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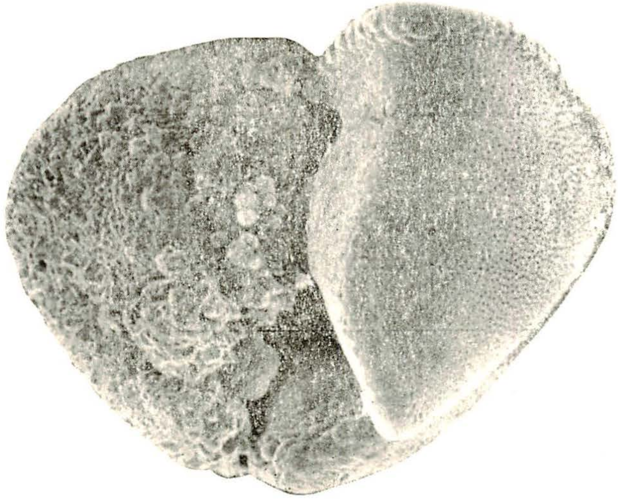

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Fossils on the cover is *Globorotalia truncatulinoides* (D'ORBIGNY, 1839).
The photograph was taken on a scanning electron microscope, JEOL-JSM-2, ×100.

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548. FOSSIL SPORES AND POLLEN GRAINS FROM THE NEOGENE DEPOSITS IN NOTO PENINSULA, CENTRAL JAPAN—I A PALYNOLOGICAL STUDY OF THE LATE MIOCENE WAKURA MEMBER*

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能登半島新第三系産化石胞子・花粉—I；中新世後期和倉層の花粉学的研究： 能登半島に広く分布する新第三系に含まれている化石胞子・花粉について研究を行った。今回はその第1報として，能登半島中央部に発達する中新世後期の和倉含珪藻泥岩層の16層準について，各層準毎に，化石群集の構成・変化を明らかにし，併せて，和倉層堆積時の古気候・古地理的環境，和倉層の時代について，くわしい考察を行った。 藤 則雄

Introduction

Some diatomaceous deposits occur at different stratigraphical horizons in the Tertiary (Neogene) System distributed in the northern and central parts of Noto Peninsula, Ishikawa Prefecture, Central Japan.

The diatomaceous deposits of Noto Peninsula are classified into four horizons, ranging from the Middle to Late Miocene in age. These four horizons differ from one another in their environmental conditions, namely, one is non-marine in origin, whereas the other three are marine. The most conspicuous horizon is represented by the marine diatomaceous mudstone of the Late Miocene age. The diatomaceous deposits in Noto Peninsula are distributed in main three areas of Nanao-Nakajima, Suzu, Wajima areas.

The present writer has been studying the fossil pollen grains and spores found from the diatomaceous deposits of Neogene age in the Hokuriku region since 1960. The present article is the first report on the palynological researches of the diatomaceous deposits and treats the pollen grains and spores collected from the Late Miocene Wakura Member near Nanao City in the central part of Noto Peninsula.

The scope of the investigation based on the microfossils is the systematic determination of the microfossils, the palaeoclimatic condition and palaeogeographical environment under which the Wakura Member was deposited in the Late Miocene. Further, correlation and comparison of the conditions and environment of the Wakura Member with the Hijirikawa, Tsukada and I'izuka diatomaceous Members distributed in the central and northern parts of Noto Peninsula are also undertaken.

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Outline of the Geology

Many diatomaceous mudstones of Neogones age are distributed widely in the central and northern parts of Noto Peninsula. They are mainly composed of homogeneous silty mudstone characterized with the dominance of fossil microorganisms. In the central part of the peninsula, the diatomaceous deposits are distributed locally, and their rock-facies are variable, especially around Mt. Sekidô-san near Nanao City. In the northern part of Nanao the Neogene deposits which overlie the Anamizu Andesite Group with unconformity are classified into six members in ascending order as follows: the Akaura sandstone, Nanao calcareous sandstone, glauconitic sandstone, Wakura diatomaceous mudstone and Kojima sandstone Members overlain with unconformity by Pleistocene deposits.

These strata are distributed in and around Wakura and in the adjacent areas of Nanao City in the central part of Noto Peninsula. Each stratigraphic units is below, in ascending order.

The Anamizu Formation: This formation is distributed locally along the western coast near Wakura and also in the area south of Okuhara. It is generally classified into two parts, namely, one is of pyroxyne andesite or hornblende pyroxyne andesite, and the other consists of andesitic pyroclastic rocks intercalated with dacitic tuff layers. This formation may be Early Miocene in geological age.

--- unconformity ---

The Akaura sandstone Member: In areas of Nanao, Takahama and Mt. Bijô-zan, an arkose sandstone derived from granite, which may be correlated with the Hida metamorphic complex, is distributed widely. It is named the Akaura sandstone Member near Nanao City. This member consists of a yellowish gray coarse-grained sandstone with granule sandstone showing remarkable cross lamination structures. The member has yielded a fossil mollusc as *Patinopecten kagamianus permirus*. The thickness of this member is about 200 meters.

—— interfingering with the upper part of the Akaura Member ——

The Nanao calcareous sandstone Member: The upper part of the Akaura Member interfingers with the calcareous sandstone, which is named the Nanao calcareous sandstone Member. This member occurs locally at Iwaya, Hosoguchi and Ôsugi-zaki in the limits of

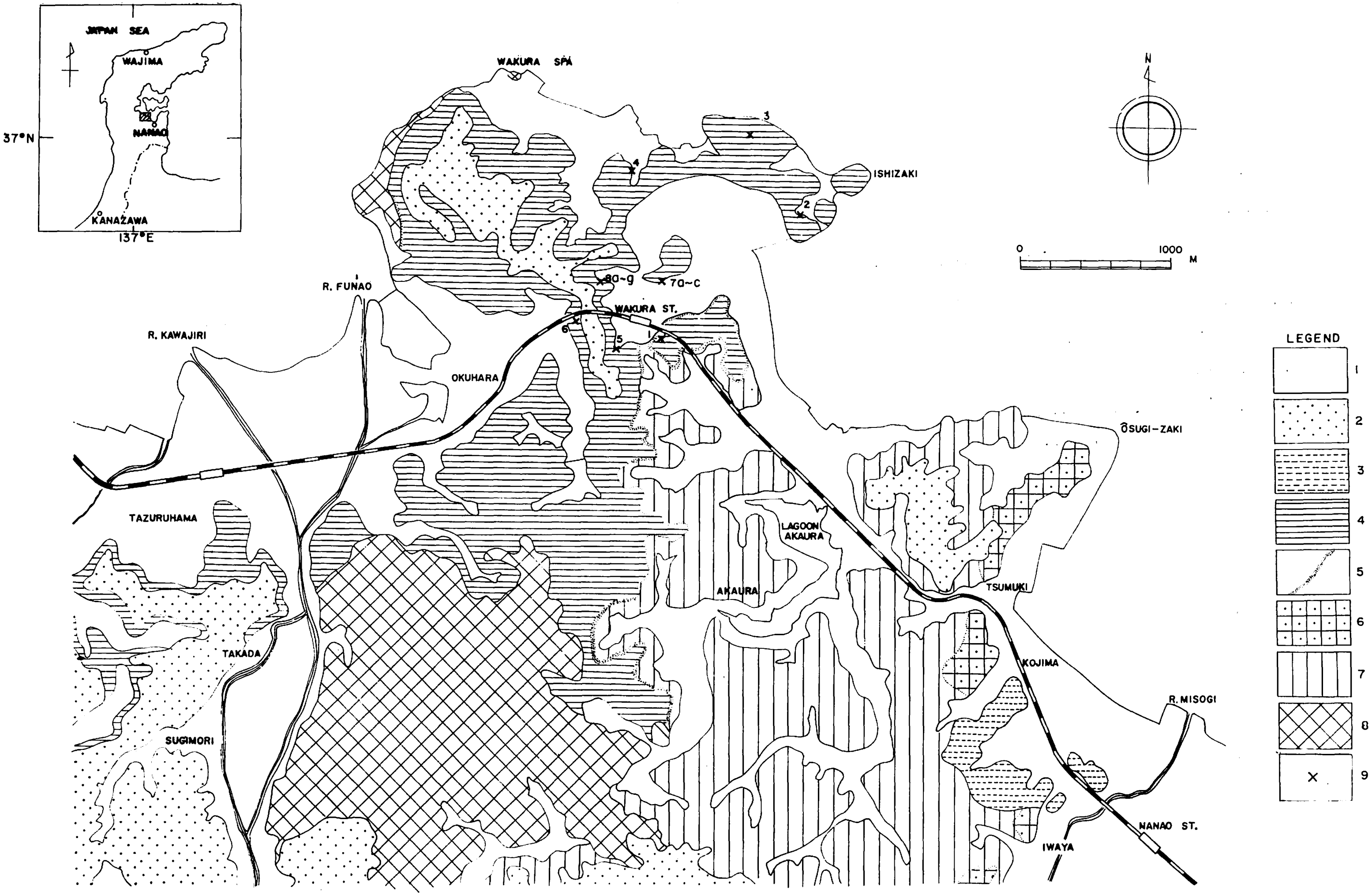

Fig. 1. Geological map of the Nanao area, central part of Noto Peninsula, Japan (Compiled by Y. KASENO, 1963; after N. FUJI, T. AOKI, Y. KITAMURA and HOKURIKU QUATERNARY RESEARCH GROUP). 1: Holocene deposits, 2: Pleistocene deposits, 3: Kojima siltstone Member, 4: Wakura diatomaceous mudstone Member, 5: glauconitic sandstone, 6: Nanao calcareous sandstone Member, 7: Akaura sandstone Member, 8: Andesite and andesitic pyroclastic rocks, 9: sampling localities.

Table 1. Correlation table of the Neogene Tertiary diatomaceous deposits distributed in Noto Peninsula, Central Japan.
" ": diatomaceous deposits.

Geological Age	Standard stratigraphic division of the oilfields in North Japan	Standard stratigraphic division in Hokuriku Region	Hijirikawa area	Nakajima area	Wakura — Notojima area	Suzu area
Pliocene	Shibikawa	Hanyu				
	Wakimoto	Himi	Ogijima Oginoya		Kojima	
Late Miocene	Kitaura	Otogawa	"Hijirikawa"		Akasaki	
	Funakawa		Hara	"Kasashio"	"Wakura" glauconite	"Iizuka" glauconite
Middle Miocene	Onnagawa	Higashibessho	Tonokuma Akage Shingu	Hamada	Nanao calcareous sandst. Akaura	"Iida diatomaceous mudstone member" "Hojuji diat. mst. m." Higashi-Innai
	Nishikurosawa	Kurosedani		Araya | Kusaki | "Yamatoda"	Nanahara	Yanagida
Early Miocene	Daijima	Iwaine		Anamizu	Anamizu	Anamizu

Nanao City. Most of the sandstone member consists of granule and coarse-grained sandstone. Fossils are very abundant, namely, sponge spicules, bryozoa, smaller foraminifers as *Nonion pompilioides*, *Angulogerina hughesi*, *Cassidulina margareta*, *Cibicides* sp., *Fissulina* sp., *Lagena apiopleura*, *Nonion nicobarense*, *Rotalia* sp., *Uvigerina* sp. etc., molluscs as *Patinopecten kagamianus permirus*, *Miyagipecten matsumoriensis*, *Nanaochlamys notoensis*, *Chlamys crassivenia*, brachiopods as *Terebratella coreanica*, *T. gouldi*, *Terebratulina japonica*, *T. crossei*, *T. peculiaris*, *Terebratella nipponensis*, *Laqueus rubellus*, *Coptothyris grayi*, and *Hemithyris psittacea* etc. are known to occur.

—— conformity ——

The glauconitic sandstone Member: This member is distributed in the Sakiyama, Nanao and Noto-jima areas. It represents the earlist phase of the Otokawa stage of which age is considered to be the Middle Miocene generally consists of a glauconitic sandstone, in which flinty shale is intercalated and this suggests an interruption of sedimentation or a diastem. These glauconitic sandstones or shales are thought to have been deposited on a shallow sea bottom and they have yielded abundant remains of a silicisponge such as *Aphrocallistes* sp. and a mollusc called *Chlamys crassivenia*.

—— conformity ——

The Wakura diatomaceous mudstone Member: This member has been studied by Takuji OGAWA (1908), Yanosuke OTUKA (1935) and Yoshio KASENO (1963) from the viewpoint of stratigraphy. The Wakura Member is distributed locally in the areas of Wakura, Okuhara and Ishizaki in the northern part of Nanao City. The Entsunagi mudstone Member, which is distributed at Han'noura, Suso, Sanami and Kôda of Notojima Island near Nanao City, coresponds to this member. The rock-facies is generally a homogeneous yellowish brown on a weathered surface and a bluish gray on a fresh surface diatomaceous mudstone. The fossils from the member are diatoms as *Actinocyclus flos*, *Actinoptychus senarius*, *Arachnoidiscus ehrenbergii*, *Coscinodiscus subtilis*, *C. lineatus*, *C. marginatus*, and *Stephanopyxis turris*, sponge spicules and pollen grains. This member is about 80 meters in thickness.

The member developed in the Wakura area forms a small basin structure.

- - - unconformity - - -

The Kojima sandstone Member: The member is developed locally in the mapped area, that is, it is distributed from near Kojima and Iwaya to the northwest of the Nanao Station. This sandstone member overlies with unconformity the Akaura sandstone and Nanao calcareous sandstone Members, and is a light bluish gray or grayish yellow silty sandstone containing abundant remains. Fossil molluscs from the member are such as *Turritella saishuensis motidukii*, *Neptunea* sp., *Epitonium angulatosimile*, *Dentalium* sp., *Pecten* spp., *Astarte hakodatensis*, *Cardium*, sp., and foraminifers as *Angulogerina hugesi*. This member attains about 100 meters in thickness.

- - - unconformity - - -

The Quaternary deposits of this district are classified into five units, namely, the Takashina, Okuhara, Nishiminato, Tokuda gravel Members and Holocene deposits in ascending order.

The Takashina Member which yielded such marine molluscs as *Cerilbideopsilla cingulata*, *C. djadjariensis* and *Tegillarca granosa* var. in its middle horizon may be correlated with the Kamitako Member (Middle Pleistocene) in the Himi district of Toyama Prefecture. It is noteworthy that the marine environment during the Middle Pleistocene along the Japan Sea coast is well represented in the Takashina Member.

The Okuhara Member including the Wakura-eki shell bed is classified into two members, that is, the lower or mud submember and the upper or sand submember. Marine molluscs as *Scapharca satowi*, *Dosinella penicillata* and *Paphia undulata*, and marine diatoms such as *Coscinodiscus* were found from the lower submember. A study of the deposits reveals that there occurred one major marine transgression which attained a maximum rise of 50 meters above the present sealevel during the Late Pleistocene, probably due to the glacial eustatic movement called the Hiradoko phase in the Hokuriku region. This phase can be correlated with the Shimosueyoshi phase of the Kwanto region, Central Japan.

The Nishiminato Member is divided into two submembers: the lower or mud and upper or sand submembers. The lower part of the mud submember preserves wood stumps and plant remains as *Trapa macropoda*, *Alnus japonica* and *Juglans mandshurica*, which indicate a marsh environment. Molluscs and diatoms of marine origin are found in the upper part of the mud submember, which may be correlated with the lower part of the Okuhara Member.

The Tokuda gravel Member is a non-marine deposit, the age of which is judged to be the Latest Pleistocene (Würm glacial age).

Palynological Research

(1) Foreword

As already stated different kinds of diatomaceous deposits occur in the Noto Peninsula, and there have yielded abundant microfossils as diatoms, flagellates, foraminiferes, pollen grains and spores. Although several papers have been published on the deposits, there were concentrated to stratigraphical investigations, and no literature has appeared concerning the fossil pollen grains and spores until comparatively recently. The writer has been studying the diatomaceous mudstone members, and previous works have been summarized (FUJI, 1964, 1966 & 1968) on the Early Miocene Yamatoda, Middle Miocene Hojuji and I'ida, and Late Miocene Hijirikawa, I'izuka and Nakayama-toge Members.

The purpose of the present study is to interpret the significance of the pollen grains and spores from the samples collected from the Late Miocene Wakura Member, mainly in terms of palaeoclimatic condition and palaeogeographical environment. These records, which are thought to reflect, in a relative manner in general, the fluctuation of atomospheric temperature in the southern part of Noto Peninsula during the Late Miocene to Pliocene, is based on the criteria gained by the writer during his about ten years palynological researches.

The samples taken by the writer in collaboration with NOHARA and KITAMURA, serve as an example for the application of the criteria for the pollen grains analysis of the samples from Central Japan.

(2) Sampling, Preparation of Materials and Method of Study

Among the samples analysed six (Sample nos. 1-6) were collected by the writer, KITAMURA and NOHARA in the summer season of 1961. The other samples (7a-7c and 8a-8g, ten samples in total) were obtained from two wells drilled for the research of the diatom earth distributed

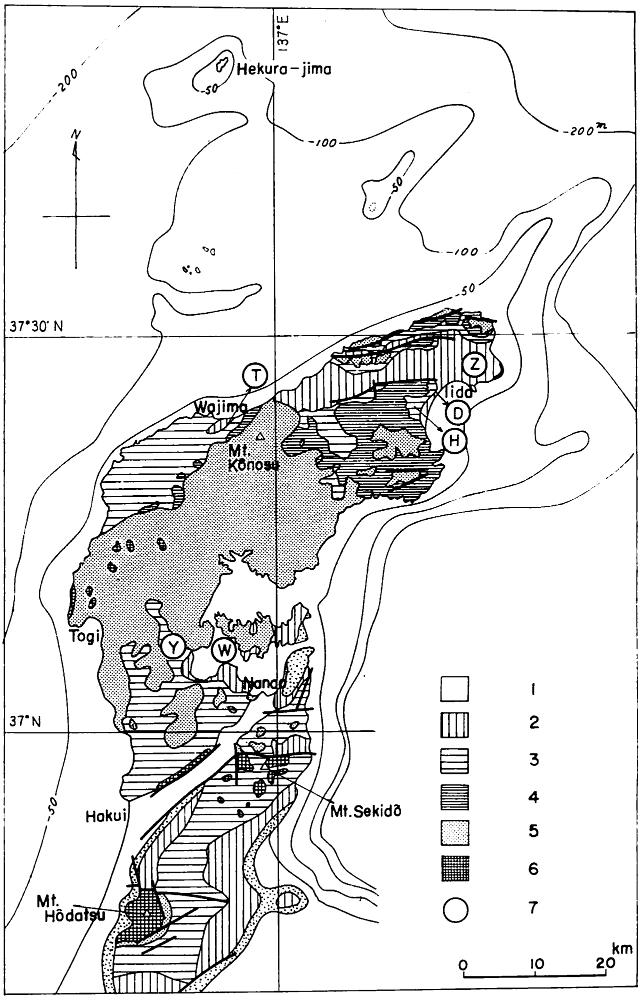

Fig. 2. Geological outline of Noto Peninsula and distribution of diatomaceous deposits (After W. ICHIKAWA & Y. KASENO, 1963). 1: (denoted by a few spot) Pliocene series, 2: Upper Miocene series, 3: Middle Miocene series (sedimentary rocks), 4: Middle Miocene series (pyroclastic rocks), 5: Lower Miocene series, 6: Pre-Tertiary system (granite & gneiss), 7: diatomaceous deposits: Z: I'izuka Member, T: Tsukada Member, W: Wakura Member, D: I'ida Member, H: Hojuji Member, Y: Yamatoda Member.

widely in Noto Peninsula. The sampling localities and stratigraphical horizons in the Wakura Member are shown in Figs. 1 and 3.

