

# Mesozoic Plants from Kōzuke, Kii, Awa, and Tosa.

By

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## General Remarks.

In 1890, Prof. A. G. Nathorst, of Stockholm, published a very valuable paper on the fossil plants of Shikoku entitled *Beiträge zur mesozoischen Flora Japans*<sup>1)</sup> The present treatise deals with the same subject, and indeed partly with the fossils therein described.

When I wrote my memoir on the Middle Jurassic flora of Kaga and its neighbouring provinces,<sup>2)</sup> I thought that the plants occurring in Shikoku also belong to the same geological epoch ; but as meanwhile the investigations of the Swedish palæobotanist had shown them to be decidedly younger than the Kaga flora, namely, either Upper Jurassic or Wealden, I deemed it advisable to extend the investigations further than he had carried it, and if possible, obtain a more precise knowledge as to the age in which the Shikoku plant-beds were deposited. With this view I have been engaged for some years in gathering as many specimens as possible, not only from the localities whence Nathorst obtained his material, but also from several other places where similar

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1) *Denkschriften der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften, Wien, Bd. LVII, 1890.*

2) Yokoyama.—*Jurassic Plants from Kaga, Hida, and Echizen. Journal of the College of Science, Imperial University, Japan, vol. III, 1889.*

fossils occur. These specimens, together with those already in the museum of the Imperial University, Tōkyō, form the subject of the following pages.

Before entering, however, into the consideration of the general character of the above fossils, it may be well to give a brief account of the geological nature of each locality in which plants are found.

The places whence I obtained my material are the following :

1. Kagahara, province Kōzuke.
2. Yuasa, province Kii.
3. Sakamoto, Fujikawa, and Tannō, in the Katsuragawa basin, province Awa (Ashū).
4. Kataji, Ishiseki, and Tōgodani, near Ryōseki, province Tosa.
5. Kaisekiyama, not far from Sakawa, province Tosa.
6. Yoshida-Yashiki, near Sakawa, province Tosa.
7. Chōja, in the Shiraishigawa-valley, province Tosa.

### 1. Kagahara.

In a long and narrow Mesozoic depression in the northern part of the Chichibu Mountains, commonly known as the Sanchu-Ditch, there occurs a thick series of shales and sandstones with subordinate layers of conglomerate. The greater part of this formation was found to belong to the Gaulto-Cenomanian epoch. From beneath these Cretaceous rocks, there peeps out, in the valley of the Hachimanzawa, a set of strata consisting of conglomerates in the lower part, and of shales and sandstones in the upper. The shales and sandstones contain in their lower horizon innumerable remains of fresh-water shells, of which *Cyrena* forms the most important part. Plants occur

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1) Yokoyama.—*Versteinerungen aus der japanischen Kreide. Palæontographica, vol. XXXVI, 1890. On some Cretaceous Fossils from Shikoku. Journal of Coll. Science, Imp. Univ., Japan, vol. IV, pt. II, 1891.*

in a horizon higher than the shells, and are imbedded in a dark, soft, often sandy, and at the same time micaceous, shale, easily splitting into slabs. The state of preservation of the fossils leaves much to be desired, most of them being changed into a black coaly substance. The number of species which I could distinguish is 7, among which *Cyprisidium* (?) *japonicum* is by far the most abundant.

## 2. Yuasa.

In 1881, while I was engaged in reconnoitring the geology of Kii, I discovered fossil plants on the northern shore of the Bay of Yuasa, Yuasa being a town about 7 ri south of Wakayama. The spot is locally known as Mizutani, and lies between low and high water marks. Here a well stratified sandstone crops out from beneath the water, steeply dipping towards the north. This sandstone passes above into a conglomerate overlaid by a dark-blue shale. The rock in which I found the fossils is the sandstone. It is soft, fine-grained, greyish to yellow, brittle and often argillaceous, and easily splitting into thin plates. The fossils are generally in good preservation, but owing to the brittle nature of the rock, large specimens are difficult to obtain. The number of species found is 13, among which *Pecopteris Geyleriana* is the most frequent. I obtained here also a species of *Estheria*.

## 3. Sakamoto, Fujikawa, and Tanno.

These three places all lie in the valley of the Katsuragawa, in Awa, and very close to one another. The discoverer of the fossils was my lamented colleague, the late Prof. Y. Kikuchi, who surveyed the district in 1882. According to his report,<sup>1)</sup> the valley is composed of the Mesozoic plant-bearing series, overlaid by the Cretaceous sandstone

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1) *Geology of Awa, 1883 (M.S.)*.

in which I had already recognised the occurrence of the Middle Cretaceous *Trigoniae*.<sup>1)</sup> The plant-bed consists of shales and sandstones, and is sometimes in such close relation with the *Trigonia* sandstone that it is difficult to distinguish the boundary between the two.

From Sakamoto I possess many small fragments of a dark grey shale in which badly preserved molluscan shells are found, and a big block of the same rock containing a single species of *Zamiophyllum Buchianum* Ett. sp.

At Fujikawa the plant-bearing rock is a dark-grey, hard, fine-grained sandstone which is sometimes clayey and passes to shale. Owing to the more or less rough nature of the sandstone, the preservation is far from satisfactory, the minute details of the plants being in most cases obliterated. The number of species found at this locality is 5.

The plants of Tanno are found in a dark brittle shale, exposed in a valley called Kashiwaradani, deeply cut by a stream. The upper part of this shale becomes sandy, and on it is superposed the Cretaceous sandstone. Kikuchi found in pebbles probably derived from the sandy part of the shale some remains of fresh-water molluscs. The preservation of the plants is generally excellent, but we have only four species from this locality and all in small fragments.

From Hiura in Mitani, near Sakamoto, Nathorst obtained 3 species, but in my collection there is none which comes from the same place.

#### 4. Kataji, Ishiseki, and Tōgodani.

These localities all lie in the Ryōseki "Hügelland" of Dr. Naumann. The geological nature of this district has been recently studied by Mr. M. Yamagami, now a geologist in the Imperial

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1) *On some Cretaceous Fossils from Shikoku. Op. cit.*

Geological Survey. According to his report,<sup>1)</sup> the lowest Mesozoic stratum in the vicinity of Ryōseki consists of a black shale upon which there is a coarse conglomerate occupying the greater part of the district. The plant-bearing rocks are shales and sandstones which overlie this conglomerate. Immediately over the plant-bed, there rests the Cretaceous formation with its characteristic *Trigonia pocilliformis*, and in the midst of this formation there peeps out at Okuminodani a dark compact limestone, exactly similar to the Upper Jurassic limestone of Torinosu in Sakawa, and containing the spines of the same glandiferous *Cidaris* as occurs in it. The relation of this limestone to the plant-bed is not exactly known, but from its direction of dip, it seems to underlie the latter.

The fossil locality of Kataji is in a river bed. The rock is a dark-grey, hard, fine-grained sandstone, more or less clayey and easily splitting into large slabs. Fossils are numerous, but rare in species. Furthermore, owing to the smoothly polished and carbonised nature of the vegetable substance, the details of the plants are for the most part effaced. The number of species and varieties obtained is 13, among which *Pecopteris Geyleriana* and *Zamiophyllum Buchianum* seem to play the most important part.

The fossil layer at Ishiseki which is a place very near to Kataji, is exposed in a little stream-bed, and is a sandstone similar to that of the preceding place, although somewhat lighter-coloured. The number of plants is many, but of species few. Moreover, the state of preservation is exactly like that of Kataji, so that the two localities seem to belong to exactly the same horizon. The number of species here obtained is 6; *Chladophlebis Nathorsti* is the most frequently observed.

In the upper part of Tōgodani, a small side-valley of the Kasanogawa, is a cliff which is the fossil locality here. The rock is a

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1) *On the Plant-bearing Beds of the Ryōseki Basin, 1892 (M.S.).*

greenish-grey sandy shale which passes into a shaly sandstone. It is fine-grained and tolerably firm, but where it is exposed to air, it is yellowish and more brittle. The plants are very well preserved. I obtained 8 species, but principally *Pecopteris Browniana*, *Zamiophyllum Buchianum* and *Nilssonia schauburgensis*.

The majority of the fossils from the above three localities are those sent by Mr. Gyōken Otsuka of Ryōseki at the request of Prof. Kotō.

Nathorst in his paper described also some from Yakyō, Ueno, Torikubi, Ōtani, and Haginotani, places all in the neighbourhood of Ryōseki.

### 5. Kaisekiyama.

This is a mountain north of Sakawa, also called Kompirayama from a temple dedicated to Kompira standing on its top. The spot where plants occur is on the southern flank of this mountain, in a soft, yellow, sandy shale, where there are numerous impressions of plants from which collection has been made partly by Mr. T. Nasa, and partly by myself. The preservation is excellent, but the rock is so soft and brittle that unless the greatest care is taken, the specimens are apt to fall to pieces. The number of species which I could distinguish from this locality amounts to 8, besides 1 variety, among which *Pecopteris Browniana* is the most abundant.

### 6. Yoshida-Yashiki.

At this place close to the town of Sakawa a series of sandstones and shales covers unconformably a dark, compact, bituminous, so-called Torinosu-limestone containing fossils which are referable to the Malm.<sup>1)</sup> The plants occur in shales which are ash-grey and

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1) Naumann und Neumayr — *Zur Geologie und Palaeontologie von Japan*. *Denksch. d. mathem.-naturw. Cl. d. Kaiserl. Akad. d. Wissensch.*, LVII Band, 1890.

sandy, and easily split into thin plates. The only species which I could find in a collection made by Mr. Nasa is that already described by Nathorst, viz., *Pecopteris Browniana*. However from the specimens, which are present in large numbers, I could convince myself how variable the form of the pinnules is in different parts of the frond. In the underlying limestone we find also now and then impressions of plants which have been very probably drifted into it. I have been able to distinguish only two forms, one a *Chladophlebis*, and the other a *Nilssonia* resembling *N. pterophylloides*. However, owing to their unfavourable state of preservation precise determination is not possible.

### 7. Chōja.

Chōja is a mountain village in the valley of the Shiraiishigawa, many kilometers to the west of Sakawa. I got only a single piece of stone from this locality, collected by Mr. Toyama, a zealous collector of fossils at Sakawa. It is an ash-grey sandy shale, quite similar to that of Yoshida-yashiki, and contains also only a single species, *Pecopteris Browniana*. According to Toyama and others, a limestone occurs in the locality.

### Conclusion.

The number of fossils which I have been able to obtain from the above enumerated places amounts to 24 species and 1 variety. Of these 24 species, 23 are plants and 1 a phyllopod. Adding to these, 3 species and 1 variety described by Nathorst, viz. *Macrotenipteris marginata*, *Lycopodites* sp., *Ptilophyllum* cf. *cutchense* and *Podozamites lanceolatus* var. *latifolia*, the total number becomes 26 species and 2 varieties of plants, and 1 species of animal. Before proceeding, however directly to the conclusion which is to be drawn from the occurrence

of these fossils, it is very necessary to examine whether the floras of all the localities represent one and the same geological horizon. In the first place, that the 8 localities around Ryōseki, namely, Kataji, Ishiseki, Tōgodani, Yakyō, Ueno, Torikubi, Ōtani, and Haginotani, palæontologically belong to the same formation is not to be the least doubted; for out of 15 species which were obtained from all the places together, 12 are found at Kataji, so that Ishiseki with 6, Tōgodani with 8, Ueno with 4, Yakyō, Torikubi, Ōtani, and Haginotani, each with 2, may be fairly considered as a part of the Kataji flora. Of the 3 species which are not found at Kataji, 1 is from Ueno, 1 from Tōgodani, and 1 from Yakyō, the last of which, however, is represented in several other spots out of the Ryōseki District.

