# Jurassic Plants from Kaga, Hida, and Echizen.

By

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## 1. General Remarks.

Until recently very little was known of the fossil flora of Japan. The first systematic treatment of it is found in the work [1] of Dr. H. Th. Geyler who, in 1877, described and figured 12 species of Jurassic plants collected by Dr. J. Rein in the valley of the Tetorigawa in Kaga. Three years later the same author in the "Botanischen Mittheilungen" [2] referred to the occurrence of *Carpinus grandis Unger* in the Tertiary formation of Mikawa [3] in Honshū. [4] This was the only literature relating to the fossil flora of our country down to the year 1881, when for the first time, Prof. A. G. Nathorst

1) Dr. H. Th. Geyler:—*Ueber Fossile Pflanzen aus der Juraformation Japans*, with 11 pages and 5 plates. (Palaeontographica, 1876—1877. vol. XXIV, 5th livr.)

Prof. Dr. D. Brauns mentions in his "*Vorläufige Notizen über Vorkommnisse der Juraformation in Japan*" (Mittheilungen der deutschen Gesellschaft für Natur-und Völkerkunde Ostasiens, June, 1880, p. 440—442) the following species of plants based on his examination of Dr. Kotō's collection: *Podozamites, Asplenium argutulum Hr., Thyrsopteris elongata Geyl., Adiantites, Taeniopteris solitaria Phill. sp (=Scolopendriites solitarius Phill.)* and *Ginkgo sibirica Hr.* An examination of the specimens to which these names relate led me to the conviction that Prof. Brauns' *Taeniopteris solitaria* is in reality *Nilssonia ozoana m.*, and as to *Ginkgo sibirica* which is mentioned by him, I was not able to find out any specimen undoubtedly referable to that species.

2) Dr. H. Th. Geyler:—*Carpinus grandis Ung. in der Tertiärformation Japans* (Botanischen Mittheilungen in Abhandlungen der Senkerbergischen Naturforschenden Gesellschaft, 1880.)

3) Mikawa is the name of a province. The exact locality is probably *Komura* in *Nishi-kamogōri*, as no other place is as yet known to yield Tertiary plants in that province.

4) The name *Honshū* applies to the main island of Japan and is certainly preferable to any other of the names that are sometimes used.

of Stockholm published a preliminary communication [5] on more than 70 species of Tertiary plants collected by Prof. Nordenskjold on his visit to Japan during the famous Vega Expedition around the Asiatic continent. This work was soon followed by a more complete one, [6] in which leaves collected by Hilgendorf are also described. The work principally treats of the young Pliocene, or, perhaps, the oldest Quaternary flora of Mogi, a very important group, from which the author was able to draw interesting conclusions as to the origin and climatic relations of our recent flora. In this work he also mentions [7] 12 species of the older Tertiary plants from Ezo (Hokkaido) and Honshū determined by Leo Lesquereux, but which were up to that time yet unpublished.

During the last two years our Geological Survey has sent to Prof. Nathorst a large collection of Tertiary plants for investigation, on a part of which he has already drawn up a brief preliminary report. [8] These were exclusively from Northern and Central Japan. For the most part they belonged to the older Tertiary, corresponding in age to the floras of Sachalin and Alaska. Prof. Nathorst mentions in this paper plants collected by Mr. Petersen at Nagasaki. About these, and the plants last sent chiefly including those of Shikoku and Kyūshū, he will write other memoirs.

By the study of these fossils we shall be enabled to form quite a comprehensive idea regarding the Tertiary flora of Japan; but as to

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5) Dr. A. G. Nathorst:—*Förutskickadt meddelande om Tertiärfloran vid Nangasaki på Japan.* Aftryck ur Geologiska Föreningens i Stockholm Förhandlingar, 1881, No. 68, vol. V, No. 12.

6) Dr. A. G. Nathorst:—*Bidrag till Japans Fossila Flora.* Ur dvega expeditionens Vetenskapliga jakttagelserd. Stockholm 1882, vol. II, 105 pp. w. 16 pl. 8°—Also in a French translation:—*Contribution à la flore fossile du Japon*, 92 pp. w. 16 pl. 8° (Kongl. Svenska Vetenskaps Akademiens Handlinger, 1883, vol. 20, No. 2).

7) *Contribution à la flore fossile du Japon, p.* 5.

8) Dr. A. G. Nathorst:—*Beiträge No.* 2 *zur Tertiärflora Japans, Vorläufige Mittheilung.* (Botan. Centralbl. f. d. Gesammtgeb. d. Botanik d. In-u. Auslandes, vol. XIX, 1884. No. 29. Cassel.)

the Mesozoic flora nothing further has been done[8'] since the publication of the work by Dr. Geyler.

Since Dr. Rein's discovery of Jurassic plants, the valley of the Tetorigawa has been twice visited by geologists. The first visit, a very short one, was made in 1880 by Dr. B. Kotō. On his return he made a brief report[9] accompanied by a sketch map of the river valley and four geological sections. The second and more extensive visit was undertaken my friend Mr. Tadatsugu Kochibe.

In 1883 the Imperial Geological Survey undertook the reconnoissance of various parts of Central Japan, one of which was a region including the provinces of Kaga, Hida, Echizen and Etchū, between the parallels of 35° and 37° N. Lat. The survey was conducted by my friends, Mr. T. Kochibe as geologist and Mr. K. Kōdari as topographer. This survey which lasted three months brought back many interesting fossils, some of which together with those formerly collected by Dr. Kotō, form the subject of the present paper.

As a detailed account of this survey will appear in future reports of the Geological Survey, I need not dwell on this point more than to indicate briefly the general outline of the geographical and geological features of this part of Japan. This is done from data kindly furnished to me by Mr. Kochibe.

First, as to the geography. A mountain chain beginning with Ishidogiyama in Noto runs nearly due south, with the provinces of Kaga and Echizen on one side, and those of Etchū and Hida on the other. This culminates in Hakusan, a group of volcanoes which rise on the boundaries between Kaga, Hida and Echizen. There are three

8') A. Schenk, in *Richthofen's China vol. IV* (p. 263, *pl. LIV. fig.* 1) 1883, described and figured a single specimen of *Thyrsopteris elongata Geyl.* from an unknown locality in Japan.

9) B. Kotō:—*Ishikawa-ken ka Kaga no Kuni Tetorigawa Kinbō Chishitsu Gaisoku.* Published by the Imperial Geological Survey of Japan, 1880, Tōkio.

peaks, viz., the northern or Okunoin 2664 m. high, the southern or Bessan 2376 m. high, and the central or Gozen, which is the highest of all, 2687·5 m.[10] high. These peaks are for the most part of the year covered with snow, to which fact the origin of the name Hakusan or 'white mountains' is probably due. From this part a range branches off to the west, forming the boundary between Kaga and Echizen, and a little further south, another branch runs in the opposite direction, crossing the boundary between Hida and Mino. For some distance the central range trends southward; then turns to the west and then again to the south. Here it blends with the chain of Ibuki in Omi. The range in Kaga quickly decreases in height as it extends westward, ending in a broad belt of plain running parallel with the coast of that province.

The Hakusan group, occupying the highest part in the whole chain and soaring between the three provinces above named, gives rise to numerous watercourses which feed the Tetorigawa in Kaga, the Kuzuryūgawa in Echizen and the Shirakawa in Hida, all of which empty themselves into the Japan Sea.

The *Tetorigawa* has two sources. A stream that springs in Okunoin called Ozōgawa flows northward and joins with the Hakusangawa coming from Bessan at Kinameri. The river then runs northward through a narrow valley down to Tsuruki, a little below which it trends to the west, and flowing through a wide alluvial flat finally enters the sea at Yoshikawa, after a course of 20 ri (78 kilom.)

The *Kuzuryūgawa* is fed by three principal streams. One of these, the Ishidoshirogawa, has its source in Bessan and flows southwest from that mountain to Asahi, where it joins with the other two coming from the boundary of Mino. The river then pursues a north-

10) This is the mean of two barometric measurements by Messrs. Kochibe and Kōdari. These measurements may be considered more accurate than those published hitherto.

westerly direction, and constantly fed by mountain torrents on its way, unites with the Managawa near the town of Ōno. After this confluence the river is called the Asuwagawa, and after its junction at Kumaru, with the Hinogawa, a large river coming from the south, empties itself into the sea at the port of Sakai. The total course of the river is about 32 ri (125 kilom.), for $^1/_3$ of which it goes through a plain.

The *Shirakawa* of Hida has two sources. One stream, rising in Bessan, flows easterly until it joins the Shōgawa at Okami. Here the river takes the name of Shirakawa and rushes almost due north through deep ravines for 18 ri (72 kilom.) to the boundary of Etchiu, through which province, under the name of the Imizugawa, it runs for 40 ri (157 kilom.), till it enters the Bay of Toyama at the port of Fushiki after a total course of more than 58 ri (230 kilom.).

Secondly as regards the geology, I shall here enumerate the rocks and formations as observed by Mr. Kochibe.

Among the sedimentary rocks we find

1. Crystalline Schists, mainly mica-schist and chlorite-schist, but also serpentine and crystalline limestone, taking only a subordinate part in the formation of the mountain system, and occasionally out-cropping from beneath the younger rocks, e. g., in the valleys of the Tetorigawa, the Shirakawa, and also the Ishidoshiragawa.

2. Sandstones, Clay-slates and Limestones, barren of fossils, but probably referable to the younger part of the Palaeozoic Group. These rocks are exposed only in the southern part of the chain near Mino.

3. Mesozoic Group, consisting of sandstones, shales and conglomerates of the *Jurassic Period*, and occupying a great part

of the system near Hakusan. Very rich in fossils.

4. Tertiary System, consisting of tuffs and sands, and composing lower mountains and hills on the western flank of the chain. A part of these tuff layers contains fruits of *Trapa borealis Hr.*,[11] and a part, leaves which are probably Pliocene.[12] The sands are probably younger than the harder tuffs. They are very rich in young marine shells[13] offering many identical species with those of the environs of Tokyo.[14]

5. Quaternary System, covering the plains along the coast of Kaga and Echizen which, in the former, consists of heavy clayey loam.[15]

The eruptive rocks may be described under four groups.

1. Granites, mainly found in Hida, also in patches in Kaga and Echizen. Their exact age is yet unknown, but evidently they are the oldest of all the eruptive rocks, as they are traversed by dykes of porphyries and porphyrites.

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11) Dr. A. G. Nathorst:—*Beiträge No. 2 zur Tertiärflora Japans (Vorläufige Mittheilung)*, p, 5.

12) Idem. p, 7. The exact fossil locality is *Ushigatani* from which place Dr. Nathorst mentions *Fagus japonicus Max. fossilis Nath., Polygonum cuspidatum Sieb. et Zucc. fossile Nath., and Phyllites sp.*

13) These fossils I found to belong to the genera, *Turritella, Odostomia, Ringicula, Pleurotoma, Clavatula, Terebra, Chemnitzia, Rissoa, Eburna, Murex, Skenea, Trophon, Cancellaria, Globulus, Trochus, Valvata, Bulla, Adeorbis, Natica, Dentalium, Pecten, Ostrea, Anomia, Pectunculus, Limopsis, Nucula, Nuculana, Arca, Saxidomus, Cytherea, Mactra, Diplodonta, Lucina, Tellina, Cardita, Cardium, Lasaea, Leda, Ungulina* and *Venus*. Many of these are identical with those described by Prof. Brauns, the chief of which are *Turritella communis, Pleurotoma tigrina, Ringicula arctata, Terebra bipartita, Eburna japonica, Globulus superbus, G. monilifer, Dentalium entale, Pecten plica, P. laqueatus, P. yessoensis, Pectunculus glycimeris, Nucula Cobboldiae, Diplodonta trigonula, Lucina borealis, Saxidomus purpuratus, Cardium Californiense, Laevicardium bullatum, Lasaea rubra, Leda confusa, Cytherea meretrix* and *Ostrea gigas*, to which are to be added *Dentalium costatum Sow., Nuculana ovalis Wood, Tellina venulosa Schrenk, Arca Kraussi Phill., Cardita scalaris Sow.* and *Lucina crenulata Wood*. Besides these there are many species yet undetermined, but decidedly identical with those occurring near Tokyo, among which there may be also forms which are entirely new.

14) Dr. David Brauns.—*Geology of the Environs of Tokio*. Memoirs of the Science Department, Tokio Daigaku, No. 4, Tokio, 1881.

15) B. Kotō:—*Tetorigawa Kinbō Chishitsu Gaisoku*, p. 19.

2. Porphyries and Porphyrites, forming a considerable part of the mountain chain in Hida and Kaga. One of these (hornblende-porphyrite) also occurs as dykes in the Jurassic rocks, which must therefore be older.

3. Andesites, very extensive and covering the Jurassic system. The Hakusan group is made up of these rocks with which the Tertiary tuffs above mentioned may be contemporaneous.

4. Modern Lavas, covering the top of Gozen, and also found in valleys beneath in the form of loose pebbles.

The *Jurassic System*, whose vegetable remains are the sole object of the present monograph, extends over the provinces of Kaga, Hida and Echizen, between 36° 20′ and 35° 50′ N. Lat., approximately forming a rhombic outline, with one diagonal pointing north and south, and with its sides varying in length from 9 to 10 ri (35—40 kilom.). The general strike of the strata is N.E. with dip to N.W., in most cases very gentle (10°—15°), but sometimes as much as 70°. It is as above stated covered with andesites which form a belt over the system crossing it from N.E. to S.W., and also characteristically pierced with dykes of hornblende-porphyry, which Mr. Kochibe observed in several places. The system has also been observed near Kurouchi in Hida, forming a small basin in itself.

The fossils obtained from the system are very numerous. They belong to Ostracoda,[16] Mollusca,[17] and plants; the first represented by the genus *Estheria*, and the second, with the exception of a few badly preserved Ammonites, by the genera *Cyrena*, *Corbicula*, *Melania (?)*, *Placuna*, *Ostrea*, *Solen* and *Natica*. The first three with many species are abundantly represented by individuals, some of which are

16) Ostracoda are found at Tanimura in Echizen, Okamigo in Hida and Ichinose in Kaga.

17) Mollusca are found at Kurouchi and Ushimaru in Hida, Kinomeri, Yanagidani, Ichinose and Chūgū in Kaga, and Nochino and Kaizara in Echizen.

of very large size. The last four are scantily represented both as regards species and individuals, thus showing that the system is in great measure of freshwater or brackish origin. But that it is not wholly so is shown by the occurrence of the Ammonites discovered by Mr. Kochibe in a dark clayey shale of Shimoyama in Echizen. These animal remains are tolerably plentiful in species, and therefore require a separate treatment. It may be here stated that the shell-layer always occurs below the plant-bed as observed at Ushimaru.

The plant remains are considerably more numerous than those of the mollusca, offering at least a decidedly greater number of species than the latter. They were obtained in several places, which will now be described along with their geological features.

(1.) *Shimamura* (Prov. Kaga), situated on the upper part of the Tetorigawa (the Hakusangawa), about 15 ri (59 kilom.) up the river and 5 ri (20 kilom.) N.W. of Gozen, and 413 m. above the sea-level. Here the fossils occur in yellowish-grey sandstone, sometimes argillaceous and dark-coloured, sometimes reddish and then highly micaceous. They are generally very well preserved. Together with these plants I obtained a single specimen of a Bivalve, which however is too imperfect for correct determination. It may be referable to one of the *Unionidae*.

(2.) *Yanagidani* (Prov. Kaga), situated up the Hakusangawa from Shimamura. Fossils occur in loose pebbles in the river-valley. Mr. Kochibe observed occasionally pebbles containing shells and plants between Ushikubi (about 1 ri above Shimamura and 489 m. above the sea) and Ichinose (about 3 ri above Ushikubi and 814 m. above the sea). The plants are found in grey shaly sandstone. They may be considered only as a portion of the Shimamura flora as the fossils themselves show.

(3.) *Ozō* (Prov. Kaga) on the Ozōgawa, a branch of the Tetorigawa, about 3 ri (12 kilom.) in direct distance N.E. of Shimamura, and 370 m. above the sea-level. Here the fossils are found mainly in black carbonaceous, partly micaceous, sandy shale, from which the plants, which are also black, can hardly be distinguished, unless by their more shining colour; and partly in highly micaceous dark sandstone, which may be considered as differing from the shale in having less clay admixed.

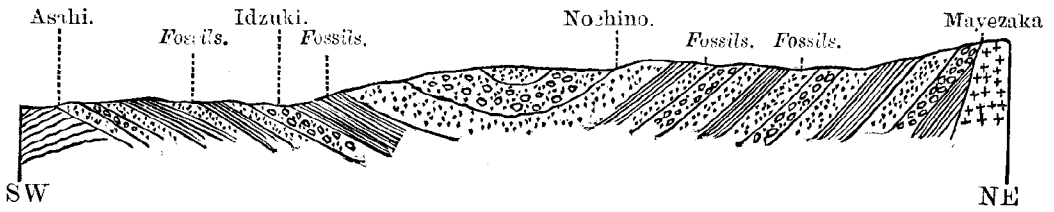
At Setomura, a village lying between this place and Kinameri, Mr. Kochibe observed the following series of rocks:

a. *Siliceous Sandstone*, grey and medium-grained, underlayed by

b. *Marly Conglomerate*. The pebbles composing this rock are partly of limestone, which is often dissolved out, leaving cavities. The solution penetrates amongst the combining medium, making the rock harder and harder.

c. *Black Shale*, which is the lowest, probably corresponding to the fossil bearing rock of Ozō.

(4.) *Hakogase* (Prov. Echizen), situated in the upper valley of the Kudzuriugawa, very near the boundary of Mino, and about 10 ri (39 kilom.) S.E. of the town of Ōno. The strata are somewhat irregular, but generally strike N.W. with dip, varying from a very gentle one to up to 70° at Mochiana. The following is a section along the Ishidoshirogawa from Maezaka (529 m.) to Asahi (430 m.), a distance of 2 ri (7.8 kilom.)




Siliceous Sandstone, medium-grained, firm, with fossil shells.


Siliceous Conglomerate, firm.


Clay and Sandy Shale, with fossil shells.


Crystalline Schists.


Porphyry.

} Jurassic.

The plant-fossils occur in yellowish to dark-grey shaly sandstone or sandy shale, and are excellently preserved. They were collected, not in place shown in the section, but very near the village of Hakogase, which is about 2 ri (8 kilom.) S.E. of Asahi.

(5.) *Tanimura* (Prov. Echizen), lying on a road between the town of Katsuyama in Echizen and Ushikubi on the Tetorigawa. It is 6 ri (23 kilom.) south of Shimamura and 293 m. above the sea. Here the system consists of

a. *Sandstone*, argillaceous, dark and also highly micaceous, with nodules of clay-iron-stone, and filled with Ostracoda; often with intercalating layers of black carbonaceous shale with fossil-stems, and of seams of coal. This is the plant-bed of the place, underlayed by

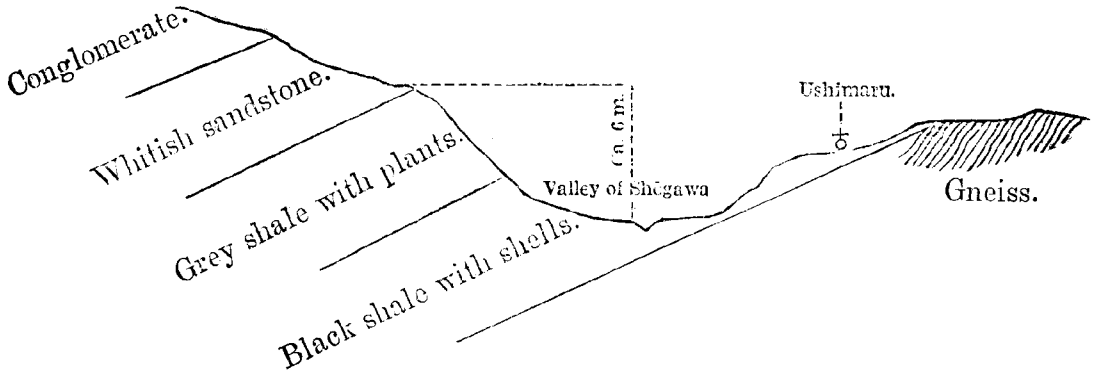
b. *Sandstone and Conglomerate*, the former of a whitish colour and with indistinct prints of plants.

