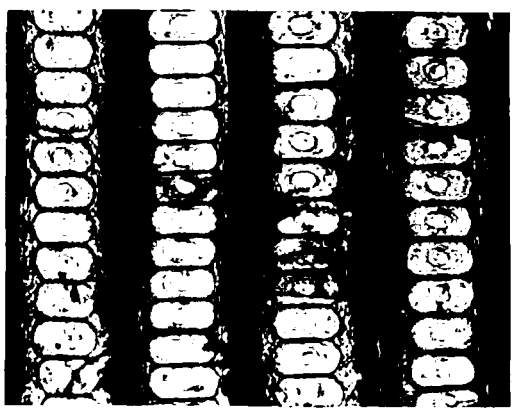
日本古生物学會報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series No. 48



日本古生物学会

Palaeontological Society of Japan

November 30th, 1962

CONTENTS

TRANSACTIONS

All Communications relating to this Journal should be addressed to the
PALAEONTOLOGICAL SOCIETY OF JAPAN
Geological Institute, Faculty of Science, University of Tokyo, Japan

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 48, pp. 311-320, pl. 48, Nov. 30, 1962

438. *CHLAMYS* AND *VENERICARDIA* FROM THE "ASHIYA" GROUP IN THE YUYA-WAN AREA, YAMAGUCHI PREFECTURE, SOUTHWEST JAPAN*

MITSUO NAKANO

Institute of Geology and Mineralogy, Faculty of Science,
Hiroshima University

and

KAZUO OKAMOTO

Shinonome Branch School, Faculty of Education,
Hiroshima University

山口県油谷湾地域の"芦屋"層群産 *Chlamys* と *Venericardia* について：本地域産の多数の標本について古生物学的研究を行なった。その結果、*Venericardia* (*Venericor*) *subnipponica* NAGAO については成長過程における形態の変化、および個体変異のいちじるしいことが判明した。 中野光雄・岡本和夫

Introduction and Acknowledgements

It has been well known that the Tertiary strata are distributed widely in the Yuya-wan area of the Japan Sea side in Yamaguchi Pref., Southwest Japan.

In 1942, SUDO reported the occurrence of the so-called Ashiya fauna, such as *Acila mirabilis* var. *ashiyaensis* NAGAO, *Venericardia subnipponica* NAGAO, and *Polinices* (*Euspira*) *ashiyaensis* NAGAO from Kiwado in Hioki-mura of the area. The fact mentioned above was, however, unfortunately not remarked by many geologists and palaeontologists. Subsequently, the Tertiary stratigraphy in this area was studied by WADA (1955) and others, and detailed investigation is still by the junior author in progress. At present, the strata containing the "Ashiya fauna" are named under the "Ashiya" group which is divided into the Sakaigawa, Ohuchiyama, and Taoyama formations in ascending order. It may correspond with the Yamaga and Sakamizu formations of the typical Ashiya group (Oligo-Miocene) in the Chikuho coal-field of Kyushu (OKAMOTO, 1960).

Since 1956, the junior author has engaged in study of the Tertiary geology of the area, and a large amount of fossil molluscs belonging to the "Ashiya fauna" were collected from various horizons and localities. Recently, the senior author had the good opportunity of studying them in cooperation with the junior author. As a result, the following forms of genera *Chlamys* and *Venericardia* are discriminated:

Chlamys (*Chlamys*) *ashiyaensis* (NAGAO)
Venericardia (*Venericor*) *subnipponica*

* Received March 22, 1962; read June 2, 1962.

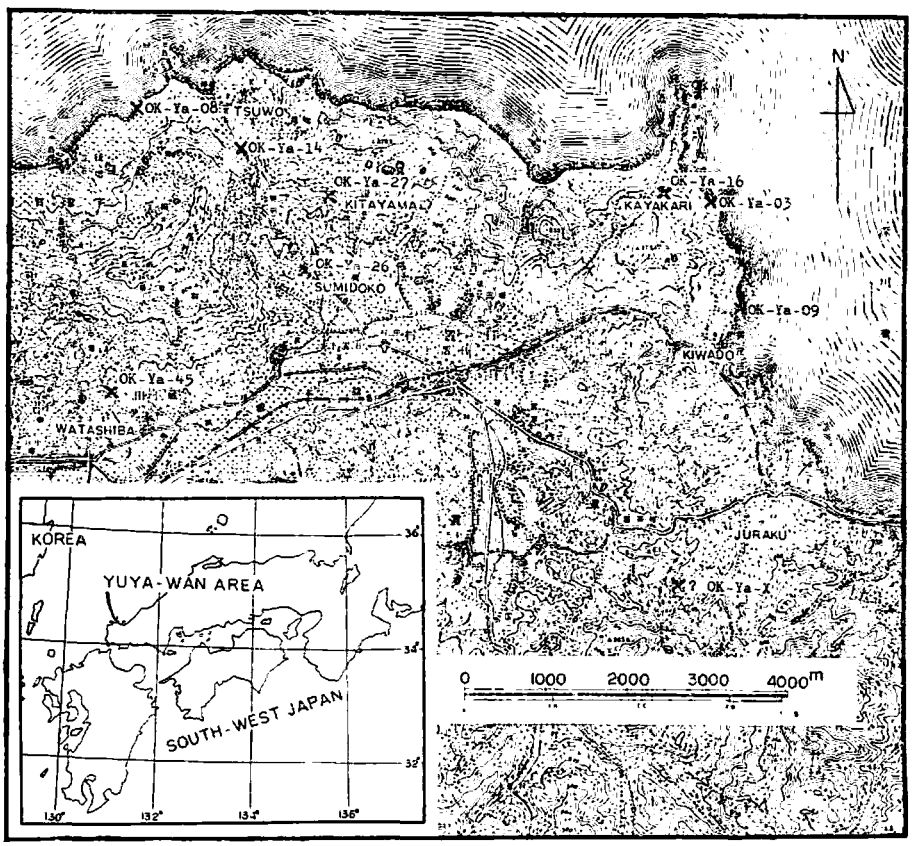
NAGAO

Venericardia (*Venericor*) *subnipponica* presents somewhat remarkable change of characters during ontogeny, and has a fairly large extent of the variation. It is an interesting fact that in *Chlamys* (*Chlamys*) *ashiyaensis* the ctenorium is distinct in the right valve.

The materials dealt with in this paper are stored in the Shinonome Branch School, Faculty of Education, Hiroshima University.

The authors express their sincere thanks to Professor Sotoji IMAMURA of the Hiroshima University for his kind guidance. The authors also thank to Professor Hisashi KUSUMI of the Shinonome Branch School of the same university and Dr. Atsuyuki MIZUNO of the Geological Survey of Japan for their helpful suggestions and facilities to study the specimens kept in their institutes.

Acknowledgements are due to Messrs Yasumitsu FUNAMOTO and Kozo MISHIMA of the same school and Mr. Hiroshi MATSUOKA in Hioki-mura, Ohtsu-gun, Yamaguchi Prefecture for supply of the fossil specimens. Finally, the authors are indebted to the grant in aid of the Ministry of Education.



Text-figure 1. Map showing the fossil localities in the Yuya-wan area, Yamaguchi Prefecture.

Description

Family Pectinidae LAMARCK

Genus *Chlamys* RÖDING, 1798

Subgenus *Chlamys* s. s.

Chlamys (Chlamys) ashiyaensis (NAGAO)

Plate 48, Figures 7-10

1928. *Pecten (Chlamys) ashiyaensis* NAGAO, *Sci. Rep., Tohoku Imp. Univ., Ser. 2. Vol. 12, No. 1*, pp. 39-40, pl. 8, figs. 2 and 17; pl. 9, figs. 1, 2, 9, 10, 20 and 21.

1928. *Pecten (Chlamys) ashiyaensis* var. *denselineatus* NAGAO, *Ibid., Vol. 12, No. 1*, p. 40, pl. 8, figs. 3-4.

1956. *Chlamys ashiyaensis* HIRAYAMA, *Sci. Rep. Tokyo Kyoiku Daigaku, Sect. C, Vol. 5, No. 45*, pp. 103-104, pl. 6, figs. 5-6.

1960. *Chlamys (Chlamys) ashiyaensis* OYAMA, MIZUNO and SAKAMOTO, *Illust. Handb. Japan. Paleog. Mollusc.*, p. 119, pl. 28, figs. 1a-g.

Material:—Holotype, NAGAO's original specimen (1928, pl. 9, figs. 2 and 2a; IGPS. Reg. No. 36448), from the Yamaga formation of the Ashiya group at Yamaga, Ashiya-machi, Onga-gun, Fukuoka Pref., Kyushu.

Several specimens at hand are more or less well preserved. Among them, OK-Ya-45-001~003 were collected from the Taoyama formation at Watashiba in Yuya-machi, Ohtsu-gun and OK-Ya-03-001 was obtained from the Sakaigawa formation in the east coast of Kayakari, Hioki-mura, Ohtsu-gun, Yamaguchi Pref.

Description:—Shell large in size, acline, inequivalve, almost fan-shaped and equilateral exclusive of auricles, nearly as long as high; left valve moderately inflated but right one not so much; antero- and postero-dorsal margin nearly straight or slightly concave and almost equal in length and inclination, forming the apical angle of about 95 degrees against with each other; ventral margin semicircular and well rounded but sometimes subangulated at junction with antero- or postero-dorsal margin; hinge-line straight, about two-thirds of the length of the shell; umbo lying near mid-point of the length; byssal auricle large, about twice as wide as posterior, protruded, depressed, linguiform or triangular, supported by a developed auricular sulcus, forming a profound byssal notch below; left anterior auricle large, about twice as large as posterior, triangular, provided with a slightly sinuated anterior margin which corresponds with byssal notch on counter valve; posterior auricle subequal between two valves, rather small, obtuse-trigonal, well-defined.

Surface sculpture quite similar in both valves, composed of about 40, slightly elevated, round-topped, radial ribs which are almost straight and broadly spaced but they are slightly curved upwards and narrowly disposed in the anterior and posterior parts; some 20 ribs of the central part except in the vicinity of the umbo much broader and more elevated than those of the anterior and posterior portions, separates into one large main and two narrow lateral parts by two narrow longitudinal grooves but often bipartite into nearly equal parts by a radial groove; intercostal spaces of ribs shallow and more or less wider than ribs, sometimes intercalate a single narrow rib of the second order; auricules including byssal one marked with numerous radials and several lamellae. Growth-lines distinct fairly on the whole surface, and concentrically and finely imbricated at the intersections with radial sculptures.

Internally, resilifer triangular, ctenorium present, and ventral margin plicated. Test thin and less than 1 mm.

Measurements in mm.

Specimen	Valve	Length	Height
OK-Ya-45-001B	Left	56.0	63.0
002	Right	ca. 55.0	ca. 54.0

Remarks:—The present specimens are, though rather smaller and more convex than NAGAO's original specimens and the topotypes collected by IMAMURA, identifiable with this species because of their shell form and surface costation. In NAGAO's original and the topotype specimens, the ribs of the second order in the spaces between the main ribs are well developed on the whole surface through growth, but they are limited to the anterior and posterior parts in the illustrated specimen (pl. 48, figs. 7a-b). Main ribs are usually tripartite in the common left valve, but in the other form on fig. 8 in pl. 48 they are usually bipartite.

It is interesting to see in a rather small, but imperfect, external mould in fig. 9 on pl. 48 that ctenorium is distinct and well developed and consists of about 5, very small and short, triangular masses.

As suggested already by OYAMA et al. (1960, pp. 120-121), NAGAO's *Pecten* (*Chlamys*) *ashiyaensis* var. *denselineatus* (1928, p. 40, pl. 8, fig. 9 non figs. 3-4) is an interesting form. It is probably a member of subgenus *Mimachlamys* of genus *Chlamys* because of numerous radial ribs in equal strength and width on its moderately inflated right valve. In this aspect, this form looks quite similar to certain one of *Chlamys* (*Mimachlamys*) *sakitoensis* (NAGAO). The other illustrated forms (pl. 8, figs. 3-4) belong possibly to *Chlamys* s. s. as can be judged from the surface sculpture and shell form, and they are closely allied to some forms of *Chlamys* (*Chlamys*) *ashiyaensis* NAGAO.

Occurrence:—Rare in pebble conglomerate of the Sakaigawa formation in the east coast of Kayakari, Hioki-mura, Ohtsu-gun and in tuffaceous coarse-grained sandstone of the Taoyama formation at Watashiba of Yuya-machi, Ohtsu-gun, Yamaguchi Pref.

This form is associated with in the former locality *Glycymeris cisshuensis* MAKIYAMA (NAGAO's type), *Ostrea* sp., *Crassatellites* (*Eucrassatella*) *yabei* NAGAO, *Pitar* sp., *Dosinia* (*Phacosoma*) *chikuzenensis* NAGAO etc., but in the latter place *Solamen subfornicatum* (NAGAO), *Venericardia* (*Venericor*) *subnipponica* NAGAO, *Turritella* sp., *Euspira ashiyaensis* (NAGAO) and others were collected.

Family Carditidae LAMARCK

Genus *Venericardia* LAMARCK, 1801

Subgenus *Venericor* STEWART, 1930

Venericardia (*Venericor*) *subnipponica* NAGAO

Plate 48, Figures 1-6

1928. *Venericardia subnipponica* NAGAO, *Sci. Rep., Tohoku Imp. Univ., Ser. 2., Vol. 12. No. 1*, pp. 55-57, pl. 13, figs. 9 and 19; pl. 14, figs. 1-29.

1955. *Venericardia subnipponica*, UOZUMI, *Trans. Proc. Palaeont. Soc. Japan, N.S., No. 19*, pp. 76-77.

1956. *Venericardia subnipponica*, MIZUNO, *Bull. Geol. Surv. Japan, Vol. 7, No. 6*, pl. 1, figs. 9 and 9'.

1960. *Venericardia* (*Venericor*?) *subnipponica*

OYAMA, MIZUNO and SAKAMOTO, *Illust. Handb. Japan. Paleog. Mollusc.*, pp. 155-156, pl. 47, figs. 1a-m.

1961. *Venericadia* (*Venericor*) *subnipponica*, HASHIMOTO, *Rep. Fac. Sci., Dep. Gen. Edu., Kyushu Univ., No. 7*, pp. 84-85, pl. 10, figs. 1-7.

1961. *Venericarcia subnipponica*, KATTO, *Explan. Text, Geol. Min. Res. Map Kochi Pref.*, pl. 4, fig. 11.

Material:—Holotype, NAGAO's original specimen (1928, pl. 14, figs. 19 and 19a; IGPS. Reg. No. 36045), from the Yamaga formation of the Ashiya group at Taya, Ashiya-machi, Onga-gun, Fukuoka Pref., Kyushu.

A great number of fairly complete specimens were collected from several localities in the Yuya-wan area of Yamaguchi Pref. OK-Ya-09-001~027 were collected from the Sakaigawa formation at the north coast of Kiwado in Hioki-mura. OK-Ya-X-001 was derived from the Sakaigawa or the Ohuchiyama formation in the vicinity of Juraku of Nagato-city. OK-Ya-26-001 and -27-001 were obtained respectively from the Sakaigawa formation (?) at Sumidoko and Kitayama in Hioki-mura. OK-Ya-08-001~002 and -14-001 were collected from the Sakaigawa formation in the west coast and the south of Tsuwo in Yuya-machi. OK-Ya-16-001 came out from the Taoyama formation at Kayakari of Hioki-mura.

Description:—Shell medium to fairly small in size, suborbicular to somewhat trigonal-ovate, more or less inequilateral, a little broader than high, gently convex from umbo to venter and from anterior to posterior except for an indistinct ridge extending from the umbo to the boundary between the ventral and the postero-ventral margin. Antero-dorsal margin nearly a half to a third as long as the shell, sloped steeply downward, somewhat excavated beneath the umbo; antero-ventral margin well rounded but often subangulated at junction with antero-dorsal, passing gradually into broadly curved ventral; postero-ventral margin rounded or subtruncated, forming occasionally an obtuse angle with ventral or postero-dorsal margin; postero-dorsal margin slightly curved or almost straight and more or less longer than that of the antero-dorsal. Umbo rather large but fairly improminent, commonly with an indistinct ridge streching from the umbo to the postero-ventral part; beak prosogyrous, pointed at about anterior third but sometimes subcentral. Escutcheon somewhat small and depressed, indistinct; lunule small-cordiform and excavated.

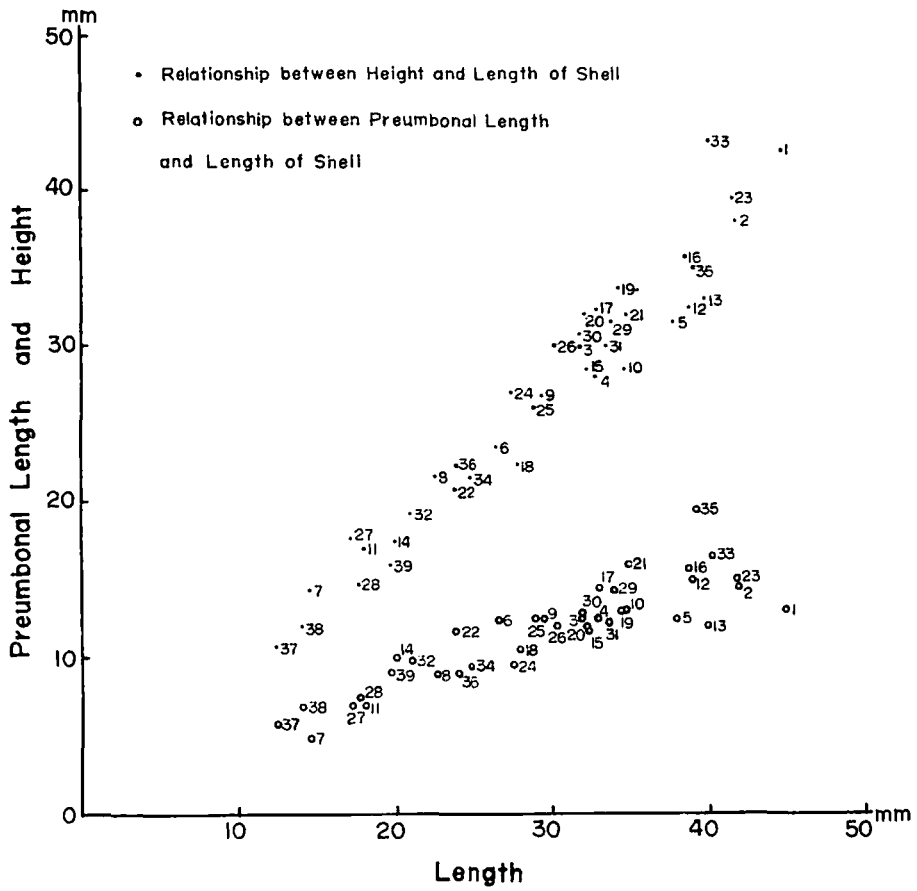
Surface sculptured with numerous round-topped, radial ribs which are narrowly disposed and nearly equal in width to the grooves on the umbonal side but broad and somewhat roof- or flat-topped and alternated with narrow grooves on the ventral part; 7 or so on the postero-dorsal slope almost straight, narrowly spaced and weaker than those of the other portions; anteal about 5 ribs on the median part of the shell curved anteriorly but posteal 5 or so almost straight or slightly curved forward; about 8 on the rest of the shell curved diagonally. Radial grooves distinct in the vicinity of the umbo but gradually become narrow and obscure in the later. Growth-lines well developed on the whole surface, especially on the ventral periphery and the postero-dorsal region.

