Although numerous species have been described from Japan, the types were often based on imperfect specimens, thus, their morphological characters and geological significances were not well known. Therefore, the writer since 1951, has studied the Miocene Pectinidae from the environs of Sendai City and their related species from other Neogene localities of Japan. As the result eight genera and 24 species or subspecies were described from the environs of Sendai and 10 species or subspecies from elsewhere in Japan. Among them two genera and 10 species or subspecies were described as new to science. The Miocene Pectinidae from the environs of Sendai represent about 1/3 of the species hitherto known from the Miocene of Japan. The purpose of the present article is stated in the title.

Acknowledgements

The writer is greatly indebted to Dr. Kotora HATAI of the Institute of geology and Paleontology, Faculty of Science, Tohoku University for his continuous guidance and supervision during the course of the present study.

Deep appreciation is also due to the Ministry of Education of the Japanese Government and to the Saito Ho-on Kai Museum. for grants from their Scientific Expedition fund.

Historical Review of the Miocene Pectinidae from the Environs of Sendai

The Miocene Pectinidae reported from the environs of Sendai are outlined in the following list arranged in alphabetic order or author and year with original names and geological formations.

* Received April 3, 1959; read at the annual meeting of the Society at Tokyo. Dec. 7, 1958.

MATSUMOTO, H. (1930)	
Pecten islandicus MÜLLER+	Moniwa formation
Pecten akitanus YOKOYAMA	ditto
Pecten natoriensis MATSUMOTO+	ditto
Pecten natoriensis subovalis MATSUMOTO+	ditto
Pecten natoriensis inequilateralis MATSUMOTO+	ditto
Pecten plicicostulatus MATSUMOTO+	ditto
Pecten (Pseudamusium) akihoensis MATSUMOTO+	ditto
Velopecten survivans MATSUMOTO+	ditto
NAKAMURA M. (1940A)	
Pecten (Chlamys) miyatokoensis NOMURA and HATAI	Ôtsutsumi formation
Pecten (Chlamys) yanagawaensis NOMURA and ZINBO	ditto
Pecten (Chlamys) arakawai NOMURA	ditto
Pecten (Chlamys) notoensis YOKOYAMA	ditto
Pecten (Chlamys) kaneharai YOKOYAMA	Ôtsutsumi, Aoso and Nanakita formations
Pecten (Chlamys) kagamianus miyagiensis NAKAMURA+	Ôtsutsumi formation
Pecten (Swiftopecten) swiftii BERNARDI	Ôtsutsumi and Nanakita formations
Pecten (Swiftopecten ?) cosibensis YOKOYAMA	Ôtsutsumi, Aoso and Nanakita formations
Pecten (Swiftopecten ?) otutumiensis NOMURA and HATAI	Ôtsutsumi formation
Pecten (Patinopecten) paraplebejus NOMURA and HATAI	Aoso formation
Pecten (Patinopecten) kimurai tiganouraensis NAKAMURA+	Ajiri formation
Pecten (Patinopecten) kimurai matumoriensis NAKAMURA+	Nanakita formation
Pecten (Pseudamusium) akihoensis MATSUMOTO	Ôtsutsumi, Aoso and Nanakita formations
NAKAMURA, M. (1940B)	
Pecten (Swiftopecten) nanakitaensis NAKAMURA+	Nanakita formation
NOMURA S. and K. HATAI (1937)	
Pecten (Chlamys) kaneharai YOKOYAMA+	Nanakita and Aoso formations
Pecten (Chlamys) miyatokoensis NOMURA and HATAI+	Ôtsutsumi formation
Pecten (Chlamys) miyatokoensis matumori NOMURA and HATAI+	Nanakita formation
Pecten (Chlamys) arakawai NOMURA	Ôtsutsumi formation
Pecten (Swiftopecten) swiftii BERNARDI+	ditto
Pecten (Swiftopecten) otutumiensis NOMURA and HATAI	ditto
Pecten (Swiftopecten) cosibensis YOKOYAMA	Nanakita formation
Pecten (Patinopecten) kimurai YOKOYAMA+	ditto
Pecten (Patinopecten) paraplebejus NOMURA and HATAI+	ditto
Pecten (Pseudamusium) akihoensis MATSUMOTO	ditto
NOMURA, S. (1940)	
Pecten (s. s.) *kagamianus* YOKOYAMA+	Moniwa formation
Pecten (Chlamys) arakawai NOMURA+	ditto
Pecten (Chlamys) protomollitus NOMURA+	ditto
Pecten (Chlamys) nisataiensis (OTUKA)+	ditto
Pecten (Chlamys) kaneharai YOKOYAMA	ditto
Pecten (Chlamys) notoensis YOKOYAMA+	ditto
Pecten (Aequipecten) yanagawaensis NOMURA and ZINBO+	ditto
Pecten (Pseudamusium) akihoensis MATSUMOTO+	ditto
Pecten (Chlamys) crassivenius YOKOYAMA+	Tsunaki formation

NOMURA S. and H. ONISI (1940)

Chlamys protomollita NOMURA +	Moniwa formation
Chlamys notoensis YOKOYAMA	ditto
Chlamys kaneharai YOKOYAMA +	ditto
Chlamys yanagawaensis NOMURA and ZINBO	ditto
Chlamys sp. +	ditto
Pecten kagamianus YOKOYAMA +	ditto
Pecten sp. +	ditto
Pseudamusium akihoensis MATSUMOTO	ditto

+..............illustrated

Among the listed species almost all of the generic names and some species used by the previous authors were revised, as shown in Table I.

Table 1.

Author	Original Name	Revised Name
MATSUMOTO (1930)	*Pecten islandicus* MULLER	*Chlamys arakawai* (NOMURA)
	Pecten natoriensis MATSUMOTO	*Nanaochlamys notoensis* (YOKOYAMA)
	Pecten natoriensis subovalis MATSUMOTO	*Nanaochlamys notoensis* (YOKOYAMA)
	Pecten natoriensis inequilateralis MATSUMOTO	*Nanaochlamys notoensis* (YOKOYAMA)
	Pecten plicicostulatus MATSUMOTO	*Patinopecten kagamianus kagamianus* (YOKOYAMA)
	Velopecten survivans MATSUMOTO	? *Nanaochlamys notoensis* (YOKOYAMA)
NAKAMURA (1940-A)	*Pecten* (*Chlamys*) *kagamianus miyagiensis* NAKAMURA	*Nanaochlamys notoensis* (YOKOYAMA)
,, (1940-B)	*Pecten* (*Swiftopecten*) *nanakitaensis* NAKAMURA	*Gloripallium crassivenium* (YOKOYAMA)
NOMURA and HATAI (1937)	*Pecten* (*Swiftopecten*) *swiftii* BERNARDI	*Chlamys cosibensis hanzawae* MASUDA
	Pecten (*Swiftopecten* ?) *otutumiensis* NOMURA and HATAI	*Nanaochlamys notoensis* (YOKOYAMA)
	Pecten (*Patinopecten*) *kimurai* YOKOYAMA	*Patinopecten matumoriensis* (NAKAMURA)
	Pecten (*Pseudamusium*) *akihoensis* MATSUMOTO	*Miyagipecten matsumoriensis* MASUDA
NOMURA (1940)	*Pecten* (*Chlamys*) *protomollitus* NOMURA	*Placopecten nomurai* MASUDA
	Pecten (*Chlamys*) *kaneharai* YOKOYAMA	*Chlamys arakawai* (NOMURA)
NOMURA and ONISI (1940)	*Pecten protomollita* NOMURA	*Placopecten nomurai* MASUDA

Materials studied

The materials studied are preserved in the collections of the Department of Geology, Faculty of Education, of the Institute of Geology and Paleontology, Faculty of Science, both of the Tohoku University and of the Saito Ho-on Kai Museum, all in Sendai City, and in the collection of the Institute of Geology, Faculty of Science, Tokyo University, Tokyo.

The specimens of the mentioned collections are from localities distributed

Table 2. Geographical Distribution and Geological Range of the Miocene

	A			B			C	Range				
								Miocene		Pliocene		
	Moniwa	Hatatate	Tsunaki	Ôtsutsumi	Aoso	Nanakita	Ajiri	Early	Late	Early	Late	Recent
Miyagipecten matsumoriensis MASUDA				□	△	○		—				
Palliolum cf. *peckhami* (GABB)					△			—	—	—		
Chlamys arakawai (NOMURA)	□			△				—				
Ch. cosibensis cosibensis (YOKOYAMA)					△	△		—	—	—		
Ch. cosibensis hanzawae MASUDA	△		△	△			△	—	—			
Ch. kaneharai (YOKOYAMA)				○	□	○		—				
Ch. kumanodoensis MASUDA	□							—				
Ch. miyatokoensis (NOMURA and HATAI)				○				—				
Ch. miyatokoensis matumori (NOMURA and HATAI)						△		—				
Ch. nisataiensis OTUKA	□							—				
Ch. (*Swiftopecten*) *swiftii* (BERNARDI)				△				—	—	—	—	—
Nanaochlamys notoensis (YOKOYAMA)	○	△		△			△	—				
Gloripallium crassivenium (YOKOYAMA)		△	△		△	△		—				
Gl. izurensis MASUDA							△	—				
Cryptopecten yanagawaensis (NOMURA and ZINBO)	○			△				—				
Placopecten akihoensis (MATSUMOTO)	○							—				
Pl. nomurai MASUDA	○							—				
Patinopecten kagamianus kagamianus (YOKOYAMA)	○							—				
Pat. kagamianus moniwaensis MASUDA	○							—				
Pat. kimurai murayamai (YOKOYAMA)							△	—				
Pat. kimurai iiganouraensis (NAKAMURA)							□	—				
Pat. matumoriensis (NAKAMURA)					△	○		—				
Pat. nakajimai MASUDA	△							—				
Pat. paraplebejus (NOMURA and HATAI)						△		—				

A—Sendai proper and the southern area, B—Tomiya area, C—Shiogama area
○—Abundant, □—Common, △—Few or Rare

Pectinidae from the Environs of Sendai

Distribution (Each name indicates a stratigraphic unit)
Inagozawa, Ginzan, Tanagura, Utsuno, etc.
Kamenoo, Onnagawa, Yakumo, etc.
Imagane*, Tanosawa, Yanagawa
Koshiba, Hamada, Sawane, Setana, etc.
Sugota, Ginzan, Nanao, Oido, Utsuno
Kanomatazawa, Ginzan, Tanagura, etc.
Imagane*
Ginzan, Utsuno
Shiratori
Daishaka, Ginzan, Sawane, Setana, etc.
Nanao, Imagane*, Oido, Yanagawa
Nanao, Kotsunagi, Suzukamogawa, etc.
Kokozura, Suenomatsuyama
Yanagawa, Utsuno
Nanao, Oido
Nanao, Kimachi, Imagane*
Nanao
Sugota, Futatsugoya, Orito, Tanosawa, etc.
Higashi-Innai
Tanagura, Ginzan, Kobana

*—Lower part of the Setana formation (NAGAO and SASA, 1934)

throughout Japan and include nearly all from where the Pectinidae fossils have been known to occur.

The important localities of the fossil pectinids in the environs of Sendai are given in the following list.

A. Sendai proper and its southern area
1. Moniwa, Sendai City .... Moniwa formation
2. Kita-Akaishi, Sendai City.. ditto
3. Ainosawa, Kita-Akaishi, Sendai City .... ditto
4. Nakayachi, Kita-Akaishi, Sendai City .... ditto
5. Kumanodô, Natori City ....ditto
6. Jyûnishindô, Kumanodô, Natori City .... ditto
7. Kanagase, Ôgawara-machi, Shibata-gun ....ditto
8. Takada, Sendai City ....Hatatate formation
9. Hongô, Sendai City ....ditto
10. Tsunaki, Sendai City ....Tsunaki formation

B. Tomiya area
1. Ôtsutsumi, Taiwa-machi, Kurokawa-gun ....Ôtsutsumi formation
2. Dôdokoro, Izumi-machi, Miyagi-gun .... ditto
3. Hôzawa, Izumi-machi ....ditto
4. About 1.5 km. west of Ishikura, Taiwa-machi ....Aoso formation
5. Aoso, Sendai City ....ditto
6. Yuba, Rifu-mura, Miyagi-gun .... ditto
7. Matsumori, Izumi-machi .... Nanakita formation
8. Naragi, Tomiya-mura, Kurokawa-gun ....ditto
9. Nagashiba, Tomiya-mura ......ditto
10. Kumagai, Tomiya-mura ....ditto

C. Shiogama area
1. Higashi-Shiogama, Shiogama City ....Ajiri formation
2. East of Sato-hama, Miyato-jima, Naruse-machi, Monoo-gun .... Hamada (Ajiri) formation

Catalogue

Subfamily Amusiinae

Genus *Miyagipecten* MASUDA, 1952

Type-species:—*Miyagipecten matsumoriensis* MASUDA

1952. *Miyagipecten* MASUDA. *Trans. Proc. Palaeont. Soc. Japan. N. S., no. 8.* p. 251.