Also that the four places in the valley of the Katsuragawa, viz., Sakamoto, Fujikawa, Tanno, and Mitani, belong to the same terrain, although the number of species is not so large, and the relation of the respective floras to one another is not so evident as in Ryōseki, there is every reason, both geological and palæontological, to believe. We have therefore in all 7 distinct localities from which fossils were got. These localities show close affinity in their floras, as will be seen from the following table:—



NAME OF LOCALITIES.	Total no. of spec. found.	Number of species in common with.							Total no. of spec. found elsewhere.
		Kagahara.	Yuasa.	Katsuragawa.	Ryōseki.	Kaisekiyama.	Yoshida-yashiki.	Chōja.	
Kagahara .....	7	—	5	4	4	3	0	0	5
Yuasa .....	13	5	—	4	9	6	0	0	8
Katsuragawa .....	9	4	4	—	6	4	1	1	7
Ryōseki .....	15	4	9	6	—	7	1	1	10
Kaisekiyama .....	8	3	6	4	7	—	1	1	7
Yoshida-yashiki ...	1	0	0	1	1	1	—	1	1
Chōja .....	2	0	0	1	1	1	1	—	1
Unknown locality...	1	0	0	0	0	0	0	0	0

Thus, Kagahara has 7 species, 5 in common with others; Yuasa 13, 8 in common with others; Katsuragawa 9, 7 in common with others; Ryōseki 15, 10 in common with others; and Kaisekiyama 8, 7 in common with others; while Yoshida-yashiki has only 1, represented in many other localities, and Choja 2, 1 of which is the same as that of the preceding place. Such being the case, the floras of all the places except the last may be safely looked upon as belonging to the same epoch. Of Chōja we shall speak more later on.

Having thus proved the close relationship existing between the floras of the respective localities, the next question is their age. Except Chōja, and an unknown locality yielding *Macrotaniopteris marginata*, the number of plants collected in various localities amounts to 25 species and 2 varieties. Of these 25 species, 3 are not determinable, and 15 are peculiar to Japan and indeed to the formation in question; so that what might be available, if ever available, for the fixing of the age would be the following:

1. *Onychiopsis elongata* Geyl. sp.
2. *Pecopteris Browniana* Dunk.
3. *Pecopteris cf. virginiensis* Font.
4. *Podozamites lanceolatus* Lindl. var. *minor* Heer.
5. *Podozamites lanceolatus* Lindl. var. *latifolia* Heer.
6. *Podozamites pusillus* Velenov.
7. *Zamiophyllum Buchianum* Ett. sp.
8. *Zamiophyllum Buchianum* Ett. sp. var. *angustifolia* Font.
9. *Nilssonia schauburgensis* Dunk. sp.
10. *Nilssonia Johnstrupi* Heer.

Let us now speak of each species separately. *Podozamites lanceolatus* has a very wide geographical range, but its vertical distribution is equally as wide, for it appears in the Rhætic and goes up as high as the Cenomanian, according to Velenovsky. It is not improbable that we have here to deal, in many cases, with forms which are in reality specifically different, but as long as we are left to rely only on leaves in their determination, we can not but consider these forms as belonging to one and the same species. Therefore this cycad only tells us that we have here a formation which is referable to the Mesozoic group. *Onychiopsis elongata* has hitherto been found only in the Dogger of Japan where, however, it forms one of the most abundant plants. On this account we do not know yet how wide its vertical range may be. The case is different with the three species of *Pecopteris Browniana*, *Nilssonia schauburgensis*, and *Zamiophyllum Buchianum*. The first two are characteristic Wealden plants in Europe, and the first has been also described from the Potomac Formation in America which Fontaine considers as Neocomian. The third one is Urgonian in Europe and Potomac in America, and is very abundant in the latter region. These three species are therefore very important for Japan, especially because they occur in many localities and sometimes

also in great profusion. *Pecopteris virginensis* and *Zamiophyllum Buchianum angustifolia* are also Potomac, and if the latter is really identical with *Dioonites abietinus*, as Fontaine asserts, it occurs also in the European Wealden. The two remaining forms, *Podozamites pusillus* and *Nilssonia Johnstrupi* are hitherto only Cretaceous, the former being found in the Cenomanian of Bohemia, and the latter in the Kome-beds of Greenland, considered by Heer as of Lower Cretaceous age. Thus, the greater part of the fossils point to the Wealden or to the Lower Cretaceous. But as the Wealden is generally looked upon as the fresh-water equivalent of the lowest Cretaceous, I go a step further than Prof. Nathorst, and say that the plant-bearing beds of Kōzuke, Kii, and Shikoku represent the whole Neocomian series, corresponding to the Potomac of America. This assertion is in accordance with their geological position. On the one hand they show a close relationship to the *Trigonia* Sandstone of the Gault-Cenomanian, and on the other to the so-called Torinosu or *Cidaris* Limestone, which has been considered as Upper Jurassic. As to Chōja, which has yielded only *Pecopteris Browniana* and *Ptilophyllum cf. cutchense*, it is difficult at present to make any definite statement; but the occurrence of a *Pecopteris* so characteristic of Wealden seems to show, in spite of the other, that we have here to deal with strata which in all probability belong to the same geological formation as the other localities.

In contrast to the Middle Jurassic flora of Kaga, a marked feature in the one above discussed, is the comparative rarity of species already found in other countries. This is no doubt due, not only to the preponderance of marine deposits in the early part of the Cretaceous period and consequent scarcity in rocks containing vegetable remains, but also to the fact that the already known floras of this epoch such as the Wealden and the Potomac belong to provinces widely distant from

ours; whilst in the Dogger flora we have a comparatively rich one from Siberia.

The determination of the age of the plant-beds leads to the conclusion that on the outer or convex side of Japan, as far as our present investigation goes, no Middle Jurassic fresh-water formation is developed. But whether the converse holds true, that no Younger Mesozoic plant-beds have been deposited on the inner or concave side of Japan is at present difficult to say and must be left for future investigation to determine.

For convenience' sake I propose the name of *Ryōseki Series* for all those strata containing Younger Mesozoic plants in distinction to those containing Middle Jurassic ones. For the latter I also suggest the name *Tetori Series*, from the valley of the river Tetori in Kaga, where they were first discovered.

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	Kō-zukē.		Awa.				Tosa (Ryōseki district).							Tosa.			Unknown Locality.	
	Kagahara.	Yuasa.	Sakamoto.	Fujikawa.	Tanno.	Mitani.	Kataji.	Ishiseki.	Togodani.	Yakyo.	Ueno.	Torikubi.	Ōtani.	Haginotani.	Kaisekiyama.	Yoshida-Yashiki.		Chōja.
FILICES.																		
1. <i>Thyrsopteris</i> sp. ....	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2. <i>Dicksonia tosana</i> .....	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
3. <i>Dicksoniopteris Naumanni</i> .....	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..
4. <i>Onychiopsis elongata</i> .....	+	+	..	+	..	+	+	+	+	+	..	+	+	+	..	..	..	..
5. " <i>elegans</i> .....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
6. <i>Adiantites yuasensis</i> .....	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
7. <i>Pteris</i> (?) sp. ....	+	?	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8. <i>Sphenopteris tenuicula</i> .....	+	+	..	..	..	..	..	..	+	..	..	..	..	..	+	..	..	..
9. <i>Pecopteris Browniana</i> .....	..	..	..	+	..	..	+	..	+	..	..	..	?	+	+	+	..	..
10. " <i>Geyleriana</i> .....	..	+	..	+	..	..	+	..	..	..	+	..	..	+	..	..	..	..
11. " <i>cf. virginiensis</i> .....	..	..	..	+	?	..	..	..	..	..	..	..	..	..	..	..	..	..
12. <i>Chladophlebis Nathorsti</i> .....	..	+	..	..	..	?	+	+	+	..	+	..	..	+	..	..	..	..
13. <i>Macrotæniopteris</i> (?) <i>marginata</i> .....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
LYCOPODIACEÆ.																		
14. <i>Lycopodites</i> sp. ....	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
CYCADEACEÆ																		
15. <i>Podozamites</i> sp. ....	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
16. " <i>lanceolatus</i> var. <i>minor</i> .....	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
16 a. " " <i>latifolia</i> .....	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
17. " <i>pusillus</i> .....	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
18. <i>Zamiophyllum Buchianum</i> .....	+	+	+	..	+	..	+	+	+	..	+	+	+	..	+	..	..	..
18 a. " " var. <i>angustifolia</i> .....	..	+	..	..	..	..	+	..	..	..	..	..	..	..	+	..	..	..
19. " <i>Naumanni</i> .....	..	+	..	..	..	..	+	+	+	..	..	..	..	+	..	..	..	..
20. <i>Glossozamites parvifolius</i> .....	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
21. <i>Nilssonia Johnstrupi</i> .....	..	..	..	..	..	..	+	..	+	..	..	..	..	..	..	..	..	..
22. " <i>schaumburgensis</i> .....	+	+	..	..	..	+	+	..	+	..	..	..	..	..	..	..	..	..
23. " <i>pterophylloides</i> .....	..	+	..	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..
24. <i>Ptilophyllum cf. cutchense</i> .....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..
CONIFERÆ.																		
25. <i>Cyparissidium</i> (?) <i>japonicum</i> .....	+	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
26. <i>Torreya venusta</i> .....	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
PHYLLOPODA.																		
27. <i>Estheria rectangula</i> .....	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Middle Jurassic of Kaga, Hida, etc.

Wealden of Europe. Potomac of America.

Potomac of America.

Rhætic, Jurassic and Cretaceous of Europe.

Middle Jurassic of Kaga etc.

Cenomanian of Bohemia.

Urgonian of Europe, Potomac of America.

Potomac of America.

Kome beds of Greenland.

Wealden of Europe.

Rajmahal of India.

## Description of the Species.

## Filices.

1. *Thyrsopteris* sp.

Pl. XXIII, Figs. 2, 3.

On a piece of stone, represented in fig. 2, there are many elongated pinnæ apparently belonging to a twice pinnated frond. They taper very gradually forward, and seem to be tolerably distant. The pinnules are long, alternate, more or less directed forwards, close together, and sharply toothed. The general appearance of the fern reminds us of the many species of *Thyrsopteris* hitherto described from the Jurassic and Cretaceous rocks. It also closely resembles *Onychiopsis elongata* Geyl. (see further on), which possesses, however, more acutely directed pinnules. It is to be regretted that the lateral veins are so indistinct as not to permit of any stricter comparison with the already known forms being made.

Fig. 3 probably represents an apical part of the same fern. Pinnules are here linear and not unlike those of *Pecopteris virginianensis* Font. described below.