Internally, ventral margin crenulated; test thick and measures about 2 mm. in common forms (L=35 mm., H=33 mm.).

Measurements:—in mm.

Specimen	Valve	Length	Height	Preumbonal Length	L/H	** U/L
1.* OK-Ya-09-001	Right	45.0	42.6	13.0	1.06	0.29
2. 002	Right	42.0	38.0	14.5	1.11	0.35
3. 003	Left	32.0	29.9	12.5	1.07	0.39
4. 004	Right	33.0	28.0	13.0	1.18	0.39
5. 005	Right	38.0	31.5	12.5	1.21	0.33
6. 006	Left	26.7	23.5	12.4	1.14	0.46
7. 007	Left	14.5	14.3	4.8	1.01	0.34
8. 008	Left	22.6	21.6	9.0	1.05	0.40
9. 009	Right	29.6	27.0	12.5	1.10	0.42
10. 010	Left	34.8	28.4	13.1	1.23	0.40
11. 011	Right	18.0	17.0	7.0	1.06	0.39
12. 012	Right	39.0	32.4	15.0	1.20	0.38
13. 013	Right	40.0	33.0	12.0	1.21	0.30
14. 014	Left	20.0	17.5	10.0	1.14	0.50
15. 015	Left	32.4	28.4	11.7	1.14	0.36
16. 016	Left	38.8	35.7	15.7	1.09	0.41
17. 017	Left	33.1	32.3	14.5	1.02	0.44
18. 018	Left	28.0	22.4	10.6	1.25	0.38
19. 019	Left	34.5	33.7	13.0	1.02	0.38
20. 020	Left	32.3	32.0	12.0	1.01	0.37
21. 021a	Left	35.0	32.0	16.0	1.09	0.46
22. 021b	Left	23.8	20.8	11.5	1.14	0.48
23. 022a	Left	41.8	39.5	15.0	1.06	0.38
24. 022b	Left	27.6	26.9	9.5	1.03	0.34
25. 023a	Left	29.0	26.0	12.6	1.12	0.43
26. 024	Left	30.4	30.0	12.0	1.01	0.39
27. 025a	Left	17.2	17.7	7.0	0.97	0.41
28. 025b	Left	17.7	14.7	7.5	1.20	0.42
29. 026a	Left	34.0	31.5	14.3	1.08	0.42
30. 026b	Left	32.0	30.7	12.8	1.04	0.40
31. 026c	Left	33.7	30.0	12.3	1.12	0.37
32. 027a	Right	21.0	19.3	9.8	1.09	0.47
33. OK-Ya-X-601	Bivalved	40.3	43.2	16.5	0.93	0.41
34. OK-Ya-27-001	Right	24.8	21.6	9.5	1.15	0.38
35. OK-Ya-08-001	Left	39.3	35.0	19.5	1.12	0.50
36. 002	Left	24.0	22.3	9.0	1.08	0.38
37. OK-Ya-26-001	Right	12.4	10.7	5.8	1.16	0.47
38. OK-Ya-14-001	Left	14.0	12.0	6.9	1.17	0.49
39. OK-Ya-16-001	Left	19.7	16.0	9.0	1.23	0.41

* Numbers correspond to those in text-fig. 2. ** Preumbonal Length.



Text-figure 2. Graph showing the relationships between the height and length and between the preumbonal length and length of *Venericardia* (*Venericor*) *subnipponica* NAGAO.

Remarks:—In the present form, round-topped ribs near the umbo tend to be flat-topped at the ventral periphery and the test is thick. In this aspect, this species may belong to a member of subgenus *Venericor* of *Venericardia*.

The surface ornamentation is rather constant in ontogenetic development, but the shell form is somewhat variable.

In the earlier stages, the shell (less than 30 mm. long and 27 mm. high) is subcircular to somewhat ovate in outline and the beak is situated at the position of subcentral but sometimes anterior third. The height-length proportion is 1 : 0.97 to 1 : 1.25, mostly 1 : 1.05 to 1 : 1.15.

In the later stages, when the shell is 30-45 mm. long and 28-43 mm. high, its outline becomes subcircular to ovately trigonal and the beak shift to about anterior third in many forms but rarely subcentral or anterior fourth. The height-length proportion ranges 1 : 0.93 to 1 : 1.25, but in common cases it is 1 : 1.00 to 1 : 1.15.

As already pointed out by NAGAO

(1928), UOZUMI (1955) and others, this form is variable to a large extent in outline and number of ribs.

Because of ill-preservation in many forms the surface sculptures on the postero-dorsal slope and the anterior extremity are not well observable. There are 20 to 32 ribs on the whole surface, but in many cases they are 24 to 27. More precisely, the main part of the surface is sculptured with 8 to 13 ribs, mostly 10 to 12. On the other hand, the postero-dorsal and anterior extremity have respectively 6 to 9 and 6 to 10 ribs, but both are 7 to 8 in many cases.

In the outline, the present species has a certain degree of the variation. For instance, the outlines are not always the same even among specimens of similar size. The illustrated specimens (pl. 48, figs. 2 and 5) have the orbicular to subcircular outline, while the other forms (pl. 48, figs. 1 and 4a-b) are triangularly ovate in shape. On the other hand, there are a relatively pentagonal form (pl. 48, fig. 6) and a fairly ovate one (pl. 48, fig. 3). The figured specimen (pl. 48, figs. 4a-b) is higher than broad, but broader than high in common specimens. In this specimen the postero-dorsal slope of the shell is somewhat broadly flattened in a plane almost at right angle to the commissure, but it is more or less indistinct in the others.

Comparison:—The present species is closely allied to *Venericardia nipponica* YOKOYAMA from the Eocene in North Kyushu, but is different in smaller shell and more numerous ribs. *Venericardia* (*Cyclocardia*) *vestitoides* MIZUNO from the Tokuman formation of the Nishisonogi group in North Kyushu is closely similar to some immature forms of the present species, but differs in less numerous ribs. It has some resemblances to *Venericardia laxata* YOKOYAMA from the Oligocene to the Miocene formations of North Japan and Hokkaido in shell form and surface sculpture, but is easily distinguishable from the latter by arcuate ribs on the surface and the umbo being more prominent. *Venericardia pacifera* YOKOYAMA from the upper Oligocene of North Japan and from the Miocene in North and Central Japan is distinct from the present form by having wider intercostal spaces and more distinct flat-topped radial ribs.

Occurrence:—Abundant in coarse-grained sandstone to shale of the Sakaigawa and Ohuchiyama formations and also in tuffaceous pebble conglomerate and tuff of the Ohuchiyama and Taoyama formations.

In the north coast of Kiwado, this species is associated with *Portlandia* ? sp., *Acila* (*Acila*) *ashiyaensis* (NAGAO), *Dosinia* (*Phacosoma*) *chikuzenensis* NAGAO, *Angulus* (*Tellinides*) *maximus* (NAGAO), *Cultellus* sp., *Periploma* sp., *Euspira ashiyaensis* (NAGAO), bone of mammal ? etc. In the Sakaigawa formation, *Acila* (*Acila*) *ashiyaensis* (NAGAO) and *Dosinia* (*Phacosoma*) *chikuzenensis* (NAGAO) are always associated with the present species. *Solamen subfornicatum* (NAGAO), *Chlamys* (*Chlamys*) *ashiyaensis* (NAGAO), *Turritella* sp. and *Euspira ashiyaensis* (NAGAO) are associated with this species, and were collected from the Taoyama formation at Watashiba, Yuya-machi.

References

HABE, T. (1951-53): *Genera of Japanese Shell* (in Japanese). Kyoto.

HASHIMOTO, I. (1960): Tertiary Molluscan Fossils from the Kadogawa Formation, Miyazaki Prefecture, Japan. *Rep. Fac. Sci., Dep. Gen. Edu., Kyushu Univ., No. 7*, pp. 69-94, pls. 8-10.

HIRAYAMA, K. (1955): The Asagai Forma-

tion and Its Molluscan Fossils in the Northern Region, Joban Coal-field, Fukushima Prafecture, Japan. *Sci. Rep. Tokyo Kyoiku Daigaku, Sect. C, Vol. 4, No. 29*, pp. 79-130, pls. 1-5.

—— (1956): Tertiary Mollusca from Hikoshima, Yamaguchi Prefecture, Japan, With Remarks on the Geological Age of the "Ashiya Fauna". *Ibid., Vol. 5, No. 45*, pp. 81-127, pls. 6-8.

IMAMURA, S. and K. OKAMOTO (1959): The Stratigraphy and Geologic Structure of the Neogene and Paleogene Tertiary in the Yuya-wan Area, Yamaguchi Prefecture (in Japanese). *Jour. Geol. Soc. Japan, Vol. 65, No. 766*, pp. 440-441.

KATTO, J. et al. (1960): *Geological and Mineralogical Resources Map of Kochi Prefecture and Its Explanatory Text* (in Japanese). Kochi Pref.

MIZUNO, A. (1952): Descriptions of the Paleogene Molluscs from Sakito, Nagasaki Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N.S., No. 5*, pp. 185-193, pl. 17.

—— (1956): A Preliminary Note on the Megafaunal Zones of the Paleogene in Northwestern Kyushu, Japan (for correlation of the Paleogene formation in Japan) (in Japanese). *Bull., Geol. Surv. Japan, Vol. 7, No. 6*, pp. 25-34, pls. 1-2.

NAGAO, T. (1928a): A Summary of the Palaeogene Stratigraphy of Kyushu, Japan, with Some Accounts on the Fossiliferous Zones. *Sci. Rep., Tohoku Imp. Univ., 2nd Ser., Vol. 12, No. 1*, pp. 1-10, pl. A.

—— (1928b): Palaeogene Fossils of the Island of Kyushu, Japan. *Pt. 2. Ibid., Vol. 12, No. 1*, pp. 11-140, pls. 1-17.

OKAMOTO, K. (1960): The Smaller Foraminiferal Faunule from the Tertiary Formations in the Environs of Yuya-wan, Yamaguchi Prefecture (Preliminary Report) (in Japanese). *Yukochu (Foraminifera), No. 11*, pp. 48-53.

—— (1961): Cenozoic Formations of Tsunoshima (Island), Hohoku-cho, Toyoura-gun, Yamaguchi Prefecture (in Japanese). *Jour. Geol. Soc. Japan, Vol. 67, No. 791*, pp. 476-483.

OTUKA, Y. (1939): Tertiary Crustal Deformations in Japan (with Short Remarks on Tertiary Palaeogeography). *Jub. Publ. Comm. Prof. Yabe's 60th Birthd.*, pp. 481-519.

OYAMA, K., A. MIZUNO and T. SAKAMOTO (1960): *Illustrated Handbook of Japanese Paleogene Molluscs*. Geol. Surv. Japan.

STEWART, R. B. (1930): GABB's California Cretaceous and Tertiary Type Lamellibranchs. *Phil. Acad. Nat. Sci., Sp. Publ., No. 3*, pp. 1-314, pls. 1-17.

SUDO, T. (1942): Geology and Mineralogy of the Tertiary Iron-Sand Deposits in Japan (in Japanese). *Jour. Geol. Soc. Japan, Vol. 49, No. 558*, pp. 335-355.

UOZUMI, S. (1955): On some Molluscan Fossils from the Paleogene Wakkanabe Formation in Hokkaido. *Trans. Proc. Palaeont. Soc. Japan, N.S., No. 19*, pp. 73-80, pl. 12.

WADA, T. (1955): On the Historical Geology of the Yuya-wan Area, Yamaguchi Prefecture—With Special Reference to the Tertiary Stratigraphy and Fossils (in Japanese). *Mem. Funairi Senior High School (Hiroshima), No. 2*, pp. 33-48.

——, S. IMAMURA and A. HASE (1951): The Paleogene Tertiary lying to the East of Yuya-wan, Ohtsu-gun, Yamaguchi Prefecture (in Japanese). *Jour. Geol. Soc. Japan, Vol. 57, No. 670*, p. 306.

YOKOYAMA, M. (1911): Some Tertiary Fossils from the Miike Coal-field. *Jour. Coll. Sci., Imp. Univ. Tokyo, Vol. 27, Art. 20*, pp. 1-16, pls. 1-3.

—— (1924): Molluscan Remains from the Lowest Part of the Joban Coal-field. *Ibid., Vol. 45, Art. 3*, pp. 1-25, pls. 1-5.

Postscript:

The name of "Ashiya" group in this area was changed to Hioki group by OKAMOTO and IMAMURA (1962). In the last summer, they also ascertained that the Ohuchiyama formation is evidently equivalent to the upper part of the Sakaigawa formation. The revised stratigraphy of the Hioki group will be soon reported.

Explanation of Plate 48

(All ×0.9)

Venericardia (*Venericor*) *subnipponica* NAGAO ..... p. 314

Fig. 1. Left valve specimen (OK-Ya-09-022a). Adult stage.

Fig. 2. Left valve specimen (OK-Ya-09-026a). Early adult stage.

Fig. 3. Left valve specimen (OK-Ya-09-016). Adult stage.
Sakaigawa formation in the north coast of Kiwado, Hioki-mura.

Figs. 4a-b. Bibalved specimen (OK-Ya-X-001). Adult stage; derived from the Sakaigawa or Ohuchiyama formation in the vicinity of Juraku, Nagato-city.

Fig. 5. Left valve specimen (OK-Ya-09-020). Early adult stage.

Fig. 6. Left valve specimen (OK-Ya-09-006). Middle stage.
Sakaigawa formation in the north coast of Kiwado, Hioki-mura.

Chlamys (*Chlamys*) *ashiyaensis* (NAGAO) ..... p. 313

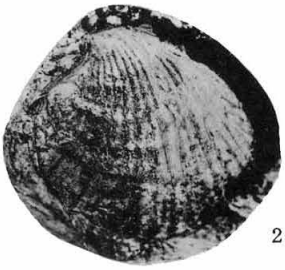
Figs. 7a-b. An imperfect right valve specimen (OK-Ya-45-002A-B); Taoyama formation at Watashiba in Yuya-cho.

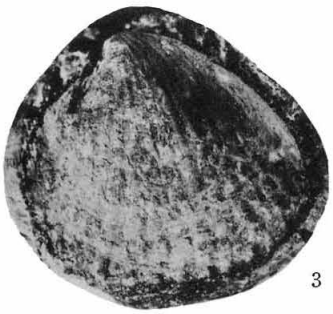
Fig. 8. An Imperfect left valve specimen (OK-Ya-03-001), showing the surface ornament: Sakaigawa formation in the east coast of Kayakari, Hioki-mura.

Fig. 9. An imperfect immature right valve specimen (OK-Ya-45-003), showing ctenorium.

Fig. 10. Internal cast of the left valve specimen (OK-Ya-45-001B).
Taoyama formation at Watashiba in Yuya-cho.

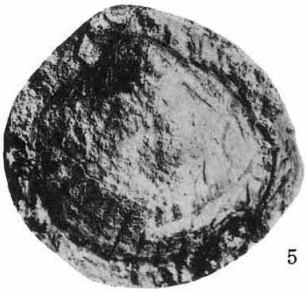

1

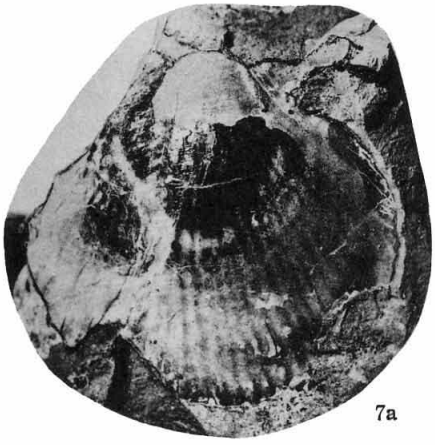

2

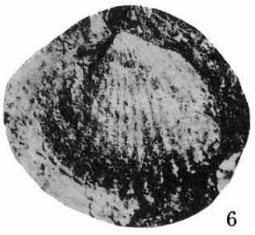

3


4b


4a

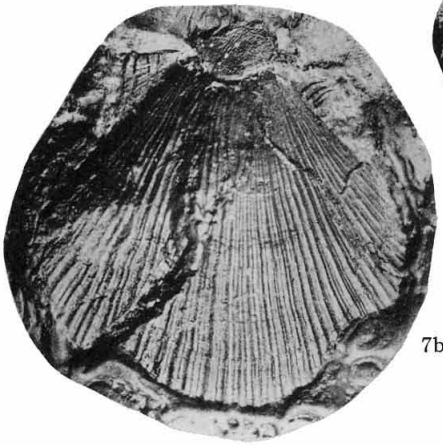

5

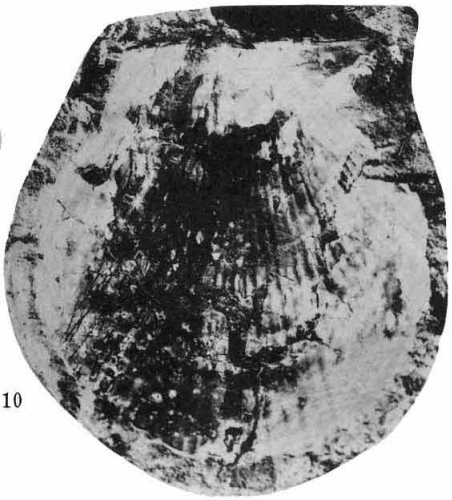

7a


6


8


9


7b


10

Trans. Proc. Palaeont. Soc. Japan. N.S., No. 48, pp. 321-330, pls. 49, 50, Nov. 30, 1962.

439. LOWER CARBONIFEROUS BRYOZOA FROM THE OMI LIMESTONE, JAPAN
PART 1: DISCOVERY OF THE *PROFUSULINELLA* ZONE, AND DESCRIPTIONS OF *PROFUSULINELLA*, CYCLOSTOMATA, TREPOSTOMATA AND *FENESTELLA**

SUMIO SAKAGAMI

Department of Geology, Hokkaido Gakugei University

青海石灰岩産下部石炭紀蘚虫化石。その1：青海石灰岩の C_1 帯から産した蘚虫化石13属22種を識別し，この蘚虫動物群と外国産のものとの比較検討をなし，そのうち9種を記載した。尚，蘚虫化石を含む薄片中に *Profusulinella* sp. を識別したので，その記載もおこなった。従来，青海石灰岩では *Profusulinella* 帯が知られていなかったが，*Profusulinella* sp. の発見によって，藤田 (1958) の *Millerella*-Coral-Brachiopod 帯を *Millerella* 帯と *Profusulinella* 帯に二分すべきことを述べた。

坂 上 澄 夫

Introduction and Acknowledgements

HAYASAKA (1924) described and illustrated six species of Bryozoa with the other invertebrates from the Omi limestone. This was the first description of the Paleozoic Bryozoa in Japan.

In the summer of 1961, the writer visited the fossil localities of the Omi limestone and collected many bryozoan specimens from the limestones cropping out at Nishiyama and Higashiyama. These localities are included into the Coral-Brachiopod zone of KAWADA (1954) and the *Millerella*-Coral-Brachiopod zone of FUJITA (1958).

The Bryozoa described in this article comprise 22 species in 13 genera and were collected from the upper part of the *Millerella*-Coral-Brachiopod zone from which FUJITA reported the occurrence of eight species of Bryozoa which was discriminated by KATAOKA.

The present paper contains the descriptions of one fusulinid, *Profusulinella* sp., and nine species of Bryozoa in the first part and 13 species of Bryozoa in the second.