Of the sample collected from outcrops, one sample consisted of three to five pieces of rock ever collected at random along the length of one meter, measured parallel to the stratification of the member. These rock pieces were mixed together to form a composite sample, which is taken here to represent the

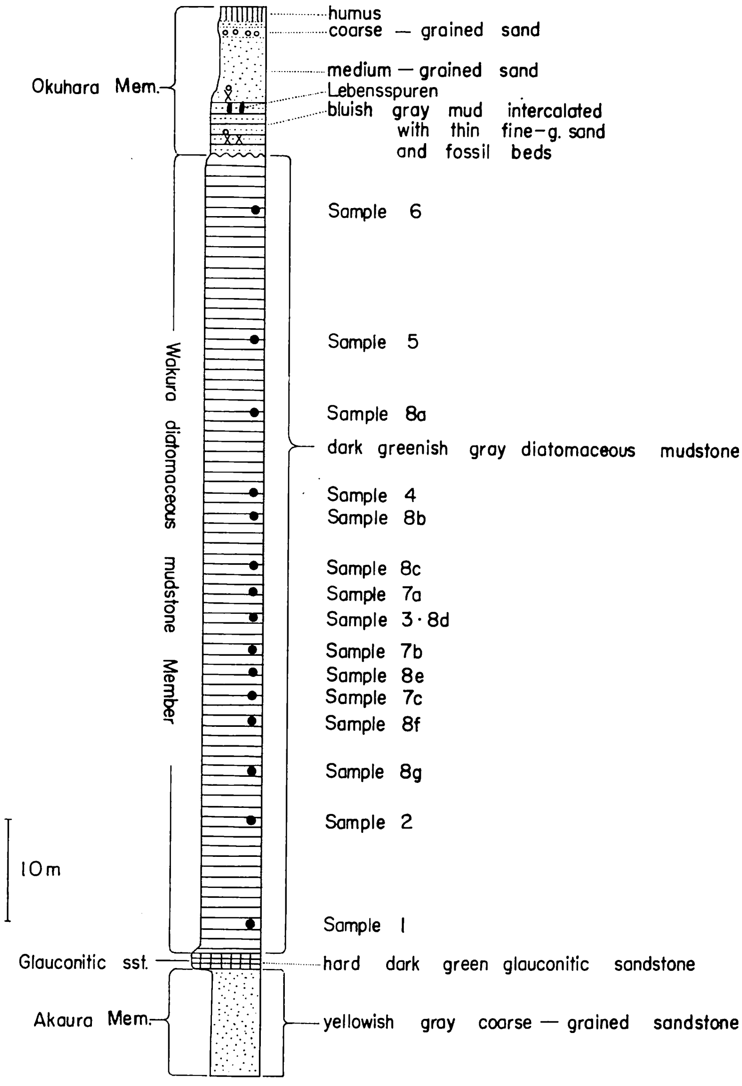

Fig. 3. Columnar section showing the sampling horizons of the Wakura diatomaceous mudstone Member.

outcrop. The present study is based on the composite samples. Many rock samples and separate specimens for reference at the writer's disposal, materially facilitated the present work in checking the distribution and confirming the identification of the pollen grains and spores.

The analytical procedure of the samples is the same as was stated previously by the writer (FUJI, 1965). The composite samples were treated by the NaOH-HF-acetolysis method.

To record the position of a specimen in the slide for taxonomical and biostratigraphical studies, Maltwood's finder or England finder were used to register the necessary specimens in this investigation.

The specimen registered in this study can be easily brought under the microscopic field whenever necessary by placing the slide which includes the specimen registered with the finder. The counting is made along the chosen lines with use of a mechanical stage and finder. All of the specimens which appeared while traversing the slide along the chosen line are observed and counted. The counting is continued until 200 specimens are identified and counted. When the specimens counted from one slide are less than 200, the counting is proceeded on another slide prepared from the same sample to count a total number of 200. Therefore, more than 10 slides must be prepared from each sample to count 200 specimens.

The frequency of each genus obtained by the count of 200 specimens from every sample is recorded on the distributed diagram. All of the stream slides are examined under the same magnification of 600 times in counting.

The slides counting the registered specimens are deposited in the collection of the Institute of Earth Science, Faculty of Education, Kanazawa University (register abbreviation: EKZJ), Kanazawa City, Ishikawa Prefecture, Japan.

(3) Description of the Pollen and Spore Assemblages

(a) General Statement

The present flora is composed of the species which are adapted to the physical phenomena which constitute the environment. But the fossil assemblage of any locality may be the total accumulation composed of a biocoenosis and/or a thanatocoenosis. Therefore, to interpret the geological and palaeoecological significances of the fossil assemblage it is necessary to make an analysis of the fossil composition from the viewpoint of the presence or absence, abundancy and distribution of every climatic element to know the palaeoclimatic condition and palaeogeographical environment at the time of deposition.

(b) Stratigraphical Relations of the Samples

The localities of the samples studied are widely distributed in the present field and the depths from the surface in the wells drilled may be correlated to the exposures on the surface. They can be illustrated as a columnar section and for the sake of convenience are called horizons in this work. Here, the term horizon is used to denote the same or nearly same stratigraphic position or level within the stratigraphic unit.

The samples analysed in the present work can be classified into 13 horizons shown as the columnarl section (Fig. 3).

(c) Description of Assemblages

The assemblage of the fossil pollen grains and spores found from the analysed 16 samples is shown in Figs. 4-8, and is explained as follows in ascending order.

Sample 1: This sample which belongs to the lowermost horizon of the Wakura Member. It yielded, Gymnosperm-four genera and one family; Dicotyledon-12 genera and two subgenera; Monocotyledon-two families and one genus; and 4 genera of spores. Among them, *Pinus* and Gramineae are abundant, 11% in frequency, being the highest concentration in this composite sample. *Quercus* (evergréen), this genus includes two types, one is of large size and the other of small size based on the diameter of grain, the latter belongs to the evergreen

6%. Gymnosperm appers with a high rate of 23%, and Dicotyledon, Monocotyledon and Pteridophyta are respectively type, and attains 6%. *Juglans* and *Myriophyllum* are common, both being about 46%, 14% and 29%. *Metasequoia*, *Cunninghamia*, *Glyptostrobus*, *Taiwania*, the evergreen *Quercus* and *Liquidambar* are the representative plants of a warm temperate and subtropical region and

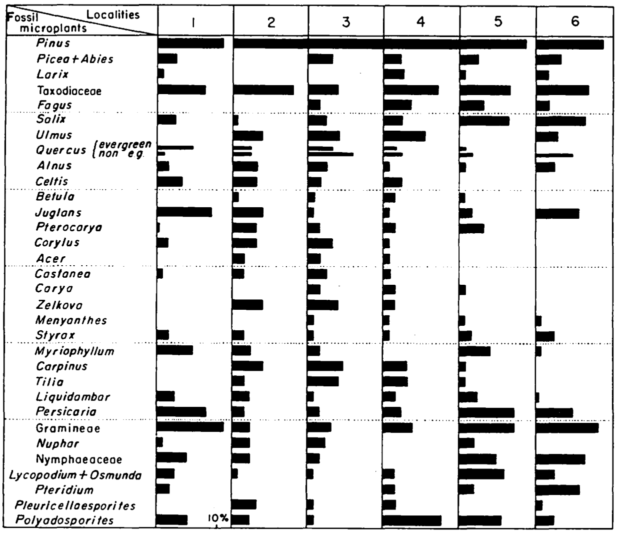

Fig. 4. Pollen diagram (1) of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3.

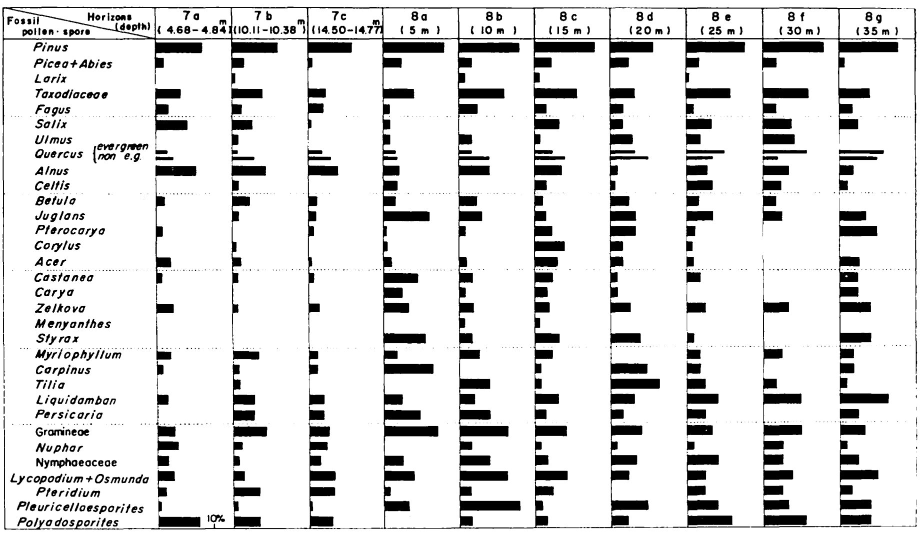

Fig. 5. Pollen diagram (2) of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3.

are denoted by "B" in Fig. 6. *Pinus*, *Tsuga*, Taxodiaceae without the warm elements mentioned above, the deciduous *Quercus*, *Zelkova*, *Fagus*, *Salix*, *Juglans*, *Castanea*, *Tilia* and *Ilex* are the representative plants of the temperate to cool temperate regions analogous with the Hokuriku region (indicated by "C" in Fig. 6). Also admixed in the composite sample are *Abies*, *Picea*, *Fagus*, *Betula* etc., the representative plants of the cooler to cold regions (indicated by "A" in Fig. 6). According to the result, "A" appeared with a very low frequency of 7% in total. On the contrary, the plants of the warmer type denoted as "B" and the cool temperate type "C" are respectively 16% and 77% in frequency. The frequency of the spore which certainly belongs to Pteridophyta is as high as that of an originary marine deposit, being 10%. The frequency of the plants of the warm temperate and subtropical regions gives the highest ratio in the treated sample. The phenomena seem in the composite sample will be explained in later pages on the discussion on the palaeoclimatic condition and palaeogeographical environment.

To facilitate considerations on the ecological environments under which some ancient plants lived, the modern equivalents of the fossil species are grouped into four habitats, namely upland, mixed-slope, stream-side or riparian, and lake or marshy elements. From the viewpoint of the above mentioned significant statistics the fossil pollen grains and spores from this composite sample can be classified into upland, mixed-slope and stream-side elements, occupying respectively 18%, 38% and 44% of the total.

Sample 2: The composite sample yielded one genus and one family of the Gymnosperm (23%), 17 genera and two subgenera of the Dicotyledon (60%), one genus and two families of the Monocotyledon (9%), three genera of the Pteridophyta and two genera of the other groups (1% and 7% respectively). Among them, *Pinus* and Taxodiaceae are abundant (13% and 10% respectively). *Ulmus*, *Juglans*, *Zelkova* and *Carpinus* are common (5% to 6%). The other genera and families are rare in frequency. The boreal elements attain 5%, the temperate ones 87% and the others indicated by "B" in Fig. 6 about 8%.

The fossil pollen grains and spores found from the composite sample are divided into three groups based on the habitat as follows;

upland element..................20%
mixed-slope element 52%
stream-side and/or riparian
element 28%

Sample 8g: The sample was taken from the well drilled at Locality No. 8 situated about 150 meters northwest of the Wakura Station. A depth of the sample is about 35 meters below the present ground surface. The analysed sample contains three genera and one family of the Gymnosperm (16%), 17 genera and two subgenera of the Dicotyledon (66%), two genera and one family of the Monocotyledon (8%), and three genera of the Pteridophyta and two genera of plants lower than Pteridophyta (respectively 8% and 10%).

Among the pollen grains and spores found from the sample, *Pinus* is abundant (10%). It is noteworthy that *Liquidambar* and evergreen *Quercus* as the representative plants of warm elements are 8% and 7% respectively in frequency. The other genera and families are few, ranging from 1% to 6%. The boreal (indicated by "A"), warm (indicated by

" B ") and temperate (indicated by " C ") elements are respectively 4%, 21% and 75%. As the mentioned previous in the description, the relative frequency of the warm climatic elements obtained from this sample is higher than those from Samples 1 and 2. On the other hand, the upland, mixed-slope, and stream-side and/or riparian elements are 17%, 38% and 45% respectively.

Sample 8f: Although the locality of this sample is similar to that of Sample 8g, its depth is about 30 meters below the present ground surface. This sample yielded three genera and one family of Gymnosperm (16%), 12 genera and two subgenera of the Monocotyledon (12%), and three genera of the Pteridophyta and two genera belonging to another group (8% and 13% respectively). *Pinus*, Taxodiaceae and evergreen *Quercus* are abundant (respectively 10%, 8% and 7.5%). *Liquidambar* is the representative plant of warm element (7%). For this sample the relative frequency of warm components is higher than those from some higher horizons. Namely, the boreal, warm and cooler temperate elements are 9%, 19% and 72% respectively. The upland, mixed-slope and stream-side elements are 21%, 42% and 37% respectively.

Sample 7c: This sample is from the well drilled at Locality No. 7 situated about 100 meters north of the Wakura Station. The depth of the sample is 14.50-14.77 meters below the present ground surface. The sample yielded three genera and one family of Gymnosperm (15%), 13 genera and two subgenera of Dicotyledon (38%), two genera and one family of Monocotyledon (12%), three genera of Pteridophyta and two genera belonging to the plants lower than Pteridophyta which shows 12% and 6% respectively. Among them, *Pinus* is abundant (10%). *Alnus, Liquidambar* and *Osmunda* are common, being 6% in every genus. The other genera and families are rare (1% to 4%). *Liquidambar* is the representative plant of warm component but amounts to 3%. The cold or subalpine, warm and temperate elements are respectively 13%, 13% and 74%. The upland, mixed-slope and stream-side and/or riparian elements are 23%, 54% and 23% respectively.

Sample 8e: The sample is from the well drilled at Locality No. 8, and its depth is 25 meters below the present ground surface. The sample yielded four genera and one family to the Gymnosperm (20%), 18 genera and two subgenera of Dicotyledon (54%), two genera and one family of Monocotyledon (10%), three genera of Pteridophyta and two genera belonging to the plants lower than Pteridophyta, attaining respectively 6% and 10%.

The relative frequency of *Pinus*, Taxodiaceae and *Polyadosporites* are 10%, 7% and 6.5% respectively. Evergreen *Quercus*, Gramineae, Nympaceae, *Lycopodium* and *Osmunda* are common (5% to 6%).

The boreal, warm and temperate elements are respectively 9%, 16% and 75%. In connection with the palaeogeographical environment the stream-side and/or riparian, upland and mixed-slope elements are 34%, 52% and 14% respectively.

Sample 7b: From this sample, of which the locality is similar to Lolality No. 7, *Pinus* is abundant, being 10%.

The genera of common frequency are Taxodiaceae, *Alnus*, Gramineae, *Pteridium* and *Polyadosporites*, being about 6% to

7%. *Picea, Abies, Fagus, Salix,* deciduous *Quercus, Betula, Acer, Liquidambar, Persicaria, Nuphar, Lycopodium* and *Osmunda* are of rare frequency, and the other genera are very few. Gymnosperm includes *Pinus, Picea, Abies, Larix* and Taxodiaceae (about 20%). Dicotyledon containing mainly *Alnus, Myriophyllum* and *Liquidambar* etc., Monocotyledon and Pteridophyta respectively 44%, 10% and 8%. The boreal, temperate and warm elements are respectively 16%, 8% and 76%.

The upland, mixed-slope and stream-side components are 18%, 50% and 32% respectively.

It is noteworthy that the relative frequency of the warm climatic elements such as *Liquidambar* and evergreen *Quercus* which occurred from the horizons higher than that of Sample 7b is lower than that of the other horizons. In the horizon lower than that Sample 7b the warm climatic elements show frequency higher than that of the cold and/or cooler climatic elements.

Sample 3: The composite sample is from Locality No. 3, situated at about 500 meters northerneast of the Wakure Station.

Pinus and deciduous *Quercus* are abundant (10% to 12.5%). Taxodiaceae, *Ulmus, Zelkova, Carpinus* and *Tilia* are of common (5%) without *Carpinus* which is about 6% in frequency. The other genera and families are rare (less than 3%).

The cold, temperate and warm climatic elements are 11.7% and 82% respectively. The upland, mixed-slope and riparian and/or stream-side components are respectively 17%, 55% and 28%.

Sample 8d: The stratigraphical horizon of this sample is similar probably to that of Sample 3.

Tilia, Pinus, deciduous *Quercus, Carpinus* and *Pleuricelloesporites* are abundant in relative frequency. The boreal, temperate and warm climatic elements are 11%, 11% and 78% in relative frequency.

In the connection with the palaeoecological environment the stream-side and/or riparian, upland and mixed-slope components are 35%, 10% and 55% respectively.

Sample 7a: This sample, of which the locality is similar to Locality No. 7, yielded: *Pinus* is abundant (10%). The other genera showing a high frequency except for *Pinus* are *Alnus* and *Polyadosporites* (9%). All of the Taxodiaceae, *Salix* and *Nuphar* are common (4% to 6%). *Liquidambar* (2%) represents a warm climate together with the evergreen *Quercus.* All of *Picea, Abies, Fagus* and *Betula,* which grow under a climate cooler than that of the present day Hokuriku region, are 2% in relative frequency. Gymnosperm contains three genera and one family (17%), Monocotyledon has one genus and two families (11%), Dicotyledon comprises 11 genera and two subgenera (57%), Pteridophyta and five other genera, amount to about 15%. The warm, temperate and cold climatic elements are respectively 7%, 83% and 10%. In respect to the palaeoecological environment, the upland, mixed-slope and stream-side components are 21%, 51% and 28% respectively.

Sample 8c: With respect to the assemblage of specimens found from this sample which is from about 15 meters below the present ground surface in Locality No. 8, the Gymnosperm containing four genera and one family (20%); the Dicotyledon 20 genera and two subgenera (61%), the Monocotyledon one genera and two families (8%), and the Pteridophyta and the others amount to 11%.

The warm, temperate and cold climatic components are 9%, 81% and 10% respectively, and the upland, stream-side and/or riparian and mixed-slope elements respectively 14%, 32% and 54%.

Sample 8b: This sample yielded twenty two genera, two subgenera and three families; namely, four genera and one family of Gymnosperm (20%); Monocotyledon one genera and two families (15%); Dicotyledon 16 genera and two subgenera (43%); Pteridophyta three genera (10%) and the other group gave a frequency of 12%. The boreal climatic plants such as *Picea, Abies, Larix* and *Betula* amounted to 16%, the plants which grow in the temperate climatic region 76% and the warm climatic elements 8%. With respect to the palaeoecological environment the upland, mixed-slope and stream-side or riparian elements are respectively 17%, 58% and 25%.

Sample 4: The mixed sample from Locality No. 4, where situated about 1 km north of the Wakura Station, belongs to the middle horizon of the Wakura Member.

This sample yielded four genera and one family of the Gymnosperm (27% in total frequency), 19 genera and two subgenera of Dicotyledon (46%), one genus of Monocotyledon (5%), three genera of Pteridophyta (4%) and two genera of the other lower plants.

Among the pollen grains and spores from the sample, *Pinus* is abundant (13%), deciduous *Quercus* and *Carpinus* are common (7% and 6% respectively), and the others are rare or few (1% to 5%).

The boreal (A), warm (B) and temperate (C) climatic elements are respectively 24%, 7% and 69%. And also, the upland, mixed-slope and stream-side components are respectively 19%, 55% and 26%.

Sample 8a: The sample is from the well drilled at Locality No. 8 situated northwest of the Wakura Station. The depth of the sample is some 5 meters below the present ground surface.