*Loc.*—Fujikawa, in the Katsuragawa basin.

2. *Dicksonia tosana* m.

Pl. XXV, Figs. 13, 13a.

*Frond tripinnated; rachises of various orders rather slender; primary rachis bent somewhat zigzag, others nearly straight; primary pinnae elongated, distant, rising at nearly right angles to the rachis; secondary pinnae comparatively short, alternate, close together and a little overlapping, those on the back of the rachis being more acutely directed forward and*

bearing more elongated pinnules than those on the front pinnules linear to elliptical, acute at apex, directed more or less forwards and close together; veins fine, few, indistinct, an evanescent midvein sending off a few simple lateral veins.

This slender and elegant fern is, I believe, to be brought under *Dicksonia*, and indeed close to *D. acutiloba* Heer (Yokoyama, Jurassic Plants. p. 24, Pl. I. figs. 2, 2a, 1b), from which however it is distinguished in having shorter ultimate pinnæ, which on the back of the secondary rachis are more acutely directed forward than on the front. The pinnæ with the linear pinnules look also not unlike those of *Onychiopsis elongata* Geyl. Veins are in most cases not distinctly visible, in one or two cases however they were observed, and then arranged as in fig. 13a.

*Loc.*—Tōgodani near Ryōseki. Only a single specimen.

### 3. *Dicksoniopteris Naumanni* Nath.

Pl. XXV, Fig. 4.

*Dicksoniopteris Naumanni*.—Nathorst, Beitr. zur mesoz. Flora Japans, p. 11, pl. V, fig. 4.

What Nathorst described from Haginotani under the above name was found also at two other localities cited below. The fern is rather slender, with distant, opposite pinnæ rising at an angle of 60–65° from a straight main (?) rachis. Pinnules are elongated, finger-like, obtuse, more or less crenulate and quite close together, although not overlapping. The margins of these pinnules show on each side 4 or 5 round fruit-dots, most of which however have left only slight impressions on the stone. Veins have been nearly obliterated, the only thing which I can now and then observe being a very fine midvein which near the apex is indistinct.

*Loc.*—Kataji and Ishiseki, near Ryōseki. Rare.

4. *Onychiopsis elongata* Geyl.

Pl. XX, Fig. 8. Pl. XXI, Figs. 1, 4.

*Onychiopsis elongata*—Yokoyama, Jurassic Plants, p. 27, pl. II, fig. 1-3, III 6d, XII, 9,10. Nathorst, Beitr. z. mesoz. Flora Japans, p. 4, pl. I, fig. 1-3, p. 8, p. 10, p. 13, p. 14, pl. VI, fig 5.

*Thyrsopteris elongata*—Geyler, Ueb. Foss. Pflanzen a. d. Juraform. Japans, p. 224, pl. XXX, fig. 5, XXVI, 4, 5. Schenk, in Riechthofen's China, vol. IV, part X, p. 263 pl. LIV, fig. 1.

This fern, which is so numerous in the Middle Jurassic of Kaga, Hida, and Echizen, is also abundantly represented in several of the localities in Tosa and Awa. It is easily distinguished from the nearly related forms by the characteristic long linear pinnules acutely directed forward. Sterile as well as fertile fronds were obtained, the fertile ones being quite similar to those figured by me in the above mentioned work.

Nathorst's opinion that *Sphenopteris Mantelli* Schenk of the Wealden and *Thyrsopteris capsulifera* Velen. from the Cenomanian of Bohemia belong to *Onychiopsis*, is, I believe, quite justified.

*Loc.*—Numerous at Kaisekiyama near Sakawa, and Fujikawa in the Katsuragawa basin, less so at Yuasa and Kagahara. It also occurs at Kataji, Tōgodani, and Ishiseki, and by Nathorst it has been also described from Yakyō, Ueno, Ōtani, Haginotani and Hiura (Mitani).

5. *Onychiopsis elegans* m.

Pl. XXVIII, Fig. 7, 7a.

*Frond twice pinnated; pinnae elongated, rachis slender with a terminal pinnule; pinnules tolerably close together, thin, opposite or alternate, directed forwards, lanceolate, broadest at base and gradually tapering above, entire in the lower half and coarsely toothed at the upper, with apex obtusely pointed.*



*Veins rather numerous with distinct but evanescent midvein; lateral veins acute, simple or once forked.*

The general features of this graceful fern are those of *Onychiopsis*, although in some respects it also resembles *Dicksonia*. The generic determination is therefore not settled.

*Loc.*—Kaisekiyama. Only one specimen.

### 6. *Adiantites yuasensis*, *n.*

Pl. XXI, Fig. 15.

I have only a single and not quite perfect specimen of this fern. It shows a pinna with a slender rachis on which we see subopposite, distant, very thin, oval pinnules cuneate at base and furnished with a short stalk. The upper margin is not well preserved. Veins are very typical, being fine, very numerous, equal, divergent, and repeatedly dichotomous. Therefore, there is not the least doubt that we have here to deal with a fern closely akin to our recent *Adiantum*.

Schenk described from the Albours Chain a similar form under the name of *Adiantum Tietzei* (Die von E. Tietze in der Albourskette gesam. foss. Pflanzen, p. 3, pl. II, fig. 2) which possesses larger and more closely set pinnules.

*Loc.*—Yuasa in Kii.

### 7. *Pteris* (?) sp.

Pl. XX, Fig. 9. Pl. XXI, Fig. 6, 7. (?)

A fragment of a fern from Kagahara (Pl. XX, fig. 9) having thin, parallel-sided, spathulate pinnules, which measure a little over 2 cm. in length and 8–9 mm. in breadth. One of the pinnules is seen attached to the slender rachis by the greater part of the base. Veins are fine and numerous. The midvein is distinct. The lateral

veins are very fine, once or twice forked, and rise at first acutely, but soon bend outward so as to be nearly perpendicular to the midvein.

The fragments in Figs. 6 and 7, pl. XXI, from Kii with evanescent midvein resemble in many respects the fern just described. But the pinnules seem to be broader and the veins coarser.

The specimens represented in the figures above cited are at all events too imperfect to allow even a correct generic determination.

*Loc.*—Kagahara, Yuasa (?). Rare.

### 8. *Sphenopteris tenuicula* m.

Pl. XX, Fig. 11. Pl. XXI, Figs. 2, 2a. Pl. XXVIII, Fig. 6.

*Frond tripinnated; rachises of various orders slender; ultimate pinnae short; pinnules thin, remote, obtuse, very acutely directed forward, cuneate at base, entire or lobed or even pinnately parted; lobes or partitions few, also obtuse and some of them may again be furnished with 2 or 3 coarse crenations; veins few, equal, fine, divergent, and several times forked.*

This fern is present only in small fragments, yet is sufficiently characterised to be treated as a new form. It seems to have been tolerably delicate, as can be judged from the slender rachises and thin pinnules.

*Sphenopteris Auerbachi* Trautschold (Der Klin'sche Sandstein, p. 19, pl. XVIII, fig. 5) and *Sphenopteris Goeperti* Dunker (Monographie der norddeutschen Wealdenbildung, p. 4, pl. I, fig. 6, IX, 1-3) are near relatives of our Japanese species. But in the former the venation is obsolete, while in the latter the lobes are single-veined. *Thyrsopteris brevipennis* Fontaine (The Potomac or Younger Mesozoic Flora, p. 124, Pl. XXXIV, fig. 3, XXXVI, 2) is also not unlike our plant, but possesses more numerous veins.

What Nathorst calls *Sphenopteris cf. Goeperti* Dunker (Beiträge, p. 11, pl. VI, fig. 2, 3) probably pertains to the same fern.

*Loc.*—Yuasa (numerous fragments), Kaisekiyama (rare) and Kagahara (rare).

### 9. *Pecopteris Browniana* Dunk.

Pl. XXIV, Fig. 2, 3. Pl. XXVII. 1-4, 5*ed.*

*Pecopteris cf. Browniana*—Nathorst, Beitr. z. mesoz. Flora Japans, p. 13, pl. V, fig. 5.

*Pecopteris Browniana*—Dunker, Monographie d. norddeutschen Wealdenbildung, p. 5, pl. VIII, fig. 7. Schenk, Fossile Flora der nordwestdeutschen Wealdenformation, p. 215, pl. XXVI, figs. 2, 2*a.* Fontaine, The Potomac or Younger Mesozoic Flora, p. 88, pl. XXII, fig. 10, 11, XXIII, 2-7, XXVI, 3, 13.

*Alethopteris Browniana*—Schenk, Zur Flora der nordwestdeutschen Wealdenormation, p. 159, pl. XXVI, fig. 3-5.

*Fronde tripinnate; rachises of the first and second order comparatively slender, but rigid; primary pinnae subopposite; secondary pinnae elongated, straight or lightly curved, opposite, subopposite or alternate, more or less directed forward; pinnules leathery, opposite or alternate, quite close or a little separate, finger-shaped, obtuse or acute, sometimes lightly falcate at the end of the pinnae, and attached to the rachis with the whole base; they are generally entire in the middle part of the frond, but in its posterior part, or in its anterior part where secondary pinnae are reduced to pinnules, they are crenate or toothed, much more elongated even to linear, and now and then, strongly falcate; veins in smaller entire pinnules indistinct, in larger and crenate or toothed ones, with a distinct midvein which sends off acute, simple or sometimes even twice to thrice forked lateral veins.*

This is the most abundant fern at Kaisekiyama and Fujikawa. Nathorst had already compared it with *Pecopteris Browniana* Dunker. The shape of the pinnules in this fern is very different in different

parts of the frond, and this has been already noticed by Fontaine in his American specimens. *Pecopteris brevipennis* Font. (The Potomac Flora, p. 88. pl. XXVI, fig. 4) seems to be only a part of the frond of this fern with toothed pinnules. *Pecopteris* sp. of Nathorst from Haginotani (*l. c.* Pl. VI, fig. 4) also appears to belong to it.

In one of the fragments apparently belonging to this fern, pinnules were observed bearing sori (pl. XXVII, fig. 1, 1*a*) which are preserved as black round dots in number of 2-4 on each side of the midvein. This mode of fructification strongly reminds us of the recent genus *Aspidium*.

*Loc.*—Kaisekiyama (most abundant), Yoshida-Yashiki (numerous), Chōja, Fujikawa (frequent), Tōgodani.

#### 10. *Pecopteris Geyleriana* Nath.

Pl. XXI, Fig. 12. Pl. XXIII, Fig. 1, 1*a*. Pl. XXVIII, Fig. 5.

*Pecopteris Geyleriana*—Nathorst, Beiträge zur mesoz. Flora Japans, p. 8, pl. IV, fig. 1, VI, 1.

This plant first described by Nathorst from Ryōseki has been since found in several other localities. As this author had already pointed out, many of the pinnules are eared, not only on the anterior side, but also often on the posterior side, so that they become more or less triangular in shape. And it is a peculiar character of this fern that the lowest pinnules on the front of the rachis are often falcate backward instead of forward. The pinnules are in general blunt, but in those which are elongated are often pointed. Veins are in most cases indistinct save the evanescent midvein; in some cases, however, dichotomous lateral veins were observed (pl. XIII, fig. 1*a*).

