Trans. Proc. Palaeont. Soc. Japan, N.S., No. 80, pp. 371-389, pls. 42, 43, Dec. 20, 1970

572. ON THE ÔMICHIDANI FLORA (UPPER CRETACEOUS), INNER SIDE OF CENTRAL JAPAN*

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

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

I. Introduction

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

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

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

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

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

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

* Received June 8, 1970; read Jan. 25, 1969 at Tôkyô.

manuscripts of this paper.

II. A Geological Sketch of the Ômichidani Area

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

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

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

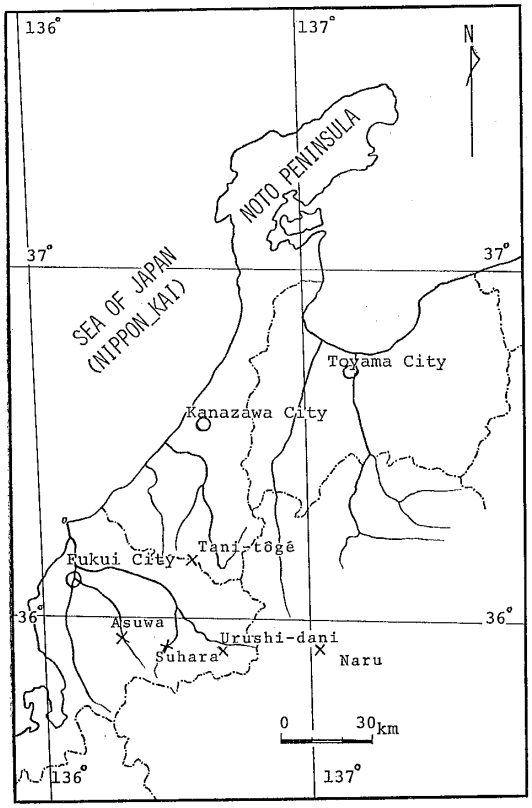


Fig. 1. Situational map of the Tani-tôgé area.

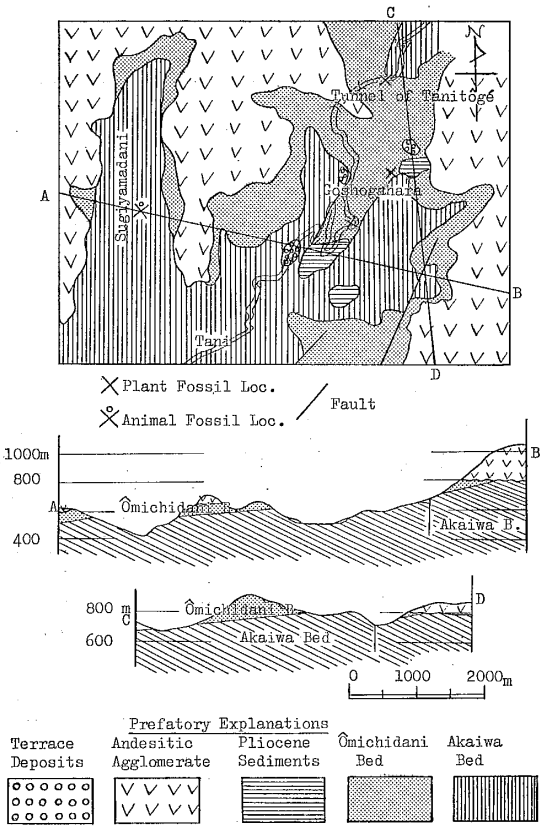


Fig. 2. Geological Map of the Environments of the Tani-tôgé (after H. MATSUO in 1962).

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

In the middle reaches of Takinami-gawa, I, with the aid of some students, have been able to collect shells of *Corbicula*, *Ostrea* and *Viviparus* spp. as well

as a plant *Onychiopsis elongata*. The layer bearing these fossils is contained within the Kuwajima bed of the lower part in the Tedori Group.