Miyagipecten matsumoriensis MASUDA, 1952 ....Early Miocene (late)

Genus *Palliolum* MONTEROSATO, 1884

Type-species:—*Pecten testae* BIVONA

1884. *Palliolum* MONTEROSATO. *Nom. Gen. Conch. Medit.*, p. 5 (fide VERRILL, *Trans. Conn. Acad. Arts Sci., vol. 10,* p. 65, 1897).

Palliolum cf. *peckhami* (GABB), 1869 ....Oligocene to Pliocene

Subfamily Pectininae

Genus *Chlamys* (BOLTEN) RÖDING, 1798

Type-species:—*Pecten islandicus* MÜLLER

1798. *Chlamys* RÖDING, *Mus. Bolten., Pt. 2,* p. 161 (fide DALL, *Trans. Wagner Free Inst. Sci., vol. 3, pt. 4.* p. 695, 1898).

Subgenus *Chlamys* s. s.

Chlamys (s. s.) *arakawai* (NOMURA), 1935 .... Early Miocene
Chlamys (s. s.) *cosibensis cosibensis* (YOKOYAMA), 1921 ....Early Miocene (late) to Pliocene (early)
Chlamys (s. s.) *cosibensis hanzawae* MASUDA, 1959 ....Early Miocene to Late Miocene
Chlamys (s. s.) *kaneharai* (YOKOYAMA), 1926 .... Early Miocene
Chlamys (s. s.) *kumanodoensis* MASUDA, 1953.................. Early Miocene
Chlamys (s. s.) *miyatokoensis* (NOMURA and HATAI), 1937 ....Early Miocene
Chlamys (s. s.) *miyatokoensis matumori* (NOMURA and HATAI), 1937 .... Early Miocene (late)

Subgenus *Swiftopecten* HERTLEIN, 1935

Type-species:—*Pecten swiftii* BERNARDI

1935. *Swiftopecten* HERTLEIN, *Proc. Calif. Acad. Sci., Ser. 4, vol. 21, no. 25,* p. 319.

Chlamys (*Swiftopecten*) *swiftii* (BERNARDI) ....Early Miocene to Recent

Genus *Nanaochlamys* HATAI and MASUDA, 1953

Type-Species:—*Pecten notoensis* YOKOYAMA

1953. *Nanaochlamys* HATAI and MASUDA, *Trans. Proc. Palaeont. Soc. Japan, N. S., no. 11,* p. 76.

Nanaochlamys notoensis (YOKOYAMA), 1929 .... Early Miocene

Genus *Gloripallium* IREDALE, 1939

Type-species:—*Ostrea pallium* LINNÉ

1939. *Gloripallium* IREDALE. *Great Barrier Reef Exped., 1928-29, Sci. Rep., vol. 5, no. 6, Moll., Pt. 1,* p. 357.

Gloripallium crassivenium (YOKOYAMA), 1929 ....Early Miocene
Gloripallium izurensis MASUDA, 1958 .... Early Miocene

Genus *Cryptopecten* DALL, BARTSCH and REHDER, 1938

Type-species:—*Cryptopecten alli* DALL, BARTSCH and REHDER

1938. *Cryptopecten* DALL, BARTSCH and REHDER, *Bernice P. Bishop Mus., Bull. 153*, p. 93.

Cryptopecten yanagawaensis (NOMURA and ZINBO), 1936 ....Early Miocene

Genus *Placopecten* VERRILL, 1897

Type-species:—*Pecten clintonius* SAY

1897. *Placopecten* VERRILL, *Trans. Conn. Acad. Arts Sci., vol. 10*, p. 69.

Placopecten akihoensis (MATSUMOTO), 1930 .... Early Miocene
Placopecten nomurai MASUDA, 1953...... .... Early Miocene

Genus *Patinopecten* DALL, 1898

Type-species:—*Pecten caurinus* GOULD

1898. *Patinopecten* DALL, *Trans. Wagner Free Inst. Sci., vol. 3, pt. 4*, p. 695.

Patinopecten kagamianus kagamianus (YOKOYAMA), 1923 ....Early Miocene
Patinopecten kagamianus moniwaensis MASUDA, 1958 ....Early Miocene
Patinopecten kimurai murayamai (YOKOYAMA), 1926 ....Early Miocene
Patinopecten kimurai tiganouraensis (NAKAMURA), 1940 ....Early Miocene
Patinopecten matumoriensis (NAKAMURA), 1940 ....Early Miocene (late)
Patinopecten nakajimai MASUDA, 1954 .. .. Early Miocene
Patinopecten paraplebejus (NOMURA and HATAI), 1936 ....Early Miocene (late)

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386. MOLLUSCAN FOSSILS FROM THE NAKAZATO FORMATION IN YOKOHAMA*

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横浜の中里層産の貝化石について： 横浜市南部に発達する三浦層群上部の，中里層より産出した貝化石について報告し，貝化石の産状，群集型，古生態についてふれた。また，同層からの *Macoma* 属の1新亜種を記載した。 青木直昭

Introduction

The molluscan fossils from the northern part of the Miura Peninsula, Kanagawa Prefecture, were first described and figured by YOKOYAMA (1920), whose pioneer work was recently re-examined and revised by TAKI and OYAMA (1954), besides OYAMA (1951) discussed on the fossil molluscan assemblages of this region with special reference to their paleoecological significances.

The present paper deals with the molluscan fossils, collected by the writer during 1955 to 1958, from the rocks exposed in the southern half of Yokohama City, Kanagawa Prefecture. The fossils and fauna from the mentioned area have not been reported fully by previous authors.

Here, the writer expresses his thanks to Prof. Wataru HASHIMOTO, Messrs. Shigeru AOKI, Saburo KANNO, and Masae OMORI of our Institute for their kind supervision, and to Prof. Kotora HATAI of the Tohoku University for his kind reading of this manuscript.

General Geology

The Tertiary stratigraphy of the Miura Peninsula and its northern adjacent area was first studied in detail by OTUKA (1930, 1937), and subsequently by many authors.

According to the recent study by AKAMINE and others (1956), the Tertiary deposits of the said Peninsula can be divided into two groups, namely, the Miocene Hayama and the "Pliocene" Miura groups. An upper part of the Miura group exposed in Yokohama City and its environs is subdivided into the following lithologic units, in decending order.

Tomioka alternations
Nakazato siltstone
Koshiba sandstone
Ofuna siltstone
Nojima tuffaceous siltstone

The molluscan fossils treated in this paper are from the middle to lower horizons of the Nakazato formation. This formation is composed mainly of massive bluish gray siltstone which partially grades into sandy siltstone or very fine-grained sandstone, intercalating thin layers of sandstone and white tuff.

The Nakazato is unconformably overlain by the "Pleistocene" Naganuma and Byobugaura formations and is conformably superposed on the Koshiba sandstone in the southern area of Yoko-

* Received May 23, 1959; read May 23, 1959.

hama and the siltstone-rich Tsurukawa alternations in the northern area.

Although there still remain some questions concerning the stratigraphic relation of the Nakazato to its underlying formations, it is considered that the lower part of the Nakazato formation grades laterally into the upper part of the Koshiba formation.

Fossil Localities

Loc. 1. Cliff in Maruyama-machi, Minami-ku, Yokohama City.

Loc. 2. Cliff behind the water-supply office, Nakamura-machi, Minami-ku, Yokohama City.

Loc. 3. Hill-side cliff, near the electric-power station, Bessho-machi, Minami-ku, Yokohama City.

Loc. 4. Cliff near the Hama Primary School, Hama-machi, Isogo-ku, Yokohama City. This is the type-locality of the Pleistocene Byobugaura formation.

Loc. 5. Small outcrop of the stream-side, in the grounds of the shrine, Hino-machi, Minami-ku, Yokohama City.

Text-figure 1. Map showing the fossil localities in Yokohama City.

Faunal List

The total number of the species distinguished by the writer from five localities of the Nakazato formation, are given in Table 1. The molluscan fossils comprise more than 57 species of pelecypoda, 2 of scaphopoda and 23 of gastropoda, some of which are figured in the plate and one new form is described hereinafter.

Mode of Occurrence and Ecological Notes on the Molluscan Faunules

According to their modes of occurrence and the lithological facies, the representative species or faunal associations of the species are as follows:—

1) Faunal association from the siltstone—

The molluscan fossils are scattered sporadically throughout the massive Nakazato siltstone and are generally well preserved. Most of the pelecypods, besides *Periploma* cf. *mitsuganoense* consist of isolated valves, but fragmental specimens are rare.

Such characteristic species as, *Nucula* cf. *tenuis*, *Acila minuta*, *Yoldia naganumana*, *Portlandia japonica*, *Limopsis crenata*, *L. azumana*, *Solamen diaphana*, *Macoma calcarea yokohamaensis* AOKI, n. subsp., *Periploma* cf. *mitsuganoense*, *Dentalium septentrionale* and *Turritella ikebei* were collected from the siltstone.

Considering these species, they represent a rather deep, mud- or sandy mud-bottom assemblage, and are autochthonous in occurrence.

2) Faunal association from the fine-grained sandstone—

At Locality 5, the molluscan fossils are crowded on a small scale in the very fine-grained sandstone of the formation. Small shells of *Limopsis crenata* are dominant, and some of them consist of intact valves.

Table 1. List of the molluscan fossils from the Nakazato formation.

Species names \ Localities	1	2	3	4	5
PELECYPODA					
Nucula cf. *tenuis*	f	—	—	r	—
Acila minuta	c	r	r	r	—
*Neilonella coix**	a	r	—	—	—
Nuculana yokoyamai	f	—	—	—	r
Saccella confusa	r	—	—	—	—
S. gordonis	r	—	—	—	—
Portlandia japonica	c	r	a	f	—
*Yoldia naganumana**	a	r	a	r	—
Arca cf. *miyatensis*	f	—	—	—	—
Anadara sp.	r	—	—	—	—
Glycymeris yessoensis	f	—	—	—	—
Limopsis tokaiensis	—	r	—	—	—
L. crenata	a	r	—	—	a
L. azumana	a	—	—	—	—
Solamen diaphana	f	r	r	c	—
Chlamys cf. *vesiculosus*	f	—	—	—	—
C. cf. *nobilis*	r	—	—	—	—
*Patinopecten tokyoensis**	c	—	—	—	—
"*Pecten*" sp. A.*	f	—	—	—	—
"Pectinidae" 2 spp.	f	—	—	—	—
Promantellum hakodatense	c	—	—	—	—
Monia radiata	r	—	—	—	—
Ostrea gigas	r	—	—	a	—
O. sp.	f	—	—	—	—
Crassatellites nanus	c	—	—	—	—
Venericardia ferruginea	a	—	—	—	—
Joannisiella semiasperoidea	r	—	—	—	—
Lucinoma annulata	f	—	—	—	—
"Lucinidae" sp.	r	—	—	—	—
Chama reflexa	r	—	—	—	—
Clinocardium californiense	c	—	—	—	—
Fulvia mutica	r	—	—	—	—
Nemocardium samarangae	c	—	—	—	r
Dosinia japonica	c	—	—	—	r
Protothaca adamsi	f	—	—	—	—
Paphia 2 spp.	r	—	—	—	—
Mercenaria sp.	—	—	r	—	—
Clementia vatheleti	c	—	—	—	—
"Veneridae" 2 spp.	r	—	—	—	r
Mactra cf. *crossei*	r	—	—	—	—
Spisula sachalinensis	—	—	—	a	—
S. cf. *voyi*	r	—	—	—	—
*Mactrinula dolabrata**	c	—	—	r	—
Oxyperas bernardi	r	—	—	—	—
*Macoma calcarea yokohamaensis**	a	c	a	r	r
Moerella kurodai	f	—	—	—	—
Peronidia venulosa	r	—	—	—	—
Cadella lubrica	f	—	—	—	—
Solen gouldi	f	—	—	—	—
S. krusensterni	r	—	—	r	—
Cultellus sp.	r	—	—	—	—
Anisocorbula venusta	a	—	—	—	—
Cryptomya busoensis	r	—	—	—	—
Myadora japonica	f	—	—	—	—
Periploma cf. *mitsuganoense*	c	c	c	a	—
*Cuspidaria fujitai**	r	—	—	—	—
C. cf. *iridella**	r	—	—	—	—
SCAPHOPODA					
Dentalium septentrionale	c	—	c	—	—
D. 2 spp.	r	—	—	—	f
GASTROPODA					
Turcicula cf. *argenteonitens*	r	r	—	—	—
Umbonium sp.	r	—	—	—	—
Leptothyra amussitata	c	—	—	—	—
Minolia sp.	r	—	—	—	—
*Turritella ikebei**	a	r	—	—	f
Bittium sp.	r	—	—	—	—
"Pyramidellidae" sp.	r	—	—	—	—
Natica severa	c	f	—	—	c
Polinices sp.	r	—	—	—	—
Neverita didyma	—	—	—	—	r
Tonna luteostoma	f	—	—	—	—
Babylonia sp.	r	—	—	—	—
"*Buccinum*" 2 spp.	r	—	—	—	—
Nassarius caelatus	f	—	—	—	—
"*Drillia*" cf. *dainichiensis*	r	—	—	—	—
Turricula sp.	r	—	—	—	—
Clavus jeffreysii	f	—	—	—	—
C. benten var.	r	—	—	—	—
Clavatula sp.	r	—	—	—	—
Myurella sp.	—	—	—	—	r
Pupa cf. *clathrata*	r	—	—	—	—
Ringicula doliaris	r	—	—	—	—
Adamenestia japonica	—	—	—	—	r