Nathorst's assumption, that the specimens with smaller and more pointed pinnules like those represented in fig. 2, 6, pl. IV of his work

may represent a thrice pinnated portion of a frond, has been verified in several specimens in my collection. That the pinnæ were not all in one plane is also shown by having them more or less overlapping.

This species, which exhibits a close relationship to *Pecopteris exilis* Phillips (Yokoyama, Jurassic Plants, p. 35, pl. I, fig. 8-10.), is distinguished from it by auriculate and at the same time more falcate pinnules.

*Log.*—Fujikawa (very frequent), Yuasa (do.), Kataji (do.), Fujikawa (less frequent), Tōgodani. By Nathorst it has been also described from Torikubi.

### 11. *Pecopteris* cf. *virginiensis* Fontaine.

Pl. XXIV, Fig. 1.

*Pecopteris virginiensis*.—Fontaine, The Potomac or Younger Mesozoic Flora, p. 82, pl. VIII, figs. 1-7, IX, 1-6, XXIV, 2, CLXIX, 3.

A fragment of a pinna with alternate or subopposite, distant, long linear, toothed pinnules no doubt belongs to a fern which, if not identical with, is at least very closely allied to, *Pecopteris virginiensis* Fontaine, from the Potomac Formation of America. The lateral veins, owing to the thick consistence of the leaf are not quite distinct, but so far as I can see, they seem to be acutely directed forward and at least once forked.

*Loc.*—Fujikawa, Tanno (?).

### 12. *Chladophlebis* Nathorsti *n.*

Pl. XXVIII, Figs. 3, 4, 10, 11.

*Chladophlebis* sp.—Nathorst, Beiträge z. mesoz. Flora Japans, p. 4, pl. I, figs. 1-3, p. 8, 13.

*Frond* bipinnated; *rachises* comparatively slender; *pinnæ* alternate, elongated, narrowed at base; *pinnules* coriaceous, opposite or alternate, close

together, often confluent at base, triangular to lanceolate, entire, falcate, obtuse or pointed, and shorter in the posterior than in the middle part of the pinnæ; veins distinct; midvein disappearing near the apex; lateral veins directed acutely forward and once dichotomous.

I have no doubt that what Nathorst calls *Chladophlebis* sp. in his Beiträge refers to this fern. This author had already recognised its difference from the closely allied *Asplenium* (*Chladophlebis*) *whitbiense* Brgt. in having the pinnæ narrowed at base. The reason why he left it unnamed was the indistinct venation which characterises most of the fossils of Ryōseki. At Kaisekiyama, however, where the state of preservation is much more favourable, the veins are well preserved, and are quite similar to those of *Asplenium Roesserti* Presl. from the Rhætic of Yamanoi. (Yokoyama, on some Fossil Plants from the Coal-bearing Series of Nagato, pl. XXIV, figs. 1, 2, 5). The difference between the latter and *A. whitbiense*, which species are often very difficult to distinguish, has been given in the work just mentioned. In truth, *Chladophlebis Nathorsti* shows such a close affinity to *Asplenium Roesserti* that it would be often quite impossible to distinguish the two, especially when the specimens are present only in fragments.

*Loc.*—Kaisekiyama; numerous. Yuasa; frequent but in fragments; Kataji and Ishiseki; numerous. According to Nathorst, the plant occurs also at Ueno, Tōgodani, and Hiura.

### 13. *Macrotæniopteris* (?) *marginata* Nath.

*Macrotæniopteris* (?) *marginata*.—Nathorst, Beiträge, *loc. cit.*, p. 14, pl. VI, fig. 6, 6a.

What Nathorst has described under the above name from an unknown locality is not represented in my collection.

### Lycopodiaceæ.

#### 14. *Lycopodites* sp.

*Lycopodites* sp.—Nathorst, Beiträge, *loc. cit.*, p. 10, pl. II, fig. 3.

This species found by Nathorst at Ueno is also not represented in my collection.

### Cycadeaceæ.

#### 15. *Podozamites lanceolatus* Lindley et Hutton.

Pl. XXIII, Figs. 4, 5.

*Podozamites lanceolatus*.—Heer, Beitr. zur. Juraflora Ostsib. u. d. Amurl., 1876, p. 110, pl. XXVII, figs. 6, 7, 8, 5*ab*. Yokoyama, Jurassic Plants, *l.c.* p. 45, pl. V, fig. 8. Velenovsky, Die Gymnospermen d. böhm. Kreideform. p. 11, pl. II, figs. 11–19, 24.

There are only two leaflets in my collection which are referable to the well known *Podozamites lanceolatus*. One of them (fig. 5) has the petiole preserved, and the other (fig. 4) the apex. Both seem to belong to the variety *minor* of Heer.

*Loc.*—Tanno.

Nathorst mentions and describes in his Beiträge p. 10, pl. IV, fig. 7, another variety *latifolia* of the same species from Kataji.

#### 16. *Podozamites pusillus* Velenov.

Pl. XX, Fig. 2, 3*b*, 4, 5, 7.

*Podozamites pusillus*.—Velenovsky, Die Gymnospermen der böhm. Kreideform., p. 11, Pl. II, figs. 20–22, 24*a*.

A number of small cycadeous leaflets, mostly isolated, but rarely attached to the rachis, oval or elongate oval in shape, rounded or blunt at apex, and when well preserved, furnished with a short petiole.

These are no doubt to be identified with *Podozamites pusillus*, a species founded by Velenovsky on a Cretaceous form from Bohemia. Fig. 5 represents a leaflet about 22 mm. long and 6. mm. broad belonging to a longer form. It possesses 22 distinct elevated parallel veins between which a single interstitial vein is visible. Fig. 4 represents one attached to a strong rachis. It also shows distinct veins. In other specimens they are more or less defaced. A leaflet represented in fig. 2 left, is much slenderer than others and resembles *Podozamites lanceolatus*, so that it is not impossible that this species may afterwards turn out to be only a variety of the latter.

*Podozamites lanceolatus* var., which I described from Kaga (Jurassic Plants, Pl. V, fig. 5), is not unlike the longer forms of *Podozamites pusillus*, although more abruptly tapering above and acutely ending.

*Loc.*—Kagahara; frequent.

#### 17. *Podozamites* sp.

Pl. XXV, Fig. 8–12.

Many fragments of a leaf with small, elongate oblong to lanceolate leaflets which look very much like those of the preceding species. In most of them, however, the veins are completely obliterated, and when slightly visible they seem to be much coarser than in *Podozamites pusillus*. In this latter respect, the plant resembles some species of the genus *Nageiopsis* described by Fontaine from the Potomac Formation, e.g., *Nageiopsis heterophylla* (Fontaine, *loc. cit.* pl. LXXXVI, fig. 6).

*Loc.*—Kataji.

#### 18. *Zamiophyllum Buchianum* Ett sp.

Pl. XX, Fig. 1. Pl. XXII, Figs. 1, 2. Pl. XXIII, Fig. 6.

Pl. XXVII, Fig. 5*ab*. Pl. XXVIII, Fig. 1, 2.

*Zamiophyllum Buchianum*.—Nathorst, Beiträge z. mesoz. Flora Japans, p. 6, pl. II, figs. 1–2, III, V, 2, p. 9.



*Pterophyllum Buchianum*.—Ettingshausen, Beitrz. Flora d. Wealdenperiode, p. 21, pl. I, fig. 1. Schenk, Die Fossilen Pflanzen d. Wernsdorferschichten i. d. Nord Carp. p. 8, Pl. III, fig. 5.

*Dioonites Buchianus*.—Fontaine, The Potomac or Younger Mesozoic Flora, p. 182, pl. LXVIII, fig. 1, LXIX, 1, 3, LXXI, 1, LXXII, 1, 2, LXXIII, 1-3, LXXIV, 1-3.

This plant first pointed out by Nathorst as occurring at Ryōseki is profusely represented in my collection. A specimen shown in fig. 6, pl. XXIII is from Sakamoto. It represents a leaf belonging to its upper part. The leaflets are narrower than those figured by Nathorst, the broadest being about 5 mm. with 15-18 veins. It looks more like fig. 2, pl. LXX of Fontaine. The specimens from other localities show no essential difference from those described by Nathorst. In some, however, the apex of the leaflets were observed, and in one from Kaisekiyama it was bluntly pointed (fig. 5*ab*. Pl. XXVII), while in that of Yuasa it was acute (fig. 2, Pl. XXII.).

Fontaine in describing this species from the Potomac, where it seems to be very abundant, used the generic name of *Dioonites*, but as this name is now applied to a cycad whose leaflets or segments are attached in front of the rachis with their whole base, it would be advisable to retain that proposed by Nathorst.

*Loc.*—Kaisekiyama, Yuasa, Sakamoto, Tanno, Kagahara, Tōgodani, Ishiseki, Kataji. According to Nathorst, the plant occurs also at Ōtani, Torikubi, and Ueno.

### 18*a*. *Zamiophyllum Buchianum* Ett. sp.

var. *angustifolia* Font.

Pl. XXII, Fig. 4. Pl. XXV, Fig. 5. Pl. XXVIII, Figs. 8, 9.

*Dioonites Buchianus* var. *angustifolius*.—Fontaine, The Potomac or Younger Mesozoic Flora, p. 185, pl. LXVII, fig. 6, LXVIII, 4, XVI, 2.

None of the specimens which I refer to this form are quite well preserved; still I think I am sufficiently justified in placing them under it, as the leaflets exhibit essentially the same characters as the foregoing species. They are long, linear, 2–2.5 mm. broad, acute at apex, and somewhat narrowed at base. They are tolerably close together, directed acutely forward, and one of them seems to terminate the leaf. Fig. 4, pl. XXII shows a specimen from Yuasa. Its leaflets possess 7–9 parallel veins. Two fragments from Kaisekiyama show also 7–9 veins. A specimen from Kataji (fig. 5, pl. XXV) has them quite obliterated.

Fontaine considers *Dioonites abietinus* Miq. (Schenk, Fossil Flora d. norddeutsch. Wealdenform. p. 32, pl. XVI, fig. 1) as referable to this variety of *Zamiophyllum Buchianum*, to which indeed it shows a great resemblance.

*Loc.*—Kataji, Kaisekiyama, Yuasa; rare.

### 19. *Zamiophyllum Naumanni* Nath.

Pl. XXII, Fig. 3. Pl. XXVI.

*Zamiophyllum Naumanni.*—Nathorst, Beitr. z. mesoz. Flora Japans, p. 7, pl. V, fig. 1.

I possess a large specimen of a *Zamiophyllum* from Ishiseki which is undoubtedly referable to the species founded by Nathorst. The leaflets are distant, opposite and not tapering towards the base at which place however they are a little contracted. The breadth measures up to 20 mm. Besides this undoubted specimen of *Zamiophyllum Naumanni*, there are many fragments of leaflets from other localities which measure 12–15 mm. in breadth, and are broader than those of *Z. Buchianum* figured by Nathorst and Fontaine, in which the breadth seems never to exceed 10 mm. These are therefore to be

considered as those of *Z. Naumanni*. However as the difference between the two species lies not in the breadth, but in the form of the leaflets and in their mode of attachment to the rachis, it is in many cases impossible to decide which of the two species we are really dealing with, especially when the specimens are in small fragments. Moreover there is much doubt whether *Z. Naumanni* is not a species founded on the lower part of a leaf of *Z. Buchianum*.

