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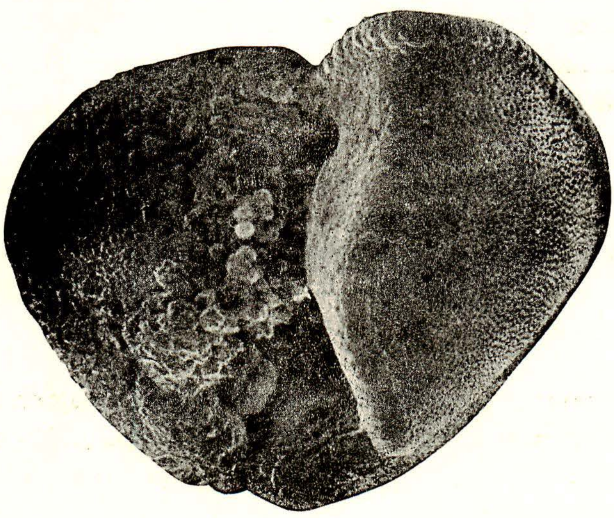

日本古生物学会

Palaeontological Society of Japan
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Fossils on the cover is *Globorotalia truncatulinoides* (D'ORBIGNY, 1839).
The photograph was taken on a scanning electron microscope, JEOL-JSM-2, ×100.

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571. NANNOPLANKTONS FROM THE DEEP-SEA OOZE OF THE EQUATORIAL PACIFIC*

SHIRO NISHIDA

Department of Earth Science, Nara University of Education, Nara, Japan

赤道太平洋の深海軟泥中の石灰質超微プランクトン： 1968年1月東京大学海洋研究所の研究船・白鳳丸が赤道太平洋 (KH67-5-St. 21: 南緯 00°39.6′, 東径 160°36.7′, 深度 2940 m) から採取した有孔虫軟泥中の石灰質超微プランクトンについて報告する。軟泥の大部分は Grobigerinaceae からなり，これ以外はほとんど Coccolithophorid よりなっている。この軟泥中から電子顕微鏡観察により 28種の石灰質超微プランクトンを記載した。光学顕微鏡下ではさらに2種が確認されている。

本試料の採集された南赤道海流域からは HASLE (1959) が 32 種の現棲の Coccolithophorids を報告しているが，本試料中よりそのうち6種が見出されている。また KAMPTNER (1963) が本海流域の鮮新世から現世におよぶ 2 本の core 試料から 41 種の Coccolithophorids を報告しているが，そのうち 9種が本試料中に見出される。同時に彼が赤道反流域の core から報告している 8種のうち4種が，北赤道海流域の core および dredge 試料より報告している 35種のうち 3種が本試料中のものと共通している。

量的には KH67-5-St. 21 試料のナノプランクトン群集の 76% は *Cyclococcolithus leptoporus* (MURRAY & BLACKMAN), *Gephyrocapsa oceanica* と *Umbilicosphaera mirabilis* の 3 種からなるが同じ白鳳丸 KH67-5-St. 23 core 試料 (北緯 00°49′, 東経 164°00′, 深度 4330 m, コア長 271 cm) の表層部では *Cycl. leptoporus* (MURRAY & BLACKMAN), *Ellipsoplacolithus productus* と *Gephyrocapsa aperta* の 3 種で全体の 88% を占め，*G. aperta* のみで 51% に達する。St. 23 core ではこのような構成がコア長 271 cm にわたりほとんど変化しない。また絶対個数では軟泥の湿重 1 g 当り 3×10^9 個程度に達する。

同じ海流域についてみてもこのような現棲種群や試料ごとの共通種の違いの原因は BRAMLETTE (1961) の言う 5000 m/10 年というような沈降速度とその間における海流の循環，混合，表層海流と深層海流のちがいや気候変化などに求められよう。

MCINTYRE & BE (1967) と MCINTYRE & LOUISE (1969) は太西洋と太平洋で Coccolithophorid についてそれぞれ 5 つの floral group を区別したが，それによると本試料中の Coccolithophorid 群集は tropical ないし subtropical assemblage の様相を示す。

西田史朗

Introduction

The significance of the Coccolithophoridae as an important constituent of the modern deep-sea sediment has well been recognized since the mid-nineteenth century. Towards the end of the century, the Challenger Expedition revealed their world wide distribution in calcareous ooze. LOHMANN (1902) made a contribution to floristic relationships between the Coccolithophorids of living planktons and those of the sediment on the underlying sea floor. Since then, a large number of species of this minute organism have been described chiefly by

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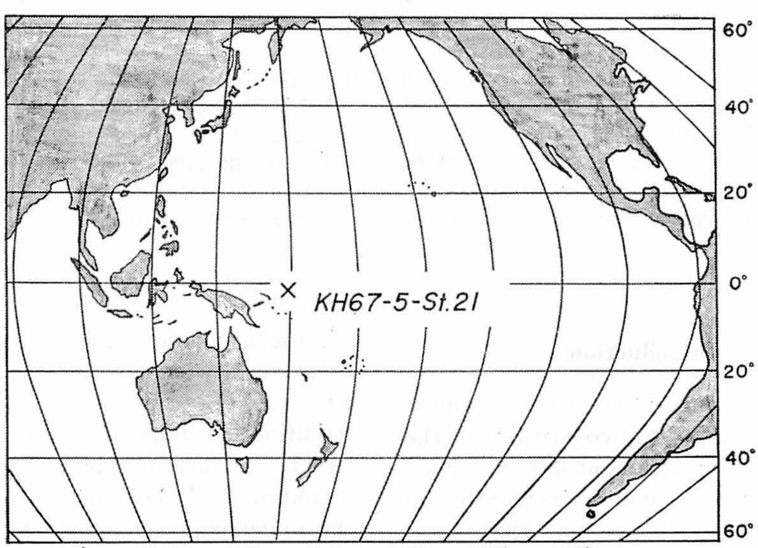
the structural features of coccoliths, which are skeletal elements made of calcite crystals arranged in an orderly pattern. In recent years, occurrence of coccoliths in the oceanic sediment has been given attention for its geological value which has become to be proved. Paleontological studies of coccoliths were carried out by many investigators. Most of them are, however, of land samples ranging from Jurassic to Pleistocene in age. And the majority of the studies of pelagic samples are restricted in the Atlantic Ocean, while reports of the coccoliths from the Pacific are rather few, reported by KAMPTNER (1963), HA SLE (1959 & 1960), MARTINI & BRAMLETTE (1963), MARTINI (1965), MCINTYRE & LOUISE (1969) and others. In Japan, TAKAYAMA (1968) reported orally on discoasters from the deep-sea core of the Philippine Sea at the Ordinary Meeting of the Palaeontological Society of Japan held at Kyushu University, Fukuoka, Japan. Also TAKAYAMA (1969) reported on the stratigraphical distribution of the discoasters in the same core and discussed their occurrences on land in connection with the sequences from mid latitudes in Italy and Japan. Biogeographical researches on living Coccolithophoridae are carried strongly by MCINTYRE et al., OKADA and others.

The author would like to acknowledge the continuing guidance and encouragement of Professor Misaburo SHIMAKURA and to Assistant Professor Naofumi KITAGAWA of this university for a critical reading of the manuscript. He is also grateful to Professor Noriyuki NASU of Ocean Research Institute, University of Tokyo, for providing the samples.

Material studied

The material here used is from the deep-sea sample dredged up by the Hakuho-Maru, a research vessel of Ocean Research Institute, University of Tokyo, in her KH67-5 cruise, at the Station 21,



Text-fig. 1. Geographical location of deep-sea ooze Hakuho-Maru 67-5-St. 21.

Lat. 00°39.6′S, Long. 160°36.7′E, from a depth of 2940 meters on the sea floor of the Equatorial Pacific Ocean on January 5th, 1968. In the present paper the author mentioned briefly on nannoplankton flora of KH67-5-St. 23 core obtained in the same cruise. The station at which the present sample was taken is situated in the western part of the South Equatorial Current. The HASLE's (1959) stations (St. 88-Lat. 00°01′N, Long. 145°02′W, St. 1-Lat. 00°58.6′N, Long. 145° 05.2′W & St. 2-Lat. 00°00.7′N, Long. 145° 05.6′W), the two (St. 61-Lat. 00°06′S, Long. 135°58′W & St. 62-Lat. 03°00′S, Long. 136°00′W) of the KAMPTNER's (1963) stations and KH67-5-St. 23 (Lat. 00°49′N, Long. 164°00′E) of Hakuho-Maru (NISHIDA, in preparation) are located in the eastern part of the same current.

Twenty-eight species of calcareous nannoplankton are described below from this sample by means of the electron-microscopical observation. Some other nannoplanktons were observed under the optical microscope; they are fragments of *Discoaster brouweri* and *D. perplexus*. Besides the nannoplanktons, the present sample contains abundant planktonić foraminifera, almost all of which belong to the Globigerinaceae.

Preparation method

An outline of the preparation method is given below; the crude sample sent to the present author was soaked in about 5 percent solution of sodium hexametaphosphate for a day under the normal condition. The sample was centrifuged at 250G for 5 seconds and the supernatant part was reserved. This centrifuging was repeated until the supernatant became clear under the same condition. The remainder is mostly composed of planktonic foraminiferal tests belonging to Globigerinidae. Then, the supernatant part was again centrifuged at 350G for 1 minute and the deposit was repeatedly centrifuged at the same condition with water until the finer material was taken off. The same volume of hypochloride solution was added to the sample and boiled in water bath for 10 minutes. After washing of this sample with water, carbon replicas were prepared in the following manner; a drop of concentrated suspension of nannoplanktons in water is smeared on a mica flake and allowed to dry. Carbon was evaporated on the mica flake in the bell jar evacuated to about 10^{-4} torr. The resulting carbon film was separated off the mica flake and floated on a bath of about 5 percent of hydrochloric acid. Before this course of procedure, the evaporated carbon film on the flake was sectioned to squares of about 2 milimeters. This sectioning is appreciable for preventation of destroying of the film and for easiness of its handling in the proceeding procedures. After about 10 minutes it was transferred to the bath of distilled water and the sectioned carbon film was picked up on a 200 mesh copper electron-microscope support screen. Sometimes the present author used potassium hydroxide and hydrofluoric acid in this course of procedure.

Replicas made by this manner were examined and photographed with a Japan Electron Optics JEM-SS electronmicroscope at an accelerating voltage of 30 kV. and a filament current of 60 mA.

Because the specimens itself were destroyed in the course of preparation, the type specimens described in this article are substituted by electronmicrographed negatives. Serial numbers were given to them. The negative films are preserved in Department of Earth Science, Nara University of Education, Nara, Japan.

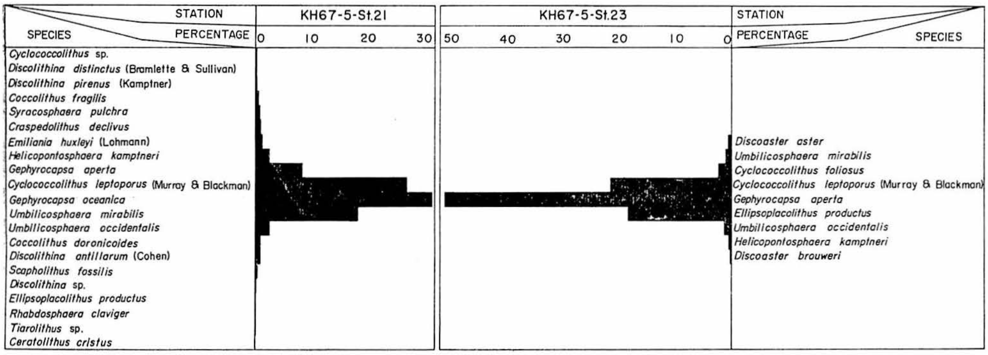
Coccolithophorid assemblage

Of twenty-eight species of nannoplanktons obtained from the present sample, six planktonic living species *Emiliania huxleyi* (LOHMANN)=*Coccolithus huxleyi* (LOHMANN), *Coccolithus fragilis* (LOHMANN)=*Cyclococcolithus fragilis* (LOHMANN), *Cycl. leptoporus*, *Umbilicosphaera mirabilis*=*Cycl. mirabilis* (LOHMANN), *Helicopontosphaera kamptneri* = *Helicosphaera carteri* (WALLICH) and *Syracosphaera pulchra*, were reported by HASLE (1959) from the stations mentioned above. He reported thirty-two planktonic coccolithophorids from the same stations but the present author could recognized only six of HASLE's species in the sample from the bottom sediment under the same current. This disagreement regarding the coccolithophorid assemblage between HASLE and the present author seems to be derived from several sources; the difference of preparation method, the difference of component between the planktonic living samples and the sediment sample, and the difference of the current conditions between surface and deep-sea.

BRAMLETTE (1961) reported that coccoliths settled requiring at rates more than 10 years to reach 5000 meters depth. Calculated from this datum, the present material requires as long as about 6 years to settle the floor. Therefore, it is highly possible that, during this period, the original tropical assemblage of coccolithophorids becomes mixed with different kinds of assemblages and there occurs sorting or selecting among their components to form finally a sedimentary assemblage which is quite distinct from the original, planktonic one.

KAMPTNER (1963) reported forty-one species of nannoplanktons ranging from Pliocene to Holocene in age from the previously mentioned core samples. Nine species of them are found in the present dredge sample; they are *Ceratolithus cristus*, *Emiliania huxleyi* (LOHMANN)= *Coccolithus huxleyi* (LOHMANN), *Craspedolithus declivus*, *Cycloplacolithus laevigatus*, *Ellipsoplacolithus productus*, *Gephyrocapsa aperta*, *G. oceanica*, *Helicopontosphaera kamptneri*=*Helicosphaera carteri* (WALLICH) and *Rhabdosphaera claviger*. Besides he reported seven species of nannoplanktons regarded from Holocene to early Pleistocene in age, from the core sample (MP10-1-Lat. 04°35′N, Long. 139° 57′W), which has its geographical location in the Equatorial Countercurrent zone. Four species of them are found in the present sample; they are *Ceratolithus cristus*, *Emiliania huxleyi* (LOHMANN)=*Coccolithus huxleyi* (LOHMANN), *Helicopontosphaera kamptneri* = *Helicosphaera carteri* (WALLICH) and *Rhabdosphaera claviger*. And he reported thirty-five species of nannoplanktons ranging from Upper Paleocene to Pliocene in age, from three cores and a dredge samples (St. 53-Lat. 15°34′N, Long. 127°11′W, MP40-1-Lat. 15°32′N, Long. 177°32′W, MP25c-1-Lat. 19°40′N, Long. 168°32′W & MP33c-Lat. 17°45′N, Long. 174°16′W), which have its geographical location in the North Equatorial Current Zone. Three species of them are found in the present sample; they are *Ceratolithus cristus*, *Emiliania huxleyi*=*Coccolithus huxleyi* (LOHMANN) and *Helicopontosphaera kamptneri*=*Helicosphaera carteri* (WALLICH). These disagreement regarding the nannoplankton assemblage between KAMPTNER and the present author are kept for future settlement.

Recently the present author commenced the work on calcareous nannoplanktons of the deep-sea core KH67-5-St. 23. In comparison with the nannoplankton flora between the uppermost part of the core



Text-fig. 2. Relative frequencies of nannoplanktons from the samples KH67-5-St. 21 and KH67-5-St. 23.

(KH67-5-St. 23 core) and the above mentioned dredge sample (KH67-5-St. 21 sample), considerable differences are evident in quality and quantity. Relative frequencies of both floras are presented in the text-fig. 2. In the sample from the KH67-5-St. 21, *Cyclococcolithus leptoporus*, *Gephyrocapsa oceanica* and *Umbilicosphaera mirabilis* are representative species, and they attain to about 76 percent of all. On the contrary, in the uppermost part of the KH67-5-St. 23 core, *Cyclococcolithus leptoporus*, *Ellipsoplacolithus productus* and *Gephyrocapsa aperta* are representative and they attain to about 88 percent of all. Especially it is noted that *Gephorocapsa aperta* alone occupies 51 percent of all. Occurrences of discoasters from both samples are a question under present conditions.

On the coccolithophorid floral assemblage, McINTYRE & BE (1967) and McINTYRE & LOUISE (1969) distinguished five floral groups in the Atlantic and Pacific respectively. According to them, the present assemblage is regarded to belong their tropical or subtropical coccolithophorid assemblage, judged from abundant occurrence of *Gephyrocapsa oceanica*, *Helicopontosphaera kamptneri*=*Helicosphaera carteri* (WALLICH), *Emiliania huxleyi* (LOHMANN)=*Coccolithus huxleyi* (LOHMANN), *Umbilicosphaera mirabilis* and *Cyclococcolithus leptoporus* (MURRAY & BLACKMAN).

Systematic description

Genus Coccolithus SCHWARTZ, 1894

Coccolithus doronicoides BLACK & BARNES, 1961

Pl. 41, fig. 4

Coccolithus doronicoides BLACK & BARNES, 1961, p. 142, pl. 25, fig. 3; McINTYRE et al., 1967, pp. 8–9, fig. A; COHEN & REINHARDT, 1968, p. 293, pl. 20, fig. 4.

Description:—Placolith, circular and conical with closely appressed shields concave distally, convex proximally and the inner end of the distal shield turns to the connecting tube. The larger proximal and the smaller distal shields composed of thin and long segment, and serrate in margin. The number of the segments of each shield is about fifty-six. The suture lines of the distal shield radiate straight at right-angle in the outer half of it.

The diameter of the distal shield is

4.0 μ. The diameter of the proximal shield is 4.4 μ.

Hypotype: Pl. 41, fig. 4. (KH67-5-St. 21-76).

Coccolithus aff. *C. fragilis* LOHMANN, 1912

Pl. 39, fig. 6

Coccolithus fragilis LOHMANN; DEFLANDRE & FERT, 1953, p. 329.

Description:—Placolith, circular in plane view with a serrate ellipse in the central pore. Shield consisting of eighteen to nineteen wedge-shaped segments which show sinistral imbrication. Sutures of the shield radiate straight in outer part but curve slightly with approach to the central pore. Central serrated ellipse is composed of more minute segments with arrangement in both sides of the central slit. The segments in a side of the central disc are numerated eight to nine.

The diameter of the shield is 4.5 μ.

Hypotype: Pl. 39, fig. 6. (KH67-5-St. 21-43).

Genus Craspedolithus KAMPTNER, 1963

Craspedolithus declivus KAMPTNER, 1963

Pl. 40, figs. 6-7

Craspedolithus declivus KAMPTNER, 1963, p. 161, pl. 2, fig. 16; KAMPTNER, 1967, p. 127, pl. 3, figs. 16 & 18.

Description:—Placolith, circular in plane view with closely appressed ring-like shields. The distal shield narrower, the proximal wider and larger, with a wide central pore bearing no fine structure. The distal shield is narrow, concave conically in the inner half and composed of about thirty, nearly equal segments which radiate at right-angle to the ring. The larger proximal shield composed of many irregularly sized and shaped segments which arranged with dextral imbrication. The outer margin of the shield is rough and knotched.

The diameters of the distal shield are about 6.7 μ. The diameters of the proximal shields are about 9.5 μ. The diameters of the central opening are about 5.2 μ.

Hypotype: Pl. 40, figs. 6-7. (6; KH67-5-St. 21-227, 7; KH67-5-St. 21-203).

Genus Cyclococcolithus KAMPTNER, 1954

Cyclococcolithus leptoporus (MURRAY & BLACKMAN) KAMPTNER, 1954

Pl. 39, figs. 1-3

Coccosphaera leptopora MURRAY & BLACKMAN, 1898, pp. 430-437 & 439, pl. 15, figs. 1-7.

Coccolithophora leptopora (MURRAY & BLACKMAN) LOHMANN, 1902, pp. 137-138, pl. 5, fig. 52.

Coccolithus leptoporus (MURRAY & BLACKMAN) SCHILLER; BLACK & BARNES, 1961, p. 143, pl. 24, figs. 3-4.

Umbilicosphaera leptopora (MURRAY & BLACKMAN) COHEN & REINHARDT, 1968, p. 296, pl. 20, fig. 11.

Cyclococcolithus leptoporus (MURRAY & BLACKMAN) KAMPTNER, 1954, p. 23, fig. 20; COHEN, 1964, p. 237, pl. 2, fig. 4; COHEN, 1965b, pp. 25-26, pl. 18, figs. a-e, pl. 19, figs. a-b & pl. 20, figs. a-b; HAY et al., 1967, pl. 10-11, fig. 3; MCINTYRE & BE, 1967, p. 569, pl. 7, figs. A-C; KAMPTNER, 1967, p. 129, pl. 3, fig. 21; GARTNER, 1967, pp. 1-4, pl. 1, figs. 1-4 & pl. 2, figs. 1-4; NISHIDA, 1969, pp. 89-90, pl. 1, figs. 4-5.

