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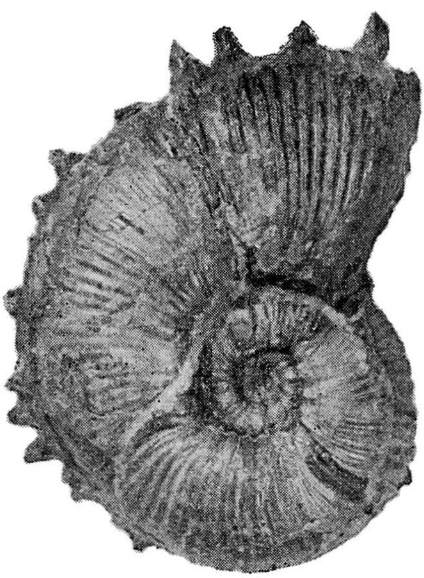

日本古生物学会

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July 15, 1981

The fossil on the cover is an adult example (T. TAKAHASHI coll.) of *Mikasaites orbicularis* MATSUMOTO (subfamily Marshallitinae, family Kossmaticeratidae) from the Lower Cenomanian (Cretaceous) of the Mikasa area, central Hokkaido. (photo by M. NODA, natural size)

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729. FOSSIL PLANTS FROM THE TAMA AND AZUYAMA HILLS, SOUTHERN KWANTO, JAPAN*

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Abstract. From the Oyabe Formation in the Tama Hill and the nearly coeval Bushi Formation in the Azuyama Hill, Southern Kwanto, we report the occurrence of fossil plants belonging to *Picea*, *Pinus*, *Metasequoia*, *Salix*, *Juglans*, *Alnus*, *Quercus*, *Gleditsia*, *Buxus*, *Paliurus* ?, *Ilex* and *Trapa*, and describe them. Judging from the floristic composition, this flora may correspond to the Akashi-type flora of TANAI (1961). The geological age of this flora may possibly be Plio-Pleistocene.

Introductory notes

We collected many fossil plants from two localities in the southern Kwanto: Narahara, along the Kita-Asakawa, Hachioji City in Tokyo and Sasai, along the Irumagawa, Iruma City in Saitama Prefecture. This paper mentions the general remarks on this flora and deals with the description of these plants.

(1) The Narahara locality (Fig. 1) was first found by one of us, YOSHIYAMA in 1967. He found fossil erect stumps together with many fossil leaves in a tuff bed (ca. 1 m thick) covered by a rather thick and light coloured sandstone bed without fossils (KIMURA *et al.*, 1967). The tuff bed contains erect stumps, wood and bark fragments, shoots, leaves, nuts, cones, seeds pollen and spores. Cuticles are preserved in most leaves.

We feel sure that this plant-bearing tuff bed belongs to the Oyabe Formation (ca. 40 m thick), the lowest part of the Miura Group (OTUKA, 1932; TOKUNAGA *et al.*, 1949; FUJIMOTO, 1968; FUJIMOTO *et al.*, 1961).

We determined the following species from the Narahara locality: *Picea* cf. *maximowiczii* REGEL (cone), *Pinus fujiii* (YASUI) MIKI (cones), *Metasequoia* cf. *glyptostroboides* HU and CHENG (cones, shoots, leaves), *Juglans cinerea* LINNÉ var. *megacinerea* MIKI (nuts), *Quercus* sp. (cuple), *Gleditsia* cf. *japonica* MIQUEL

* Received August 27, 1980; Revised manuscript received March 17, 1981; Read Jan. 21, 1977 at Tokyo.

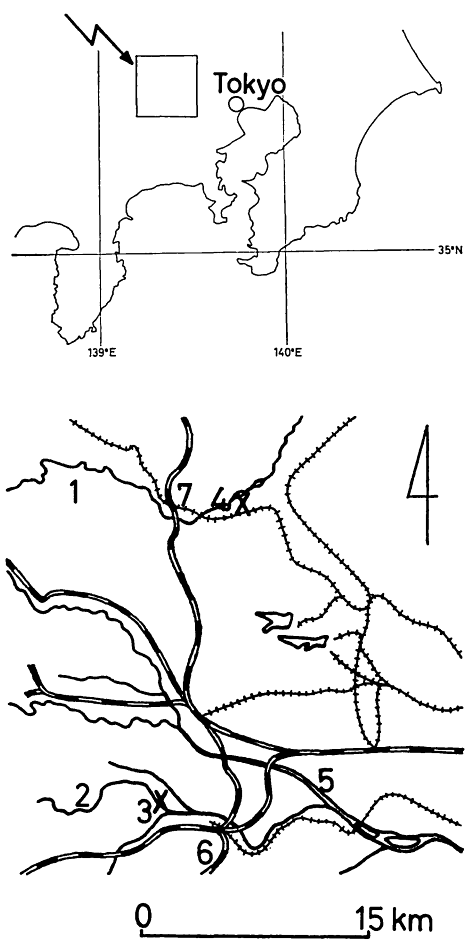


Fig. 1. Index map; the lower map corresponds to the indicated area in the upper one. 1; Irumagawa River. 2; Kita-Asakawa River. 3; Narahara locality. 4; Sasai locality. 5; Tama River. 6; Hachioji City. 7; Han-no City.

(spiny branches), *Buxus microphylla* SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON (leaves), *Paliurus* ? sp. (leaf), *Trapa macropoda* MIKI (fruits) and *T. maximowiczii* KORSHINSKY (fruits).

(2) The Sasai locality (Fig. 1) belongs to the Bushi Formation (FUJIMOTO, 1932 and others). According to FUKUDA and TAKANO (1951), the Bushi Formation (60–70 m thick) corresponds to the Hirayama Formation (OTUKA, 1932 and others) conformably overlying the Oyabe Formation in the Tama Hill. In our opinion the Bushi Formation is nearly coeval with the Oyabe Formation or possibly rather younger.

We determined the following species from the Sasai locality: *Metasequoia* cf. *glyptostroboides* HU and CHENG (cones, shoots, leaves), *Salix* cf. *integra* THUNBERG (leaves), *S.* sp. (capsules), *Alnus* cf. *japonica* SIEBOLD and ZUCCARINI (female spike), *Ilex cornuta* LINDLEY and PAXTON (leaves) and *Trapa maximowiczii* KORSHINSKY (fruits).

Besides above, SHIMAKURA (1934, '35, '36) recorded the following wood remains and a nut from the different localities of the Bushi Formation: *Taxodioxylon sequoianum* GOTHAN, *T.* cf. *sequoianum* GOTHAN, *T.* sp., *Piceoxylon* spp., *Cupressinoxylon* spp., *Glyptostroboxylon tenerum* CONWENTZ, *G.*? sp., *Buxus* sp. and a *Juglans* nut.

By 1948 the late Professor MIKI (1948) identified 249 plant-species belonging to 156 genera and 76 families from 101 localities in Kinki and its adjacent districts. Afterwards he (1950a) revised the numbers as 264, 154 and 78, respectively. Based on his plant-material, MIKI (1948) proposed the floristic sequence and discussed the palaeoclimate and other features.

In the Osaka Group located in the Kinki district (about 500 km to the west of Tokyo), the boundary between the Pliocene and Pleistocene is put at the horizon just below 'Ma-1' (KAMEI *et al.*, 1969) (Fig. 2), based on their reason that the first 'cold'-type plants are observed in 'Ma-1' horizon, such as *Picea maximowiczii, P. koribai, Pinus* spp., *Alnus japonica, Trapella lissa, Menyanthes trifoliata* in association with *Metasequoia*.

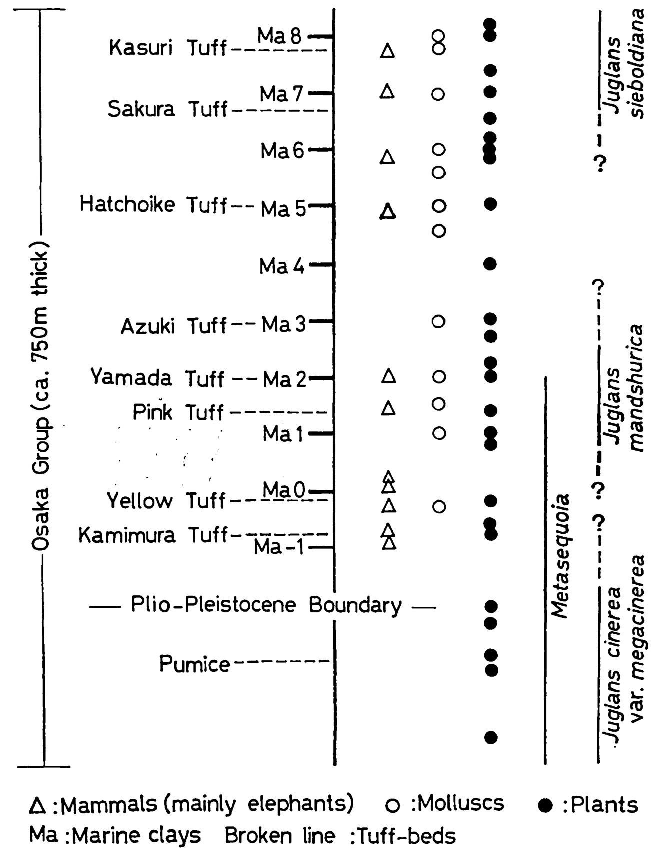


Fig. 2. Brief columnar section of the Osaka Group (after Ishida & Yokoyama, in Kamei *et al.*, 1969), and the stratigraphical ranges of *Juglans* species in the Osaka Group (after Nirei, 1969a, b).

According to Nirei (1969a, b), three *Juglans* species of the Osaka Group have their restricted stratigraphic ranges as shown on the right side of Fig. 2.

Judging from the floristic composition, our flora may correspond to the Akashi-type flora of Tanai (1961) flourished at swampy area under the temperate climate.

We have at present no positive base dating our flora, but judging from the coexistence of *Juglans cinerea* var. *megacinerea* and *Metasequoia* our flora may possibly be correlated with that of the lower part (Plio-Pleistocene age) of the Osaka Group.

Acknowledgements

We first express our sincere gratitude to Professor Emeritus Thomas M. Harris, F. R. S. of the University of Reading for his very helpful suggestions in palaeobotany. We also thank Professor T. Tanai of the Hokkaido University and Dr. K. Uemura of the National Science Museum, Tokyo for their valuable criticisms. This study was supported in part by the Grant-in-Aid for Scientific Research of the Ministry of Science and Culture (no. 154290-1978).

Systematic description

The cuticles here described were prepared by the maceration with HNO_3+KClO_3 followed by diluted KOH. Specimens here described are kept in the Department of Astronomy and Earth Sciences, Tokyo Gakugei University.

Gymnospermae-Coniferales

Family Pinaceae

Genus *Picea* A. DIETRICH

Picea cf. *maximowiczii* REGEL

Pl. 9, Fig. 1; Text-figs. 1a-c

Comparable specimens:

Picea cf. *maximowiczii* REGEL: MIKI, 1941, p. 255, fig. 5J.

Picea maximowiczii REGEL: MIKI, 1948, p. 111, fig. 3G; 1956, p. 450; 1957, p. 241, pl. 5, figs. A-B; fig. 5C.

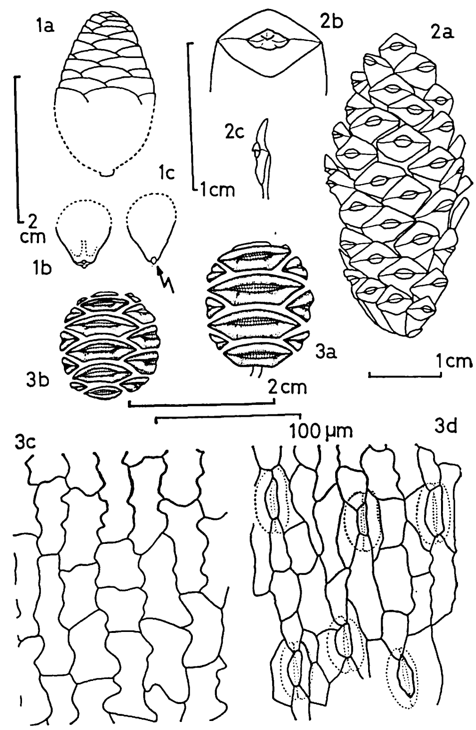
Material: HAC-2004.

Locality: Narahara.

Occurrence: Rare.

Observation: A single cone (Text-fig. 1a) is small, ovoid in outline, 2 cm long and 1.4 cm wide. Its apex is missing. The cone-scales are obovoid in outline, wedge-shaped at base, without stalk and with thin entire margin as shown in Text-fig. 1b-c, 10 mm long and 8 mm maximum-wide. The bract are small, coming easily off, leaving its scar on the abaxial base of each cone-scale. Seeds are unknown.

Remarks: Unfortunately, we failed to make the exact phyllotaxis of this cone clear. Our cone is similar in form to that of *Picea maximowiczii*, but smaller in size than those of living ones. So we regard our cone as *Picea* cf. *maximowiczii*.



Text-figs. 1-3. 1. *Picea* cf. *maximowiczii* REGEL. 1a; a detached cone (HAC-2004). 1b-c; cone-scales drawn from HAC-2004, 1b; adaxial view, 1c; abaxial view, an arrow indicating the scar of fallen bract scale. 2. *Pinus fujiii* (YASUI) MIKI. 2a; a detached cone (HAC-2002). 2b-c; a proximal cone-scale drawn from HAC-2002, 2b; front view, 2c; lateral view, showing an eschtcheon with hook-like umbo. 3. *Metasequoia* cf. *glyptostroboides* HU and CHENG. 3a-b; detached cones with decussately arranged cone-scales (HAC-2001A, G), 3c-d; leaf-cuticle (slide no. IR-2104B), 3c; upper cuticle, showing cells with undulated cell-walls, 3d; lower cuticle (a part of a stomate zone), showing sunken guard cells and their orientation.

Picea latibracteata originally described by MIKI (1957) from the Plio-Pleistocene plant-beds in Kinki district, resembles *P. maximowiczii*, but it differs from *P. maximowiczii* in its broader cone-scale as shown by its specfic name, and its broader bract.

The living *Picea maximowiczii* is now restricted in distribution to a small area in eastern montane area of Nagano Prefecture and on the slope of Mt. Fuji, Central Japan.

Genus *Pinus* LINNÉ

Pinus fujiii (YASUI) MIKI

Pl. 9, Figs. 2-3; Text-figs. 2a-c

Pinites fujiii YASUI: YASUI, 1928, p. 431, pls. 20-21, text-fig. 12.
Pinus fujiii (YASUI) MIKI: MIKI, 1939, p. 244 (nomenclature); 1941, p. 255, pl. 4, fig. G; fig. 5K-M; 1957, p. 250, pl. 7, figs. H-K; fig. 7B; TANAI, 1961, p. 255, pl. 2, fig. 9; pl. 3, fig. 10.

Material: HAC-2002, 2003.
Locality: Narahara.
Occurrence: Rather rare.
Observation: Two incomplete cones (Pl. 9, figs. 2-3; Text-fig. 2a) were obtained. The cones are ovate in form, 3.5-4.5 cm long and 2 cm maximum-across measured on compressed surface, and stipitate. The conescales (Text-fig. 2b) are elongate-rectangular in form, 1.2-1.3 cm long and 4-6 mm wide at middle and with an expanded and thickened apex forming a flattened-rhomboidal escutcheon with hook-like umbo (Text-fig. 2c). Bractscales and seeds are unknown.

Remarks: Our cones are referable to those of *Pinus fujiii* described by previous authors from the Pliocene and the Miocene in Japan. The cone character of this species resembles those of living *Pinus densiflora* SIEBOLD and ZUCCARINI and *P. thunbergii* PARLATORE, both growing wild in Japan and korea. But *Pinus fujiii* is distinguished from *P. densiflora* by its broad cone-scales and its expanded umbo, and from *P. thunbergii* by its hook-like umbo.

Family Taxodiaceae

Genus *Metasequoia* MIKI ex HU and CHENG

Metasequoia cf. *glyptostroboides* HU and CHENG

Pl. 9, Figs. 4-6; Pl. 10, figs. 1-3; Text-figs. 3a-d

Material: HAC-2001 and many others.
Localities: Narahara and Sasai.
Occurrence: Very abundant (cones, leafy twigs and needles).
Observation: The cones (Pl. 9, Figs. 4-6; Text-figs. 3a-d) are short-cylindrical or elliptic in side-view, 1.6-1.8 cm long and 0.9-1.3 cm across, consisting of 16-20 cone-scales. The cone-scales are decussately arranged, 2-4 mm high (mean 3 mm) and 7-13 mm wide (mean 10 mm). The peduncles are mostly missing and no seed is preserved on the cone-scales. The deciduous shoots are with distichous and pectinate leaves. The leaves are linear and mostly obtuse at apex, 0.7-1.1 cm long and 1 mm wide and with a midnerve persisting near the tip.

The leaf-cuticle is hypostomatic (Pl. 10, Fig. 1). The upper cuticle (Pl. 10, Fig. 2; Text-fig. 3c) consists of rectangular normal cells, typically 56 μm long and 19 μm wide and with undulate lateral walls. The cells on a midnerve and along the margins are long and narrow, typically 71 μm long and 16 μm wide with straight cell-walls.

The lower cuticle (Pl. 10, Fig. 3; Text-fig. 3d) consists of a pair of stomate zones and zones of normal cells. The stomate zone (Text-fig. 3d) consists of stomata, subsidiary cells and normal cells which are typically 48 μm long and 14 μm wide and with more or less undulate cell-walls. The stomata are elliptic, typically 42 μm long and 22 μm wide and with 4-6 subsidiary cells, forming a pit over the sunken guard cells. The apertures are parallel to the midnerve. The density of stoma is about 170 per mm^2. The normal cells outside the stomate zone are elongate-rectangular, typically 76 μm long and 15 μm wide with nearly straight cell-walls. Normal cells on the midnerve are 68 μm long and 14 μm wide and with straight cell-walls.

Remarks: Our cones, shoots and leaves agree well with those of the living *Metasequoia glyptostroboides.* But our cuticle is somewhat different from that of living species; in ours the normal cells on the midnerve and the marginal sides of leaf are straight-walled, while in living species the normal cell-walls are, so far as our observation is concerned, usually undulated everywhere. Accordingly we here regard ours as *Metasequoia* cf. *glyptostroboides.*

Our cones, shoots, leaves and their cuticle resemble those originally described by MIKI (1941) as *Metasequoia disticha* (HEER) and *M. japonica* (ENDO). *Metasequoia japonica* is, according to MIKI (1941), characterized by its cones with narrow and smaller number of cone-scales. However, we think both are conspecific, because it is considered that the cones with narrow and small number of cone-scales fall within the range of variance.

CHANEY (1950) made two combinations of *Metasequoia, M. occidentalis* (NEWBERRY) and *M. cuneata* (NEWBERRY). According to CHRISTOPHEL (1976), *Metasequoia cuneata* is conspecific with *M. occidentalis.*

Outside Japan, nearly all the fossil *Metasequoia* specimens except the Russian ones, were descrebed under the name of *M. occidentalis* (for further details, see CHANEY, 1950; SCHLOEMER-JÄGER, 1958; BROWN, 1962; SCHWEITZER, 1974; CHANDRASEKHARAM, 1974; CHRISTOPHEL, 1976). The Russian specimens have mostly been regarded as *Metasequoia disticha* by the Russian authors.

TANAI (1961) adopted *Metasequoia occidentalis* for the Japanese specimens instead of *M. disticha,* by the reason that MIKI's specific name *disticha* was derived from HEER's *Sequoia disticha* based on the foliage shoots, and *M. disticha* on the basis of cones was, in his opinion, doubtful to be correctly coincided with HEER's original specimens.

Our cones, shoots and leaves also resemble those regarded as *Metasequoia occidentalis,* but we reserve the full comparison between ours and *M. occidentalis,* because, so far as we know, the leaf-cuticles have not been described in the leaves regarded as *M. occidentalis.*

Angiospermae-Dicotyledonae

Family Salicaceae

Genus *Salix* LINNÉ

Salix cf *integra* THUNBERG

Pl. 10, Figs. 4-5; Text-figs. 4a-c

Material: IR-4101 and many others.
Locality: Sasai.
Occurrence: Locally very abundant.
Observation: Many broken leaves were obtained. They are elongate-oblong in form, typically 3.5 cm long and 1.4 cm maximum-wide and with finely serrate margins (Text-fig. 4a). The midnerve is arcuate. Secondary nerves arise at an

angle of 40-50 degrees, then bending upwards near the margin. Tertiary nerves are nearly perpendicular to the secondary ones, sometimes forking in course. Quaternary nerves are mostly inconspicuous (Pl. 10, Fig. 4) and nearly perpendicular to the tertiary ones. Ultimate veinlets are free (Text-fig. 4b).

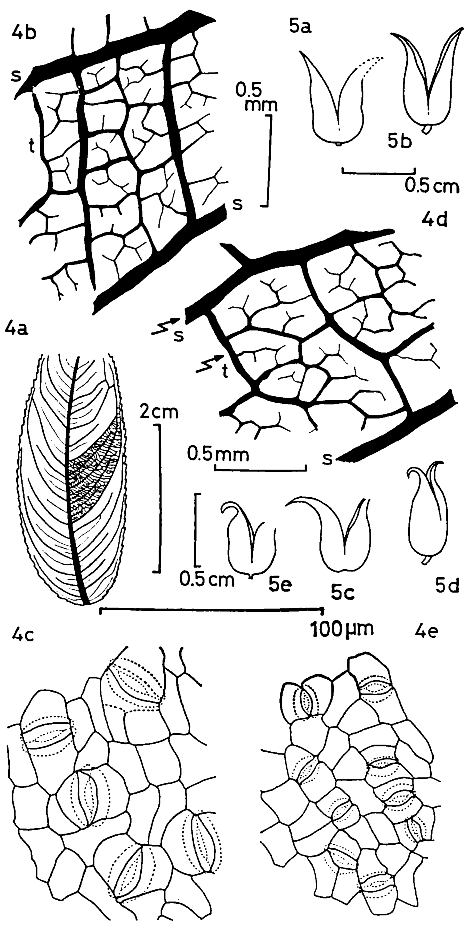
The cuticle is hypostomatic. The upper cuticle (Pl. 10, Fig. 4) consists of normal cells and elongate vein cells. Normal cells are pentagonal or hexagonal in form, 9-15 μm in diameter. The lower cuticle (Pl. 10, Fig. 5; Text-fig. 4c) consists of stomata, normal cells and elongate vein cells. A stoma consists of guard cells and paired subsidiary cells (brachyparacytic, after DILCHER, 1974). Stomata are small-sized, irregular in orientation and crowded, about 240 per mm^2 in density. Guard cells are sunken, 7-10 μm long and 3-4 μm wide. Normal cells are narrower than those of upper ones, 10-30 μm long and 7-10 μm wide. No hair is found on both surfaces.

Remarks: Among more than 300 living *Salix* species, our leaves resemble *Salix integra* THUNBERG in their leaf-form and cuticle, but our normal cells and stomata are larger in size than those of living *S. integra* as shown in Text-figs. 4c and 4e for comparison.

It seems to be difficult to distinguish *Salix* species depending on their cuticles, because they are often similar and we merely designate our leaves as *Salix* cf. *integra*. In addition, *Salix* species bear various hybrids each other to make the specific distinction difficult, as well seen among the living *Salix* species.

In Japan, the first record of fossil leaves like the living *Salix integra* was made by HUZIOKA (1952) from the Miocene of Hokkaido.

According to MIKI (1953), *Salix* leaves occur locally or sporadically in the Plio-Pleistocene plant-beds in Japan. To be sure, *Salix* leaves or fruits have not been found from Narahara, although its pollen grains are fairly abundant.



Text-figs. 4-5. 4a-c. *Salix* cf. *integra* THUNBERG. 4a; an incompletely preserved leaf (IR-4101). 4b; detailed venation drawn from IR-4101 (s; secondary nerves, t; tertiary nerves). 4c; lower cuticle drawn from IR-4101. 4d-e. Living *Salix integra* THUNBERG (for comparison) (cultivated in the campus of Tokyo Gakugei University). 4d; detailed venation. 4e; lower cuticle, (guard cells are sunken). 5a-e. *Salix* sp. (capsules) (IR-4002).

Salix sp.

Pl. 10, Fig. 6; Text-figs. 5a-c

Material: IR-4002 and mony others.
Locality: Sasai.
Occurrence: Locally abundant.
Observation: A good number of detached *Salix* capsules as shown in Pl. 10, Fig. 6 is obtained. Capsule is as a whole short-lanceolate in side-view, with a short stalk, 0.5 mm long and 0.3 mm across (Text-fig. 5a), and deeply divided into two parts. Apical half of each part is tapering to the pointed apex and sometimes reflexed outwards as shown in Text-figs. 5b-e.

Remarks: Our capsules resemble in general form those of several living *Salix* species or possibly a *Toisusu* species in Japan, But the capsules of living *Salix integra* are far smaller in size than ours.