a: abundant, c: common, f: few, r: rare.
The species marked by the asterisks are figured in the plate.

3) Faunal association from the sandstone layer—

With one exception of Locality 4, no molluscan shell was found from the sandstone layers intercalated in the siltstone. At Locality 4, *Ostrea gigas* and well-grown *Spisula sachalinensis* were found crowded in somewhat dense arrangement only within the sandstone layer, whereas *Macoma calcarea yokohamaensis* and *Periploma* cf. *mitsuganoense* besides rare individuals of *Yoldia*, *Port-*

landia and *Solen* occur sporadically in the siltstone. The above mentioned species from the sandstone layer are considered to bė shallow water dwellers transported by currents to a deeper place to be deposited with sands.

4) Faunal association from the bed of "silt-pebbles"—

In the cliffs around Maruyama-machi (Loc. 1), one remarkable bed of about two meters thick is well exposed, intercalated in massive siltstone. It is characterized by its abundant bearing of contemporaneous "silt-pebbles", perhaps due to submarine sliding (mudflows) and cemented by coarse and granule sands. It has a sharp basal boundary and grades upwards gradually into silt-sized rock. Abundant shells were found in the sands of the matrix and at the surface of the "silt-pebbles" in this bed, but none within them.

This fossiliferous bed is continuous to the hill-side cliffs at Loc. 2 and nearby, and many fossil shells occur not only in this bed, but also in the siltstone intercalating the former.

Besides all of the species of the above mentioned faunal assemblages, many interesting ones were found from this bed. *Yoldia naganumana*, *Neilonella coix*, *Limopsis* 2 spp., *Patinopecten tokyoensis*, *Venericardia ferruginea*, *Clinocardium californiense*, *Macoma calcarea yokohamaensis*, *Nemocardium samarangae*, *Anisocorbula venusta* and *Turritella ikebei* are dominant.

Most of the above listed species seem to be deep-water dwellers in the Recent sea, but, as shown in the total list, shallow-water types are abundant, and intermingled with them.

Though a few species which seem to be fond of warm-waters are mixed in the list, the occurrence of some shells living in cold-waters from the Nakazato formation (Locs. 1, 4) are to be noted. Considering from the fact that the most of them are members of shallow-waters, it may be well infered that the temperature of the sea-waters at that time was rather lower than at present.

Systematic Description

Family Pectinidae

Genus "*Pecten*" MÜLLER, 1776

"*Pecten*", generic name, is used here in the wide sense.

"*Pecten*" sp. A.

Plate 34, Figures 7-9

Left valve (young) flat, equilateral, orbicular in shape. Height nearly equal to length, with straight hinge-line, about half of shell length. Apical angle nearly 110°. Ribs about 13 in number, low, round topped, straight, separated by flat interspaces of same width as ribs; provided with a few faint radial threads near dorsal margins. Internal ribs plate-like, carinated at sides at ventral margin. Regular, distinct, concentric growth lines numerous, covering whole shell. Auricles subequal in size, both anterior and posterior borders nearly truncated at right angle, marked with fine concentric growth lines.

Right valve (one fragment), with very low and round radial ribs, as wide as flat interspaces. Internal ribs somewhat edged at distal end as in left valve.

Dimensions:—Height, 29.7mm.; length, 30.5 mm. (left valve)

Remarks:—The shell outline and fewer number of ribs of the left valve are somewhat similar to those of *Pecten iitomiensis* OTUKA, but the present one differs from the latter by having wider rib-interspaces of the right valve, and the internal ribs of the left valve are edged only at the ventral margin.

The left valve of the present indetermined species is distinguished from that of *Pecten naganumana* YOKOYAMA by having a narrower apical angle, and from *Pecten yessoensis* SOWERBY by having fewer ribs.

Owing to the lack of good specimens of the right valve, it is impossible at present to make detail comparison with previously described species and to determine its specific name.

Occurrence:—Three specimens were collected from Loc. 1, Maruyama-machi, Yokohama City.

Family Tellinidae

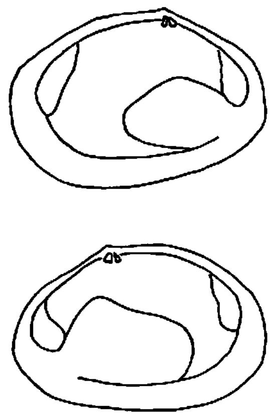
Genus *Macoma* LEACH, 1819

Macoma calcarea yokohamaensis AOKI, n. subsp.

Plate 34, Figures 15-17, Text-figure 2

Shell medium in size, much compressed, transversly subovate; test thin, height about 2/3 of shell length. Left valve slightly more inflated than right; beak low but prominent, situated at posterior two-fifths; antero-dorsal margin straight for a short distance before beak, parallel with ventral margin and continued to circular front, forming an indistinct obtuse angle between them; ventral margin, broadly arcuated and ascending behind gradually to narrowly rounded extremity, postero-ventral corner somewhat truncated; postero-dorsal border slightly convex. Posterior folding weak but distinct, turned to right. Weak and obscure ridge runs from beak to postero-ventral corner.

Surface marked by fine distinct growth-lines, more or less unequal in strength. Two small cardinal teeth in each valve, no laterals. Pallial sinus unequal in each valve, but not clearly observable; rather high and profound sinus in left valve; but its rounded distal end does not meet oblong anterior muscule scar; in right valve, it shows roundly rhomboidal shape, about half length between two muscle scars (Text-fig. 2).



Text-figure 2. Pallial sinus of *Macoma calcarea yokohamaensis* AOKI, n. subsp.

Dimensions:—

	L	H	W	
Holotype	34.5	22.8	ca. 5.0mm.	(Reg. No. 6686)
Paratype	30.0	21.0	ca. 4.5	(Reg. No. 6687)
	24.7	17.2	ca. 3.5	(Reg. No. 6688)

Remarks:—The young shell of this new subspecies closely resembles *Macoma calcarea* (GMELIN) from the Northern Pacific, but in adult specimens, the former is distinguishable from the latter by having more ovate shell and characteristic antero-dorsal margin.

Macoma inflatula DALL (OLDROYD, 1924, p. 174, pl. 1, figs. 2, 8; pl. 13, fig. 15) from British Columbia, is another allied one, but it has a somewhat rostrated posterior end and a more anteriorly situated beak.

Macoma izurensis YOKOYAMA (1925, p. 19, pl. 2, fig. 12) from the Miocene of the Joban coal-field and *M. praetexta oinomikadoi* OTUKA (1939, p. 28, pl. 2, figs. 15-18) from the Pliocene Hamada formation, Aomori-Prefecture, are also allied to this subspecies, but the former has a larger and higher shell and the latter a more sharply truncated posterior dorsal margin.

Occurrence:—Frequent in the siltstone of the Nakazato formation. The Holotype is from Loc. 3, Bessho-machi, Yokohama City.

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Explanation of Plate 34

Figs. 1-3. *Neilonella coix* HABE. 1, 2, ×2; 3, ×3. Loc. 1.

Figs. 4-6. *Yoldia naganumana* (YOKOYAMA). 4a, ×1. 5; 4b, 5, 6, ×1. Loc. 3.

Figs. 7-9. "*Pecten*" sp. A. ×1. Loc. 1. 7, inner side of left valve; 8, outer side of right valve; 9, outer side of left valve.

Figs. 10, 11. *Patinopecten tokyoensis* (TOKUNAGA). ×1. Loc. 1.

Figs. 12-14. *Mactrinula dolabrata* (REEVE). ×1. 12, Loc. Noborito, Tama-hill, northwest of Yokohama City, Pliocene Iimuro Formation, for comparison; 13, Loc. 3; 14, Loc. 1.

Figs. 15-17. *Macoma calcarea yokohamaensis* AOKI, n. subsp. ×1. 15, 16, Loc. 3; 17, Loc. 1. 15, Holotype. 16, 17, Paratypes.

Figs. 18-21. *Periploma* cf. *mitsuganoense* ARAKI. 18-20, ×2/3; 21, ×2. Loc. 4. 19, inner surface of left valve; 21, showing condrophore.

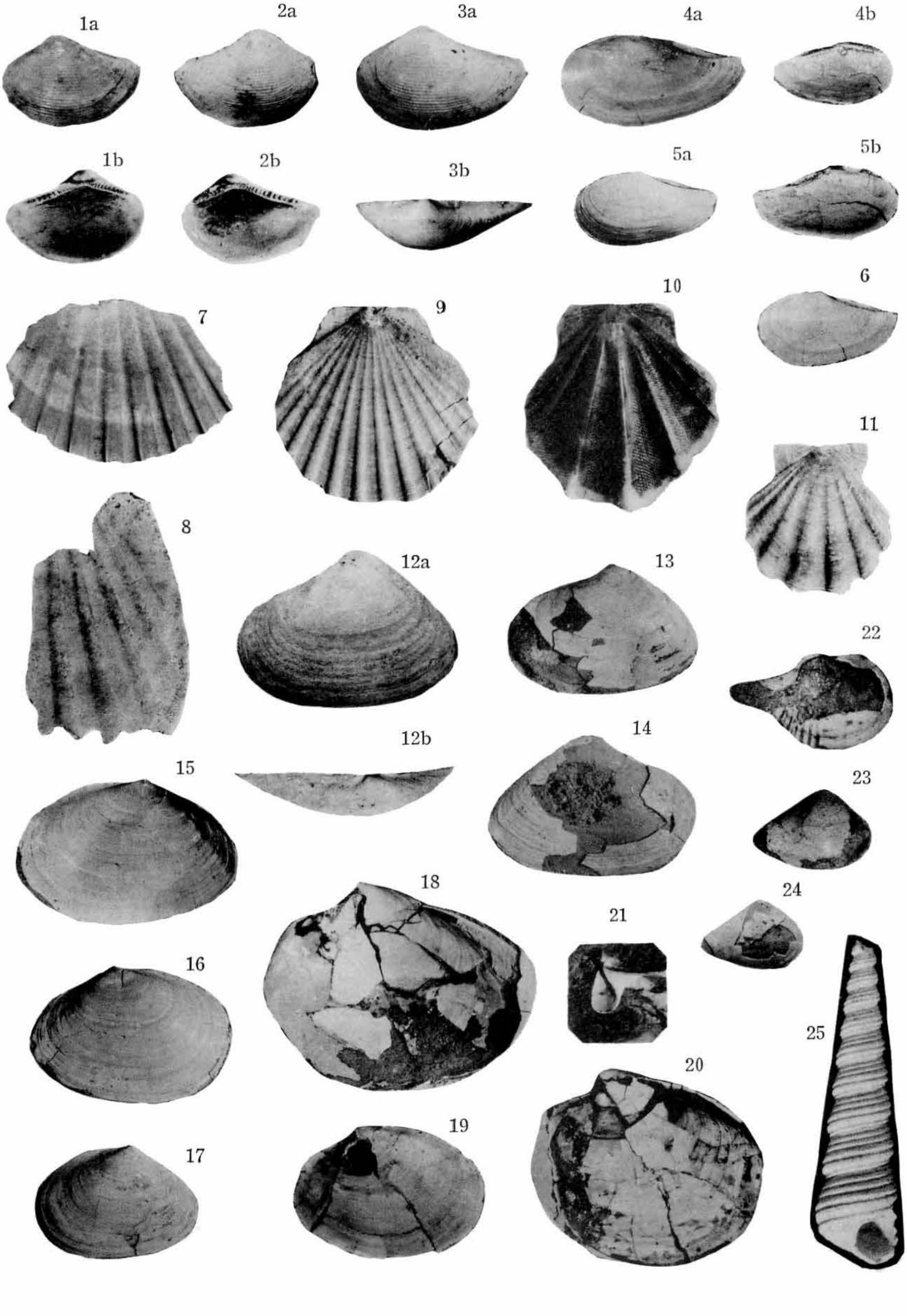
Fig. 22. *Cuspidaria fujitai* KURODA. ×2. Loc. 1.