Among the pollen grains and spores found from the sample, Gymnosperm attains 18%, Monocotyledon 12%, Dicotyledon 54%, Pteridophyta 12% and the others 4%. *Pinus*, Gramineae and *Carpinus* are abundant (8% to 10%); *Juglans, Castanea, Stylax* and *Persicaria* are common (6% to 8%); the boreal, warm and temperate elements are respectively 8%, 7% and 85%, and the stream-side and/or riparian, mixed-slope and upland elements are 44%, 42% and 14%. It is noteworthy that the stream-side and/or riparian components such as *Salix, Celtis, Juglans, Pterocarya, Styrax* and *Liquidambar* etc. are more common than the mixed-slope and upland elements.

Sample 5: The mixed sample is collected from Locality No. 5 at about 200 metres south of the Wakura Station. This sample belongs to the middle part of the upper horizon of the Wakura Member.

The upland, mixed-slope andstre amside elements are respectively 20%, 35% and 45%. The cold, warm and temperate climatic elements contain 18%, 7% and 75% respectively.

The Gymnosperm including *Pinus, Picea, Abies* and *Larix* (23% in relative frequency), Monocotyledon (18%), Dicotyledon (42%), Pteridophyta (10%) and others (7%) are found. *Pinus*, Taxodiaceae, *Salix*, *Persicaria* and Gramineae represent the pollen-flora of Sample 5.

Sample 6: The mixed sample from Locality No. 6, where situated at about 500 meters west of the Wakura Station, belongs to the uppermost horizon of the Wakura Member. At this locality the Pleistocene Okuhara Member overlies with unconformity the Wakura diatomaceous mudstone Member and was analysed for a palynological research. The Wakura-eki shell bed (NI'INO & YAMADA, 1946) occupies the lower part (mudstone in rock-facies) of the Okuhara Member. The horizon of this Sample 6 is just under to the unconformity separating member mention ed above.

The pollen-flora of Sample 6 is represented by *Pinus*, Gramineae, Taxodiaceae and *Salix* (11%, 10%, 8.5% and 8% re-

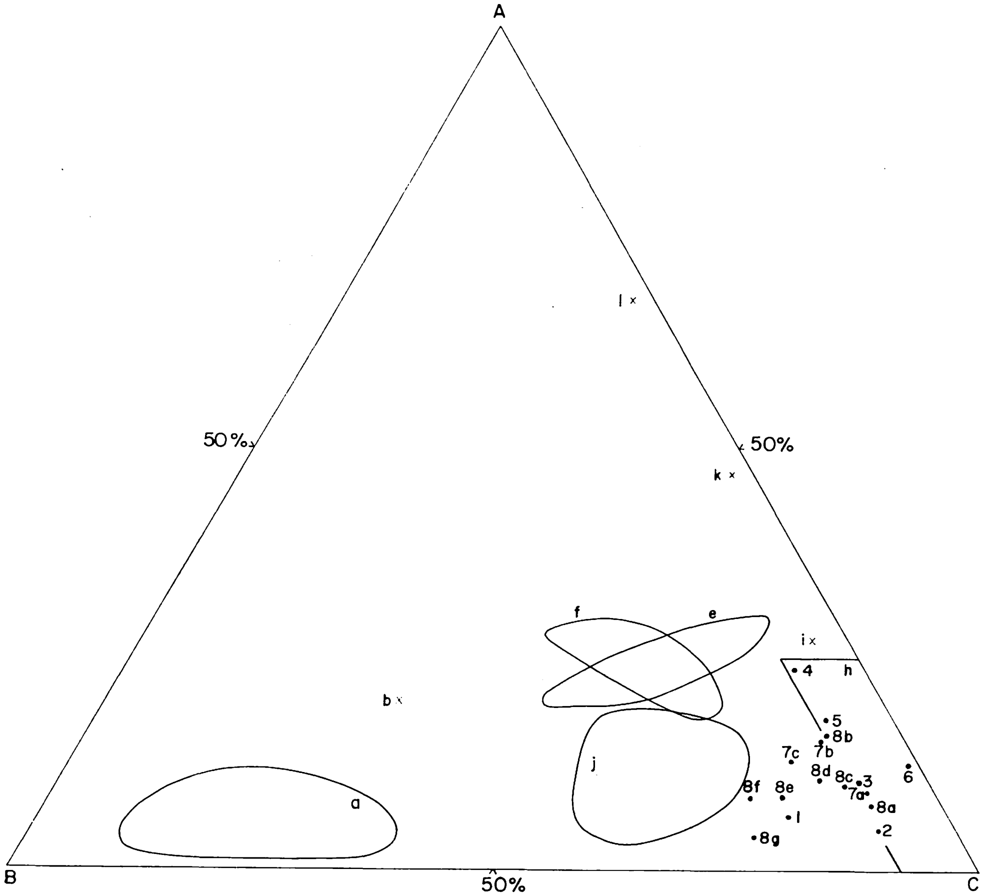

Fig. 6. Pollen diagram (3): Triangular diagram showing the relationship between cold & cool climatic, temperate climatic and warm climatic elements found from several samples of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3. a: Yamatoda Member, b: Sunagozaka Member, e: Hojuji Member, f: I'ida Member, h: present deposit of Lagoon Hojozu-gata, i: Nakayama-toge Member, j: Hijirikawa Member, k: Takakubo Member, l: Omma Member. A: cold & cool climatic element, B: warm climatic element, C: temperate climatic element.

spectively). The Gymnosperm (one family and four genera in this sample) attains 24.5%, Monocotyledon (two families 18%, Dicotyledon (ten genera and one family) 43.5%, Pteridophyta (three genera) 10% and the other (two genera) 4%.

In respect to the palaeoecological environment, the upland, mixed-slope and stream-side and/or riparian elements are respectively 18%, 42% and 40% in relative frequency.

(4) Discussion

From analysis of the pollen grains and spores a general interpretation can be made of the physical conditions prevailing during growth of the sedimentary basin in which they were found. In this section, the writer will discuss on the palaeoclimatic condition, palaeographical environment and geological age of the stratigraphical units based upon the microfossils.

(a) Palaeoclimatic Condition

The pollen grain and spore assemblages have been analysed and from the results the general characters of the palaeoclimatic condition can be presented. The methods for analysing assemblages for palaeoclimatic interpretation have been developed by ERDTMAN, FAEGRI and IVERSEN, besides palynologists, and the writer has used another method for palaeoclimatic analysis of his palynological researches on the Neogene Tertiary and Holocene deposits developed along the coastal region of Japan Sea, and reported that the results agreed well with the climatic indications deduced by the other methods (FUJI, 1964 & 1966). The methods used by the present writer are classified into a warmth index, triangular and/or quadrilateral diagrams.

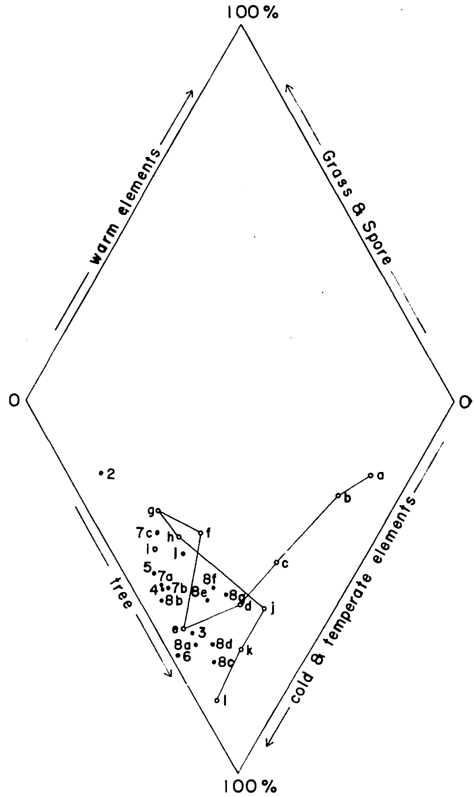

Fig. 7. Pollen diagram (4): Quadrilateral diagram showing the palaeoclimatic condition and palaeoecological environment during the sedimentation of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3. a: Yamatoda Member, b: Sunagozaka Member, c: Higashi-in'nai Member, d: Najimi Member, e: Hojuji Member, f: I'ida Member, g: Wakura Member, h: I'izuka Member, i: Nakayama-toge Member, j: Hijirikawa Member, k: Takakubo Member, 1: Omma Member.

According to the writer's investigation, as shown in the triangular diagram (Fig. 6), the warm and subtropical plants such as *Liquidambar* and *Metasequoia* from the Wakura Member is far less in number of specimens than from the Yamatoda and Sunagozaka Members which correspond to the Daijima stage, namely, the latter yielded 61% to 85% in average for the total specimens, and the former 8% to 16%. The present result is closely similar to the analytical results on the pollen and spore assemblages from the Hojuji and I'ida Members studied previously (FUJI, 1966). With respect to the relative frequency of warm and subtropical elements found throughout this member, the higher the horizon is, the less the frequency becomes. However, on the contrary in respect to the cool and cold elements, the higher the horizon is, the more the frequency becomes. The relationship between the temperate, warm and cold elements is illustrated in Fig. 9.

Comparison between the fossil plants and similar living equivalents whose climatic requirements are known is frequently used for climatic analysis of a fossil flora. Where the modern relationships are known definitely, this method is probably useful for accurate information. The Neogene Tertiary species are comparatively modernized in morphological features, so it is not difficult to compare them with living equivalents with some exceptions. The genera comprising the Neogene flora in Japan are mostly distributed now in East Asia, and nearly all of the temperate Dicotyledonous genera in the fossil flora are now growing in Japanese Islands. However, exotic genera are sometimes commonly contained in the fossil flora. The exotic coniferous genera such as *Metasequoia, Glyptostrobus, Sequoia, Pseudolarix* and *Keteleeria* are found throughout the Neogene flora of Japan, and they are mostly living now in China, and some of them are known in the western part of North America. The nearest living equivalents of the pollen floras from thd Wakura Member and their modern distribution in East Asia are shown in Table 2. According to this table, the Wakura pollen flora consists mainly of temperate genera, with warm climatic elements commonly associated. The dominant genera among the temperate ones are *Alnus, Fagus, Castanea, Quercus, Ulmus, Zelkova, Acer* and *Tilia*. The modern species equivalent to them, according to TANAI (1961), are mostly distributed in Japan proper, especially from Central Japan to Kyûshû. However, some of them are rather luxuriantly distributed in Northern Honshû and Hokkaido. Further, the pollen flora sometimes contains many exotic conifers such as *Cunninghamia, Taiwania, Metasequoia, Glyptostrobus* and *Liquidambar* of the Dicotyledons, though they are not abundant in number of specimens and are rather relicts which survived from the previous Yamatoda and Sunagozaka pollen floras. Such presumption regardingthe climatic conditions is supported by the fact that the pollen flora frequently contains the warm climatic elements.

Thus, according to the writer's researches, the pollen flora of the Wakura Member comprises temperate and warm climatic elements mingled in floristic composition as already described in the previous part of this work. From the viewpoint of leaf character analysis reported on the Late Miocene floras from various localities by TANAI (1961) the Wakura pollen flora is related to the present temperate or somewhat temperate forest in Central and Southern Japan, and they seem to have grown under a warm temperate climatic condition. However, the reduction of warm and subtropical plants evidently indicates that the temperature had lowered in comparison with that of the Daijima stage.

(b) Palaeogeographical Environment

To facilitate the considerations on the

Table 2. Modern equivalents of the fossil microplants from the Wakura diatomaceous mudstone Member.

Fossil microplants	Near fossil macroplants	Modern equivalent macroplants	1	Japan					7	8	China					Habitat
				2	3	4	5	6			9	10	11	12	13	
Pinus	*P. palaeopentaphylla*	*P. parviflora*		×	×	×										U
Abies	*A. protofirma*	*A. firma*			×	×	×	×								M
Picea	*P. kaneharai*	*P. polita*				×	×	×								U
	P. jessoensis	*P. jessoensis*	×	×						×					×	M
	P. koribai	*P. excelsa*														M
Larix																U
Taxodiaceae	*Cun. protokonishii*	*C. konishii*							×							U
	Gly. europaeus	*G. pensilis*											×			R
	Met. occidentalis	*M. glyptostroboides*										×				M
	Seq. affinis	*S. sempervirens*														M
	Tai. japonica	*T. cryptomeroides*							×				×	×		U
	Tax. dubium	*T. distichum*														R
Fagus	*F. palaeocrenata*	*F. crenata*	×	×	×	×	×									M~U
	F. protojaponica	*F. serrata*		×	×	×	×									M
Ulmus	*U. protojaponica*	*U. japonica*	×	×	×	×			×	×	×				×	R
	U. protolaciniata	*U. laciniata*	×	×	×	×			×	×	×					M
	U. subparvifolia	*U. parvifolia*					×	×				×	×			M
Salix	*S. k-suzukii*	*S. jessoensis*		×	×	×										R
Quercus (evergre.)	*Q. protosalicina*	*Q. salicina*		×	×	×	×		×							M
Quercus (non e.g.)	*Q. miocrispula*	*Q. crispula*	×	×	×	×	×			×	×	×			×	M
	Q. protodentata	*Q. dentata*	×	×	×	×	×		×	×	×	×		×	×	M
	Q. protoserrata	*Q. serrata*	×	×	×	×	×			×	×	×	×	×		M~R
Alnus	*A. miojaponica*	*A. japonica*	×	×	×	×	×						×		×	R
	A. protohirsuta	*A. hirsuta*	×	×	×	×	×								×	M~R
	A. protomaximowicziana	*A. maximowicziana*	×	×	×				×						×	U
Juglans	*J. nipponica*	*J. ailanthifolia*	×	×	×	×	×	×								U
Celtis	*C. nathorsti*	*C. jessoensis*	×	×	×	×	×		×							M
	C. nordenskiöldii	*C. occidentalis*														M
Betula	*B. miomaximowicziana*	*B. maximowicziana*	×	×	×											M~U
	B. onbaraensis	*B. grossa*		×	×	×	×									M
	B. protoermanni	*B. ermanni*	×	×	×				×							M~U
	B. protoglobispica	*B. globispica*		×	×											M

	B. protojaponica	*B. japonica*	×	×	×											M
Pterocarya	*P. nipponica*	*P. rhoifolia*		×	×	×	×	×			×					M~R
	P. asymmetrosa	*P. paliurus*										×	×	×		R
	P. protostenoptera	*P. stenoptera*								×	×	×	×	×		R
Corylus																M
Acer	*A. nordenskiöldi*	*A. palmatum*			×	×	×	×								M
	A. palaeodiabolicum	*A. diabolicum*			×	×	×	×								M
	A. palaeorufinerve	*A. rufinerve*			×	×	×	×								M
	A. protojaponicum	*A. japonicum*		×	×	×	×	×								M
	A. protosieboldianum	*A. sieboldianum*		×	×	×	×	×								M
	A. prototrifidium	*A. trifidium*										×	×			M
	A. pseudocarpinifolium	*A. carpinifolium*			×	×	×	×								M
	A. submayri	*A. mono*		×	×	×	×	×		×	×			×	×	M
	A. svbpictum	*A. mono*		×	×	×	×	×		×	×			×	×	M
Castanea	*C. miocrnata*	*C. crenata*	×	×	×	×	×									M
Carya	*C. miocathayensis*	*C. cathayensis*										×	×			M
Zelkova	*Z. ungeri*	*Z. serrata*		×	×	×	×		×			×	×			M
Menyanthes																R
Styrax	*S. protoobassia*	*S. obassia*		×	×	×	×	×		×	×				×	M
	S. japonica	*S. japonica*		×	×	×	×	×		×	×	×				M
Carpinus	*C. miocenica*	*C. laxiflora*	×	×	×	×	×		×							M
	C. nipponica	*C. lanceolata*										×	×			M
	C. stenophylla	*C. carpinoides*		×	×	×	×									M
	C. subcordata	*C. cordata*	×	×	×	×	×		×	×	×	×			×	M~R
	C. subyedoensis	*C. tchonoskii*		×	×	×	×		×			×				M~R
Tilia	*T. distans*	*T. amuraensis*								×	×	×				M
	T. miohenryana	*T. henryana*										×	×			M
	T. protojaponica	*T. japonica*		×	×	×	×	×							×	M
Liquidambar	*L. mioformosana*	*L. formosana*						×				×	×	×		R

Member and their modern distribution

Modern Distribution

1 : Saghalien and Kurile Is., 2 : Hokkaido, 3 : Northern Honshû, 4 : Central Honshû, 5 : Southwestern Honshû, 6 : Kyûshû and Shikoku, 7 : Formosa and Loochoo Is., 8 : Korea, 9 : North China, 10 : Central China, 11 : Southeastern China, 12 : Southwestern China, 13 : Manchuria and Primorskaya Prov.

Habitat

U : upland, M : mixed-slope, R : riparian and stream-side

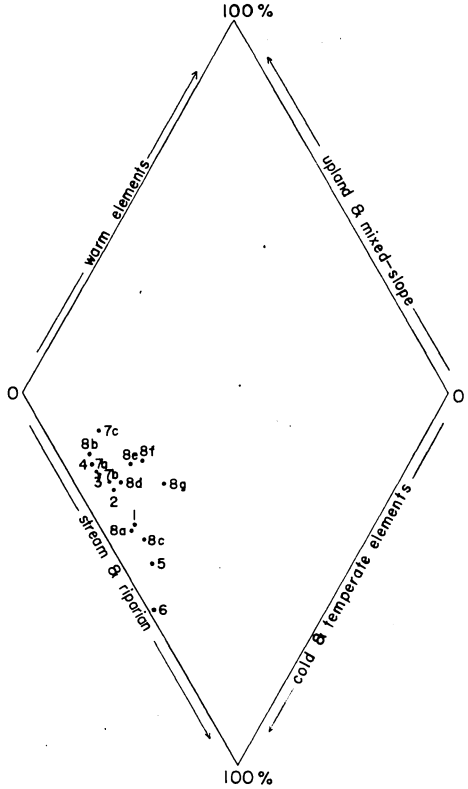

Fig. 8. Pollen diagram (5) : Quadrilateral diagram showing the relationship between cold & temperate climatic and warm climatic elements, stream & riparian and upland & mixed-slope elements found from several samples of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3.

probable ecological environments under which some ancient plants lived, the modern equivalents of the fossil species are grouped according to their habitats, namely; four types of upland, mixed-slope, stream-side or riparian, and lake or marshy elements.

The Wakura pollen flora is mainly comprised of mixed-slope or mixed-slope—riparian plants in number of specimens, and also contains upland—mixed-slope plants. Namely, this flora seems to represent a mixed-slope to riparian forest. For instance, the mixed-slope plants amount to 44% in frequency on average, stream-side and riparian plants 30% and the remainder of upland plants. On the other hand, judging from the lithofacies, poor contents of planktonic foraminifers, fossil diatom assemblages and diversity in the thickness of the deposits, the sea under which the Wakura Member was deposited during the Neogene Tertiary seems to have been a more or less closed embayment in the Wakura area of central part of Noto Peninsula, though the sea in southern part of Noto Peninsula widened during the Late Miocene age. The spread of this semi-opened sea is shown in Fig. 10.

The friquency of grass-pollen grains and spores have been generally accepted to be related to the geographical environments. Accordingly, such presumption on the marine terrain is supported by that the frequency of the grass-pollen grains and spores ranges from 36% to 50% in the Wakura Member, though from 26% in the Hijirikawa to 46% in the I'izuka Members.

(c) Geological Age

In the Japanese Islands the correlation and age determination of the Tertiary floras have been frequently made by the use of several characteristic fossils and assemblages. The Neogene flora of Japan has been described by YABE and ENDO, SUZUKI, TANAI and many other authors, and consequently the floristic composition of each flora is comparatively well known at present. On the basis of these researches, TANAI (1961) classified the Neogene floras of Japan into six types, considering the floristic composition and components, along with the geological ages indicated by them.