It is impossible to determine our capsules specifically, because their stigmas and hairs which are taxonomically useful appendages, are all missing. Very likely our capsules belong to *Salix* cf. *integra,* being in close association with the leaves in occurrence. However, we here regard them as *Salix* sp. because of lacking any positive proof of their attribution.

Family Juglandaceae

Genus *Juglans* LINNÉ

Juglans cinerea LINNÉ var. *megacinerea* MIKI

Pl. 9, Figs. 7-9; Text-figs. 6a-b

Juglans cinerea LINNÉ: KRYSHTOFOVICH, 1915, p. 21, pl. 1, figs. 3-7; HAYASAKA, 1926, p. 55, pl. 5; ENDO, 1933, p. 305, figs. 1-9; 1934a, p. 62, pl. 3; 1934b, p. 374; 1934c, p. 345, pls. 42-43; 1954, pl. 1, figs. 2-3; SHIMAKURA, 1935, p. 45, fig. 2; MIKI, 1936, p. 170, fig. 2A; 1937, p. 310, pl. 8, fig. 1; fig. 2A; 1941, p. 265, fig. 9F; ONISHI, 1940, p. 78, fig. 2; OKUTSU, 1955, p. 83, pl. 8, figs. 1-3.

Juglans megacinerea CHANEY: MIKI, 1953, p. 127, fig. 17F.

Juglans megacinerea LINNÉ: KOKAWA, 1955, pl. 1, figs. 1-3.

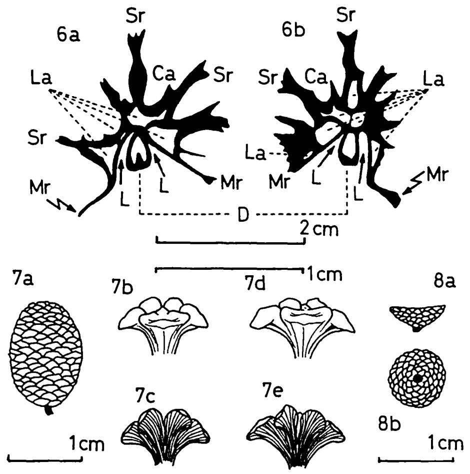
Juglans cinerea LINNÉ var. *megacinerea* (CHANEY) MIKI: MIKI, 1955, p. 133, pl. 2, fig. A; fig. 2B; TANAI, 1961, p. 274, pl. 6, figs. 1-2, 7; NIREI, 1975, p. 34, pl. 1, figs. 6-12; text-figs. 3-4.

Material: HAC-4001-4005 and many others.
Locality: Narahara.
Occurrence: Abundant.
Observation: Many nut remains were obtained. They are represented mostly by the valve separated by its sutural plane, but sometimes by the complete nut, although more or less crushed. The nuts (Pl. 9, Figs. 7-9) are oblong-ovoid in outline, 5.5-6.8 cm long and 2.7-3.2 cm maximum-wide, acuminated at apex and rounded at base. Ribs are prominent, typically 8 in number, about 5 mm deep, with marked sculptures. In cross section, there are 8 or more lacunae in the endocarp around a loculus (Text-figs. 6a-b).

Remarks: Our nuts agree well with those described by previous authors under the names of *Juglans cinerea, J. megacinerea* or *J. cinerea* var. *magacinerea.*

According to NIREI's detailed study on the walnut (1975), *Juglans cinerea* var. *megacinerea* is safely distinguishable from fossil and living *J. cinerea* by the number of locunae (viz. 4 in *J. cinerea,* while 6-10 in var. *megacinerea*) and the nut-size.

According to TANAI's suggestion, we removed the author's name '(CHANEY)' from this variety, because we could not find CHANEY's reference to this variety. It would be better to regard this variety as ranking with a distinct species because



Text-figs. 6-8. 6a-b. *Juglans cinerea* LINNÉ var. *megacinerea* MIKI. 6a; an equatorial cross section of a fairly deformed valve. 6b; a cross section of the same valve just below its equator (HAC-4004B) (D; dissepimentum, L; loculus, La; lacuna, Mr; main rib, Sr; subrib, Ca; canal). 7a-c. *Alnus* cf. *japonica* SIEBOLD and ZUCCARINI. 7a; a detached female-spike (IR-4001A). 7b-c; a scale drawn from IR-4001A, 7b; abaxial view, 7c; adaxial view. 7d-e. Living *Alnus japonica* SIEBOLD and ZUCCARINI; a scale (for comparison) (collected from the montane area of Tokyo), 7d; abaxial view, 7e; adaxial view. 8. *Quercus* sp. (cuple) (HAC-4012). 8a; lateral view, 8b; outer surface view.

of its number of lacunae and nut-size. However, here we would like to keep it as a variety of *Juglans cinerea,* until its vegetative organs are known.

Family Betulaceae

Genus *Alnus* GAERTNER

Alnus cf. *japonica* SIEBOLD and ZUCCARINI

Pl. 9, Fig. 10; Text-figs. 7a-c

Material: IR-4001 A-D.

Locality: Sasai.

Occurrence: Rather rare.

Observation: Four detached female-spikes were obtained. The female-spikes (Pl. 9, Fig. 10; Text-fig. 7a) are oval in side-view, 1.3-1.7 cm long and 0.7-1.0 cm maximum-wide and with a large number of spirally arranged scales. The scales (Text-figs. 7b-c) are fan- or wedge-shaped and their apical halves are divided into 5 lobes, among which a central one is larger in size than others and with a small projection at apex.

Remarks: Our spikes, especially having 5 lobed scales, resemble those of living *Alnus japonica* growing wild mainly on swampy areas in Japan, Korea, Northeast China and Ussuri. So far as we know, except *Alnus japonica* (Text-figs. 7d-e for comparison), there is no living *Alnus* species having 5 lobed scales in Japan and adjacent areas. We, however, here reserve the full specific identity of our spikes to living species, because our spikes are smaller in size than those of living species (1.5-2 cm long and 9-15 mm wide) and the specimens at hand are too small in number for satisfactory comparison.

Family Fagaceae

Genus *Quercus* LINNÉ

Quercus sp.

Pl. 9, Fig. 11; Text-figs. 8a-b

Material: HAC-4012.

Locality: Narahara.

Occurrence: Rare.

Observation: A single detached cuple was obtained. Cuple (Pl. 9, Fig. 11) is small, shallow-cup-like in form, 8.5 mm in diameter and 2.5 mm high, and with thin margin. Its outer surface is densely ornamented with the imbricated minor scales as shown in Text-figs. 8a-b.

Remarks: The outer ornamentation of our cuple resembles those of such living oaks in Japan as *Quercus phillyraeoides* A. GRAY, *Q. serrata* THUNBERG and *Q. crispula* BLUME. Among them, our cuple is most close to that of *Quercus serrata* growing wild in Japan and Korea, owing to its shallow-cup-like form.

Family Leguminosae

Genus *Gleditsia* LINNÉ

Gleditsia cf. *japonica* MIQUEL

Pl. 9, Fig. 12; Text-fig. 9a

Comparable specimens:

Gleditsia horrida MAKINO (non WILLDENOW): MIKI, 1936, p. 171, figs. A-E.
Gleditsia japonica MIQUEL: MIKI, 1937, p. 318, figs. 6A-E (=*G. horrida* MAKINO in MIKI, 1936); 1938, fig. 5F.

Material: HAC-4015, 4016.
Locality: Narahara.
Occurrence: Rare.
Observation: The specimens found are detached main-spines bearing subopposite branch-spines at 45 degrees. The main spine is 2 mm across up to its second branch when it is more slender. Its apex is broken. The branch-spines are 2 mm wide below and 10-23 mm long and taper to sharp points. They are slightly decurrent basally and the main spine has longitudinal striations.

Remarks: Our spiny branches, though small fragments, agree in general outline with those illustrated by MIKI (1936, '37, '38) from the *Stegodon* and *Elephas* beds of Akashi and Katada (for further details, see MIKI, 1938), as *Gleditsia japonica* MIQUEL. But they differ from those of living *Gleditsia japonica* in having longer and stouter spiny-branches. Text-fig. 9b shows some spiny branches of living *Gleditsia japonica* for comparison. Accordingly we prefer to regard our specimens as *Gleditsia* cf. *japonica.*

The spiny branches illustrated by MIKI (1938, fig. 2Ka, b) agree well with those of living *Gleditsia japonica. Gleditsia* cf. *macrocantha* DESFONTAINES illustrated by MIKI (1941) is an allid form to *G.* cf. *japonica* in its large-sized spiny branches.

Family Buxaceae

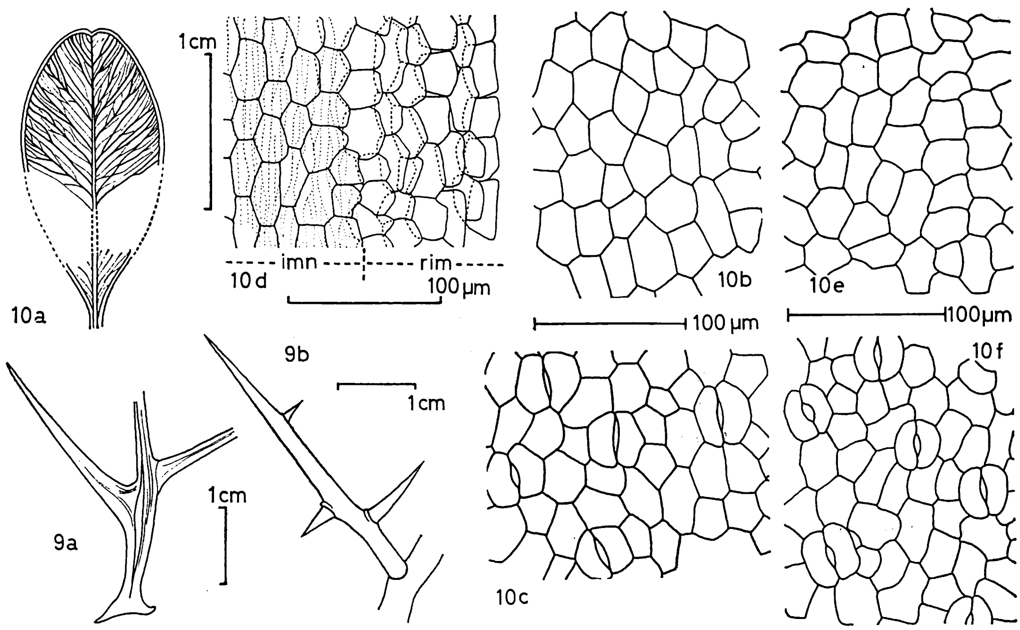
Genus *Buxus* LINNÉ

Buxus microphylla SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON

Pl. 9, Fig. 13; Pl. 11, Figs. 1-4; Text-figs. 10a-d

Buxus japonica MUELLER-AARGAU: MIKI, 1936, p. 20, figs. 7A-B; 1937, p. 320, figs. 7A-B; 1941, p. 281, fig. 16D; TAKAHASHI, 1954, p. 60, pl. 7, figs. 13a-g.

Material: HAC-4101-4104.
Locality: Narahara.
Occurrence: Rather rare.
Observation: Four detached leaves were obtained. They (Pl. 9, Fig. 13; Text-fig. 10a) are small, 1-1.7 cm long and 0.7-0.9 cm wide, elliptic or obovate in outline, rounded or emarginate at apex, acute or attenuate at base, and shortly petiolate. The mid-primary nerve is stout, nearly straight and sending off about 15 pairs of rather slender secondaries at an angle of 50-60 degrees. A pair of lateral-primary nerves is thinner than the mid-primary nerve, originating from the petiole, then each forming an intra-marginal nerve. Secondaries are mostly parallel to each other, then dichotomously forking twice or thrice, straight or curving and finally joining the intra-marginal nerve. Tertiaries are mostly distinct but slender, diverging at an acute angle from the secondaries,



Text-figs. 9-10. 9a. *Gleditsia* cf. *japonica* MIQUEL; a deformed spiny branch (HAC-4015). 9b. Living *Gleditsia japonica* MIQUEL; a spiny branch (for comparison) (cultivated at Kodaira City, Tokyo). 10a-d. *Buxus microphylla* SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON. 10a; a detached leaf and its venation (HAC-4102). 10b; upper cuticle (slide no. HAC-4102S). 10c; lower cuticle, showing anomocytic subsidiary cells (slide no. HAC-4102S). 10d; marginal cells, forming a 'rim' (right side, indicated as rim) and venous cells (dotted lines) of an intra-marginal nerve (left side, indicated as imn); marginal cells are thick and their margins are lying one upon another. 10e-f. Living *Buxus microphylla* SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON; cuticle (for comparison) (cultivated in Tokyo). 10e; upper cuticle. 10f; lower cuticle, showing anomocytic subsidiary cells.

irregularly forking, ending freely in intercostal area and not forming areole, although they are often joining. The leaf-margin is entire, forming a very narrow and nerveless 'rim' all around, consisting of the aggregation of thick-walled cells.

The cuticle is hypostomatic, both the upper and the lower cuticles are thick. The upper cuticle (Pl. 11, Fig. 1; Text-fig. 10b) consists of normal cells which are pentagonal-hexagonal in outline and nearly isodiametric, 15-40 μm in diameter. The lower cuticle (Pl. 11, Fig. 2; Text-fig. 10c) consists of stomata and normal cells similar in form to those of the upper cuticle. Stomata are circular in outline, typically 38 μm in diameter, scattered evenly, about 120 per mm^2 in density, their apertures are irregularly oriented. Subsidiary and encircling cells are indistinct, anomocytic (after DILCHER, 1974). Marginal cells forming the 'rim' are thick isodiametric, 25 μm in diameter and with rather thickened cell-walls as shown in Pl. 11, Figs. 3-4 and Text--fig. 10d.

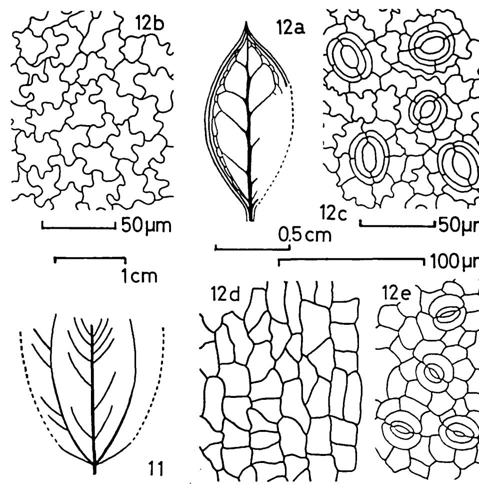
Remarks: Among about 70 living *Buxus* species and their varieties, our leaves are just like those of *Buxus micro-*

phylla var. *japonica* externally redefined by HATUSIMA (1942) in leaf-form, size and venation. In addition, our cuticle is like those of living *Buxus microphylla* var. *japonica*, too (Text-figs. 10e-f for comparison).

Buxus microphylla var. *japonica* resembles *B. protojaponica* originally described by TANAI and ONOE (1961) from the Upper Miocene of Japan, and recently reexamined by UEMURA (1979) based upon many fossil leaves with his detailed cuticular observation. However, *Buxus microphylla* var. *japonica* is possibly distinguished from *B. protojaponica* by its almost glabrous habit, instead of having unicellular hairs both on the petiole and basal leaf-margins in *B. protojaponica*.

Our leaves are indistinguishable from those described by MIKI and TAKAHASHI under the name of *Buxus japonica* shown in synonymy in their leaf-form, size and cuticles, although they are glabrous or not is uncertain.

Buxus microphylla var. *japonica* is similar in leaf-form, venation and cuticle to *B. corchika* POJARK, *B. pliocenica* SAPORTA and MARISON and *B. sempervirens* LINNÉ known from the Tertiary of Eurasia. Their brief comparison was already carried oun by UEMURA (1979).



Text-figs. 11-12. 11. *Paliurus* ? sp.; a broken leaf (HAC-4105B). 12a-b. *Ilex cornuta* LINDLEY and PAXTON. 12a; a broken small-sized leaf with a spine at its apex; high ordered nerves are invisible (IR-4004). 12b; upper cuticle (slide no. IR-4004S). 12c; lower cuticle, showing the stomata with nearly staurocytic subsidiary cells (slide no. IR-4004S). 12d; cells between leaf-margin (right edge) and venous area of an intramarginal nerve (slide no. IR-4004S). 12e. Living *Osmanthus aquifolium* SIEBOLD and ZUCCARINI (for comparison) (cultivated in the campus of Tokyo Gakugei University); lower cuticle, showing the stomata with paracytic subsidiary cells.

Family Rhamnaceae

Genus *Paliurus* MILLER

Paliurus ? sp.

Text-fig. 11

Material: HAC-4105B.
Locality: Narahara.
Occurrence: Rare.
Remarks: A single broken leaf was obtained. Judging from its three strong nerves originating at the top of petiole, this leaf may belong to the genus *Paliurus* now growing wild along warm-temperate sea-side. However, this leaf is too incomplete to make the specific determination.

Family Aquifoliaceae

Genus *Ilex* LINNÉ

Ilex cornuta LINDLEY and PAXTON

Pl. 11, Figs. 5-7; Text-figs. 12a-d

Ilex cornuta LINDLEY and PAXTON: MIKI, 1937, p. 320, pl. 9, figs. 7F-H; 1938, p. 224, fig. 6E.

Material: IR-4003, 4004. *Locality:* Sasai. *Occurrence:* Rare.

Observation: Two detached leaves were obtained. The larger one is 5 cm long and 2.4 cm wide, the smaller one (Text-fig. 12a), 1.3 cm long and 0.6 cm wide. They are elliptic with a single short apical spine and with a base narrowed to the petiole. The primary nerve is strong, appearing slightly sinuous and persisting to the apical spine. A pair of lateral primary nerves originates at the top of the petiole, running inside of each margin to form a strong intra-marginal nerve and joining the central primary nerve in the apical spine. Four-five pairs of secondaries originate alternately at an angle of about 55 degrees. They fork widely near the margin. Each branch forms a loop with an adjoining one as shown in Text-fig. 12a. The small nerves between the secondaries are indistinct because of ill-preservation.

Cuticle is hypostomatic. The upper cuticle (Pl. 11, Fig. 5; Text-fig. 12b) consists of irregular-shaped normal cells with strongly undulate cell-walls, 12 μm $\times$35 μm in mean-size. Lower cuticle (Pl. 11, Fig. 6; Text-fig. 12c) consists of stomate-complexes and normal cells. Stomata are evenly distributed, about 300 per mm^2 in density, except the marginal 'rim' outside the intra-marginal nerve and the spine. Guard cells are neither sunken nor raised, randomly oriented, 20 μm$\times$32 μm in mean-size and are surrounded by 4 subsidiary cells. The subsidiary cells are narrow and more or less equal in size, and their anticlinal walls extend at right angle from the poles and middle of the guard cells (nearly staurocytic, after DILCHER, 1974). Lower normal cells are generally smaller in size than upper ones, 10 μm$\times$25 μm in mean-size and with strongly undulate cell-walls. The area between the leaf-margin and the venous region of an intra-marginal nerve consists of rectangular and tetragonal cells varying in size with nearly straight or slightly undulate cell-walls, forming cell-files consisting of 1–2 cell-rows of about 17 μm wide as shown in Pl. 11, Fig. 7 and Text-fig. 12d. Cells on the venous region are not specialized. So far as our observation is concerned, trichomes or hairs are absent.

Remarks: MIKI (1937) described the various leaf-forms and cuticle of this species now growing wild in Northern China and Southern Korea, from the Plio-Pleistocene plant beds in Kinki district. Judging from their form and cuticle, our leaves are referable to some of those described by MIKI (1937, e.g. his figs. 7Fg-i, Ga-b), although our leaves at hand have no lateral spines.

According to MIKI (1937), this species differs from *Ilex aquifolium* LINNÉ now growing wild in Europe, Western Asia and China in its leaf-form and short petiole.

Osmanthus aquifolium SIEBOLD and ZUCCARINI now growing wild in South-west Japan and China, has various leaf-form, and some of its leaves resemble our leaves. However, their cuticles are very different from one another. *Ilex cornuta* has very sinuous cell-walls and nearly staurocytic stomata, while *Osmanthus aquifolium* (Text-fig. 12e for comparison) has nearly isodiametric polygonal to rounded cells and paracytic stomata.

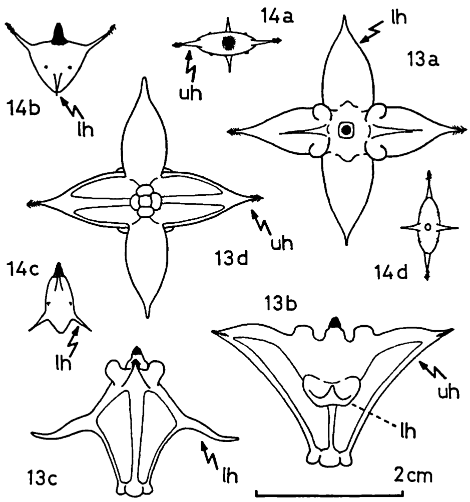
Family Hydrocaryaceae

Genus *Trapa* LINNÉ

Trapa macropoda MIKI

Pl. 9, Figs. 14–16; Text-figs. 13a–d

Trapa macropoda MIKI: MIKI, 1933, p. 625, figs. 3A–B; 1938, pp. 220, 225, figs. 5H, 7B–C; 1952, p. 20, pl. 2, fig. F; figs. 10A–C.



Text-figs. 13-14. 13. *Trapa macropoda* MIKI. A fruit (HAC-4006A). 13a; upside view. 13b-c; lateral view. 13d; basal view (uh; upper horn, lh; lower horn). 14. *Trapa maximowiczii* KORSHINSKY. A fruit (IR-4003). 14a; upside view. 14b-c; lateral view. 14d; basal view.

Trapa bicerata MIKI: MIKI, 1938, p. 225, pl. 4, fig. 1; fig. 7B.

Material: HAC-4006A-Z and many others.

Locality: Narahara.

Occurrence: Locally very abundant.

Observation: Typical fruits are large and have two upper and two lower horns. The upper horn is thick and conical, and acuminate at apex, being covered with many fine forwardly directed spines. On each side of an upper horn, a marked stipule-like tubercle is seen. The lower horn is thin, and with a glabrous apex. The apical corona is tetragonal in form, with a central tubercle covered with fine hairs directed forwards. The calyx-tube is thick and its surface is ribbed by the decurrence of horn-midribs thickened at its base.

Remarks: Our fruits agree well with the original ones of *Trapa macropoda* describe dy MIKI in all features. *Trapa macropoda* is distinct in all features from other *Trapa* species summarized by MIKI (1952).

Trapa maximowiczii KORSHINSKY

Pl. 9, figs. 17-20; Text-fig. 14a-d

Explanation of Plate 9

Fig. 1. *Picea* cf. *maximowiczii* REGEL; a detached cone (HAC-2004), ×2.

Figs. 2-3. *Pinus fujiii* (YASUI) MIKI; detached cones (Fig. 2; HAC-2003, Fig. 3; HAC-2002), ×2.

Figs. 4-6. *Metasequoia* cf. *glyptostroboides* HU and CHENG; detached cones (HAC-2001B-D), ×2.

Figs. 7-9. *Juglans cinerea* LINNÉ var. *megacinerea* MIKI; Fig. 7; surface view, Fig. 8; inner view, Fig. 9; inner view of a deformed valve (Figs. 7-8; HAC-4001, Fig. 9; HAC-4005B), ×1.

Fig. 10. *Alnus* cf. *japonica* SIEBOLD and ZUCCARINI; surface view of a female-spike (IR-4001A), ×2.

