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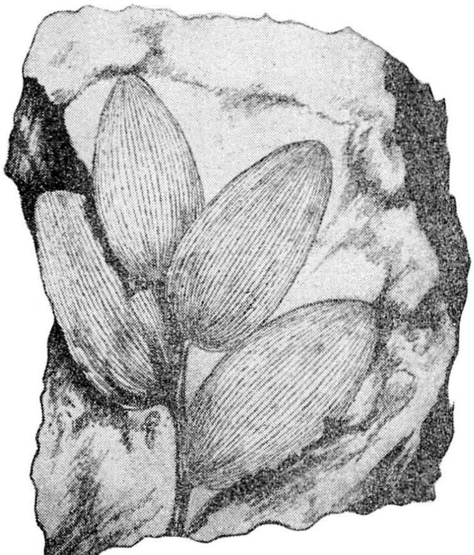

日本古生物学会

Palaeontological Society of Japan
June 30, 1977

The fossil on the cover: Original figure of *Podozamites Reinii* GEYLER, 1877, from the Tetori group. GEYLER's description marked the onset of modern palaeontology in Japan.

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675. *NUMMULITES BONINENSIS* FROM THE AMAMI PLATEAU IN THE NORTHERN MARGIN OF THE PHILIPPINE SEA*

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奄美海台からの *Nummulites boninensis*: 奄美海台からドレッジにより得られたヌンムリテスは，小笠原諸島母島の中部始新統から産する *Nummulites boninensis* HANZAWA に同定され，微球型は外形上厚型，うす型の2型に分かれる。前者を *N. boninensis* forma *M*, 後者を *N. boninensis* forma *S* とし，その2型について，外部形態，内部構造，とくに lamella と chamber の発達様式を比較，記載した。

紺田　功，松岡数充，西村　昭，大野照文

Introduction

The eleventh research cruise of Japanese Geodynamics Project in the West Pacific was carried out by the R/V Tokaidaigaku-maru II in August, 1974. During this cruise, in which the authors participated, many traverses of echo sounding and seismic reflection profiling and frequent sampling of bottom sediments were enforced. A brief note and a paleontological preliminary report were already made by the Research Members of GDP-11 Cruise (1975) and KONDA *et al.* (1975).

Discovery of Eocene larger foraminifers including nummulitids from the Amami Plateau in the northern margin of the Philippine Sea is one of the most noticeable results of this cruise. Several hundreds of microspheric nummulitids and a large number of megalospheric ones were obtained. These specimens of nummulitids are all identified to *Nummulites boninensis* HANZAWA, described originally from the middle Eocene strata of Haha-jima (Hillsborough Island), Ogasawara (Bonin) Islands (HANZAWA, 1947). The microspheric specimens, however, are divided into two forms with thick test and thin test from the external views. Such a phenomenon was first reported from Haha-jima by YOSHIWARA (1902), who assigned the thicker form to *Nummulites javanus* VERBEEK described from the Eocene of

* Received July 30, 1975: read January 26, 1975 in Tokyo.

Java and the thinner one as a variety of the same species or a different species. HANZAWA (1947) distinguished nummulitids of Haha-jima from other known species and established a new species, *Nummulites boninensis*. He mentioned briefly a wide morphological variation of the microspheric specimens but did not describe it in detail. Lately, IWASAKI and AOSHIMA (1970) reported that the flatter and irregularly undulated form is more abundant in the fine-grained rock, while the thicker form is contained more abundantly in the coarse-grained rock.

In the present article, the authors describe the morphology of the two forms of microspheric generation of *Nummulites boninensis* HANZAWA obtained from the Amami Plateau. As the information about their mode of occurrence is relatively poor because of the dredge haul, the geological and paleontological significance of their coexistence is not discussed. The morphological criteria of the two forms, however, are shown in the present article.

Acknowledgements

First of all, the authors are deeply indebted to Captain Magoshichi SATO and the crew members of the Tokai-daigaku-maru II, who contributed to the survey by their excellent operation and navigation during the GDP-11 cruise. Thanks are due to Professor Tsunemasa SHIKI (Chief scientist of the Cruise) and Dr. Takao TOKUOKA of Kyoto University, Professor Hitoshi AOKI and Dr. Yoshifumi MISAWA of Tokai University for valuable suggestions on the geology of Amami Plateau. Appreciation is expressed to students of the Tokai University who cooperated in the work on board. The authors' grateful thanks are

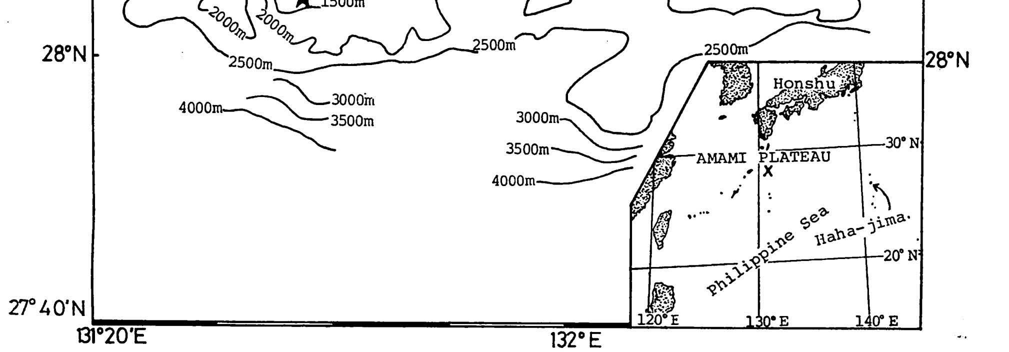


Fig. 1. Map showing the fossil locality (asterisk). Contor is shown in meters, adapted from MISAWA and HOSHIZAWA (1975).

due to Professor Emeritus Shoshiro HANZAWA of Tohoku University, Professor Yokichi TAKAYANAGI of the same university, Dr. Hiroshi UJIIÉ of National Science Museum and Dr. Kuniteru MATSUMARU of Saitama University for valuable suggestions and discussions on the paleontological problems.

Materials and Methods

The sampling locality is situated on the Amami Plateau in the northern margin of the Philippine Sea (Station No. GDP-11-9, 28°04.0′N, 131°37.8′E—28°04.4′N, 131°37.8′E, 1390-1410 m in depth). About two hundred isolated microspheric specimens of nummulitids were obtained together with many ferromanganese nodules by a chain bag dredge. In a cylindrical sampler employed at the same locality, several hundreds of microspheric specimens, a large number of megalospheric ones, numerous specimens of other Eocene larger foraminifers, a few ferromanganese nodules, and limestone gravels were contained together with a large quantity of Recent foraminiferal sand. The nummulitids are coated with thin ferromanganese oxide peel, and some of the microspheric forms are bored by organisms.

HANZAWA (*op. cit.*) assigned the age of *Nummulites boninensis* from Haha-jima to the middle Eocene (Lutetian), and SAITO (1962) also correlated the planktonic foraminiferal fauna accompanied by the nummulitids from Haha-jima with the *Porticulasphaera beckmanni* Zone of Trinidad (=*P. mexicana* Zone of BOLLI, 1957) considered to represent a part of the middle Eocene. KANEOKA *et al.* (1970) reported that the pyroxene andesite conformably overlain by a tuff layer with abundant *Nummulites boninensis* HANZAWA indicates a K-Ar age of about 40 m. y. which may be slightly younger than the true age. Anyway, the age of the nummulitids from Haha-jima is now thought to be the middle Eocene. As already mentioned, many larger foraminifers are associated with the nummulitid in the sample from the Amami Plateau. They are *Asterocyclina penuria* COLE, *Asterocyclina* sp. and *Discocyclina* sp. Although these coexisting larger foraminifers may have been derived from some different horizons, all of them indicate the middle to late Eocene age. Furthermore, because the nummulitids and these larger foraminifers are well preserved, they are thought to have been derived from the middle to upper Eocene strata in the adjacent area of the sampling station. For the present study about two hundred microspheric and about fifty megalospheric specimens were utilized. The observations were made on the external views, thin sections along the axial and sagittal planes, and artificial splits mentioned by HANZAWA (1947). And ARNY's (1967) graphic presentation of the growth mode was adopted to show the diagnostic features of the growth mode in the two forms of a single species. The measurements along the sagittal line and spiral axis were made on 1) the height of chambers, 2) the same height plus the thickness of spiral lamella and 3) distance between the outer side of spiral lamella in each whorl and the floor of chamber of the second whorl near the center of test (see Figs. 4 and 5).

Measured and illustrated specimens are deposited in the paleontological collections of the Department of Geology and Mineralogy, Faculty of Science, Kyoto University, Kyoto.

Systematic Description

Family Nummulitidae
DE BLANVILLE, 1825

Genus *Nummulites* LAMARCK, 1801

Nummulites boninensis HANZAWA, 1947

Pl. 7, figs. 1-9, Pl. 8, figs. 1-4

Nummulites boninensis HANZAWA: HANZAWA, 1947, pp. 247-259, pl. 39, figs. 1-7, pl. 40, figs. 1-9.

Description.

Megarospheric form: Test lenticular with an acute periphery, 3.5 mm in average diameter and 1.8 mm in average thickness, rarely asymmetrical, with one side more inflated than another; surface smooth, septal filaments numerous, radial, flush with the general surface of test; heads of pillars embedded in spiral lamellae, usually found on septal filaments as tiny spots, sometimes elevated as granules on the surface of test; septa a little inclined, slender and gently curved; chambers generally higher than broad with their dimensions not changing much from central to outer whorls; later chambers occasionally becoming broad and low; thickness of spiral lamellae fairly constant, 300 to 330 microns in sagittal section, and 125 to 250 microns in axial section, though becoming thicker from central to peripheral part of test; development of pillars variable, several narrow pillars scattered in central part of test and their diameters attaining to 150 microns in some sections, but scarcely developed in the other.

Microspheric form: Test discoidal with diameter of 20 to 35 mm in general, of 41 mm in maximum, and consisting of a minute proloculus and closely coiled whorls, usually more than 25 in number; thickness of test indicating bimodal frequency distribution with two peaks, around 4 to 6 mm and 7 to 10 mm, so that the sample is divided into two types: thicker one with a rounded periphery and flatter one with an acute periphery; number of individuals of the thicker type as twice as that of flatter one; granulation invisible on surface of test.

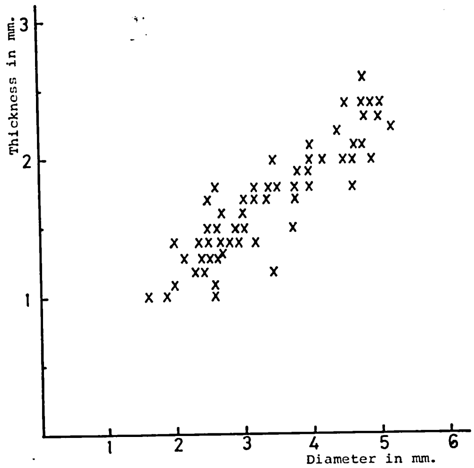


Fig. 2. Scatter diagram showing the relation between the diameter and thickness of the megalospheric tests.

Table 1. Number of chamber in the earlier stage of the microspheric specimens. I, II……: first whorl, second whorl, ……;

Whorls	type specimen*	forma *M*	forma *S*
I	10	11	12
II	23	12～16	12～21
III	25	18～26	22～30
IV	31	21～23	29～37
V	35	22～34	33～40

* Based on a figure illustrated in the original description (HANZAWA, 1947, pl. 40, fig. 6).

Numerous septal filaments clearly visible through semi-transparent spirothecal wall, meandriform and complicatedly anastomosing; three filaments counted within 1 mm; septa diagonal, gently curved and connected with outer lamella in a narrow angle; pillars numerous and starting from sagittal plane of test up to 170 microns in diameter, but their heads embedded in spiral lamellae and not raised on general surface of test.

Remarks: Some important features of present specimens of microspheric and megalosperic generations such as septa, septal filaments and pillars are quite coincident to those of *Nummulites boninensis* HANZAWA from Haha-jima. In microspheric generation, however, two forms are distinguished mainly on the basis of the thickness of test and the acuteness of periphery. In the present article, the thicker and thinner forms are called henceforth forma *M* and *S* respectively.

Forma *M* shows thick test with broadly rounded periphery and relatively small form ratio (diameter/thickness proportion ranging from 2.0 to 4.0. Because the test shape resembles Manju (a Japanese bean-jam bun), the initial of Manju is applied for the name of this forma. In sagittal section, the height of chamber and the thickness of spiral lamella increase as far as fifth to eighth whorls,

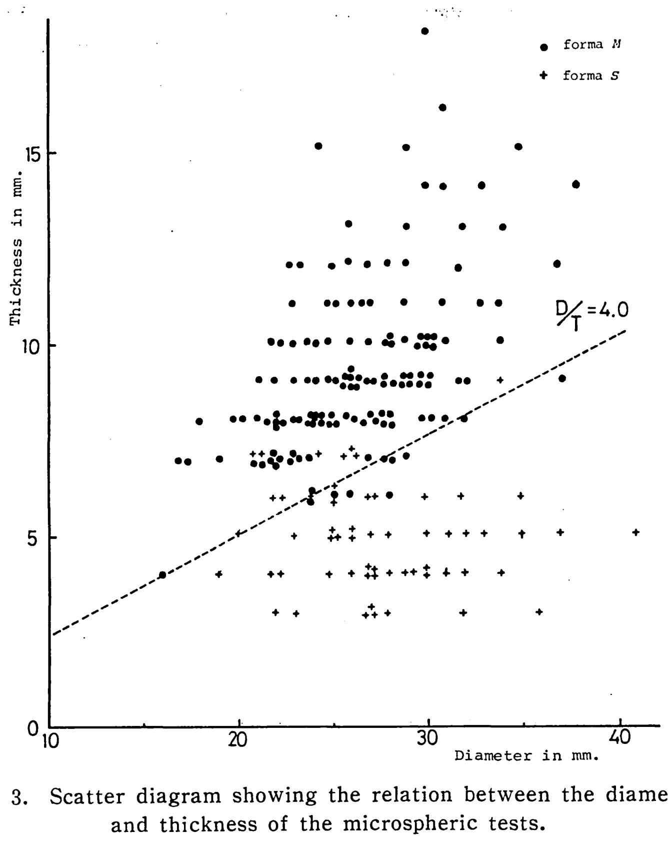


Fig. 3. Scatter diagram showing the relation between the diameter and thickness of the microspheric tests.

where they attain about 350 and 250 microns respectively (see Fig. 4). From there to outer whorls, the height of chamber becomes variable. Its change is greater and more frequent in the middle whorls than in the inner and the outer ones. In the outer whorls of spire, the height of chamber is fairly constant

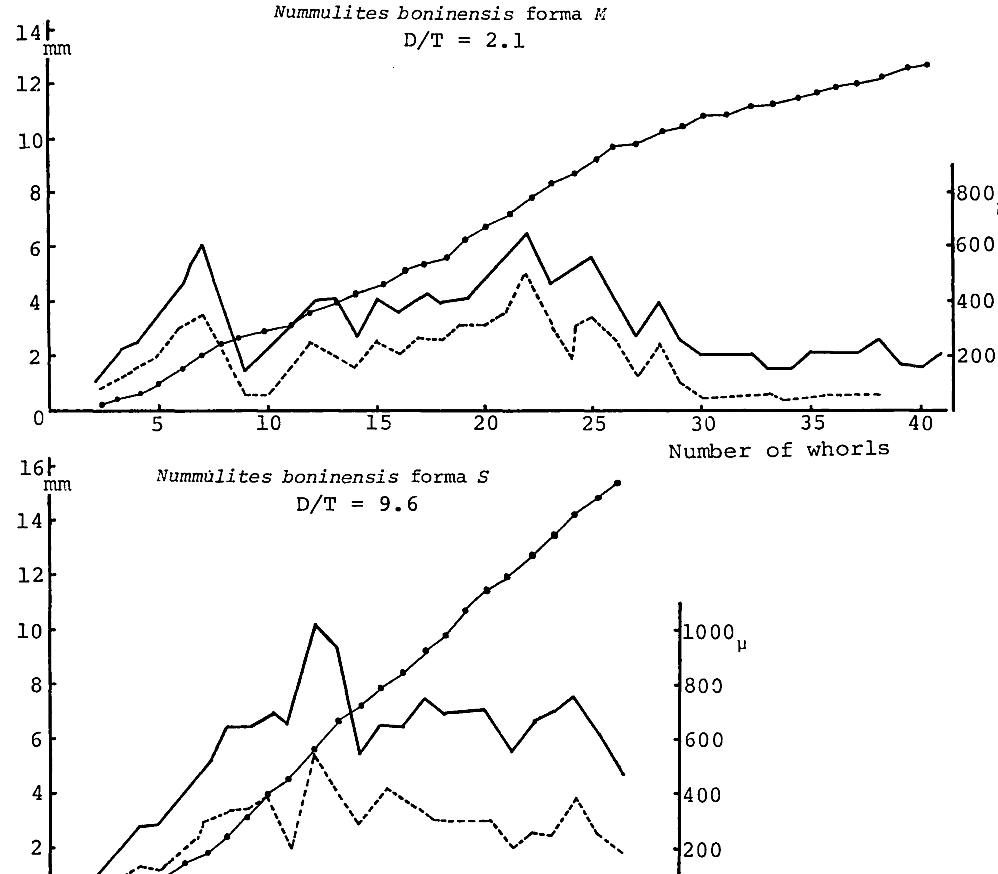


Fig. 4. Graphic projections of the characteristics of the microspheric form in sagittal sections.

Broken line and thick line show the height of chamber and the same height plus the thickness of spiral lamella in each whorl, respectively (scale on the right side). The distance between these two lines, therefore, represents the thickness of spiral lamella. Thin line connecting dots shows the distance between the outer side of spiral lamellae in each whorl and the floor of chamber of the second whorl, and consequently, it corresponds to the well-known "winding curve". In the measurements of the height of chamber and the same height plus the thickness of spiral lamella, the first whorl is omitted because of difficulty in accurate measurements of them.

and about 50 microns. Thus, the height/length proportion of chamber varies from the inner part to the outer, i. e., three to one in the inner, one to one in the middle, and one to two in the outer part. The thickness of spiral lamella scarcely changes throughout the whole spire except for the inner whorls, where it is larger than in the outer. The mean value of thickness of spiral lamella is about 140 microns, and the number of whorls is about 43 on an average. In axial section, the height of chamber increases with test growth. The spiral lamellae, on the other hand, are thicker in the early stage of growth than in the later (see Fig. 5).

Forma *S* is characterized by the thin test with a narrow and rounded to more or less acute periphery and relatively large form ratio ranging from 4.0 to 10.0. This type is similar in shape to

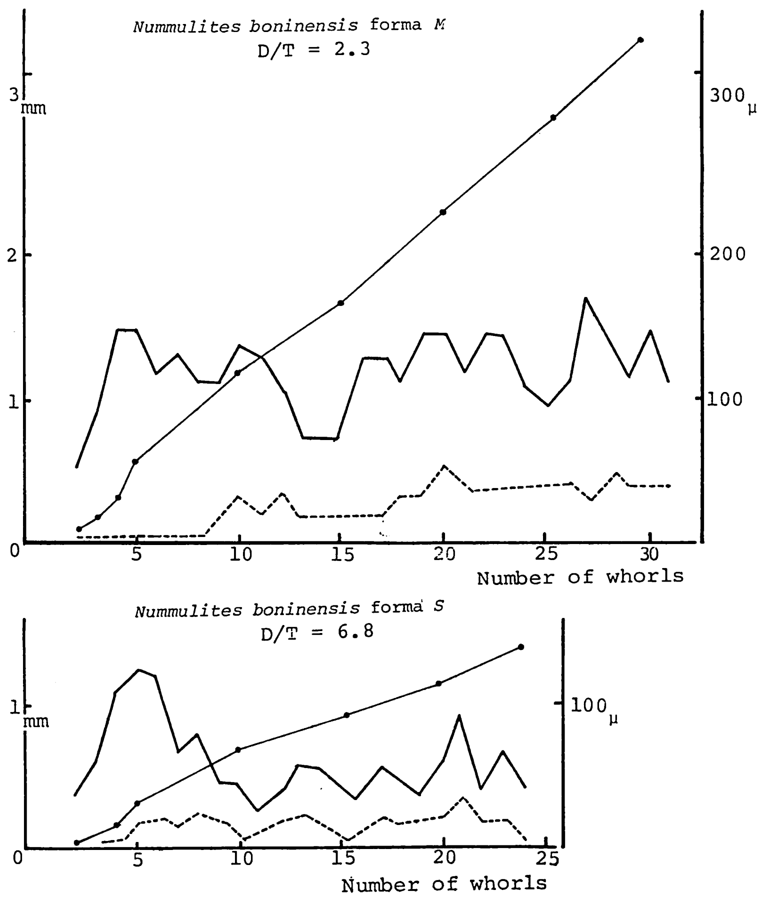


Fig. 5. Graphic projection of the characteristics of the microspheric form in axial sections. Broken line and thick line show the height of chamber along the axis and the same height plus the thickness of spiral lamella in each whorl, respectively (scale on the right side). Thin line connecting dots represents the increase of the thickness of test (scale on the left side).

Senbei (a Japanese rice cracker), the initial of which is used for this forma. In sagittal section, the height of chamber and the thickness of spiral lamella increase together with the test growth as far as the seventh to eighth whorl, where they attain to about 400 and 250 microns, respectively (see Fig. 4). From there to the outer whorls, the height of chamber decreases abruptly. In the outer whorls of spire, it is about 100 microns, and the chamber is slightly higher than broad. The height/length proportion of chamber is about two to one in the inner several whorls and about one to one in the major part.

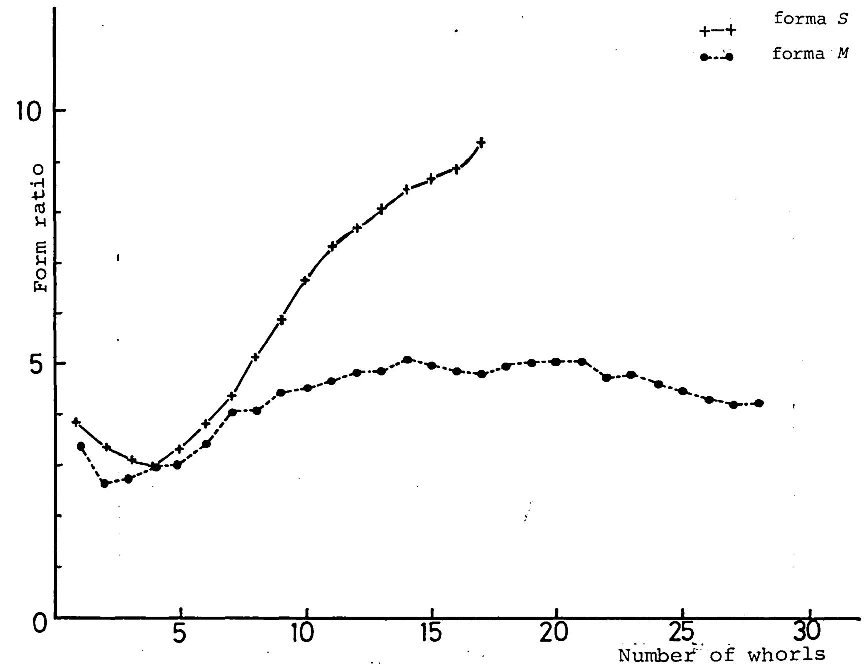


Fig. 6. Changes of form ratio (diameter/thickness proportion) with test growth.