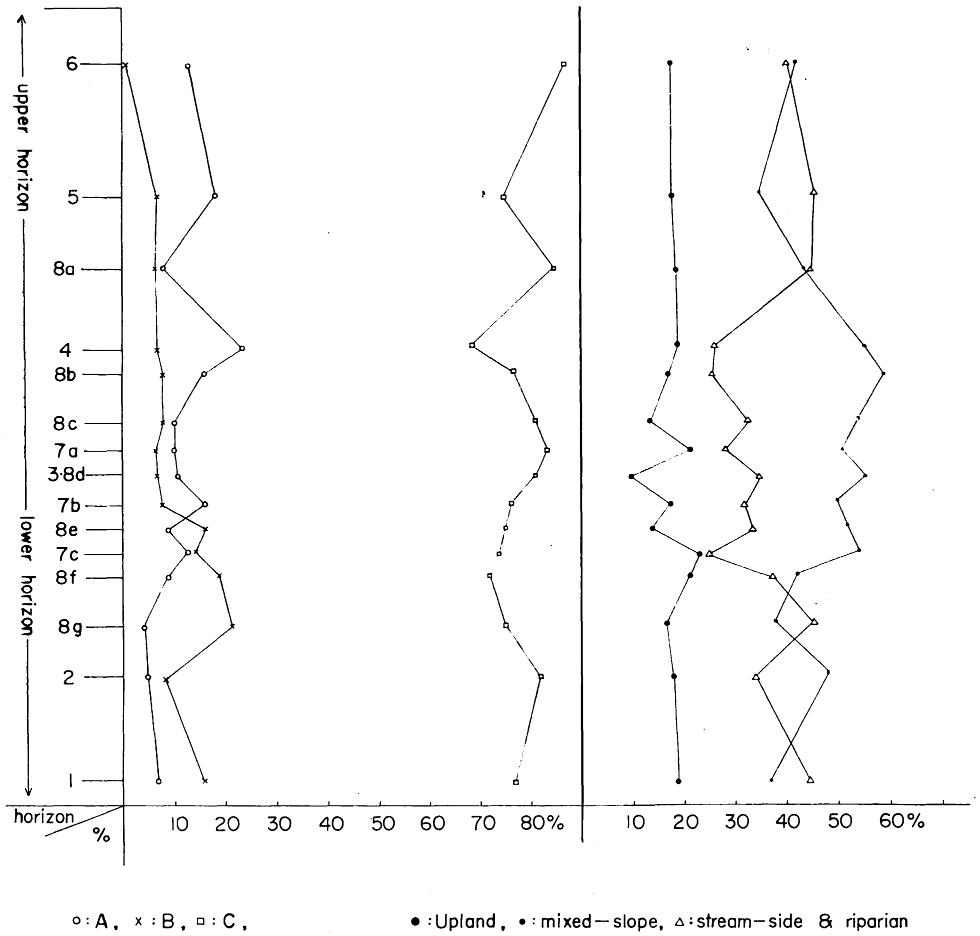

Fig. 9. Pollen diagram (6) : Figure showing the relationship between cold & cool climatic, temperate climatic, warm climatic, upland, mixed-slope and riparian elements found from several samples of the Wakura diatomaceous mudstone Member. Numbers refer to Figs. 1 and 3.

These types are in ascending order the Ainoura (Earliest Miocene), Aniai (Early Miocene), Daijima (Middle Miocene), Mitoku (Late Miocene to Mio-Pliocene), Shinjô (Early Pliocene) and Akashi (Late Pliocene) types.

The Wakura pollen flora is very similar in generic composition to the Mitoku-type flora. It contains a few exotic elements which are found abundantly in the Noroshi and Yamatoda floras. It is commonly found in the Late Miocene floras of Europe and in the western part of the United States where the modernized plants are dominant. Thus, in comparison with various floras of the Neogene in Japan and from the viewpoint of its stratigraphical evidences the Wakura pollen flora can be nearly correlated with the Mitoku-type flora, and the geochronological position of the Wakura Member seems to be Late Miocene.

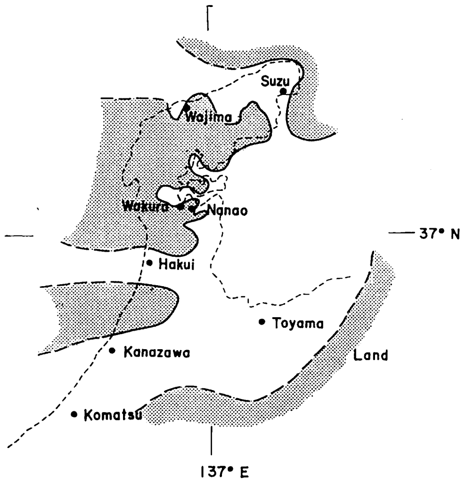

Fig. 10. The Palaeogeographical map during the sedimentation of the Wakura diatomaceous mudstone Member (the Otogawa stage of Late Miocene age) (After Y. KASENO, 1963).

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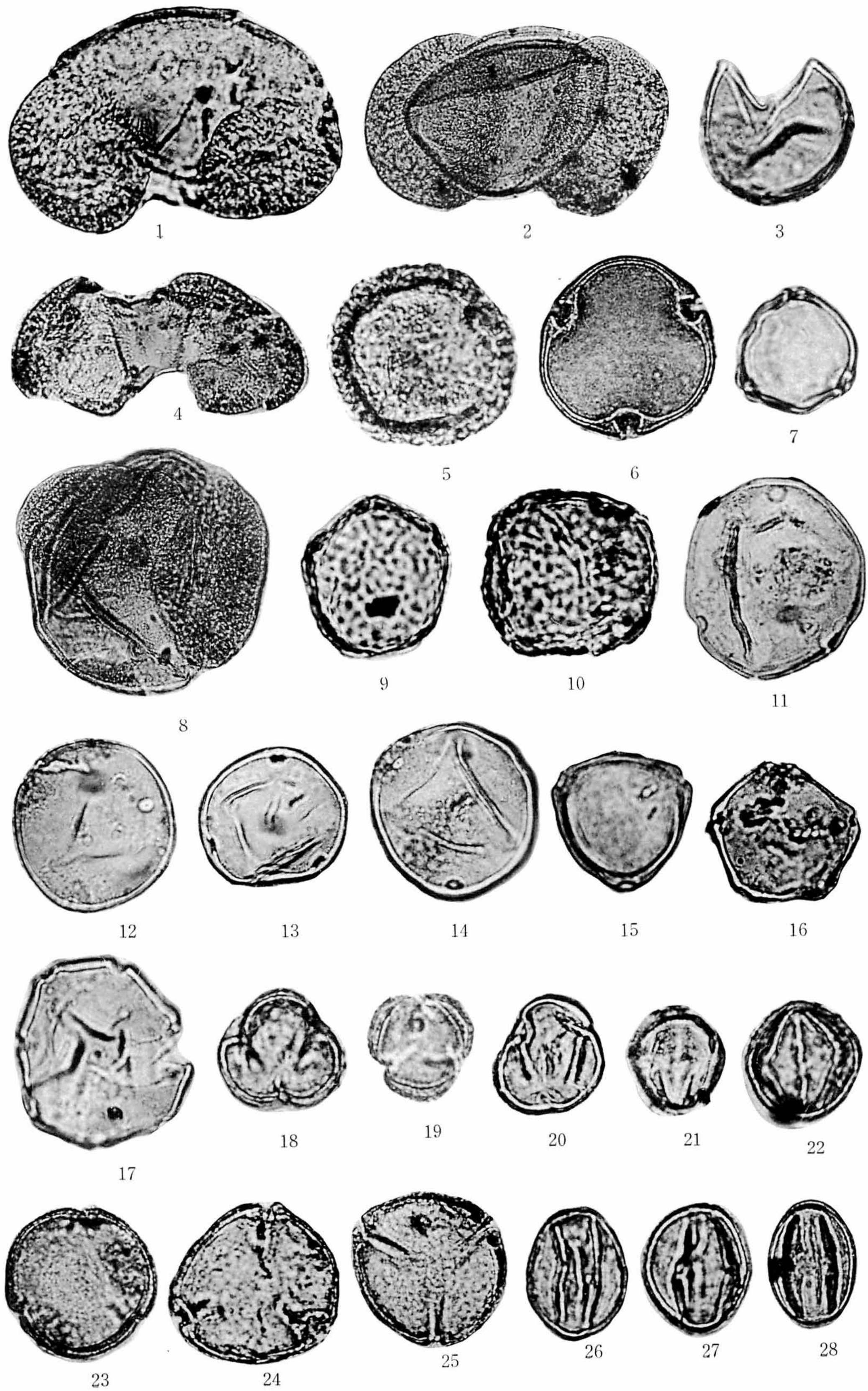
Explanation of Plate 1

Fig. 1: *Picea;* Locality 3; EKZJ coll. cat. no. 20019.
Fig. 2: *Abies;* Locality 8, Horizon b; EKZJ coll. cat. no. 20020.
Fig. 3: Taxodiaceae; Locality 7, Horizon a; EKZJ coll. cat. no. 20021.
Fig. 4: *Podocarpus;* Locality 7, Horizon d; EKZJ coll. cat. no. 20022.
Fig. 5: *Tsuga;* Locality 6; EKZJ coll. cat. no. 20023.
Fig. 6: *Tilia;* Locality 8, Horizon d; EKZJ coll. cat. no. 20024
Fig. 7: *Betula;* Locality 4; EKZJ coll. cat. no. 20025.
Fig. 8: *Podocarpus;* Locality 6; EKZJ coll. cat. no. 20026.
Fig. 9: *Zelkova;* Locality 8, Horizon c; EKZJ coll. cat. no. 20027.
Fig. 10: Cfr. *Zelkova;* Locality 7, Horizon b; EKZJ coll. cat. no. 20028.
Fig. 11: *Carya;* Locality 8, Horizon g; EKZJ coll. cat. no. 20029.
Fig. 12: *Carya;* Locality 8, Horizon d; EKZJ coll. cat. no. 20030.
Fig. 13: Aff. *Carya;* Locality 3; EKZJ coll. cat. no. 20031.
Fig. 14: *Carya;* Locality 3; EKZJ coll. cat. no. 20032.
Fig. 15: *Carya;* Locality 4; EKZJ coll. cat. no. 20033.
Fig. 16: *Alnus;* Locality 1; EKZJ coll. cat. no. 20034.
Fig. 17: *Pterocarya;* Locality 5; EKZJ coll. cat. no. 20035.
Fig. 18: *Salix;* Locality 8, Horizon c; EKZJ coll. cat. no. 20036.
Fig. 19: *Salix;* Locality 7, Horizon b; EKZJ coll. cat. no. 20037.
Fig. 20: *Salix;* Locality 8, Horizon g; EKZJ coll. cat. no. 20038.
Fig. 21: *Castanea;* Locality 7, Horizon a; EKZJ coll. cat. no. 20039.
Fig. 22: *Quercus* (small), evergreen *Quercus;* Locality 4; EKZJ coll. cat. no. 20040.
Fig. 23: *Fagus;* Locality 7, Horizon a; EKZJ coll. cat. no. 20041.
Fig. 24: *Nyssa;* Locality 2; EKZJ coll. cat. no. 20042.
Fig. 25: *Nyssa;* Locality 4; EKZJ coll. cat. no. 20043.
Fig. 26: *Quercus* (large), deciduous *Quercus;* Locality 6; EKZJ coll. cat. no. 20044.
Fig. 27: *Quercus* (large), deciduous *Quercus;* Locality 6; EKZJ coll. cat. no. 20045.
Fig. 28: *Quercus* (large), deciduous *Quercus;* Locality 5; EKZJ coll. cat. no. 20046.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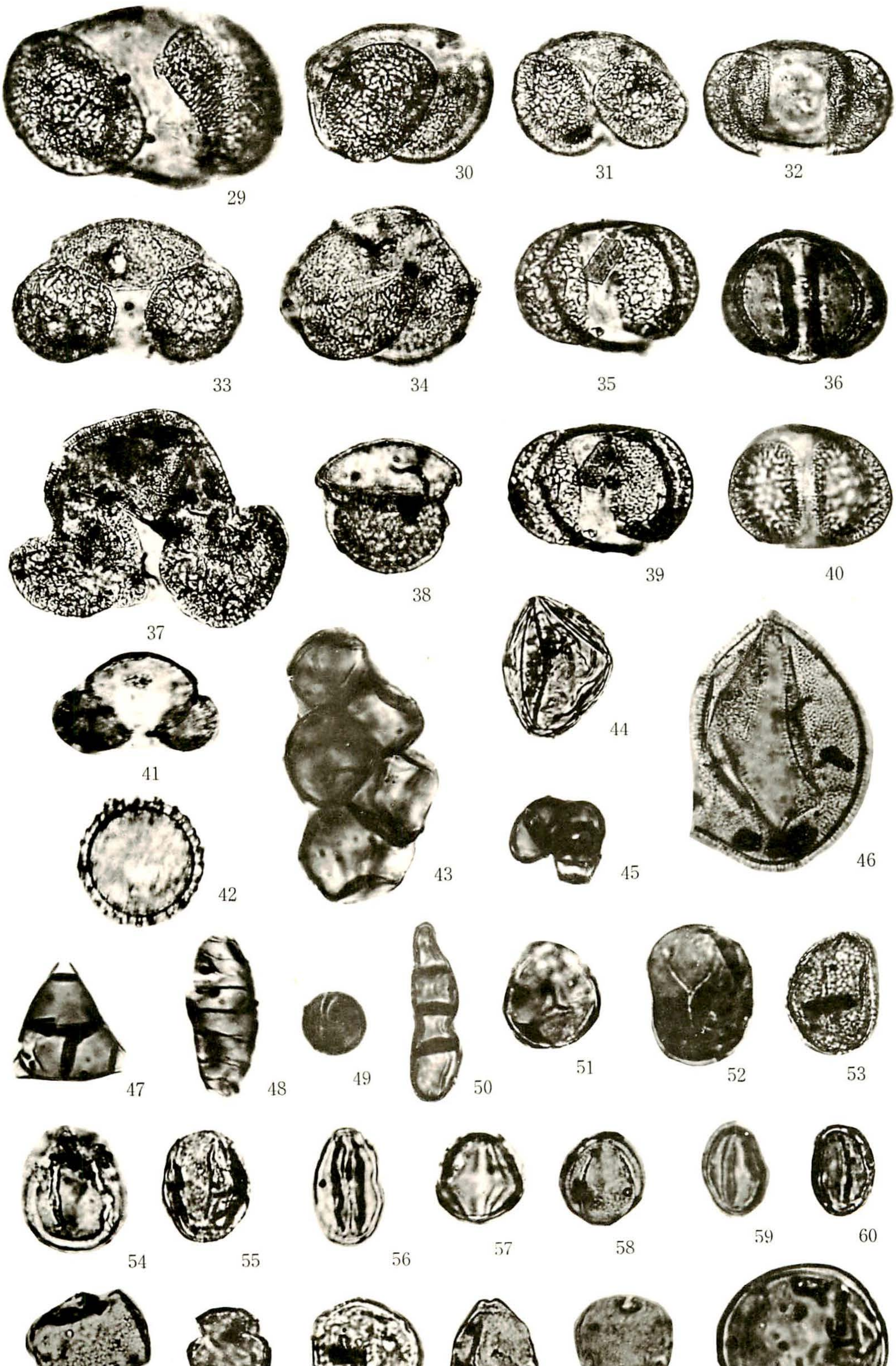
Ainoura	相　浦	Himi	氷　見
Akashi	明　石	Hiradoko	平　床
Akaura	赤　浦	Hojuji	法住寺
Anamizu	穴　水	Hosoguchi	細　口
Aniai	阿仁合	I'izuka	飯　塚
Daijima	台　島	Ishizaki	石　崎
Hijirikawa	聖　川	Iwaya	岩　屋

Kamitako	上田子	Mt. Sekidô-san	石動山
Kôda	向 田	Nakayama-toge	中山峠
Kojima	小 島	Nanao	七 尾
Mitoku	三 徳	Nishiminato	西 湊
Mt. Bijô-zan	眉丈山	Noto	能 登

Explanation of Plate 2

Fig. 29: *Pinus;* Locality 6; EKZJ coll. cat. no. 20047.
Fig. 30: *Pinus;* Locality 8; Horizon b; EKZJ coll. cat. no. 20048.
Fig. 31: *Pinus;* Locality 2; EKZJ coll. cat. no. 20049.
Fig. 32: *Pinus;* Locality 7, Horizon c; EKZJ coll. cat. no. 20050.
Fig. 33: *Pinus;* Locality 8, Horizon e; EKZJ coll. cat. no. 20051.
Fig. 34: *Pinus;* Locality 4; EKZJ coll. cat. no. 20052.
Fig. 35: *Pinus;* Locality 7, Horizon c; EKZJ coll. cat. no. 20053.
Fig. 36: *Pinus;* Locality 2; EKZJ coll. cat. no. 20054.
Fig. 37: *Abies;* Locality 3; EKZJ coll. cat. no. 20055.
Fig. 38: *Pinus;* Locality 8, Horizon d; EKZJ coll. cat. no. 20056.
Fig. 39: *Pinus;* Locality 7, Horizon c; EKZJ coll. cat. no. 20053.
Fig. 40: *Pinus;* Locality 2; EKZJ coll. cat. no. 20054.
Fig. 41: *Pinus;* Locality 7, Horizon a; EKZJ coll. cat. no. 20057.
Fig. 42: *Persicaria;* Locality 4; EKZJ coll. cat. no. 20058.
Fig. 43: Spore, gen. indet.; Locality 4; EKZJ coll. cat. no. 20059.
Fig. 44: *Monosulcopollenites;* Locality 4; EKZJ coll. cat. no. 20060.
Fig. 45: *Pleuricellaesporites;* Locality 7, Horizon c; EKZJ coll. cat. no. 20061.
Fig. 46: *Monosulcopollenites;* Locality 5; EKZJ coll. cat. no. 20062.
Fig. 47: *Triadosporites;* Locality 8, Horizon c; EKZJ coll. cat. no. 20063.
Fig. 48: *Pleuricellaesporites;* Locality 5; EKZJ coll. cat. no. 20064.
Fig. 49: *Inapertisporites;* Locality 3; EKZJ coll. cat. no. 20065.
Fig. 50: *Pleuricellaesporites;* Locality 6; EKZJ coll. cat. no. 20066.
Fig. 51: Trilate type spore, gen. indet.; Locality 6; EKZJ coll. cat. no. 20067.
Fig. 52: Trilate type spore, gen. indet.; Locolity 5; EKZJ coll. cat. no. 20068.
Fig. 53: *Lycopodium;* Locality 3; EKZJ coll. cat. no. 20069.
Fig. 54: *Tricolporopollenites;* Locality 8, Horizon d; EKZJ coll. cat. no. 20070.
Fig. 55: *Tricolporopollenites;* Locality 7, Horizon c; EKZJ coll. cat. no. 20071.
Fig. 56: *Tricolporopollenites;* Locality 8, Horizon d; EKZJ coll. cat. no. 20072.
Fig. 57: *Castanea;* Locality 4; EKZJ coll. cat. no. 20073.
Fig. 58: *Tricolporopollenites;* Locality 1; EKZJ coll. cat. no. 20074.
Fig. 59: *Tricolporopollenites;* Locality 4; EKZJ coll. cat. no. 20075.
Fig. 60: *Tricolporopollenites;* Locality 8, Horizon d; EKZJ coll. cat. no. 20076.
Fig. 61: *Acer;* Locality 7, Horizon e; EKZJ coll. can. no. 20077.
Fig. 62: *Castanea;* Locality 6; EKZJ coll. cat. no. 20078.
Fig. 63: Pollen grain (?); Locality 8, Horizon c; EKZJ coll. cat. no. 20079.
Fig. 64: *Corylus;* Locality 6; EKZJ coll. cat. no. 20080.
Fig. 65: *Tilia;* Locality 8, Horizon a; EKZJ coll. cat. no. 20081.
Fig. 66: *Carya;* Locality 6; EKZJ coll. cat. no. 20082.