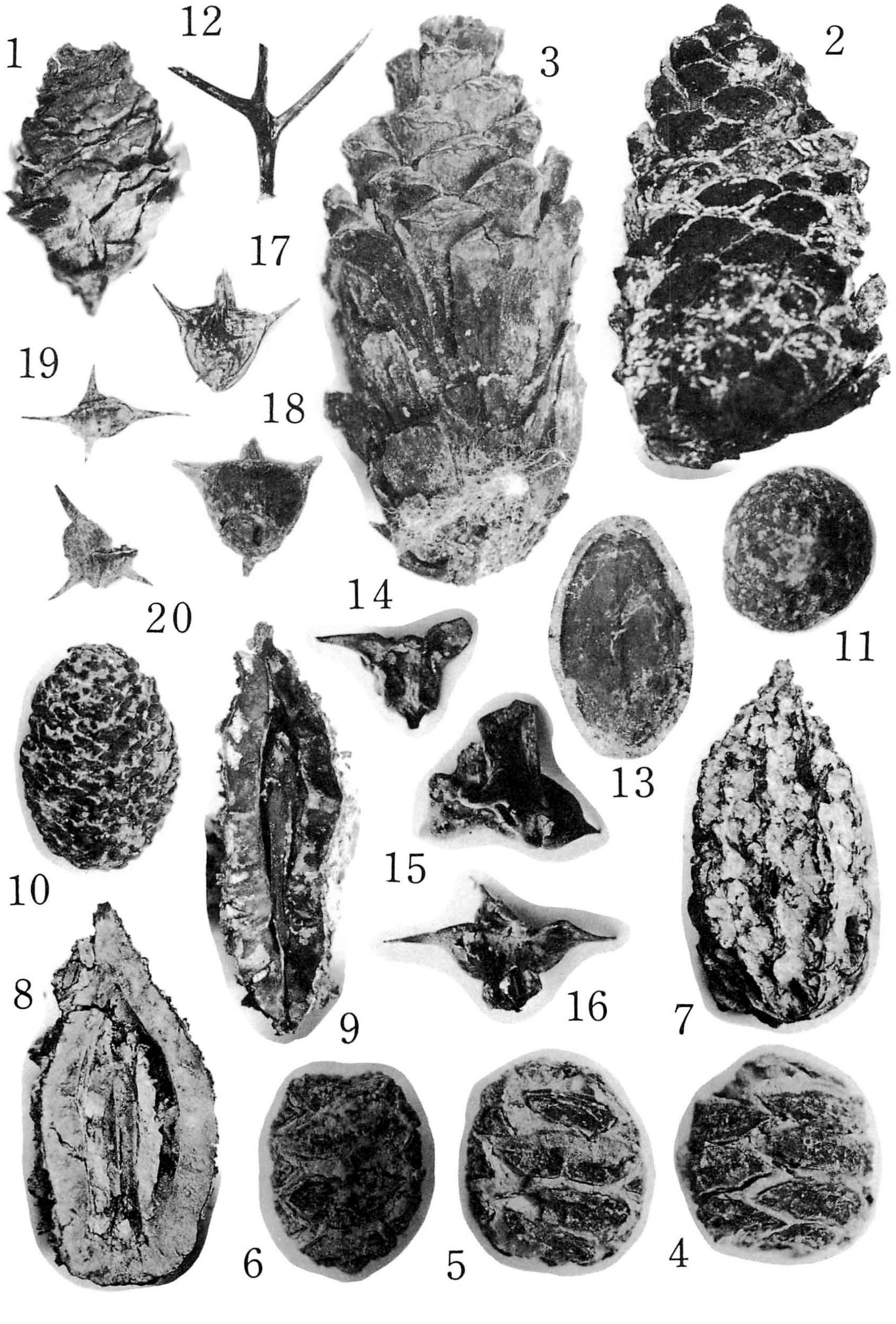
Fig. 11. *Quercus* sp.; surface view of a detached cuple (HAC-4012), ×2.

Fig. 12. *Gleditsia* cf. *japonica* MIQUEL; a deformed spiny branch (HAC-4015), ×1.

Fig. 13. *Buxus microphylla* SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON; a detached leaf (HAC-4101), ×2.

Figs. 14-16. *Trapa macropoda* MIKI; fruits. Fig. 14; lateral view, Fig. 15; basal view, Fig. 16; upside view (HAC-4006B-D), ×1.

Figs. 17-20. *Trcpa maximowiczii* KORSHINSKY; fruits. Figs. 17-18, 20; lateral view, Fig. 19; upside view (IR-4003A-D), ×2.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Trapa maximowiczii KORSHINSKY: MIKI, 1952, p. 16, figs. 9A-S.

Material: IR-4003A-D and others.
Localities: Narahara and Sasai.
Occurrence: Rather rare.
Observation: The fruits are small and triangular in side-view as shown in Text-fig. 14b. The two upper horns are long and slender. The upper horn is longer than the lower one and directed forwards and has many fine spines directed backwards on its apical part. The lower horns are directed downwards and are without spines. The tubercles are four in number, small, more or less obscure, and distributed around the equatorial part of calyx tube. The central protuberance is tube-like, with forwardly directed hairs on the limb. The caryx tube is smooth, and the scar of peduncle is ring-like but obscurely preserved.

Remarks: *Trapa maximowiczii* resembles living *T. incisa* SIEBOLD and ZUCCARINI (or *T. natans* LINNÉ var. *incisa* MAKINO), but it is distinguished from *T. incisa* by the existence of ring-like scar of peduncle and tube-like protuberance.

References

BROWN, R. W. (1962): *Paleogene flora of the Rocky Mountains and Great Plains.* 119 pp., 69 pls. Geol. Surv. Prof. Paper 375, Washington.

CHANEY, R. W. (1951): A revision of fossil *Sequoia* and *Taxodium* in Western North America based on the recent discovery of *Metasequoia*. *Trans. Amer. Phil. Soc.*, vol. 40, pt. 3, p. 171-263, incl. pls. 1-12.

CHANDRASEKHARAM, A. (1974): Megafossil flora from the Genesee locality, Alberta, Canada. *Palaeontographica*, Abt. B, Bd. 147 (1-3), p. 1-41, pls. 1-22.

CHRISTOPHEL, D. C. (1976): Fossil floras of the Smoky Tower locality, Alberta, Canada. *Ibid.*, Bd. 157 (1-4), p. 1-43, pls. 1-17.

DILCHER, D. L. (1974): Approaches to the identification of Angiosperm leaf remains. *Bot. Rev.*, vol. 40, no. 1, p. 1-157.

ENDO, S. (1933): The American white walunt or butternut, *Juglans cinerea* L., from the Upper Pliocene of Japan. *Journ. Washington Acad. Sci.*, vol. 23, no. 6, p. 305-308.

—— (1934a): Two new localities of fossil *Juglans cinerea* L. *Journ. Geol. Soc. Tokyo*, vol. 41, no. 485, p. 61-66, pl. 3 (in Japanese).

—— (1934b): Extinct plants in the latest geological age of Japanese Islands. *Ibid.*, no. 489, p. 373-376 (in Japanese).

—— (1934c): The butternut (*Juglans cinerea* L.) from the Upper Pliocene. *Jap. Journ. Geol. Geogr.*, vol. 11, nos. 3-4, p. 345-347, pls. 42-43.

—— (1954): Notes on the Cainozoic plants of West Asia (3-6). *Kumamoto Journ. Sci.*, ser. B, no. 4, p. 1-9, pls. 1-4.

FUJIMOTO, H. (1932): *Geology of Kwanto District, 4th Edit.* 290 pp. Chukokan, Tokyo (in Japanese).

—— (1968): Geology in the vicinity of Hachioji City. *Trans. Educ. Inst., Private Sch. Japan*, no. 3, p. 1-10, 2 figs. (in Japanese).

FUJIMOTO, H., JUEN, S. and HATORI, K. (1961): *Geology of the Tama Hill.* 23 pp., 6 pls. Educ. Comm. Tokyo (in Japanese).

FUKUDA, O. and TAKANO, T. (1951): Geology of the Azuyama Hill. *Journ. Geol. Soc. Japan*, vol. 57, no. 674, p. 459-472 (in Japanese).

HATUSIMA, S. (1942): A revision of the Asiatic *Buxus*. *Journ. Dep. Agric., Kyushu Imp. Univ.*, vol. 6, no. 6, p. 261-342, pls. 16-27.

HAYASAKA, I. (1926): Fossil walnuts from Hanamaki, Iwate Prefecture. *Journ. Geogr. Soc. Tokyo*, vol. 38, no. 444, p. 55-65, pl. 5 (in Japanese).

HUZIOKA, K. (1952): The explanation of Neogene fossils in the northern Japan. 21. Plant fossils (5). *Cenozoic Research (Shinseidainokenkyu)*, no. 14, p. 260-264 (in Japanese).

KAMEI, S. *et al.* (Kinki Group) (1969): *Quaternary System of Kinki District. In* 'Quaternary System of Japan' by Research Group on Quaternary of Japan, p. 331-354. *Assoc. Geol. Collab. Japan*, Mon. 15, 435 pp. (in Japanese).

KIMURA, T. *et al.* (Narahara plant-bed research group) (1967): Preliminary notes on the Neogene gymnospermous erect stumps and associated flora at the river-bed of Kita-Asakawa, Hachioji City, Tokyo. *Journ. Geol. Soc. Japan*, vol. 73, no. 9, p. 441-442 (in Japanese).

KOKAWA, S. (1955): Plant and insect fossils found in the Mikasayama Area, Nara Prefecture. *Ibid.*, vol. 61, no. 714, p. 93-102, pls. 1-2 (in Japanese).

KRYSHTOFOVICH, A.N. (1915): The butternut (*Juglans cinerea* L.) from freshwater deposits of the province of Yokoutsk. *Mém. Com. Géol.*, N.S., Livr. 124, p. 1-32.

MIKI, S. (1933): On the Pleistocene flora in Prov. Yamashiro, with the description of 3 new species and 1 new variety. *Bot. Mag.* (Tokyo), vol. 47, no. 561, p. 619-631, pl. 1.

—— (1936): Plant fossils from *Stegodon* and *Elephas* beds near Akashi. *Chikyu*, vol. 26, no. 3, p. 155-190 (in Japanese).

—— (1937): Ditto. *Jap. Journ. Bot.*, vol. 8, no. 4, p. 303-341, pls. 8-9.

—— (1938): On the change of flora of Japan since the Upper Pliocene and the floral composition at the present. *Ibid.*, vol. 9, no. 2, p. 213-251, pls. 3-4.

—— (1939): On the remains of *Pinus trifolia* n. sp. in the Upper Tertiary from Central Honshu in Japan. *Bot. Mag.* (Tokyo), vol. 53, no. 630, p. 239-247, pl. 4.

—— (1941): On the change of flora in Eastern Asia since Tertiary Period (1). The clay or lignite beds flora in Japan with special reference to the *Pinus trifolia* beds in Central Hondo. *Jap. Journ. Bot.*, vol. 11, p. 237-303, pls. 4-7.

—— (1948): Floral remains of Kinki and adjacent districts since the Pliocene, with description of 8 new species. *Sci. Rep., Osaka Sec. Teacher's Coll.*, no. 2, p. 105-144, incl. pls. 1-5 (in Japanese with English description of 8 new species).

—— (1950a): A study on the floral remains in Japan since the Pliocene. *Sci. Rep., Osaka Lib. Arts Univ.*, no. 1, p. 69-116 (in Japanese).

—— (1950b): Taxodiaceae of Japan, with special reference to its remains. *Journ. Inst. Polytechn., Osaka City Univ.*, ser. D, vol. 1, p. 1-15.

—— (1952): *Trapa* of Japan with special reference to its remains. *Ibid.*, vol. 3, p. 1-30, pls. 1-2.

—— (1953): *On Metasequoia. fossil and living.* 142 pp., incl. 10 pls. Kyoto (in Japanese).

—— (1955): Nut remains of Juglandaceae in Japan. *Journ. Inst. Polytechn., Osaka City Univ.*, ser. D, vol. 6, p. 131-144, pls. 1-3.

—— (1956): Remains of *Pinus koraiensis* S. et Z. and associated remains in Japan. *Bot. Mag.* (Tokyo), vol. 69, nos. 820-821 (Ogura Comm. Numb., pt. 1), p. 447-454, pl. 13.

—— (1957): Pinaceae of Japan, with special reference to its remains. *Journ. Inst. Polytechn., Osaka City Univ.*, ser. D, vol. 8, p. 221-272, pls. 1-10.

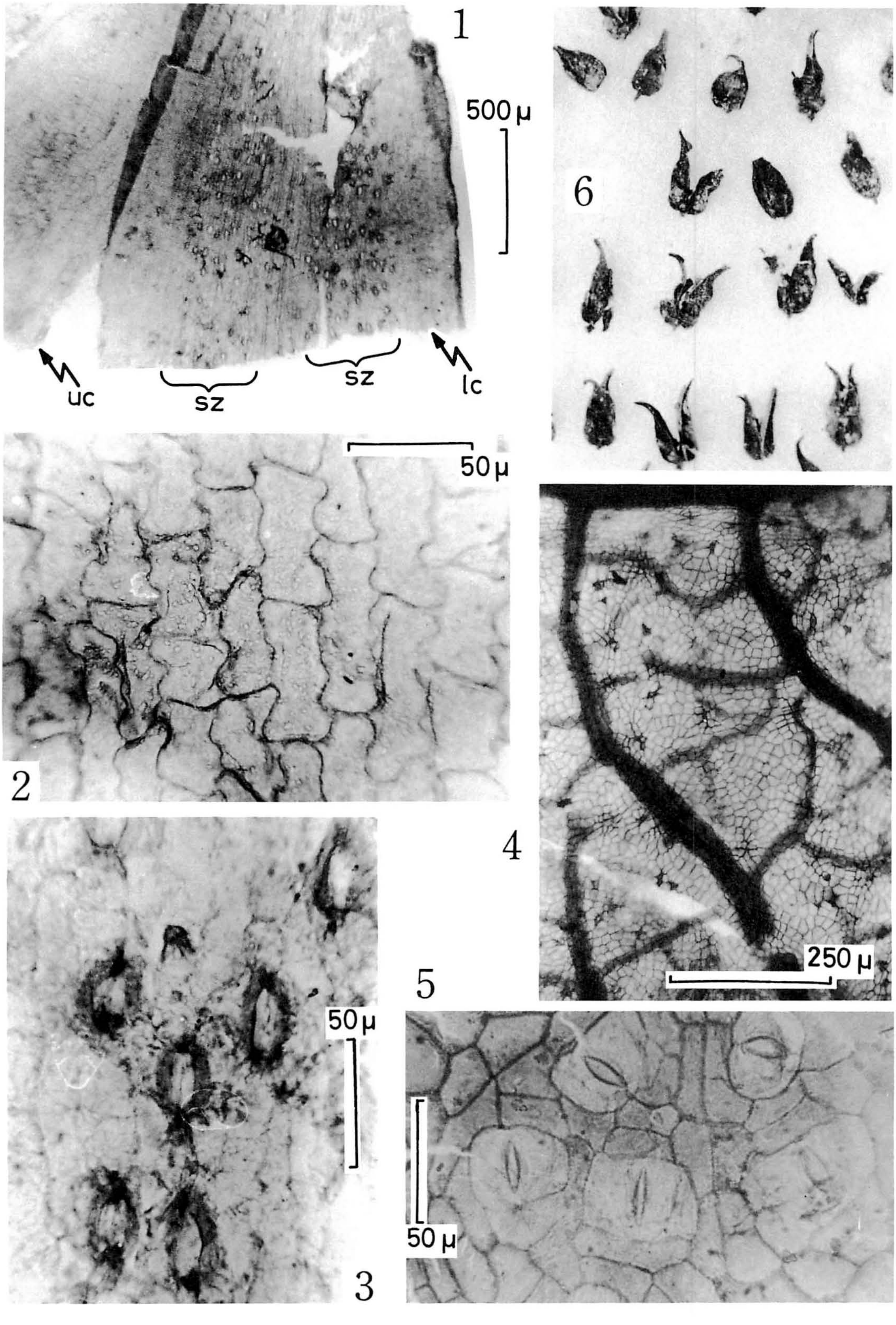
NIREI, H. (1969a): Early Pleistocene flora of Kanazawa region, Ishikawa Prefecture,

Explanation of Plate 10

Figs. 1-3. *Metasequoia* cf. *glyptostroboides* HU and CHENG.
Fig. 1; both upper (uc) and lower (lc) cuticles prepared from the apical part of a leaf (slide no. IR-2104A), sz; stomate zone. Fig. 2; upper cuticle enlarged from Fig. 1. Fig. 3; lower cuticle (a part of stomate zone) enlarged from Fig. 1.

Figs. 4-5. *Salix* cf. *integra* THUNBERG. Fig. 4; upper cuticle and the venation of high ordered nerves (slide no. IR-4101). Fig. 5; lower cuticle (slide no. IR-4148).

Fig. 6. *Salix* sp.; detached capsules (IR-4002), ×2.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Central Japan, with special reference to the evolution of *Juglans*. *Journ. Geosci., Osaka City Univ.*, vol. 12, art. 2, p. 7-25, incl. pls. 1-3.

—— (1969b): On the Utatsuyama formation around Kanazawa City, Central Japan. *Journ. Geol. Soc. Japan*, vol. 75, no. 9, p. 471-484 (in Japanese).

—— (1975): A classification of fossil walnuts from Japan. *Journ. Geosci., Osaka City Univ.*, vol. 19, art. 2, p. 31-63, incl. pls. 1-3.

OKUTSU, H. (1955): On the stratigraphy and paleobotany of the Cenozoic plant beds of the Sendai Area. *Sci. Rep., Tohoku Univ.*, sec. ser., vol. 26, p. 1-114, pls. 1-8.

ONISHI, H. (1941): *Juglans cinerea* LINNÉ and *Cervus* cf. *yesoensis* HEUDE from the vicinity of Hachioji City, Tokyo Prefecture. *Journ. Geol. Soc. Japan*, vol. 47, no. 566, p. 474-476 (in Japanese).

OTUKA, Y. (1932): Geology of Tama Hill, Part 1. *Ibid.*, vol. 39, no. 469, p. 641-655 (in Japanese).

SCHLOEMER-JÄGER, A. (1958): Alttertiäre Pflanzen aus Flözen der Brögger-Halbinsel Spitzbergens. *Palaeontographica*, Abt. B, Bd. 104, p. 39-103, pls. 1-14.

SCHWEITZER, H. J. (1974): Die 'Tertiären' Koniferen Spitzbergens. *Palaeontographica*, Abt. B, Bd. 149 (1-4), p. 1-111, pls. 1-20.

SHIMAKURA, M. (1934): Notes on fossil wood, III. *Journ. Geol. Soc. Japan*, vol. 41, no. 484, p. 9-19 (in Japanese).

—— (1935): Fossil *Juglans cinerea* L. occurring in Kanagawa Prefecture. *Ibid.*, vol. 42, no. 496, p. 45-47 (in Japanese).

—— (1936): Notes on fossil wood, IV. *Ibid.*, vol. 43, no. 512, p. 269-296 (in Japanese).

TAKAHASHI, K. (1954): Zur fossilen Flora aus der Oya-Formation von Kiushiu, Japan. *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, no. 1, p. 47-67, pls. 1-8.

TANAI, T. (1961): Neogene floral change in Japan. *Journ. Fac. Sci., Hokkaido Univ.*, ser. 4, vol. 11, no. 2, p. 119-398, pls. 1-32.

TANAI, T. and ONOE, T. (1959): A Miocene flora from the Northern part of the Joban Coal Field, Japan. *Bull. Geol. Surv. Japan*, vol. 10, no. 4, p. 261-286, pls. 1-7.

—— and —— (1961): A Mio-Pliocene flora from the Ningyo-toge area on the border between Tottori and Okayama Prefectures, Japan. *Rep. Geol. Surv. Japan*, no. 187, p. 1-63, pls. 1-18.

TOKUNAGA, S., GOHARA, Y. and KUWANO, Y. (1949): Geology of Tama Hills in the western vicinity of Tokyo. *Misc. Rep. Res. Inst. Nat. Resour.*, no. 14, p. 43-60 (in Japanese).

UEMURA, K. (1979): Leaf compressions of *Buxus* from the Upper Miocene of Japan. *Bull. Natn. Sci. Mus.* (Tokyo), *ser. C*, vol. 5, no. 1, p. 1-8, pls. 1-2.

YASUI, K. (1928): Studies on the structure of lignite, brown coal, and bituminous coal in Japan. *Journ. Fac. Sci., Imp. Univ. Tokyo*, sec. 3, vol. 1, p. 381-468, pls. 9-23.

Akashi 明石, Azuyama 阿須山, Bushi 仏子, Hachioji 八王子, Hirayama 平山, Irumagawa 入間川, Kinki 近畿, Kita-Asakawa 北浅川, Kwanto 関東, Miura 三浦, Narahara 楢原, Osaka 大阪, Oyabe 大矢部, Sasai 笹井, Tama 多摩

南関東の多摩および阿須山丘陵の植物化石：多摩丘陵に分布する三浦層群下位の大矢部層，およびこれとほぼ同時代と考えられる阿須山丘陵の仏子層から，つぎの諸属に属する植物化石を得たので，記載・報告する；*Picea, Pinus, Metaseqnoia, Salix, Juglans, Alnus, Quercus, Gleditsia, Buxus, Paliurus ?, Ilex* および *Trapa.*

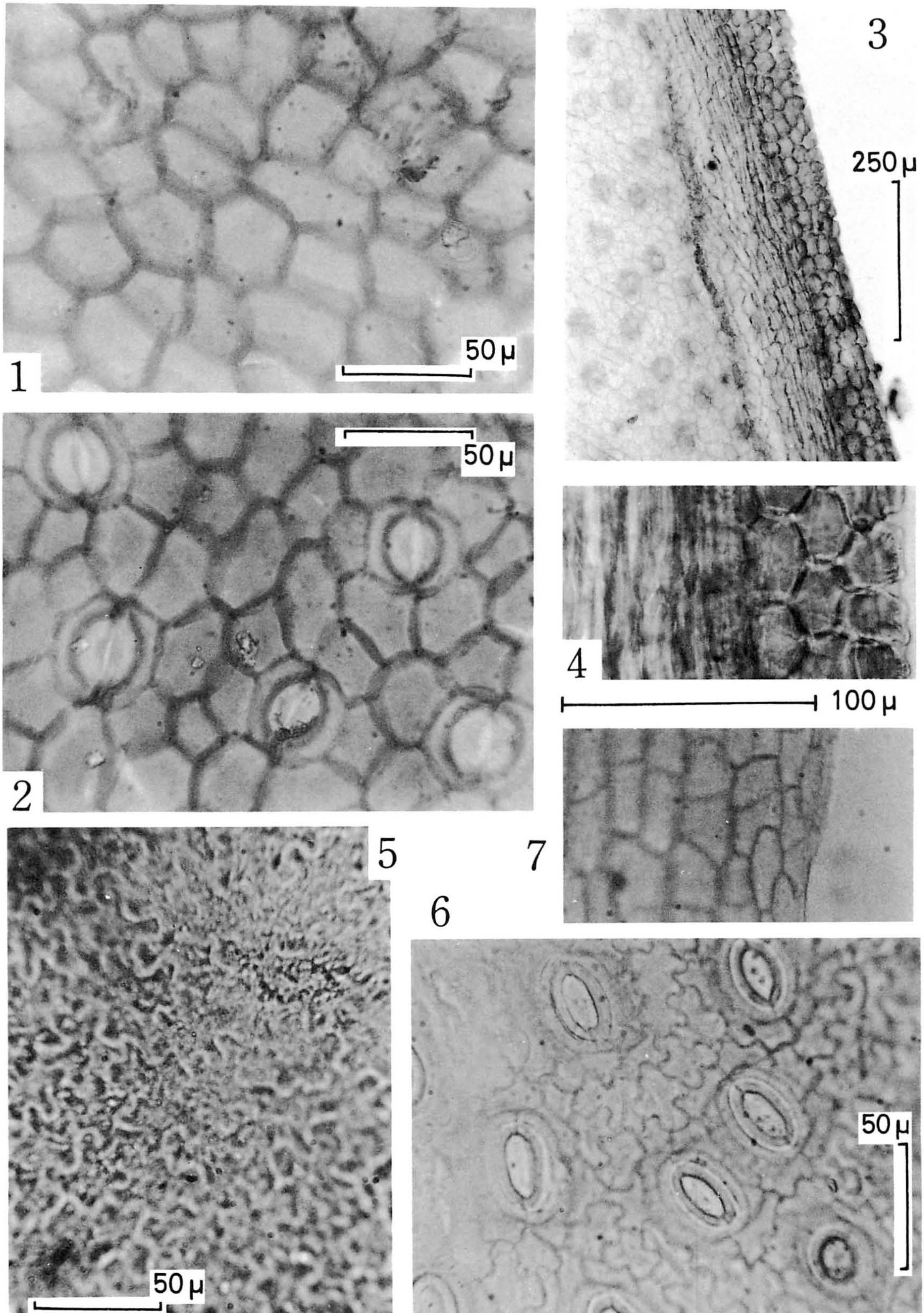
この両層の植物群は，組成から判断して，棚井敏雅のいう明石型植物群と一致するものと考えられ，近畿地方の大阪層群下位の植物群に対比される。したがって，この植物群の時代は，鮮新―洪積世と判断される。

木村達明・吉山　寛・大花民子

Explanation of Plate 11

Figs. 1-4. *Buxus microphylla* SIEBOLD and ZUCCARINI var. *japonica* REHDER and WILSON. Fig. 1; upper cuticle. Fig. 2; lower cuticle. Fig. 3; marginal part of a leaf (lower cuticle); from right to left, marginal cells zone without stoma, venous cells zone of intra-marginal nerve and ordinary lower cuticle with stomata. Fig. 4; marginal and venous cells zone enlarged from Fig. 3. All prepared from HAC-4102 (slide no. HAC-4102S).

