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The ostracod carapace on the cover is an adult specimen of *Manawa konishii* NOHARA (Suborder Palaeocopina, Family Punciidae) from the East China Sea. (photo by K. ABE, x190)

756. MORPHOLOGICAL CHANGE IN THE PERMIAN RADIOLARIA, PSEUDOALBAILLELLA SCALPRATA IN JAPAN

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Abstract.   *Pseudoalbaillella scalprata* Holdsworth and Jones from the Permian red bedded chert in the Sasayama area, Southwest Japan is described. This species consists of three morphotypes; m. *scalprata*, m. *postscalprata* (in this paper) and m. *rhombothoracata*. Discontinuous variation of the three morphotypes is discussed on the basis of mensurations. Concerning the stratigraphic frequency distribution of the three morphotypes, m. *rhombothoracata* occurs later than the first appearances of the other two morphotypes and gradually increases its individual number in contrast with the decrease of that of m. *scalprata*.

Introduction

Recently much progress has been made in Permian radiolarian biostratigraphy. It is mainly based on the paleontologic examination of species which belong to the suborder Albaillellaria, because these radiolarians have a characteristic shape and rather short range of occurrence. Among them, genus *Pseudoalbaillella* Holdsworth and Jones, 1980 is characterized by bilaterally symmetrical, imperforate shell wall which consists of apical cone, winged pseudothorax and pseudoabdomen. Until now 14 species have been described (Holdsworth and Jones, 1980; Ishiga and Imoto, 1980; Kozur, 1981; Ishiga *et al.*, 1982 a, b).

Topotype specimens of *Pseudoalbaillella rhombothoracata* Ishiga and Imoto from the Sasayama area, Southwest Japan exhibit wide morphological differences, and it is found that three forms can be discriminated among them. One of them is identifiable with *Ps. scalprata* Holdsworth and Jones, according to the original diagnosis. The second one belongs to *Ps. rhombothoracata*, and the last one is intermediate between *Ps. scalprata* and *Ps. rhombothoracata*. In this paper, the three forms mentioned above are described as morphotypes of a single species, *Ps. scalprata*, and chronological change of relative frequency among the three forms is examined. Furthermore, discontinuous variation of the three forms is discussed on the basis of mensurations.

Material studied

This study is based on the material collected from the locality 401-7 (Ishiga *et al.*, 1982a), which is located at about 4 kilometers north of Sasayama in Sasayama-cho, Taki-gun, Hyogo Prefecture, Southwest Japan. In the subsequent notes on the occurrence of each species, the sample number in the Text-fig. 1 and 2 is the same as that given in table 1 in Ishiga and Imoto (1980).

The specimens described in this paper are registered and deposited in the Department of Earth Sciences, Kyoto University of Education (KUE PR).

Systematic Paleontology

Subclass Radiolaria Müller, 1858

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* Received April 14, 1982.

Order Polycystina Ehrenberg, 1838,
emend. Riedel, 1967

Suborder Albaillellaria Deflandre, 1953,
emend. Holdsworth, 1969

Family Albaillellidae Deflandre, 1952,
emend. Holdsworth, 1977

Remarks.—The classification of families under the suborder Albaillellaria is currently based on the internal structure and external framework. Albaillellidae Deflandre is characterized in having internal two rods (dorsal and ventral columella) and external cross-bar of the H-frame (Holdsworth, 1969). Follicucullidae Ormiston and Babcock is distinguished from Albaillellidae in that no counterparts to the H-frame of the Albaillellidae is observed in the Follicucullidae (Ormistone and Babcock, 1979; Kozur, 1981), but external framework of these radiolarians are so delicate that it is easily broken off or dissolved in the process of diagenesis. It is difficult to determine whether *Pseudoalbaillella* has the external crossbar of the H-frame or not, so the family-level assignment of this genus is only tentative pending future study of well-preserved specimens.

Genus *Pseudoalbaillella* Holdsworth
and Jones, 1980

Type species.—*Pseudoalbaillella scalprata* Holdsworth and Jones, 1980. p.284, figs. A, B.

Pseudoalbaillella scalprata
Holdsworth and Jones

1980. *Pseudoalbaillella scalprata* Holdsworth and Jones, *Geology*, vol. 8, p.284, figs. A, B.

1980. *Pseudoalbaillela rhombothoracata* Ishiga and Imoto, *Earth Sci. (Chikyu Kagaku)*, vol. 36, no. 1, pl. 3, figs. 9—12.

Specific diagnosis.—A species of *Pseudoalbaillella* which consists of unconstricted apical cone, triangular-rhombohedral pseudothorax and unconstricted pseudoabdomen without pores.

Remarks.—Three forms are discriminated among specimens from the Sasayama area. They reveal discontinuous variation as will be discussed in the chapter on morphology, but they are similar each other concerning the broad features given in the specific diagnosis. So they are regarded to be variation within an evolutionary species, *Ps. scalprata* and under this scheme, *Ps. rhombothoracata* becomes synonymous with *Ps. scalprata*. In this paper, three forms of *Ps. scalprata* are treated as morphotypes. In the designation of morphotype, the letter m. is added before the morphotype name in order to avoid any confusion between subspecific name and morphotype name. Three morphotypes, namely, m. *scalprata*, m. *postscalprata* and m. *rhombothoracata* are described below.

Pseudoalbaillella scalprata m. *scalprata*

Pl. 1, Figs. 1—18.

1980. *Pseudoalbaillella scalprata* Holdsworth and Jones *Geology*, vol. 8, p.284, figs. A, B.

Material.—Eighteen specimens, figured in this paper, and more than 50 specimens from Fujioka-oku, Sasayama town, Hyogo Prefecture, are concerned with the present description. Standard specimen of this morphotype is the holotype of *Ps. scalprata* (USGS MR 0203 of Holdsworth and Jones, 1980) from the Havallah Formation, Nevada.

Description.—Apical cone without segmentation, distinctly inclined to ventral side. In cross section proximal part subelliptical or flat, distal part subcircular, and slightly inflated. In some specimens shell surface smooth without clear boundary between apical cone and pseudothorax. Pseudothorax triangular in outline, not so inflated. Shoulder of dorsal wing round and that of ventral wing straight, the two shoulders forming an angle of 55—80°. Shoulders blade-like at the outer margin. Opening of wing-pit semi-circular in outline. Height of wing-pit short, being 3/20—1/5 length of pseudothorax. Pseudo-abdomen short, elliptical in cross section about 1/8—3/20 length of shell body and slightly inclined to ventral side, distally decreasing its

width. Dorsal and ventral flaps extending nearly vertically downward and slightly inclined inward. Apertural margin between dorsal and ventral side weakly drooping.

Remarks.—The holotype of *Pseudoalbaillella scalprata* has broad apical cone, more strongly inflated pseudothorax and shorter pseudoabdomen than the paratype of this species. Holdsworth and Jones (1980) described that apical cone is sometimes weakly segmented, but on the holotype ventral surface of apical cone seems to be even and have no segmentation, judging from the illustration. The paratype also seems to have no segmentation at apical cone. The Sasayama specimens have no constriction at apical cone and closely resemble the paratype. Morphotype *scalprata* from the Sasayama area differs from m. *postscalprata*, described below, in having triangular pseudothorax. Two forms are discriminated within m. *scalprata* on the basis of the angle between the two shoulders, which ranges 55—60° and 75—80°, respectively. The latter value (75—80°) is the same as that of m. *postscalprata*, but these two forms are included in m. *scalprata*, since they have shorter pseudoabdomen than that of m. *postscalprata* and do not differ significantly from each other in other features.

Occurrence.—Late Wolfcampian red bedded chert in the Tamba Belt, Southwest Japan and Leonardian (?) Havallah Formation in Nevada (Holdsworth and Jones, 1980).

Pseudoalbaillella scalprata m. *postscalprata* (nov.)

Pl. 2, Figs. 1—16.

1980. *Pseudoalbaillella rhombothoracata* Ishiga and Imoto, *Earth Sci. (Chikyu Kagaku)*, vol. 36, no. 1, pl. 3, fig. 12 only.

Material.—Sixteen specimens, figured in this paper, and more than 70 specimens from Fujioka-oku, Sasayama town, Hyogo Prefecture. Standard specimen of this morphotype is KUE PR 39—86 (Plate 2, Fig.1).

Description.—Apical cone without segmentation, curving slightly to the ventral portion,

about 2/5 length of shell body. Proximal part of apical cone well-inflated and subcircular in cross section. Weak constriction along the boundary between apical cone and pseudothorax. Pseudothorax slightly inflated and square-shouldered. Shoulder of dorsal wing straight or slightly curving downward and that of ventral wing slightly curving downward. Two shoulders forming an angle of 80—100°. The outer margin of shoulders blade-like. Wings keel-shaped. Dorsal wing curving downward, and ventral wing recurving downward. The height of wing-pit being 1/4—3/10 length of pseudothorax. Dorsal and ventral wing-pit broadly arcuate. Weakly constricted band runs between pseudothorax and pseudoabdomen. Pseudoabdomen square, 1/5—3/10 length of shell body. Apertural margin slightly dillated and elliptical in cross section. Apertural margin between dorsal and ventral side convex and tongue-like in shape. Dorsal and ventral flaps incline to ventral side, forming an angle 5—40° to the side of pseudoabdomen, and both sides of flaps concave and slitted. Dorsal slits stronger than ventral ones.
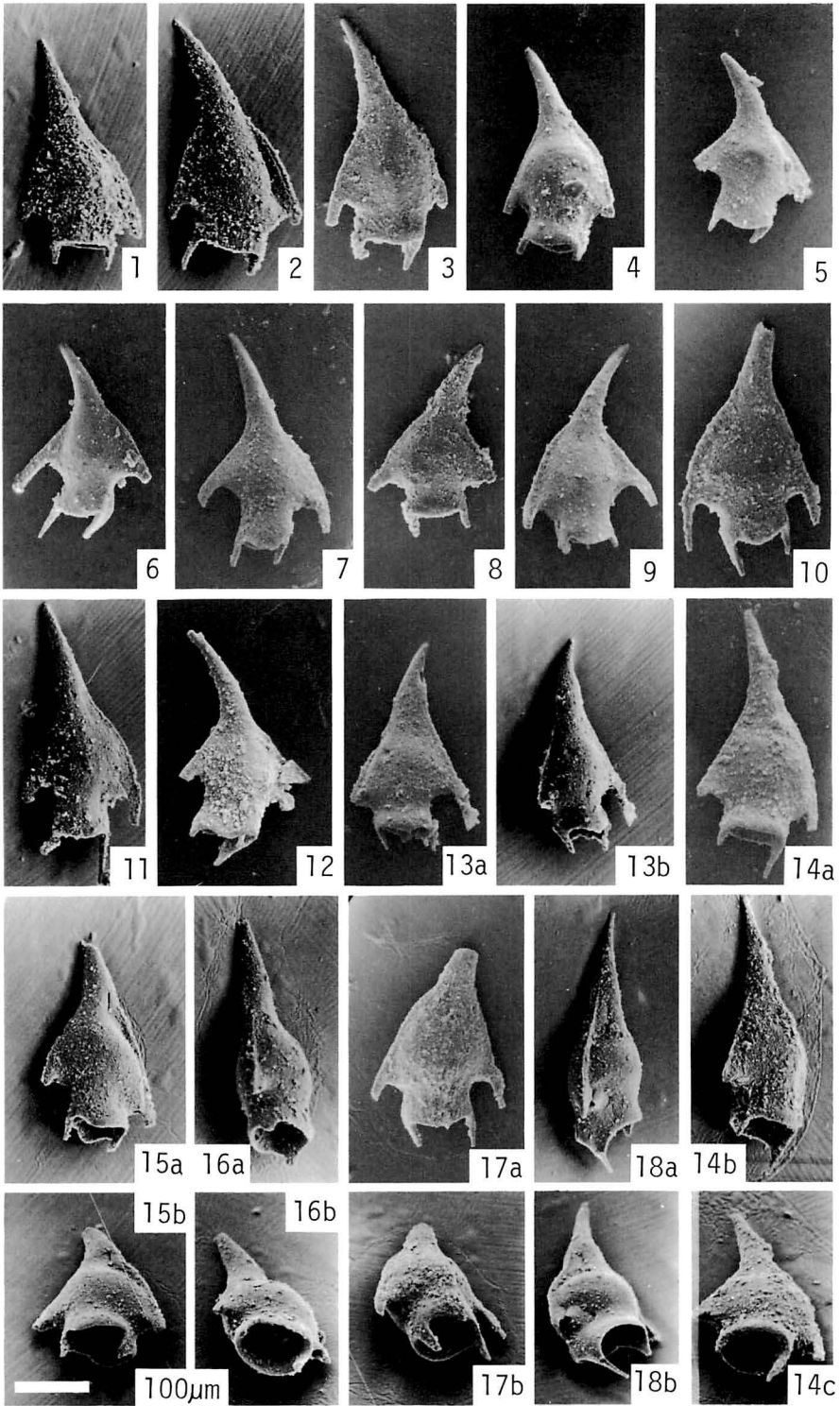
Remarks.—Morphotype *postscalprata* differs from m. *scalprata* in having nearly rhombohedral pseudothorax and longer pseudoabdomen, and from m. *rhombothoracata*, described below, in having smaller wing-pit and shorter pseudoabdomen. The angle between shoulders of m. *postscalprata* and that of m. *rhombothoracata* are nearly equal and the two morphotypes resemble each other in the ratio of height of wing-pit to the height of pseudothorax. Morphotype *postscalprata* differs from m. *rhombothoracata* in having a similar but larger pseudoabdomen. *Ps. rhombothoracata* (KUE PR 8—29) designated in Ishiga and Imoto (1980, pl. 3, fig. 12) belongs to m. *postscalprata*, because this specimen has smaller pseudothorax and shorter pseudoabdomen.

Occurrence.—Late Wolfcampian red bedded chert in the Tamba Belt, Southwest Japan.

Pseudoalbaillella scalprata m. *rhombothoracata*

Pl. 3, Figs. 1—12.

1980. *Pseudoalbaillella rhombothoracata* Ishiga
and Imoto, *Earth Sci. (Chikyu Kakaku)*, vol.
36, no. 1, pl. 3, figs. 9—11 (not 12).

Material.—Twelve specimens, figured in this
paper, and more than 45 specimens from Fujioka-
oku, Sasayama town, Hyogo Prefecture. Standard
specimen of this morphotype is KUE PR 8—11
designated in Ishiga and Imoto (1980), pl. 3,
fig. 9.

Description.—Apical cone without segmenta-
tion, curving slightly to the ventral portion, sub-
circular in cross section. Narrow concave band
developed between apical cone and pseudothorax.
Pseudothorax nearly rectilinear rhombohedral in
outline and rather inflated, with strongly squared
shoulders. Outer margin of shoulder straight and
blade-like. Dorsal wing curving downward,
ventral one distally recurving. Two shoulders
forming an angle of 80—100°. Opening of
wing-pit broad and nearly straight in outline.
Height of wing-pit 1/4—3/10 length of pseudo-
thorax. Pseudoabdomen cyrindrical without
segmentation, about 3/10 length of shell body.
Apertural margin dillated like a trumpet, and
obliquely facing toward ventral side. A shallow
groove on lower half of the dorsal side of pseudo-
abdomen, continuing to the basal part of dorsal
flap. Two flaps running nearly parallel each
other, inclined to the ventral side, forming an
angle of 40—70° to the side of pseudoabdomen.
Apertural margin between dorsal and ventral
side convex and tongue-like in shape.

Remarks.—Morphotype *rhombothoracata* dif-
fers from the other two morphotypes in having
a large rectilinear rhombohedral pseudothorax
and a longer pseudoabdomen with more strongly
inclined flaps, but the width of pseudoabdomen
in the former morphotype is the same as that in

the other morphotypes of *Ps. scalprata* from
the Sasayama area.

Occurrence.—Late Wolfcampian red bedded
chert in the Tamba Belt, Southwest Japan.

Biostratigraphy

The stratigraphic distribution of the three
morphotypes of *Pseudoalbaillella scalprata* and
some other radiolarians in the Fujioka-oku

Text-fig. 1. Characteristic radiolarian
species and distribution of the three morpho-
types of *Pseudoalbaillella scalprata* in the
Sasayama area after Ishiga & Imoto (1980).

Explanation of Plate 1

Fig. 1—18. *Pseudoalbaillella scalprata* m. *scalprata*
    1; KUE PR 39-30, 2; KUE PR 39-29, 3; KUE PR 39-16, 4; KUE PR 39-25, 5; KUE PR 39-26,
    6; KUE PR 39-6, 7; KUE PR 39-1, 8; KUE PR 39-10, 9; KUE PR 39-4, 10; KUE PR 39-3,
    11; KUE PR 39-28, 12; KUE PR 39-23, 13; KUE PR 39-9, 14; KUE PR 39-14, 15; KUE PR
    39-8, 16; KUE PR 39-24, 17; KUE PR 39-5, 18; KUE PR 39-27. All from sample 4-38.

section of the Sasayama area is given in Text-fig. 1. The sequence is composed of well-bedded reddish cherts and siliceous shales as described elsewhere (Ishiga and Imoto, 1980).

Text-fig. 2 coresponds to the middle portion of Text-fig. 1 and shows the distribution of the three morphotypes. Morphotype *scalprata* and m. *postscalprata* first appeared in the horizon 28-11. From the horizon 28-11 to 4-41, m. *scalprata* gradually diminishes in individual number, while m. *postscalprata* is contained at the constant rate of 50% in each sample (Text-fig. 2). Morphotype *rhombothoracata* first appeared in the horizon 4-18 and gradually increases its number in contrast with the decrease of that of m. *scalprata*. *Pseudoalbaillella scalprata* is absent in samples from the horizons above 4-41 and a sharp break in fossil assemblage shown between the horizon 4-41 and 4-48 is thought to be hiatus (Text-fig. 1). The assemblages below

and above the hiatus are called the *Pseudoalbaillella* assemblage and *Follicucullus* assemblage, respectively (Ishiga and Imoto, 1980). The horizons from 28-11 to 4-41 shown in Text-fig. 2 correspond to the zone of *Ps.* sp. A—*Ps. rhombothoracata* sub-assemblage which is the heighest of the three sub-assemblages within the *Pseudoalbaillella* assemblage (Ishiga and Imoto, 1980). Subsequent studies on the radiolarian biostratigraphy in areas outside of Sasayama reveals that three assemblages, namely *Albaillella* sp. D assemblage, *Ps. globosa* assemblage and *Follicucullus monacanthus* assemblage in ascending order, are missing in the Fujioka-oku section at that hiatus (Ishiga *et al.*, 1982b). Morphotype *rhombothoracata* is contained in the *Albaillella* sp. D assemblage, while both m. *scalprata* and m. *postscalprata* have not been found yet in this assemblage.

In samples 4-11, 4-18 and 4-26, occurrence of *Sweetognathus whitei* (Rhodes) was reported and the age of the examined column was thought to be late Wolfcampian (Ishiga and Imoto, 1980).

Text-fig. 2. Frequency distribution of individual number of the three morphotypes of *Pseudoalbaillella scalprata*.
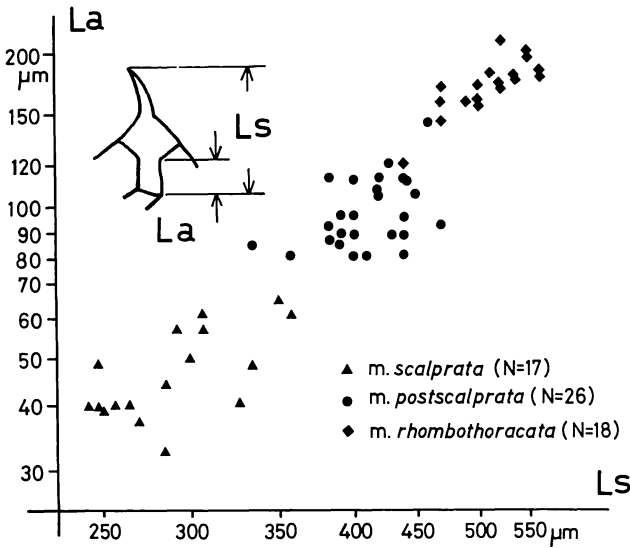
Morphology

The three morphotypes of *Pseudoalbaillella scalprata* are characterized in having the triangular-rhombohedral pseudothorax. In these morphotypes, the apical cone is not constricted, the pseudothorax is flattened or slightly inflated, and the pseudoabdomen is not constricted and not ornamented with pores. *Ps. simplex* Ishiga and Imoto has a simple shell-construction, and closely resembles *Ps. scalprata* m. *scalprata*, but differs from it in having a sub-spherical, weakly inflated pseudothorax and more weakly constricted band between the pseudothorax and pseudoabdomen. Other species of *Pseudoalbaillella* in the Sasayama area have more elaborately ornamented shell wall (such as constricted apical cone and pseudoabdomen like those of *Ps. lomentaria* Ishiga and Imoto, and perforated pseudoabdomen like that of *Ps. ornata* Ishiga and Imoto).

The author newly obtained 99 specimens from the horizon 4-38 (Text-fig. 2) and practiced
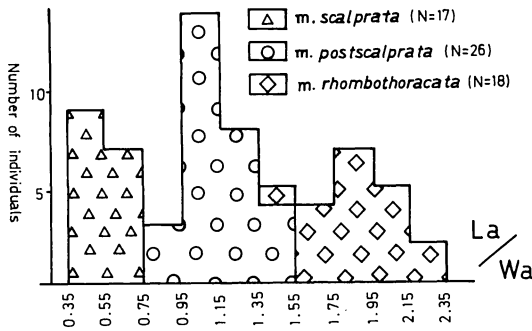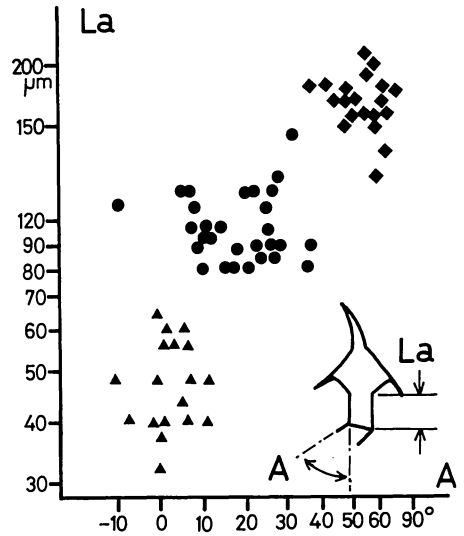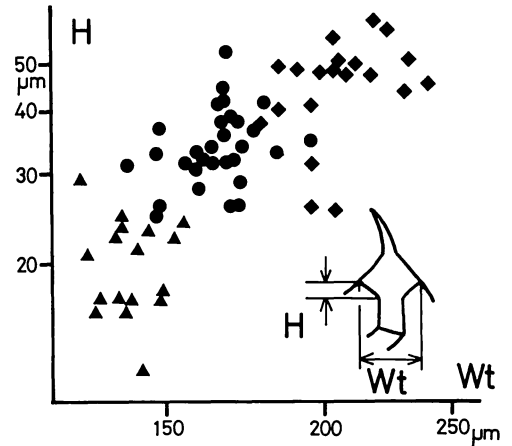
Text-fig. 3. Double logarithmic scatter diagram showing the relationship between the length of shell excluding flaps (Ls in μm) and the length of pseudoabdomen (La in μm). (Sample 4-38).

Text-fig. 4. Frequency distribution of morphological change of pseudoabdomen. Wa: width of pseudoabdomen in μm; La length of pseudoabdomen in μm.

Text-fig. 5. Diagram showing the relationship between the length of pseudoabdomen (La in μm) and the inclination of ventral flap (A).

Text-fig. 6. Double logarithmic scatter diagram showing the size of pseudothorax. Wt: width of pseudothorax in μm; H: height of wing-pit in μm.

Explanation of Plate 2

Figs. 1—16. *Pseudoalbaillella scalprata* m. *postscalprata*
　　　1; Standard specimen, KUE PR 39-86, 2; KUE PR 39-43, 3; KUE PR 39-44, 4; KUE PR 39-42, 5; KUE PR 39-61, 6; KUE PR 39-95, 7; KUE PR 39-54, 8; KUE PR 39-61, 9; KUE PR 39-36, 10; KUE PR 39-102, 11; KUE PR 39-12, 12; KUE PR 39-77, 13; KUE PR 39-85, 14; KUE PR 39-100, 15; KUE PR 39-96. All from sample 4-38.
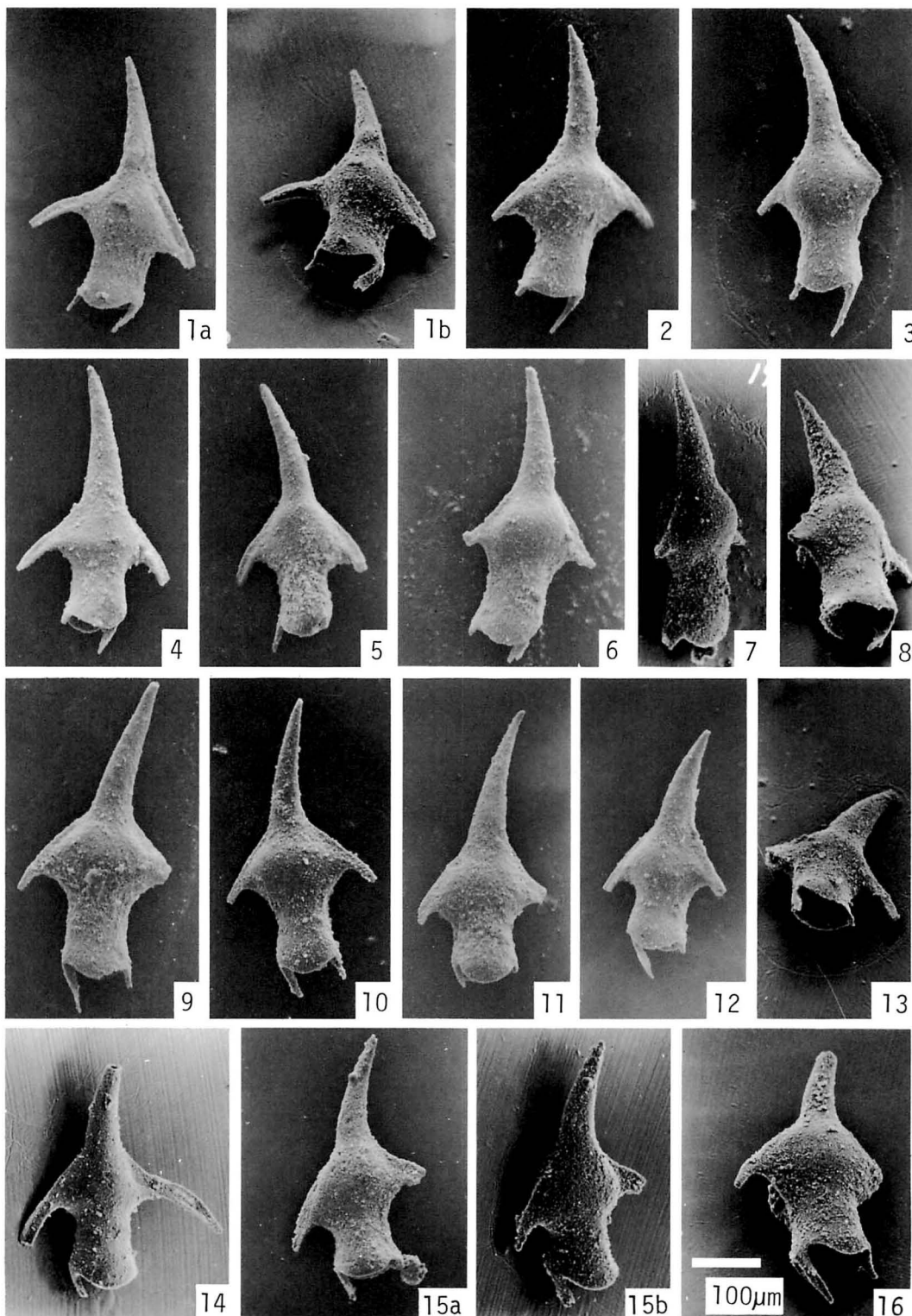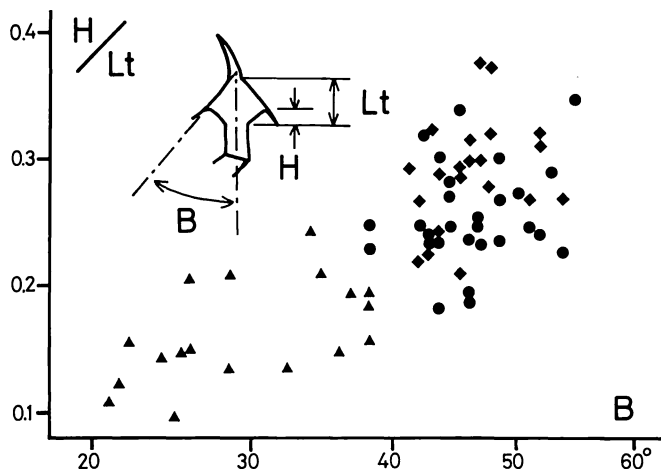
Text-fig. 7. Diagram showing the morphological change of pseudothorax. B: an angle between the shoulder of ventral wing and the central axis. Lt: length of pseudothorax in μm.

mensuration. The discontinuous variation among the three morphotypes of *Ps. scalprata* is well represented by morphological change of pseudoabdomen. The logarithmic scatter diagram, La/Ls (Text-fig. 3) reveals three distinct forms which correspond to the three morphotypes. Concerning the pseudoabdomen, length (La)/width (Wa) ratio is also applicable to the representation of the morphological difference. As shown in Text-fig. 4, the frequency distribution of this index is trimodal. Although two of the three slightly overlap at the interval 1.35—1.55, the individuals of the left peak in the histogram (La/Wa$<$0.75) always belongs to morphotype *scalprata*, those of the central peak (0.75$<$ La/Wa$<$1.55) to m. *postscalprata* and those of the right peak (La/Wa$>$1.35) to m. *rhombothoracata*. Text-fig. 5 shows the relationship between the length of pseudoabdomen (La) and the inclination of ventral flap (A). Here also we can notice the three distinct clusters which correspond to the three morphotypes.