The writer is greatly indebted to Professor Haruyoshi FUJIMOTO of the Yamagata University, Professor Teiichi KOBAYASHI of the University of Tokyo and Professor Wataru HASHIMOTO of the Tokyo University of Education for their continued guidance and encouragements. He is also grateful to Professor Kotora HATAI of the Tohoku University for his kindness in reading the manuscript and Mr. Hiroshi FUJITA of the Tohoku Boring Co. Ltd. for his paper on the Omi limestone. The writer also wishes to express his respect to Dr. Ichiro HAYASAKA whose pioneer works on Bryozoa have stimulated his study.

All of the specimens treated in this article are preserved in the collection of the Department of Geology, Hakodate

* Received March 31, 1962; read June 2, 1962.

School of the Hokkaidô Gakugei University.

Discovery of the *Profusulinella* zone

FUJITA (1958) found *Millerella* sp., from the *Millerella*-Coral-Brachiopod zone and stated that this zone is underlain directly by the *Fusulinella* zone although no stratigraphic break between the two zones could be observed. He suggested that the *Millerella*-Coral-Brachiopod zone may correspond to the *Profusulinella* zone in the Akiyoshi limestone of TORIYAMA (1954) because the many corals from the *Millerella*-Coral-Brachiopod zone indicate the Visean-Namurian age. He further suggested that the *Profusulinella* zone which was defined by THOMPSON (1948) may be contained even though no species of *Profusulinella* have been found.

During the microscopic observation of the Bryozoa, the writer found a few *Profusulinella* sp. in the thin sections. Accordingly, the writer believes that the *Millerella*-Coral-Brachiopod zone of FUJITA can be divided into two zones, the *Millerella* zone and *Profusulinella* zone, although the stratigraphic relation between them remains to be determined.

Literatures used for the present study will be given at the end of Part 2.

Description of *Profusulinella*

Profusulinella sp. indet.

Plate 49, Figures 1-4

One of the three tangential sections cut near the axis shows the essential generic characters of the indetemined species. Shell minute, fusiform with slightly inflated median part. Axial length about 2.0 mm, median width about 1.0 mm, and form ratio about 1 : 2. Mature shell with 5 or 6 volutions. Spirotheca thin, composed of thin tectum, upper and lower tectoria, and no observable diaphanotheca. Thickness of spirotheca 0.24 mm in the outer volutions of best specimen but obscure in inner volutions. Septa thin and almost unfluted throughout. Tunnel about one-third to half as high as chambers. Chomata rather well developed in outer volutions. Tunnel sides of chomata very steep, but poleward slopes gentle.

Remarks:—Because of the badly oriented specimens and insufficiency of the material at hand, more materials are necessary before the species name can be determined. However, the present form belongs to the genus *Profusulinella* and its similar to *Profusulinella beppensis* TORIYAMA which was described from the Cm^{α} zone of the Akiyoshi limestone in the size and general appearance of inner structures except for the lateral slopes of the present form which are straighter.

Of the three specimens at hand, the first (Reg. no. 11202) occurred in association with *Rhabdomeson yabei* SAKAGAMI, n. sp. and *Sulcoretepora complicata* SAKAGAMI, n. sp., and the second (11211) with *Prismopora nipponica* SAKAGAMI, n. sp.; but the third (11230) was not found in association with any bryozoan species in a section.

Locality:—Nishiyama.

Remarks on the Bryozoan Fauna

The following forms of Bryozoa from the C_1 zone of the Omi limestone were described and illustrated by HAYASAKA (1924):

Fistulipora minima HAYASAKA
Fenestella spp.
Polypora sp.
Phyllopora sp.
Batostomella sp.

Of the above mentioned forms, *Phyllopora* sp. may be referable to *Protoretepora hayasakae* SAKAGAMI, n. sp. The genus *Phyllopora* KING is included in the genus *Protoretepora* DEKONINCK as a synonym by BASSLER (1953). *Batostomella* sp. may belong to the genus *Hayasakapora* as already mentioned by the writer (1960).

Recently, FUJITA (1958) reported without descriptions and illustrations the following eight forms of Bryozoa, which were discriminated by KATAOKA:

Ascopora sp.
Fenestella sp.
Fistulipora cf. *minima* HAYASAKA
Moorephylloporina ? sp.
Penniretepora sp.
Phyllopora ? sp.
Protoretepora sp.
Thamniscus sp.

The genus *Ascopora* determined by KATAOKA in the above list is a Permian to Carboniferous genus in Soviet Russia but is not known from deposits of similar age in the United States of America. The writer observed many thin sections containing Bryozoa of the area and failed to find any specimens of *Ascopora* but could observe abundant *Streblascopora*. There are some similarities between *Ascopora* and *Streblascopora* in the presence of central bundle, and it is thought by the writer that *Ascopora* sp. discriminated by KATAOKA may belong to *Streblascopora*. *Moorephylloporina* ? sp. is a genus *Moorephylloporina* know only from the middle Ordovician of Strasburg, and its occurrence in FUJITA's collection may be doubtful.

The writer discriminated the following 22 species distributed among 13 genera from Nishiyama and Higashiyama.

Nishiyama:

Fistulipora minima HAYASAKA
Fistulipora sp. indet.
Cheilotrypa sp. indet.
Prismopora nipponica SAKAGAMI, n. sp.
Stenopora nishiyamensis SAKAGAMI, n. sp.
Fenestella kawadae SAKAGAMI, n. sp.
Fenestella binodosa SAKAGAMI, n. sp.
Fenestella cf. *triserialis* ULRICH
Fenestella sp. indet.
Polypora fujitae SAKAGAMI, n. sp.
Penniretepora cf. *irregularis* (NEKHOROSHEV)
Penniretepora regularis SAKAGAMI, n. sp.
Penniretepora sp. indet.
Protoretepora hayasakae SAKAGAMI, n. sp.
Rhabdomeson yabei SAKAGAMI, n. sp.
Streblascopora amabilis SAKAGAMI, n. sp.
Streblascopora grossa SAKAGAMI, n. sp.
Streblotrypella ? sp. indet.
Sulcoretepora complicata SAKAGAMI, n. sp.

Higashiyama (the limestone containing Bryozoa were collected in the tunnel No. 2. This tunnel is divided into two and the writer researched the left one):

i) At about 100 m from the entrance of the tunnel:
Rhombopora sp. indet.
Sulcoretepora ? sp. indet.
Fragments of fenestrate bryozoa, etc.

ii) At about 350 m from the entrance of the tunnel:
Penniretepora higashiyamensis SAKAGAMI, n. sp.
Streblascopora grossa SAKAGAMI, n. sp.
Fragments of *Fenestella* and *Rhombopora* etc.

They were found in a grey limestone in association with *Millerella* sp.,

Profusulinella sp., corals, brachiopods and crinoid columnals. Among the 22 species discriminated from the bryozoan specimens, 12 are determined to be new to science, 7 are indeterminable, 1 is identical with a previously known form from the Omi limestone and 2 show resemblance with known foreign forms.

Fistulipora minima HAYASAKA described here coincides with the type speciemen which HAYASAKA described and illustrated from the C_1 zone of Omi limestone in 1924. *Fenestella* cf. *triserialis* ULRICH and *Pennniretepora* cf. *irregularis* (NEKHOROSHEV) seem to be related to the named species. *Fenestella triserialis* was described originally from the Keokuk group of Kentucky of the United States of America by ULRICH (1890) and reported from the lower Carboniferous of Soviet Russia by NIKIFOROVA (1933), NEKHOROSHEV (1948, 1953) and TRIZNA (1958). *Pennniretepora irregularis* (NEKHOROSHEV) was recorded originally from the middle Carboniferous of Soviet Russia by NEKHOROSHEV (1948). The other species described as new to science are more or less related to some previously described Russian species as mentioned later.

In general, the present fauna seem to be related more to the Russian fauna than to the North American fauna.

Description of Species

Genus *Fistulipora* M'COY, 1850

Fistulipora minima HAYASAKA

Plate 49, Figure 5

1924. *Fistulipora minima* HAYASAKA, *Sci. Rep., Tohoku Imp. Univ., Ser. 2, Vol. VIII, No. 1*, p. 55, pl. VII, fig. 4.

Zoarium lamellate, variable in thickness, maximum thickness about 3 mm. Zooecial tubes usually straight from the proximal to distal ends, small in size and circular or oval in tangential section. Their larger diameter 0.21 mm to 0.22 mm and shorter one 0.14 mm to 0.16 mm. There are usually five to seven zooecia per 2 mm. Lunarium developed in zooecial tube of mature zone, about 0.04 mm thick, occupying about one-third to one half of zooecial circumference; however, absent in immature zone. Interspaces between zooecial tubes 0.16 mm to 0.21 mm and filled with well developed vesicular tissue which is regularly arranged in longitudinal rows, subquadrate in longitudinal section, and irregularly polygonal in tangential section. Two to three rows of vesicles in interspace between zooecial tubes. Vesicular tissue becoming gradually fine on approaching surface of zoarium. Diaphragms straight or slightly concave, and spaced at intervals of one to two times of zooecial diameter, seven to eight per 2 mm of zooecial tube.

Remarks:—The present species was reported originally from the Omi limestone by HAYASAKA (1924). There are some defferences between HAYASAKA's original description and the present one. HAYASAKA described that "horizontal tubulae (diaphragm) rather rarely developed", but the present form has diaphragms spaced at intervals of one to two times of zooecial diameter. The writer also observed the zooecial tube having rarely developed diaphragms in some sections of the species and the zooecial tubes lacking diaphragms had been destroyed or dissolved by the secondary phenomenon. So, the writer believes that HAYASAKA's specimen had many diaphragms originally although many of them were lost later. From the above mentioned consideration, the present form is included in *Fistulipora*

minima HAYASAKA.

Locality:—Nishiyama. Reg. nos. 11251, 11255, 11257, 11275.

Fistulipora sp. indet.

Plate 49, Figure 6

Only one section of zoarium attached to fenestrate bryozoa. Zoarium lamellate, its thickness measured in part of longitudinal section about 1.3 mm. Diameter of zooecial tube 0.24 mm to 0.28 mm and about the same from inner to outer. Interspace between zooecial tubes filled by well developed vesicular tissue which is scale-like in longitudinal section, one to three rows of vesicles in interspace between zooecial tubes. Lunarium present, but very weak. Stereom covering vesicular tissue not developed. Diaphragm may be absent.

Remarks:—The present form can be distinguished easily from *Fistulipora minima* by coarser structures. The detailed comparison with the previously described species is reserved until better preserved specimens accumulate.

Locality:—Nishiyama. Reg. no. 11221.

Genus *Cheilotrypa* ULRICH, 1884

Cheilotrypa sp. indet.

Plate 49, Figure 7

A single transverse section after dichotomosing, so two axial tubes observed in a section. Diameter of zoarium about 2.8 mm, that of axial tube 0.52 mm to 0.60 mm. Ratio of axial tube to diameter 1 : 4.5. Zooecial tubes may run for a short distance along contact with axial tubes, but curve outward, become perpendicular to surface of zoarium. Diameter of zooecium measured in shorter one 0.24 mm to 0.28 mm. Interspaces between zooecial tubes well developed, vesicular tissue scale-like in transverse section. Lunarium may occur but indistinct. No dark fibrous tissue covering vesicular tissue. Diaphragms usually not observed, but one in inner zone of some tubes.

Remarks:—Insufficient for comparison with known species.

Locality:—Nishiyama. Reg. no. 11221.

Genus *Prismopora* HALL, 1883

Prismopora nipponica SAKAGAMI, n. sp.

Plate 49, Figures 8–10

Four transverse sections were obtained from the same zoarium. Zoarium triradiate at an angle of about 120° to each other, sharply triangular with concave sides in transverse section. Usually, width of sides measured from edge to edge variable, 4 mm, 4.5 mm and 4.5 mm in smallest specimen, 11 mm, 12 mm and 14 mm in largest one. Three rays of mesotheca straight or somewhat curved, radially developed from center to edges, measuring 2.0 mm, 2.5 mm and 2.8 mm in smallest specimen, about 7 mm, 9 mm and 9 mm in largest one. Thickness from center to most concaved points 0.60 mm, 0.68 mm and 1.2 mm in smallest specimen, about 2.5 mm, 3.0 mm and 3.0 mm in largest one. Zooecial tubes about parallel to mesotheca for a very short distance, then passing upwards to surface. Zooecium oval, 0.16 mm to 0.21 mm in tangential section, with well developed lunarium. Lunarium occupying about one half of zooecial circumference, its thickness not measurable owing to ill-preservation. Diaphragm usually lacking, but sometimes one disposed at inner part of zooecial tube. Interspaces between zooecial tube filled by well developed vesicular tissue regularly arranged in longitudinal rows, sub-

quadrate or scale-like in shape. Two to three rows of vesicles in interspaces between zooecial tubes. Vesicular tissue rather coarse in inner part, but becoming gradually fine on approaching surface of zoarium.

Remarks:—Only three species of the genus *Prismopora* have been described from the Carboniferous of the United States of America by ULRICH (1890), and one of them was given no specific name. The present form can be easily distinguished from those three species by the larger zoarium and more complicated inner structures. Recently, CROCKFORD (1957) reported on three species of *Prismopora* but two of them were questionably referred to the genus from the permian Noonkanbah formation of the Fitzroy Basin, West Australia. The present form is rather similar to one of them, namely, *Prismopora*? *triradiata* in the complicated inner structures. The present form, however, is smaller than *P.*? *triradiata* in the size of zoarium and zooecial diameter, and the mode of vesicular tissues is also different. Further, the present form have no diaphragm and well developed lunarium but *P.*? *triradiata* has many diaphragms in the zooecial tube and lacks the lunarium.

Locality:—Nishiyama. Reg. nos. 11250 (holotype), 11242, 11243, 11248.

Genus *Stenopora* LONSDALE, 1844

Stenopora nishiyamensis SAKAGAMI, n. sp.

Plate 50, Figures 1-2

Two oblique sections from the same zoarium. Zoarium consisting of cylindrical stem, about 5 mm in diameter. Zooecial tube bending gradually outward in longitudinal section, and circular near surface, rounded polygonal in immature zone in tangential section. Arrangement and form of zooecial apertures not observed. Diameter of zooecial tube in mature zone 0.24 mm to 0.32 mm, and 5 to 6 zooecia per 2 mm. Zooecial wall thin in immature region, becoming gradually thick to surface. Moniliform thickening of wall developed but not so strong. Mesopore rare, usually circular in form, and its diameter 0.08 mm to 0.13 mm. One megacanthopore usually present at each point of intersection of zooecial walls and a few micracanthopores in one row but somewhat irregular in each interspace of megacanthopores. Diaphragm usually lacking but one very rarely occurred in mature zone of tube.

Remarks:—BASSLER (1953) defined the genus *Stenopora* as follows: "Zooecia thick walled, with well developed monilae; without diaphragms. One megacanthopore on distal side of each zooecial tube and many micracanthopores between tubes, mostly at zooecial angles; mesopores lacking". Many of the previously described species, however, have diaphragms in the zooecial tubes. Although the writer unfortunately could not refer to the original description of the genus *Stenopora* by LONSDALE, there are some questions to include the present form in this genus because the present form has diaphragm but very occasionally in the mature zone of tube. The present form differs from the known species of *Stenopora* and its similar genera.

Locality:—Nishiyama. Reg. nos. 11234 (holotype), 11235.

Genus *Fenestella* LONSDALE, 1839

Fenestella kawadae SAKAGAMI, n. sp.

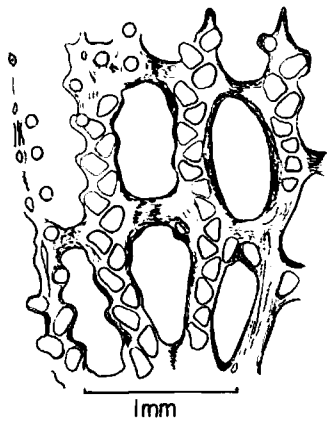
Plate 50, Figure 6; Text-figure 1

A single tangential section, fan-

shaped of straight branches connected by dissepiments at regular intervals. Width of branch slightly narrower than fenestrule, usually 0.21 mm to 0.24 mm, above bifurcation 0.16 mm. 18 to 20 branches in 10 mm horizontal. Fenestrules oval to elongated elliptical in outline, its width and length 0.22 mm to 0.45 mm and 0.67 mm to 0.77 mm, respectively. 11 to 12 in 10 mm length of branch. Dissepiment very strong, its width about as wide as that of branches, 0.16 mm to 0.24 mm. Zooecial tube bending outward, circular at upper level of branch, 0.08 mm in diameter, but becoming triangular with rounded corners at middle and lower levels of branch. Zooecial apertures 20 in 5 mm length of one row, and almost perfectly stabilized in position of aperture in relation to dissepiments, usually 3.5 apertures per fenestrule. Interspaces between zooecial apertures 0.16 mm to 0.18 mm. Carina well developed, straight, but its height is unknown. Nodes regularly arranged on carina. Outside diameter of node about 0.064 mm, about 15 in 5 mm length of branch. Distance between nodes 0.21 mm to 0.27 mm. Usually, a couple of ovicell like substances attached at proximal sides of dissepiment.

Meshwork formula:—18-20/11-12//20/15.

Remarks:—The nearest to *Fenestella kawadae* SAKAGAMI, n. sp. is *Fenestella bukhtarmensis* which NEKHOROSHEV (1956) reported from the lower Carboniferous (upper Tournaisian to lower Visean) of the Altai Mine and Kuznetz basin in the meshwork formula (18-20/11-13//19-20/13-15). However, the present form differs from *F. bukhtarmensis* by the shape of zooecial tubes in the tangential section. It may be an important character of the present form that there is a couple of ovicell like substances usually attached at the proximal sides of each dissepiment.



Text-figure 1. *Fenestella kawadae* SAKAGAMI, n. sp., tangential section, holotype (Reg. no. 11204-B).

The specific name is dedicated to Dr. Shigema KAWADA who was engaged in the stratigraphic and paleontological studies of the Omi limestone.

Locality:—Nishiyama. Reg. no. 11204-B (holotype).

Fenestella binodosa SAKAGAMI, n. sp.

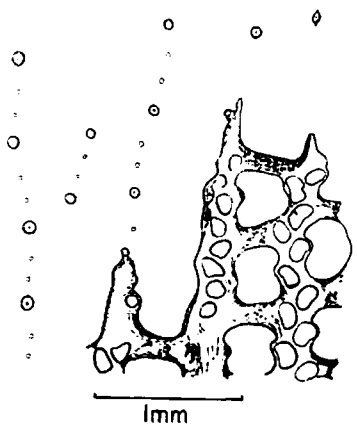
Plate 50, Figure 5; Text-figure 2

A single tangential section. Form of zoarium uncertain. Branches straight, parallel, bifurcate at wide intervals, narrower than width of fenestrules. Width of branch 0.21 mm to 0.24 mm, 18 to 20 branches in 10 mm. Fenestrules rectangular with rounded corners in outline and its width and length 0.34 mm to 0.38 mm and 0.37 mm to 0.43 mm, respectively, and about 20 in 10 mm length of branch. Width of dissepiment moderate, measures 0.14 mm to 0.16 mm. Zooecial tube bending outward, kidney-like form at upper level of branch and rounded trapezoidal at base. Zooecial aperture circular, 0.08 mm to 0.10 mm in diameter,

20 in 5 mm length of one row, and perfectly stabilized in position of aperture in relation to dissepiments, 2 apertures per fenestrule. Interspaces between zooecial apertures 0.13 mm to 0.15 mm. Carina developed probably but low. Two kinds of nodes regularly arranged on straight carina. Diameters of larger and smaller nodes 0.08 mm to 0.11 mm and 0.03 mm to 0.05 mm, respectively. Two smaller nodes usually disposed between larger ones. Interspaces between larger nodes measures 0.40 mm to 0.48 mm. between larger and smaller nodes 0.10 mm to 0.18 mm and between smaller nodes 0.06 mm to 0.13 mm.