Description:—Placolith, circular in plane view with shield convex distally, concave proximally. Segments petaloid with dextral imbrication in the distal shield at the view from the proximal side. The suture line on the distal surface of the shield is radial for about one-half the distance from the central column and then curves sinistrally. In the column each segment intergrows to make a crateriform pit closed at the base in the present specimen. The proximal surface of the shield shows straight suture line. Directions of the imbrication are variable and show sinistral, dextral and zigzag straight types.

The diameter of the distal shield ranges from 7.8 μ to 10.4 μ. The diameter of the proximal shield ranges from 4.1 μ to 7.7 μ.

Hypotype: Pl. 39, figs. 1-3. (1; KH67-5-St. 21-8, 2; KH67-5-St. 21-230, 3; KH 67-5-St. 21-271).

? *Cyclococcolithus* sp.

Pl. 39, fig. 13

Description:—Placolith, undecagonal in plane view with shield convex distally. Segments triangular with straight dextral imbrication. The suture line on the distal surface of the shield is radial.

The diameter of the shield is 7.4 μ.

Hypotype: Pl. 39, fig. 13. (KH67-5-St. 21-231).

Genus Cyclolithella LOEBLICH & TAPPAN, 1963

cf. *Cyclolithella* sp.

Pl. 39, fig. 5

Description:—Cyclolith, circular in plane view having a single shield. The shield composed of about fifteen wedge-shaped segments having a sinistral imbrication in the outer circle and becoming straight with approach to the central pore. The inner end of the each segment becomes slender, overlaps and confuses. The central area is perforated and the margin is serrate.

The diameter of the shield is about 3.4 μ.

The present specimen differs from *Pyrocyclus* in the shape of the shield, and from *Cyclolithus* in the width of the central pore.

Hypotype: Pl. 39, fig. 5. (KH67-5-St. 21-107).

Genus Cycloplacolithus KAMPTNER, 1963

Cycloplacolithus laevigatus KAMPTNER, 1963

Pl. 41, fig. 5

Cycloplacolithus laevigatus KAMPTNER, 1963, p. 168, pl. 9, figs. 47–49.

Description:—Placolith, circular in plane view with closely appressed shields, slightly convex distally and the central pore closed. The distal shield small, the proximal shield large. Each shield composed of the same number of petaroidal segments. The segments of the distal shield imbricate dextrally and its inner end makes up the lid of the central pore. The segments of the proximal shield radiate at right angle.

The diameter of the distal shield is about 4.4 μ. The diameter of the proximal shield is about 6.2 μ.

Hypotype: Pl. 41, fig. 5. (KH67-5-St. 21-33).

Genus Discolithina LOEBLICH & TAPPAN, 1963

Discolithina antillaria (COHEN)

Pl. 40, figs. 9–11

Discolithus antillarum COHEN, 1964, p. 236, pl. 1, fig. 3 & pl. 2, fig. 2; MCINTYRE et al., 1967, pp. 7–8, figs. C–D.

Description:—Discolith, circular in plane view with asymmetrical construction of the shields. The larger distal and the smaller proximal shields connected by a column. Segments of both shields are wedge-shaped without imbrication. The sutures of the distal shield are straight but sinuous in the proximal shield. The number of segments is counted about fifteen in both shields.

The diameter of the distal shield ranges from 3.5 μ to 6.3 μ. The diameter of the proximal shield ranges from 1.7 μ to 4.1 μ.

Hypotype: Pl. 40, figs. 9-11. (9; KH67-5-St. 21-255, 10; KH67-5-St. 21-248, 11; KH-67-5-St. 21-171).

Discolithina distincta (BRAMLETTE & SULLIVAN)

Pl. 40, fig. 13

Discolithus distinctus BRAMLETTE & SULLIVAN, 1961, p. 141, pl. 2, figs. 8-9; SULLIVAN, 1964, p. 182, pl. 4, fig. 4; SULLIVAN, 1965, p. 33, pl. 4, figs. 1-6.

Description:—Discolith, elliptical in plane view with narrow, thick rim and perforated wide central area. The outer part of the rim finely serrated, wind sinistrally and the inner part of the rim composed of many minute rectangular segments which radiate at right-angle to the rim. The central or the basal plate irregularly perforated by the conspicuous pores characterized by its arrangement and shape.

The diameter of hypotype are 7.0 μ in length and 4.7 μ in width. The diameters of the basal part are 5.5 μ and 3.2 μ.

Hypotype: Pl. 40, fig. 13. (KH67-5-St. 21-97).

Discolithina pirena (KAMPTNER)

Pl. 39, fig. 12

Discolithus pirenus KAMPTNER, 1967, pp. 134 & 171, pl. 5, fig. 33.

Description:—Discolith, elliptical in plane view with double narrow rims and wide central area. In the central area minute calcite crystals show a screw-form around a small central pore.

The longitudinal diameter of the hypotype is 5.0 μ and the width is 3.5 μ. The width of the rim is 0.5 μ and the width of the central pore is 1.0 μ.

Hypotype: Pl. 39, fig. 12. (KH67-5-St. 21-290).

Discolithina sp.

Pl. 40, fig. 12

Description:—Discolith, elliptical in plane view with narrow thick rim and perforated wide central area. Both the rim and the central area are composed of minute calcite crystals which wind sinistrally along the longitudinal central suture. In the central area irregularly arranged small pores and a fine longitudinal central suture are characteristic. About fifty pores are counted and its diameters are about 0.4 μ.

The longitudinal diameter of the hypotype is approximately 10 μ and the width is 6 μ.

Hypotype: Pl. 40, fig. 12. (KH67-5-St. 21-169).

Genus Ellipsoplacolithus KAMPTNER, 1963

Ellipsoplacolithus productus KAMPTNER, 1963

Pl. 40, fig. 8

Ellipsoplacolithus productus KAMPTNER, 1963, pp. 172-173, pl. 8, figs. 42 & 44.

Description:—Placolith, elliptical in plane view with shield convex distally, concave proximally. Segments petaloid with slightly sinistral imbrication in the proximal shield at the view from the proximal side. Each shield is composed of twenty-six segments and have indented end peripherally. Central longitudinal slit is conspicuous.

The longitudinal diameter of the distal shield is 2.7 μ. The longitudinal diameter of the proximal shield is 2.4 μ.

Hypotype: Pl. 40, fig. 8. (KH67-5-St. 21-202).

Genus Emiliania HAY & MOHLER, 1967

Emiliania huxleyi (LOHMANN) HAY & MOHLER, 1967

Pl. 41, figs. 1-3

Pontosphaera huxleyi LOHMANN, 1902, p. 130, pl. 4, figs. 1-9 & pl. 6, fig. 69.

Coccolithus huxleyi (LOHMANN) KAMPTNER; KAMPTNER, 1952, p. 234, fig. 10; BRAARUD et al., 1952, pp. 129-131, text-fig. 3 & pl. 1, figs. a-f; BRAARUD & NORDLI, 1952, p. 361, text-figs. a & b; DEFLANDRE & FERT, 1953, pl. 2, fig. 1; DEFLANDRE & FERT, 1954, p. 37, pl. 1 & pl. 2, figs. 1-10; HASLE, 1960, pl. 1, fig. 2 & pl. 2, fig. 2; BLACK & BARNES, 1961, p. 141, pl. 20 & pl. 21, figs. 1-6; BLACK, 1965, p. 134, fig. 24; COHEN, 1965b, pp. 11-12, pls. 8-10, pl. 11, figs. c-e & pl. 12, figs. a-b; KAMPTNER, 1967, p. 125, pl. 3, fig. 17; McINTYRE & BE, 1967, pp. 568-569, pl. 5, fig. D, pl. 6, figs. A-B & pl. 12, fig. B.

Emiliania huxleyi (LOHMANN) HAY & MOHLER, 1967, p. 447, pl. 10-11, figs. 1-2.

Description:—Placolith, oval in plane view with shields equal in size, convex distally and concave proximally. The large elliptical central pore is normally covered by a plate. The T-shaped elements form the distal shield or occasionally both shields. The end of the each element interlocked. The elements of the proximal shield show two types in the present sample. One of the types is like those described above, having T-shaped elements in the proximal shield (vid. Pl. 41, fig. 2) and another is having a solid shield of flatten elements (vid. Pl. 41, figs. 1 & 3). Experimentally it is proved by WATABE & WILBUR (1966) that the former is of a warm water species and the latter is of a cold water one.

The diameter of the both shields ranges from 2.8 μ to 4.3 μ.

Hypotype: Pl. 41, figs. 1-3. (1; KH67-5-21-114, 2; KH67-5-St. 21-205, 3; KH67-5-St. 21-259).

Genus Gephyrocapsa KAMPTNER, 1943

Gephyrocapsa aperta KAMPTNER, 1963

Gephyrocapsa oceanica KAMPTNER; BLACK & BARNES, 1961, pl. 25, figs. 1-2; COHEN, 1964, p. 240, pl. 3, fig. 3 & pl. 4, figs. 4-5; McINTYRE et al., 1967, pl. 1, figs. A-B; COHEN & REINHARDT, 1968, pl. 20, fig. 10.

Gephyrocapsa aperta KAMPTNER, 1963, p. 173, pl. 6, figs. 32 & 35.

Description:—Placolith, elliptical in plane view with closely appressed shields convex distally, concave proximally and a conspicuous imperfect bridge of two thick calcite elements arching across the central pore. The central pore is not covered except for such a bridge. The segments of the proximal shield imbricate sinistrally and dextrally in the distal shield. The edge of the segments at the margin is pointed.

Normally it is difficult to distinguish *Gephyrocapsa aperta* from *G. oceanica* which the central structure broken off. But electronmicroscopically *G. oceanica* has some trace of the structure on the inner side of the central pore.

The length of this specimen about 4 μ.

Width about 3 μ.
Hypotype: (KH67-5-St. 21-40).

Gephyrocapsa oceanica KAMPTNER, 1943

Pl. 40, figs. 1-3

Gephyrocapsa oceanica KAMPTNER; DEFLANDRE & FERT, 1954, p. 154, pl. 3, fig. 6; KAMPTNER, 1956, p. 179, pl. 16, figs. 4-5; BLACK, 1963, p. 43, pl. 1, fig. 4; COHEN, 1964, p. 240, pl. 4, fig. 3; MCINTYRE & BE, 1967, p. 570, pl. 9, figs. A-B; HAY et al., 1967, pls. 12-13, figs. 5-6.

Description:—Placolith, elliptical in plane view with closely appressed shields convex distally, concave proximally and a conspicuous bridge of two calcite elements arching obliquely across the central pore on the distal side. The central pore is covered on the proximal side by a delicate plate of inter-connected rods radiating from the central line. The segments of the shields slightly imbricate, sinistral in the proximal and dextral in the distal shield. The sutures are nearly at right-angle to the connecting tube.

The length of the hypotype ranges from 3.9 μ to 4.2 μ. The width of them ranges from 3.3 μ to 4.0 μ.

Hypotype: Pl. 40, figs. 1-3. (1; KH67-5-St. 21-222, 2; KH67-5-St. 21-242, 3; KH67-5-St. 21-26).

Genus Helicopontosphaera HAY & MOHLER, 1967

Helicopontosphaera kamptneri HAY & MOHLER, 1967

Pl. 40, figs. 14-15

Coccolithus carteri (WALLICH) KAMPTNER, 1941, p. 93, pl. 8, figs. 134-136.
Helicosphaera carteri (WALLICH) KAMPTNER, 1954, p. 22, figs. 17-19; BLACK & BARNES, 1961, p. 139, pl. 22, fig. 1 & pl. 23, figs. 1-2; KAMPTNER, 1963, p. 173, pl. 3, figs. 19 & 21; COHEN, 1964, p. 238, pl. 4, fig. 1; COHEN, 1965a, p. 340, pl. 2, fig. A; COHEN, 1965b, p. 21, pl. 17, figs. a-d; MCINTYRE & BE, 1967, p. 571, pl. 11, fig. A; MCINTYRE et al., 1967, pp. 12-13, pl. 6, figs. A-B; COHEN & REINHARDT, 1968, p. 298, pl. 20, figs. 5 & 8.
Helicopontosphaera kamptneri HAY & MOHLER, 1967, p. 448, pl. 10-11, fig. 5.

Description:—The center of the proximal surface is covered by a large flat elliptical shield, consisting of elongate plates disposed approximately at right-angle to the periphery of the shield. For this arrangement of the plates, they meet at a focal point of the shield and make two wedge-shaped pores. Surrounding of the central shield is a flange of narrow radiating plates. They wind round the shield dextrally viewing from the proximal shield, and form a wing-like expansion. Proximal shield is formed by the tangentially arranged crystals concealing the structure seen on the distal surface except the wing.

The length of the hypotype ranges from 6.3 μ to 10.0 μ. The width ranges from 4.4 μ to 7.8 μ.

Hypotype: Pl. 40, figs. 14-15. (14; KH 67-5-St. 21-252, 15; KH67-5-St. 21-21).

Genus Syracosphaera LOHMANN, 1902

Syracosphaera pulchra LOHMANN, 1902

Pl. 40, figs. 4-5

Syracosphaera sp., COHEN, 1965b, p. 20, pl. 25, fig. f; COHEN & REINHARDT, 1968, pp. 291-292, pl. 20, fig. 1.
Syracosphaera pulchra LOHMANN, 1902, pp. 133-134, pl. 4, figs. 33 & 36-37; DEFLANDRE & FERT, 1954, pl. 5, figs. 1 & 4-5; HALLDAL & MARKALI, 1955, p. 12, pl. 11, figs. 1 & 4; BLACK & BARNES, 1961, p. 139, pl. 19, figs. 1-2; COHEN, 1965b, p. 20, pl. 12, fig.

d & pl. 14, figs. a–b; COHEN & REINHARDT, 1968, p. 292, pl. 20, fig. 3.

Description:—Discolith, nearly elliptical, somewhat oblong in outer shape, and have narrow, thick double rings. The central area occupied three-fourth of its diameter is large, having radial ribs. The radial ribs are seen to be arranged in bundles or sheaves, overlapping to some extent at the center. The distal ring consists of short crystals directed to the center of the area and being concave cylindrically.

The length and the width of the hypotype are both 3.1 μ.

Hypotype: Pl. 40, figs. 4–5. (4; KH67-5-St. 21-167, 5; KH67-5-St. 21-223).

Genus Tioarolithus KAMPTNER, 1958

Tiarolithus sp. A

Pl. 39, fig. 4

Description:—Circular shield with central pore in plane view. The shield composed of twenty-six segments which imbricate sinistrally. Inner end of each segment curls up and makes ring-like pile surrounding the central pore. This specimen supposed perhaps to be a separated shield of some placoliths.

The diameter of the shield is 3.2 μ.

Hypotype: Pl. 39, fig. 4. (KH67-5-St. 21-211).

Tiarolithus sp. B

Pl. 41, fig. 7

Description:—Circular button-shaped shield in plane view. The shield composed of thirteen short wedge-shaped segments. The central pore is open and four small knobs protrude oppositly from the segments.

The diameter of the shield is 1.7 μ.

Hypotype: Pl. 41, fig. 7. (KH67-5-St. 21-32).

Genus Umbilicosphaera LOHMANN, 1902

Umbilicosphaera mirabilis LOHMANN, 1902

Pl. 39, figs. 8–11

Cyclococcolithus mirabilis (LOHMANN) KAMPTNER, 1954, p. 24, text-figs. 21–23; COHEN, 1964, p. 237, pl. 1, fig. 4 & pl. 2, fig. 3.

Umbilicosphaera mirabilis LOHMANN, 1902, p. 139, pl. 5, fig. 66; DEFLANDRE, 1952, fig. 354; BLACK & BARNES, 1961, p. 140, pl. 25, figs. 4–5; BLACK, 1963, p. 44, pl. 1, fig. 3; MCINTYRE et al., 1967, p. 13, pl. 2, figs. C–D; MCINTYRE & BE, 1967, pp. 571–572, pl. 12, fig. A; COHEN & REINHARDT, 1968, p. 294, pl. 19, figs. 8 & 12, & pl. 21, fig. 2.

Description:—Placolith, circular in outline and perfectly flat proximal shield joined to an arched distal shield of equal size by a wide cylindrical tube. The proximal shield consists of a ring made of about thirty crystals surrounding the wide circular central pore. Towards the periphery of the distal shield, the crystals are further modified by expansion of the exposed face to form a series of overlapping flanges. They terminate at the circular margin of the shield but don't overlap perfectly in many specimens. The distal shield consists of thin flat segments, equal in number of the crystal in the proximal shield. Central pore is large, open and empty.

In the present nannoplankton flora two types of *Umbilicosphaera mirabilis* are distinguished. Namely one of the type is shown in Plate 39, figures 8 and 9. Another type is shown in the same plate, figures 10 and 11. They differ in the degree of development of the segment on the distal surface and the diameter of the central pore.

The diameter of the proximal shield ranges from 4.5 μ to 5.5 μ.

Hypotype: Pl. 39, figs. 8-11. (8; KH67-5-St. 21-243, 9; KH67-5-St. 21-172, 10; KH67-5-St. 21-81, 11; KH67-5-St. 21-181).

Umbilicosphaera occidentalis COHEN & REINHARDT, 1968

Pl. 39, fig. 14

Cyclococcolithus leptoporus var. *inversus* DEFLANDRE & FERT, 1954, p. 150, pl. 4, figs. 4-7.
Cyclococcolithus inversus DEFLANDRE; HAY et al., 1966, pp. 389-390, pl. 7, fig. 2.
Markalius inversus (DEFLANDRE) BRAMLETTE & MARTINI, 1964, p. 302, pl. 2, figs. 4-9 & pl. 7, fig. 2.
Umbilicosphaera occidentalis COHEN & REINHARDT, 1968, p. 295, pl. 21, fig. 6.

Description:—Placolith, circular with closely appressed shields, and connected by a large central tube. The distal shield composed of about thirty segments and the proximal shield of the same number of segments. The segments arranged radially and the margin somewhat serrate. Fine sinistral striae are observable on the proximal shield. The central connecting tube is made of smaller plates arranged with sinistral imbrication.

The diameter of the distal shield ranges from 5.6 μ to 4.5 μ. The diameter of the proximal shield ranges from 3.0 μ to 3.7 μ.

Hypotype: Pl. 39, fig. 14. (KH67-5-St. 21-241).

Umbilicosphaera sp.

Pl. 39, fig. 7

Description:—Placolith, circular in plane view, with closely appressed shields convex distally. The distal shield small, the proximal shield large, and the central pore unconspicuous. The number of

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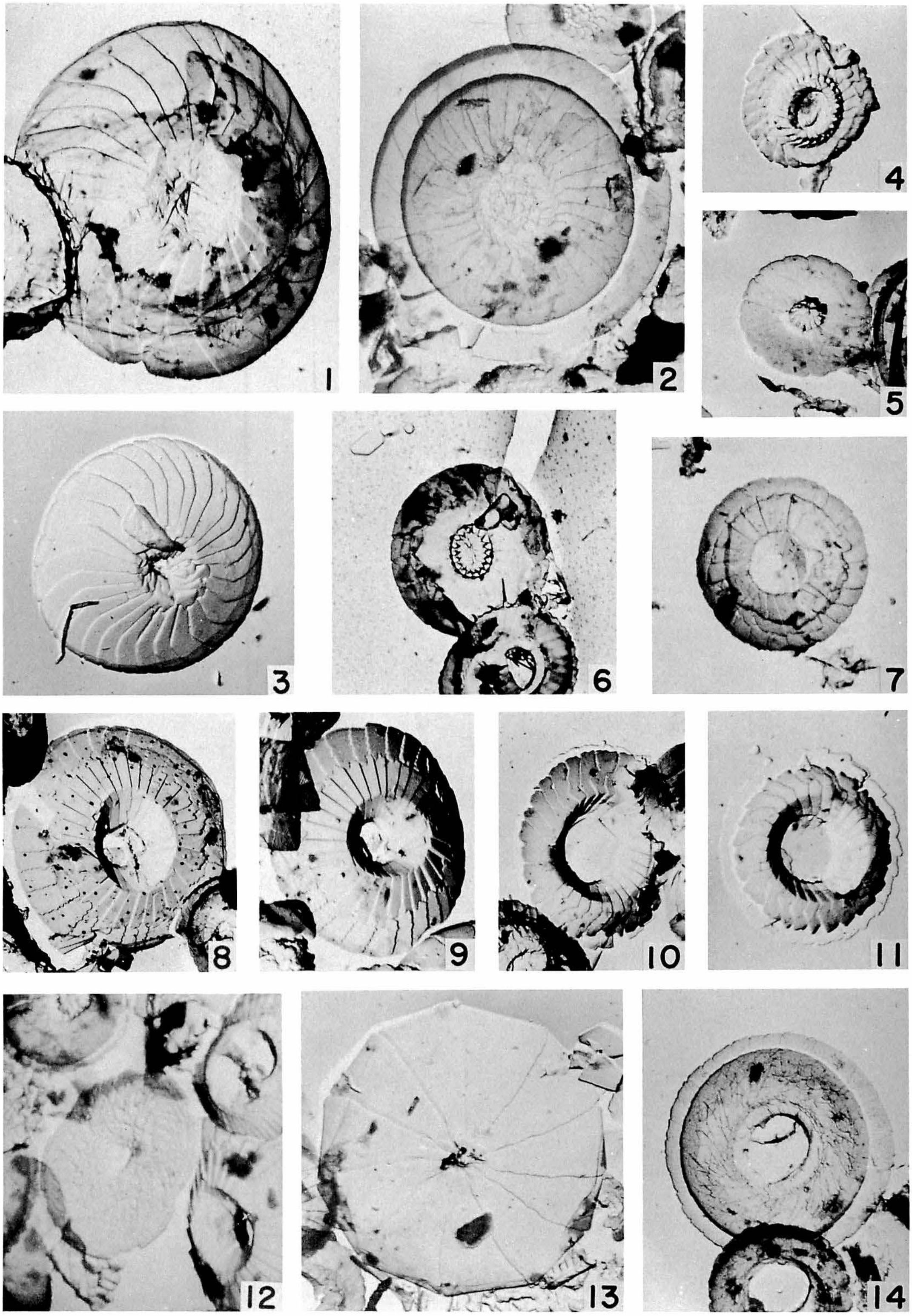
Explanation of Plate 39

Electronmicrographs of Carbon replica.