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

III. Composition of the Ômichidani Flora

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

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

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

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

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

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

The following is the list of the Ômichidani flora:

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

IV. Palaeoecology of the Ômichidani Flora

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Kuji flora { Kadonosawa phytozone / Uzume phytozone

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

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

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

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

(7) The Kamogata flora, at the Sugitani, outskirts of Kamogata-machi, Okayama Prefecture, Honshû.
(8) The Ikuno flora, in the Ikuno-machi, Hyôgo Prefecture, Honshû.
(9) The Asuwa flora, at Sarao, Ikeda-machi, Fukui Prefecture, Honshû.

Asuwa flora { Suhara phytozone / Sarao phytozone

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

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

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

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

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

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

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

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

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

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

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

VI. Systematic Description of the Ômichidani Flora

Equisetaceae

Equisetum sp.

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

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

Localities: Tani-tôgé and Goshogahara.

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

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

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

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

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

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

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

⊕: Identification by Xylem

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

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

Osmundaceae

Osmunda sp.

Pl. 42, fig. 1

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

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

Locality : Tani-tôgé.

Reg. No.=DGLAKZ-14966a.

Polypodiaceae

Onoclea cfr. *sensibilis* LINNAEUS

Pl. 42, fig. 5

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

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

Locality : Goshogahara.

Reg. No.=DGLAKZ-11205.

Asplenium sp. ?

Pl. 42, fig. 2

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

Locality : Goshogahara.

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

Salviniaceae

Salvinia sp.

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

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

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

Locality : Tani-tôgé.

Reg. No.=DGLAKZ-15963b.

Mesophyta Fern

Cladophlebis sp.

Pl. 42, figs. 3 & 4

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

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

Locality : Goshogahara.

Repository : Tôkyô University.

Nilssoniaceae

Nilssonia asuwensis MATSUO

Pl. 42, figs. 11 & 12

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

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

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

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

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Nilssonia densinerve (FONTAIN) BERRY

Pl. 42, figs. 6 & 7

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

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

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

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

Locality: Goshogahara.

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

Nilssonia serotina HEER

Pl. 42, fig. 8

1925. *Nilssonia serotina* HEER; ENDÔ, Sci. Rep. Tôhoku Imp. Univ., 2nd Ser. Vol. VII, p. 8, pl. VI, figs. 1, 3, 6, 7, 10.

1962. *N. serotina* HEER; MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, No. 1, p. 211, pls. VI, figs. 4, 5a; VII, 2a; IX, 6a, Text-fig. 9d.

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

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Ginkgoaceae

Ginkgoites pseudoadiantoides (HOLLICK) FLORIN

Pl. 42, figs. 9, 10 & 15

1962. *Ginkgoites pseudoadiantoides* (HOLLICK)

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

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

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

Localities: Tani-tôgé and Goshogahara.

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

Repository: Tôkyô University.

Pinaceae

Pseudotsuga mesowilsoniana new species

Pl. 42, fig. 17

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

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

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

Locality: Tani-tôgé.

Holotype=DGLAKZ-14858a.

Pinus mesothunbergii new species

Pl. 42, fig. 13

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

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

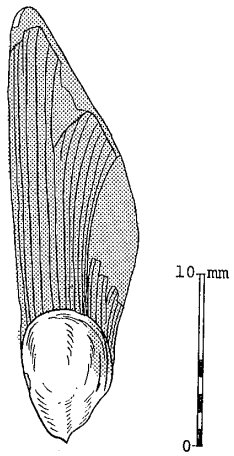


Fig. 3. *Pinus mesothunbergii* new species (seed).

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

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

Locality: Tani-tôgé.

Holotype=DGLAKZ-14856.

Taxodiaceae

Cunninghamia sp.

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

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

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

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

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

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

Locality: Goshogahara.

Reg. Nos.=DGLAKZ-11195 and 11210.

Glyptostrobus sp.

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

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

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

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

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

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

Locality: Tani-tôgé.

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

Sequoia sp.

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

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

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

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

Localities: Tani-tôgé and Goshogahara.

Reg. Nos.=DGLAKZ-10097 and 115557.