(Figs. 30–32, 37–38, 41–44, 47, 49, 51–53, 64–65 are measured by a right scale, 20 μ, and the other figs. by a left scale, 15 μ. All specimens illustrated are kept in the Institute of Earth Science, Kanazawa University)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66
15 μ
20 μ

Noto-jima	能登島
Okuhara	奥原
Ôsugi-zaki	大杉崎
Otogawa	音川
Sakiyama	崎山
Sanami	佐波
Shinjô	新庄
Sunagozaka	砂子坂
Suso	須曾
Takashina	高階
Tokuda	徳田
Tsukada	塚田
Wakura	和倉
Wakura-eki	和倉駅
Yamatoda	山戸田

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 73, pp. 26-31, pl. 3, April 30, 1969

549. OCCURRENCE OF *TUTCHERIA* FROM THE LOWER JURASSIC OF WEST JAPAN*

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西日本下部ジュラ紀層から *Tutcheria* の産出： *Tutcheria* Cox, 1946 は Carditidae と Astartidae の特徴を兼ね備えることで興味ある二枚貝である．今回，豊浦層群東長野層基底部から本属の新種が採集されたので記載する。この機会に *Tutcheria* 属の分類学上の位置につき検討を加えた結果，Astartidae よりも Carditidae に含める方が妥当であるとの結論に達した。 速 水 格

Tutcheria is an interesting bivalve genus, because it has both the characters of the Carditidae and the Astartidae. It was proposed by Cox (1946) for nine European species, some of which had been referred to *Cardium*, *Cardita*, *Isocardia* or *Anisocardia*. Its known distribution is almost restricted stratigraphically to the Lower Jurassic (mainly Hettangian to Pliensbachian) and geographically to western Europe, although an Upper Triassic carditid from east Siberia, *Cardita cloacina sibirica* KIPARISOVA, 1966, may belong to this genus.

In the course of his geologic survey for the graduation thesis Mr. Masataka ITO, a student of the Kyushu University 1962-1966, collected many fossil bivalves from the Higashinagano formation of the Toyora group in the Ishimachi area of Yamaguchi Prefecture. Most of them belong to the already described species by YEHARA (1921) and HAYAMI (1958, 1959), but some seem to represent undescribed species. Recently I have found a new species of *Tutcheria* in his collection, and the result of examination is reported here. An interpretation on the systematic position of *Tutcheria* is also presented. This is probably the first report for the occurrence of this genus in a region outside western Europe.

Before going further, I wish to record my sincere thanks to Prof. Tatsuro MATSUMOTO of the Kyushu University for his kind instruction and supervision of this manuscript and to the late Dr. Leslie Reginald Cox of the British Museum (Natural History) for his kind information about European Jurassic bivalves including the genus in question. Acknowledgements are also due to Mr. Masataka ITO of the Bulldozer Engineering Company of Osaka for his kind supply of the material and some unpublished data.

Description and discussions

Order Veneroida

Superfamily Carditoidea

Family Carditidae FLEMING, 1829

Genus *Tutcheria* Cox, 1946

* Received Oct. 18, 1968; read Nov. 30, 1968 at Shizuoka.

Type-species.—Cardium submulticostatum D'ORBIGNY, 1850 (=*Cardium multicostatum* PHILIPS, 1829, non BROCCHI), Middle Lias, western Europe. (original designation)

Discussions.—The genus *Tutcheria* is, as defined clearly in the original diagnosis, characterized by the small size, numerous radial riblets (or threads) interrupted by some widely spaced imbricating growth lamellae, denticulate ventral margin in accordance with the radial ornament and *Astarte*-like dentition as formulated: $\frac{\text{AI 3b PI (PIII)}}{\text{AII 2 4b} \quad \text{PII}}$. The absence of the teeth 3a and AIII and the tubercular shape of both lateral teeth are noteworthy.

Notwithstanding the fact that the external morphology of this genus recalls strongly that of the Carditidae such as *Palaeocardita*, *Pseudocardia*, *Glans* and *Venericardia*, the hinge structure, especially the presence of anterior lateral teeth, is similar to that of the Astartidae. COX (1946, pp. 36-37) laid stress on the resemblance of hinge structure between *Tutcheria* and astartids, suggesting the derivation of the former from the same ancestral stock which gave rise also to the latter. He did not mention which family *Tutcheria* should be referred to, but from his discussion this genus was evidently regarded as more closely related to the Astartidae than to the Carditidae.

In relation to the taxonomic and phylogenetic problem of *Tutcheria*, I think that the following facts and acknowledged opinions should be taken into consideration.

1) Such a strong radial ornamentation is very common in the Carditidae but unknown at all in any described species of the Astartidae. Although some species of the genus *Ensio* COX, 1962 (type-species: *Ptychomya agassizi* LYCETT, 1850) of the Astartidae have peculiar divaricated sculpture, they are certainly unrelated to *Tutcheria*. The sculpture of *Ensio* does not correspond with the marginal crenulation but is probably a modification of concentric ribs.

2) In view of the presence of distinct marginal crenulation in the adult shells of many astartids, it might be presumed that certain radial shell structure related to the crenulation would be concealed in the interior of shells. WRIGLEY (1946, pp. 11, 18), however, denying the truth of this presumption, clarified that no radial shell structure is visible in several species of fossil *Astarte* from the Eocene London Clay, though such a structure was said to be common in the Crassatellidae. It is probably the same with the Mesozoic species of *Astarte* and many genera of the Astartidae. I have sometimes etched the test of fossil astartids with dilute HCI in order to observe the internal structure, but have never seen any radial structure in the course of etching. It may be, therefore, concluded that *Tutcheria* is fundamentarily different from the Astartidae not only in the surface ornamentation but also in the structure of shell.

3) Anterior and posterior lateral teeth are commonly well developed in the Astartidae, especially in the Mesozoic species, although in some species they tend to be weakened through the growth. On the other hand they are scarcely seen in the adult individuals of *Cardita* and *Venericardia* from the Cenozoic and Recent. However, the absence of lateral teeth does not necessarily serve as a diagnostic criterion for the Carditidae. For example, many species of the genus *Palaeocardita* CONRAD, 1867, from the Triassic (BITTNER, 1895) and an aberrant species of "*Pseudocardia*" from the Lower Cretaceous (HAYAMI, 1965, p. 79)

have distinct posterior lateral teeth. Furthermore, in some Cenozoic and Recent species of the genus *Glans* MEGERLE VON MÜHLFELD, 1811 (type-species: *Chama trapezia* LINNAEUS, 1758) there are weak traces of anterior lateral teeth AI and AII.

BERNARD (1895) and DOUVILLÉ (1913, 1921) explained successfully the evolution of heterodont hinge teeth on the basis of ontogenetical development of some living and fossil species. According to them, the cardinal teeth of heterodont bivalves are nothing but the products by the terminal thickening of anterior lateral teeth. It is rather reasonable to interpret that in early ontogenetical stage there are anterior lateral teeth in all the species of heterodont bivalves. The cardinal teeth 3a and 2 of the Carditidae and Astartidae are, of course, considered to be originated from the anterior lateral teeth AIII and AII respectively, regardless the condition that the anterior laterals may or may not be persistent in the adult shells. Anyhow, the strength and persistence of anterior lateral teeth are regarded as changeable from species to species in these families. In *Tutcheria* the cardinal tooth 3a and the lateral tooth AIII are actually not demarcated from the valve margin. Such a state is, however, commonly met with both in the Astartidae and the Carditidae.

4) The combination of radial sculpture and anterior lateral teeth is known in the Condylocardiidae which are represented by *Condylocardia* BERNARD, 1896, *Carditella* SMITH, 1881, and a few other genera in the Cenozoic and Recent. Although little has been known about their Mesozoic ancestors, it is possible that fossil representatives of this family have been overlooked, because the shell-size is generally very small in the known species. In some characters *Tutcheria* is similar to *Carditella*, but the former differs from the latter in the worse developed cardinal tooth 3a and more prosogyrous umbo.

Eventually I am inclined to conclude that *Tutcheria* may have been derived from a certain common root of the Carditidae and the Astartidae but that it had better be referred, if anything, to the Carditidae as done by some previous authors and recently by VOKES (1967, p. 257). It is interesting to see that *Cardita cloacina sibirica* KIPARISOVA, 1966, from the Norian of east Siberia has *Tutcheria*-like concentric rings on the surface. Further discovery of the direct ancestors of *Tutcheria* in the Triassic would make its systematic position more distinct.

Tutcheria itoi sp. nov.

Pl. 3. figs. 1–5

Material.—The holotype (GK. G6882) is an external mould of left valve from the lower part of the Higashinagano formation at loc. It. 108, Higashinagano. Six paratypes (GK. G6860–GK. G6865) from the same locality.

Diagnosis.—Medium-sized and non-carinated species of *Tutcheria*, characterized by the suborbicular outline, prosogyrous and comparatively narrow umbo, narrow lunule, strongly impressed adductor scars and about 45 radial ribs which are interrupted by a few widely spaced and strong imbrications of growth stages on the middle-ventral surface.

Description.—Shell medium-sized for the genus, about 12 mm long in the largest specimen, suborbicular in outline, nearly as high as long, strongly inflated, never carinated; test moderate in thickness; antero-dorsal margin concave in front of umbo, fairly long, passing gradually into the anterior margin; postero-dorsal margin comparatively short, gently arcuate; ventral margin evenly rounded; umbo comparatively narrow, prosogyrous, rising a little above the hinge margin, placed at about three-sevenths of length from the anterior end; lunule narrow but deep, delimited by a weak ridge; escutcheon probably not demarcated; ligament opisthodetic, external; surface ornamented with about 45 fine regular radial ribs which are nearly as wide as their interspaces; a few strong and widely spaced imbrications, which indicate some growth-stages, interrupting the radials on the middle-ventral surface, although their number and interval are quite irregular; ventral margin finely crenulated internally in accordance with the radial ribs; hinge plate moderate in breadth, comparatively short; dentition typical of *Tutcheria*, generally as formulated: $\frac{\text{AI 3b PI (PIII)}}{\text{AII 2 4b PII}}$; cardinal teeth divergent from the beak; 3a undeveloped at all; 2 vertical, thin; 3b very large, triangular, rounded at top; 4b thin, adjacent to the nymph; lateral teeth of both sides in two valves short, clearly separated from the cardinal teeth; AI tuberculiform, stronger than AII; AIII not separated from the antero-dorsal margin; PI and PIII relatively weak, separated from each other by an oblong recess for the reception of the tubercular lateral tooth PII; PIII not clearly separated from the postero-dorsal margin; adductor scars subequal in size, oblong, strongly impressed; pallial line simple; umbonal cavity moderate in depth.

Measurements in mm.—

Specimen	Length	Height	Thickness
Holotype (GK. G6859) left ex. mould	10.2+	11.4	ca. 3.0
Paratype (GK. G6860) left ex. mould	11.8	11.0+	2.8+
Paratype (GK. G6861) left ex. mould	11.4+	11.2+	2.8+
Paratype (GK. G6862) left ex. mould	11.4+	12.6	ca. 3.4
Paratype (GK. G6863) right in. mould	12.4	12.2	3.2+
Paratype (GK. G6864) left in. mould	10.8	10.8	2.8+
Paratype (GK. G6865) right in. mould	12.6	11.8	3.2+

Observations and comparisons.—Four external moulds including the holotype reveal the characteristic surface ornamentation, though none of them are complete. Three internal moulds, from which silicone rubber casts were taken successfully, show a dentition of typical *Tutcheria*. The test is not preserved at all. Owing to the arenaceous matrix, these specimens are almost free from secondary deformation, but further biometrical studies seem to be difficult.

The present species may be closely allied to *Tutcheria nortonensis* Cox, 1946, from the Middle Lias of England. However, apart from its much larger size the present species differs from the British one in the more tuberculiform anterior lateral tooth AI, less elongated posterior lateral tooth PII and narrower hinge plate. *Tutcheria cingulata* (GOLDFUSS, 1837) from the Lower Lias of Würtemberg and England (COX, 1946) also resembles the present species, but the ratio of length/height is distinctly larger in the former than in the latter. *Tutcheria heberti* (TERQUEM, 1855) from the Lower Lias of France (DUMORTIER, 1864) and England (COX, 1946) shows comparable size and number of radials with the present species. The radials and concentric imbrications, however, are apparently much weaker than in any of the present specimens.

Cox (1946) proposed at the same time the genus *Pseudopis* (type-species: *Pseudopis astonensis* Cox, 1946) for three Lower Jurassic species which have *Tutcheria*-like structure and more or less sharp carina. According to Cox there are some species intermediate between *Tutcheria* and *Pseudopis*, and the derivation of the latter from the former is suggested. The present species, however, has no affinity with *Pseudopis*.

Occurrence.—All the present specimens were collected by M. ITO from a weathered sandstone of the basal member of the Higashinagano formation (Nbs bed by MATSUMOTO and ONO, 1947, or *Cardinia toriyamai* bed by HAYAMI, 1959) at loc. It. 108, a small valley, about 500 m southeast of Narusebashi, Higashinagano, Toyoda town, Toyora County, Yamaguchi Prefecture. The present species is accompanied by *Oxytoma* (*Oxytoma*) *inequivalvis* (SOWERBY), *Meleagrinella japonica* HAYAMI, *Chlamys textoria* (SCHLOTHEIM), *Entolium* sp. cf. *E. calvum* (GOLDFUSS), *Plagiostoma* (*Plagiostoma*) *matsumotoi* HAYAMI, *Sphaeriola nipponica* HAYAMI and *Pholadomya* sp. The age is probably Sinemurian, because an *Arietites*-like ammo-

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Explanation of Plate 3

Figs. 1–5. *Tutcheria itoi* sp. nov. .... p. 28

1. Left external mould, GK. G6862 (1a) and its rubber cast (1b), paratype, ×2.
2. Left external mould, GK. G6859 (2a) and its rubber cast (2b), holotype, ×2.
3. Rubber cast of two left external moulds, GK. G6860 (lower) and GK. G6861 (upper), paratypes, ×2.
4. Right internal mould, GK. G6863 (4a) and its rubber cast (4b), paratype, ×2.
5. Left (lower) internal mould, GK. G6864 and right (upper) internal mould, GK. G6865, (5a), and their respective rubber casts (5b, 5c), paratypes, ×2.

All the specimens were collected by M. ITO from the basal part of the Higashinagano formation at It. 108, Higashinagano, Toyoda town, Toyoda County, Yamaguchi Prefecture.

Figs. 6–11. *Oxytoma* (*Oxytoma*) *mojsisovicsi* TELLER .... p. 35

6. Left valve, GK. F6887, ×1.5.
7. Rubber cast of a left external mould, GK. F6888, ×2.
8. Left internal mould, GK. F6889, ×2.
9. Left valve, GK. H6890, ×2.
10. Left external mould, GK. F6885 (10a) and its rubber cast (10b), ×1.
11. Rubber cast of a right external mould, GK. F6886, ×1.5.

Fig. 12. *Chlamys* (?) sp. indet. .... p. 36

12. Right valve, GK. F6891, ×2.

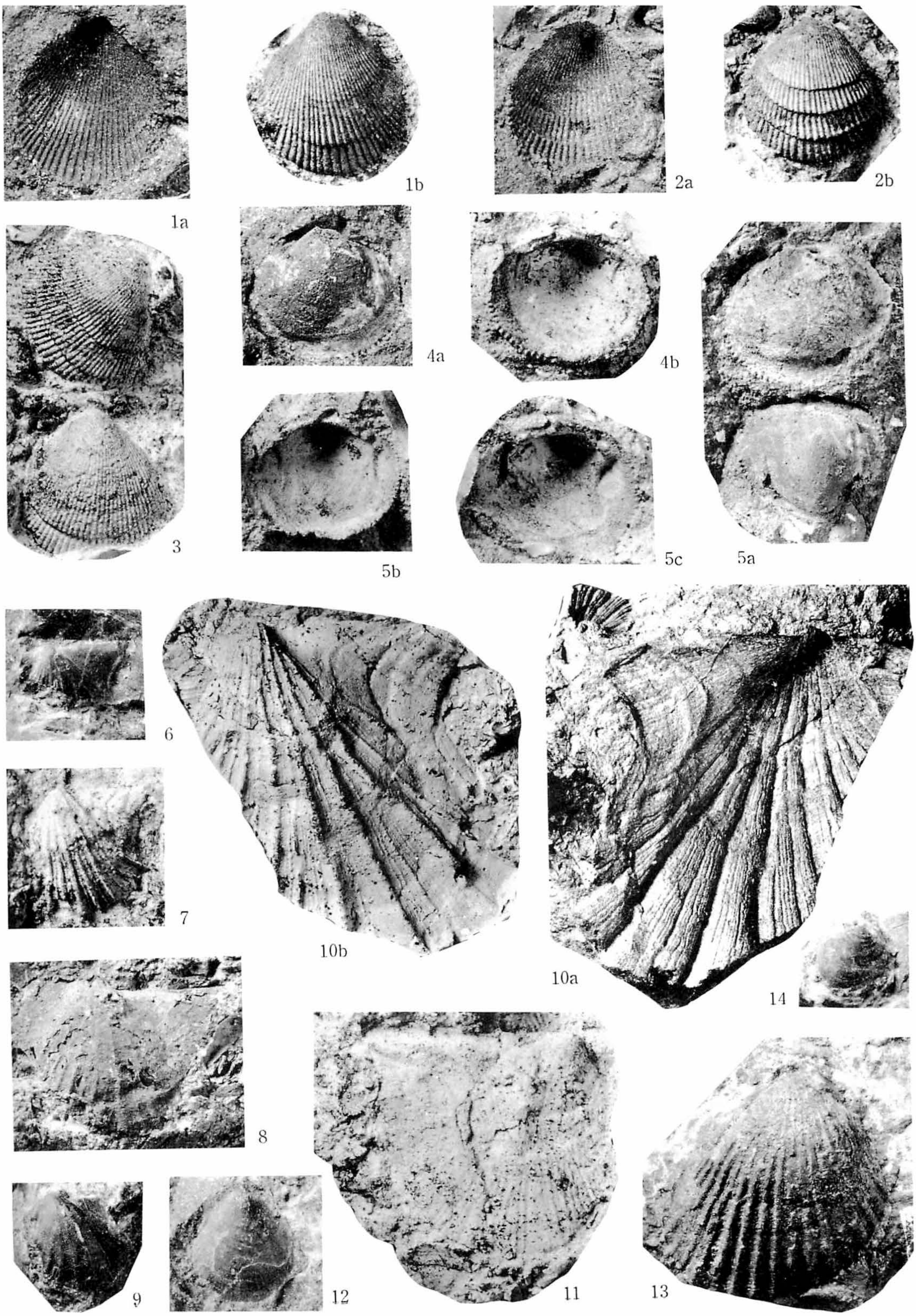
Fig. 13. *Pseudolimea naumanni* (KOBAYASHI and ICHIKAWA) .... p. 37

13. Left valve, GK. F6892, ×2.

Fig. 14. *Astarte* sp. indet. .... p. 38

14. Right valve, GK. F6894, ×2.

The specimens illustrated in Figs. 6, 9, 12, 13, 14 were collected by OZAWA from lenticular limestone of the Tachigaya formation at Tachigaya, Ome City, Tokyo Prefecture, those in Figs. 7, 8, 10, 11 by OZAWA and HAYAMI from the adjacent calcareous sandstone at the same locality.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nite was collected from the same sandstone at another locality.