Explanation of Plate 7

Fig. 1. Lateral view of *Nummulites boninensis* forma *M*. Sample No. JC 1001. ×1.7

Fig. 2. Lateral view of *Nummulites boninensis* forma *S*. Sample No. JC 1002. ×1.7

Fig. 3. Peripheral view of the same specimen as Fig. 1. ×1.7

Fig. 4. Peripheral view of the same specimen as Fig. 2. ×1.7

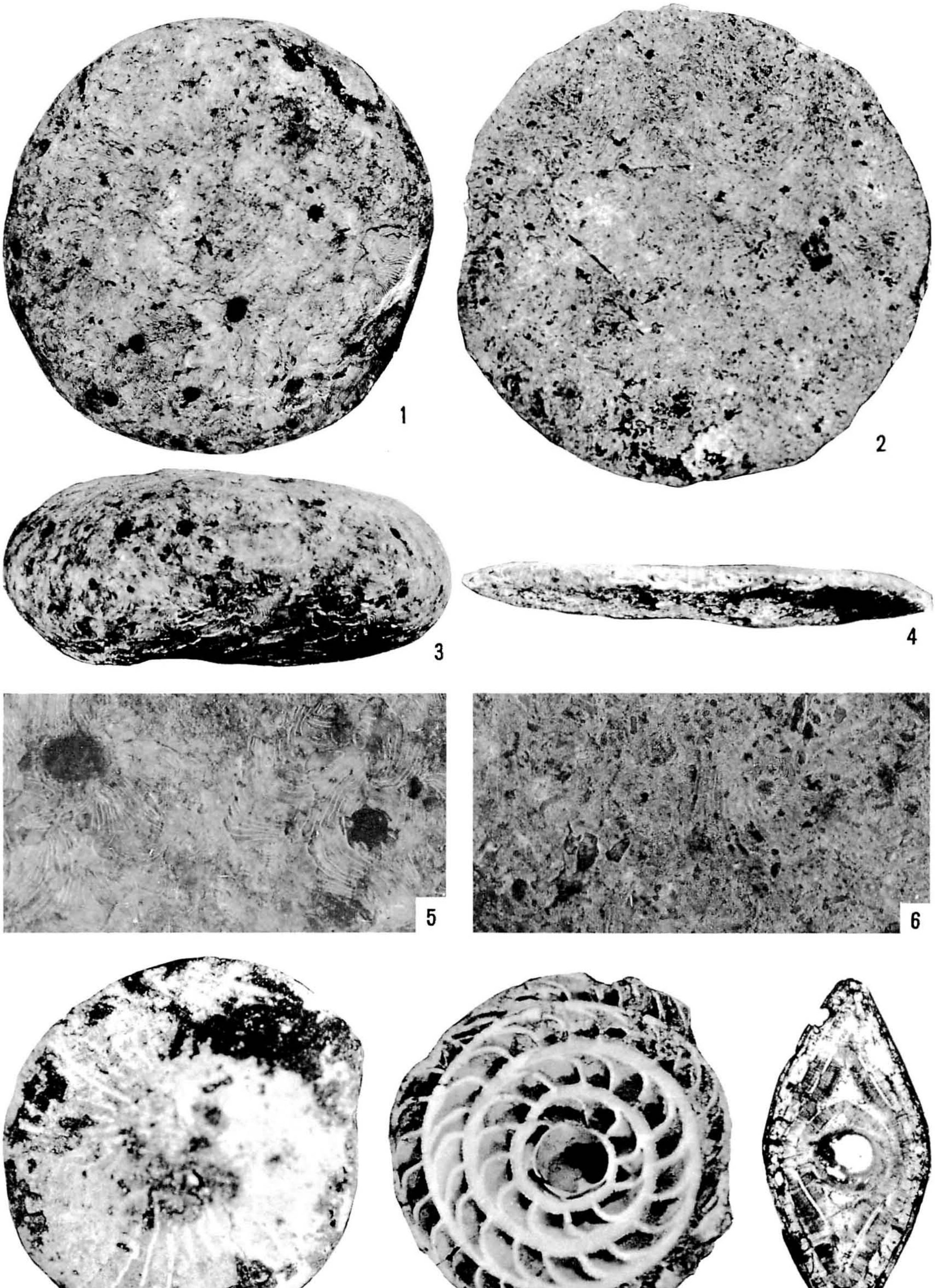
Fig. 5. A part of lateral view of the same specimen as Fig. 1. ×5

Fig. 6. A part of lateral view of the same specimen as Fig. 2. ×5

Fig. 7. Lateral view of megalospheric form of *Nummulites boninensis* HANZAWA. Sample No. JC 1007. ×12

Fig. 8. Sagittal section of megalospheric form of *Nummulites boninensis* HANZAWA. Sample No. JC 1008. ×12

Fig. 9. Axial section of megalospheric form of *Nummulites boninensis* HANZAWA. Sample No. JC 1009. ×12



The thickness of spiral lamella scarcely changes throughout the whole spire except for the inner whorls. Its mean value is about 200 microns. The number of whorls is about 30 on an average. In axial section, the height of chamber is generally smaller than in forma *M* and furthermore, the thickness of spiral lamella is smaller than a half of that of forma *M* (see Fig. 5). Consequently, the test of forma *S* becomes flatter with the growth in comparison with forma *M*. The microspheric specimens of *N. boninensis* illustrated by HANZAWA (1947, Pl. 39, figs. 1-8, Pl. 40, fig. 6) seem to be assigned to forma *S* here described.

In conclusion, these two forms of microspheric generation seem to represent a range of variation within a single species, *Nummulites boninensis* HANZAWA, because such essential characteristics as internal structure and skeletal pattern are the same, and because any difference corresponding to this variation is not observed in the megalospheric specimens.

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Table 2. Statistics of megalospheric specimens.
I, II, ······: first whorl, second whorl, ······.

Specimens	Diameter of proloculus (μ)	Number of whorls	Numbers of chambers in whorl				Height of whorls (mm)			
			I	II	III	IV	I	II	III	IV
1	783	$3\frac{3}{4}$	7	15	26		1.46	2.54	3.38	
2	696	3	6	17	28		1.42	2.25	2.83	
3	826	$4\frac{1}{2}$	6	12	24	33	1.92	2.75	3.63	4.33
4	730	$4\frac{3}{4}$	7	12	20	28	1.71	2.46	3.17	4.01
5	1042	$4\frac{1}{2}$	7	14	22	30	2.13	3.25	4.00	4.46

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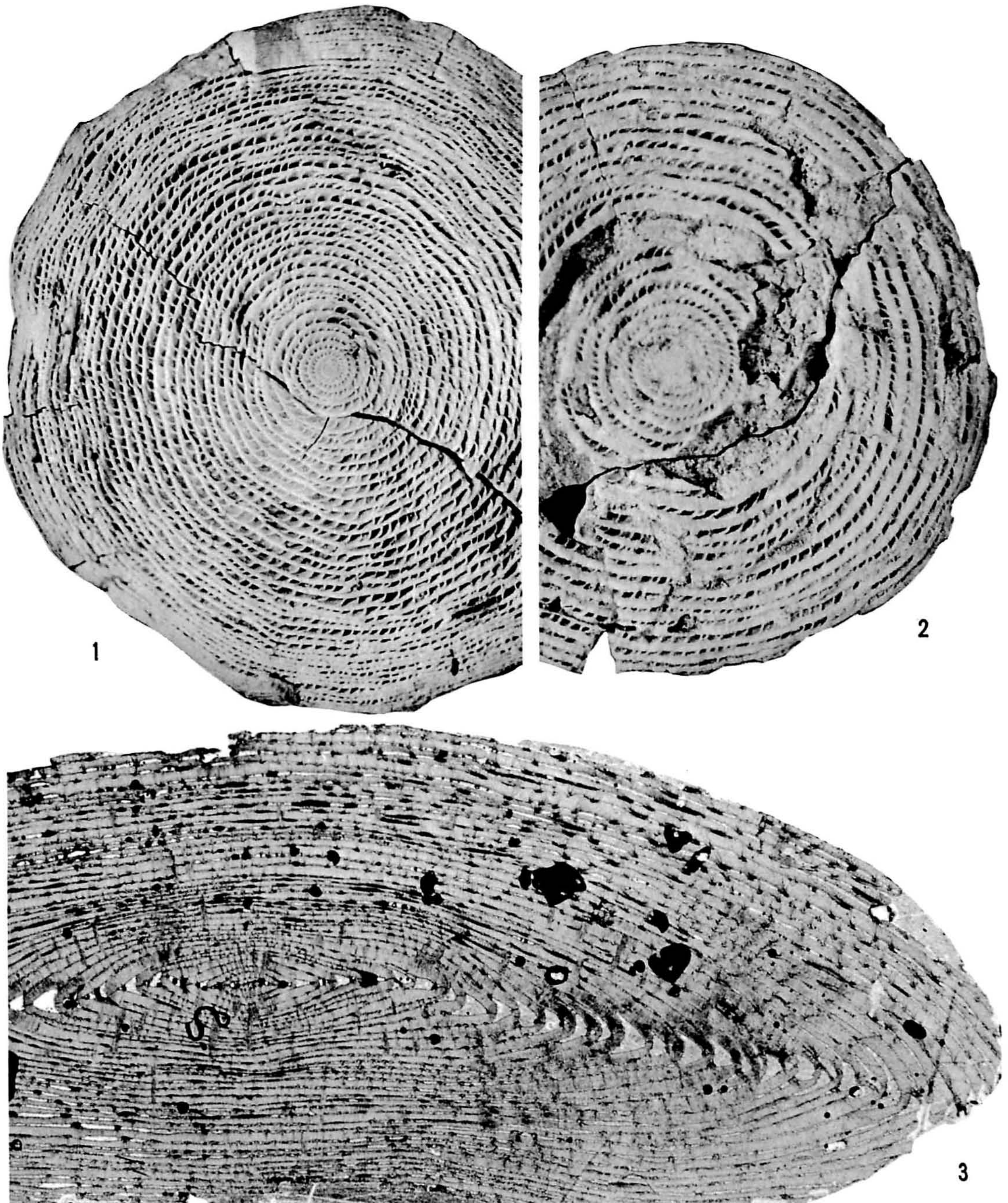
Amami Plateau 奄美海台, Ogasawara (Bonin) Islands 小笠原諸島, Haha-jima (Hillsborough Island) 母島

Explanation of Plate 8

Fig. 1. Sagittal section of *Nummulites boninensis* HANZAWA forma *M*. Sample No. JC 1003. ×2.5
Fig. 2. Sagittal section of *Nummulites boninensis* HANZAWA forma *S*. Sample No. JC 1004. ×2.5
Fig. 3. Axial section of *Nummulites boninensis* HANZAWA forma *M*. Sample No. JC 1005. ×8
Fig. 4. Axial section of *Nummulites boninensis* HANZAWA forma *S*. Sample No. JC 1006. ×8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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 106, pp. 71-88, pls. 9-12, June 30, 1977

676. PALYNOLOGY OF THE LOWER TERTIARY CONCEPCIÓN FORMATION, CENTRAL CHILE*

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中央チリー下部第三紀コンセプション層のパリノロジー：南米チリー国中央部のコンセプションの南部のコロネル炭田のコンセプション夾炭層の石炭から得られた花粉・胞子群集は羊歯植物・蘚苔類の胞子 62% (trilete 53.5%, monolete 8.5%), 裸子植物花粉 4% (saccate 0.5%, inaperturate 3.5%), 被子植物花粉 34% (monocolpate 1.5%, dicolpate と tricolporate 1.5%, triporate 31%) よりなる。胞子では5種を，花粉では3種を新種として記載し，また胞子では3種が，花粉では12種が下部第三紀に既に知られている種類であることを明らかにした。*Triorites minor* COUPER はこれまでニュージーランド，オーストラリアの上部白亜紀に知られているものである。*Myrtaceidites parvus* COOKSON & PIKE はこれまでオーストラリアの始新世～鮮新世に知られているものであり，各種類の出現の時代を検討すると第三紀初期ないし始新世に出現しているものがかなり多く，コンセプション層の時代は始新世と考えられる。

この花粉・胞子群集を日本の古第三紀のものと比較すると，その構成の特徴は全く異なっており，とくに胞子の出現率が高く，裸子植物花粉の出現率が低いのは特異である。この群集は *Stereisporites—Gleicheniidites—Triporopollenites—Myrtaceidites—Subtriporopollenites* の組合せが主体となっている。

高橋　清

Introduction

The coal material investigated was provided by Prof. S. MAEDA, Department of Geology, Faculty of Science, Chiba University, who collected it from the Eocene Concepción Formation in the Concepción area, central Chile.

The author has found many spores and pollen grains in the coal material from the Concepción Formation. Thirty-four species of plant microfossils consisting of microspores and pollen grains, are described in this paper. Eight species are instituted as new species.

* Received Feb. 12, 1977; read Jan. 21, 1977 in Tokyo.

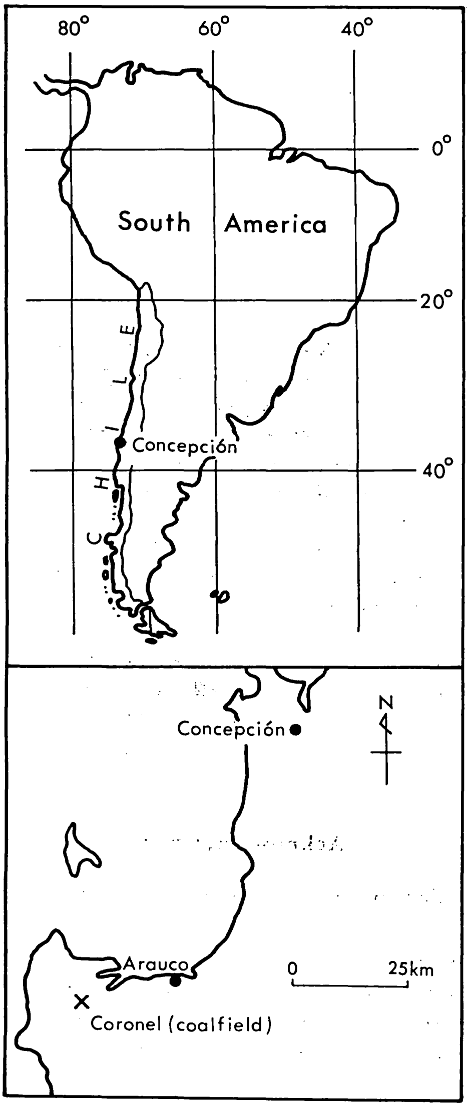
Acknowledgements

The author expresses his gratitude to Prof. Dr. S. MAEDA, Department of Geology, Faculty of Science, Chiba University, for supplying the sample material upon which this study is based. Thanks are also due to Prof. Dr. T. KIMURA, Department of Earth Sciences, Tokyo Gakugei University, for providing some literature on paleobotany and palynology of South America.

Material and method

The examined coal sample was obtained from the Concepción Formation in the Concepción area, central Chile. The sample is a bituminous coal.

The material was processed by me-



Text-fig. 1. Index map showing the sampling locality (×) at Coronel coalfield near Concepción.

chanical and chemical methods (maceration by $KClO_3$ and conc. HNO_3, treatment by 15% KOH and then by acetolysis method, centrifuging and washing in pure water after each step). The residues were mounted in glycerine jelly. All slides were sealed with a mixture of solid paraffin and canada balsam.

All specimens illustrated in this paper and the sample from which they were obtained are in the palynological collection of the Department of Geology, Nagasaki University.

Palynological assemblage

The plant microfossils recovered from the studied coal material indicate a total of 34 palynomorph types which appear to be important for characterizing the Concepción palynological assemblage. This includes 17 arboreal angiosperms, 2 probable or known non-arboreal angiosperms, 4 gymnosperms, a moss and 11 ferns. Approximate percentages of counted specimens for the entire assemblage are moss and ferns 62% (trilete-53.5%, monolete-8.5%), gymnosperms 4% (saccate-0.5%, inaperturate-3.5%), and angiosperms 34% (monocolpate-1.5%, dicolpate and tricolporate-1.5%, triporate-31%).

The fossil genera and species found are as follows:

Trilete spores:
- *Deltoidospora* sp.
- *Leiotriletes minus* n. sp.
- *Leiotriletes microadriennis* KRUTZSCH
- *Stereisporites concepcionensis* n. sp.
- *Concavisporites* sp.
- *Triplanosporites minor* n. sp.
- *Triplanosporites* sp.
- ? *Punctatisporites* sp.
- *Gleicheniidites speciosus* n. sp.
- *Gleicheniidites circinidites* (COOKSON) n. comb.

Monolete spores:
- *Laevigatosporites ovulatus* n. sp.
- *Laevigatosporites dehiscens* TAKAHASHI

Pollen grains:
- *Dacrydiumites* cf. *florinii* COOKSON & PIKE
- *Inaperturopollenites pseudodubius* TAKAHASHI
- *Inaperturopollenites laevigatus* TAKAHASHI

Ephedripites sp.
Monocolpopollenites cf. *kyushuensis* TAKAHASHI
Liliacidites variegatus COUPER
Smilacipites setarius (R. POTONIÉ) R. POTONIÉ
Triatriopollenites sp.
Triporopollenites festatus TAKAHASHI
Momipites sp.
Myrtaceidites parvus COOKSON & PIKE forma *anesus* COOKSON & PIKE
Myrtaceidites parvus COOKSON & PIKE forma *nesus* COOKSON & PIKE
Myrtaceidites sp.
Triorites minor COUPER
Triorites cf. *harrisii* COUPER
Subtriporopollenites rotundus n. sp.
Subtriporopollenites falsus n. sp.
Subtriporopollenites levius TAKAHASHI
Dicolpopollis sp.
Tricolporopollenites sp.
Rhoipites bradleyi WODEHOUSE
Rhoipites sp.
Foveotricolporites foveolatus n. sp.

The microflora of the Concepción Formation consists mainly of many species appearing in Lower Tertiary: *Leiotriletes microadriennis* KRUTZSCH, *Gleicheniidites circinidites* (COOKSON) n. comb., *Laevigatosporites dehiscens* TAKAHASHI, *Dacrydiumites* cf. *florinii* COOKSON & PIKE, *Inaperturopollenites pseudodubius* TAKAHASHI, *Inaperturopollenites laevigatus* TAKAHASHI, *Monocolpopollenites* cf. *kyushuensis* TAKAHASHI, *Liliacidites variegatus* COUPER, *Smilacipites setarius* (R. POTONIÉ) R. POTONIÉ, *Triporopollenites festatus* TAKAHASHI, *Subtriporopollenites levius* TAKAHASHI, *Triorites* cf. *harrisii* COUPER, *Rhoipites bradleyi* WODEHOUSE, *Myrtaceidites parvus* COOKSON & PIKE forma *anesus* COOKSON & PIKE, and *Myrtaceidites parvus* COOKSON & PIKE forma *nesus* COOKSON & PIKE.

Of these species, *Leiotriletes microadriennis* KRUTZSCH, *Gleicheniidites circinidites* (COOKSON) n. comb., *Smilacipites setarius* (R. POTONIÉ) R. POTONIÉ, *Subtriporopollenites levius* TAKAHASHI, *Triorites* cf. *harrisii* COUPER, *Rhoipites bradleyi* WODEHOUSE, *Myrtaceidites parvus* COOKSON & PIKE forma *anesus* COOKSON & PIKE, and *Myrtaceidites parvus* COOKSON & PIKE forma *nesus* COOKSON & PIKE appear only in Paleogene or Tertiary. Other species appear in both Lower Tertiary and Upper Cretaceous. *Triorites minor* COUPER is only an Upper Cretaceous species from New Zealand. *Foveotricolporites foveolatus* n. sp. is similar to *Foveotricolporites caldensis* GUZMÁN from the pollen zone I(a) (Lower Eocene) of Tibu area, Colombia.

All above-mentioned species except *Triorites minor* COUPER appear commonly in Paleogene or Eocene. Accordingly, the Concepción Formation indicates a possibility to be an Eocene age.

Stratigraphic and geographic distribution of all above-mentioned species is summarized as follows.

Leiotriletes microadriennis KRUTZSCH
Eocene: Geiseltal, Germany.
Eocene: Dorog, Bakony, Hungary.

Gleicheniidites circinidites (COOKSON) n. comb.
Early Tertiary: S. Australia, Victoria, Australia.

Laevigatosporites dehiscens TAKAHASHI
Paleogene-Miocene: W. Honshu, N. Kyushu, Japan.
Campanian-Maastrichtian: Hokkaido, Japan.
Upper Cretaceous: Quiriquina Formation, Chile.

Dacrydiumites florinii COOKSON & PIKE
Paleocene-Pliocene: New Guinea, N. S. Wales, Victoria, S. Australia, W. Australia, Tasmania.
Maastrichtian-Paleocene: Dorotea Formation, Argentina.

Inaperturopollenites pseudodubius TAKAHASHI
Paleogene-Miocene: W. Honshu, N.

Kyushu, Japan.
Cretaceous-Paleogene: Hokkaido, NE. Honshu, Japan.

Inaperturopollenites laevigatus TAKAHASHI
Paleogene-Miocene: W. Honshu, N. Kyushu, Japan.
Cretaceous-Paleogene: Hokkaido, NE. Honshu, Japan.
Upper Cretaceous: Quiriquina Formation, Chile.

Monocolpopollenites kyushuensis TAKAHASHI
Paleogene-Miocene: W. Honshu, N. Kyushu, Japan.
Upper Cretaceous-Paleogene: Hokkaido, Japan.

Liliacidites variegatus COUPER
Paleocene: Chubut Province, Argentina.
Maastrichtian-Paleocene: Dorotea Formation, Argentina.
Maastrichtian-Miocene, Southland, New Zealand.

Smilacipites setarius (R. POTONIÉ) R. POTONIÉ
Eocene: Geiseltal, Germany.

Triporopollenites festatus TAKAHASHI
Paleogene-Miocene: W. Honshu, N. Kyushu, Japan.
Upper Cretaceous-Paleogene: Hokkaido, Japan.
Turonian-Eocene: Sarawak, Malaysia.
Upper Cretaceous: Quiriquina Formation, Chile.

Myrtaceidites parvus COOKSON & PIKE forma *anesus* COOKSON & PIKE
Eocene-Pliocene: W. Australia, S. Australia, Victoria, New Guinea.
Upper Cretaceous: Quiriquina Formotion, Chile

Myrtaceidites parvus COOKSON & PIKE forma *nesus* COOKSON & PIKE
Eocene-Pliocene: S. Australia, Victoria, N. S. Wales, Queensland, Australia.

Triorites minor COUPER
Upper Cretaceous: Kaitangata coalfield, New Zealand.
Turonian: Port Campbell No. 2, Victoria, Australia.

Triorites harrisii COUPER
Early Tertiary: Wangerrip Group, Victoria, Australia.
Oligocene: Southland, New Zealand.

Subtriporopollenites levius TAKAHASHI
Paleogene: N. Kyushu, Japan.

Rhoipites bradleyi WODEHOUSE
Eocene: Green River Formation, U. S. A.

Descriptive palynology

Anteturma **Sporites** H. POTONIÉ 1893.

Turma Triletes REINSH 1881 emend. R. POTONIÉ & KREMP 1954.

Subturma Azonotriletes LUBER 1935.

Infraturma Laevigati BENNIE & KIDSTONE 1886 emend. R. POTONIÉ 1956.

Genus *Leiotriletes* NAUMOVA 1937 emend. POTONIÉ & KREMP 1954.

Type species: *Leiotriletes sphaerotriangulus* (LOOSE 1932) POTONIÉ & KREMP 1954.

Leiotriletes minus n. sp.

Pl. 9, figs. 19-21

Description: Spores trilete; outline triangular in polar view, with slightly concave sides and somewhat rounded angles. Trilete mark straight and reaching to the equator. Prominent folds 1.5 μ wide, often of unequal length, accompany the trilete mark. Exine thin, chagrenate. Grain size 23.5-27.2 μ.

Holotype: Pl. 9, fig. 20; grain size 27.2 μ, exine thin; slide GN 2527.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are superficially similar to *Leiotriletes* spp. (G. M. BRATZEBA, 1969, pl. 8, fig. 3; pl. 20, fig. 4) from the Upper Cretaceous formations, Far East.

Botanical affinity: ? Schizaeaceae.

Leiotriletes microadriennis KRUTZSCH

Pl. 10, fig. 1

1959. *Leiotriletes microadriennis* KRUTZSCH, *Geologie*, vol. 8, no. 21-22, p. 61, pl. 1, figs. 3-7.

Dimensions: Grain size 51.7 μ, exine 1.3 μ thick, chagrenate.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: This specimen is identified with *Leiotriletes microadriennis* described by W. KRUTZSCH from the lower coal seams (middle Eocene) at Geiseltal.

Botanical affinity: Schizaeaceae, cf. *Lygodium.*

Genus *Stereisporites* THOMSON & PFLUG 1953.

Type species: *Stereisporites stereoides* (POTONIÉ & VENITZ 1934) THOMSON & PFLUG 1953.