Another morphological difference among the three morphotypes is represented by the shape of the pseudothorax. Text-fig. 6 shows the size distribution between width of the pseudothorax (Wt) and height of the wing-pit (H). Text-fig. 7 shows distribution of an angle B and a morphological change of pseudothorax (using an index

H/Lt: where Lt is length of pseudothorax). In these three morphotypes, the dorsal shoulder is convex and it is impossible to measure the exact angle between the central axis and the dorsal shoulder. So, an angle B between the ventral shoulder and central axis is used, for the ventral shoulder is usually straight in the measured specimens. In accordance with the increase of the morphological change, the shape of pseudothorax changes from triangular to square in outline.

The morphological change of the pseudothorax is bimodal in the three morphotypes. Measurements of morphotype *postscalprata* and *rhombothoracata* are plotted almost on the same region, but m. *scalprata* is distinguished from the above two morphotypes. In conclusion, pseudothorax of m. *postscalprata* is smaller than that of m. *rhombothoracata*, but the two morphotypes have the same configuration of pseudothorax.

Evolutionary Change

The main trend of the evolutionary change in *Pseudoalbaillella scalprata* lies in the development of the pseudothorax and the elongation of the pseudoabdomen. Morphotype *scalprata* has a smaller triangular pseudothorax, while m. *postscalprata* has a nearly rhombohedral pseu-

dothorax. This morphological change is well explained by the degree of the angle between shoulders of dorsal and ventral wing. Morphotype *rhombothoracata* has a more developed, broader wing-pit. The broadness and rectilineation of the wing-pit is consistent with the elongation of pseudothorax.

The length of pseudothorax varies among the three morphotypes, but the width is nearly equal. The inclination of flaps becomes stronger, consistent with the elongation of pseudoabdomen.

There is no obvious ancestor to *Pseudoalbaillella scalprata* Holdsworth and Jones in the Sasayama assemblages, but *Ps. simplex* Ishiga and Imoto is supposed to be ancestral species, and possibly, *Ps. scalprata* was derived from certain simple *Pseudoalbaillella* in the early Wolfcampian. *Pseudoalbaillella* sp. cf. *Ps. scalprata* Holdsworth and Jones (KUE PR 1-7, 2-1, 2, 5, 8, in Ishiga and Imoto, 1980, pl. 2, figs. 4—8) is closely related to *Ps. scalprata* m. *scalprata*, but has the strongly inflated pseudothorax. *Ps. scalprata* m. *scalprata* probably gave rise to m. *postscalprata* in the early Wolfcampian, which in turn, gave rise to m. *rhombothoracata* in the late Wolfcampian.

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ペルム紀放散虫 *Pseudoalbaillella scalprata* の形態変化について：兵庫県多紀郡篠山町 藤岡奥に分布する ペルム系赤色層状チャート層より 産出した *Pseudoalbaillella scalparata* Holdsworth and Jones を記載した。この種は3つの morphotypes (m. *scalprata*, m. *postscalprata* および m. *rhombothoracata*) よりなる。これら3つの morphotypes の形態 変化を計測に基づき検討した結果，それらは不連続変異を示すことが明らかとなった。3つの morphotypes の産出頻度については，m. *rhombothoracata* が他の2つの morphotypes に 遅れて出現し，その頻度は次第に増加する。一方，m. *scalprata* は時間とともに減少する。

石賀裕明

Explanation of Plate 3

Figs. 1—12. *Pseudoalbaillella scalprata* m. *rhombothoracata*
　　1; KUE PR 40-9, 2; KUE PR 40-21, 3; KUE PR 40-8, 4; KUE PR 40-1, 5; KUE PR 40-33, 6; KUE PR 40-2, 7; KUE PR 40-4, 8; KUE PR 40-31, 9; KUE PR 40-10, 10; KUE PR 40-5, 11; KUE PR 40-29, 12; KUE PR 40-7. All from sample 4-38.
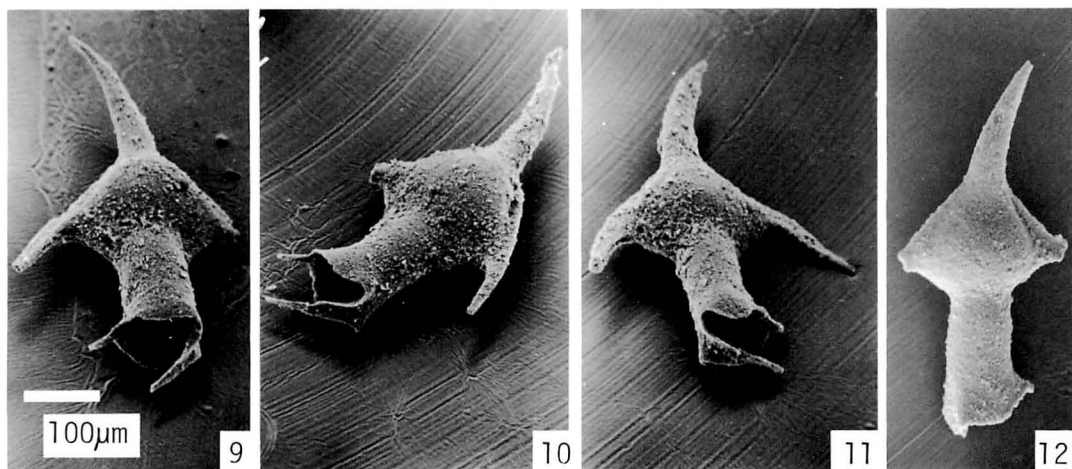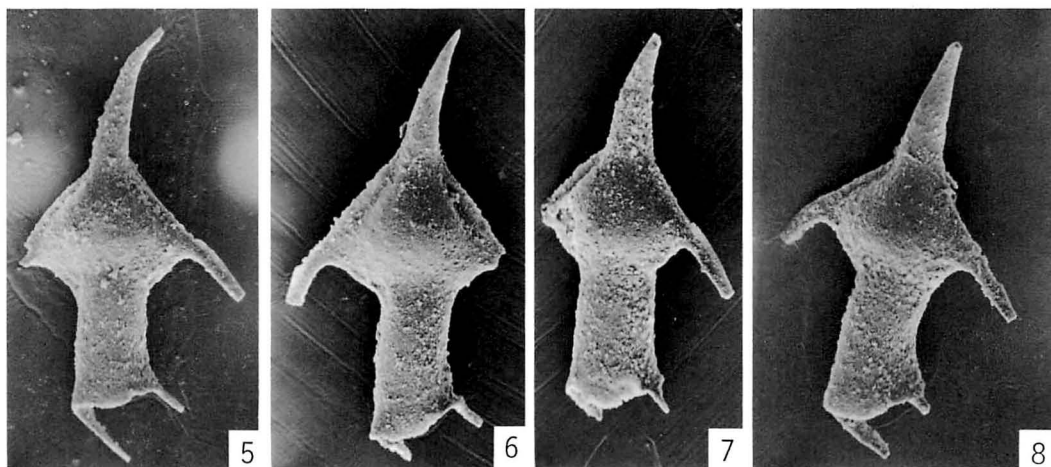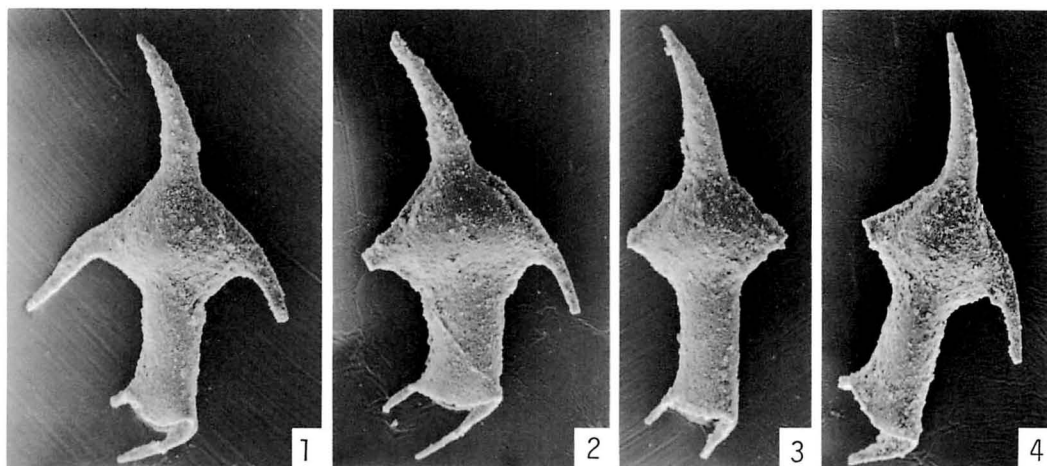
757. CRETACEOUS NAUTILOIDS FROM HOKKAIDO — I*

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Abstract.   I am going to monograph the Cretaceous nautiloids from Hokkaido on the available material in a series of papers, sometimes with coauthors. This paper contains, as Part 1, descriptions of three species from the Turonian and Coniacian of central Hokkaido. To describe two of them I establish a new genus (*Kummeloceras*) which is interpreted as a member of the root stock of the Nautilaceae derived directly from *Cenoceras*. In connexion with the establishment of the new genus, discussion is extended to the evaluation of the Eutrephoceratidae Miller, 1951 with necessary revision and the alteration of the concept of the Nautilidae, with Hercoglossidae Spath, 1927 as its synonymy.

The three species are new but allied to certain previously known species outside Japan. The first species is similar to "*Nautilus*" *splendens* Blanford and occurs in the Middle Turonian. The second is allied to "*Nautilus*" *fleuriausianus* d'Orbigny and occurs in the Coniacian. They are referred to the new genus. The third is allied to "*Nautilus*" *indicus* d'Orbigny and is assigned to *Eutrephoceras*. It occurs in the Lower Turonian.

Preface

Fossil cephalopods represented by various kinds of Ammonoidea occur abundantly in the Cretaceous deposits of Hokkaido and have been monographed to a considerable extent since the date of Yokoyama (1890). For some reasons, however, little work has been accomplished as to the Cretaceous nautiloids from Hokkaido. This is a great contrast to the situation in Europe, North America and certain other regions (e.g. India), where numerous species of Cretaceous and Jurassic nautiloids were described in the nineteenth century.

The scarcity of the work on the belemnoid cephalopods from the Upper Cretaceous of Hokkaido indeed owes to the absence or scarcity of the group in the North Pacific region for a palaeobiogeographic reason, but the same reason is not applicable for the nautiloids. The unfortunate situation was due to our collection

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failure and little scientific interests.

In fact some species of nautiloids have been already reported on the material from the Cretaceous of various areas in Japan by our predecessors, e.g. Yabe and Shimizu (1924), Shimizu (1931, 1935) and Yabe and Ozaki (1953), and by some palaeontologists of this generation, e.g. Matsumoto and Amano (1964), Matsumoto (1967), Obata *et al.* (1976), Obata and Ogawa (1976), Morozumi (1979), Matsumoto *et al.* (1980) and Furuichi (1982). These works are mostly concerned with the species from the areas other than Hokkaido, except for Shimizu (1935) and Matsumoto (1967). Shimizu (1935) covered most comprehensively the Japanese islands, but he only listed a few species, without giving palaeontologic descriptions.

While I have been doing field work for the Cretaceous biostratigraphy of Hokkaido, some nautiloids have been obtained along with ammonites, inoceramids and other fossils. Some friends of mine working in Hokkaido have also obtained nautiloids. Some of them have kindly

provided their specimens to me and others joined with me as coauthors. The hitherto obtained material shows some changes from a stage to another and includes several new species. In this work palaeontological descriptions are given to show what species occur in which stage of whereabouts. I hope this would give stimulation for further advances. As the coauthors are different from stage to stage, the papers are to be issued in series under the same major title. The material dealt with by Shimizu (1935), which is kept in the Palaeontological Collection of Tohoku University, is not included in the present study. That should be studied on another occasion.

The repositories of the specimens to be described in the following serial papers are as follows with abbreviations (or symbols) at each head:

GK.= Geological Collection, Kyushu University, Fukuoka 812

MC.= The Muramotos' Collection, Mikasa 068-22

MNH.= T. Miyauchi's Natural History Collection of Northern Hokkaido, Wakkanai 097

TTC.= Takumi Takahasi's Collection, Mikasa 068-22

UMUT.= University Museum, University of Tokyo

The areas where the described specimens were obtained are as follows from north to south (Text-fig. 1):

A. Cape Soya, northern Hokkaido

B. Island of Rebun, off the west coast of northern Hokkaido

C. Abeshinai-Saku area, Teshio province, northwestern Hokkaido

D. Haboro area, Teshio province, northwestern Hokkaido

E. Obira area, Rumoi district, northwestern Hokkaido

F. Ikushumbets area (Mikasa), central Hokkaido

G. Oyubari area, central Hokkaido

H. Hobetsu area, central Hokkaido

I. Urakawa area, southern Hokkaido

More specimens from these and other areas would be obtained in the future.

The stages to which the described specimens are assigned range from Barremian to Campanian. Some species from the Maastrichtian of Hokkaido would be expected, since there are few examples from Southwest Japan.

The following papers will be serially published under the present major title by the author(s) indicated in parentheses:
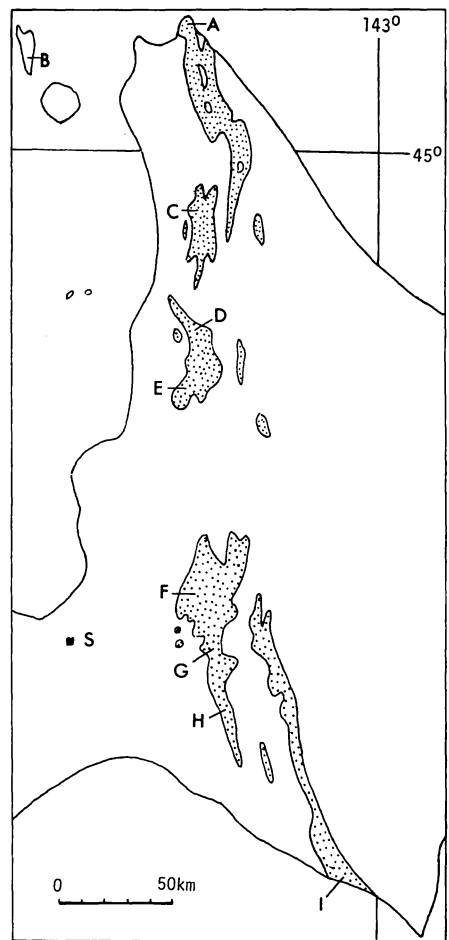
Text-fig. 1. Map of the main part of Hokkaido, showing post-Neocomian Cretaceous outcrops with dotted areas. The area where described nautiloids occurred are A = Soya, B = Rebun, C = Abeshinai-Saku, D = Haboro, E = Obira, F = Ikushumbets, G = Oyubari, H = Hobetsu, I = Urakawa.

Before going further, I express my sincere thanks to the above coauthors and other persons (whose names are to be indicated in respective parts) for their kind cooperation with me. I owe much to the authorities of the institutions listed as the repositories and also the Museum of Mikasa City for facilities given to this study. I appreciate very much Dr. Masayuki Noda's friendly help in taking photographs of the specimens and Miss Kazuko Hara's faithful assistance in preparing the typescript.

Part 1. Some Nautiloids from the Turonian and Coniacian of Central Hokkaido

Introduction

To cooperate with the activity of the IGCP (International Geological Correlation Program) "Mid-Cretaceous Events" [MCE] project, research work in the stratigraphy and palaeontology of the sequences from Aptian to Conacian has been very active in our country. Owing to the intensive field work, some interesting nautiloid specimens have been obtained. This paper is a result of my study of the nautiloids from the Turonian and Coniacian of central Hokkaido.

Through this work I have arrived at an idea which may be concerned with the fundamental problem in the taxonomy of post-Jurassic nautiloids. It will be discussed at length in connection with the proposal of a new genus.

Before going further, I appreciate very much the friendly cooperation of Dr. Masayuki Noda and Messers. Takemi Takahashi, Minoru Yamashita and Hiroharu Kokubu with me in providing the specimens which they obtained in the field work to the present study.

As stated above, this is a contribution to the MCE project, in which I owe much to the kind encouragement given by Professor R. A. Reyment, the project leader, and certain other members. Dr. Jost Wiedmann kindly sent me a copy of a reference which is inaccessible in Japan. Thanks are extended to Dr. Ikuwo Obata for fruitful discussions.

Palaeontological Description

Class Cephalopoda

Subclass Nautiloidea

Order Nautilida

Superfamily Nautilaceae

Family Eutrephoceratidae Miller, 1951

The family Eutrephoceratidae was proposed by Miller (1951, p. 31) but has been neglected by subsequent authors. I would evaluate Miller's idea, though with some revision. My reasoning will be presented in the discussion of a new genus proposed below.

Wiedmann (1960) treated the Nautilinae rather comprehensively, including in it the Nautilinae (with Eutrephoceratinae synonymized), Hercoglossinae and Aturinae in the sense of Kummel (1956). One of the reasons for this is that the genera belonging to these subfamilies are intimately connected through certain species with transitional features. He also ranked the group at the level of subfamily. On the other hand, Kummel (1964) in the *Treatise*, to conform with others, ranked up his 1956 subfamilies

to families under the superfamily Nautilaceae.

In this paper I should follow generally Kummel's (1964) scheme in the authorized publication *Treatise*, although I propose to revise it. The presence of "transitional forms" would not necessary be an objection again the classification of continuously evolving organisms and the diversities in evolution should be expressed by genera, subfamilies, families, etc. according to their order of magnitude.

Genus *Kummeloceras* nov.

Type species:—*Kummeloceras yamashitai* sp. nov. (to be described below).

Generic diagnosis:—Shell nautiliconic and involute, with very narrow umbilicus; subdiscoidal to subglobose in shape. Whorl typically ovoid in section, a little higher than broad, with a moderately arched venter, gently convex flanks, abruptly rounded umbilical shoulders and incurved walls. It may be more compressed with narrower venter in some species or somewhat broader than high with inflated flanks in some others.

Surface nearly smooth, with only growth lines or lirae, which show a ventral sinus. The reticulate ornament may remain in some species.

Septa considerably concave adorally. Septal suture characterized by a more or less pronounced large saddle on the ventral part without ventral lobe, a broad but distinct lobe of typically moderate depth on the main part of the flank and an incipient, small and low saddle at about the umbilical shoulder. Annular lobe may be present in some species.

Siphuncle subcentral to subdorsal in the typical species, but may vary considerably between species.

Etymology:—This genus is dedicated to the late Professor Bernhard Kummel, who made admirable contributions to the palaeontology of the cephalopods, including the Mesozoic nautiloids.

Remarks:—In addition to the type species I refer to this genus *Nautilus splendens* Blanford (1861, p.21, pl. 9, fig. 5; pl. 10, fig. 1), from the

Upper Cretaceous of India and Spain, which was left untouched by Kummel (1956, unlisted in p. 342 and p. 383) and assigned to *Eutrephoceras* by Wiedmann (1960, p. 168), *Nautilus angustus* Blanford (1861, p. 27, pl. 14, figs. 1, 1a, b, 2), from the Cenomanian of southern India, which was referred to *Cimomia* by Kummel (1956, p. 450) and Wiedmann (1960, p. 176), *Nautilus cookana* Whitefield (1892, p. 285, pl. 48, fig. 1; pl. 49, figs. 4, 5) (Miller, 1947, p. 30, pl. 10, figs. 1, 2; pl. 11, figs. 1—3; pl. 12, fig. 1; pl. 13, figs. 1, 2), from the Eocene of New Jersey, which was assigned to *Eutrephoceras* by Miller (1947) and Kummel (1956, p. 381), and preferably *Nautilus bryani* Gabb (1877) (see Whitfield, 1892, p.244, pl. 38, figs. 5, 6; also Miller, 1947, p. 28, pl. 8, figs. 1—3), from the Eocene of New Jersey, which was assigned to *Eutrephoceras* by Kummel (1956, p. 380) and to *Angulithes* by Wiedmann (1960, p. 180, pl. 18, fig. M). *K. cookanum* and *K. bryanni* have an annular lobe. As will be discussed below, there are some other species which are better transferred to this genus.

Comparison and discussion:—In the classification of the Nautilaceae at generic level, the pattern of the septal suture is significant among other characters. The generic diagnosis may be manifested also in the conch shape, surface ornamentation and siphuncle position in some cases, but in certain plastic genera these characters are considerably variable. This general principle has been lead by the comprehensive and profound studies of our predecessors, especially the late Drs. L. F. Spath, A. K. Miller and Bernhard Kummel, although there may be minor differences in observation among the authors.

The suture-line of *Nautilus pompilius*, the type species of *Nautilus* Linnaeus, 1758, was finely illustrated by Miller (1947, pl. 5, figs. 1, 2; text-fig. 3), showing a pronounced and broad saddle like curve on the ventral part without a ventral lobe, a large and distinct lateral lobe and a smaller but distinct saddle near the umbilical shoulder. A similar, if not quite identical, pattern of suture is shown in many species of *Cimomia*

Conrad, 1866, represented by the type species: *C. burtini* (Galeotti) (reproduced by Miller, 1947, pl. 26, fig. 1 and Kummel, 1956, pl. 24, fig. 1), *C. wylliei* (Newton) (see Haas and Miller, 1952, p. 335, text-fig. 5; pl. 24, figs. 3, 4; pl. 25, figs. 1, 2), *C. vaughani* (Gardner) (1923, p. 115, pl. 33, figs. 1—3) (also Miller, 1947, p. 47, pl. 32, figs. 1, 2), etc. The only but probably minor difference is that there is a small annular lobe at the middle of the shallow and broad dorsal lobe in *Nautilus pompilius* but none in *C. wylliei*. As to the annular lobe Foord (1891, p. 180), Spath (1927, p.24) and Miller (1947, p. 27) have given remarks suggesting that it is of little taxonomic significance. There is a considerable variation in the intensity of the lateral lobe and saddle among various species of *Cimomia*. Similarly there is considerable extent of variation in shell-form from subglobular to subdiscoidal among various species of *Cimomia*. If we take the species with subdiscoidal shape, such as *C. schlöderi* (Wiedmann) (1960, p. 180, pl. 21, fig. K, pl. 27, figs. 6—8; text-figs. 11—13), no significant difference is recognized between *Cimomia* and *Nautilus*. The reason why the two genera were distinguished by previous authors is not clear. *Nautilus* is well know biologically through the study of the living species, whereas *Cimomia* has been studied on fossil material with emphasis on the transitional feature in sutural folding towards *Hercoglossa* Conrad, 1866. Another reason may be that there is a break of available records of nautiloids in the Pleistocene and also Pliocene. There is no record of *Cimomia* in the Miocene either.

Anyhow, the morphological difference between *Nautilus* and *Cimomia* does not seem to be great. All the living species of *Nautilus* are fairly high whorled, whereas many species of *Cimomia*, including the type species, *Nautilus burtini* Galeotti, have a subglobular shell with inflated broader whorls. Should this be taken as a generic distinction, then such species as *C. schlöderi* (Text-fig. 2B) and *Nautilus sowerbianus* d'Orbigny (which will be explained later) would be good examples of *Nautilus* in the Cretaceous. The genus *Nautilus*, thus, could have a long

geological range from sometime in the Cretaceous to the Recent, with a few living species as its survivors.

Many species of *Cimomia* show the sutural pattern with lower ventral saddle and broader and shallower lateral lobe than *Nautilus pompilius*, but this difference is not celarly maintained in some species. For example, there is little difference of sutural pattern between *C. wyllieri* and *N. pompilius* (see Text-fig. 3A, B). Thus, the close similarity between *Cimomia* and *Nautilus* cannot be denied.

Because *Cimomia* is intimately connected with *Hercoglossa*, it has been included in the family Hercoglossidae Spath, 1927. Since *Cimomia* is closely similar to *Nautilus*, the family
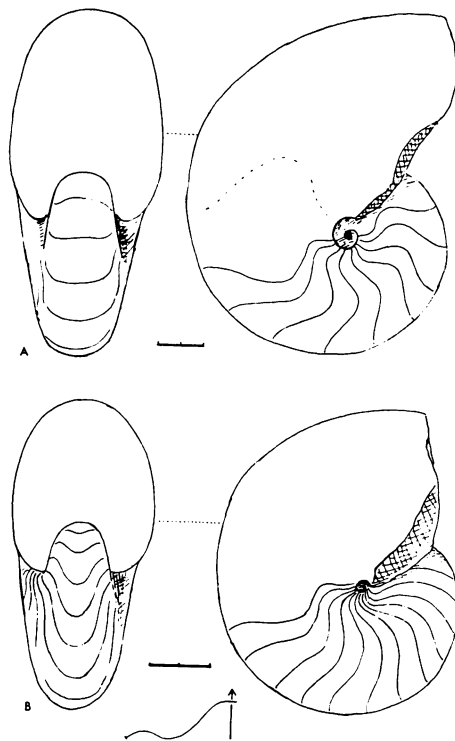
Text-fig. 2. *Nautilus* and compressed "*Cimomia*" in comparison.
A = *Nautilus pompilius* Linnaeus (adapted from Miller, 1947, pl. 5, figs. 1, 2). B = "*Cimomia*" *schlöderi* (Wiedmann) (adapted from Schlüter, 1876, pl. 45, fig. 3; suture after Wiedmann. 1960, fig. 12). Bar = 20mm

Hercoglossidae falls in the synonymy of the family Nautilidae de Blainville, 1825.