This system at Ushigatani is directly overlaid by nearly horizontal strata of Tertiary tuff to which an allusion has already been made. (See page 6).

(6.) *Okamigō* (Prov. Hida), situated on the Shirakawa, about 1000 m. above the sea, and 5 ri (20 kilom.) east of Hakusan. Here the fossil-bearing rock is dark highly sandy slate, often splitting into thin plates. The fossils are for the most part splendidly preserved.

(7.) *Ushigatani* (Prov. Hida), also on the Shirakawa, about 5 ri

(20 kilom.) S.E. of the preceding place, and 780 m. above the sea-level. Mr. Kochibe observed the following section, with strata striking N.W. and




dipping 15° S.W. Here the plant-beds evidently overlie the shell-layer. The fossils are brown-coloured, imbedded in gray shale, which, when weathered, also becomes brownish, so that in this case they are not easily distinguished. Sometimes the shale is somewhat arenaceous and greyish-green in colour.

The species of fossil plants which I have been able to obtain from the above seven localities number in all 45, to which are to be added four others already described by Dr. Geyler, [18] viz., *Pecopteris Saportana Hr.*, *Zamites parvifolius Geyl.*, *Cycadeospermum japonicum Geyl.* and *Ginkgo sibirica Hr.* [19] This makes the total number 49 which way be classified and distributed as follows :

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18) Dr. Geyler also mentions *Adiantites amurensis Hr.*, *Pecopteris exiliformis Geyl.*, and *Podozamites ensiformis Hr.* The first I consider as doubtful, as the pinnules of his specimens show pointed instead of rounded apices. The second I believe to be identical with *Pecopteris exilis Phill.*, and the third to be the leaflets of *Podozamites lanceolatus genuinus Hr.*

19) These four species will be considered together with those of Shimamura in the tables, as Rein's descriptions of the fossil locality seem to point to that place.

| | Total. | Shima-mura. | Yanagi-dani. | Ozō. | Hako-gase. | Tani-mura. | Oka-migō. | Ushi-maru. |
|---|---|---|---|---|---|---|---|---|
| Filices ..... | 19 | 14 | 1 | 5 | 6 | 2 | 4 | 1 |
| Rhizocarpeae | 1 | — | — | 1 | — | — | — | — |
| Equisetaceae. | 2 | — | — | — | — | — | 1 | 1 |
| Cycadeaceae.. | 15 | 10 | 1 | 4 | 2 | 3 | 5 | 2 |
| Coniferae ... | 10 | 6 | 1 | 2 | 1 | 1 | 4 | — |
| Dubia ..... | 2 | 1 | — | 2 | — | — | — | — |
| | 49 | 31 | 3 | 14 | 9 | 6 | 14 | 4 |

The next table shows the number of species which each locality has in common with others.

| | Total No. of Spec. found. | Number of Species Common with | | | | | | | Total No. of Spec. found in other loc. |
|---|---|---|---|---|---|---|---|---|---|
| | | Shima-mura. | Yana-gidani. | Ozō. | Hako-gase. | Tani-mura. | Oka-migō. | Ushi-maru. | |
| Shimamura ..... | 31 | — | 3 | 6 | 4 | 6 | 8 | 1 | 14 |
| Yanagidani ..... | 3 | 3 | — | 2 | 1 | 2 | 3 | 0 | 3 |
| Ozō ..... | 14 | 6 | 2 | — | 3 | 2 | 5 | 2 | 9 |
| Hakogase ..... | 9 | 4 | 1 | 3 | — | 2 | 3 | 1 | 4 |
| Tanimura ..... | 6 | 6 | 2 | 2 | 2 | — | 3 | 0 | 6 |
| Okamigō ..... | 14 | 8 | 3 | 5 | 3 | 3 | — | 0 | 10 |
| Ushimaru ..... | 4 | 1 | 0 | 2 | 1 | 0 | 0 | — | 3 |

Shimamura has given the greatest number of species, of which 45 % are identical with those of other localities. Yanagidani with 3 and Tanimura with 6 species are only parts of the Shimamura flora, as all their species are included in those of the latter. Ozō, with 14 species and 9 in common with others, and Hakogase, with 9 species and 4 in common with others, may safely be considered as contemporaneous with Shimamura. The same is the case with Okamigō, whose species number a little less than one half those of

Shimamura. Okamigō has 8 species in common with Shimamura and 3 with Ozō and Hakogase. Ushimaru up to this time has given only 4 well determinable species, of which 2 are also found in Ozō, so it is probably referable to the same geological horizon as the latter.

Thus we see that the floras of the seven localities of Kaga, Hida and Echizen are so closely related to one another, that they may be considered as forming one great flora that has flourished during the Jurassic period in Central Japan. In giving a general survey of this flora, we have at least five orders of plants to distinguish, viz.,

1. Filices. Represented by at least 8 genera and 19 species, 14 of which are Polypodiaceae. All of them except one belong to the well known Jurassic genera *Dicksonia*, *Thyrsopteris*, *Asplenium*, and *Adiantites*, the first with 4 species and the rest each with 3 species. The most interesting species of the first genus is *Dicksonia nephrocarpa*, first found in England, and afterwards in Siberia. The species has been founded on a fertile frond of a fern which strongly resembles that of the recent *Dicksonia culcita L'Herit*. To this are to be added three other Siberian forms, *D. acutiloba*, *D. gracilis* and *D. cfr. Glehniana*. *Thyrsopteris* is at least represented by two already known species, *Th. Murrayana* and *Th. prisca;* the former originally described from Yorkshire, the latter from Kamenka, but both found in Siberia. Very interesting is the discovery of *Aspleniums* which all belong to forms already described. Foremost of these is *A. Whitbiense*, which is *the* fossil of the Jurassic period. No less important are the two others, namely, *A. argutulum* and *A. distans*, both of which are European as well as Asiatic. *Adiantites* are all new; one of them—*A. Heerianus*—showing a fructification like that of *A. capillus-veneris L.* of recent times. The most interesting, however, of all the Polypodiaceae is *Onychiopsis elongata*, a new form of fern with elongated sori strongly suggestive of the recent genera of *Onychium* and *Crypto-*

*gramme*. It is moreover a very important fossil, occuring, as it does, in all the fossil localities—except at Ushimaru where indeed very few species have been found—especially at Shimamura, Okamigō and Tanimura, where it is the most abundant of all. The other genera of this order are *Pecopteris*, *Sphenopteris* and *Macrotaeniopteris*. The first is represented by two important species, *Pecopteris exilis* and *P. Saportana*, both of which have been found in Spitzbergen; the former being originally described from Yorkshire. *Sphenopteris* and *Macrotaeniopteris* are each represented by a single species, the latter probably identical with the Chinese form *M. Richthofeni*.

2. Rhizocarpeae. Represented by a single species of *Sagenopteris* resembling very much *Sagenopteris rhoifolia Presl* of the Rhaetic and Liassic of Europe.

3. Equisetaceae. Only two species of the genus *Equisetum* which are so far imperfect; one of them however with tubers preserved recalling those of recent species.

4. Cycadeaceae. These are nearly quite as numerous as the ferns. They belong chiefly to the family *Zamieae*, the foremost of which is *Zamites parvifolius*, so far a strictly Japanese species. The genus with the greatest number of individuals is *Podozamites*, represented by at least 3 species. Of these *P. lanceolatus* with 6 varieties occurs plentifully at Shimamura and Okamigō. It is very important, as it may be called almost cosmopolitan, being found in nearly all the countries where Jurassic flora flourished. Another species of *Podozamites*, viz., *Podozamites tenuistriatus*, may be considered as a veay close ally of *P. lanceolatus*, being quite like the latter in form, only with finer veins. Very remarkable are the leaflets of *P. Reinii* which are as numerous as those of *P. lanceolatus*. On the one hand it exhibits nearly rounded leaflets, and on the other, very elongated ones, thus affording passages to that cosmopolitan species through its variety

*ovalis*. The genus *Nilssonia* is represented by at least 3 species; one of which, *N. orientalis*, is found both in England and Siberia. It characterizes the flora of Hakogase. The two others are new, one of them *N. nipponensis* being closely akin to *N. acuminata Schenk* of the Rhaetic of Europe. *Anomozamites*, the brother genus of the preceding, is so far very doubtfully represented. Very interesting is the occurrence of a species of *Dioonites* closely related to *D. Brongniarti* of the Wealden. But the most interesting of all is *Dictyozamites indicus Fstm.*, a genus and species hitherto restricted to the Rajmahal flora of India. It is found great abundance at Ozō. Allied ot the preceding, but with coarser veins and nets, is *Dictyozamites grossinervis*, a new species, found at Shimamura. The family of *Cycadeae* is known so far by a seed described by Dr. Geyler under the name of *Cycadeospermum japonicum*, which is the largest known from this order.

5. Coniferae. Represented by 6 genera and 10 species, of which 4 genera with 7 species are *Taxaceae*, and the rest, *Abietaceae*. Of the first family the new genus of *Ginkgodium* is the most abundant in individuals. It is closely allied to *Ginkgo*, but decidedly distinguishable by its numerous, simple, parallel veins and its short petiole. So far only a single species has been discovered forming however, a characteristic feature in the flora of Shimamura. The next important genus is the *Ginkgo* itself. Though much less numerous in individuals, it has yielded 3 species, all belonging to forms already described. The most important of these is *Ginkgo digitata* which has been found in Yorkshire, Spitzbergen and Siberia. In the general form of the leaves this species approximates very closely to our living *G. biloba*, however with rarer veins. *G. sibirica* and *G. cfr. lepida*, with the lamina separated into many narrow lobes, are closely allied to each other. So far, they are strictly Asiatic. Then

comes *Czekanowskia*, which, though imperfect, seems to be referable to an already known form. The two species of *Taxites*, being present only in isolated leaflets, do not admit of strict specific determination. Much less numerous are the *Abietaceae*, represented by 2 genera and 3 species. The most interesting as well as the most important of these is *Pinus Nordenskjoldi* which Prof. Schmalhausen brings under his new genus *Cyclopitys* founded on similar leaves found in Siberia which are arranged in whorls around the stem as in our recent *Sciadopitys*. The species occurs in Japan only in isolated leaves, for which I reason have adopted the older generic denomination of Heer. It occurs also in Siberia, Russia and Spitzbergen, and perhaps also in Andö in Norway and Nancy in France. *Pinus cfr. prodromus*, obtained so far only in fragments in Japan, has already been found in Spitzbergen and Siberia. The last is the very interesting genus *Palissya*. It is decidedly Rhaetic in Europe, and as a Jurassic plant has hitherto been confined to India—to the three groups of Rajmahal, Kach and Jabalpur. Its discovery in Japan, a country intermediate in climatic conditions between Siberia where the genus is unknown and India where it is known, is of high interest, imperfect though the specimen itself is.

## Conclusion.

Out of the 36 well determined species of plants which Japan has afforded, 20 species have been identified with those already known in other countries. Of these 16 or 80 % are found in the 'Brown Jura' [20] of Siberia; viz.,

1. *Thyrsopteris Murrayana Brgt.*
2. ,, *prisca Eichw.*

20) Dr. Oswald Heer:—*Beiträge zur Juraflora Ostsibiriens und des Amurlandes*, p. 20. (Mémoirs de l'Acad. impér. des Sciences de St. Petersbourg, VII[e] Série, Tome XXII, No. 12 et dernier). Flora Fossilis Arctica, vol. IV.

3. *Dicksonia acutiloba Hr. var.*
4. ,, *gracilis Hr.*
5. ,, *cfr. Glehniana Hr.*
6. ,, *nephrocarpa Bunb.*
7. *Asplenium whitbiense Brgt.*
8. ,, *argutulum Hr.*
9. ,, *distans Hr.*
10. *Nilssonia orientalis Hr.*
11. *Podozamites lanceolatus Lindl.*
12. *Ginkgo digitata Brgt.*
13. ,, *cfr. lepida Hr.*
14. ,, *sibirica Hr.*
15. *Pinus Nordenskjoldi Hr.*
16. ,, *cfr. prodromus Hr.*

With the flora of the same epoch[21] in Spitzbergen we have 6 species in common that is, 30 °/₀ of the indentified species ; viz.,

1. *Pecopteris exilis Phill.*
2. ,, *Saportana Hr.*
3. *Podozamites lanceolatus Lindl.*
4. *Ginkgo digitata Brgt.*
5. *Pinus Nordenskjoldi Hr.*
6. ,, *cfr prodromus Hr.*

Our flora has a nearer relation to that of the Yorkshire coast,[22] distant though it is, having as many as 9 species or 45 °/₀ in common. They are the following :—

1. *Thyrsopteris Murrayana Brgt.*
2. *Dicksonia nephrocarpa Bunb.*

21) Dr. Oswald Heer:—*Beiträge zur fossilen Flora Spitzbergens*, p. 27. (Kongl. Svenska Vetenskaps Akademiens Handlingar, Bandet 14, No. 5). Flora Fossilis Arctica, vol. IV.

22) Bath Oolite.

3. *Asplenium whitbiense Brgb.*
4. ,, *argutulum Hr.*
5. ,, *distans Hr.*
6. *Pecopteris exilis Phill.*
7. *Nilssonia orientalis Hr.*
8. *Podozamites lanceolatus Lindl.*
9. *Ginkgo digitata Brgt.*

With the Chinese and Mongolian Oolitic flora worked out by Newberry,[23] Schenk[24] and Schmalhausen,[25] we have four identifications, *Asplenium whitbiense*, *A. argutulum*, *Macrotaeniopteris cfr. Richthofeni* and *Podozamites lanceolatus*; while with the peculiar Indian flora of Kach and Jabalpur[26] we have only two, *Asplenium whitbiense* and *Podozamites lanceolatus*.

The Jurassic flora of Russia—from the regions of Orenburg and Isjum in its southern part, and from Petschora-Land on the western flank of the northern part of the Ural Mountains—has several species in common with ours. Among the plants mentioned by Eichwald[27] and Schmalhausen[28] we find many Japanese forms such as *Asplenium whitbiense*, *A. argutulum*, *Thyrsopteris prisca*, *Podozamites lanceolatus* and *Ginkgo digitata*, which last is an important Oolitic species. Our flora is also allied to that of Andö[29] and Turkestan,[30] whence how-

23) J. S. Newberry:—*Description of Fossil Plants from the Chinese Coal-bearing Rocks* in R. Pumpelly's *Geological Researches in China, Mongolia, and Japan.* (Smithsonian Contributions to Knowledge, Jan., 1866.)

24) A. Schenk:—*Jurassische Pflanzen* in *Richthofen's China*, vol. IV, part. X.

25) J. Schmalhausen:—*Pflanzen aus der nordwestlichen Mongolei.* (Mélange biologique tirés du Bulletin de l'Acad. Impér. d. Sc. d. St. Petersbourg, tome XI, March, 1883.)

26) O. Feistmantel considers both Kach and Jabalpur as of Lower Oolitic series. Cf. *Jurassic Flora of Kach, p.* 71. and *Jurassic flora of the Jabalpur Group, p. 20.*

27) E. d'Eichwald:—*Lethaea Rossica, II.*

28) J. Schmalhausen:—*Beiträge zur Juraflora Russlands.* (Bullotin de l'Acad. Impér. d. Sciences de St. Petersbourg, Tom. XI, Jan. 1879.)

29) O. Heer:—*Ueber die Pflanzen-Versteinerungen von Andö in Norwegen.* Flora Fossilis Arctica, vol. IV.

30) G. Romanowski:—*Materialien zur Geologie von Turkestan.*

ever we know as yet a comparatively small number of species.

We have still two interesting plants remaining, viz. *Dictyozamites indicus Fstm.* and a *Sagenopteris;* the first hitherto confined to the Rajmahal or Liassic[31] flora of India, and the second allied to *Sagenopteris rhoifolia Presl* which is also partly Liassic, but principally Rhaetic in Europe. This latter has also been described from the Mesozoic formation of Queensland in Australia, which Feistmantel is inclined to believe to be Liassic.[32]

From what I have stated above, 19 species or 95 % of those identified have been found in the 'Brown Jura' of other parts of the world, and only 1 species or 5 % in the lower deposits. Therefore, as Dr. Geyler had already done,[33] *I do not hesitate to conclude that the Jurassic flora of Kaga, Hida and Echizen belongs to the same geological horizon as the floras of Siberia, Spitzbergen, and Yorkshire, namely, to the Bathonian Stage of the Inferior Oolite,* with special relations to the flora of Siberia. This view is moreover justified by the occurrence of *Czekanowskia, Taxites* and *Palyssia,* which have their nearest allies in forms already found in the Inferior Oolite.

It may perhaps be urged, that although the plants from most of the localities are decidedly Oolitic, yet Ozō which has given *Dictyozamites indicus* and a *Sagenopteris* allied to *Sagenopteris rhoifolia,* might belong to a horizon somewhat lower than that of the Inferior Oolite. This question, as far as our present investigation goes, must be answered in the negative, as the place has yielded, besides these two

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31) Comp. Feistmantel's *Jurassic Flora of the Rajmahal Group,* p. 109.

32) O. Feistmantel:—*Palaeozoische und Mesozoische Flora im östlichen Australien,* Palaeontogr. 1879, Suppl. III, Lief. III, Heft 4, p. 174. In this work the author mentions 6 other species as occurring with *Sagenopteris rhoifolia,* viz., *Sphenopteris elongata Carr., Thinnfeldia odontopteroides Fstm., Cyclopteris cuneata, Taeniopteris Daentreei Mc Coy, Otozamites cfr. Mandeslohi Kurr,* und *Cardiocarpon australe Carr.* These are quite foreign to our flora and possess an Indian aspect.

33) Ueber foss. Pflanz. a. d. Juraform. Japans, p. 223.

species, forms which are also found in other localities ; viz., *Onychiopsis elongata*, *Asplenium whitbiense*, *A. argutulum*, *A. distans*, and *Podozamites Reinii*, which are all very important Oolitic types.

Among other interesting forms of the Japanese plants, I may mention *Nilssonia nipponensis m.* closely akin to *N. acuminata Schenk* of the Rhaetic, and *Dioonites Kotoei m.*, and *Equisetum ushimarense m.*, resembling respectively *Dioonites Brongniarti Schenk*, and *Equisetum Buchardti Schimp.* of the Wealden. With the Infra-Liassic flora of Tongking described by Zeiller, [34] we have no species in common, save *Podozamites distans* ,which Heer has shown [35] to be one of the many forms of *Podozamites lanceolatus.*

As seen from a foregoing table, 19 species or 39 °/₀ of the whole plants are ferns, 15 species or 30 °/₀ cycads, 10 species or 20 °/₀ conifers, and the remaining 11 °/₀ are taken up by Rhizocarpeae, Equisetaceae and Dubia. Therefore the ferns are the most numerous in the Japanese flora, next to which come the cycads ; while conifers are only half as numerous as ferns. In the Indian flora of Kach and Jabalpur, whence indeed we at present know 48 species of plants, 40 °/₀ are cycads, 29 °/₀ ferns and 29 °/₀ conifers, thus showing a great preponderance of cycads, over the two others. Again, a different order holds in the great flora of Siberia. There, the two able palaeophytologists Heer and Schmalhausen, have already discovered 127 species [36] of Jurassic plants. Of these, conifers take the lead, making up about 40 °/₀ of the whole flora ; while ferns and cycads range a little above 20 °/₀, the former perhaps a little more abundant than the latter. Therefore our own flora may be considered as a

34) Zeiller :—*Examen de la flore fossile des couches de charbon du Tongking* in *Annales des Mines*, 8e Serie, tome II, 5e livr., 1882.