Taiwania mesocryptomerioides new species

Pl. 43, figs. 2 & 3

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

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

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

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

ly and spirally arranged.

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

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

Locality: Goshogahara.

Holotype=DGLAKZ-12511a.

Syntype=DGLAKZ-12520.

Cupressaceae

Chamaecyparis sp.

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

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

Locality: Goshogahara.

Reg. Nos.=DGLAKZ-11476a and 11476b.

Hydrocaryaceae

Hemitrapa angulata (BROWN) new combined

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

1960. *Nymphaeites trapelloides* MATSUO, Trans. Proc. Palaeont. Soc. Japan, N.S., No. 40, pp. 329-336, pl. XXXVIII, figs. 1-5 and text-figs. a-d.

1962. *Nymphaeites ? trapelloides* MATSUO, Sci. Rep. Kanazawa Univ., Vol. VIII, no. 1, pp. 230-231, pl. XXIII, figs. 1-7.

1962. *Trapa angulata* (NEWBERRY) BROWN, U.S. Geol. Surv. Prof. Paper 375, pp. 83-84, pl. LVIII, figs. 1-12.

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

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

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

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

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

Localities: Tani-tôgé and Goshogahara.

Holotype=DGLAKZ-10096.

Incertae Sedis

Phyllites sp. A.

Pl. 43, fig. 19

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

Locality: Goshogahara.

Reg. No.=DGLAKZ-14901.

Carpolithes sp. A.

Pl. 43, figs. 15 & 16

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

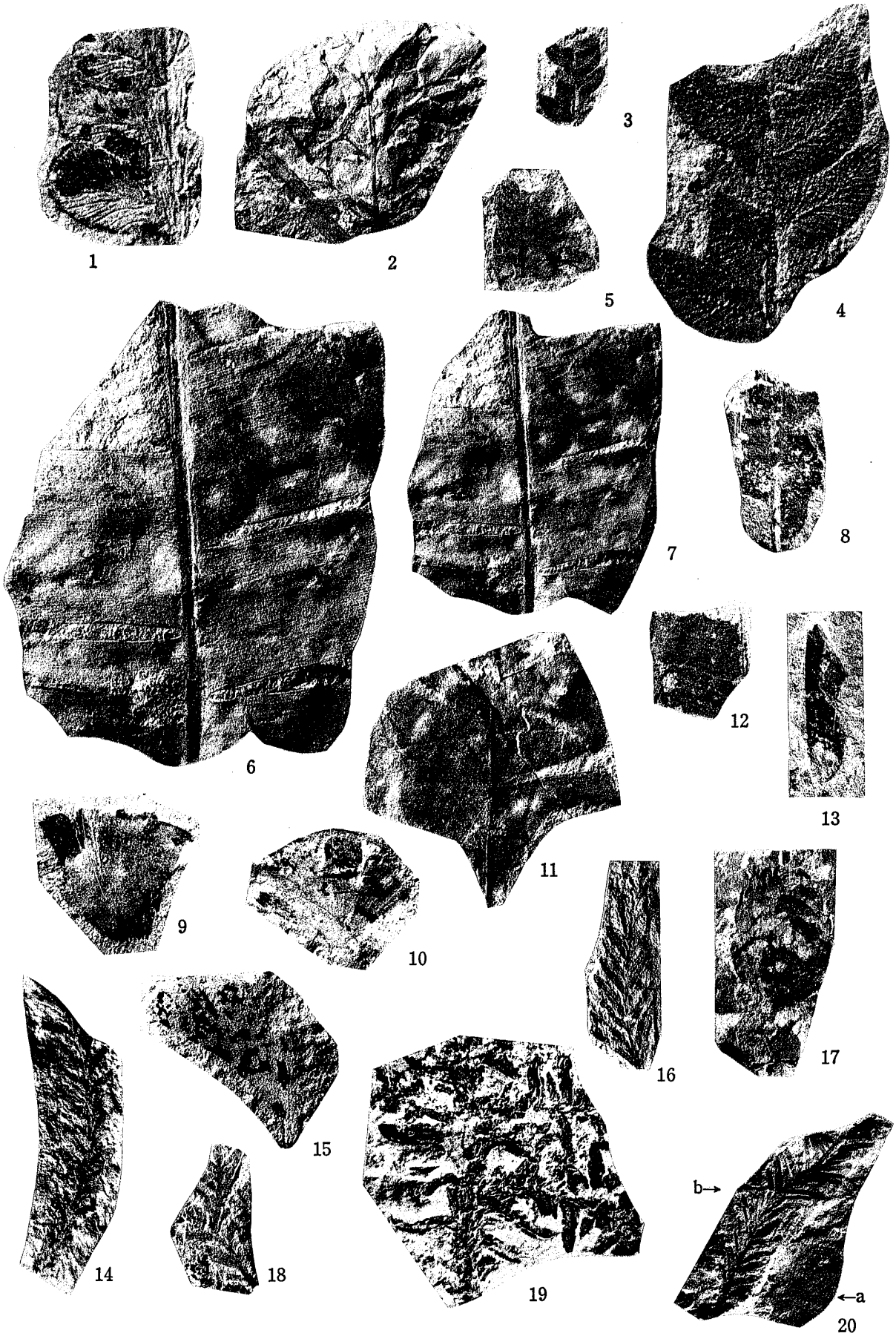
Locality: Tani-tôgé.