Meshwork formula:— 18-20/20//20/10*.

Remarks:—The present form is the nearest to *Fenestella ivanovi* SHULGA-NESTERENKO (1951) from the Kasimovsky horizon ($C_1^{k_s}$) of the Russian Platform in the meshwork formula (18/18//18) and in the width of branch being narrower than that of fenestrule, but it can be distinguished by thicker zooecial wall and two kinds of nodes arranged on straight carina. There are a few species known which have two kinds of nodes, such as *Fenestella praeforaminosa* NEKHOROSHEV but it has five smaller nodes between larger ones.



Text-figure 2. *Fenestella binodosa* SAKAGAMI, n. sp., tangential section, holotype (Reg. no. 11222).

Locality:—Nishiyama. Reg. no. 11222 (holotype).

Fenestella cf. *triserialis* ULRICH, 1890

Plate 50, Figure 4; Text-figure 3

1890. *Fenestella triserialis* ULRICH, *Geol. Surv. Illinois, Vol. VIII*, p. 541, pl. L, figs. 4, 4a.

1933. *Fenestella* aff. *triserialis*, NIKIFOROVA,

* 10: number of larger nodes in 5 mm.

Explanation of Plate 49

Figs. 1-4. *Profusulinella* sp. indet.
1-3, tangential sections, ×20. Reg. nos. 11211, 11230 and 11202, respectively, 4, enlarged part of Fig. 1, showing the structures of the spirotheca, ×60.

Fig. 5. *Fistulipora minima* HAYASAKA
Longitudinal section, ×20, Reg. no. 11257.

Fig. 6. *Fistulipora* sp. indet.
Longitudinal but partly oblique section, ×10, Reg. no. 11228.

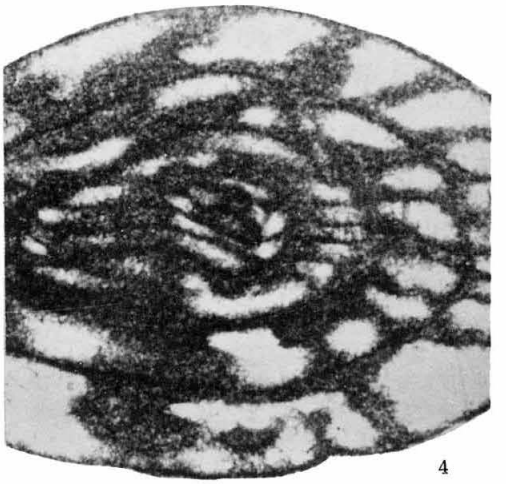
Fig. 7. *Cheilotrypa* sp. indet.
Transverse section, ×10, Reg. no. 11221.

Figs. 8-10. *Prismopora nipponica* SAKAGAMI, n. sp.
8, transverse section of holotype, ×10, Reg. no. 11250, 9, enlarged part of holotype, ×40, 10, enlarged part of paratype, Reg. no. 11248, showing the central zone, ×40.

1

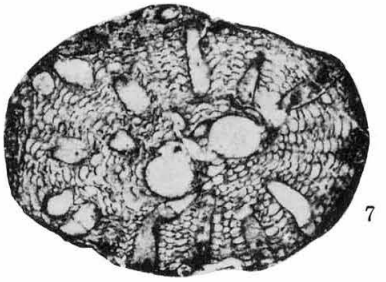
2

8

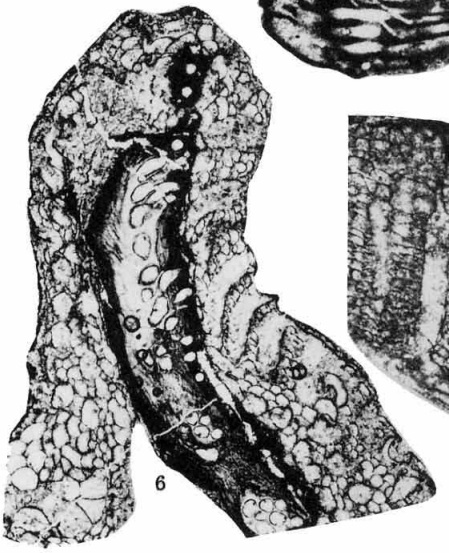


4

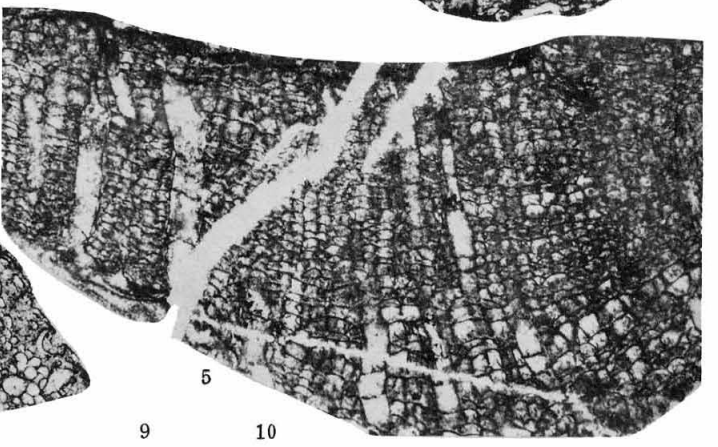
3



7

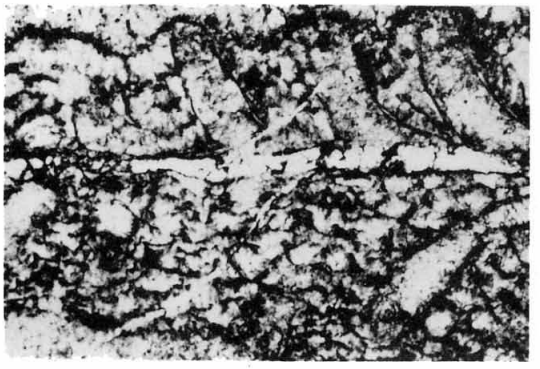


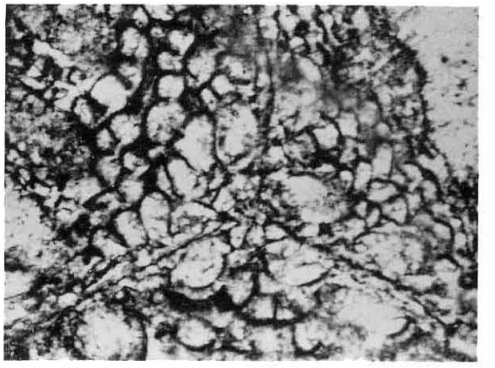
6



5

9 10





SAKAGAMI photo.

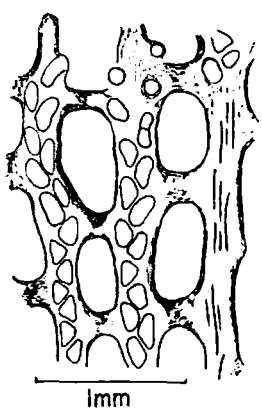
Trans. United Geol. Prospecting Serv. USSR, Fasc. 207, p. 18.

1948 *Fenestella* cf. *triserialis*, NEKHOROSHEV, *Akad. Nauk Kaz. SSR.*, pp. 23, 24.

1953. *Fenestella triserialis*, NEKHOROSHEV, *Akad. Nauk SSSR.*, pp. 96, 97, pl. 10, figs. 1a, b, pl. 12, figs. 1, 2.

1958. *Fenestella triserialis*, TRIZNA, *Trudy VNIGRI, 122*, pp. 140, 141, pl. XLI, fig. 2, text-fig. 14.

A single tangential section. Form of zoarium uncertain. Branches straight, parallel, bifurcate at wide intervals, as wide as width of fenestrules. Width of branch 0.21 mm to 0.30 mm, 19 branches in 10 mm. Fenestrules elongated elliptical in outline, its width and length 0.24 mm to 0.32 mm and 0.51 mm to 0.64 mm, respectively, 13 in 10 mm length of branch. Dissepiments relatively strong, its width 0.18 mm to 0.19 mm. Zooecial apertures 0.06 mm to 0.08 mm, 20 to 21 in 5 mm length of one row, usually 3 apertures per fenestrule; rounded triangular at lower and middle levels. Interspaces between zooecial apertures about 0.10 mm. Carina and nodes developed, but interspaces between nodes indeterminable. Stereom covering the reverse side, rather coarse striations developed along the length of branch.



Text-figure 3. *Fenestella* cf. *triserialis* ULRICH, tangential section, (Reg. no. 11232).

Meshwork formula:—19/13//20-21/?.

Remarks:—*Fenestella triserialis* ULRICH was first recorded from the Keokuk group of the United States of America, and subsequently from several localities in Soviet Russia by NIKIFOROVA (1933), NEKHOROSHEV (1948, 1953) and TRIZNA (1958). There are no conspicuous differences between the present form and ULRICH's holotype except for the absence of the small spots disposed between the zooecial tubes, which are shown in the holotype. The present form is the nearest to NEKHOROSHEV's specimen which was reported from the upper Tournaisian ($C_1^{\alpha 2}$) of Kazakhstan, Soviet Russia in the meshwork formula (18-20/12-13//18-19) and other characters.

Locality:—Nishiyama. Reg. no. 11232.

Fenestella sp. indet.

Plate 50, Figure 3

A single fragmentary tangential section. Form of zoarium uncertain but probably fan-shaped. Width of branch less than a half or width of fenestrule, 0.19 mm to 0.21 mm. Fenestrules rectangular with rounded corners in outline, their width about 0.48 mm, but their length indeterminable. Dissepiment rather weak, its width 0.11 mm to 0.13 mm. Zooecial tubes trapezoidal with rounded corners at lower to middle levels of tangential section, but not observed at upper level. Number of zooecial tubes about 20 in 5 mm length of one row. Single row of nodes regularly arranged. Outside diameter of node about 0.048 mm, about 20 in 5 mm length of branch. Interspaces between nodes 0.22 mm to 0.24 mm.

Meshwork formula:—15/?//20/20?.

Remarks:—The present form can be distinguished from the above described

three species, but it is not named owing to the ill-preservation and indistinction of the number of fenestrules per 10 mm of zoarium.

Locality:—Nishiyama. Reg. no. 11239-A.

Explanation of Plate 50

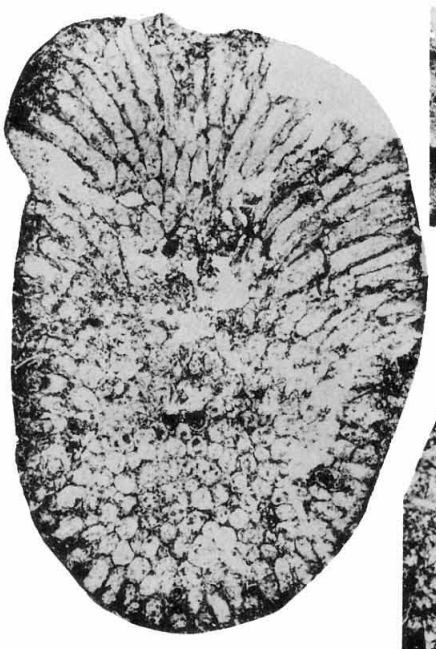
Figs. 1, 2. *Stenopora nishiyamensis* SAKAGAMI, n. sp.
1, oblique section of holotype, ×10, Reg. no. 11234. 2, enlarged part of holotype, showing the wall structure, ×20.

Fig. 3. *Fenestella* sp. indet.
Tangential section, ×10, Reg. no. 11239-A.

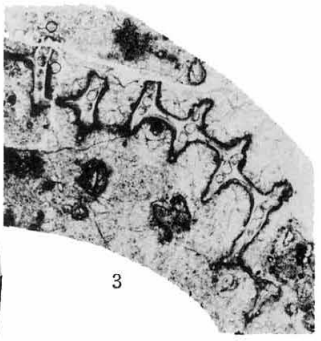
Fig. 4. *Fenestella* cf. *triserialis* ULRICH
Tangential section, ×20, Reg. no. 11232.

Fig. 5. *Fenestella binodosa* SAKAGAMI, n. sp.
Tangential section of holotype, ×20, Reg. no. 11222.

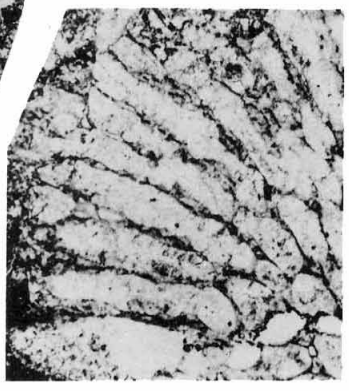
Fig. 6. *Fenestella kawadae* SAKAGAMI, n. sp.
Tangential section of holotype, ×20, Reg. no. 11204-B.



1

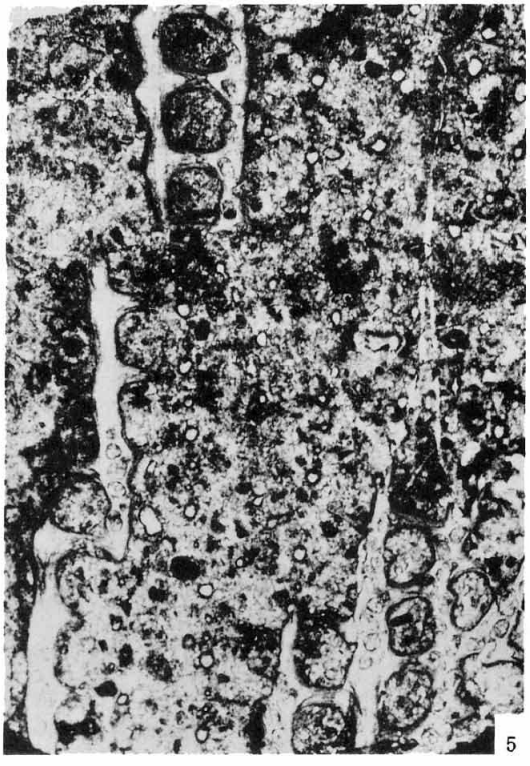


3

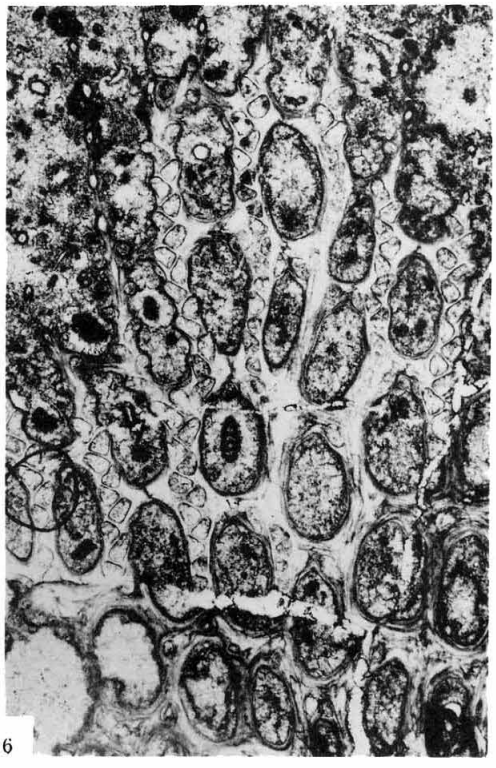


2

4



5



6

SAKAGAMI photo.

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 48, pp. 331-342, pls. 51, 52, Nov. 30, 1962.

440. NOTES ON *GLOBIGERINA NEPENTHES* TODD, 1957*

TSUNEMASA SAITO

Institute of Geology and Paleontology,
Tohoku University

Globigerina nepenthes TODD, 1957 について：浮遊性有孔虫 *G. nepenthes* の諸形質を多くの Topotype および各地域から得られた Hypotype をもとにして論じた。本種の地質時代と地理的分布を，カリブ海地域・欧州・日本・中部太平洋地域等の報告にもとずいて検討し，浮遊性有孔虫化石による第三系帯分のために有する本種の価値を論述した。その結果，本種は上部 Helvetian および Tortonian 階の重要な示準化石となることが想定される。

斎 藤 常 正

Introduction

The planktonic Foraminifera, *Globigerina nepenthes* TODD, was originally described from the Miocene Donni sandstone member of Saipan, Mariana Islands in 1957. This species, as stated in the type description, is distinctive in having the protruding thumb-like final chamber resembling the pitcher plant flower *Nepenthes*. Owing to this morphological peculiarity, it is one of the most characteristic Miocene planktons which may be easily discriminated from foraminiferal assemblages. Outside the type locality, *G. nepenthes* was also noted by the original author in Cuba, the Dominican Republic, Trinidad, Morocco and Kabu in East Java. Through the comprehensive studies on the planktonic Foraminifera of the Caribbean regions by BOLLI (1957) and BLOW (1959), the stratigraphic range of this species was definitely allocated in terms of planktonic foraminiferal zones.

During the studies on the planktonic Foraminifera from Japan and some foreign regions, the writer found the species from many new localities and thus had the opportunity to compare them with the topotype. And special interest of the writer was attracted to the occurrence of *G. nepenthes* from the type Tortonian locality in Italy in connection with inter-regional correlation of the planktonic foraminiferal zones. From the studies of previous authors and the writer, it appears that *G. nepenthes* is geographically widely distributed and restricted in time. Nevertheless, the record of the present species seems to be rather rare in the papers on planktonic Foraminifera. In this concern, the present study is devoted to the discussion of the age, distribution and morphology of *Globigerina nepenthes* TODD.

The writer thanks Dr. Shoshiro HANZAWA for his permission to study the foraminiferous rock samples from Micronesia. Thanks are also extended to professors Kiyoshi ASANO and Kotora HATAI of the Institute of Geology and Paleontology, Tohoku University for their continuous guidances and encour-

* Received April 17, 1962; read at the Annual Meeting of the Society at Sendai, Jan. 20, 1962.

agements. Dr. Hiroshi UJIIÉ, of the Geological and Mineralogical Institute, Tokyo University of Education, kindly aided in preparing the oriented thin sections and photomicrographs. Mr. Naoaki AOKI of the same Institute generously shared his rock samples bearing *G. nepenthes* from the Kiyosumi formation in the Boso Peninsula, Japan.

Materials and Scope of the Present Study

The topotype and hypotypes herein illustrated are from the four localities mentioned below. And brief notes on the lithology of each rock samples, from which *G. nepenthes* was extracted, are also added. All of the types are deposited in the Institute of Geology and Paleontology, Tohoku University. The prefix IGPS to the collection catalogue numbers is the abbreviation for Institute of Geology and Paleontology, Sendai.

1. Donni Sandstone Member: South of Sadog I Hasngot, Saipan, Mariana Islands. Locality S 162 of HANZAWA (1957, p. 16, pl. 39). White friable *Globigerina* marl.

2. Type Tortonian locality: Stazzano, Sant'Agata dei Fossili, Tortona, 20 kilometers east of Alessandria, Italy.

3. Shimoshiraiwa locality: Shimoshiraiwa, Nakaizu-machi, Shizuoka Prefecture; Izu Peninsula. Lat. 34°58′N., long. 138°59′E. Light brown, loose calcareous coarse grained sandstone with abundant *Lepidocyclina* (see HANZAWA, 1931).

4. Kiriyama Mudstone, Sagara Group: A cliff along the Katsumata River, midway between Honda and Nishimura, Kiriyama, Haibara-cho, Shizuoka Prefecture. Lat. 34°46′13″N., long. 138°10′44″E. Gray mudstone.