35) O. Heer :—*Beiträge zur Juraflora Ostsib. u. d. Amurl.*, 1876, p. 107.

36) O. Heer :—*Nachträge zur Juraflora Sibiriens* p. 2 (Mémoirs d. l'Acad. Imp. d. St. Petersbourg, VIIe série, Tome XXVII, no. 10). Flora Fossilis Arctica, vol. VI.

# Tabular View of the Jurassic Plants of Kaga, Hida and Echizen.

| No. | Names. | Kaga. | | | Echizen. | | Hida. | | Occurrence of identical or allied Species in other countries. |
|---|---|---|---|---|---|---|---|---|---|
| | | Shimamura. | Yanagidani. | Ozō. | Hakogase. | Tanimura. | Okamigō. | Ushimaru | |
| | CLASS 1. CRYPTOGAMAE. | | | | | | | | |
| | ORDER 1. FILICACEAE. | | | | | | | | |
| | Fam. 1. Polypodiaceae. | | | | | | | | |
| 1. | *Thyrsopteris Murrayana Brgt.* ... | − | − | − | − | − | + | − | Siberia, Yorkshire. |
| 2. | „ *prisca Eichw.* ..... | + | − | − | − | − | − | − | Siberia, Russia. |
| 3. | „ *kagensis nov. sp.*..... | + | − | − | − | + | − | − | |
| 4. | *Dicksonia gracilis Hr.* ..... | + | − | − | − | − | + | − | Siberia. |
| 5. | „ *acutiloba Hr. var*..... | + | − | − | − | − | − | − | Siberia. |
| 6. | „ *cfr. Glehniana Hr.* ... | − | − | − | + | − | − | − | Siberia, Yorkshire (?) |
| 7. | „ *nephrocarpa Bunb.* ... | + | − | − | − | − | − | − | Siberia, Yorkshire. |
| 8. | *Onychiopsis elongata Geyl.* ..... | + | + | + | + | + | + | − | |
| 9. | *Adiantites Heerianus nov. sp.* ... | + | − | − | − | − | − | − | |
| 10. | „ *Kochibeanus nov. sp.*... | + | − | − | − | − | − | − | |
| 11. | „ *lanceus nov. sp.*..... | − | − | − | + | − | − | − | |
| 12. | *Asplenium whitbiense Brgt.* ..... | + | − | + | − | − | − | − | Siberia, China, Mongolia, India, (Jabalpur and Kach), Yorkshire, Turkestan, Rajmahal. |
| 13. | „ *argutulum Hr.*..... | + | − | + | + | − | + | − | Siberia, Mongolia, Russia, Yorkshire. |
| 14. | „ *distans Hr.* ..... | + | − | + | + | − | − | + | Siberia, Yorkshire. |
| | Fam. 2. Sphenopterideae. | | | | | | | | |
| 15. | *Sphenopteris sp.* ..... | − | − | − | + | − | − | − | *Sphenopteris Williamsonis Brgt.* of Oolite and *S. Mantelli Brgt.* of Wealden. |
| | Fam. 3. Pecopterideae. | | | | | | | | |
| 16. | *Pecopteris exilis Phill* ..... | + | − | − | − | − | − | − | Spitzbergen, Yorkshire. |
| 17. | „ *Saportana Hr.*..... | + | − | − | − | − | − | − | Spitzbergen. |
| | Fam. 4. Taeniopterideae | | | | | | | | |
| 18. | *Taeniopteris (?)* ..... | − | − | + | − | − | − | − | |
| 19. | *Macrotaeniopteris cfr. Richthofeni Schenk*..... | + | − | − | − | − | − | − | China. |
| | ORDER 2. RHIZOCARPEAE. | | | | | | | | |
| | Fam. 1. Salviniaceae. | | | | | | | | |
| 20. | *Sagenopteris sp.* ..... | − | − | + | − | − | − | − | *Sagenopteris rhoifolia Presl.* of Liassic and Rhaetic of Europe. |
| | ORDER 3. CALAMARIEAE. | | | | | | | | |
| | Fam. 1. Equisetaceae. | | | | | | | | |
| 21. | *Equisetum ushimarense nov. sp.*... | − | − | − | − | − | − | − | *Equisetum Buchardti Schimp.* of Wealden. |
| 22. | „ *sp.* ..... | − | − | − | − | − | + | − | |
| | CLASS 2. PHANEROGAMAE. | | | | | | | | |
| | SUBGL. GYMNOSPERMAE. | | | | | | | | |
| | ORDER 1. CYCADEACEAE, | | | | | | | | |
| | Fam. 1, Zamieae. | | | | | | | | |
| 23. | *Anomozamites sp.* ..... | + | − | − | − | − | − | − | |
| 24. | *Nilssonia orientalis Hr.*..... | − | − | − | + | − | − | − | Siberia, Yorkshire. |
| 25. | „ *ozoana nov. sp.* ..... | − | − | + | − | − | − | − | |
| 26. | „ *nipponensis nov. sp.* ... | + | − | − | − | − | + | − | *Nilssonia acuminata Göp.* of Rhaetic. |
| 27. | „ (?) | − | − | + | − | − | − | − | |
| 28. | *Dioonites Kotoei nov. sp.* ..... | + | − | − | − | + | − | − | *Dioonites Brongniarti Schenk* of Wealden. |
| 29. | *Zamites parvifolius Geyl*..... | + | − | − | − | − | − | − | |
| 30. | *Padozamites lanceolatus Lind.* ... | + | − | − | + | + | + | + | Siberia, China, Spitzbergen, Yorkshire. |
| | var. b. *intermedia Hr.* | + | − | − | − | − | + | − | Siberia, China, Mongolia. |
| | var. c. *Eichwaldi Hr.* | + | − | − | − | + | + | + | Siberia, China, Spitzbergen, Russia. |
| | var. d. *minor Hr.* | + | − | − | − | − | − | − | Siberia. |
| | var. e. *latifolia Hr.* | + | − | − | − | − | − | − | Siberia, China, Mongolia. |
| | var. f. *brevis Schenk* ..... | − | − | − | − | − | + | − | China. |
| | var. g. ..... | + | − | − | − | − | − | − | |
| 31. | *Podozamites tenuistriatus Geyl*... | + | − | − | − | − | + | − | |
| 32. | „ *Reinii Geyl.* ..... | + | + | + | − | + | + | − | |
| 33. | „ *sp.* ..... | − | − | − | − | − | + | − | |
| 34. | „ *sp.* ..... | + | − | − | − | − | − | − | |
| 35. | *Dictyozamites indicus Fstm. var. distans* ..... | − | − | + | − | − | − | + | *Dictyozamites indicus. Fstm.* Rajmahal. |
| 36 | „ „ *grossinervis nov. sp.* | + | − | − | − | − | − | − | |
| | Fam 2. Cycadeae. | | | | | | | | |
| 37. | *Cycadeospermum japonicum Geyl,* | + | − | − | − | − | − | − | |
| | ORDER 2. CONIFERAE. | | | | | | | | |
| | Fam. 1. Taxaceae. | | | | | | | | |
| 38. | *Ginkjodium Nathorsti nov. sp.*... | + | + | − | − | − | + | − | |
| 39. | *Ginkgo digitata Brgt.* ..... | − | − | − | − | − | + | − | Siberia, Spitzbergen Yorkshire. |
| 40. | „ *cfr. lepida*..... | − | − | − | + | − | − | − | Siberia. |
| 41. | „ *Sibirica Hr.*..... | + | − | − | − | − | − | − | Siberia. |
| 42. | *Czekanowskia rigida Hr. (?)* ... | − | − | + | − | − | + | − | Siberia, China, Russia, Yorkshire Rhaetic of Sweden. |
| 43. | *Taxites sp.* ..... | − | − | + | − | − | + | − | *Taxites brevifolius Nath.* of Yorkshire. |
| 44 | „ *sp.* ..... | + | − | − | − | − | − | − | |
| | Fam. 2. Abietaceae. | | | | | | | | |
| 45. | *Pinus cfr. prodromus Hr.* ..... | + | − | − | − | + | − | − | Siberia, Spitzbergen. |
| 46 | „ *Nordenskjoldi Hr.* ..... | + | − | − | − | − | − | − | Siberia, Spitzbergen, Russia, Andö? Nancy? |
| 47. | *Palissya sp.*..... | + | − | − | − | − | − | − | *Palissya jabalpurensis Fstm,* Jabalpur. |
| | INCERTAE SEDIS. | | | | | | | | |
| 48. | *Vallisneriites jurassicus Hr. (?)*... | + | − | + | − | − | − | − | Siberia. |
| 49. | *Carpolithes ginkjoides nov. ps.*... | − | − | + | − | − | − | − | |

kind of connecting link between the northern or Siberian, and the southern or Indian, facies of one great Oolitic flora. The occurrences of Indian elements like *Dictyozamites* and *Palyssia* like-wise hint at the same.

It may be here added, that within a last few years Jurassic plants have been discovered in many other parts of our country. In the Mesozoic basins of Awa and Tosa in Shikoku, plants seem to be tolerably numerous, also animal remains, which are referable to the three main periods of the Mesozoic Era. In the province Kii, to the south of the city of Ōsaka, plants again occur; and this is the case also in the little basin of Kagahara in the province Kōzuke, where however, as far as I know, they are very rare. Jurassic plants have also been brought from the northern part of Shinano, where they were observed in pebbles. These, I hope, will form a subject of another paper on the Jurassic plants of Japan.

# 2. Description of the Species.

## Class 1. Cryptogamae.

## Order 1. Filicaceae.

## Fam. 1. Polypodiaceae.

### 1. Thyrsopteris *Kze.*

#### 1. Thyrsopteris Murrayana *Brgt. sp.*

Pl. XII, fig. 5.

*Thyrsopteris Murrayana*—Heer, Beitr. zur Jura-flora Ostsib. u. d Amurl., 1876, p. 30, pl. I, fig. 4, II, 1-4, VIII, 116. Beitr. 1878, p. 1, pl. I, fig. 6. Nachträge, p. 6, pl. I, fig. 1.

*Pecopteris Murrayana*—Brongniart, Veget. Foss. I, p. 358, pl. CXXVI, fig. 1, 4.

*Sphenopteris Murrayana*—Zigno, Enum. Filic. Eoss. Oolith., p. 20.

*Hymenophyllites Murrayana*—Zigno, Flora Foss. Form. Oolith., p. 92.

*Tympanophora racemosa*—Lindley and Hutton, Fossil Flora of Great Britain, vol. III, pl. 170.

*Coniopteris Murrayana*—Schimper, Palaeont. Veget., vol. III, p. 471.

This species ocurs only in small fragments, one of which I have here figured. It is distinguished from its closely related species, *Thyrsopteris prisca Eichw.* in having the tertiary veins simple. The discovery of undoubted, though fragmentary, specimens of this plant in Japan is very important, as it not only occurs in Siberia, but has already been described by Brongniart and Lindley from the Oolitic flora of Yorkshire. Loc.—*Okamigō.*

## 2. Thyrsopteris prisca *Eichw. sp.*

Pl. I, fig. 3, 3a, 4.

*Thyrsopteris prisca*—Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., p. 86, pl. XVIII, fig. 8. Schmalhausen, Nachtr. zur Juraflora des Kohlenbassins von Kusnezk am Altai, p. 548, pl. I, fig. 2-4.

*Sphenopteris prisca*–Eichwald, Lethaea Rossica, II, p. 14, pl. IV, fig. 2.

Although our specimens are by no means complete, yet the elongated pinnae, the ovately-triangular and pinnatifid pinnules, and the obtuse lobes, together with the dichotomous tertiary veins, suffice to show that the species, first found at Kamenka and afterwards in Siberia, is also represented in the Japanese Jurassic system. From the preceding species, to which this is very closely akin, it is distinguished in having the tertiary veins dichotomous, as shown in fig. 3a. Loc.—*Shimamura.*

## 3. Thyrsopteris Kagensis *m.*

Pl. I, fig. 6, 6a. Pl. XI, fig, 7.

*Frond bi-tripinnated; pinnae elongated; pinnules coriaceous, alternate, acutely directed forward, ovate-lanceolate, gradually tapering below and contracted at base, lobed or even pinnatipartite; lobes or partitions narrow, acutely directed forward, acute at apex; veinlets dichotomous.*

This fern seems to have been twice to thrice pinnated. Some of the upper part of the upper pinnae show quite an entire margin, while others are furnished with lobes. A pinna in the lower part of the frond (Pl. I, fig. 6, left) however exhibits lobes nearly separate from one another, so that each of them here takes the place of the pinnules above. The substance of the pinnules seems to have been tolerably thick in consistence. A vein given off into each lobe or partition again dichotomizes as represented in fig. 6a. These veinlets

are acutely directed forward like the lobes themselves. A fragment from Tanimura (Pl. XI, fig. 7) with acutely directed, in some cases irregularly lobed pinnules very probably belongs to the some species.

The generic position of this fern is at present uncertain; but the general aspect of the pinnules, and their mode of lobing remind us of many of the *Thyrsopteri* which are widely spread in the Jurassic system. Rare. Loc.—*Shimamura, Tanimura.*

## 2. Dicksonia *L'Herit.*

### 4. Dicksonia gracilis *Heer.*

Pl. I, fig. 5, 5a. Pl. XII, fig. 13.

*Dicksonia gracilis*—Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 92, pl. XVII, fig. 3., Beitr. 1878, p. 13, pl. III, fig. 8-14.

The specimens from both localities represent the upper part of a frond. Although they are rather imperfect, and the impressions more or less indistinct, yet the thickly-set narrow pinnae, with small, broadly lanceolate, oblique, entire-margined, rather acutely pointed pinnules, tend more to point to *D. gracilis* than to its close ally *D. acutiloba Hr.* Heer speaks of his *gracilis* as having obsolete and *acutiloba* distinct venation. Just so in our specimens; the venation is in most cases very indistinct. By strong enlargement, however, we can observe faint undivided secondary veins rising acutely from the fine median vein, as shown in fig. 5a.

This species seems to have been very rare. Loc.—*Shimamura, Okamigō.*

### 5. Dicksonia acutiloba *Heer* var.

Pl. I, fig. 2a, 2, 1b.

*Dicksonia acutiloba*-Heer, Beitr. zur Juraflora Ostsib, u. d. Amurl., 1876, p. 92, pl. XVIII, fig. 4.

Closely akin to the preceding, but distinguished in having more sharply pointed pinnules and dichotomous secondary veins. A specimen here figured (fig. 2) shows slender pinnae with acutely directed, lanceolate pinnules, which are therefore narrower than the majority of those figured by Heer. They correspond more to those represented in the left-hand extremity of Heer's figure. Fig. 1b shows a fragment of a pinna with long acute pinnules whose inferior veinlets are dichotomous (fig. 2a); so it is probably one of this species. Yet on account of the narrower nature of the pinnules as compared to those described by Heer, I name the Japanese form a variety. Very rare.

Loc.—*Shimamura.*

### 6. Dicksonia cf. Glehniana *Heer.*

Pl. XIV, fig. 11, 11a, 12a.

*Dicksonia Glehniana*—Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 91, pl. XVII, fig. 4, XVIII, 6, 7.

Heer's diagnosis runs as follows:

"Frond bipinnated, coriaceous; pinnae alternate, acutely directed forward, narrow; pinnules oval, strongly oblique, narrowed at base, decurrent, entire, apex obtuse; veins very fine."

In the alternate, obliquely-oval pinnules, obtuse at apex and with simple lateral veins, our specimens agree with the figures and descriptions of Heer, but they are too meagre and fragmentary for an exact determination. The substance of the frond, just as Heer says, seems to have been quite thick. Fig. 11a is an enlarged view of fig. 11, to show the veins more distinctly.

According to the investigations of Prof. Nathorst, this species is doubtfully represented in the Oolite of Yorkshire. Loc.—*Hakogase.*

### 7 Dicksonia nephrocarpa *Bunb. sp.*

Pl. I, fig. 1, 1*a*.

*Sphenopteris nephrocarpa*—Bunbury, Quart. Journ. of Geol. Soc.,

1851, vol. VII, p. 179, pl. XII, fig. 1a, 1b.

*Dicksonia clavipes*—Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 33, pl. II, fig. 7, 7b.

On a small piece of sandstone from Shimamura, there occur fertile pinnae of a fern, which possess comparatively large, kidney-shaped sori 1.5—2 mm in breadth, each of which is borne at the apex of a short lobe more or less narrowed towards the base. Under a magnifier, a vein is seen going into each sorus, sometimes giving off delicate lateral veinlets (fig. 1a).

These pinnae no doubt belong to a *Dicksonia* which is at least very closely allied to *D. clavipes Hr.* from Kaja in Siberia (Beitr. 1876, p. 33). This latter species is considered by Prof. Nathorst as identical with *Sphenopteris nephrocarpa Bunb.* from the Oolite of Yorkshire. To this opinion Heer assents in his Nachträge, p. 6. As I see no sufficient character to separate the Japanese from the Siberian fossil, I identify them, and following Heer (Nachtr., p.6) in the denomination of the species, I call it *Dicksonia nephrocarpa Bunb. sp.*

To this group may be referred the fertile pinnules figured by Oldham and Morris as *Sphenopteris Bunburyana (The Flora of the Rajmahal series, pt. XXXII fig. 5, 6, 7)*, which Feistmantel includes, together with our present species, under *Hymenophyllites Göp. (Jurassic Flora of the Rajmahal Group, p. 26-27).* Loc. *Shimamura.*

## 3. Onychiopsis *m.*

Fertile segments different from the sterile. Sori terminal, linear, on each side of the midrib, parallel with the margin, involucrate ; the involucrum of each side confluent over the midrib.

This new genus, which I have founded on a plant first described by Dr. Geyler under the name of *Thyrsopteris elongata* and afterwards

mentioned by myself as *Dicksonia elongata* in the Bulletin, shows a fructification apparently resembling that of *Cryptogramme R. Br.* and *Onychium Kaufl.* of the recent flora. The sori were probably linear, placed on each side of the midrib as in *Onychium.* The involucrum may possibly have been formed of the rolled-up margin of the segment or pinnule as in *Cryptogramme.* The general appearance of the fertile segments and the terminal nature of the sori remind us strongly of the latter genus.

*Onychiopsis* may provisionally be treated under *Polypodiaceae*, in the neighbourhood of the tribe *Pteridae*, until the discovery of sporangia points out its true systematic position among the ferns.

## 8. Onychiopsis elongata *Geyl. sp.*

Pl. II. fig. 1—3. Pl. III, fig. 6 d. Pl. XII, fig. 9,10.

*Frond slender, bi-tripinnated; sterile pinnae alternate or rarely opposite, elongated, their length rapidly increasing towards the lower part of the frond; pinnules alternate, acutely directed forward, lanceolate or linearly-lanceolate, entire or lobed or even pinnately parted; lobes or partitions acute at apex and acutely directed forward just like the pinnules themselves. Venation obsolete, secondary veins simple, each going into a lobe. Fertile pinnules elongated, with a linear terminal sorus on both sides of the midrib.*

*Thyrsopteris elongata*—Geyler, Ueber foss. Pflanzen a. d. Juraform. Japans, p. 224, pl. XXX, fig. 5, XXVI, 4,5. Schenk in Richthofens China, vol. IV, part X, p. 263, pl. LIV, fig. 1.