*Loc.*—Kaisekiyama, Kataji, Tōgodani, Ishiseki, Yuasa.

## 20. *Glossozamites parvifolius* m.

Pl. XXI, Figs. 5, 5a.

I possess a small fragment only of a pinna in which the rachis dichotomises, with small, distant, opposite or subopposite, entire, obovate leaflets, about 5 mm. in length and attached to the rachis almost perpendicularly. Veins are few, equal, divergent, those in the middle part of the leaflet dichotomous, and those near the lateral margin simple.

This plant reminds us of *Podozamites* (*Glossozamites*) *obovatus* Schenk (Die Foss. Pflanzen d. Wernsdorferschichten i. d. Nordcarpathen, p. 10, pl. II, figs. 7-10, III, 1-3), which however possesses much larger leaflets.

*Loc.*—Yuasa.

## 21. *Nilssonia Johnstrupi* Heer.

Pl. XXV, Figs. 1-4.

*Nilssonia Johnstrupi*.—Heer, Flora der Komeschichten, Flora Fossilis Arctica, Vol. VI. p. 44, pl. VIII, figs. 1-6.

*Nilssonia cf. orientalis*.—Nathorst, Beiträge. *l. c.*, p. 5, Pl. I. fig. 4-5.

Now and then there occur at Ryōseki oval or linear oval, entire leaves of a cycad which exhibits a close resemblance to *Nilssonia ori-*

*entalis* Heer (Yokoyama, Jurassic Plants, Pl. XIV, figs. 4-9). These leaves are in general larger than those from Echizen, some attaining 4 cm. in breadth and up to 20 cm. in length. In this respect they resemble more those of *Siberia* figured by Heer. But the veins in the Ryōseki plant are doubly as coarse, there being only 2 in a millimeter, while in the other we can count 4 in the same space. Therefore we have here to deal with another species of *Nilssonia*, and indeed with *N. Johnstrupi* Heer from the Lower Cretaceous of Greenland, which agrees exactly with the Japanese form both in number of veins and also in the more oval shape of the leaves.

*Nilssonia bohémica* Velenov. (die Gymnospermen d. böhm. Kreideform. p. 11, pl. II, fig. 25-28) seems also to be a very nearly related species. It has however the leaves longer and narrower.

Loc.—Kataji and Tōgodani ; rare.

## 22. *Nilssonia schaumburgensis* Dkr.

Pl. XX, Figs. 12, 14. Pl. XXI, Fig. 14. Pl. XXII, Figs. 5-7.

*Nilssonia cf. schaumburgensis*.—Nathorst, p. 5, pl. I, figs. 6-9a, p. 9, 13.

*Pterophyllum schaumburgense*.—Dunker, Ueb. d. Norddeutsch. Wälderthon. Progr. d. höheren Gewerbeschule in Cassel, p. 116. Monogr. d. Norddeutsch. Wealdenform., p. 15, pl. I, fig. 7, II, 1, VI, 5-10. Eittingshausen, Beitr. z. näheren Kenntn. d. Flora d. Wealdenperiode, p. 22.

*Anomozamites schaumburgensis*.—Schenk, Die Flora d. Nordwestdeutsch. Wealdenform. p. 231, pl. XXXIII, figs. 1-9.

Nathorst has rightly referred this plant to the well known Wealden form *Nilssonia schaumburgensis* Dkr. sp. The only difference existing between the Japanese and European forms is the entire absence of segments with rounded apex, the segments here being more or less pointed in all the specimens. But as there are also such forms in the European plant (*ex. gr.*, figs. 4, 7, Pl. XII of Schenk), so there is no

reason why we can not unite the two, especially when we consider that the shape of the segments in this genus is generally very variable.

All the specimens hitherto found in Japan belong to the form with narrow leaves, that represented in fig. 14, Pl. XX being the broadest.

*Loc.*—Yuasa, Kataji, Tōgodani; numerous. Kagahara; rare. The plant is also mentioned as from Hiura by Nathorst.

### 23. *Nilssonia pterophylloides m.*

Pl. XXII, Figs. 8–10 Pl. XXV. Fig. 7.

*Leaf elongated gradually tapering anteriorly and ending in a terminal segment, deeply and regularly segmented; segments alternate, directed slightly forward, linear, parallel sided, apex obtuse or obtusely pointed; veins fine, parallel, simple, 8–10 in number.*

Although this plant looks like *Pterophyllum*, the insertion of the leaf on the rachis distinguishes it from the latter genus.

The segments are all regular, narrow, parallel margined, 3–4 mm. in breadth, and standing inclined at about 70° to the moderately strong rachis. The apex is obtuse in those at the posterior part of the leaf and more pointed in those at the anterior part of it, and their line of meeting on the surface of the rachis appears to have been zigzag, as seen in fig. 10, pl. XXII.

I am acquainted with no form of the genus which can be directly compared with our species. Indeed, *Zamites gracilis* Kurr (Beitr. z. foss. Flora d. Juraform. Württ., p. 11, pl. I. fig. 4) and *Pterophyllum pecten* Lindley and Hutton (Fossil Flora of Great Britain, vol. II, p. 102) greatly resemble the Japanese form, as far as their external appearance is concerned, but according to Schimper (Zittel, Handbuch der Palaeontologie, Abth. Palaeophytologie, p. 223) they both belong

to *Ctenophyllum* in which the veins are partly forked and those near the margin run unto it.

A specimen represented in fig. 7, pl. XXV is a splendid one from Kataji, showing the under side of the leaf, although the veins are not well visible. The other figures represent fragments found at Yuasa.

*Loc.*—Kataji, Ishiseki, Yuasa; not rare.

#### 24. *Ptilophyllum* cf. *cutchense* Morris.

*Ptilophyllum* cf. *cutchense*.—Nathorst, Beitr. z. mesoz. Flora Japans, p. 12, Pl. IV, fig. 8.

What Nathorst has described from Chōja under the above denomination, I have not been able to find in my collection.

### Coniferæ.

#### 25. *Cyparissidium* (?) *japonicum* m.

Pl. XX, Figs. 3a, 6, 6a, 13. Pl. XXIV, Fig. 4.

*Branches copious, alternate, rising at an acute angle, slender, and cord-like, straight or very slightly curved, ultimate branches about 1 mm. in breadth; leaves imbricated, closely appressed, acute at apex, with a longitudinal ridge on their backs.*

In Kagahara there are remains of a coniferous plant whose branches thickly cover the faces of stones. Unfortunately however they are so flatly pressed and smoothed that the minute details of the leaves are not well visible; but in a specimen from Tanno which is much better preserved, the imbricate leaves, as they are always partly covered by the two preceding ones, appear lozenge-shaped. The longitudinal ridge is distinct and tolerably elevated, and in external impressions of leaves, it is present as a deep groove. It is not possible to decide as to what genus the plant belongs, there being several genera with a similar type of leaves. I have brought it therefore provisionally

under the genus *Cyparissidium* Heer on account of its great resemblance to *C. gracile* Heer (Kreideflora der Arktischen Zone, p. 74, pl. XIX). It is also not unlike some of the *Arthrotaxopsis* described by Fontaine from the Potomac.

*Loc.*—Kagahara; in great abundance. Tanno, Fujikawa; rare.

## 26. *Torreya venusta* m.

Pl. XXII, Figs. 11, 12, 12a.

*Stem slender; leaves tolerably close together, subopposite, directed somewhat forward, small, linear, straight or slightly curved outwards, gradually tapering in front into an acute apex, base abruptly rounded and distichous; no distinct midrib.*

There occur fragments of a little conifer whose leaves measure 5–6 mm. long and 1 mm broad, and are directed forwards at an angle of about 60° to the stem. They possess no midrib; but in its stead, two strong cord-like longitudinal lines were observed in one or two leaves. Therefore it is not wholly improbable that we have here to deal with a plant at least closely akin to the recent genus *Torreya*. The leaf-substance, however, as it appears on stone, seems not quite so firm as might be expected in this genus. Therefore the generic determination must be left still unsettled.

Fontaine describes a similar conifer from the Potomac under the name of *Torreya virginica* (*l. c.* p. 2234, pl. CIX, fig. 8).

*Loc.*—Yuasa; not frequent.

## Phyllopoda.

### 27. *Estheria rectangula* m.

Pl. XXI, Fig. 13.

*Carapace-valves small, quadrate, moderately ventricose, broader than high with umbo terminal; the dorsal margin straight and parallel with the*

anterior portion of the ventral margin, the posterior part of the latter obliquely ascending to the straight posterior margin, and forming at the point of junction a rounded angle; anterior margin truncate, parallel to the posterior and at right angles to the dorsal as well as to the anterior portion of the ventral margin, so that the valves assume a decidedly quadrate shape; from the umbo run two flat diagonal edges, one to the postero-ventral angle and one, which is flatter than the other, to the middle part of the ventral margin, which at this point ascends backwards; surface with about twelve short concentric ridges, between which there are still finer interstitial lines. Length 7.5 mm. height 3.5 mm., thickness of the left valve, 2 mm.

I possess only a single specimen of this species in the form of an external impression. My figure was drawn after a clay cast of it. The four-sided shape and two oblique edges are characters which remind us more of the Carboniferous Genus *Leaia* Jones (A Monograph of the Fossil *Estheriæ*, Appendix, p. 117, pl. I, fig. 19-21. Palæontogr. Soc. London, vol. XV, 1862) than any of the hitherto described *Estheriæ*.

*Loc.*—Yuasa.





PLATE XX.

Plate XX.

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KAGAHARA.

- Fig. 1.*—*Zamiophyllum Buchianum* Ett. sp.  
,, 2, 3b, 4, 5, 7, 10.—*Podozamites pusillus* Vel.  
,, 3a, 6, 6a, 13.—*Cyparissidium* (?) japonicum Yok.  
,, 8.—*Onychiopsis elongata* Geyl. sp.  
,, 9.—*Pteris* (?) sp.  
,, 10.—*Sphenopteris tenuicula* Yok.  
,, 12, 14.—*Nilssonia schauburgensis* Dunk. sp.

