JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.

VOL. XL., ARTICLE 8.

On the Cretaceous Flora of Russian Sakhalin.

By

A. KRYSHTOFOVICH,

Geologist to the Geological Survey of Russia.

With 15 figures in the text.

I. Introduction.

The fossil flora of the Island of Sakhalin, which is very rich in species, has been a subject of investigations since the middle of the last century, and has hitherto been regarded as exclusively of the Miocene age.

But after the paleobotanical studies there, in the summer of 1917, I came to the conclusion, that its so-called Miocene flora belongs in fact to several geological horizons, not only of the Tertiary period, but also of the Cretaceous. Nearly all the fossil plants of Russia, hitherto described as Cretaceous, belong to the typical Mesozoic flora. The flora of the Klin sandstone, represented by ferns, conifers and cycads, and described by AUERBACH (1844), EICHWALD (1862; 1865), and TRAUTSCHOLD (1876), probably belongs to the Barremian. Except some true Cretaceous woods, recorded by MERCKLIN (1855) and KRENDOVSKY (1880), nearly all the so-called Cretaceous plant fossils in Russia are of some other age; for instance, the plants in the white quartz-sandstone of South Russia, described by EICHWALD as *Quercus venulosa*,

Q. spathulata,[1] etc. are decidedly not Cretaceous but Paleogene, though Miss STOPES recently took them for Neocomian,[2] as did EICHWALD. But the single specimen of *Platanus* cf. *Heeri*, reported by ROMANOWSKY[3] from Western Turkestan, is doubtless Cretaceous; though that leaf was quite erroneously regarded by Prof. SEWARD[4] as belonging to the Jurassic fern *Clathropteris*. The first treatment of a more complete and well preserved flora of Cretaceous (Cenomanian) Angiosperms from the Ural Province was recently announced by the present author,[5] as follows:

Pteris frigida HR. ?
Asplenium Dicksonianum HR.
Pinus Quenstedtii HR. ?
Platanus (*Credneria*) *Geinitziana* UNG.
P. (*Cr.*) *Velenovskyana* KRASS.
P. (*Cr.*) *cuneifolia* BRONN.
Platanus sp.
Zizyphus dakotensis LESQ.
Cissites uralensis KRYSHT.
Sterculia Vinokurovii KRYSHT.

But I have now come to the conclusion, that besides these scarce materials, many luxuriant Cretaceous floras from Siberia have for a long time been regarded as of the "Tertiary" and "Miocene." Most of these have not been revised since the first publication, notwithstanding the great progress in Paleobotany.

The most important work on these fossil floras appears to be the "Miocene Flora der Insel Sachalin," in which HEER (1878) described a mixture of Tertiary and Cretaceous plants as altogether Miocene.

1) EICHWALD (1865), p. 62, 63, pl. III, f. 9, 10, 11.
2) STOPES (1913), p. 196.
3) ROMANOWSKY (1890), vol. III, p. 139–141.
4) SEWARD (1907), p. 43.
5) KRYSHTOFOVICH (1914), p. 603.

I further consider as true Cretaceous, the peculiar flora of Simonova[1] in South West Siberia, from the river Chulym, announced as Miocene by HEER.[2] Many local floras of Amurland[3] will probably belong to the Laramie age or Upper Cretaceous.

But before a full revision of them is made we can not use them for comparison.

Later studies on the fossil flora of Sakhalin.

The plant remains of Sakhalin[4] appeared so very conspicuous in the stratigraphy, that their study was taken up at the very beginning of explorations in the island. They have been collected by SCHMIDT at Cape Khoinju near Post Dui, by GLEHN and KOEPPEN at Mgach, and by ANDREA at Nayassi and Sertunai. Besides, Admiral FURUHJELM has sent some of the fossils to Stockholm without exact statement of the locality. All these collections were treated of by HEER in some of his papers,[5] especially in one large monograph[6] which appeared in 1878, in which he describes seventy four different forms. Of these five are Pteridophytæ, two Cycadales, one Ginkgo, four Coniferæ and all the rest Angiospermæ, the materials being mostly from Mgach and Dui (Khoinju). During these forty years, the work remained unrevised and was taken as a standard work for all the Tertiary Arctic floras; HEER's views expressed there have until now met with no objections. But now it seems to me to contain many misleading determinations of

1) HEER (1878 b), p. 36.

2) Even the famous savant of Arctic floras, Prof. NATHORST, has expressed, already in 1888. p. 54, foot note, his suspicion about the Tertiary age of the Simonova flora, but said nothing whatever about that of Sakhalin.

3) HEER (1878 b), pp. 44–50; KONSTANTOW (1914).

4) In the present paper I intend to imply by the name "Island of Sakhalin" the entire island in a geographical sense, while by the word "Sakhalin" only the Russian part. The Japanese part will be called specially "Japanese Sakhalin."

5) HEER (1871 c); id. (1874 a); id. (1878 d).

6) HEER (1878 c).

forms, the undoubtedly Cretaceous species being included among the Tertiary ones, for example a *Nilssonia*, which is a characteristic Mesozoic representative.

Although some bulky collections of plant fossils were made afterwards in the whole of Russian Sakhalin, during 1908–1910, by N. TIKHONOVICH and P. POLEVOI, nothing new has been published about them, all being left untouched and consequently not made use of in their scheme of stratygraphy.[1] This lack of investigation necessitated a more careful study IN SITU, for which I was specially dispatched by our Russian Geological Survey in 1917.

A little before, Mr. POLEVOI put at my disposal a few remains of the plants, found in a collection in Petrograd. A glance at these plant impressions raised my suspicion about the correctness of age-determination of the older Dui Series and the Mgach Series believed to be younger, for the fossils from Mgach really looked just as old as the plant remains from Pilevo, correctly taken as Cretaceous by POLEVOI. But the authority of the great paleobotanist HEER and the actual presence of true Tertiary plants in collections from Mgach elaborated by him did not allow me to make such a considerable change in the dominating views about the age of the Mgach flora. However, in our first trip to the environs of Alexandrofsk we collected, in strata hitherto believed to be Tertiary, true Cretaceous plants allied to those found in the Dakota Series. We were thus convinced of the quite unexpected presence of a Cretaceous flora of a considerably low horizon in Sakhalin. The collections made by Mr. POLEVOI, Miss STADNICHENKO and myself in the littoral outcrop of Mgach also proved the occurrence of a Cretaceous flora, but in the upper parts of the same cliffs and also in the coal bearing beds of the Mgach coal mine,

1) TIKHONOVICH and POLEVOI (1915).

lying one and a half kilometers inland, we discovered a flora with decidedly Tertiary aspect, containing *Acer*, *Juglans*, *Carpinus*, *Quercus* etc., without any elements resembling the flora of underlying beds. Such a presence of two different floras side by side has misled SCHMIDT and HEER. The latter, in his endeavour to modernize the age of Arctic floras, has altogether neglected the occurrence of *Nilssonia*. SCHIMDT thinking, that the broad-leaved floras of Sakhalin are generally Tertiary, was content to explain the relations of the beds at Cape de la Jonquière by inversion,[1] where steep and partly even vertical strata show the actual order of succession, with basalt covering the conglomerates above the *Inoceramus* and *Ammonites* beds, which are again underlain by sandstones with broad leaves.