The genus *Angulithes* Montfort, 1808, with *A. triangularis* (Montfort, 1802) (see Kummel, 1956, p. 452, pl. 25, figs. 1, 2) as the type species, has the same type of suture-line (Text-fig. 3C) as *Cimomia* or *Nautilus* and is only distinguished by its trigonal to subtrigonal whorl section. Incidentally, Kummel (1956, p. 453) regarded *Deltoidonautilus* Spath, 1927 (with type species *Nautilus sowerbyi* Wetherell, 1836) as synonymous with *Angulithes*, but Teichert (in Kummel, 1964, p. K456) holds *Deltoidonautilus* as valid and treated *Angulithes* as *nom. dub.* As I have no basic material to discuss this nomenclatural problem, I follow Kummel (1956) in this paper.

Now, as to the suture-line of the present new genus *Kummeloceras*, which is to be shown clearly in the description of the type-species and also represented by that of *K. splendens* (see Wiedmann, 1960, text-fig. 9), the saddle on the ventral part is nearly as pronounced as that of *Nautilus* (or some "*Cimomia*"), the lateral lobe is broader and somewhat shallower than that of the recent species of *Nautilus*, but fairly similar to that of many species of *Cimomia*. In *Kummeloceras* the second saddle on the umbilical side of the lateral lobe is much lower and smaller and situated closer to the umbilical margin than that of *Nautilus* or typical *Cimomia*. We can see in *Kummeloceras* the fundamental sutural framework which can develop into the sutural pattern of *Nautilus* and that of some *Cimomia* as well as *Angulithes*. In other words, the saddle at or near the umbilical shoulder is incipient in *Kummeloceras*. If it is strengthened and shifted somewhat outwards, then the sutural pattern of *Nautilus* or certain "*Cimomia*" or *Angulithes* comes out.

If the sutural pattern is evaluated, *Nautilus fleuriausianus* d'Orbigny (1840, p. 82, pl. 15,
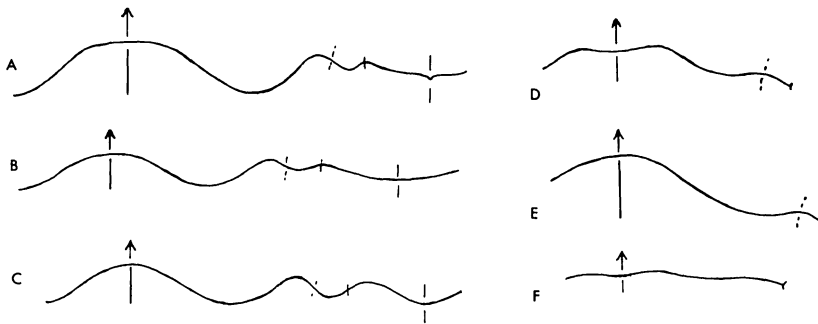
Text-fig. 3.   A — C. Suture-lines of *Nautilus*, *Cimomia* and *Angulithes*. D — E. External suture-lines of *Cenoceras*, *Kummeloceras* and *Eutrephoceras*.
A = *N. pompilius* Linnaeus (adapted from Miller, 1947, pl. 5, figs. 1, 2; text-fig. 3), B = *Cimomia wyllieri* (Newton) (adapted from Haas and Miller, 1952, pl. 25, figs. 1, 2; text-fig. 5), C = "*Deltoidonautilus*" *ellioti* Stenzel (adapted from Miller, 1947, text-fig. 14B), D = *Cenoceras orbignyi* (Prinz) (adapted from Kummel, 1956, pl. 1, figs. 1, 2), E = *Kummeloceras yamashitai* sp. nov., F = *Eutrephoceras sublaevigatum* (d'Orbigny) (adapted from d'Orbigny, 1840, pl. 17).

Explanation of Plate 4

        Holotype, GK. H5923 [= M. Yamashita Coll. 3301]; back (a) and left lateral views, ×1.
        Photos in pls. 4—9 all by courtesy of Dr. M. Noda

Plate 4

1a

1b

figs. 1—3; Wiedmann, 1960, p. 183, pl. 26, figs. 4, 5; text-figs. 14, 15), from the Upper Cretaceous of Europe, may be better regarded as a species of *Kummeloceras*, which shows a tendency towards *Angulithes* in the subtrigonal whorl section. The form called *N. fleuriausianus* var. by Stoliczka (1866, p. 206, pl. 94, fig. 1, 1a) and Spengler (1910, p. 143, pl. 13, fig. 1a, b), from the Cretaceous of southern India, shows a further step towards the *Angulithes* like shell-form but its suture is of *Kummeloceras* type. Anyhow, these forms strongly suggest that *Angulithes* was derived from *Kummeloceras*.

On the other hand, *Angulithes sowerbianus* (d'Orbigny) (1840, p. 83, pl. 16, fig. 1, 2) (Kummel, 1956, p. 456), from the Cretaceous (Cenomanian?) of France, which resembles *K. fleuriausianus* in shell-form but has a moderately arched venter and the "*Angulithes*-like suture", could be referred to *Nautilus* in view of its essential similarity in the sutural pattern and shell-form to *Nautilus*. The minor point that its lateral lobe is broader and shallower than that of *N. pompilius* might be a specific difference. Thus, in my view, *N. sowerbianus* could be a good example of Cretaceous *Nautilus*, as "*Cimomia*" *schlöderi* mentioned above. This fact suggests strongly that *Nautilus* and also some (if not all) *Cimomia* may have evolved from *Kummeloceras*, which is a member of the regular stock of the Nautilaceae.

I agree with Kummel (1956, p. 362) in regarding the genus *Cenoceras* Hyatt, 1883 as the fundamental stock of the Nautilaceae in the Jurassic, with its ultimate origin in Late Triassic *C. trechmanni* (Kummel) (1953, p. 2, pl. 1, figs. 1, 2 under *Bisiphytes*; revised to *Cenoceras* in 1956, pl. 2, figs. 1—3). According to Kummel (1956, p. 366), *Cenoceras* is very plastic showing a great variation in shell-form and other characters. Its suture-line, however, as seen in the type species, *Nautilus intermedius* d'Orbigny (*non* Sowerby) [= *N. orbignyi* Prinz (1906, p. 213)] (see Kummel, 1956, pl. 1, figs. 1, 2) and other species, is fairly constant, showing a large, broadly projected saddle like curve on the ventral part, a broad asymmetric lobe on the main part

of the flank and a small incipient saddle at about the umbilical shoulder. This is fundamentally similar to the suture of *Kummeloceras*, but in *Cenoceras* there is a very shallow ventral lobe and the lateral lobe is sometimes shallower (see Text-fig. 3D, E). The presence or absence of the small annular lobe may not be significant enough for the generic distinction.

Nautilus turcicus Krumbeck (1905, p. 137, pl. 14, fig. 6a, b), from the Upper Jurassic of Libya, was described to have a short saddle at the umbilical edge. Probably on this ground it was assigned to *Cimomia* by Kummel (1956, p. 452), but I presume that it may be a Late Jurassic example of *Kummeloceras*. Its lateral lobe is shallower and its shell-form is more globular than in *K. yamashitai* and *K. splendis*. It may represent a transitional form from *Cenoceras* to *Kummeloceras*.

Another distinctive character of *Cenoceras* is the reticulate ornamentation on the surface of the shell which persists up to the adult stage, as clearly illustrated by Kummel (1956, pl. 1, figs. 1, 2; pl. 2, figs. 1, 2; pl. 3, figs. 1, 2). This is probably another original character of the Nautilaceae. The same kind of reticulate ornament or lattice structure is clearly recognized in the early immature shell of *Nautilus pompilius* (see Miller, 1947, pl. 2, figs. 1—4), *Eutrephoceras montanense* (Meek) (1876, p. 496, pl. 27, figs. 1, 1a-e; pl. 27, figs. 2, 2a-f) (*non* Kummel, 1954), from the Upper Cretaceous of the Western Interior, and also in the young and the middle-aged shells of *Nautilus justus* Blanford (1861, p. 22, pl. 10, figs. 2, 3; also Stoliczka, 1866, p. 206, pl. 93, fig. 2), from the Upper Cretaceous of India. The last species is possibly referable to *Kummeloceras*.

Under some weakly weathered condition, as seen in a specimen of *N. pompilius* in the Geological Collection of Kyushu University and in some examples of *Eutrephoceras*, such as *E. thomi* Reeside (1927, p. 7, pl. 44, figs. 1, 2), faint longitudinal striae are discernible on the ventral part, which may reflect the fundamental structure of the shell.

On these and other lines of evidence, I con-

sider that the smooth looking shell of *Eutrepho-ceras* and *Nautilus* does not imply the primitive, fundamental character but a reduction in the evolution of the Nautilaceae, whereas the original reticulate shell is best manifested in *Cenoceras*, that is the oldest and the fundamental stock of the Nautilaceae.

In the type species of *Kummeloceras* and also in Blanford's specimen of *K. splendens*, the same kind of reticulate ornamentation is not shown on the mature shell but could be expected in early immature shells, which ought to be examined on some material of favourable preservation. It is, however, interesting to note that *Nautilus clementinus* d'Orbigny (1840, p. 77, pl. 13 bis, figs. 1—6), from the Cretaceous (Albian) of Europe, resembles *K. splendens* in many respects, as Wiedmann (1960, p. 169) pointed out. It has a finely reticulate ornament even on the adult shell. The specimen of *K. splendens* from Spain (Wiedmann, 1960, p. 169) seems to show the spiral striae weakly. Therefore, it is better to refer *N. clementinus* to *Kummeloceras* rather than to *Eutrephoceras* (Kummel, 1956, p. 381; Wiedmann, 1960, p. 168). The reticular orna-ment as seen in *Cenoceras*, thus, survived in some species of *Kummeloceras*.

It should be noted that *Nautilus cantabrigen-sis* Foord (1891, p. 237, text-fig. 63), another Albian species from England, closely resembles *K. clementinum* but has more sinuous *Cimomia* like suture. This is another example to suggest the derivation of *Cimomia* or *Nautilus* from *Kummeloceras*.

The genus *Eutrephoceras* Hyatt, 1894, has been regarded as representing the fundamental stock of the Nautilidae which showed a great plasticity giving rise to various offshoots (e.g. Kummel, 1956, p. 380). I have, however, some doubt about this statement. The type species of *Eutrephoceras*, *N. dekayi* Morton (1834)

(see Miller and Garner *in* Richards *et. al.*[ed.], 1962, p. 102, pl. 65, figs. 5, 6; pl. 66, figs. 1, 2) has "more or less straight and directly transverse external sutures". The suture may be slightly sinuous in some species (e.g. *E. sublaevigatum* (d'Orbigny) (Text-fig. 3F), *E. balchistanense* (Spengler), *E. ahltensense* (Schlüter), etc.), but the ventral and lateral lobes are very shallow and the external suture runs roughly transversely. I interpret that the seemingly simple suture of *Eutrephoceras* does not imply the primitive, fundamental character but is a product of a reduced evolution from a little more sinuous suture of *Cenoceras*, just as the seemingly smooth shell is so as mentioned above. The difference in sutural pattern between the two genera is by no means sharp and gradational features may be seen in some species.

From the above observation, I am indeed sympathetic with Miller (1951; *in* Miller and Garner, 1962, p. 101) in stating that "the genus *Eutrephoceras* is not particularly close to *Nauti-lus*." Miller (1951, p. 31) proposed the mono-genetic family Eutrephoceratidae, but I should refer *Cenoceras*, *Pseudocenoceras* and *Kummelo-ceras* to the family Eutrephoceratidae in addition to *Eutrephoceras*. This is the group composed essentially of the genera which represent the fundamentsl root stock of the Nautilaceae and a few genera which were close to the root but deviated to a certain extent. *Eutrephocreas* and *Pseudocenoceras* belong to the latter subgroup. Although the Cenoceratidae might be preferable for the family name, we should use the Eutre-phoceratidae in a revised sense following the rule of priority in the nomenclature.

There are several species of "*Eutrephoceras*" which show fairly sinuous sutures, such as "*E.*" *splendens*, "*E.*" *clementinum*, "*E.*" *bryani* and "*E.*" *cookanum*. They are better transferred to *Kummeloceras*, as mentioned above. Wiedmann

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Explanation of Plate 5

Fig. 1. *Kummeloceras yamashitai* sp. nov. .... Page 18
    Holotype, GK. H5923 [= M. Yamashita Coll. 3301]; frontal (a) and right lateral views, ×1.

Plate 5

MATSUMOTO: *Cretaceous Nautiloids*

1a

1b
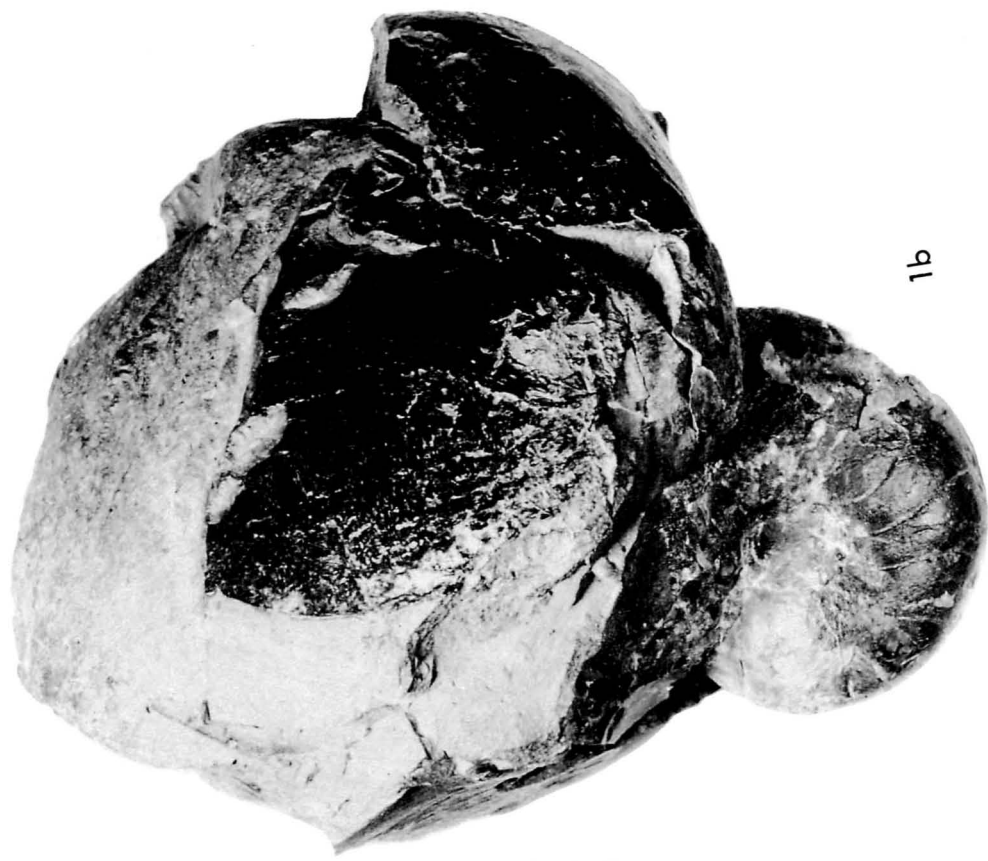
(1960, p. 151) listed many species under *Eutrephocreas* with "cimomider Sutur", in which the species with slightly sinuous sutures were included. There are a few species, e.g. *E. darupense* (Schlüter) (1876, p. 176, pl. 49, figs. 4, 5), which show a seemigly intermediate degree of sutural sinuousity between the typical patterns of *Eutrephoceras* and *Cenoceras* or *Kummeloceras*. This does not necessarily mean the genetically transitional forms. It would be desirable to express quantitatively the degree of sinuosity and other features in the sutural pattern, although I do not porpose a formula or an index at the moment. Anyhow, the true genetical relationship should be led through consideration of all the characters as well as stratigraphic occurrences.

The genus *Pseudocenoceras* Spath, 1927, which is represented by the type species *Nautilus largilliertianus* d'Orbigny (1840, p. 86, pl. 18, figs. 1—4) and several other Cretaceous species, is interpreted here to have been derived either directly from *Cenoceras* or by way of early *Kummeloceras*, acquiring the subtrapezoidal to subrectangular whorl section, with subangular umbilical shoulders, flattened flanks and a subrounded to flattened venter, smooth shell and subdorsal to dorsal position of the siphuncle. It should be noted that the sutural patterns in several species of *Pseudocenoceras* varies from the one which is similar to that of *Cenoceras* to the more sinuous *Kummeloceras* like and even *Angulithes* like ones, as is shown in *P. archiacianus* (d'Orbigny) (1840, p. 91, pl. 21, figs. 1—4), *P. applanatum* (Wanner) (1902, p. 143, pl. 30, figs. 20, 20a) and *P. fittoni* (Sharpe) (1853, p. 17, pl. 6,.fig. 4). In the latter cases, therefore, *Pseudocenoceras* is distinguished from *Kummeloceras* or *Angulithes* only by its shell-form.

Two other genera of the Eutrephoceratidae, *Carinonautilus* Spengler, 1910, based on the type species *C. ariyalurensis* Spengler (1910, p. 149, pl. 14, figs. 1a-c), from the Upper Cretaceous of southern India, and *Obinautilus* Kobayashi, 1954, based on the type species *O. pulchra* Kobayashi (1954, p. 183, pl. 22, figs. 1—4),
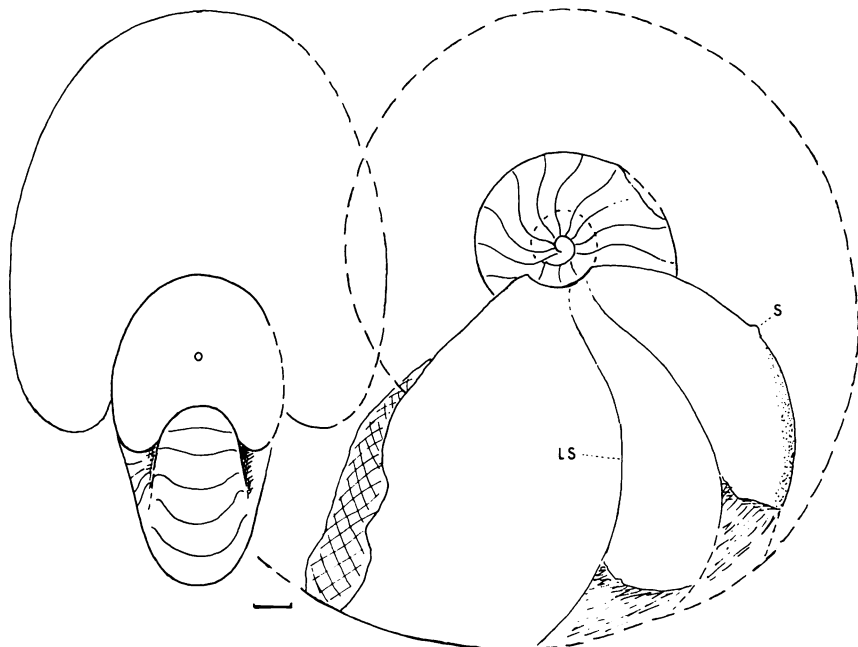
Text-fig. 4. *Kummeloceras yamashitai* sp. nov.
Diagrammatic sketch (frontal and left lateral views) of holotype. Broken line = reconstructed; LS = last septum, S = siphuncle. Scale bar = 10 mm.

from the Lower Tertiary of southern Kyushu (Japan), are, in my preliminary view, the derivatives of *Pseudocenoceras* rather than *Eutrephoceras*, although their sutural patterns and young shells should be examined on suitable material.
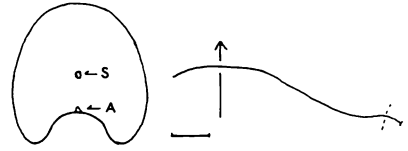
Kummeloceras yamashitai sp. nov.

Pl. 4, Fig. 1; Pl. 5, Fig. 1;
Pl. 6, Fig. 1; Pl. 7, Fig. 1;
Text-figs. 4—6

Material:—Three specimens are before me, of which the holotype is GK. H5923, a part of the outer whorl and the next inner whorl, represented by the internal mould for the most part, with a portion of the shell, collected by Mr. Minoru Yamashita (MY. 3301 on 1973. 5. 5), from loc. Y5203 on the Hakkin-zawa, Oyubari area and transferred to me for this study. Paratype 1, GK. H5920, collected by Mr. Takemi Takahashi (TTC. 1968. 10. 20) from the Kaneo-
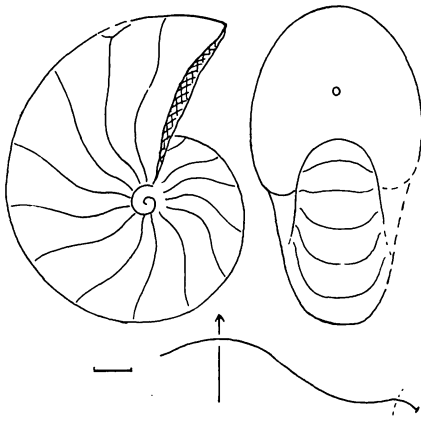
Text-fig. 5. *Kummeloceras   yamashitai* sp. nov.
Left lateral and frontal views and external suture of paratype 1 (GK. H5920). Bar = 10 mm.

Text-fig. 6. *Kummeloceras   yamashitai* sp. nov.
Whorl-section and external suture-line of paratype 2 (GK. H5921). A = annular lobe. S = siphuncle. Bar = 10 mm.

betsu, Oyubari area and GK. H5921, collected by Mr. Hiroharu Kokubu from the Pombets Colliery; both internal moulds with a partly preserved test; both transferred to me for this study.

Description:—The shell is fairly large, as is shown by the incompletely preserved holotype, whose diameter would be over 220 mm (nearly 250 mm) in a roughly restored outline on the assumption that the body-chamber occupied about 150°. The whorl increases with a moderate rate, about 1.57 in the proportion of radius per half whorl in the paratype 1. The umbilicus is narrow, about 10 percent of the shell diameter in the holotype and slightly less than that amount in the paratypes.

The whorl is ovoid in section, slightly higher than broad, with B/H = 0.96 in the holotype and 0.97 in the paratypes, and broadest somewhat below the mid-height. The umbilical wall is incurved and the umbilical shoulder is abruptly rounded. The flanks are gently inflated and convergent, passing to the moderately arched venter.

The surface of the internal mould is smooth. (Occasionally there are irregular depressions as seen in GK. H5920. They can be interpreted as impressions of the shell injury.) The surface of the partly preserved shell is nearly smooth, but

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Explanation of Plate 6

1a

1c

1b

1d

Table 1.   Measurements (in mm), *Kummeloceras yamashitai* sp. nov.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
GK. H5923	[175 (1)]	[21 (.12)]	102 (.58)	98 (.56)	0.96
" (inner)	79.0 (1)	10.4 (.13)	46.0 (.58)	44.0 (.56)	0.96
GK. H5920	83.0 (1)	7.5 (.09)	48.0 (.58)	46.5 (.56)	0.97
" (−180°)	54.0 (1)	—	31.0 (.57)		
GK. H5921	67.0 (1)	5.9 (.09)	38.5 (.57)	37.5 (.56)	0.97

[   ] measured on restored outline

for very fine lirae or striae which show a moderately backward curvature on the venter.

The septa are considerably concave adorally and of moderate density, numbering 7 or 8 per half whorl. The suture-line is considerably sinuous. No ventral lobe is perceptible and the suture-line descends strongly from the venter to the flank forming a large and pronounced saddle like curve on the ventral part, an asymmetric lateral lobe of moderate depth on the main part of the flank and then an indistinct, small and low saddle near the umbilical margin.

The siphuncle is dorsocentral, a little below the midst of the dorso-ventral median line of the septum. Annular lobe is discernible in GK. H5921.

Comparison:—This species resembles *Kummeloceras splendens* (Blanford) (1861, p. 21, pl. 9, fig. 5; pl. 10, fig. 1), from the Upper Cretaceous of India and Spain (Wiedmann, 1960, p. 168, pl. 18, fig. N; pl. 27, figs. 4, 5; text-fig. 9) in the frequency and pattern of sutures, dorso-central positon of siphuncle and proportion of B/H, but is distinguished in that the latter has subparallel, instead of convergent, flanks, closed umbilicus and more dorsad position (inner third of the median line) of the siphuncle.

It should be noted that this species is fairly similar to such species as *"Nautilus" sowerbianus* d'Orbigny and *"Angulithes (Cimomia)" schlöderi* Wiedmann in having the ovoid whorl section, narrow umbilicus, pronounced saddle like curve of suture on the venter and reclining broad but distinct lateral lobe. The difference is the presence of distinct (instead of incipient) saddle

near (outside of) the umbilical shoulder in the latter two species. If the less globular but subdiscoidal shells like these two are excluded from *Cimomia* and transferred to *Nautilus*, the above facts can be taken as indicating the possible derivation of Cretaceous species of *Nautilus* directly from *Kummeloceras* by developing the second lateral saddle.

Occurrence:—The holotype was obtained by M. Yamashita from the mudstone exposed at loc. Y5203 on the left side of the Hakkin-zawa of the Oyubari area (see text-figs. 1, 2 in Hirano *et al.*, 1977 for the location), which is referred to the middle part of the Turonian. Paratype 1 was obtained by T. Takahashi from the floated nodule in the Kaneobetsu of the Oyubari area. It is probably from the Zone of *Inoceramus hobetsensis*, middle part of the Turonian. Paratype 2 was obtained by H. Kokubu from the sandy siltstone exposed on the subground 700 m level in the eastern gallery of the Pombets Colliery (now abandoned). The rock is probably referable to either upper or middle part of the Turonian (unpublished information of the coal mining company).

Kummeloceras yezoense sp. nov.

Pl. 7, Fig. 2; Pl. 8, Fig. 1; Text-figs. 7—9

Material:—Holotype, GK. H5922, collected by myself at loc. Ik5605 (Samata-zawa) of the Ikushumbets area, Coniacian, wholly septate internal mould with a portion of squashed outer whorl. Paratypes GK. H5929, collected by H. Kokubu (47. 6. 26) from the Obira area; a specimen (Kw3) of Y. Kawashita (56. 5. 5) from

the Oyubari area; a specimen of M. Koshisaka (46. 8. 10) from his loc. 27 of the Oyubari area, now on display in the Museum of Mikasa City (550704-20).

Description:—The shell is fairly large, as seen in the last two specimens, in which the diameter is about 170 mm at the end of the phragmocone. It is involute, with a very narrow umbilicus, about 10 percent of the diameter in the internal mould. The umbilicus seems to be covered by callus when the shelly material is preserved.

The whorl grows with a fairly high ration in height. It is slightly broader than high in a young stage but fairly higher than broad in later stages, with B/H = 0.8 or less (0.79 to 0.76 in actual measurements) at the end of the phragmocone. It is ovoid in section, being broader in its lower part, with gently convex and convergent flanks and a rounded (earlier) and then more narrowly arched (later) venter.