*Dicksonia elongata*–Yokoyama, On the Jurassic Plants of Kaga, Hida and Echizen (Bull. Geol. Soc. Japan, part B, vol. I, No. 1) p. 6.

This plant seems to have been very slender and graceful in general appearance, with twice to thrice pinnated fronds whose lightly bent pinnae are in most cases set alternately along a slender rhachis (fig. 2,

Pl. II). The pinnules are much elongated, being longest near the base of the pinna. They are quite entire in the upper pinnae, but become lobed as they get downward, and the incision between the lobes becomes deeper and deeper, so that at last the individual lobes look quite like the pinnules of the upper part of the frond. Fig. 3, Pl. II, represents a pinna belonging to the lower part of the frond, whose extremely elongated pinnules give such an appearance as above alluded to; fig. 3 a is an enlarged view of a part of one of them. The length of a pinnule here attains about 37 mm, the breadth being only 3 mm. Fig. 10, Pl. II also represents an inferior pinna.

Along with these sterile pinnae are found fertile pinnules which are either borne quite on a separate pinna or, as is sometimes the case, mixed with the sterile pinnules (comp. fig. 1, 4 a, b, Pl. II, fig. 6d, Pl. III, fig. 9, Pl. XII). The sori are placed two at the end of each pinnule which is considerably narrowed looking like a winged stalk. These double sori are opposite, elongated, linear, meeting each other along the midrib.

This splendid fern is the chief and characteristic fossil of the Japanese flora, being found in all of the fossil localities.

## 4. Adiantites *Göp.*

### 9. Adiantites Heerianus *m.*

Pl. XII, fig. 1, 1a. 1b, 2

*Pinnae elongated; pinnules alternate, acutely directed forward, rhomboidal, attenuated below, acute at apex, acutely lobed; veins equal, fine, repeatedly dichotomous*

The four pinnae shown in fig. 1 and 2, I believe, to belong together. The pinnules are, as a general rule, obliquely rhomboidal in shape, attenuated towards the base, and acutely pointed at the apex. They are mostly acutely lobed, but becoming entire and more lanceolate in

shape towards the upper part of the pinnae. As to the venation, no distinct median vein is observable, but the veins are fine, nearly equal in size, and several times forking (fig. 1a) Pinnules of a pinna lying in the middle of fig. 1 show dark spots around their margin, which are probably due to the presence of fruit-dots. Each of these dots or sori seems to have been borne on the tip of each lobe at the ends of veins (fig. 1b), just as in the recent *Adiantums* of the group of *A. capillus-veneris L.* Therefore our plant, together with *Adiantites Schmidtianus Hr. (Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 36, pl. II, fig. 12, 13)*, in which Heer observed a similar kind of fructification, very probably belongs to the genus *Adiantum.* However as *Dicksonia* in a fossil state sometimes shows quite a similar looking fructification, it many be most prudent at present to refer our fossil to the provisional genus of *Adiantites Göp.*

This species may be compared to *A. nympharum Hr. (Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 93, pl. XVII, fig. 5)* which, however, has obtusely lobed pinnules.

Rather rare. Loc.—*Shimamura.*

I may here notice that the pinnae figured as *Adiantites amurensis Hr.* by Dr. Geyler *(Foss. Pflanz. a. d. Juraform. Japans, p. 225, pl. XXXI, fig. 2, 3)* seem to possess pinnules, most of which are acute at the apex and are quite different from those figured by Heer (see *Beitr. 1876, pl. XXI, fig. 6 a d).* I doubt whether they do not belong to *Heerianus m*, although it cannot be positively decided, so imperfect are the Geyler's specimens.

## 10. Adiantites Kochibeanus *m.*

Pl. I, fig. 7, 7a.

*Frond pinnated; pinnae elongated; pinnules alternate, acutely directed forward, entire, broadly lanceolate, cuneate at base, acute at apex;*

*veins many, equal, divergent, repeatedlg dichotomous.*

This fern seems to have been pretty slender in its general appearance. Along a rhachis, which is by no means strong, are arranged alternate or opposite, elongated pinnae more or less directed forward, but often bent apparently by the weight of ovately or obovately lanceolate, thick, entire pinnules, which are tolerably acutely directed forward. Veins are pretty distinct, and radiate towards the apex and margin of the pinnules, two to five times forking on their way (fig. 7a).

This species is closely related to the preceding in the form of the pinnules which, however, are not in this case lobed.

Very scarce. Loc.—*Shimamura.*

## 11. Adiantites lanceus *m.*

Pl. XIV, fig. 3, 3a.

*Pinnules alternate, acutely directed forward, lanceolate, acute at apex, constricted at base, entire; veins numerous, equal, divergent, repeatedly dichotomous.*

Along a slender rhachis, are arranged lanceolate pinnules which are tolerably acutely directed forward. At the base they are sensibly narrowed and apparently provided with a short petiole. They appear to have been thin in texture, with numerous distinct veins diverging towards the apex and margin, and repeatedly dichotomizing on their way (fig. 3a), reminding us of the venation of many of the recent *Adiantums.* None of the pinnules in our specimen are perfect ; but in two of them, in which the apex and base are preserved, the length measures 50—42 mm. and the breadth $6\frac{1}{2}$—7 mm.

I know none among the Mesozoic plants which can aptly be compared to this species. The preceding species, to which it bears some resemblance in form of the pinnules and the mode of venation, has

much smaller pinnules and less numerous veins, and is in general more strongly built.

Very rare ; I possess only a single specimen, the one here figured.

Loc.—*Hakogase.*

## 5. Asplenium *L.*

### 2. Asplenium whitbiense *Brogt. sp.*

Pl. III, fig. 3. Pl. X, fig. 1, 2 a.

*Asplenium whitbiensis*—Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 38, pl. I. fig. 1 c, III, 1-6, p. 94, XIV, 8, XX, 1, 6, XXI, 3, 4, XXII, 4 g, 9 c., Beitr. 1878, p. 3, 15, pl. II, fig. 14-17, Nachtr. p. 7. Schmalhausen, Beitr. zur Juraflora Russl., p. 17, pl. II, fig. 1-10, XIV, fig. 4, 5. Schenk in Richthofen's China, vol. IV, part X, p. 246, pl. XLVI, fig. 5, 6, 7, XLVIII, 3-5, XLVIII, 1-4, XLXIX, 4a, 6b, p. 247, pl. XLVIII, fig. 5a, p. 253, pl. LII, fig. 1-3.

*Pecopteris whitbiensis*—Brongniart, Veget. Foss. p. 231, pl. 109, fig. 2-4. Lindley and Hutton, Fossil Flora. Vol. II, p. 145, pl. 134. Newberry in Pumpelly's Geological Researches in China, Mongolia and Japan, p. 122, pl. IX, fig. 6.

*Alethopteris whitbyensis*—Feistmantel, Fossil Flora of Jabalpur Group, p. 87, pl. II, pg. 2-7. Fossil Flora of Kach, p. 22, pl. III, fig. 1-4.

*Alethopteris indica*—Feistmantel, Fossil Flora of Rajmahal Hills, p. 37, pl. XXXVI, fig. 4a, pl. XLVI, fig. 3-4.

Although our specimens are by no means well preserved, yet the short and more or less falcate pinnules show us that we are dealing with the wide-spread *A. whitbiense Brgt. sp.*, and indeed with the variety *tenue* of Heer.

The specimens from Ozō have the pinnae a little more acutely directed forward than in the typical forms, with some of the falcate and blunt pinnulae more closely set together, thus reminding us also of the sterile pinnulae of *Pecopteris Williamsonis Brgt.* (e. g. Hist. Végét. Foss., pl. CX, fig. 12) the original specimen of which I had an opportunity of examining in the museum of Stockholm.

Loc.—*Shimamura, Ozō.*

## 13. Asplenium argutulum *Heer.*

Pl. III, fig. 1. Pl. XII, fig. 8. Pl. XIII,fig. 9. Pl. XIV. fig. 2.

*Asplenium argutulum*—Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 225, pl. XXXI, fig. 1. Heer, Beitr. zur Juraflora Ostsib. u. d. Amurl., 1876, p. 41, pl. III, fig. 7, p. 96, pl. XIX, fig. 1-4. Schenk in Richthofen's China, vol. IV, part X, p. 246, pl. XLVI, fig. 2-4. Schmalhausen, Beiträge zur Juraflora Russlands, p. 23, pl. II, fig. 12.

This species is a close ally of the preceding, but with pinnules narrower, straighter, and more acute at apex. A specimen from Shimamura (Pl. III, fig. 1) shows some of the pinnules crenulate, on which account it may be prudent for the present to consider it as a variety. That from Hakogase figured in Plate XIV has also a great resemblance to some forms of *Pecopteris Phillipsii Brgt.=P. exilis Phill.* (comp. *Brongniart*, Hist. Végét. Foss., pl. CIX, fig. 2).

This species like the preceding has a wide geographical distribution, as it is also mentioned from Yorkshire by Prof. Nathorst.

Not frequent. Loc.—*Shimamura, Ozō, Hakogase, Okamigō.*

## 14. Asplenium distans *Heer.*

Pl. III, fig. 2. Pl. XI, fi. 4. Pl. XIII, fig. 4. Pl. XIV, fig. 1.

Frond pinnated ; pinnae elongated ; pinnules either free or united at base, lanceolate, entire, more or less falciform, acute at apex ;

10-20 mm. long, 4-6 mm. broad; secondary veins fine, acutely directed forward, dichotomous. (Heer).

*Asplenium distans*—Heer, Beitr. z. Juraflora Ostsib. u. d. Amurl, 1876, p. 97, pl. XIX, fig. 5-6.

*Pecopteris recentior*—Phillips, Geology of Yorkshire, p. 119, pl. VIII, fig. 15? Zigno, Flora Foss. Form. Oolith. I, p. 195.

*Neuropteris recentior*—Lindley and Hutton, Fossil Flora, vol. I, p. 195, pl. 68. Göppert, Syst. Filic. p. 205. Unger, Gen. et Spec. Plant. Foss. p. 85. Sternberg, Flora der Vorwelt, II, p. 76.

*Cladophlebis recentior*—Brongniart, Tabl. Gen. Végét. Foss. p. 105.

*Alethopteris recentior*—Schimper, Pal. Végét. vol. I, p. 566.

*Pteris recentior*—Ettingshausen, Farn. d. Jetztwelt, p. 113.

This species is distinguished from the preceding by having longer and narrower pinnules, and more delicate secondary veins directed more acutely forward.

The pinnules are entire and attached to the rhachis by their whole base. This is seen in every one of the specimens here figured. In a specimen from Shimamura (Pl. III, fig. 2) which may be considered the best we possess, the pinnules are quite free from one another, the longest measuring 19 mm. in length and 5½ mm. in breadth. Veins are here very distinct. They are delicate, all dichotomous and acutely directed forward. A specimen from Ozō (Pl. XIII, fig. 4) is only a fragment from the upper part of a pinna; but it is readily recognised by the acute course of the veins. That from Hakogase is much better as far as the number of pinnules preserved is concerned; but all of them are more or less wanting along their margins, so that they look more slender than they really are. Their slightly contiguous nature at the base, and their falcate shape are, however, perhaps best shown in this specimen (Pl. XIV, fig. 1). The Ushimaru specimen (Pl. XI, fig. 4) is also a fragment like that from Ozō. I possess

another from the same locality with more pinnules preserved; but they are so mutilated, and in part so indistinct, that I thought it not worth while to figure it along with decidedly better, though more fragmentary, specimens.

This species described from Gristhorpe and the Amoor regions, though obtained from the four localities, seems to have been frequent in none of them. Loc.—*Shimamura*, *Ozō*, *Hakogase*, *Ushimaru*.

## Fam. 2. Sphenopterideae.

### 6. Sphenopteris *Brgt.*

#### 15. Sphenopteris sp.

Pl. XIV, fig. 13, 13 a.

I obtained only a fragment of this fern, which I believe is to be placed in the group of *Sphenopteris Davallioides Schimper*. My specimen belongs to the upper extremity of a frond, or perhaps of a primary pinna, and shows five long linear pinnules, two on each side and one at the apex. These pinnules are all close together, obtuse at the apex and acutely directed forward. They measure about 7 mm. long and only 1 mm. broad, each pierced with a single delicate vein in the middle (fig. 13 a, enlarged).

I know none among the Oolitic plants that can aptly be compared to this species, except *Sphenopteris Williamsonis Brgt.* from Yorkshire (Lindley, *Fossil Flora, p. 131, pl. 131*), the greater part of the group of *Davallioides* being hitherto known from the Palaeozoic flora. Our plant is also not unlike *Sphenopteris Mantelli Brgt.* of the Wealden (Schenk, *Flora d. Norddeutschen Wealdenform p. 208, pl. XXV, fig. 6*) in the formation of the pinnules (comp. 6 a, pt. XXV of Schenk). However our specimen is too imperfect for a strict specific determination. Loc.—*Hakogase*.

## Fam. 3. Pecopterideae.

### 7. Pecopteris *Brgt.*

#### 16. Pecopteris exilis *Phill.*

Pl. I, fig. 8-10, 9a.

Frond tripinnated; pinnae elongated; secondary pinnae also elongated, linear, opposite or alternate, a little directed forward; pinnules entire, oblong, obtuse, close together, free, but contiguous at base in the upper pinnae; median vein distinct, evanescent.

*Pecopteris exilis*—Phillips, Geology of Yorkshire, p. 119, pl. VIII, fig. 16. Bunbury, Quart. Journ. Geol. Soc. 1851, VII, p. 188, pl. XIII, fig. 5 a. 56. Heer Beitr. zur Foss. Flora Spitzb. p. 29, pl. VI, fig. 1, 16. Zigno, Flora Foss. Form. Oolith I, p. 144. Schimper, Pal. Végét. vol. I, p. 536.

*Pecopteris obtusifolia*—Lindley and Hutton, Fossil Flora, vol. III, pl. 158.

*Pecopteris exiliformis*—Geyler, Ueber foss. Pflanz a. d. Juraform, Japans, p. 226, pl. XXX, fig. 1 a.

This species, first found in Yorkshire and afterwards in Spitzbergen, is also represented in the Japanese flora. Fig. 9 shows a specimen in which two primary pinnae are preserved. These pinnae possess long linear secondary ones which are often curved and provided with alternate oblong obtuse pinnules, exactly agreeing with the figure of Lindley. Pinnae of the second order measure 15-20 mm. in length and 4-5 mm. in breadth; but they become much shorter above where they appear crenate, owing to the contiguous state of pinnules at their bases. The rhachises (fig. 9.) which are by no means strong are slightly geniculate, especially in a pinna represented on the right-hand side of the figure; but I believe this to be no permanent character of the plant.

Fig. 8 and 10, both exhibiting crenate pinnae, probably belong to the same species. The latter figure represents a rather indistinct specimen. It shows, however, a primary rhachis which, when compared with that of the second order, may be called pretty strong. It is by no means weaker than that of an English specimen figured by Lindley, as the latter might represent a part of a frond lying lower in position than our own.

Venation is indistinct, save a median vein which is in most cases very clearly seen. It is comparatively delicate, disappearing near the apex of the pinnules (fig. 9a).

What Dr. Geyler described as *Pecopteris exiliformis* from the Tetorigawa-valley is, I dare say, no other than the present species. He considers his plant to be more slender in general appearance than the Scarborough species; but his figures as well as my own only show the upper parts of primary pinnae, while conversely the figure of Lindley represents only their lower parts. Be that as it may, after a careful comparison between my specimens and Lindley's figures, I could find no character sufficient to separate the Japanese from the English species.

Bunbury observed in a pinnule of this fern capsules arranged in a single row on each side of a midrib (*Quart. Journ. Geol. Soc., 1851, p. 188, pl. XIII, fig. 5a, b*), a fructification which he compares with that of *Ancimia* and *Mohria* among *Schizaeaceae*.

Rarely found at *Shimamura*.

## 17. Pecopteris Saportana *Heer.*

*Pecopteris Saportana*—Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 226, pl. XXX, fig. 4. Heer, Beitr. zur foss. Flora Spitzb., p. 29, pl. VI, fig. 4-7a, VII, 46.

This species was described by Geyler, but not a single new specimen was obtained referable to it.

## Fam. 4. Taeniopterideae.

### 8. Taeniopteris *Brgt.*

#### 18. Taeniopteris (?)

Pl. X, fig. 2c.

A very small fragment of a fern (?) from the above locality situated by the side of *Nilssonia ozoana m.* shows very fine curved veins which are often found to fork, when examined with a magnifier, just as in *Taeniopteris densinervis* Feistmantel *(Jurassic Flora of Kach, pl. II, fig. 6a).* The specimen, however, is too meagre even for a certain generic determination. Loc.—*Ozō.*

### 9. Macrotaeniopteris Schimp.

#### 19. Macrotaeniopteris cf. Richthofeni *Schenk.*

Pl. III, fig. 4, 5.

Frond elongated, entire, acuminate at apex; secondary veins numerous, dense, rising at acute angles at base and then becoming horizontal towards the margin, simple or dichotomous.

The two figures above cited represent two faces of the same leaf. It is a fragment, belonging to the apical part which is long drawn out. The specimen measures about 27 mm. in breadth near its base, from which place it appears to taper downward. Therefore the frond is not a large one such as is possessed by many of the species described under this genus. The midrib is rather weak and gets weaker towards the apex. The secondary veins are dense, many of which furcating near the point of rising along the midrib, but many also remaining simple for their whole length. Very rarely, forking takes

place after they have gone on for a considerable distance towards the margin.

Our plant shows a great resemblance to *Macrotaeniopteris Richthofeni Schenk (Richthofen's China vol. IV, pl. LI, fig. 4, 6)* in having acuminate fronds and numerous dense veinlets, with which I indeed compare it, notwithstanding the somewhat smaller size of frond. Loc.—*Simamura.*

## Order 2. Rhizocarpeae.

## Fam. 1. Salviniaceae.

### 1. Sagenopteris *Presl.*

#### 20. Sagenopteris *sp.*

Pl. X, fig. 3, 3a.

On a piece of black sandy shale from Ozō there lie a few scattered fragments of longly-obovate leaflets with an evanescent median vein and numerous fine veinlets, radiating towards their margin and forming, as they go, much elongated nets or areoles. The leaflets are more or less oblique in shape, and acute at apex. These characters at once show that we are dealing with a species of *Sagenopteris* that is at least very closely allied to *S. rhoifolia Presl.*, under which name indeed I mentioned it in Bull. Geol. Soc. Japan, Part B, Vol. I, No. 1, p. 6. But now I am of opinion that it is better to consider these fragments under the simple name of *Sagenopteris sp.* Loc.—*Ozō.*

## Order 3. Calamarieae.

## Fam. 1. Equisetaceae.

### 1. Equisetum *L.*

## 21. Equisetum ushimarense *m.*

Pl. XI, fig. 1—3.

*Rhizome ribbed ; tubers roundly ovate, single or joined like beads..*

The three specimens here figured I believe to belong to one and the same species. They all represent underground stems which are generally slender. In fig. 3, these stems measure 1½—2 mm. in breadth with internodes 15—20 mm. in length, and are seen with 2—3 strong ribs. Tubers are of various shapes owing to distortions under pressure ; but in general they are roundish or roundly-ovate and single or rarely joined like beads. (Fig. 3, small ones on the left). In fig. 3, the diameter of these tubers is approximately 5—9 mm, while in fig. 2 (right) a slender rhizome only 1 mm. broad possesses a large tuber 15 mm. long and 13 mm. broad, in fact the largest we have. Fig. 1 shows comparatively a broad rhizome (5 mm.) with 3—4 strong ribs and a tuber 8—11 mm. in diameter. Sometimes these underground stems are still seen with root-hairs attached.