For the present study, 136 specimens of the species were extracted from the rock samples of the Donni type locality as the topotypes. The morphological variations of *G. nepenthes* were studied in comparing with those from outside the type locality. Variations of the topotypes and several hypotypes are discussed and some representatives are illustrated. An approach to trace the morphological variation during ontogeny is attempted by dissecting the later chambers and studying the thin-section of the test.

Globigerina nepenthes TODD, 1957

Plate 51, Figures 1–4; Plate 52, Figures 1–8

Globigerina nepenthes TODD, 1957, p. 301, pl. 78, figs. 7a, b. Type locality: Northeast-central Saipan, USGS f 21578 (S 621), Donni Sandstone Member, Miocene, Mariana Islands.

Globigerina nepenthes TODD. BOLLI, 1957, pp. 111, pl. 24, figs. 2a–c. *Globorotalia mayeri* and *Globorotalia menardii* Zone, Lengua Formation, Miocene, Trinidad.

Globigerina nepenthes TODD. BLOW, 1959, pp. 178, 179, pl. 8, figs. 44, 45. *Globorotalia mayeri/Globigerina nepenthes* Subzone and *Globorotalia menardii menardii/Globigerina nepenthes* Zone, Pozón Formation, Miocene, Venezuela.

Sphaeroidinellopsis nepenthes (TODD). BERMUDEZ, 1961, pp. 1277, 1278, pl. 10, figs. 1a, b. La Trinchera, Provincia Azua, Republica Dominicana, Miocene.

Sphaeroidinellopsis nepenthes (TODD), var. *constricta* BERMUDEZ, 1961, p. 1278, pl. 10, figs. 2a, b. Atlantis Sta. 2971 (lat. 20°34′ N., long. 74°24′W.), depth of 810 fathoms, north of Baracoa, Prov. Oriente, Cuba, Middle Miocene.

Globigerina nepenthes TODD. TAKAYANAGI and SAITO, 1962, p. 89, pl. 25, figs. 2a–c. A cliff, 100 m east of Nobori, Muroto-City, Shikoku (IGPS loc. no. Ko-25; lat. 33°22′9″N., long. 134°3′33″E.), Nobori Formation, Middle Miocene, Japan.

Diagnosis of the original author:— " Test small, compactly coiled except for the last-formed protruding chamber; height of spire ranges between three-quarters of and equal to diameter of spire. Chambers indistinct, slightly inflated; 4 chambers constituting the last whorl, with a fifth elongate chamber extending downward and at an angle to the axis of coiling. Sutures indistinct, except the last few which are indented. Wall thin, calcareous, perforate, ornamented by a rather coarse cancellation. Aperture large and semicircular or broad and arched at the umbilical edge of the protruding chamber, bordered by a thickened and slightly upturned lip of clear shell material. Diameter exclusive of protruding chamber 0.30-0.37 mm; greatest dimension of test 0.42-0.58 mm." (TODD, *loc. cit.*).

Remarks:—The most characteristic and distinctive feature of *G. nepenthes* is its protruding thumb-like final chamber which extends from the penultimate chamber at an angle to the axis of coiling. Usually five chambers constitutes the last whorl, but the fifth protruding chamber is sometimes not developed as discussed later. The forms with four chambers in the last whorl, as well as those removed of the fifth chamber, show a tendency to become more strongly embracing and globular in shape. In such globular forms, the apertural lip is often indistinct except for the ones in wet condition (pl. 51, figs. 1a-c; pl. 51, figs. 2a-c). Considerable variations are observed in the mode of development of the fifth chamber as discussed below in detail. The aperture is umbilical, interiomarginal and varies in size considerably in accordance with the form of the last chamber. The chamber wall is usually rather coarsely cancellated except for fifth one. The earlier chambers show fairly high trochospiral arrangement in coiling. The sutures are indistinct in the earlier whorls and the chambers of the earlier ontogenetic stage are frequently obscure. In the later chambers, however, the sutures become to be indented, but show no traces of the chamber flange. The coiling of the tests is observed in the Donni to be nearly random in direction (slight preference to the left in 72 to 64 among 136 specimens) and no morphological difference due to the mode of coiling is noted. Having no supplementary apertures on the spiral side, this species is easily distinguished from the genus *Globigerinoides*. The maximum diameter measured in the present study ranges from 0.20 to 0.43 mm exclusive of the protruding chamber; maximum diameter of the test 0.22 to 0.56 mm.

BERMUDEZ (*loc. cit.*) transferred this species to the genus *Sphaeroidinellopsis*, laying stress on that; " Last chamber is much reduced, the wall is very thick and the aperture has a tendency to extend towards the dorsal side of the test. characters which are related more with the famous species of *Sphaeroidinellopsis grimsdalei* (KEIJZER) and has the chambers more enlarged towards the ventral side, which nearly completely cover the umbilicus" (freely translated).

According to the generic diagnosis of *Sphaeroidinellopsis* originally given by BANNER and BLOW (1959, p. 15), this genus has the wall structure similar to that of *Sphaeroidinella* and the primary aperture is furnished with a smooth or crenulate lip, though these features are variable. But in the present species, the writer could observe neither traces of the shiny shell surface due to the development of cortex, nor the crenulate lip. *Sphaeroidinellopsis grimsdalei* (KEIJZER) which was compared with the

present species by BERMUDEZ, has these generic characters. The crenulate lip of *S. grimsdalei* is traced ontogenetically as early as from the penultimate chamber, when the later chamber is precedingly dissected. The aperture of *G. nepenthes* is a simple one, bordered by a thickened, slightly upturned rim-like lip and arched at the umbilical edge of the protruding chamber. Therefore, the writer considered this species to be not a *Sphaeroidinellopsis*, but a *Globigerina* as defined originally by TODD.

In the same paper, BERMUDEZ proposed a new variety of the species, *Sphaeroidinellopsis nepenthes*(TODD) var. *constricta*, which was distinguished from the typical by having the test constantly smaller in size, usually with five chambers in the last whorl, the last and antepenultimate chambers much reduced in size, and more coarse perforations of the wall. The characters of the new variety, however, are common to many of the topotypes at hand and it seems to be evident that the new variety falls within the range of variation of the typical and the distinction between them is very difficult. Moreover, the erection of a new variety after the year 1958 has no taxonomic status even subspecifically according to the mimeographed Draft Code adopted in 1958 at the 15th International Zoological Congress in London (Art. 12, Sec. 3). Therefore, the new variety *constricta* is herein included in the typical as a synonym.

Morphology

Although only two figures of the holotype, side and umbilical view, were shown by TODD, considerable variations of *G. nepenthes* are found in the shape, wall ornamentation and mode of development of the peculiar fifth chamber. In the same population of the present species, however, the forms without development of the fifth chamber in the last whorl are frequently recognized. These forms and also those removed of the protruding fifth chamber show generally one embracing globular shape of the test (pl. 51, figs. 1a-c ; pl. 52, figs. 2a-c). This globular test is a common morphological character of *G. nepenthes* up to the stage before adding of the final protruding chamber. And it is characterized by having the uniformly cancellated test, one arched aperture which is nearly symmetrically placed above the two sutures between the three earlier chambers. These morphological features are traced as early as from the first whorl of the test and the rim-like lip of the aperture becomes more indistinct (pl. 52, fig. 3). Nevertheless, the four chambered forms as discussed above should not be considered as the immature stage, considering the size of the test, but seem to be related with some ecological conditions during life. In the Donni, they are rather rare in occurrence, but only the type without the fifth chamber is found in the Kiyosumi formation of the Boso Peninsula, Japan (lat. 35°11′45″N.), and it appears to be identical with the specimens from the type Tortonian locality.

The fifth chamber is very lobulate and protruded and extends from the penultimate towards the peripheral end of the preceding coils. A study on the variation of the typical *nepenthes*, the forms with its protruding fifth chamber, reveals two types in morphology. One general type comprises the forms bearing the same wall thickness and perforation throughout the stages of chamber development. The other is typified by the final chamber with very thin and finely perforated wall (pl. 51, figs. 4a-c ; pl. 52, fig. 1). In the latter case, the final

chamber has the same appearance as the bulla found in several planktonic species: namely, the chamber wall is composed of one layer of shell material (see pl. 51, fig. 8), resulting in the fragile, somewhat translucent appearance, and the chamber sometimes shows a transformed development as in the specimen of pl. 52, fig. 1. However, it differs from the typical bulla in not covering wholly the aperture of the penultimate chamber. In this point, it also may be compared with those found in *Globigerina angustiumbilicata* var. (TAKAYANAGI and SAITO, 1962), but the distinction is possible in that every last chamber of *G. nepenthes* is in full growth as large as the penultimate one in contrast to those of *G. angustiumbilicata* var. which is like as an appendage.

The writer once assumed that the difference of the wall characters in the final chamber might be caused by the dimorphic life-cycle of Foraminifera. Although some attempts were made to prove the statement with the thin-section of the test, no marked difference in the size of the proloculus was found among the two types as discussed above. However, recent investigations have proved that the size of the proloculus was not always the factor to discriminate gamont or agamont of Foraminifera and that occasionally there is even the reversed relations of each gamont or agamont to the absolute size of the proloculus (HALL, 1961, p. 257).

It also may be supposed that the forms with this bulla-like fragile fifth chamber represent the preparing stage of sporulation as discussed in some planktonic Foraminifera by HOFKER (1959). Much to be studied, but this is reserved for another opportunity.

Age and Distribution

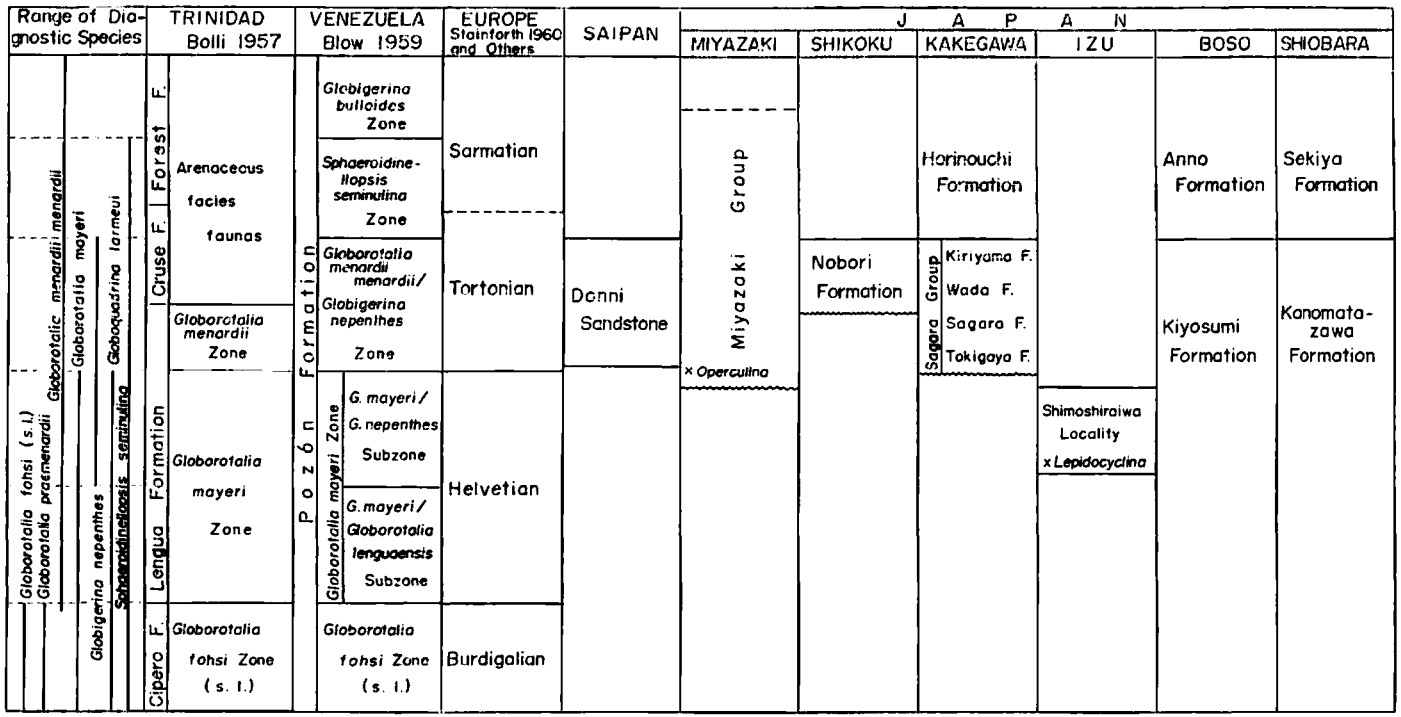
Since the publication of this taxon, the geographical distribution of *G. nepenthes* has been proved to be wide. In the following paragraphs, reviews and discussions are made on the geological age of the present species reported from the different regions and some new localities are added.

Trinidad

In Trinidad, BOLLI (1957) described the planktonic assemblages of the Cipero and Lengua formations, ranging in age from Oligocene to Miocene, and divided them into 13 planktonic foraminiferal zones. Two of them, namely the *Globorotalia mayeri* and *Globorotalia menardii* Zone in ascending order, are in the Lengua formation. *G. nepenthes* was recorded from the upper part of the *G. mayeri* Zone from where it extends to the *G. menardii* Zone. This stratigraphic range of the present species in Trinidad had been reported in the type description (TODD, *loc. cit.*). In a later paper, BOLLI (1959) regarded these two zones as ranging in age from the uppermost Burdigalian to the lower Helvetian.

Venezuela

In 1959, BLOW made a detailed study on the foraminiferal fauna on the upper Tocuyo and Pozón formations in the eastern Falcón region of Venezuela. In this study, two zones were newly established above the *G. menardii* Zone of BOLLI, and the *G. mayeri* and *G. menardii* Zones of BOLLI were emended laying stress on the restricted range of *G. nepenthes*; namely, the *Globorotalia mayeri* Zone was subdivided into the two Subzones, *G. mayeri/G. nepenthes* and *G. mayeri/Globorotalia lenguaensis*, and the *Globorotalia menardii* Zone was extended upwards stratigraphically as the *G. me-*



Text-figure 1. Zonal correlation of the *Globigerina nepenthes*-bearing formations (Zone name emended in part).

nardii menardii/G. nepenthes Zone. These relations are tabulated in text-fig. 1. According to the study of BLOW, the stratigraphic range of *G. nepenthes* was allocated in terms of planktonic foraminiferal zones. Although not definitely stated, he suggested that the Tortonian/Helvetian boundary might be placed between the *G. mayeri* Zone and *G. menardii menardii/G. nepenthes* Zone laying stress on the first appearance of *Globorotalia acostaensis* and the extinction of *Globorotalia mayeri* in the Tortonian.

Antillean region

In this region, BERMUDEZ (1961) reported new localities of the species. One is in Provincia Azua, Republica Dominicana and the other is off the coast of Cuba. The former is assigned to the Miocene age and the latter to the middle Miocene.

Europe

In regard to the correlation of planktonic foraminiferal zones with the classic European type stage, hitherto the opinions diverged because of the poor planktonic fauna from the type areas. However, these disagreements are gradually lessening with the accumulation of new evidences.

STAINFORTH (1960) reviewed and discussed the transatlantic Oligo-Miocene correlation by means of planktonic Foraminifera. According to him, the level of extinction of *Globorotalia mayeri* (= the boundary between *G. mayeri/G. nepenthes* Subzone and *G. menardii menardii/G. nepenthes* Zone) coincides well with the Helvetian/Tortonian boundary. And *Globorotalia menardii menardii* developed from *Globorotalia praemenardii* at about the top of the *Globorotalia fohsi* Zone (s. l.). However, none was verified by him at the top of the Tortonian stage. TAKAYANAGI and the present writer (1962), examined the type Tortonian fauna and gave some discussions on this problem. In their study, the following planktonic species were identified from the type Tortonian locality: *Globigerina apertura* CUSHMAN, *G. bulloides* D'ORBIGNY, *G. eamesi* BLOW, *G. nepenthes* TODD, *Globigerinoides bollii* BLOW, *Sphaeroidinellopsis seminulina* (SCHWAGER), *Orbulina universa* D'ORBIGNY, *Globorotalia scitula scitula* (BRADY) and *etc.* Also referring the study of DIECI (1959) on the Tortonian fauna in Italy, they assumed that the type Tortonian fauna might be correlated with the *G. menardii menardii/G. nepenthes* Zone. But they refrained from defining the top of the Tortonian in terms of planktonic foraminiferal zones because of inaccessibility of the materials.

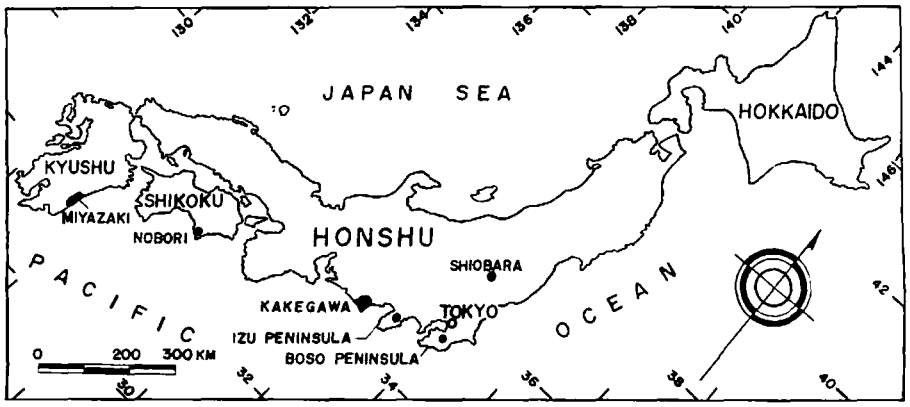
During investigations of Foraminifera, the writer had the opportunity to examine the Helvetian fauna collected from Tuilerie d'Aigues Vives (Hérault), France and found such species as: *Globorotalia mayeri* CUSHMAN and ELLISOR, *Globoquadrina larmeui* AKERS, *Globigerina concinna* REUSS and *etc.*, but not *G. nepenthes*. If stress is given to the coexistence of *G. mayeri* and *G. larmeui*, the Helvetian fauna of that region is older than the *G. menardii menardii/G. nepenthes* Zone. This result seems to coincide with STAINFORTH's (*loc. cit.*). From the foregoing paragraphs, the conclusions derived are as follows.

The Helvetian/Tortonian boundary is marked by the top of the *G. mayeri/G. nepenthes* Subzone.

Although it was not found from the Helvetian probably due to some ecological condition, *G. nepenthes* may be assumed to have its stratigraphic range contemporaneous with the upper Helvetian and Tortonian.

Japan

In the course of study on the planktonic Foraminifera of Japan, many new



Text-figure 2. Index map showing the distribution of *Globigerina nepenthes* in Japan.

localities of the present species were found by the writer and his colleagues. *G. nepenthes* bearing formations of Japan are tabulated in text-fig. 1, comparing its fauna with the planktonic foraminiferal zones. Only the diagnostic ones among the species associated with *G. nepenthes* are listed in each localities for the sake of age consideration.

Miyazaki District:—Planktonic fauna of the area was studied by NATORI of our Institute. *G. mayeri* was found only in the basal part of the Miyazaki group together with large *Operculina*. And in the lower half of the group, *G. nepenthes* is continuously found in association with the following species.