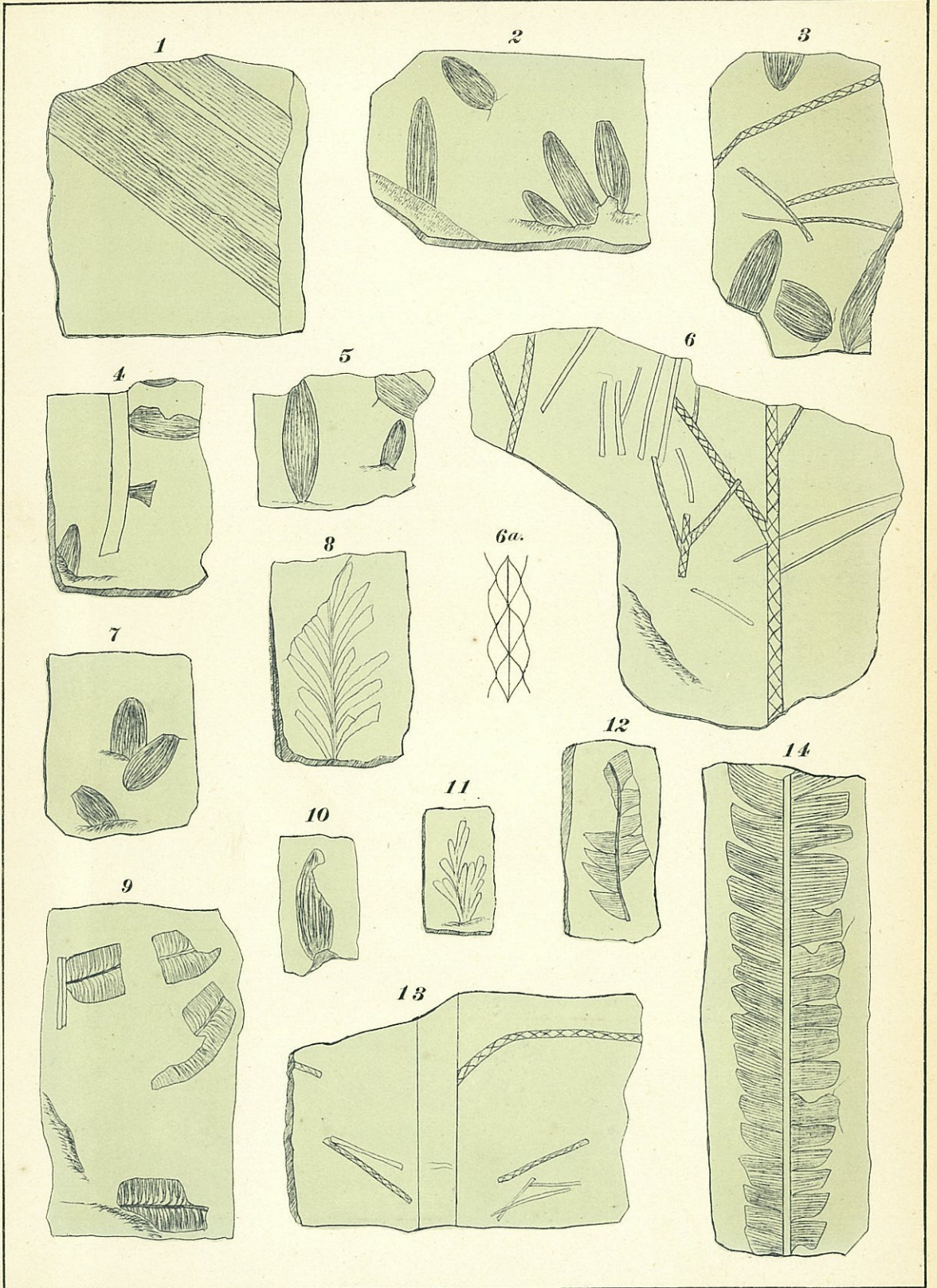


PLATE XXI.

## Plate XXI.

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Y U A S A.

- Fig. 1, 4.*—*Onychiopsis elongata* Geyl. sp.  
,, *2, 2a, 3.*—*Sphenopteris tenuicula* Yok.  
,, *5, 5a.*—*Glossozamites parvifolius* Yok.  
,, *6, 7.*—*Pteris* (?) sp.  
,, *8-11.*—*Chladophlebis Nathorsti* Yok.  
,, *12.*—*Pecopteris Geyleriana* Nath.  
,, *13.*—*Estheria rectangula* Yok.  
,, *14.*—*Nilssonia schauburgensis* Dunk. sp.  
,, *15.*—*Adiantites yuasensis* Yok.

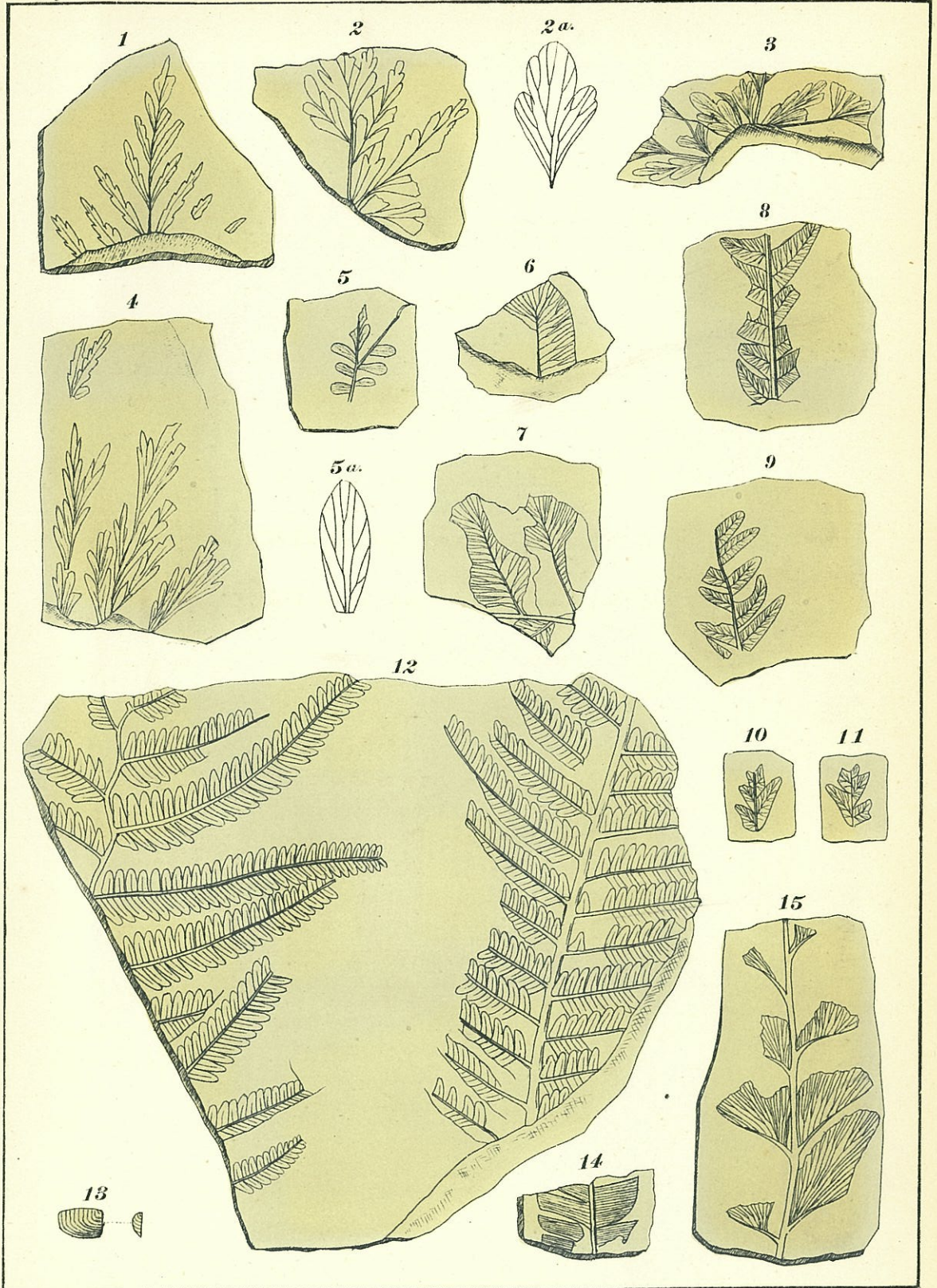


PLATE XXII.

Plate **XXII.**

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Y U A S A.

- Fig. 1, 2.*—*Zamiophyllum Buchianum* Ett. sp.  
,, 3.—*Zamiophyllum Naumanni* Nath.  
,, 4.—*Zamiophyllum Buchianum* var. *angustifolia* Font.  
,, 5-7.—*Nilssonia schauburgensis* Dunk. sp.  
,, 8-10.—*Nilssonia pterophylloides* Yok.  
,, 11, 12, 12a.—*Torreya venusta* Yok.



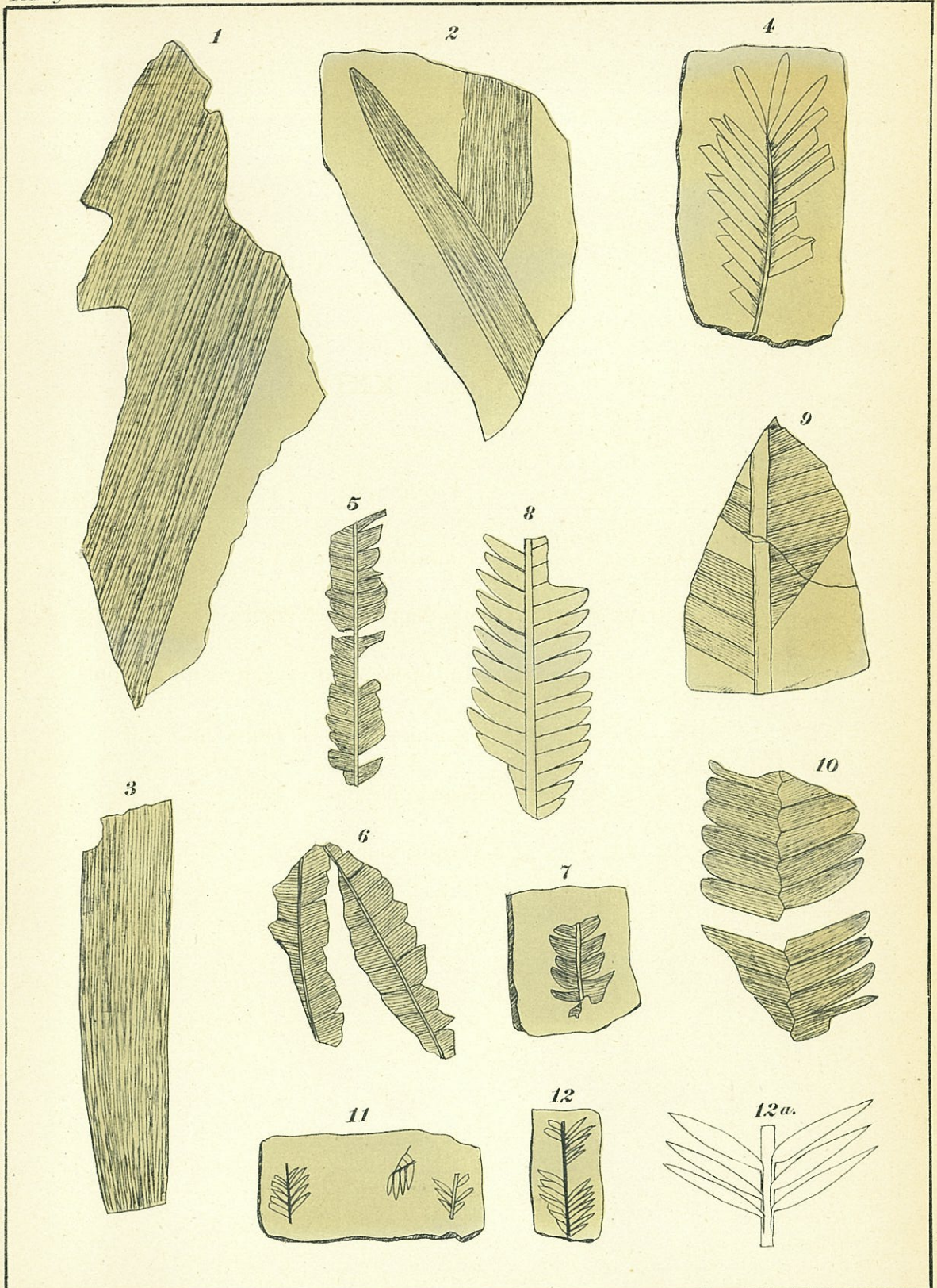


PLATE XXIII.