Figs. 23, 24. *Cuspidaria* cf. *iridella* KURODA. ×2. Loc. 1.

Fig. 25. *Turritella ikebei* KOTAKA. ×1. Loc. 1.

All illustrated specimens are deposited in the collection of the Institute of Geology and Mineralogy, Tokyo University of Education.

Photo by Shozo AOKI.


1a
2a
3a
4a
4b
1b
2b
3b
5a
5b
6
7
9
10
11
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12a
13
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12b
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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 39, pp. 307-310, pl. 35, Sept. 1, 1960

387. TWO NEW SPECIES OF *KEWIA* FROM JAPAN*

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日本産 *Kewia* の二新種： *Kewia* は Echinarachniidae の進化系列上その幹をなすものと考えられ，殻は概して小さく，かつ口側面における殻板の配列状態，歩帯溝の状態が未分化である。日本および南樺太から，すでに4種が報告されている。このたび男鹿半島の西黒沢層から1種，秩父盆地の第三系の基底から1種が発見されたが，いずれも新種と考えられ，前者を *Kewia ugoensis*，後者を *Kewia minuta* と命名した。　　柴田松太郎

Kewia is the smallest of all the sand dollars known. It is known that it has not only the smallest test but also some primitive characters. It is consequently thought to be an ancestral stock of Echinarachniidae. Thus it is the important genus in the consideration of the evolution of Echinarachniidae.

Some specimens of *Kewia* were offered by Dr. Saburo KANNO and Mr. Naoaki AOKI of the Institute of Geology and Mineralogy, Tokyo University of Education. The writer expresses his sincere thanks to both the colleagues.

On carefully examining the materials, they were proved to represent two new species, respectively: the one is *Kewia ugoensis* and the other, *Kewia minuta*.

The writer thanks to Professors Haruyoshi FUJIMOTO and Wataru HASHIMOTO of the Institute of Geology and Mineralogy, Tokyo University of Education, for the tendering the seat for carrying out this study. He is also deeply indebted to the members of the same Institute for their suggestions through discussions. In conclusion, he expresses his sincere thanks to Professor Ichiro HAYASAKA of the Shimane University for reading manuscript.

* Received Sept. 11, 1959; read May 23, 1959.

Genus *Kewia* NISIYAMA, 1935

Kewia NISIKAWA, 1934, *Jour. Geol. Soc. Japan*, *41*, *489*, p. 362 (Genus without species); 1935, *Saito Ho-on Kai Mus. Res. Bull.*, *no. 5*, p. 136 (foot-note); 1940, *Jubilee Publ. Commem. Prof. H. Yabe*, pp. 819-821; J. Wyatt DURHAM, 1955, *Univ. Calif. Publ., Geol. Sci.*, *31*, *4*, pp. 164-166.

Type species: *Scutella blancoensis* KEW, 1920, orig. desig.

This genus is closely related to *Echinarachnius*, but differs from it by the supramarginal periproct, more elongate first pair of post-basicoronal interambulacral plates, and the simple, straight, and unbranched ambulacral furrows on oral surface.

Kewia ugoensis n. sp.

Plate 35, Figures 1, 2; Text-figures 1, 2.

Test very small, subpentagonal in outline, narrowly rounded anteriorly; margins of ambulacra I and V slightly notched; broadest in the posterior paired interambulacra. Aboral surface higher anteriorly; highest at a little distance in front of apical system, being 2.95 mm from the anterior edge in the holotype; apical system moderate in size, somewhat eccentric anteriorly, situated 3.95 mm from the anterior edge in the holotype; genital pores 4 in number; periproct supramarginal, in a very shallow groove. Petals indistinct, extending one-half the length of radius; odd anterior ambulacral petal shortest, and broadly open at extremity; paired petals all alike, more or less closed at distal ends; peripheral edge of test thin and acute.

Oral surface concave; peristome circular, moderate in size, 3.50 mm from anterior margin, that is, eccentric anteriorly in the holotype; ambulacral furrows distinct, simple, straight, and unbranched; interambulacral basicoronal plates comparatively large, and are in contact with post-basicoronal plates in interambulacra 1, 2, 3 and 4, but widely separated from post-basicoronal plates in interambulacrum 5; 2 or 3 post-basicoronal interambulacral plates to a column. One of the most interesting characters is that the first paired post-basicoronal interambulacral plates are more elongated than others.

1 2

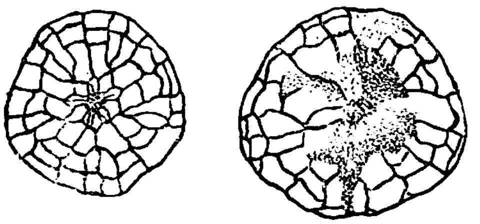

Diagram showing the arrangement of plates on oral surface
Text-fig. 1. *Kewia ugoensis* SHIBATA Holotype Reg. No. 6273 ×3
Text-fig. 2. *Kewia ugoensis* SHIBATA Paratype Reg. No. 6274 ×3

Dimensions:—8.5 mm in length, 8.5 mm in width, 2.1 mm in height, L/W 1.00, H/L 0.25 in the holotype; 9.7 mm in length, 10.0 mm in width, 2.3 mm in height, L/W 0.97, H/L 0.24 in the paratype.

Repository:—Holotype Reg. No. 6273; paratype Reg. No. 6274 of the Institute of Geology and Mineralogy, Tokyo University of Education.

Locality:—Hirasawa, Togamura, Minamiakita-gun, Akita Prefecture.

Horizon:—Nishikurosawa formation, middle Miocene.

Collector:—Mr. Naoaki AOKI.

Affinities:—The present species are closely related to *Kewia minuta* n. sp. described below but is distinguished from it by the outline of test, broader first pair of post-basicoronal interambulacral plates and more anterior position of the highest point. Moreover these specimens appear very much or closely allied to *Kewia minoensis* in its smaller test, distinctly differing from it by its outline and the frontward eccentricity of the highest point. Further, this species is closely allied to *Scaphechinus brevis* in the outline of test, but is distinguished from it by having simple and unbranched ambulacral furrows on oral surface, and the different arrangement of oral coronal plates.

Kewia minuta n. sp.

Plate 35, Figures 3-9; Text-figures 3, 4.

Test very small, variable in shape, subpentagonal to subcircular, narrowly rounded anteriorly, rather broadly rounded posteriorly or very slightly notched at posterior paired ambulacra, broadest in interambulacra 1 and 4; highest point more commonly corresponds to apical system, slightly anterior to apical system, which is situated at about the center, or slightly eccentric anteriorly.

Aboral surface moderately inflated near centre; genital pores 4 in number; ambulacral area petaloid; odd petal widely opens at ambitus, paired petals all alike, somewhat closed at distal ends; interporiferous area 0.7 mm wide, poriferous area 0.4 mm wide at the end of the odd petal; it has about 15 pore-pairs in the holotype: interporiferous area 0.5 mm wide, poriferous area 0.35 mm at the middle part of anterior paired petals, having 15 pore-pairs, that conjugate in the holotype: periproct supramarginal, situated 0.4 mm to 0.6 mm from the posterior periphery, and placed in a very shallow groove in the paratypes, circular to elliptical: peripheral edge more or less tumid; petals about one-half to three-fifths of radius.

Oral surface nearly flat to slightly concave, peristome rather large, situated almost at the centre: ambulacral furrows comparatively distinct, simple, straight, and unbranched; post-basicoronal plates in interambulacra 1, 2, 3 and 4 in contact with basicoronal plates, interambulacrum 5 widely separated from basicoronal plates in the holotype and some paratypes, interambulacral areas 1a, 1b, 2a, 3b, 4a, and 4b with 3 post-basicoronal plates, areas 2b and 3a with 4 post-basicoronal plates, areas 5a and 5b with 2 post-basicoronal plates to a column in the holotype: post-basicoronal plates in each interambulacrum in contact with basicoronal plates, all interambulacral areas with 2 to 3 post-basicoronal plates to a column in the paratype (Text-fig. 4, Reg. No. 7549); post-basicoronal ambulacral plates on oral surface 3 to 5 to a column in the holotype and some paratypes: interambulacral areas one-third to one-half as wide as ambulacral areas at ambitus, area 5 narrowest in the holotype, and area 1 the narrowest in the paratype: on oral surface first pair of post-basicoronal plates in all interambulacral areas very long.

Inner row of pore-pairs diverge near center and parallel towards extremities, outer rows of pore-pairs diverge near center and converge towards extremities.

3 4

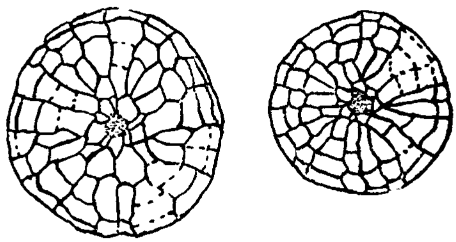

Diagram showing the arrangement of plates on oral surface.
Text-fig. 3. *Kewia minuta* SHIBATA Holotype Reg. No. 7543, ×3
Text-fig. 4. *Kewia minuta* SHIBATA Paratype Reg. No. 7549, ×3

Dimensions:—(in mm)

	Reg. No.	Length	Width	Height	L/W	H/L
holot.	7543	12.0	11.2	3.1	1.07	0.26
paratype	7544	11.8	12.4	3.3	0.95	0.28
	7545	8.4	8.4	2.2	1.00	0.26
	7546	6.7	7.1	1.7	0.94	0.25
	7547	9.0	8.1	2.0	1.11	0.22
	7548	7.5	7.2	2.0	1.04	0.27
	7549	9.6	9.4	2.2	1.02	0.23

Repository:—Holotype Reg. No. 7543; paratypes Reg. Nos. 7544-7549 of the Institute of Geology and Mineralogy, Tokyo University of Education.

Locality: — Kanizawa, Minanomachi, Chichibu-gun, Saitama Prefecture.

Horizon:—Sirasu sandstone, *Echinarachnius-Turritella* zone, Ushikubitoge formation, Hikokubo group, Oligo-Miocene.

Collector:—Dr. Saburo KANNO.

Affinities:—The present species is very closely related to *K. minoensis*, but differs from the latter by being longer than wide, the periproct being placed in a very shallow groove, the highest point almost corresponding to apical system. This species is also related to *K. parva*, but differs by being longer than wide, the periproct lying nearer to the posterior edge of test, and in point of outline of the test.

Kewia minuta has been called "ophiuroidea" because they have been always found in vertical or horizontal sections, but no body has ever found their arms.