It is much to be regretted that no overground stem was found with these remains.

*Equisetum Buchardti Schimp. (Schenk, Flora der nordwestdeutsch. Wealdenform., p. 205, pl. XXII, fig. 1—5)* from the Wealden exhibits quite a similar kind of spherical tubers which are said to have been tridentate at the apex. An Oolitic species with tubers has heen described by Heer (*Beigtr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 99, pl. XXII, fig. 5—7)* from Bureja, which however had them more elongated than in our own.

Numerous in a greenish-grey arenaceous shale at *Ushimaru.*

## 22. Equisetum *sp.*

Pl. XII, fig. 7.

Only a small fragment of an overground stem was obtained,

which is 11 mm. broad and provided with numerous fine crowded longitudinal striae. It is too imperfect for specific determination, but that it is one of the Equisetaceous plants is shown by the presence of a joint. Loc.—*Okamigō*.

## Class. 2. Phanerogame.

## Subclass 1. Gymnospermae.

## Order 1. Cycadeaceae.

## Fam. 1. Zamieae.

### 1. Anomozamites *Schimp.*

#### 23. Anomozamites *sp.*

Pl. VII, fig. 1d.

A rather imperfect specimen of a leaf of an *Anomozamites*, or perhaps, of a *Nilssonia*, with subopposite quadrangular segments rounded at angles and possessed of fine simple parallel veins, looks not unlike some of the figures of *A. inconstans Göp.* from the Infra-Liassic series of Tongking (Zeiller, *Examen de la flore fossile des couches de charbon du* Tongking, pl. XI, fig. 7), and also those of *Nilssonia comtula Heer (Beitr. z. Juraflora Ostsib, u. d. Amurl., 1878, pl. IV, fig. 12, 13)* from the Lena regions in Siberia. However, a positive determination must be postponed until better specimens are obtained.

Loc.—*Simamura*.

### 2. Nilssonia *Brgt.*

#### 24. Nilssonia orientalis *Heer.*

Pl. XIV. fig. 4-9.

Leaf entire or rarely segmented, truncated at apex, rounded at base; veins fine, dense, slightly curved and directed forwards.

*Nilssonia orientalis*–Heer, Beitr. z. Juraflora Ostsib, u. d. Amurl., 1878, p. 18, pl. IV, fig. 5-9.

Specimens of a *Nilssonia* represented in the above cited figures are, I believe, to be identified with what was described by Heer as *N. orientalis* from Ajakit on the Lena in Siberia. Our specimens are all entire-margined, which though variable in form, always possess a truncated apex. Fig. 5, though broken, shows an entire leaf which is about 23 mm. broad and only 44 mm. long ; so it is tolerably short. Fig. 4 represents a large leaf, 25 mm. broad with 46 mm. of the length preserved ; therefore it is probably a much longer leaf than the above. In all of our specimens the veins, which are curved and directed forward, are densely crowded, occurring as many as four to the millimetre, and thus exactly agreeing in venation with the Siberian specimens.

Every one of our specimens shows a strong convexity on the upper surface of the leaf, and a sharp edge on the rhachis where the blades meet from both sides. Sometimes a leaf is found quite doubled over.

Heer compares this species to *N. polymorpha Schenk* of the Rhaetic flora of the Franconia and Sweden, the entire forms of which indeed the Japanese leaves in some cases resemble. Yet a decidedly denser state of veins distinguishes the latter from the Rhaetic species.

According to the investigations of Prof. Nathorst, this species also occurs in the Oolite of Yorkshire.

Very numerous at *Hakogase*, though mostly fragmentary, and forming there the most abundant fossil.

## 25. Nilssonia ozoana *m.*

Pl. X, fig. 2b, 11-14.

*Leaf elongated, entire or rarely segmented, parallel-sided, rounded at apex; veins very fine, dense, perpendicular to the rhachis.*

This species at first sight reminds us of the genus *Taeniopteris* among ferns, but is decidedly different from that genus in having the blade of the segments inserted on, and not laterally to, the rhachis. The leaf seems to have been in most cases entire, with sides strictly parallel except near the apex, where it is sometimes seen slightly to taper (fig. 11). Fig. 12 shows such a parallel-sided leaf. It is 58 mm. long and about 12 1/2 mm. broad without any appreciable difference in breadth in its upper and lower extremities. Fig. 14 shows a narrower leaf which measures 9 mm. in breadth. But that the leaves were not always entire is shown by fig. 2 b, which represents one side of a leaf divided into rectangular segments about 8 mm. broad. The veins are very fine and dense, about four to the millimetre. They are very faint, and almost obliterated in fig. 11, but are distinct in fig. 13 and 14.

Leaves are in most cases strongly convex on their upper surface along the rhachis, but concave on both sides of it, as is seen in fig. 13 and 14.

This species is allied to the preceding in having very dense veins and generally entire leaves, but is distinguished in having the former strictly at right angles to the rhachis and the latter narrower and more elongated.

Fragments are frequent at *Ozō*.

## 26. Nilssonia nipponensis *m.*

Pl. VI, fig. 8d. Pl. VII, fig. 2-7, 8a. Pl. XII, fig. 6.
Pl. XIII, fig. 1.

*Leaf petioled, segmented, incisions sharp; segments opposite or alternate, acute, more or less concave in the upper margin, convex in the lower,*

*upper ones longer, with the uppermost shortened, lower ones shorter and triangular with the upper margin straight, veins dense, simple, parallel, equal, rising at right angles to the rhachis.*

The leaves were petioled (fig. 1, Pl. XIII). Segments are in most cases separate from one another but sometimes a slightly contiguous at base. They may be opposite as in fig. 6, Pl. VII, or alternate as in fig. 1, Pl. XIII. They are always acutely pointed at the angle where the upper and lateral margins meet. They are generally concave in the upper margin and strongly convex in the lower, and are longer than broad; but in the upper part of the leaf, they are much broader than long (fig. 4, Pl. VII), with the upper and lower margins more parallel-sided. The lower segments are more or less triangular in shape with the upper margin straight (fig. 6, Pl. VII, and fig. 6, Pl. XII). The uppermost segments are comparatively short, as may be seen from fig. 3, Pl. VII, which represents the apical part of a leaf. Fig. 5, Pl. VII, is also such an example, while fig. 7 and 8a show segments lying intermediate between the apex and the base.

This species is very closely allied to the European Rhaetic form, *N. acuminata Schenk (Flora der Grenzschichten, p. 131, pl. XXXII, fig. 1—7, XXXIII, 1.)*, from which, however, it is distinguished by having less acuminate segments, pierced with much denser veins (ca. 3 falling in a millimetre).

Not frequent. Loc.—*Shimamura, Okamigō.*

## 27. Nilssonia (?)

Pl. XIII, fig. 3.

A broken leaf, about 34 mm. in breadth, with the length preserved for 60 mm, seems to have been longly-elliptical in shape to judge from its rapidly tapering state both above and below. It also

appears to have been entire-margined with a comparatively weak midrib. The leaf has been flatly pressed on to the stone, and the venation is almost wholly defaced. By a careful examination, however, it exhibits faint traces of delicate parallel veins perpendicular to the rhachis ; and as the blade seems to lie upon the rhachis, our specimen is probably referable to *Nilssonia*. A positive determination however must be postponed until better specimens are discovered.

## 3. Dioonites *Bornem.*

### 28. Dioonites Kotoei *m.*

Pl. VII, fig. 1a, b, c, 1e. Pl. XIV, fig. 14.

*Leaf pinnated; segments opposite or alternate, lightly curved and more or less directed forward, long, linear-lanceolate, acute, inserted on the rhachis with the whole base; veins fine, equal, parallel, 7–14 in number.*

Segments of this species vary much in length and breadth, but are commonly 7-9 times as long as broad, and broadest at base. The longest segment in our specimens measures $4\frac{1}{2}$ mm. in breadth and 33 mm. in length, with apex a little broken off. The segments are in most cases quite separate from one another; but sometimes a little contiguous. Their directions are not always the same, some being directed more acutely forward than others, some being tolerably falcate in shape, while others are more straight. Veins are delicate, and rise perpendicular to the rhachis (fig. 1e enlarged).

Very closely akin to *Dioonites Brongniarti Schenk* (*Flora der nordwestdeutsch. Wealdenform., p. 336, pl. XXXII, fig. 2, 2a*) from the Wealden of Germany, from which however the Japanese form is distinguished in having longer segments traversed by a greater number of veins (in *D. Brongniarti*, 5–6). Our fossil may also be com-

pared to the Gristhorpe forms such as *D. medianus Bean* and *D. angustifolius Bean* (Leckenby, *Proc. Geol. Soc., vol. XX, 1864, p. 77, pl. VIII, fig. 2 and 3*), the first of which however has shorter, and the second, more straight and gradually sharpening segments.

Rather rare. Loc.—*Shimamura, Tanimura.*

## 4. Zamites *Brgt.*

### 29. Zamites parvifolius *Geyl.*

*Zamites parvifolius*–Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 227, pl. XXXII, fig. 2a. Zigno, Flora Foss. Form. Oolith., II, p. 57.

I have not been able to find any specimen that can be referable to this species.

## 5. Podozamites *Fr. Braun.*

### 30. Podozamites lanceolatus *Lindl. et Hutt. sp.*

*Podozamites lanceolatus*–Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 228, pl. XXXII, fig. 1, 4, XXXIII, 1–3, 4b, XXXIV, 3a, 5b. Heer, Beitr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 45, pl. I, fig. 3a, p. 106, XXIII, 1c, 4a, b, c, XXVI, fig. 2–10, XXVII, 1–8. Beitr. 1878, p. 6, p. 20, pl. V, fig. 1–11. Beiträge zur foss. Flora Spitzbergens. p, 35, pl. VII, fig, 1–7 c, d. Schmalhausen, Beitr. zur Juraflora Russl., p. 29, pl. V, fig. 3, 4, 5c. Schenk, in Richthofen's China, vol. IV, p. 248, pl. XLIX, fig. 4, 5, p. 251, L, 1–6, p. 255, LI, 3, LII, 8, p. 258, LI, 7, p. 261, LIV, 2c. Feistmantel, Foss. Flora of Jabalpur Group, p. 11, pl. III, fig. 4–7, IV, 1–10.

This well known species is very widely spread in the Jurassic flora, being known from Yorkshire, Spitzbergen, Russia, Siberia,

Mongolia, China, India, Persia and Tongking. From the Rhaetic it has been described under the name of *Podozamites distans*. In Japan it occurs in great abundance and can be distinguished into the following varieties :—

### a.) P. lanceolatus var. genuina *Heer*.

Pl. IV, fig. 2. Pl. VII, fig. 8b. Pl. XIV, fig. 12b ?

This variety is distinguished by having long narrow leaflets, each of which is drawn out into an acuminate apex.

The leaflets of this variety are frequently met with at *Shimamura* and *Okamigō*. Fig. 2, Pl. IV, has the upper part of the leaflet strongly falcate, is about 50 mm. long and 9 mm. broad, and is furnished with about 25 fine longitudinal veins. Fig. 8b, Pl. VII, has the apical end broken off; but, to judge from its superiorly gradually narrowing form, it is evident that it has terminated in an acuminate apex. It measures 5·5 mm. in breadth, and has about 27 veins. Fig. 12b, Pl. XIV, from Hakogase is a doubtful case, but its general form points more to this than to any other variety. It possesses 25 veins, and is 5·5 mm. broad near the base.

### b.) P. lanceolatus var. intermedia *Heer*.

Pl. IV, fig. 3a, 4a. Pl. V, fig. 3, 7, 9.

Leaflets in this variety are gradually narrowed towards the apex which is bluntly pointed.

Specimens are by no means rare at *Shimamura* and *Okamigō*, but those from the former locality are alone figured here. Fig. 3, Pl. IV, which is the longest of the specimens with both apex and base preserved, measures 83 mm. in length and 12·5 mm. in breadth; fig. 4a, which is shorter, is 55 mm. long and 14–15 mm. broad, whilst fig.

3, Pl. V is 57 mm. by 10·5 mm. Fig. 7 and 9, Pl. V, represent leaflets which seem to have been longer when compared with the above three, and are indeed the typical specimens of this variety, the shorter ones representing what may be considered as passage forms between this and the succeeding group. Veins vary between 20 and 25 in number.

### c.) P. lanceolatus var. Eichwaldi *Heer.*

Pl. IV, fig. 1a, 4b, c. Pl. V, fig. 2, 4, 5a, b, c, 6.
Pl. XI, fig. 6.?

Leaflets are more or less parallel-sided, with apex obtuse or nearly rounded.

As in Bureja, China and Spitzbergen, this is the most frequent of all the varieties of *P. lanceolatus* occurring in Japan. The specimens I have figured vary considerably in size and breadth, some being much smaller and some much longer than others. Smaller forms are represented in fig. 1, 4, Pl. IV, and fig. 5, Pl. V, of which the last is perhaps the smallest that has as yet been figured, though not completely preserved. Fig. 4, Pl. V, is a broader form and corresponds to the typical figures of Heer (comp. Beitr. 1876, pl. XXVII, fig. 1). So is fig. 6. Fig. 26, Pl. V, seems to have been considerably longer than others; but as it has the sides nearly parallel and the apex blunt, it must be referred to this variety. A leaflet (Pl. V, fig. 2a) which I formerly considered as *Podozamites pulchellus Hr. (Bull. Geol. Sec. Japan, B, Vol. I, p. 6)* is probably an abnormal form of *P. lanceolatus Eichwaldi*, as it seems to have been furnished with a short stalk. So is the leaflet from Ushimaru (Pl. XI, fig. 6) with 25 veins and mentioned in the *Bulletin* as a new species.

Found at *Shimamura*, *Okamigō*, *Tanimura* and *Uhimaru*.

### d.) P. lanceolatus var. minor *Heer*.

Pl. V, fig. 8.

A single specimen with three leaflets attached to a rhachis was obtained at *Shimamura*. These leaflets are narrowly lanceolate with acute apex and with about 18 veins. Heer says of his variety *minor*, that the leaflets are narrow, linear-lanceolate with sharply pointed apex and with 14–16 veins *(Beitr. 1876, p. 110)*. To this our specimen must be referred, so like is it to the figures of Heer *(Beitr. 1876, pl. XXVII, fig. 7, 8)*, although in number of veins it slightly exceeds the Siberian.

A leaflet on the right hand side of our drawing is very unfavourably situated. It looks narrower than it actually is. It measures about 6·5 mm. in breadth, and is not at all narrower than others which also possess a nearly equal breadth.

### e.) P. lanceolatus var. latifolia *Heer*.

Pl. IV, fig. 1c. Pl. V, fig. 1. Pl. VI, fig. 1.

This variety is distinguished by having larger, longly-oval, obtuse leaflets with 20–30 veins.

The specimens, though all incomplete, I cannot but identify with this variety. Fig. 1c, Pl. IV, which is wanting both at apex and base, measures 20 mm. in breadth, and is pierced with about 30 veins. Fig. 1, Pl. V, shows two leaflets, one with the apex and the other with the base. These leaflets agree in form with those figured by Heer from Spitzbergen (*Beitr. 3. Foss. Flora Spitzb., pl. VIII, fig. 3)*. Veins are very numerous—about 30 in number-and the breadth in the broadest part of the blade is 19 mm. Fig. 1, Pl. VI has 28 veins and is 17 mm. broad.

Specimens were obtained at *Shimamura* where they seem to have been rather rare.

### f.) P. lanceolatus var. brevis *Schenk.*

Pl. XII, fig. 18.

Leaflets small, longly oval; apex acute; veins fine, about 20 in number.

A specimen from Okamigō is longly-oval in shape, 30 mm. long and 11 mm. broad with the broadest part near the middle of the leaflet. It is pointed at apex, and possessed of about 20 delicate veins. It agrees very well in general form with one figured by Schenk *(Richthofen's China, vol. IV, p. 251, pl. L, fig. 1)* from Patat-shu, west of Peking in China, though ours is somewhat longer.

### g.) P. lanceolatus var.

Pl. V, fig. 5d.

Leaflets small, abruptly narrowed above and ending in acute apex.

A leaflet which I have here separated from others is very small when compared with the leaflets of other varieties. It corresponds in size to the smallest form of *P. lanceolatus Eichwaldi* already alluded to (Pl. V, fig. 5), from which it differs in having the blade quickly narrowing above and ending in pointed apex. It is 24 mm. long and 6 mm. broad, and possesses about 20 fine veins. It may be a young leaflet belonging to one of the many varieties of *P. lanceolatus*, which however is very difficult to determine.

## 31. Podozamites tenuistriatus *Geyl.*

Pl. XII, fig. 19.

Leaflets lanceolate, gradually attenuated above, suddenly narrowed at base, acute; veins fine, 14–16 in number; interstitial veinlets very fine.

*Podozamites tenuistriatus*–Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 228, pl. XXXII, fig. 2 b.

Dr. Geyler established this species on a leaflet from the Tetorigawa-valley, which was 50 mm. long and 10 mm. broad, and pierced with 14–16 fine veins. The only specimen which I could obtain of this species is a leaflet from Okamigō, 32 mm. long and 10 mm. broad, therefore somewhat shorter than the one figured by Geyler. It is furnished with about 15 very faint delicate veins between which I have often observed one or two extremely fine veinlets. Its form is lanceolate with the broadest part near the base, and above gradually narrowing into a rather acute apex. *Podoz. ensiformis Hr.*, with which Geyler compares this species, has much slenderer leaflets pierced with a somewhat less number of coarser veins.

I may here advance my opinion concerning the fragmentary specimens of a *Podozamites* identified with *P. ensiformis Hr.* by Geyler *(Foss. Pflanzen, p. 227, pl. XXXII, fig. 1).* This author gives for his specimens 20–22 veins, whilst Heer's species possesses only 10–13 *(Beitr. 1876, p. 46);* and he rejects *Zamites Schmidtii Andr.* from the Liassic flora of Steierdorf for the very reason that the latter has 14–16 veins. Here evidently Dr. Geyler is mistaken; and this mistake has been noticed by Heer *(Nachtr. p. 3)* who considers the Japanese specimens as referable to *P. tenuistriatus Geyl.* But, as already mentioned, they possess 20–22 veins, whilst leaflets of *P. tenuistriatus* have only 14–16, only a little more than in *P. ensiformis.* Therefore I think it most proper to refer the specimens described by Dr. Geyler as *P. ensiformis Hr.* to *P. lanceolatus var. genuina Hr.*, to which indeed his broken leaflets show the greatest resemblance. Loc.—*Okamigō.*

## 32. Podozamites Reinii *Geyl.*

Pl. III, fig. 6a b c. Pl. IV, 1b, 3b. Pl. VI, fig. 2, 3b c d, 4–7, 8a b c e. Pl. IX, fig. 12a. Pl. XII, fig. 4.

Leaflets alternate, distant, more or less directed forward, ovate,

oblong, or nearly round, obtuse at apex, unequal at base, shortly petioled; veins numerous, simple, parallel, 34–50 in number; interstitial veins very fine.

*Podozamites–Reinii* Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 229–230, pl. XXXIII, fig. 4a, XXXIV, 1, 2, 5a, XXXIV, 3 b, 4.

Leaflets of this Japanese species of *Podozamites* are very plentifully found at Shimamura and Okamigō, where they show great diversities in shape, which however are, I believe, to be considered merely as a variability so frequent among the leaves of cycads. On this account I do not adopt the varietal names of *latifolia* and *angustifolia* proposed by Dr. Geyler.