Stereisporites concepcionensis n. sp.

Pl. 9, figs. 1-7

Description: Spores trilete, outline triangular or subtriangular in polar view, with convex sides and rounded angles. The laesurae of the tetrad scar simple, about 1/2-2/3 spore radius. Arcuate thickening of the spore wall on the proximal face subtent angles between the laesurae. Exine psilate, less than 1 μ thick; a thickend zone 2-3.5 μ wide surrounds the equator Equatorial diameter 19.3-25.4 μ.

Holotype: Pl. 9, fig. 5; equatorial diameter 22 μ, laesurae about 1/2 spore radius (5 μ long), a thickened zone 3.5 μ wide; slide GN 2536.

Occurrence: Frequent; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are very similar to *Sphagnum antiquasporites* WILSON & WEBSTER (1946, p. 273, fig. 2) from the Paleocene Fort Union Formation of Montana, but the Concepción specimens are different from the Montana species in thickness of the thickened zone.

Botanical affinitv: *Sphagnum.*

Genus *Concavisporites* PFLUG 1953 emend. DELCOURT & SPRUMONT 1955.

Types pecies: *Concavisporites rugulatus* PFLUG 1953.

Concavisporites sp.

Pl. 9, fig. 22

Description: Spore trilete. Amb triangular in polar view, with concave sides and rounded angles. Trilete mark straight and reaching to the equator. Exine thin, punctate or chagrenate. Grain size 29 μ.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This is similar to *Concavisporites macellus* TAKAHASHI (1964, p. 192-193, pl. 23, figs. 18-19) from the Campanian

Hakobuchi Group, Hokkaido, Japan, but is different from the latter in length of Y-mark.

Botanical affinity: Unknown.

Genus *Triplanosporites* PFLUG 1953.

Type species: *Triplanosporites sinuosus* PFLUG 1953.

Triplanosporites minor n. sp.

Pl. 10, figs. 2-3

Description: Spores trilete, outline in equatorial view rhombic; polar axis longer than equatorial axis. Trilete mark distinct, reaching almost to the periphery. The proximal and distal poles peaked. Exine thin, psilate. Grain size: polar axis 20-27.3 μ, equatorial axis 18.5-27 μ.

Holotype: Pl. 10, fig. 3; polar axis 27.3 μ, equatorial axis 27 μ; exine thin; slide GN 2532.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: The species differs from *Triplanosporites microsinuosus* PFLANZL (F. MÜRRIGER & G. PFLANZL, 1955, p. 87, pl. 5, figs. 12a-b; pl. 6, figs. 21a-b; W. KRUTZSCH, 1962, p. 42, figs. 1-16) in having extremely thin exine and smaller size.

Botanical affinity: Unknown.

Triplanosporites sp.

Pl. 10, fig. 4

Description: Spore trilete; outline in equatorial view compressed rhombic; polar axis shorter than equatorial axis. Trilete mark distinct, reaching almost to the periphery. Exine chagrenate, thin. Grain size: polar axis 26.3 μ, equatorial axis 30 μ. The distal pole rounded.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen differs from *Triplanosporites minor* n. sp. in having compressed rhombic form and rounded distal pole.

Botanical affinity: Unknown.

Genus *Punctatisporites* IBRAHIM 1933 emend. POTONIÉ & KREMP 1954.

Type species: *Punctatisporites punctatus* IBRAHIM 1933.

? *Punctatisporites* sp.

Pl. 10, fig. 5

Description: Spore trilete; outline circular in polar view. Trilete mark strong, straight and not reaching to the equator. Exine 5 μ thick, fine punctate (?). Grain size 71 μ in diameter.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: It is not accurately determined whether the present specimen belongs to *Punctatisporites* or not, because of its poor preservation.

Botanical affinity: Unknown.

Subturma Zonotriletes WALTZ 1935.

Infraturma Cingulati POTONIÈ & KLAUS 1954.

Genus *Gleicheniidites* ROSS 1949 ex DELCOURT & SPRUMONT 1955 emend. DETTMANN 1963.

Type species: *Gleicheniidites senonicus* ROSS 1949.

Gleicheniidites speciosus n. sp.

Pl. 9, figs. 8-15

Description: Spores trilete; outline triangular in polar view, with usually somewhat convex or concave sides and more or less rounded angles. The proximal wall flattened. Exine 4-6 μ thick at the sides and psilate or chagrenate (on a few spores a faint rugulate was observed). Trilete mark straight or sometimes somewhat undulating and always reaching to the equator. Grain size 35-42.7 μ in diameter.

Holotype: Pl. 9, fig. 8, grain size 39 μ, exine 5 μ thick at the sides; slide GN 2535.

Occurrence: Frequent; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are similar to *Gleicheniidites marginatus* TAKAHASHI (1964, p. 191-192, pl. 23, figs. 4-17; pl. 40, fi. 1) from the Campanian and Maastrichtian Hakobuchi Group, Hokkaido, Japan, but the former differs from the latter in size and in details of form.

Botanical affinity: Gleicheniaceae—*Gleichenia.*

Gleicheniidites circinidites (COOKSON) n. comb.

Pl. 9, figs. 16-18

1953. *Gleichenia circinidites* COOKSON, *Aust. Jour. Bot.*, vol. 1, no. 3, p. 464, pl. 1, figs. 5-6.

Dimensions: Grain size 32.8-40 μ in diameter, exine psilate, at the corners 2-2.5 μ thick and increasing to 3-4 μ at the sides.

Occurrence: Common; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are referable to *Gleichenia circinidites* COOKSON (1953) from the Early Tertiary coal at 619.6 feet of core at Comaum, South Australia, Australia.

Botanical affinity: Gleicheniaceae—*Gleichenia.*

Turma Monoletes IBRAHIM 1933.

Subturma Azonomonoletes LUBER 1935.

Infraturma Laevigatomonoleti DYBOVA & JACHOWICZ 1957.

Genus *Laevigatosporites* IBRAHIM 1933.

Type species: *Laevigatosporites vulgaris* IBRAHIM 1933.

Laevigatosporites ovulatus n. sp.

Pl. 10, figs. 6-10

Description: Spores monolete; outline in lateral view broadly bean-shaped, 26-39×21-30 μ (ratio of width to length 0.7-0.9). Exine smooth, thin (less than 1 μ). Monolete mark straight or somewhat convexly curved and not bordered by ridges. Sometimes folding along the dehiscence furrow.

Holotype: Pl. 10, fig. 7; grain size 39×28.2 μ in lateral view, exine thin; ratio of width to length 0.72; slide GN 2536.

Occurrence: Common; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are closely similar to *Laevigatosporites ovatus* WILSON & WEBSTER (1946, p. 273, fig. 5) from the Paleocene Fort Union Formation of Montana and *Laevigatosporites major* (COOKSON) KRUTZSCH (*al. Monolites major* COOKSON, p. 135, pl. 15, fig. 56) from the Tertiary lignites and carbonaceous sandstone in Kerguelen

Island, but differ from the *ovatus* form in having a thin wall and from the *major* form in having a small size and thin wall.

Botanical affinity: Polypodiaceae.

Laevigatosporites dehiscens TAKAHASHI

Pl. 10, gg. 11

1961. *Laevigatosporites dehiscens* TAKAHASHI, *Mem Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 9, no. 3, p. 290, pl. 16, figs. 4-8.

Dimensions: Grain size in lateral view 31×19 μ, exine thin.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: This specimen is identified with *Laevigatosporites dehiscens* TAKAHASHI from the Paleogene and Miocene formations of Japan.

Botanical affinity: Polypodiaceae.

Anteturma **Pollenites** R. POTONIÉ 1931.

Turma Saccites ERDTMAN 1947.

Subturma Disaccites COOKSON 1947.

Genus *Dacrydiumites* COOKSON 1953 ex HARRIS 1965.

Type species: *Dacrydiumites florinii* COOKSON & PIKE 1953.

Dacrydiumites cf. *florinii* COOKSON & PIKE

Pl. 10, figs. 18-20

1953. *Dacrydiumites florinii* COOKSON & PIKE, *Aust. Jour. Bot.*, vol. 1, no. 3, p. 479, pl. 3, figs. 20-35.

Dimensions: Total length of the grain 35.6-43 μ, total height of the grain 30.7-37.4 μ, width of the air sacs 24.2-26.3 μ, height of the air sacs 14.5-23.3 μ.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are poor in preservation, but they are barely referable to *Dacrydiumites florinii* COOKSON & PIKE, ranging from Paleocene to Pliocene in Australia.

Botanical affinity: *Dacrydium.*

Turma Aletes IBRAHIM 1933.

Subturma Azonaletes LUBER 1935 emend. POTONIÉ & KREMP 1954.

Infraturma Psilonapiti ERDTMAN 1947.

Genus *Inaperturopollenites* PFLUG & THOMSON 1953 emend. R. POTONIÉ 1958.

Type species: *Inaperturopollenites dubius* (POTONIÉ & VENITZ 1934) THOMSON & PFLUG 1953.

Inaperturopollenites pseudodubius TAKAHASHI

1957. *Inaperturopollenites pseudodubius* TAKAHASHI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 5, no. 4, p. 216, pl. 38, figs. 11-17; pl. 39, figs. 13-14.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: This species appears in Paleogene and Miocene of Japan. This is similar to *Inaperturopollenites dubius* (POTONIÉ & VENITZ) THOMSON & PFLUG, but differs from the latter in having a very thin wall.

Botanical affinity: Taxodiaceae.

Inaperturopollenites laevigatus TAKAHASHI

Pl. 10, figs. 15-17

1957. *Inaperturopollenites laevigatus* TAKAHASHI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 5, no. 4, p. 216-217, pl. 38, fig. 18; pl. 39, fig. 16.

Dimensions: 21-36.7 μ in diameter, exine thin, laevigate.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present pollen grains fold very often. They are referable to *Inaperturopollenites laevigatus* TAKAHASHI from the Paleogene strata of western Japan.

Botanical affinity: Taxodiaceae.

Infraturma Subpilonapiti ERDTMAN 1947 emend. VIMAL 1952.

Genus *Smilacipites* WODEHOUSE 1933 emend. R. POTONIÉ 1960.

Type species: *Smilacipites echinatus* WODEHOUSE 1933.

Similacipites setarius (POTONIÉ) POTONIÉ

Pl. 12, fig. 27

1934. *Pollenites setarius* POTONIÉ, *Arb. Inst. Palaeobot. Petrogr. Brennst.*, vol. 4, p. 93, tab. 5, fig. 24, 28.
1960. *Smilacipites setarius* (POTONIÉ), POTONIÉ, *Beih. Geol. Jb.*, no. 39, p. 86-87, pl. 5, fig. 88.

Dimensions: Grain size 31.5 μ; length of spine 1.8-2.4 μ.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen is identified with *Smilacipites setarius* (POTONIÉ) POTONIÉ from the Eocene lignite of Geiseltal.

Botanical affinity: ? *Smilax.*

Turma Plicates NAUMOVA 1939 emend. POTONIÉ 1960.

Subturma Polyplicates ERDTMAN 1952.

Genus *Ephedripites* BOLCHOVITINA 1953.

Type species: *Ephedripites mediolobatus* BOLCHOVITINA 1953.

Ephedripites sp.

Pl. 10, fig. 14

Description: Pollen grain ellipsoidal, without a furrow, 24 μ long and 15.8 μ broad. Exine firm, smooth with about 15 longitudinal ridges. Width of ridge 1.1 μ.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This pollen grain belongs to the form-genus *Ephedripites.*

Botanical affinity: ? Ephedraceae.

Subturma Monocolpates IVERSEN & TROELS-SMITH 1950.

Genus *Monocolpopollenites* PFLUG & THOMSON 1953.

Type species: *Monocolpopollenites tranquillus* (R. POTONIÉ 1934) THOMSON & PFLUG 1953.

Monocolpopollenites cf. *kyushuensis* TAKAHASHI

Pl. 10, figs. 12-13

1961. *Monocolpopollenites kyushuensis* TAKAHASHI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 11, no. 3, p. 292, pl. 16, figs. 17-23.

Dimensions: Pollen grain 32-33.5× 17.7-22.5 μ; exine less than 1 μ, chagrenate.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens resemble *Monocolpopollenites kyushuensis* TAKAHASHI from the Upper Cretaceous and Tertiary strata of Japan.

Botanical affinity: Palmae.

Genus *Liliacidites* COUPER 1953.

Type species: *Liliacidites kaitangataensis* COUPER 1953.

Liliacidites variegatus COUPER

Pl. 12, fig. 28

1953. *Liliacidites variegatus* COUPER, *New Zealand Geol. Surv., Paleont. Bull.*, vol. 22, p. 56, pl. 7, figs. 98-99.

Dimensions: Length of the grain 31.5 μ, breadth of the grain 18.4 μ; exine reticulate, muri baculate, 0.6 μ high, lumen of reticulum 1 μ±in diameter.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimen is referable to *Liliacidites variegatus* COUPER from the Oligocene (Landonian) strata, Mataura Valley, Southland, New Zealand.

Botanical affinity: Liliaceae.

Subturma Dicolpates ERDTMAN 1947.

Genus *Dicolpopollis* PFLANZL 1956 ex R. POTONIÉ 1966.

Type species: *Dicolpopollis kockeli* PFLANZL 1956.

Dicolpopollis sp.

Pl. 12, fig. 26

Description: Pollen grain dicolpate; outline in polar view circular. Colpus not reaching to the pole. Exine thin, smooth. Grain size 42 μ.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen belongs to the form-genus *Dicolpopollis* established by G. PFLANZL (1956).

Botanical affinity: Unknown.

Subturma Ptychotriporines NAUMOVA 1939.

Infraturma Prolati ERDTMAN 1943.

Genus *Rhoipites* WODEHOUSE 1933.

Type species: *Rhoipites bradleyi* WODEHOUSE 1933.

Rhoipites bradleyi WODEHOUSE

Pl. 12, figs. 30-31, 33a-b

1933. *Rhoipites bradleyi* WODEHOUSE, *Bull. Torr. Bot. Club*, vol. 60, p. 513, fig. 45.

Dimensions: Length of the grains 20-25.8 μ, breadth of the grains 28.8-32 μ; exine finely reticulate.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are identifiable with *Rhoipites bradleyi* WODEHOUSE from the Eocene Green River Formation, U. S. A.

Botanical affinity: Unknown.

Rhoipites sp.

Pl. 12, fig. 29

Description: Pollen grain tricolporate;

outline in lateral view elliptical. Colpi narrow, with large ora, almost reaching to the pole. Exine very finely reticulate. Muri finely baculate. Grain size 15× 25.6 μ.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen is similar to *Rhoipites bradleyi* WODEHOUSE.

Botanical affinity: Unknown.

Genus *Foveotricolporites* PIERCE 1961.

Type species: *Foveotricolporites rhombohedralis* PIERCE 1961.

Foveotricolporites foveolatus n. sp.

Pl. 12, figs. 32a-b

Description: Pollen grain tricolporate, subprolate. Colpus with rounded pore relatively narrow. Exine thin, foveolate; lumina less than 1 μ in diameter. Grain size 30×35 μ.

Holotype: Pl. 12, figs. 32a-b; grain size 30×35 μ; slide GN 2527.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimen is similar to *Foveotricolporites voluminosus* GUZMAN from the Lower and Middle Eocene of the Tibú area, Colombia, but differs from the latter in having thin wall and smaller lumina.

Botanical affinity: Unknown.

Turma Poroses NAUMOVA 1937 emend. R. POTONIÉ 1960

Subturma Triporines NAUMOVA 1939 emend. R. POTONIÉ 1960.

Genus *Triatriopollenites* PFLUG 1953.

Type species: *Triatriopollenites rurensis* THOMSON & PFLUG 1953.

Triatriopollenites sp.

Pl. 11, figs. 10a-b

Description: Triporate pollen. Equatorial contour triangular-convex. Pores small, equatorial, sometimes one or two pores subequatorial. Exine thin, 0.7 μ thick, chagrenate, without annulus and tumenscens, but with distinctly developed atrium in the pore areas. Grain size 30 μ in diameter.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimen with developed atrium is identified with the form-genus *Triatriopllenites.*

Botanical affinity: Myricaceae.

Genus *Triporopollenites* PFLUG & THOMSON 1953 emend. R. POTONIÉ 1960.

Type species: *Triporopollenites coryloides* PFLUG 1953.

Triporopollenites festatus TAKAHASHI

Pl. 11, figs. 1-8

1961. *Triporopollenites festatus* TAKAHASHI, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 11, no. 3, p. 301, pl. 19, figs. 29-37.

1968. *Triorites festatus* (TAKAHASHI) MULLER, *Micropaleontology*, vol. 14, no. 1, p. 15, pl. 3, fig. 10.

Dimensions: Grain size 26-32.8 μ in equatorial diameter; exine 0.6-1.4 μ thick, forming annulus in the pore areas.

Occurrence: Common; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are

identified with *Triporopollenites festatus* TAKAHASHI from the Paleogene and Upper Cretaceous formations of Japan.

Botanical affinity: Betulaceae.

Genus *Momipites* WODEHOUSE 1933.

Type species: *Momipites coryloides* WODEHOUSE 1933.

Momipites sp.

Pl. 12, figs. 5-6

Description: Triporate pollen grains. Equatorial contour triangular-convex. Pore small, equatorial. Exine without atrium, annulus and labrum in the pore areas, thin, 1 μ thick, chagrenate. Grain size 16-19.5 μ in diameter.

Occurrence: Rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only two specimens were found. These specimens belong undoubtedly to the form-genus *Momipites.*

Botanical affinity: Betulaceae.

Genus *Myrtaceidites* COOKSON & PIKE 1954 ex R. POTONIÉ 1960.

Type species: *Myrtaceidites mesonesus* COOKSON & PIKE 1954.

Myrtaceidites parvus COOKSON & PIKE forma *anesus* COOKSON & PIKE

Pl. 12, figs. 7-11

1954. *Myrtaceidites parvus* COOKSON & PIKE forma *anesus* COOKSON & PIKE, *Australian Jour. Bot.*, vol. 2, no. 2, p. 206, pl. 1, figs. 27-28.

Dimensions: Grain size 12-13.6 μ in equatorial diameter; exine smooth or chagrenate; polar islands absent.

Occurrence: Common; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are identical with the species *Myrtaceidites parvus* COOKSON & PIKE forma *anesus* COOKSON & PIKE described by I. C. COOKSON and K. M. PIKE (1954) from the Eocene to Pliocene sediments in Australia.

Botanical affinity: Unknown.

Known range in Australia: Eocene to Pliocene.

Myrtaceidites parvus COOKSON & PIKE forma *nesus* COOKSON & PIKE

Pl. 12 figs. 12-24

Explanation of Plate 9

(All figures ×1000)

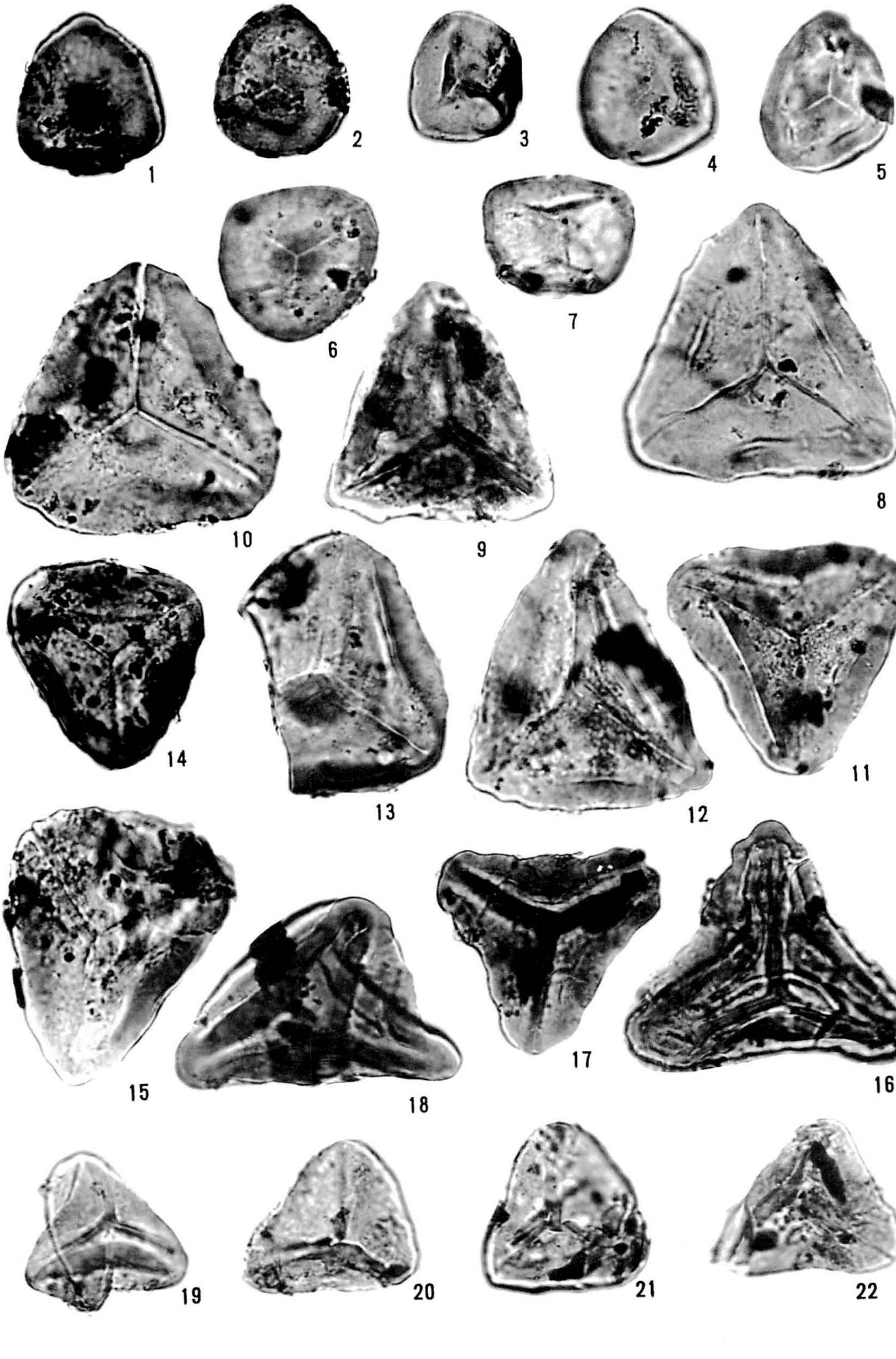
Figs. 1-7. *Stereisporites concepcionensis* n. sp.
Figs. 1, 2: slide GN 2531; fig. 3: slide GN 2533; fig. 4: slide GN 2534; fig. 5: holotype, slide GN 2536; fig. 6: slide GN 2541; fig. 7: slide GN 2548.

Figs. 8-15. *Gleicheniidites speciosus* n. sp.
Fig. 8: holotype, slide GN 2535; figs. 9, 10: slide GN 2532; fig. 11: slide GN 2540; fig. 12: slide GN 2548; fig. 13: slide GN 2533; fig. 14: slide GN 2508; fig. 15: slide GN 2536.

Figs. 16-18. *Gleicheniidites circinidites* (COOKSON) n. comb.
Fg. 16: slide GN 2507; fig. 17: slide GN 2508; fig. 18: slide GN 2537.

Eigs. 19-21. *Leiotriletes minus* n. sp.
Fig. 19: slide GN 2528; fig. 20: holotype; figs. 20, 21: slide GN 2527.

Fig. 22. *Concavisporites* sp.
Slide GN 2535.



1954. *Myrtaceidites parvus* COOKSON & PIKE forma *nesus* COOKSON & PIKE, *Australian Jour. Bot.*, vol. 2, no. 2, p. 206, pl. 1, figs. 29-31.

Dimensions: Grain size 10.7-12.5 μ in equatorial diameter; exine smooth or faintly patterned; polar islands distinct.

Occurrence: Abundant; Concepción Formation (Eocene) in the Concepción area.

Remarks: The specimens are referable to *Myrtaceidites parvus* COOKSON & PIKE forma *nesus* COOKSON & PIKE described by I. C. COOKSON K. M. PIKE (1954) from the Eocene to Pliocene formations in Australia.

Botanical affinity: Unknown.