During the three months of last summer I visited the western coast from Cape Rogatyi to Cape Boshniak, the distance being nearly one hundred kilometers. A more detailed paleobotanical study was made of the seashore from Cape Spassionyi on the south to the village Mgach on the north, and the inland district from here to the Western Range. The plant-remains there are so abundantly imbedded in nearly all the horizons of the Tertiary and Cretaceous, that the quantity of materials collected was limited owing to difficulties of transport and length of time at my disposal. Nearly 200 outcrops with plant-remains, both Tertiary and Cretaceous, were examined. More or less complete collections were made in about ten localities, on the route from Cape Khoinju to Cape Tangi.

In several localities, near Cape Rogatyi, at Cape de la Jonquière, at the coal mine "Tretya Padj" in the vicinity of Alexandrofsk, and the village Krasnyi Yar, the plant impressions were

1) SCHMIDT (1873).

found closely connected with the Cretaceous fauna. The plant-remains have been found to represent different horizons of Cretaceous and caused a considerable change in the stratigraphy of Sakhalin.

Although I was not able to look through the whole of our collections, but only a small part of it presented to the Imperial University of Tōkyō and the Geological Survey of Japan, I could determine not less than thirty four different species. Some of the plants were preliminarily determined, either IN SITU or only from my sketches.

When the present paper was nearly finished, Dr. H. TANAKADATE kindly showed me his manuscript, written in 1908, entitled "General Geology of the southern part of the Naibuchi Coal-field on the river Onnenai, Sakhalin." The Cretaceous of South Sakhalin, which he computes to be 3000 feet in thickness, he compared with the upper part of the Senonian in Hokkaidō, and found there, together with *Ammonites* and other animal fossils, several plants, as

Sequoia Reichenbachii (GEIN.) HEER v. *longifolia* WILL.
S. fastigiata STERN. (?)
Thyrsopteris cf. *varians* WILL.
Ginkgo sp. A.
Ginkgo sp. B.

and some seeds and cones. These plants he compared with the Upper and Middle Cretaceous forms of Europe and America. Besides, Mr. TANAKADATE and Prof. JIMBŌ have kindly shown me a part of their collections from Sakhalin.

II. Geological sketch of the "Coal mining district."

The part of Sakhalin, which we investigated, consists of Tertiary and Cretaceous deposits, besides more or less consolidated Post-pliocene gravels and Alluvium. The Tertiary occupies a far less

extensive area than was formerly believed. The lower part of the Tertiary rocks, just as in Japanese Sakhalin and in Hokkaidō, is lying conformably upon the Cretaceous, with two thick conglomerates at the boundary, which are intercalated with thin layers of coal-bearing shales. The relation between the Lower and Upper Tertiary coal-bearing rocks have not been well observed, but the latter rest disconcordantly upon the Cretaceous, being itself only slightly disturbed.

The Lower Tertiary or the Dui Series is chiefly coal-bearing and consists of sandstones, some conglomerates and shales with coals, which are partly of a good coking quality. This Tertiary includes two different horizons of shales with marine shells which have not yet been determined, besides there are some basalt sheets with tuffs associated with them, and mainly overlying the marine strata of the Series.

The Upper or Mgach Series consists chiefly of rather loose sandstones and shales with some seams of long-flamed coal in the lower part, which are covered by loose light-grey clayish sandstones and clays with marine shells.

The Dui Series is found on the sea coast only between Cape Rogatyi and Cape de la Jonquière, being partly disturbed and pierced or replaced by basaltic effusives. A little to the south of a line drawn between Khoinju and Krasny Yar, the Lower Tertiary rises up just to the ridge of the Coastal Range.

The other places of the coast are occupied only by the Cretaceous and by coal-bearing and marine divisions of the Younger Tertiary.

The valley of the river Dui, (officially called now "Alexandrofka"), represents a deep *graben*, showing a compressed synclinal of the coal-bearing and marine Tertiaries.

The young marine beds appear also on the seashore, from the

north of the mouth of the Dui to the mouth of the Little Sertunai. There are calcareous concretions with *Pecten propatulus* Conr., *Cardium decoratum* Grew., *C. coosense* Dall, *C. calvartensium* Glehn, *C. meekianum* Gabb, *Thracia condoni* Dall, determined by N. Tikhonovich and P. Polevoi.[1]

The underlying coal-bearing strata appear only a little inland, as in the Vladimirsky and Mgachinsky coal-mines, which belong to the eastern wing of the coastal anticlinal. More to the north, just at the village Mgach,[2] the Tertiary beds, mostly coal-bearing, are found on the sea coast, unconformably overlying the Cretaceous and partly covering it, by simple slipping down along minute faultings in the cliff in an imperfectly consolidated state, and probably partly by more complicated movements. To the north of the village Machi, the high scarp of sea shore consists of nearly horizontal marine deposits, replaced by the Cretaceous only on the space from Cape Tangi to Cape Khoi. There are some indications of the probable occurrence of the Tertiary, developed far inland on the river Tangi.

The general stratigraphy of the Tertiary is not yet clearly established, on account of the want of detailed determination of fossils.

Cretaceous. The Cretaceous deposits play an important part in the structure of the western part of Russian Sakhalin in a far greater degree than was formerly assumed. The whole Coastal Range between the river Dui (Alexandrofka) and the Gulf of Tartary is Cretaceous, partly covered by Tertiary rocks, whose lower division is conformable but the upper unconformable with the Cretaceous. The ridge of the Western Range is also Cretaceous, and the rocks appear like steep ribs, projecting out of younger deposits of the

1) Tikhonovich and Polevoi (1915), p. 40.

2) In official writings, the place is called Machi, and the mine Mgach; the latter being the more exact transliteration of the Gyliak original.

loose Tertiary rocks of the Alexandrofka valley. Besides some mighty exposures near Rogatyi, at Spasennyi and at Cape de la Jonquière, the Cretaceous is found also on the sea shore between Little Sertunai and a place lying a little to the north of Myngidai. Another area of Cretaceous extends from a place lying a little to the south of Tangi as far as slightly beyond Cape Khoi.

The part of the Cretaceous of Sakhalin known before and represented by marine deposits was hitherto considered as belonging to the Senonian, and its thickness was estimated at 3500 feet. But we know now that there are also Turonian, Cenomanian and probably even older divisions of the Cretaceous, thus doubling the thickness and making it at least 7000 feet altogether. The new annexed part, represented by these lower divisions, was as a whole treated before as Tertiary.

The strike of the Cretaceous strata is meridional, with some deviations here and there, the dip being generally westward on the sea coast, and chiefly eastward inland, that is to say on the slopes of the Western Range.

The Cretaceous deposits consist of sandstones (partly coarse), conglomerates (gray and bluish-gray) and shales partly carbonaceous; besides some coals, which contain generally more ashes than those of the Tertiaries. All the Cretaceous rocks, except the marine facies, mainly developed in the Coastal Range and belonging to the upper part of the formation, are characterized by numerous impressions of plant leaves in fine rocks and traces of wood in coarse ones. Based on the study of the leaves, I have to propose a triple division of these beds, which will be characterized as follows:

I. The Orokkian Series.

This series is made up of light-gray and light-greenish sand-

stones with a few but rather thick intercalations of dark shales, with a fauna composed of *Inoceramus Schmidtii* MICHAEL, *Gaudryceras striatum* JIMBŌ, *Puzosia* cf. *japonica* JIMBŌ, *Pachydiscus* cf. *Jimbōi* YABE, etc. Some of the localities are on both slopes of the Coastal Ranges, but the principal one is at Cape de la Jonquière. According to modern views, the fauna is contemporaneous with that of the *Pachydiscus*-bed of Hokkaidō. But the animal fossils are limited to a very small part of the entire thickness of the series. The other parts above and below are characterized by the presence of leaves of *Populus*, *Credneria*, *Viburnum*, etc., which bring the sediments into the age of the Patoot-Bed of Greenland, which to a greater part belongs to the Senonian, but partly also probably to the Turonian. The presence of the Orokkian Series outside of the Coastal Range, which it composes, was observed in the continental facies on the opposite side of the Alexandrofka graben, that is on the slopes of the Western Range a little above Petrovsky's coal mine. Considering the beds of Cape de la Jonquière as equivalent to the *Pachydiscus*-bed of Hokkaidō, i.e. typically Senonian, we must regard the thick conglomerates occupying the lowermost part of the conformably overlying "Tertiary" as probably the Danian or Laramie. The Orokkian Series was for the greater part deposited continentally; and only in the upper part, that is surely later than the beginning of the Senonian, the transgression of deep sea took place during a short time at places to the south of Alexandrofsk. Coals are found in the uppermost and probably also in the lower part of the Orokkian.