Plate **XXIII.**

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*FUJIKAWA.*

*Fig. 1, 1a.*—*Pecopteris Geyleriana* Nath.

„ *2, 3.*—*Thyrsopteris* sp.

*TANNŌ.*

*Fig. 4, 5.*—*Podozamites lanceolatus* Lind. et Hutt. sp.

*SAKAMOTO.*

*Fig. 6.*—*Zamiophyllum Buchianum* Ett. sp.

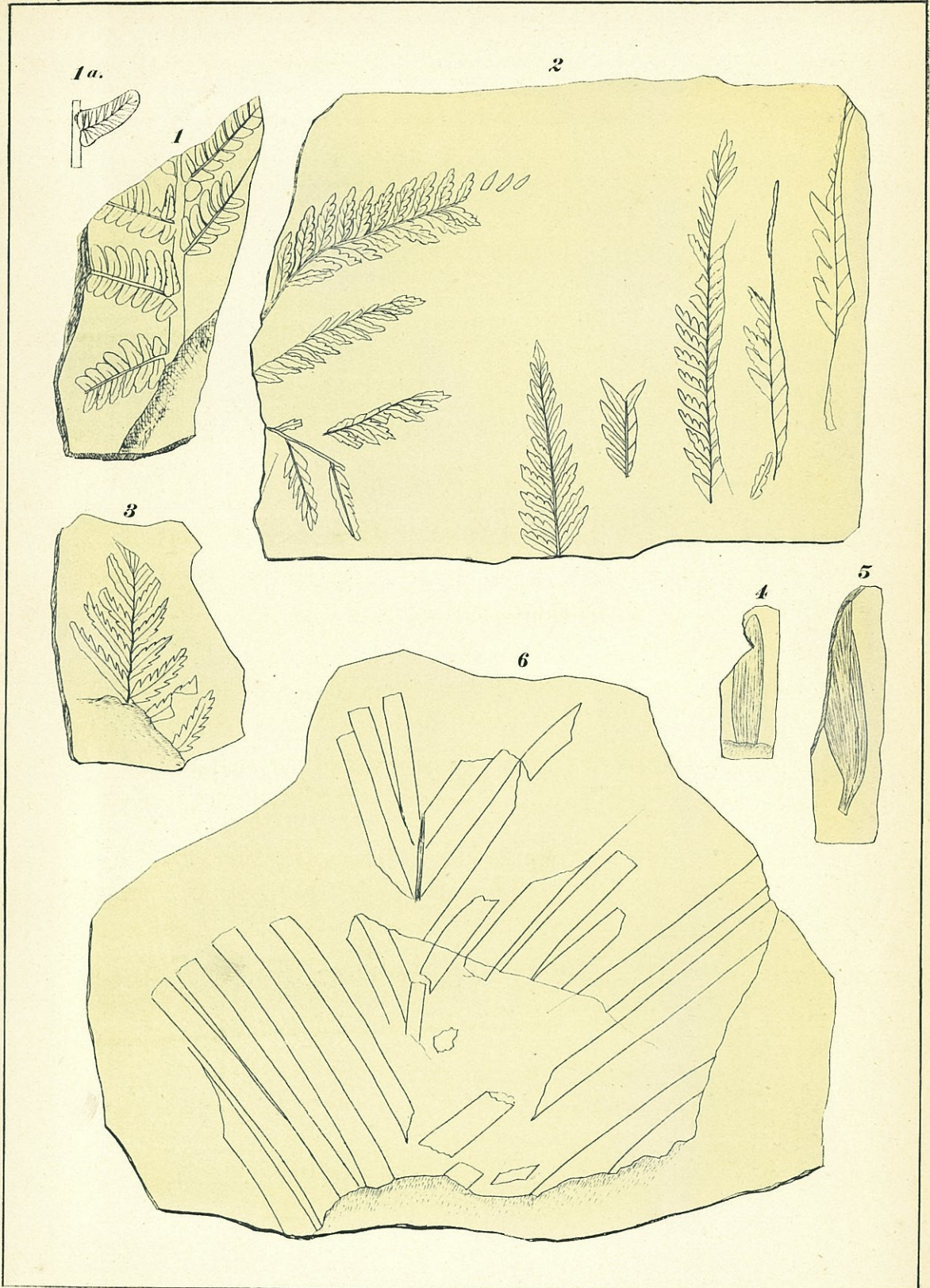


PLATE XXIV.

Plate XXIV.

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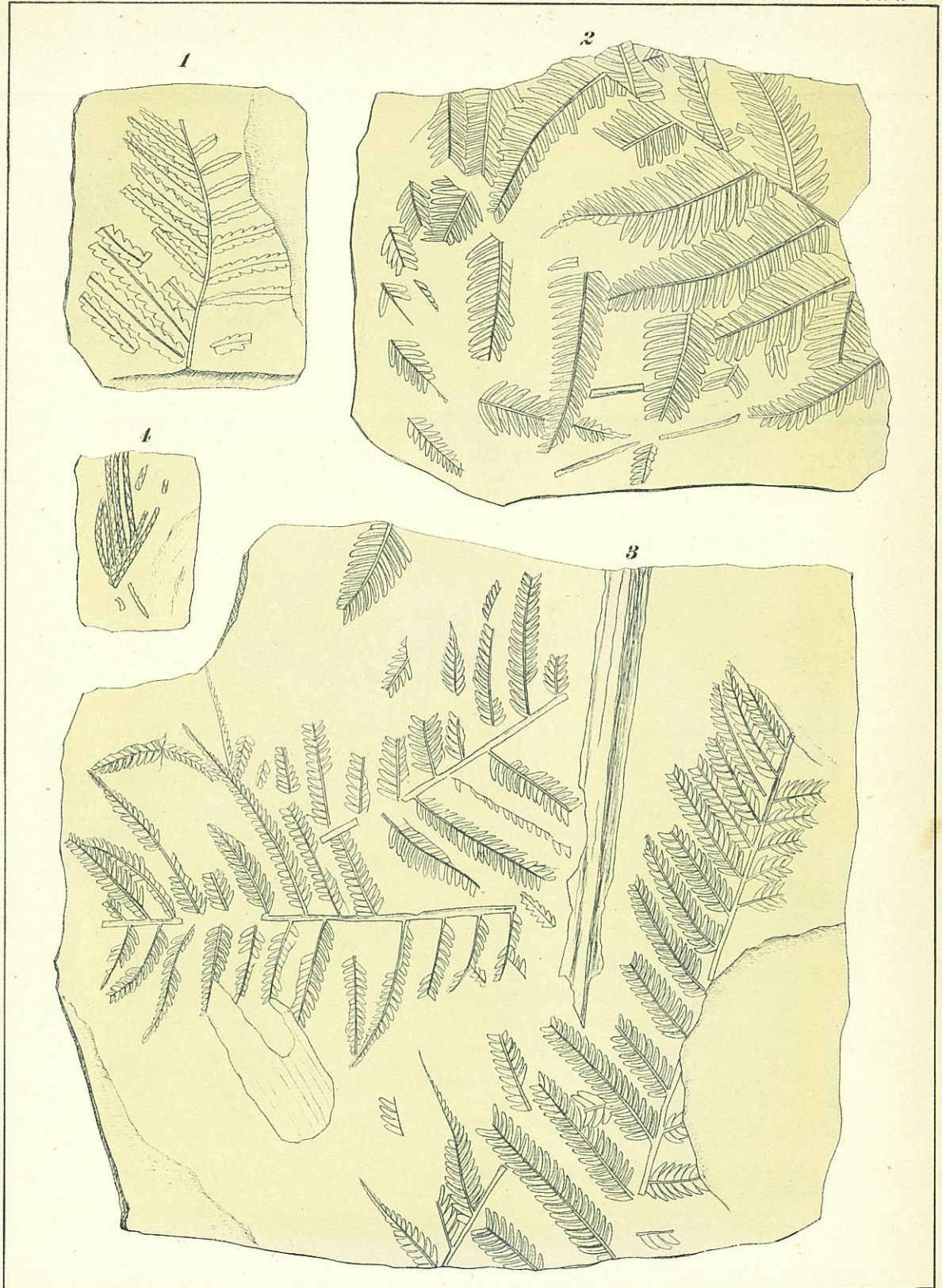
*FUJIKAWA.*

*Fig. 1.*—*Pecopteris cf. virginiensis* Font.

„ 2, 3.—*Pecopteris Browniana* Dunk.

*TANNŌ.*

*Fig. 4.*—*Cyparissidium (?) japonicum* Yok.



*Auctor in lapidem del.*

PLATE XXV.



Plate **XXV.**

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*RYŌSEKI.*

- Fig. 1-4.*—*Nilssonia Johnstrupi* Heer.  
,, *5.*—*Zamiophyllum Buchianum* var. *angustifolia* Font.  
,, *6.*—*Dicksoniopteris Naumanni* Nath.  
,, *7.*—*Nilssonia pterophylloides* Yok.  
,, *8-12.*—*Podozamites* sp.  
,, *13, 13a.*—*Dicksonia tosana* Yok.