Known range in Australia: Eocene to Pliocene.

Myrtaceidites sp.

Pl. 12, fig. 25

Description: Grain size 17.5 μ in equatorial diameter. Amb with straight or slightly convex sides. Arci prominent, polar islands absent. Exine thin, chagrenate or faintly punctate.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen coincides with the characteristics of the form-genus *Myrtaceidites.*

Botanical affinity: Unknown.

Genus *Triorites* ERDTMAN 1947
ex COUPER 1953 emend.
R. POTONIÉ 1960.

Type species: *Triorites magnificus* COOKSON 1950.

Triorites minor COUPER

Pl. 11, fig. 11

1953. *Triorites minor* COUPER, *N. Z. Geol. Surv., Paleont. Bull.*, vol. 22, p. 61, pl. 7, figs. 112-113.

Dimensions: Grain size 19.7 μ in equatorial diameter. Exine thin, punctate or chagrenate.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen coincides with the characteristics of *Triorites minor* COUPER (1953) from the Upper Cretaceous (Sub-Wangaloan) of the Kaitangata coalfield (New Zealand).

Botanical affinity: Unknown.

Triorites cf. *harrisii* COUPER

Pl. 11, figs. 21a-b

1953. *Triorites harrisii* COUPER, *N. Z. Geol. Surv., Paleont. Bull.*, vol. 22, p. 61, pl. 7, fig. 111.

Dimensions: Grain size 20.8 μ in equatorial diameter. Ora 3.2-4.8 μ in diameter. Exine thin, annulus and labrum around ora, chagrenate.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. This specimen is closely similar to *Triorites harrisii* COUPER described by R. A. COUPER (1953) from the Oligocene sediments in the Ford's Old Lignite Mine, Southland (New Zealand).

Botanical affinity: Unknown.

Genus *Subtriporopollenites* PFLUG & THOMSON 1953.

Type species: *Subtriporopollenites simplex* (R. POTONIÉ 1931) THOMSON & PFLUG 1953.

Subtriporopollenites rotundulus n. sp.

Pl. 11, figs. 9, 12-13; pl. 12, fig. 4

Description: Pollen grain triporate. Grain circular to subtriangular in polar view. Pores circular, 2.4 μ in diameter; one or two pores subequatorial. Exine 0.8-1.5 μ thick, chagrenate, annulus in the areas. Grain size 30.6-36.6 μ in equatorial diameter.

Holotype: Pl. 11, fig. 12; grain size 32 μ in equatorial diameter; exine 1 μ thick, chagrenate; slide GN 2530.

Occurrence: Few; Concepción Formation (Eocene) in the Concepción area.

Remarks: The present specimens are similar to the Japanese species *Subtriporopollenites kyushuensis* TAKAHASHI (1961, p. 305-306, pl. 20, figs. 35-37; pl. 21, figs. 1-10), but the former differs from the latter in structure of exine in the pore areas (annulus).

Botanical affinity: Juglandaceae—? *Carya.*

Subtriporopollenites falsus n. sp.

Pl. 11, figs. 14-20; pl. 12, figs. 2-3

Description: Pollen grain triporate. Grain circular to subtriangular with rounded sides in polar view. Pores small, circular to elliptical; all pores subequatorial, sometimes one pore equatorial. Exine sometimes with weak annulus and labrum, less than 1.5 μ thick, chagrenate or faintly punctate. Grain size 21.5-29 μ in equatorial diameter.

Holotype: Pl. 11, fig. 19; grain size 26.5 μ in equatorial diameter; pore 1.7 μ

Explanation of Plate 10

(All figures ×1000)

Fig. 1. *Leiotriletes microadriennis* KRUTZSCH
Slide GN 2530.

Figs. 2-3. *Triplanosporites minor* n. sp.
Fig. 2: slide GN 2533; fig. 3: holotype, slide GN 2532.

Fig. 4. *Triplanosporites* sp.
Slide GN 2532.

Eig. 5. ? *Punctatisporites* sp.
Slide GN 2526.

Figs. 6-10. *Laevigatosporites ovulatus* n. sp.
Figs. 6, 7: slide GN 2536; fig. 7: holotype; fig. 8: slide GN 2534; fig. 9: slide GN 2537; fig. 10: slide GN 2535.

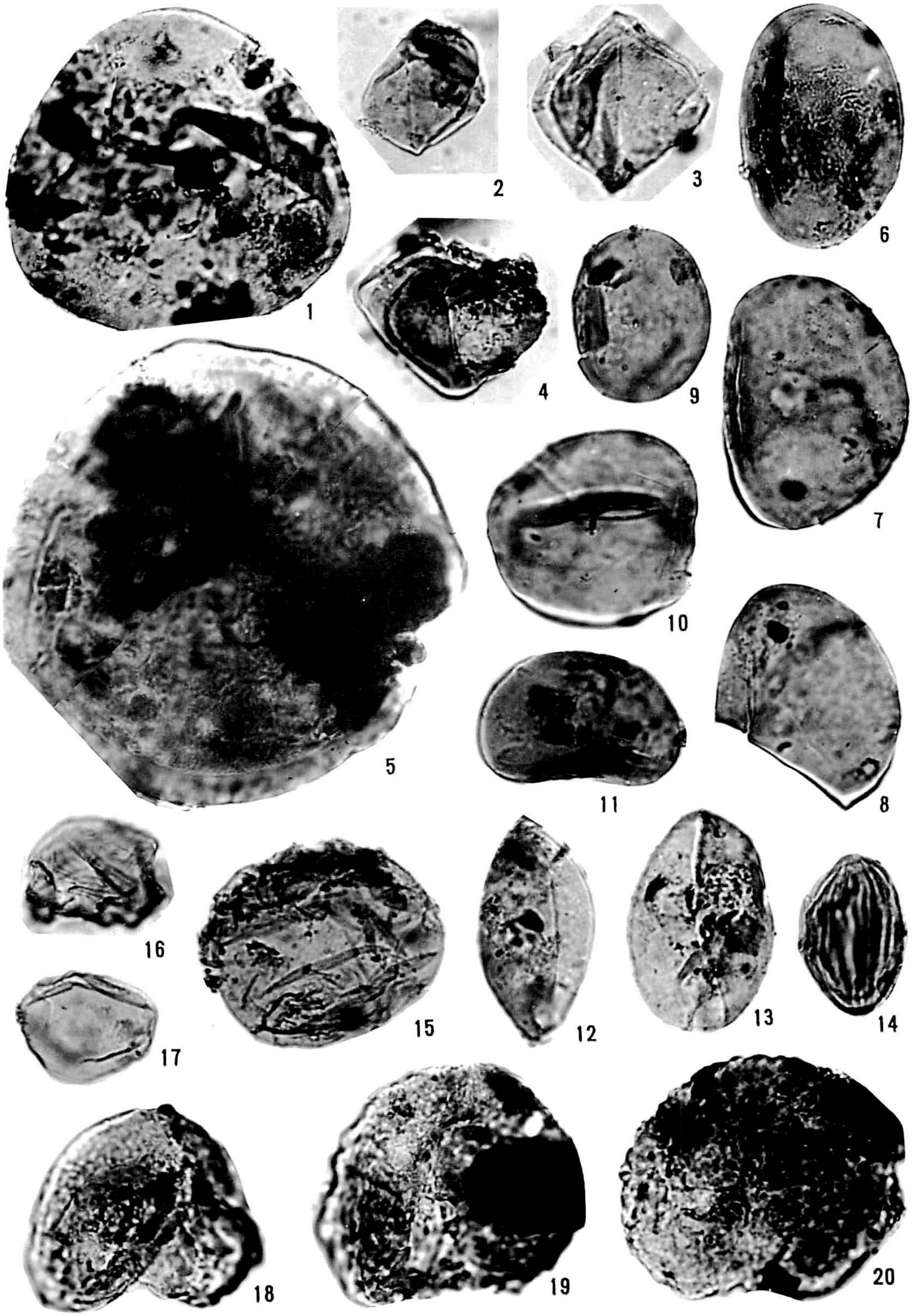
Fig. 11. *Laevigatosporites dehiscens* TAKAHASHI
Slide GN 2507.

Figs. 12-13. *Monocolpopollenites* cf. *kyushuensis* TAKAHASHI
Fig. 12: slide GN 2533; fig. 13: slide GN 2540.

Fig. 14. *Ephedripites* sp.
Slide GN 2508.

Figs. 15-17. *Inaperturopollenites laevigatus* TAKAHASHI
Figs. 15, 16: slide GN 2532; fig. 17: slide GN 2533.

Figs. 18-20. *Dacrydiumites* cf. *florinii* COOKSON & PIKE
Figs. 18, 19: slide GN 2530; fig. 20: slide GN 2539.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in diameter; exine thin, chagrenate; slide GN 2536.

Occurrence: Abundant; Concepción Formation (Eocene) in the Concepción area.

Remarks: The Japanese species *Subtriporopollenites kyushuensis* TAKAHASHI (1961, p. 305-306, pl. 20, figs. 35-37; pl. 21, figs. 1-10) is compared with the present specimens.

Botanical affinity: Juglandaceae—? *Carya*.

Subtriporopollenites levius TAKAHASHI

Pl. 12, fig. 1

1961. *Subtriporopollenites levius* TAKAHASHI *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 11, no. 3, p. 306, pl. 21, fig. 12.

Dimensions: Grain size 20 μ in equatroial diameter; exine thin, roughly rugulate.

Occurrence: Very rare; Concepción Formation (Eocene) in the Concepción area.

Remarks: Only one specimen was found. The present specimen belongs to the species *Subtriporopollenites levius* TAKAHASHI (1961) from the Lower Oligocene formations of the Kasuya and Karatsu coalfields in north Kyushu, Japan. The former is smaller in size than the latter.

Botanical affinity: ? Juglandaceae.

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Explanation of Plate 11

(All figures ×1000)

Figs. 1-8. *Triporopollenites festatus* TAKAHASHI
Fig. 1: slide GN 2532; fig. 2: slide GN 2508; figs. 3, 4: slide GN 2507; fig. 5: slide GN 2528; fig. 6: slide GN 2538; fig. 7: slide GN 2530; fig. 8: slide GN 2536.

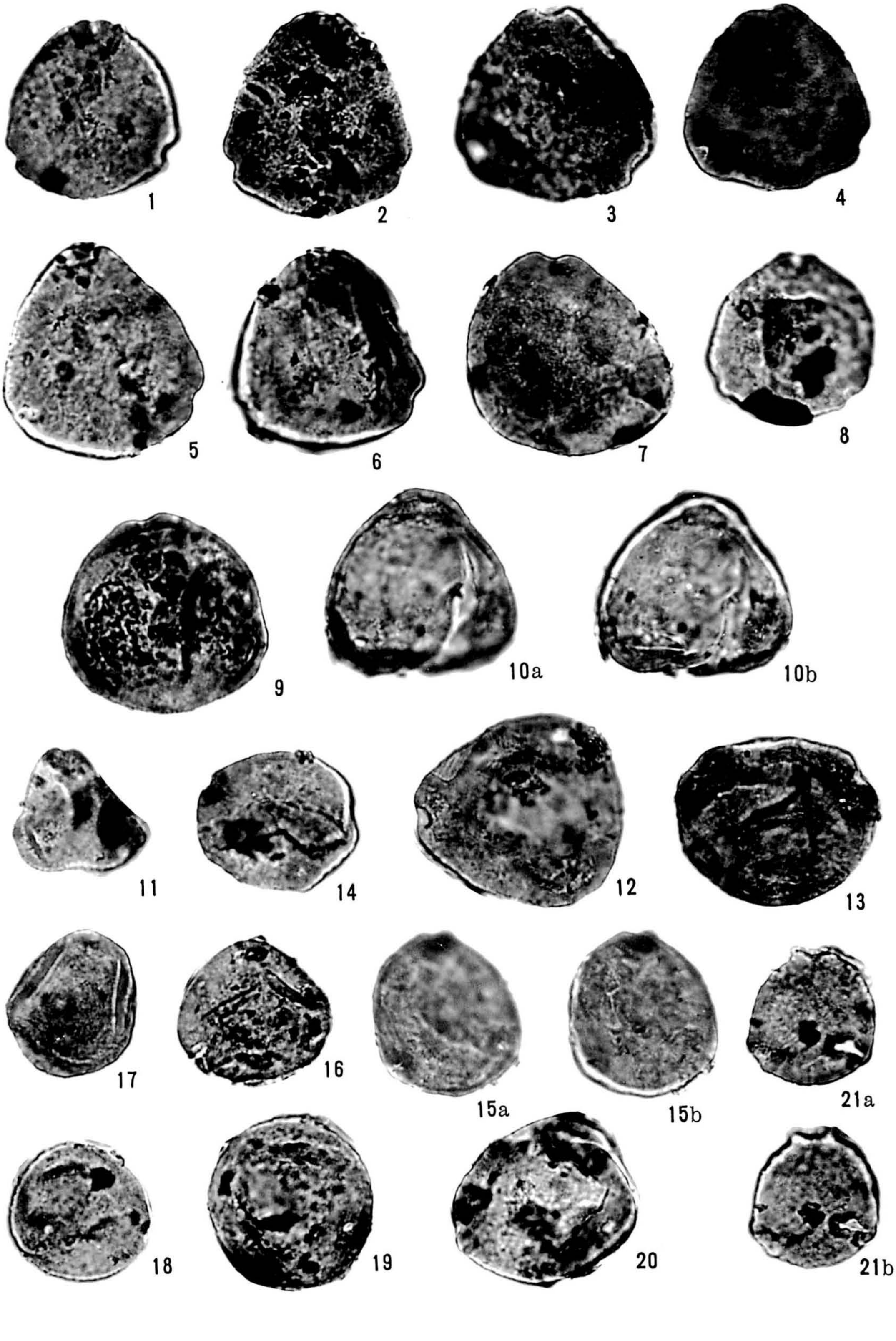
Figs. 9, 12, 13. *Subtriporopollenites rotundulus* n. sp.
Fig. 9: slide GN 2528; fig. 12: holotype, slide GN 2530; fig. 13: slide GN 2508.

Figs. 10a-b. *Triatriopollenites* sp.
Slide GN 2529.

Fig. 11. *Triorites minor* COUPER
Slide GN 2536.

Figs. 14-20. *Subtriporopollenites falsus* n. sp.
Fig. 14: slide GN 2535; fig. 15: slide GN 2532; fig. 16: slide GN 2538; fig. 17: slide GN 2534; fig. 18: slide GN 2537; fig. 19: holotype, slide GN 2536; fig. 20: slide GN 2527.

Figs. 21a-b. *Triorites* cf. *harrisii* COUPER
Slide GN 2538.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Explanation of Plate 12

(All figures ×1000)

Fig. 1. *Subtriporopollenites levius* TAKAHASHI
Slide GN 2536.

Figs. 2-3. *Subtriporopollenites falsus* n. sp.
Fig. 2: slide GN 2539; fig. 3: slide GN 2532.

Fig. 4. *Subtriporopollenites rotundulus* n. sp.
Slide GN 2528.

Figs. 5-6. *Momipites* sp.
Fig. 5: slide GN 2533; fig. 6: slide GN 2536.

Figs. 7-11. *Myrtaceidites parvus* COOKSON & PIKE forma *anesus* COOKSON & PIKE
Fig. 7: slide GN 2538; figs. 8, 11: slide GN 2535; fig. 9: slide GN 2532; fig. 10: slide GN 2533.

Fgs. 12-24. *Myrtaceidites parvus* COOKSON & PIKE forma *nesus* COOKSON & PIKE
Fig. 12: slide GN 2534; figs. 13-17, 21: slide GN 2535; figs. 18, 24: slide GN 2539; figs. 19, 20, 23: slide GN 2536; fig. 22: slide GN 2508.

Fig. 25. *Myrtaceidites* sp.
Slide GN 2534.

Fig. 26. *Dicolpopollis* sp.
Slide GN 2536.

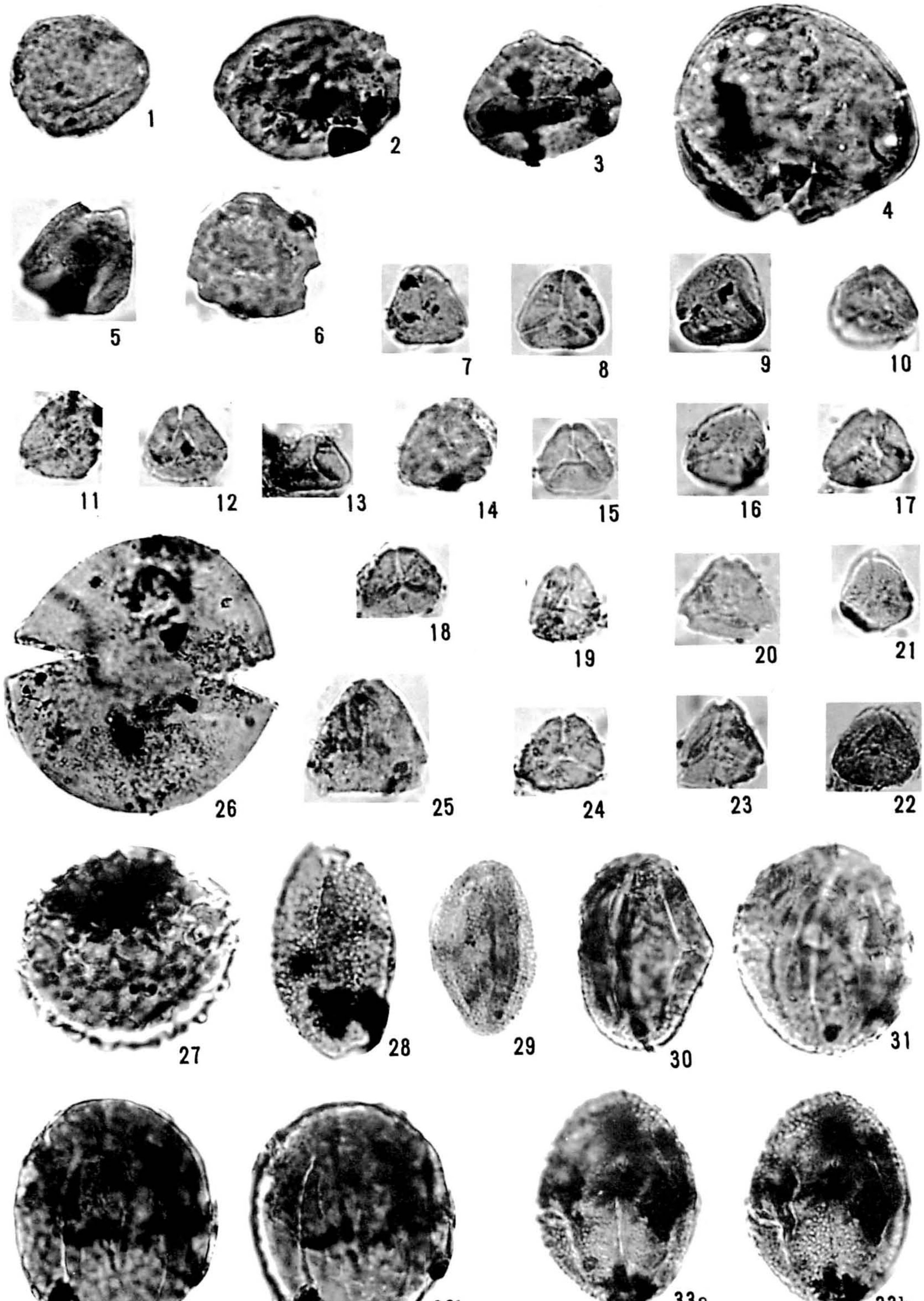
Fig. 27. *Smilacipites setarius* (POTONIÉ) POTONIÉ
Slide GN 2530.

Fig. 28. *Liliacidites variegatus* COUPER
Slide GN 2532.

Fig. 29. *Rhoipites* sp.
Slide GN 2525.

Figs. 30-31, 33a-b. *Rhoipites bradleyi* WODEHOUSE
Fig. 30: slide GN 2530: fig. 31: slide GN 2529; fig. 33: slide GN 2532.

Figs. 32a-b. *Foveotricolporites foveolatus* n. sp.
Holotype, slide GN 2527.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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 106, pp. 89-99, pl. 13, 14, June 30, 1977

677. UPPER PERMIAN FUSULINACEANS CONTAINED IN THE PEBBLES OF THE BASAL CONGLOMERATE OF THE ADOYAMA FORMATION, KUZU, TOCHIGI PREFECTURE, JAPAN

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栃木県葛生付近のアド山層基底礫岩の礫に含まれる上部二畳系のフズリナについて：アド山層は三畳系で，基底部に石灰岩礫岩が発達し中部二畳系の鍋山層を不整合におおう。この礫岩の礫に上部二畳系を指示するフズリナが含まれ，鍋山層が大きく削剝されたことを示す．これらフズリナを記載すると共に，不整合の意義を論じた。　猪郷久義・猪郷久治

Introduction

Upper Paleozoic and Lower Mesozoic rocks are widely distributed in the Kuzu district, Tochigi Prefecture, about 80 km north of Tokyo. YOSHIDA (1956, 1957), FUJIMOTO (1961), WATANABE et al. (1957), HATORI (1965), SHOJI (1967), YANAGIMOTO (1973) and others have contributed to geology and sedimentology of this district. Although no comprehensive paleontological works have been published, MORIKAWA and HORIGUCHI (1956), MORIKAWA and TAKAOKA (1961), IGO (1964a) and several others described some Middle Permian fusulinaceans from the Nabeyama Formation.

Recently, Triassic conodonts were recovered from the Adoyama Formation which overlies unconformably the Nabeyama Formation. Thus the stratigraphy and geochronology of the Aso and Tochigi Groups in this district were considerably revised by KOIKE, IGO, IGO and KINOSHITA (1974). The purpose of this paper is to discuss the geological significance of the unconformity between the Permian Nabeyama and Triassic Adoyama Formations and to describe some Upper Permian fusulinaceans contained in the pebbles of basal conglomerate of the Adoyama Formation. To date, this fusulinacean faunule rarely occurs in Japan. Fusulinaceans treated herein are *Codonofusiella* sp., *Paradoxiella* sp., *Dunbarula suzukii* IGO and IGO, n. sp., *Reichelina changhsingensis* SHENG and CHANG, *Nankinella kuzuensis* IGO and IGO, n. sp., *Yabeina globosa* (YABE) and *Yabeina kanmerae* IGO.

* Received Feb. 22, 1977; read Jan. 16, 1973 at Sendai.

Geologic Setting

We revised the stratigraphy of the Permian and Triassic rocks in this district as shown in Fig. 1. The Aso Group of our definition is subdivided into two formations, namely, the Izuru and Nabeyama Formations in ascending order.

The Izuru Formation consists mainly of dark green, dark gray and partly variegated basic tuff, agglomerate and lava. These volcanoclastic and volcanic series are 500 m in maximum thickness, but vary their thickness by the thrust fault. The Nabeyama Formation overlies conformably the Izuru and consists mainly of limestone and dolostone. This formation is subdivided into the lower Yamasuge Limestone, middle Hanezuru Dolostone and upper Karasawa Limestone Members. This calcareous facies attains about 300 m in maximum thickness. *Parafusulina* and other Middle Permian fusulinaceans are very abundant at various levels and localities. They represent almost entire part of the Zone of *Parafusulina*.

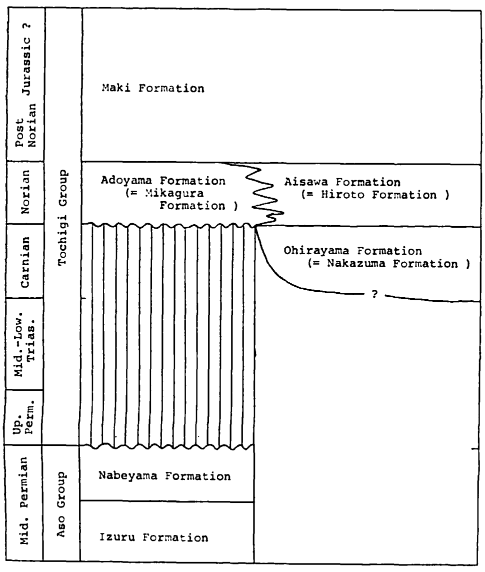

Fig. 1. Stratigraphy and Geochronology of the Aso and Tochigi Groups.