II. THE GYLIAKIAN SERIES.

This series is composed of shallow water sandstones, with thick conglomerates in some places, besides dark-grey shales with coals and coaly shales. This division is characterized only by an

exceptional luxuriance of flora, consisting of ferns, cycades, conifers and dicotyledons, and found to be equivalent to the Atane Bed of Greenland, and the Dakota, Raritan and Magothy of America, all of which essentially correspond to the Cenomanian, but partly to the Turonian, of Europe. The fauna is entirely wanting, but the corresponding series in Hokkaidō is that with *Mammites*, *Pectunculus*, *Thetis*, *Trigonia* and *Lytoceras*.

The deposits of this series are developed on the sea coast, from the Mgach coal mine down to the Gulf of Khoi, however with some interruptions, as mentioned before. They are overlain and in places completely covered by Tertiary strata. Another region of the same series is found on the littoral slope of the Western Range near the Pilenga Pass.

The Orokkian and Gyliakian Series are not actually observed lying one upon the another, and therefore it is not yet possible to draw a sharp boundary line between them. Probably the uppermost part of the beds exposed at Tangi may represent the continental equivalent of the marine beds of the Orokkian.

The type fossils of the Gyliakian are *Nilssonia serotina*, *Protophyllocladus subintegrifolius* and *Aralia Polevoii* n. sp.

III. The Ainuan Series.

Having established the undoubtable presence in Sakhalin of a fossil horizon other than formerly believed, that is the Gyliakian, I ventured to proceed to find one still older. As such I have now to consider the coal-bearing beds in the region of the "Duisko-Nevelsky Coal mine" of Erikson to the north-east-east of Alexandrofsk, in the upper coarse of the rivulet Polovinka. Polevoi expressed as his opinion, that the abnormal SW dip here marks the existence of an older horizon not yet observed elsewhere. These beds are made up of light-gray sandstones and dark shales

with coals, and are characterized by ferns, chiefly *Gleichenia*, together with some primitive *Dicotyledones*.

The real extent, thickness, composition, as well as the relation to the series above, have not yet been ascertained.

Mutual relations of the Cretaceous Beds of Sakhalin and Hokkaidō.

In literature, partly published and partly in manuscript, we find sufficient evidence to regard the Orokkian Series of Russian Sakhalin to have an equivalent in Japanese Sakhalin, which is distinguished by animal remains and a few plant fossils. Nothing, however, can be expressed on the probable equivalents of the Gyliakian and Ainuan in Japanese Sakhalin.

The Cretaceous of Hokkaidō is represented by facies different from those exposed in Sakhalin.[1] Thus, beginning from Cenomanian, the marine beds with rich faunas in Hokkaidō represent rather deep and long existing seas, while contemporaneous deposition in Russian Sakhalin took place mostly on land and partly in shallow seas. Only near the end of the Cretaceous period marine transgression took place in Sakhalin in the horizon corresponding to the *Pachydiscus* horizon of Hokkaidō, and showing homogeneous facies. All the other divisions of the Cretaceous in Russian Sakhalin are represented by shallow sea or continental coal-bearing deposits without any fauna except some tracks of animals, known as *Fucoids*, among these I determined *Gyrochorda* aff. *comosa* Heer on the Tymovskaya river. Probably, the above mentioned transgression did not extend further north than Cape de la Jonquière, all the Cretaceous deposits being continental beyond this limit. The contemporaneous horizons in Russian Sakhalin and Hokkaidō may be represented as follows:

(1 Yabe (1909).

	Hokkaidō	Sakhalin	
Senonian	upper *Pachydiscus* lower	Orokkian	plant-beds *Inoceramus* beds plant-beds
Turonian	*Scaphites*	Gyliakian	*Pteris*, *Nilssonia*, *Aralia Polevoii*.
	Mammites		
	Pectunculus		
Cenomanian	*Thetis*		
	Trigonia		
	Lithoceras		
Lower Cretaceous		Ainuan	*Gleichenia*, etc.

III. Cretaceous Floras of Sakhalin.

The present enumeration of plant-fossils of Sakhalin has been made with specimens from all the known localities, though a greater part of the collections lie in Petrograd still unpacked. Most of the fossil plants determined are from the Gyliakian Series. The systematic list of all the determined species without subdivision into series is as follows :—

Gleichenia rigida Hr.,
Gl. Zippei (Corda) Hr.,
Gl. sp. (sectio *Eugleichenia*),

Dicksonia Mamiyai n. sp.,
Asplenium Dicksonianum Hr.,
Pecopteris bohemica Corda,
P. virginiensis Font.,
Pteris frigida Hr.,
Stenopteris Jimbōi n. sp.,
Sagenopteris variabilis (Vel.) Vel.,
Cycas Steenstrupii Hr.,
Glossozamites aff. *Schenkii* Hr.,
Nilssonia serotina Hr.,
Ginkgo sp. A. and B.,
Protophyllocladus subintegrifolius (Lesq.) Berry,
Dammara borealis Hr.,
Sequoia Reichenbachii (Gein.) Hr.,
S. fastigiata Stern.,
S. Smittiana Hr.,
Thuja cretacea (Heer) Newb.,
Populus arctica Hr.,
Populus cf. *potomacensis* Ward,
Cocculus aff. *extinctus* Velen. ?,
Credneria aff. *integerrima* Zenk.,
Credneria sp.,
Platanus sp. ?,
Bauhinia cretacea Newb.,
Celastrophyllum Yokoyamai n. sp.,
Aralia Polevoii n. sp.,
A. Tikhonovichii n. sp.,
Hedera McClurii Hr.,
Viburnum Schmidtianum Hr.,
McClintockia sachalinensis n. sp.

A glance at this table already gives an impression of the

Cretaceous age. When the complete study of all the materials has been made, the number of species will surpass one hundred. The composition of forms from the different localities has enabled me to trace roughly the following evolution of the flora in Sakhalin in three stages from the Middle Cretaceous to the Upper.

1. The Orokkian Flora.

The Upper Cretaceous in Sakhalin, formerly regarded as its sole representative of this system in this island, contains several animal fossils, belonging to the Senonian. The occurrence of a rich flora, also Senonian, was only observed in 1917 and permitted us to establish a real Senonian standard of flora for all Eastern Asia.

At Cape de la Jonquière, a rich flora has been collected below the *Inoceramus* horizon. It appeared to be that which misled Schmidt to the conclusion of an inversion of strata found there, which really does not exist. The same explanation was made by Heer about the Nanaimo Group of Vancouver,[1] with a true Cretaceous fauna and a flora with young aspect.