The surface of the internal mould is smooth. That of the shell, as seen in a part of Kokubu's specimen, is nearly smooth, with weak growth lines or lirae which are very gently flexuous on the flank and show a backward sinus on the venter.

The septa are fairly concave adorally. They are of moderate density, about 8 or 9 per half whorl. The septal suture shows a moderately pronounced saddle like curve on the ventral part, an asymmetrically reclining broad but distinct lobe on the main part of the flank and an indistinct small or low saddle near the umbilical margin.

The siphuncle is subdorsal, being situated at the point at about lower one third of the dorsoventral median line of the septum.

Comparison:—This species is closely allied to
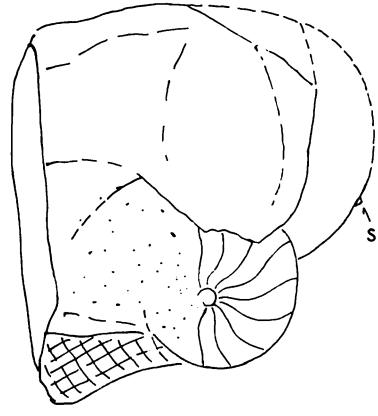
Text-fig. 7. *Kummeloceras yezoense* sp. nov.
Sketch (right lateral view) of holotype, whose outer whorl is squashed. S = siphuncle. Bar = 10 mm.
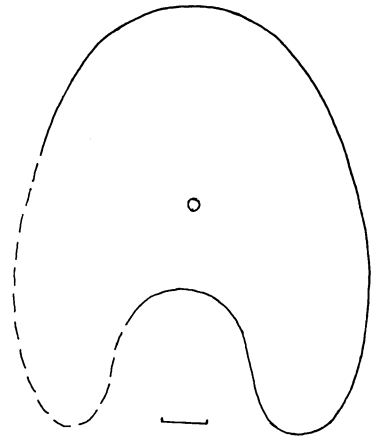
Text-fig. 8. *Kummeloceras yezoense* sp. nov.
Diagrammatic whorl section of M. Koshisaka's specimen on display at Mikasa Museum (550704-20). Bar = 10 mm.

Explanation of Plate 7

Fig. 1. *Kummeloceras yamashitai* sp. nov. .... Page 18
   Paratype 2, GK. H5921 [= H. Kokubu's Coll. from Pombets Colliery], ventral (a) and left lateral (b) views, ×1.
Fig. 2. *Kummeloceras yezoense* sp. nov. .... Page 19
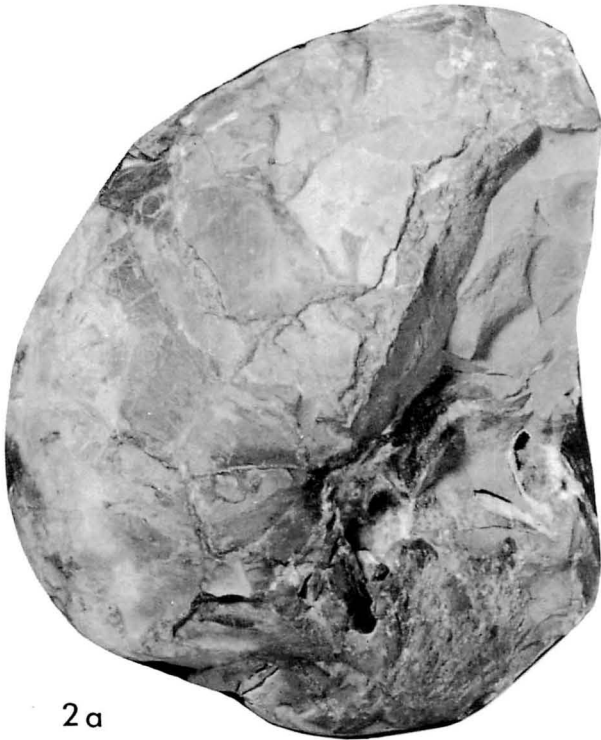   Paratype 1, GK. H5929 [= H. Kokubu's Coll. 47-6-26], left lateral (a) and frontal (b) views, ×2/3.

1a

1b

2a

2b

Table 2. Measurements (in mm), *Kummeloceras yezoense* sp. nov.

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
GK. H5922 [restored]			62	48	—
" −360°	45.0 (1)	4.2 (.09)	25.6 (.57)	—	0.77
" −450°	37.0 (1)	3.5 (.09)	20.9 (.57)	23.0 (.62)	1.10
GK. H5929	155 [restored]	--	~96 (.61)	~75 (.48)	0.78
" −90°	131.5	~15.0 (.11)	80.0 (.61)	~70 (.53)	0.85
Kw. 3	176.0	14.0 (.08)	108.6 (.61)	86.2 (.48)	0.79
550704-20	~170.0	—	~97. (.54)	~74 (.44)	0.76
"	108.0	12.0 (.11)	67.0 (.62)	~52 (.48)	0.77
	—	—	41.0	38.0	0.92

~ measurement approximate

Kummeloceras fleuriausianum (d'Orbigny), which has been mentioned in the discussion of the genus, in many respects including the sutural pattern, but distinguished by the rounded, somewhat broader venter and somewhat broader umbilicus. Its inner whorl is more inflated and more rounded than that of *K. fleuriausianum*. The subtrigonal whorl section of that species, which shows a tendency to the characteristic shell-form of *Angulithes*, is not manifested clearly in the present species. The seemingly

Text-fig. 9. *Kummeloceras yezoense* sp. nov.
Sketch of Y. Kawashita's specimen in lateral and frontal views. LS = last suture. Bar = 10 mm.

sharpened venter of the outer whorl of GK. H5922 and GK. H5929 are probably the product of the secondary distortion. The original outline of the outer whorl in section is oval in the present species, whereas that of *K. fleuriausianum* is subtrigonal with narrowly arched to nearly sharpened venter.

K. yezoense is somewhat similar to *K. yamashitai* but distinguished by its more rapid increase of whorl-height and more dorsad positon of siphuncle.

Occurrence:—The holotype came from the mudstone exposed at loc. Ik5605 of the Samatazawa, a tributary in the upper reaches of the River Ikushumbets, central Hokkaido. At loc. Ik5606, close to Ik5605, *Inoceramus uwajimensis* occurs commonly and, accordingly, these two localities are assigned to Coniacian. H. Kokubu's specimen was obtained on the stream Kamikinembets, at loc. 300 m upstream from its confluence with the River Obirashibe, Obira area, northwestern Hokkaido. This part is again Coniacian. Y. Kawashita's specimen was collected on the stream of Masago-zawa, a branch of the River Shiyubari in the Oyubari area, central Hokkaido. Coniacian strata are exposed along the Masago-zawa. M. Koshisaka's specimen was from a locality on the River Shiyubari.

Etymology:—Yezo is the old name for Hokkaido.

Genus *Eutrephoceras* Hyatt, 1894

Type species:—Nautilus dekayi Morton, 1834.

*Remarks:—*In the preceding description I have excluded certain species from *Eutrephoceras* and referred them to the new genus *Kummeloceras*. In my opinion, *Eutrephoceras* does not represent a root stock from which *Nautilus* and certain other genera were derived but is a somewhat modified derivative of the root stock represented by *Cenoceras* and *Kummeloceras*. Reasoning for this idea has been discussed in the description of *Kummeloceras*.

Eutrephocreas nodai sp. nov.

Pl. 9, Fig. 1; Text-fig. 10

*Material:—*A single specimen, GK. H5924, from loc. Y6014a obtained by Dr. Masayuki Noda during the 1975 field work with me in the Oyubari area: holotype.

*Description:—*The shell is fairly large, nearly 200 mm in diameter in the probably adult stage. The whorl increases with a moderate rate (about 1.37 in a half whorl) in both height and breadth. It is higher than broad, with B/H = 0.8, and ovoid in cross-section, with the maximum breadth somewhat below the mid-height. The venter is moderately arched in early stage and more narrowly arched later. The flanks are gently convex and the umbilical shoulders are rounded. The umbilicus is very narrow (7.6 per cent of diameter) in the internal mould and covered by callus when shelly material is preserved.

The surface of the internal mould is smooth and that of the shell nearly smooth, with only weak growth lines or lirae which show a backward curve on the ventral part.

Septa is of moderate density, numbering 9 per half whorl. The last septum is at whorl-height =
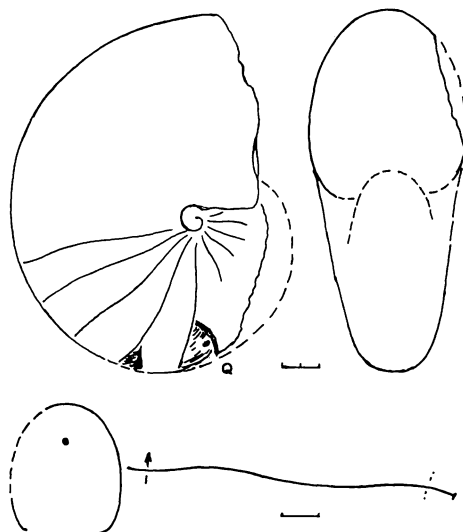
Text-fig. 10. *Eutrephoceras nodai* sp. nov. Sketch of holotype in left lateral and frontal views and also diagrammatic whorl-section at Q; bar = 20 mm. Last second external suture-line; bar = 10 mm.

88 mm. The septal suture is only slightly sinuous, with a very shallow and broad lateral lobe and a very slight saddle like elevation at about the umbilical shoulder. It runs nearly radially and crosses the venter nearly straightly or with slight backward sinus.

The siphuncle is subventral but not close to the ventral margin.

Comparison:—E. nodai is closely allied to *E. indicum* (d'Orbigny) (1850, p. 211) [= *Nautilus sowerbianus* d'Orbigny, 1846, pl. 4, figs. 1, 2] (see Wiedmann, 1960, p. 159, pl. 21, fig. G; pl. 24, figs. 1—4; text-figs. 3—5), from the Senonian of Quiriquina (Chile) and southern India and the Turonian of Spain, in the general shell form, nearly smooth surface, only slightly sinuous or nearly linear suture and ventral position of siphuncle, but is distinguished by its
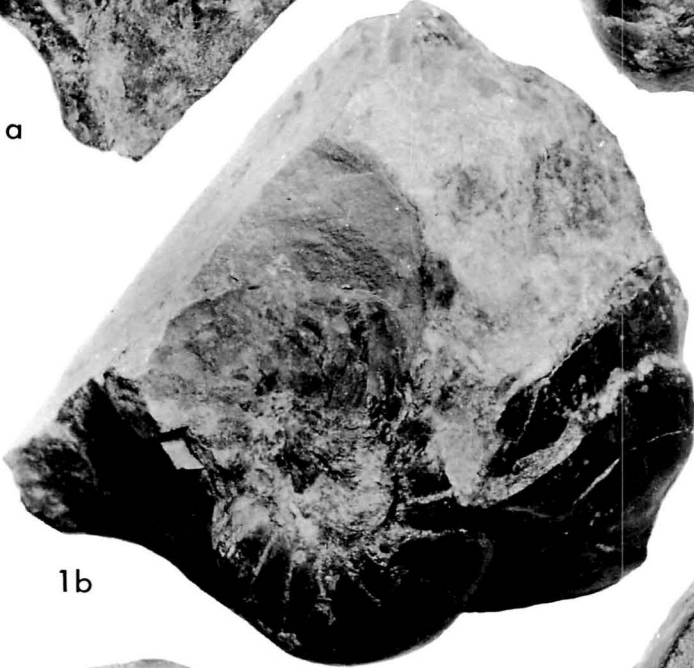

Explanation of Plate 8

Fig. 1. *Kummeloceras yezoense* sp. nov. .... Page 19
    Holotype, GK. H5922 [= T. Matsumoto Coll. from loc. IK5605], left (a) and right (b, c)
    lateral, back (d) and frontal (e) views. b, d, e: ×1; a, c: ×0.9 (umbilicus developed in c).
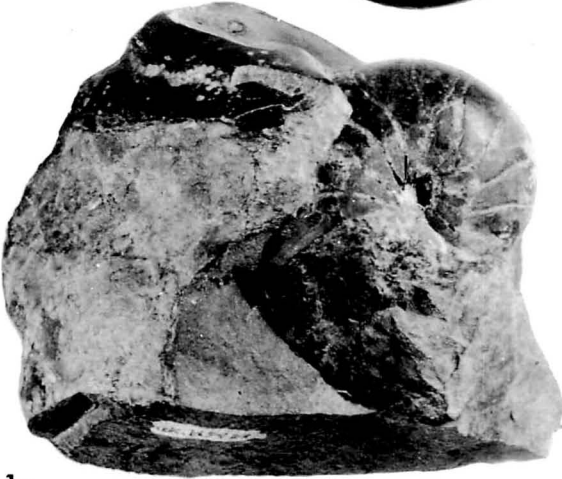
Plate 8
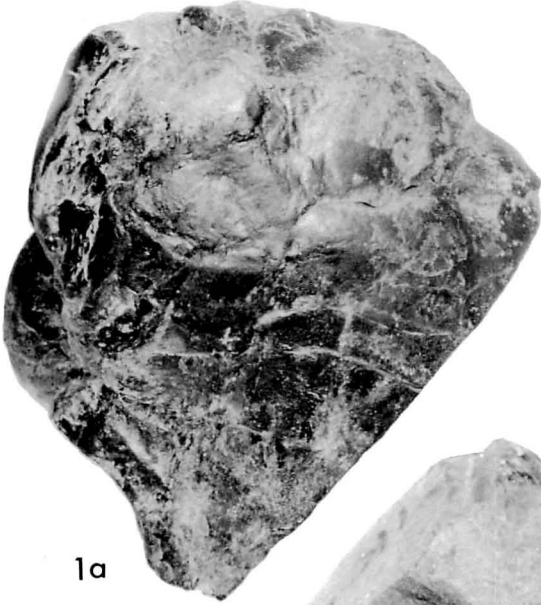
1a

1d

1b

1c

1e

ovoid, higher than broad whorl-section. *E. indicum* has a subtrigonal whorl-section, with the maximum breadth near the umbilical shoulder and is nearly as high as broad. Its siphuncle is closer to the ventral margin.

Occurrence:—In the middle part (a) of the exposure at loc. Y6014 [= Y5111], on the right side of the Takino-sawa, Oyubari area, central Hokkaido (for the location see text-figs. 1, 4 in Hirano *et al.*, 1977), obtained by Dr. M. Noda who donated the specimen to the Geological Collection of Kyushu University through me. The siltstone with intercalated sandstone of this locally is referred to Lower Turonian, because *Mammites* sp. was found at loc. Y5112 [=Y6015] below Y6014 and *Mytiloides mytiloides* (Mantell) occurs abundantly at loc. Y6013, stratigraphically slightly above loc. Y6014.

Etymology:—This species is dedicated to Dr. Masayuki Noda who is contributing much in the Cretaceous palaeontology and stratigraphy.

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Explanation of Plate 9

Fig. 1. *Eutrephoceras nodai* sp. nov. .... Page 22
    Holotype, GK. H5924 [= M. Noda Coll. from loc. Y6014a], ventral (a), left lateral (b) and frontal (c) views, ×4/5 (Scale bar = 20 mm).

Plate 9

1a

1b

1c
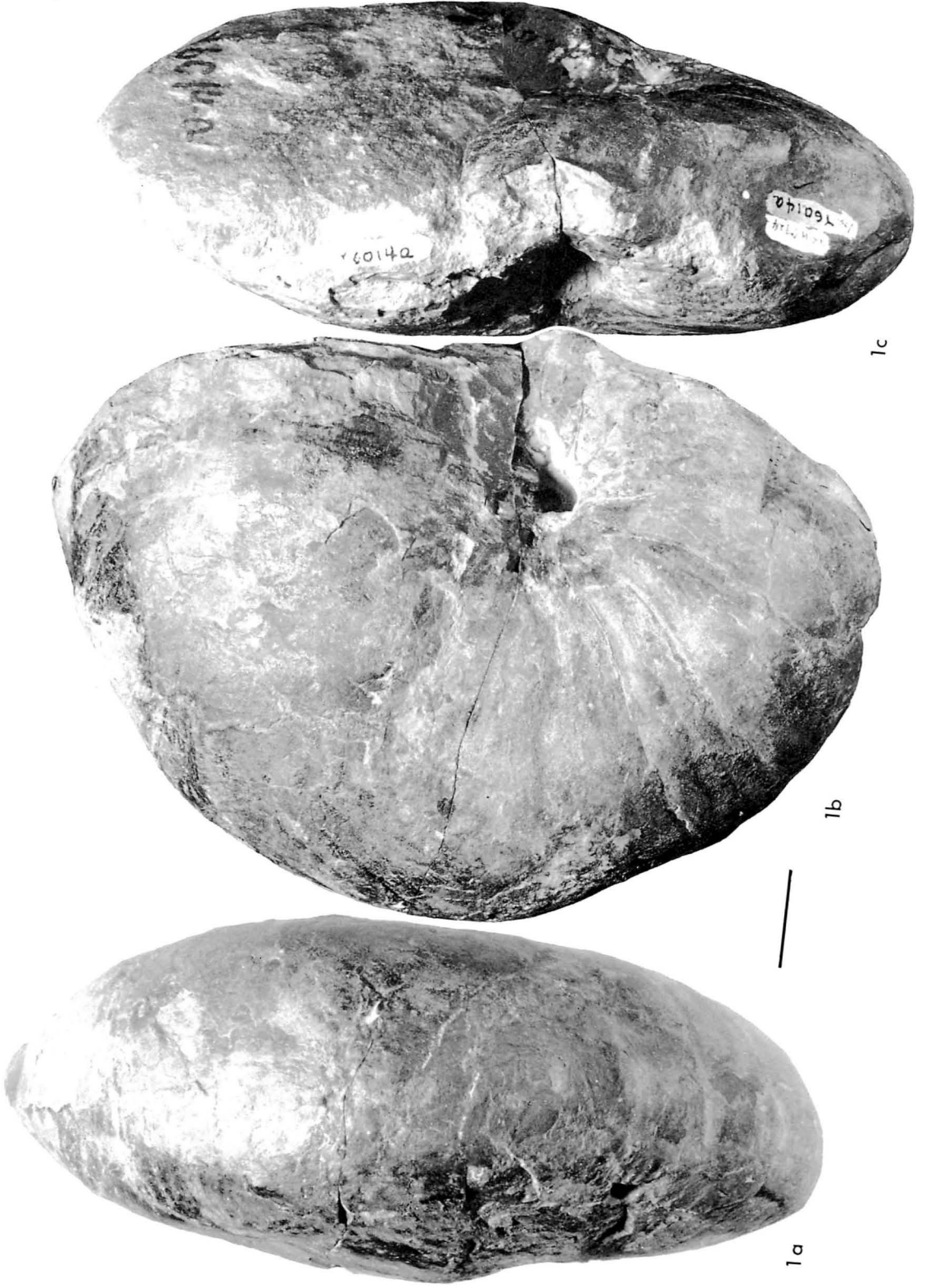
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Abeshinai アベシナイ (安平志内)　　Haboro 羽幌　　Hakkin-zawa 白金沢　　Hobetsu 穂別　Ikushumbets ［＝Ikushunbetsu］ 幾春別　　Kamikinembets ［＝Kamikinenbetsu］ 上記念別　Kaneobetsu カネオベツ　　Masago-zawa 真砂沢　　Mikasa 三笠　　Obira 小平　　Obirashibe 小平蘂　　Oyubari 大夕張　　Pombets ［＝Ponbetsu］ 奔別　　Rebun 礼文　　Rumoi 留萌　Saku 佐久　　Samata-zawa 左股沢　　Shiyubari ［＝Shuyubari］ 主夕張　　Takino-sawa 滝ノ沢　Urakawa 浦河

北海道産白亜紀オウムガイ類―Ⅰ. 現在扱うことのできる材料に基づき，北海道産白亜紀オウムガイ類を記載・図示していくが，今回はその1としてチューロニアンとコニアシアン産の3種を新種として記載した。種の記載に当たり1新属 (*Kummeloceras*) を提唱し，これは *Cenoceras* から直接由来したもので，Nautilaceae の根幹をなす。これらは派生した *Pseudocenoceras*, *Eutrephoceras* などとともに Eutrephoceratidae を構成する。*Nautilus* は *Cimomia* などとともに縫合線がしゅう曲を示す類で，Hercoglossidae は Nautilidae とシノニムであり，白亜紀にも *Nautilus* に帰属可能の種があることを指摘した。記載した3種のうち，*K. yamashitai* (チューロニアン) は *K. splendens* (Blanford)，*K. yezoense* (コニアシアン) は *K. fleuriausianum* (d'Orbigny)，*Eutrephoceras nodai* (チューロニアン) は *E. indicum* (d'Orbigny) にそれぞれ類似するが，差異も明確にあり新種とした。

松本達郎

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758. ONTOGENIC AND PHYLOGENIC DEVELOPMENT
OF TWO UPPER CAMBRIAN TRILOBITES
FROM THE NOLICHUKY FORMATION, TENNESSEE*

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Abstract.   The ontogenic and phylogenic development of *Aphelaspis tarda* Rasetti and *A. tumifrons* Resser are described. The morphogenesis of the trilobites are subdivided into five different metamorphic stages: anaprotaspid, metaprotaspid, paraprotaspid, early meraspid, and late meraspid stages. The genus *Aphelaspis* was possibly of allogenic origin in North America and has no progenitor in this area. This genus shows continuum neotenic evolutionary characteristics throughout *Elvinia-Irvingella, Parabolinoides-Taenicephalus* to the *Ptychaspis-Prosaukia* stocks.

Introduction

The purpose of the present report is to describe the ontogenic and phylogenic development of *Aphelaspis tarda* Rasetti and *A. tumifrons* Resser, two Upper Cambrian trilobites from the Nolichuky Formation, Tennessee, North America. The ontogenic sequence of the complete growth sequence is subdivided into anaprotaspid, metaprotaspid, paraprotaspid, early meraspid, and late meraspid stages. Each of these growth stages had distinct morphologic characteristics. The anaprotaspid shield has four axial rings; the metaprotaspid shield has five axial rings; the paraprotaspid shield has a small protopygidium which lies behind of the cephalon; in the early meraspid cranidium the anterior border appears and in the late meraspid, the cranidium with the completion of the preglabellar field and the glabellar furrows.

The progenitor of the genus *Aphelaspis* was not a resident of the North American continent, but allogenic in origin; it was either derived from the *Olenus* or shared a same common ancestor in the olenoid stock. The genus *Aphelaspis* migrated from outside of the North American continent — Fennoscandian shield? — during early Late Cambrian time. This is the remostest ancestor of the Late Cambrian trilobites in North America. The genera *Dunderbergia, Elvinia, Irvingella, Parabolinoides, Taenicephalus,* and *Ptychaspis* were possibly descendants of *Aphelaspis* through a continuum orthogentic neoteny of the animals.

Paleontological Description

Genus *Aphelaspis* Resser, 1935

Aphelaspis tarda Rasetti

Pl. 10, Figs. 1—37; Text-fig. 1, 2

Aphelaspis tarda Rasetti, 1965, p. 79, pl. 20, figs. 1—18.

Remarks:—The present species is represented by numerous mature and immature skeletons. They show very complete growth sequences from the early protaspid to the fully grown adult forms. The morphologic characteristics of the materials are identical to those reported by Rasetti (1965) from the same general area. In these assemblages three rare example of exceptional, and possibly pathologic specimens were found, two were pygidia and one, a large librigena. The small unusal pygidium (Pl. 10, Fig. 27; Text-fig. 1H) shows a right lateral marginal border which is marked by quite a few faint, subparallell trails. These were possibly etched by nematodes. The large pygidium (Pl. 10, Fig. 29; Text-fig. 1L) shows a left marginal border with irregular teeth whereas the right side is complete; furthermore, the left axial lobe has two well-developed axial rings whereas the right side bears three; the librigena (Pl. 10, Fig. 30; Text-fig. 1K) has no genal spine. These peculiar morphologic features may represent injury by predator — possibly a cephalopod? — They appear to have been inflicted during life.

Aphelaspis tarda Rasetti, ontogeny

Anaprotaspid stage (Pl. 10, Fig. 1; Text-fig. 1A):—This instar is 0.22—0.25 mm in length (sag.), moderately convex, round to subround in outline; the axial lobe is slender cylindrical, composed of a large frontal lobe, two pairs of median glabellar nodes, and a small terminal portion; these are well delimited by dorsal, longitudinal, and transverse grooves; a pair of eye-brow-shaped ridges extent laterally from the sides of the frontal lobe; these eye-brow-shaped ridges are distinctly marked off by a pair of frontal pits and the inner eye-brow furrows; the elongated oval terminal protion of the fourth axial node is marked by an arrow-shaped median impression; this lobe appears to

be the original fourth glabellar segment, which will divided into two segments, one of which remains as the fourth glabellar segment and the other becoming the occipital ring. The surface of the instar is covered by fiant granules.

Metaprotaspid stage (Pl. 10, Figs. 2—5; Text-fig. 1B):—The instar is round to subround in outline, moderately convex, and measures from 0.30—0.55 mm in length (sag.). In the morphogenesis of the instars of this stage the axial lobe consists of five rings; these rings are differentiated into a large frontal lobe, a small terminal portion, and three pairs of central lobes, the three pairs of central lobes are combined into three complete axial rings during the later period of the stage; the small terminal portion increases in size and becomes the occipital ring.

Paraprotaspid stage (Pl. 10, Figs. 6—9; Text-figs. 1C, D):—The cranidium is subround to trapezoidal in outline, convex and measures 0.40—0.80 mm in length (sag.); with or without a protopygidium. In the morphologic development of the cranidial shield during the present stage the cranidium changes from subround to trapezoidal in outline; the posterior fixigena increases in width; and the protopygidium appears.

A small pygidium is arbitrarily assigned to the protaspid rank without any specific growth stage differentiation since it occurs disassociated from the cranidium. This small pygidium (Pl. 10, Fig. 23) is made of 6—7 segments, triangular to semicircular in outline, convex, and well separated into axial and pleural lobes by dorsal furrows; the pygidial segments are all freely articulated, showing the thoracic segmental structures.

Early meraspid stage (Pl. 10, figs. 10, 12—15, 24; Text-figs. 1E, F):—The cranidium is trapezpidal or truncato-triangular in outline, convex; its measurement is 0.75—1.20 mm in sagittal length; the morphogenic characteristics of the cranidium during the present stage mark the appearance of the anterior border; the backward migration of the eye-brow-shaped ridges from the anterior border; the narrowing of the fixigenal lobe; and the near completion of the palpebral furrow.

The assigned pygidium of the present stage (Pl. 10, Fig. 24; Text-fig. 1H) is semicircular in outline; it consists of a three to four semi-ankylosed pygidial segments and freely articulated thoracic segments; the terminal portion of the axial lobe is less bulged and without distinct segmental or furrow structures. This portion might be the original germinal zone for pygidial segmentation.