The Tochigi Group of our sense can be subdivided into the following four lithologic units, such as, Adoyama, Aisawa, Ohirayama and Maki Formations and these lithologic units are mostly Triassic in age. The Hiroto, Mikagura and Nakazuma Formations proposed by the previous authors are contemporaneous with the Aisawa, Adoyama and Ohirayama Formations, respectively. The Adoyama Formation consists mainly of chert and shale and about 80 to 450 m in thickness. The basal part of this formation is locally limestone conglomerate and unconformably overlies the Nabeyama Formation. There can be observed very interesting features of the buried karst topography, crevices, shafts or wells sinkhole and caves at the base of the Adoyama. The basal part of the Adoyama is typically exposed at the northern part of the quarry of Miyata Lime Industry Co. Ltd at Semba, north of Kuzu Town.

The following succession is exposed at this quarry in descending order.

Chert; red to green, thin-bedded, intercalating thin layers of siliceous shale, radiolarian remains, conodonts, sponge spicules, arenaceous foraminifers and many other microfossils .... more than 50 m thick.

Shale; dark gray, occasionally red and green, intercalating bedded chert, radiolarian remains and conodonts .... about 6 m thick.

Limestone conglomerate; consisting of various shaped and sized pebbles of limestone, dolostone and chert cemented by calcarenite and calcilutite .... variable in thickness, 0 to 10 m thick.

———unconformity———

Limestone; massive, pale gray to white, partly silicified and dolomitized.. .... 0 to 4 m thick.

Limestone; coquinoidal, composed of silicified shells of *Parafusulina* and other fragments of invertebrate fossils ....about 9 m thick.

Limestone; gray, massive or thickly bedded, highly fossiliferous and containing black chert concretions ....more than 80 m thick.

Upper Permian fusulinaceans described herein were collected from the boulder of the basal conglomerate of the Adoyama Formation.

The Aisawa Formation was once considered as Permian, but it yields Triassic conodonts, such as *Epigondolella abneptis*, *E. postera* and others. It consists mainly of shale and sandstone and intercalating thin layers of chert and chert breccia. Thickness of this formation was estimated as 1500 m by FUJIMOTO (1961). According to our recent observation, however, this formation is repeated by folding and the true thickness is thinner than 500 m.

The Ohirayama and Nakazuma Formations are also composed of chert. The former unit attains approximately 800 m and the latter is about 700 m in thickness. They yield *Epigondolella nodosa*, *Gladigondolella tethydis*, *Neogondolella polygnathiformis*, *Neospathodus* sp. and are considered to be Carnian.

From the above mentioned revised stratigraphy, the geologic history in this district during the Permian and Triassic is summarized as follow. The Nabeyama Formation started its calcareous deposition on the elevated submarine volcanic rise consisting of the Izuru Formation in Middle Permian and continued up to the end of Permian. The upper part of these carbonate deposits apparently comprises the *Neoschwagerina*, *Yabeina*, *Codonofusiella-Reichelina* and *Palaeofusulina-Reichelina* Zones. However, the Nabeyama Formation was deeply denuded and more than two-thirds of this formation was eroded away. The Upper Triassic Adoyama overlies unconformably this etched surface of carbonate rocks. The lime-sand and lime-silt consisting of the matrix of the basal conglomerate of the Adoyama yield Upper Scythian species of conodonts intermingled with Middle to Upper Triassic conodonts. Therefore, the denudation before the deposition of the Adoyama was first started in Early Scythian and repeated calcareous condensed deposition and subsequent denudation until late Carnian or Norian. The mixed reworked conodonts ranging from the Upper Scythian to Norian show the mentioned sedimentation and erosion. Chert-rich facies of the Norian Adoyama Formation laterally changed into shale and sandstone facies of the Aisawa and Hiroto Formations. The Ohirayama and Nakazuma Formations consisting mainly of chert represent the Carnian off-shore sediments and are overlain by the Aisawa and Hiroto Formations.

The Maki Formation consisting mainly of sandstone is probably Jurassic in age and overlies Triassic formations. However, the stratigraphic relationship between the Upper Triassic formations and the Maki Formation still remains unknown.

Fusulinacean faunule contained in the pebbles of the Aisawa Formation and its geological significance

FUJIMOTO (1961) reported the occurrence of *Yabeina columbiana* (DAWSON) and *Neoschwagerina* spp. from the

Karasawa Limestone Member. Therefore, the upper part of the Karasawa Limestone Member was correlated with the Upper Permian by several subsequent authors. However, it is evident that these Upper Permian fusulinaceans are apparently derived fossils by the remarkable denudation before the deposition of the Adoyama Formation.

Upper Permian fusulinacean-bearing limestone boulders in the basal conglomerate of the Adoyama show two types of lithic character. One is algal-biosparitic gray limestone and more than 2 m in diameter. The other is microcrystalline black limestone and more than 1 m in diameter. The former is numbered 4052A and the latter is 4052B. Fusulinacean faunule contained in 4052A is as follows; namely:—

Dunbarula suzukii IGO and IGO, n. sp. .... common
Reichelina changhsingensis SHENG and CHANG .... common
Nankinella kuzuensis IGO and IGO ....rare

The following species are yielded from 4052B, such as:

Yabeina kanmerae IGO............abundant
Yabeina globosa (YABE) ....rare
Codonofusiella sp. ....rare
Paradoxiella sp. ....rare
Dunbarula sp. ....rare

Dunbarula suzukii is similar to *Dunbarula paleofusulinaeformis* SHENG described from the Wuchiaping Limestone in South China. *Nankinella kuzuensis* is similar to *Nankinella quasihunanensis* SHENG and *N. hunanensis* (CHEN) described from the uppermost Permian of South and Northwest China. Therefore, the faunule contained in 4052A can be correlated with the Upper Permian fauna of the Wuchiaping or Changhsing Limestone.

Fusulinacean faunule came from 4052A is characterized by *Yabeina kanmerae* IGO which was originally described from the Kono Formation of the Nyukawa Group in Hida Massif, Central Japan. Although the occurrence is rare, the association of *Paradoxiella* sp., *Codonofusiella* sp. and *Dunbarula* sp. is also worthy to note. This faunule can be correlated with the upper part of the *Yabeina* Zone in Japan and slightly older than the faunule contained in 4052A.

To date, the uppermost Permian Lopingian fusulinacean fauna is rather poorly known in Japan. The Mitai Formation in Miyazaki Prefecture and the uppermost part of the Tsukumi Limestone in Oita Prefecture, both in Kyushu contain rather prolific *Codonofusiella-Reichelina* and *Palaeofusulina-Reichelina* faunas (KANMERA, in KANMERA and NAKAZAWA, 1973). The upper part of the Maizuru Group distributed in the Maizuru Belt also contains the *Palaeofusulina* fauna (NOGAMI, 1958). SAITO and KATO (1971) briefly reported the occurrence of *Reichelina* and other upper Permian foraminifers from Umeki, slightly north of the present area. Recently, KOBAYASHI (1975) described the *Palaeofusulina-Reichelina* fauna from the pebbles of the Triassic conglomerate in the Itsukaichi district, west of Tokyo. The present discovery of the *Reichelina-Dunbarula* faunule from the Triassic conglomerate and KOBAYASHI's (1975) observation show considerable denudation took place in certain areas in Japan after the end of Permian and before the deposition of the Upper Scythian. There are positive possibilities that the uppermost Permian fusulinacean fauna will be found from the Triassic pebbly facies in various regions in Japan.

Description of Species

Genus *Reichelina* ERK, 1941

Reichelina changhsingensis SHENG and CHANG

Pl. 13, figs. 21-24

Reichelina changhsingensis SHENG and CHANG, 1958, p. 211, pl. 1, figs. 1-11; SHENG 1963, p. 150-151, pl. 1, figs. 23-29.

Shell lenticular, minute, planispiral and involute with slightly convex polar regions, short axis of coiling and uncoiled last volution. Inner one or two volutions with rounded periphery. Axial length 0.13 to 0.20 mm, median width 0.80 to 2.08 mm with uncoiled portion and form ratio 1 : 0.03 to 1 : 0.25. Proloculus minute, spherical and about 25 to 45 μ in outside diameter.

Spirotheca thin, composed of two layers of thin tectum and diaphanotheca. Septa also thin, almost plane and arcuate anteriorly in outer volutions. Chomata low, extending to polar regions and slightly asymmetrical. Tunnel low and slit-like. Axial filling weak and restricted to axial region.

Remarks:—The present material is very similar to the Chinese specimens described by SHENG and CHANG from the Changhsing and Wuchiaping Limestones. *Reichelina matsushitai* NOGAMI is also allied species to our specimens, but the former has rather thin uncoiled part in the axial section.

Occurrence:—Commonly yielded from 4052A, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5000, 5001, 5002, 5003, 5004, 5005.

Genus *Nankinella* LEE, 1933

Nankinella kuzuensis IGO and IGO, n. sp.

Pl. 13, figs. 1-6

Shell minute, thickly discoidal with narrowly angular to bluntly pointed periphery and convex polar regions. The holotype specimen consists of 5 1/2 volutions and attains 0.83 mm in length, 1.68 mm in median diameter, giving a form ratio 1 : 0.5. Proloculus minute, spherical and about 45 μ in outside diameter.

Spirotheca relatively thin and composed of tectum and lower less dense layer, but secondary mineralization obliterates detailed structure of spirotheca. Septa numerous, not fluted and plane. Chomata low, asymmetrical and extending laterally to polar regions. Tunnel narrow, low and having rather irregular path.

Remarks:—This new species resembles *Nankinella quasihunanensis* SHENG and *Nankinella hunanensis* (CHEN) described from the Wuchiaping Limestone and Chinghsichung Limestone of South China,

Table 1. Measurements of *Reichelina changhsingensis* SHENG & CHANG (in mm.)

Specimen	L.	W.	F. R.	D. P.	Height of volutions				Thickness of spirotheca			
					1	2	3	4	1	2	3	4
10	0.13	2.08	0.06	0.03	0.03	0.04	0.07	0.87	—	0.008	0.008	0.008
12	0.20	0.80	0.25	0.04	0.02	0.03	0.06	0.50	0.005	0.018	0.010	0.020
13	0.18	0.50	0.35	0.02	0.02	0.02	0.07	0.20	0.005	0.005	0.010	0.005
15	0.20	1.13	0.18	0.04	0.02	0.03	0.10	0.55	0.003	0.005	0.010	0.003
16	0.13	0.75	0.17	0.03	0.02	0.05	0.06	0.50	0.003	0.003	0.003	0.003

Table 2. Measurements of *Nankinella kuzuensis* IGO & IGO, n. sp. (in mm.)

Specimen	L.	W.	F. R.	D. P.	Height of volutions						Thickness of spirotheca				
					1	2	3	4	5	6	1	2	3	4	5
20	0.83	1.68	0.49	0.04	0.06	0.15	0.17	0.20	0.18		0.02	0.02	0.03	0.03	0.03
21	0.88	1.30	0.67	0.03	0.03	0.04	0.07	0.10	0.17	0.22	0.02	0.02	0.03	0.05	0.03
22	1.08	1.75	0.61	0.07	0.06	0.12	0.15	0.17	0.27		0.02	0.02	0.02	0.02	0.02
23	0.50	1.20	0.42	0.05	0.05	0.10	0.12	0.25			—	—	0.02	0.02	
24	0.38	0.73	0.51	0.02	0.05	0.07	0.10	0.12			—	0.01	0.02	0.02	

respectively. It can be easily distinguished from the latters by less numerous and smaller shell at maturity.

Occurrence:—Rare in 4052A, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5006 (Holotype), 5007, 5008, 5009, 5010, 5011, 5012 (Paratypes)

Genus *Dunbarula* CIRY, 1948

Dunbarula suzukii IGO and IGO, n. sp.

Pl. 13, figs. 7-20

Shell small, short fusiform with inflated median part and bluntly pointed poles. Mature shells having 5 to 5 1/2 volutions. Axial length 1.60 to 2.00 mm, median diameter 0.88 to 1.25 mm, and from ratio 1 : 1.7 to 1 : 2.4 in well-oriented mature specimens.

Inner two to three volutions discoidal or lenticular and coiled almost right angle to the later volutions. Spirotheca composed of thin tectum and underlying thicker diaphanothecal layer. Spirotheca thin, 5 to 20 μ in inner juvenile volutions. Proloculus minute, spherical and its outside diameter 30 to 50 μ. Septa numerous, more or less strongly and rather irregularly fluted throughout shell. Chomata rather distinct in outer volutions and asymmetrical. Tunnel low and rather narrow and having irregular path.

Remarks:—The present new species is very similar to *Dunbarula paleofusulinaeformis* SHENG described from the Wuchiaping Limestone, Kueichou, South China in many respects. However, *Dunbarula suzukii* has weaker septal fluting, smaller proloculus and more distinct chomata than the Chinese species.

Occurrence:—Common in 4052A, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5013 (Holotype), 5014, 5015, 5016, 5017, 5018, 5019, 5020, 5021, 5022, 5023, 5024, 5025 (Paratypes)

Genus *Paradoxiella* SKINNER and WILDE, 1955

Paradoxiella sp.

Pl. 13, figs. 25, 26

Remarks:—Several incomplete specimens were obtained. Minute shell consists of 3 to 3 1/2 volutions and with uncoiled disc-shaped flare. General biocharacters are identical with those of *Paradoxiella* SKINNER and WILDE. However, we could not obtain any complete horizontal axial section and specific identification is reserved. ISHII and TAKAHASHI (1960) described *Paradoxiella japonica* from the Ogamata Formation distributed in the Kanto Massif. The

Table 3. Measurements of *Dunbarula suzukii* IGO & IGO, n. sp. (in mm.)

Specimen	L.	W.	F.R.	D.P.	Height of volutions						Thickness of spirotheca					
					1	2	3	4	5	6	1	2	3	4	5	6
1	1.75	0.88	2.00	0.05	0.04	0.06	0.09	0.13	0.29		0.008	0.013	0.018	0.038	0.025	
2	2.00	0.85	2.35	0.03	0.02	0.04	0.04	0.07	0.15	0.19	0.005	0.005	0.008	0.025	0.028	0.025
3	—	1.25	—	0.05	0.05	0.05	0.07	0.04	0.08		0.008	0.018	0.023	0.013	0.025	
4	1.70	1.03	1.66	0.04	0.05	0.10	0.15	0.22			—	0.013	0.020	0.025		
5	1.93	0.83	2.33	0.03	0.05	0.06	0.12	0.18			0.013	0.015	0.025	0.030		
6	1.50	0.80	1.88	—	—	0.03	0.07	0.11	0.17		—	0.005	0.013	0.030	0.045	
7	1.88	1.05	1.79	0.05	—	0.03	0.05	0.15	0.22		—	0.003	0.020	0.025	0.045	
8	1.60	0.88	1.82	0.05	—	0.03	0.06	0.15	0.22		—	0.005	0.010	0.030	0.023	
9	1.63	1.03	1.59	0.05	—	0.05	0.10	0.12	0.20		—	0.008	0.013	0.030	0.025	

present material resembles *Paradoxiella japonica* in several respects.

Occurrence:—Very rare in 4052B, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5026, 5027, 5028.

Genus *Yabeina* DEPRAT, 1914

Yabeina kanmerae IGO

Pl. 14, fig. 2-7

Yabeina kanmerae IGO, 1964b, p. 647, pl. 106, figs. 1-4.

Shell large, highly inflated fusiform with convex lateral slopes and bluntly rounded poles. Mature specimens have 21 to 25 volutions. The largest specimen 13.20 mm in axial length, 8.40 mm in median diameter and 1:1.57 in form ratio. Inner one or two volutions commonly discoidal and coiled askew to later volutions. Proloculus very small, spherical and 33 to 80 μ in outside diameter.

Spirotheca thin, consists of tectum and fine alveolar keriotheca. Thickness of spirotheca about 10 μ in juvenile volutions, 50 to 80 μ in outer volutions. Septa also thin, numerous, rather widely spaced and unfluted throughout. Septal counts 30 to 35 in 20th and later volutions. Axial septula variable both in shape and numbers per chamber. One axial septulum developed in inner fourth to sixth volutions, commonly 2 or 4 in 8th to outer volutions, 4 to 10 in 20th volution. Primary transverse septula thin, appear throughout shell, unite with thin and rather high delicate parachomata and about one half of height of volutions in younger stages, but about one third in adult stages. Secondary transverse septula also thin, short and delicate. They first appear in 8th or

9th volutions and regularly alternate with primary transverse septula in 10th or 11th volution and outerward. Two secondary transverse septula rarely appear between adjacent primary septula in outer volutions.

Remarks:—*Yabeina kanmerae* was first described from the Kono Formation of the Nyukawa Group. Hisayoshi IGO pointed out that this species resembles *Yabeina columbiana* (DAWSON) in many respects, but it differs from the latter in slightly larger shell, higher chambers in the adult stage and small proloculus. *Yabeina syrtalis* (DOUVILLÉ) which was fully redescribed by SKINNER and WILDE (1967) from Tunisia is also an allied species.

Occurrence:—Abundant in 4052B, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5029, 5030, 5031, 5032, 5033, 5034.

Yabeina globosa (YABE)

Pl. 14, fig. 1

Neoschwagerina globosa YABE, 1906, p. 4, pl. 1, fig. 5, pl. 3, fig. 1; OZAWA, 1927, p. 159-160, pl. 41, figs. 2, 9, pl. 42, figs. 1, 2, 4, 6, pl. 43, figs. 1b, 4; *Yabeina globosa*, MORIKAWA and SUZUKI, 1961, p. 67-68, pl. 10, fig. 2, pl. 16, fig. 8, pl. 21, fig. 1.

[For further synonymy refer KAHLER (1966, p. 818-819).]

Remarks:—We have obtained several sectioned specimens associated with *Yabeina kanmerae*. They have 18 to 21 volutions measuring 11.4 to 11.8 mm in length and 7.3 to 8.2 mm in median diameter. Primary transverse septula developed throughout, united with thick and high parachomata especially in outer volutions. Secondary transverse septula first appear in 6th or 7th volution. General biocharacters are very similar to the topotype specimens came from the Akasaka Limestone.

Occurrence:—Rare in 4052B, Semba, Kuzu Town, Aso County, Tochigi Prefecture.

Reg. nos. 5035, 5036.

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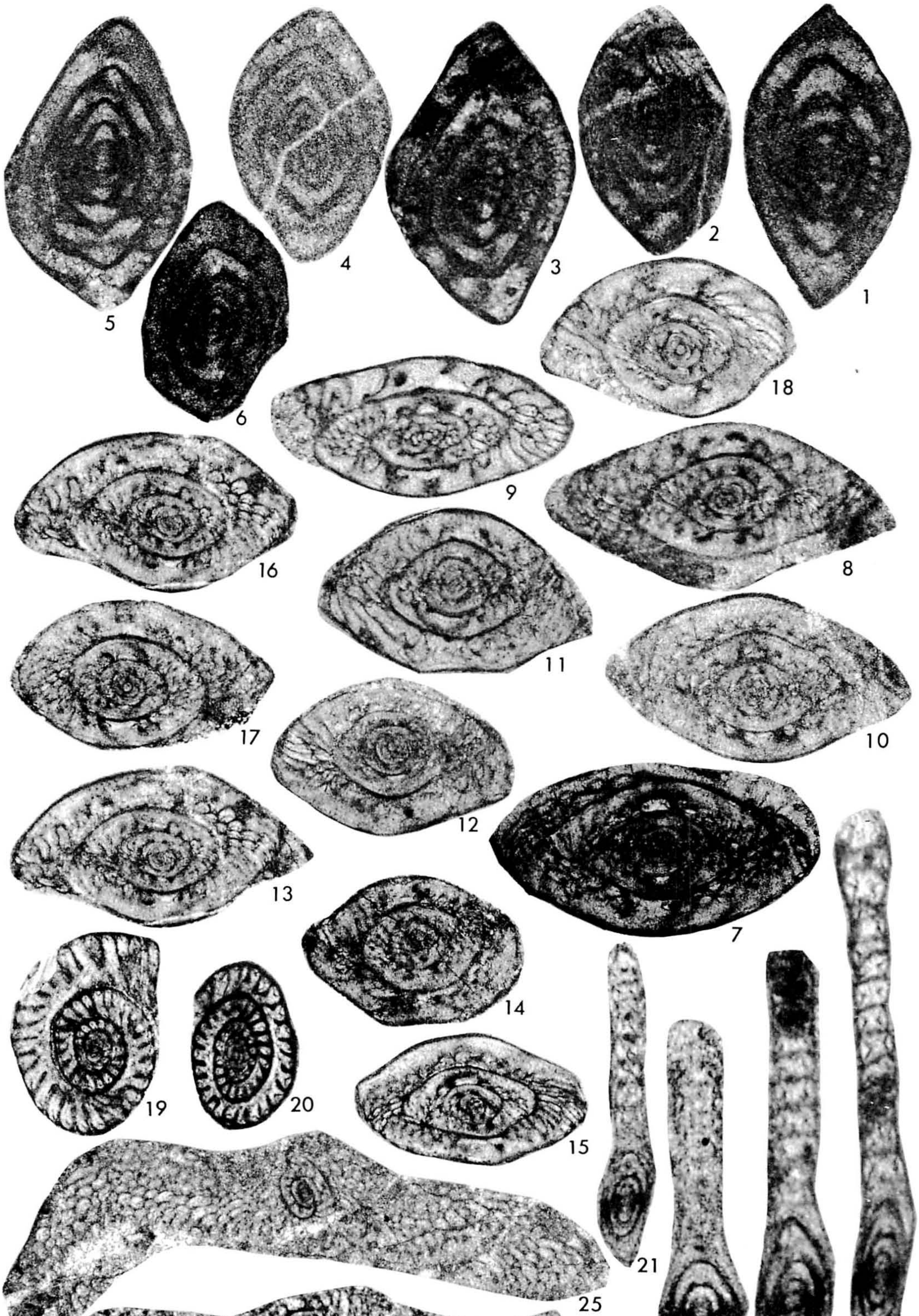
Explanation of Plate 13

Figs. 1-6. *Nankinella kuzuensis* IGO and IGO, n. sp.
1, Axial section of the holotype; 2, 4-6, axial sections of paratypes; 3, tangential section of paratype; ×30.

Figs. 7-20. *Dunbarula suzukii* IGO and IGO, n. sp.
7, Axial section of the holotype; 8-18, axial sections of paratypes; 19, 20, sagittal sections of paratypes; ×25.

Figs. 21-24. *Reichelina changhsingensis* SHENG and CHANG
Axial sections, ×30.

Figs. 25, 26. *Paradoxiella* sp.
Sagittal sections, ×30.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ADACHI of the University of Tsukuba for typing this manuscript.

Repository:—All specimens described in this paper are preserved at the Institute of Geoscience, the University of Tsukuba.

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Table 4. Measurements of *Yabeina kanmerae* IGO (in mm.)