In all the three specimens interambulacral basicoronal plates are in contact with post-basicoronal interambulacral plates. This fact shows that this is one of the most primitive species of the genus.

Conclusive:—In Japan, the following species are referred to this genus; that is, *Kewia nipponica* (NAGAO, 1928) from the Yamaga beds of the Ashiya group of Kyushu, *Kewia parva* NISIYAMA, 1940 from the Sirahimeyama sandstone beds of south Saghalien, *Kewia elongata* NISIYAMA, 1940 from sandstone beds near Tyagama-zawa of south Saghalien, *Kewia minoensis* (MORISHITA, 1955) from the middle Miocence of Nagano, Gifu, Kyoto, Nara, and Yamaguchi Prefectures, *Kewia ugoensis* n. sp. SHIBATA from the Nishikurosawa formation of Oga Peninsula, Akita Prefecture, *Kewia minuta* n. sp. SHIBATA from the Sirasu sandstone of the Ushikubitoge formation of the Hikokubo group, Saitama Prefecture.

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Explanation of Plate 35

Fig. 1. *Kewia ugoensis* SHIBATA Holotype Reg. No. 6273, ×3. a: aboral view: b: side view; c: oral view (polished), showing the arrangement of plates.

Fig. 2. Ditto Paratype Reg. No. 6274, ×3. a: aboral view; b: side view; c: oral view; (polished), showing the arrangement of plates.

Fig. 3. *Kewia minuta* SHIBATA Holotype Reg. No. 7543, ×3. a: aboral view; b: side view; c: oral view (polished), showing the arrangement of plates.

Fig. 4. Ditto Paratype Reg. No. 7544, ×3. a: aboral view; b: side view; c: oral view (polished).

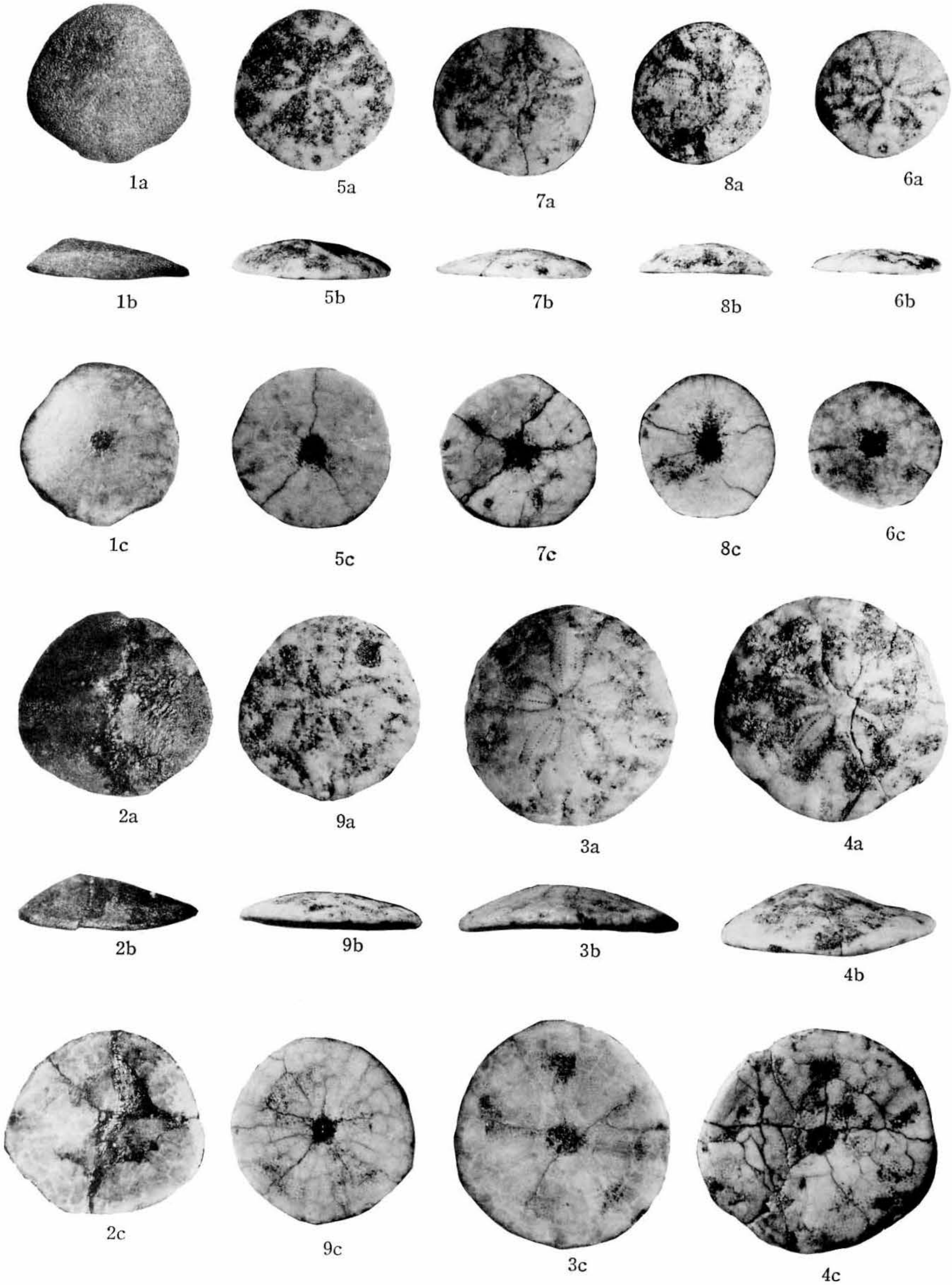
Fig. 5. Ditto Reg. No. 7545, ×3. a: aboral view; b: side view; c: oral view (polished).

Fig. 6. Ditto Reg. No. 7546, ×3. a: aboral view; b: side view; c: oral view (polished).

Fig. 7. Ditto Reg. No. 7547, ×3. a: aboral view; b: side view; c: oral view (polished), showing the mode of the ambulacral furrows.

Fig. 8. Ditto Reg. No. 7548, ×3. a: aboral view; b: side view; c: oral view (polished).

Fig. 9. Ditto Reg. No. 7549, ×3. a: aboral view; b: side view; c: oral view (polished), showing the arrangement of plates.


1a
5a
7a
8a
6a
1b
5b
7b
8b
6b
1c
5c
7c
8c
6c
2a
9a
3a
4a
2b
9b
3b
4b
2c
9c
3c
4c

S. Aoki photo

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388. RESTUDY OF *VERBEEKINA SPHAERA* OZAWA*

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Verbeekina sphaera OZAWA についての再検討： 岐阜県赤坂石灰岩, *Cancellina nipponica* zone より産した *Verbeekina sphaera* OZAWA について従来, 種の定義が不明瞭であり, 混乱していた。 筆者は上記のものについて詳細な記載をした。 さらに同種は *Verbeekina* 属中で最も原始的な形態をそなえており, かつ *Misellina* 属： *M. claudiae* (DEPRAT) と非常に近縁な関係があり, おそらく *Verbeekina* 属は *Misellina* 属から由来して来たものであろう。

杉　智光

Introduction

The late Dr. OZAWA was the first who dealt with fusulinids of the Japanese Islands in a systematic way. He established a number of species of fusulinid from Akiyoshi (1925) and Akasaka (1927), most of which, however, needs restudy on their specific diagnosis, systematic position and stratigraphic distribution under the light of our present knowledge.

Being the most primitive form of the genus *Verbeekina*, *Verbeekina sphaera* OZAWA bears an important significance in consideration on the phylogeny of the genus and the related ones. As a result of my study, however, it has been clarified that *Verbeekina sphaera* OZAWA hitherto studied was heterogeneous in origin including some forms which should at present be separated as some distinct species. To define the species more exactly detailed description of the species is given here and the systematic significance is also remarked.

* Received Sept. 30, 1959; read Sept. 28, 1957.

Acknowledgements

I wish to express my sincere thanks to Professor R. TORIYAMA of Kyushu University for his continuous guidance during the study of the fusulinid fossils and for his kindness of reading over my manuscript, and to Assistant Professor K. KANMERA of the same University for the opportunity to study his collection, for his kind guidance and encouragement through this study and for his kindness of reading over my manuscript. I also wish to express my thanks to Professor T. KOBAYASHI of the University of Tokyo for giving me the opportunity to examine the OZAWA's collection.

Previous Study

In 1925 OZAWA set up *Verbeekina verbeeki sphaera* as a smaller variety of *V. verbeeki* (GEINITZ) based on the specimens from Kaerimizu of Akiyoshi, Japan, but he gave only a brief account on this form (p. 51) with an illustration comprising incomplete figures of sagittal and a tangential section (Pl. X, fig. 3b). At that time he referred it to the form described by DEPRAT as *Schwagerina verbeeki* from Yunnan, South China (1912, p. 40, Pl. I, figs. 7-11), Lang-Nac and Cammon, Indochina (1913, p. 47) and Akasaka, Japan (1914, p. 19, 20, Pl. II, figs. 5-7). Later he supplemented several ill-oriented specimens from Akasaka (1927, Pl. XXXV, fig. 10b; Pl. XLIV, fig. 6b). In the meantime he (1925, 1927) considered DEPRAT's *V. douvillei* (1912) and *V. pseudoverbeeki* (1913) as being synonymous with *V. verbeeki* (GEINITZ), and designated them *V. verbeeki verbeeki*. In short he classified the species of the genus *Verbeekina* known up to that time into two forms, the larger one—*V. verbeeki verbeeki* and the smaller one—*V. verbeeki sphaera*, and considered the former to be a mutation of the latter (1927).

A little earlier than the OZAWA's publication YABE (in HAYASAKA, 1924, p. 15) distinguished DEPRAT's *V. verbeeki* of 1912 from Yunnan as a distinct species and named *V. deprati*. Furthermore THOMPSON (1936, p. 195) distinguished DEPRAT's *V. verbeeki* of 1914 from Akasaka from OZAWA's *V. verbeeki sphaera* and the other known species of the genus, and proposed the name *V. akasakensis* for it. Moreover, he set up the specific name *V. sphaera* for OZAWA's *V. verbeeki sphaera*.

Afterwards, CHEN (1956) reported two specimens from the Maok'ou limestone, Southwestern China, as *Verbeekina verbeeki sphaera*. However, Judging from CHEN's description and illustration, his specimens differ from *V. sphaera* in several points. Therefore, I am rather inclined to regard the CHEN's species as a new species in the present state of my knowledge.

KANMERA (1956) found the specimens referable to *V. sphaera* from the Kuma massif, Southwest Japan, which, however, have not been reported as *V. sphaera*, but as *V.* "*sphaera*" because of the ambiguity of the specific definition.

Having studied the OZAWA's specimens and KANMERA's supplemented ones from Akasaka as well as the KANMERA's materials from the Kuma massif, I have come to the conclusion that the species under consideration is clearly different from the other known species of the genus *Verbeekina* in the characters discussed below, and that it deserves the rank as an independent species.

Reexamination of the Original Specimens

Through the courtesy of Prof. T. KOBAYASHI of the University of Tokyo, I have been able to reexamine the OZAWA's collection from Akiyoshi and the supplemented one from Akasaka. As a result of the study, it has been clarified that the specimens assigned to *V. sphaera* by OZAWA from those localities include at least three distinct forms which should be discriminated one another.

The thin-section of the OZAWA's original specimen from Akiyoshi which was illustrated as *V. sphaera* (Pl. X, p. 51, fig. 3b) has unfortunately been lost, and moreover I have not been able to find any other conspecific specimens of that form in his collection. Such being the case, the loss of the original specimen and the incompleteness of the original illustration and description make us unable to reexamine the characters of the original specimen nor compare it with the form which was supplemented later from Akasaka for the sake of completeness. In spite of the OZAWA's mention that *V. sphaera* was found abundantly at Kaerimizu of Akiyoshi, all his specimens belonged to the genus *Verbeekina* from that locality have been described, illustrated and labeled as *V. verbeeki*.

According to TORIYAMA's recent study (1958), the specimens of *Verbeekina* obtained at Kaerimizu are all referable to *V. verbeeki* (GEINITZ) which is, as stated by OZAWA, associated there with *Schwagerina japonica* (GÜMBEL), *Neoschwagerina craticulifera* (SCHWAGER) and *Pseudodoliolina lepida* (SCHWAGER). Under these circumstances, judging from OZAWA's illustration and description on the Akiyoshi specimen, it is most probable that the original specimen is immature form of *V. verbeeki* (GEINITZ).