(Co-existence throughout the range of *G. nepenthes*)

Globorotalia menardii menardii (PARKER, JONES and BRADY)
Globoquadrina altispira altispira (CUSHMAN and JARVIS)
Globoquadrina venezuelana (HEDBERG)
Globigerinoides bollii BLOW
Pulleniatina obliquiloculata (PARKER and JONES)
Sphaeroidinellopsis seminulina (SCHWAGER)

(Only in the upper part of the range of *G. nepenthes*)

Globorotalia menardii miocenica PALMER
Globigerina apertura CUSHMAN
Globoquadrina dehiscens (CHAPMAN, PARR and COLLINS)

Shikoku:—Planktonic fauna from the Nobori formation of Shikoku had been described by TAKAYANAGI and the writer (1962). The Nobori fauna is closely correlated with the *G. menardii menardii*/*G. nepenthes* Zone.

Kakegawa District:—The Sagara group yielded the present species throughout in its sequence. One representative from nearly the top horizon of this group is shown in plate 52. The concomitant species are as follows.

Globorotalia menardii menardii (PARKER, JONES and BRADY)
Globorotalia menardii miocenica PALMER
Globorotalia menardii miotumida JENKINS
Globigerinoides bollii BLOW
Sphaeroidinellopsis seminulina (SCHWAGER)
Sphaeroidinellopsis kochi (CAUDRI)

Izu Peninsula:—Since the earlier part of this century, the *Lepidocyclina* bearing calcareous sandstone exposed at Shimoshiraiwa attracted the interest of many Japanese geologists. The larger Foraminifera from that locality was studied in detail by HANZAWA (1931). With regard to the stratigraphy, however, opinions diverge because of the narrow exposure

and the isolated distribution of the sedimentary rock series. The following planktonic Foraminifera were noted in association with abundant *Lepidocyclina* in the same rock sample.

Globorotalia lenguaensis BOLLI
Globorotalia mayeri CUSHMAN and ELLISOR
Globorotalia menardii menardii (PARKER, JONES and BRADY)
Globigerina glutinata EGGER
Globigerina nepenthes TODD
Globoquadrina dehiscens (CHAPMAN, PARR and COLLINS)
Globoquadrina larmeui AKERS
Globoquadrina venezuelana (HEDBERG)
Globigerinoides bollii BLOW

This assemblage is evidently that of the *G. mayeri/G. nepenthes* Subzone. And the fauna has close affinity with those from the Pozón formation of Venezuela.

Boso Peninsula:—Lower to middle part of the Kiyosumi formation; *G. nepenthes* is rarely found with some other planktonic species.

(Middle part of the formation)
Globorotalia menardii miocenica PALMER
Globigerina diplostoma REUSS
Globigerinoides bollii BLOW
(Lower part of the formation)
Globigerina angustiumbilicata BOLLI

The middle assemblage is correlative with the *G. menardii menardii/G. nepenthes* Zone. But the lower one only indicates that it may be placed in the range of *G. nepenthes*.

Shiobara District:—The Kanomatazawa formation in this district yielded a rich molluscan fauna and Foraminifera. From the upper part of that formation, the present species was recognized in association with:

Globorotalia lenguaensis BOLLI
Globorotalia menardii menardii (PARKER, JONES and BRADY)
Globigerina woodi JENKINS
Globoquadrina venezuelana (HEDBERG)
Globigerinoides bollii BLOW
Sphaeroidinellopsis seminulina (SCHWAGER)

This is the northernmost locality of *G. nepenthes* (lat. 36°57′N., long. 139°53′E.) hitherto known in Japan.

Saipan

A detailed and comprehensive study on the geology of Saipan, Mariana Islands was published in 1956 by CLOUD *et al.* In the paper, the Donni sandstone, from which *G. nepenthes* was originally described, was defined as a member of the Miocene Tagpochau limestone. They noted the following field relations of the Donni to the Tagpochau proper. "Although at any given place the Donni member may lie relatively above, below, or within the local Tagpochau succession, its general distribution pattern suggests that it properly occupies a position somewhere near the middle of the formation...Although the Donni member appears transitional to other beds at some places and wedges out into presumably equivalent strata at others, it also seems to abut generally contemporaneous or slightly older strata at other places (p. 69)." "...the Donni sandstone member was observed to wedge out into and beneath lower Tertiary *e Heterostegina borneensis* limestones (=Tagpochau limestone) (p. 70)."

However, if their observations of the field relations between the Donni and Tagpochau are accepted, great discrepancy results in the age assignment of the two, based upon the larger and smaller planktonic Foraminifera.

The Tagpochau larger foraminiferal fauna is considered to be the Tertiary *e* stage in the Indonesian letter time scale (=now considered as equivalent to the Aquitanian stage), from the yield of *Lepidocyclina* (*Eulepidina*), *Spiroclypeus*, *Miogypsinoides* and other. On the con-

trary, the writer found planktonic species from the Donni which may be correlated with the Tortonian age (=*G. menardii menardii/G. nepenthes* Zone): such as, *Hastigerina siphonifera* (D' ORBIGNY), *Globorotalia menardii menardii* (PARKER, JONES and BRADY), *G. tumida* (BRADY), *Globigerina nepenthes* TODD, *Globigerinoides bollii* BLOW, *G. conglobatus* (BRADY), *G. immaturus* LEROY, *G. sacculifer* (BRADY), *Globoquadrina altispira altispira* (CUSHMAN and JARVIS), *G. eximia* (TODD), *Orbulina universa* D' ORBIGNY, *Sphaeroidinellopsis seminulina* (SCHWAGER), *S. kochi* (CAUDRI), *S. subdehiscens* (BLOW), *Pulleniatina obliquiloculata* (PARKER and JONES), and *etc.*

A similar contradicting age determination based on these two types of Foraminifera was also recognized in the study of the Map fauna of Yap, Caroline Islands as a result of correlation with those of Saipan (COLE *et al.*, 1960). But no satisfactory explanation for their conflicting age determination had been given.

From the viewpoint of evolution of planktonic Foraminifera, as stated also by COLE *et al.* (*op. cit.*), local expansion of ranges of index species or changes of sequence of zones are unlikely. This trouble seems first to originate in that the same kind of Foraminifera, whether it is larger benthonic or smaller planktonic, could not be found through the two formations. The Tagpochau mainly consists of hard limestone and its microfauna must be studied with rock sections which is unsuitable for the study of smaller planktonic, on the other hand the Donni comprises soft tuffaceous marine sediments without larger Foraminifera, but from which the planktonic fauna may be easily extracted. And second it is also possible that the Donni sandstone may not be a member of the Tagpochau but a separate formation overlying it.

To settle the problem, an attempt was made in the present study, to extract the planktonic fauna from the Tagpochau. After treatment with Glauber's salt, the species listed below were fortunately available from the Tagpochau proper in association with several larger Foraminifera in the same sample. The larger Foraminifera as listed below were identified by S. HANZAWA.

Locality S 22 of HANZAWA (1957), ravine head of Kanat Tadung Mahetog, Saipan (IGPS coll. cat. no. 65873):

Spiroclypeus tidoenganensis VAN DER VLERK
Globorotalia cf. *kugleri* BOLLI
Globigerina angustiumbilicata BOLLI
Globigerina woodi JENKINS
Globigerinoides altiapertura BOLLI

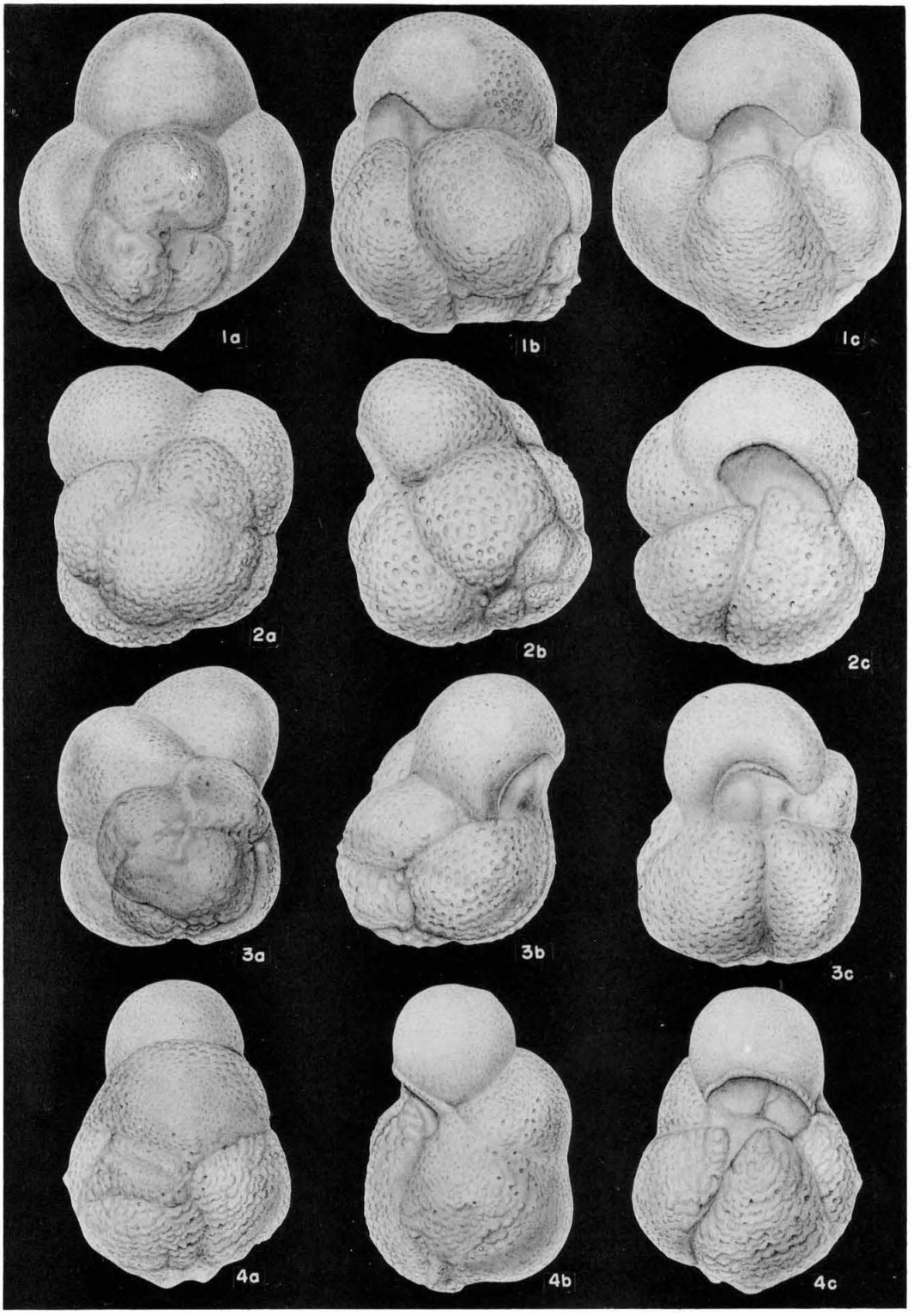
Locality: Laulau railway cut, Saipan (IGPS coll. cat. no. 65878):

Lepidocyclina (*Eulepidina*) *formosa* (SCHLUMBERGER)
Globigerina angustiumbilicata BOLLI
Globoquadrina rohri (BOLLI)

Explanation of Plate 51

All figures are ×117
(a, spiral; b, side; c, umbilical view)

Figs. 1–4. *Globigerina nepenthes* TODD.
1a–c, Topotype (IGPS 79020); 2a–c, Topotype (IGPS 79021); 3a–c, Topotype (IGPS 79022); 4a–c, Topotype (IGPS 79023) with thin-walled protruding fifth chamber.


1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c

Globoquadrina venezuelana (HEDBERG)

HANZAWA (1957) stated the age of the Tagpochau larger Foraminifera to be equivalent to the Aquitanian stage. The present planktonic fauna is characteristics of the *Catapsydrax dissimilis* Zone (BOLLI, 1957) and it is now considered as correlative with the Aquitanian stage. Accordingly it is evident that the planktonic fauna from the Donni is not synchronous to that from the Tagpochau and the geologic succession established in Saipan by CLOUD *et al.* (*op. cit.*) should be revised in part. Therefore, the foraminiferous rocks of Saipan may be rearranged stratigraphically by the planktonic Foraminifera as shown in table 1.

Table 1. Inferred Geologic Succession of Saipan.

TORTONIAN	*Globorotalia menardii menardii*/ *Globigerina nepenthes* Zone	Donni Sandstone
AQUITANIAN	*Globigerinatella insueta*/ *Globigerinoides bisphericus* Subzone	Fina-sisu Formation
	Catapsydrax dissimilis Zone	Tagpochau Limestone

Accordingly the field relations of the Donni and the Tagpochau (CLOUD *et al.*, *loc. cit.*), may a low angle thrust as supposed by HANZAWA (oral communication). Thus the geological age of the *G. nepenthes* assemblage from the Donni may be in harmony with that of many other regions outside Saipan.

References

BANNER, F. T. and BLOW, W. H., (1959) : The classification and stratigraphical distribution of the Globigerinaceae, Part 1. *Palaeontology*, *2* (*1*), pp. 1-27, pls. 1-3, text-figs. 1-5.

BERMUDEZ, P. J., (1961) : Contribucion al estudio de las Globigerinidea de la region Caribe-Antillana (Paleoceno-Reciente). *Mem. III Congreso Geol. Venez., tomo 3, Bol. Geol., Publ. especial 3* (1960), pp. 1119-1393, pls. 1-20.

BLOW, W. H., (1959) : Age, correlation and biostratigraphy of the upper Tocuyo (San Lorenzo) and Pozón formations, eastern Falcón, Venezuela. *Bull. Amer. Paleont.*, *39* (*178*), pp. 69-252, pls. 6-19, text-figs. 1-5, maps 1-4, charts 1-4.

BOLLI, H., (1957) : Planktonic Foraminifera from the Oligocene-Miocene Cipero and Lengua formations, Trinidad, B. W. I. *U. S. Nat. Mus. Bull.*, (*215*), pp. 97-124, pls. 22-29, text-figs. 17-21.

—— (1959) : Planktonic Foraminifera as Index fossils in Trinidad, West Indies and their value for worldwide stratigraphic correlation. *Eclogae geol. Helv.*, *52* (*2*), pp. 627-637, 1 table.

CLOUD, P. E. Jr., SCHMIDT, R. G. and BURKE, H. W., (1956) : Geology of Saipan, Mariana Islands ; Pt. 1. General Geology. *U. S. Geol. Surv., Prof. Paper, 280-A*, pp. i-vii, 1-126, pls. 1-25, text-figs. 1-10, tables 1-11.

COLE, W. S., TODD, R. and JOHNSON, C. G., (1960) : Conflicting age determinations suggested by Foraminifera on Yap, Caroline Islands. *Bull. Amer. Paleont.*, *41* (*186*), pp. 77-112, pls. 11-13, text-fig. 1, tables 1-3.

DIECI, G., (1959) : I foraminiferi Tortoniani di Montegibbio e Castelvetro. *Palaeontographia Italica*, *54* (*n. ser. 24*), *Anno 1959*, pp. 1-113, pls. 1-8, text-figs. 1, 2.

HALL, R. P., (1961) : Protozoology. *Modern Asia Ed.*, *vi+682* pp., 264 text-figs., 2 tables, Prentice-Hall, Inc., Englewood Cliffs, N. J.

HANZAWA, S., (1931) : On some Miocene rocks with *Lepidocyclina* from the Izu and Boso Peninsulas. *Tohoku Imp. Univ., Sci. Rep., 2nd Ser. (Geol.)*, *12* (*2a*), pp. 159-170, pls.

27, 28, text-fig. 1.

—— (1957) : Cenozoic Foraminifera of Micronesia. *Geol. Soc. America, Mem.*, (*66*), pp. 1-163, pls. 1-41, 5 tables, 3 maps.

HOFKER, J., (1959) : On the splitting of *Globigerina*. *Cushman Found. Foram. Res., Contr.*, *10*(*1*), pp. 1-9, text-figs. 1-25.

STAINFORTH, R. M., (1960) : Current status of transatlantic Oligo-Miocene correlation by means of planktonic Foraminifera. *Revue de Micropaléontologie*, *2*(*4*), pp. 219-230, 1 text-fig.

TAKAYANAGI, Y. and SAITO, T., (1962) : Planktonic Foraminifera from the Nobori formation, Shikoku, Japan. *Tohoku Univ., Sci. Rep., 2nd Ser. (Geol.), Spec. Vol.*, (*5*), pp. 67-106, pls. 24-28, text-figs. 1-2, table 1.

TODD, R., (1957) : Geology of Saipan, Mariana Islands : Smaller Foraminifera. *U. S. Geol. Surv., Prof. Paper*, *280-H*, pp. i-iii, 265-320, pls. 64-93, tables 1-4.

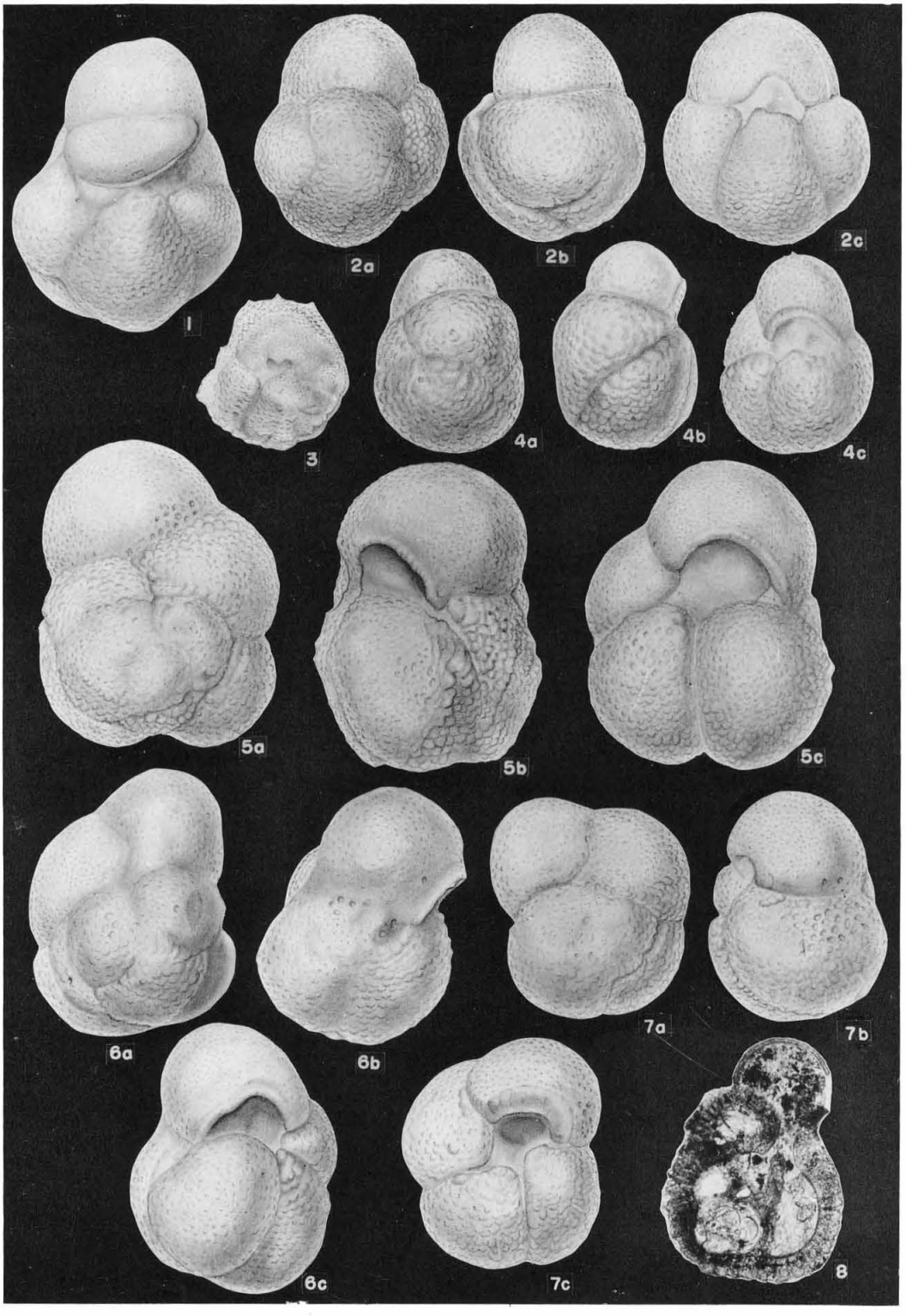
Explanation of Plate 52

Figure 8, ×114; all others ×117

(a, spiral; b, side; c, umbilical view)

Figs. 1-8. *Globigerina nepenthes* TODD.