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550. TRIASSIC *OXYTOMA* BED IN THE SUBURBS OF ÔME CITY, KWANTO MOUNTAINS*

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青梅市郊外に発見された三畳紀 *Oxytoma* 層： 東京都下青梅市北西方約 4 km の立ケ谷部落付近に上部古生代の地層に断層ではさみこまれた三畳系の狭小な分布が知られた. 全厚約 110 m に達し，立ケ谷層と呼んで古生層から区別する。本層は主として砂岩・頁岩からなり，中部に石灰岩の小レンズを有する。今回，この石灰岩 およびその 上位 に続く石 灰質砂岩から *Oxytoma* (*Oxytoma*) *mojsisovicsi*, *Pseudolimea naumanni* を含む二枚貝群が発見された。この構成は三畳紀後期（おそらくカーニアン）を示し，本層を西南日本外帯の川内ケ谷層群下部に対比することが可能である。 小 沢 智 生・速 水 格

TAKAGI (1944) reported the occurrence of a specimen of *Monotis* (*Entomonotis*) *ochotica* from a conglomeratic sandstone exposed near the JNR station of Ishigamimae (formerly called Rakurakuen) in the Ôme area, Tokyo Prefecture. However, little has been known about the exact distribution of Triassic strata in this area, because no more fossil occurrence prevents ones from discriminating them from the surrounding Carboniferous-Permian strata of the Chichibu terrain.

In the field survey of the Upper Paleozoic strata one of us (T. O.) discovered unexpectedly a characteristic limestone lens bearing fossil bivalves and some other marine organisms near the hamlet of Tachigaya, about 4 km northwest of the center of Ôme City (Fig. 1). The other of us (I. H.) jointly examined the collection and identified the following bivalves:

Oxytoma (*Oxytoma*) *mojsisovicsi* TELLER
Chlamys (?) sp. indet.
Pseudolimea naumanni (KOBAYASHI and ICHIKAWA)
Astarte sp. indet.

Because the first and third species have

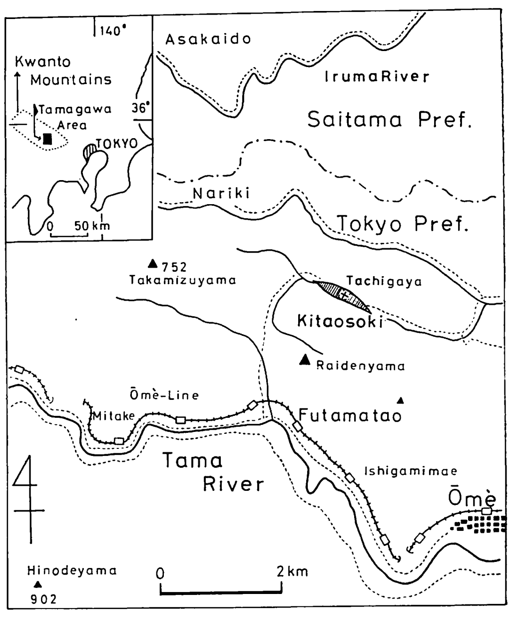

Fig. 1. Map showing the locality of fossils and the distribution of the Tachigaya formation.

* Received Oct. 18, 1968; read Nov. 30, 1968 at Shizuoka.

been known only from the Upper Triassic (mainly Carnian) in Japan and East Siberia, we regard the fossil bed in question as Upper Triassic (Carnian if not Norian). The fossil bearing strata is denominated here the Tachigaya formation. The aim of this paper is to describe the stratigraphy and fossils of this formation in some detail.

Before going into description, we express our sincere thanks to Prof. Tatsuro MATSUMOTO and Prof. Ryuzo TORIYAMA of the Kyushu University for their kindness in reading the manuscript. Acknowledgements are also due to Prof. Emeritus Teiichi KOBAYASHI of the University of Tokyo for his generous advice in the Triassic stratigraphy and paleontology, to Dr. Kametoshi KANMERA of the Kyushu University for his valuable suggestion on the field work and also to Miss Seiko HAYAKAWA for her assistance in drafting.

Stratigraphic notes

In the Ôme area of southeast Kwanto mountains Upper Paleozoic rocks are widely distributed, showing a general

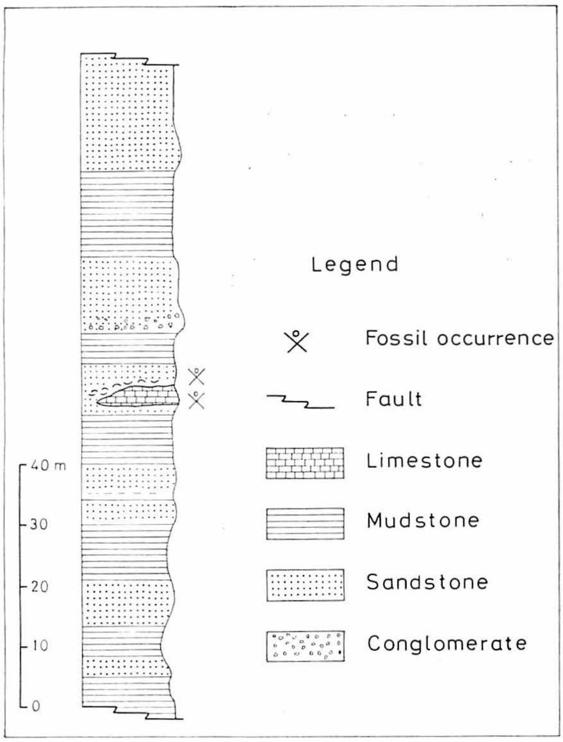

Fig. 2. Idealized columnar section of the Tachigaya formation.

Fig. 3. Limestone (bivalve biosparudite) of the Tachigaya formation at the southern bank of Kitaosoki river, Tachigaya (×10). Numerous bivalvian shell fragments cemented by sparry calcite.

strike of NW-SE or NWW-SSE. Several striking thrust faults are developed in parallel to the general trend and divide these rocks into many belts. Zonal distribution of formations is well recognized in this area as usual in the Kwanto mountains and also in the Outer Zone of Southwest Japan. The newly discovered Triassic strata are situated in a belt of Carboniferous and Permian formations, which is here called the Raidenyama belt. As shown in Fig. 1, the Triassic strata, denominated the Tachigaya formation in this paper, are narrowly distributed along the Kitaosoki river in the environs of Tachigaya. The Tachigaya formation itself forms a synclinal structure with a general strike of NW-SE dipping to the north or south at angles as high as 70 or 80 degrees. The northern and southern borders are cut by faults, and the Triassic strata are in contact with the Upper Carboniferous Kitaosoki formation on the north and with the Lower-Middle Permian Raidenyama formation on the south.

The Tachigaya formation is composed of black shale with subordinate fine- to medium-grained sandstone in the lower part (ca. 45 m) and of thickly bedded medium- to coarse-grained sandstone with occasional granule conglomerate and thick black shale in the upper part (ca. 65 m). A small lens of dark gray shell limestone (ca. 1.5 m) with sparry calcite cement occurs in the lower portion of the upper (Figs. 2 and 3). It gradually becomes sandy and passes into calcareous sandstone. The fossil beds are best seen on the southern bank of the Kitaosoki river at Tachigaya, the type locality of this formation.

Oxytoma (*Oxytoma*) *mojsisovicsi* is especially abundant in the limestone and calcareous sandstone, although most of the individuals are fragmentary and probably immature. In the same limestone *Pseudolimea naumanni*, *Chlamys* (?) sp., *Astarte* sp., and indeterminable species of brachiopod and echinoid are also contained. Incidentally, such a shelly limestone has never been found in the Upper Paleozoic formations of this area.

Description of fossils

Class Bivalvia

Order Pterioida

Family Oxytomidae ICHIKAWA, 1958

(*nom. transl.* by COX, 1962,
ex Oxytominae ICHIKAWA, 1958)

Genus *Oxytoma* MEEK, 1864

Subgenus *Oxytoma* s. str.

The generic diagnosis of *Oxytoma* was clearly given by ICHIKAWA (1958) and COX (1962). This genus is composed of three subgenera, *Oxytoma* (s. str.), *Hypoxytoma* ICHIKAWA, 1958, and *Palmoxytoma* COX, 1962. All the Triassic species of *Oxytoma* from Japan seem to belong to *Oxytoma* (s. str.).

Oxytoma (*Oxytoma*) *mojsisovicsi* TELLER

Pl. 3, figs. 6–11

1886. *Oxytoma mojsisovicsi* TELLER *in* MOJSISOVICS, *Mem. Sci. St. Pétersbourg*, sér. 7, vol. 33, no. 6, p. 129, pl. 19, figs. 7, 8.
1927. *Pseudomonotis zitteli:* YEHARA, *Japan. Jour. Geol. Geogr.*, vol. 5, nos. 1–2, p. 30, pl. 4, figs. 7, 8.
1927. *Oxytoma zitteli:* YEHARA, *Ibid.*, vol. 5, nos. 1–2, p. 32, pl. 4, figs. 9, 10.
1950. *Oxytoma zitteli:* KOBAYASHI and ICHI-

KAWA, *Jour. Fac. Sci., Univ. Tokyo*, ser. 2, vol. 7, pts. 3–5, p. 220, pl. 2, figs. 3–6.

1950. *Oxytoma subzitteli* KOBAYASHI and ICHIKAWA, *Ibid.*, sec. 2, vol. 7, pts. 3–5, p. 221, pl. 2, figs. 7, 8.

1950. *Oxytoma yeharai* KOBAYASHI and ICHIKAWA, *Ibid.*, sec. 2, vol. 7, pts. 3–5, p. 222, pl. 2, figs. 1, 2, pl. 3, fig. 13.

1957. *Oxytoma subzitteli:* NAKANO, *Jour. Sci., Hiroshima Univ.*, sec. C, vol. 2, no. 1, p. 64, pl. 9, fig. 1.

1959. *Oxytoma zitteli:* TOKUYAMA, *Japan. Jour. Geol. Geogr.*, vol. 30, p. 7, pl. 1, figs. 19–21.

1959. *Oxytoma subzitteli:* TOKUYAMA, *Ibid.*, vol. 30, p. 8, pl. 1, figs. 23, 24.

1963. *Oxytoma* cf. *subzitteli:* NAKAZAWA, *Mem. Coll. Sci., Kyoto Univ.*, ser. B, vol. 30, no. 2, p. 54, pl. 2, figs. 10–12.

1964. *Oxytoma* cf. *subzittel:* NAKAZAWA, *Ibid.*, ser. B, vol. 30, no. 4, p. 36, pl. 5, figs. 6–8.

1966. *Oxytoma mojsisovicsi:* KIPARISOVA *in* KIPARISOVA, BUCHKOV and POLUBOTKO, *Late Triassic Bivalve Moll. Fast Siberia*, p. 31, pl. 2, figs. 14, 15, pl. 3, fig. 2 (with a list of complete synonymy in USSR)

Material.—Although most of the specimens are fragmentary, the external features of adult valves are shown in two external moulds (GK. F6885, GK. F6886). In addition four other smaller specimens (GK. F6887-GK. F6890) are available for the descriptive study.

Description.—Shell moderate or rather large for the genus, highly inequivalve. The left valve moderately inflated, pteriform, prosocline, provided with ten to twelve prominent primary radial ribs, which are highly elevated and sometimes slightly spinose; each interspace of primary ribs divided subequally into two parts by a secondary rib which is clearly discriminated in prominence from numerous fine tertiary ribs; ribs slightly curved outwards in the anterior and posterior areas; anterior wing comparatively small; posterior wing flattened, as broad as the main part, provided with numerous weak radial riblets of the tertiary strength, pointed backwards; umbo nearly orthogyrous, comparatively narrow, rising a little above the hinge line, placed at about one-fifth of hinge line from the anterior end. Right valve, on the contrary, nearly flat except for the slightly convex umbonal area; byssal auricle of moderate size, clearly demarcated by a deeply incised subauricular notch; ctenolium not observed; surface marked with numerous fine radial riblets of a single order of prominence; posterior wing not clearly defined, provided with one or two blunt oblique ridges near the dorsal periphery. Hinge, ligament and musculature not observable in the present material.

Observations and comparisons.—As the available specimens are mostly fragmentary and poorly preserved, it is not readily realized that they belong actually to one species. However, we think so,

Measurements in mm.

Specimen	Length	Height	Thickness
Left ex. mould (GK. F6885)	48.5	53.5	ca. 11.0
Right ex. mould (GK. F6886)	27.5	25.0	ca. 3.5
Left valve (GK. F6887)	10.5	6.5+	ca. 2.5
Left ex. mould (GK. F6888)	9.0+	9.5	ca. 2.0
Left in. mould (GK. F6889)	14.5	11.5+	ca. 3.5
Left in. mould (GK. F6890)	8.5+	8.5+	ca. 2.5

because the mode of radial ornamentation of the left valves is essentially the same and because they were extracted from crowded fossil banks in a limestone lens and adjacent calcareous sandstone at the same locality.

The present specimens, especially the two larger ones (GK. F6885, GK. F6886), are quite similar to *Oxytoma mojsisovicsi* TELLER, 1886, from the Upper Triassic of East Siberia. Int he Sakawa basin of Shikoku and other areas of Japan similar specimens were described by KOBAYASHI and ICHIKAWA (1950) and others under the name of *Oxytoma zitteli* (TELLER), *Oxytoma subzitteli* KOBAYASHI and ICHIKAWA or *Oxytoma yeharai* KOBAYASHI and ICHIKAWA. As NAKAZAWA (1963, 1964) suggested already, *Oxytoma zitteli* (TELLER) (=*Pseudomonotis zitteli* TELLER) from Siberia may be specifically distinct from "*Oxytoma zitteli*" from Japan, which is probably conspecific with *Oxytoma subzitteli*. Furthermore, KIPARISOVA *in* KIPARISOVA, BUCHKOV and POLUBOTKO (1966) regarded "*O. zitteli*" and *O. yeharai* by KOBAYASHI and ICHIKAWA respectively as a synonym and a variety of *O. mojsisovicsi*. Accepting her opinion, we refer the present specimens to *Oxytoma mojsisovicsi*, which actually includes "*O. zitteli*", *O. subzitteli* and *O. yeharai*. The number of radial ribs and the form ratio are generally fairly variable in one species of pterioids, and the insignificant difference between these nominal species may not serve even as a subspecific criterion.

Another problem has arisen for many years as to the relationship between *Oxytoma mojsisovicsi* and *Pseudomonotis zitteli*, since TELLER (1886) described originally the former species on the basis of left valves and the latter on the basis of a right valve. We agree with KOBAYASHI and ICHIKAWA (1950) in considering that the specimens from the Sakawa basin, which YEHARA (1927) described under these two specific names, are actually conspecific. However, we are not in a position to discuss this problem on the basis of their type specimens.

Occurrence.—Lenticular limestone and superjacent calcareous sandstone of the Tachigaya formation at the southern bank of Kitaosoki river, near the hamlet of Tachigaya, Ôme City, Tokyo Prefecture. OZAWA and HAYAMI coll.

Family Pectinidae RAFINESQUE, 1815

Genus *Chlamys* RÖDING, 1798

Chlamys (?) sp. indet.

Pl. 3, fig. 12

This species is represented only by a small left valve (GK. F6891, 7.5 mm long, 8.5 mm high) from the same lenticular limestone as the preceding species. The anterior wing is much larger than the posterior, suggesting the development of a byssal auricle in the counter valve. The surface is marked with numerous faint radial riblets. It belongs to the subfamily Chlamydinae, but at present the generic assignment is uncertain and the specific identification impossible. The general outline is somewhat similar to that of *Chlamys mojsisovicsi* KOBAYASHI and ICHIKAWA, 1949, from the Carnian of Shikoku. The present species, however, differs from that in the larger apical angle and more delicate radial riblets.

Family Limidae RAFINESQUE, 1815

Genus *Pseudolimea* ARKELL, 1932

Pseudolimea naumanni (KOBAYASHI

and ICHIKAWA)

Pl. 3, fig. 13

1939. *Lima naumanni lata* KATAYAMA, *Jour. Geol. Soc. Japan*, vol. 46, no. 546, p. 135 (*nom. nud.*).
1939. *Lima naumanni obliqua* KATAYAMA, *Ibid.*, vol. 46, no. 546, p. 135, pl. 8, fig. 6 (*nom. nud.*).
1949. *Lima naumanni* KOBAYASHI and ICHIKAWA, *Japan. Jour. Geol. Geogr.*, vol. 21, nos. 1-4, p. 177, pl. 6, figs. 13-15.
1949. *Lima naumanni* var. *obliqua* KOBAYASHI and ICHIKAWA, *Ibid.*, vol. 21, nos. 1-4, p. 178, pl. 6, figs. 16, 17.
1952. *Lima (Pseudolimea?) naumanni*: NAKAZAWA, *Mem. Coll. Sci., Univ. Kyoto*, ser. B, vol. 20, no. 2, p. 102, pl. 9, figs. 7, 8, pl. 10, fig. 3.
1954. *Pseudolimea? naumanni*: ICHIKAWA, *Jour. Inst. Polytec. Osaka City Univ.*, ser. G, vol. 2, p. 55, pl. 3, fig. 12.
1954. *Pseudolimea? naumanni* var. *obliqua*: ICHIKAWA, *Ibid.*, vol. 2, p. 56, pl. 3, fig. 11.

Material.—A left valve (GK. F6892) and an internal mould of right valve (GK. F7893).

Description.—Shell medium in size, inequilateral, opisthocline, trigonally ovate, higher than long, strongly inflated; test comparatively thin; umbo placed posteriorly from the mid-length of shell, not prominent, with an apical angle of about 75 degrees; auricles depressed, probably of moderate size; anterior umbonal ridge absent; no "lunule"; surface of main body ornamented with about 19 straight, roof-shaped, plicated and non-bifurcated radial ribs, interspaces of which are marked respectively with a faint secondary rib; growth-lines crossing the radial ribs, distinct especially near the ventral periphery, giving rise to serration in accordance to the radial ribs; internal structure not observed.

Measurements in mm.

Specimen	Length	Height	Thickness
Left valve (GK. F6892)	17.5	19.0	ca. 5.0
Right in. mould (GK. F6893)	17.5	19.5	ca. 4.0

Observations and comparisons.—The left valve is well preserved and shows the characteristic ornament in detail, though both auricles are incomplete. It is quite similar to the holotype and paratypes of *Lima naumanni* KOBAYASHI and ICHIKAWA, 1949, from the Carnian of the Sakawa basin of Shikoku. The right internal mould (GK. F6893) is rather similar to the specimens called *Lima naumanni* var. *obliqua* KOBAYASHI and ICHIKAWA, 1949, in view of the somewhat obliquely elongated outline. Because of the suggested sympatric relation at many localities (KATAYAMA, 1939; KOBAYASHI and ICHIKAWA, 1949; ICHIKAWA, 1954; etc.), the "variety" may not constitute a distinct subspecies.

The reference of the present species to the genus *Pseudolimea* has been suggested by NAKAZAWA (1952) and ICHIKAWA (1954). As pointed out by ICHIKAWA (1954) on a specimen from the Sakuradani area of Shikoku, many important characters of the present species agree with the diagnosis of *Pseudolimea* given by ARKELL *in* DOUGLAS and ARKELL (1932) and COX (1944). However, the resilifer appears to be much narrower and more prosocline in the present species than in many Jurassic species of *Pseudolimea*. It is an interesting fact that Triassic *Mysidioptera* has similarly a narrow and prosocline resilifer in comparison with Jurassic *Plagiostoma*. Because *Plagiostoma* is believed to have been derived from *Mysidioptera* (COX, 1943, 1952), it is probable that a comparable transformation of ligament structure occurred in the evolutionary history of *Pseudolimea*. From the present material, however, no further knowledge could be obtained about the ligament structure, and we regard provisionally the present species as an early member of *Pseudolimea*.

Occurrence.—Lenticular limestone of the Tachigaya formation at the southern bank of Kitaosoki river near the hamlet of Tachigaya, Ôme City, Tokyo Prefecture. OZAWA coll.