The following forms were collected in the Orokkian, chiefly at Cape de la Jonquière:

Asplenium Dicksonianum Hr.,
Sequoia Smittiana Hr.,
Populus arctica Hr.,
Credneria sp.,
Hedera McClurii Hr.,
Viburnum Schmidtianum Hr.

Near Cape Rogatyi, *Populus arctica* and other Dicotyledons were collected above the *Inoceramus* horizon. The specimens from this series, besides those mentioned above, have not yet been fully

1) Heer (1867).

determined by me, so as to allow a detailed comparison with the best known floras of other regions. Still, the above list shows some important features, namely:—1) scarcity of ferns and conifers' 2) abundance of broad-leaf plants, and 3) identity of the floras found above and below the *Inoceramus* horizon. The forms in the list are quite foreign to the overlying Tertiary, with the exception of a few; but they show more affinities with the inferior horizon, the Gyliakian, though looking a little younger than latter. It is not to be denied, that the flora in question bears a close resemblance to some of the so-called Arcto-Tertiary, and I shall put the Orokkian flora in the same rank with the Patoot Bed and with the Haldem and Quedlinburg in Europe; these are mostly Senonian and partly Turonian. The animal fossils, corresponding to the Turonian, have not been observed in Sakhalin. The general question as to the age of the so-called Arcto-Tertiary floras and their relations to the Cretaceaus in general, necessitates a full revision of previous materials and great care in future collections. For instance, the "Tertiary" beds of Vancouver have already been properly placed into the Cretaceous, though HEER (1867) tried to explain, but erroneously, the apparently underlying position of the really Cretaceous broad-leaved flora by means of inversion of strata. ASA GRAY, GARDNER, and SAPORTA long ago, as KNOWLTON did more recently, expressed their opinion about the Eocene age of the Arctic floras, which HEER treated as Miocene.

Also DAWSON, in his papers on the fossil floras of Canada, persisted in lowering the age of some of them into the Cretaceous, notwithstanding HEER's objections. It is very probable that some of the very typical Upper Cretaceous elements, as *Platanus*, *Populus arctica* and others, represented in the Orokkian, have generally passed over into the Tertiary and afterwards widely spread towards the south. Therefore, if not all the Arctic floras with *Populus*

arctica are Upper Cretaceous, at least a part of them must be of this age. We must here keep in mind, moreover, that several collectors took specimens from pebbles together with those from exposures, and generally they were not careful enough in distinguishing them, thus introducing strange elements into some floras, as was noticed by NATHORST,[1] who remarked also that the Tertiary flora of Greenland, with *P. arctica*, is by no means homogeneous, and must be divided into 1) prebasaltic flora with *MacClintockia* and some other ancient forms and 2) basaltic without them. The prebasaltic flora is also to be divided into two horizons. The knowledge of the flora contemporaneous with the *Inoceramus* horizon, which is typically Senonian, gives stronger ground for a critical study of the age of some "Tertiary" floras of Siberia. For instance, the flora, found on the Bureya, a tributary of the Amur river, with *Populus arctica* abundant, which is Miocene according to HEER,[2] was recently revised by KONSTANTOW[3] and determined as Paleogene. This author, however, speaks about some horizons of different ages in the observed exposure, without arranging different species according to horizons, in his description of the fossils.

I have remarked that the flora of Mount Boguchan on the Amur river, with *Platanus Heeri*, must be Upper Cretaceous, and probably has connection with the *Dinosauria* Bed on the opposite side of the river. After studying the contents of the Senonian flora in the Far East, I am now able to confirm my former opinion on account of similarity of the floras of Boguchan and de la Jonquière. May not the floras of Zagayan on the Bureya and of other places on the Amur be much younger than this, that is, probably equivalent to Laramie? I regard the Anadyr flora, collected by Mining Engineer POLEVOI[4] as either of the same age

1) NATHORT (1888), p. 52. 2) HEER (1878 b). 3) KONSTANTOW (1914). 4) POLEVOI (1915).

as the Bureya Flora or a little younger, however, the flora of Simonova in West Siberia is surely Cretaceous.

2. The Gyliakian Flora.

This flora has been studied, and more exactly than others, with the collections from Mgach. The occurrence of plant-remains in this series is very important, as there are no other fossils for the determination of its age. The following table shows a correlation of the plant fossils with those of the allied floras.[1]

Mgach Flora.	Greenland.			Dakota Raritan.	Patapsco.	Europa.		Ryoseki	Up. Cret. of Japan.	Remarks on the allied species.
	Kome.	Atane.	Patoot.			Cenom.	Senon.			
Dicksonia Mamiyai n. sp.										
Asplenium Dicksonianum Hr.	×	×		×		×				
Pecopteris bohemica Corda		×				×				
Pecopteris virginiensis Font.					×			×		
Pteris frigida Hr.	×	×				×				Allied to *S. virginica* Font. of Patapsco.
Stenopteris Jimbōi n. sp.										
Sagenopteris variabilis Vel.				×		×				
Cycas Steenstrupii Hr.		×								Allied types in Middle and Upper Cretaceous. Allied to forms of Atane.
Nilssonia serotina Hr.										
Ginkgo sp.										
Protoph. subintegrifolius Berry.		×		×						
Dammara borealis Hr.		×		×		×				
Sequoia fastigiata Stern.		×	×			×	×			
S. Reichenbachii Hr.	×	×		×	×	×	×			
S. Smittiana Hr.	×									
Thuja cretacea Newb.		×		×						Allied species represented in Upper Cretaceous of Vancouver; same species in Arcto-Tertiary Floras.
Populus arctica Hr.										
Cocculus aff. extinctus Vel.						×				
Credneria aff. integerrima Zenk.		×					×			
Bauhinia cretacea Newb.			×							
Celastrophyllum Yokoyamai n. sp.										Allied species represented in Raritan Form.
Aralia Polevoii n. sp.										Allied species represented in Patapsco.
A. Tikhonovichii n. sp.										Allied species in Cenomanian of Bohemia.

1) *Glossozamites* and *McClintockia sachalinensis* are not included in this table as being found in another locality.

Thus the Gyliakian flora, so far as the plant determination has been completed, consists of 6 ferns, 2 cycads, 2 ginkgos (species not yet identified), 6 conifers and 7 angiosperms, which show altogether a considerably ancient character, especially in connection with the forms other than Angiosperms. We find in the Gyliakian no species which is also represented in the Mgach Tertiary flora. Only *Populus arctica* and perhaps a few other not yet determined species are common to the Gyliakian and the Dui flora which is believed to be Eocene. The Gyliakian is most closely allied to the famous Cretaceous floras of the Atane Beds in Greenland, and also to the Dakota, Raritan, Magothy and Patapsco of America, besides the European Cenomanian. This resemblance is made very clear by the very distant relation of the Gyliakian with the still older floras of Kome in Greenland, and of Arundel (Potomac) in America, also with the later ones of Patoot, Fox-Hills and Laramie. The scarcity of Dicotyledons in Kome is quite in contrast with their abundance and variety in the Gyliakian. If we take, for comparison with our flora, the uppermost horizon of the Potomac Formation, and the Patapsco Bed, on one side, and the more superior flora of Dakota and Raritan on the other, a closer affinity will appear with the latter. Although the Gyliakian flora has some of the forms closely allied to those in Patapsco, there are in our series some typical forms quite common with the Dakota, as *Protophyllocladus subintegrifolius*, *Dammara borealis* and *Bauhinia cretacea*. The presence here of the typical *Populus arctica*, usually found in the highest horizons of the Cretaceous and in the Paleogene also compels us rather to bring up the age of this series into the higher part of the Cretaceous. It is quite probable that the deposition of the Gyliakian was not completed in Cenomanian but continued up to Turonian, perhaps with intervention of conglomerates. In Senonian the area was visited by

marine transgression, but at the same time elsewhere, and especially afterwards, sedimentation was going on steadily in continental conditions.