Reg. No.=DGLAKZ-14880.

Explanation of Plate 42

(All figures are natural size unless otherwise stated)

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



Carpolithes sp. B.

Pl. 43, fig. 5

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. C.

Pl. 43, figs. 13 & 14

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

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-11503a.

Carpolithes sp. D.

Pl. 43, figs. 20 & 21

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. E.

Pl. 43, fig. 17

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. F.

Pl. 43, fig. 11

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

Locality: Tani-tôgé.

Repository: Tôkyô University.

Carpolithes sp. G.

Pl. 43, figs. 18b

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

Locality: Tani-tôgé.

Reg. No.=DGLAKZ-14860.

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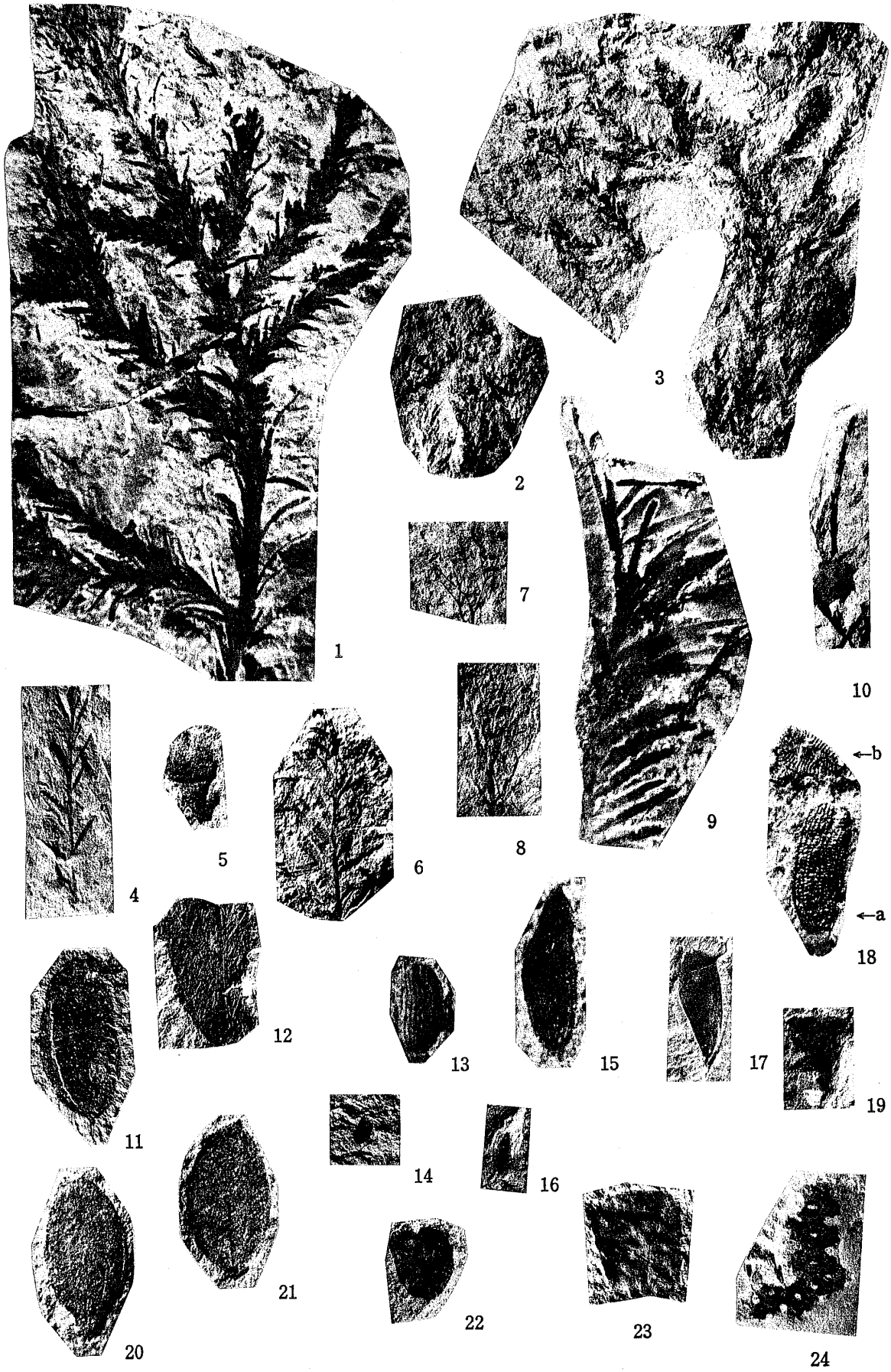
Explanation of Plate 43