Late meraspid stage (Pl. 10, Figs. 16—20, 25, 31; Text-fig. 1G):—The cranidium is trucato-triangular to subquadrate in outline, convex; it measures 1.0 to 1.8 mm in length (sag.); a medium-sized librigena is arbitrary assigned to
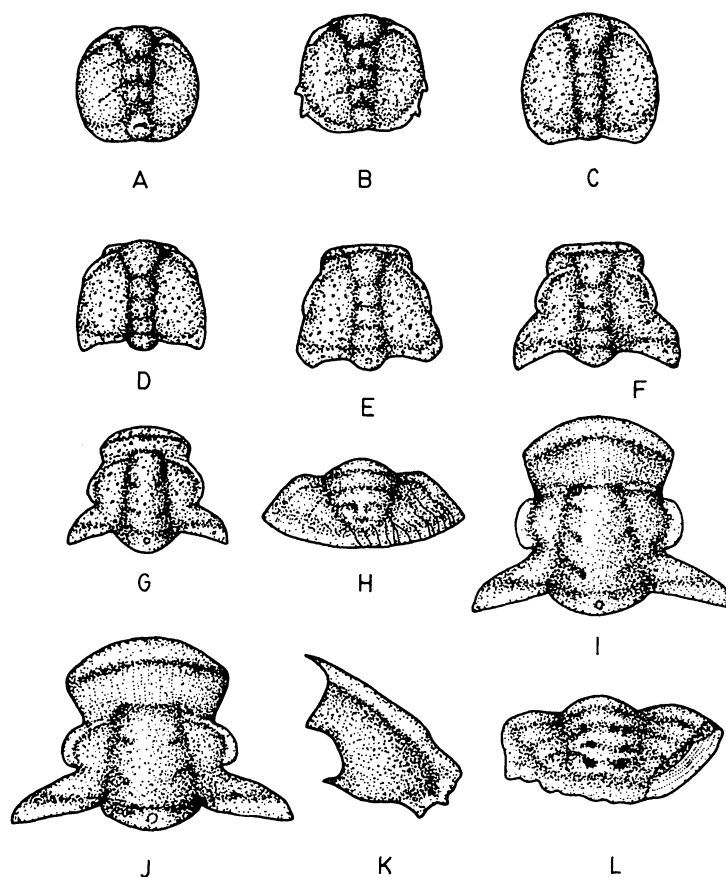
Text-fig. 1. *Aphelaspis tarda* Rasetti. A, anaprotaspis, showing four axial rings. ×43; B, metaprotaspis, showing five axial rings. ×40; C, D, a small and a large-sized paraprotaspides, showing the annular axial rings and the absence of the proto-pygidium but well developed posterior fixigenal border. ×40, ×33; E, F, two early meraspid cranidia, showing the anterior border and the posteriorly migrated pal-pebral lobe. ×20, ×15; G, a late meraspid cranidium, showing the presence of the preglabellar field and complete glabellar furrows. ×10; H, an injured pygidium; notice the faint trails on the right pleuron. ×5; I, J, "male" and "female" cranidia; notice the morphologic differences of the glabella and the cranidial shape. ×5; K, an injured librigena, showing the absence of the genal spine. ×5; L, a pathologic "male" pygidium, showing the differences between the left and right pleural lobes. ×5.
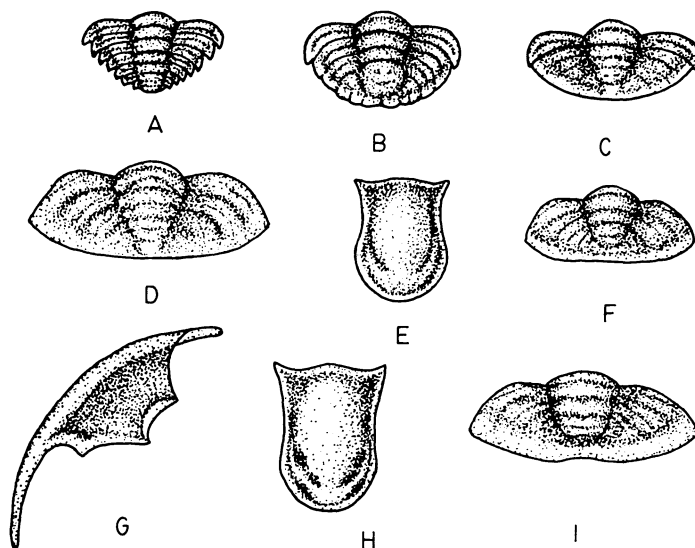
Text-fig. 2. *Aphelaspis tarda* Rasetti. A, B, protaspid and early meraspid pygidia, showing the articulation of the thoracic segments and the dis-ankylosed pygidial plate. ×20, ×10; C, a late meraspid pygidium associated with a thoracic segment, ×10; D, F, a large and a small "male" pygidia. ×4, ×7; E, H, a small and a large hypostomata. ×20, ×10; G, a librigena. ×2; I, a "female" pygidium. ×6.

the present stage (Pl. 10, Fig. 31; Text-fig. 1K); it is crescentic with a broad genal angle and has a broad-based but medium-sized genal spine; the lateral furrow and the posterior genal furrow are not connected at the genal angle area, and are separated by an elevation.

The assigned late meraspid pygidium (Pl. 10, Fig. 25) is semicircular in outline, convex, and consists of three pygidial segments and a thoracic segment; the pygidial segments are all well ankylosed as a complete plate, and the thoracic segments shows freely articulated structure lying in front of the pygidial plate; the surface is covered by medium-sized granules along the pleural bands.

This stage differs from the previous stage in that the preglabellar field here appears, the glabella becomes conical, the fixigena is narrower, and the pygidial segments are ankylosed as a complete plate.

Figured specimens:—Topotype GMUC. 43345, 43345a-z, 43345a'-j'.

Aphelaspis tumifrons Resser

Pl. 11, Figs. 1—42; Text-figs. 3, 4

Aphelaspis tumifrons Resser, 1938, p. 60, pl. 13, fig. 15; Rasetti, 1965, p. 91, pl. 19, fig. 1—7.

The ontogenic sequence of the present species is less well preserved; four different morphologic stages are recognizable: metaprotaspid, paraprotaspid, early meraspid, and late meraspid. They are briefly described as follows.

Metaprotaspid stage (Pl. 11, Figs. 1—3; Text-fig. 3A, B):—This instar is rounded to subrounded in outline, moderately convex, and measures about 0.25—0.35 mm in length (sag.); the morphogenesis of the instars during this stage shows that the axial lobe consists of five rings, which are separated into a large frontal lobe, a small terminal portion, and three pairs of central lobes. The three pairs of central lobes are combined into three complete axial rings during the later period of the stage; the small terminal portion
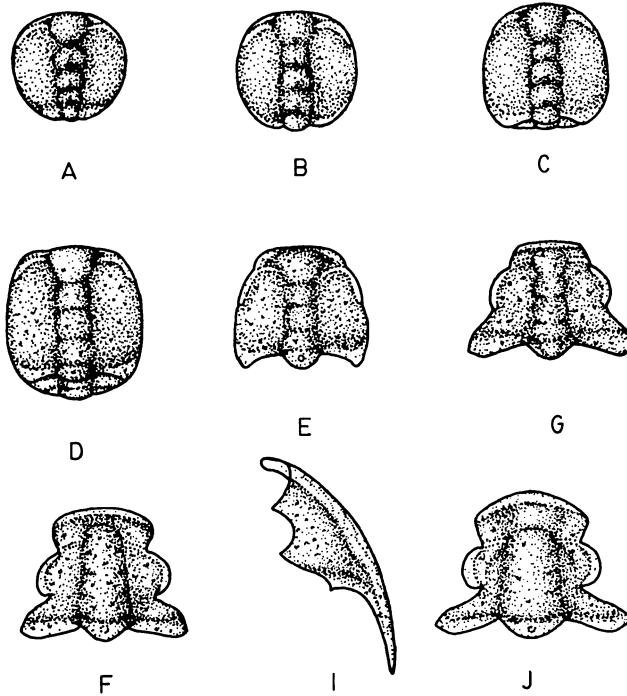
Text-fig. 3. *Aphelaspis tumifrons* Resser. A, B, two metaprotaspid shields, ×55; C, D, two paraprotaspid shields, ×50; F, G, two early meraspid cranidia, ×12; I, an holaspid librigena, ×6.

increases in size and becomes the occipital ring. The skeletal surface is covered by faint granules.

Paraprotaspid stage (Pl. 11, Figs. 4—7, 9—12; Text-figs. 3C, D):—The complete skeleton consists of cephalic and pygidial shields, and varies from 0.40—0.60 mm in length (sag.); it is moderately convex, subrounded to trapezoidal in outline; the cranidium is divided into the cylindrical glabella and the triangular fixigena by well-defined dorsal furrows; the glabella consists of four axial segments and an occipital ring; the axial segments are all ellipsoidal except the frontal lobe which is large and trapezoidal; the skeletal surface is covered by both of faint and coarse granules; the distinct morphologic characteristics during this stage are that the cranidium change from subround to trapezoidal in outline; the posterior fixigena increases in width; the transverse small protopygidial plate appears.

Early meraspid stage (Pl. 11, Figs. 13—20; Text-figs. 3E, G):—The cranidial shield is 0.61—1.0 mm in length (sag.); the glabella is cylindrically convex, marked by four glabellar rings; the occipital furrow is narrow across the central line and broadens laterally; the narrow anterior border arches slightly forward, and is distinctly delimited by a frontal furrow; the triangular fixigena is convex, with the rear border of about the same width as the occipital ring; the cranidial surface is heavily covered by coarse granules.

The smallest pygidium which might be assigned to the present stage (Pl. 11, Figs. 28, 31, 36; Text-figs. 4A, B) is made of 5—6 dis-ankylosed segments; it is triangular to semicircular in outline, convex, and well-separated into axial and pleural lobes by dorsal furrow.

Late meraspid stage (Pl. 11, Figs. 27, 30—41; Text-figs. 3F, J):—The cranidium is 1.0—1.6 mm
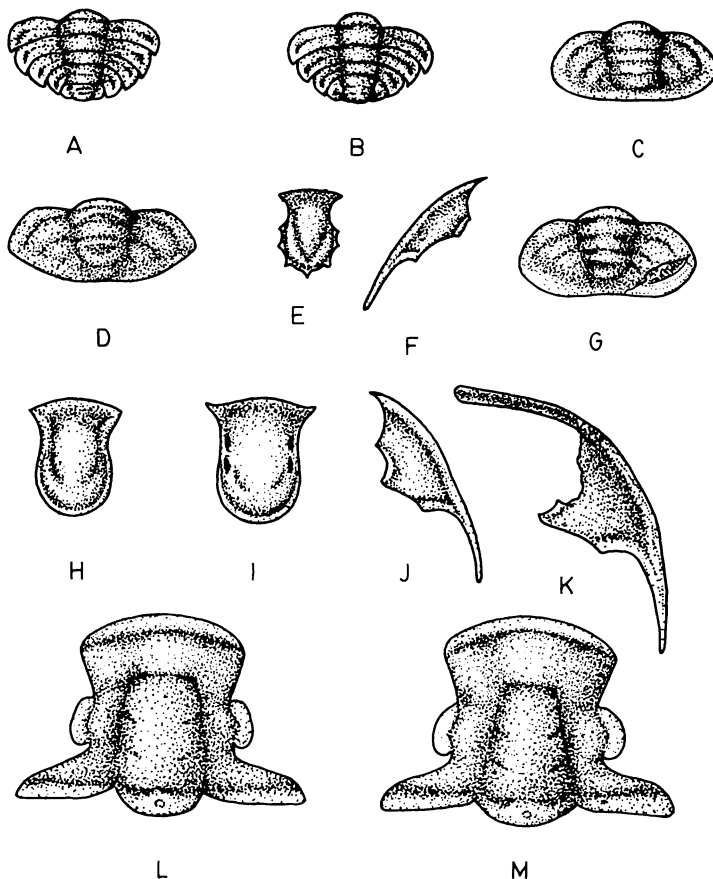
Text-fig. 4. *Aphelaspis tumifrons* Resser. A, B, two early meraspid pygidia, ×20, ×14; C, G, two late meraspid pygidia, ×30, ×12; D, an holaspid pygidium, ×6; E, H, I, a series of hypostomata, ×50, ×21, ×9; F, J, K, three different sized librigenae, ×21, ×15, ×4; L, M, two different sized cranidia, showing the morphologic varieties. ×3, ×6.

long (sag.); the glabellar furrows are complete; the narrow elevated crescentic anterior border is twice as wide as the preglabellar field, and distinctly defined by a frontal furrow; the anterior branch of the facial suture is divergently convex, and the posterior one is divergent-laterally convex or slightly straight; the cranidial surface is covered by medium-sized granules and sparsely with few coarse ones; a small and a medium-sized librigena (pl. 11, figs. 8, 26;text-figs. 4F, J) might be assigned to this stage.

During this stage the ocular platform increases in width and the genal pine increases in length.

The assigned pygidium (pl. 2, figs. 25, 37; text-figs. 4C, G) is 0.4—0.6 mm in length (sag.), semi-circular in outline, convex, and consisting of 3—4 pygidial segments; the pygidial segments are well ankylosed as a complete plate.

Figured specimens:—Topotypes, GMUC. 43364, 43364a-z, 43364a'-q'.

Phylogeny

The ontogenic development of the present species are identical to those of *Aphelaspis* sp.

(Palmer, 1962), *A. subditus* Palmer (Hu, 1969), *A. walcotti* Resser (Hu & Tan, 1971). All possess morphologically similar instars. No doubt, they are diversified from a common ancestor and constitute as natural specific group.

There are quite a few earlier instars belonging to different species from early Upper Cambrian — pre-*Aphelaspis* Zone (= *Crepicephalus* Zone) — which are reported from North America. They are: *Welleraspis lata* Howell, *W. swartizi* (Tasch) (Rasetti, 1965; Hu, 1964, 1968), *Coosella convexa* Tasch, *Pemphigaspis bullata* Hall, *Kingstonia ara* (Walcott), *Genevievella plesiochielus* Tasch, *Wilsonella pennsylvanica* Hu (Hu, 1968), *Welleraspis lochmanae* Hu (1969), *Komaspidella laevis* Rasetti (Hu, 1970), *Coosia albertensis* Resser, *Blountia nixonensis* Lochman

(Hu, 1975), *Crepicephalus deadwoodensis* Hu (1971) . . . etc. However, it interesting to note that no instars of any of them have morphologic characteristics similar to those of the genus *Aphelaspis*. Evidently, the genus *Aphelaspis* has an independent progenitor in the North American continent. It is believed that there was possibly a short biologically catastrophic period between pre-*Aphelaspis* and *Aphelaspis* zones. Strangely enough, the earlier instars of *Olenus gibbosus* (Wahlenberg) (Strand, 1927; Størmer, 1942; Hu, 1971) are very similar to those of *Aphelaspis* reported from earliest Upper Cambrian of Norway; both possess the cylindrical axial lobe, broad triangular fixigena, and many characteristics in common. Therefore, the *Olenus* and *Aphelaspis* are congenera and

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Explanation of Plate 10

Figs. 1—37. *Aphelaspis tarda* Rasetti.
   1, a complete anaprotaspis, showing the four axial rings; notice that the fourth or the terminal ring is marked by an arrow-shaped median impression. ×43, GMUC. 43345.
   2—5, a growth series of metaprotaspides; notice the morphogenesis of the axial lobe from the small to larger instars. ×40, ×42, ×40, ×40; GMUC. 43345a-d.
   6—9, a growth series of paraprotaspides; notice the appearance of the large cranidial and the small protopygidial shields. ×42, ×37, ×33, ×30; GMUC. 43345e-h.
   10, 12—15, several early meraspid cranidia, showing the presence of the anterior border and the differentiation of the glabellar furrows. 10, 12, 13, ×20; 14, 15, ×16; GMUC. 43345i, 43345k-n.
   11, a nearly complete hypostoma. ×20, GMUC. 43345j.
   16—20, a few late meraspid cranidia, showing the appearance of the preglabellar field and the completion of the glabellar furrows. 16, 15; 17, ×13; 18—20, 10. GMCU. 433450-s.
   21, 22, two early holaspid cranidia, showing the varieties of the preglabellar field and the glabellar shapes. ×8, ×6; GMUC. 43345t, u.
   23—25, three immature pygidia; notice the morphogenesis during the different growth stages. 23, ×20; 24, 25. ×10; GMUC. 43345v-x.
   26, a "female" pygidium, showing the inward bend of the posterior marginal border. ×6, GMUC. 43345y.
   27—29, three "male" pygidia; notice the presence of pathologic features: the etched grooves, saw toothed marginal border, the poorly differentiated axial lobe, and comparison with a regular pygidium. 27, ×10; 28, ×4; 29, ×5; GMUC. 43345z, a', b'.
   30, a pathologic librigena, showing the absence of the genal spine. ×5, GMUC. 43345c'.
   32, small and large librigena, showing the lengthening of genal spine and broadening of the genal angle. ×8; ×1.5; GMUC. 43345d', g'.
   33, 34, 36, three "female" cranidia, showing the shorter and broader glabella. 33, ×3.5; 34, ×4.5; 36, ×2.8; GMUC. 43345e', f', i'.
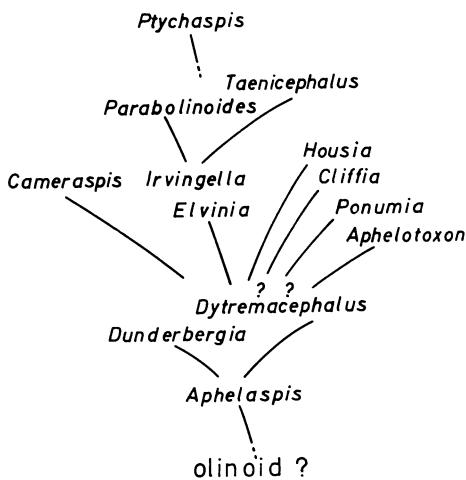   35, 37, two "male" cranidia, showing the narrow elongate glabella. ×5, GMUC. 43345h', j'.
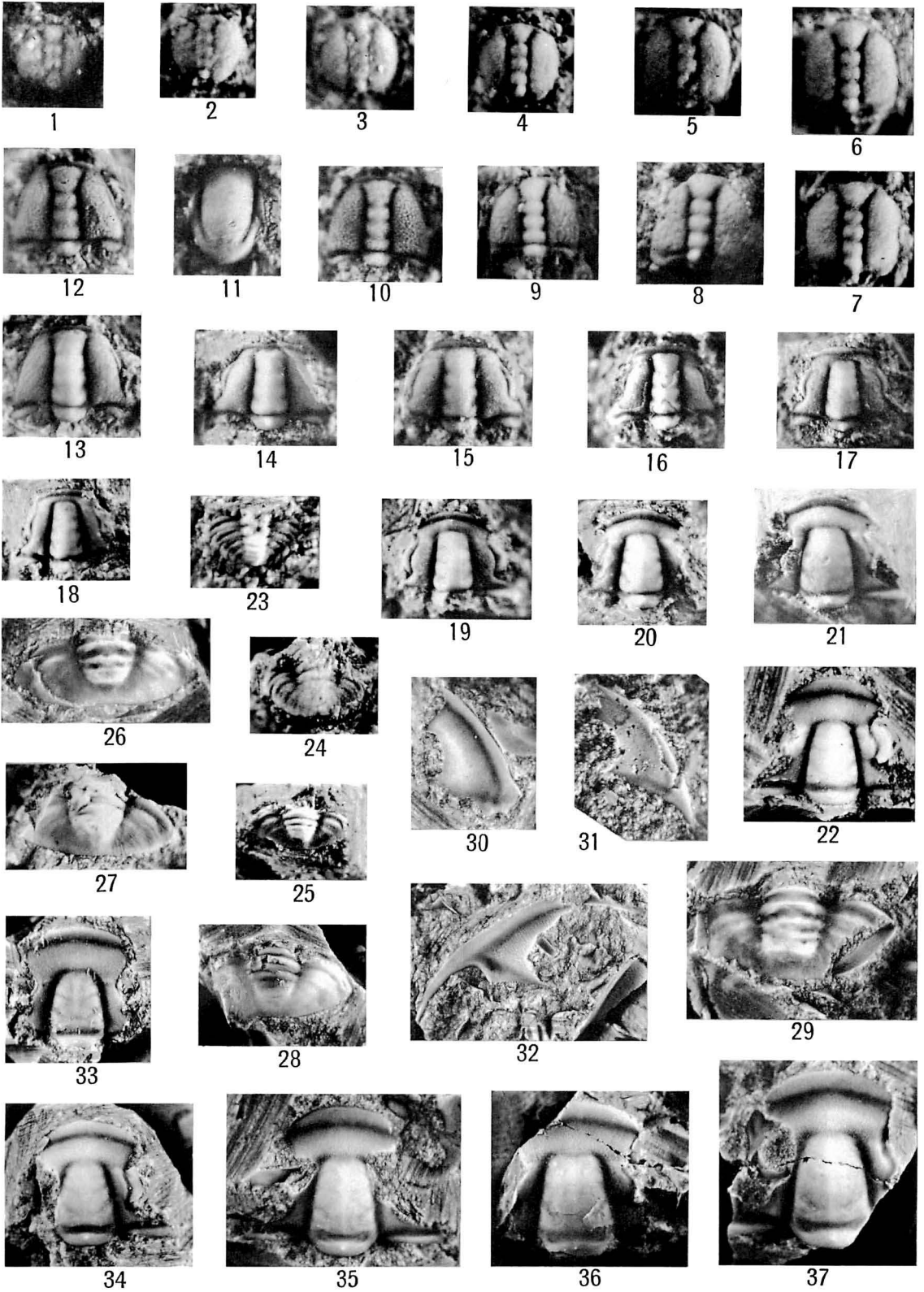
were possibly descent from a common ancestor: one of them — *Olenus* — resided in the Scandinavian area and the other — *Aphelaspis* — migrated into the North America or following the Dresbachian stage.

The genus *Aphelaspis* is possibly the direct ancestor of *Dytremacephalus granulosa* Palmer, *Dunderbergia anyta* (Hall & Whitfield) (Hu, 1971), and *Cameraspis convexa* (Whitfield) (Hu, 1979), and the indirect ancestor of *Elvinia roemeri* (Shumard), *Irvingella major* Ulrich & Resser, *Parabolinoids contractus* Frederickson, *Taenicephalus shumardi* (Hall) (Hu, 1969, 1981), and *Ptychaspis bullasa* Lochman & Hu (Hu, 1971). The adult cranidia of these species are rather similar to those of early or late meraspis of *Aphelaspis* all have a narrow or lack a preglabellar field, and show a narrow convex anterior border, imcomplete glabellar furrows, small to medium-sized palpebral lobe, broad triangular fixigenae, and medium to coarsely granulated skeletal surface. Obviously that these were due to the neoteny of meraspis of the *Aphelaspis-Dunderbergia* stock. Presumably neotenic evolution was an orthogenetic continuum from the *Aphelaspis-Dunderbergia*, *Elvinia-Irvingella*, throughout the *Parabolinoides-Taenicephalus* to the *Ptychaspis-Prosaukia* stocks. (Text-fig. 5)

Text-fig. 5. Phylogenic tree showing some generic relationships among Upper Cambrian trilobites.

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米国テネシー州のノリチュキー層産上部カンブリア紀三葉虫2種の個体および系統発生：
テネシー産の *Aphelaspis tarda* Rasetti および *A. tumifrons* Resser の個体発生を記載し，
系統を考察した。これら三葉虫の形態発生史は5つの異なった発生段階，すなわち前原楯期，
後原楯期，準原楯期，早中年期，晩中年期に区分される。*Aphelaspis* 属はおそらく北米外の
地域に起源を有し，この地域には祖先が知られない。本属から *Elvinia-Irvingella, Parabo-
linoides-Taenicephalus* を通して *Ptychaspis-Saukia* に到る継続的な幼形進化が考えられる。

胡　忠恒

Explanation of Plate 11

Figs. 1—42. *Aphelaspis tumifrons* Resser.

1—3, a growth series of metaprotaspides, showing the completion of the glabellar rings. ×54, ×58, ×60; GMUC. 43364, 43364a, b.

4—7, 9—12, a growth series of paraprotaspides, showing the presence of the protopygidium and the lateral expension of the fixigena. ×60, ×48, ×48, ×28, ×37, ×47, ×51, ×56; GMCU. 43364c-k.

13—20, a series of early meraspid cranidia, showing the appearance of the preglabellar border. ×21, ×24, ×20, ×25, ×21, ×25, ×14, ×16; GMUC. 43364l-s.

21—25, a growth sequence of hypostomata, showing the absence of the marginal spines and the buldging of the median body. ×55, ×25, ×20, ×50, ×10; GMUC. 43364t-x.

8, 26, two immature librigenae, showing the widening of the ocular platform. ×23, ×11; GMUC. 43364y, z.

27, 30, 40, 41, a sequence of late meraspides, showing the presence of the preglabellar field and the completion of the glabellar furrows. ×12, ×9, ×6, ×41; GMUC. 43364 a'-d'.

28, 31, 35—37, a growth sequence of the pygidium, showing the ankylose of the pygidial segments during their different morpholgenic stages. ×20, ×18, ×14, ×40, ×37; GMUC. 43364e'-i'.

29, 32, 34, three different sized pygidia. ×10, ×6, ×7; GMUC. 43364j'-l'.

33, 39, two cranidia, showing the morphologic varieties; ×7, ×3.6; GMUC. 43364m'-n'.

38, 42, two large sized librigenae, showing the granulate surface and the boublure; ×5, ×5; GMUC. 43364p'-q'.
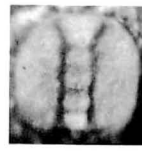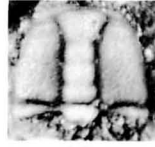
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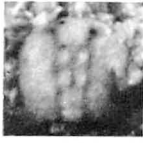
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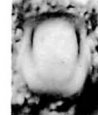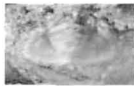
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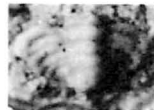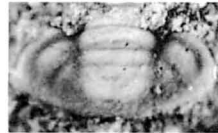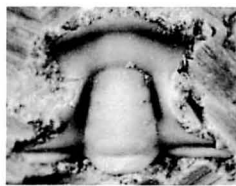27

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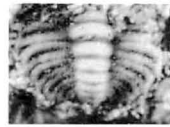
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759. EARLY JURASSIC PLANTS IN JAPAN. PART 5*

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Abstract. This is the fifth of our serial papers on the early Jurassic plants in Japan. In this paper we describe *Ctenis kaneharai, Pseudoctenis nipponica* sp. nov., *Nilssonia* cfr. *inouyei, N. japonica* sp. nov. and *N.* spp. (A-E) belonging to Cycadales, and the following unclassified forms in Cycadopsida: *Cycadites* cfr. *saladini, Taeniopteris gracilis, T.* cfr. *jourdyi* and *T.* spp. (A-D) including one *Marattia*-like form.

Introduction and acknowledgements

In continuation of our previous papers (Kimura and Tsujii, 1980a, b, '81, '82), we here describe the leaves belonging to cycadales and those of uncertain affinities in Cycadopsida from the Lower Jurassic Kuruma Group and Iwamuro Formation. The details of the stratigraphy on the plant-bearing formations and fossil localities were already mentioned in our first paper (Kimura and Tsujii, 1980a).

We express our sincere gratitude to Professor Emeritus Thomas M. Harris, F. R. S. of the University of Reading for his helpful suggestions and critical reading over the present manuscript. Our thanks are extended to Mr. Gumpei Mori, Mr. Noriyuki Sasaki, Mr. Akihiro Kobayashi and many students of the Tokyo Gakugei University who helped us in collecting the fossil plants.