3. The Ainuan Flora.

This flora, observed in Erikson's coal-mine on the river Polovinka, differs very much from the succeeding floras of the Gyliakian and Orokkian, as shown in the following list of the Ainuan plants:—

Gleichenia rigida Hr.,
Gleichenia Zippei Corda *sp.*,
Gleichenia sp.,
Asplenium Dicksonianum Hr.,
Populus cf. potomacensis Ward.

The characteristic aspect of this flora, quite strange to that of all Gyliakian localities in the neighbourhood, the predominance of ferns, the greater part of which still remains undetermined, and the scarcity of Angiosperms, bring us to the conclusion that this flora is the oldest among the Cretaceous horizons, notwithstanding our incomplete knowledge of the stratigraphy of that part of Russian Sakhalin. *Populus* shows an affinity with a form in the Potomac, while the general aspect of the whole flora is allied to that of Kome of Greenland, which may correspond either to Albian only or also to an older system. The contents and distribution of the Ainuan flora will be a most interesting subject for future studies. The following diagram shows the stratigraphic position of our floras in comparison with contemporaneous floras of the Northern Hemisphere.

	Europe.	America.	Greenland.	Russian Sakhalin.	Other Asiatic Countries.
Danian.		Laramie.	Patoot.		Bureya. Boguchan.
Senonian.		Fox-Hills.		Orokkian.	*Nilssonia* bed in Hokkaidō (?)
Turonian.	Priesen. Teplitz. Malnitz. Weissenberg.	Niobrara. Magothy. Dakota.	Atane.	Gyliakian.	Simonova.
Cenomanian.	Niederschöna. Peruc.	Raritan.			S. Ural.
Albian.		Patapsco.		Ainuan. ?	
Aptian.		Lakota			
Barremian.	Klin. Wernsdorf.	Patuxent.	Kome.		
Neocomian.		Arundel.			Ryōseki.

4. Relations of the Cretaceous and Tertiary Floras of Sakhalin.

After establishing the general contents of the Cretaceous flora in Sakhalin, we must confirm the Tertiary age of the flora of the workable seams of Mgach and also of the coal mines of Alexandrofsk. This flora of the Mgach Coal mine (not of the seashore), being now quite freed of the Cretaceous elements, shows a very close similarity to the Tertiary floras of Japan, described by Nathorst,[1] also to the true Tertiary floras of the Russian Maritime Province. Consisting chiefly of Amentifloræ and containing very few ferns, this flora is quite different from that of the Cretaceous. An object of considerable interest is the occurrence of *Salvinia* sp. in Mgach. The relation between the Cretaceous and Lower Tertiary floras of Sakhalin seems to be a distant one. The proper Gyliakian flora has nothing in common with the Tertiary, probably with the only exception of *Populus arctica*. The study of the relation of the Orokkian with the Lower Tertiary in Sakhalin is yet a task for future studies, and nothing on this question can be expressed at present. The Lower Tertiary is anyhow closely allied to the flora of the Naibuchi coal-field in Japanese Sakhalin and that of Hokkaidō, as well as to the Japanese "Pre-pliocene" floras of Nathorst.

5. Relations between the Cretaceous Floras of Sakhalin and Japan.

The Cretaceous floras of Sakhalin stand quite solitary in position in the Far East. An unpublished paper of Mr. H. Tanakadate treats of some fossils, from Makai and Onnenai, both in Japanese Sakhalin, which I regard as probably Orokkian. Besides some Cretaceous plant-leaves collected from Hokkaidō by

1) Nathorst (1888).

JIMBŌ[1] and mentioned by him in 1892, without any description, there is in Japan one rich Cretaceous flora of the Ryōseki Series (Neocomian), containing plant leaves, described by YOKOYAMA.[2] The Upper Cretaceous flora from Hokkaidō, treated by STOPES and FUJI,[3] shows a peculiar state of preservation (petrification) and thus could not be compared with the flora of Sakhalin, which is represented by impression of leaves; though leaves of Dicotyledons and of *Nilssonia* too have been also observed in Hokkaidō. Some fossil woods from Hokkaidō have been described by REISS.[4] Besides, I am of opinion, that the flora of the Lower Division of the fresh-water series in the province of Ishikari, which contains *Nilssonia*, may also be compared with the Upper Cretaceous flora of Sakhalin.

According to the ancient view that *Nilssonia* may be a member of the Tertiary, as in Sakhalin, there was no objection to put the Series of Ishikari into the Tertiary, especially when we consider the affinity of its flora with the "Tertiary" of Greenland. However, in the present stage of our knowledge about the true origin of *Nilssonia* and its complete absence everywhere in the Tertiary, I am also inclined to put the *Nilssonia*-bearing bed of Ishikari into the Cretaceous. The absence of sharp demarcation between the Cretaceous and fresh-water Supra-Cretaceous of Hokkaidō probably corresponds to a similar relation in Sakhalin between the Upper Cretaceous and the Dui series to the south of Cape de la Jonquière, though some fossiliferous beds may be discovered in Hokkaidō corresponding to the non-fossiliferous conglomerate of Dui-Rogatyi. It is necessary to make a special study of the age, to establish it as either true Tertiary or Laramie, of the Upper division of the Fresh-water series, from which some

1) JIMBŌ (192), p. 29. 2) YOKOYAMA (1894). 3) STOPES and FUJII (1909); id. (1910). 4) REISS (1907).

plants fossils, now in the collection of the Sapporo College of Agriculture, were long ago determined by LESQUEREUX and mentioned afterwards by NATHORST[1] and JIMBŌ.[2]

We find some other indications of Japanese fossil floras, supposed to be Cretaceous, mentioned in HARADA'S "Japanische Inseln" and in "Outlines of the Geology of Japan" published by the Imperial Geological Survey of Japan. These are the Dicotyledon leaves found in the Mikura Bed in Abegōri in the Province of Suruga and also in the province of Kii (HARADA, p. 109); and the fucoids (*shōbu-ishi*) and *Sequoia* sp. in the Izumi sandstone of the Sanuki-Range, Island of Shikoku (l.c. p. 107). In the same sandstone, in the Island of Kyū-shū, were observed (HARADA, p. 108) Dicotyledon leaves at Kidobaba and impressions of *Arundo*, *Populus*, *Salix*, (?) *Quercus* (?) *Fagus*, *Platanus* and *Cinnamomum* at Komatsu-mura (Outlines, p. 66). If they are really Cretaceous, they belong probably to its uppermost part.

IV. The Cretaceous in Russian Sakhalin as coal-bearing strata.

As has been mentioned above, the Cretaceous system of Sakhalin is coal-bearing nearly throughout its whole extent, except the horizon of marine transgression. The coal seams occur in the lower and probably also in the uppermost division of the Orokkian, as well as in the whole Gyliakian. The Ainuan is also coal-bearing, but nothing can at present be said about the distribution of its coal.

Though sometimes of a great thickness and being coking, the Cretaceous coals are distinguished by almost constant abundance of ashes, and numerous intercalations of coaly shales, Besides, the coal is traversed by numerous clefts filled with calcite, thus in-

1) NATHORST (1883), p. 5. 2) JIMBŌ (1892), p. 46, 47.

creasing the ashes. The old assumption, that the quality of Sakhalin coals depends only on the degree of tectonic disturbances, and not on the age, is of a limited significance, although the Cretaceous coals are generally much influenced by such movements.