Specimen	L.	W.	F.R.	D.P.	Height of volutions									
					1	2	3	4	5	6	7	8	9	10
3	11.20	8.60	1.38	0.05	0.05	0.05	0.07	0.07	0.12	0.11	0.13	0.16	0.17	0.20
4	13.20	8.40	1.57	0.08	0.01	0.07	0.07	0.15	0.16	0.16	0.17	0.19	0.18	0.45
5	11.60	9.10	1.27	0.03	0.02	0.03	0.03	0.07	0.10	0.10	0.12	0.14	0.16	0.17
6	10.30	7.07	1.46	0.04	0.04	0.02	0.15	0.09	0.12	0.13	0.15	0.17	0.21	0.21
7		7.63		0.05	0.03	0.06	0.05	0.08	0.18	0.12	0.14	0.15	0.17	0.16

Height of volutions														
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.20	0.20	0.20	0.26	0.31	0.25	0.27	0.32	0.32	0.30	0.32				
0.19	0.24	0.24	0.12	0.39	0.29	0.30	0.31							
0.17	0.21	0.25	0.30	0.25	0.27	0.27	0.30	0.27	0.27	0.27	0.27	0.30	0.28	0.27
0.21	0.24	0.24	0.24	0.31	0.21	0.21	0.31							
0.18	0.21	0.24	0.21	0.23	0.26	0.24	0.18	0.27	0.21					

Specimen	Thickness of spirotheca											
	1	2	3	4	5	6	7	8	9	10	11	12
3	0.01	0.01	0.02	0.02	0.02	0.02	0.05	0.08	0.05	0.02	0.02	0.02
4	0.01	0.01	0.01	0.02	0.02	0.05	0.03	0.03	0.03	0.02	0.03	0.03
5	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.04	0.04	0.03	0.02	0.02
6	—	—	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
7	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Thickness of spirotheca												
13	14	15	16	17	18	19	20	21	22	23	24	25
0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02			
0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02					
0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
0.02	0.02	—	—	—	—							
0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		

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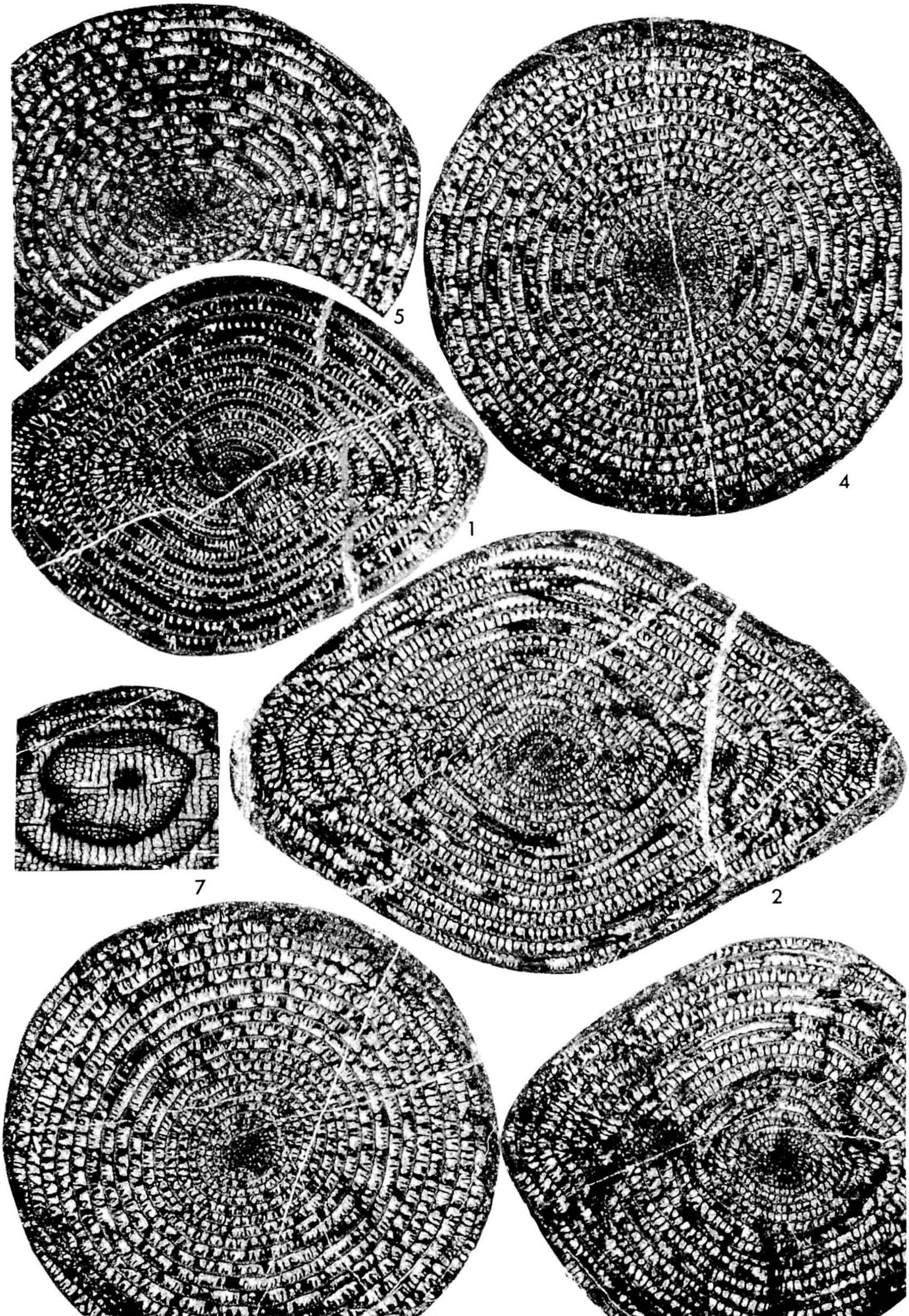
Explanation of Plate 14

Fig. 1. *Yabeina globosa* (YABE)
Axial section, ×8.

Figs. 2-7. *Yabeina kanmerae* IGO
2, Axial section; 3, slightly oblique axial section; 4-6, sagittal sections; 7, tangential section, ×8.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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 106, pp. 100-105, pl. 15, June 30, 1977

678. MIDDLE JURASSIC AMMONITES FROM BISHO, KUMAMOTO PREFECTURE, KYUSHU*

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熊本県美生産中期ジュラ紀アンモナイト： 熊本県八代郡東陽村美生からは，かって赤津健によりアンモナイト3個が採集され，松本達郎により当地域に中部ジュラ系の存在することが示唆されていた。最近，佐野は当該地域の調査を行い，問題とされていた地層の分布範囲と層序を明らかにした。また新たにベレムナイト1個が得られた。これの化石はいずれも断片的ではあるが，検討の結果アンモナイトの1個は *Cadomites* sp.，他の1個は *Planisphinctes* ? sp. と鑑定された。ベレムナイトはジェレツキー博士の鑑定により *Parahastites* ? sp. といえる。以上の三者の共通の生存期間は中期ジュラ紀であり，調査された地層の主部は中部ジュラ系を含むと考えられる。得られた化石の保存はよくないが，化石産出層の岩相及び構造上の位置をあわせ考えると地史考察上貴重な資料となるので，図示し記載した。

平野弘道・佐野弘好

Introduction

The Bisho area in Toyo-mura (previously called Kawamata-mura), Yatsushiro-gun, Kumamoto Prefecture was geologically studied by Ken AKATSU for the graduation thesis of Kyushu University in 1957 under the supervision of Prof. T. MATSUMOTO. He collected a few ammonite specimens at Bisho in the area but did not describe them. MATSUMOTO (1962, p. 235) briefly recorded this fact, mentioning that the ammonite bearing formation could be Middle Jurassic.

At the suggestion of Prof. MATSUMOTO one of us (H. S.) restudied the geology of the same area in 1974 and clarified the distribution and the stratigraphic sequence of the formation in question (SANO, 1977), with acquisition of a belemnite; the other of us (H. H.) endeavoured to identify the ammonites collected by Mr. AKATSU. This paper is to describe briefly the results of our study.

We thank Prof. MATSUMOTO for the pertinent supervision, Dr. K. KANMERA and Dr. K. TANABE for their help in the field work, Mr. K. AKATSU for his generosity to provide the specimens for the study, Dr. J. A. JELETZKY for the identification of a belemnite, and Messers MURASAKI and INOUE of Toyo-mura for their offer of facilities in the field work.

Geological setting

The localities of ammonites and a belemnite are near a small village called Bisho in the tributary of the River Hikawa and are geologically in the Hinagu belt of the Chichibu terrain (MATSUMOTO

* Received March 22, 1977; read June 27, 1976 at Hiroshima.

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and KANMERA, 1952; KANMERA, 1953), where sediments from the upper Permian to the lower Cretaceous are complicatedly distributed (Fig. 1). The Jurassic Bisho Formation is narrowly distributed and surrounded with faults by the Norian in the north, the Albian Yatsushiro Formation in the south and east and the Norian and the Aptian Hinagu Formation in the west (Fig. 2). The Jurassic strata trend from NEE to SWW, dipping steeply to the south. They are composed of massive shale and alternation of sandstone and shale. The conformable series is stratigraphically divided into three parts, the upper, the middle and the lower. The ammonites are presumed to have come from the shale of the middle part (Fig. 3).

Palaeontographic description

Family Stephanoceratidae
NEUMAYR, 1875

Genus *Cadomites* MUNIER-CHALMAS, 1892

Type-species.—*Ammonites deslongchampsi* DEFRANCE in D'ORBIGNY, 1846 (ICZN Opinion 324).

Cadomites sp.

Pl. 15, Fig. 2

Material.—An internal mould (right side) of a quarter whorl, GK. G. 11432.

Description.—The whorl is of moderate involution. The primary rib is rectiradiate and generally strong with some-

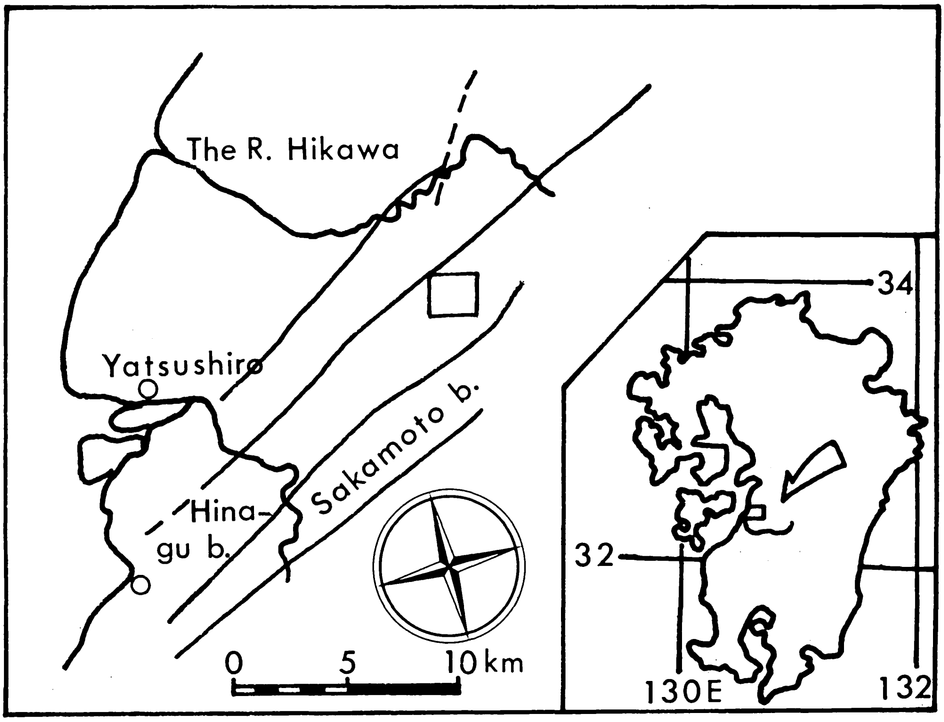

Fig. 1. Map showing the studied area and the Hinagu and Sakamoto belts.

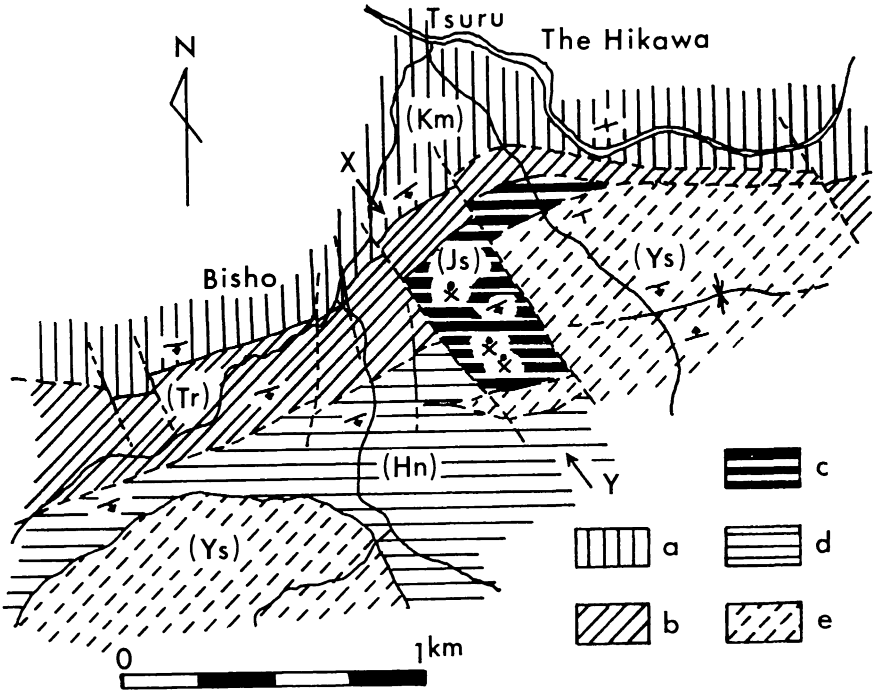

Fig. 2. Geological map of the Bisho area. a: Kuma Formatiom, b: Upper Triassic Formation (Tr), c: Middle Jurassic Formation, d: Hinagu Formation (Hn), e: Yatsushiro Formation (Ys).

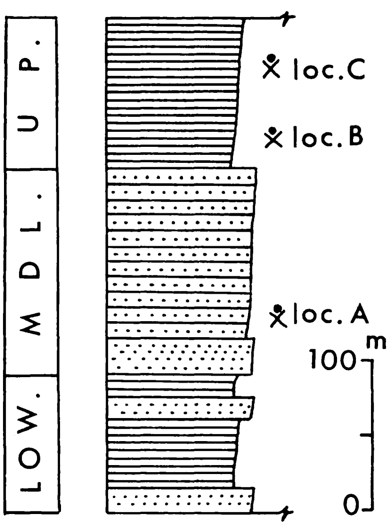

Fig. 3. Columnar section of the Jurassic near Bisho. Fossil localities, A: ammonite, B: belemnite, C: bivalve. Solid line: shale, dot: sandstone, alternating line and dots: alternation of sandstone and shale.

what sharp crest. It starts from the umbilical seam, becoming stronger outward and bifurcates or trifurcates at the middle of the flank, where it is swollen if not tuberculate. The swell is fairly high in the earlier part but becomes weaker on the later part. The secondary rib is much finer and much lower than the primary. The interspace of the primary ribs is about two times as wide as the primary rib, and the interspace of the secondary ribs is as narrow as the secondary rib. The venter, cross section, early whorls and suture are not seen.

Comparison.—The present specimen is similar to the specimens of *C. deslongchampsi* (d'ORBIGNY) (ARKELL, 1952, text-fig. 21), from England, and *C. psilacanthus* (WERMBTER) (WESTERMANN and RIOULT, 1975, p. 871, pl. 105), from Normandy, in the strength of primary rib, the mode of furcation, the weakness of secondary rib, and the mode of coiling but is distinguished by the absence of tubercle at the point of furcation.

The present specimen also resembles MAUBEUGE's (1969, p. 76) specimen of *C. septicostatusiformis* (MAUBEUGE), from Bâle-Campagne, in the general characters but has much stronger primary ribs which show clearer furcation.

It is distinguished from a specimen of *C. septicostatus* BUCKMAN (1923, part 42, pls. 422a-b) by the wider interspace of ribs, that is, the interspace in the latter is as narrow as the width of the rib, although both two lack a distinct tubercle at the point of furcation.

Only *C. bandoi* TAKAHASHI (1969, p. 61, pl. 5, figs. 4, 6-8, 13) has been hitherto known from Kitakami as a species of *Cadomites* in the Japanese Jurassic but the present specimen is not allied to any specimen of *C. bandoi* in that it has stronger primary ribs and no tubercles at the points of furcation.

Locality.—Locality A in the route map (Fig. 4). It is a small tributary of the River Hikawa, running near Bisho, Toyomura, Yatsushiro-gun, Kumamoto Prefecture, Kyushu.

Family Perisphinctidae
STEINMANN, 1890

Subfamily Pseudoperisphinctinae
SCHINDEWOLF, 1925

Genus *Planisphinctes* BUCKMAN, 1922

Type-species.—*Planisphinctes planilobus* BUCKMAN, 1922

Planisphinctes (?) sp.

Pl. 15, Figs. 1a-b

Material.—A left external mould of a fragmentary specimen, GK. G. 11433.

Description.—The whorl is fairly evolute. The primary rib radially runs from the umbilical seam. Its crest is sharp at the umbilical shoulder and becomes flat and low outward. The interspace of the ribs is nearly as wide as or somewhat broader than the rib. Several ribs show bifurcation immediately below the umbilical seam of the next whorl. The ventral area is so incompletely preserved that its characters are not observable.

Comparison.—Because the present specimen is fragmentary and because its outer part is not observable, it is hardly identified. The described characters, however, suggest that it may be a species of *Planisphinctes*. It is indeed similar to *Planisphinctes planilobus* BUCKMAN (1922,

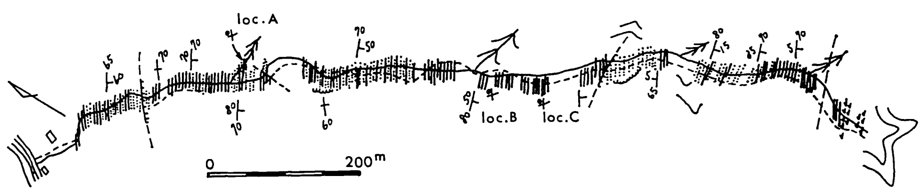

Fig. 4. Route map of the fossil localities. Symbols are the same as those in Fig. 3.

pl. 327; ARKELL, 1958, p. 230, pl. 33, figs. 7a-c) in the widely separated somewhat sharp primary ribs and evolute whorls but exact comparison should be done on better preserved specimens.

Locality.—Locality A in the route map (Fig. 4), Bisho, Toyo-mura, Yatsushiro-gun, Kumamoto Prefecture, Kyushu.

Concluding remarks

In Europe *C. deslongchampsi* ranges from the Parkinsoni Zone to the Zigzag Zone, and *C. psilacanthus* is restricted to the Parkinsoni Zone. Genus *Cadomites* is said to range from the upper Bajocian to the Bathonian or to the lower Callovian with question. The age of Genus *Planisphinctes* is the lower Bathonian. One unfavourably preserved specimen, of which characters suggest that it may belong to a middle or upper Jurassic ammonite, illustrated in the plate (Pl. 15, Fig. 3) also was obtained at loc. A by AKATSU.

A belemnite, collected at loc. B by TANABE, is similar to *Parahastites* (personal comm. by Dr. JELETZKY) which ranges from Pliensbachian to Bajocian. At loc. C an unfavourably preserved bivalve was obtained, but is too incomplete to be identified.

From these facts the main part of the studied succession is regarded as the middle Jurassic, especially from Bajocian to Bathonian.

Hitherto known middle Jurassic in the Chichibu terrain is the Naradani Formation in Sakawa, Shikoku and the Tsurubami Formation in the Kuma mountains, Kyushu. These two formations are shale and sandstone with lenticular, partly oolitic limestones containing brachiopoda, echinoid spines etc. (TAMURA, 1960), but the studied middle Jurassic sequence is shale and alternation of sandstone and shale without limestone. Furthermore, it should be noted that the middle Jurassic formation of Bisho is distributed in the Hinagu belt whereas the upper and middle Jurassic Torinosu and Tsurubami formations are in the Sakamoto belt to the south of the Hinagu belt (Fig. 1).

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Explanation of Plate 15

(All in natural size)

Fig. 1. *Planisphinctes* ? sp.
1a. External mould, GK. G. 11433, loc. A. 1b. Rubber cast of 1a.

Fig. 2. *Cadomites* sp.
2. GK. G. 11432, loc. A.

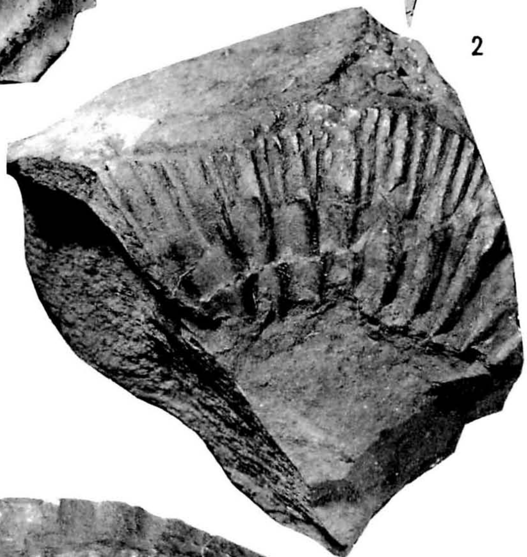
Fig. 3. Gen. et sp. indet.
3. GK. G. 11435, loc. A.

Fig. 4. *Parahastites* ? sp.
4a. Lateral view of rubber cast, GK. G. 11434, loc. C. 4b. Dorsal view of rubber cast. 4c. Ventral view of rubber cast.

1b

4c

2



4a

4b

3

1a

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 106, pp. 106-121, pl. 16, June 30, 1977

679. A MOLLUSCAN ASSEMBLAGE OF THE SETOGAWA GROUP

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瀬戸川層群産の貝化石群：瀬戸川層群は化石に乏しく，これに関する報告は多くないが，小野は地質調査の傍ら，同層群中部の滝沢層下底にある玄武岩熔岩の直上から数十点の保存のあまりよくない貝化石を採集した。この中から巻貝6種，二枚貝8種を識別したので報告する。この内，スソキレガイ類の一種は新種と認められたので *Emarginula tokuyamai* と命名し記載した。この化石群集は，かって水野 (1956) が簡単に記述したことがある。巻貝種に富むこと，表生・内生の二つの異った群集型の混合を示すことを特徴とする。棲息域はおおむね下部浅海帯と推定され，海底熔岩とそれから派生した角礫などが構成する底質に伴う表生種群及びやや異った場所の砂泥底に伴う内生種群が混合したものと考えられる。巻貝，付着性二枚貝などの表生の種群が卓越するためか，元来，内生の二枚貝を主とする同時代他地域の貝化石群集と共通する種は少いが，傾向としては古第三紀の浅貝ー幌内型動物群との近似性が認められる。

岩崎泰穎・小野　進

Introduction

The Setogawa Group, widely distributed in Shizuoka and Yamanashi Prefectures, central Japan, is a series of thick clastic sediments of Paleogene age. Our biostratigraphical and paleontological knowledge on this group, however, remains quite insufficient owing to its poor fossil occurrence, compared with other Cenozoic deposits of Japan. From 1967 to 1972, one of the writers, ONO surveyed this group in almost all the distributed area for the structural analysis.

Some results on the stratigraphy and structural geology were already reported (ONO, 1973). In the course of his field survey, ONO collected molluscan fossils at several localities. The majority of nearly fifty fossil specimens for the present study were derived from a single outcrop at Ashikubo, northern part of Shizuoka city. Fossil collection was made several times at this outcrop and adjacent areas in order to obtain better specimens for identification. The molluscan fossils, especially the fossil assemblage, were studied mainly by IWASAKI. 16 species were discriminated in the total collection, although 12 of them are specifically indeterminable owing to the poor preservation. The results of taxonomic study are summarized in this

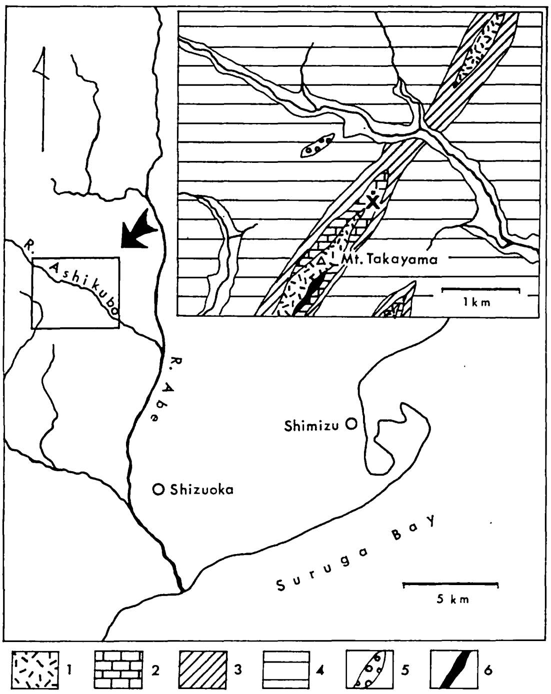
* Received April 9, 1977; read January 31, 1976 at Kawatabi.

article with some notes on the fossil occurrence and on the upper Paleogene molluscan faunas. All specimens numbered with prefix CM are deposited in the Department of Geology and Palaeontology, University Museum, University of Tokyo.