Systematic description

Cycadales

Genus *Ctenis* Lindley and Hutton, 1834: 63

Ctenis kaneharai Yokoyama

Pl. 12, Fig. 1; Pl. 13, Fig. 1; Text-figs. 1a—f

Ctenis Kaneharai Yokoyama: Yokoyama, 1906,

p. 29, pl. 9, fig. 1, 1A (Saimaji Coal-Field, Liaoning: Lower Jurassic Changliangzi Formation ?): Yabe and Oishi, 1933, p. 226 (remarks): Harris, 1950, p. 1001 text-figs. 1—3, 4B (Yorkshire); 1964, p. 112, text-figs. 48, 49 (ditto): Sze et al., 1963, p. 191, pl. 55, fig. 4; pl. 57, fig. 2 (Yokoyama's specimens).

Material: SHI-136, 141, 143, 152—158, 160, 167 (Shinadani), NNW-778 (Nishi-Neiridani), and many pinna fragments mainly from Shinadani.

Description:—The leaf is probably very large. The rachis is up to 2 cm wide, with prominent longitudinal striations on its surface. The pinnae are attached perpendicularly to the lateral sides of rachis, remotely set, separated by gaps of 1—2 cm. No complete pinna is preserved, but the pinnae appear to be straight, increasing in width to a maximum at about one-third the distance from the rachis to apex, then tapering evenly towards the acuminated apex, acroscopic basal margin is more or less contracted and sometimes decurrent, more than 6 cm long and 1.6 cm wide at the widest portion. Pinna margins are entire. Veins are prominent, 11—18 per cm in density at the middle of pinna. Vein-meshes are 1.2—2.4 cm long. Cuticle is not preserved.

Occurrence:—Rare.

Remarks:—Twelve leaf-fragments from the Shinadani belong originally to a single leaf. They were broken in pieces during the collection. Our

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leaf is characterized by its very thick rachis bearing remotely set pinnae, and is referable to *Ctenis kaneharai* originally described by Yokoyama and later by Harris in detail, although our rachises are far thicker than those of previous authors.

A single leaf-fragment from the Nishi-Neiridani belongs possibly to this species, although its vein-meshes are shorter in length. One of us, Kimura (1959a) described a broken leaf from the Iwamuro Formation (A-5002) as *Ctenis?* sp. indet. This specimen may represent the upper portion of a leaf of this species. *Ctenis* sp. described by Yokoyama (1906) from the Lower-Middle Jurassic Fangzi Group, Shandong, China may belong to this species and may represent the distal portion of a leaf.

Harris (1964) mentioned the possibility that the Yorkshire and the Asiatic specimens were distinct. But at present we cannot distinguish them on their external morphology.

One of us, Kimura (1961) and Kimura and Sekido (1972) described *Ctenis* leaves from the Lower Cretaceous Itoshiro Group in the Inner Zone of Japan as *C. kaneharai*. But now we think they are not referable to *Ctenis kanehari* but to *C. nipponica* described in detail by Kimura and Sekido (1972).

Ctenis japonica originally described by Oishi (1932a) from the Nariwa Group is very close to *C. kaneharai*. But at present it is difficult to settle their specific identity because the pinna apex of Oishi's species is still unknown.

Kuandiania crassicaulis recently instituted by Zheng and Zhang (1980) from the Middle Jurassic Zuanshanzi Formation, Southern Liaoning, China looks similar to our leaf. But it is distinguished by its obliquely set pinnae whose acroscopic basal margin appears to originate from the upper surface of rachis.

Genus *Pseudoctenis* Seward, 1911: 691

Pseudoctenis nipponica
Kimura and Tsujii sp. nov.

Pl. 12, Figs. 2—3; Pl. 13, Figs. 2—4;
Pl. 14, Fig. 1; Text-figs. 2a—d

Material: Holotype; NEG-011 (Negoya). Paratypes; NEG-032, NNW-514 (Nishi-Neiridani), A-710518-1, 7307083 (Iwamuro). Other specimens; A-0030, 710518 (2-4), 7307084, 7307085, NEE-192 (Higashi-Neiridani), NNW-791, 794, 795, 797, NEG-016, 053, 054, 099, 208. *Stratum typicum*: Negoya Formation, Kuruma Group. *Locus typicus*: The Negoya Valley, a branch of the Dairagawa, Asahi-machi, Shimo-Niikawa-gun, Toyama Prefecture. *Derivatio nominis*: After Nippon meaning Japan in Japanese.

Diagnosis:—Leaf rather small-sized, ca. 14 cm wide. Rachis up to 0.5 cm wide, surface nearly smooth. (Whole leaf unknown.) Pinnae borne laterally on rachis, arising at an angle of 55—70 degrees, but angle reduced distally, never crowded, separated by a distance about equal to their own width. Pinnae linear-lanceolate, pinna base contracted just above its origin, gradually widening to the maximum width in the middle region, then gradually tapering to an acutely pointed apex. Lower pinnae much contracted near the base and reaching the maximum width rather quickly. Acroscopic margin of pinna usually contracted at the point of origin, never running up the rachis. Basiscopic margin usually more or less decurrent, decurrence rather marked in middle and upper pinnae. Veins moderately conspicuous, mostly simple, parallel, but rarely anastomosed, about 30 per cm in density at the middle region of pinna. In distal part of pinna, vein-number reduced by the lateral veins running into the margins. (Reproductive organs not known and cuticle not preserved.)

Distribution and *occurrence:*—*Pseudoctenis nipponica* is locally common in the Negoya and Iwamuro Formations.

Comparison and *discussion:*—There is no positive evidence showing that our material is not a bennettitalean but a cycadean because of the lack of cuticle. However, externally it would be distinguished by its elongate pinnae and markedly decurrent pinna bases from *Zamites* and most species of *Pterophyllum*, although our basal pinnae are contracted near base as shown in our Text-fig. 2c. Thus we prefer to assign
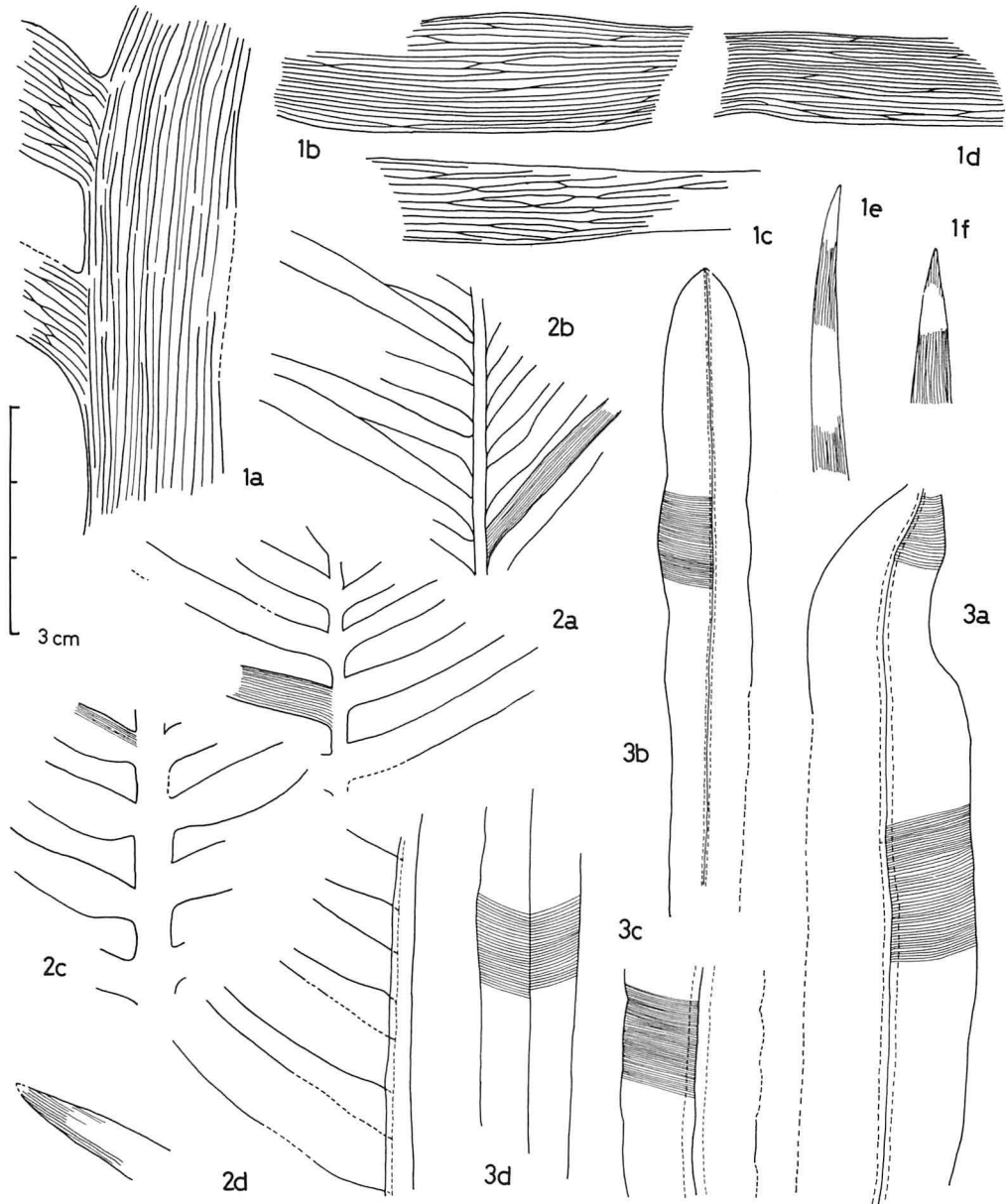
Text-figs. 1—3 (All natural size).

1. *Ctenis kaneharai* Yokoyama: 1a; a thick rachis bearing remotely set pinnae (SHI-141, Pl. 13, Fig. 1). 1b-d; broken pinnae with logitudinally elongated vein-meshes 1b; SHI-153, 1c; NNW-778, 1d; [SHI-154, Pl. 12, Fig. 1 (in part)]. 1e-f; apices of pinnae (1f; SHI-153, 1e; SHI-152).

2. *Pseudoctenis nipponica* Kimura and Tsuii sp. nov.: 2a; a distal part of leaf, veins are 13 in number in each pinna (NEG-011, Pl. 12, Fig. 2, holotype). 2b; ditto, veins are 9 in each pinna (NNW-514, Pl. 13, Fig. 2, paratype). 2c; a proximal part of leaf (NEG-032, Pl. 14, Fig. 1, paratype). 2d; ditto, veins end at apical margin of pinna (A-7307083, paratype).

3. *Nilssonia* cfr. *inouyei* Yokoyama: 3a; vein-density is 26—30 per cm, transverse wrinkles are not shown (NEE-075). 3b; vein-density is 36 per cm (NEE-079). 3c; vein-density is 40 per cm (KA-012). 3d; vein-density is 22—27 per cm (A-035, Pl. 13, Fig. 7).

our material to *Pseudoctenis*.

Pseudoctenis nipponica is characterized by its rather small-sized leaf and crowded veins. Among over 30 *Pseudoctenis* species hitherto described, the following species resemble ours in external form but all of them are distinguished as mentioned below:

Pseudoctenis capensis Du Toit, 1927: Upper Triassic of South Africa.

P. carteriana Du Toit, 1927: Ditto.

P. cteniforme (Nathorst) Harris, 1950: Upper Triassic (?) of Sweden.

P. herriesi Harris, 1945: Middle Jurassic of Yorkshire.

P. lanei Thomas, 1913: Ditto.

P. weberi (Seward) Prynada, in Delle, 1967: Middle Jurassic of Georgia and Caucasia.

Both *Pseudoctenis capensis* and *P. carteriana* are distinguished by their large-sized pinnae with small number of veins (6-10 in number in each pinna) forking at base. *Pseudoctenis cteniforme* is distiguished by its thicker rachis, and *P. herriesi* by its large-sized pinnae with expanded acroscopic base and thick rachis. *Pseudoctenis weberi*, although its pinnae are similar in form to ours, is also distinguished by its thicker rachis (3—8 mm wide).

Pseudoctenis lanei is morphologically most close to ours, but it differs from ours in its large-sized leaf (30 cm wide, according to Harris, 1950) with thick rachis. In our species pinnae do not exceed 5.5 cm in length.

Pseudoctenis leaves described by Oishi (1940) as *P. lanei* from the Upper Jurassic Oginohama Formation, Oshika Group, Miyagi Prefecture, Japan is, as mentioned by Oishi, externally very close to Thomas' species. But Oishi's leaves are, as mentioned by Harris (1950, '64), different from normal Yorkshire leaves in having crowded veins (25 per cm) and are rather similar to ours.

Cfr. *Pseudoctenis brevipennis* described by Takahasi (1951) from the Upper Jurassic Kiyosue Formation, Yamaguchi Prefecture, Japan based on a single broken leaf is rather similar in external feature to ours than to *P. brevipennis*. But Takahasi's leaf is too incomplete to identify.

Pseudoctenis sp. described by Oishi (1940) from the Kiyosue Formation (locality; Takaji) is distinguished from ours by its crowded pinnae attached to the slender rachis at an angle of about 45 degrees.

Genus *Nilssonia* Brongniart, 1825: 200

We discriminated 2 species and 5 characteristic forms of *Nilssonia* from the Kuruma Group and Iwamuro Formation. We succeeded to separate *Nilssonia japonica* sp. nov. from *N.* ex gr. *orientalis* Heer based on our numerous specimens newly collected. This separation had been of a long-pending problem for us. Besides above, Oishi (1940) described *Nilssonia brevis* Brongniart from the Lower Jurassic Higashinagano Formation, Yamaguchi Prefecture. But at present we are sure that *Nilssonia brevis* is too poorly preserved to make the precise identity.

Nilssonia cfr. *inouyei* Yokoyama

Pl. 13, Figs. 5—7; Text-figs. 3a—d

Comparable specimens:

Nilssonia inouyei Yokoyama: Yokoyama, 1905, p. 9, pl. 1, fig. 4; pl. 2, fig. 4 (Upper Triassic Yamanoi Formation): Thomas, 1911, p. 40, pl. 6, figs. 4, 4a, 5 (Middle Jurassic of Kamenka): Oishi, 1932b, p. 64 (emended diagnosis); 1940, p. 302 (remarks): Prosvirjakova, 1966, p. 95, pl. 18, figs. 1—3 (Middle Jurassic of Mangwishlak): Wu et al., 1980, p. 107, pl. 20, figs. 8—9; pl. 24, figs. 3—4; pl. 25, figs, 7—8 (Lower Jurassic Xiangxi Formation, China).

Material: NEE-052, 075, 079 (Higashi-Neiridani), KA-006, 009 (Kawagurodani), DAI-030 (Dairagawa), A-033, 035 (Iwamuro).

Description:—The leaves are simple, elongated, narrow, widening gradually from the basal portion upwards, then rather abruptly narrowing to the obtusely pointed apex. The margins are shallowly undulated at long intervals. The lamina covers the upper surface of a thin rachis, typically 0.7 mm wide, and often wrinkled transversely as shown in Pl. 13, Figs. 5—6;

the wrinkles are 3—7 per cm. The veins are simple, crowded and nearly perpendicular to the rachis, 36 per cm. The petiole and cuticle are not preserved.

Distribution and *occurrence:*—Rarely known from the Negoya and Iwamuro Formations.

Remarks:—Macroscopically our leaves are most close to those of *Nilssonia inouyei*, but differ in vein-density; the vein-density is, according to Oishi (1932b), 20—23 per cm in Japanese leaves, 17—30 per cm in Chinese leaves (Wu et al., 1980) and 22—24 in Russian leaves (Prosvirjakova, 1966). Thus we reserve stating the identity of our leaves with Yokoyama's species.

Our leaves differ from those described by Thomas (1911) as *Nilssonia inouyei* in that according to his illustration (in his pl. 6, fig. 4a), veins are often forking.

The following species are macroscopically similar to ours, but they are distiguished by the respective reasons briefly mentioned below:

Nilssonia elegans Arber: Arber 1917, Middle Jurassic of New Zealand: Rachis rather thick, exposed on upper surface, margins mostly deeply lobed.

N. nigracollensis Wieland: in Ward, 1905, Lower Cretaceous Kootanie Formation, U.S.A.: Vein-density, 22 per cm.

N. orientalis Heer var. *minor* Fontaine: Prosvirjakova, 1966, Middle Jurassic of Mangwishlak: Lamina broader, vein-density 20—26 per cm.

N. parvula Fontaine: in Ward, 1905, Jurassic of Oregon: Lamina more slender, rachis thicker.

N. revoluta Harris: Harris, 1964, Middle Jurassic of Yorkshire: Lamina more slender, curved downwards and revolute.

N. Schaumburgensis (Dunker) var. *parvula* Yabe: Yabe, 1913, Lower Cretaceous in the Outer Zone of Japan: Lamina more slender and Often incised at long intervals. Veins always indistinct.

N. simplex Oishi: Oishi, 1932a, Upper Triassic Nariwa Group: Veins often forking once close to the rachis. Vein-density 23 per cm.

N. undulata Harris: Harris, 1932a, Liassic of Greenland: Lamina broader. Vein-density typically 20 per cm.

Macroscopically our leaves are also close to

those of *Nilssonia vittaeformis* Prynada (in Genkina, 1963; Prosvirjakova, 1966; Delle, 1967; Baranova et al., 1975; Iminov, 1976) from the Middle Jurassic of Central Asia, but these Central Asian laminae are not entire but often incised.

Taeniopteris gracilis originally described by Kimura (1959a) from the Iwamuro Formation, is similar in leaf-form to our leaves, but it is distinguished from ours by its lamina attached laterally to the rachis and its forked veins.

It is difficult to identify ribbon-like *Nilssonia* leaves such as ours on their external features alone.

Nilssonia japonica Kimura and Tsujii sp. nov.

Pl. 14, Figs. 2—4; Text-figs. 4a-g

Nilssonia orientalis Heer: Oishi, 1932a, p. 336, pl. 45, figs. 5—6; pl. 46, figs. 1—2 (Nariwa Group); 1940, p. 307 (pars), pl. 26, figs. 1, 5 (non figs. 2—4) (Neiridani, Kuruma Group): Kimura, 1959a, p.21, pl. 7, figs. 2—4; pl. 8, fig. 2; pl. 9, figs. 1—4 (Iwamuro Formation).

Nilssonia sp.: Kimura, 1959a, p. 22, pl. 7, fig. 1 (Iwamuro Formation).

Material: Holotype; A-69028-2 (Iwamuro). Paratype; NNW-047 (Nishi-Neiridani). Other specimens: A-0302 and other 94 sepcimens, NE-010 and other 44 (Neiridani), NEE-004 and other 12 (Higashi-Neiridani), NNW-015 and other 151, NEG-002 and other 20 (Negoya), DAI-005 and other 12 (Dairagawa), SHI-014 (Shinadani), KA-001 and other 2 (Kawagurodani), TOB-042 (Tobiiwadani), Kr-075 and other 3 (Tsuchizawa). *Stratum typicum*: Iwamuro Formation. *Locus typicus*: Iwamuro, Shirasawamura, Tone-gun, Gumma Prefecture. *Derivatio nominis*: After Japan.

Diagnosis:—Leaf large, reaching 50 cm long and 9—10 cm wide at the widest portion. Rachis slender in most part of leaf, up to 7 mm wide near the base. Lamina elongate-oblanceolate in outline, widening gradually upwards and abruptly contracting to the broadly rounded or notched apex, entirely covering the upper sur-

face of rachis. Lamina usually dissected rather regularly into segments by sinuses reaching the rachis, but often entire in the basal part. Segments broadly rectangular with truncate distal margin. Veins distinct, simple, parallel, meeting at the median line of the rachis, not bending downwards near their origin, often curving upwards distally. Density of veins variable, 10—30 in number per cm. (Petiole not known

and cuticle not preserved.)

Distribution and *occurrence:—Nilssonia japonica* is locally abundant in the Negoya and Iwamuro Formations, but rather rare in the Shinadani Formation. This species is common in the Upper Triassic Nariwa Group.

Discussion and *comparison:—Nilssonia japonica* is characterized by its large-sized and elongate-oblanceolate leaf mostly divided into

Table 1. Width and vein-density of the leaves regarded as *Nilssonia orientalis* Heer and its allied forms. This list does not cover all records of *Nilssonia orientalis*.

Specific names	Authors	Ages* and localities	Leaf-width (cm)	**	Remarks
N. orientalis Heer	Heer 1878	Kl-Lena Basin	1.1-4.2		type specimen
	Yokoyama 1889	J3-Tetori	1.7-2.3	21-30	
	Nathorst 1890	Kl-Shikoku	3.0	40	
	Nathorst 1897	J-Spitzbergen	2.8	35-40	
	Yabe 1905	Kl-Nagdong	2.4-4.4	23-34	
	Kryshtofovich 1910	T3-Primorye	2.5	26	
	Stopes 1910	K2-Hokkaido	4.0	20	
	Thomas 1911	J2-Kamenka	?	?	
	Kryshtofovich 1916	Kl-Primorye	3.6	40	
	Kimura 1958, '59b	J3-Tetori	2.0	36	
	Vassilevskaja & Pavlov 1963	Kl-Lena Basin	4.8	?	
	Genkina 1963	J2-East Ural	2.0-3.0	13-17	rachis thick
	Sze et al. 1963	T3-J1 Anhui Hubei	3.5	22	
	Abramova 1970	Kl-Lena Basin	2.0	40	
	Sixtel et al. 1971	J1-Fergana	2.5	?	
	Feng et al. 1977	T3-J1 Hubei	3.5-4.0	22	
	Wu et al. 1980	J1-Hubei	1.4-4.0	30-40	
N. ex gr. orientalis Heer	Genkina 1963	J2-East Ural	1.9-2.3	7-16	
	Krassilov 1967	Kl-Primorye	2.5-3.2	28	
	Doludenko & Orlovskaja 1976	J3-Kazakhstan	4.3	23	
	Kimura 1976	Kl-Kyushu	1.3-2.5	20	
N. cfr. orientalis	Endo 1925	K2-Hokkaido	2.8-4.0	20	
Cfr. N. orientalis	Huang et al. 1980	T3-Shaanxi	10+	30	probably distinct
	Zhang et al. 1980	J2-Beipiao	4.0	24	
N. orientalis var. minor Fontaine	Prosvirjakova 1966	J2-Mangwishlak	1.4-1.7	20-26	
N. cfr. johnstrupi Heer	Endo 1925	K2-Hokkaido	3.5-4.0	20	
N. ozoana Yokoyama	Yokoyama 1889	Kl-Tetori	0.9-1.4	40	
N. tanakai Kimura	Kimura 1959b	J3-Tetori	o.9-1.1	32-35	

    * T3=Upper Triassic, J=Jurassic, J1=Lower Jurassic,
       J2=Middle Jurassic, J3=Upper Jurassic, Kl=Lower Cretaceous,
       K2=Upper Cretaceous.
   ** Vein-density per cm.
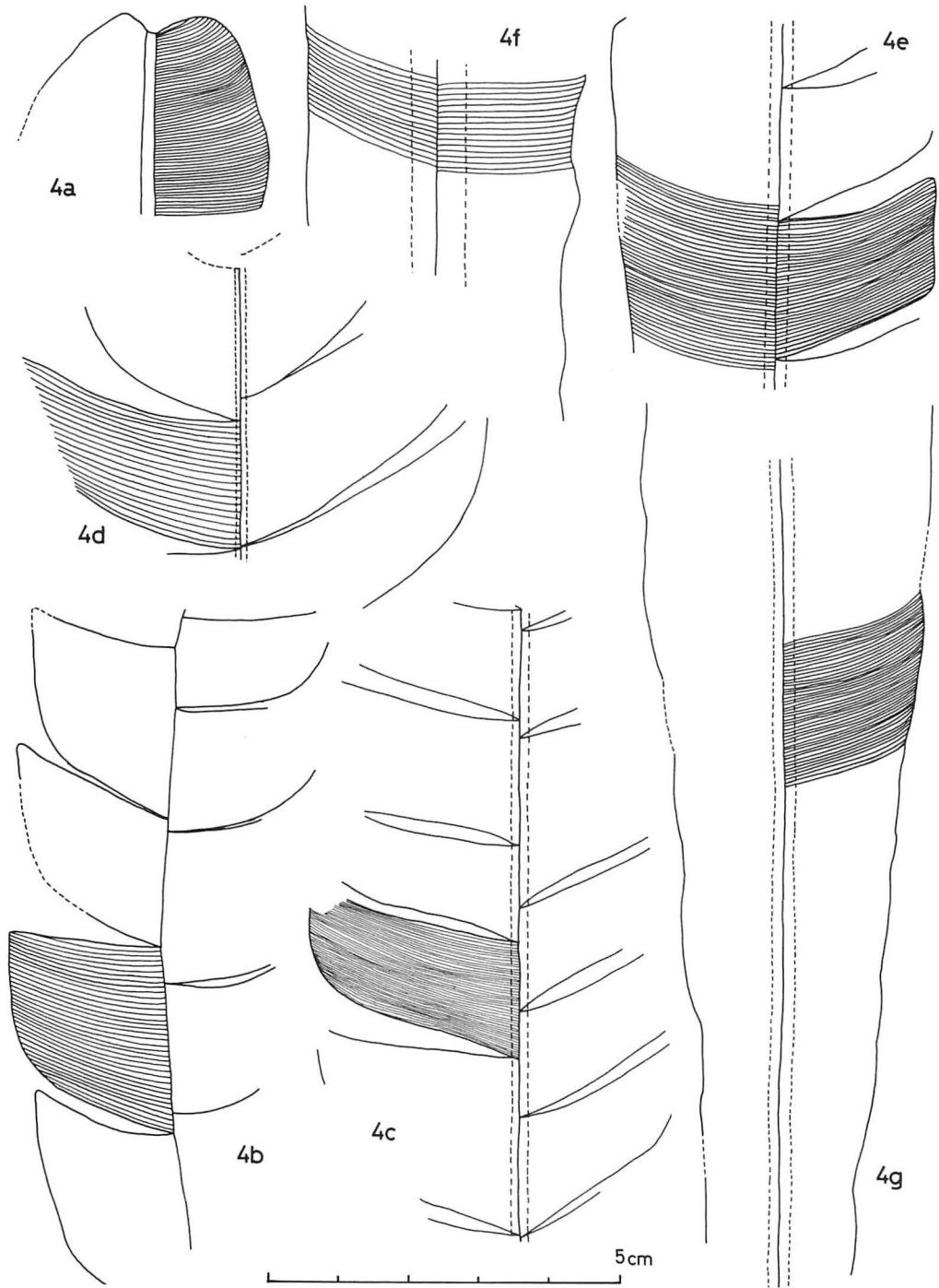
Text-fig. 4 (All natural size).
Nilssonia japonica Kimura and Tsujii sp. nov.: 4a; NNW-350 (23/cm). 4b; NE-012 (14—15/cm). 4c; NNW-492, Pl. 14, Fig. 3 (26/cm). 4d; NE-139. 4e; NNW-563 (18/cm). 4f; NNW-247B (13—16/cm). 4g; NNW-247A (23/cm).
(Vein-density given in brackets).

rectangular segments with simple veins variable in density (10—30 per cm).

One of us, Kimura has long felt that the large *Nilssonia* leaves assigned by the previous authors to *N. orientalis* from the older Mesozoic plant-beds in Japan are specifically distinct from the small ones assigned also to *N. orientalis* from the younger Mesozoic plant-beds. This is now confirmed by the numerous new specimens from the Iwamuro Formation and Kuruma Group.

Heer's original specimens of *Nilssonia orientalis* from the Lower Cretaceous of Lena Basin were represented by small leaf-fragments with entire or irregularly undulated margins as redrawn in Text-figs. 5a-d. Similar leaves have been described by many authors under the name of *Nilssonia orientalis*, *N.* ex gr. *orientalis*, *N.* cfr. *orientalis* or other specific names as shown in Table 1.