Those coals in Sakhalin which were formerly regarded as Tertiary and possessing very different characters, may be separated now into two groups of quite different ages, Tertiary and Cretaceous. From these two groups the Cretaceous coals are quite uniform, on the other hand, the Tertiary coals look now also not so varied in quality.

In contrast to most of the Cretaceous coals, the lowermost coals of the Tertiary Dui Series are of an exceptional good quality; thus possibly a good coal could be found either in the uppermost Cretaceous or in the transition to the overlying Tertiaries.

V. Summary.

From all that has been said above, the following conclusions may be drawn:

1. In the study of the Sakhalin flora, HEER had unfortunately only mixed collections to rely upon. Though his Dui Flora was almost purely Tertiary, a considerable part of his Mgach Flora was truly Cretaceous.

2. The really mesozoic form *Nilssonia* must be excluded from the Tertiary flora.

3. Below the formerly described sole representative of the Cretaceous, namely the Senonian, we have now to add deposits of considerable thickness, belonging to the Turonian, Cenomanian and probably also still lower horizons.

4. All the Cretaceous in Russian Sakhalin, so far known, will be subdivided into the three Series: Orokkian, Gyliakian and

Ainuan, which correspond well with the plant-bearing strata of Greenland and America.

5. The fixed composition of these floras in the definite horizons of the Upper-Cretaceous shows the development of vegetation in Eastern Asia, and furnishes material for the discussion on the origin of younger floras.

6. The present study will lead to the revision of Siberian Cretaceous floras, until now mistaken for Tertiary.

7. There is a probability of close affinity of some plant-bearing horizons in Sakhalin and Hokkaidō.

8. The Cretaceous coals of Russian Sakhalin, so far known, contain more ashes than its Tertiary coals.

The full revision of plant-fossils in Hokkaidō and Sakhalin, in connection with the simultaneous occurrence of different floras and faunas, will fix a firm base for their comparison with the other floras of Eastern Asia, and consequently the proper determination of their ages. The work will, moreover, afford important materials for discussion on the origin and migration of the Dicotyledonous Flora, probably radially from the Arctic region, as asserted by Asa Gray[1] and others, and recently by Berry.[2]

Finally, I feel it an agreeable duty to say that the successful elaboration of the specimens for the present work has been realized solely by the very kind support of the Geological Institute of the Imperial Tōkyō University and the Tōhoku University at Sendai, and of the Imperial Geological Survey of Japan. I take this opportunity to express my cordial thanks to the representatives of all these Institutions, to Professors M. Yokoyama, K. Jimbō, and H. Yabe, and Director K. Inoue.

1) Asa Gray (1859); Saporta (1872) p. 328 etc.; Saporta et Marion (1876), p. 49 etc.
2) Berry (1911), p.50, 51.

To Mr. H. TANAKADATE, who placed his fossil collections from Japanese Sakhalin at my disposal, and to the assistants and several students of all these Institutions I have much pleasure in expressing my best thanks for their kind help.

VI. Systematic Paleobotany.

FILICALES.

1. *Gleichenia rigida* HEER.

1868. HEER, Die foss. Flora der Polarländer, p. 80, pl. XLIV, f. 1.

1874. HEER, Die Kreideflora der arctischen Zone, p. 43, pl. I, f. 1, 1 b, 5, 5 a, 5 b.

1882. HEER, Die foss. Flora Grönlands, p. 6, pl. II, f. 6, 7.

Locality: Erikson's coal mine.

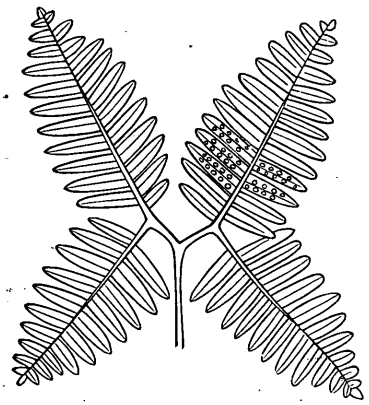

Fig. 1.
Gleichenia rigida Hr.
(Sketch made in situ)

This species is represented by a single specimen of a part of the frond, found in the light-grey sandstone, together with some other ferns of the genus. The frond in this specimen forks twice and is furnished with narrow linear segments. On both sides of the midrib the two rows of sori are seen. The fern has so far been recorded only in the Kome Beds of Greenland.

2. *Gleichenia Zippei* (CORDA) HEER.

1846. *Pecopteris Zippei*, CORDA in REUSS, Versteinerungen, p. 95, pl. XLIX f. 1.

1867. *P. Zippei*, UNGER, Kreidepflanzen aus Oesterreich, p. 8 (sep. cop.), pl. II, f. 1.

1868. *Gleichenia Zippei*, HEER, Fossile Flora der Polarländer, F. F. A., vol. I, p. 79, pl. XLIII, f. 4.

1871. HEER, Flora von Quedlinburg, p. 4, pl. I, f. 1, 1 b.
1874. HEER, Die Kreideflora der arctischen Zone, F. F. A., vol. III, p. 44, 90, 97, pl. IV; V; VI, f. 1–3; VII, f. 2; XXV, f. 1–3; XXVI, 10–13.
1876. HEER, Beitr. zur foss. Fl. Spitzbergens, F. F. A., vol. IV, p. 49, pl. XXXII, f. 6, 7.
1882. HEER, Die fossile Flora Grönlands, F. F. A., vol. VI, Abt. 2, p. 36, pl. III. f. 2.
1883. HEER, Flora der Patootschichten, F. F. A., vol. VII, p. 7.
1888. VELENOVSKY, Die Farne der böhmischen Kreideformation, p. 6, pl. III, f. 7.
1889. STUR in TOULA, Geologische Untersuchungen im Zentr. Balkan, p. 27–29, p. 33.
1896. NEWBERRY, Flora of Amboy Clays, p. 37, pl. III, f. 5 b.
1899. WARD, The Cretaceous Formation, p. 664, pl. CLXII, f. 9.
1904. BERRY, Additions Flora Matawan Form., p. 67, pl. IV, f. 6.
1905. ZEILLER, Sur quelques empreints des végét. supracrét. des Balkans, p. 649.
1906. BERRY, Contrib. to the Flora of the Atlant. Coast, p. 164.
1911. BERRY, The Flora of Raritan Formation, p. 64.

Locality: Erikson's coal mine.

This typically Cretaceous and most important form has been chiefly observed in the light-grey sandstone of this mine, belonging to the lowest known Cretaceous horizon of Russian Sakhalin, together with other different species of *Gleichenia* ferns, partly determined.

This species shows, in some of the impressions, two rows of sori, one on each side of the midrib. *G. Zippei* is represented in all Cretaceous floras of Greenland, from Kome up to Patoot. In North America, it was recognized in floras from the Black-Hills up to Raritan, Dakota and Magothy of Delaware and New-Jersey, besides in the Upper Cretaceous of the West. In Europe, the same species was observed in the Cenomanian of Bohemia and in the Senonian of Saxony, Bulgaria and Bohemia.

3. *Gleichenia sp.* (Subgenus *Eugleichenia*).

Locality: Erikson's coal mine.