Verbeekina sphaera from Akasaka comprises two distinct forms, the larger and the smaller one, both of which seem to be different from Akiyoshi specimen. The smaller form is represented in the OZAWA's illustrations as figure 10b of Pl. XXXV, fig. 6g of Pl. XXXVII, figs. 14 and 16a of Pl. XXXVIII and fig. 11b of Pl. XV. The larger form is similar to the smaller one in having a long axis of coiling but can easily be distinguished by its larger shell, more numerous volutions, less developed and less massive parachomata and thinner spirotheca for the size of the shell than those of the smaller form. Furthermore the larger form occurs in the upper stratigraphic horizon than the smaller one, being associated with the more advanced fusulinid species as mentioned below. Owing to the insufficiency of the original material the larger form can not be exactly identified with the known species, but it is allied to *V. akasakensis* THOMPSON more closely than any other known forms in having a long axis of coiling and a thin spirotheca. In short *V. sphaera* from Akasaka originally includes two distinct forms, both of which differ from Akiyoshi specimens.

At any rate, since OZAWA's original specimen of *V. sphaera*, which was represented by an incomplete sagittal section of immature specimen, has mysteriously been lost, it is inappropriate to regard it as the type of *V. sphaera*. Accordingly *V. sphaera* should be based on only the specimens supplemented from Akasaka, and its type should be chosen among them. However, as already mentioned, *V. sphaera* from Akasaka involves two different forms, of which the larger form is associated with *Neoschwagerina craticulifera* (SCHWAGER), while the smaller one with *Neoschwagerina simplex* OZAWA and *Cancellina nipponica* OZAWA. The assemblage stated by OZAWA as that of *V. sphaera* is the latter. Therefore the type of *V. sphaera* should be chosen from the specimens of the smaller form. Accordingly I am regarding the axial section of the figure 16 on OZAWA's plate XXXVIII as the lectotype of *V. sphaera*, and its specific diagnosis is defined as described in the following pages.

This species is of a special interest in being not only of morphologically an intermediate form between *Misellina* and *Verbeekina* but also, in so far as known up to present, of stratigraphically the earliest occurrence of the *Verbeekina* in the Japanese Islands. The following description is based on the material collected by K. KANMERA from the Akasaka limestone in addition to the OZAWA's original material.

Description of Species

Verbeekina sphaera OZAWA, 1925

Plate 36, Figures 1-20.

The shell is exceedingly small in the genus, subspherical to ellipsoidal with umbilicate polar regions, attaining eight to ten volutions in mature specimens. In many specimens the shell coils planispirally with a straight axis of coiling, but in other the first volution coils at large angles to the axis of the outer volutions. The shell is 2.23 mm long and 1.95 mm wide in average of nine specimens of eight volutions, giving form ratio of 1.16. The first volution is discoidal, and the following two or three volutions are ellipsoidal with short axis of coiling. From the third or fourth volution to maturity, the shell assumes nearly spherical shape and extends gradually the axis of coiling. Average form ratios in thirteen specimens are .69, .81, .95, 1.08, 1.13, 1.14, 1.11 and 1.16, respectively for the first to eighth volution.

The proloculus is relatively large, spherical to subspherical, and its outside diameter averages 76 microns long and 64 microns wide for the twenty specimens. The shell expands uniformly throughout the growth. Average height of volution in twenty-four specimens is 49, 60, 83, 114, 152, 170, 195, 207 and 216 microns, respectively for the first to ninth volution.

The spirotheca is thin in inner one or one and a half volutions, consisting of only a dense layer, tectum. Beyond the second volution, it becomes to be composed of a thin tectum, rather thick clear central layer, alveolar keriotheca, and a lower very thin dense layer, perhaps secondary calcite deposits. In the clear central layer of spirotheca fine parallel dark lines are seen from the top to base of keriotheca and do not branch off toward the tectum. The upper surface of spirotheca is partly coated with a discontinuous layer of dense material which seems to be continuous with the parachomata. Average thickness of spirotheca measured at the center of the shell is 6, 12, 23, 28, 30, 31, 30, and 31 microns, respectively for the first to eighth volution of twenty-four specimens.

The septa are somewhat thicker than the spirotheca, composed of a downward deflection of tectum and anterior and posterior downward extensions of the keriotheca. The septa are almost plane and unfluted throughout the length of shell, extending forward to meet spirotheca of the preceeding volution at an angle of about 75 to 80 degrees in the fifth volution. The edge of the septa, however, is coated with the deposits of dense materials which seem to be continuous with the parachomata. The average septal count in the first to ninth volution of thirteen specimens is 5-6, 8-9, 10-11, 11-12, 13-14, 15-16, 16-17, 18-19, and 21, respectively for the first to ninth volution.

Foramina are circular to elliptical in cross-section. In a typical specimen they are 2, 3, 1, 7, 8 and 3, respectively for the third to eighth volution.

Parachomata considerably well develop in the third to the outermost volution, where they are massive, rather high and broad, but in the inner two volutions they do not occur or are rudimentary if present. The parachomata in the third to eighth volution of a typical specimen are one-third as high as chambers. Average number of parachomata in thirteen specimens is 3-4, 5-6, 7-8, 10-11, 12-13, 11-12, and 12, respectively for the third to ninth volution. The parachomata are continuous across one chamberlet and moreover extend completely across the following chamber.

Remarks:—*Verbeekina sphaera* is the smallest among the species of the genus *Verbeekina* hitherto described, although

Measurement of *Verbeekina sphaera* OZAWA

No.	Section Number	Number of figure in the Phot. no. Plate	Length (in mm.)	Width (in mm.)	Ratio	Diameters of Proloculus (in microns)	Rate of Growth (in mm.)									
							1	2	3	4	5	6	7	8	9	10
1	As 57-11	1, 7	2.31	2.48	1.02	—	0.15	0.28	0.46	0.70	1.04	1.39	1.81	2.26	2.48(8½ vol.)	
2	-61	2, 6	3.01	2.38	1.27	57-71	0.14	0.22	0.34	0.50	0.81	1.11	1.50	1.94	2.38	—
3	-46	4	1.44	1.76	1.22	52-71	0.18	0.29	0.43	0.71	1.02	1.44	1.64(6½ vol.)			
4	-31	5	1.79	1.99	1.10	57-71	0.09	0.21	0.34	0.50	0.79	1.05	1.46	1.79	—	—
5	-20	8	2.10	1.83	1.15	62-71	0.16	0.28	0.43	0.69	1.09	1.46	1.83	—	—	—
6	-47A	9	2.49	2.16	1.16	—	0.11	0.25	0.39	0.52	0.88	1.08	1.58	1.76	2.16	—
7	-29	10	1.92	1.69	1.13	84-98	0.21	0.34	0.46	0.71	0.99	1.33	1.69	—	—	—
8	-39A		2.52	2.09	1.21	57-67	0.11	0.21	0.35	0.52	0.74	1.04	1.36	1.55	2.09	—
9	-48		2.67	2.30	1.11	76-78	0.16	0.26	0.41	0.65	0.95	1.49	1.81	2.30	—	—
10	-66		1.99	1.90	1.04	56	0.18	0.29	0.39	0.51	0.81	1.13	1.47	1.90	2.24(8½ vol.)	
11	- 2		2.11	1.60	1.13	71-76	0.15	0.28	0.46	0.65	0.94	1.32	1.60	1.81(7½ vol.)		
12	-35		2.39	2.30	1.16	—	0.13	0.22	0.39	0.56	0.87	1.21	1.62	2.07	2.30(8½ vol.)	
13	-39B		2.25	1.95	1.16	71	0.17	0.28	0.42	0.60	0.85	1.19	1.58	1.95	—	—
14	-47B	3, 16	—	2.27	—	59-71	0.15	0.27	0.45	0.67	0.93	1.30	1.69	2.14	2.27 (8⅓ vol.)	
15	-59	13	—	2.62	—	68	0.19	0.31	0.56	0.83	1.19	1.62	2.12	2.58	2.62 (8¼ vol.)	
16	-27	14	—	2.43	—	63-73	0.14	0.23	0.39	0.58	0.83	1.17	1.58	2.04	2.43	—
17	-23	15	—	1.77	—	58-126	0.27	0.44	0.69	1.00	1.39	1.77	—	—	—	—
18	-28	17	—	2.54	—	73-90	0.27	0.35	0.48	0.69	0.99	1.31	1.71	2.16	2.54	—
19	-64		—	1.54	—	58-78	0.12	0.21	0.32	0.44	0.63	0.85	1.21	1.54(7½ vol.)		
20	-24		—	2.27	—	—	0.25	0.42	0.59	0.80	1.25	1.66	2.04	2.27(7½ vol.)		
21	-25		—	2.31	—	48-53	0.08	0.15	0.27	0.42	0.60	0.78	1.16	1.57	1.96	2.31 (9½ vol.)
22	-48A		—	2.62	—	—	0.20	0.37	0.54	0.81	1.11	1.39	1.83	2.25	2.62	—
23	-65		—	2.27	—	78-88	0.15	0.31	0.46	0.69	1.04	1.39	1.77	2.23	2.27(8¼ vol.)	
24	-26		—	1.77	—	73	0.22	0.38	0.54	0.76	1.07	1.36	1.75	1.77(7¼ vol.)		
25	Ozawa's specimen		2.90	2.81	1.03	70-84	0.25	0.42	0.65	1.01	1.43	1.89	2.34	2.81	—	—
26	Ozawa's specimen		—	2.07	—	—	0.20	0.43	0.73	1.13	1.57	2.07	—	—	—	—

Section number	Height of Volution (in microns)									
	1	2	3	4	5	6	7	8	9	10
As 57-11	—	56	98	140	182	175	224	224	—	—
-61	38	48	76	90	168	154	210	203	224	—
-46	62	62	77	154	168	210	—	—	—	—
-31	38	48	70	98	140	112	182	182	—	—
-20	52	71	100	143	180	180	209	—	—	—
-47A	—	62	67	100	128	145	158	195	242	—
-29	48	67	71	109	147	185	157	—	—	—
-39A	52	52	71	95	124	162	190	166	176	—
-48	46	49	83	132	142	210	234	259	—	—
-66	—	57	64	98	140	182	196	210	—	—
- 2	62	67	90	109	157	169	190	—	—	—
-35	—	52	104	109	143	182	224	231	—	—
-39I	56	62	76	112	140	154	210	210	—	—
-47I	49	56	76	107	171	149	200	234	—	—
-59	78	81	110	161	190	224	244	224	—	—
-27	37	44	79	102	146	185	200	239	239	—
-23	63	76	99	149	181	198	—	—	—	—
-28	51	55	73	90	185	132	188	207	197	—
-64	34	54	63	85	107	127	146	242	—	—
-24	—	79	151	146	181	200	205	—	—	—
-25	25	39	48	69	86	119	145	106	211	215
-48A	—	88	88	127	166	166	200	210	220	—
-65	50	55	88	130	169	195	205	210	—	—
26	37	59	78	85	112	171	166	166	—	—
Ozawa's specimen	—	112	140	180	217	238	252	238	—	—
Ozawa's specimen	70	105	168	210	251	266	—	—	—	—