(All figures are natural size unless otherwise stated)

Fig. 1. *Cunninghamia* sp.
Figs. 2 and 3. *Taiwania mesocryptomerioides* new species
Figs. 4, 6, 9 and 10. *Glyptostrobus* sp.
Fig. 5. *Carpolithes* sp. B.
Figs. 7 and 8. Incertae sedical matter (aquatic plant)
Fig. 11. *Carpolithes* sp. F.
Fig. 12. Incertae sedical matter.
Fig. 13. Enlarged fig. 14.
Fig. 14. *Carpolithes* sp. C.
Fig. 15. Enlarged fig. 16.
Fig. 16. *Carpolithes* sp. A.
Fig. 17. *Carpolithes* sp. E.
Fig. 18a. Insect ?
Fig. 18b. *Carpolithes* sp. G.
Fig. 19. *Phyllites* sp. A.
Figs. 20 and 21. *Carpolithes* sp. D.
Figs. 22 and 23. *Hemitrapa angulata* (BROWN) new combined.
Fig. 24. Incertae sedical matter.



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Akaiwa	赤岩	Nôhi	濃飛
Asuwa	足羽	Ôarai	大洗
Goshogahara	御所ケ原	Ômichidani	大道谷
Ha'amidani	ハアミ谷	Omodani	面谷
Hakobuchi	函渕	Sarao	皿尾
Ikuno	生野	Shiramine	白峯
Izumi	和泉	Sugiyamadani	杉山谷
Kadonosawa	門ノ沢	Suhara	巣原
Kamogata	鴨方	Suritaki	摺滝
Kariyasu	刈安	Taiwan	台湾
Katsuyama	勝山	Takinami-gawa	滝波川
Kuji	久慈	Tani-tôgé	谷峠
Kumo-gawa	雲川	Tedori-gawa	手取川
Kuwajima	桑島	Urushidani	漆谷
Kuzuryû-gawa	九頭竜川	Uzume	宇津目
Mitsuse	三ツ瀬	Yûbari-gawa	夕張川
Naktong	洛東	Yunnan	雲南
Naru	那留		