This specimen, showing a single sorus on each segment, is to be properly put into the subgenus *Eugleichenia*. *Gleichenia nervosa*[1] is most closely allied, in form to our specimen. Though previously regarded by HEER as *Eugleichenia*, it was afterwards separated by himself[2] from this subgenus, for which reason the comparison with *G. nervosa* of our real *Eugleichenia* may not be admitted. From the very similar species *G. Nordenskiöldii* HR.[3] and *G. rotula* HR.,[4] our species differs by the segments attached on their entire base, which is not contracted above it as in these species, which are, moreover, furnished with a single sorus only in exceptional cases. The true species of *Eugleichenia*, namely, *G. acutipennis*,[5] *G. delicatula*,[6] and *G. micromera*[7] are quite different from our species. *G. optabilis*[8] seems to be more allied with it, but is represented only by specimens too fragmentary to speak of real identity. Probably it may later appear advisable to separate our fossil as a new particular species.

4. *Dicksonia Mamiyai* n. sp.

Locality: Sea-shore at Mgach.

A single plate of shale shows a part of the pinna or the frond with narrow lanceolate pinnules bearing triangular segments stretched forward. The sori are disposed on the proximal edge of

1) HEER (1874), p. 53, pl. XI., f. 3-6.
2) HEER (1882), p. 8.
3) HEER (1874), p. 50, pl. IX, f. 6-12; id. (1882) p. 8, pl. I, f. 1.
4) HEER (1874), p. 48, pl. VIII, f. 4, 5; IX, f. 1-4.; id. (1882) p. 8; pl. II, f. 8.
5) HEER (1874), p. 53, pl. X, f. 12; id. (1882), p. 9.
6) HEER (1874), p. 54, pl. IX, f. 11; X, f. 16, 17; id. (1882) p. 9.
7) HEER (1874), p. 55, pl. X, f. 14, 15; id. (1882) p. 9.
8) HEER (1880), p. 5, pl. I, f. 13; id. (1882) p. 9.

segments in the bottom of the sinus between them. The nerves of segments run forward making an acute angle. Closely allied to the present species in form of frond and the position of sori is *Dicksoniopteris vernonensis* (WARD) BERRY[1] from the Potomac, which has been compared by BERRY with *Dicksonia bellidula* HR.,[2] from which our species differs by sori being found strictly on the edge of the segments, as in some Jurassic *Coniopteris*. In the same point, our species resembles *Dicksonia concinna* HEER[3] of the *Coniopteris* type from the Jurassic of the Amur river.

5. *Asplenium Dicksonianum* HEER.

1874. HEER, Die Kreideflora der arct. Zone, F. F. A. vol. III, part 2, p. 31, t. I, f. 1–5.

1882. HEER, Die fossile Flora Grönlands, F. F. A. vol. VI, part 2, p. 3, t. II, f. 2, 2 b; p. 33, t. XXXII, f. 1–8.

1883. DAWSON, On the Cretaceous and Tertiary Floras of British Columbia and the North West Territory, p. 11.

1886. DAWSON, On the Mesozoic Floras of the Rocky Mountains Region of Canada p. 5, pl. III, f. 1.

1886. DAWSON, Annual Report Canad. Geol. Survey, p. 76.

1892. LESQUEREUX, Flora of the Dakota Group, p. 24, pl. I, f. 1, 1 a.

1893. DAWSON, On the Correlation of early Cretaceous Floras in Canada and in United States, p. 91.

1894. WARD, The Cretaceous Rims of Black Hills, p. 259, 261.

1895. NEWBERRY, The Flora of the Amboy Clays, p. 39, pl. I, f. 6, 7; II, f. 1–8; III f. 3.

1899. FONTAINE, in WARD'S 19th Annual Report, p. 664, pl. CLXII, f. 6–8.

1899. WARD, The Cretaceous Formation of the Black Hills, p. 704, pl. CLXX, f. 1.

---

1) BERRY (1911 c), p. 23, pl. XXVIII, f. 3, 4.

2) HEER (1874), p. 35, pl. II, f. 17 c, 17 d; XI, f. 8; HEER (1882), p. 1; HEER (1883), p. 173.

3) HEER (1876 b), p. 87, pl. XVI, f. 1-7.

1902. KURTZ, Contributiones a la Palaeophytologia Argentina. II: Sobre la existencia de una Dakota Flora en la Patagonia Austro-Occidental, p. 49.

1911. BERRY, The Flora of the Raritan Formation, p. 68, pl. V. f. 34.

1914. KRYSHTOFOVICH, The discovery of the Angiosperm Flora in the Cretaceous of Ural province, p. 605, f. 2.

Locality: Erikson's coal mine; Petrovsky's coal mine; sea-shore at Mgach, etc.

Among the numerous ferns in our collection partly still undetermined, we can easily recognize *A. Dicksonianum*, which is quite common in Kome and Atane Beds, as well as in the Lower Cretaceous and the Dakota Formation of N. America, besides the Cenomanian of Western Europe and Russia. Prof. BERRY[1] expressed the opinion, that some specimens of *Asplenium Dicksonianum* described by DAWSON from Canada and by HEER from Greenland, should be referred to *Thyrsopteris Goeppertii* (SCHENK) in the new sense of BERRY, embracing some species of the Potomac, also in the Wealden of Europe and the Lower Cretaceous in Japan. He puts into the latter species also *Thyrsopteris varians* FONT., under which name SHIMOTOMAI-TANAKADATE recorded only *in litteris*, a fern from Makai in Japanese Sakhalin (upper part of the Lower Division of the Cretaceous in S. Sachalin).

6. *Pecopteris bohemica* CORDA.

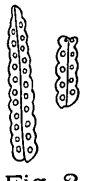

Fig. 2. Pecopteris bohemica CORDA.

1846. CORDA, in Reuss Versteinerungen, p. 95, pl. XLIX, f. 1.

1874. HEER, Die Kreideflora der arctischen Zone, p. 96, pl. XXVI, f. 17 a d.

1882. HEER, Die fossile Flora Grönlands, p. 35, t. XXXVI, f. 2 b.

Locality: Sea-shore at Mgach.

1) BERRY (1911 b), p. 327.

Many pieces about 1–2 cm. in length, of the narrow segments near 3 mm. in width with two longitudinal series of round sori, are seen on some plates of shale. The width of segments corresponds more to that of Bohemian than of Greenlandian specimens but no complete pinnula has been observed hitherto.

This type is allied to genus *Matonidium* by the position of its sori and the presence of a central hole in it but rather to *Laccopteris* by their round form.

The edge of the segment is crenate, a little more than is figured by HEER, but possibly that comes chiefly from the contraction of the soft tissue between the rigid sori.

The fern has been recorded from the Atane Bed and Untere Quadersandstein of Bohemia and Saxony (Niederschöna).

7. *Pecopteris virginiensis* FONTAINE.

1889 (1890). FONTAINE, The Potomac Flora, p. 82, pl. VIII, f. 1–7; IX, f. 1–6; XXIV, f, 2; CLXIX, f. 3.

1894. YOKOHAMA, (cf.), Mesozoic Plants from Kōzuke, Kii, Awa and Tosa, p. 220, pl. XXIV, fig. 1.

1906. FONTAINE, Report on various collections of Fossil Plants from the Older Potomac of Virginia and Maryland, in WARD's Status of the Mesozoic Floras, p. 480, 538, pl. CXVI fig. 3, 4.

Locality: Sea-shore at Mgach.

On several plates of shale from this locality parts of the frond are seen, with pinnules tapering to the top and slightly acute-dentate on the edge; the frond is either quite identical with or closely allied to the Virginian species. *Phegopteris Kornerupii* HR.[1] from the Patoot Bed is nearly similar, but HEER's sketch, which is rather incomplete, shows crenate pinnules instead of dentate.