However, we do not think they belong to a single species. Among the leaves shown in Table 1 such elongate leaves as described by Thomas (1911), Sze (1933, '49) and Sze et al. (1963), Genkina (1963), Sixtel et al. (1971), Doludenko and Orlovskaja (1976), appear to be macroscopically close to *Nilssonia bargi-bidi* described by Barnard and Miller (1976) from the Middle Jurassic of Iran. At any rate, except for Genkina's leaves with thick rachis and the leaves by Huang et al. with larger lamina exceeding 10 cm in width, most leaves shown in Table 1 are far smaller in size than those of *Nilssonia japonica*.

Thus *Nilssonia japonica* is distinguished from *N. orientalis* and its allied forms mainly by the size and the manner of dissection of lamina. In small *Nilssonia* leaves assigned to *N. orientalis* and its allied forms, the sinus of dissection, even if present, never reaches the rachis.

Among the numerous *Nilssonia* species hitherto described, the following species are comparable with our in leaf-size, but they are distinguished from ours as briefly mentioned below:

Nilssonia complicatus Li, P. J.: in Sze et al., 1963, Lower Jurassic of Hubei (Xiangxi Formation) and Guangxi, China: Size variable, lamina elongate-tongue-shaped, entire, trans-

versely wrinkled, veins often forking.

N. gigantea Kryshtofovich and Prynada [non *N. gigantea* (Schenk) Prynada, non *N. gigantea* Zhou, T. S.]: Kryshtofovich and Prynada, 1932; Vakhrameev, 1958; Vassilevskaja and Pavlov, 1963, Lower Cretaceous of Southern Primorye and the Lena Basin: Lamina entire, vein-density 18—20 per cm.

N. gigantea (Schenk) Prynada (non *N. gigantea* Kryshtofovich and Prynada, non *N. gigantea* Zhou, T. S.): in Schenk, 1867 and others, Upper Triassic of Franken and Middle Jurassic of Georgia: Large-sized leaf, lamina probably entire.

N. gigantea Zhou, T.S. [non *N. gigantea* Kryshtofovich and Prynada, non *N. gigantea* (Schenk) Prynada]: Zhou, T. S., 1978, Lower Jurassic of Fujian, China: Lamina transversely corrugate, margins shallowly undulated, vein-density 6—13 per cm.

N. grandifolia Delle (non *N. grandifolia* Huang and Zhou, H. Q.): Delle, 1967, Middle Jurassic of Georgia: Large-sized leaf, margins probably entire, vein-density 12—18 per cm.

N. grandifolia Delle f. *rarinervis* Delle: Delle, 1967, ditto: Vein-density 5—7 per cm.

N. grandifolia Huang and Zhou, H. Q. (non *N. grandifolia* Delle): Huang and Zhou, H. Q., 1980, Middle Triassic of Shaan-Gan-Ning Basin, China: Lamina rather irregularly segmented, vein-density 30—40 per cm.

N. grossinervis Prynada: in Samylina, 1964, Lower Cretaceous of Kolyma Basin: Veins often forking, vein-density 14—19 per cm.

N. macrophylla Jacob and Shukla: Jacob and Shukla, 1955, Middle Jurassic of Northern Afghanistan: Segments more elongated, vein-density about 40 per cm.

N. magnifolia Samylina: Samylina, 1964, '76, Lower Cretaceous of Kolyma Basin and Magadan District: Segments with irregularly serrate distal margin, vein-density 11—16 per cm.

N. saighanensis Seward: Seward, 1912a, Middle Jurassic of Afghanistan: Lamina entire, mostly narrower, veins occasionally forked close to rachis, vein-density about 10 per cm.

N. stenophylla Hsü and Hu: Hsü et al., 1979, Upper Triassic of Southwestern Sichuan, China: Rachis and petiole thick, 7 mm and 1—1.1 cm respectively, segments rectangular, veins occasionally forking, vein-density 18—
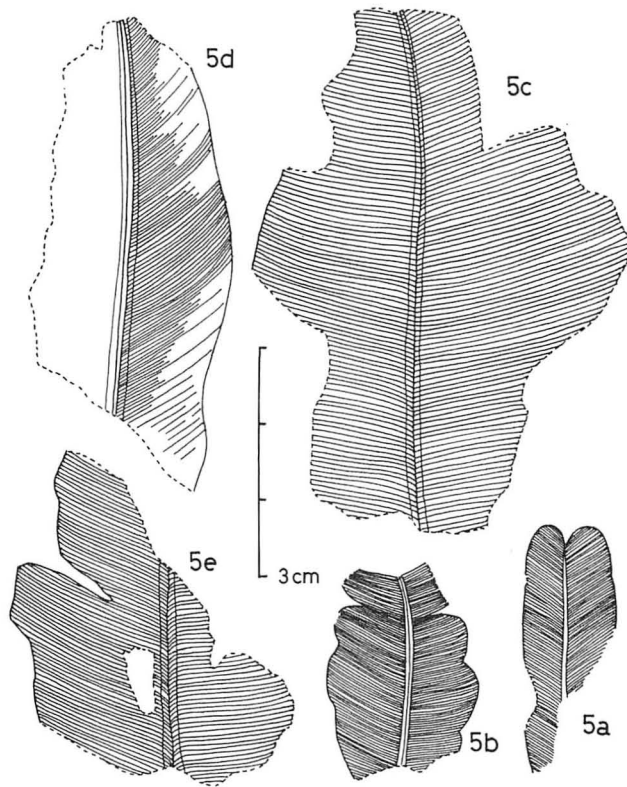
Text-fig. 5 (All natural size).
Nilssonia orientalis Heer: Original specimens redrawn from Heer, 1878, pl. 15, Figs. 5—9 for comparison. Text-figs. 5a-e correspond to his figs. 5—9 respectively.

23 per cm.

N. taeniopteroides Halle: Halle, 1913, Middle Jurassic (?) of Graham Land: Lamina elongated, almost entire, vein-density 15—20 per cm.

N. taeniopteroides Halle var. *bifurcata* Prosvirjakova: Prosvirjakova, 1966, Middle Jurassic of Mangwishlak: Lamina elongated, entire, vein-density 18—20 per cm.

N. thomasi Harris: Harris, 1964, Middle Jurassic of Yorkshire: Lamina with entire or slightly and irregularly incised margins, rachis thick.

Nilssonia sp. A

Pl. 14, Fig. 5; Text-fig. 6

Pterophyllum jaegeri Brongniart: Oishi, 1931, p. 246, pl. 18, fig. 3 (Tsuchizawa); 1940,

p. 343 (pars) (a specimen from Tsuchizawa).

Nilssonia muensteri (Presl) Schimper: Oishi, 1932a, p. 340, pl. 46, fig. 5; pl. 47, figs. 1—2 (Nariwa Group); 1940, p. 304 (remarks).

Material:—NEE-063, 122 (counterpart) (Higashi-Neiridani).

Description:—A single leaf-fragment obtained is more than 8.5 cm long and 4.8 cm wide above and 3.2 cm wide below. The rachis is 3 mm wide. The lamina entirely covers the upper surface of rachis and is dissected into narrow segments. The segments are set more or less remotely and are nearly perpendicular to the rachis, elongate-triangular in form and often slightly falcate. Both acroscopic and basiscopic bases are lightly expanded, then narrowing gradually towards the blunt apex; acroscopic margin is nearly

straight and basiscopic margin curved. The segmentation of lamina is rather regular and the lamina of each segment is not contiguous with adjacent ones at base. Large segments are 2.4 cm long and 0.7 cm wide at base, and smaller ones 1.6 cm long and 0.4 cm wide. The veins are simple, straight, distinct, parallel, ending at the distal margin, numbering 9 in each segment (density 18 per cm near the base). Cuticle is not preserved.

Distribution and *occurrence:—Nilssonia* sp. A is rarely known from the Kuruma and Nariwa Groups.

*Remarks:—*Macroscopically our leaf resembles the following species known from the Jurasso-

Cretaceous plant-beds: *Nilssonia borealis* Samylina (Kolyma Basin), *N. brongniarti* (Mantel) Bronn (Sussex, Northwest Germany and Southern Primorye), *N. kotoi* (Yokoyama) Oishi (Inner Zone of Japan) and *N. sinensis* Yabe and Oishi (Northeast China). But they are distinguished from ours by their more slender habit of segments with weaker veins.

Our leaf is most close to *Nilssonia muensteri* (Presl) Schimper, but so far as our observation of published features of European specimens [e.g. Bartholin, 1894; Möller, 1903 (cfr. *muensteri*); Nathorst, 1909] is concerned, *Nilssonia muensteri* differs from ours in having the segments with more roundish apices and in that in
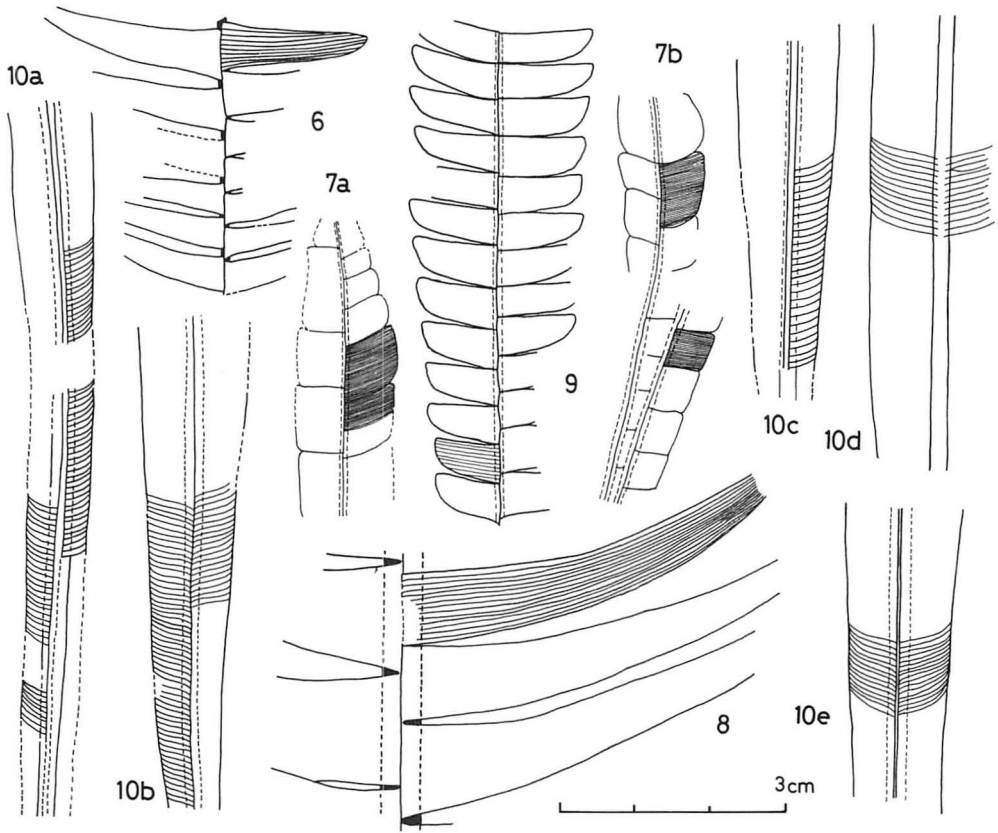
Text-figs. 6—10 (All natural size).
6. *Nilssonia* sp. A: Showing the pinna form and venation (NEE-063, Pl. 14, Fig. 5). 7. *Nilssonia* sp. B: 7a; vein-density is 54 per cm (SHI-028). 7b; vein-density is 48 per cm (SHI-044). 8. *Nilssonia* sp. C: (NEE-010). 9. *Nilssonia* sp. D: Vein-density is 18 per cm (SHI-047). 10. *Nilssonia* sp. E: 10a; (DAI-002). 10b; (Kr-014). 10c; (NEE-042). 10d; (DAI-002). 10e; (NNW-111).

Nathorst's leaves the veins are bending downwards at the proximal end. *Nilssonia* leaves regarded by Oishi (1932a) as *N. muensteri* from the Nariwa Group, are quite similar to ours in all features. Thus it is likely that Oishi's leaves and ours belong to a new species. But we refrain from making it because the specimens from the Kuruma and Nariwa Groups are few and incomplete.

Oishi (1931) described a leaf-fragment as *Pterophyllum jaegeri* from Tsuchizawa. It is now clear that his leaf is referable to our *Nissonia* sp. A, his drawing represents it lower surface.

Macroscopically the following leaves resemble our *Nilssonia* sp. A:

Nilssonia acuminata (Presl) Goeppert: Krassilov and Schorochova, 1973, Lower Jurassic of the Petrovka River (Primorye).

N. cfr. *compta* (Phillips) Bronn: Sze, 1949, Lower Jurassic Xiangxi Formation, Hubei, China.

N. sp. 1: Sze and Lee, 1952 in Sze et al., 1963, Lower Jurassic of Sichuan.

Kawasaki (1925) described *Nilssonia* leaves in palmate occurrence from the Daedong Supergroup, North Korea as *N. pterophylloides* Nathorst and later he (1926, '39) changed its name to *N. muensteri*. This specimen has often been discussed as to its identity (e.g. Yabe and Oishi, 1929; Oishi, 1932a; Harris, 1964). Kawasaki's specimen is similar in form of segments to our *Nilssonia* sp. A, but differs in downward-bending veins at the proximal end.

Nilssonia sp. B

Text-figs. 7a, b

Material: SHI-028, 044 (Shinadani).

Description:—The leaves are small in size. The lamina is probably up to 6 cm long, oblanceolate in outline and 1.3 cm wide at the widest portion. The lamina entirely covers the upper surface of the comparatively thick rachis, 1.5 mm wide below. The lamina is irregularly dissected by the sinuses reaching to the rachis into nearly square or trapezoid segments, nearly perpendicu-

lar to the rachis; the width of segments ranges from 0.3 to 1.2 cm. The veins are very crowded, simple and parallel; the vein-density ranges from 48 to 54 per cm. Leaf apex and petiole are not known and cuticle is not preserved.

Distribution and *occurrence*: —*Nilssonia* sp. B is rare and only known from the Shinadani Formation.

Remarks:—Our leaves are characterized by their small-size, irregularly divided segments and very crowded veins. In size and form they resemble *Nilssonia minor* Harris (1932a) from the Rhaetic of Greenland. But Harris' species is distinguished from ours by its vein-density, about 30 per cm instead of 48—54 in ours.

Occasional leaves of *Nilssonia compta* (Phillips) Bronn, *N. polymorpha* Schenk and *N. schaumburgensis* (Dunker) Nathorst described by various authors, are similar in size and form to our *N.* sp. B, but they are also distinguished by their less crowded veins.

Nilssonia schmidtii (Heer) Seward [Seward, 1912a; Vakhrameev and Doludenko, 1961; Lebedev, 1974 (cfr. *schmidtii*), Kimura and Sekido, 1978] is also distinguished from ours by its segments with roundish distal margin and often with forked veins.

There are several fragmental leaves resembling our *Nilssonia* sp. B macroscopically:

Nilssonia sp. 2: Vassilevskaja and Pavlov, 1963, Lower Cretaceous of Lena Basin.

N. sp.: Tsao, 1965, Upper Triassic of Guangdong, China: (But twice as large as ours.)

N. sp. 2: Genkina, 1966, Middle Jurassic of Issyk-Kul Basin.

N. sp. A: Lebedev, 1974, Lower Cretaceous of West-Priokhotie.

N. ? sp.: He et al., 1979, Upper Triassic of Qinghai, China.

They are too little known for close comparison with our *Nilssonia* sp. B.

Nilssonia sp. C

Text-fig. 8

Cfr. *Nilssonia tenuicaulis* (Phillips) Fox-Strangways: Oishi, 1940, p. 318, pl. 34, fig. 4 (Kuruma).

Material: NEE-010 (Higashi-Neiridani), NNW-752 (Nishi-Neiridani).

Description:—Two broken leaves were obtained. One leaf is possibly represented by the proximal portion with rather thick rachis, 4 mm wide; the lamina-width is estimated at 9.4 cm. The lamina apparently covers the upper surface of rachis and is rather regularly dissected into segments. Segments are at wide angle to the rachis, straight, 5 cm long and 0.9—1.5 cm wide basally, and in contact with adjacent ones, then gradually narrowing to about 0.5 cm near the obtuse apex. Veins are simple, parallel and not converging at apex and 15 per cm at their origin.

Another leaf is possibly represented by the distal portion with thin rachis, 2 mm wide. Its segments are slightly curving upwards. Veins are 25 per cm in density. Cuticle is not preserved.

Distribution and *occurrence:*—*Nilssonia* sp. C is rare and only known from the Negoya Formation.

Remarks:—Although their vein-density differs, we consider our two leaves belong to the same species because of the close similarity of their segments in size and form.

Macroscopically our leaves resemble those of *Nilssonia tenuicaulis* (Phillips) Fox-Strangways described in detail by Harris (1943, '64) from the Middle Jurassic of Yorkshire. But our leaves and a single broken leaf described by Oishi (1940) from Kuruma (Kuruma Group) as Cfr. *Nilssonia tenuicaulis*, are too incomplete to identify them with the Yorkshire species.

In East Asia macroscopically similar leaves to ours were described by the previous authors as follows:

Nilssonia mediana (Leckenby): Seward, 1912b, Lower Cretaceous of Bureja Basin (fragment, the length of segments unknown); Vakhrameev and Doludenko, 1961, Upper Jurassic-Lower Cretaceous of Bureja Basin (rather remotely set segments).

N. tenuicaulis (Phillips) Fox-Strangways: Yabe and Oishi, 1929, Lower-Middle Jurassic of Hebei, China and Upper Triassic (?) of North Korea (Korean leaf quite incomplete).

Pterophyllum ? sp. aff. *Nilssonia tenuicaulis* described by Oishi and Huzioka (1938) from the Nariwa Group is possibly referable to ours, but its mode of attachment of lamina to the rachis is uncertain.

Kawasaki (1926) described a single broken *Nilssonia* (?) leaf as Cfr. *N. tenuicaulis* from the Daedong Supergroup, Korea. His leaf is possibly distinguished from ours by the acuminate apices of its segments.

Nilssonia sp. D

Text-fig. 9

Material: SHI-047 (Shinadani).

Description:—Four leaf-fragments are preserved on a single slab. The leaves are small-sized, probably oblanceolate in outline, more than 8.5 cm long and 2.5 cm wide above and 1.8 cm wide below. The lamina entirely covers the upper surface of a thin rachis (1.5 mm wide) and is rather regularly dissected into segments which are not contiguous one another at their base. The upper segments are rather elongate-rectangular in form, 1.3 cm long and 0.4 cm wide, with rounded apex. The lower segments are short-rectangular in form, 0.9 cm long and 0.5 cm wide at base and with truncated apex. Acroscopic margin is mostly straight but basiscopic margin curved. The veins are simple, parallel, ending at distal margin; the density is 18 per cm (or 9 in number in each segment). Cuticle is not preserved.

Distribution and *occurrence:*—*Nilssonia* sp. D is rare and only known from the Shinadani Formation.

Remarks:—*Nilssonia* sp. D is characterized by its small-sized leaf whose lamina is rather regularly dissected into rectangular segments each with 9 simple veins. *Nilssonia* sp. D is clearly distinguished from *N.* sp. B here described together by the form of segments and the vein-density.

Certain specimens of the following species resemble *Nilssonia* sp. D but differ as mentioned below:

Nilssonia compta (Phillips) Bronn and *N. kendalli* Harris: Harris, 1964, Middle Jurassic of Yorkshire: Laminae and segments polymorphous.

N. incisoserrata Harris: Harris, 1932a, Liassic of Greenland: Leaf larger in size, rachis thick, veins denser (13—15 in each segment).

N. minor Harris: Harris, 1932a, Rhaetic of Greenland: Segments broader.

N. schaumburgensis (Dunker) Nathorst: Various authors from the younger Mesozoic (see Kimura, 1976, p. 202): Laminae and segments polymorphous.

So far as we know, from Japan and her adjacent lands, no species or form referable to *Nilssonia* sp. D has not been known.

Nilssonia sp. E

Pl. 13, Fig. 8; Text-figs. 10a-e

Material: DAI-002, 010, 038, 052, 101 (Dairagawa), NEE-042, 183 (Higashi-Neiridani), NNW-111, 250 (Nishi-Neiridani), Kr-014 (Tsuchizawa).

*Description:—*The lamina is entire and covers the upper surface of thick rachis, and is ribbon-like, very narrow, more than 8.5 cm long and 0.7—1.7 cm wide basally, width gradually increases towards the apical part. Whole leaf is unknown. Veins are mostly simple, rarely forking once at the origin, parallel, mostly bending forwards distally and often bending downwards basally; vein-density is 10—14 per cm. Cuticle is not preserved.

Distribution and *occurrence:—Nilssonia* sp. E is rare and only known from the Kuruma Group.

Remarks:—Nilssonia sp. E is characterized by its entire and slender ribbon-like leaves with coarser veins. The following *Nilssonia* species are similar in form to *N.* sp. E, but are distinguishable as mentioned below:

Nilssonia inouyei Yokoyama: Yokoyama, 1905, Upper Triassic Yamanoi Formation: Lamina narrower, veins denser.

N. nigracollensis Wieland: in Ward, 1905, Lower Cretaceous Dakota Formation: Lamina narrower, vein-density 22 per cm.

N. parvula Fontaine: in Ward, 1905, Jurassic of Oregon: Lamina slender.

N. revoluta Harris: Harris, 1964, Middle Jurassic of Yorkshire: Lamina narrower, with margins curved downwards and revolute.

N. sp.: Stanislavsky, 1971, Upper Triassic of Donbass: Vein-density 18—20 per cm.

Nilssonia simplex originally described by Oishi (1932a) from the Nariwa Group is the closest to ours, but differs in more crowded (23 per cm) and often forked veins.

Unclassified Cycadopsida and *Marattia*-like leaves

Genus *Cycadites* Sternberg, 1825: 32

Cycadites cfr. saladini Zeiller

Pl. 12, Fig. 4

Comparable specimens:
Cycadites saladini Zeiller: Zeiller, 1882, p. 322, pl. 11, figs. 8—9, 10A; 1903, p. 154, pl. 41, figs. 1—4 (Upper Triassic of North Viet-Nam).

Material: NEG-056, 067 (counterpart) (Negoya).

*Description:—*Pl. 12, Fig. 4 shows the only specimen obtained. The leaf is pinnate, with thick rachis (1 cm wide). Pinnae are linear, straight, parallel-sided, set very closely, more than 4.5 cm long and 2 mm wide, slightly expanded at the base, and attached to the lateral sides of rachis at an angle of 70—90 degrees. Midnerve is thick, about 1 mm wide. Margins are usually reflexed. Cuticle is not preserved.

Distribution and *occurrence:—Cycadites* cfr. *saladini* is very rare and only known from the Negoya Formation.

*Remarks:—*Macroscopically our specimen resembles *Cycadites saladini* Zeiller and *C. manchurensis* Oishi. In *Cycadites saladini* its cuticle is not known. The similar looking leaves, *Pseudocycas* and *Paracycas* are mainly distinguished from *Cycadites* by their cuticles.

Cycadites manchurensis was first described by Oishi (1935) together with its cuticle from the Lower Cretaceous Muling Formation (Ju,

R. H. et al., 1981), at Dongning (formerly Tungning), SE-Heilongjian, NE-China. Later Hsü (1954) altered it as *Pseudocycas manchurensis* (Oishi) because of its bennettitalean syndeto-cheilic stomata. *Cycadites saladini* was first described by Zeiller (1882) from the Upper Triassic of Hongay Coal-Field, North Viet-Nam.

In the absence of microscopic details from the cuticle we only tentatively identify our specimen.

Form-genus *Taeniopteris* Brongniart, 1828: 31

Under this form-genus we recognized five forms from the Kuruma Group and Iwamuro Formation.

Taeniopteris gracilis Kimura

Text-figs. 11a-d

Taeniopteris gracilis Kimura: Kimura, 1959a, p. 28, pl. 10, figs. 8—12; pl. 12, fig. 7; text-fig. 15 (Iwamuro).

Material: Lectotype; A-1085 (Iwamuro). Paralectotypes; A-2093, 2095, 2098. Other specimens: A-2087, 2094, 3049, 7532B. *Stratum typicum*: Iwamuro Formation. *Locus typicus*: Iwamuro, Shirasawa-mura, Tone-gun, Gumma Prefecture. *Derivatio nominis*: According to the slender leaves.

Emended diagnosis: Leaves long and narrow, more than 5 cm long and 4—6 mm wide, with short petiole. Lamina nearly parallel-sided for the most part, sometimes width gradually increasing towards the apex, apex obtusely pointed or rounded, base attenuated, margins entire, attached to the upper lateral sides of comparatively thick rachis up to 1.5 mm wide, thus the upper surface of rachis exposed. Lateral veins nearly perpendicular to the rachis, forking twice, the first forking at the middle and the second near the margin, crowded, density about 40 per cm near the margin. (Reproductive organs not known and cuticle not preserved.)

Distribution and *occurrence:—Taeniopteris gracilis* is rare and only known from the Iwamuro Formation.

Discussion and *comparison:*—We here emended the original diagnosis given by Kimura (1959a) mainly in regard to the venation. *Taeniopteris gracilis* is characterized by its small-sized and slender leaves with twice forked lateral veins.

Taeniopteris gracilis resembles the following in its size, but differs as mentioned below:

Taeniopteris daintreei McCoy: Arber, 1917; Medwell, 1954; Douglas, 1969 and many other authors, Older Mesozoic of Australia and New Zealand: Some larger in size (the largest reaching 20 cm long and 2 cm wide), margins occasionally lobed.

T. parvula Heer: Heer, 1876, Jurasso-Cretaceous of the upper Amur: Lateral veins simple.

T. cfr. *parvula* Heer: Hsü, 1954; Sze et al., 1963, Lower-Middle Jurassic of Hubei (Xiangxi Formation), China: Ditto.

T. sp. 1: Sze et al., 1963, Upper Triassic Genkou Formation, near the boundary area between Guangdong and Hunan Provinces, China:

Text-figs. 11—15 (All natural size, unless otherwise indicated).

11. *Taeniopteris gracilis* Kimura: 11a; (A-2093, paralectotype). 11b; (A-2098, paralecto-type). 11c; a thick line shows a median furrow on the upper surface of rachis (A-2095, enlarged twice, paralectotype). 11d; (A-1085, lectotype).

12. *Taeniopteris* cfr. *jourdyi* Zeiller: 12a; (A-0459, Pl. 13, Fig. 9 in part). 12b; vein-density is 23 per cm (NNW-843). 12c; vein-density is 24 per cm (A-0407). 12d; vein-density is 36 per cm (NNW-259).

13. *Taeniopteris* sp. A: 13a; (NE-052). 13b; (A-3029, Pl. 12, Fig. 5 enlarged twice). 13c; vein-density is 16 per cm (NNW-048).

14. *Taeniopteris* sp. D: 14a; vein-density is 60 per cm (NEE-151). 14b; vein-density is 78 per cm (NNW-259).