Order Veneroida

Family Astartidae D'ORBIGNY, 1843

Genus *Astarte* SOWERBY, 1816

Astarte sp. indet.

Pl. 3, fig. 14

This species is represented by five minute specimens (GK. F6894-GK. F6898) from the same lenticular limestone as the preceding. The length of the largest specimen scarcely exceeds 7 mm. Although the hinge structure is not observable, it belongs undoubtedly to the genus *Astarte* of wide sense, judging from the general outline, clearly excavated lunule and the distinct concentric ribs on the umbonal area. This species differs from *Astarte*? *iwayai* ICHIKAWA, 1954, from the Carnian of Shikoku in the smaller size, less triangular outline and more densely spaced and narrowly restricted concentric ribs. So far as we are aware, there is no comparable species of *Astarte* in the Triassic, while the present species looks somewhat similar to some small Jurassic and Cretaceous species of *Astarte* (s. str.) such as *Astarte* (*Astarte*) *semicostata* NAGAO, 1934, from the Aptian-Albian of north Japan.

Concluding remarks

In the northwestern suburbs of Ôme City, Tokyo Prefecture, there is a narrow distribution of Triassic strata, which are denominated here the Tachigaya formation. As described above, this formation is partly calcareous and contain some fossil bivalves and other organisms in a lenticular limestone and superjacent calcareous sandstone. This faunule comprising *Oxytoma* (*Oxytoma*) *mojsisovicsi* and *Pseudolimea naumanni* indicates an Upper Triassic (probably Carnian) age at least for the fossiliferous part.

Incidentally, the genus *Oxytoma* ranges widely from the Lower Triassic to the Upper Cretaceous, but Lower and Middle Triassic species seem quite rare. In Eastern Asia such large specimens as the present ones have been known only from the Upper Triassic. *Oxytoma* (*Oxytoma*) *mojsisovicsi* itself has been reported from the lower part of the Kochigatani group at Sakawa and Sakuradani-Kito areas, the Kyowa formation of the Nariwa area and the lower part of the Mine group of the Omine area. Although some identifiable specimens with this species were described also from such Norian *Monotis*-bearing strata as the Jito formation of the Nariwa area (NAKAZAWA, 1963) and the upper part of the Saragai group of the Shizukawa area (NAKAZAWA, 1964), it is certain that *O.* (*O.*) *mojsisovicsi* shows an acmaeic prosperity in the Carnian stage in Japan as well as in East Siberia.

As pointed out by ICHIKAWA (1958, p. 163), "*Oxytoma* sp. aff. *O. mojsisovicsi*" described by CHEN (1950) from the Lower Triassic of southeast China is probably referable to *Eumorphotis*.

The occurrence of *Pseudolimea naumanni* also supports the assignment of the fossiliferous part to the Carnian, because this species has been known only from the Carnian such as the lower part of the Kochigatani group in the Sakawa and Sakuradani-Kito areas, the lower part of the Mine group of the Omine area and the Nabae group of the Maizuru area. NAKAZAWA (1956) suggested that this species characterizes the upper part of the Sakawan (≑ Carnian) sediments in the Maizuru area.

Although the constituent species of this faunule is few, the assemblage is undoubtedly of the lower Kochigatani fauna. It has been known that the Kochigatani group in the Outer Zone of Southwest Japan is partly calcareous. For instances, the "*Oxytoma-Mytilus* beds" at Okunominetani of the Sakawa area are fairly calcareous (KOBAYASHI and ICHIKAWA *in* Geol. Surv. Japan, 1951, p. 101), and, moreover, the "*Proarcestes* beds" at Yoshinosakadani of the Taho (=Tao) area and the Tanoura formation of the Tanoura area bear occasionally some lenses of impure limestone (ICHIKAWA *in* Geol. Surv. Japan, 1951, p. 109; MATSUMOTO and KANMERA, 1964, p. 57). In the Kwanto mountains the Arai formation of the Itsukaichi area, which is generally regarded as Carnian if not Norian, has also some impure limestone lenses (ICHIKAWA and KUDO *in* Geol. Surv. Japan, 1951, p. 29), although its bivalvian assemblage is quite different from that of the Kochigatani fauna (ICHIKAWA, 1954a).

To sum up we have come to the conclusion that the Tachigaya formation is a representative of the lower part of the Kochigatani series in the southern Kwanto mountains. We have, however, on positive evidence to determine its stratigraphic relation to the *Monotis*-bearing formation of the present area and to the Arai formation of the Itsukaichi area, because they are distributed separately in narrow areas.

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Ishigamimae	石神前	Ôme	青梅
Kitaosoki	北小曾木	Tachigaya	立ケ谷

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 73, pp. 41-48, pls. 4-6, April 30, 1969

551. PLANT MICROFOSSILS FROM THE PERMIAN SANDSTONE IN THE SOUTHERN MARGINAL AREA OF THE TANBA BELT*

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丹波帯南縁部のペルム紀砂岩産植物微化石： 筆者らの一人，八尾は京都府相楽郡和束町原山北方の丹波帯南縁部（または領家帯えの漸移部）のペルム紀泥岩層中のレンズ状砂岩から多数の植物微化石を検出した。筆者らの他の一人，高橋はこれらの微化石を検鏡し，花粉としては ?*Araucariacites gloriosus* n. sp., ?*Florinites* sp. (?Cordaitales), *Reticulatasporites foraminulatus* n. sp. を，またマイクロプランクトンとして *Tasmanites tanbaensis* n. sp. を識別したので記載し，報告する。 高橋 清・八尾 昭

Introduction

The junior author, A. YAO, has collected samples from lenticular sandstones in the Permian mudstone member in the southern marginal area of the Tanba belt. Mechanical and chemical treatment of the samples were carried out by him under the direction of Professor M. SHIMAKURA, Nara University of Education and he has found many plant microfossils under the microscope.

The senior author, K. TAKAHASHI, has minutely observed some sections which the junior author has provided and preliminarily studied [YAO, 1966 (MS) Graduation Thesis, Nara University of Education]. Consequently, the authors have here reported and described three species of sporomorphs and one species of phytoplankton. This paper is the first report on the Paleozoic sporomorphs and phytomicroplankton in Japan.

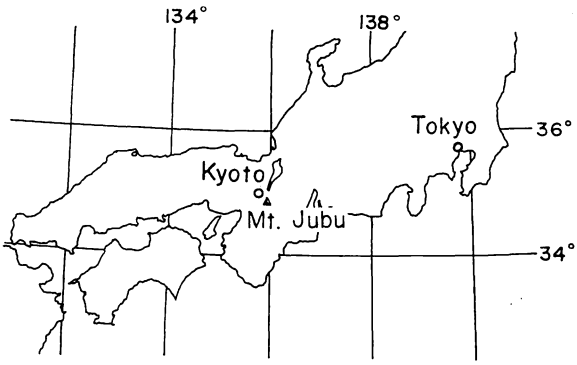
The authors wish to thank Professor Dr. Koichiro ICHIKAWA, Department of Geosciences, Osaka City University, for his suggestion and valuable advice on the stratigraphic relation and geologic age, Professor Dr. Misaburo SHIMAKURA, Nara University of Education, for his kind direction of analytical method, and Professor Dr. Hermann WEYLAND, Wuppertal-Elberfeld (West-Germany), for his kind suggestion on botanical species of the epidermal cell.

* Received October 28, 1968; read June 22, 1968 at Sendai.

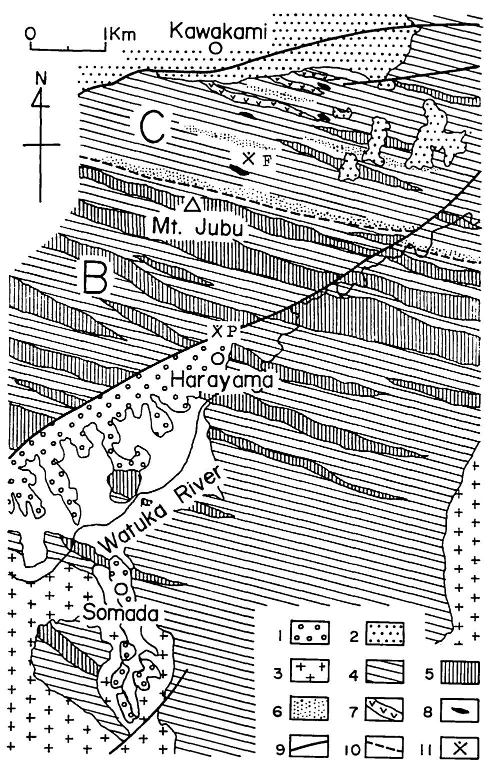
Geologic setting

The strata distributing in the Jubusen (Mt. Jubu) area, Kyoto Prefecture, are divided into three formations, A, B, and C, which are conformable each other (YAO, 1968). The A formation is apparently lowermost and the C formation is uppermost.

The A formation lies in the southern



Text-fig. 1a.



Text-fig. 1b.

Text-fig. 1a-b. Index map (1a) and Geological map of Mt. Jubu area, Kyoto prefecture (1b).

1. Equivalent of the Osaka Group (Plio-Pleistocene)
2. Tsuzuki Group (Miocene)
3. Granitic rocks (pre-Cenozoic)
4-8. Permian (divided into the B and the C formation)
4. Pelitic rocks
5. Cherts
6. Psammitic rocks
7. Submarine basic volcanics
8. Limestones
9. Fault
10. Boundary between the B and the C formation
11. Fossil localities
    - P: Plant microfossils, described in this paper.
    - F: Neoschwagerinids, reported by YAO (1968).

part of this area and consists mainly of mudstone intercalating chert and sandstone. The B formation is distributed in the central part of the area and composed predominantly of mudstone and chert with some sandstone beds, but basic pyroclastic rocks and limestones are very rare. Many spore-pollen grains and phytoplankton were found from the fine to medium lenticular sandstone (30–50 cm in thickness) of this formation, about 500 m north of Harayama, Watsuka-cho. The C formation occupies the northern part of the area and mainly consists of mudstone and sandstone with basic pyroclastic rocks, limestones, and cherts. Fusulinid fossil, *Yabeina* (or *Neoschwagerina*) sp., was found from the limestone of this formation. Consequently, it is estimated that its geologic age will be upper Middle Permian. As the B formation is seemingly lower than the C formation, the geologic age of the former will be naturally before upper Middle Permian.

Preparation of material and microfossils

After crushing, the samples were macerated in mixed solution with HNO_3 and HCl, rinsed with water and then boiled for a few minutes with 10% KOH solution. The samples were then rinsed repeatedly with water. Organic residue in upper part of the precipitates was concentrated and subsequent oxidation (HNO_3+HCl) and alkali (5% KOH) treatment were usually used. Finally concentrated HF was used for the purpose of excluding minerals. The preparations were mounted in glycerine jelly.

A number of specimens were found under the microscope. Above all, pollen grains of ?*Araucariacites gloriosus* are abundant. They are similar to *Florinites* belonging to Cordaitales from the Permian and Carboniferous, but they possess no morphologic character which is recognized as air-sacs. On the other hand, they are very similar to pollen grains of Araucariaceae, but the latter is granulate in ornamentation of exine. For the time being, the authors report the present specimens as ?*Araucariacites gloriosus*.

Only one pollen grain of ?*Florinites* was found. This is morphologically similar to ?*Araucariacites gloriosus*, but this has central body which is surrounded with air-sac (?).

Many species of *Reticulatasporites* were reported from the Carboniferous of Germany and U. S. A. The present Permian specimens belong certainly to *Reticulatasporites*.

About *Tasmanites* there are some reports of A. EISENACK and others. The present specimens are closely similar to *Tasmanites* cf. *tardus* Eisenack which was reported by S. MANUM (1964) from the Cretaceous of Graham Island and Ellef Ringes Island of Arctic Canada. The shell wall of *Tasmanites tardus* Eisenack is far thicker than that of the Japanese species.

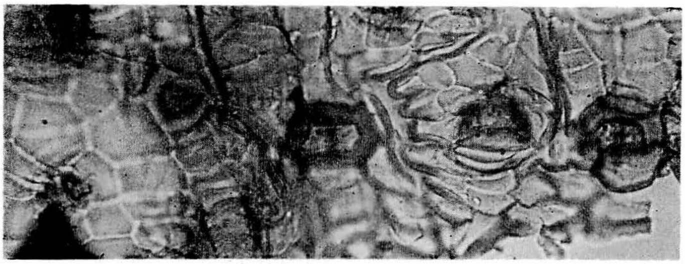
The epidermal cells illustrated in text-figure 2, coexisting with spores and pollen grains, cannot be exactly determined, because of the insufficient materials for reliable decision. However, these materials remine us of gymnospermous plant.

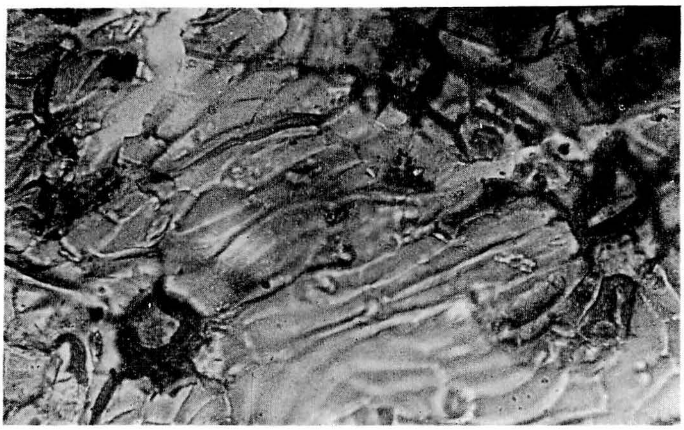
Many undeterminable microfossils were also found, but these microfossils are not dealt with in this paper.

All preparations are kept in the Department of geosciences, Osaka City University.

Systematic description

Anteturma: Pollenites

a


b


Text-fig. 2a–b. Epidermal cell (lower cuticle) of gymnospermous plant (?). ×420.

R. POTONIÉ, 1931

Turma: Aletes IBRAHIM, 1933

Subturma: Azonaletes (LUBER 1935) POTONIÉ & KREMP, 1954

Infraturma: Granulonapiti COOKSON, 1947

Genus: *Araucariacites* COOKSON, 1947

Type species: *Araucariacites australis* COOKSON, 1947

?*Araucariacites gloriosus* n. sp.

Pl. 4, figs. 1–9; text-fig. 3a, b

Holotype:—Slide 66041104-13; Pl. 4, fig. 3; size 133×100μ.

Type locality:—500 m north of Harayama, Watsuka-cho, Sōraku-gun, Kyoto Prefecture.

Type horizon:—Sandstone in the mudstone member of the B formation in the Jubusen area of the Tanba belt.

Description:—Inaperturate pollen grains; shape originally spheroidal or oval with diameter of 100 to 160μ. Exine about 0.8 to 1.7μ thick with both endexine and ektexine approximately of equal thickness, sculptured with rod-like elements in optical section of the exine (see text-fig. 3a) and with fine rugulate

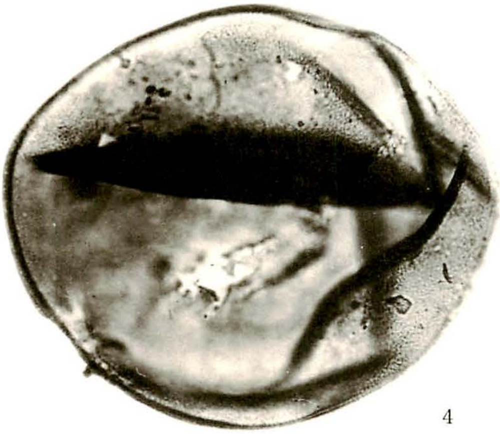
Explanation of Plate 4

Figs. 1–9. ?*Araucariacites gloriosus* n. sp. ×420.
Fig. 3: Holotype, slide 66041104-13.

1

2

3



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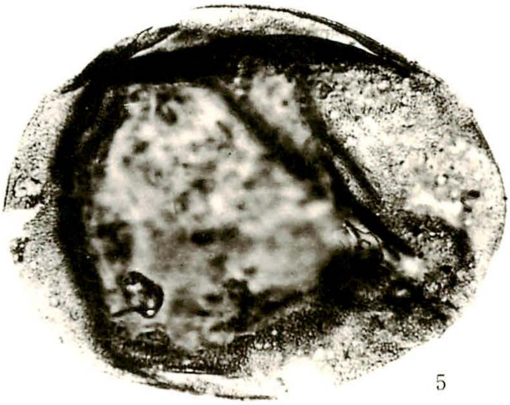

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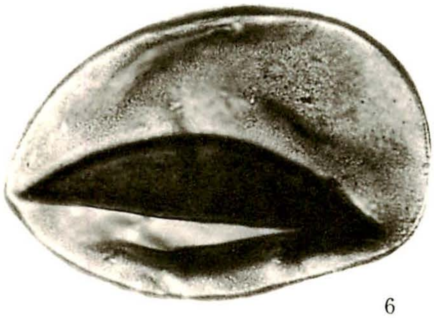

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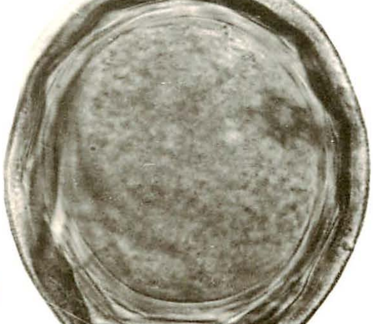
8



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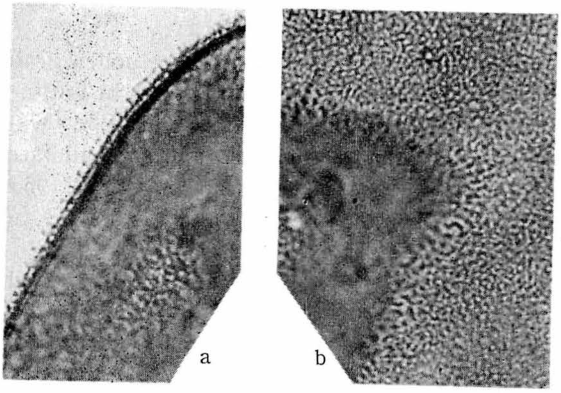


Text-fig. 3a–b. Enlargement of the ornamentation of ? *Araucariacites gloriosus*. ×1050. 3a : optical section ; 3b : surface of the exine.

arrangement on the surface of the exine (see text-fig. 3b): rod-like (baculate or clavate) elements 1.3 to 1.7μ long. On account of excessive folds the shape and size vary greatly.

Remarks:—The present specimens are similar to *Inaperturopollenites insignis* MANUM (S. MANUM, 1962, p. 39, pl. 6, figs. 3, 4) from the lower light sandstone series (Tertiary) S_4, Spitsbergen, in the shape and ornamentation, but differ in the form size and the composition of the exine.

B. E. BALME (1957) described the similar species, *Inaperturopollenites limbatus* BALME (B. E. BALME, 1957, p. 31, pl. 7, figs. 83, 84) and *Inaperturopollenites turbatus* BALME (B. E. BALME, 1957, p. 31, pl. 7 figs. 85, 86; pl. 8, fig. 87), from the Mesozoic of Western Australia. The former has smaller size and thicker exine and the latter has smaller size and a differetially thickened circular polar area about 40μ in diameter.

The present species is distinguished from *Araucariacites australis* COOKSON from Tertiary lignites and carbonaceous sandstone of Kerguelen Island (I. C. COOKSON, 1947, p. 130, pl. 13, figs. 1-4) by its size and ornamentation.

Botanical affinity:— ? Araucariaceae.

Infraturma : Reticulorapiti (ERDTMAN, 1947) VIMAL, 1952

Genus : *Reticulatasporites* (IBRAHIM, 1933) POTONIÉ & KREMP, 1954

Type species : *Reticulatasporites facetus* IBRAHIM, 1933

Reticulatasporites foraminulatus n. sp.