1, Topotype (IGPS 79024) with thin-walled protruding fifth chamber showing transformed chamber development; 2a-c, Dissected topotype (IGPS 79025), showing the globular test removed of the protruding fifth chamber; 3, Dissected topotype (IGPS 79026), showing the earlier ontogenetic stage of chamber development with an arched aperture and coarsely perforated wall; 4a-c, Small topotype (IGPS 79027) with embracing chamber arrangement; 5a-c, Hypotype (IGPS 79028) from Shimoshiraiwa, Izu Peninsula, Japan; 6a-c, Hypotype (IGPS 79029) from the Sagara Group, Shizuoka Pref., Japan; 7a-c, Hypotype (IGPS 79030) from the type Tortonian locality, Italy; 8, Section (IGPS 79031) of *G. nepenthes* (Topotype), showing the very thin wall of the fifth chamber in contrast to the earlier ones.


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

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 48, pp. 343-351, pl. 53, Nov. 30, 1962.

441. SOME LOWER CRETACEOUS PELECYPODS FROM THE AKAIWA SUBGROUP, THE UPPER DIVISION OF THE TETORI GROUP IN CENTRAL JAPAN*

SHIRO MAEDA

Geological Institute, Chiba University

赤岩亜層群産下部白亜紀二枚貝類：赤岩亜層群の北谷互層産非海棲動物群は，小林・鈴木両博士 (1937) により詳報された手取非海棲動物群とは構成種を全く異にし，一方，洛東・脇野動物群に酷似する。従って北谷互層は古生物学的に下部白亜紀と確証される。この度，*Plicatounio* の 2 新種と *Nakamuranaia* とを記載し，併せ，*Plicatounio* の系統発生上の若干の考察を加えた。 前 田 四 郎

The Akaiwa subgroup, i.e. the upper division of the Tetori group, is extensively distributed in the Kitadani district in the westernmost part of the Hakusan region. There the subgroup well exposed along the Takinami river, a tributary of the Kuzuryu river, has been studied stratigraphically by Y. OTSUKI and N. KIYONO (1933), S. FUKUI (1947) and others, and the occurrence of several land plants was reported by S. OISHI (1933). However, our knowledge concerning the subgroup in this district was, as a whole, very few, if compared with that of other districts where the Tetori group was developed. Since 1952 the writer has repeated field surveys with assistance of some students of his university. As a result, some non-marine molluscan fossils were newly found

Andesites
Quartz-porphyry
Omichidani alternation (about 45 m thick)
Kitadani alternation (about 300 m thick) } Akaiwa subgroup } Tetori group
Akaiwa sandstone (about 400 m thick) }
fault
Hida gneiss

in the valley of the Nakanomata river, a tributary of the Takinami river, as follows:

Trigonioides (?) sp.
Plicatounio kobayashii MAEDA, new species
Plicatounio tetoriensis MAEDA, new species
Nakamuranaia chingshanensis (GRABAU)

* Received Dec. 20, 1961; read at 80th Meeting of the Palaeontological Society on November 18, 1961 at Fukuoka.

"*Schistodesmus*" sp.
Viviparus sp.

Their localities are as follows:

1) The left bank of the Nakanomata river in the north of Sugiyama.

2) The right bank of the Nakanomata river in the east of Sugiyama.

3) The left bank of the Nakanomata river in the east of Sugiyama.

The stratigraphical sequence of this district is shown below:

The Akaiwa sandstone consists of coarse-grained arkose sandstone with occasional intercalations of conglomerate, and is non-fossiliferous. It is a remarkable fact that *Xenoxylon latiporosum* (CRAMER) was found from its upper horizon. The Kitadani alternation, whose type locality is in this district, is composed of fine to medium-grained sandstone alternated with black micaceous shale and tuffaceous rock and has a few coal seams. The Omichidani alternation consists of laminated black shale, thin-bedded light greyish coarse-grained sandstone, beside intercalations of reddish tuffaceous rock, and contains the characteristic dicotyledonous leaves and other plants.

The non-marine molluscan fossils were collected from the middle horizon of the Kitadani alternation, and *Cladophlebis exiliformis*, *Onychiopsis elongata*, *Podozamites Reinii*, *P. lanceolatus* and other plants from the same horizon. These non-marine faunal assemblages differ entirely from the so-called Tetori faunal one which was described by T. KOBAYASHI and K. SUZUKI in 1937. The faunas are, however, closely related to that of the Eo-Cretaceous Naktong-Wakino series which is extensive in South Korea and North Kyushu.

Judging from the above reason, the Kitadani alternation, which lies below the Upper Cretaceous Omichidani alternation is considered to be Eo-Cretaceous instead of Upper Jurassic as formerly considered. Palaeogeographically, the Eo-Cretaceous non-marine deposit in the Hida massif including the Kitadani district, in the inner side of the Eo-Nippon Cordillela (KOBAYASHI, 1941), occupies the easternmost part among the Cretaceous non-marine sediments in eastern Asia.

Among the species distinguished, *Plicatounio* and *Nakamuranaia* are common elements of the fauna, while *Trigonioides* (?) and *Viviparus* are uncommon.

These fossils were collected from thin layers which were cemented by tuffaceous material. While adult bivalves are isolated, most immature shells are intact valves. From the mode of occurrence and state of preservation of molluscan fossils, it is presumed that they have been scarcely transported from their habitats. Peculiar surface sculptures of *Plicatounio* and *Trigonioides* (?) suggest an unusual environment.

The writer expresses his sincere thanks to Prof. T. KOBAYASHI of the University of Tokyo. He is also indebted to Mr. Y. HORI, the Fukui Natural History Museum, Messrs S. ISHII, M. SANO, N. KAWAGISHI, S. SAITO and many other persons for their kindness in the collection of the specimens. A part of the expense for this study was defrayed by the grant given to the writer from the Ministry of Education.

Historical review

A) *Plicatounio*

1) KOBAYASHI and SUZUKI (1936) proposed the genus *Plicatounio*, in describing *P. naktongensis* and *P. triangularis* from the Lower Cretaceous Naktong-Wakino series of South Korea and North Kyushu. From the hinge character it

was referred to the Unioninae.

2) HOFFET (1937) described two new species of *P. suzuki* and *P. maxima* from the Senonian formation in Muong Phalane of Laos.

3) YABE and HAYASI (1938) reported one new subspecies, *P. naktongensis manchuricus* based on some internal moulds from Manchuria.

4) SUZUKI (1943) described one new subspecies of *P. naktongensis multiplicatus* from the Naktong series in South Korea and pointed out that *P. naktongensis manchuricus* is almost identical with *P. naktongensis* s. str.

5) KOBAYASHI (1956) pointed out that COX's *Trigonioides kodairai* is diagnostic of *Plicatounio naktongensis*, and *P. triangularis* must be excluded from *Plicatounio*, s. str.

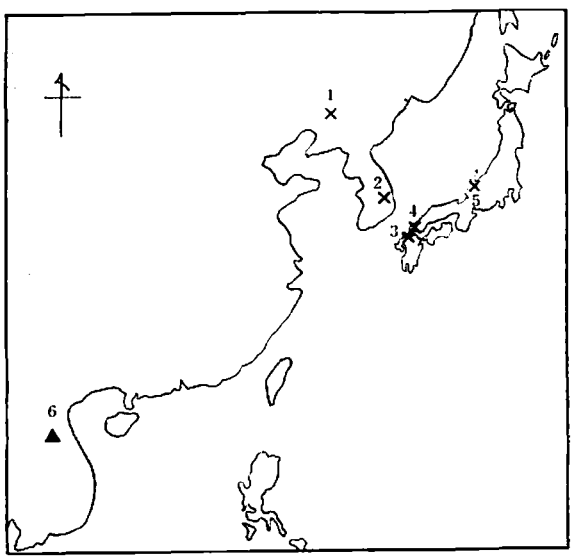
6) OTA (1959a) noted the distinction among *Plicatounio*, "*Nippononaia*" and *Trigonioides*. In another paper he described *P. kwanmonensis* new species from the Wakino subgroup of North Kyushu and concluded that *P. naktongensis multiplicatus* was introduced from *P. naktongensis* s. str.

7) HASE (1960) reported *P.* aff. *naktongensis naktongensis* from the upper part of the Wakino subgroup.

B) *Nakamuranaia*

1) SUZUKI (1943) erected the genus *Nakamuranaia*, based on *Leptesthes chingshanensis* GRABAU, 1923 and synonymyized "*Unio*" cf. *menkei*, *Cristaria*? sp. aff. "*Leptesthes*" *chingshanensis* and *Corbicula* (*Leptesthes*?) *coreanica* with *N. chingshanensis*.

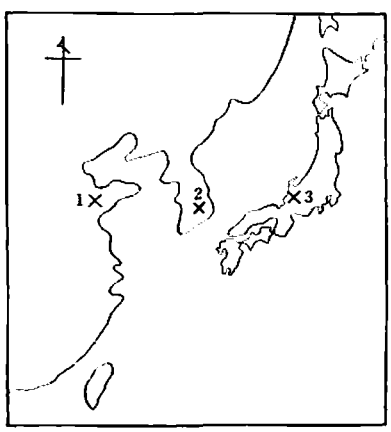
2) OTA (1960) reported that *N.* (?) sp. cf. *N. chingshanensis* is rare in the lower part but abundant in the upper part of the Wakino subgroup.



Text-figure 1. Distribution of *Plicatounio*.

Triangle and Cross: Localities of *Plicatounio* in the Upper and Lower Cretaceous respectively.

1. South Manchuria
2. Keishu, South Korea
3. Fukuoka, North Kyushu
4. Yamaguchi, West Chugoku
5. Tetori basin, Central Japan
6. Muong Phalane, Lower Laos



Text-figure 2. Distribution of *Nakamuranaia chingshanensis*.

1. Chingshan series, Shantung Province, North China.
2. Naktong series, South Korea.
3. Tetori group, Central Japan.

Distribution of *Plicatounio* and *Nakamuranaia*

A) *Plicatounio*

Now nine forms of *Plicatounio* including two new species are known as follows:

1) *Plicatounio naktongensis* KOBAYASHI and SUZUKI 1936, from the Lower Cretaceous Naktong-Wakino series in South Korea and North Kyushu.

2) *Plicatounio triangularis* KOBAYASHI and SUZUKI 1936, from the Lower Cretaceous Wakino series in North Kyushu.

3) *Plicatounio suzuki* HOFFET 1937, from the Upper Cretaceous in Laos.

4) *Plicatounio maxima* HOFFET 1937, from the Upper Cretaceous in Laos.

5) *Plicatounio naktongensis manchuricus* YABE and HAYASI 1938, from the Lower Cretaceous in South Manchuria.

6) *Plicatounio naktongensis multiplicatus* SUZUKI 1943, from the Lower Cretaceous Naktong series in South Korea.

7) "*Plicatounio*" *kwanmonensis* OTA 1959, from the Lower Cretaceous Wakino series in North Kyushu.

8) *Plicatounio kobayashii* MAEDA, new species, from the Lower Cretaceous Akaiwa subgroup in Central Japan.

9) *Plicatounio tetoriensis* MAEDA new species, from the Lower Cretaceous Akaiwa subgroup in Central Japan.

These forms occur from the lacustrine deposits. In the Wakino series, for example, the three species of *Plicatounio* are associated with *Brotiopsis wakinoensis*, *B. kobayashii*, *Melanoides* (*Yoshimonia*) *katsukiensis*, *Trigonioides paucisulcatus*, *Sphaerium anderssoni* s. str. and other non-marine fossils (KOBAYASHI and SUZUKI; 1936, OTA; 1960, HASE; 1960). It is interesting that most species appeared in Lower Cretaceous age, except the two Laotian species.

B) *Nakamuranaia*

As shown in Text-figure 2, the fossil beds at the three localities including Central Japan are all Lower Cretaceous in age. Therefore *N. chingshanensis* is an index fossil to the non-marine Lower Cretaceous.

On the Grouping of *Plicatounio*

Plicatounio has been grouped based on shell outline and surface ornament as follows:

1. Subelliptical outline and indistinct radial ribs in front ..... *P. naktongensis* s. str. and *P. naktongensis manchuricus*.
2. Subelliptical outline and distinct radial ribs all over the surface ..... *P. naktongensis multiplicatus*, *P. maxima*.
3. Subelliptical outline and strong radial ribs all over the surface ..... *P. suzuki*.
4. Subtrigonal outline and radial ribs all over the surface ..... *P. triangularis*.
5. Subquadrate outline and sculpture similar to *P. naktongensis* ..... "*P.*" *kwanmonensis*.

Among them *P. naktongensis multiplicatus* is identical with *P. naktongensis* s. str. in outline, but the former differs from the latter in radial ornament. Laotian *P. maxima* is quite different from *P. naktongensis* s. str. and *P. naktongensis multiplicatus* in shell-outline and radial ornament. *Plicatounio* comprises subelliptical and non-subelliptical forms. It is remarkable among subelliptical ones that radial ribs become more numerous and somewhat stronger in a way or finer in another. The Laotian species may have been introduced from the Tetori species-like form.

Systematic description

Family Unionidae

Subfamily Unioninae

Genus *Plicatounio* KOBAYASHI et SUZUKI, 1936

1936. *Plicatounio* KOBAYASHI et SUZUKI, *Japan. Jour. Geol. Geogr., Vol. 13, Nos. 3-4*, p. 250.
1937. *Plicatounio*, HOFFET, *Bull. Serv. Geol. l'Indochine, Vol. 24, No. 1*, p. 15.
1938. *Plicatounio*, YABE et HAYASI, *Japan. Jour. Geol. Geogr., Vol. 15, Nos. 1-2*, p. 31.
1943. *Plicatounio*, SUZUKI, *Jour. Shigenkagaku Kenkyusyo, Vol. 1, No. 2*, p. 210.
1959. *Plicatounio*, OTA, *Trans. Proc. Pal. Soc. Japan, N.S., No. 33*, p. 15.
1960. *Plicatounio*, HASE, *Jour. Sci., Hiroshima Univ., Ser. C, Vol. 3, No. 2*, p. 313.

Diagnosis:—Shell medium in size, subelliptical to subtrigonal or subquadrate, inequilateral, relatively short and rounded in front, prolonged behind, subtruncated or rounded at the posterior end, broadly arcuated on ventral side, moderately inflated; test rather thin. Beak large and located anteriorly, prominent, not high, and prosogyrous. Posterior ridge blunt. Surface ornamented with many radial ribs and concentric fine growth lines. Hinge well developed with smooth or finely crenulated teeth; pseudocardinals 2 on each valve; lateral teeth somewhat longer than the pseudocardinal one, 1 on the right valve, 2 on the left. Pallial line simple. Inner side crenulated on the ventral margin and radially grooved in the posterior part.

Remarks:—Most important characteristics of this genus are in shell-outline, surface ornamentation and hinge structure. The surface is ornamented with plications or many radial ribs. Posterior plications are usually strong, while anterior radial ribs are fairly variable among species. They are indistinct or fine or more or less strong. Though the shell-outline is very variable, the general forms are subelliptical. It is remarkable that *P. triangularis* is subtrigonal and "*P.*" *kwanmonensis* is subquadrate. KOBAYASHI (1956) has pointed out that the former "must be excluded from *Plicatounio* s. str. because of its triangularly ovate high outline and its median umbo." The two forms are indeed exceptional for the genus.

Plicatounio kobayashii MAEDA, new species

Plate 53, Figures 1-4

Description:—Shell medium, elliptical in outline, inequilateral, relatively short and well rounded in front, prolonged behind, and fairly well rounded at the end. Postero-dorsal margin fairly long, nearly straight, parallel to ventral, merging into the posterior without making any angle; posterior margin well rounded and bent forward into the ventral, forming an obtuse angle; ventral margin fairly long, very broadly arched, often straightened in the middle part; anterior margin well rounded; antero-dorsal margin relatively short, sloping and slightly arched. Umbo scarcely prominent, not high, more or less incurved, prosogyrous, placed at about one-fourth the shell-length from the anterior extremity. Surface ornamented with numerous radial ribs and growth lines; radial ribs fine, closely set and counted about 17 in anterior half, but counted widely spaced strong 4 or 5 in posterior half; growth lines very fine, folded and elevated at irregular intervals. Hinge well developed; lateral teeth 1 on right valve, 2 on left, much longer than

pseudocardinal, left ones distinctly crenulated, right one scarcely crenulated in upper side but obliquely, finely striated in lower side. Adductor scars well impressed. Pallial line simple, faintly impressed. Inner side of the shell markedly crenulated on ventral margin and especially radially grooved in posterior half.

Measurement:—Four specimens scarcely deformed are measured in mm as listed below.

Rg. Number	Valve	Length	Height	Width
R. 61102701	Right, Left	64	32	15
R. 61102702	Left (Holotype)	57	25	5
R. 61102703	Right, Left	56	25	10
R. 61102704	Left	52+	25	5

Comparison:—The radial ribs of this species closely resemble those of *Plicatounio naktongensis* especially figured by OTA from the Wakino subgroup in North Kyushu (1959, p. 18, pl. 3, figs. 4-8), but the former differs from the latter by anteriorly situated and rather small umbo and transversely elongated elliptical outline which narrows more or less forward. Though *P. naktongensis multiplicatus* by SUZUKI in 1943 from the Naktong series shows some resemblances to this new species in general aspects, the two species differ in outline and radial ribs especially in anterior portion. This new species is also related to *P. suzuki* HOFFET (fig. 1 on pl. 4, 1937), but the former is easily distinguishable from the latter by the position of the umbo, nearly straight ventral margin and the sculpture.

Occurrence:—The Kitadani alternation of the Akaiwa subgroup; right bank of the Nakanomata river, north of Sugiyama and the left bank of the same river, north of Sugiyama, Kitadani village, Fukui Pref.

Plicatounio tetoriensis MAEDA, new species

Plate 53, Figures 5-7

Description:—Shell medium in size, transversely elongated elliptical in outline, inequilateral, short and rounded in front, strongly produced behind. Postero-dorsal margin very long, nearly straight, parallel to ventral; posterior well rounded; ventral long, straight or broadly arched and gradually going over into the well rounded anterior; antero-dorsal margin short, sloping and weakly rounded. Umbo not high, placed at about one-fourth of the shell-length from anterior extremity. Surface ornamented with radial ribs and concentric weak lines of growth; strongly and widely spaced 4 plications slope from umbo to postero-ventral and ventral margins, but numerous fine and weak ribs run from umbo to ventral and anterior. Internally the shell markedly crenulated on ventral margin and impressed by big striae running obliquely on the posterior portion corresponding to the external ribs. Adductor scars situated close to the extremities of the laterals faintly impressed. Pallial line simple.