All figures presented are magnified to about 6000 times.

Fig. 1. *Cyclococcolithus leptoporus* (MURRAY & BLACKMAN) KAMPTNER, 1954. Distal view. KH67-5-St. 21-8.
Fig. 2. *Cyclococcolithus leptoporus* (MURRAY & BLACKMAN) KAMPTNER, 1954. Proximal view. KH67-5-St. 21-230.
Fig. 3. *Cyclococcolithus leptoporus* (MURRAY & BLACKMAN) KAMPTNER, 1954. Distal view. KH67-5-St. 21-271.
Fig. 4. *Tiarolithus* sp. A. KH67-5-St 21-211.
Fig. 5. cf. *Cyclolithella* sp. KH67-5-St. 21-107.
Fig. 6. *Coccolithus* aff. *C. fragilis* LOHMANN, 1912. KH67-5-St. 21-43.
Fig. 7. *Umbilicosphaera* sp. Distal view. KH67-5-St. 21-127.
Fig. 8. *Umbilicosphaera mirabilis* LOHMANN, 1902. Distal view. KH67-5-St. 21-243.
Fig. 9. *Umbilicosphaera mirabilis* LOHMANN, 1902. Distal view. KH67-5-St. 21-172.
Fig. 10. *Umbilicosphaera mirabilis* LOHMANN, 1902. Distal view. KH67-5-St. 21-81.
Fig. 11. *Umbilicosphaera mirabilis* LOHMANN, 1902. Distal view. KH67-5-St. 21-181.
Fig. 12. *Discolithina pirena* (KAMPTNER). KH67-5-St. 21-290.
Fig. 13. ? *Cyclococcolithus* sp. Distal view. KH67-5-St. 21-231.
Fig. 14. *Umbilicosphaera occidentalis* COHEN & REINHARDT, 1968. Proximal view. KH67-5-St. 21-241.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the segments of the shield is equal in both shields and counted twenty-five respectively. The segments of the shields slightly imbricate, dextrally in the outer part and sinistrally in the inner part.

The diameter of the hypotype is about 3.8 μ.

Hypotype: Pl. 39, fig. 7. (KH67-5-St. 21-127).

Genus Ceratolithus KAMPTNER, 1950

Ceratolithus cristus KAMPTNER, 1950

Pl. 41, fig. 6

Ceratolithus cristus KAMPTNER; DEFLANDRE, 1952, p. 468, fig. 364E; KAMPTNER, 1954, p. 45, figs. 44-45; COHEN, 1965b, p. 36, pl. 3, figs. m-n; KAMPTNER, 1967, p. 123, pl. 1, figs. 6-9 & pl. 2, fig. 8; TAKAYAMA, 1967, p. 196, pl. 1, figs. 2-4.

Ceratolithus cf. *C. cristus* KAMPTNER; BRAMLETTE & RIEDEL, 1954, p. 394, pl. 38, fig. 9.

Description:—Horse-shoes shaped calcareous body with pointed end. The ends of this specimen are broken off and on the outer side the round serration protrude as a mane.

Dimension of the specimen is approximately 6 μ.

Hypotype: Pl. 41, fig. 6. (KH67-5-St. 21-224).

Genus Rhabdosphaera HAECKEL, 1894

Rhabdosphaera claviger MURRAY & BLACKMAN, 1898

Pl. 41, fig. 8

Rhabdosphaera claviger MURRAY & BLACKMAN, 1898, pl. 16, fig. 13; DEFLANDRE & FERT, 1954, p. 156, pl. 5, figs. 14-15; COHEN, 1964, p. 240, pl. 5, figs. 2a-g & pl. 6, fig. 1; COHEN, 1965b, p. 22, pl. 3, figs. a-c, pl. 22, figs. a-b & pl. 23, fig. e; COHEN, 1965a, pl. 3; BLACK, 1965, p. 134, fig. 25; KAMPTNER, 1967, pp. 144-145, pl. 7, figs. 51 & 53 & pl. 8, fig. 55; HAY et al., 1967, pls. 10-11, fig. 4; COHEN & REINHARDT, 1968, pp. 292-293, pl. 19, figs. 18 & 22, pl. 20, figs. 6-7 & pl. 21, fig. 4.

Description:—The stem is formed by numerous minute elongate rhombic calcite crystals in imbricated arrangement.

Dimension of the hypotype is about 7 μ.

Hypotype: Pl. 41, fig. 8. (KH67-5-St. 21-234).

Genus Scapholithus DEFLANDRE, 1954

Scapholithus fossilis DEFLANDRE, 1954

Pl. 41, figs. 9-10

Scapholithus fossilis DEFLANDRE, 1954, p. 165, pl. 8, figs. 12 & 16-17; COHEN, 1964, p. 244, pl. 3, fig. 4 & pl. 4, fig. 3; COHEN, 1965b, pp. 24-25, pl. 3, figs. j-l; COHEN & REINHARDT, 1968, p. 293, pl. 19, figs. 9 & 13, & pl. 20, fig. 2.

Description:—Scapholith shows the elongate parallelogram in outer shape, and becomes thicker and round towards the central area. Triangular or round knobs situated along the edge. Many lamellae transversely connecting the both sides of edges.

The length of the hypotype ranges from 7.3 μ to 8.7 μ and the width ranges from 1.5 μ to 1.6 μ.

Hypotype: Pl. 41, figs. 9, 10. (9; KH67-5-St. 21-112, 10; KH67-5-St. 21-210).

Genus Thoracosphaera KAMPTNER, 1927

Thoracosphaera cf. *T. albatrosiana* KAMPTNER, 1967

Pl. 41, fig. 11

Thracosphaera albatrosiana KAMPTNER, 1967, pp. 154-157, text-fig. 24, pl. 11, figs. 78-79 & pl. 12, fig. 80.

Description:—Globe-like body with regularly arranged pores on the surface.

Diameter of the hypotype is about 12 μ.

Hypotype: Pl. 41, fig. 11. (KH67-5-St. 21-165).

Thoracosphaera cf. *T. sexea* STRADNER, 1961

Pl. 41, fig. 13

Thoracosphaera sexea STRADNER, 1961, p. 84, text-fig. 71.

Description:—Globe-like body with fine wrincle pattern on the surface.

Dimension of the hypotype is about 13 μ.

Hypotype: Pl. 41, fig. 13. (KH67-5-St. 21-191).

Thoracosphaera sp.

Pl. 41, fig. 12

Description:—Outer shape globe-like body with scattered pores irregularly on the surface.

The diameter of the hypotype is about 11.5 μ.

Hypotype: Pl. 41, fig. 12. (HK67-5-St. 21-103).

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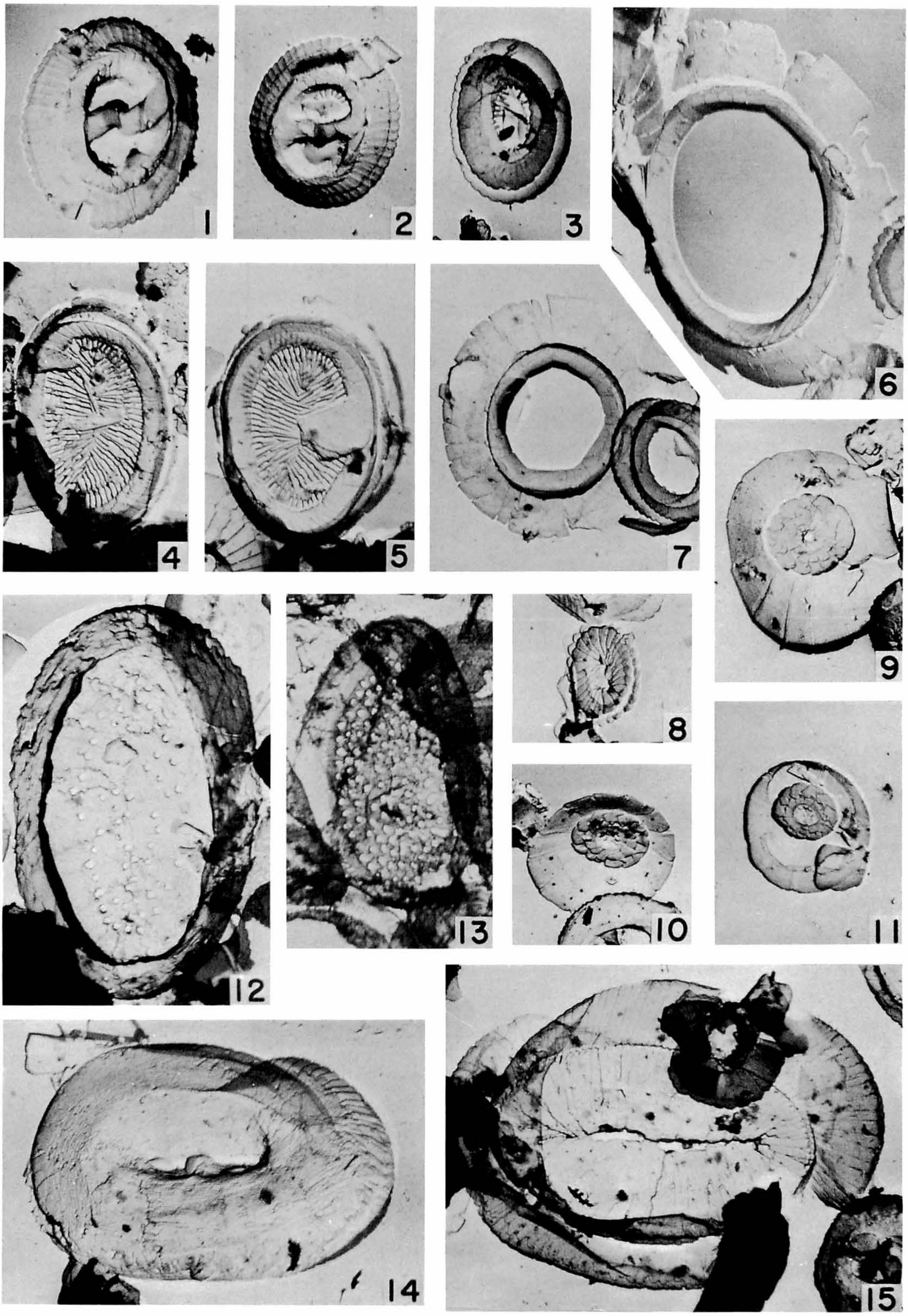
Explanation of Plate 40

Electronmicrographs of Carbon replica.

All figures presented are magnified to about 6000 times.

Fig. 1. *Gephyrocapsa oceanica* KAMPTNER, 1943. Distal view. KH67-5-St. 21-222.
Fig. 2. *Gephyrocapsa oceanica* KAMPTNER, 1943. Distal view. KH67-5-St. 21-242.
Fig. 3. *Gephyrocapsa oceanica* KAMPTNER, 1943. Proximal view. KH67-5-St. 21-26.
Fig. 4. *Syracosphaera pulchra* LOHMANN, 1902. KH67-5-St. 21-167.
Fig. 5. *Syracosphaera pulchra* LOHMANN, 1902. KH67-5-St. 21-223.
Fig. 6. *Craspedolithus declivus* KAMPTNER, 1963. Distal view. KH67-5-St. 21-227.
Fig. 7. *Craspedolithus declivus* KAMPTNER, 1963. Distal view. KH67-5-St. 21-203.
Fig. 8. *Ellipsoplacolithus productus* KAMPTNER, 1963. Proximal view. KH67-5-St. 21-202.
Fig. 9. *Discolithina antillaria* (COHEN). Proximal view. KH67-5-St. 21-255.
Fig. 10. *Discolithina antillaria* (COHEN). Proximal view. KH67-5-St. 21-248.
Fig. 11. *Discolithina antillaria* (COHEN). Proximal view. KH67-5-St. 21-171.
Fig. 12. *Discolithina* sp. KH67-5-St. 21-169.
Fig. 13. *Discolithina distincta* (BRAMLETTE & SULLIVAN). KH67-5-St. 21-97.
Fig. 14. *Helicopontosphaera kamptneri* HAY & MOHLER, 1967. Proximal view. KH67-5-St. 21-252.
Fig. 15. *Helicopontosphaera kamptneri* HAY & MOHLER, 1967. Distal view. KH67-5-St. 21-21.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Explanation of Plate 41

Electronmicrographs of Carbon replica.

All figures presented are magnified to about 6000 times.

Fig. 1. *Emiliania huxleyi* (LOHMANN) HAY & MOHLER, 1967. Distal view. Cold water type. KH67-5-St. 21-114.

Fig. 2. *Emiliania huxleyi* (LOHMAN) HAY & MOHLER, 1967. Proximal view. Warm water type. KH67-5-St. 21-205.

Fig. 3. *Emiliania huxleyi*(LOHMANN) HAY & MOHLER, 1967. Distal view. Cold water type. KH67-5-St. 21-259.

Fig. 4. *Coccolithus doronicoides* BLACK & BARNES, 1961. Proximal view. KH67-5-St. 21-76.

Fig. 5. *Cycloplacolithus laevigatus* KAMPTNER, 1963. Distal view. KH67-5-St. 21-33.

Fig. 6. *Ceratolithus cristus* KAMPTNER, 1950. KH67-5-St. 21-32.

Fig. 7. *Tiarolithus* sp B. KH67-5-St. 21-32.

Fig. 8. *Rhabdosphaera claviger* MURRAY & BLACKMAN, 1898. KH67-5-St. 21-234.

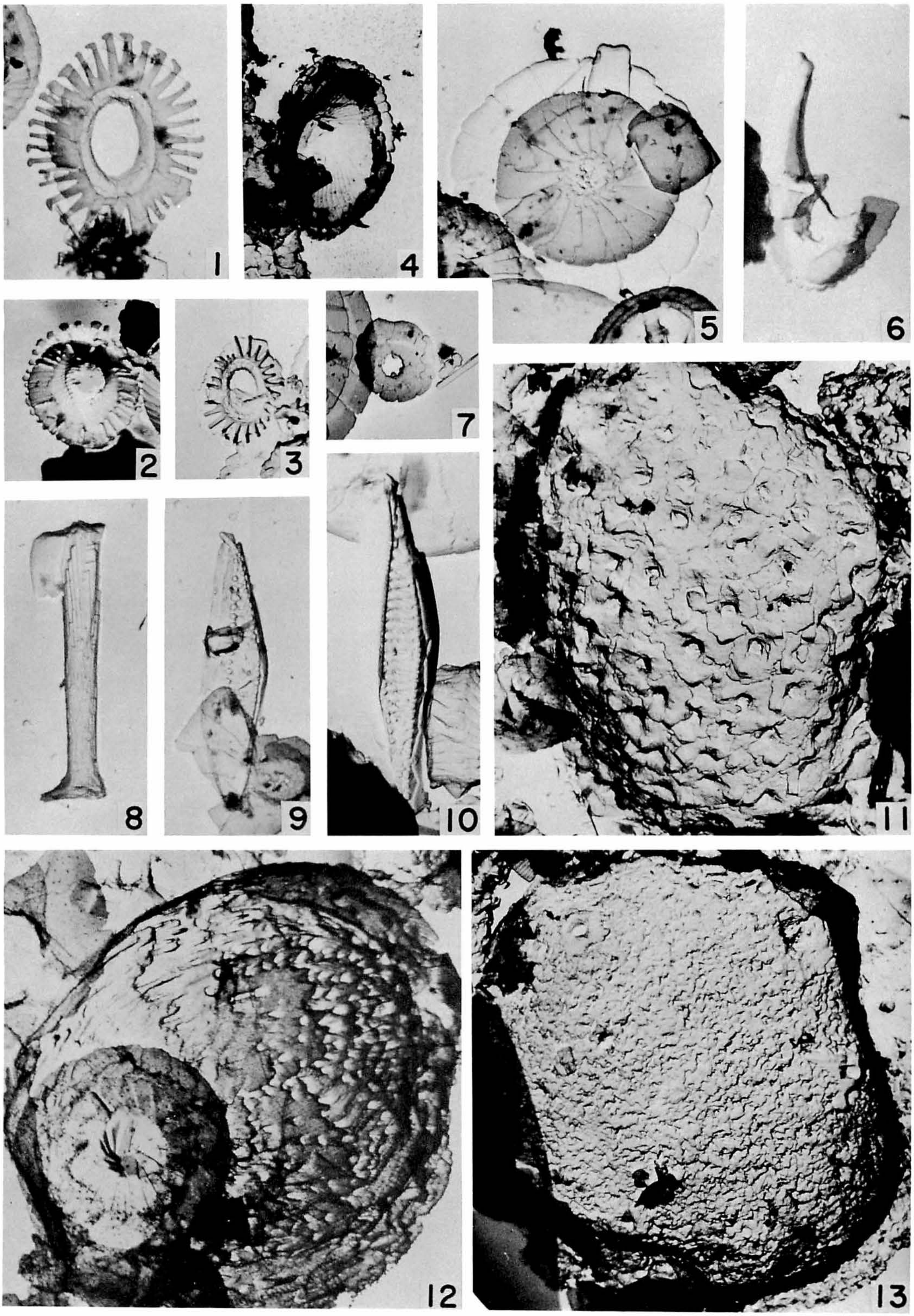
Fig. 9. *Scapholithus fossilis* DEFLANDRE, 1954. KH67-5-St. 21-112.

Fig. 10. *Scapholithus fossilis* DEFLANDRE, 1954. KH67-5-St. 21-210.

Fig. 11. *Thoracosphaera* cf. *T. albatrosiana* KAMPTNER, 1967. KH67-5-St. 21-165.

Fig. 12. *Thoracosphaera* sp. KH67-5-St. 21-103.

Fig. 13. *Thoracosphaera* cf. *T. sexea* STRADNER, 1961. KH67-5-St. 21-191.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572. ON THE ÔMICHIDANI FLORA (UPPER CRETACEOUS), INNER SIDE OF CENTRAL JAPAN*

HIDEKUNI MATSUO

Department of Geology, College of Liberal Arts, Kanazawa University

大道谷植物群について： 1951年，石川県石川郡白峯村大道谷において，前田四郎教授は上部白亜紀植物化石を採集された。その材料は遠藤誠道・天野昌久両教授によって函渕植物群に匹敵する新期白亜紀植物群であると報告された (1952年)。このたび，小林貞一・前田四郎両教授の御好意によって大道谷産の材料を見せて戴く機会に恵まれたので，今までに谷峠および福井県勝山市谷町御所ケ原で採集した植物化石をも含めて報告する。

大道谷植物群は毬果植物に富む植相をしめすが，採集した個体数では *Hemitrapa* が圧倒的に多い。堆積層は湖成相をしめし，最大層厚 150 m 位で，面谷流紋岩類の間に存在する。この特徴ある新期白亜紀酸性岩類を伴なっている足羽植物群に比較すると，大道谷植物群の層準は上位であるが，領石統の *Nilssonia densinerve* を産出する。しかし，本邦では第三紀的要素である *Pseudotsuga*, *Pinus* 等を産出する特徴を持っている。 松 尾 秀 邦

I. Introduction

When I described the Asnwa flora of the upper Cretaceous age in 1962, I considered that the Ômichidani specimens represent a member of the Asuwa flora (1962; p. 178 and p. 181). However, the Ômichidani flora is now considered to a younger member of the late Cretaceous floras developed in the Central Japan, as referred to in 1964 (p. 58).