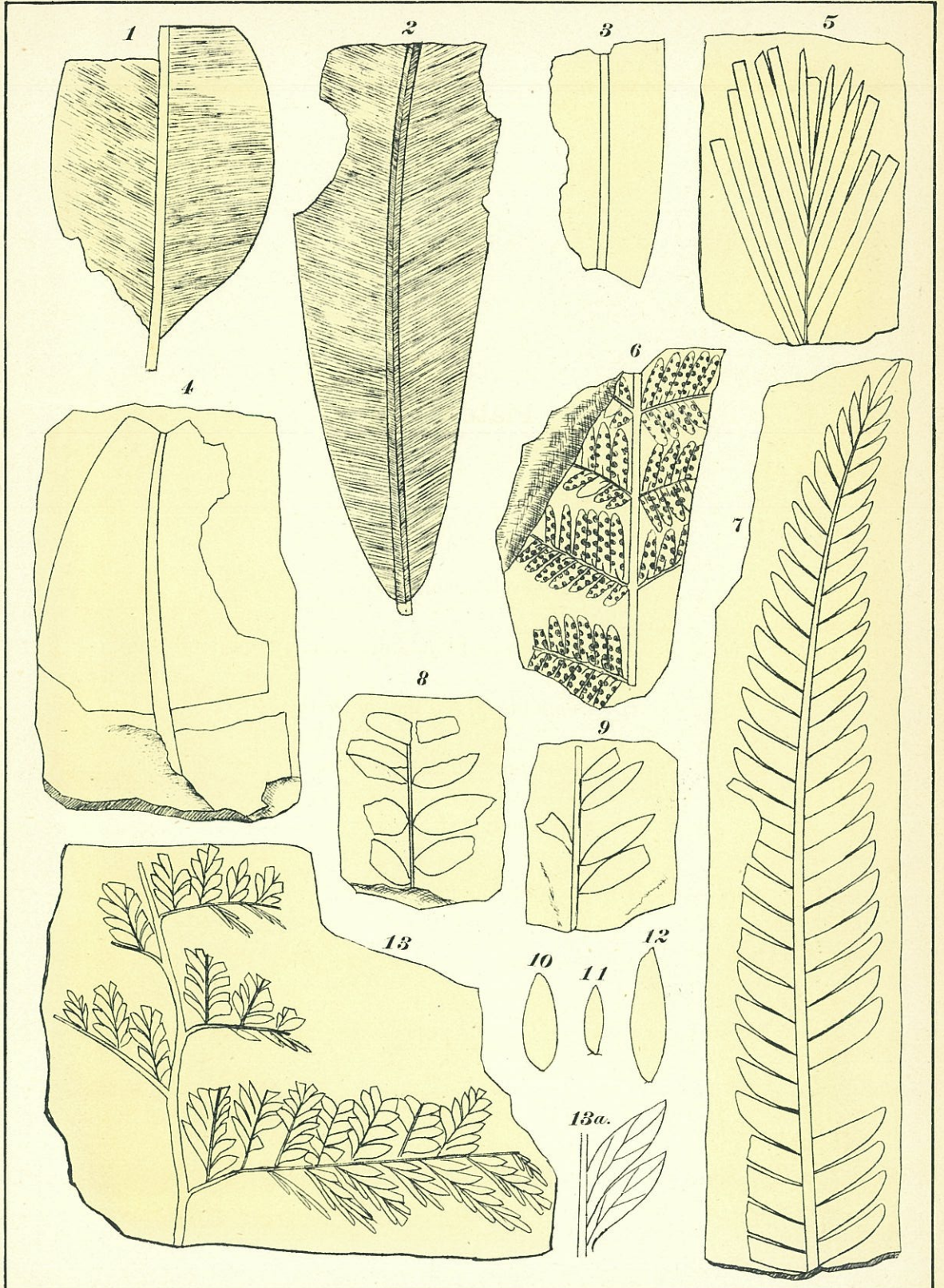


PLATE XXVI.

**Plate XXVI.**

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*ISHISEKI (RYŌSEKI).*

Zamiophyllum Naumanni Nath.

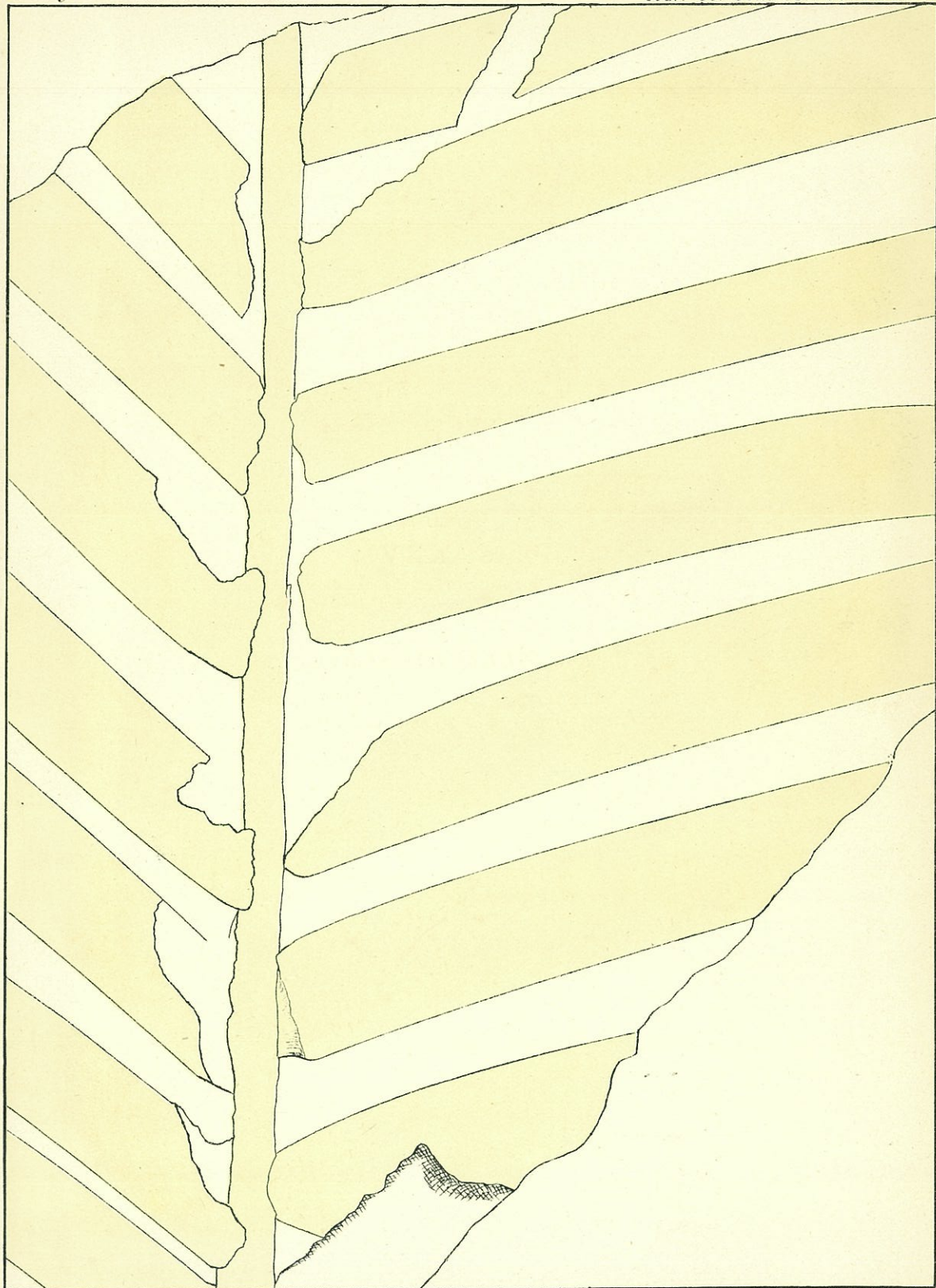


PLATE XXVII.

**Plate XXVII.**

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*KAISEKIYAMA.*

*Fig. 1, 1a, 3, 3a, 4 5cd.*—*Pecopteris Browniana* Dunk.

„ *5ab.*—*Zamiophyllum Buchianum* Ett. sp.

*SHIRAIISHIGAWA.*

*Fig. 2.*—*Pecopteris Browniana* Dunk.

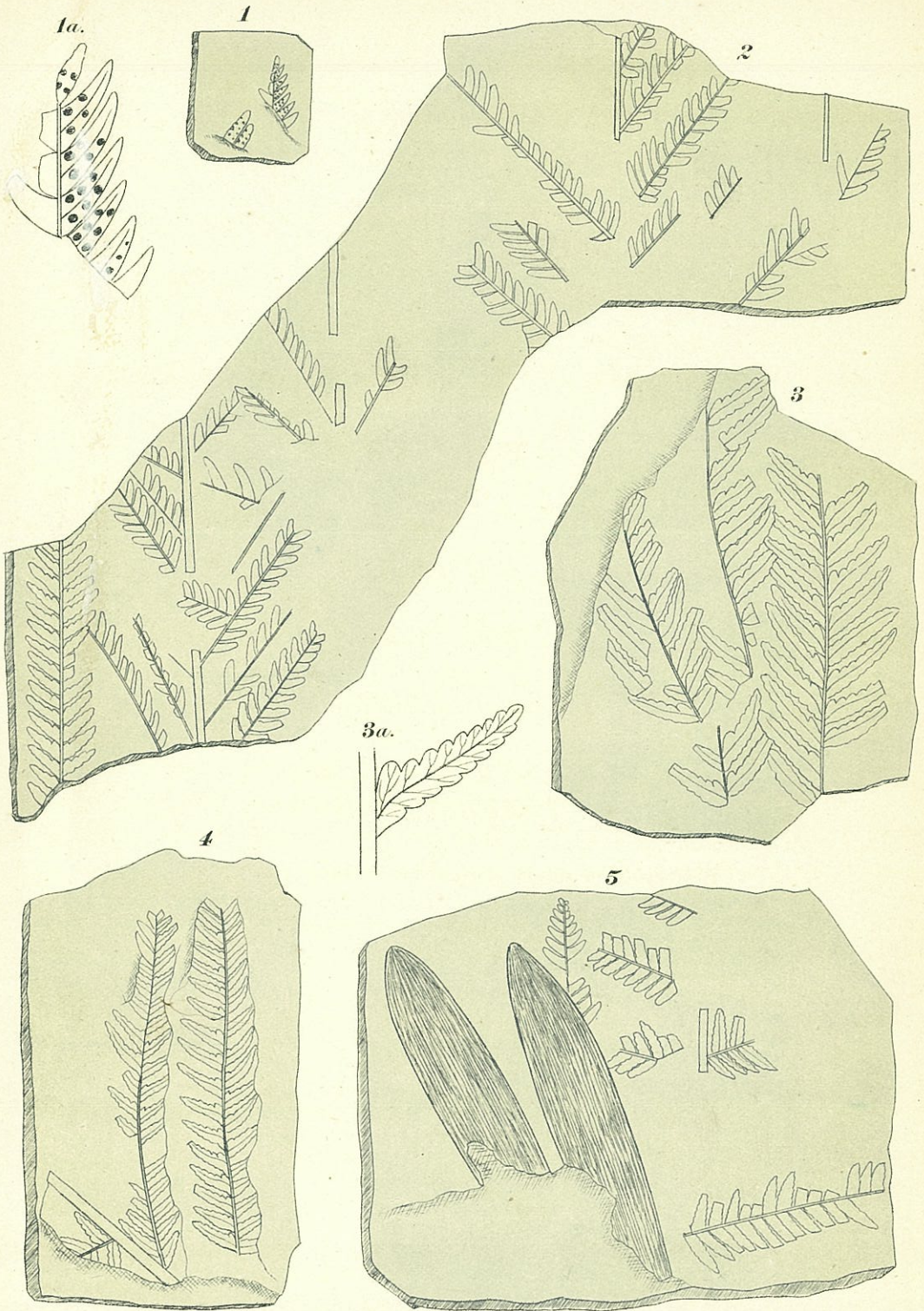




PLATE XXVIII.

Plate XXVIII.

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*KAISEKIYAMA.*

- Fig. 1, 2.*—*Zamiophyllum Buchianum* Ett. sp.  
,, *3, 4, 10, 11.*—*Chladophlebis Nathorsti* Yok.  
,, *5.*—*Pecopteris Geyleyriana* Nath.  
,, *6.*—*Sphenopteris tenuicula* Yok.  
,, *7, 7a.*—*Onychiopsis elegans* Yok.  
,, *8, 9.*—*Zamiophyllum Buchianum* var. *angustifolia* Font.