15. *Taeniopteris* sp. C: Vein-density is 16 per cm (A-3020).
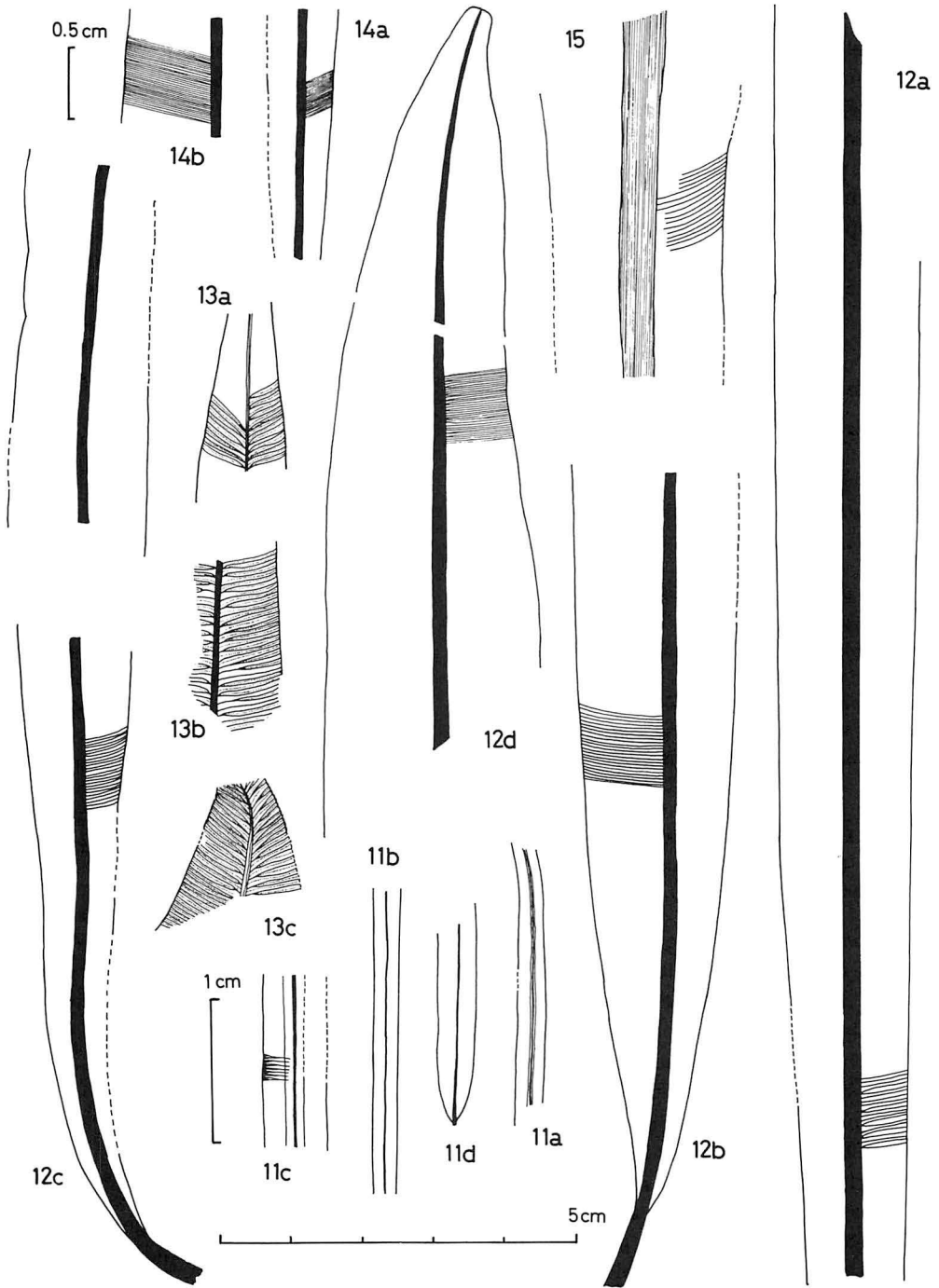
Text-figs. 11—15

Lateral veins set obliquely.

Some small-sized leaves regarded as *Taeniopteris spatulata* McClelland also resemble ours in form and size, but they differ from ours in their laminae often characterized by marked fold or wrinkles as shown by Zeiller (1903). *Taeniopteris stenophylla* originally described by Kryshtofovich from the Upper Triassic Mongugai Group is most close to ours in form, but differs in its obliquely set (about 55 degrees) and coarser (18 per cm) lateral veins.

Taeniopteris cfr. *jourdyi* Zeiller

Pl. 13, Figs. 9—10; Pl. 14, Fig. 6; Text-figs. 12a-d

Comparable specimens:
Macrotaeniopteris jourdyi Zeiller: Zeiller, 1886, p. 459, pl. 25, figs. 1—3 (Hongay Coal-Field).
Taeniopteris jourdyi Zeiller: Zeiller, 1903, p. 66, pl. 10, figs. 1—6; pl. 11, figs. 1—4; pl. 12, figs. 1—4, 6—8; pl. 13, figs. 1—5 (ditto). Zeiller's specimens were later included in *Taeniozamites jourdyi* (Zeiller) by Harris (1932b) and *Nilssoniopteris jourdyi* (Zeiller) by Florin (1933) and Harris (1937).

Material: A-0341 and other 12 specimens (Iwamuro), DAI-070, 110 (Dairagawa), NEE-061 and other 5 (Higashi-Neiridani), NEG-138, 140 (Negoya), Kr-029 (Tsuchizawa).

Description:—The leaves are simple, long and narrow, large-sized and petiolate; petiole is 1.0—1.1 cm long. The lamina is attached to the lateral sides of rachis, attaining 25 cm long or more and 3 cm wide at the widest portion, nearly parallel-sided in the middle region, gradually narrowing towards the pointed or notched apex and wedge-shaped base. The margins are entire or sometimes very shallowly undulated. The rachis is up to 2.5 mm wide, slightly expanded at the base of petiole. The lateral veins are nearly perpendicular to the rachis, parallel, mostly simple but sometimes forking at their origin and often gently bending forwards near the margin, density 20—36 per cm. Reproductive organs are not known and cuticle is not preserved.

Distribution and *occurrence:*—*Taeniopteris* cfr. *jourdyi* is locally abundant in the Negoya and Iwamuro Formations. They are sometimes thickly massed and appressed.

Remarks:—Our leaves are closest in form and size to *Taeniopteris jourdyi* originally described by Zeiller (1886, 1903) from the Upper Triassic of North Viet-Nam. But in our leaves, the veins are less crowded (20—36 per cm) than in Zeiller's *Taeniopteris jourdyi* (35—50 per cm). The base of lamina in ours is usually wedge-shaped but in the original leaves some bases of laminae are markedly rounded. Under these circumstances, we designate our leaves as *Taeniopteris* cfr. *jourdyi.*

The following *Taeniopteris* or *Nilssoniopteris* species are similar in form and size to ours, but they differ as mentioned below:

Nilssoniopteris ajorpokensis (Harris) Florin: Harris, 1932b, '37; Florin, 1933, Rhaetic-Liassic of Greenland: Vein-density 11 per cm.
Taeniopteris inouyei Tateiwa: Tateiwa, 1929; Oishi, 1940, Lower Cretaceous Nagdong Group (or Gyeongsang Group), Korea: Rachis very thick, the base of lamina rounded, vein-density 17 per cm.
T. richthofeni (Schenk) Sze: Schenk, 1883 (including *Oleandrium eurychoron* Schenk); Sze, 1933, Upper Triassic Xujiahe Formation, China: Vein-density 32—36 per cm, leaves not so long as ours.

Some our smaller leaves resemble *Doratophyllum decoratum* originally described with its cuticle by Li, P. J. (1964) from the Xujiahe Formation in form and vein-density (28—34 per cm), but as their cuticles are not preserved full comparison is impossible.

Taeniopteris sp. A

Pl. 12, Fig. 5; Text-figs. 13a-c

Taeniopteris sp. cfr. *T. nabaensis* Oishi: Kimura, 1959a, p. 29, pl. 12, fig. 8; text-fig. 16 (Iwamuro).

Material: A-3029 (Iwamuro), NE-052 (Neiridani), NNW-048 (Nishi-Neiridani).

Description:—Two additional specimens were obtained since 1959. The leaves are all of fragments. Text-fig. 13a and 13c show the apical portion and 13b shows the middle portion of leaf. The leaves are entire, about 1.8 cm wide. The laminae are attached to the lateral sides of rachis. The rachis is rather slender, 1 mm wide, sending off once forked and occasionally simple veins at a wide angle in the middle portion of leaf and at a reduced angle apically. The vein-density is 16 per cm at the margin. Marked *venuli recurrentes* are present as shown Text-figs. 13a-c. Fructification is unknown.

Distribution and *occurrence:*—*Taeniopteris* sp. A is rarely known from the Negoya and Iwamuro Formations.

Remarks:—Judging from the presence of *venuli recurrentes*, our leaves may belong to a Marattiaceous fern, but as we have no synangia we leave it in *Taeniopteris. Taeniopteris* sp. A differs from *Marattia asiatica* (see Kimura and Tsujii, 1980b) in its veins which are mostly forked instead of mostly simple. Kimura (1959a) described specimen A-3029 as having twice forked veins but this was a mistake and is now corrected. The *venuli recurrentes* were taken as true veins. Thus *Taeniopteris nabaensis* which has twice forked veins is well distinguished.

Taeniopteris sp. B

Taeniopteris sp. B: Kimura, 1959a, p. 29, pl. 10, fig. 2; text-fig. 17 (Iwamuro).

Material: A-3025.

Occurrence:—Only a single broken leaf is known from the Iwamuro Formation.

Remarks:—As the specimen is quite imcomplete, we make no further comparison with other leaves.

Taeniopteris sp. C

Text-fig. 15

Taeniopteris sp. C: Kimura, 1959a, p. 30, pl. 10, fig. 3 (Iwamuro).

Material: A-3020, 5025, 5060, 3046 (Iwamuro).

Occurrence:—Rare, only known from the Iwamuro Formation.

Remarks:—*Taeniopteris* sp. C is characterized by the leaves with very thick rachis (0.5 cm wide) and coarse simple lateral veins (about 16 per cm).

The leaves are similar in form and size to those of *Taeniopteris* cfr. *jourdyi* here described together, but among the large number of our collection of *T.* cfr. *jourdyi*, none have such a thick rachis.

Taeniopteris sp. D

Text-figs. 14a-b

Material: NEE-092, 151, 204, 288 (Higashi-Neiridani), NNW-259, 847 (Nishi-Neiridani), A-0486 (Iwamuro).

Description:—The leaves are elongate-oblanceolate in form, more than 13.5 cm long and 2.3 cm wide at the widest portion, but whole shape is uncertain. The lateral veins are at 65—75 degrees to the lateral sides of slender rachis (up to 1.5 mm wide), very crowded, simple or once forked at their origin; the density is 60—78 per cm. Cuticle is not preserved.

Distribution and *occurrence:*—*Taeniopteris* sp. D is rare and only known from the Negoya and Iwamuro Formations.

Remarks:—*Taeniopteris* sp. D is characterized by its elongate-oblanceolate leaf with densely crowded lateral veins. The leaves appear to be similar in form and size to the small-sized leaves of *Taeniopteris* cfr. *jourdyi* here described together, but are distinguished by their very crowded lateral veins. Owing to the scantiness of our material, we make no further comparison with other leaves.

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Explanation of Plate 12

1. *Ctenis kaneharai* Yokoyama: Broken leaf-fragments bearing thick rachises. An arrow shows a pinna base attached to the rachis. Most of pinnae are broken and detached (SHI-154, Text-fig. 1d).

2—3. *Pseudoctenis nipponica* Kimura and Tsujii sp. nov.: 2. Distal portion of a leaf (NEG-011, holotype, Text-fig. 2a). 3. Two distal leaf-fragments, showing the venation (NNW-797, enlarged twice).

4. *Cycadites* cfr. *saladini* Zeiller: A leaf-fragment with thick rachis (NEG-056).

5. *Taeniopteris* sp. A: (A-3029, Text-fig. 13b, enlarged twice).
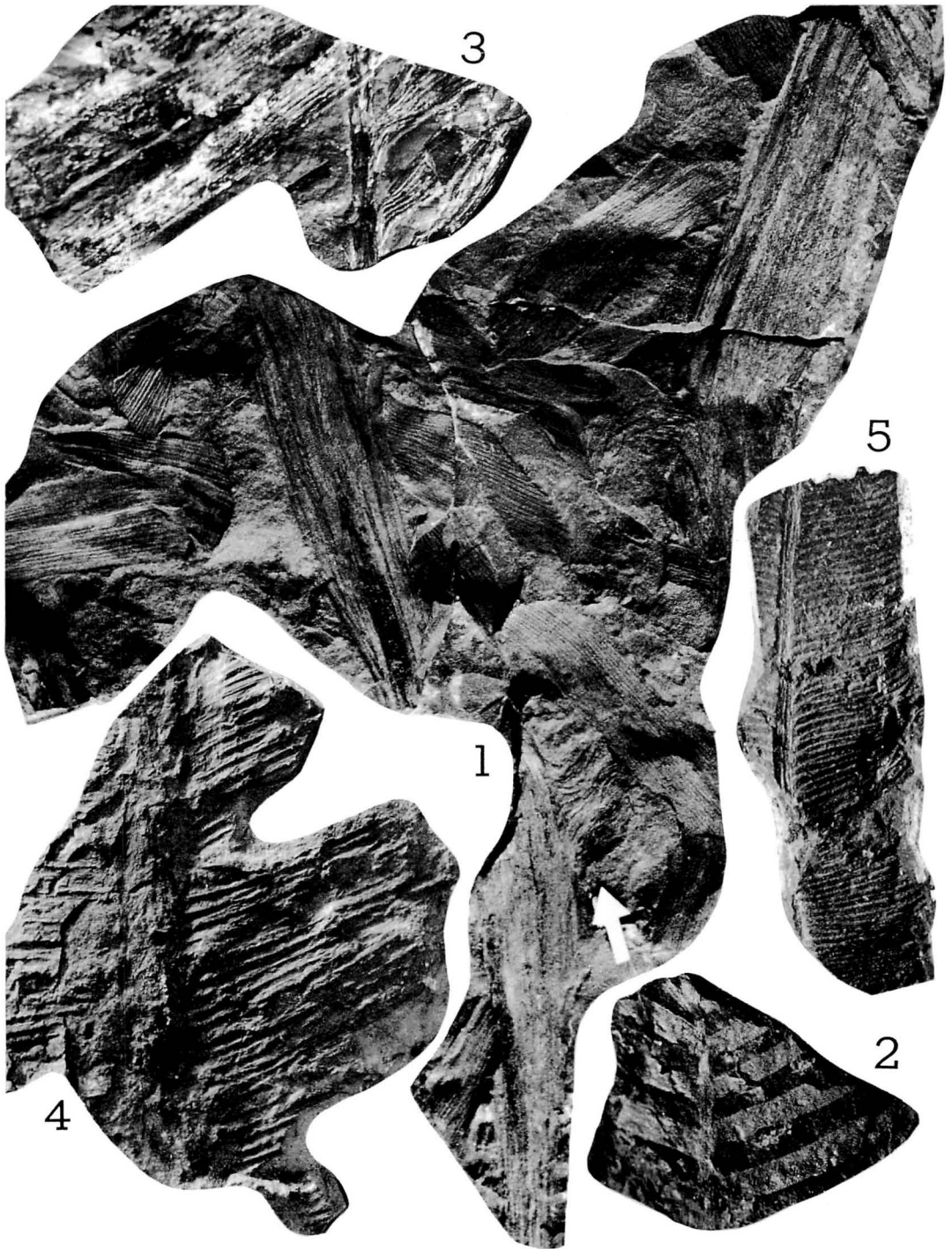
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Explanation of Plate 13

1. *Ctenis kaneharai* Yokoyama: A broken leaf with thick rachis. Arrows show the basal part of pinnae set remotely (SHI-141).

2—4. *Pseudoctenis nipponica* Kimura and Tsujii sp. nov.: 2. Distal portion of a leaf of which pinnae are decurrent (NNW-514, paratype, Text-fig. 2b). 3. Proximal part of a leaf with thick rachis and broader pinnae with contracted bases (A-7307084). 4. Distal portion of a leaf bearing pinnae with decurrent bases (A-7307085, enlarged twice).

5—7. *Nilssonia* cfr. *inouyei* Yokoyama: 5. A detached leaf with transversely wrinkled lamina, both ends are broken and missing (NEE-075). 6. Counterpart of NEE-075. 7. A leaf-fragment, showing the venation (A-035, Text-fig. 3d).

8. *Nilssonia* sp. E: A leaf-fragment with coarser veins (NEE-183).

9—10. *Taeniopteris* cfr. *jourdyi* Zeiller: 9. Long and narrow leaf of which both ends are missing (A-0459). 10. Leaf with short petiole (NNW-843).

Plate 13

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Geographical names in China: Anhui 安徽   Beipiao 北栗   Changliangzi 長梁子   Dongning 東寧   Fangzi 坊亐   Fujian 福建   Genkou 良口   Guangdong 広東   Hebei 河北   Hubei 湖北   Hunan 湖南   Muling 穆稜   Qinghai 青海   Saimaji 寞馬集   Shaan-Gan-Ning 陝甘寧   Shaaxi 陝西   Sichuan 四川   Xiangxi 香渓   Xujiahe 須家河   Zuanshanzi 転山子

Geographical names in Korea: Daedong 大同   Gyeongsang 慶尚   Nagdong 洛東

Explanation of Plate 14

1. *Pseudoctenis nipponica* Kimura and Tsujii sp. nov.: Proximal part of a leaf bearing thick rachis and oval-shaped pinnae (a part of NEG-032, paratype, Text-fig. 2c).
2—4. *Nilssonia japonica* Kimura and Tsujii sp. nov.: 2. A medium-sized full grown leaf of which both ends are missing, in association with two broken leaves (NNW-359). 3. A regularly segmented leaf (NNW-492). 4. A leaf-fragment with notched apex (A-0427).
5. *Nilssonia* sp. A: A leaf-fragment with fairly thick rachis (NEE-063).
6. *Taeniopteris* cfr. *jourdyi* Zeiller: Showing the leaf-apex (A-0342).

Plate 14
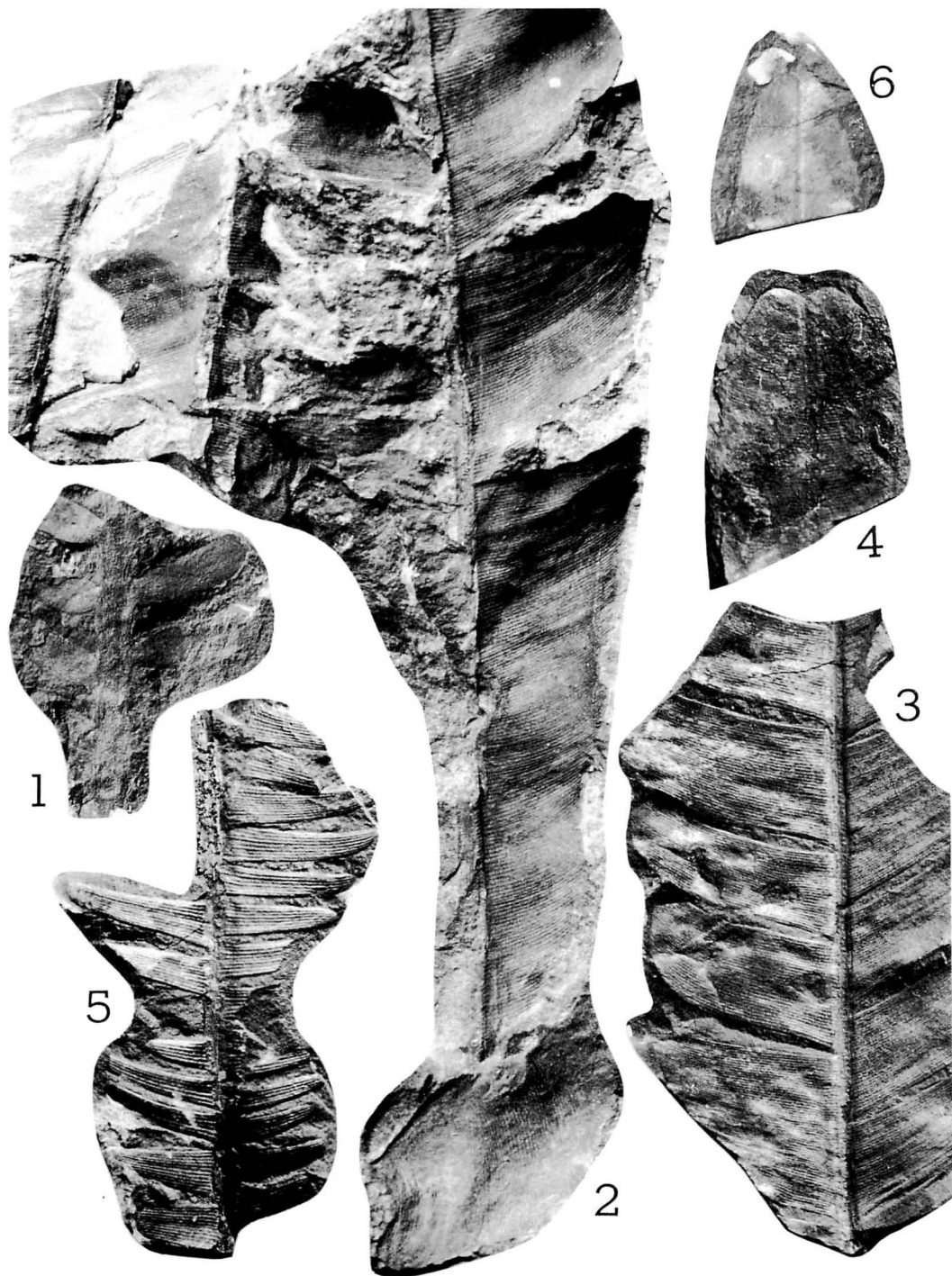
　日本の初期ジュラ紀植物化石。その5：前編につづき，来馬層群および岩室累層から，つぎのソテツ目に属する化石，およびソテツ綱のうち，分類上の位置不明の化石を記載した。

　ソテツ目：*Ctenis kaneharai* Yokoyama, *Pseudoctenis nipponica* Kimura and Tsujii sp. nov., *Nilssonia* cfr. *inouyes* Yokoyama, *N. japonica* Kimura and Tsujii sp. nov., *N.* spp. (A–E)

　ソテツ綱に属する分類上の位置（目）の不明の植物：*Cycadites* cfr. *saladini* Zeiller, *Taeniopteris gracilis* Kimura, *T.* cfr. *jourdyi* Zeiller, *T.* spp. (A–D)

　なお以上のうち *Taenioyteris* sp. A は，りゅうびんたい科（シダ）に属する可能性が強い。

　Nilssonia japonica はかつて *N. orientalis* Heer とされてきたものであるが，きわめて多数の標本から，後者とは完全に区別できることを明らかにした。　　　木村達明・辻井正則

PROCEEDINGS OF THE PALAEONTOLOGICAL
SOCIETY OF JAPAN

日本古生物学会 1983 年会・総会

日本古生物学会年会・総会が 1983 年 1 月 22, 23 日に，東京大学理学部を会場として開催された（参加者 210 名）。

夜 間 小 集 会

ポスターセッション

標 本 展 示

○本誌 No. 128 に編集係のミスによる誤植がありましたので，おわびして訂正します。

Errata

Takemura, Atsushi and Nakaseko, Kojiro (1982): Two new Jurassic genera of family Palaeoscenidiidae (Radiolaria). *Trans. Proc. Palaeont. Soc. Japan*, N.S., No. 128, pp. 452–464, pls. 70–73.

Page	Line	Read	For
452	16	Hilarisirecinae	Hilarisisirecinae
452	17	re-examined	re-examinned
453, 455, 457, 459, 461, 463, Pl. 70-73	head-line	Palaeoscenidiidae	Paleoscenidiidae
456	left 40	reported	described
456	left 43	*quadrangularis*	*quadranqularis*
457	left 43	them	it
458	Explanation of Plate 70	*quadrangularis*	*quadrangulalaris*
458	ditto	stereophotographs	stereographs
460	caption of Text-fig. 5	*rangularis*	*ranqularis*
460	right 17	bar, two	bar two
461	right 13	ridge	ridges
462	left 26	Grasse, P. P. ed.	*Grasse, P. P. ed.*

○1981-82 年度に本誌投稿原稿の校閲者として尽力された諸兄に深謝いたします（御氏名は申合せにより公表いたしません）。

編 集 委 員 会

New members approved by the Council Meeting held on January 21, 1983

Ordinary Members

CHOE, Kae-Lim; FURUOYA, Hiroyuki; FUTAKAMI, Masao; HATTORI, Kouji; ITO, Yoshihiko; KASE, Yasuyuki; KATO, Yoshinori; KIKUCHI, Hiroyuki; KIYOTA, Yasuyuki; KOJIMA, Natsuhiko; KONDO, Yasuo; MIYAUCHI, Toshiya; MORITA, Kozi; MUTO, Asako; NAGANO, Norihiro; NISHIZAWA, Hikaru; NISHIZAWA, Yasuo; OGIHARA, Masaki; ŌHASHI, Toshio; OKAWARA, Hitomi; OWADA, Kiyotaka; SAIKI, Kenichi; SAITO, Hareru; SETOGUCHI, Takeshi; SHIMIZU, Hideto; SUZUKI, Seiichi; TANAKA, Hiroyuki; TAKAHASI, Sizuo; TOHNISHI, Keiji; YAGIOKA, Akemi; YAMAUCHI, Moriyoshi; YANAGISAWA, Yukio; YASUHARA, Naoki

Fellows

HAIKAWA, Takehiko; HASEGAWA, Shiro; HONDA, Yutaka; MINOURA, Kouji; SHIMAZAKI, Togo; SUZUKI, Mitsuo; UEDA, Yoshiro; YAMAGATA, Osamu; YAMANOI, Tohru; YANAGISAWA, Ichiro; YOSHIDA Takashi

行　事　予　定

	開　催　地	開　催　日	講演申込締切
第 131 回例会	宇 都 宮 大 学	1983年 6 月19日	1983年 4 月19日

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

お 知 ら せ

◎「化石」が本会の定期発行の機関誌になりましたので，従来本誌で扱っていた学会記事の一部を「化石」に掲載することになりました。

◎今春から常務委員などの役割分担が一部変更になりました。会務の円滑を期するため，1983-84年度の本会関係の連絡先を用務別に記しておきますのでよろしく御協力下さい。

○会費の払込→お送りしている銀行振込用紙で日本学会事務センター

○会費に関する問合せ→会計係：木村達明（東京学芸大学地学教室）

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

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

○報告紀事への投稿→なるべく書留便で同上に，または編集係：速水　格（東京大学総合研究資料館）〔原稿コピー 1 部と投稿カードを同封または別送して下さい。投稿にあたっては編集出版規約（No. 121）と原稿作成上のお願い（No. 122）を参照して下さい。報告紀事に関する問合せ・投稿カードの請求も上記にお願いします。〕

○本会所蔵の図書閲覧の問合せ→速水　格（同上）〔No. 120 に外国誌の目録と利用案内を掲載してあります。〕

○特別号に関する問合せ・購入申込→特別号編集委員会：首藤次男・柳田寿一（九州大学理学部地質学教室）（三和銀行福岡支店普通預金口座 12172；振替　福岡 19014）〔一部の特別号バックナンバーの郵送によらない直接販売は 東大総合研究資料館（速水　格），国立科学博物館分館（藤山家徳）でも取扱います。〕

○"化石"に関する問合せ・投稿・バックナンバー購入申込→化石編集部：高柳洋吉・石崎国煕（東北大学理学部地質学古生物学教室）（振替　仙台 17141）

○各種の賞に関する問合せ・推薦依頼→賞の委員会幹事：鎮西清高（同上）〔1983年度のみ〕

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