These Ômichidani materials occurred in two localities, namely, 1) the Tani-tôgé, in the valley of Ômichidani, Shiramine-mura, Ishikawa Prefecture, and 2) Goshogahara in the outskirts of the Katsuyama City, Fukui Prefecture.

In 1950, I collected a few needle leaves of *Pinus* sp. and *Pseudotsuga* ? sp. in Tani-tôgé locality, which I considered to represent the late Tertiary flora.

In 1951, Dr. S. MAÉDA of the Chiba University collected some dicotyledonous leaves together with some small pieces of *Nilssonia*, which is a characteristic form-genus of the Mesophyta. The presence of these elements was reported by S. ENDÔ and M. AMANO in a preliminary note, that they are corresponding to a horizon of the Hakobuchi flora of Hokkaidô (1952; p. 317).

Thus, the Ômichidani flora has to be referred to a horizon of the latest Cretaceous age: as a matter of fact, the flora contains elements of the same antiquity in Europe, Siberia, Manchuria, Indo-China, Sakhalin, North America and Green-land.

Before writing this report, I wish to express my sincere thanks to Drs. T. KOBAYASHI and S. MAÉDA, who provided me with the valuable materials occurred in the Ômichidani locality; besides, my thanks are due to Dr. I. HAYASAKA for his kindly criticism and reading the

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manuscripts of this paper.

II. A Geological Sketch of the Ômichidani Area

The Ômichidani bed with the Ômichidani flora is exposed along the border-line area between Ishikawa and Fukui Prefectures, and is contained within the late Cretaceous acidic eruptives, the Omodani Rhyolitic Rocks (syn. Nôhi Rhyolite), that are distributed on the Inner Side of Central Japan.

The Ômichidani bed includes no layer of marine facies, being consisted of alternating fine mud layers and tufaceous silty layers, with the maximum thickness of about 150 m.

Dr. S. MAÉDA carried out the geological survey in the upper reaches of the Tedori-gawa, and collected many valuable

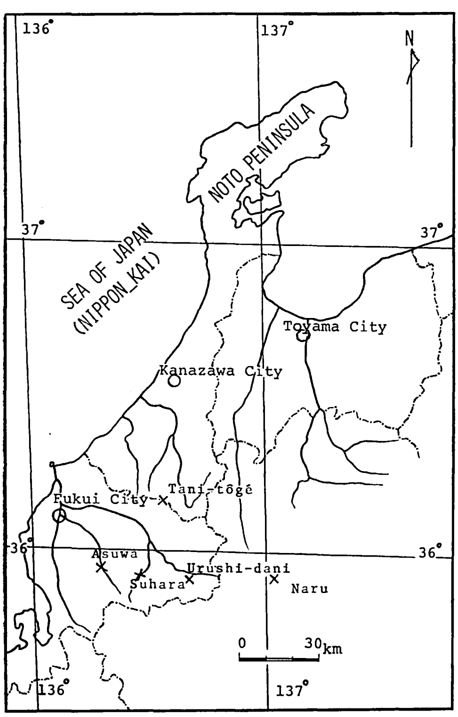


Fig. 1. Situational map of the Tani-tôgé area.

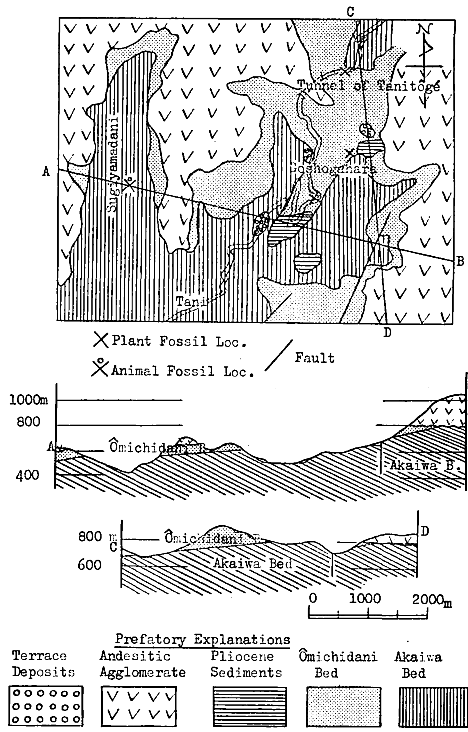


Fig. 2. Geological Map of the Environments of the Tani-tôgé (after H. MATSUO in 1962).

plant fossils of the late Mesozoic at Kariyasu in the Ômichidani valley in 1951. He discovered a bed with non-marine shells in the Sugiyamadani (a branch stream of the Takinami-gawa), around Katsuyama City, in 1953. He described them as the early Cretaceous sediments containing brackish and fresh water molluscs, such as *Unio* (*Nipponomaia*) sp., *Plicatounio* sp., *Nakamuranaia chingshanensis*, *Viviparus* (*Sinotaia* ?) *keishoensis*, etc.: according to him they belong to the horizon same as the Naktong Series in Southern Korea, which corresponds to the Akaiwa bed of the Tedori Group in the Inner Side of Central Japan.

In the middle reaches of Takinami-gawa, I, with the aid of some students, have been able to collect shells of *Corbicula*, *Ostrea* and *Viviparus* spp. as well as a plant *Onychiopsis elongata*. The layer bearing these fossils is contained within the Kuwajima bed of the lower part in the Tedori Group.

It may be concluded that the Ômichidani bed was deposited during the late Cretaceous age, because it lies unconformably on the Sugiyamadani and Takinamigawa beds (≒Akaiwa bed).

III. Composition of the Ômichidani Flora

In 1952, S. ENDÔ and M. AMANO identified the following species, which had been collected by S. MAÉDA; namely,

Cladophlebis cfr. *frigida* HEER
Sagenopteris sp.
Osmunda sp.
Nilssonia a and *b* sp.
Ginkgoites digitata (BRONGNIART) HEER
Sequoia smithiana HEER
S. heterophylla VELENOVSKY
Trapa (*Trapella*) sp.
Carpolithes sp.

Dr. T. KOBAYASHI sent me MAÉDA's collection in Tani-tôgé locality, in 1962. Besides I was able to collect some macrophytofossils in Tani-tôgé and Goshogahara localities during 1950–1967.

The Ômichidani flora, referred to above, appears to contain 10 families, 16 genera and 18 species; among these, the genera *Equisetum, Osmunda, Asplenium, Salvinia, Pseudotsuga, Cunninghamia, Glyptostrobus, Sequoia* and *Chamaechyparis* can not be assigned specifically until more complete material will have been studied.

Some additional taxa, representing one kind of leaf and seven kinds of seeds, are placed under Incertae Sedis.

Further, some fossil insects are now being studied by Dr. I. FUJIYAMA of the National Science Museum in Tôkyô: the result is expected to be published shortly.

The following is the list of the Ômichidani flora:

Equisetaceae
  Equisetum sp.
Osmundaceae
  Osmunda sp.
Polypodiaceae
  Onoclea cfr. *sensibilis* LINNEAEUS
  Asplenium sp. ?
Salviniaceae
  Salvinia sp.
Mesozoic Fern
  Cladophlebis sp.
Nilssoniaceae
  Nilssonia asuwensis MATSUO
  N. densinerve (FONTAIN) BERRY
  N. cfr. *serotina* HEER
Ginkgoaceae
  Ginkgoites pseudoadiantoides (BRONGNIART) HEER
Pinaceae
  Pseudotsuga mesowilsoniana new species
  Pinus mesothunbergii new species
Taxodiaceae
  Cunninghamia sp. ?
  Glyptostrobus sp.
  Sequoia sp.
  Taiwania mesocryptomerioides new species
Cupressaceae
  Chamaecyparis sp.
Hydrocaryaceae
  Hemitrapa angulata (BROWN) new combined
Plantae insertae Sedis
  Phyllites sp. *A*.
  Carpolithes sp. *A*. (*Cercidiphyllum* like seed)
  C. sp. *B*. (seed)
  C. sp. *C*.
  C. sp. *D*. (Palmocarpon like seed)
  C. sp. *E*.
  C. sp. *F*.
  C. sp. *G*.

IV. Palaeoecology of the Ômichidani Flora

The 18 taxa of the Ômichidani flora include a scouring-rush (*Equisetum*), five ferns, three Mesozoic cycads (*Nilssonia*),

Table 1. Distributed and Abscission Habits of Living Equivalents in Asia.

Fossil Species	Modern Species	Abscission Habit	Climate & Habit														
			Temp.					Subtrop.					Trop.				
			A	S	P	H	M	A	S	P	H	M	A	S	P	H	M
Equisetum sp.	*E. ramossimum*	Dec.		*	*				*	*				*	*		
Osmunda sp.	*O. cinnamomea*	Dec.				*											
Onoclea cf. *sensibilis*	*On. sensibilis*	Dec.			*	*											
Asplenium sp. ?	*Asplenium* species	Dec.			*					*					*		
Salvinia sp.	*S. natans*	Dec.	*					*					*				
Cladophlebis sp.	Osmundaceae and/or Polypodiaceae	Dec.			×	×				×	×				×	×	
Nilssonia asuwensis	Primitive Cycas	?								×	×				×	×	
N. densinerve																	
N. cfr. *serotina*																	
Ginkgoites pseudoadiantoides	Cfr. *Ginkgo biloba*	Dec.			×	×											
Pseudotsuga mesowilsoniana	*P. wilsoniana*	Egr. nd.									*						*
Pinus mesothunbergii	*P. thunbergii*	Egr. nd.			*	*											
Cunninghamia sp.	*C. lanceolata* or *C. konishii*	Egr. nd.									*						*
Glyptostrobus sp.	*G. lineatus*	Dec. nd.												*			
Sequoia sp.	*S. sempervirens*	Egr. nd.							*								
Taiwania mesocryptomerioides	*T. cryptomerioides*	Egr. nd.										*					*
Chamaecyparis sp.	*C. obtusa*	Egr. nd.			*	*											
Hemitrapa angulata	Ancient *Trapa* species	Dec. br. (ser)	×					×					×				
		Total	2	1	7	6	0	2	2	4	4	1	2	2	4	2	3

A=Aquatic habit; S=Close by the Stream or Sea; P=Plain; H=Hill-side and M=Mountainous land (over altitude 1,000 m); Dec.=Deciduous leafed; Dec. nd.=Deciduous needle-leafed; Dec. br. (ser.)=Deciduous broad leafed (serrated margin); Egr.=Evergreen leafed; Egr. nd.=Evergreen needle-leafed.
×=Habit in species comparable to the living species.

one extinct maiden-hair tree (*Ginkgoites*), seven conifers and one dicotyledon; eight Insertae sedical matters excepted.

In table-1, I have summerized the distributional data of the living equivalents, and tried to suggest the general type of climatic condition of the Ômichidani flora.

Two members of the flora, *Salvinia* sp. and *Hemitrapa angulata* have aquatic living relatives which range through regions of temperate to tropical climates; they will be discarded from the climatic discussion.

Six fossil species have modern relatives which live in regions of temperate climate, and five of them are restricted to such regions; especially, conifer genera, *Pinus* and *Chamaechyparis* to-day range northward into snow line areas.

Only one fossil species has a modern equivalent, *Glyptostrobus lineatus* (syn. *G. pensilis*), which is exclusively tropical: its range, however, appears to have been a wider and more northerly range in the past, as was with the late Cretaceous ancestor. Further, the two subtropical mountainous conifers, *Cunninghamia konishii* and *Taiwania cryptomerioides*, are so restricted in distribution as to suggest that their habitats might have been remnants of such altitudes as 300–1,000 m in Taiwan, and Yunnan Provinces in China. Now as the climatic influence seems to have prevailed in the temperate region, it may well be considered that those Late Cretaceous ancestors had been dispersed more widely and more northwardly.

A brief survey of the distribution of the species represented in the Ômichidani flora, thus, confirms a temperate climate. However, the existence of the Mesozoic primitive cycas *Nilssonia* is interpreted as indicating subtropical to tropical climates, as is the Cycadales in Recent forests.

Nevertheless, the absence of evergreen broad-leafed wood plants, which are commonly understood as indicating warm to tropical climates, makes it difficult for us to explain the tropical conditions of the Ômichidani flora. Thus, the Ômichidani forest suggests that it has a range in the cool- to the warm-temperate conditions, as seen in the modern Japanese archipelago, by the reasons that there are two existing equivalent species of the Conifers, *Pinus thunbergii* and *Chamaechyparis obtusa*; and that there are two living ferns which live under cool temperate climatic condition, namely, *Osmunda cinnamomea* and *Onoclea sensibilis*.

V. Comparison of the Late Cretaceous Plant bearing Beds in Japan with the Ômichidani Flora

There are some hitherto known floras of the late Cretaceous age from Hokkaidô, Honshû, Kyûshû in Japan corresponding to the Ômichidani. They are as follows:

(1) The Hakobuchi flora, at Hakobuchi (Gorge of the Middle Yûbari-gawa) in Hokkaidô.

(2) The Kuji flora, at Kadonosawa, outskirts of Kuji City, Iwate Prefecture, Honshû.

Kuji flora { Kadonosawa phytozone
Uzume phytozone

(3) The Ôarai flora, in Ôarai-machi outskirts of Mito City, Ibaraki Prefecture, Honshû.

(4) The Izumi flora, at Kada-machi, Wakayama City, Wakayama Prefecture, Honshû.

(5) The Mitsuse flora, at the prospecting-pit, Takashima colliery, outside of Nagasaki Harbour, Nagasaki Prefecture, Kyûshû.

(6) The Suritaki flora, at Sakugi-mura, Hiroshima Prefecture, Honshû.

(7) The Kamogata flora, at the Sugitani, outskirts of Kamogata-machi, Okayama Prefecture, Honshû.

(8) The Ikuno flora, in the Ikuno-machi, Hyôgo Prefecture, Honshû.

(9) The Asuwa flora, at Sarao, Ikeda-machi, Fukui Prefecture, Honshû.

Asuwa flora { Suhara phytozone / Sarao phytozone

(10) The Naru flora, at Naru, outskirts of Mino-Shirotori machi, Gifu Prefecture, Honshû.

A few other floras at the upper reaches of the Kuzuryû-gawa, Fukui Prefecture (Suhara, Urushidani, Ha'amidani, etc.).

Among above ten floras, the Ôarai and the Suritaki floras may be considered to represent the Palaeogene, by reason that the occurrence of the genus *Nilssonia* of the Mesophyta is not recognized in these floras.

The last four floras, Kamogata, Ikuno, Asuwa and Naru, are characterized by the tuffaceous sandstone layers which look, at a glance, like quartz-porphyry and/or lipalitic rocks, which are assumed to be closely allied lithologically to the Omodani rhyolitic rocks (syn. Nôhi rhyolitic rocks) in the Inner Side of Central and Western Honshû. Then these floras are considered as of the same horizon as the Ômichidani flora.

In the Hakobuchi, Kuji, Izumi and Mitsuse floras has been as yet not recognized the existence of the Characteristic Omodani rhyolitic rocks, suggesting that these are of the later horizon than the Ômichidani.

In table 2; the early Cenophyta floras in Japan show a mixed cycad and coniferous forest, but such a forest is unknown in modern vegetable kingdom. If sought in the Far East, it is found at the mountainous land (300–1,000 m) in Yunnan Province, S. China and Taiwan.

In table 3: the late Cretaceous floras bearing *Nilssonia* in Japan show that the deltoid leafed *N. serotina* is commonly found, and *N. asuwensis* is a form in the late Cretaceous. But *N. densinerve* is found in the early Cretaceous in Japan so that this Ômichidani material may be regarded to be a relict element of the Mesophyta forest.

In table 4: *Sequoia* species show the characteristic elements of the late Cretaceous floras in Japan.

Very important material of the genus *Araucaria* (it is found in the Southern Hemisphere) occurs in the Hakobuchi and Kuji floras; but it makes its appearance in the Cretaceous forests of Europe, abundantly.

The genus *Cunninghamia*, which flourished in the Northern Hemisphere in Cretaceous age, is assumed to be a mountainous conifers element of the tropical-subtropical climatic region.

Then (in table 5) I have summarized the correlation of the late Cretaceous floras in Japan from the data of the tables 2, 3 and 4.

VI. Systematic Description of the Ômichidani Flora

Equisetaceae

Equisetum sp.

Some fragments of jointed stems are clearly referable to the genus *Equisetum*.

In Japan, this genus has been known to belong to the form-genus *Equisetites* from the Mesophyta. But I do not recognize any difference between the living genus and the Ômichidani materials.

Localities: Tani-tôgé and Goshoga-hara.

Table 2. Comparison of the early Cenophyta floras in Japan.

Flora / Early Cenophyta Family	Hakobuchi	Kuji	Ôarai	Izumi	Mitsuse	Suritaki	Kamogata	Ikuno	Asawa	Naru	Ômichidani	Suhara	Urushidani
Equisetaceae			◎		○						○	○	○
Osmundaceae	○	○							○		○	○	
Polypodiaceae	○	○							○		○		?
Cladophlebis	○	○	○	○		○	○		○		?	○	○
Salviniaceae					○						○		
Nilssoniaceae	◎	◎		○				○	◎	?	◎	○	○
Ginkgoaceae									○	○	○	○	
Cycadaceae	◎	○	◎	○		◎	○		○	○		○	
Pinaceae											○		
Taxodiaceae	⊕	○	○	○				○	◎	⊕	◎	○	○
Cupressaceae	⊕										○		
Palmae			○						⊕				
Liliaceae			○									?	
Salicaceae	○	○	○										
Juglandaceae		○	○										
Betulaceae												?	
Fagaceae	⊕	○	○						?			?	
Moraceae		○		○									
Nymphaeaceae									○				
Lauraceae											?		
Platanaceae	○	○	○				○						
Hydrocaryaceae	○	○									○		

◎: Occurrence of more than two species.
⊕: Identification by other organs (ex. xylem, seed, cone, etc.).

Table 3. Comparison of the *Nilssonia* bearing floras of the late Cretaceous in Japan.

Floras / *Nilssonia* species	Hakobuchi	Kuji	Izumi	Ikuno	Asuwa	Ômichidani	Suhara	Urushidani
Nilssonia densinerve						○		
N. serotina	○		?		○	○		
N. asuwensis					○	○		
N. orientalis	○			○	○		○	○
N. species		◎	○		◎			

Table 4. Comparison of the Conifers bearing floras of the late Creaceous in Japan.

Floras / Conifer genus	Hakobuchi	Kuji	Ôarai	Izumi	Sugitani	Ikuno	Asuwa	Naru	Ômichidani	Suhara	Urushidani
Araucaria	○	○									
Pseudotsuga									○		
Pinus									○		
Taxodium			○				○				
Cunninghamia	⊕			○			○		○		
Glyptostrobus			○						○		
Sequoia	○	○	○		○	○	○	?	○	○	○
Taiwania									○		
Metasequoia			?				○				
Cryptoneria	⊕								○		
Chamaecyparis	⊕								○		
Libocedrus	○										

⊕: Identification by Xylem

Table 5. Correlation of the late Cretaceous floras in Japan (H. MATSUO, 1970).

	Approximate Correlation to the standard Scale		Sakhalin	Korea and Manchuria	Japan	North Japan Flora		Central Japan Flora	Western Japan Flora	Volcanic activity	
Palaeo-gene	Palaeo-Eocene				?				Kôtsuki		
Upper Cretaceous	Danian		Orokkian	Bukkokuji	Hetonaian	Ôarai					Izumi acidic rocks
	Maastrichtian					Hakobuchi					
	Campanian	Senonian		Sungari	Urakawan	Kuji Flora			Izumi		
							Kadonosawa				
	Santonian			?							
	Coniacian						Uzume		Kamogata		
								Ômichidani		Omodani rhyolitic rocks	Chugoku acidic rocks
	Turonian		Gyliakian	Shiragi	Gyliakian			Asuwa			
	Cenomanian										

Osmundaceae

Osmunda sp.

Pl. 42, fig. 1

In this incomplete pinnule is seen a once forking venation of the lateral veins as in the living Osmundaceae and Polypodiaceae. Among those genera, the Tani-tôgé specimen may be compared with the *Osmunda cinnamomea* LINNAEUS, which characterizes the temperate-zone of the Northern Hemisphere.

The fern recorded as *Osmunda* sp. from the Tani-tôgé locality by S. ENDÔ and M. AMANO was collected by S. MAÉDA in 1951: I consider that MAÉDA's material seems to be comparable with this species.

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-14966a.

Polypodiaceae

Onoclea cfr. *sensibilis* LINNAEUS

Pl. 42, fig. 5

At first, I could not assure this specimen to be identical with the living *Onoclea sensibilis* LINNAEUS, because it lacks an apex and a base; however, its veins, more carefully examined, proved to be identifiable with those of the present species commonly found in Japan.

It may be equivalent to the Palaeocene *O. hesperia* in North America, described by R. BROWN (1962; p. 43, pl. VII, figs. 1 and 4), which is represented by the characteristic sterial pinna.

Locality: Goshogahara.