Figs. 5-7. *Ilex cornuta* LINDLEY and PAXTON. Fig. 5; upper cuticle. Fig. 6; lower cuticle. Fig. 7; marginal cells zone without stoma. All prepared from IR-4004 (slide no. IR-4004S).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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 122, pp. 105-121, pls. 12-14, July 15, 1981

730. NEOGENE MICROFOSSILS OF CHLOROPHYCEAE, PRASINOPHYCEAE AND ACRITARCHS FROM NIIGATA, CENTRAL JAPAN*

KIYOSHI TAKAHASHI and KAZUMI MATSUOKA

Department of Geology, Nagasaki University, Nagasaki 852

Abstract. This is a report on the microplankton of the Chlorophyceae, Prasinophyceae and acritarchs from the Neogene sediments in the Niigata district, central Japan. Two species and two subspecies of the Chlorophyceae, one of the Parsinophyceae and eight of the acritarchs belonging to eight form genera are described and illustrated: *Tytthodiscus densiporosus* n. sp. subsp. *densiporosus* n. subsp., *T. densiporosus* n. sp. subsp. *minus* n. subsp., *Palambages* sp., *Pterospermella pterina* n. sp., *Leiosphaeridia* cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT, *L. grandiformis* n. sp., *L. minuscula* n. sp., *Lancettopsis* sp., *Micrhystridium ariakense* TAKAHASHI, *Baltisphaeridium sphaeroides* n. sp., *B. nakajoense* n. sp. and *Cymatiosphaera pulchella* n. sp. Morphological characteristics of the genera *Tytthodiscus*, *Crassosphaera*, *Pleurozonaria*, *Tasmanites* and *Leiosphaeridia* are discussed. According to PARKE et al. (1978), the fossil genus *Pterospermella* is a synonym of the recent genus *Pterosperma*, but the authors are inclined to accept the genus *Pterospermella*.

These phytomicroplankton described in this paper are important for a basic knowledge of their stratigraphic and geographic distribution in the Neogene formations around the Sea of Japan.

Introduction

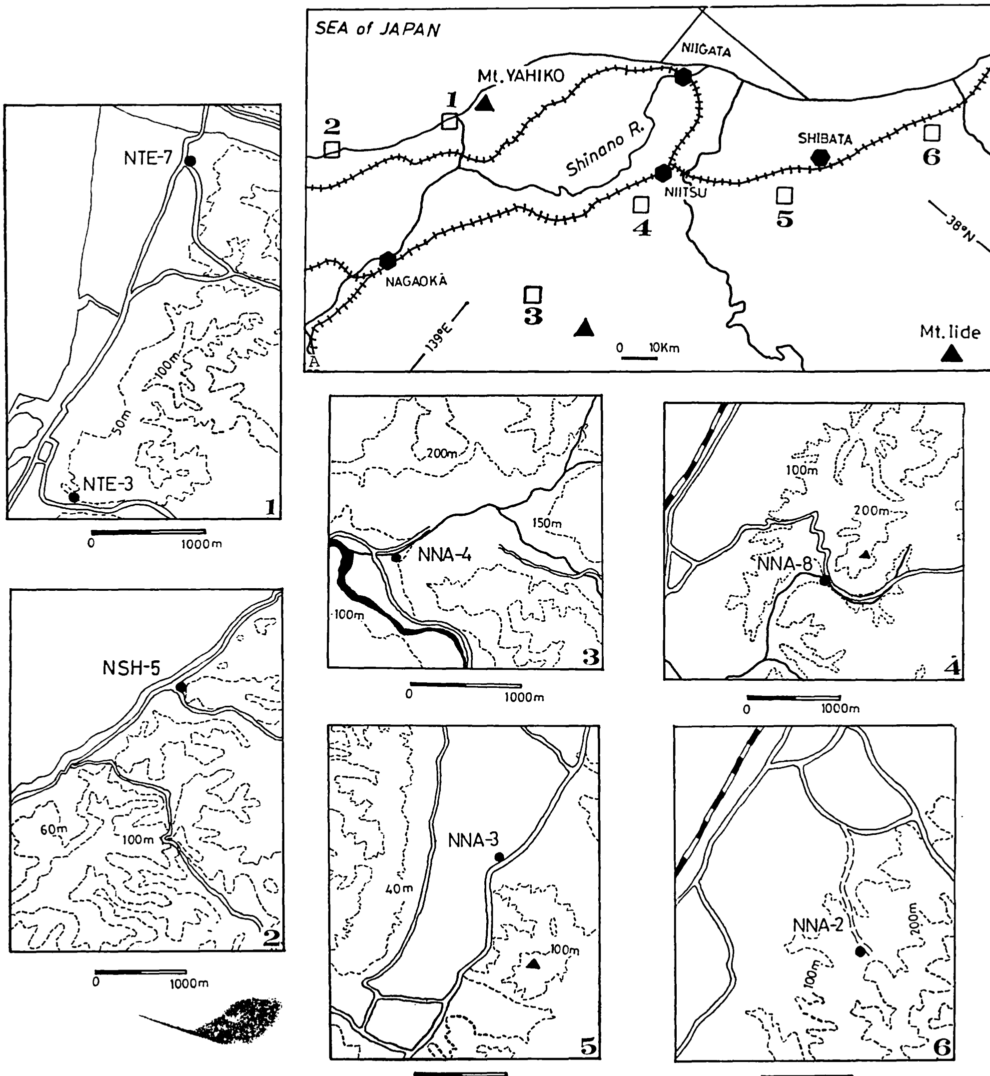
The junior author, K. MATSUOKA, engaged in research on dinoflagellates from the Neogene and Quaternary sediments in the Niigata district, central Japan. At that time, he made many slides and found many dinoflagellates and other phytomicroplankton.

The senior, K. TAKAHASHI, has examined these slides and recognized many specimens of the Chlorophyceae, Prasinophyceae and acritarchs. These phytomicroplankton are described and illustrated in detail.

This is the first report on the phytomicroplankton of the Chlorophyceae (*Tytthodiscus* and *Palambages*), Prasinophyceae (*Pterospermella*) and acritarchs recovered from the Neogene sediments in the Niigata district. Morphological characteristics of the genera *Tytthodiscus*, *Crassosphaera*, *Pleurozonaria*, *Tasmanites* and *Leiosphaeridia*, which have morphologically similar feature, are discussed.

According to PARKE et al. (1978), the genus *Pterospermella* EISENACK 1972 is a synonym of the recent genus *Pterosperma*, but the authors are inclined to use the genus *Pterospermella* as a form or organ genus in the family Pterospermataceae of the class Prasinophyceae.

* Received September 22, 1980; read June 29, 1980 at Kochi.



Text-fig. 1. Sample location map. A: Index map; 1: Teradomari area, 2: Ishiji area, 3: Imogawa area, 4: Tedoriga-fuchi area, 5: Shibata area, 6: Nakajo area

The phytomicroplankton examined in this paper should offer the first basic data for research of the biostratigraphical and geographical distribution in the Neogene sediments around the Sea of Japan.

Geological setting and sample locations

The Neogene and Quaternary marine sediments are widely distributed in the Niigata sedimentary basin, central Honshu. They are divided into following six forma-

Table 1. Location and lithology of the Neogene Formations in the Niigata district.

Sample	Formation	Lithology	Location
NNA-2	Nanatani Formation	dark grey hard mudstone	2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Pref.
NNA-3	Nanatani Formation	dark grey hard mudstone	1 km west of Matsuoka, Shibata City, Niigata Pref.
NNA-4	Nanatani Formation	dark grey hard mudstone	Minami-Imogawa, Shitada-mura, Minami-Kanbara-gun, Niigata Pref.
NNA-8	Nanatani Formation	dark grey hard mudstone	Tetoriga-fuchi, Tagami-cho, Minami-Kanbara-gun, Niigata Pref.
NTE-3	Teradomari Formation	dark grey laminated siltstone	Teradomari, Teradomari-cho, Santo-gun, Niigata Pref.
NTE-7	Teradomari Formation	black hard laminated siltstone	Shiraiwa,Teradomari-cho, Santo-gun, Niigata Pref.
NSH-5	Shiiya Formation	dark grey hard mudstone	Ishiji, Nishiyama-cho, Kariwa-gun, Niigata Pref.

tions; the Nanatani, Teradomari, Shiiya, Nishiyama, Haizume and Oguni Formations in ascending order. There have been many geological and palaeontological studies for the purpose of petroleum exploration. Recently biostratigraphical investigations in this district have been much promoted by several micropalaeontologists, MAIYA (1978) on planktonic foraminifera, NAKASEKO & SUGANO (1973) on radiolaria, NISHIDA (1976) and SATO & TOMIZAWA (1979) on calcareous nannoplankton, KOIZUMI (1977) on diatom and YAMANOI (1978) on pollen grains. According to these results, the geological ages of these formations are as follows.

Nanatani Formation……Early to Middle Miocene

Teradomari Formation………Middle to Late Miocene

Shiiya Formation………Late Miocene to Early Pliocene

Nishiyama Formation……Late Pliocene to Early Pleistocene

Haizume Formation (including Wanatsu and Tsukayama Formations)……Early to Middle Pleistocene

Oguni Formation……Middle Pleistocene

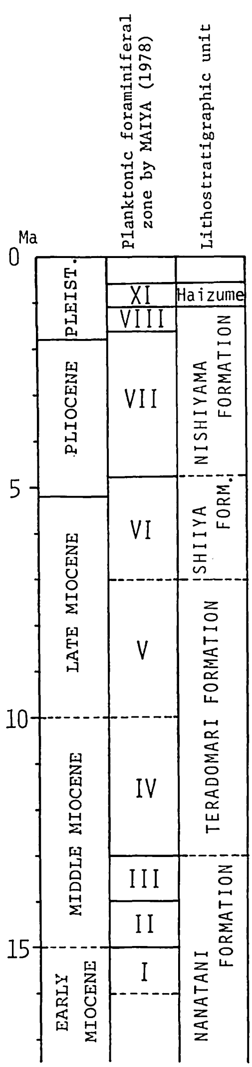
Location and lithology of the samples examined are listed in Table 1.

Preparation method

Preparation for palynological analysis was carried out by mechanical and chemical methods [treatment by 10% KOH, maceration by mixed acid solution of HCl, HNO_3 and H_2O (1 : 1 : 1), and then by 30 % HF, centrifuging and washing in pure water after each step].

The residual material contains pollen grains, spores, dinoflagellate cysts, algae, acritarchs etc. These phytomicrofossils were mounted in glycerine jelly on slides. Cover-slips on the slides were sealed with nail enamel.

All slides are kept in the palynological collection of the Department of Geology, Nagasaki University.



Text-fig. 2. Stratigraphy and geologic ages of the Neogene formations in the Niigata district.

Tytthodiscus, *Crassosphaera*, *Pleurozonaria*, *Tasmanites* and *Leiosphaeridia*

The genus *Tytthodiscus* was first described by NOREM (1955) from Tertiary marine sediments in the San Joaquin Valley of California. According to him, this genus is disk-shaped organisms, whose wall is thick and consists of elongated hexagonal segments which are solid or provided with small central tubule which may extend all or part-way through the wall. Wall surface is smooth or uniformly granular. Size ranges from 25 to 200 microns in diameter. However, his description is not enough to distinguish the genus *Tytthodiscus* from the genera *Pleurozonaria* O. WETZEL 1933 and *Crassosphaera* COOKSON & MANUM 1960. Accordingly, MÄDLER (1963) emended the NOREM's description and defined as follows; the genus *Tytthodiscus* is spherical and often disk-shaped organisms whose wall is composed of a relatively thick, very resistant, radially arranged, fibrous to prismatic crystallite, whose inner side consists of a poroid layer and outer surface is membranous. Canal pores are completely penetrated from the inner side to outer surface.

Our present specimens which have a poroid layer with a honeycomb-like or reticulate pattern on the inner side of the wall belong surely to the genus *Tytthodiscus*. Especially, the specimens with eroded wall show clearly the honeycomb-like or reticulate pattern. The larger form, *Tytthodiscus densiporosus* n. sp. subsp. *densiporosus* n. subsp., and the smaller form, *T. densiporosus* n. sp. subsp. *minus* n. subsp., are described in this paper.

Already described species of *Tytthodiscus*.

Tytthodiscus californiensis NOREM 1955 (Pliocene to Eocene in the Wasco oil field, California; 80-200 μm)

T. mecsekensis NAGY 1965 (Neogene—Middle Miocene, Mecsek Mountains, Hungary; 63 μm)

T. schandelahensis (THIERGART 1944) MÄDLER 1963 (Lower Jurassic, Posidonian shales, Germany; 90-180 μm)

T. vanderhammeni SOLE DE PORTA 1959 (Upper Oligocene, North Colombia)

COOKSON and MANUM (1960) described and illustrated the new genus *Crassosphaera* with originally spherical body, of which wall is ornamented with prominences or projections which may or may not form a regular pattern and is perforated by minute radial tubules which are composed of a tubule to each prominence.

They stated that the main differences between *Crassosphaera* and *Tytthodiscus* are the shape of the body and the construction of the wall, and that a more important difference is the segmented wall of *Tytthodiscus* as against the unsegmented wall of *Crassosphaera*.

According to them, the genus *Crassosphaera* differs from the other genera *Tytthodiscus* and *Tasmanites* in having the wall ornamented with prominences or projections, of which center is perforated by radial branched or unbranched canal pores.

Previously described species of *Crassosphaera*.

Crassosphaera concinna COOKSON and MANUM 1960 (Neocomian, Komewu, Papua, New Guinea; Lower Tertiary, Forlandsundet, Vestspitsbergen; Komewu specimen 65-85 μm, Spitsbergen specimen 106 μm)

C. cooksoni KRIVÁN-HUTTER 1963 (Palaeogene, Dorog Basin, Hungary)

C. digitata COOKSON and MANUM 1960 (Neocomian, Komewu Papua; 65 μm)

C. hexagonalis WALL 1965 (Lower Jurassic, Jet Rock, Yorkshire; 60-150 μm)

C. manumi KRIVÁN-HUTTER 1963 (Palaeogene, Dorog Basin, Hungary)

C. minor KRIVÁN-HUTTER 1963 (Palaeogene, Dorog Basin, Hungary)

C. stellulata COOKSON and MANUM 1960 (Eocene, Rottnest Island, Western Australia; 67-99 μm)

C. stellulata COOKSON and MANUM var. *minor* KEDVES 1962 (Sparnacian, Eocene, Dudar, Hungary)

According to O. WETZEL (1933, p. 29) and MÄDLER (1963, p. 331-332), the genus *Pleurozonaria* is spherical and disk-shaped organisms, whose wall consists of a relatively thick and very resistant organic material, yellow to brown in colour, columnar or hexagonal elements (poroids) which are visible to be a honeycomb-like pattern and penetrated by many canal pores which may pass completely through the wall. The canal pores are branched or unbranched. A pylome may be presented, but not yet be firmly proved.

MÄDLER (1963) accepted *Crassosphaera* as a junior synonym of *Pleurozonaria*. However, MURI and SARJEANT (1971) preferred to maintain as separate entities, pending reconsideration of the taxonomy of the whole group.

Pleurozonaria chondrota (NOREM 1955) MÄDLER 1963 (Miocene, Freeman-Jewett and Vedder members, Temblor Formation, California; 25-140 μm)

P. distans MÄDLER 1963 (Lower Jurassic, Goslar; 80-84 μm)

P. diversipora MÄDLER 1963 (Lower Jurassic, Goslar; 130-132 μm)

P. globulus WETZEL 1933 (Cretaceous, Krywonogi, Poland; 40-48 μm)

P. macropora (EISENACK 1967) MÄDLER 1963 (Lower Jurassic, Goslar; 75-105 μm)

P. media MÄDLER 1963 (Lower Jurassic, Posidonian shales; 100-130 μm)

P. polyporosa MÄDLER 1963 (Lower Jurassic, Goslar and Doernten; 120-170 μm)

P. spongiosa MÄDLER 1963 (Lower Jurassic, boringhole Lingen 330; 90-100 μm)

P. suevica (EISENACK 1957) MÄDLER 1963 (Lower Jurassic, Fukoiden-Kalk, Balingen; Posidonian shales; 70-102 μm)

P. wetzeli MÄDLER 1963 (Lower Jurassic, Goslar; 110-120 μm)

According to EISENACK (1958, p. 2), the genus *Tasmanites* NEWTON 1875 is spherical and disk-shaped organisms, whose wall consists of a relatively thick and very resistant organic material, yellow to dark red-brown in colour and penetrated by pores which may pass completely or partially through it. A large circular opening, the pylome, may be rarely present in some specimens. Younger specimens possess always a thin wall and no pore. Accordingly, these younger specimens are not distinguishable from the genus *Leiosphaeridia*.

Sporangites huronensis (= *Tasmanites huronensis*) was first described by DAWSON as a sporangium from the Devonian black shales at Kettle Point, Lake Huron (EISENACK 1958, 1963; WALL 1962). NEWTON (1875) newly described such forms as *Tasmanites punctatus* from Australia and Tasmania. EISENACK (1938) established the genus *Leiosphaera* for similar spherical cysts from the Baltic and other European Silurian and named them *Leiosphaera solida* (=*Bion solidum* EISENACK 1931). KRÄUSEL immediately informed him that DAWSON already described such forms as *Sporangites huronensis* and later KRÄUSEL corrected many mistaken interpretation described by DAWSON and renamed *Sporangites huronensis* as *Leiosphaera huronensis*. SCHOPF et al. (1944) criticized the ambiguous term *Sporangites* and proposed that the genus *Tasmanites* is valid. With references of the description of DAWSON, NEWTON, KRÄUSEL and SCHOPF et al. and by a microscopic examination of the DAWSON's preparates, which were sent by KRÄUSEL, EISENACK (1958) recognized that the spherical organisms described as *Leiosphaera solida* (=*L. huronensis*) identify with the DAWSON's forms and they accord with *Tasmanites punctatus* described by NEWTON (1875). Further, he stated that the genus *Leiosphaera* must be replaced by the genus *Tasmanites* for the organisms suitable to the NEWTON's definition and he proposed the new genus *Leiosphaeridia* for *Leiosphaera* which was given for the organisms unsuited to the DAWSON's and NEWTON's description.

According to the WALL's account (1962), OSTENFELD described two spherical green algae, *Pachysphaera pelagica* n. gen. et sp. and *Halosphaera minor* n. sp., which were collected at the time of Greenlandic and Icelandic sailing by WANDEL, KUNDSEN and OSTENFELD. They appear to be comparable with leiospheres. Prior to this, OSTENFELD determined that *Pachysphaera* possesses a thick wall penetrated by pores with a separation of about 3 μm and *Halosphaera minor* OSTENFELD differs from *Pachysphaera* in having thin wall and no pore.

Pachysphaera pelagica is closely similar to several species of *Tasmanites* in size, shape and wall thickness. The wall structure is generally identical with that of *Tasmanites* and the cell wall often possesses a straight or weakly arched suture. No pylome of *Pachysphaera* was observed.

WALL (1962) concluded that the genus *Tasmanites* is to be regarded as a fossil green alga with biological affinities to the present marine organism *Pachysphaera pelagica* OSTENFELD and other species of *Pachysphaera*, and *Pachysphaera* is regarded as a living representative of the fossil genus *Tasmanites*.

Previously described species of *Tasmanites*.

Tasmanites alaskansis (WHITE 1929) WINSLOW 1962 (Lower Cretaceous, Northern Alaska; Upper Devonian — Lower Mississippian, Ohio)

T. asperum BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

T. avelinoi SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. balteus FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. balticus EISENACK 1963 (Ordovician, Baltic region)

T. bobroeskae WAZYNSKA 1967 (Sinian and Cambrian, boreholes, Bialowieza, Poland)

T. chicagoensis (REINSCH 1884) SCHOPF, WILSON and BENTALL 1944 (Devonian, Kettle Point, Ontario; Chicago Boulder Clay; Permian, Tasmania)

T. corrugatus FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. decorus BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

T. derbyi SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. distinctus BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

T. eisenacki UTECH 1962 (Middle Buntsandstein, Lower Triassic, Hildesheim Forest, Germany)

T. erichsenii SOMMER and VAN BOEKEL 1963 (Devonian, Para, Brazil)

T. erraticus EISENACK 1963 (Gotlandian, Wenlockian—Lower Ludlow, North Germany)

T. euzebioi SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. ferruginus BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

T. fissura FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. fulgidus FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. globulus (O. WETZEL 1933) MORGENROTH 1966 (Cretaceous, Krywonogi, Poland; Lower Eocene, North Germany)

T. hartti SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. huronensis (DAWSON 1871) SCHOPF, WILSON and BENTALL 1944 emend. WINSLOW 1962 (Devonian, Kettle Point, Lake Huron, Canada; Upper Devonian—Lower Mississippian, Ohio)

T. kaljoi TIMOFEYEV 1966 (Late Precambrian, Cambrian, Ordovician, Silurian, Poland; USSR)

T. lamegoi SOMMER 1956 (Devonian, Para, Brazil)

T. mangaseus TIMOFEYEV 1966 (Late Precambrian, Cambrian, Ordovician, Silurian, Poland; USSR)

T. martinssoni EISENACK 1958 (Ordovician, Baltic region)

T. medius (EISENACK 1931) EISENACK 1958 (Silurian, Baltic region)

T. minutus EISENACK 1965 (Ordovician, Baltic region)

T. mourai SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. newtoni WALL 1962 (Liassic, Lower Jurassic, Great Britain)

T. normi EISENACK 1962 (Lower Carboniferous, Woodford Formation, Oklahoma)

T. plicatilis BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

T. porosus FELIX 1956 (Neogene—Upper Miocene, Louisiana)

T. primigenus (NAUMOVA 1950) DOWNIE and SARJEANT 1964 (Upper Devonian, Russian platform)

T. punctatus NEWTON 1875 (Permian, La Trobe, Tasmania)

T. roxoi SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. salustianoi SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. sinuosus WINSLOW 1962 (Upper Devonian—Lower Mississippian, Ohio)

T. sommeri WINSLOW 1962 (Upper Devonian—Lower Mississippian, Ohio)

T. tanbaensis TAKAHASHI and YAO 1969 (Permian, Tanba Belt, Japan)

T. tapajonensis SOMMER 1953 emend. SOMMER and VAN BOEKEL 1966 (Devonian, Para, Brazil)

T. tardus EISENACK 1958 (Liassic, Lower Jurassic, Germany)

T. tenellus VOLKOVA 1968* (Lower Palaeozoic, USSR)

T. trematus EISENACK 1962 (*Expansns* Limestone, Ordovician, Öland, Baltic region)

T. usitatus FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. validus FELIX 1965 (Neogene—Upper Miocene, Louisiana)

T. vanboekeli MUIR and SARJEANT 1971 (Devonian, Para, Brazil)

T. variabilis VOLKOVA 1968* (Lower Palaeozoic, USSR)

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* See MUIR and SARJEANT (1971).

T. verrucosus EISENACK 1962 (Ostsee Limestone, South Finland)
T. winslowae BONEHAM 1967 (Devonian, Michigan, Ohio, Ontario)

EISENACK (1958) established the fossil genus *Leiosphaeridia* with thin wall and no wall pore. WALL (1962) stated that the thin-walled organism *Halosphaera minor* OSTENFELD can be compared with members of the fossil genus *Leiosphaeridia* EISENACK 1958. Further, he concluded: "a similar relationship is envisaged between members of the genus *Leiosphaeridia* EISENACK 1958 and the recent green alga *Halosphaera minor* OSTENFELD 1899 and other green algae with a thicker but almost entirely non-punctate wall and the genus *Leiosphaeridia* probably includes forms which are unrelated to the Chlorophyceae as well. The evidence connecting *Pachysphaera* with *Tasmanites* (and *Halosphaera minor* with *Leiosphaeridia*) is sufficient to justify classification of the fossil genera in the Chlorophyceae."

Taxonomy of *Pterosperma* and *Pterospermella*

EISENACK (1972) established a new genus *Pterospermella* with the type species *P. aureolata* (COOKSON and EISENACK 1958) EISENACK 1972 for species of *Pterospermopsis* W. WETZEL 1952, because of insufficient description of its type species *Pterospermopsis danica* W. WETZEL and vagueness of its systematic position. Upon this reason, he (1972) transferred all species of *Pterospermopsis* except *P. danica* W. WETZEL to the genus *Pterospermella*. Further, he emphasized that the genus *Pterospermella* is closely similar to the recent genus *Pterosperma* POUCHET and provided a new family Pterospermellaceae including the genera *Pterospermella* EISENACK (type genus), *Cymatiosphaera* O. WETZEL 1933 emend. DEFLANDRE 1954, *Dictyotidium* EISENACK 1955 emend. STAPLIN 1961, *Pterosphaeridia* MÄDLER 1963, *Cymatiosphaeropsis* MÄDLER 1963, *Duvernaysphaera* STAPLIN 1961 and *Enigmasphaera* COOKSON and EISENACK 1971. However, he stated that transference of these genera to the family Pterospermataceae which includes the recent genera *Pachysphaera* OSTENFELD and *Pterosperma* POUCHET depends on result of the future investigation on the mode of the opening and the construction of the wall.