On the occurrence of fossils

Fossil molluscs here treated were collected from one outcrop in a small valley on the northern slope of Mt. Takayama, about 500 m south from the Ashikubo river, at Yazawa, Ashikubo-Okugumi, Shizuoka city, which is located in the central part of the distribution area of the Setogawa group (Text-fig. 1).

There expose layers of titan-augite bearing alkali basalt flow, and tuffaceous and calcareous lithic sandstone steeply dipping to ESE. They make up a core of an anticline of NNE-SSW trend. Fossil bearing rock is a thin lithic sandstone overlying the lava flow. Fossils are found close to the basalt as if they were contained in volcanic rocks. Molluscs occur rather sporadically in association with corals and algal fragments except for some shell clusters of *Lima sameshimai*. As almost all the shell materials are dissolved, only outer and inner molds can be obtained. However, the tests of *Lima, Brachidontes* and



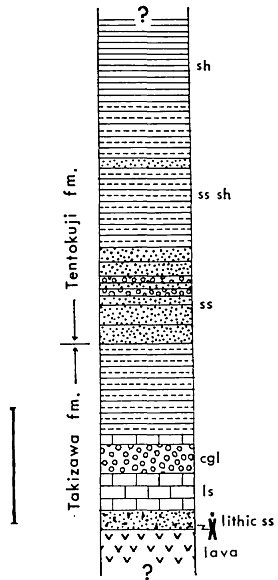
Text-fig. 1. Map showing fossil collecting location at Ashikubo, Shizuoka City. Explanation of geological map; 1. basalt lava, 2. lower calcareous member of the Takizawa Formation, 3. upper sandstone and shale member of the Takizawa Formation, 4. Tentokuji Formation, 5. conglomerate of the Tentokuji Formation, 6. picrite.

"*Minolia*" species remain unsolved in part. The preserved material of the former two bivalves seems to be recrystallized calcite which primarily formed the outermost calcite layer. Similar partial preservation of the calcite shell layer was also found in the Eocene molluscs in the nummulite-bearing sandstone of Hahajima (IWASAKI, 1975). Most bivalve shells are disarticulated. A muddy limestone layer is found above the lithic sandstone, and silicified shell-like fragments are contained. But no generically determinable molluscan fossils are found (Text-fig. 2). Thick argillaceous sedimentary rocks successive to the limestone scarcely yield molluscan fossils in the neighborhood of Ashikubo.

Among the fossils from Ashikubo, six gastropod and eight bivalve species are discriminated. They are:

Emarginula tokuyamai IWASAKI and ONO, n. sp.
"*Minolia*" *ikebei* (OZAKI, 1958)
Tonna ? sp.
Fusitriton sp.
Mitra (*Tiara*) sp.
Hemiconus sp. [= ? *Conus sameshimai* MIZUNO, MS]
Brachidontes (*Hormomya*) sp.
Lima (*Plicacesta*) *sameshimai* OYAMA and MIZUNO, 1958
Thyasira (*Axinopsida*) sp.
Trapezium cf. *jobanicum* HATAI and NISIYAMA,
Crassatella sp.
Crassatina (*Chattonia*) sp.
Nemocardium cf. *iwakiense* (MAKIYAMA, 1934)
Cadella sp.
Two other bivalves were found from Ichinose.
Chlamys cf. *irregularis* (SOWERBY)
Lucinoma annulata (REEVE)

Fossil occurrence from Ashikubo was once briefly reported by MIZUNO (1956) in a paper on biostratigraphy of the Japanese Paleogene. Among several molluscan species listed by him, *Lima* (*Acesta*) *sameshimai* and *Minolia tsuchii* were later described by OYAMA and MIZUNO (1958).



Text-Fig. 2. Columnar section of mapped area in Text-fig. 1. Scale bar indicates 10 m.

Among eight bivalve species, *Lima sameshimai*, *Brachidontes* sp. and *Trapezium* cf. *jobanicum* are epifaunal, and they may have attached themselves to some hard objects. On the contrary, *Nemocardium* cf. *iwakiense*, *Thyasira* sp. and *Crassatella* sp. are infaunal and presumed to have inhabited in fine sand bottom. Most of the gastropod species listed above are epifaunal and probably dwellers on hard, gravelly bottom or sand bottom. Dominant species of this assemblage are *Lima sameshimai* among bivalves, and "*Minolia*" *ikebei* among gastropods, whereas *Nemocardium* cf. *iwakiense* is the most abundant among the infaunal species. Thus, this assemblage is predominated by epifaunal species which inhabited on rocky or gravelly bottom made up of the basalt pillow lava and its breccia. The living places of these epifaunal and infaunal species do not seem to be far from each other. The two ecologically inconsistent groups of molluscs were most likely mixed in the course of deposition.

Remarks on the stratigraphy and comparison with other molluscan faunas

Stratigraphically, the Ashikubo fauna occurs from the lower part of the Takizawa Formation, and two other bivalves of Ichinose occur from the Tentokuji Formation of ONO (1973). The Setogawa Group in the neighborhood of Ashikubo is subdivided into the following five formations in descending order:

Domoto Formation

Tentokuji Formation

Takizawa Formation

Sangozawa Formation

Oyakuzure Formation

——— fault ———

The Takizawa Formation is mainly composed of sandstone and siltstone. Limestone and conglomerate are intercalated in the lower part. Titan-augite bearing alkali basalt lava and basaltic breccia including lithic sandstone are found at the basal part of this formation. The basalt shows pillow structure in part. The fossils are contained in the lower part of the formation. No significant unconformity is observable in the sequence of these formations. The Takizawa Formation occupies the middle part of the group indicating the stage of basic volcanic activity. According to TOKUYAMA (1974), the Setogawa Group is a series of eugeosynclinal sediments accumulated in the outer belt of the Southwest Japan. The Setogawa Group is said to be geotectonically distinguishable from the Shimantogawa Group and the Oigawa Group, both of which are adjacent to the Setogawa Group with faults.

ONO's stratigraphic subdivision of the Setogawa Group is remarkably different from the results by TOKUOKA (1964), MATSUMOTO (1966) and MAKIYAMA in MAKIYAMA et al. (1975), owing to different interpretation of the complicated geological structure. However, the fossil-bearing horizon at Ashikubo seems, anyhow, to belong to the Takizawa Subgroup or Formation, the middle division of the Setogawa Group, of these authors, because the basic volcanic layer, a key bed, is included in the named formation.

Molluscs comprising the Ashikubo assemblage have no useful indicator of water depth. Most genera of the assemblage show remarkably wide bathymetrical distribution judging from the occurrence of living related species. The suggested depth from the assemblage is between 30 and 200 m, likely somewhere from outer sublittoral zone to the bathyal slope. Judging from the vertical and lateral change of sedimentary facies, the living place of these species was probably on the top of a mound or bank on the sea floor formed by the volcanic activity.

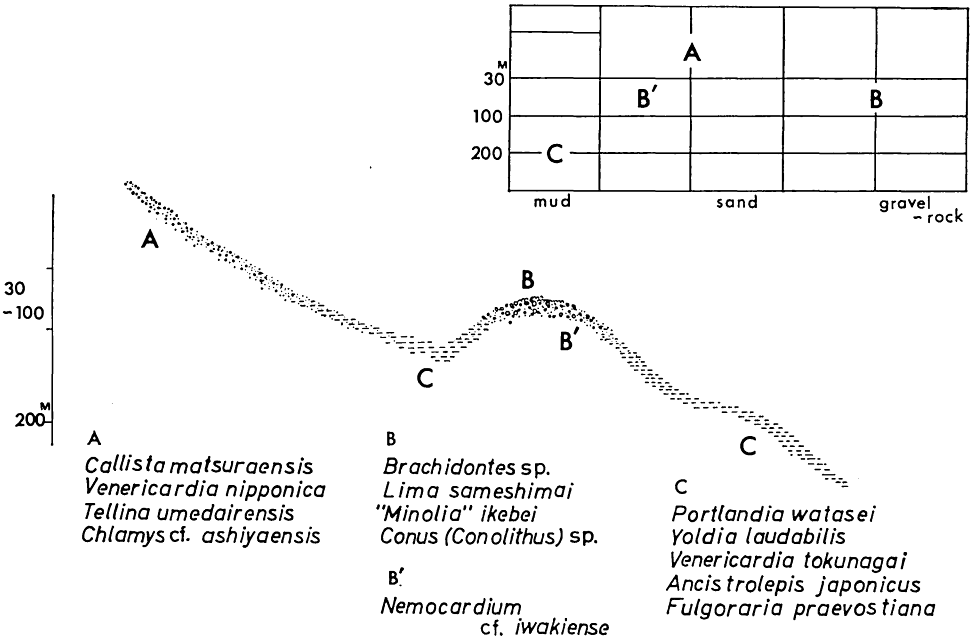
Occurrences of molluscan fossils were reported by ICHIKAWA (1946), MATSUMOTO (1964, 1971) and MATSUMOTO and HIRATA (1972) from the Setogawa Group at some other localities. All of them were recorded from the southwestern area, and from calcareous or non-calcareous sandstone and mudstone of younger members than the present fossil bed. The species composition is characterized by the predominance of bivalves, especially by soft bottom burrowing species. No common species with the Ashikubo fauna is found. MATSUMOTO (1964, 1971), described two different types of molluscan fauna from the Oga and Wappazawa Formations, the uppermost and the lowermost parts of the Setogawa Group of his division. The former is represented by *Yoldia laudabilis* YOKOYAMA, *Venericardia tokudai* TAKEDA and *Phaxas izumoensis jobanicus* (KANNO), and is to be correlative to the Oligocene Asagai-Poronai type fauna of Northeast Japan. On the contrary, the latter is predominated by *Callista matsuraensis* (NAGAO) which is an Oligocene species common to the lower Miocene formations in northern Kyushu, Southwest Japan. MATSUMOTO and HIRATA (1972) reported the occurrence of *Adulomya uchimuraensis* KURODA which was originally described from the Miocene Bessho Formation. MATSUMOTO estimated the geological age of the Setogawa Group to be Oligocene to younger Miocene on the basis of these molluscan fossils.

On the other hand, HONJO and MINOURA (1968) reported a *Discoaster* species from the calcareous rocks of the "Takizawa" Formation and correlated the formation with the Eocene of U. S. A. and Europe. NAKAZAWA (1973) considered the geological age of the Setogawa Group as Eocene to Oligocene on the basis of regional stratigraphic correlation of the Shimanto terrain of Southwest Japan.

Useful index fossils are scarcely included in the Ashikubo fauna, although MIZUNO (1956) once attempted to correlate *Moropopholus* aff. *effingeri* WEAVER from the present locality with *M. effingeri* of the Lincoln stage of U. S. West Coast. In the present collection, there are comparable specimens with *Nemocardium iwakiense* of the Asagai Formation and *Trapezium jobanicum* of the Iwaki Formation in the Joban coal-field. *Brachidontes* sp. morphologically resembles *B. matchgarensis* reported by MAKIYAMA (1934) from the Oligocene formation at the northern end of Sachalien. These evidences suggest that the Ashikubo fauna is somewhat allied to the Asagai-Poronai fauna which is a cold water representative mainly distributed in the northeastern part of Japan, as already mentioned by MATSUMOTO (1964) in the case of the molluscan fossils of his Oga formation.

Most species comprising the Ashikubo assemblage are, however, endemic to the Setogawa Group. It may be partly due to the predominance of epifaunal species in the assemblage, which are generally minor elements in the Japanese Cenozoic molluscan faunas, and partly due to their peculiar habitat, submarine bank, as shown in Text-fig. 3. In the molluscan fossils of the Setogawa Group reported by MATSUMOTO, bivalve species of soft bottom dwellers are main constituents.

Among rich molluscan faunas in the lower Miocene of Japan, the Ogurui faunule (KOBAYASHI and HORIKOSHI, 1958) shows peculiar association of species which is characterized by such gastropods of rocky substrate *Turbo* and *Tectus*, and has few common elements to the species of shallow sand bottom typified by the Kadonosawa fauna. The relationship between the Ogurui faunule and the Kadonosawa type fauna seems to be similar to that between the Ashikubo assemblage and the Japanese Oligocene molluscan faunas. *Lima sameshimai*, *Emarginula tokuyamai* and some other molluscs are recorded only from one locality, although the individual number



Text-fig. 3. Sea bottom profile showing estimated habitat of the Ashikubo assemblage, and relation with other molluscan assemblages during the Setogawa stage. Upper diagram showing relation of molluscan assemblage-type with water depth and bottom sediments. Adapted from ITOIGAWA and SHIBATA (1973).

of these species is not small. Their distribution may not be restricted to a small area near Ashikubo, but presumably they had no chance to be preserved at any places where the similar environment to Ashikubo was prevailed.

ITOIGAWA and SHIBATA (1973), in their paleoecological study of Miocene molluscs of the Setouchi district, recognized more than 20 types of molluscan assemblages. They attempted to plot these assemblages in a diagram of grain size of sediments in abscissa and water depth in ordinate. The Ashikubo assemblage appears to be different from any assemblage types of their work, i. e., it represents sand-gravel bottom of 30 to 100 m deep in the diagram, where no corresponding assemblage is found in the Setouchi district. Two molluscan assemblages described by MATSUMOTO (1964, 1971) seem to correspond either to ITOIGAWA and SHIBATA's *Saccella-Cultellus* or *Macoma-Lucinoma* assemblage.

No molluscan assemblage representing littoral or near-shore facies has been found in the Setogawa Group. The representative of near-shore type molluscan assemblage from the group is likely similar to what once reported by SHIKAMA (1951) from the southernmost area of Nagano Prefecture. *Callista matsuraensis* (NAGAO), *Venericardia nipponica* YOKOYAMA, *Tellina umedairensis* SHIKAMA, *Chlamys* cf. *ashiyaensis* (NAGAO) and some other species were described from the Wada Formation, and this assemblage has been regarded as allied to the Ashiya fauna of northern Kyushu. Although the Wada Formation is situated beyond the Chichibu terrain about 50 km northwesterly distant from Ashikubo, it is one of the nearly distributed fossil-bearing Paleogene sediments. Paleogeographical relationship between the Wada Formation and the Setogawa Group can presumably be compared with that between the Nakaoku Formation of SHIIDA (1962) and the Muro Group in the Kii Peninsula. The Muro Group, which is stratigraphically correlative with the Setogawa Group (NAKAZAWA, 1973), is characterized by thick and deeper water fine-grained clastic sediments. On the other hand, the approximately contemporaneous Nakaoku Formation is comparatively thin and composed of shallow water coarse-grained sediments, and its distribution is restricted to the pre-Cenozoic Chichibu terrain. Molluscan fossils occurring from the Muro Group were summarized by MIZUNO (1973). Most species belong to two assemblage types. One is equivalent to those described by MATSUMOTO (1964), and the other is a deeper water dwelling group comparable with muddy bottom species from the Hota Group of the Boso Peninsula described by HATAI and KOIKE (1957), including *Solemya bosoana* HATAI and *Acila vigilia* SCHRENCK, *Portlandia watasei* (KANEHARA), *Periploma besshoense* (YOKOYAMA), *Ancistrolepis bicordata* HATAI and KOIKE. The latter seems to correspond to the *Nuculana-Yoldia* or *Neilonella-Palliolum* assemblage of ITOIGAWA and SHIBATA (1973).

Thus, in Text-fig. 3 is shown a topographic section, bottom sediments and corresponding molluscan species groups at the discussed area during the Setogawa stage, presumably of Eocene to early Miocene age. The annexed diagram in Text-fig. 3 is adapted from ITOIGAWA and SHIBATA (1973).

As MIZUNO (1956, 1973) and MATSUMOTO (1964) stated, the molluscan fauna of the Setogawa Group, particularly the deeper elements, has apparent relationship to the northern Asagai-Poronai type fauna. These deeper elements seem to be extensively distributed to the area of the Muro Group. The Asagai-Poronai type fauna appears to extend its distribution southward, gradually changing its optimal habitat to deeper domains of bathymetry. The shallow water elements are, on the other hand, have much alliance to the southern Ashiya type fauna, and this area seems to be near the northern extremity of the warm water elements. As the Setogawa Group is distributed geographically in the middle part of the Japanese Islands, its molluscan fauna is characterized by two different Paleogene faunal elements developing typically in Kyushu and Hokkaido, southern and northern extremities of Japan respectively. Thus, the Setogawa Group containing both types of faunas is likely situated in the transitional area of the two zoogeographical provinces in late Paleogene times.

Systematic description

Family Fissurellidae FLEMING, 1822

Subfamily Emarginulinae GRAY, 1834

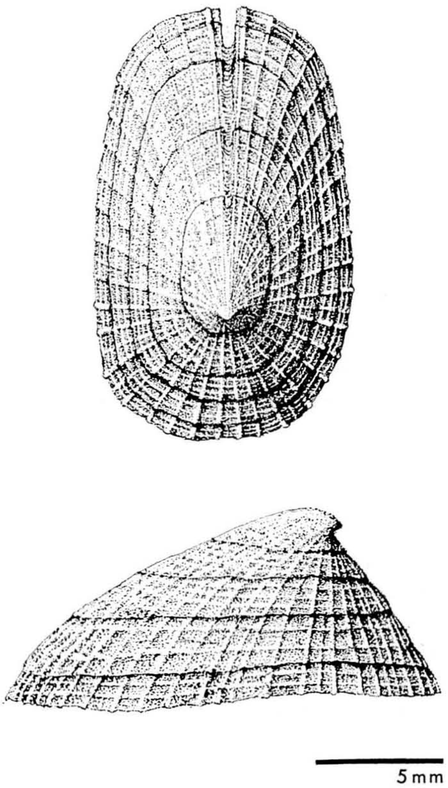
Genus *Emarginula* LAMARCK, 1801

Emarginula tokuyamai IWASAKI and ONO, new species

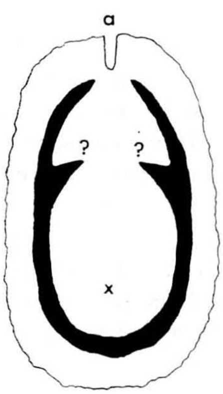
Pl. 16, figs. 3-5; Text-figs. 4, 5

Diagnosis.—Small, antero-posteriorly elongated patelliform gastropod, with distinct anterior slit and with cancellated surface ornamentation.

Description. — Shell small, conical, moderately elevated. Apertural shape



Text-fig. 4. *Emarginula tokuyamai* IWASAKI and ONO, n. sp.



Text-fig. 5. Muscle scar of *Emarginula tokuyamai* IWASAKI and ONO. Illustration method by MACCLINTOCK (1963).

anteriorly elongated elliptical, but somewhat quadrate like that of *Scutus*. Apex located at about two-third back of anterior margin pointing to rear. Shell almost symmetrical bilaterally. Anterior slope gently convex, but posterior slope concave near apex. Slit present at anterior margin and distinctly emarginated. Its length and width moderate for the genus. Selenizone weakly depressed but distinct. Shell surface ornamented with fine radial ribs, cancellated with growth lines that regularly spaced and less elevated than the radial ribs. No septal structure found on inner surface. Muscle scar discontinuous anteriorly, brancning pattern imperfectly preserved (Text-fig. 5).

Measurements.—(in mm)

	Length	Width	Height
CM 8446	16.8	9.6	6.5 paratype
CM 8447	16.9	10.2+	6.1 〃
CM 8448	14.8	10.7	6.5 holotype

Remarks.—Three specimens are examined for the description. They are mostly mold specimens, but original surface ornamentation seems to be well preserved on their surface. This is the first record of *Emarginula* species from the Japanese Paleogene. Thus no comparable species is found in contemporaneous faunas. *Emarginula hiranoae* OZAKI, 1958 of the Pliocene Na-arai Formation is similar in shell size to the present species, but is taller, more conical in outline, finer in surface ornamentation and narrower in slit shape than the present species. Moreover, the shell of *E. hiranoae* is asymmetrical, because the slit and the sculpture of selenizone are biased rightward from midline of shell like *Loxotoma*. Two recent species, *Emarginula fragilis* YOKOYAMA, 1920 which also occurs as fossils and *E. crassicosta* SOWERBY, are distinguishable from the present species in more posteriorly situated apex and round shell outline. *Emarginula variegata* A. ADAMS is distinguishable from the present species by its depressed shell height and rounder outline.

The muscle scar of the present species is open anteriorly, a fissurellid form of MACCLINTOCK (1963), and narrow bridging scar is not observable partly due to the ill preservation.

Judging from the impression of surface sculpture, the original shell of the present species seems to be thin like that of *E. fragilis*. The species name *tokuyamai* is dedicated to Prof. A. TOKUYAMA of the Shizuoka University to whom the writers, especially ONO, are indebted for his useful suggestion on the geology of the Setogawa Group.

Family Trochidae RAFINESQUE, 1815

Subfamily Solariellinae POWELL, 1951

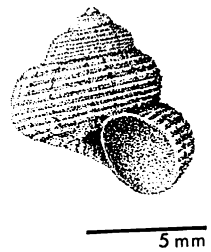
Genus *Minolia* A. ADAMS, 1860

"*Minolia*" *ikebei* (OZAKI, 1958)

Pl. 16, figs. 8-10; Text-fig. 6

Calliostoma ikebei OZAKI; OZAKI, 1958 March, p. 140-141, pl. 8, figs. 14, 15.
Minolia tsuchii OYAMA and MIZUNO; OYAMA and MIZUNO, 1958 September, p. 2, pl. 1, fig. 1.
Minolia tsuchii: OYAMA, MIZUNO and SAKAMOTO, 1960, p. 27, pl. 1, fig. 9.

Description.—A small turbiniform gastropod having four to five spires of moderate height. Six to eight distinct spiral ribs on roundly shouldered spire. Body whorl having ten to forteen spiral ribs that also distribute near umbilicus. Suture distinct. No axial ribs observable. Growth lines slightly prosoclinal. Aperture round-shaped. Umbilicus deep but



Text-fig. 6. "*Minolia*" *ikebei* (OZAKI, 1958).

not large in diameter. No callus developing on parietal region. Operculum unknown.

Measurements.—(in mm)

	Height	Diameter	Number of spires
CM 8449	7.5	8.0	4
CM 8450	7.1	7.8	5
CM 8451	9.0	8.4	5
CM 8452	8.5	9.0	5
CM 8453	7.9	8.0	4
CM 8454	8.1	8.4	4
CM 8455	7.0+	7.8	3
CM 8456	8.3	9.9	4

Remarks.—More than ten specimens were collected, but eight are examined and measured for the present study.

This gastropod from Ashikubo was formerly named *Minolia tsuchii* by OYAMA and MIZUNO. In the original description of *M. tsuchii*, which was also subsequently reproduced by OYAMA, MIZUNO and SAKAMOTO (1960), measurements of shell were given in error. The correct values should be ten times of the figures. *Calliostoma ikebei* OZAKI was originally described from the Pliocene Na-arai Formation. It is very similar in outline to *M. tsuchii* and its type specimen is ornamented with spiral ribs which are seven in number on each spire and 17 on the body whorl. *Calliostoma ikebei* has an umbilicus and turbinate base. Thus, it is certainly congeneric with *M.*

tsuchii. Genus "*Minolia*" is more appropriate for that shell than genus *Calliostoma*.

Minolia tsuchii is virtually indistinguishable from "*Minolia*" *ikebei* in shell morphology except for slight large size of the latter. *Minolia tukiyosiensis* (OYAMA and SAKA, 1944) in ITOIGAWA, SHIBATA and NISHIMOTO (1974) from the Miocene Togari Formation of the Mizunami basin is one of the morphologically allied species, but is distinguishable in sparsely spaced spiral ribs especially on its base. "*Lirularia*" *condoni* (DALL, 1909) distributed on the opposite side of the Pacific coast seems to resemble the present species. The living species *Minolia punctata* A. ADAMS is distinguishable from the present species in angular shoulder and in large and deep umbilicus.

"*Minolia*" *ikebei* is traditionally regarded as a trochid species without description of operculum. Some paleontologists still consider it as a turbinid, *Homalopoma* species, based on its overall shell outline. Further examination will be required for the generic assignment.