Reg. No.=DGLAKZ-11205.

Asplenium sp. ?

Pl. 42, fig. 2

This *Sphenopteris*-like small fern seems to belong to the living *Dennstaedtia* and *Asplenium* species in Polypodiaceae, which is found in the cosmopolitan species in the World. But I consider that the Goshogahara material is more similar to the *Asplenium* than the other genera in Polypodiaceae.

Locality: Goshogahara.

Reg. No.=DGLAKZ-14974 and 11511a-a'.

Salviniaceae

Salvinia sp.

Although this material is very poorly preserved, it shows a striate and punctate pinnule as the characteristic features of the aquatic fern *Salvinia*.

The upper Cretaceous species *Salvinia mitsusense* yielded from Takashima coal-field in northwestern Kyûshû (1967: pp. 52-53, pl. V, figs. 1-6) was described by me, which is so far the second oldest known from Eastern Asia.

Then the Tani-tôgé material is the oldest evidence of the late Cretaceous occurrence in Japan, because it occurred in the horizon older than the Mitsuse horizon of Takashima.

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-15963b.

Mesophyta Fern

Cladophlebis sp.

Pl. 42, figs. 3 & 4

This pinnule bearing single forked lateral veins seems comparable with the mesophyta fern *Cladophlebis*, which is considered to belong to the *Osmunda* in Osmundaceae, *Dryopteris* in Polypodiaceae, etc. of the living species.

This Ômichidani material is more similar to the living *Dryopteris* than the *Osmunda*.

Locality: Goshogahara.

Repository: Tôkyô University.

Nilssoniaceae

Nilssonia asuwensis MATSUO

Pl. 42, figs. 11 & 12

1962. *Nilssonia asuwensis* MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, No. 1, p. 213, pls. IV, fig. 8b; VI, 1a, 2 and 3 (Holotype); VII, 4; IX, 1-3; XV, 1b; XVI, 1c; XIX, 4a and Text-fig. 9e.

This incomplete specimen which has cut-shaped segments, was collected by S. MAÊDA in 1951 at Tani-tôgé locality.

As to the *Nilssonia asuwensis* which occurred in Sarao and Shizuhara localities of the Asuwa area in the Inner Side of Central Japan, in 1962: I described this as a new species.

S. MIURA of the Fukui University collected a few more pieces of this species from the Suhara locality in 1964 (upper reaches of the Kumogawa, a branch stream of the Kuzuryû-gawa, Fukui Prefecture), which is known to have been occupied by the upper Cretaceous Suhara bed in the Omodani Rhyolitic Rocks. Thus, this occurrence proves the existence of the upper Cretaceous in the Inner Side of Central Japan.

This material lacks apex, base and half lateral part, but I consider that it does belong to the Asuwa species *N. asuwensis*, because it has a rectangular cut-shaped segments.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Nilssonia densinerve (FONTAIN) BERRY

Pl. 42, figs. 6 & 7

1940. *Nilssonia densinerve* (FONTAIN) BERRY, ÔISHI, Sci. Rep. Hokkaido Univ., Ser. IV, pp. 300-301, pl. XXIV, figs. 2-4.

These specimens closely resemble the Ryôseki Series species *Nilssonia densinerve*, which was described by S. ÔISHI from the Ryôseki flora in 1940.

Each segment of those specimens has rectangular rounded and/or broadly apical form; the former shape resembles the *N. asuwensis* and the latter is shown as the characteristic feature of the *N. serotina*.

These materials lack the apex and base, but I consider that these may be compared with the lower Cretaceous species *N. densinerve* from the Outer Side of Central Japan.

Locality: Goshogahara.

Reg. No.=DGLAKZ-12510a and 12534.

Nilssonia serotina HEER

Pl. 42, fig. 8

1925. *Nilssonia serotina* HEER; ENDÔ, Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. Vol. VII, p. 8, pl. VI, figs. 1, 3, 6, 7, 10.
1962. *N. serotina* HEER; MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, No. 1, p. 211, pls. VI, figs. 4, 5a; VII, 2a; IX, 6a, Text-fig. 9d.

This small specimen of an apically rounded segment was collected by S. MAÊDA in 1951: this was yielded together with the above mentioned *N. asuwensis*.

It very closely resembles the Asuwa species *N. serotina*, and I consider that it is a dwarf form of the *N. serotina* of the Asuwa flora.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Ginkgoaceae

Ginkgoites pseudoadiantoides (HOLLICK) FLORIN

Pl. 42, figs. 9, 10 & 15

1962. *Ginkgoites pseudoadiantoides* (HOLLICK)

FLORIN; MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, No. 1, p. 222, pls. IX, fig. 6b; X, 3 and 4; XII, 2b and 3; XIV, 5b; XXIV, 1a and 2; Text-fig. 10b.

MAÉDA's collection was reported by S. ENDÔ and M. AMANO as *Ginkgoites digitata* which is the common species of the Mesophyta in the Northern Hemisphere; however, this Ômichidani species seems to be comparable with a dwarf shaped leaf of the *G. pseudoadiantoides*.

The leaf impression recorded as *Ginkgo adiantoides* (UNGER) HEER from the late Cretaceous age of the Kolyma area in Siberia (BAIKOVSKAJA, T.N.; 1956, XIII, fig. 7) may also represent *Ginkgoites pseudoadiantoides*.

Localities: Tani-tôgé and Goshogahara.

Reg. Nos.=DGLAKZ-12515, 11534 and 11505.

Repository: Tôkyô University.

Pinaceae

Pseudotsuga mesowilsoniana new species

Pl. 42, fig. 17

I collected needle leaves of the *Pseudotsuga*? sp. at Tani-tôgé in 1950, these specimens have been lost, however: it is evident that the shape of the leaf of the *Pseudotsuga* differs from the other Pinacean leaves. So, I consider that this female cone very closely resembles the living *Pseudotsuga wilsoniana* HAYATA, which found in the mountainous terrains of the western Yunnan, Mekong Basin and Taiwan.

Description:—Female cone ovoid, cylindrical, with short gynopore, composed of 20± rounded scales, thick, woody and 22 mm long 15 mm wide; cone scale overlapped; seed unknown, two seed scars; staminate cone ovoid, 5 mm long and 3 mm wide.

Discussion:—This Tani-tôgé material shows a female cone with a small staminate cone, and it is recognized the short gynopore. The distinctive character that the staminate cone occurs in the gynopore is shown as the characteristic feature of the Pinaceae. Among the Pinacean genera, the living *Pseudotsuga wilsoniana* is the most resembling to the Tani-tôgé material.

Locality: Tani-tôgé.

Holotype=DGLAKZ-14858a.

Pinus mesothunbergii new species

Pl. 42, fig. 13

This Tani-tôgé material is only one at hand, which was collected by me in 1950.

Description:—Winged seed is 25 mm long, lacks lateral part, asymmetrically oblanceolate in complete shape; actual seed obovate and top a spit, 8 mm long and 5 mm wide; wing 18 mm long; twice as long as seed, widest 1/3 of part bihind posterior, costal veins attached to the seed at parallel and anal vein some obliquely parallel.

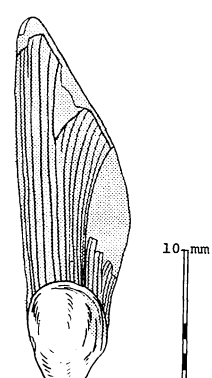


Fig. 3. *Pinus mesothunbergii* new species (seed).

Discussion:—This material has a relationship with the seeds of *Pinus thunbergii* PARL (*Kuro-matsu* in Japanese), which is commonly found in the sea-coast of Japanese Islands (except the Northern part of Hokkaidô).

This upper Cretaceous specimen is larger than the living than the living species, but it seems to me to be identical with winged seed formed by the living *Kuromatsu*. Though it has a poorly preserved wing, it may be compared with a wing seed of the Miocene species *P. miocenica* TANAI (TANAI, T., K. HUZIOKA and H. MATSUO: 1963; p. 231, pl. 43, fig. 8), which was described by me from the Noto Peninsula of Central Japan, and which was yielded together with a cone and many staminate aments.

Locality: Tani-tôgé.

Holotype=DGLAKZ-14856.

Taxodiaceae

Cunninghamia sp.

Pl. 42, fig. 19; Pl. 43, fig. 1

1962. cfr. *Sequoia sternbergi* (GÖPPERT) HEER; MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, No. 1, p. 224, pl. XIX, fig. 3.

A magnificant twig was obtained by one of our students in 1956, at the Goshogahara locality. It was considered possibly be compared with Green-land specimen *Sequoia sternbergi* HEER (1883; Flora fossilis arctica, Bd. VII, pl. XCVI, figs. 5b and 10): the likeness was deduced on account of a cone-impression found in association with the Goshogahara specimen.

After my description of this magnificant twig as *Sequoia sternbergi*, was prepared, the cone-impression was broken off by chance, when the Geological Department was removing to the new building, in 1964.

The twigs with these decurrent, linear, lanceolate and accuminated leaves resemble very closely the living species *Cunninghamia lanceolate* HOOKER (syn. *C. sinensis*) and *C. konishii* HAYATA. In the marginal parts of those leaves, however, is not recognized the minute serration (this character and the two stomatiferous bands in the lower side of leaves are very important characteristic features of the leaf-form of the genus *Cunninghamia*); those are only poorly preserved in the muddy rocks.

Nevertheless, I am strongly inclined to consider that the Goshogahara materials may belong to an upper Cretaceous *Cunninghamia*, because of the characters of shown by the twig, i. e. the leaves in 2 the ranks are spirally arranged and spreaded.

Locality: Goshogahara.

Reg. Nos.=DGLAKZ-11195 and 11210.

Glyptostrobus sp.

Pl. 43, figs. 4, 6, 9 & 10

These incomplete spirally arranged leaves resemble the living *Glyptostrobus lineatus* (POIRHT) DRUCE (syn. *G. pensilis* (STAUNTON) K. KOCH), which is usually found in damp grounds on the banks of streams in Kwantung and Fukien Provinces, S. China.

The *Glyptostrobus lineatus* has two kinds of leaves. According to HARRISON's note (pp. 233-234): "—Two kinds of leaves are produced, those on terminal barren branchlets 1/3-1/2 in. long, arranged in 3 ranks, and those on the fruiting branchlets, and on mature persistent vegetative branchlets, over-lapping and scale-like, —"

The spirally arranged linear-leaves of the *G. lineatus* closely resemble those of the *Taxodium distichum*, but I recognized that there is a very important difference between these two genera; namely, the former has arrangement of 3 ranks and the latter 2. The linear-leaves of the Ômichidani materials (DGLAKZ-14892 and 11196) seem to be identical with 3 ranks formed by the living *G. lineatus*.

And I took scale-like specimen (DGLAKZ-10100) of the Tani-tôgé as the lower Miocene species *G. orientalis*, which was described by S. ENDÔ in 1953 (p. 13, pl. IV, figs. 4-7) from South Korea; and the scale-like specimen from Tani-tôgé may be identified with the middle Miocene species *G. europeaus* (BRONGNIART) HEER of the Notonakajima flora in Central Japan (TANAI, T., K. HUZIOKA and H. MATSUO; 1963, p. 232, pl. XLIII, fig. 2).

Then these Ômichidani materials can be compared with the genus *Glyptostrobus* provided that the cone will have been known.

Locality: Tani-tôgé.

Reg. Nos.=DGLAKZ-14892, 11196 and 10100.

Sequoia sp.

Pl. 42, fig. 14, 16, 18 & 20b

These incompletely spirally arranged linear or lanceolate leaves are very closely similar to the living *Sequoia sempervirens* (D. DON) ENDLICHER, which is a monotypic genus and is confined to the coastal region of California.

The oldest evidence of the *Sequoia* was discovered by S. ENDÔ from the upper Jurassic formation in South Manchuria (1936; pp. 172-175), and the Cretaceous *Sequoia* species has been known very widerspread in the Northern Hemisphere.

In Japan, it is found in the Asuwa flora (Upper Cretaceous age), and it has been known as *S.* cfr. *sempervirens* (MATSUO, H.; 1962, pp. 223-224). And the Ômichidani materials more closely resemble the living species than the Asuwa specimens, but the cone is unknown in the Ômichidani material.

Localities: Tani-tôgé and Goshogahara.

Reg. Nos.=DGLAKZ-10097 and 115557.

Taiwania mesocryptomerioides new species

Pl. 43, figs. 2 & 3

These materials with female cones were collected by me and some students of our University at Goshogahara in 1962.

These specimens very closely resemble the living species *Taiwania cryptomerioides* HAYATA, which is a monotypic genus with a single species, and confined to the mountainous land in *Taiwan*, and as well as Yunnan Province, S. China.

Description:—Leaves dimorphic, scale-like and short needled (*Cryptomeria japonica*-like); acute apex and broad base; opposite, arranged with alternate pairs. Cones small and obovate, similar to male strobili of *Cryptomeria japonica* or *Sequoiadendron giganteum* (LINDLEY) BUCHHOLZ, persistent and terminal on twigs, 6-8 mm long and 4-5 mm across.

Discussion:—S. ENDÔ established the new genus *Eotaiwania* from the Fushun coal-field in South Manchuria in 1942 (p. 37, pl. XV, fig. 9), as an ancestral genus distinct from the living species *Taiwania cryptomerioides* HAYATA; this Fushun species shows a scar of adhesion between the seminiferous- and bract-scales, while the living species has these scales loosely and spirally arranged.

When I described a new species *Taiwania eocenica* from Takashima coal-field in Kyûshû, Japan, it was my belief that this Eocene species is more similar to *Taiwania* rather than to *Eotaiwania* (1967a; p. 45, pl. II, figs. 2, 4 and 5).

Moreover, the Goshogahara species has a twig with a few cones on their terminal ends; thus, I believe the upper Cretaceous species is more similar to *T. cryptomerioides* than to other Palaeogene species.

Locality: Goshogahara.
Holotype=DGLAKZ-12511a.
Syntype=DGLAKZ-12520.

Cupressaceae

Chamaecyparis sp.

This small cupressaceous twig closely resembles the living genera, *Thuja* and *Chamaecyparis*. The former resembles most closely the latter except the shapes of cones and leaves.

I consider that the Goshogahara material (cones unknown) can be compared with the Cretaceous cupressaceous species; among them, especially, however, it shows a close resemblance to *Thuja cretacea* (HEER) NEWBERRY from the upper Cretaceous flora in Siberia (BAIKOVSKAJA, T.N.; 1956, pl. XIII, fig. 2 and XX, fig. 7) and from the Viliuyian Depression (SVESHNIKOVA, I.N.: 1967, p. 198, pl. XI, figs. 9-11 and XII, 1-4). However, I believe that it is more similar to the living species *Chamaecyparis obtusa* ENDLICHER than the Cretaceous *Thuja* species.

Locality: Goshogahara.
Reg. Nos.=DGLAKZ-11476a and 11476b.

Hydrocaryaceae

Hemitrapa angulata (BROWN) new combined

Pl. 42, fig. 20a; Pl. 43, figs. 22 & 23

1960. *Nymphaeites trapelloides* MATSUO, Trans. Proc. Palaeont. Soc. Japan, N.S., No. 40, pp. 329-336, pl. XXXVIII, figs. 1-5 and text-figs. a-d.
1962. *Nymphaeites ? trapelloides* MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, no. 1, pp. 230-231, pl. XXIII, figs. 1-7.
1962. *Trapa angulata* (NEWBERRY) BROWN, U.S. Geol. Surv. Prof. Paper 375, pp. 83-84, pl. LVIII, figs. 1-12.

In 1949, W. A. BELL emended this incertae-sedical genus into *Nymphaeites*, which had been described under the names of *Dicotylophyllum*, *MacClintockia*, *Nymphaeites*, *Trapa* ?, etc. (1949; pp. 16-25). A. KRYSHTOFOVICH used the generic name of *Querxia* for the Cretaceo-Palaeocene species *Trapa ? microphylla* (1960: KRYSHTOFOVICH, A. and T. N. BAIKOVSKAJA); but many palaeophytologists use the name *Trapa ? microphylla* or *Trapa microphylla* (the first name established by L. LESQUEREUX). And most recently, R. W. BROWN noted on this genus as follows (1962; pp. 83-84): BERRY (1935, p. 61) and BELL (1949, p. 64) have summerized the history and information concerning this species, but BELL did not refer to the report by BROWN and HOULDSWORTH (1939) of the fruit-bearing specimens from the Ravenscrag formation in southern Saskatchewan, Canada. These fruits have been found in nearly all localities in association with the characteristic leaves.

According to my own knowledge, however, this small aquatic leaf does not belong either to the Pedaliacean aquatic plant (i. e. *Trapella*), the Hydrocaryaceae (i. e. *Trapa*) or to Nymphaeaceae (i. e. *Nymphaeites*).

Nevertheless, the fruits of the BROWN's figure (1962, pl. LVIII, figs. 7-12) very closely resembles those of the extinct genus *Hemitrapa*, which was established by S. MIKI as a new genus, from the Plio-Pleistocene lignite layers in the Central Honshû, Japan (1941; p. 289, pl. VIID, fig. 19D).

The Palaeocene fruits of the Rocky Mountains lacked the conspicuous "antenna like horns" of the *Hemitrapa trapelloidea* MIKI, but I regarded the BROWN's figure (LVIII, fig. 12) as one incomplete antenna; and besides, I have found the characteristic "water-caltrop head" of the living *Trapa*, and of the extinct *Hemitrapa* among the BROWN's fruits (LVIII, figs 7-12).

These being the case, these American Palaeocene *Trapa angulata* might very likely be identified with the Cretaceo-Palaeocene *Hemitrapa*; I consider, thus, that the Ômichidani small floating leaves might belong to the *Hemitrapa angulata*.

Localities: Tani-tôgé and Goshogahara.

Holotype=DGLAKZ-10096.

Incertae Sedis

Phyllites sp. A.

Pl. 43, fig. 19

This small craspedromous leaf impression is similar to the herbaceous plant: the marginal part shows an incisus shape, so that I take this to be comparable with the genus *Aster*.

Locality: Goshogahara.

Reg. No.=DGLAKZ-14901.

Carpolithes sp. A.

Pl. 43, figs. 15 & 16

This small oblong seed measures 6 mm long and 2 mm wide, and shows nine striate costae in the impression which is a characteristic feature of the genus *Cercidiphyllum*, *Sorbus*, etc. I consider that it is similar to the seed of *Sorbus* species.

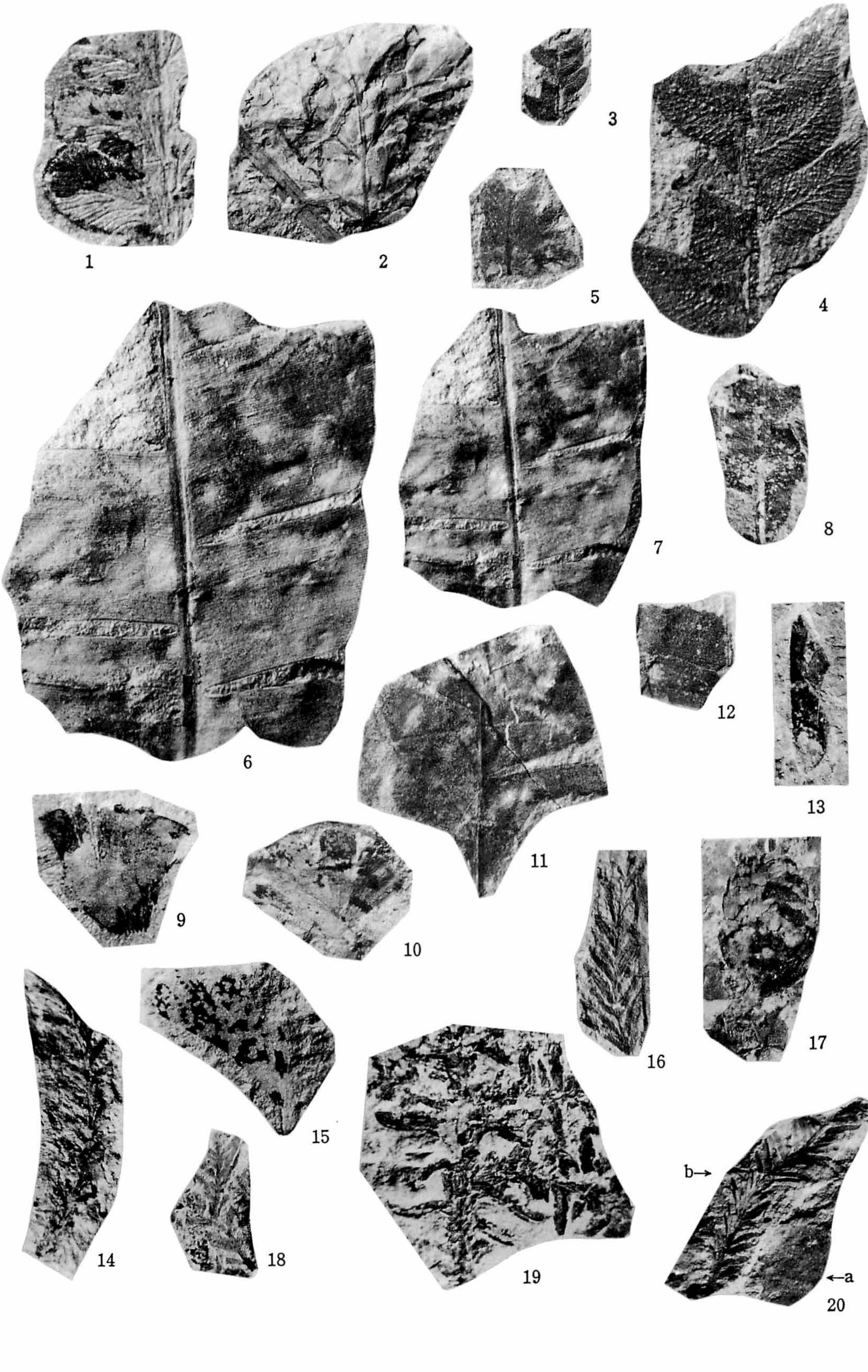
Locality: Tani-tôgé.