Pl. 5, figs. 1-8

Holotype:—Slide 66041104-10; Pl. 5, figs. 4a, b; size 73μ.

Type locality:—500 m north of Harayama, Watsuka-cho, Sōraku-gun, Kyoto Prefecture.

Type horizon:—Sandstone in the mudstone member of the B formation in the Jubusen area of the Tanba belt.

Description:—Tetrad mark not visible, circular to oval in outline, exine thin walled, with many circular to elliptical pores of diameter 3.9 to 6.5μ. Exine colour colourless. Size range: length 68 to 103μ; breadth 50 to 75μ.

Remarks:—The present specimens do not closely resemble any known species of *Reticulatasporites*. All species of *Reticulatasporites* were described by F. LOOSE (1934) (*R. mediapudens*), A. C. IBRAHIM (1933) (*R. facetus*, *R. viscendus*, and *R. spongiosus*), R. POTONIÉ & G. KREMP (1955) (*R. facetus* and *R. taciturnus*) and D. C. BHARDWAJ (1957) (*R. novicus* and *R. teichmüllerii*) from the Upper Carboniferous of Germany, R. KRÄUSEL & G. LESCHIK (1955) (*R. aduncus* and *R. densus*) from the Upper Triassic of Switzerland, and C. J. FELIX & P. P. BURBRIDGE (1967) (*R. lacunosus*) from the Springer Formation (Carboniferous) of southern Oklahoma, U. S. A. The mesh-like network of the present Japanese species is relatively similar to that of the American species *R. lacunosus*, but the latter has very large muri.

Botanical affinity:—Unknown.

Turma: Saccites ERDTMAN, 1947

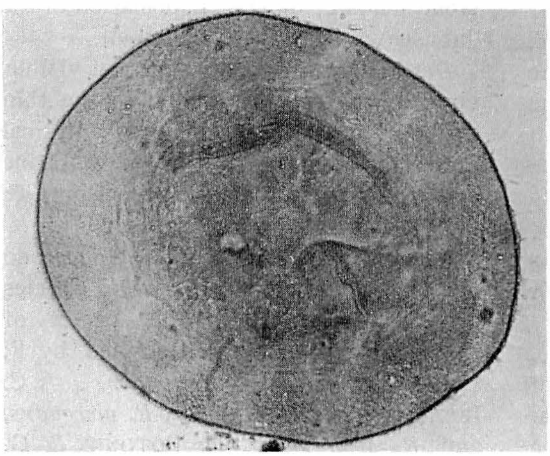
Subturma: Monosaccites (CHITALEY, 1951) POTONIÉ & KREMP, 1954

Infraturma: Aletesacciti LESCHIK, 1955

Genus: *Florinites* SCHOPF, WILSON & BENTALL, 1944

Type species: *Florinites antiquus* SCHOPF, 1944

?*Florinites* sp.



Text-fig. 4. ? *Florinites* sp. ×420.

Text-fig. 4

Description:—Monosaccate pollen grain ?; circular or bread elliptical in outline, diameter of grain 152×127μ. Body wall very thin, very fine rugulate or punctate. Central body somewhat indistinct, 96×87μ in diameter, roughly reticulate ?, no tetrad mark recognizable.

Occurrence:—Sandstone in the mudstone member of the B formation in the Jubusen area of the Tanba belt; 500 m north of Harayama, Watsuka-cho, Sōraku-gun, Kyoto Prefecture.

Botanical affinity:—?Cordaitales.

Microplankton

Incertae Sedis

Group: Acritarcha EVITT, 1963

Class: Chlorophyceae

Family: Tasmanaceae SOMMER, 1956

Genus: *Tasmanites* Newton, 1875

Tasmanites tanbaensis n. sp.

Pl. 6, figs. 1–8

Holotype:—Slide 66041104-13; Pl. 6, fig. 2; size 128×119μ in diameter; wall 6.7μ in thickness.

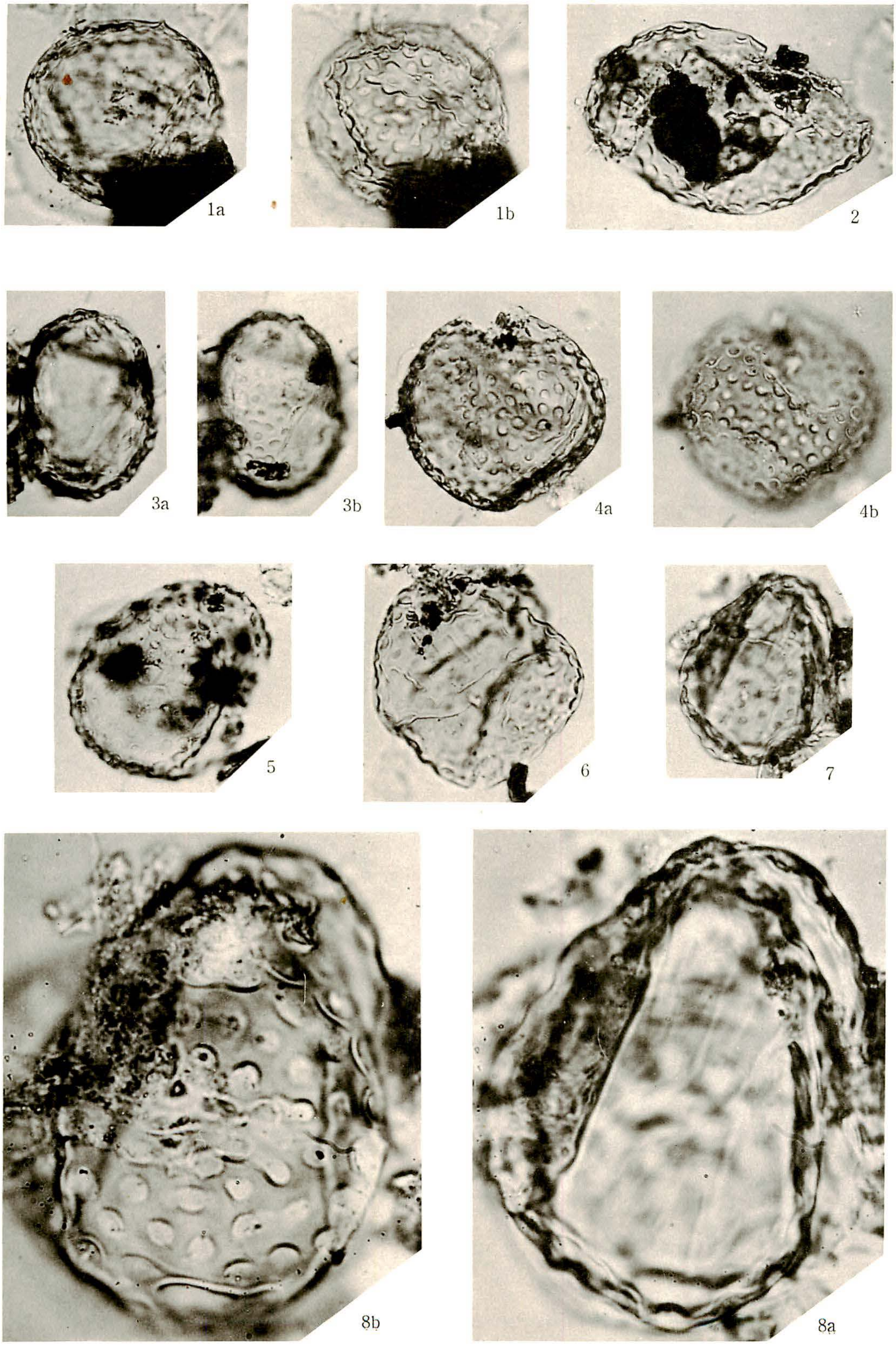
Type locality:—500 m north of Harayama, Watsuka-cho, Sōraku-gun, Kyoto Prefecture.

Type horizon:—Sandstone in the mudstone member of the B formation in the Jubusen area of the Tanba belt.

Description:—Grains circular or somewhat elliptical in outline, range of diameter 107–152μ×82–144μ.

Explanation of Plate 5

Figs. 1–8. *Reticulatasporites foraminulatus* n. sp.
Figs. 4a–b: Holotype, slide 66041104-10;
Figs. 1–7: ×420; Figs. 8a–b: ×1050.


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

Wall dark brown or reddish brown, 5 to 6.7μ in thickness. Very small pores of the wall are found here and there, especially by fig. 8 remarkable.

Remarks:—The present specimens are similar to the specimen from the Cretaceous of the Graham Island and Ellef Ringes Island, Arctic Canada which was treated by S. MANUM (1964) as *Tasmanites* cf. *tardus* EISENACK (S. MANUM, 1964, p. 22, pl. 7, fig. 9). The shell wall of the present species is far thinner than that of *Tasmanites tardus* EISENACK.

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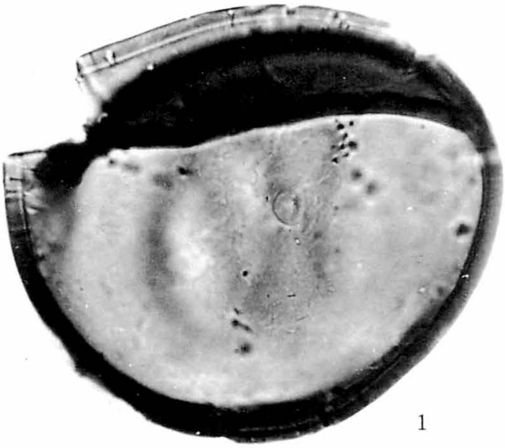
Harayama	原 山	Tanba	丹 波
Jubusen	鷲峯山	Watsuka-cho	和束町
Sôraku-gun	相楽郡		

Explanation of Plate 6

Figs. 1-8. *Tasmanites tanbaensis* n. sp. ×420.
Fig. 2.: Holotype, slide 66041104-13.



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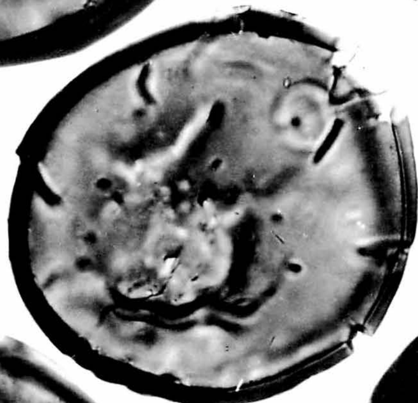

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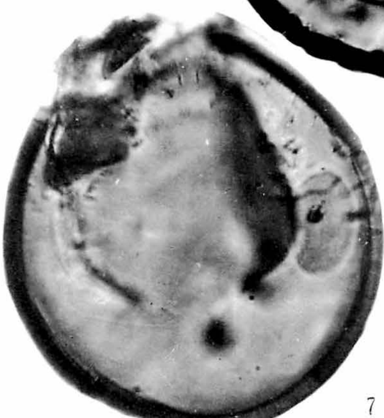

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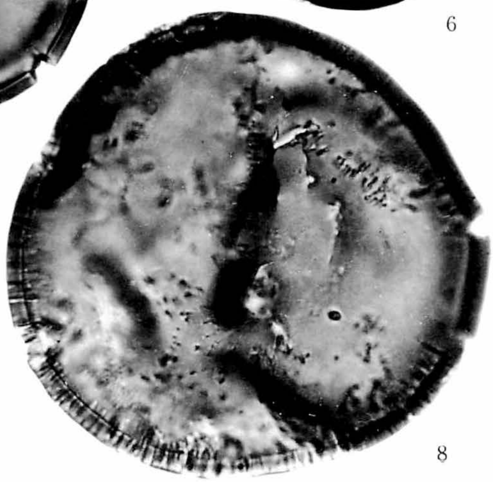

8

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第101回例会は，1968年11月30日（土）午後1時より，静岡大学理学部において開催された（参加者33名）。

個　人　講　演

志摩青峰層群二地（フタジ）帯産の紡錘虫と珊瑚について（代読）…………………山際延夫

上部成田層産の蟹類化石について ……福田芳生

伊豆滑川（ナメガワ）に共存する *Amussiopecten* と *Lepidocyclina* ……土　隆一・茨木雅子

Triassic *Oxytoma* bed in the Environs of Ōme City, Kwanto mountains ………… ……Tomowo OZAWA and Itaru HAYAMI

Occurrence of *Tutcheria* from the Lower Jurassic of west Japan ….Itaru HAYAMI

クイチガイサルボウの形態変異について ……………………………………岩崎泰頴

Review of the Philippine Palaeontology ………………………Wataru HASHIMOTO

日本古生物学会1969年総会・年会は1969年1月25日（土），26日（日）東京国立科学博物館2号館において開催された。（参加者104名）

個　人　講　演（25日）

Two Interesting Fossil Specimens from the Upper Paleozoic System in Japan …… ………………… R. ENDO & R. MORI,

Mesozoic Filicales of Japan ………… ……………… T. KIMURA & S. SEKIDO

Mesozoic Plants from the Yatsushiro Formation, Kyushu, Japan ……T. KIMURA

Addition to the Mesozoic Plants from the Iwamuro Formation, Gumma Prefecture, Japan ……………………T. KIMURA

石川・福井県境谷峠トンネル付近の大道谷植物群について……………………松尾秀邦

仙台湾底質中の *Braarudosphaera bigelowi* (GRAN & BRAARUD) について ….高山俊昭

青海石灰岩産下部石炭紀のコノドントについて ……………………渡辺耕造・小池敏夫

On the Genus *Thecosphaera* from the Neogene Formation, Japan ….K. NAKASEKO

Phylogeny and Classification of the Fusulinacean Family Verbeekinidae..T. OZAWA

Lepidolina multiseptata (DEPRAT), the type-species of the Verbeekinid Genus *Lepidolina* LEE, 1933 ………….T. OZAWA

志摩築地層群について ……………山際延夫

志摩で発見された *Yabeina shiraiwensis*—*Lepidolina toriyamai* 化石群について …. ……………………山際延夫・坂　幸恭

Analysis of the Recent Foraminiferal Faunas from Miyako and Yamada Bays, Northeastern Japan ……………………… …………. H. UJIIE & T. KUSUKAWA

Four New Species of Foraminifera from Miyako and Yamada Bays ……….. …………. H. UJIIE & T. KUSUKAWA

房総半島における *Globorotalia tosaensis*—*Globorotalia truncatulinoides* の産出層準について（予報）………………高山俊昭

琉球石灰岩産サンゴ化石の年代 ………… ……………………小西健二・大村明雄

栃木県那須産中新世セミ化石について ..藤山家徳

フィリッピン・タヤバス地区産の中新統貝化石群…………………………岩崎泰頴

Pliocene Boring Shells and their Burrows from the Environs of Sendai, Japan…. ………………K. MASUDA & H. NODA

大桑層産 *Glycymeris yessoensis* の産状に関する一考察……………………小西健二

Glycymeris 個体群に関する2・3の検討…… ……………………………速水　格

Lower Cretaceous Ammonites from the Miyako Group. Pt. 3. Some Douvilleiceratids from the Miyako Group …… ………………………… I. OBATA

Selected Acanthoceratids from Hokkaido .. ……………………… T. MATSUMOTO, T. MURAMOTO & T. TAKAHASHI

前会長記念講演 (26日)

Pre-Paleozoic Natural History について……浅野 清

特 別 講 演 (26日)

米・ソ古生物学の動向—シルル・デボン系研究での一例……浜田隆士

シンポジウム「日本新生代貝類化石群の時空分布」(世話人：小高民夫，鎮西清高，岩崎泰頴) は26日の午前・午後にわたって行なわれた。

日本近海における現生貝類の生態学的生物地理……堀越増興
貝類の生体群集と遺骸群集……波部忠重
腹足類の初期発生と，その地理的分布分類に関する一考察……首藤次男
Calyptogena 群集について……鹿間時夫・増島愛子
椎谷層の化石，特に *Turcicula* について……野田浩司
西山層の貝化石群集……津田禾粒
茂庭層の貝化石群集……増田孝一郎
雨龍炭田の中部第三系の貝化石群……大原 隆・菅野三郎
掛川貝化石群の変遷，特に *Suchium suchiense* について……土 隆一
瀬戸内東部地域中新統の貝化石群集……糸魚川淳二
山口県特牛港付近の日置層群の芦屋動物化石群……岡本和夫
本邦における漸新世貝化石群の存否……鎌田泰彦
青森県における新生界の軟体動物化石層序……岩井武彦
貝化石群による秋田油田地域の新第三系層序……高安泰助

学 会 記 事

◎ 1969年度よりの入会者 (1969年1月25日の評議員会で承認)
普通会員22名，在外会員5名，(敬称略，申込順)
平田茂留，久光正雄，八尾 昭，NESTELL, M. K.，大上和良，土井清磨，ORDOÑEZ, E. P., YAGO, R. E., ANDAL, P. P., SUNTHARALINGAM, T.，吉田瓊一，野原朝秀，中道 修，吉本裕一，本庄 丕，渡辺其久男，讃良紀彦，白神孝，玉生志郎，秋葉文雄，柴田 晃，家田享一，菅野耕三，佐藤貞子，江藤哲人，阿久津ヤウ，実崎悟郎

◎ 1968年度中に会員大野作太郎君が逝去された。

◎ 1968年度中の退会者 (1名) 市原 実

◎ 1969年1月25日の評議員会に於いて，次の諸君が特別会員に推薦された。(9名 順不同)
坂東裕司，千地万造，今西茂，糸魚川淳二，亀井節夫，野上裕生，坂口重雄，須鎗和巳，田中啓策

◎ 1968年末に行われた，1969，1970年度評議員選挙の結果，次の諸君が当選した。
(五十音順)
浅野 清，市川浩一郎，尾崎 博，金谷太郎，勘米良亀齢，小高民夫，小西健二，小林貞一，鹿間時夫，高井冬二，畑井小虎，花井哲郎，速水 格，松本達郎，湊 正雄。

◎ 1969年1月25日の評議員会における会長選挙の結果，高井冬二君が新たに選ばれた。

◎ 学会誌論文賞が，1969年度総会の席上，小沢智生君の「*Pseudofusulinella*, a Genus of Fusulinacea」に対して贈られた。なお学術奨励金は今回は該当者なく見送られた。

◎ 1969，1970年度学会役員，幹事及び職務分担は表紙裏に示した通りである。

◎ 1969年度中に行われる例会は都合により2回になった。詳細は裏表紙掲載の通りである。

例　会　通　知

	開　催　地	開　催　日	講演申込締切日
102回　例　会	神奈川県立博物館	1969年6月14,15日	1969年5月1日
103回　例　会	鹿児島大学	1969年11月29,30日	1969年10月25日
1970年総会，年会	東北大学	1970年1月下旬	1969年12月1日

102回例会（神奈川県立博）：シンポジウム，植物の分布と進化（世話人：浅間一男，徳永重元）。
103回例会（鹿児島大）：日本地質学会西日本支部例会と合同。シンポジウム，九州の第四系―九州近海海底ならびに南西諸島地域を含む（世話人：首藤次男，早坂祥三）。

NEWS

◎ 特別会員遠藤隆次君は，1969年4月1日に逝去された。同君の多年にわたる本会への貢献に対して，弔辞をおくり冥福を祈った。

◎ II Planktonic Conference (International Conference on Micro(and Nanno) Plankton) が，1970年9月29日より10月7日まで，Roma で開催される。参加費は。U.S $30—. 連絡先は，Dr. Bruno Accordi, II Planktonic Conference, Istituto di Geologia e Paleontologia, Citta Universitaria-00100 Roma, Italia.

◎ The 3rd International Conference on Palynology が，1971年，Novosibirsk, USSR において開催される。連絡先は，Professor M. I. Neustadt, Institute of Geography of the Academy of Sciences of USSR, Staromonetny per-29, Moscow B-17, U. S. S. R.

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