PARKE et al. (1978) reported in detail on the life-history of the recent genus *Pterosperma* POUCHET with the two phases, motile and non-motile. Information concerning the non-motile phycoma phase of members of the Pterospermataceae is very important for the fossil genus *Pterospermella*. By PARKE et al. the phycomata of seven species of *Pterosperma* have been produced and grown in culture from the motile cells liberated from phycomata obtained from the sea. They proposed *Pterosperma rotundum* POUCHET as the type species of the genus *Pterosperma* POUCHET 1893 and indicated the genera *Pterosphaera, Cysta, Trochiscia, Pterocystis, Pterococcus, Cymatiosphaera, Pterospermopsis* and *Pterospermella* as the synonymy of the genus *Pterosperma* in the phycoma phase.

According to their opinion, the fossil genus *Pterospermella* is the synonym of the recent genus *Pterosperma*. However, the authors are of opinion that the fossil genus *Pterospermella* EISENACK 1972 should be placed independently in the family Pterospermataceae, because this genus always indicates its phycoma phase and never its motile phase.

Descriptive palynology

Class Chlorophyceae KÜTZING 1843

Order Tasmanales MÄDLER 1963

Family Tasmanaceae SOMMER 1956 emend. MÄDLER 1963

Genus *Tytthodiscus* NOREM 1955 emend. MÄDLER 1963

Type species: *Tytthodiscus californiensis* NOREM 1955.

Tytthodiscus densiporosus n. sp.

Pl. 12, Figs. 1-15; Pl. 13, Figs. 1-2

Description: Body spherical to ellipsoidal, 54-174 μm in diameter. Wall 1.5-9 μm thick, penetrated by distinct canal-pores; canal-pores always appear to pass from inner wall side with a poroid layer of a honeycomb-like or network pattern to the outer surface. The canal-pores are uniformly and densely distributed 1-3 μm apart, 1 μm± wide on the inner wall surface, with appreciable taper. The specimen with eroded wall shows clearly the honeycomb-like pattern on the inner wall side (see Pl. 12, Fig. 3). Body surface smooth, characterized by very small pores visible at high magnification, with occational minor folding; surface often has weathered or corroded appearence and sometimes rounded pyrites (?) originated from the organic body of the specimens (see Pl. 12, Figs. 5 and 6). Colour yellow to orange in transmitted light.

Remarks: The genus *Tytthodiscus* is similar to the genera *Crassosphaera*, *Pleurozonaria* and *Tasmanites*, but differs from three latters in having the poroid layer with the honeycomb-like or network pattern on the inner wall side.

Tytthodiscus densiporosus n. sp. subsp. *densiporosus* n. subsp.

Pl. 12, Figs. 1-9

Description: Body spherical to ellipsoidal, 96-174 μm×84-147 μm in diameter. Wall 2.5-9 μm thick, penetrated by distinct canal-pores; canal-pores always appear to pass from the inner wall surface to the outer surface. The canal-pores are uniformly and densely distributed 2-3 μm apart, 1 μm± wide on the inner wall surface, with appreciable taper. The inner wall side is composed of a poroid layer ornamented with a honeycomb-like or fine network pattern. Body surface laevigate, characterized by very small pores visible at high magnification, with occasional minor folding; surface often has weathered or corroded appearence and sometimes rounded pyrites (?) originated from the organic body of the specimens (see Pl. 12, Figs. 5 and 6). The corroded specimens show clearly the honeycomb-like or network pattern on the inner wall side (see Pl. 12, Fig. 3). Some specimens show a single straight(?) suture on the wall. Colour yellow to orange in transmitted light.

Holotype: Pl. 12, Fig. 2; 126×120 μm in diameter; wall 4.5 μm thick; canal-pores are uniformly distributed 2.3-3 μm apart, 1 μm± in diameter, with appreciable taper; slide NNA-2-3; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence and range: Abundant; Nanatani, Teradomari and Shiiya Formations, Niigata Prefecture.

Comparison: This new subspecies is easily distinguished from the other Neogene and pre-Neogene specimens by its size, wall thickness and densely arranged wall canal-pores. This is closely similar to *Tytthodiscus schandelahensis* (THIERGART 1944) MÄDLER 1963 from the Lower Jurassic Posidonian shales, Germany and *Tytthodiscus mecsekensis* NAGY 1965 from the Middle Miocene grey clayey marl, Mecsek Mountains, Hungary, but the former differs from *T. schandelahensis* in having much thinner wall and *T. mecsekensis* in having much larger size.

Tytthodiscus densiporosus n. sp. subsp. *minus* n. subsp.

Pl. 12, Figs. 10-15; Pl. 13, Figs. 1-2

Description: Body spherical to ellipsoidal or oval, 54-85.5 μm×43.5-81 μm in diameter. Wall 1.5-5.4 μm thick, penetrated by canal-pores, which always appear to pass from the inner wall surface, but only partly reach the outer wall surface. The pores are densely distributed 1-2 μm apart, less than 1 μm in width on the inner wall surface. The inner wall side consists of the poroid layer ornamented with the weak network pattern, sometimes this network pattern is not visible. Body surface smooth, characterized by very small penetrated pores only partly visible at high magnification through a microscope, with occasional minor folding; surface sometimes is cleft. Colour yellow to orange in transmitted light.

Holotype: Pl. 12, Fig. 15; 75×73.5 μm in diameter; wall 4.2 μm thick; pores are uniformly distributed 2 μm± apart, less than 1 μm in diameter; slide NNA-4-5; Nanatani Formation (Early-Middle Miocene), Minami-Imogawa, Shitada-mura, Minami-Kanbara-gun, Niigata Prefecture.

Occurrence: Few from the locality Nakajo and abundant from the locality Minami-Imogawa; Nanatani Formation (Early-Middle Miocene).

Remarks: The present subspecies is the smallest *Tytthodiscus*. This is much smaller than *T. densiporosus densiporosus*.

Order Chlorococcales MARCHAND orth. mut. et emend. OASCHER 1915

Family Hydrodictyaceae (GRAY) DUMORTIER orth. mut. COHN 1880

Genus *Palambages* O. WETZEL 1961

Type species: *Palambages morulosa* O. WETZEL 1961.

Palambages sp.

Pl. 14, Fig. 15

Description: The colony is spherical to subspherical. The individual cells 14-19 μm×12-13 μm in diameter. The wall in profile smooth, thin, 0.8 μm thick. The number of cells per colony is about 20 in optical section (on one surface). Colony size 45.9×42 μm in diameter.

Occurrence: Very rare; Nanatani Formation (Early-Middle Miocene), Chujo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Comparison: Only one specimen was found. This is superficially similar to *Palambages morulosa* O. WETZEL from the Baltic Senonian and Danian chalk and flint and *Palambages* sp. (TAKAKASHI and SHIMONO, 1980) from the Pleistocene Minoshirotori lake deposits, Gifu Prefecture, but differs from *Palambages morulosa* and *Palambages* sp. in having much smaller colony and single cells.

Class Prasinophyceae CHRISTENSEN 1962

Order Pterospermatales

Family Pterospermataceae OSTENFELD 1902

Genus *Pterospermella* EISENACK 1972

Type species: *Pterospermella aureolata* (COOKSON & EISENACK 1958) EISENACK 1972.

Pterospermella pterina n. sp.

Pl. 14, Figs. 1-5.

Description: Central body circular to oval in polar view, provided with a relatively large undulating and radially folded equatorial wing. The radial folds of wing somewhat spine-like, about 13-16 in number. The equatorial wing is diaphanous. Contour of wing circular to elliptical. Surface of shell smooth. Overall diameter 150-228 μm × 135-207 μm. Diameter of central body 72-126 μm × 60-114 μm. Thickness of central body wall 3 μm or less. Breadth of wing 25-66 μm.

Holotype: Pl. 14, fig. 3; overall diameter 228×168 μm; diameter of central body 126×102 μm; breadth of wing 30-54 μm; radial folds 14 in number; slide NNA-2-3; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajocho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Few, Nanatani Formation, Nakajo-cho; rare, Teradomari Formation, Teradomari-cho, Santo-gun, Niigata Prefecture.

Comparison: *Pterospermella australiensis* (DEFLANDRE & COOKSON, 1955) EISENACK from the Lower Cretaceous, Onepah Station, New South Wales, is much smaller than the present specimens. *P. pterina* is closely similar to *P. barbarae* (GORKA 1963) EISENACK from the Upper Cretaceous (Campanian) strata, Magnuszew, Poland and from the Eocene and Oligocene strata, Meckelfeld near Hamburg, Germany, but the former is different from the latter in having smooth surface of the central body and equatorial wing (ala). *P. helientoides* (DE CONINCK 1968) EISENACK from the Ypresian, Sondage de Kallo near Antwerpen, Belgium, possesses much thicker wall of the central body.

Incertae sedis

Group Acritarcha EVITT 1963

Subgroup Sphaeromorphitae DOWNIE, EVITT & SARJEANT 1963

Genus *Leiosphaeridia* EISENACK 1958 emend. DOWNIE & SARJEANT 1963

Type species: *Leiosphaeridia baltica* EISENACK 1958.

Leiosphaeridia cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT

Pl. 13, Figs. 3-6

1961. *Leiosphaeridium fastigatirugosum* STAPLIN, Palaeontology, vol. 4, pt. 3, p. 408, pl. 50, fig. 9.

1963. *Leiosphaeridia fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT, Palaeontology, vol. 6. pt. 1, p. 95.

Description: Body originally spherical to ellipsoidal, 102-180 μm×78-105 μm in diameter. Wall smooth (laevigate), very thin. Canals or pores not present on cell wall and no evidence of pylome. Body outline irregular, always conspicuously crumpled and plicated with the numerous folds being characteristic of the species.

Occurrence: Few, Nanatani Formation (Early-Middle Miocene); rare, Shiiya Formation (Late Miocene to Early Pliocene).

Remarks: The present specimens are very closely similar to *Leiosphaeridia fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT from the Upper Devonian of Alberta, Canada and possess both spherical and ellipsoidal forms, although the latter has only spherical form. Accordingly, the authors describe them as *L.* cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT.

Comparison: This species is very closely similar to *Leiosphaeridia* sp. (PICHLER, 1971, p. 325-326, pl. 3, figs. 42, 46) from the Devonian Upper Junkerberg Formation of the Eifel Synclinorium, W-

Germany and the authors accept that the latter may be the same species as *L. fastigatirugosa.*

Leiosphaeridia grandiformis n. sp.

Pl. 13, Figs. 7-10

Description: Body originally spherical to ellipsoidal, 121-165 μm×109.5-156 μm in diameter. Wall finely rugulate to verrucate or rarely smooth, 5.4-7.5 μm thick (sometimes 2 μm±). Canals or pores not present on cell wall and no evidence of pylome. Body surface irregular, always conspicuously folded.

Holotype: Pl. 13, Fig. 9; 141×120 μm in diameter; wall finely rugulate, 7.5 μm thick; more or less folded; slide NNA-2-2; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Common, Nanatani Formation, Nakajo-cho.

Comparison: This new species is apparently different from *Leiosphaeridia* cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT in having much thicker wall and finely rugulate to verrucate ornamentation on wall surface and from *Leiosphaeridia minuscula* n. sp. in having larger size, thicker wall and finely rugulate to verrucate ornamentation.

Leiosphaeridia minuscula n. sp.

Pl. 13, Figs. 12-13

Description: Body originally spherical to ellipsoidal, 52-93 μm×50-75 μm in diameter. Wall somewhat laevigate to chagrenate, 3.5-4.5 μm thick. Canals or pore not present on cell wall and no evidence of pylome. Body surface somewhat irregular, always crumpled with some folds.

Holotype: Pl. 13, Fig. 12; 93×72 μm in diameter; wall somewhat laevigate, 4.5 μm thick, with some folds; slide NNA-2-2; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Few, Nanatani Formation, Nakajo-cho, Niigata Prefecture.

Comparison: The present specimens are superficially similar to *Leiosphaeridia* (*al. Protoleiosphaeridium*) *orbiculata* (STAPLIN) DOWNIE & SARJEANT (STAPLIN, 1961, p. 405, pl. 48, fig. 12; DOWNIE & SARJEANT, 1963, p. 95; HEMER & NYGREEN, 1967, p. 187, pl. 3, figs. 5-6), but the former differs from the latter in having larger size. They are similar to *L. pusila* MÄDLER (1963, p. 348, pl. 25, figs. 10-13) from the Posidonian shales, borehole Etzel 24, Glockenberg near Doernten, brickyard Osterfeld near Goslar, W. Germany, but the former is different from the latter in having thicker wall.

Genus *Lancettopsis* MÄDLER 1963

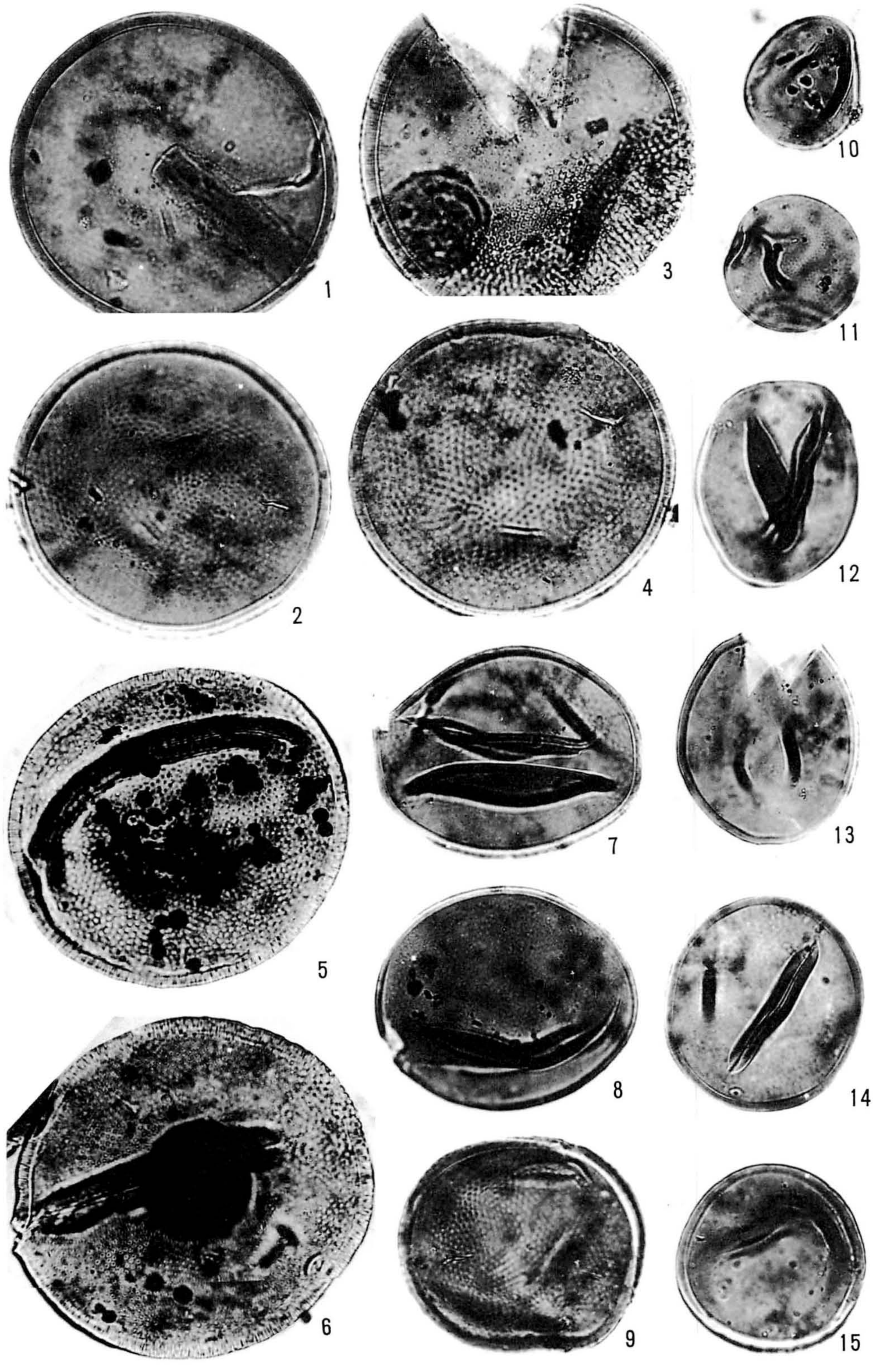
Type species: *Lancettopsis lanceolata* MÄDLER 1963.

Explanation of Plate 12

(All figures magnified ×400)

Figs. 1-9. *Tytthodiscus densiporosus* n. sp. subsp. *densiporosus* n. subsp.
Figs. 1, 8: slide NNA-2-2; figs. 2, 7, 9: slide NNA-2-3; fig. 3: slide NNA-3-4; fig. 4: slide NNA-2-5; fig. 5: slide NTE-3-1; fig. 6: slide NTE-3-2; fig. 2: holotype.

Figs. 10-15. *Tytthodiscus densiporosus* n. sp. subsp. *minus* n. subsp.
Fig. 10: slide NNA-2-2; figs. 11, 15: slide NNA-4-5; fig. 12: slide NNA-4-1; figs. 13, 14: slide NNA-4-2; fig. 15: holotype.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Lancettopsis sp.

Pl. 13, Fig. 11

Description: Body lanceolate, 124.2 μm long, 35.4 μm wide. Wall smooth (laevigate), very thin. Canals or pores not present on cell wall and no evidence of pylome. Body outline irregular, always conspicuously crumpled and plicated with the numerous folds.

Occurrence: Very rare, Nanatani Formation (Early-Middle Miocene), Nakajo-cho, Niigata Prefecture.

Remarks: The genus *Lancettopsis* was established by MÄDLER (1963, p. 351-353). He (1963) distinguished the genera *Lancettopsis* and *Campenia* from the genus *Leiosphaeridia*. *Lancettopsis lanceolata* MÄDLER (1963, p. 353, pl. 28, figs. 4-8; pl. 29, figs. 1-3), which is the type species of the genus *Lancettopsis*, is only one species of this genus and possesses much larger shell than the present specimen.

Subgroup Acanthomorphitae DOWNIE, EVITT & SARJEANT 1963

Genus *Micrhystridium* DEFLANDRE 1937 emend. DOWNIE & SARJEANT 1963

Type species: *Micrhystridium inconspicuum* (DEFLANDRE 1935) DEFLANDRE 1937.

Micrhystridium ariakense TAKAHASHI

Pl. 14, Figs. 6a-b, 7

1971. *Micrhystridium ariakense* TAKAHASHI, Trans. Proc. Palaeont. Soc. Japan, N. S. No. 81, p. 19-20, pl. 4, figs. 1-10

Dimensions: Test diameter 18×16.5 μm (Figs. 6a-b) to 19×14 μm (Fig. 7); test wall thin; length of spines less than 1 μm.

Occurrence: Rare, Nanatani Formation (Early-Middle Miocene), Nakajo-cho and Minami-Imogawa, Shitada-mura, Niigata Prefecture.

Remarks: Hitherto, one of the authors, TAKAHASHI, described this species from the Pleistocene lower formation of the Ariake Sea area, west Kyushu (TAKAHASHI, 1971) and from the Miocene formations in the Yeoungill Bay district, Korea (TAKAHASHI and KIM, 1979).

Genus *Baltisphaeridium* EISENACK 1958 emend. DOWNIE & SARJEANT 1963

Type species: *Baltisphaeridium longispinosum* (EISENACK 1931) EISENACK 1958.

Baltisphaeridium sphaeroides n. sp.

Pl. 14, Figs. 8-9

Description: Test spherical to ellipsoidal, 45-50 μm × 42-43.5 μm in diameter. Wall smooth, 1.8-2 μm thick, spines very fine, straight, 1-1.5 μm long; number of spines numerous. Wall surface always more or less folded.

Holotype: Pl. 14, Fig. 9; 45×42 μm in diameter; wall smooth, 1.8 μm thick; spines very fine, straight, numerous, 1-1.2 μm long; slide NNA-2-3; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Rare, Nakajo-cho, Nanatani Formation.

Comparison: This new species differs apparently from *Micrhystridium koraiense* TAKAHASHI (TAKAHASHI and KIM, 1979, p. 65, pl. 25, figs. 10-11, 14-15) and *Baltisphaeridium kimurae* TAKAHASHI (TAKAHASHI and KIM, 1979, p. 65-66, pl. 25, figs. 35-36) from the Yonil Group, Korea in having much larger size and very fine spines.

Baltisphaeridium nakajoense n. sp.

Pl. 14, Figs. 10-12

Description: Test originally spherical, 28.5-41.8 μm×24-35 μm in diameter. Wall relatively thin, 1-1.6 μm thick; spines small, echinate or conical sometimes with truncated or rounded tips, 0.8-1.5 μm high; number of spines numerous. Wall surface always conspicuously folded.

Holotype: Pl. 14, Figs. 11a-; b30.4×27.3 μm in diameter; wall 1.6 μm thick, spines numerous, straight, echinate or conical, with truncated or rounded tips; slide NNA-2-3; Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Few, Nakajo-cho, Nanatani Formation.

Comparison: The present specimens are superficially similar to *Baltisphaeridium aquaticum* TAKAHASHI and SHIMONO (1980, p. 10-11, pl. 1, figs. 1-9; pl. 2, figs. 1-6) from the Pleistocene Minoshirotori lake deposits, Gifu Prefecture, Japan, but the former differs from the latter in having much smaller size, thinner wall and much shorter spines.

Subgroup Herkomorphitae DOWNIE, EVITT & SARJEANT 1963

Genus *Cymatiosphaera* O. WETZEL 1933 emend. DEFLANDRE 1954

Type species: *Cymatiosphaera radiata* O. WETZEL 1933.

Cymatiosphaera pulchella n. sp.

Pl. 14, Figs. 13-14

Description: Shell spherical with 15-16 polygonal fields, 67.5 μm×60-63 μm in diameter. Wall relatively thin, less than 2.5 μm thick. The width of the polygonal fields varies from 21 to 27 μm. The spines, muri of the networks, are relatively slender and shorter, 1.8-2.7 μm high. The networks connect with the straight line.

Holotype: Pl. 14, Figs. 14a-b; shell size 67.5×63 μm in diameter; width of the networks 21-27 μm; muri 1.8-2.7 μm high; slide NNA-2-5; Nanatani Formation (Early-Middle Miocene), 2 km SSE of Sekizawa, Nakajo-cho, Kita-Kanbara-gun, Niigata Prefecture.

Occurrence: Few, Nanatani Formation, Nakajo-cho.

Comparison: This new species is comparable with *Cymatiosphaera globulosa* TAKAHASHI (1964, 1971) from the Oligocene Asagai Formation in the Joban coalfield and from the Pleistocene upper for-

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Explanation of Plate 13

(All figures magnified ×400)

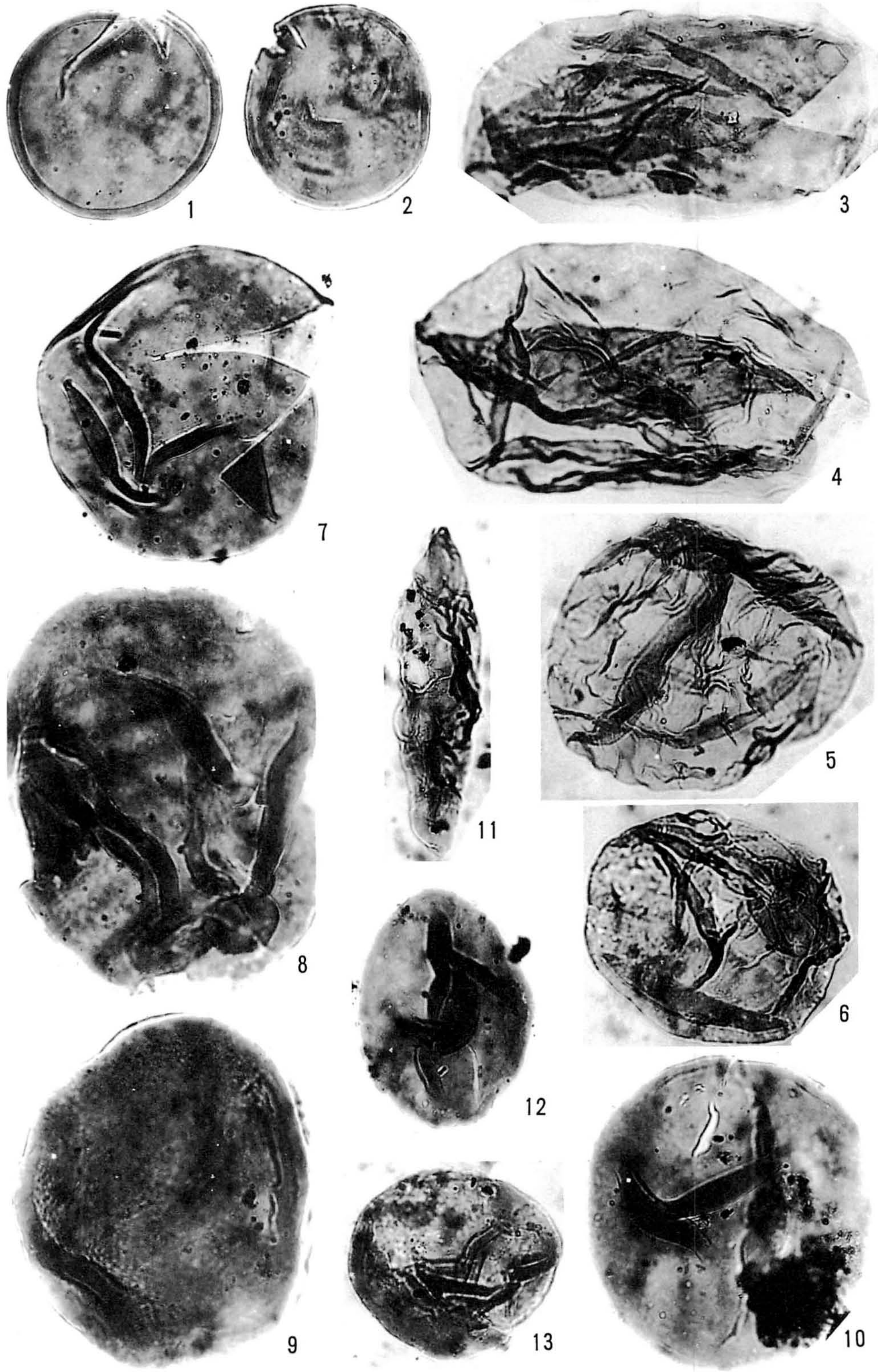
Figs. 1-2. *Tytthodiscus densiporosus* n. sp. subsp. *minus* n. subsp.
Fig. 1: slide NNA-4-2; fig. 2: slide NNA-4-5.