Reg. No.=DGLAKZ-14880.

Explanation of Plate 42

(All figures are natural size unless otherwise stated)

Fig. 1. *Osmunda* sp.
Fig. 2. *Asplenium* sp. ?
Fig. 3. *Cladophlebis* sp.
Fig. 4. Enlarged fig. 3.
Fig. 5. *Onoclea* cfr. *sensibilis* LINNAEUS
Fig. 6. Enlarged fig. 7.
Fig. 7. *Nilssonia densinerve* (FONTAIN) BERRY
Fig. 8. *Nilssonia serotina* HEER
Figs. 9, 10 and 15. *Ginkgoites pseudoadiantoides* (HOLLICK) FLORIN
Figs. 11 and 12. *Nilssonia asuwensis* MATSUO
Fig. 13. *Pinus mesothunbergii* new species
Figs. 14, 16, 18 and 20b. *Sequoia* sp.
Fig. 17. *Pseudotsuga mesowilsoniana* new species
Fig. 19. *Cunninghamia* sp.
Fig. 20a. *Hemitrapa angulata* (BROWN) new combined.



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Carpolithes sp. B.

Pl. 43, fig. 5

The shape of this material is similar to the fruits of Lauracean genera. But it is identified with a nut which may belong to the schizocarp-type. It measures 13 mm long and 8 mm across.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. C.

Pl. 43, figs. 13 & 14

This small oblong seed has a ribbed costae in the impression, and it measures 4 mm long and 2.2 mm wide. It is similar to the seed of the *Nyssa* species.

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-11503a.

Carpolithes sp. D.

Pl. 43, figs. 20 & 21

These seeds bearing lineate costae in the impression are similar in shape to the Palmocarpon species. These measure 23-25 mm long and 12.5 mm wide. thus, these materials show smaller than the late Cretaceous Palmocarpon species in size.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. E.

Pl. 43, fig. 17

This specimen is similar to the wing-seed; it more closely resembles in a shape, the ligulate petal. It measures 18 mm long and 6 mm wide.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. F.

Pl. 43, fig. 11

This material is similar to an involucre of the genus *Ostrya*. But it has not a seed impression at the top part of the petiole. It shows a fine lineolate costae in the impression (it belongs to a petal). It measures 25 mm long and 12 mm wide.

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. G.

Pl. 43, figs. 18b

This incomplete small seed-like material is similar in shape to Vitacean type of seed.

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-14860.

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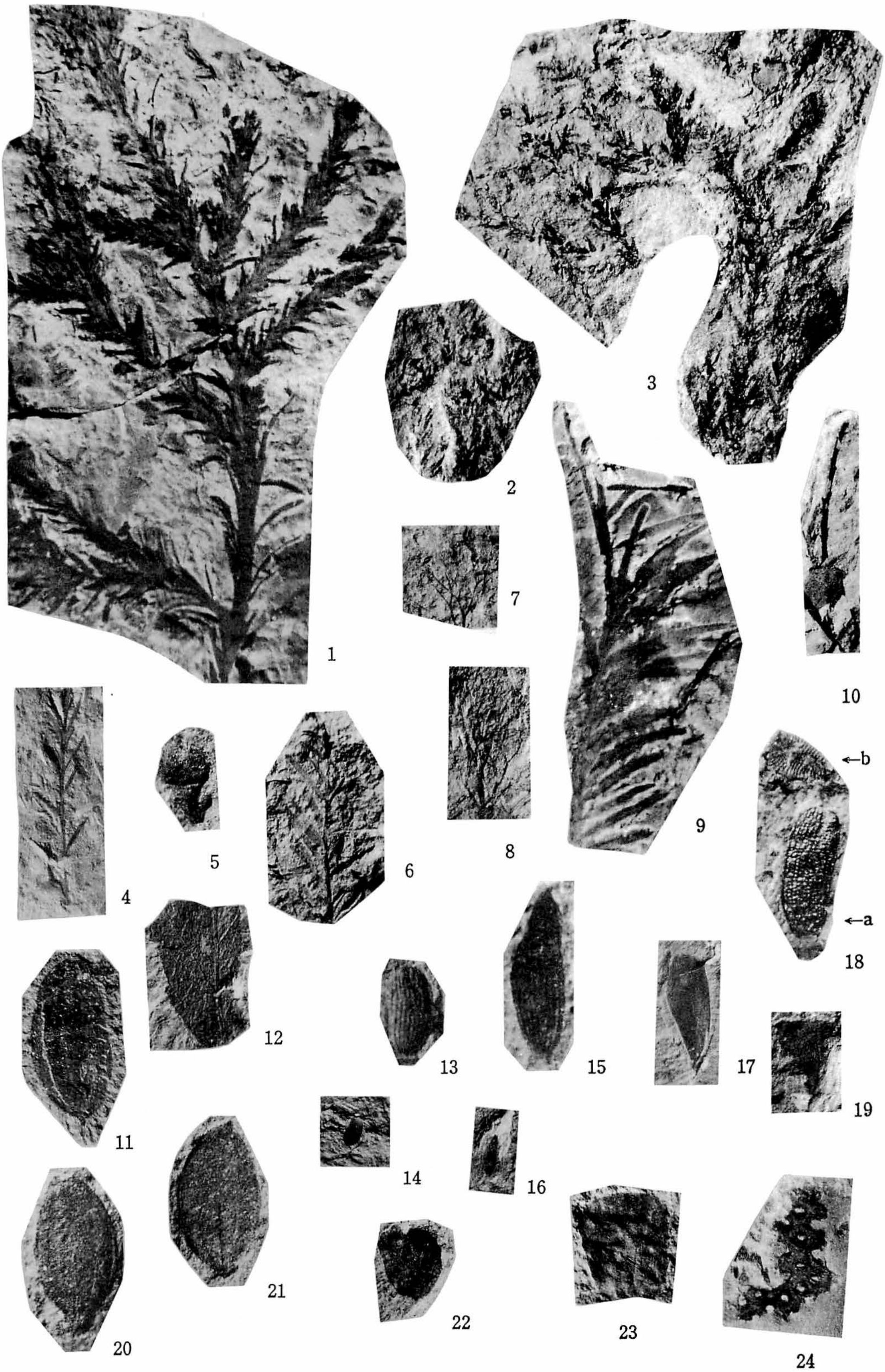
Explanation of Plate 43

(All figures are natural size unless otherwise stated)

Fig. 1. *Cunninghamia* sp.
Figs. 2 and 3. *Taiwania mesocryptomerioides* new species
Figs. 4, 6, 9 and 10. *Glyptostrobus* sp.
Fig. 5. *Carpolithes* sp. B.
Figs. 7 and 8. Incertae sedical matter (aquatic plant)
Fig. 11. *Carpolithes* sp. F.
Fig. 12. Incertae sedical matter.
Fig. 13. Enlarged fig. 14.
Fig. 14. *Carpolithes* sp. C.
Fig. 15. Enlarged fig. 16.
Fig. 16. *Carpolithes* sp. A.
Fig. 17. *Carpolithes* sp. E.
Fig. 18a. Insect ?
Fig. 18b. *Carpolithes* sp. G.
Fig. 19. *Phyllites* sp. A.
Figs. 20 and 21. *Carpolithes* sp. D.
Figs. 22 and 23. *Hemitrapa angulata* (BROWN) new combined.
Fig. 24. Incertae sedical matter.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Akaiwa	赤岩
Asuwa	足羽
Goshogahara	御所ケ原
Ha'amidani	ハアミ谷
Hakobuchi	函渕
Ikuno	生野
Izumi	和泉
Kadonosawa	門ノ沢
Kamogata	鴨方
Kariyasu	刈安
Katsuyama	勝山
Kuji	久慈
Kumo-gawa	雲川
Kuwajima	桑島
Kuzuryû-gawa	九頭竜川
Mitsuse	三ツ瀬
Naktong	洛東
Naru	那留
Nôhi	濃飛
Ôarai	大洗
Ômichidani	大道谷
Omodani	面谷
Sarao	皿尾
Shiramine	白峯
Sugiyamadani	杉山谷
Suhara	巣原
Suritaki	摺滝
Taiwan	台湾
Takinami-gawa	滝波川
Tani-tôgé	谷峠
Tedori-gawa	手取川
Urushidani	漆谷
Uzume	宇津目
Yûbari-gawa	夕張川
Yunnan	雲南

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 80, pp. 390-396, pl. 44, Dec. 20, 1970

573. PLIOCENE SIRENIA IN JAPAN*

TOKIO SHIKAMA

Geological Institute, Yokohama National University, Yokohama

and

DARYL P. DOMNING

Department of Paleontology, University of California, Berkeley

1965年8月当時横浜国立大学地学教室学生であった龍野伸武と同教室の尾崎公彦が，長野県上水内郡戸隠村土合の水内層群猿丸層（猿丸砂岩礫岩層下部）より哺乳類の巨大な肋骨を発見した。現地は裾花川と楠川の合流点の近くの川岸である。一見海牛類のものであることは明かであったので，鹿間は1969年 Berkeley 滞在中 DOMNING と共同研究をした。骨はバナナ状に肥厚し強く曲り，先端部は断面が円形に近い。California 大学の標本と比較検討の結果，現世絶滅の有名なリチナ海牛に近い種 *Hydrodamalis* sp. であることが判った。リチナ海牛 *H. gigas* の最小に近い大形の中新世種 *Metaxytherium jordani* の肋骨よりは曲り方大であるが，基部の形はリチナ海牛よりも中新世種に近い。California の鮮新統より *jordani* と *gigas* の中間的な新種が発見されているので，之との比較が考えられる。北太平洋の海牛の系列は単系的で *Metaxytherium jordani* より *Hydrodamalis gigas* への進化しか見られない。現世ベーリング海に分布した *Hydrodamalis* が鮮新世には太平洋の両岸ではるか南方にまで分布していたことは意義深い。 鹿間時夫・Daryl P. DOMNING

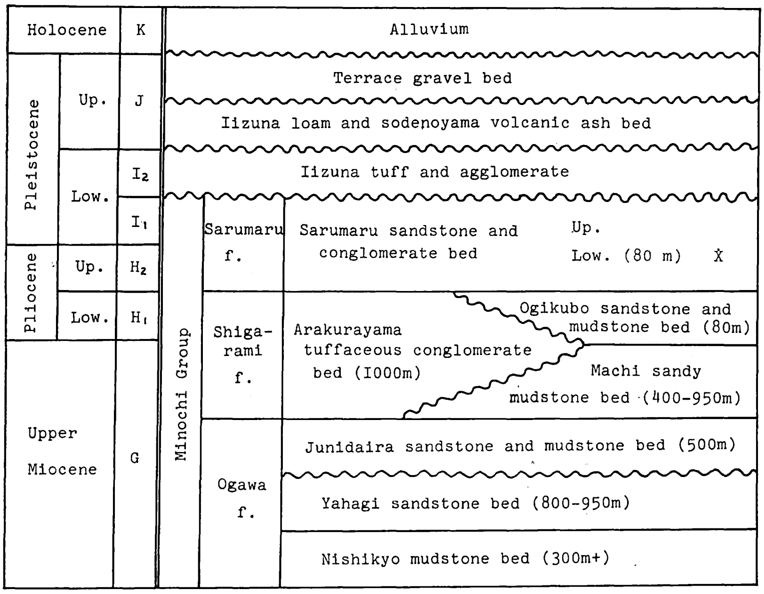
Introduction

On August 11th, 1965 N. TATSUNO, then a student of the Geological Institute, Yokohama National University and K. OZAKI of the same Institute found a mammalian bone from the Lower Sarumaru sandstone and conglomerate bed at Do-ai, Togakushi-mura, Kami-minochi-gun, Nagano Prefecture, Central Japan. TATSUNO had been engaged in the geologic survey of the Shigarami area, west of Nagano City, for his graduation thesis. The bone in question is a dense large sized costa of Sirenia, which is a very interesting material being the first occurrence of fossil Sirenia in East Asia. The present paper reports on this bone. Here the writers express their cordial thanks to Prof. D. SAVAGE of the Department of Paleontology, University of California, for his kind guidance, and to Messrs N. TATSUNO and K. OZAKI for their help in different ways.

Geology of the Locality

The Sigarami area along the Susobana River is famous for abundant molluscan fossils and has been studied by many geologists. According to T. TOMIZAWA (1958), the geology of the area is composed of the following formations in descending order.

* Received June 20, 1970; read June 27, 1970.



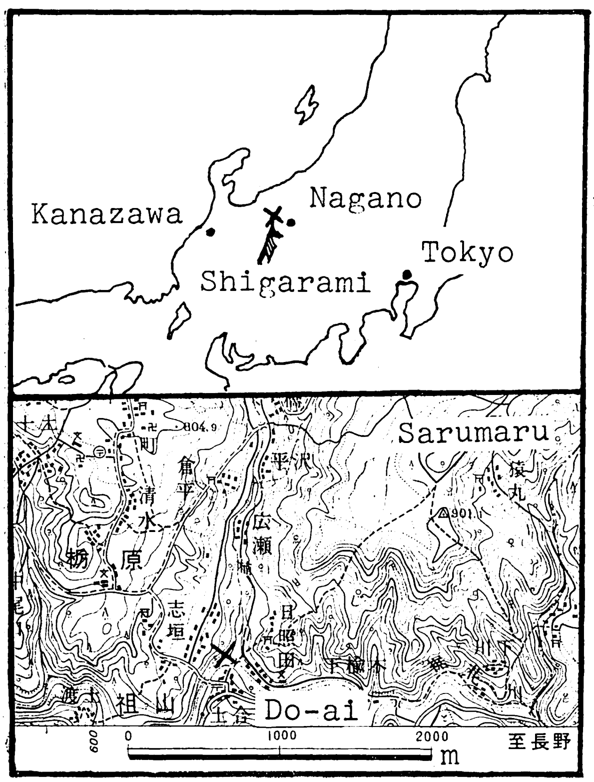


Fig. 1. Map of the locality.

The Minochi Group is a thick marine formation, distributed in northern Nagano Prefecture with a general trend of NE-SW, tolerabley folded, occupying the mountainous area between the Nagano basin and the Azumi valley, and is overlain by the Pleistocene Iizuna volcanic mass. In the Shigarami area no basement rock is exposed. The Upper Palaeogene Moriya, Early Miocene Uchimura-Bessho and Middle Miocene Aoki formations those are known in central Nagano Prefecture are not distributed here. The Ogawa formation is a sandstone and siltstone member of regressive facies. S. TOKUNAGA (1934) reported an occurrence of *Hipparion* (his *Pliohippus*) from the formation at Miasa-mura, Kitaazumi-gun but nowadays it is impossible to restudy the material as it was destroyed by the war. In 1926 he reported *Cervavus oweni hira-*

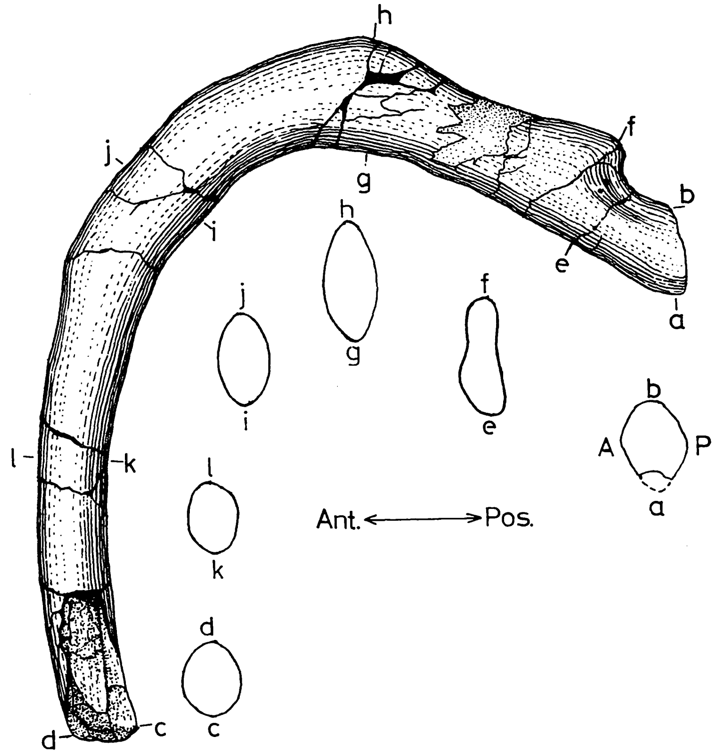


Fig. 2. Index figure of the fossil bone.
ab: Head, f: Tuberculum, h: Angulus.

bayashii TOKUNAGA from the shale bed at Shikamichi, Hibara, Shinsyushinmachi, Kamiminochi-gun. F. HOMMA referred the bed to the Aoki formation but F. TAKAI (1938) regarded it as the Ogawa formation. The Ogawa formation abounds in plant fossils. The Shigarami formation is characterized by conspicuous volcanic activity, and the Arakurayama tuffaceous agglomerate bed carries andesitic boulders and dykes. TATSUNO called the formation the Shigarami tuffaceous agglomerate bed, following T. SUZUKI (1938) and H. FUJIMOTO (1946). The Ogikubo sandstone and mudstone bed bears many molluscan fossils as follows: *Turritella saishuensis* YOK., *Natica janthostoma* DESHAYES, *N. janthostomoides* KURODA & HABE, *Arca miyatensis* YOK., *Anadara amicula* (YOK.), *A. satowi castellata* (YOK.), *Limopsis tokaiensis* YOK., *Glycymeris yamasakii* YOK., *Modiolus akanudaensis* KURODA, *Mytilus grayanus* DUNKER, *Volsella nitida* (REEVE), *Anomia lischkei* D. & F., *A. nipponensis* YOK., *A. lunula* YOK., *Chlamys swifti* (BERNARDI), *Patinopecten yessoensis* (JAY), *P. yamasakii* (YOK.), *P. triblium* (YOK.), *Calyptogena* (?) *longissima* YOK., *Lucina mochizukii* KURODA, *Laevicardium angustum* (YOK.), *Serripes* sp., *Macrocallista brevisiphonata* (CARPENTER), *Callista chinensis* HOLTEN, *Mercenaria chitaniana* (YOK.), *M. sigaramiensis* (MAK.), *M. makiyamai* YOK., *Venus jedoensis* LISCHKE, *Spisula sachalinensis*

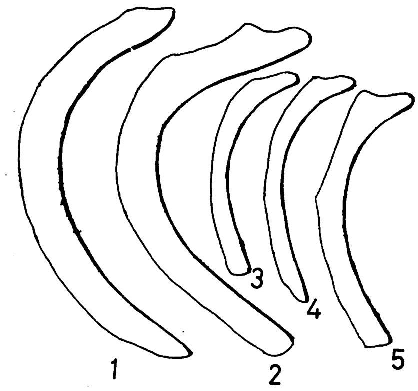


Fig. 3. The costa in question in comparison with the related bones. 1: *Hydrodamalis gigas* ZIMMERMANN from the Bering Islands (Recent) (UCMP 23050), 2: *Hydrodamalis* sp. from Do-ai, Togakushi-mura, Nagano Pref. (Late Pliocene), 3: *Metaxytherium jordani* KELLOG (eighth costa) from Santa Cruz, California (Late Miocene) (UCMC 77073), 4: Ditto (seventh costa), 5: Ditto (sixth costa).