Section number	Form Ratio of Volution									
	1	2	3	4	5	6	7	8	9	10
As 57-11	.73	.85	.94	.98	1.00	1.02	1.02	1.02	—	—
-61	.50	.60	.82	1.00	1.18	1.08	1.12	1.36	1.13	—
-46	.70	1.00	1.13	1.17	1.13	1.22	—	—	—	—
-31	.79	.82	.85	1.16	1.15	1.19	1.11	1.10	—	—
-20	.90	.85	1.00	1.04	1.03	1.13	1.15	—	—	—
-47A	.80	.84	1.25	1.33	1.17	1.35	1.05	1.20	1.16	—
-29	.80	.88	1.03	1.08	1.14	1.09	1.13	—	—	—
-39A	.59	.80	.93	1.08	1.08	1.14	1.14	1.36	1.21	—
-48	.52	.54	.92	1.06	1.19	1.05	1.18	1.11	—	—
-66	.62	.81	.86	.99	1.43	1.20	1.06	1.04	—	—
- 2	.67	.80	.95	1.03	1.04	1.02	1.13	—	—	—
-35	.59	.75	.82	1.05	1.02	1.25	1.15	1.16	—	—
-39I	.79	.95	.79	1.07	1.17	1.08	1.04	1.16	—	—
-47I	—	—	—	—	—	—	—	—	—	—
-59	—	—	—	—	—	—	—	—	—	—
-27	—	—	—	—	—	—	—	—	—	—
-23	—	—	—	—	—	—	—	—	—	—
-28	—	—	—	—	—	—	—	—	—	—
-64	—	—	—	—	—	—	—	—	—	—
-24	—	—	—	—	—	—	—	—	—	—
-25	—	—	—	—	—	—	—	—	—	—
-48A	—	—	—	—	—	—	—	—	—	—
-65	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—
Ozawa's specimen	.70	.83	.97	1.00	1.00	.99	1.01	1.03	—	—
Ozawa's specimen	—	—	—	—	—	—	—	—	—	—

Section number	Thickness of spirotheca (in microns)									
	1	2	3	4	5	6	7	8	9	10
As 57-11	5	10	24	28	29	23	42	33	—	—
-61	5	12	26	28	42	70	32	36	28	—
-46	5	12	28	42	46	42	—	—	—	—
-31	5	10	14	20	24	20	29	24	—	—
-20	5	15	24	29	23	28	19	—	—	—
-47A	5	10	17	19	23	19	19	24	29	—
-29	5	14	16	19	24	24	19	—	—	—
-39A	5	12	29	19	21	17	24	19	21	—
-48	5	8	29	39	49	54	51	41	—	—
-66	7	14	29	49	56	28	28	28	—	—
- 2	5	12	24	38	29	24	19	—	—	—
-35	7	10	24	24	28	28	35	32	—	—
-39I	6	10	24	14	24	19	19	19	—	—
-47I	7	15	22	28	31	27	26	29	—	—
-59	10	17	33	44	44	59	78	49	—	—
-27	6	8	20	20	24	37	40	44	49	—
-23	12	29	24	34	38	41	—	—	—	—
-28	5	7	15	24	20	33	24	41	35	—
-64	5	10	17	20	17	15	15	24	—	—
-24	—	20	29	39	38	39	29	—	—	—
-25	5	6	12	15	15	17	17	17	27	25
-48A	—	15	20	24	20	20	33	33	27	—
-65	5	10	21	29	39	33	36	24	—	—
26	5	12	24	24	22	24	29	—	—	—
Ozawa's specimen	9	21	18	28	28	42	35	28	—	—
Ozawa's specimen	10	19	33	52	52	52	—	—	—	—

Section number	Septal count										Count of parachomata									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
As 57-11	—	—	—	—	—	—	—	—	—	—	—	—	4	6	9	11	16	18	—	—
-61	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5	9	12	12	7	—
-46	4	—	—	—	—	—	—	—	—	—	—	—	4	6	10	14	—	—	—	—
-31	—	—	—	—	—	—	—	—	—	—	—	—	2	5	7	10	15	8	—	—
-20	—	—	—	—	—	—	—	—	—	—	—	—	3	5	9	12	16	—	—	—
-47A	—	—	—	—	—	—	—	—	—	—	—	—	4	7	9	11	14	13	14	—
-29	—	—	—	—	—	—	—	—	—	—	—	—	3	6	9	10	10	—	—	—
-39A	—	—	—	—	—	—	—	—	—	—	—	—	3	6	7	10	13	12	18	—
-48	—	—	—	—	—	—	—	—	—	—	—	—	4	6	8	10	11	14	—	—
-66	—	—	—	—	—	—	—	—	—	—	—	—	3	3	5	7	10	13 14	9	—
-2	—	—	—	—	—	—	—	—	—	—	—	—	2	4	9	9	13	—	—	—
-35	—	—	—	—	—	—	—	—	—	—	—	—	—	3	7	10	10	9	—	—
-39B	3	—	—	—	—	—	—	—	—	—	—	—	6	8	9	10	12	8	—	—
-47B	6	10	12	12	14	18	20	25	—	—	—	—	—	—	—	—	—	—	—	—
-59	6	9	10	10	13	14	16	18	—	—	—	—	—	—	—	—	—	—	—	—
-27	6	8	10	12	15	13	14	17	23	—	—	—	—	—	—	—	—	—	—	—
-23	5	9	10	11	13	15	18	—	—	—	—	—	—	—	—	—	—	—	—	—
-28	6	9	10	12	12	15	16	18	19	—	—	—	—	—	—	—	—	—	—	—
-64	6	5	10	13	14	16	16- 17	14- 16	—	—	—	—	—	—	—	—	—	—	—	—
-24	6	10	11	12	15	18	18	—	—	—	—	—	—	—	—	—	—	—	—	—
-25	4	6	10	10	14	14	16	21	20	—	—	—	—	—	—	—	—	—	—	—
-48A	7	8	12	12	18	19	18	19	22	—	—	—	—	—	—	—	—	—	—	—
-65	6	9	10	11	11	14	17	15	—	—	—	—	—	—	—	—	—	—	—	—
-26	—	6	10	11	13	13	15	—	—	—	—	—	—	—	—	—	—	—	—	—
Ozawa's specimen	4	—	—	—	—	—	—	—	—	—	—	3	5	7	9	13	17	20	—	—
Ozawa's specimen	3	8	10	12	13	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—

it shows a considerable variation in expansion of whorls and thickness of spirotheca within individuals.

It closely resembles *V. grabaui* THOMPSON and FOSTER from the Yanghsi limestone of the Mt. Omei region, China in regards to the size and rate of expansion of the shell in the first eight volutions, but the former apparently differs from the latter which has more numerous volutions at maturity, less elliptical shape, much thinner spirotheca, smaller proloculus, more rapid expansion and fewer septa for the corresponding volutions. The parachomata of *V. sphaera* are essentially well developed and extend completely across the chambers except the inner one or two volutions. On the contrary, those of *V. grabaui* do not extend completely across the chamber except the outer two to three volutions of mature shell.

V. minor Chen from the Chihsia limestone, China is somewhat similar to this species. The detailed comparison between them is very difficult, because his species is based on only a tangential section. *V. minor*, however, is more spherical in shape, and perhaps smaller for the corresponding volutions, and has much thinner spirotheca than *V. sphaera*. The parachomata of *V. minor* are apparently not developed as in the present species.

V. akasakensis Thompson is allied to the present species in general shape, from which the former is distinguished by its larger and more rapidly expanding shell, more numerous volutions in maturity, more poorly developed parachomata in the inner volutions, thinner spirotheca and smaller proloculus.

V. crassispira Chen from the MaoK'ou limestone, Southwestern China is somewhat similar to the present species in general shape. However, *V. sphaera* apparently differs from *V. crassispira* which has larger shell, more numerous volutions at maturity, more elliptical shape, thinner spirotheca, and more poorly developed parachomata.

As pointed out by Thompson (1948), *Verbeekina* most closely resembles *Eoverbeekina* from which the former might have been derived. The major differences are the singular tunnel in the inner volutions, the more nearly discoidal inner volutions, and the indistinct parachomata of *Eoverbeekina*. The shell of the latter is generally replaced by secondary mineralization.

Eoverbeekina cheni Thompson and Foster somewhat resembles the species under consideration in general shape, but the former can easily be distinguished from the latter in having low and narrow tunnel in the outer volutions, absence or very rudimentary chomata or parachomata, and the replacing of shell with mineralization.

Kochansky-Devidé (1955) proposed the genus *Kahlerina* [type species: *K. pachytheca*] from Bled and Bohinjska, Yugoslavia. He pointed out that *Kahlerina* is the most primitive genus in the subfamily Verbeekininae, having small shell, chomata, tunnel and more poorly developed parachomata. *Kahlerina* is slightly similar to *Verbeekina*. However, the former has smaller shell and fewer volutions at maturity. In the latter foramina occur throughout the shell, the parachomata are more distinct and the tunnel and chomata are absent.

K. pachytheca has a similar character to the general shape of the inner volutions of *V. sphaera*. However, *K. pachytheca* apparently differs from *V. sphaera* which has more numerous volutions at maturity, less rapid expansion and larger form ratios for the corresponding volutions. The former has broad and low tunnel and more or less developed chomata, whereas the latter has neither tunnel nor chomata, but well developed parachomata.

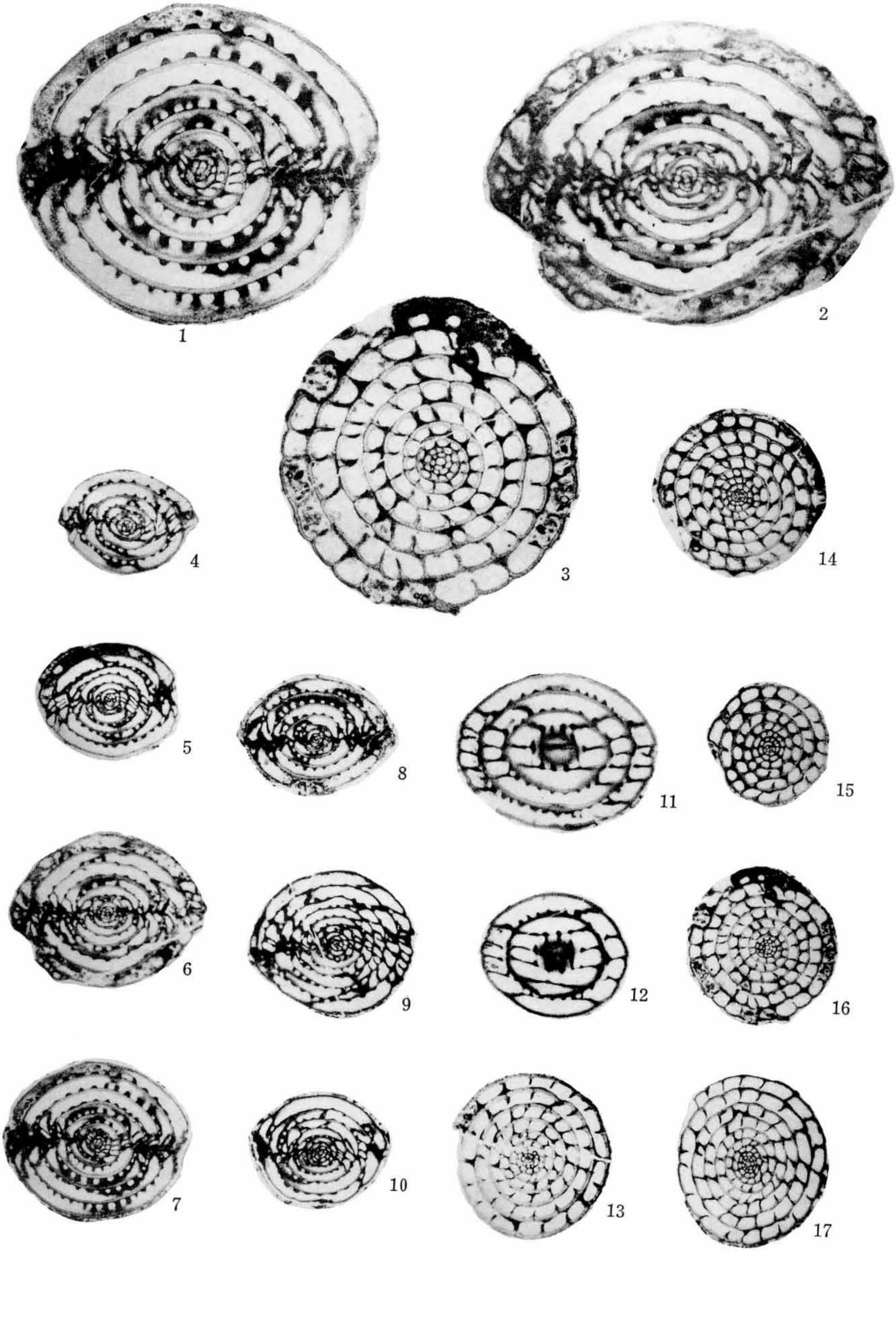
Paraverbeekina M.-Maclay resembles *Verbeekina* closely in size, development of parachomata and foramina and spirothecal structure. The major distinction is more inflated fusiform to ellipsoidal shape of the shell in the former.