Figs. 3-6. *Leiosphaeridia* cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT.
Fig. 3: slide NNA-4-2; fig. 4: slide NNA-4-1; fig. 5: slide NNA-4-5; fig. 6: slide NSH-5-5.

Figs. 7-10. *Leiosphaeridia grandiformis* n. sp.
Figs. 7, 8, 10: slide NNA-2-3; fig. 9: holotype, slide NNA-2-2.

Fig. 11. *Lancettopsis* sp.
Slide NNA-2-2.

Figs. 12-13. *Leiosphaeridia minuscula* n. sp.
Slide NNA-2-2; fig. 12: holotype.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mation of the Ariake Sea bottom, off the coast of Kojiro, Shimabara Peninsula, but the former differs from the latter in its much larger size and much wider networks.

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References

BONEHAM, R. F. (1967) : Devonian *Tasmanites* from Michigan, Ontario, and northern Ohio. *Pap. Mich. Acad. Sci.*, 52, 163-173, pl. 1, text-fig. 1.

COOKSON, I. C. and MANUM, S. (1960) : On *Crassosphaera*, a new genus of microfossils from Mesozoic and Tertiary deposits. *Nytt Mag. Bot.*, 8, 5-8, pls. 1-2.

DOWNIE, C., EVITT, W. R., and SARJEANT, W. A. S. (1963) : Dinoflagellates, hystrichospheres, and the classification of the acritarchs. *Stanford Univ., puble. Geol. Sci.*, 7, 3, 1-16.

DOWNIE, C. and SARJEANT, W. A. S. (1963) : On the interpretation and status of some hystrichosphere genera. *Palaeontology*, 6, 1, 83-96.

—— and —— (1964) : Bibliography and index of fossil Dinoflagellates and acritarchs. *Mem. Geol. Soc. Amer.*, 94, 1-180.

EISENACK, A. (1938) : Hystrichosphaerideen und verwandte Formen in baltischen Silur. *Z. Geschiebeforsch.*, 14, 1-30, Taf. 1-4, Abb. 1-7.

—— (1958) : *Tasmanites* Newton 1875 und *Leiosphaeridia* N. G. als Gattungen der Hystrichosphaeridea. *Palaeontographica*, A, 110, 1-3, 1-19, Taf. 1-2.

—— (1962) : Mitteilungen über Leiosphären und über das Pylom bei Hystrichosphären. *N. Jb. Geol. Paläont., Abh.*, 114, 1, 58-80, Taf. 2-4, 2 Abb.

—— (1963) : Über einige Arten der Gattung *Tasmanites* NEWTON 1875. *Grana Palynologica*, 4, 2, 203-216, Taf. 1.

—— (1965) : Die Mikrofauna der Ostseekalke. I. Chitinozoen, Hystrichosphären. *N. Jb. Geol. Paläont., Abh.*, 123, 2, 115-148.

—— (1972) : Kritische Bemerkung zur Gattung *Pterospermopsis* (Chlorophyta, Prasinophyceae). *N. Jb. Geol. Paläont., Mh.*, 10, 596-601, 3 Abb.

FELIX, C. J. (1965) : Neogene *Tasmanites* and Leiospheres from Southern Louisiana, U. S. A. *Palaeontology*, 8, 1, 16-26, pls. 5-8.

HEMER, D. O. and NYGREEN, P. W. (1967) : Algae, acritarchs and other microfossils incertae sedis from the Lower Carboniferous of Saudi Arabia. *Micropaleontology*, 13, 2, 183-194, pls. 1-3.

KEDVES, M. (1962) : *Noremia*, a new microfossil genus from the Hungarian Eocene, and systematical and stratigraphical problems about the Crassinosphaeridae. *Acta Miner. Petrogr., Szeged.*, 15, 19-27, pls. 1-2.

KOIZUMI, I. (1977) : Diatom biostratigraphy in the North Pacific region. *Proc. 1st. Inter. Cong. Pacific Neog. Strat.*, 235-254.

KRIVAN-HUTTER, E. (1963) : Microplankton from the Palaeogene of the Dorog Basin I. *Ann. Univ. Sci. bpest. Rolando Eötvös, sec. Geol.*, 6, 71-79, pls.1-6.

MÄDLER, K. (1963) : Die figurierten organischen Bestandteile der Posidonienschiefer. *Beih. Geol. Jb.*, 58, 287-406, 4 Abb., 3 Tab. Taf. 1-16.

MAIYA, S. (1978) : Late Cenozoic planktonic foraminiferal biostratigraphy of the oil-field region of Northeast Japan. *Cenozoic Geol. Japan (Prof. N. Ikebe Mem. Vol.)*, 35-60.

MORGENROTH, P. (1966) : Mikrofossilien und Konkretionen des nordwesteuropäischen Untereozäns. *Palaeontographica*, B, 119, 1-3, 1-53, Taf. 1-11, Tab. 1.

MUIR, M. D. and SARJEANT, W. A. S. (1971) : An annotated bibliography of the Tasmanaceae and of related living forms (Algae: Prasinophyceae). *Microfossiles organiques du Paleozoique, 3 Les Acritarches, C. I. M. P.*, 59-117.

NAGY, E. (1965) : The microplankton occuring in the Neogene of the Mecsek mountains. *Acta Bot. Hung.*, 11, 197-216, pls. 1-6.

NAKASEKO, K. and SUGANO, K. (1973) : Neogene Radiolarian zonation in Japan. *Mem. Geol. Soc. Japan*, 8, 23-34.

NEWTON, E. T. (1875) : On "Tasmanite" and Australian white coal. *Geol. Mag. Ser. 2*, 2, 8, 337-342, pl. 10.

NISHIDA, S. (1976) : Late Cenozoic calcareous nannofossils in the Pacific and the Japan Sea sides. *Circular "Chronology and correlation in the Hokuriku district"*, 52-57.

NOREM, W. L. (1955) : *Tytthodiscus*, a new microfossil genus from the California Tertiary. *Jour. Paleont.*, 29, 4, 694-695, pl. 68.

PARKE, M., BOALCH, G. T., JOWETT, R., and HARBOUR, D. S. (1978) : The genus *Pterosperma* (Prasinophyceae) : species with a single equatorial ala. *J. mar. biol. Ass. U. K.*, 58, 239-276, pls. 1-14.

PILCHER, R. (1971) : Mikrofossilien aus dem Devon der südlichen Eifer Kalkmulden. *Senckenbergiana Lethaea*, 52, 4, 315-357, Taf. 1-6, 8 Abb. 1 Tab.

SATO, T. and TOMOZAWA, A. (1979) : Calcareous nannofossils from Furutsu 1 well in Niigata oil fields and the Pliocene-Pleistocene boundary. *Jour. Jap. Ass. Petrol. Technol.*, 44, 6, 372-376.

SCHOPF, J. M., WILSON, L. R., and BENTALL, R. (1944) : An annotated synopsis of Paleozoic fossil spores and the definition of generic groups. *Illinois State Geol. Surv., Rep. Invest.*, 91, 1-72.

SOMMER, F. W. (1953) : O esporomorfas do fohelho de Barreirinha, Brazil. *Bolm. Div. Geol. Minu., Bras.*, 140, 1-49, text-figs. 1-8.

—— (1956) : South American Paleozoic sporomorphae without haptotype structures. *Micropaleontology*, 2, 2, 175-181, pls. 1-2.

SOMMER, F. W. and BOEKEL, N. M. VAN (1963) : Some new Tasmanaceae from the Devonian of Para. *Anais Acad. Bras. Cienc.*, 35, 1, 61-65.

—— and —— (1966) : Revisao das Tasmanaceae Paleozoicas brasileiras. *Anais Acad. Bras. Cienc.* 38,, 53-65.

STAPLIN, F. L. (1961) : Reef-controlled distribution of Devonian microplankton in Alberta. *Palaeontology*, 4, 3, 392-424, pls. 48-51, text-figs. 1-9.

TAKAHASHI, K. (1964) : Microplankton from the Asagai Formation in the Joban coalfield. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, 54, 201-214, pls. 30-33.

—— (1971) : Microfossils from the Pleistocene sediments of the Ariake Sea area, west Kyushu. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, 81, 11-26, pls. 2-5.

TAKAHASHI, K. and YAO, A. (1969) : Plant

Explanation of Plate 14

Figs. 1-5. *Pterospermella pterina* n. sp.
Fig. 1: slide NNA-2-1, ×200; fig. 2: slide NTE-7-10, ×280; fig. 3: slide NNA-2-3, holotype, ×200; figs. 4, 5: slide NNA-2-2, ×400.

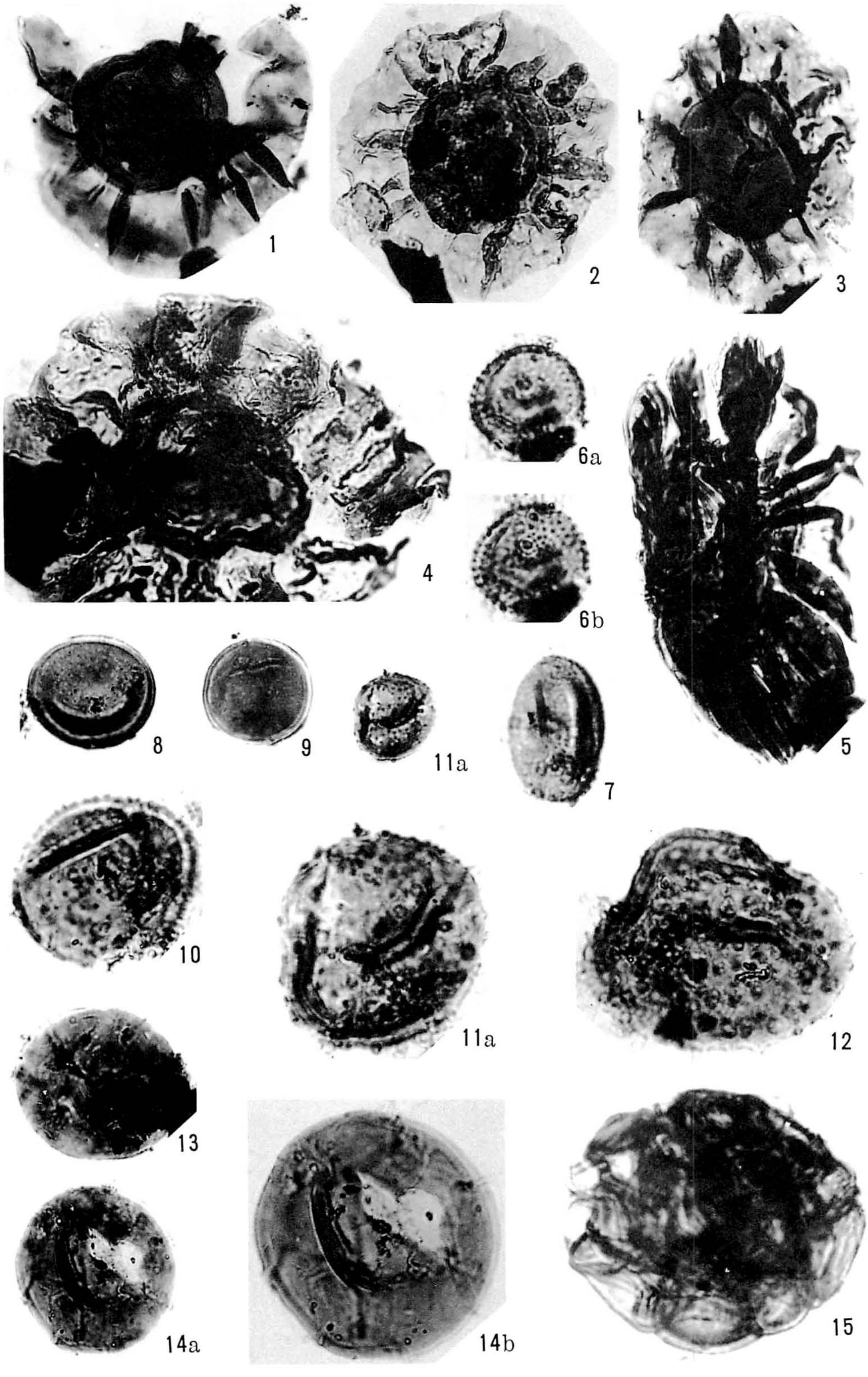
Figs. 6-7. *Micrhystridium ariakense* TAKAHASHI ×1000
Figs. 6a-b: slide NNA-2-3; fig. 7: slide NNA-4-2.

Figs. 8-9. *Baltisphaeridium sphaeroides* n. sp. ×400
Fig. 8: slide NNA-2-2; fig. 9: slide NNA-2-3, holotype.

Figs. 10-12. *Baltisphaeridium nakajoense* n. sp.
Figs. 10, 11a-b: slide NNA-2-3; fig. 10, 11b: ×1000; fig. 11a: ×400; figs. 11a-b: holotype; fig. 12: slide NNA-2-5, ×1000.

Figs. 13-14. *Cymatiosphaera pulchella* n. sp.
Fig. 13: slide NNA-2-1, ×400; figs. 14a-b: slide NNA-2-5, holotype; fig. 14a: ×400; fig. 14b: ×600.

Fig. 15. *Palambages* sp.
Slide NNA-2-5, ×1000.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microfossils from the Permian sandstone in the southern marginal area of the Tanba belt. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, 73, 41-48, pls. 4-6.

TAKAHASHI, K. and KIM, B.K. (1979) : Palynology of the Miocene formations in the Yeoungill Bay district, Korea. *Palaeontographica*, B, 170, 1-3, 10-80, pls. 1-28, 5 text-figs.

TAKAHASHI, K. and SHIMONO, H. (1980) : Phytoplankton from the Minoshirotori lake deposits, Gifu Prefecture. *Bull. Fac. Lib. Arts, Nagasaki Univ., Natural Sci.*, 20, 2, 7-18, pls. 1-2.

TIMOFEYEV, B.V. (1966) : Investigations of ancient microplankton suites. *Acad. Nauk. SSSR, Lab. Geol. Dokembriya*, 1-147.

UTECH, K. (1962) : Über eine *Tasmanites*-Art aus dem mittleren Buntsandstein des Hilsheimer Waldes. *N. Jb. Geol. Paläont., Mh.*, 90-91.

WALL, D. (1962) : Evidence from recent plankton regarding the biological affinites of *Tasmanites* NEWTON, 1875 and *Leiosphaeridia* EISENACK, 1958. *Geol. Mag.*, 99, 4, 353-362, pl. 17, text-figs. 1-2.

—— (1965) : Microplankton, pollen, and spores from the Lower Jurassic in Britain. *Micropaleontogy*, 11, 2, 151-190, pls. 1-9.

WAZYNSKA, H. (1967) : Wstepen badania mikroflorystuczne osadow sinianu i Kambru z obszaru Bialowiezy. *Kwart. Geol.*, 2, 1, 10-19.

WETZEL, O. (1933) : Die in organischen Substanz erhaltenen Mikrofossilien des Baltischen Kreide-Feuersteins mit einem sedimentpetrographischen und stratigraphischen Anhang. *Palaeontographica*, A, 77, 1-3, 147-186; 78, 1-110, Taf. 1-7.

—— (1961) : New microfossils from Baltic Cretaceous flintstones. *Micropaleontology*, 7, 3, 337-350, pls. 1-3.

WETZEL, W. (1952) : Beitrag zur Kenntnis des danzeitlichen Meeresplanktons. *Geol. Jb.*, 66, 381-420.

WINSLOW, M.R. (1962) : Plant spores and other microfossils from Upper Devonian and Lower Mississippian rocks of Ohio. *U.S.G.S. Prof. Paper*, 364, 93 pp., 22 pls.

YAMANOI, T. (1979) : Neogene pollen stratigraphy of the Oga Peninsula, Northeast Honshu, Japan. *Jour. Geol. Soc. Japan*, 84, 2, 69-86.

Ishiji 石地, Kariwa-gun 刈羽郡, Kita-Kanbara-gun 北蒲原郡, Minami-Imogawa 南五百川, Nakajo-cho 中条町, Nanatani 七谷, Niigata 新潟, Nishiyama-cho 西山町, Santo-gun 三島郡, Sekizawa 関沢, Shiiya 椎谷, Shiraiwa 白岩, Shitada-mura 下田村, Tagami-cho 田上町, Teradomari 寺泊, Tetoriga-fuchi 手取ケ淵

中部日本新潟産緑藻綱，プラシノ藻綱，アクリターチの新第三紀微化石：新潟地方の新第三紀層産緑藻綱，プラシノ藻綱およびアクリターチの微小プランクトンに関する報告である。8つの形態属に属する緑藻綱の2種と2亜種，プラシノ藻綱の1種およびアクリターチの8種が記載・図示された。それらは *Tytthodiscus densiporosus* n. sp. subsp. *densiporosus* n. subsp., *T. densiporosus* n. sp. subsp. *minus* n. subsp., *Palambages* sp., *Pterospermella pterina* n. sp., *Leiosphaeridia* cf. *fastigatirugosa* (STAPLIN) DOWNIE & SARJEANT, *L. grandiformis* n. sp., *L. minuscula* n. sp., *Lancettopsis* sp., *Micrhystridium ariakense* TAKAHASHI, *Baltisphaeridium sphaeroides* n. sp., *B. nakajoense* n. sp. および *Cymatiosphaera pulchella* n. sp. である。

Tytthodiscus 属，*Crassosphaera* 属，*Pleurozonaria* 属，*Tasmanites* 属および *Leiosphaeridia* 属の形態的特徴について述べた。パーク他 (1978) によれば，化石属 *Pterospermella* は現生属 *Pterosperma* と同義であるが，筆者等は *Pterospermella* を受入れる考えである。

この論文に記載された，これらの植物性微小プランクトンは日本海周辺の新第三紀層における層位学的および地理学的分布の基礎知識に重要である。

高橋　清・松岡数充

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 122, pp. 122-126, July 15, 1981

731. NOTES ON THREE CYTHERELLOIDEA OSTRACODES FROM THE RYUKYUS*

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Abstract. Further information on the geographical and depth distribution of three species of the ostracode genus *Cytherelloidea*, previously reported from the Ryukyus, is presented. *C. senkakuensis* is widely distributed in both area and depth, whereas *C. asatoensis* and *C. hanaii* have restricted area distribution and occur within narrow depth ranges. *C. asatoensis* has different surface ornamentation in successive molt stages, but *C. hanaii* and *C. senkakuensis* show few changes through molt stages. The right and left valves of *C. hanaii* have different ornamentation.

Introduction

Genus *Cytherelloidea* is one of the dominant constituents of tropical ostracode assemblage. There are many studies on this genus in Southeast Asia (LEROY, 1940 and 1941, KINGMA, 1948, VAN DEN BOLD, 1950, KEIJ, 1964, HU, 1976 and 1977, and HU and CHENG, 1977). Previously, one species of the genus *Cytherelloidea* was reported from Honshu, Japan (ISHIZAKI, 1968) and nine species from the Ryukyus (NOHARA, 1976).

Study of representatives of the genus indicates that the type specimens for the species *C. shinzatoensis* and *C. yakenaensis* are juvenile instars, and further research is necessary to identify their adult forms.

Sampling localities

The specimens discussed in this paper are mainly from dredged samples in the southern part of East China Sea near Senkaku-retto and from coral reefs southeast of Komesu of Okinawa-jima. The fossil specimens are from Somachi Formation of Kikai-jima and Shinzato Tuff, Chinen Sands, and Naha Limestone of Okinawa-jima.

The sampling localities are listed below.

Loc. 1.—Senkaku-retto, 48 Stations (Lat. 25° 45′9″-27°47′5″N, Long. 123°7′-125°37′7″E) Dredged sample: St. 8, Senkaku-retto, dark brownish gray, fine to medium sand, 95 m in depth, water temperature 18.5°C. in depth of 85 m. Dredged sample, Recent.

Loc. 2.—Komesu, Itoman City, Okinawa-jima. St. 1, Komesu traverse section, about one hundred meters from shoreline, 2 m in depth, 700 m S.E. of Komesu (Lat. 26°5′N, Long. 127°43′E), Dredged sample, Recent.

Loc. 3a-d.—Somachi Formation, Kikai-jima. a, No. 7512404A, 500 m east of Keraji (Lat. 28°7′N, Long. 128°59′E) gray siltstone, Pliocene: b, No. 7512502A, 500 m north of Nagamine (Lat. 28°21′N, Long. 129°59′E), 1 m above road, gray siltstone: c, No. 7512507, 300 m S.E. of Isago (Lat. 28°21′

* Received October 8, 1980; read Oct. 16, 1977 at Kumamoto University.

N, Long. 129°59′E), gray siltstone: d, No. 7512508C 1,400 m S. E. of Isago (Lat. 28° 21′N, Long. 129°59′E), 3 m above road, gray siltstone.

Loc. 4a-c.—Shinzato Tuff, Okinawa-jima. a, No. 75122902D, the type locality about five hundred meters southeast of Shinzato, Sashiki (Lat. 26°9′5″N, Long. 127°46′7″E), bluish gray silty sand, 1 m above the tuff bed of the base of the type locality, Pliocene: b, No. 7571602, about two hundred meters east of Yakena near harbour, Yonagusuku-son (Lat. 26°19′N, Long. 127° 55′E), brownish gray sand: c, No. 7592601, 1 km north of Asato, Gushichan-son (Lat. 26°7′30″N, Long. 127°44′E), dark gray siltstone, 4 m above the cultivated land.

Loc. 5.—Chinen Sands, the type locality, about five hundred meters east of Kudeken, Chinen-son, Okinawa-jima. No. 7571703 (Lat. 26°10′N, Long. 127°49′E), 3 m above road, silty sand, Pleistocene.

Loc. 6a, b.—Naha Limestone. a, 100 m east of National highway 51 and south of Machinato river, Machinato, Urasoe City, Okinawa-jima, No. 7512302 (Lat. 26°10′N, Long. 127°44′E), soft brownish limestone, Pleistocene: b, siltstone included in Naha Limestone, Yokatsu Senior High School, 500 m south of Uchima, Yonagusuku-son (Lat. 26°19′N, Long. 127°54′E), gray siltstone.

Discussion

Recent species of the ostracode genus *Cytherelloidea* seem to be restricted to tropical and subtropical shallow marine waters (MORKHOVEN, 1963). In Japan, however, the geographical range of *Cytherelloidea munechikai* extends to the Uranouchi Bay of Kochi Prefecture (ISHIZAKI, 1968). The species is found in Somachi Formation of Kikai-jima (Loc. 3a-d), Pliocene Shinzato Tuff (Loc. 4a), and Pleistocene Chinen Sands of Okinawa-jima (Loc. 5).