The shape of the leaflet is either ovate (e. g. fig. 2, 6, Pl. VI), or oblong (e. g. fig. 3b, Pl. IV, fig. 3c, 7a, Pl. VI) which often approaches to elliptical (e, g. fig. 7b, Pl. IV, fig. 8c, Pl. VI, fig. 12a, Pl. IX). Between these forms there are all sorts of gradations from one to the other.

A small round leaflet represented in fig. 4, Pl. XII, 11–12 mm. in diameter and with very fine veins a little over 30 in number is, I believe, an abnormal form of this species.

The base of the leaflet is either subcordate (Pl. III, fig. 6a, Pl. VI, fig. 2, 4, 6), or it passes gradually into a petiole without leaving any indentation on either side of it (Pl. III, fig. 6c, Pl. IV, fig. 1b).

It is to be noticed here that in all of the leaflets of this species interstitial veins are in most cases distinctly observable, generally one (fig. 6e, Pl. III), but sometimes two between the principal ones; and that in all of them the two sides of the base are more or less unsymmetrically formed, as may be seen most prominently in fig. 6c, Pl. III, fig. 3b, Pl. IV and fig. 3b, 3d, Pl. IV.

Loc.—*Shimamura, Ozō, Yanagidani, Tanimura, Okamigo.*

### 33. Podozamites *sp.*

Pl. XII, fig. 12.

This is an imperfect specimen which is wanting both at apex and base. It is attached to a stone in a curved state. It is 3 mm. broad, and may have been long drawn out at apex. Veins are distinct, about 8 in number with a finer one between.

The leaflet is probably referable to *Podozamites*, and indeed I mentioned it in the *Bulletin* as a new species. But now I consider it better to be designated with a simple name of *Podozamites sp.*, as the specimen is not complete enough for exact determination.

Loc.—*Okamigō.*

### 34. Podozamites *sp.*

Pl. VII, fig. 9.

A leaflet longly elliptical in form, obtuse at apex, nearly sessile at base, and furnished with 12 rather distant parallel veins. It measures 30 mm. long and 12 mm. in breadth, and resembles much the narrower forms of *P. pulchellus Heer* (*Beitr. z. foss. Flora Spitzb., p. 38, pl. IX, fig. 10–14*), from which however our specimen seems to differ in possessing 5–10 very fine dense interstitial veins. Whether Heer's species may have so many veinlets as in ours is a question which can only be settled after the discovery of a much greater number of specimens. Loc.—*Simamura.*

## 6. Dictyozamites *Oldham.*

"*Leaflets many-veined, subauriculate at base; veins dichotomous, reticulated.*" *(Oldham.)*

Oldham and Morris had described in their *Rajmahal Flora* a very interesting plant which then accorded most with the genus *Dictyopteris Gutbier* of the Carboniferous System, and therefore called by them

*Dictyopteris falcata*. Oldham, however, who had at first followed the opinion of his colleague afterwards came to the conclusion, that the plant in question is not a fern, as at first appeared, but a cycad near to the genus *Otozamites Br.* His reasons were:

Firstly, that the Indian leaflets possess not the slightest trace of a midrib which in *Dictyopteris* is present as a "quasi-midrib or bifid midrib," from which "all the veins of the fronds diverge in a flabellate or radiated form," while in the former "the strong nerves pass out parallel to each other from the base of the leaf, and proceed towards the apex in nearly right lines interrupted only by the anastomozing or reticulating cross nerves, which pass from one to the other: the areolae thus become subquadrangular, not hexagonal."

Secondly, that the texture of the leaflets is coriaceous.

Thirdly, that the equal leaflets are regularly disposed along a rhachis which is provided with a terminal leaflet.

And then he proposed for the Indian plant the new generic name of *Dictyozamites*.

Dr. Stur of Vienna also came to the same conclusion by examining the figures of this plant.

The above view of these two eminent men has also been adopted by Dr. Feistmantel who fully treats of this subject in his "*Indischen Cycadeengattungen Ptilophyllum and Dictyozamites*" (p. 17).

I possess a set of leaflets from Kaga and Hida, which I treat under the name of

### 35. Dictyozamites indicus *Feistm.* var. distans *m.*

Pl. X, fig. 4–10. Pl. XI, fig. 5.

*Leaf simple, elongated; leaflets either short and blunt, or long, falciform, and acute at apex; attached to the rhachis with the middle of the base which is either very shortly petioled or quite sessile and*

*distant from one another; corners of the base distinctly auriculate; leaf terminated by a single leaflet; veins numerous, fine, rising at base, and radiating and anastomozing; thus forming nets which are long and subparallel in the middle of the leaflet, shorter and polygonal towards the apex and the margin.*

*Dictyozamites indicus*–Feistmantel, Jurassic Flora of the Rajmahal Group, in the Rajmahal Hills, p. 70, pl. XLVI, fig. 7, 8. Jurassic Flora of the Rajmahl Group from Golapili, p. 180, pl. II, 5, 6. Ueber die indischen Cycadeengattungen Ptilophyllum *Morris* und Dictyozamites *Oldham*, p. 18, pl. IV, fig. 7, 7a, 8, pl. V, fig. 1–4, pl. VI.

*Dictyopteris falcata* and *Dictyopteris falcata var. obtusifolia*–Oldham and Morris, The Fossil Flora of the Rajmahal Series, Rajmahal Hills, Bengal, p. 38, pl. XXIV, fig. 1, 1a, pl. XXIV, fig. 2, 2a.

This species is greatly variable in the form of the leaflets. Feistmantel had already united Morris' species and variety. The distinguishing characters are the ending of the leaf at apex, the mode of attachment of the leaflets to the rhachis, the basal ears, and the reticulation of fine veins. The first two of these characters are unfortunately not to be seen in our specimens, as most of them occur in an isolated state. A single specimen was obtained with the rhachis preserved, but the preservation is such that the important character of the attachment of the leaflets is not distinctly observable. The basal ears are very distinct in fig. 4, 5a, 6, 8 and 9. The leaflets are more or less oblique with upper part often curved to one side. Fig. 5, Pl. X, represents a leaflet which has the apical portion most strongly falcate. Fig. 7 shows one with obtuse apex, which corresponds to Feistmantel's 'short and blunt' while fig. 5, 8, and 10 represent his 'long and falciform' leaflets. These latter are all more or less sharp at apex, and fig. 10 may indeed be said to possess an acuminate apex.

Most of our leaflets seem to have been sessile, as we see no in-

dication of a stalk except in fig. 8, which shows a short but distinct one.

The mode of venation is exactly as Feistmantel describes and figures. Fine, equal, numerous veins proceed from the base to the apex and margin of the leaflet, in such a way as to form long and narrow nets along its median line, and shorter and polygonal ones around its periphery.

Agreeing in all of the above mentioned characters, our plant is distinguished from the Indian one in having the leaflets not so closely set along the rhachis as in the latter. On this account I think it better to raise it to a distinct variety (see fig. 4).

This species is said to be highly characteristic of the Rajmahal Group in India. Its discovery therefore in the Jurassic system of Japan is especially noteworthy, as at Ozō it has been found associated on the one hand with a *Sagenopteris* closely akin to *S. rhoifolia Presl.* and on the other with the common Oolithic types such as *Asplenium argutulum*, *A. distans*, and *Onychiopsis elongata.*

This is the most numerous fossil at *Ozō*, where it takes the place of *Podozamites lanceolatus* of other localities, of which indeed not the least trace is here to be found. Rarer at *Ushimaru.*

Loc.—*Ozō*, *Ushimaru.*

## 36. Dictyozamites grossinervis *m.*

Pl. VII, fig. 10.

*Leaflets longly ovate, very shortly petioled at the middle of the base; basal corners subauriculate; veins equal, coarse, rising at the base of the leaflet and radiating, forming elongated nets which are longer in the middle and shorter towards the apex and margin of the leaflet.*

This species is closely akin to the preceding, in fact agreeing with it in the general form of the leaflets, their mode of attachment to the

rhachis, the auriculation of the basal corners, and in the general mode of venation, but is decidedly distinguished in having a less number of coarser veins with a correspondingly less number of nets, and in having the leaflets set more closely together. Feistmantel indeed figures leaflets which show a small number of areoles (*e. g. Cycadeen-gattungen*, pl. IV, fig. 7, VI, 4); but all of these pertain to much smaller forms. Our specimen shows larger leaflets with few nets. Therefore it is quite unsafe even to create a variety out of our specimen, the number and size of veins being considered as very important characters in the discrimination of fossil plants. However, there is no doubt that our plant is very nearly related to *Dictyozamites indicus*, and I regard it as belonging to the same genus.

Our specimen is very meagre. The apices of the leaflets could not be well exposed, therefore it is very difficult to decide whether they ended acute or obtuse.

Very rare. Loc.—*Shimamura.*

## Fam. 2. Cycadeae.

### 7. Cycadeospermum *Sap.*

#### 37. Cycadeospermum japonicum *Geyl.*

*Cycadeospermum japonicum*–Geyler, Ueber foss. Pflanz. a. d. Juraform. Jap., p. 231, pl. XXXIII, fig. 5.

I have not been able to find any specimen referable to this species.

## Order 2. Coniferae.

## Fam. 1. Taxaceae.

### 1. Ginkgodium *m.*

*Leaf coriaceous, entire or lobed, gradually narrowed towards the base*

*which is thickened at its margin and gradually passes into a short petiole. Veins numerous, simple, parallel; interstitial veins very fine.*

The leaves which I am going to describe below under this genus, I brought under *Baiera* in the *Bulletin*. But now I have reason to believe that they must be treated as a distinct genus, related on one side to *Ginkgo* and on the other to *Baiera*. With the former it has in common the thickening of the lower margin of the leaf and with the latter the numerous, simple, parallel longitudinal veins. But these veins coming down directly on the thickened margin without converging, decidedly distinguish our plant from the two above named ones. This mode of venation may be compared to that of *Whittleseya Newb.* from the Coal-Flora of Pennsylvania (*Lesquereux, Descript. of the Coal-Flora of Pennsylvania, 1880, vol. I, Pl. IV*).

The discovery of this genus standing between *Ginkgo* and *Baiera* shows more strongly the close relationship existing between these genera which was first pointed by Heer (Beitr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 51).

## 38. Ginkgodium Nathorsti *m.*

Pl. II, fig. 4e. Pl. III, fig. 7. Pl. VIII. Pl. IX, fig. 1–10. Pl. XII, fig. 14, 15.

*Leaf coriaceous, gradually attenuated below into a short petiole, entire or lobed; apex obtuse. Longitudinal veins dense, simple, parallel; interstitial veins very fine, simple.*

The leaves which I mentioned in the *Bulletin* (page 8) as three new species of *Baiera*, I now unite into one, as I was convinced by the examination of many specimens that an apparent diversity in the shape of the leaves is merely a variability. Some leaves are broad and more or less narrowly fan-shaped, and are nearly or quite entire (Pl.

VIII, fig. 4, Pl. IX, fig. 1, Pl. XII, fig. 15), or deeply lobed (Pl. VIII, fig. 2a, 5, 6, Pl. IX, fig. 2, Pl. XII, fig. 14). Some are quite entire and lanceolate with subparallel sides (Pl. VIII, fig. 2c, Pl. IX, fig. 9, 10). Between these forms there are all sorts of gradations, both in shape and in the depth of the central slit, just as in our recent *Ginkgo biloba*.

The lower margin of the leaf is thickened as in *Ginkgo*, but a little more strongly than in the latter. The petiole, however, is very short in comparison to the very long one of *Ginkgo*. The lower end of the petiole which is the point of attachment to the stem, is slightly expanded as is best seen in fig. 2a, Pl. VIII, and fig. 5, Pl. IX.

As to the number of veins, they vary from 20 to 40, according to the breadth of the leaf. In the lobed leaves 20–30 come in a lobe, and in the lanceolate entire ones we find 30–35. For example a leaf represented in fig. 9, Pl. IX, which is 66 mm. long and 21 mm. broad, possesses 30 veins with an equal number of interstitial veins, and that represented in fig. 2c, Pl. VIII, which is a little longer, has 35.

Fig. 11, Pl. VIII, representing a small leaf only 13 mm. in breadth, shows 23 veins.

In leaves of an oval shape (Pl. VIII, fig. 14, Pl. XII, fig. 15), the veins vary between 30 and 40.

In all of our specimens, interstitial veins are more or less distinctly observable and are always single (Pl. VIII, fig. 1a, 11a, Pl. IX, fig. 10a).

It is here to be added, that when the leaves are lobed they seem to have been always two-lobed, the apparent anomalies seen in some of the figures being only accidental.

Very numerous at Shimamura, but rarer in other localities.

Loc.—*Shimamura, Yanagidani, Okamigō.*

## 2. Ginkgo *Thunb.*

### 39. Ginkgo digitata *Brgt.*

Pl. XIII, fig. 2.

Leaf semicircular, entire or with two to six lobes, petioled; petiole long, slender, canaliculated above; veins numerous, repeatedly dichotomous, flabellately divergent.

*Ginkgo digitata*–Heer, Beitr. z. foss. Flora Spitzb., p. 40 pl. X, fig. 1–6. Heer in Regel's Gartenflora, 1874, pl. 807. As *G. digitata integriuscula Heer*, Beitr. z. foss. Flora Spitzb., p. 44, pl. X, fig. 7–9. Beitr. z. Juraflora Ostsib. u. d. Amurl., 1878, p. 25, pl. VI, fig. 5, 6. Nachträge, p. 5.

*Baiera digitata*–Schimper, Pal. Végét., vol. I, p. 423.

*Cyclopteris digitata*–Brgt., Végét. foss. I, p. 239, pl. 61, fig. 2, 3. Zigno, Flora Foss. Form. Oolith., I, p. 102.

A leaf of this species in an excellent state of preservation was procured from Okamigō. It measures 30 mm. in length and 52 mm. in breadth. It is fan-like in shape, and furnished with three comparatively shallow clefts on the top, one of which is nearly in the middle of the leaf and attains the depth of one-third of its length. The other two are on each side of the central one and are much nearer to it than to the lateral margins of the leaf. They are about one-half as deep as the central one. Veins are very distinct, all of them diverging from the base of the leaf and ending in its upper extremity, after having repeatedly forked on their way.

The Japanese specimen, according to the descriptions of Heer, must belong to his variety *quadriloba (Foss. Flora Spitzb., p. Pl. X, fig. 3a)*, although the central incision is much shallower than in the one figured by that author.

Heer described in his contributions to the Spitzbergen and Sibe-

rian floras closely allied, nearly entire-margined leaves as *Ginkgo integriuscula Hr.* But this species he afterwards placed under *G. digitata* as a variety only (*Nachtr. p. 5*), as Prof. Nathorst discovered in the Oolite of Scarborough specimens which show passage forms between these two species.

Seems to have been very scarce in Japan. Loc.—*Okamigō.*

## 40. Ginkgo cf. lepida *Heer.*

Pl. XIV, fig. 10.

*Ginkgo lepida*–Heer, Beitr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 62, pl. XII, pl. VII, fig. 7. Nachtr., p. 17, pl. IV, fig. 7b, 9–12, pl. V, fig. 1a, 2, 3a, 4.

A leaf which I figure here is not very complete. It is divided into four lobes, and therefore furnished with three slits, the central of which is the deepest, nearly reaching to the base of the leaf whence it goes off into a petiole. The petiole however is unfortunately not preserved. The other two slits are shallower. The lobes are narrow, parallel-sided and acute at apex, as is seen from one of them. Veins are parallel to the sides and about 6 in a lobe. Judging from these characters, our plant is probably referable to the above named species of Heer, which is distinguished from the very nearly related *G. sibirica Hr.* in possessing narrower and especially acute lobes.

Very rare. Loc.—*Hakogase.*

## 41. Ginkgo sibirica *Heer.*

*Ginkgo sibirica*–Geyler, Ueber foss. Pflanz. a. d. Juraform. Japans, p. 231, pl. XXXII, fig. 6. Heer, Beitr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 61, pl. VII, fig. 6, IX, 5b, XI, p. 116, pl. XX, fig. 3b, 6c, XXII, 3. Beitr. 1878, p. 25, pl. VI, fig. 8a b. Nachtr. p. 16, pl. IV, fig. 13, V, 5–8. Schmalhausen, Beitr. z. Juraflora Russl., p. 34.

I have not been able to find any specimen undoubtedly referable to this species.

## 3. Czekanowskia *Heer.*

This genus is doubtfully represented in Japan, and only by fragments which most approximate to

### 42. Czekanowskia rigida *Heer* (?)

Pl. XII, fig. 11. Pl. XIII, fig. 10.

An indistinct specimen from Ozō (fig. 10, Pl. XIII) has linear leaves about 1 mm. broad, which dichotomize and are in some cases seen with a distinct median vein. Leaves on the right-hand side of the stone appear as if fasciculated. Fig. 11, Pl. XII, shows a single leaf 1 mm. broad, and once forked with a distinct canal running through the lobes. From these characters our fragments seem to be referable to the above denominated species which is found in Siberia, China, Russia and England, and also in the Rhaetic of Sweden. (Comp. Heer's Beiträge z. Juraflora Ostsib. u. d. Amurl., 1876, p. 70, Pl. V, fig. 8–10, Pl. VI, 7, X, 2a, etc. Beitr. 1878, p. 7. Pl. I, fig. 16, p. 76, Pl. IV, fig. 3b c. Schenk in Richthofen's China, vol. IV, p. 251, Pl. L, fig. 7, p. 262, Pl. LIV, fig. 2a. Schmalhausen's Beitr. z. Juraflora Russl. p. 36, Pl. V, fig. 2e, 6a, 7. etc.).

Loc.—*Ozō*, *Okamigō*.

## 4. Taxites *Brogt.*

### 43. Taxites *sp.*

Pl. X, fig. 15–19. Pl. XII, fig. 16, 17.

The leaflets in the above cited figures all belong, I believe, to one and the same species. They are linear-lanceolate, 10–15 mm. long and 2.5–3 mm. broad, obtusely pointed at apex and constricted at base, with a weak midrib. In form they remind us of many of the so-called *Cycadites*, e. g. such as *C. zamioides Leckenby (Proc. Geol.*

*Soc., 1864, vol. XX, p. 77, Pl. VIII, fig. 1)* and *C. Saladini Zeiller (Examen de la Flore Fossile des Couches de Charb. du Tonking, p. 322, Pl. XI, fig. 8, 9, 10 A, Pl. XII, fig. 8, 8 A, 9, 9 A, 10).* But the former seems to have had much more linear leaflets with a stronger midrib, and the latter is said to have had a cordate base. Our plant may be most closely allied to *Taxites brevifolius Nath.** from the Oolite of England whose original specimens I had an opportunity to examine at Stockholm.

In the *Bulletin* I mentioned the leaflets now under consideration as a new species of *Cycadites.* But as Prof. Nathorst believes them to be undoubtedly the remains of a conifer, and as they occur only in an isolated state, I now satisfy myself by calling it simply *Taxites sp.* Loc.—*Ozō, Okamigō.*

### 44. Taxites *sp.*

Pl. VI, fig. 3a.

Two fragments of linear leaves, 2–3.5 mm. broad, gradually narrowed above and furnished with a distinct evanescent midrib, on both sides of which are seen fine longitudinal striae. I mentioned them in the Bulletin as belonging to *Cycadites gramineus Hr.* (?). But now I take the opportunity of bringing them under *Taxites* like the preceding species, and indeed very near to *T. longifolius Nath.* occurring in the Rhaetic formation of Schonen in Sweden. Loc.—*Shimamura.*

## Fam. 2. Abietaceae.

## 5. Pinus *L.*

### 45. Pinus cf. prodromus *Heer.*

Pl. XII, fig. 3.