(SCHRENCK), *Solen grandis* DUNKER, *Panope japonica* A. ADAMS, *Mya japonica* JAY, *Myadora japonica* HABE, *Terebratalia koyamai* MAK., etc. The molluscan communities of the bed show cool Northern Pacific neritic communities characterized by *Turritella saishuensis-Patinopecten yamasakii-Spisula sachalinensis*. The fauna corresponds to the Lower Pliocene Onma-Manganji fauna of North Japan, which is composed largely of deep sea inhabitants. Some fossils such as echinoid, *Balanus* and *Haliotis* may indicate the rocky sea floor of the Shigarami sea, which was directly connected with the Japan Sea basins of the Niigata oil-field and not with the warm Pacific basin like the Kakegawa area.

The Sarumaru formation, conformably overlying the Ogikubo sandstone and mudstone bed, is composed of yellowish brown coarse sandstone and conglomerate, intercalated with four liparitic tuff beds (T_1-T_4). TOMIZAWA and TATSUNO divided the formation into lower and upper by the T_2 tuff. The lower Sarumaru formation yields many drift woods, and T. YAGI reported some shells such as *Cyclina orientalis*, *Ostrea* sp., *Callista brevisiphonata* and *Mya japonica*, but the formation in general is almost barren of megafossils. The lower formation might have been deposited in a near shore area of the sea floor. The upper Sarumaru formation is of regressive facies, marked with cross laminae and slumping structure. The Sarumaru formation is overlain unconformably by the Iizuna tuff and agglomerate. The fossil bone in question is the most distinct fossils of the lower Sarumaru formation. The oceanographical condition of the Sarumaru Sea is not clear but assuming from the preceeding Shigarami Sea and the youngest Neogene deposits in Niigata, Akita and Hokkaido, it may be said that in the Late Pliocene period rather cool water of North Pacific Ocean invaded the northern Nagano Prefecture.

Description of the bone

Hydrodamalis sp.

Pl. 44, figs. 1-4

Hydrodamalis RETZIUS, 1794. K. Vetens Acad. Nya Handl. Stockholm, 15, 292.

Rytina ILLIGER, 1811. Prod. sys. mamm. av., 418.

Rhytina BERTHOLD, 1827. in LARTREILLE, Nat. Fam. Thierr., 62.

Rhytine BURMEISTER, 1837. Handb. Naturgesch., 792.

Specimen: Right anterior costa, stored in the Geological Institute, Yokohama National University. Plaster cast of it in the Museum of Paleontology, University of California (UCMP spec. no. 86342, accession no. 2773).

Locality: Left bank of Susobana River, just west of a junction with its tributary, Kusunoki River; Do-ai, Togakushi-mura, Kami-Minochi-gun, Nagano Prefecture, Central Japan; Lat. 36°40′18″N, Long. 138°4′30″E, UCMP loc. no. V-70112.

Formation: Late Pliocene Sarumaru formation of Minochi Group; the lower Sarumaru sandstone and conglomerate bed.

Description: Bone is greyish brown, well fossilized, rather hard, tolerably large sized, dense and strongly curved. Distal corner is broken partially and corpus itself carries several cracks. Assuming from the convexity and curvature of the bone, it belongs to the anterior right costa. In anterio-posterior view, the bone is semicircular and most strongly curved at one third of length from proximal end. Head and tuberculum are distinctly separated and collum is relatively wide. The bone is longer than wide in dorso-ventral direction in cross section. Posterior surface is relatively flat and convex between tuberculum and angulus. Proximodistal surface between head and tuberculum is shallowly depressed. Proximal surface of head is very flat and remarkably bent dorsalward; it makes an angle of 60° with the longitudinal axis of proximal corpus. In proximal view, the surface is suboval in outline with gently curved anterior and nearly straight posterior margins, though inner corner is broken. At the middle of corpus, surface is gently curved and smooth, while that of distal portion carries a median longitudinal weak crest. The middle portion of corpus is very thick in anterio-posterior direction and almost circular in cross section. The posterior surface of that portion is swollen and roughened. Distal end is broken and distal surface is nearly oval in outline.

In dorsal view, the bone is thickest in middle portion and rather narrow in proximal portion. Dorsal surface of proximal portion is neither flat nor wide between tuberculum and angulus. Both anterior and posterior margins of that portion extend in posterio-inner to anterio-outer direction, slightly oblique to the longitudinal axis of middle to distal corpus. Dorsal surface is a little depressed beside and outer side of tuberculum. Surface of middle portion of dorsal corpus has a moderate crista, but that of distal corpus is rather smooth. Posterior ventral surface of proximal portion is distinctly flat and smooth.

Measurements:

Direct length between ventral corner of both end (ac) .... 54 cm
Length along ventral margin between the both tips above mentioned 83
Ditto along dorsal margins between tuberculum and dorso-distal tip...... 88
Diameter at proximal end (ab) .... 6.7×5.3
Ditto at a tuberculum (ef) ...... 8.6×4.6
Ditto at angulus (gh) .... 8.9×5.2
Ditto at a curved point about two third length from a proximal end (ij)...... .... 6.7×6.7
Ditto at a point about 19 cm distant from a distal end (kl) .... 5.2×5.9
Ditto at a distal end (cd) ...... 6.0× ...

Comparisons: The massive pachyostotic ribs characteristically developed by sirenians serve to ballast their large buoyant bodies and lungs and aid in hydrostasis. The *Hydrodamalis* of the Pliocene and Pleistocene had larger bodies, both absolutely and relatively, than did the *Metaxytherium* from which they were descended, and this is reflected in the much greater weight and stronger curvature of their ribs.

The specimen has been compared with

ribs of both *Metaxytherium jordani* (UCMP no. 77307) and *Hydrodamalis gigas* (UCMP no. 23050). The former specimen is from the Late Miocene of California. A very old adult, it is the largest known individual of the genus, its skull being the size of that of a small adult *Hydrodamalis*. Its ribs are, however, strikingly unlike those of the latter and the Japanese specimen, being much smaller and more slender and not nearly as strongly curved. Those closest in shape to the Japanese specimen are in the region of the sixth to the eighth rib, but their shafts curve down abruptly distal to the angulus as in the Japanese rib. On the other hand the latter corresponds well in size and curvature to anterior ribs of the Recent *Hydrodamalis*, including the second rib illustrated by BRANDT (1868: pl. 7, fig. 2), except that it is more slender distally than the ribs of a normal adult *Hydrodamalis gigas*. These are swollen and banana-shaped, and have more blunt distal ends; also the articular surface on the head are often not as well developed as in *Metaxytherium*. The Japanese ribs seems to be intermediate in degree of development of the articular facets. It is probably from the region of the third to the eighth rib.

Discussion: Apart from the living dugong of the western Pacific, all the sirenians known to have occurred in the Pacific Ocean are members of a single Miocene-to-Recent lineage. This group is presently being restudied by DOMNING, and will be reviewed in detail in a future publication. The known occurrences may be summarized as follows:

Miocene: Three species of sirenians have been described from the Miocene of western North America: *Halianassa* (?) *allisoni* KILMER, 1965 (early-middle Miocene, Baja California), *Metaxytherium jordani* KELLOG, 1925 (late Miocene, northern California). These all belong to the same genus. KELLOG (1966) describes the confusion regarding the use of the name of *Metaxytherium* and *Halianassa*, and employs *Metaxytherium* for sirenians from eastern North America which appear to be congeneric with the Pacific species. In view of his remarks, and the priority of usage of *Metaxytherium* for the Pacific forms, it seems preferable to retain this name for them rather than *Halianassa*. *M. vanderhoofi* is probably a synonym of *M. jordani*.

Pliocene: Two specimens of a new species of *Hydrodamalis* have been discovered in California and are being studied by a group of worker there. This species is morphologically intermediate between *Metaxytherium jordani* (=*Halianassa vanderhoofi*) and *Hydrodamalis gigas*.

Pleistocene: A skull fragment of *Hydrodamalis gigas* was dreged from Monterey Bay, California (JONES, 1967); radiocarbon dating indicated a age of 18,940±1100 years B.P.

Recent: In historical time *Hydrodamalis gigas* was found only in the Commander Islands. A single rib of the animal was found on the island of Attu in Aleutian (BRANDT, 1868: 294).

It is evident from present knowledge that the genus *Hydrodamalis* is a direct descendant of the Late Miocene *Metaxytherium* found on the west coast of North America, and that sirenians definitely assignable to *Hydrodamalis* existed in the Pliocene.

The most practical criterion for distinguishing these two genera is the total lack of functional teeth in the adult *Hydrodamalis*. Since, however, only a rib has been found in the Japanese Tertiary sediments, we must rely on other distinctions to make a generic identification of this specimen. Since the rib of *Hydrodamalis* are normally much larger than those of *Metaxytherium* (though a large *Metaxytherium* equal in size a small *Hydrodamalis*), and, as detailed above, the Japanese specimen more closely approximates in size and shape the ribs of *Hydrodamalis*, it is reasonable to assign it to the latter genus. Its Late Pliocene age is consistent with this in view of the known existence of *Hydrodamalis* before the end of the Pliocene.

The occurrence of Pliocene *Hydrodamalis* approximately as far south in Asia as in America is not unexpected, but our knowledge of the details of sirenian evolution is on the whole so limited that it is not safe to predict where any given kind of sirenians, even *Hydrodamalis*, will or will not be found. This is particularly true of Asia, where only the most meager and fragmentary remains have been recovered, and these from the Indian and Indonesian areas. It is hoped that researches in all parts of Asia will call the attention of science to all sirenian remains which come to light, any of which will be a welcome addition to our knowledge.

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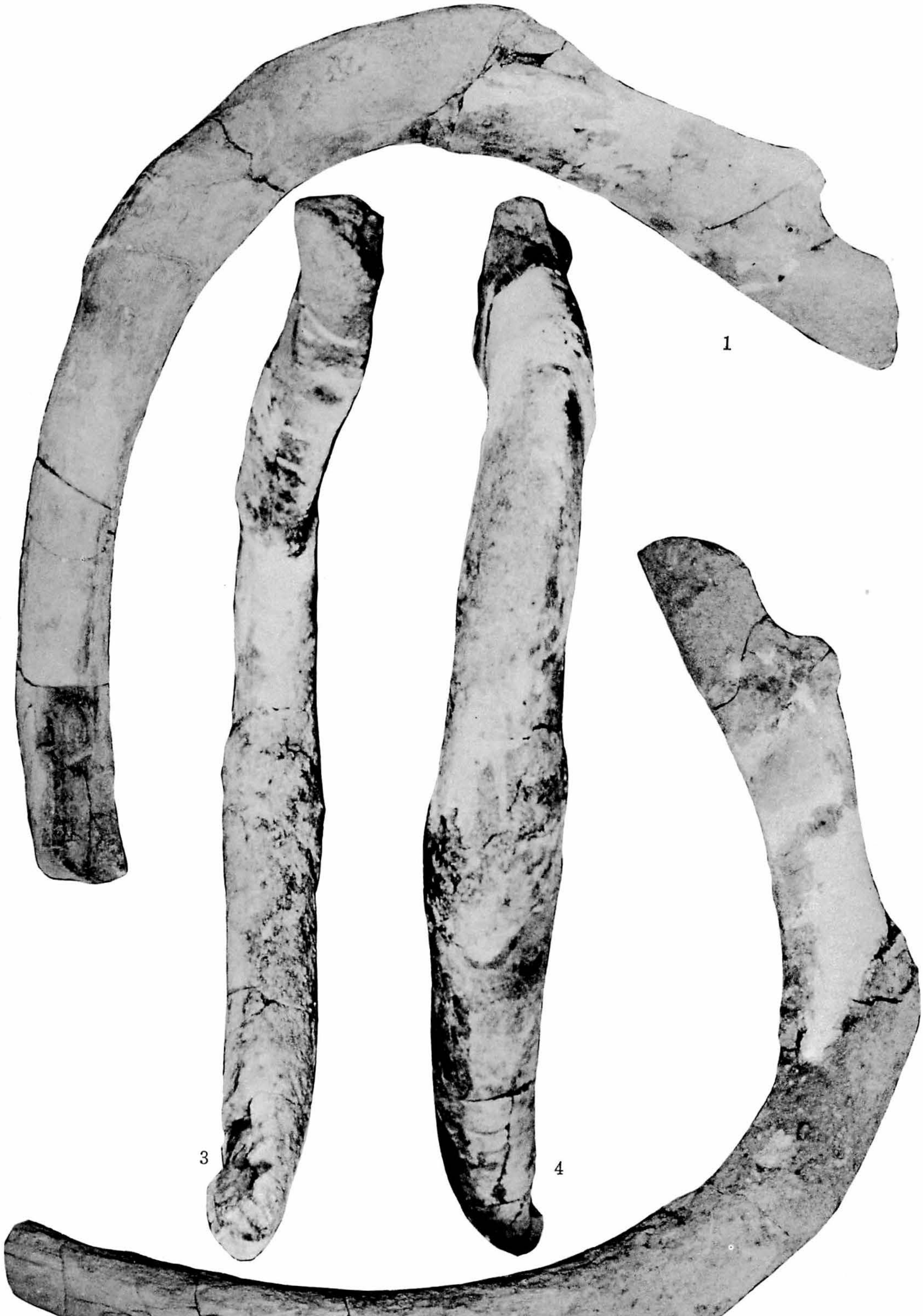
Arakurayama	荒倉山	Ogikubo	荻久保
Hibara	日原	Sarumaru	猿丸
Iizuna	飯縄	Shigarami	柵
Junidaira	十二平	Shikamichi	鹿道
Kamiminochi-gun	上水内郡	Shinsyushin-machi	信州新町
Kitaazumi-gun	北安曇郡	Susobana River	裾花川
Miasa-mura	美麻村	Yahagi	矢萩
Nishikyo	西京		

Explanation of Plate 44

Hydrodamalis sp.

Fig. 1. Anterior side of right anterior costa.
Fig. 2. Posterior side of ditto.
Fig. 3. Ventral side of middle shaft.
Fig. 4. Dorsal side of ditto.

All figures are $\times 0.25$ natural size.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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第104回例会は，1970年6月27日（土）に茨城大学理学部において開催された（参加者60名）。

個人講演

On the distribution of *Ptilophyllum* and its phytogeographical significance..KIMURA, T.

A pentoxylous plant from the Momonoki formation, Yamaguchi Pref. ....KIMURA, T. & G. OKAFUJI.

Microfossils from the Pleistocene sediments of the Ariake Sea area, West Kyushu (代読)...................TAKAHASHI, K.

添牛内・古丹別川上流地域（北海道北部）の上部白亜系の花粉分析.................鈴木順雄

Marine diatom flora from the Pliocene Tatsunokuchi formation in Fukushima Prefecture ....KOIZUMI, I.

Middle Miocene diatom assemblages from the Oidawara formation, Mizunami group in Gifu Prefecture ....KOIZUMI, I.

Significance test for the difference of growth ratio in average allometry................................ HAYAMI, I.

Lepidocyclinas from New Zealand .... MATSUMARU, K.

Fusulinacean biostratigraphy and molluscan fauna from the uppermost part of the Sakamotozawa formation, and the pre-Kanokura unconformity in the southern part of the Kitakami massif, Northeast Japan (代読)...............MURATA, M.

New anadarids and associated molluscan fauna from the Nakoshi formation, Okinawa-jima, Ryukyu Islands ....NODA, H.

Stratigraphical significance of the Miocene molluscan fauna of Minami-Tsugaru district, Aomori Prefecture, Northeast Japan ....KOTAKA, T., H. NODA, T. IWAI & S. HAYASAKA.

Texanitinae について...............松本達郎

Early Cretaceous ammonites from Rikuzen-Oshima, Northeast Japan .... TAKAHASHI, H.

Some Bajocian ammonites from Kitakami .... SATO, T.

Some Neogene Bryozoa from Okinawa Island.......................HAYAMI, T.

The ontogenies of *Ponumia obscura* (LOCHMAN), n. g., and of *Housia canadensis* (WALCOTT) (Trilobita) from the upper Cambrian of the Big Horn Mountains, Wyoming (代読) ....HU, C.H.

房総・三浦半島からの更新世の魚耳石（続報）（代読)..........................青木直昭

双葉白亜系鮫化石 ....斉藤登志雄

On a Pliocene Sirenia from Japan .... SHIKAMA, T. & D.P. DOMNING.

Some coprolites from Wakayama Prefecture, Japan....HATAI, K. & T. KOTAKA.

日本古生物学会第105回例会ならびにコロキウム「大洋堆積物と微古生物学」は，1970年9月12日（土）・13日（日）国立科学博物館において開催された。（出席者70名）。

映画「地球をひもとく大洋堆積物」ラモント地質研究所製作

コロキウム「大洋堆積物と微古生物学」

北太平洋における珪藻微古生物学の進歩 ....金谷太郎

フィリピン海コアの珪藻遺骸群集解析 ..小泉 格

フィリピン海深海コア中の放散虫群集について ....中世古幸次郎・菅野耕三

深海底コアのナンノプランクトン研究の進歩 ....高山俊昭

フィリピン海コア V21-98 に見る，後中新世浮遊性有孔虫群集の変遷....氏家 宏・三浦光生

深海底コアの微古生物学的データの因子分析 ..

……大場忠道
白鳳丸 KH-67-5 航海の赤道太平洋の深海軟泥と深海コアの石灰質超微プランクトン……西田史朗
大洋底コアの古地磁気測定について……小林和男
陸上および大洋底の古地磁気学的対比……新妻信明
大洋底堆積物より得た浮遊性有孔虫の走査型電顕による形態学的探究……高柳洋吉
総合討論

個 人 講 演

主として舟伏山二畳系で発見した，現生と同程度に進化した各種ミル化石について……岡村長之助
常磐炭田双葉層群の花粉・胞子群集（予報）……高橋 清
Correlation of late Cenozoic marine sections in Japan and the Equatorial Pacific.（代読）……BURCKLE, L. H.
Marine diatom flora from the Nobori formation, Shikoku, Japan ……KOIZUMI, I.
On some *Patinopecten* from North America.（代読）……MASUDA, K.
"Pennatae Trigonians" の表面装飾の変化と，姫浦層群産の新種について（代読）……田代正之
アラスカ産 *Aturia* について……菅野三郎
Ontogenies of two Upper Cambrian trilobites from Northern Black Hills, South Dakota.（代読）……HU, Chung-Hung & TAN, Li-Lin
成田層産の Asterpoidea について……福田芳生
秋吉石灰岩下部"大久保付近"のコノドントについて……猪郷久治・小池敏夫
横浜市内より産した *Stegodon* について……長谷川善和・松島義章
Peculiar markings on a sandstone layer of the Hagino formation, Nagano Prefecture（代読）……HATAI, K. & NODA, H.