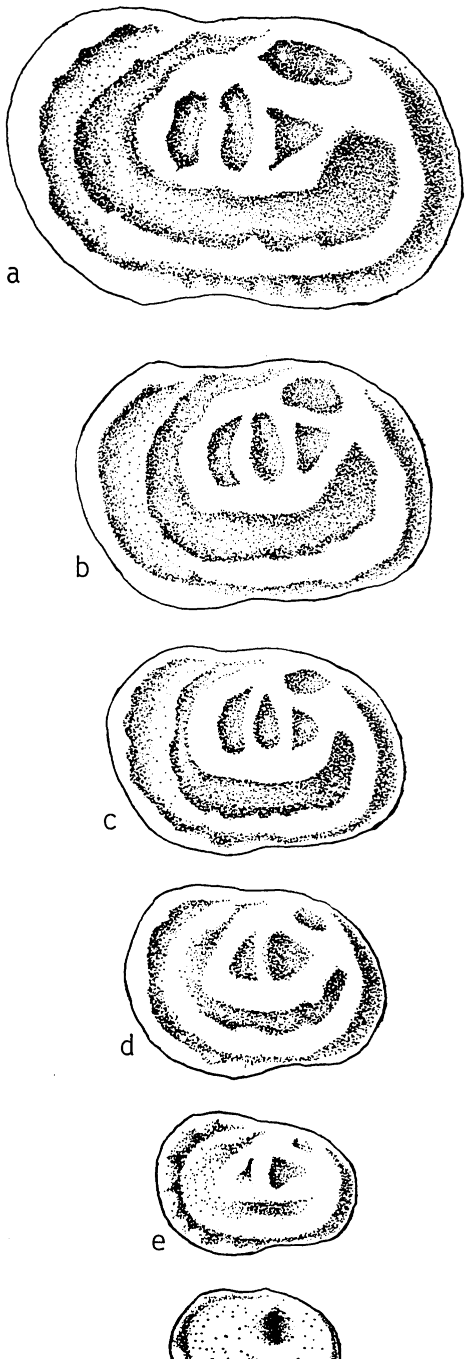
Cytherelloidea senkakuensis was originally reported from stations near Senkaku-retto where the species is common and occurs in the depth of 95 m to 370 m (NOHARA and TOMOYOSE, 1977). This species is also found in very shallow water of coral reefs near Komesu in Southern Okinawa-jima (Loc. 2).

Cytherelloidea hanaii was first reported from the Shinzato Tuff of Yakena, Yonagusuku-son, Okinawa-jima (Loc. 4b). Other fossil specimens of this species have been found in different horizons of the type locality of the Pliocene Shinzato Tuff (Loc. 4a) and Pleistocene Chinen Sands (Loc. 5) of Okinawa-jima. Living specimens of *C. hanaii* have been recorded between the depth range of 100 m and 150 m near Senkaku-retto (NOHARA and TOMOYOSE, 1977), and thus the distribution of this species seems to be restricted to narrow areas.

Cytherelloidea asatoensis was originally reported from the Pliocene Shinzato Tuff in the north of Asato, Gushichan-son, Okinawa-jima (Loc. 4c). Recent specimens are also found in stations near Senkaku-retto ranging from 100 m to 180 m in depth.

From KEIJ's measurements (1964), six molt stages seem to exist in *Cytherelloidea sabahensis* from Borneo. Specimens from the Ryukyus also suggest existence of at least five or six molt stages in our species as illustrated in Fig. 1.

The surface ornamentation is remarkably different between molt stages in some species and relatively conservative in the other. The surface ornamentation changes from young instar to mature form in *Cytherelloidea asatoensis* with increase in the size of valve (Fig. 1, f to a). On a juvenile valve (Fig. 1-f) only the marginal rim is well developed. In a later stage, central pit, median groove and an inner ridge appear. Thereafter two triangular pits develop: one in front of and the other just above the central



pit (Fig. 1-e). In the next stage, inner ridge is completed (Fig. 1-d). The presence of three pits becomes distinct in the next stage (Fig. 1-c). Formation of all surface features is completed in adult minus one stage (Fig. 1-b). In the mature stage (Fig. 1-a) a wavy depression becomes clearer between the marginal rim and the inner ridge.

No clear change in surface ornamentation is apparent in the successive stages of *Cytherelloidea hanaii*. Even in the juvenile stage, marginal rim and ridge are well developed. In *Cytherelloidea senkakuensis*, surface ornamentation including ridges and pits changes slightly and more or less continuously with the increase in valve size.

The surface ornamentation is generally similar between the right and left valves, but sometimes different between the two valves, as is the case with *Cytherelloidea hanaii*. On the left valves of *C. hanaii* (Fig. 2-a), a thick ridge runs continuously from the posterodorsal margin toward anterior, turns toward posterior making an arch anteriorly, and terminates at the posteroventral margin. On the right valve, however, posterodorsal and posteroventral ridges extend parallel to each other toward anterior (Fig. 2-b), but become obscure in the anterocentral area. Ridges of left and right valves have strongly different outline in dorsal view (Fig. 2-c). In the left, marginal rim, ridge, and dorsal pit are present; on the right, however, only the posterior ridge is distinctive. The differences of the surface ornamentation between the left and right valves may suggest unsym-

Fig. 1. Sketches of *Cytherelloidea asatoensis* from juvenile (f) to adult (a) stage. Magnification approximately ×30. Specimen from the type locality of Shinzato Tuff, Shinzato, Sashiki-son, No. 75122902 D (Loc. 4a).

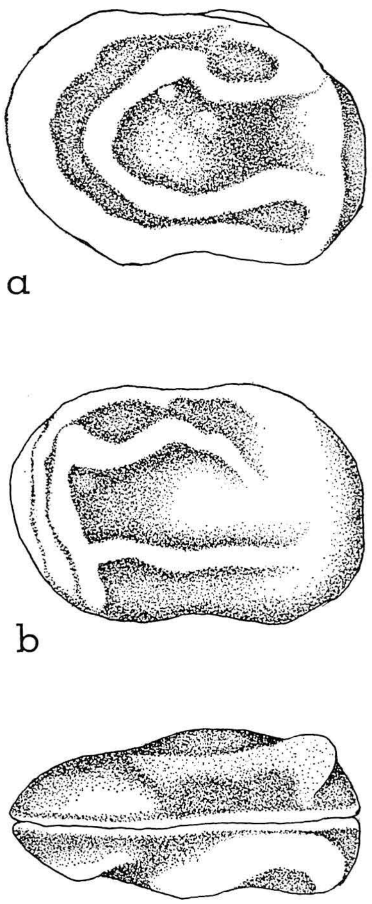


Fig. 2. Sketches of *Cytherelloidea hanaii* showing differences of surface ornamentation between two valves. Specimen from Station 8 (Lat. 27°39′9″ N, Long. 125°37′7″E) of Senkaku-retto (Loc. 1). a. lateral view of left valve ×75, b. lateral view of right valve ×75, c. dorsal view of carapace ×75

metrical orientation of carapaces during life time.

In conclusion, among *C. asatoensis, C. hanaii, C. munechikai, C. nagoensis, C. senkakuensis, C. shinzatoensis, C. yakenaensis, C.* sp. A, and *C.* sp. B reported earlier from the Ryukyu islands, new information on *Cytherelloidea hanaii, C. asatoensis, C. senkakuensis,* and *C. munechikai* is presented in this report. *C. nagoensis, C.* sp. A and *C.* sp. B occur very rarely and information at hand is not sufficient to estimate their distribution range.

Uncertainty exists concerning the diagnostic characters of two other species, *C. shinzatoensis* and *C. yakenaensis,* because the original descriptions were based on juvenile instars.

I am greatly indebted to Dr. and Mrs. H. P. SMITH for reading the first draft of the manuscript and also to Miss N. TOMOYOSE for her drawings. This study was partially financed by the Grant-in-Aid for Cooperative Research of the Ministry of Education, Science and Culture, Project No. 434042.

References Cited

BOLD, W. A. VAN DEN (1950) : *Hemikrithe*, a new genus of Ostracoda from the Indo-pacific. *Ann. Mag. Nat. Hist.*, ser. 12, vol. 3, p. 900-904, text-fig. 1.

HU, C. H. (1976) : Studies on the Pliocene ostracodes from the Cholan formation, Miaoli district, Taiwan. *Proc. Geol. Soc. China*, no. 19, p. 25-51, pl. 1-3, text-fig. 1-20.

—— (1977) : Studies on ostracodes from the Pleistocene Tonkoshan Formation in the Miaoli area, Taiwan. *Proc. Geol. Soc. China*, no. 19, p. 80-107, pl. 1-4, text-fig. 1-20.

—— and Y. N. CHENG (1977) : Ostracodes from the Late Pleistocene Lungkang Formation near Miaoli, Taiwan. *Mem. Geol. Soc. China*, no. 2, p. 191-205, pl. 1-3, text-fig. 1-13.

ISHIZAKI, K. (1968) : Ostracodes from Uranouchi Bay, Kochi Prefecture, Japan. *Sci. Rep. Tohoku Univ.* 2nd ser. (Geol.), vol. 40, no. 1, p. 1-45, 17 text-figs, pls. 1-9.

KEIJ, A. J. (1964) : Neogene to Recent species of *Cytherelloidea* (Ostracoda) from northwestern Borneo. *Micropaleontology*, vol. 10, no. 4, p. 415-430.

KINGMA, J. T. (1948) : Contributions to the knowledge of the Young-Caenozoic Ostracoda from the Malayan region. Thesis University of Utrecht, 119, 11 pl., 3 text-fig.

LeROY, L. W. (1940) : The ostracode genus *Cytherelloidea* from the late Tertiary of the Nederlands East Indies. *Natuurkd. Tijdschr. Ned.-Indie*, vol. 100, no. 4, p. 179-196, pl. 1.

—— (1941) : The ostracode genus *Cytherelloidea* from the Tertiary of the Nederlands East Indie. *J. Paleont.*, vol. 15, no. 6, p. 612-621, pl. 83.

MORKHOVEN, F. P. C. M. VAN (1963) : Post-Paleozoic Ostracoda vol. 2, 478 pp. Elsevier.

NOHARA, T. (1976) : The ostracodes genus *Cytherelloidea* from the Ryukyus. *Bull. Coll. Educ. Univ. Ryukyus*, no. 20, pt. 2, p. 1-6.

—— and TOMOYOSE, N. (1977) : Note on a few *Cytherelloidea* ostracodes from East China Sea, Okinawa. *Marine Sciences*, vol. 9, p. 46-48. (in Japanese).

琉球列島産貝形虫 *Cytherelloidea* 属について：琉球列島産新生代貝形虫 *Cytherelloidea* 属の三種 *C. hanaii*, *C. asatoensis*, *C. senkakuensis* について検討した。*C. hanaii* と *C. asatoensis* は，それぞれ 100～150 m，100～180 m の深度分布を示しているが *C. senkakuensis* は，1～300 m の深度分布を示している。

C. asatoensis は，殻の表面の装飾は脱皮ごとに変化を示していくが，*C. hanaii* と *C. senkakuensis* は装飾に顕著な変化は見られない。*C. hanaii* は左右の殻の装飾は異っている。 野原朝秀

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732. A NEW *CLINOCARDIUM* FROM THE OMAGARI FORMATION OF THE OMBETSU GROUP, KUSHIRO COAL FIELD, EASTERN HOKKAIDO*

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Abstract. The Omagari Formation (Oligocene) yields characteristic marine molluscan fossils which are called the Poronaian fauna (MIZUNO, 1964). The author describes a new species of *Clinocardium* based on 419 specimens collected from 20 localities of the formation, and discusses the relationship with one of the Oligocene index fossils, *Clinocardium asagaiense* (MAKIYAMA). This new species is one of the earliest representatives of *Clinocardium*, because the genus is considered to have originated during Oligocene in North Japan and Sakhalin, USSR (KAFANOV, 1974). *C. asagaiense* which has been reported by several authors from various localities of the Urahoro and Ombetsu Groups in the Kushiro coal field, without figures, requires re-examination in view of the occurrence of the new species.

Introduction

The Ombetsu Group (Oligocene) in the Kushiro coal field, eastern Hokkaido, can be divided into the Omagari, the Charo and the Nuibetsu Formations in ascending order, and yields abundant and characteristic marine molluscan fossils called the Poronaian fauna (MIZUNO, 1964). The Omagari Formation was proposed by SASA (1940a, b) and its type locality is located at Omagari, middle course of the Charo-gawa (river), Shiranuka-machi, Shiranuka-gun, northwestern part of the coal field. The formation is characterized by greenish gray medium- to fine-grained sandstone and ranges in thickness from 50 to 110 m in the coal field (SASA, 1940a, b).

The Omagari Formation developed in the Tokomuro district, western part of the Kushiro coal field, is composed mainly of fine-grained sandstone and sandy siltstone, with a thin gravelly coarse-grained sandstone or granular conglomerate layer at the base (YUI, 1975 MS). The formation is narrowly distributed in a N-S trend in such rivers and valleys as the Taron-no-sawa, the Pon-otakobushi-zawa, the Sango-zawa, the Kenamichichippu-zawa, the Fukuyama-gawa, the Tokomuro-gawa, etc. (YUI, 1975 MS).

The Omagari Formation in the Tokomuro district ranges in thickness from 50 to 170 m, and is conformably overlain by the Charo Formation and unconformably underlain by the Shakubetsu, the Shitakara or the Rushin Formations of the Urahoro Group (YUI, 1975 MS). Table 1 shows the stratigraphic classification in the Tokomuro district.

The Omagari Formation contains marine

* Received October 25, 1980; read January 26, 1980 at Tsukuba.

Table 1. Stratigraphic classification in the Tokomuro district (YUI, 1975MS).

AGE	GROUP	FORMATION
Holocene		Alluvium
Pleistocene		Terrace deposits
Pliocene		Hombetsu Formation
Miocene	Atsunai Group	Atsunai Formation
		Tokomuro Formation
Oligocene	Ombetsu Group	Nuibetsu Formation
		Charo Formation
		Omagari Formation
	Urahoro Group	Shakubetsu Formation
		Shitakara Formation
		Yubetsu Formation
		Rushin Formation
Late Cret.-Paleocene	Nemuro Group	Kawaruppu Formation
		Katsuhira Formation

molluscan fossils including such species as *Yoldia laudabilis* YOKOYAMA, *Portlandia watasei* (KANEHARA), *Nucula* (*Ennucula*) n. sp., *Acila brevis* NAGAO and HUZIOKA, *Venericardia laxata* YOKOYAMA, *V. tokudai* TAKEDA, *Conchocele bisecta* (CONRAD), *Nemocardium ezoense* TAKEDA, *Clinocardium omagariense*, n. sp., *Myagrewingki* MAKIYAMA, *Periploma besshoense* (YOKOYAMA), *Turritella poronaiensis* TAKEDA, "*Ampullina*" *asagaiensis* MAKIYAMA, *Tromininα ? ezoana* (TAKEDA), etc. (YUI, 1975 MS).

Three species and three subspecies of *Clinocardium* have been described from Paleogene formations of Japan and Sakhalin, USSR, and these are *Clinocardium asagaiense asagaiense* (MAKIYAMA) and *Clinocardium asagaiense makiyamae* KAMADA from the Asagai Formation of the Uchigo Group, Joban coal field, Northeast Japan, *Clinocardium asagaiense arakawae* KAMADA from the Iwaki and Asagai Formations of the Uchigo Group, and *Clinocardium matchgarense* (MAKIYAMA) and *Clinocardium yamasakii* (MAKIYAMA) from horizons 5 and 6 (Marie Formation) at Matchgar, northern Sakhalin, USSR, respectively (CYAMA, MIZUNO and SAKAMOTO, 1960; KAMADA, 1962).

KEEN (1973) listed a total of 24 Oligocene to Recent species of *Clinocardium* from Japan and Sakhalin, including the above species. A key to the 13 species of *Clinocardium* which had been described from Tertiary and Quaternary formations of Japan and Sakhalin was summarized by HIRAYAMA (1955).

The genus *Clinocardium* is considered to have originated in the northwestern Pacific (North Japan and Sakhalin) in the Oligocene and migrated to the north and east during Miocene time (KAFANOV, 1974), and this genus is essentially a northern group of cockles (HERTLEIN and GRANT, 1972).

In this paper, the author describes and discusses a new species of *Clinocardium* based on YUI's (1975 MS) specimens of 419 individuals collected from gray sandy siltstone, fine-grained sandstone or gray siltstone at 20 localities of the Omagari Formation in the Tokomuro district, western part of the Kushiro coal field. Maps of the Tokomuro district indicating fossil localities are shown in Figs. 1a, b.

Several conflicting views have been proposed as to the ages of the Urahoro and Ombetsu Groups in the coal field. For instance, SASA (1940a, b) summarized the stratigraphy of the coal field and considered that the Urahoro and Ombetsu Groups are Miocene from the stratigraphical viewpoint, but ASANO (1962) considered that they are Eocene from the smaller foraminiferal viewpoint. The author regards both groups as Oligocene in age, following the evidence of Mollusca (TAKEDA, 1953; OYAMA, MIZUNO and SAKAMOTO, 1960; MIZUNO, 1964) and paleobotany (TANAI, 1970). The ages of both groups will be discussed in detail at another opportunity.

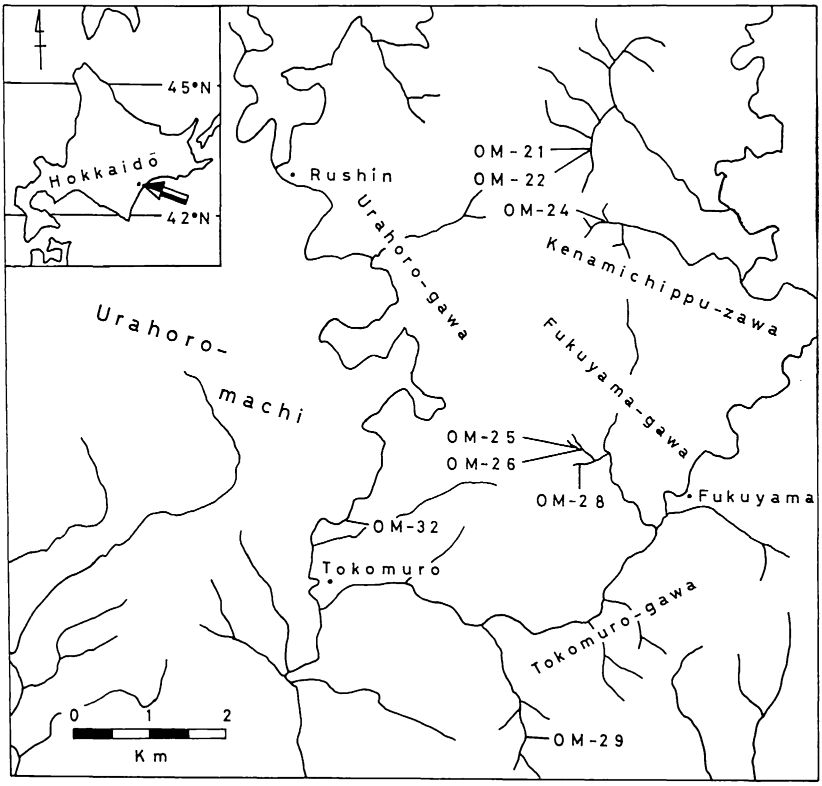

Fig. 1a. Map showing fossil localities in the southern Tokomuro district.

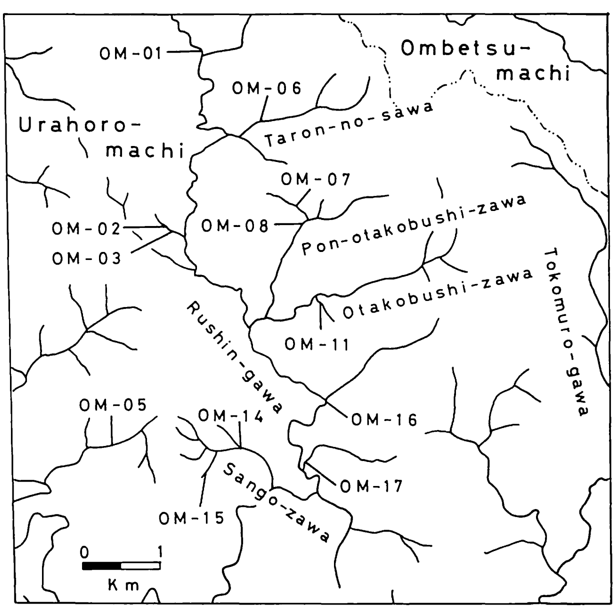

Fig. 1b. Map showing fossil localities in the northern Tokomuro district.

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Description of New Species

Family Cardiidae

Subfamily Laevicardiinae

Genus *Clinocardium* KEEN, 1936

Clinocardium omagariense HONDA, n. sp.

Pl. 15, Figs. 1-13

Description:—Shell small to medium, obliquely rounded, moderately inflated, inequilateral and rather thin. Antero- and posterodorsal margins braodly arched, ventral margin well-rounded. Posterior margin obliquely subtruncated. Beaks situated somewhat anteriorly, inconspicuous, incurved and prosogyrate. Apical angle about 120 to 130°. Height of shell a little shorter than length. Obscure ridge running from beak to posteroventral corner.

Surface sculptured with about 40 to 50 subrounded radial ribs, which are ornamented with cross-threads and are much wider than the interspaces. Surface also sculptured with numerous feeble growth lines and a few, more distinct periodic lines of growth. Escutcheon inconspicuous. Ligament external, opisthodetic and narrow. Hinge area and inner surface sculpture unknown.

Dimensions:—Dimensions are shown in Table 2.

Depository:—Holotype (IGPS* coll. cat. no. 95740-1) and five paratypes (IGPS coll. cat. nos. 95740-2, 95740-3, 95740-4, 95740-5, 95740-6).

Comparison:—The present new species resembles *Clinocardium asagaiense asagaiense* (MAKIYAMA, 1934, p. 139, pl. 5, figs. 20, 22, 23), originally described from the Asagai Formation of the Uchigo Group, Joban coal field, Northeast Japan. But the new species is distinguished from *C. asagaiense asagaiense* by its more numerous radial ribs being wider than the interspaces.

It also resembles *Clinocardium asagaiense arakawae* KAMADA (1962, p. 105, pl. 10, figs. 15-17), originally described from the Asagai Formation of the Uchigo Group, but it differs from this subspecies in its more inflated shell. The present new species also resembles *Clinocardium asagaiense makiyamae* KAMADA (1962, p. 104, pl. 10, figs. 18-21), originally described from the Asagai Formation, but the new species differs in having a smaller shell, more numerous radial ribs, and the radial ribs wider than the interspaces.

It is allied also to *Clinocardium yamasakii*

* Abbreviation for the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Table 2. Measurements (in mm) of *Clinocardium omagariense*, n. sp.

IGPS coll. cat. no.	Loc. no.	Height	Length	H/L(%)	Width	W/L(%)	No. of radial ribs Right	Left	Valve
95740-1 (Holotype)	OM-32	26.2	29.2	89.7	18.8/2	32.2	44	37+	Both
95740-2 (Paratype)	OM-32	27.4	25.5	107.5	16.4/2	32.2	33+	35+	Both
95740-3 (Paratype)	OM-32	27.0	31.9	84.6	18.2/2	28.5	45	44	Both
95740-4 (Paratype)	OM-32	24.4	28.0	87.1	16.0/2	28.6	46	45	Both
95740-5 (Paratype)	OM-32	23.4	24.2	96.7	14.9/2	30.8	50	50	Both
95740-6 (Paratype)	OM-32	23.0	23.3	98.7	14.0/2	30.0	36+	42	Both
95740-7	OM-32	22.7	24.3	93.4	14.0/2	28.8	—	44	Both
95740-8	OM-32	23.7	—	—	7.0	—	39+	—	Right
95740-9	OM-32	18.7	21.6	86.6	12.5/2	28.9	41	41	Both
95740-10	OM-32	13.1	14.6	89.7	8.3/2	28.4	41	42	Both

(MAKIYAMA, 1934, p. 138, pl. 5, figs. 21, 24), originally described from horizon 6 at Matchgar, northern Sakhalin, USSR, but it differs from *C. yamasakii* by its more numerous radial ribs and by having the radial ribs much wider than the interspaces.

It is allied also to *Clinocardium matchgarense* (MAKIYAMA, 1934, p. 137, pl. 5, figs. 30, 31), originally described from horizon 5 at Matchgar, but it can be discriminated from the latter by its more numerous and squarer radial ribs.

Remarks:—A total of 419** individuals collected by YUI (1975 MS) was examined. They occur in groups in gray sandy siltstone, fine-grained sandstone or gray siltstone at 20 localities of the Omagari Formation in the Tokomuro district, western part of the kushiro coal field. The majority of the specimens are moderately well-preserved conjoined valves with rather thin tests, although the edges of most specimens are lacking. Drillings of gastropods are observed on the surfaces of such specimens as Pl. 15, Figs. 1-4, 6, 10, 12, 13 at Loc. OM-32.