*Pinus prodromus*–Heer, Beitr. z. foss. Flora Spitzb., p. 44, pl. VII,

* Nathorst, *Berättelse, afgifven till Kongl. Vetenskaps-Akademien, om en med understöd af allmänna medel utförd vetenskapliga resa till England. p. 73*

fig. 7a, X, 11–14. Nachträge z. Juraflora Sibir., p. 27, pl. VII, fig. 12c.

Many linear leaves mostly 1 mm. in breadth, but sometimes a little broader, are found with a strong midrib, on both sides of which we can often observe fine longitudinal striae. Though they are always found scattered and only in fragments, I believe they are to be identified with the species discovered in Spitzbergen and Siberia.

A fragment of a leaf of this species is also found by the side of *Adiantites Heerianus*. (Fig. 2, Pl. XII). Loc.—*Shimamura*, *Tanimura*.

## 46. Pinus Nordenskjoldi *Heer*.

Pl. IX, fig. 12b.

*Cyclopitys Nordenskjoldi*–Yokoyama, Bull. Geol. Soc. Japan, Part B, vol. I, No. 1, p. 8. ?

(?) *Cyclopitys Nordenskjoldi*–Schmalhausen, Beitr. z. Juraflora Russlands, p. 40. Nachträge zur Juraflora d. Kohlenbassins von Kuznesk am Altai, pl. I, fig. 1.

*Pinus Nordenskjoldi*–Heer, Beitr. z. foss. Flora Spitzb., p. 45, pl. IX, fig. 1–6. Beitr. z. Juraflora Ostsib. u. d. Amurl., 1876, p. 76, pl. IV, fig. 8e, p. 117, pl. XXII, fig. 4a, b, XXVII, 9a, XXVIII, 4. Beitr. 1878, p. 26, pl. II, fig. 7–10. Nachtr., p. 28, pl. I, 8b, 6b, IX, 36.

Long linear acuminate leaves, 2–2.5 mm. in breadth, thick in texture and scattered on a stone, agree very well with those described under the above name from Spitzbergen and Siberia. The central vein is tolerably thick, and through a magnifier we can observe in some leaves 3–4 finer longitudinal parallel veins, a fact which was also noticed by Heer (*Beitr. 1876, p. 117, Pl. XXVIII, fig. 4c).*

Dr. Schmalhausen identifies the isolated leaves described by Heer as belonging to a pine with his *Cyclopitys Nordenskjoldi* in which the

needle-shaped leaves are arranged in whorls as in our recent *Sciadopitys*. In the *Bulletin* I followed the above author in the generic denomination of our species. But in reverence to Prof. Nathorst of Stockholm who thinks it still unsettled whether the plants described by Heer and Schmalhausen really belong to one and the same species, I resume the older denomination of Heer. Loc.—*Shimamura*.

## 6. Palissya *Endl.*

Species of this genus are mainly known from the Rhaetic and Lower-Liassic beds of Europe, but also from the Rajmahal, Jabalpur and Kach series in India.

### 47. Palissya *sp.*

Pl. IX, fig. 11.

A single specimen of a branch of a coniferous tree belonging to the family of Abietaceae shows linear-lanceolate leaves, 10–11 mm. long and 1½ mm. broad, constricted at base and decurrent to the stem. Each of these leaves is pierced with an indistinct midrib.

This species is undoubtedly very closely akin to *P. jabalpurensis Feistm. (Flora of the Jabalpur Group, p. 16, Pl. IX, fig. 1)* from the Oolite of India. It is also not unlike a *Palissya* figured by Feistmantel, and described as closely related to *P. indica Feistm. (Jurassic Flora of the Rajmahal Group, Pl. XLV, fig. 9)* from the Liassic series of the same country. To our great regret the Japanese specimen has the apex of all the leaves broken, and so it does not allow us to institute a stricter comparison with the above fossils.

Loc.—*Shimamura*.

## Incertae Sedis.

### 48. Vallisneriites jurassicus *Heer.* (?)

Pl. III, fig. 8. Pl. XIII, fig. 5–8.

Fragments of very long parallel-sided leaves, 2½–5 mm. in

breadth, resemble very much those described by Heer under the above name from Ust-Balei in Eastern Siberia (Beitr. z. Juraflora Ostsib. u. d. Amurl., 1878, p. 8, Pl. I, fig. 22–27). It is very much to be regretted that in nearly all of our specimens, the surface of the leaf has become entirely smooth, and even in some in which we can trace very faint delicate longitudinal striae, these striae are by no means so distinct as in the Siberian specimens.

Fig. 8, Pl. III, represents the longest leaf among our specimens. It is complete at one end, but broken at the other. Its length is 150 mm. and breadth 3.5–4.5 mm.

I obtained only one specimen from *Shimamura*, but a good many from *Ozō*.

## 49. Carpolithes ginkgoides *m.*

Pl. X, fig. 20–23.

*Fruit ovate, sharply edged, rounded at base, sharply beaked at apex.*

There occur many small ovate bodies in the black shale of Ozō, which are furnished with a sharp beak at the apex. This beak in one specimen (fig. 22) is very long drawn out. The length of these bodies is 7–11 mm. and the breadth 3.5–4.5 mm. They are all provided with a sharp longitudinal edge which is very distinct in fig. 20 and 23. Their surface, when examined through a magnifier, reveals delicate longitudinal striae.

These are perhaps nuts of *Ginkgo*, like those of Eastern Siberia, considered by Heer as belonging to *G. Sibirica Heer (Beitr. 2. Juraflora Ostsib. u. d. Amurl., p. 58, Pl. XI, fig. 13–16)*. Our specimens look most like fig. 13 of Heer; however they are all much narrower in form than those of Siberia. Loc.—*Ozō*.

# Index of the Species described.

# PLATE I.

## Plate I.

Shimamura.

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*Fig. 1, 1a.*—Dicksonia nephrocarpa *Bunb. sp.*

*1b, 2, 2a.*—Dicksonia acutiloba *Hr.*

*3, 3a, 4.*—Thyrsopteris prisca *Eichw. sp.*

*5, 5a.*—Dicksonia gracilis *Hr.*

*6, 6a.*—Thyrsopteris kagensis *m.*

*7, 7a.*—Adiantites Kochibeanus *m.*

*8–10, 9a.*—Pecopteris exilis *Phill.*


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1a
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2a
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3a
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5a
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6a
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7a
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9
9a
10
b

# PLATE II.

# Plate II.

## Shimamura.

*Fig. 1–3, 1a, 3a, 4a b c d.*—Onychiopsis elongata *Geyl. sp.*

*4e.*—Ginkgodium Nathorsti *m.*

1



2



1a

3

3a


M.Y.

*Auctor in lapidem del.*

# PLATE III.

## Plate III.

Shimamura.

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*Fig. 1.*—Asplenium argutulum *Hr. var.*

*2.*—Asplenium distans *Hr.*

*3.*—Asplenium whitbiense *Brgt. sp.*

*4, 5.*—Macrotæniopteris Richthofeni *Schenk.*

*6a b c, 6e.*—Podozamites Reinii *Geyl.*

*6d.*—Onychiopsis elongata *Geyl. sp.*

*7.*—Ginkgodium Nathorsti *m.*

*8.*—Vallisneriites jurassicus *Hr.* (?).


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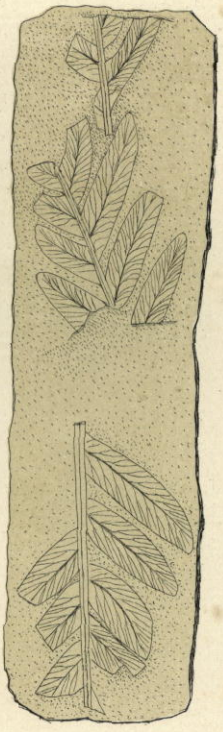
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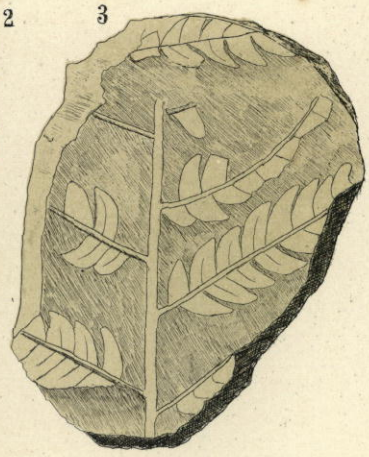
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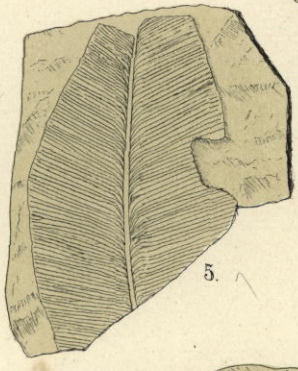
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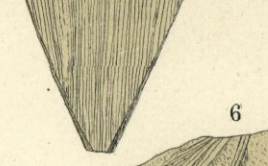
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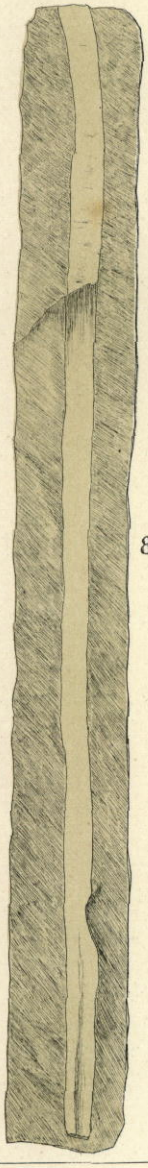
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M.Y.

Auctor in lapidem del.

# PLATE IV.

## Plate IV.

Shimamura.

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*Fig. 1a.*—Podozamites lanceolatus *L. et H. var.* Eichwaldi *Hr.*

*1b.*—Podozamites Reinii *Geyl.*

*1c.*—Podozamites lanceolatus *L. et H. var.* latifolia *Hr.*

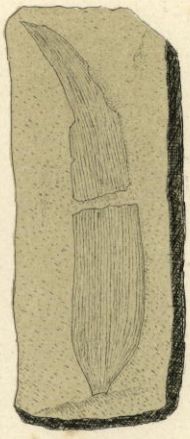
*2.*—Podozamites lanceolatus *L. et H. var.* genuina *Hr.*

*3a.*—Podozamites lanceolatus L. *et H. var.* intermedia *Hr.*

*3b.*—Podozamites Reinii *Geyl.*

*4a.*—Podozamites lanceolatus *L. et H. var.* intermedia *Hr.*

*4b, c.*—Podozamites lanceolatus *L. et H. var.* Eichwaldi *Hr.*




*Auctor in lapidem del.*

# PLATE V.

## Plate V.

Shimamura.

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*Fig. 1.*—Podozamites lanceolatus *L. et H. var.* latifolia *Hr.*

*2a* (?) *2b.*—Podozamites lanceolatus *L. et H. var.* Eichwaldi *Hr.*

*3.*—Podozamites lanceolatus *L. et H. var.* intermedia *Hr.*

*4, 5a b c.*—Podozamites lanceolatus *L. et H. var.* Eichwaldi *Hr.*

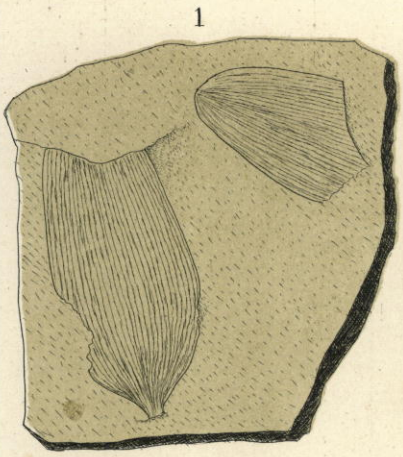
*5d.*—Podozamites lanceolatus *L. te H. var.*

*6.*—Podozamites lanceolatus *L. et H. var.* Eichwaldi *Hr.*

*7.*—Podozamites lanceolatus *L. et H. var.* intermedia *Hr.*

*8.*—Podozamites lanceolatus *L. et H. var.* minor *Hr.*

*9.*—Podozamites lanceolatus *L. et H. var.* intermedia *Hr.*



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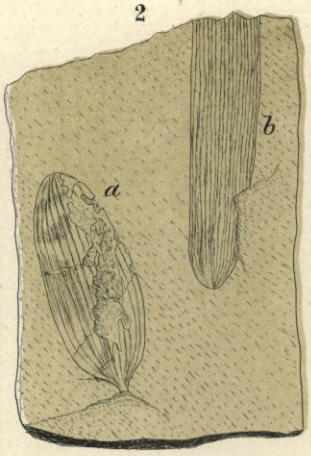


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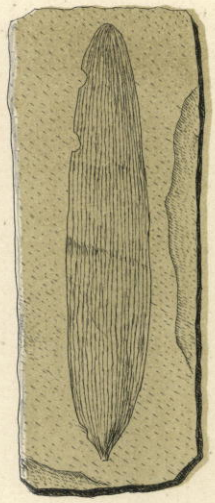

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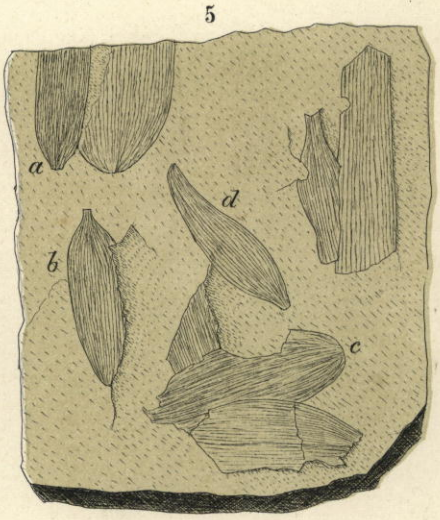


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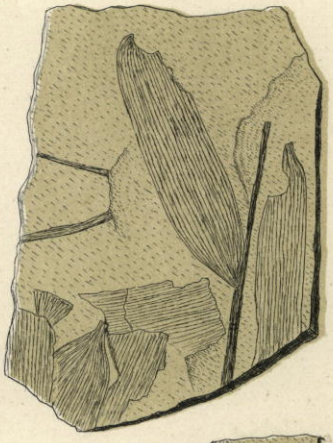

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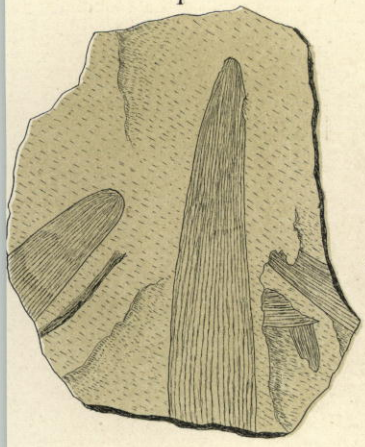

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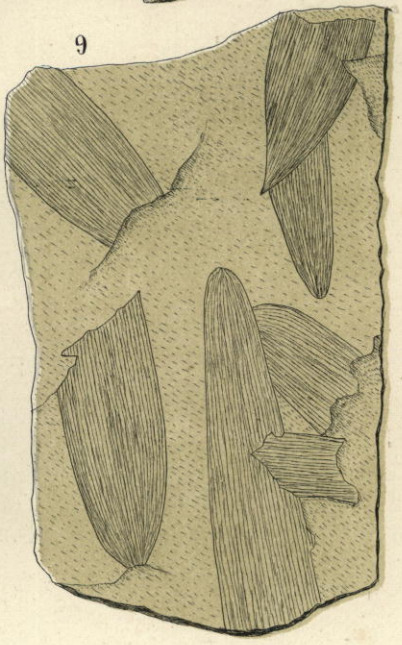

9

M.Y.

Victor in lapidem del.

# PLATE VI.

## Plate VI.

Shimamura.

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*Fig. 1.*—Podozamites lanceolatus *L. et H. var.* latifolia *Hr.*

*2.*—Podozamites Reinii *Geyl.*

*3a.*—Taxites *sp.*

*3b d c, 4–7, 8a b c e.*—Podozamites Reinii *Geyl.*

*8d.*—Nilssonia nipponensis *m.*


M.Y.

uctor in lapidem del.

# PLATE VII.

# Plate VII.

Shimamura.

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*Fig. 1a b c, 1e.*—Dioonites Kotœi *m.*

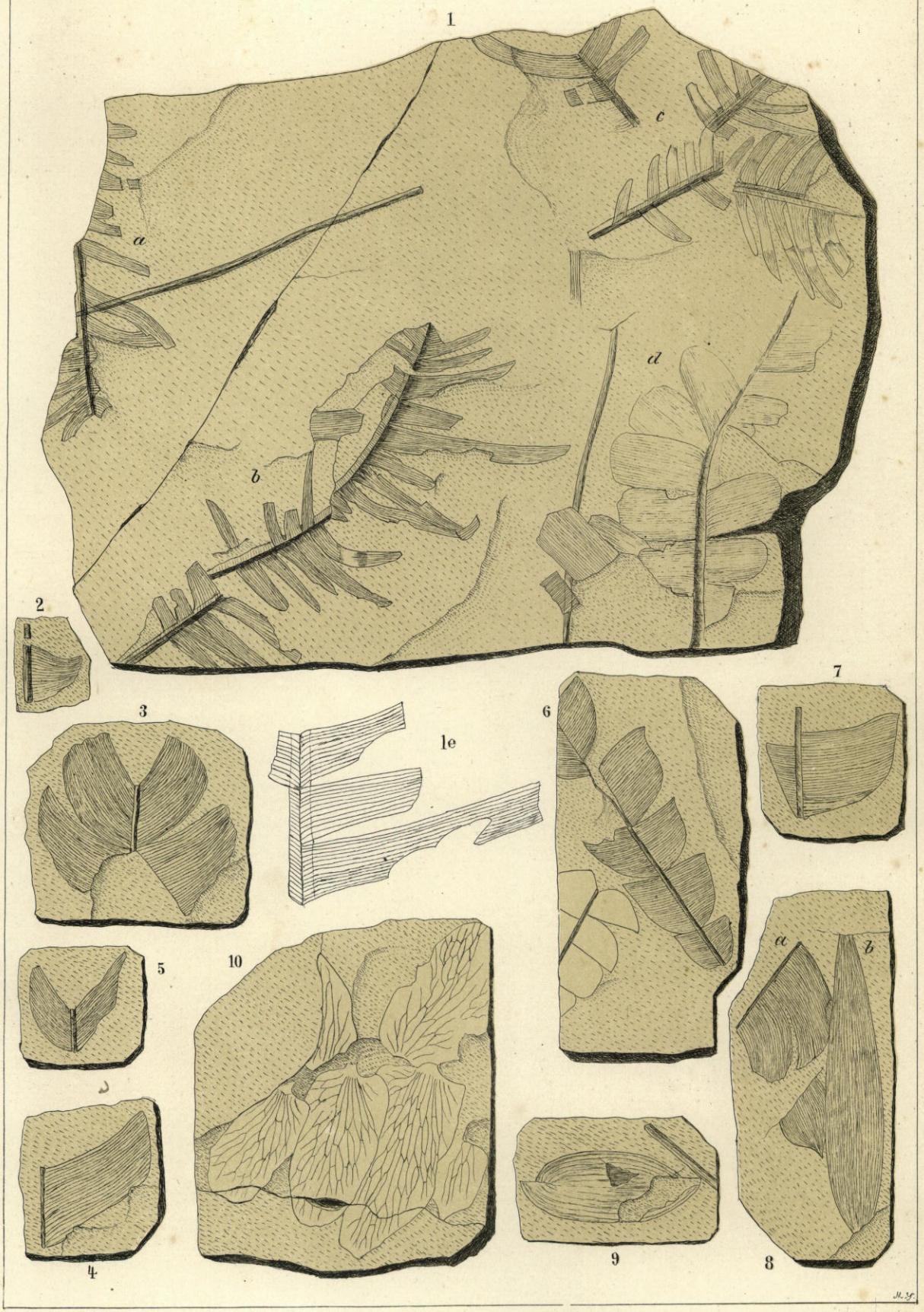
*1d.*—Anomozamites sp.