Paraverbeekina pontica M.-Maclay form Crimea, Southern Russia is allied to the present species in general shape. His description is so brief that it is very difficult to compare the former with the latter. *P. pontica*, however, has larger shell, more elliptical shape, more numerous volutions at maturity, lower and more poorly developed parachomata and thinner spirotheca for the corresponding volutions than *V. sphaera*.

Misellina closely resembles *Verbeekina*

SUGI : *Verbeekina sphaera*

Plate 36



in shape, development of foramina and parachomata, and spirothecal structure. The important differences are: the smaller size of the shell, larger form ratios for the corresponding volutions, higher and more numerous parachomata, thicker spirotheca, and the attitude of the septa in *Misellina*.

Misellina claudiae (DEPRAT) is similar to the present species in general shape and exceeding well developed parachomata. But the former has smaller shell and thinner spirotheca for the corresponding volutions. *V. sphaera* has slightly more rapidly expanding shell, fewer septa, more poorly developed parachomata and rather smaller proloculus than *M. claudiae*.

As described above and illustrated, some specimens of the present species have rather thick spirotheca and well developed parachomata. In these respects it somewhat resembles *M. claudiae* (DEPRAT), but has larger shell, less developed parachomata and smaller proloculus.

Locality and Occurrence:—In Akasaka limestone *Verbeekina sphaera* OZAWA is considerably abundant in OZAWA's Nn-zone. OZAWA's original specimen from that zone and KANMERA's supplemental ones from the same zone are asscciated with *Cancellina nipponica* (OZAWA), *Neoschwagerina simplex* OZAWA, *Schwagerina japonica* (GÜMBEL), *S.* cf. *subobsoleta* (OZAWA), *Pseudofusulina granum-avenae* (ROEMER), *Neofusulinella phairayensis* COLANI, *N.* sp., *Toriyamaia* sp. and *Minojapanella* sp.

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Explanation of Plate 36

Verbeekina sphaera OZAWA

Figures 1-3 are ×20, and others ×10.

Figures 2, 4, 5, 6, 8, 10, axial sections:
1, 7, 9, nearly centered axial sections;
11, 12, tangential sections:
13-17, sagittal sections;
6, 7, 16, the same specimens as figures 2, 1, 3, respectively.

All specimens are from the *Cancellina nipponica* zone of the Akasaka limestone.

Photos by K. KANMERA and T. SUGI

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 39, pp. 321-323, pl. 37, Sept. 1, 1960

389. *HAYASAKAPORA*, A NEW PERMIAN BRYOZOAN GENUS FROM IWAIZAKI, MIYAGI PREFECTURE, JAPAN*

SUMIO SAKAGAMI

Hokkaidô Gakugei University

宮城県岩井崎産新属化石蘚虫 *Hayasakapora*： 岩井崎石灰岩中，森川六郎等の H 層から多数の蘚虫化石を産するが，その中に隠口亜目 Rhabdomesidae 科の新属を発見したので，それを *Hayasakapora* と命名記載した。なお，岩井崎の化石蘚虫の属の組合せは，チモール，オーストラリア，ヴアンクーバー島などの二畳紀のものと酷似し，ソ連のものとも共通な要素を含んでいる。 坂上澄夫

Introduction and Acknowledgements

It is well known that Permian Bryozoa occur abundantly in the limestone of Iwaizaki in the southern part of the Kitakami massif in Northeast Japan. The stratigraphical sequence was recently studied by R. MORIKAWA et al. (1958) in detail. According to them, the limestone consists of the Permian System and is subdivided into nine members from A to I in ascending order. Of these members, the H member (35 m thick) which consists of black slate and limestone in alternation, yields Bryozoa, Brachiopoda, Corals, Pelecypoda, Crinoids and Trilobites, especially the first mentioned is dominant but lacks fusulinids. However, in thin sections of the limestone, a few fusulinids—*Codonofusiella* sp. were found. This member lies conformably above the G member (MORIKAWA et al.) which consists of black limestone (8 m thick) and has yielded *Codonofusiella* sp., *Verbeekina* sp., *Yabeina shiraiwensis* and others.

The following bryozoan species were discriminated from the H member.

- *Fistulipora iwaizakiensis* SAKAGAMI, MS.
- *Fistulipora* cf. *timorensis* BASSLER
- *Fistulipora* sp. A indet.
- *Meekopora densa* SAKAGAMI, MS.
- *Ramipora ambigua* SAKAGAMI, MS.
- *Goniocladia intricata* SAKAGAMI, MS.
- *Coscinotrypa* ? sp. indet.
- *Batostomella yamazakii* SAKAGAMI, MS.
- *Batostomella igoi* SAKAGAMI, MS.
- *Batostomella microstoma* SAKAGAMI, MS.
- *Dyscritella iwaizakiensis* SAKAGAMI, MS.
- *Dyscritella cylindrica* (CROCKFORD) ?
- *Coeloclemis minima* SAKAGAMI, MS.
- *Hayasakapora erectoradiata* SAKAGAMI, n. gen. n. sp.
- *Streblascopora delicatula* SAKAGAMI, MS.
- *Clausotrypa exillis* SAKAGAMI, MS.
- *Fenestella* spp.
- *Polypora* spp.
- *Penniretepora iwaizakiensis* SAKAGAMI, MS.
- *Penniretepora akiyamai* SAKAGAMI, MS.
- *Penniretepora rectodichotoma* SAKAGAMI, MS.
- *Penniretepora tenuis* SAKAGAMI, MS.

From this generic assemblage, the

* Received May 25, 1959; read at the 66th Annual meeting of the Geological Society of Japan at Tokyo, April 9, 1959.

Bryozoa of the limestone of Iwaizaki resembles the Permian of Timor, Australia and Vancouver Island, and some of them are common with those of U. S. S. R..

In this paper, the writer describes a new genus, *Hayasakapora*, which may belong to the Family Rhabdomesidae with *H. erectoradiata* SAKAGAMI, n. sp. as the type species.

Here, the writer is greatly indebted to the following bryozoologists, Drs. M. I. SHULGA-NESTERENKO, B. P. NEKHOROSHEV, V. TRIZNA and G. G. ASTROVA of U.S.S.R., and Drs. M. K. ELIAS and H. DUNCAN of the United States of America for sending me their papers on the Paleozoic Bryozoa for my study. The writer also expresses his gratitude to Dr. Haruyoshi FUJIMOTO, Professor Emeritus of the Tokyo University of Education for his kind guidance and encouragement, to Dr. Ichirô HAYASAKA, President of the Shimane University for his kind loan of the necessary literatures and encouragement, and to Dr. Kotora HATAI of the Tohoku University for reading the manuscript.

Description of New Genus

Hayasakapora SAKAGAMI, n. gen.

Type Species:—*Hayasakapora erectoradiata* SAKAGAMI, n. sp.

Diagnosis:—Zoarium slender and ramose. Zooecial apertures disposed on external surface in longitudinally intersecting rows. Zooecia straight and arise radially at right angles from linear axis, and that of near outer part of mature region surrounded by dense and fibrous tissue. Mesopore absent. Several minute acanthopore-like substances developed at margin of zooecia. Diaphragm absent.

Remarks:—A comparison of this new genus with the other known genera of the Family Rhabdomesidae shows considerable differences, but this new genus may belong to this family.

Hayasakapora somewhat resembles *Rhombopora* and *Clausotrypa* in a few characters. However, the present genus can be distinguished from *Rhombopora* by the mode of zooecial development and the position of the acanthopore, and from *Clausotrypa* by the lacks of mesopore and diaphragm and the existence of axis of zoarium. *Batostomella* sp. indet. which HAYASAKA described and illustrated from the Carboniferous of the Omi limestone, Niigata Prefecture, Japan, may be included into this genus. HAYASAKA's illustrated specimen which is of a single thin section well agrees with the characters of this genus in the structure of interzooecial tissue, nearly straight zooecial tube, unobservable mesopore and diaphragm except for the uncertain existence of acanthopore-like substance at the margin of zooecial aperture. However, since he described that the mesopore and acanthopore can seldom be observed, and that the diapharagm is present but not very nu-

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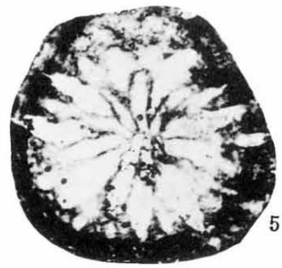
Explanation of Plate 37

Figs. 1-8. *Hayasakapora erectoradiata* SAKAGAMI, n. gen. n. sp.

1, 2, Surface, ×1 and ×10; 3, Longitudinal section of holotype, ×20, Reg. no. 5001-A; 4, 6, 7. Obliquely transverse sections, ×20, Reg. nos. 5003-A, 5003-B. and 5068-B; 5, Typical transverse section, ×20, Reg. no. 5001-B; 8, Enlarged part of Fig. 7, showing the zooecial tube enclosed by acanthopores.

3

4



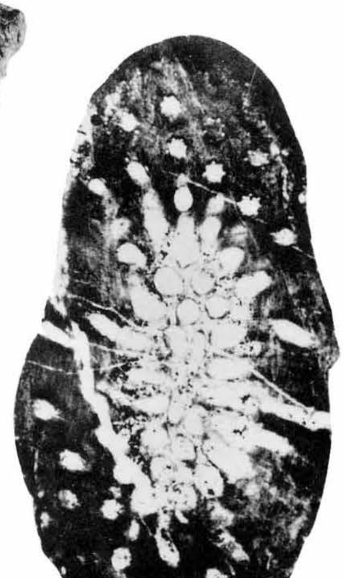
5

2

1

6

8



7

SAKAGAMI photo

merous, his *Batostomella* sp. indet. should be reexamined The new generic name, *Hayasakapora* is named in honour of Dr. Ichirô HAYASAKA, President of the Shimane University whose extensive studies on paleontology have stimulated my study.

Age:—Carboniferous (?) to Permian.

Hayasakapora erectoradiata
SAKAGAMI, n. sp.

Plate 37, Figures 1-8.

Zoarium slender and diverged branch-like, its diameter about 2 mm. Zooecial apertures disposed on surface in longitudinally intersecting rows and is somewhat narrower than diameter of zooecium. Apertures 8 to 9 in 2 mm longitudinally. Length and diameter of zooecium about 1 mm and 0.18 mm, respectively. Seven acanthopore-like substances at margin of zooecial aperture, its inner diameter about 0.017 mm. Mesopore and diaphragm lacking.

Remarks:—This species is quite unlike any described Rhabdomesonid in the internal sturcture. The present form somewhat resembles "*Batostomella* sp. indet." which HAYASAKA reported from the Omi limestone as already mentioned in the remarks of the genus. However, the present form differs from the "*B.* sp. indet.", which may belongs to the genus *Hayasakapora*, by the smaller zoarial diameter and shorter zooecial tube.

Horizon:—The H member of the limestone of Iwaizaki.

Repository:—All of the specimens treated in this paper are preserved in the collection of the Department of Geology, Hakodate Branch, Hokkaidô Gakugei University. Reg. Nos. 5001 (Holotype), 5003-A, 5003-B, 5068-B (Paratypes).

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仙台の竜沢川層からの有孔虫について ..青木直昭

日本産 *Orectosipira* について (代読) ..浦田英夫

北海道石狩統の幾春別夾炭層産二三の化石植物 ....遠藤誠道

現生カイエビ類の殼の研究から導き出される化石カイエビ類の分類について..........楠見　久

散会後三菱鉱業研究所和田コレクションを見学した。

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)

例 会 通 知

	開催地	開催日	講演申込締切日
第76回 例会	島根大学	1960年9月24日	1960年9月5日
第77回 例会	名古屋大学	1960年11月19日	1960年10月30日

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. 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。
2. 借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。

会 員 消 息

会員佐藤正君は France, Paris 大学での3年間の留学を終え本年7月下旬帰国した。

会員小林貞一君は Denmark, Copenhagen で開催された XXI International Geological Congress に本会および日本学術会議を代表して出席し，本年8月下旬帰国した。

購読御希望の方は本会宛御申込下さい

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1960年9月1日 発行

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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.