Besides the present new species from the Omagari Formation, *Clinocardium asagaiense* has been reported from the Urahoro and Ombetsu Groups in the Kushiro coal field by several authors: the Omagari, the Charo and the Nuibetsu formations of the Ombetsu Group (TAKEDA, 1953); the Shitakara Formation of the Urahoro Gaoup, the Omagari, the Charo and the Nuibetsu Formations of the Ombetsu Group (MATSUI, 1962); the Omagari Formation (INOUE and SUZUKI, 1962; MITANI, FUJIWARA and ISHIYAMA, 1964; SOGABE, 1967); the Green Sandstone Member of the Okuhombetsu Formation (MITANI, HASHIMOTO, YOSHIDA and ODA, 1959). *C.* cf. *asagaiense* has been recorded from the Omagari Sandstone Member of the Charo Formation in the Tokomuro district (ODA, NEMOTO and UEMURA, 1959), the Charo Siltstone Member of the Charo Formation (MIZUNO, SATO and SUMI, 1963), the Charo and Nuibetsu formations (MIZUNO, 1964); and *Clinocardium kushiroense* KANNO (*nom. nud.*) from the Omagari Formation (MABUCHI, 1962; MIZUNO, 1964). The Green Sandstone Member of the Okuhombetsu Formation is correlative of the Omagari

** One individual is regarded as more than half of a separated valve or a conjoined pair of valves.

Formation.

Specimens that have been reported from the Urahoro and Ombetsu Groups as *C. asagaiense*, C. cf. *asagaiense* and C. *kushiroense* require re-examination in view of the occurrence of the new species, as they were not figured in the original reports. The new species is one of the earliest representatives of *Clinocardium*, because the genus is considered to have originated in North Japan and Sakhalin, USSR during Oligocene time (KAFANOV, 1974).

Associated fauna:—The new species is commonly associated with *Portlandia watasei*, *Yoldia laudabilis*, *Venericardia tokudai*, "*Ampullina*" *asagaiensis*, and sometimes with *Venericardia laxata*, *Periploma besshoense*, *Turritella poronaiensis*, *Trominina* ? *ezoana* etc. (*compiled from:* YUI, 1975 MS).

Locality and Formation:—

OM-01: roadside cutting along the middle course of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°59′44″N, Long. 143°41′8″E).

OM-02: roadside cliff along a small northwestern tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°58′30″N, Long. 143°40′46″E).

OM-03: ditto (about 130 m SE of OM-02) (Lat. 42°58′28″N, Long. 143°40′49″E).

OM-05: roadside cliff along a northwestern tributary of the Urahoro-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42° 56′57″N, Long. 143°40′10″E).

OM-06: roadside cliff along the Taron-no-sawa, a tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42° 59′14″N, Long. 143°43′42″E).

OM-07: riverside cliff along the Pon-otakobushi-zawa, a tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°58′36″N, Long. 143°42′2″E).

OM-08: ditto (about 140 m SE of OM-07) (Lat. 42°58′32″N, Long. 143°42′5″E).

OM-11: riverside cliff along the Otakobushi-zawa, a tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°57′56″N, Long. 143°42′18″E).

OM-14: riverside cliff along the Sango-zawa, a tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42° 56′56″N, Long. 143°41′32″E).

OM-15: riverside cliff along the uppermost stream of the Sango-zawa, a tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (about 600 m SW of OM-14) (Lat. 42°56′47″N, Long. 143°41′10″E).

OM-16: riverside cliff along the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°57′16″N, Long. 143°42′20″E).

OM-17: riverside cliff along an eastern tributary of the Rushin-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°56′51″N, Long. 143°42′8″E).

OM-21: riverside cliff along a northwestern tributary of the Tokomuro-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42° 53′3″N, Long. 143°42′48″E).

OM-22: ditto (about 130 m E of OM-21) (Lat. 42°55′2″N, Long. 143°42′54″E).

OM-24: riverside cliff along the upperstream of the Kenamichippu-zawa, a tributary of the Tokomuro-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°54′33″N, Long. 143°42′58″E).

OM-25: riverside cliff along the Fukuyama-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°52′54″N, Long. 143°42′41″E).

OM-26: ditto (about 70 m SE of OM-25) (Lat. 42°52′53″N, Long. 143°42′44″E).

OM-28: ditto (about 170 m S of OM-26) (Lat. 42°52′47″N, Long. 143°42′44″E).

OM-29: riverside cliff along a southern tributary of the lowerstream of the Tokomuro-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°50′53″N, Long. 143°42′10″ E).

OM-32: riverside cliff along the Urahoro-gawa, about 1,250 m NNE from the junction between the Urahoro-gawa and the Tokomuro-gawa, Urahoro-machi, Tokachi-gun, Hokkaido (Lat. 42°52′24″N, Long. 143°40′ 32″E) (type locality). All the localities are in the Omagari Formation (*Contr.* YUI, 1975MS).

References

ASANO, K. (1962): Japanese Paleogene from the viewpoint of foraminifera with descriptions of several new species. *Contr. Inst. Geol. Paleont., Tohoku Univ.*, no. 57, p. 1-32, pl. 1 (in Japanese with English abstract and description in English).

HERTLEIN, L. G. and GRANT, U. S., 4th, (1972): The geology and paleontology of the marine Pliocene of San Diego, California (Paleontology: Pelecypoda). *San Diego Soc. Nat. Hist., Mem.* 2 (Part 2B), p. 135-411, pls. 27-57.

HIRAYAMA, K. (1955): The Asagai Formation and its molluscan fossils in the northern region, Jôban coal-field, Fukushima Prefecture, Japan. *Sci. Rep., Tokyo Kyoiku Daigaku*, sec. C, vol. 4, no. 29, p. 49-130, pls. 1-5.

INOUE, E. and SUZUKI, T. (1962): Explanatory text of the geological map of Japan. Scale 1:50,000. Ukotakinupuriyama. 72 p., *Hokkaido Development Agency* (in Japanese with English abstract).

KAFANOV, A. I. (1974): Composition, taxonomy and evolution of the group *Clinocardium* (Mollusca, Cardiidae). *Zool. Jour.*, vol. 53, no. 10, p. 1466-1475 (in Russian with English abstract).

KAMADA, Y. (1962): Tertiary marine Mollusca from the Joban coal-field, Japan. *Palaeont. Soc. Japan, Spec. Pap.*, no. 8, p. 1-187, pls. 1-21.

KEEN, A. M. (1973): Suggested generic allocations for some Japanese molluscan species. *Sci. Rep., Tohoku Univ.*, 2nd ser. (Geol.), Spec. Vol., no. 6 (*Hatai Mem. Vol.*), p. 1-6.

MABUCHI, S. (1962): A study on sedimentation and tectogenic history of the Paleogene System of the Kushiro coal field. *Contr. Inst. Geol. Paleont., Tohoku Univ.*, no. 56, p. 1-42 (in Japanese with English abstract).

MAKIYAMA, J. (1934): The Asagaian molluscs of Yotukura and Matchgar. *Mem. Coll. Sci., Kyoto Imp. Univ.*, ser. B, vol. 10, no. 2, art. 6, p. 121-167, pls. 3-7.

MATSUI, M. (1962): Sedimentological study of the Paleogene basin of Kushiro in Hokkaido, Japan. *Jour. Fac. Sci., Hokkaido Univ.*, ser. 4, vol. 11, no. 3, p. 431-480.

MITANI, K., FUJIWARA, T. and ISHIYAMA, S. (1964): Explanatory text of the geological map of Japan. Scale 1:50,000. Kamiashoro. 57 p., *Hokkaido Development Agency* (in Japanese with English abstract).

——, HASHIMOTO, W., YOSHIDA, T. and ODA, Y. (1959): Ditto Honbetsu. 83 p., *Ibid.* (in Japanese with English abstract).

MIZUNO, A. (1964): Summary of the Paleogene molluscan faunas in North Japan. *Rep. Geol. Surv. Japan*, no. 207, p. 1-28.

——, SATO, S. and SUMI, Y. (1963): Explanatory text of the geological map of Japan. Scale 1: 50,000. Akan. 74 p., *Hokkaido Development Agency* (in Japanese with English abstract).

ODA, Y., NEMOTO, T. and UEMURA, T. (1959): Ditto. Tokomuro. 54 p., *Ibid.* (in Japanese with English abstract).

OYAMA, K., MIZUNO, A. and SAKAMOTO, T. (1960): Illustrated handbook of Japanese Paleogene molluscs. 244 p., 71 pls. *Geol. Surv. Japan.*

SASA, Y. (1940a): Stratigraphy of the Tertiary deposits in the Kushiro coal field and critical review of the opinions expressed (1). *Bull. Hokkaido Coal Min. Assoc.*, no. 307, p. 1-19 (in Japanese).

——, Ditto (2). *Ibid.*, no. 308, p. 20-43 (in Japanese).

SOGABE, M. (1967): Geological maps of the coal fields of Japan. VII. Explanatory text of the northwestern district, Kushiro coal field, Hokkaido. 42+3p., *Geol. Surv. Japan* (in Japanese with English abstract).

TAKEDA, H. (1953): The Poronai Formation (Oligocene Tertiary) of Hokkaido and South Sakhalin and its fossil fauna. *Stud. Coal Geol.*, no. 3, p. i-iv, 1-45 (in Japanese); p. i-iii, 1-103 (in English); pls. 1-13: *Geol. Sec., Hokkaido Assoc. Coal Min. Tech.*, Sapporo, Japan.

TANAI, T. (1970): The Oligocene floras from the Kushiro coal field, Hokkaido, Japan. *Jour. Fac. Sci., Hokkaido Univ.*, ser. 4, vol. 14, no. 4, p. 383-514, pls. 3-20.

YUI, S. (1975MS): [Stratigraphical study in the northern part of Urahoro-machi, Tokachi-gun, Hokkaido]. *Mster's Thesis, Inst. Geol. Paleont., Tohoku Univ.*, 87+22p., 10 pls. (in Japanese, title translated).

Atsunai 厚内, Charo 茶路, Fukuyama 福山, Hombetsu 本別, Katsuhira 活平, Kawaruppu 川流布, Kenamichippu-zawa ケナミチップ沢, Nuibetsu 縫別, Okuhombetsu 奥本別, Omagari 大曲, Ombetsu 音別, Otakobushi-zawa オタコブシ沢, Pon-otakobushi-zawa ポンオタコブシ沢, Rushin 留真, Sango-zawa 三号沢, Shakubetsu 尺別, Shitakara 舌辛, Taron-no-sawa タロンノ沢, Tokomuro 常室, Urahoro 浦幌, Yubetsu 雄別

北海道東部釧路炭田，音別層群大曲層からの *Clinocardium* の一新種：音別層群（漸新世）は下部から大曲層，茶路層，縫別層の三層に区分され，幌内動物群（MIZUNO, 1964）と呼ばれる多くの特徴的な軟体動物化石群を産する。釧路炭田西部の常室地域の大曲層は主に細粒砂岩，灰色砂質シルト岩から成り，*Yoldia laudabilis, Portlandia watasei, Acila brevis, Venericardia laxata, Conchocele bisecta, Periploma besshoense, Turritella poronaiensis, "Ampullina" asagaiensis* などの海棲軟体動物化石を産する（YUI, 1975 MS）。

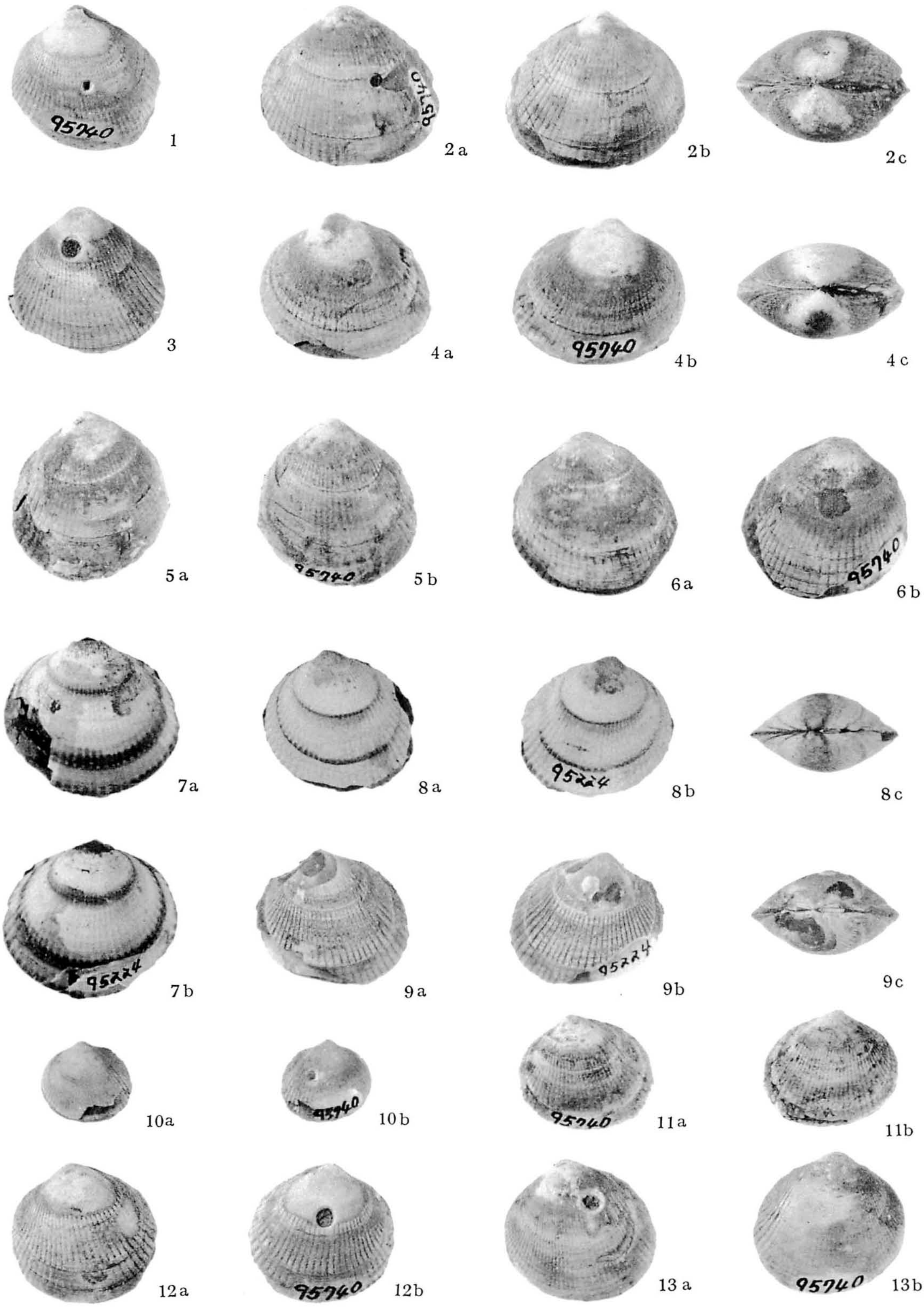
筆者は大曲層の灰色砂質シルト岩，細粒砂岩，灰色シルト岩中の20産地から YUI（1975MS）によって採集された419個体の標本に基づき，*Clinocardium* の一新種を記載し，報告する。本新種は常磐炭田の内郷層群浅貝層および石城層から記載されている，*Clinocardium asagaiense asagaiense, C. asagaiense arakawae, C. asagaiense makiyamae* などと類似するが，放射肋の数，外形，放射肋と放射肋間の比率などが異なる点で区別される。

従来，釧路炭田の浦幌層群及び音別層群からは，*C. asagaiense, C.* cf. *asagaiense* 及び *C. kushiroense* KANNO (*nom. nud.*) が報告されているが，図示された標本はなく，これらの種の両層群からの産出については再検討を要する。 本田 裕

Explanation of Plate 15

(All figures in natural size)

Figs. 1-13. *Clinocardium omagariense* HONDA, n. sp. fig. 1, IGPS coll. cat. no. 95740-7, Loc. OM-32; figs. 2a-c, IGPS coll. cat. no. 95740-1 (Holotype), Loc. OM-32; fig. 3, IGPS coll. cat. no. 95740-8, Loc. OM-32; figs. 4a-c, IGPS coll. cat. no. 95740-4 (Paratype), Loc. OM-32; figs. 5a-b, IGPS coll. cat. no. 95740-2 (Paratype), Loc. OM-32; figs. 6a-b, IGPS coll. cat. no. 95740-3 (Paratype), Loc. OM-32; figs. 7a-b, IGPS coll. cat. no. 95224-1, Loc. OM-29; figs. 8a-c, IGPS coll. cat. no. 95224-2, Loc. OM-29; figs. 9a-c, IGPS coll. cat. no. 95224-3, Loc. OM-29; figs. 10a-b, IGPS coll. cat. no. 95740-10, Loc. OM-32; figs. 11a-b, IGPS coll. cat. no. 95740-9, Loc. OM-32; figs. 12a-b, IGPS coll. cat. no. 95740-6 (Paratype), Loc. OM-32; figs. 13a-b, IGPS coll. cat. no. 95740-5 (Paratype), Loc. OM-32.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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

学　会　記　事

○日本古生物学会学会賞（横山賞）のメダル（写真）が完成したので，第127回例会の機会に受賞者松本達郎君に贈呈した。

○1981年6月20日に行われた評議員会で次の諸君の入退会を承認した。

〔入会者〕佐々木理恵，飯島東，金子篤，船山政昭本村方一，南木睦彦，井口豊，寄立徹，中井秀樹，谷祖剛，犬塚則久，石賀裕明，仲沢隆，鶴田さゆり，島本昌憲，冨田進，末包鉄郎，神谷隆宏（以上18名）

〔退会者〕岡田清史（以上1名）

日本古生物学会第127回例会

日本古生物学会第127回例会が1981年6月21日に横浜国立大学教育学部で開催された。（参会者108名）

個　人　講　演

Paleogene planktonic Foraminifera from Hokkaido..................... MAIYA, S., INOUE, Y., ICHINOSEKI, T. and MURATA, Y.

Notes on planktonic Foraminifera from Paleogene formations in Hokkaido .... KAIHO, K.

"*Lepidocyclina, Miogypsina*" 産出層準の浮遊性有孔虫について.................. 茨木雅子

東京都五日市町付近の後期古生代放散虫化石 .... 猪郷久治・西村はるみ

房総沖のコアKH-79-3, C-6の酸素同位体比の測定結果...... 大場忠道・新妻多明・斎藤常正

房総半島沖のコア（KH79-3-C6）中の微化石群集が示す後氷期の海況変遷 .... 岡田尚武・尾田太良・北里洋・小泉格・酒井豊三郎・谷村好洋・鎮西清高

A new coral species from the Upper Paleozoic in Huancavelica Department, Central Peru ....YAMAGIWA, N. and VILLACICENSIO, E.

サンゴ礁試料採取用に試作した掘削機 .... 小西健二・那須丈夫

丹沢化石サンゴ礁（中新世）................. .... 門田真人・末包鉄郎・中山克己・浜田隆士

Molluscan fossils from the Ombetsu Group in the Kushiro coal field, eastern Hokkaido ....HONDA, Y.

Some molluscs from the lower part of the Kurotaki Formation in the Mt. Mitsuishi area, Boso Peninsula ....ASAGA, M. and KAWABE, T.

A few molluscs from the Upper horizon of the Kurotaki Formation in the Yoro River area, Boso Peninsula .... KAWABE, T., ASAGA, M. and INOUE, A.

原稿の作成について（お願い）

編集委員会

日本古生物学会報告・紀事の印刷の体裁を統一し，美しく仕上げるため，投稿される方は1981年4月発行の No. 121 に掲載されている編集出版規約を御一読いただくほか，原稿作成にあたって次の点に御留意下さるようお願いいたします。

○短報を除く各原著論文には300語以内の英文アブストラクトをつけて下さい。

○半頁幅に入らない計測値の表は，本文から独立した Table として下さい。

○Formation, Group は固有名がつく時には大文字とします。本文中の図版番号，図番号の表示は当該論文については大文字（Pl. 00, Fig. 00）とし，他の論文については小文字（pl. 00, fig. 00）とします（英文の場合）。

○References（又は References cited）の書き方は本誌の最近号にならって下さい。なお，本文中に引用された文献と References にリストされる文献はたがいに過不足ないようにして下さい。

○図版は鮮明で中庸のコントラストの印画を用い，バランスよく作成して下さい。図番号は白台紙の場合には鉛筆書きで結構です。黒台紙の場合には台紙に純黒のもの（黒く焼付けた印画紙でよい）を用い，適正の大きさの白抜きの図番号を入れ，写真の切り口をはり付ける前に黒く塗って下さい。

○1982年度発行の No. 125 より，**人名を小キャピタル字体でなく普通の字体で印刷する**予定です。したがって今後投稿される方は原稿中の人名に小キャピタルの指定をせずにそのままお送り下さい。

誤植訂正

本誌 N.S. No. 121 に次の印刷ミスがありましたので，おわびして訂正します。

Erratum

HONDA, Y.: Corbiculid Mollusca from the Urahoro Group, Kushiro Coal Field, Eastern Hokkaido. *Trans. Proc. Palaeont. Soc. Japan*, n. s., no. 121, p. 14-28, pls. 2, 3, April 30, 1981.

The last two lines of page 27 (left) should be continued from the last line of page 26 (right). [MATSUI, M., 1962, Sedimentological study of the Paleogene basin of Kushiro in Hokkaido, Japan. *Jour. Fac. Sci., Hokkaido Univ.*, ser. 4, vol. 11, no. 3, p. 431-480.]

お 知 ら せ

中国地質学会成立60周年（1922-1982）中・新生代地質討論会に関するファースト・サーキュラー（1月30日付）が発行された。要点を次に記す。詳細については日本地質学会事務局（03-252-7242）または浜田隆士（東大・教養・宇地 03-467-1171 内線252）に問合せのこと。

会期：1982年8月31日～9月4日（外国人参加者は8月27日北京集合）

場所：河北省北戴河

予定シンポジウム：

1. ジュラー白亜系境界問題ならびに対比，区分に重点をおいた中～新生界層序学と古生物学
2. テチスならびに環太平洋域のテクトニクスに重点をおいた中生代―新生代の構造地質学
3. 火山活動ならびに花崗岩とそれに伴う鉱床形成に重点をおいた中生代―新生代岩石，鉱物，鉱床について
4. 化石燃料堆積盆地の堆積学に重点をおいた堆積盆地とエネルギー源問題

地質見学旅行：9月5日より3班に分れて実施の予定

1. 西蔵雅魯蔵地帯（13～16日間位，約2500～3400元）
2. 山東省の中―新生代含石炭層盆地（13日間位，約1800元）
3. 楊子峡東部の層序（13日位，約1900元）

参加費：正式参加者1人150元，同伴1人100元。参加費はUSドルでも日本円でもよい。

参加申込：指定の用紙により1981年12月1日までに中国地質学会シンポジウム事務局まで。提出論文（英文または中語文）は1982年4月1日まで。

行事予定

	開催地	開催日	講演申込締切
第128回 例会	広島大学	1981年10月3,4日	1981年8月3日

第128回例会ではシンポジウム「白亜紀非海成層の対比」が予定されている。(世話人：木村達明・田代正之・松本達郎)

講演申込先：〒113 東京都文京区弥生2-4-16 日本学会事務センター 日本古生物学会行事係

お知らせ

今春から常務委員などの役割分担が一部変更になりました。会務の円滑を期するため，1981-82年度の本会関係の連絡先を用務別に記しておきますのでよろしく御協力下さい。

○会費の払込→お送りしている銀行振込用紙で日本学会事務センター

○会費に関する問合せ→会計係：浅間一男・植村和彦（国立科学博物館分館地学研究部）

○本会の常務委員会への連絡一般→庶務係：鎮西清高・山口寿之（東京大学理学部地質学教室）

○住所変更・入退会申込・報告紀事および特別号バックナンバー購入申込→日本学会事務センター内日本古生物学会

○講演申込→日本学会事務センター内日本古生物学会，または行事係：木村達明・猪郷久治（東京学芸大学地学教室）

○報告紀事への投稿→なるべく書留便で日本学会事務センター内日本古生物学会，または編集係：速水格（東京大学総合研究資料館）〔原稿コピーと投稿カードを同封または別送して下さい。〕

○報告紀事編集・出版に関する問合せ・投稿カードの請求→編集委員会：速水格（同上），小沢智生（東京大学理学部地質学教室），小畠郁生・上野輝弥（国立科学博物館分館地学研究部）

○本会所蔵の図書閲覧の問合せ→速水格（同上），小沢智生（同上）〔本誌120号付録の案内・目録を参照して下さい。〕

○特別号に関する問合せ・購入申込→特別号編集委員会：首藤次男・柳田寿一（九州大学理学部地質学教室）（送金先：三和銀行福岡支店普通預金口座 12172；振替 福岡 19014 日本古生物学会特別号編集委員会）〔郵送によらない直接販売は東大総合研究資料館（速水格），国立科学博物館分館（藤山家徳）でも取扱います。〕

○"化石"に関する問合せ・投稿・購入申込→化石編集部：高柳洋吉・石崎国熙（東北大学理学部地質学古生物学教室）（送金先：振替 仙台 17141 化石編集部）〔誌代を送本後にお支払いただく継続予約の申込みをおすすめします。〕

○会員名薄（120号付録）の訂正の申入れ→会員係：浜田隆士（東京大学教養学部宇宙地球科学教室）

○各種の賞に関する問合せ，推薦依頼→賞の委員会幹事：小畠郁生（同上）（81年度のみ）

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CONTENTS

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