*2–7, 8a.*—Nilssonia nipponensis *m.*

*8b.*—Podozamites lanceolatus *L. et H. var.* genuina *Hr.*

*9.*—Podozamites sp.

*10.*—Dictyozamites grossinervis *m.*




*Auctor in lapidem del.*

# PLATE VIII.

# Plate VIII.

Shimamura.

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Ginkgodium Nathorsti *m.*


*Auctor in lapidem del.*

# PLATE IX.

# Plate IX.

Shimamura.

*Fig. 1–10, 10a.*—Ginkgodium Nathorsti *m.*

*11.*—Palissya sp.

*12a.*—Podozamites Reinii *Geyl.*

*12b.*—Pinus Nordenskjoldi *Hr.*


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# PLATE X.

# Plate X.

Ozō.

*Fig. 1, 2a.*—Asplenium whitbiense *Brgt. sp.*

*2b.*—Nilssonia ozoana *m.*

*2c,*—Tæniopteris (?)

*3, 3a.*—Sagenopteris *sp.*

*4–10, 8a.*—Dictyozamites indicus *Fstm. var.* distans *m.*

*11–14.*—Nilssonia ozoana *m.*

*15–19.*—Taxites *sp.*

*20–23.*—Carpolithes ginkgoides *m.*


Auctor in lapidem del.

# PLATE XI.

# Plate XI.

## Ushimaru.

*Fig. 1–3.*—Equisetum ushimarense *m.*

*4.*—Asplenium distans *Hr.*

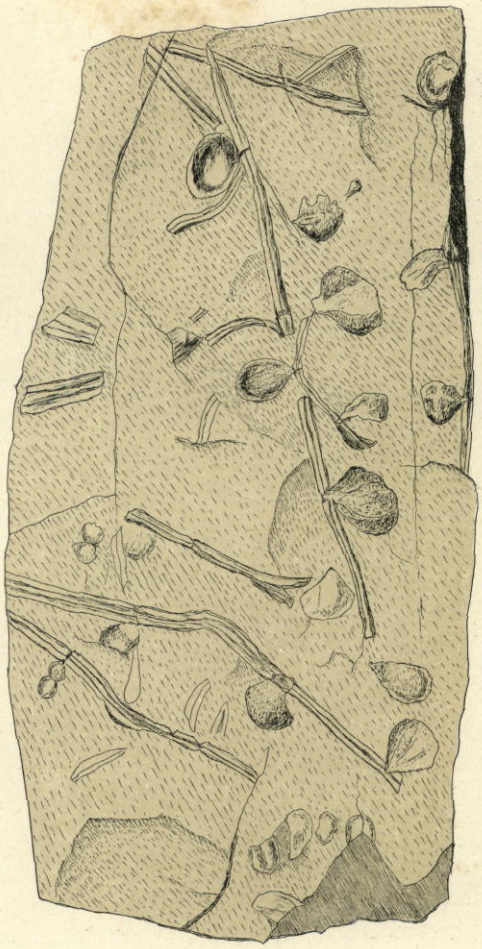
*5.*—Dictyozamites indicus *Fstm. var.* distans *m.*

*6.*—Podozamites lanceolatus *L. et H. var.* (?).

*7.*—Thyrsopteris kagensis *m.*


1


2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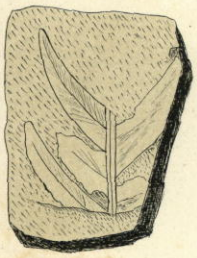
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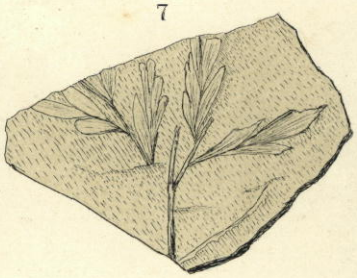
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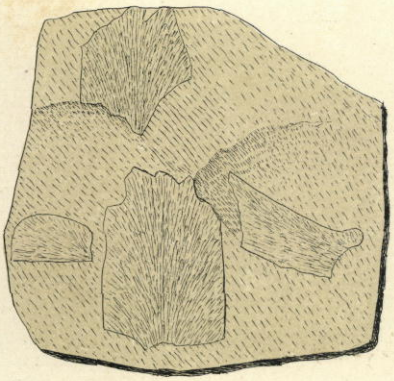
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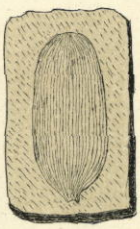
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*Auctor in lapidem del.*

# PLATE XII.

# Plate XII.

## Shimamura.

*Fig. 1, 1a b, 2.*—Adiantites Heerianus *m.*

*3.*—Pinus cfr. prodromus *Hr.*

## Okamigō.

*4.*—Podozamites Reinii *Geyl.*

*5.*—Thyrsopteris Murrayana *Brgt. sp.*

*6.*—Nilssonia nipponensis *m.*

*7.*—Equisetum *sp.*

*8.*—Asplenium argutulum *Hr.*

*9, 10.*—Onychiopsis elongata *Geyl. sp.*

*11.*—Czekanowskia rigida *Hr.* (?)

*12, 12a.*—Podozamites *sp.*

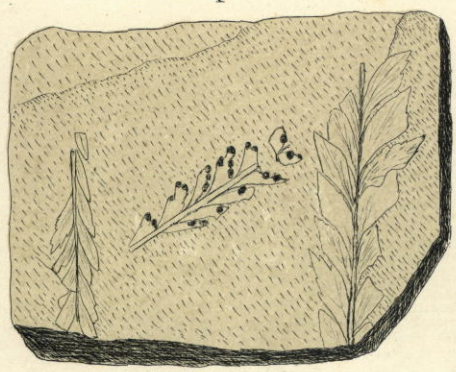
*13.*—Dicksonia gracilis *Hr.*

*14, 15.*—Ginkgodium Nathorsti *m.*

*16, 17.*—Taxites *sp.*

*18.*—Podozamites lanceolatus *L. et H. var.* brevis *Schenk.*

*19.*—Podozamites tenuistriatus *Geyl.*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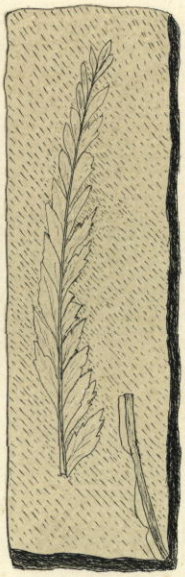
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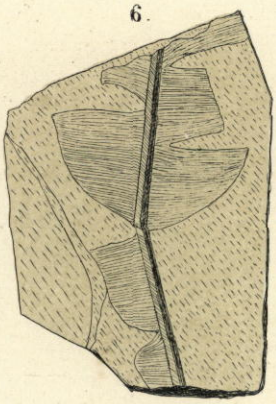
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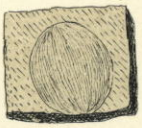
1a


1b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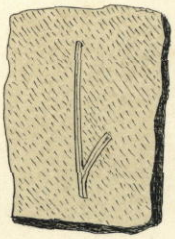
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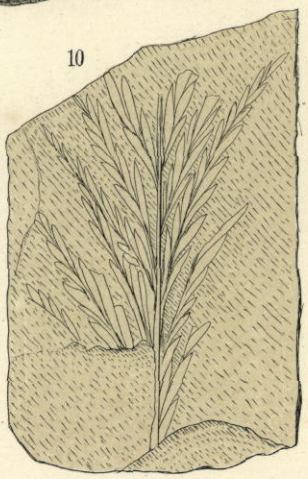
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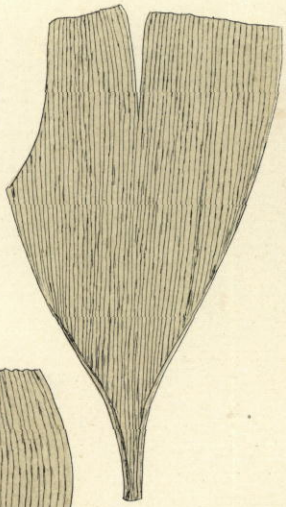
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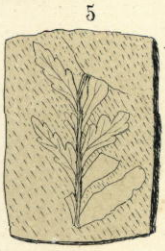
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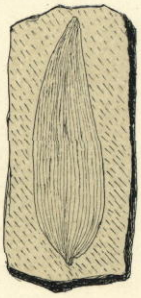
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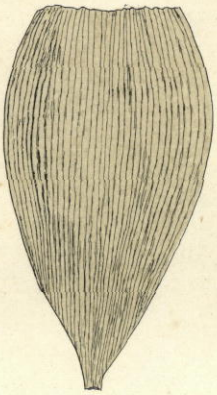
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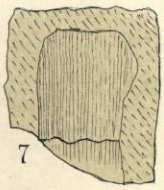
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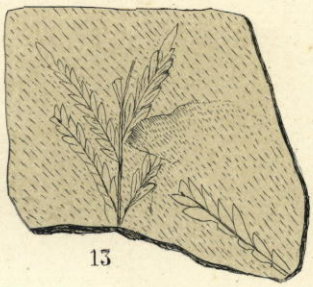
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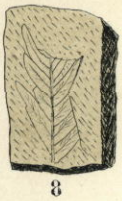
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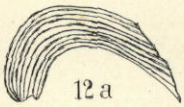

12a


17


16

N. Y.

*Author in lapidem del.*

# PLATE XIII.

# Plate XIII.

## Okamigō.

*Fig. 1.*—Nilssonia nipponensis *m.*

*2.*—Ginkgo digitata *Brgt.*

## Ozō.

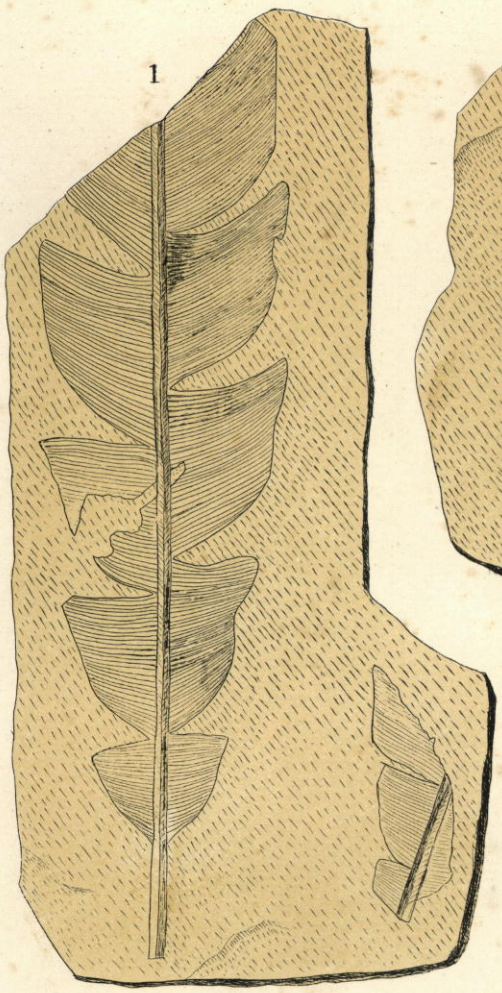
*3.*—Nilssonia (?).

*4.*—Asplenium distans *Hr.*

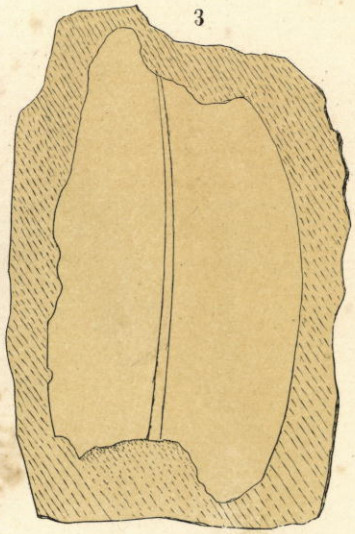
*5–8.*—Vallisneriites jurassicus *Hr.* (?).

*9.*—Asplenium argutulum *Hr.*

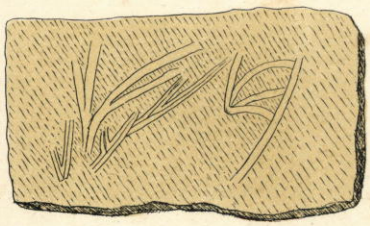
*10.*—Czekanowskia rigida *Hr.* (?).

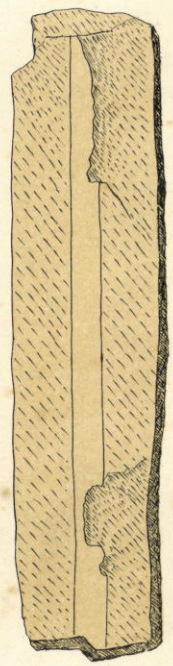


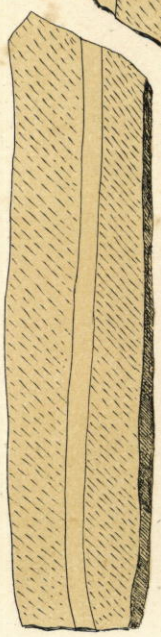


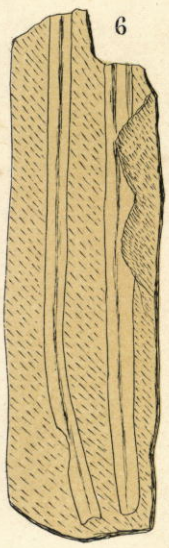


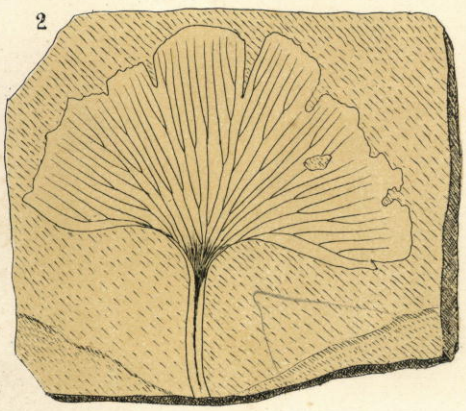



*Auctor in lapidem del.*

# PLATE XIV.

# Plate XIV.

## Hakogase.

*Fig. 1.*—Asplenium distans *Hr.*

*2.*—Asplenium argutulum *Hr.*

*3, 3a.*—Adiantites lanceus *m.*

*4–9.*—Nilssonia orientalis *Hr.*

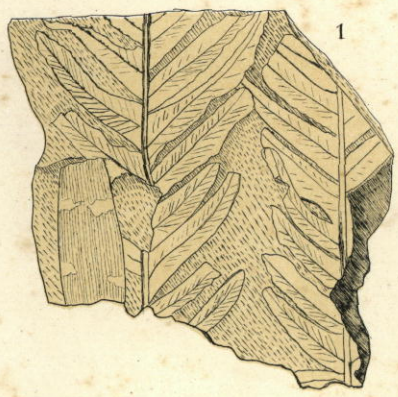
*10.*—Ginkgo cfr. lepida *Hr.*

*11, 11a, 12a.*—Dicksonia cfr. Glehniana *Hr.*

*12b.*—Podozamites lanceolatus *L. et H.*

*13, 13a.*—Sphenopteris *sp.*

*14.*—Dioonites Kotoei *m.*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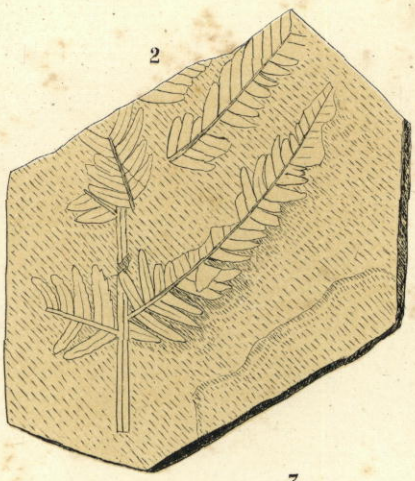
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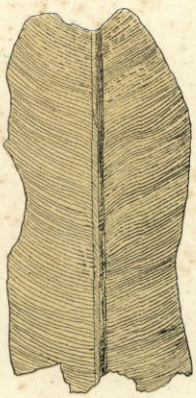
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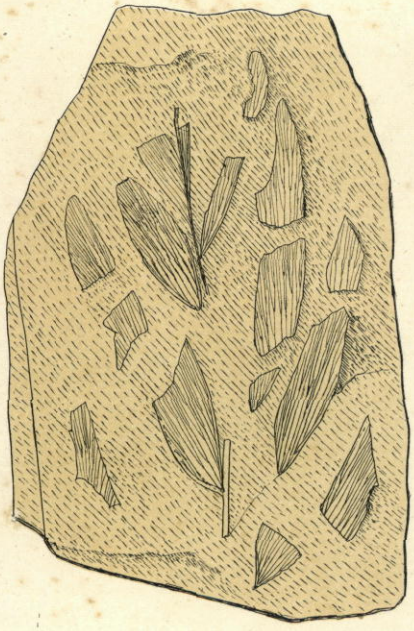
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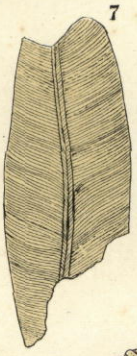
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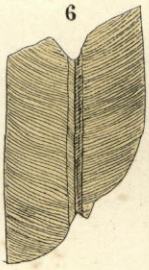
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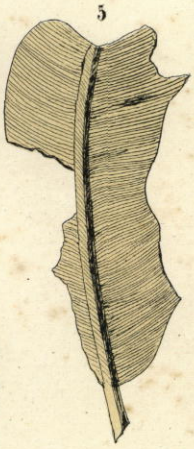
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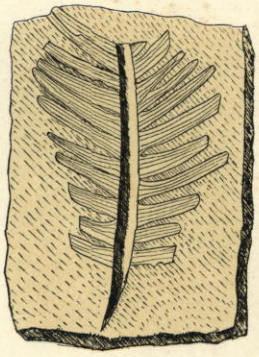
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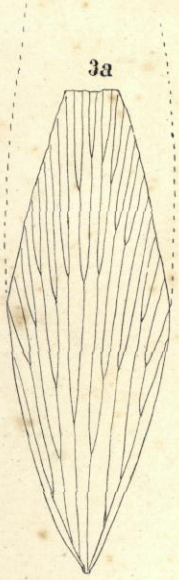
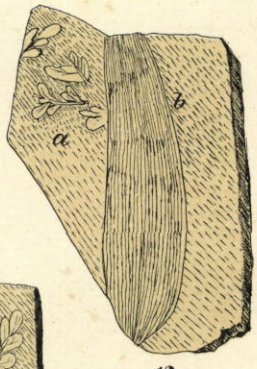

3a


11a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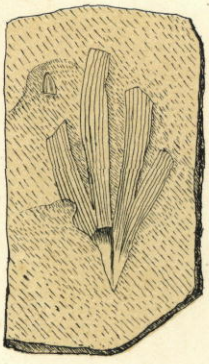
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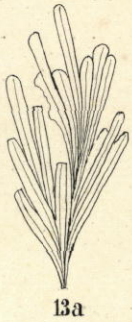
13a

M. Y.

*Auctor in lapidem del.*