Measurement:—Six specimens somewhat damaged measure in mm as follows.

Rg. Number	Valve	Length	Height	Width
R. 61102501	Left (Holotpye)	88	34	11
R. 61102502	Right	64	21	9
R. 61102503	Right	55	21	4
R. 61102504	Right	42+	19	4
R. 61102505	Right, Left	32+	19	8
R. 61102506	Left	48	18	4

Comparison:—This species is closely allied to *P. kobayashii*, in general aspect, but the former is more elongated. It is also related to *P. naktongensis* (KOBAYASHI and SUZUKI, 1956; OTA, 1960) from the Lower Cretaceous deposits of South Korea and North Kyushu of Japan, but differs in the situation of umbo and height of shell. YABE and HAYASI's form (1938, pp. 31-33, pl. 4) resembles the present species with regard to the general aspect of shell, while the latter is distinguished from the former by having an anteriorly situated umbo and different shell-outline.

Occurrence:—The Kitadani alternation, the Akaiwa subgroup, the upper division of the Tetori group. The right bank of the Nakanomata river, north of Sugiyama and a point on the left bank of the same river, north of Sugiyama, Kitadani village, Fukui Pref.

Nakamuranaia chingshanensis (GRABAU), 1923

Plate 53, Figures 8-14

Lepteslhes chingshanensis GRABAU, 1923, *Bull. Geol. Surv. China, No. 5*, p. 147, pl. 2, text-fig. 1.

"*Unio*" cf. *menkei* KOBAYASHI and SUZUKI, 1936, *Japan. Jour. Geol. Geogr., Vol. 13, Nos. 3-4*, p. 252, pl. 27, figs. 5, 6.

Cristaria? sp. aff. "*Leptesthes*" *chingshanensis*, KOBAYASHI and SUZUKI, 1936, *Ibid., Vol. 13, Nos. 3-4*, p. 254, pl. 29, figs. 11-12.

Corbicula (*Leptesthes*?) *coreanica* KOBAYASHI and SUZUKI, 1936, *Ibid., Vol. 13, Nos. 3-4*, p. 255, pl. 29, figs. 1-10.

"*Unio*" sp., gen. and sp. indet., KOBAYASHI and SUZUKI, 1936, *Ibid., Vol. 13, Nos. 3-4*, p. 255, pl. 28, figs. 9a, b.

Nakamuranaia chingshanensis, SUZUKI, 1943, *Jour. Shigenkagaku Kenkyusyo, Vol. 1, No. 2*, p. 213, pl. 19, figs. 1-6.

Description:—Shell medium in size, subtrapezoidal in outline, about 1.5 times as long as high, inequilateral, well rounded in front, subtruncated behind, well inflated; test rather thick. Postero-dorsal margin short, rounded, obtusely angulated with posterior; posterior margin more or less long, distinctly truncated, obtusely angulated near base-line; ventral margin long, broadly arched; anterior well rounded; antero-dorsal somewhat long, oblique and weakly arched. Beak large, fairly prominent, high, incurved and distinctly prosogyral placed at a point about 2/5 to 1/2 of the shell-length from the anterior end. Posterior ridge extending from umbo towards the postero-ventral angle, fairly distinct near umbo and then gradually flattened; posterior area triangular and somewhat concave. Surface ornamented with numerous fine concentric growth lines. Hinge well developed. Pseudocardinal teeth 2 on each valve, short, high and smooth; lower one of right valve stronger than the upper; lateral teeth 2 on the right valve and 1 on the left, long, lamellar, smooth; lower one of

right fairly stronger than the upper. Anterior adductor scars subovate, distinctly impressed; posterior ones indistinct. Pallial line simple. Inner side smooth.

Measurement:—Nine specimens scarcely deformed were measured in mm as listed below.

Rg. Number	Valve	Length	Height	Width
R. 61102601	Left	52+	42	15
R. 61102602	Right	58	37	13
R. 61102603	Right	50	35	12
R. 61102604	Left	47	31	12
R. 61102605	Left	45	28	11
R. 61102606	Left	43	28	10
R. 61102607	Right	37	24	10
R. 61102608	Right	30	23	9
R. 61102609	Right	34+	26	10

Remarks:—The specimens most abundant in the collection have often been deformed by rock pressure. Therefore, the specimens vary in shell-outline. Namely, some are longer than high, while others are nearly as long as high. In some specimens a groove is secondarily impressed upon the shell.

Judging from the subtrapezoidal outline, well rounded front, truncated behind, median umbo, smooth surface, teeth number and simple pallial line, this is identified with the form reported by SUZUKI (pp. 213-216, pl. 19, 1943). However, it is noteworthy that the juvenile form of the species closely resembles those of *Unio*-like species from the Kuwajima and Okurodani alternations in the Itoshiro subgroup, the middle division of the Tetori group.

Keferences

GRABAU, A. W. (1923): Cretaceous Fossils from Shantung. *Bull. Geol. Surv. China, No. 5.*

HASE, A. (1960): The Late Mesozoic Formations and their Molluscan Fossils in West Chugoku and North Kyushu, Japan. *Jour. Sci., Hiroshima Univ., Ser. C, Vol. 3, No. 2.*

HOFFET, J. H. (1937a): Sur le Genre *Trigonioides*, Mutation génétique stable du Genre *Trigonia*. *C. R. des séances de l'Acad. des Sci., Paris, 1937.*

—— (1937b): Les Lamellibranchis saumâtres du Sénonien de Muong Phalane (Bas Laos). *Bull. Serv. géol. l'Indochine, Vol. 24.*

KOBAYASHI, T. (1956): On the Dentition of *Trigonioides* and its Relation to similar Pelecypod Genera. *Japan. Jour. Geol. Geogr., Vol. 27, No. 1.*

—— and SUZUKI, K. (1936): Nonmarine Shells of the Naktong-Wakino Series. *Ibid., Vol. 18.*

MAEDA, S. (1955): Biofacies of the Tetori Group. *Jour. Coll. Arts Sci., Chiba Univ., Vol. 1, No. 4.*

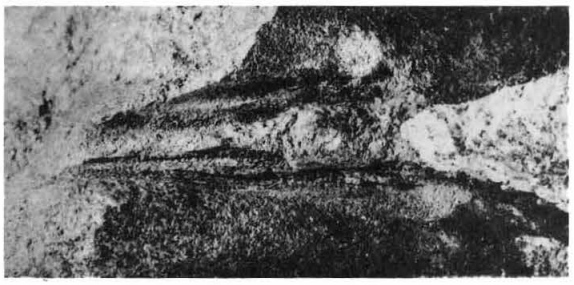
—— (1958): Stratigraphy and Geological Structure of the Tetori Group in the Hakusan District (Part 1. Stratigraphy). *Jour. Geol. Soc. Japan, Vol. 64, No. 758.*

OTA, Y. (1959a): *Plicatounio* of the Wakino Formation. *Trans. Proc. Pal. Soc. Japan, N. S., No. 33.*

—— (1959b): On the "*Nippononaia*" from the Lower Cretaceous Wakino Subgroup, North Kyushu, Japan. *Ibid., No. 34.*

—— (1960): The Zonal Distribution of the Non-marine Fauna in the Upper Mesozoic Wakino Subgroup. *Mem. Fac. Sci., Kyu-*


1


3


2


4


5


6


7


8


9


10


11


13


12


14

shu Univ., Ser. D, Geol., Vol. 9, No. 3.

SUZUKI, K. (1940): Non-Marine Molluscan Faunule of the Siragi Series in South Tyosen. *Japan. Jour. Geol. Geogr., Vol. 17.*

—— (1941): A new Naiad, *Unio* (*Nippononaia*) *ryosekiana*, n. subgen. and n. sp., from the Lower Cretaceous of Japan. *Jour. Geol. Soc. Japan, Vol. 48.*

—— (1943): Restudy on the Non-marine Molluscan fauna of the Rakuto Series in Keisyo-do, Tyosen. *Jour. Shigenkagaku Kenkyusyo, Vol. 1, No. 2.*

—— (1949): Development of the Fossil Non-marine Molluscan Faunas in eastern Asia. *Japan. Jour. Geol. Geogr., Vol. 21.*

YABE, H. and HAYASI, Z. (1938): A Mesozoic Unionid from Manchuria. *Ibid., Vol. 15.*

A Special Issue of the first All-China Conference of Stratigraphy. Report on the Mesozoic Stratigraphy of China. *Pizki Lunping* (*Geological Review*), *Vol. 19, No. 12.*

Explanation of Plate 53

All natural size except Fig. 3 (×1.6)

Plicatounio kobayashii MAEDE, new species ..... page 347

Fig. 1. Left valve, holotype (R. 61102702)
Fig. 2. Left valve, paratype (R. 61102704)
Fig. 3. Character of lateral teeth of a paratype (R. 61102701)
Fig. 4. Right valve, paratype (R. 61102701)

Plicatounio tetoriensis MAEDA, new species ..... page 348

Fig. 5. External clay cast of left valve, holotype (R. 61102501)
Fig. 6. Internal mould of right valve, paratype (R. 61102502)
Fig. 7. Left valve, paratype (R. 61102506)

Nakamuranaia chingshanensis (GRABAU) ..... page 349

Fig. 8. Right valve (R. 61102602)
Fig. 9. Internal mould of right valve (R. 61102607)
Fig. 10. Right valve (R. 61102603)
Fig. 11. Left valve (R. 61102601)
Fig. 12. Lateral view of the specimen shown in Fig. 11.
Fig. 13. Left valve (R. 61102604)
Fig. 14. Umbonal view of the specimen shown in Fig. 13.

All of the illustrated specimens are kept in the Institute of Geology, College of Arts and Sciences, Chiba University, Chiba. Loc: the Kitadani alternation in the Akaiwa subgroup, the upper division of the Tetori group, developed in Kitadani-mura (北谷村), Ono-gun (大野郡), Fukui Prefecture (福井県).

PROCEEDINGS ON THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第 82 回例会は 1962 年 9 月 29, 20 日東京教育大学理学部地質学鉱物学教室において開催された。(参会者 46 名)

個　人　講　演

Some Permian Plants from Thailand..... .....Seido ENDO

On the genus *Platanus* from Hokkaido, Japan .....Seido ENDO

Some Tertiary Plants from North Thailand .....Seido ENDO

Upper Carboniferous fusulinids from the Nakahata formation of the Hida Massif —with special reference to fusulinids similar to *Fusulinella pseudobocki* (LEE and CHEN) (代読) ....Kunihiro ISHIZAKI

Finding of *Miogypsina* from the Kadonosawa formation and its associated fauna. Northeast Japan .... Hiroshi UJIIE and Shigeru AOKI

北陸第四系の浮遊性有孔虫化石群 .....高山俊昭

Eine neue Art der Gattung *Huangia* aus dem Unterperm von Shima (代読) .... Nobuo YAMAGIWA

Silurian shelly fauna from Southwest Japan. II. Two Brachiopods from Kyushu.... .....Takashi HAMADA

On some Jurassic Trigoniids from the Tetori group in the Managawa district .....Shiro MAEDA

Some *Nipponitrigonia* in Japan..... .....Shiro MAEDA

Discovery of the Fossil *Perotrochus* from the Miike Coal-field, Kyushu (代読).... ....Hidetaka KURODA and Hideo URATA

Tertiary Mollusca from Shimonida, Gumma Pref. ..Masae OMORI and Masahiko AKIYAMA

On *Suchium jyoganjiense* n. sp. from middle Miocene Kurosedani formation in Toyama Pref., Japan.....Shoji FUJII

Significance of the variation of fossil *Batillaria cumingi* from the Quaternary deposits of South Kanto, Japan..... .....Jôji NAGASAWA

Some Lower Ordovician Trilobites from Franklin Mountains, Texas (代読) .... Chung-Hung Hu

Giant spatangoid from the Horinouchi alternation (Pliocene), Shizuoka Prefecture, Japan.....Hiroshi UJIIE

岐阜県瑞浪層群産 *Salenia* n. sp. について (代読) .....森下　晶

Lemming from the late Pleistocene of Japan ..... Yoshikazu HASEGAWA and Takuro HARA

シンポジウム　「日本中新世の下限について」

本シンポジウムの要旨および討論の内容は，本会文献雑誌「化石」第 4 号に掲載の予定である。

SYSTEMATIC INDEX

(New Series No. 41~No. 48)

PALAEOZOOLOGY

Protozoa

Coelenterata

Bryozoa

Brachiopoda

Mollusca

Echinodermata

Arthropoda

Vertebrata

PALAEOBOTANY

PROBLEMATIC FOSSILS

PRESIDENTIAL ADDRESS

INDEX OF FOSSILS

Notes: Words in italics are names of families, genera and species; words in heavy type, names of new genera and species.

V

W

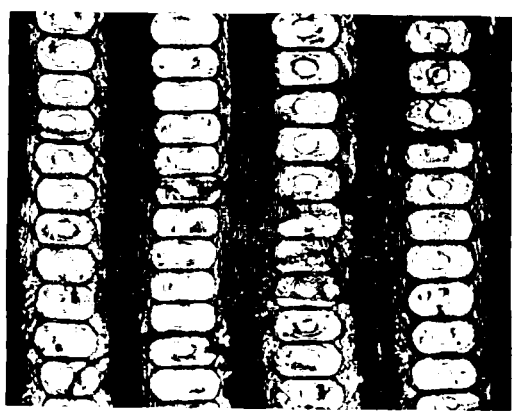
Y

Z

日本古生物学會
報告・紀事

Transactions and Proceedings
of the
Palaeontological Society of Japan

New Series
No. 41～No. 48
1961～1962



日 本 古 生 物 学 会

Palaeontological Society of Japan

The heading in Japanese commemorates the handwriting of Prof. M. YOKOYAMA, father of Japanese Palaeontology, who was Professor of Stratigraphy and Palaeontology at the Geological Institute, Imperial University of Tokyo.

The fossil on the front page is *Xenoxylon latiporosum* (CRAMER) GOTHAN, 1910.

CONTENTS

Number 41 (Published April 10, 1961)

Transactions

Presidential Address

Number 42 (Published June 10, 1961)

Transactions

Number 43 (Published September 25, 1961)

Transactions

Number 44 (Published December 15, 1961)

Transactions

Short Notes

Number 45 (Published April 10, 1962)

Transactions

Number 46 (Published June 10, 1962)

Transactions

Short Note

Number 47 (Published September 10, 1962)

Transactions

Number 48 (Published November 30, 1962)

Transactions

年　会　通　知

	開催地	開催日	講演申込締切日
1962 年総会年会	東京大学	1963 年 1 月 19 日	1962 年 12 月 15 日

学　会　記　事

◎ 本会特別出版物第 8 号として会員鎌田泰彦君の Tertiary Marine Mollusca from the Joban Coalfield, Japan が出版された。定価一部 2,000 円である。

◎ 本会邦文雑誌「化石」第 3 号が，夾炭層にかんする古生物学的研究及び海棲生物の古生態研究の 2 つのシンポジウム記事の特集として出版された。定価一部 250 円である。

◎ 本会誌の出版は一部文部省研究成果刊行費補助金による。

News

◎ Münster 大学（ドイツ）W. SCHWAN 教授は東京大学客員教授として 9 月下旬来日，各地大学での講演ならびに見学旅行の上 11 月中旬帰国した。

◎ 会員小高民夫君は 3 年間滞在の予定で New Zealand に向け 11 月 15 日出発した。

◎ この度 Michigan 大学 Dr. BURCH らを中心として，International Journal of Malacology "Malacologia" が出版されることになった。内容には軟体，動物に関する全ての研究が含まれる予定。年間購読費 5 弗。宛先は下記の通りである。

J. B. BURCH (Managing Editor, Malacologia)
Museum of Zoology, University of Michigan, Ann Arbor, Michigan, U. S. A.

◎ 会員高柳洋吉君は米国のスタンフォード大学に留学中であったが 8 月上旬帰国した。

◎ 会員石井健一・野上裕生の両君はカンボヂア学術調査のため 10 月中旬出発した。明年 1 月末に帰国の予定。

◎ 会員石和田靖章君は 9 月にテヘランで開催された ECAFE 第 2 回石油シンポジウムに出席の後クエート・台湾の油田地帯を見学の上帰国した。

◎ 会員今泉力蔵君は 9 月米国コロラド鉱山大学へ留学のため出発した。

◎ 会員新野弘・押手敬の両君はユネスコの国際印度洋調査に参加 10 月印度洋に向けて出航した。

◎ 会員石島渉君は 8 月中旬アジアおよび欧米諸国視察のためニューデリーに向けて出発した。

購読御希望の方は本会宛御申込下さい

1962 年 11 月 25 日　印　刷
1962 年 11 月 30 日　発　行

日本古生物学会報告・紀事
新　篇　第 48 号
350 円

東京大学理学部地質学教室内
日本古生物学会
編　集　者　高　井　冬　二
発　行　者　市　川　健　雄
（振替口座東京 84780 番）
印　刷　者　東京都港区芝片門前 2 ノ 13
学術図書印刷株式会社　富　田　元

Regulations for Publication in Transactions and Proceedings of the Palaeontological Society of Japan

(Jan. 15, 1961)

1. Manuscripts considered for publication should have been read at the General Meeting or the Ordinary meeting of the Palaeontological Society of Japan.
2. Manuscripts shall be written in European language, they should be typed (Pica) on one of standard-size (22.5×27.5 cm) paper and double-spaced throughout. Biological names should be in italics and be underlined by the author.
3. Manuscripts (including of text-figures, maps and tables) will be limited to 12 printed pages (less than 27 type-written pages).
4. Illustrations will be limited to one plate (14.2×20.0 cm).
5. Text-figures (2 if less than 6 tsubo, 1 tsubo is 1 square sun) should be drawn carefully on white paper with drawing or Indian ink, letters used in the figures should be either printed or typed letters pasted-in. Figures may be reduced, so authors are requested to carefully select the size and thickness of the lines or letter used.
6. Maps should be accompanied with scale, fractions should not be used.
7. The author is requested to pay for any cost extending beyond the above stated regulations. One additional plate can be added in place of 4 printed pages, with the editor's approval.
8. Manuscripts should have the title and a brief abstract in Japanese, (such will be added for persons not familiar with Japanese language).
9. Literature cited or referred to should be listed at the end of the manuscript in the form of bibliography. Bibliography should be arranged in alphabetic order of author and by year. The order will be, Author, Year, Title of Paper, Name of Journal, Volume, Page, Plate, Figure, Map, Table.
10. The author's official address should be given below his name, under the title.
11. Palaeontological notes which can be fitted into less than one printed page (including figures, maps, tables) will be published in the order received as space becomes available.
12. The desired number of reprints should be indicated on the right corner of the front page of the manuscript. 100 reprints without cover, but with reference to volume, number and year will be furnished free of charge to the author (if more than one author is involved they shall be divided). Additional reprints will be furnished at the printers rate.

Editorial Regulations

1. The Editorial Staff will transact, preserve and edit the manuscripts.
2. When the Editorial Staff transacts a manuscript, a notification with date of acceptance will be sent to the author, if the manuscript is clear, and abides with the regulations.
3. Acceptance or non-acceptance of manuscripts will be decided by the Editorial Council.
4. Manuscripts not accepted for publication will be returned to the author with notification from the Editor of the reason(s) for its rejection.
5. Manuscripts accepted will be published in the order received with the date of acceptance indicated thereon.
6. Manuscripts whose contents are altered by the author after being accepted for publication, will have their date of acceptance changed.
7. The printing style will be as Journal of Paleontology.
8. Proof reading will be done under the responsibility of the Publication Committee.