尚本例会の席上（9月13日），「矢部長克先生追悼会」が催され，早坂一郎・小林貞一両氏の講演があった。

日本古生物学会第106回例会ならびに討論会「中国地方新生界と古生物」は，1970年11月22日（日），広島大学理学部において開催された。（参加者45名）。

個 人 講 演

常磐地方の上部白亜系双葉層群の花粉学的研究……三木昭夫
On some Cretaceous conifers from the Kuji group in northeastern Honshu……TANAI, T.
和歌山県有田郡清水町井谷地域で発見された二畳系紡錘虫について……山際延夫・岩橋豊彦・羽淵高元
志摩東部で発見された *Yabeina shiraiwensis-Lepidolina toriyamai* 帯について（第2報）……山際延夫・坂 幸恭
和歌山県白崎石灰岩の紡錘虫化石について……石井健一
Note on the Permian-Triassic biostratigraphy in several districts of Afghanistan……ISHII, K. & BANDO, Y.
カリフォルニア・バケロス層からの *Lepidocyclina* 属……松丸国照
伊吹産 *Waagenophyllum* について……坂口重雄・山際延夫
On the Paleozoic Bryozoa collected by Dr. C. K. BURTON from Chumphon, Peninsular Thailand（代読）……HAYAMI, T.
種に生存期間があるか？……速水 格

討論会「中国地方新生界と古生物」

中国地方の第三紀植物群の2，3の問題……棚井敏雅
宇部植物化石群……藤岡一男・高橋英太郎
中国地方第三紀有孔虫化石群の変遷……多井義郎
山陰西部，下～中部中新統の貝類化石……岡本和夫・今村外治
東中国地方の中新統貝化石群……糸魚川淳二

SYSTEMATIC INDEX

(New Series No. 73—No. 80)

PALAEOZOOLOGY

Protozoa

Page

AOKI, Naoaki: Notes on the Stratigraphic Distributions of Some Planktonic Foraminiferal Species in the Kazusa Group, Boso Peninsula 81

SADA, Kimiyoshi: Microfossils of the Lowest Part of the Taishaku limestone (Studies of the stratigraphy and the microfossil faunas of the Carboniferous and Permian Taishaku Limestone in West Japan, No. 4) 119

Bryozoa

HAYAMI, Tomoko: Miocene Bryozoa from Southwest Hokkaido, Japan 316

Brachiopoda

YANAGIDA, Juichi and HIRATA, Motome: Lower Permian Brachiopods from Nakakubo, West Central Shikoku, Japan 89

Mollusca

BANDO, Yuji: Lower Triassic Ammonoids from the Kitakami Massif 337

ENDO, Riuji and MORI, Ryuji: Two Interesting Fossil Specimens from the Upper Paleozoic System in Japan 112

HAYAMI, Itaru: Occurrence of *Tutcheria* from the Lower Jurassic of West Japan 26

IWASAKI, Yasuhide: A Miocene Molluscan Fauna in the Philippines 205

KOBAYASHI, Teiichi and ISHIBASHI, Takashi: *Halobia styriaca*, Upper Triassic Pelecypod, discovered in Okinawa-Jima, the Ryukyu Islands 243

MASUDA, Koichiro and NODA, Hiroshi: Pliocene Boring Shells and Their Burrows from the Environs of Sendai, Japan 130

MATSUMOTO, Tatsuro and HIRATA, Motome: A New Ammonite from the Shimantogawa Group of Shikoku 177

NODA, Hiroshi: Freshwater Molluscs from the Coal-bearing Owada Formation, Southeast Rumoi, Hokkaido, Japan 235

OBATA, Ikuwo: Lower Cretaceous Ammonites from the Miyako Group................. 165

OHTA, Yoshihiha: A Review of Some Cretaceous Corbiculids in North America 291

OZAWA, Tomowo and HAYAMI, Itaru: Triassic *Oxytoma* Bed in the Suburbs of Ōme City, Kwanto Mountains.. 32

SAITO, Minoru, BANDO, Yuji and NODA, Hiroshi: Fossil Molluscs from Teshima, Shôdo-gun, Kagawa Prefecture, Southwest Japan.. 276

Arthropoda

HU, Chung-Hung: The Ontogenies of *Ponumia obscura* (LOCHMAN), N.G., and of *Housia canadensis* (WALCOTT) (Trilobita) from the Upper Cambrian of the Big Horn Mountains, Wyoming 253

Vertebrata

SHIKAMA, Tokio and DOMNING, Daryl P.: Pliocene Sirenia in Japan 390

PALAEOBOTANY

ENDO, Riuji and MORI, Ryuji: Two Interesting Fossil Specimens from the Upper Paleozoic System in Japan 112

FUJI, Norio: Fossil Spores and Pollen Grains from the Neogene Deposits in Noto Peninsula, Central Japan—I. A Palynological Study of the Late Miocene Wakura Member.. 1

———: Fossil Spores and Pollen Grains from the Neogene Deposits in Note Peninsula, Central Japan—II. A Palynological Study of the Middle Miocene Yamatoda Member.. 51

———: Fossil Spores and Pollen Grains from the Neogene Deposits in Noto Peninsula, Central Japan—III. A Palynological Study of the Pliocene Oginoya and Late Miocene Hijirikawa Members 185

HUZIOKA, Kazuo: A new species of *Sagenopteris* from Nariwa, Southwest Honshu, Japan.. 229

MATSUO, Hidekuni: On the Ômichidani Flora (Upper Cretaceous), Inner Side of Central Japan 371

NISHIDA, Shiro: Nannofossils from Japan I. Miocene Discoasters from Noto 136

———: Nannoplanktons from the Deep-sea Ooze of the Equatorial Pacific 355

TAKAHASHI, Kiyoshi and YAO, Akira: Plant Microfossils from the Permian Sandstone in the Southern Marginal Area of the Tanba Belt 41

———: Some Palynomorphs from the Upper Cretaceous Sediments of Hokkaido 265

INDEX OF FAMILIES, GENERA AND SPECIES

Notes: Words listed are names of families, genera and species, which are either described or illustrated in the Transactions and Proceedings of the Palaeontological Society of Japan, New Series, Nos. 73-80; words in heavy type are names of new genera and species.

A

Abies 18, 68, 197
Acer 19, 78, 197
Alnus 18, 68, 80, 197
Anadara multiformis 208, 209
Apollon sp. 209
Aquilapollenites cf. *mirabilis* 272
——— ***parvus*** 271
Araucariacites ? ***gloriosus*** 44
Asplenium sp. ? 380
Astraea ***furuichii*** 278, 283
——— sp. 32
Azorinus scheepmakeri 208

B

Betula 18, 78
Bursa (*Gyrineum*) *margaritula* 209, 216
Bynumiella ? *obscura* 258

C

Calamites sp. 113
Callispirina aff. *ornata* 99
Callista (*Costacallista*) *erycina* 208, 212
Callopora aurita 318
——— *corniculifera* 318
——— cf. *whiteavesi* 318
Calyptraea ***hataii*** 278, 284
——— sp. 278, 284
Cancrinella sp. 104
Cardita minoensis 278, 282
Carpinus 19, 68
Carpolithes sp. A-G 386
Carya 19, 22, 197
Castanea 19
Cauloramphus ? sp. 318
Cellaria diffusa 318
Celtis 18
Ceratolithus cristus 367
Cerithidea sp. 209
Chamaecyparis sp. 385
Chenopodium 204
Chlamys (?) sp. 32
Circe intermedia 208
Cladophlebis sp. 380
Clementia papyracea 208, 213
Coccolithus doronicoides 359
——— aff. *fragilis* 360
Conus (*Leptoconus*) *generalis* 209
——— (*Cleobula*) *minimus* 209, 217
Corbula sp. 209
Corylus 19, 68, 197
Cranwellia cf. *rumseyensis* 269
——— *striata* 268
Craspedolithus declivus 360
Crassimarginatella kumatae 278
Crepidula isimotoi 285, 318
Cultellus sp. 208
Cunninghamia sp. 383
Cyclococcolithus leptoporus 360
——— ? sp. 361
Cycloplacolithus laevigatus 361

D

Dakaria subtorquata 319
Danubites aff. *ambika* 338
——— sp. 338
Diplasioceras 178
Dipoloceras (*Diplasioceras*) ***tosaense*** 179
Discoaster aster 142
——— *barbadiensis* 142
——— *brouweri* 143
——— *challengeri* 143
——— aff. ——— 144
——— cf. ——— 144
——— *deflandrei* 144
——— *dilatus* 144
——— aff. *distinctus* 145
——— cf. ——— 145
——— cf. *divaricatus* 145
——— *gemmifer* 145

——— ***gladiatus*** 145
——— ***japonicus*** 146
——— *kugleri* 146
——— *lodoensis* 146
——— ***notoensis*** 147
——— *perplexus* 147
——— *saipanensis* 147
——— *tani* 147
——— ***trifucatus*** 148
Discolithina antillaria 361
——— *distinctua* 362
——— *pirena* 362
——— sp. 362
Dosinia sp. 208
Douvilleiceras 172
——— *mammillatum* 172
Dyadosporites 80

E

Echinaria sp. 105
Ellipsoplacolithus productus 362
Ellisina levata 318
Emiliania huxleyi 363
Endothyra ***kibiensis*** 122
Endothyra sp. 123
Enteletes gibbosus 96
Eodouvilleiceras 166
——— ***matsumotoi*** 166
——— sp. 169
Eostaffella kanmerai 120
Epitonium sp. 1 278
——— sp. 2 278
Equisetum sp. 376
Euflemingites sp. 338
Eurystomella bilabiata 319
Euspira meisensis 278, 285

F

Fagus 18, 68, 197
Figularia cf. *carinata* 318
——— *crassicostulata* 318
Flemingites sp. 338
Florinites ? sp. 46

G

Gari ? sp. 208
Gephyrocapsa aperta 363
——— *oceanica* 364
Geranium 80
Ginkgoites pseudoadiantoides 381
Glauconome virens 208
Globorotalia crassaformis 86
——— *hirsuta* 86
——— *inflata* 86
——— *tumida* 86
Globularia ? sp. 209
Glycymeris sp. 278
Glyptophiceras cf. *gracile* 338
Glyptostrobus sp. 383
Gomphina sp. 278

H

Halobia areata 244
——— *arthaberi* 244
——— *beyrichi* 244
——— *bosniaca* 244
——— *landlensis* 244
——— ? *lenticularis* 244
——— ? *lepsiusi* 244
——— *marmorea* 244
——— ? *richthofeni* 244
——— *styriaca* 244
Helicopontosphaera kamptneri 364
Hemitrapa angulata 385
Hendersona 293
——— *cardiniaeformis* 297
——— *subelliptica* 293
——— *umbonella* 295
Hincksina cf. *periporosa* 318
Hippothoa fragellum 318
Housia canadensis 254
Hydrodamalis sp. 393
Hysterichosphaeridium 202

I

Ilex 68, 197
Inapertipollenites sp. 202
Inapertisporites 24

J

Joannisiella cumingi 208, 210
Juglans 18, 68, 197
Jullienulla sp. A 318
——— sp. B 318

K

Katelysia hiantina 208
Keteleeria 68, 197

L

Lanceolaria pisciformis 238
Larix 18

Leiophyllites cf. *pitamaha* 338
——— aff. *pradyuma* 338
——— sp. 338
Leptesthes augheyi...................... 302
——— *berthoudi*...................... 301
——— *fracta* 299
Linoproductidae, sp. 105
Liquidamber...................... 19, 68, 197
Lucinoma sp. 278
Lutraria arcuata 208, 213
Lycopodium 24

M

Macoma sp. 208
Mactra antiquata 208, 213
Mancicorpus sp. 273
Margaritifeaa ***owadaensis*** 240
——— *perdahurica* 239
Marginifera ? sp. 103
Mediocris sp. 121
Meekoceras sp. 338, 346
Membraniporella cf. *bicornis*............ 318
Membraniporidra sp. 318
Menyanthes 19
Metasequoia........................... 202
Micropora coriacea 318
Microporella ciliata 319
——— *lunifera* 319
——— sp. 319
Microporina articulata.................. 318
Millerella ? sp. 120
Monoletepollenites sp. 204
Monoporella fimbriata 318
Monosulcopollenites 24
Monotaxinoides sp. 127
Mucronella labiata 331
Musashia cf. *yanagidaniensis* 278, 286
Myriophyllum 204

N

Nassarius crenulatus 209
Natica cf. *lineata* 209
Neochonetes sp. 103
Neospirifer cf. *fasciger* 100
Nilssonia asuwensis 381
——— *densinerve* 381
——— *serotina* 381
Nyssa 22, 68, 197

O

Oliva cf. *funebralis* 209, 217
Onoclea cf. *sensibilis* 380
Onychocella subsymmetrica.............. 318
Orbiculapollis globosus.................. 270
Osmunda 78
——— sp. 376
Oxytoma 34
——— (*Oxytoma*) *mojsisovicsi* 32, 34

P

Paphia exarata 208, 211
Parasmittina sp. 319
Perigastrella rectilineata 319
Persicaria 24
Phyllites sp. 386
Phricodothyris cf. *asiatica* 98
——— *echinata* 99
——— sp. 97
Picea 18, 68, 197
Pinus 18, 68, 197
——— ***mesothunbergii*** 382
Pleuricellaesporites 24
Podocarpus 22, 68
Ponumia 258
——— *obscura* 259
Porella acutirostris 319
Primovula rhodia 209
Proteacidites thalmanni 269
Pseudolimea naumanni.................. 32
Pseudorthoceras ***ouchii*** 112
Pseudotsuga 68, 197
——— ***mesowilsoniana***................ 382
Pteridium 78
Pterocarya............................. 19
Pulleniatina sp. 82
Puellina setosa 318
Pyrulella corbula 318

Q

Quercus 18, 22, 68, 197
——— (deciduous) 80, 197
——— (evergreen) 80
Quasiendothyra ***japonica***................ 124

R

Reginella nitida 318
Reticulatasporites ***foraminulatus*** 45
Rhabdosphaera claviger 367
Rhamphostemella hincksi 319
——— *spinigera* 319
Rostranteris (*Rostranteris*) cf. *nucleolus* 101
——— (———) sp. 102

S

Saccella sp. 278
Sagenopteris 231
——— ***nariwaensis*** 232
Salix 18, 68, 197
Salvinia sp. 380
Scapholithus fossilis 367
" *Schizoporella* " *scissa* 319
Sequoia sp. 384
Sphaeroidinella sp. 86
Sporopollis ? sp. 271
Stellaria 80
Strombus cf. *isabella* 209, 216
——— (*Laevistrombus* ?) *tjilonganensis* 209, 215
——— cf. *vittatus* 209
Styrax 19
Sunetta concinna 208, 212
Syracosphaera pulchra 364

T

Taiwania ***mesocryptomerioides*** 384
Tangshanella kaipingensis 91
——— ***nakakuboensis*** 91
Tapes ***nagahamaensis*** 278, 282
Tasmanites ***tanbaensis*** 46
Taxodiaceae 18, 68, 197
Tegella aquilirostris 318
——— *robertsonae* 318
——— *unicornis* 318
Tellinella virgata 208, 214
Terebra sp. 278
Thoracosphaera cf. *albatrosiana* 367
——— cf. *sexea* 368
——— sp. 368
Tiarolithus sp. A 365
——— sp. B 365
Tilia 19, 68, 197
Tournayella ***hiroshimana*** 124
——— sp. A 125
——— sp. B 126
Triadosporites 24
Tricolporopollenites 24
——— ? 204
Tsuga 22, 68, 197
Turritella sp. 278
Tutcheria 26
——— ***itoi*** 28

U

Ulmus 18, 68, 197
Umbilicosphaera mirabilis 365
——— *occidentalis* 366
——— sp. 366
Umbonula arctica 319
Uncinulus theobaldi 93
Uncinunellina ***shikokuensis*** 94
Unio (*Unio*) *uryuensis* 238

V

Vasticardium sp. 208, 278
——— ***teshimaense*** 278, 283
Veloritina cleburni 305
——— *durkeei* 304
Venericardia (*Cyclocardia*) *siogamensis* 278
Vepricardium multispinosum 208
Verminaria areolae 318
Vexillum sp. 209
Viburnum 68
Vicarya callosa 209, 214
Viviparus cf. *uryuensis* 240
Voluta (*Volutocorona*) ? sp. 209, 217

X

Xenoceltites ? sp. 338

Z

Zelkova 19, 22, 68, 197
Zirfaea ***hataii*** 133
Zirfaea sp. 133

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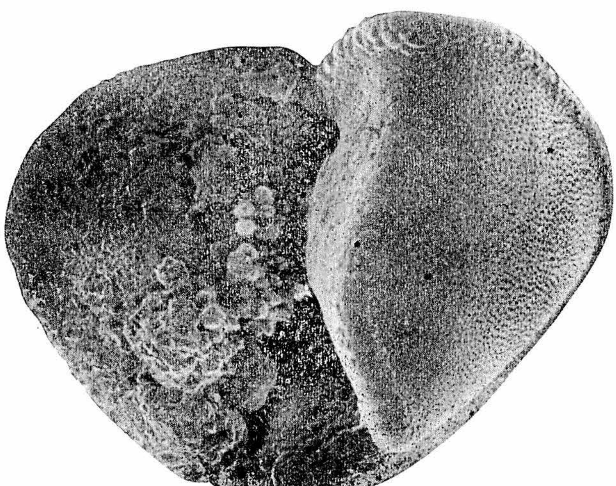
報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

New Series

No. 73 ～ No. 80

1969-1970



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Palaeontological Society of Japan

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

Fossils on the cover is *Globorotalia truncatulinoides* (D'ORBIGNY, 1839). The photograph was taken on a scanning electron microscope, JEOL-JSM-2, ×100.

CONTENTS

Number 73 (Published April 30, 1969)

Transactions

Article — Page

548. FUJI, Norio: Fossil spores and pollen grains from the Neogene deposits in Noto Peninsula, Central Japan—I. A palynological study of the late Miocene Wakura member 1-25
549. HAYAMI, Itaru: Occurrence of *Tutcheria* from the Lower Jurassic of West Japan 26-31
550. OZAWA, Tomowo and HAYAMI, Itaru: Triassic *Oxytoma* bed in the suburbs of Ōme City, Kwanto Mountain 32-40
551. TAKAHASHI, Kiyoshi and YAO, Akira: Plant microfossils from the Permain sandstone in the southern marginal area of the Tanba belt 41-48

Proceeding 40-50

Number 74 (Published June 30, 1969)

Transactions

552. FUJI, Norio: Fossil spores and pollen grains from the Neogene deposits in Noto Peninsula, Central Japan—II. A palynological study of the middle Miocene Yamatoda member 51-80
553. AOKI, Naoaki: Notes on the stratigraphic distributions of some planktonic foraminiferal species in the Kazusa group, Boso Peninsula 81-88
554. YANAGIDA, Juichi and HIRATA, Motome: Lower Permian brachiopods from Nakakubo, west Central Shikoku, Japan 89-111

Short Note

15. ENDO, Riuji and MORI, Ryuji: Two interesting fossil specimens from the Upper Paleozoic System in Japan 112-115

A tribute to the memory of Dr. Riuji ENDO *by* Haruyoshi FUJIMOTO..........116-118

Number 75 (Published September 30, 1969)

Transactions

555. SADA, Kimiyoshi: Microfossils of the lowest part of the Taishaku limestone (Studies of the stratigraphy and the microfossil faunas of the Carboniferous and Permian Taishaku limestone in west Japan, No. 4) 119-129
556. MASUDA, Koichiro and NODA, Hiroshi: Pliocene boring shells and their burrows from the environs of Sendai, Japan 130-135
557. NISHIDA, Shiro: Nannofossils from Japan—I. Miocene Discoasters from Noto 136-152
A Memorial to Professor Hisakatsu YABE *by* Ichiro HAYASAKA..............153-164

Number 76 (Published December 10, 1969)

Transactions

558. OBATA, Ikuwo: Lower Cretaceous ammonites from the Miyako group. Part 3; Some douvilleiceratids from the Miyako group 165-176
559. MATSUMOTO, Tatsuro and HIRATA, Motome: A new ammonite from the Shimantogawa group of Shikoku 177-184
560. FUJI, Norio: Fossil spores and pollen grains from the Neogene deposits in Noto Peninsula, Central Japan—III. A palynological study of the Pliocene Oginoya and late Miocene Hijirikawa members 185-204

Number 77 (Published April 10, 1970)

Transactions

561. IWASAKI, Yasuhide: A Miocene molluscan fauna in the Philippines 205-228
562. HUZIOKA, Kazuo: A new species of *Sagenopteris* from Nariwa, Southwest Honshu, Japan 229-234
563. NODA, Hiroshi: Freshwater molluscs from the coal-bearing Owada formation, Southeast Rumoi, Hokkaido, Japan 235-243
564. KOBAYASHI, Teiichi and ISHIBASHI, Takashi: *Halobia styriaca*, upper Triassic pelecypod, discovered in Okinawa-Jima, the Ryukyu Islands 243-248
Proceedings 249-252

Number 78 (Published June 30, 1970)

Transactions

565. HU, Chung-Hung: The ontogenies of *Ponumia obscura* (LOCHMAN), N. G., and of *Housia canadensis* (WALCOTT) (Trilobita) from the upper Cambrian of the Big Horn Mountains, Wyoming 253-264
566. TAKAHASHI, Kiyoshi: Some palynomorphs from the upper Cretaceous sediments of Hokkaido 265-275
567. SAITO, Minoru, BANDO, Yuji and NODA, Hiroshi: Fossil molluscs from Teshima, Shôdo-gun, Kagawa Prefecture, Southwest Japan 276-290

Number 79 (Published September 30, 1970)

Transactions

568. OHTA, Yoshihisa: A review of some Cretaceous corbiculids in North America 291-315
569. HAYAMI, Tomoko: Miocene Bryozoa from Southwest Hokkaido, Japan 316-336
570. BANDO, Yuji: Lower Triassic ammonoids from the Kitakami massif 337-354

Number 80 (Published December 20, 1970)

Transactions

571. NISHIDA, Shiro: Nannoplanktons from the deep-sea ooze of the equatorial Pacific 355-370
572. MATSUO, Hidekuni: On the Ômichidani flora (Upper Cretaceous), Inner side of Central Japan...371-389
573. SHIKAMA, Tokio and DOMNING, Daryl P.: Pliocene Sirenia in Japan 390-396
Proceedings 397-398

例　会　通　知

	開　催　地	開　催　日	講演申込締切日
1971年 総会・年会	東　京　大　学	1971年1月23・24日	1970年12月10日
107回 例　会	奈良教育大学	1971年6月27日	1971年5月10日
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◎ 108回例会（九州大学）は日本地質学会ほか3学会と共催。シンポジウムとして，「九州西方海域の地質と古生物」その他が予定されている。

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New Series No. 80 December 20, 1970

CONTENTS

TRANSACTIONS

571. NISHIDA, Shiro: Nannoplanktons from the deep-sea ooze of the equatiorial Pacific 355

572. MATSUO, Hidekuni: On the Omichidani flora (Upper Cretaceous), Inner side of Central Japan 371

573. SHIKAMA, Tokio and DOMNING, Daryl P.: Pliocene Sirenia in Japan...... 390

PROCEEDINGS 397

Systematic Index 399

Index of Families, Genera and Species 401