Family Mitridae SWAINSON, 1831

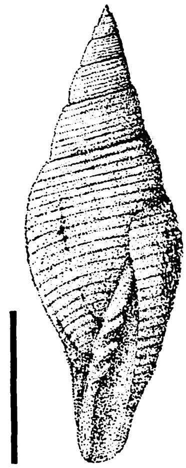
Genus *Mitra* MARTYN, 1784

Subgenus *Tiara* SWAINSON, 1831

Mitra (*Tiara*) sp. indet.

Pl. 16, fig. 6; Text-fig. 7

Description.—Shell small for the genus, fusiform in outline. Spire high. Suture not depressed. Spire slope almost straight. Body whorl large, more than a half of shell height. Aperture narrow, somewhat broadened abapically. Siphonal canal straight. Shell surface sculptured with spiral threads without axial ribs.



Text-fig. 7. *Mitra* (*Tiara*) sp. Scale bar indicates 5 mm.

Three columellar folds apparent on the inner lip. Crenulations on inner surface of outer lip unknown.

Measurements.—(in mm)

	Height	Maximum diameter
CM 8457	13.0+	5.5
CM 8458	13.2+	5.0
CM 8459	9.7	4.3

Remarks.—Three specimens were collected. They are mostly molds with partially preserved surface sculpture. Apical part of all specimens are broken. The shell shape, fine spiral costae and columellar folds are characteristic and suggest that this species belongs to *Mitra* (*Tiara*).

It resembles *Mitra* (*Tiara*) *isabella* SWAINSON in surface sculpture, but is more swollen in shell outline and much smaller in size than the latter. Specific identification will be made when better preserved specimens are obtained. It resembles *Mitra* (*Tiara*) sp. from the Nojima Formation (SHIKAMA and MASUJIMA, 1969), but is less slender than the latter.

Family Conidae RAFINESQUE, 1815

Genus *Hemiconus* COSSMANN, 1889

Hemiconus sp. indet.

Pl. 16, figs. 19, 20; Text-fig. 8

Description.—Shell small for the genus. Conispiral in outline, with moderately elevated spires. Five or six spires observable, slightly coeloconoid. Spire distinctly shouldered, without ornamentation on the shoulder. Body whorl more or less convex, without surface sculpture. Aperture narrow, straight. Test seems to be thin.

Measurements.—(in mm)

	Height	Maximum diameter
CM 8460	15.0	7.8
CM 8461	17.0+	8.4 inner mold
CM 8462	7.0	4.5 〃
CM 8463	8.5	4.6 〃

Remarks.—Four specimens are at hand. One specimen is external cast and the rest are inner molds.

The present species is regarded as the same with what was once listed as *Conus sameshimai* MIZUNO, MS (MIZUNO, 1956), because one specimen with that name stored in the Geological Survey of Japan (MIZUNO's specimen) is identical with the present materials. It is characterized by small shell and moderately slender outline with no distinct surface ornamentation. It is distinguishable from *Conus tuberculosus* SOWERBY by its smooth shoulder. Specific identification is suspended until more completely preserved specimens are available.

Family Mytilidae RAFINESQUE, 1815

Subfamily Mytilinae RAFINESQUE, 1815

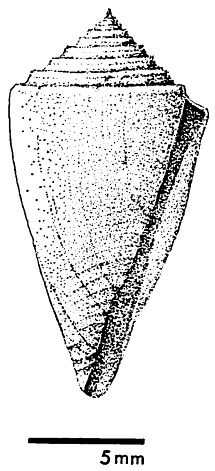
Genus *Brachidontes* SWAINSON, 1840

Subgenus *Hormomya* MÖRCH, 1853

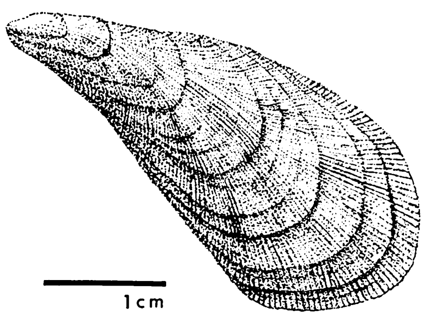
Brachidontes (*Hormomya*) sp.

Pl. 16, figs. 16, 17; Text-fig. 9

Description.—Shell medium to small in size, mytiliform, posteriorly elongated and more or less slender. Umbo not situated at anterior terminal. Hinge line short and weakly arcuated. Anterior margin straight in young shell but slightly concave in adult. Lunule indistinct. Anterior periphery almost vertical to the commissure plane. Surface sculptured



Text-fig. 8. *Hemiconus* sp.



Text-fig. 9. *Brachidontes* (*Hormomya*) sp.

with fine radial striae bifurcated at median part of the shell. No septum found on inner side of anterior terminal. Hinge teeth unknown, presumably very weak. Inner ventral margin finely crenulated.

Measurements.—(in mm)

	Length	Height	Inflation	Valve
CM 8468	44.6	21.8	13.4	Left
CM 8469	20.7	11.9	7.5	Right

Remarks.—In addition to two specimens at hand, three more specimens in the collection of the Geological Survey of Japan were examined. The latter seems to be the material as once listed as *Septifer* sp. by MIZUNO (1956).

The smaller specimen, in which shell material is preserved, has no internal septum. The remainders including those stored in the Geological Survey are mold specimens without shell materials, and have only weak impression of radial riblets. The larger specimen (Pl. 16 fig. 16) is deformed longitudinally, and shows more slender outline. Text-fig. 9 is a restored shell based on above mentioned five specimens. Shell outline, surface sculpture and absence of internal septum suggests *Brachidontes*. The shell outline of the present specimens, especially the concavity of the antero-ventral side, resembles that of *Brachidontes matchgarensis* MAKIYAMA, 1934, though the size is much smaller than *B. matchgarensis*. The present species is also similar to *B. matchgarensis* in the fine radial sculpture of shell surface, but the sculpture of the former shows frequent bifurcation. This sculpture is finer than that of *B. (Hormomya) mutabilis* (GOULD) which is a living species in the shore of the Japanese Islands.

Modiolus (Brachidontes) elequahensis WEAVER and PALMER, 1922 and *M. (B.) cowlitzensis* WEAVER and PALMER, 1922 from the west coast of U. S. A., and other allied fossil forms to the present one have coarser radial sculpture. Specific assignment is difficult, because the specimens are not in good state of preservation.

Family Limidae RAFINESQUE, 1815

Genus *Lima* BRUGUIÈRE, 1797

Subgenus *Plicacesta* VOKES, 1963

Lima (Plicacesta) sameshimai OYAMA and MIZUNO, 1958

Pl. 16, figs. 1, 15

Lima (Acesta) sameshimai OYAMA and MIZUNO; OYAMA and MIZUNO, 1958, p. 10, pl. 1, figs. 11, 12.

Lima (Acesta) sameshimai: OYAMA, MIZUNO and SAKAMOTO, 1960, p. 126, pl. 35, fig. 1.

Description.—Shell moderate in size for *Acesta* group, subauricular and more or less ventricose. Anterior auricle almost completely reduced and slight anterior gape at antero-dorsal margin. Posterior auricle ill defined, continuous to posterior shell. Radial ribs strong and well elevated. Ribs round-topped in some individuals but more or less sharply ridged in others. Number of ribs 17 and 18. Ribs distributed also on posterior auricle. Inner surface undulated radially owing to strong elevation of ribs. Shell presumably not thick.

Measurements.—(in mm)

	Length	Height	Inflation	Number of ribs	Valve
CM 8464	52.4	70.0	9.0+	17	Right
CM 8465	54.2	56.3	8.8	17	〃
CM 8466	26.7	30.1	4.0	18	Left
CM 8467	29.4	40.5+	4.6	17	Right

Remarks.—More than ten specimens were collected from several fossil aggregations. Among them, four specimens were used for observations and measurements.

This species is characterized by coarse and strong radial ribs which make a diagnostic feature. Other Cenozoic species of *Plicacesta* in the West Pacific area have rather finely ribbed shells. The present material is mostly mold specimens. In some individuals, however, thin calcareous shell is preserved and shows an apparent surface sculpture of original shell such as weak concentric growth lines and imblications, but the hingement structure is not observed. In comparison with other limid species, this shell material appears to be the outer layer which is originally made up of foliated structure of calcite. The inner surface of this shell probably represents the boundary surface between the outer foliated layer and the middle crossed-lamellar layer. Neither muscle scar nor hingement sculpture is therefore observable.

Family Cardiidae LAMARCK, 1809

Subfamily Protocardiinae KEEN, 1951

Genus *Nemocardium* MEEK, 1876

Nemocardium cf. *iwakiense* (MAKIYAMA, 1934)

Pl. 16, figs. 2, 18

Description.—Shell moderate to small in size for the genus, subcircular in outline, ventricose. Beak somewhat prominent. Posterior one third of shell surface sculptured by fine distinct radial riblets with numerous faint imblications. Remainder of the surface smooth or faintly sculpture with radial and growth lines. Hinge plate narrow. Inner ventral margin finely crenulated.

Measurements.—(in mm)

	Length	Height	Inflation	Valve
CM 8470	17.1	16.1	4.8	Right
CM 8471	30.2	29.2	8.6	Right +Left
CM 8472	18.8	17.6	5.6	Left
CM 8473	18.2	18.0	5.8	Right

Remarks.—Four mold specimens and several fragmental external molds were collected. The present specimens seem to have very thin shells. The shell morphology and surface ornamentation indicate the genus *Nemocardium.* They are similar to *Nemocardium samarangae* (MAKIYAMA, 1934), a living species of the Northwest Pacific, in the shell outline as well as thin test, but the former has coarser sculpture on the posterior slope. In comparison with *N. iwakiense* described by MAKIYAMA (1934), the present specimens are smaller in size and less inflated. Specific identification is deferred in the present study because of the poor state of preservation.

Family Trapeziidae LANY, 1920

Genus *Trapezium* MEGERLE von MÜHLFELD, 1811

Trapezium cf. *jobanicum* HATAI and NISIYAMA, 1949

Pl. 16, fig. 12

Description.—Shell subtrigonal in outline. Anterior border narrowly arcuated, and posterior border truncated. Ventral margin broadly rounded. Lunule and escutcheon indistinct. Shell surface characterized by a ridge from umbo to postero-ventral corner. Surface has faint concentric striations, but has neither concentric lamellae nor radial ribs.

Hinge teeth presumably of arcticoid type, but not confirmable. Test moderately thick.

Measurements.—(in mm)

	Length	Height	Inflation	Valve
CM 8474	18.6	15.3	5.0	Right
CM 8475	16.4	12.1	3.6	〃

Remarks.—Two specimens were collected, and two more allied ones are found in the collection of the Geological Survey of Japan. The present specimens are different from *Trapezium bicarinatum* (SCHUMACHER) in absence of distinct surface sculpture and median depression. It resembles *T. jobanicum* HATAI and NISIYAMA in shell outline, but cannot be identified because of the poor state of preservation. *T. modiolaeforme* OYAMA and SAKA, 1944 from the Tsukiyoshi Formation of the Mizunami basin differs from it in larger shell size and more trapeziform shell outline.

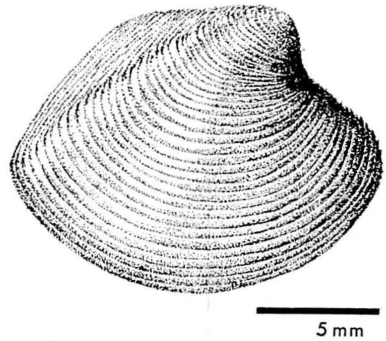
Remarks on the other illustrated specimens

Thyasira (*Axinopsida*) sp. Pl. 16, fig. 7.

One small mold specimen was collected. Umbonal part is broken. Shell is somewhat flat, round in outline. Height is slightly larger than length. Lunule is unknown. Posterior area and ridge from umbo to postero-ventral margin are distinct. This shell is most likely to belong to the genus *Thyasira*. Further, the shell morphology coincides well with the characteristics of *Axinopsida* KEEN and CHAVAN, 1951, but specific identification cannot be made because of the poorly preserved specimen.

Measurements in mm.—CM 8476, length, 13.2; height, 14.7; inflation, 2.6; right valve.

Crassatina (*Chattonia*) sp., pl. 16, fig. 13; Text-fig. 10.



Text-fig. 10. *Crassatina* (*Chattonia*) sp.

One small specimen of suboval shape was collected. It is characterized by fine and well defined concentric sculpture, and distinct posterior area. Posterior end is somewhat truncated. Shell outline is of veneroid type. Lunule and escutcheon are indistinct. Hinge structure cannot be confirmed.

Measurements in mm.—CM 8477, length, 15.1; height, 12.0; inflation, 4.1; right valve.

Crassatella sp., pl. 16, fig. 11.

One small mold specimen of left valve was collected. Shell is subtrigonal in outline with orthogyrate beak, acutely round at anterior margin but somewhat rostrated posteriorly and truncated at posterior end. Hinge plate is triangular in shape, but dentition is indistinct. Surface sculpture is unknown. The generic assignment is based on shell outline. Its specific position remains indetermined.

Measurements in mm.—CM 8478, length, 14.1; height, 10.5; inflation, 3.4; left valve.

Cadella sp., pl. 16, fig. 14.

One small mold specimen was collected. Shell is elongated ovate in outline, not ventricose. Beak is situated at one third from posterior end. Anterior margin is somewhat produced. Surface seems to be weakly sculptured with concentric striations. Hinge plate is narrow. The present specimen is similar in shell outline to *Cadella* sp. of the Nadaki Formation of the Mizunami basin reported by ITOIGAWA and others (1974).

Measurements in mm.—CM 8479, length, 10.5; height, 7.6; inflation, 2.0+; left valve.

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Explanation of Plate 16

Figs. 1, 15. *Lima (Plicacesta) sameshimai* OYAMA and MIZUNO, 1958, ×1; fig. 1, CM 8465, fig. 15, CM 8464.

Figs. 2, 18. *Nemocardium* cf. *iwakiense* (MAKIYAMA, 1934), ×1.5; fig. 2, CM 8472, fig. 18, CM 8473.

Figs. 3-5. *Emarginula tokuyamai* IWASAKI and ONO, n. sp., ×2; fig. 3, CM 8446, fig. 4, CM 8447, paratypes; fig. 5, CM 8448, holotype.

Fig. 6. *Mitra (Tiara)* sp., ×2; CM 8457.

Fig. 7. *Thyasira (Axinopsida)* sp., ×1.5; CM 8476.

Figs. 8-10. "*Minolia*" *ikebei* (OZAKI, 1958), ×2; fig. 8, CM 8450, fig. 9, CM 8449, fig. 10, CM 8451.

Fig. 11. *Crassatella* sp., ×2; CM 8478.

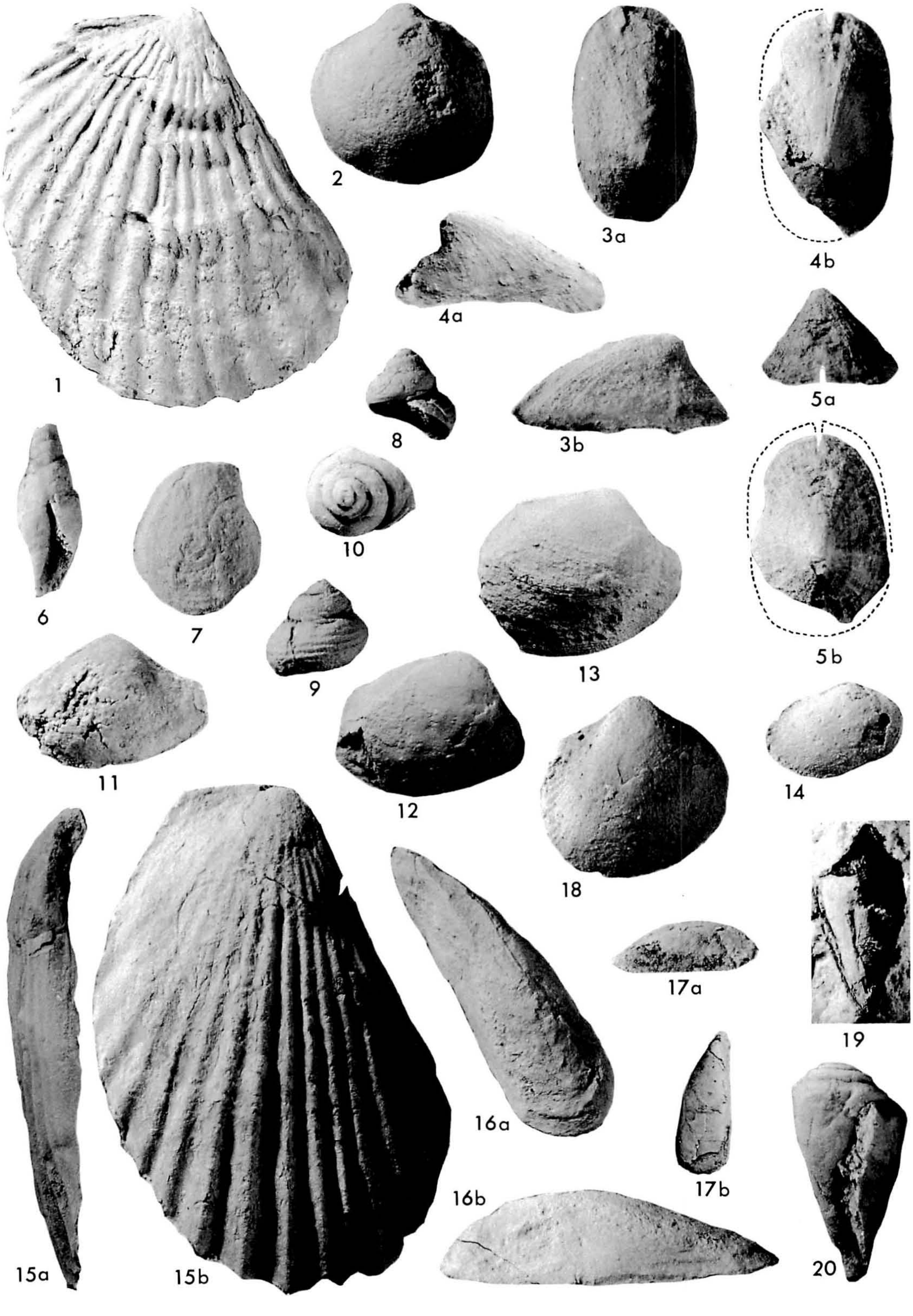
Fig. 12. *Trapezium* cf. *jobanicum* HATAI and NISIYAMA, 1949, ×1.5; CM 8474.

Fig. 13. *Crassatina (Chattonia)* sp., ×2; CM 8477.

Fig. 14. *Cadella* sp., ×2; CM 8479.

Figs. 16, 17. *Brachidontes (Hormomya)* sp., ×1; fig. 16, CM 8468, fig. 17, CM 8469.

Figs. 19, 20. *Hemiconus* sp., ×2; fig. 19, CM 8460, fig. 20, CM 8461.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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会 119 回例会は 1977 年 6 月 18 日(土) に静岡大学理学部において開催された (参加者 92 名)。

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Inoceramus schmidti に寄生する笠型巻貝 *Anisomyon giganteus* の生態標本 ......蟹江康光・速水 格
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学 会 記 事

○1977年6月17日の評議員会で承認された会員の動静は次の通りである。

〔入会者〕 安達修子，指田勝男，瀬名波任，赤井こず江，八田明夫，松居誠一郎，笠原芳男，佐藤喜男，米谷秀雄，服部修一，中島秀一，田中哲夫，本田信幸，海保邦夫 (14名)

〔退会者〕 稲田卓史，長尾捨一，太田信機，P.P. ANDAL, J.D. HILL, R.D. HOARE, G.J. VERVILLE, A. McINTYRE (8名)

〔逝去者〕 今泉力蔵 (1名)

日本古生物学会会則

(1977, 1, 21改訂)

第 1 条　本会は日本古生物学会という。

第 2 条　本会は古生物学およびこれに関係ある諸学科の進歩および普及を計るのを目的とする。

第 3 条　本会は第2条の目的を達するため次の事業を行なう。
1. 会誌そのほかの出版物の発行。2. 学術講演会の開催。3. 普及のための採集会・講演会そのほかの開催。4. 研究の援助・奨励および研究業績ならびに会務に対する功労の表彰その他第2条の目的達成に資すること。

第 4 条　本会の目的を達するため総会の議を経て本会に各種の研究委員会を置くことができる。

第 5 条　本会は古生物学およびこれに関係ある諸学科に興味を持つ会員で組織する。

第 6 条　会員を分けて普通会員・特別会員・賛助会員および名誉会員とする。

第 7 条　普通会員は所定の入会申込書を提出した者につき評議員会の議によって定める。

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会長の委嘱により本会に幹事および書記若干名を置くことができる。
常務委員会は評議員会において互選された者で構成される。但し会務上必要とする場合は，特別会員の中から常務委員若干名を評議員会の議を経て加えることができる。

第16条　会長は特別会員の中から評議員会において選出され，本会を代表し会務を管理する。
会長に事故ある場合は会長が臨時に代理を委嘱する。

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総会の議案は評議員会が決定する。
会長は必要があると認める時は臨時総会を召集する。総会は会員の十分の一以上の出席をもつて成立する。会長は会員の三分の一以上の者から会議の目的たる事項および召集の理由を記載した書面をもつて総会召集の請求を受けた場合は臨時総会を召集する。

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第20条　総会の議決は多数決により，可否同数の時は議長がこれを決める。

第21条　会長および評議員は評議員会を組織し，総会の決議による基本方針に従い運営要項を審議決定する。

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付　則　1）評議員会の議決は総て無記名投票による。

Palaeontological Society of Japan Special Papers No. 20

Devonian Trilobites of Japan

in comparison with Asian, Pacific and Other Faunas

By Teiichi KOBAYASHI and Takashi HAMADA

Issued January 31, 1977; 202 pp., 13 pls.

Price (postage and handling included) U. S. $. 24.00

This is the second outcome of a series of studies on the trilobites from Japan, following "*Silurian Trilobites of Japan*" (Spec. Pap. No. 18, 1974) by the same authors. It contains the systematic descriptions of Devonian trilobites from Japan, based mainly on new collections, consisting of 28 species of 18 genera in 9 families, of which 13 species and 2 subspecies are new. Certain families and genera are discussed at length, with the establishment of a new genus in the Scutelluidae and a new subgenus in the Cheiruridae.

Notes are given of the age and correlation of the trilobite-bearing beds. Furthermore, the known Devonian trilobite faunas of Eastern Asia, South Asia, Siberia, Turkestan, Australia and the Americas are extensively discussed in comparison with those of Japan. As a result a new scheme is proposed for the Devonian trilobite biogeographic provinces.

Palaeontological Society of Japan Special Papers No. 21

Mid-Cretaceous Events—Hokkaido Symposium, 1976

By Tatsuro MATSUMOTO et al.

Issued May 10, 1977, vi+251 pp., 3 pls.

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This is the proceeding volume of the second international conference of "Mid-Cretaceous Events" held in Hokkaido from August 29th to September 6th, 1976 as an activity of the IGCP [International Geological Correlation Program] project.

Altogether 18 papers of 20 authors are assembled. The contributors are R. A. REYMENT, N. A. MÖRNER, M. COLLIGNON, J. A. JELETZKY, M. A. PERGAMENT, C. W. WRIGHT, J. M. HANCOCK, W. J. KENNEDY, P. JUIGNET, E. G. KAUFFMAN, A. A. KURESHY, Y. TAKAYANAGI, S. MAIYA, M. OKAMURA, I. OBATA, M. FUTAKAMI, Y. KANIE, H. HIRANO, K. TANABE and T. MATSUMOTO. Each of these papers has concentrated on one of the following three major problems: (1) Cretaceous micro- or macro-biostratigraphy or history of the areas around the northern Pacific; (2) interregional correlation; (3) the problem of Cretaceous transgressions and regressions. This volume is, thus, indispensable for geological libraries as well as persons who may have interests either in academic or applied aspects of the Cretaceous events and relevant affairs.

The Special Papers are on sale at the Society. Orders must be accompanied by remittance made payable to Dr. Kametoshi KANMERA, Editor of the Special Papers, Palaeontological Society of Japan, c/o Department of Geology, Faculty of Science, Kyushu University, 33, Fukuoka (Hakata) 812, Japan. The following backnumbers are also purchasable from the same office as mentioned above.

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