1) HEER (1883), p. 3, pl. XLIX, f. 3, 3 b.

Recently BERRY,[1] taking together many of FONTAINE's original types from the Potomac, tried to include the present species in the widespread Mesozoic type *Cladophlebis Browniana* DUNK. sp., whose figures in his last work (t. XXIX, f. 1, 2) quite coincide with our fern. But owing to the lack of sufficient material in hand, I can not confirm the full identity of *C. Browniana* in its original type with *P. virginiensis* FONT.; *P. cf. virginiensis* was also recorded by Prof. YOKOYAMA[2] in the Lower Cretaceous of Awa province, together with a typical specimen of *C. Browniana*, which was observed in the Potomac Group including the Patapsco Formation, also in the Neocomian of Japan and the Gyliakian of Sakhalin.

8. *Pteris frigida* HEER.

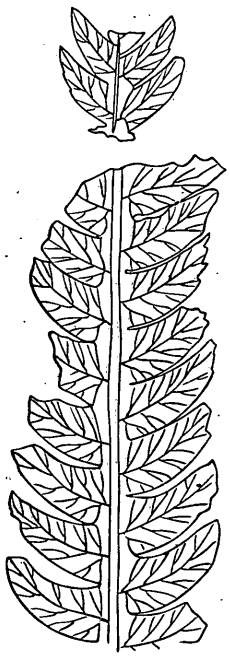

Fig. 3.
Pteris frigida HEER.

1882. HEER, Die fossile Flora Grönlands, I. Theil, p. 3 and 25, pl. II, f. 13; VI, f. 5 b; X, f. 1–4; XI; XII, f. 2; XIII, f. 2; XVII, f. 2; XVIII, f. 10 b.

1883. HEER, Die foss. Fl. Grönlands, II. Theil, p. 51, pl. CII, f. 8, 8 b.

1888. VELENOVSKY, Die Farne der böhm. Kreideform., p. 14, pl. IV, f. 1–4.

1914. KRYSHTOFOVICH, The discovery of the Angiosperm Flora in the Cretaceous of Ural Province, p. 605, f. 1.

Locality: Sea-shore at Mgach.

This typical fern, with large dentate segments in well developed specimens, was found abundantly at Mgach.

The lateral nerves of segments fork only

1) BERRY (1911 b), p. 321.
2) YOKOYAMA (1894), p. 220, pl. XXIV, f. 1.

once, except the first distal one, of which the first branch forks once more.

This species is very abundant in the Atane Bed, but scarce in Kome. HEER has described it also from the Beds of Igdlokunguak in Greenland, but regarded it as Tertiary. Its true age is not yet well known, as the specimens have been found by STEENSTRUP only in pebbles, whose geological origin has not been exactly ascertained. The species was also recorded by me from the Ural Province, and by some other authors from the Cenomanian of Bohemia. Several other ferns recorded under different names, such as *P. sitkensis* HR.,[1] *Pecopteris denticulata* HR.,[2] seem to be closely allied to the present form. Besides, DAWSON remarked its close resemblance to *Cladophlebis vancouveriana* DAWS.[3]

9. *Stenopteris Jimbōi* n. sp.

Locality: Sea-shore at Mgach.

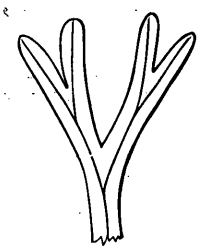

Fig. 4.
Stenopteris Jimbōi n. sp.
(Sketch made IN SITU)

The surface of some plates of shale from this locality is richly covered with narrow forking fronds, resembling those of *S. virginica* FONT.[4] Until now only a few species of *Stenopteris* have been recorded. *S. desmomera* SAP.[5] has been described from the Kimmeridgian of Lyon and *S. cretacea* HOLLICK[6] from the Upper Cretaceous of Colorado. Full analysis and discussion of these species will be made after a more complete study of our material.

1) HEER (1869 b), p. 21, pl. I, f. 7a.
2) HEER (1874), p. 95, pl. XXVI, f. 7.
3) DAWSON (1893 b), p. 55, pl. V, f. 4, 5.
4) FONTAINE (1889), p. 112, pl. XXI, f. 8.
5) SAPORTA (1873), p. 292, pl. XXXII, f. 1, 2; XXIII, f. 1.
6) HOLLICK (1902 b), p. 148, pl. III, f. 2.

10. *Sagenopteris variabilis* (VEL.) VELENOVSKY.

1885. *Thinnfeldia variabilis*, VELENOVSKY, Die Gymnospermen der böhmischen Kreideformation, p. 6, pl. II, f. 1–5; III, f. 12.

1889. *Sagenopteris variabilis*, VELENOVSKY, Kvetena českého Cenomanu, p. 40.

1902. *Thinnfeldia variabilis*, HOLLICK, Geological and Botanical notes: Cape Cod and Chappaquidick Island, Mass., p. 403, pl. XLI, f. 12.

1903. *Thinnfeldia variabilis*, BERRY, The American Species referred to Thinnfeldia, p. 444.

1906. *Sagenopteris variabilis*, HOLLICK, Cretaceous Flora of South New York and New England, p. 34, pl. I, f. 22.

Locality: Sea-shore at Mgach.

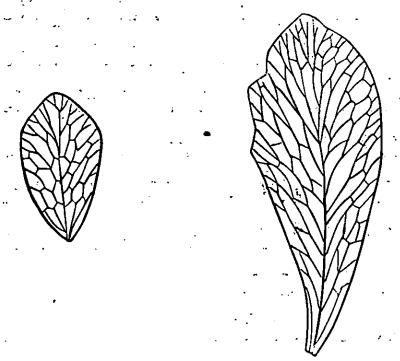

Fig. 5.
Sagenopteris variabilis (VEL.) VELEN.

We found, from this locality, several complete leaflets of this fern, 4.5 to 2.5 cm. in length. Two of them are nearly quite symmetrical; the bigger one is oblanceolate, tapering slowly toward the base. The median nerve of the same is distinct only a little above the middle of the whole length. In two other small leaflets the midrib is very slender and slightly apparent only at the base. The lateral veins, which are close together, advance under an acute angle and anastomose into a network with elongate meshes. Another leaflet with an obliquely cut top does not show any trace of the midrib, just as shown in figs. 3 and 4 of VELENOVSKY (l. c.).

The species shows the following relations to the most common Cretaceous species. It is entirely different from *Sagenopteris elliptica* FONT.,[1] which has long acute-lanceolate leaflets, with a rela-

1) FONTAINE (1889), p. 149, pl. XXVII, f. 9, 11–17.

tively strong midrib, attaining about $^2/_3$ of the length of the leaflet. Of the form *S. latifolia* FONT.[1] which is too large to compare with our species, being 8–10 cm. in length, only the upper part of the leaflet was observed. *S. virginiensis* FONT.[2] is in a similarly bad state of preservation. The specimens of *S. elliptica*, figured by BERRY,[3] do not show a very great difference, except its marked acuteness of the top. SEWARD has found resemblance between *S. virginiensis* and the Jurassic *S. paucifolia* (PHILL.) WARD, but BERRY[4] mentioned its greater resemblance to *S. Mantellii* of Wealden, having a midrib still less prominent.

But perfect identity with our species is observed in *S. variabilis* of the Cenomanian in Bohemia, represented by leaflets of a quite similar outline, with the midrib slightly prominent only at the base and branching towards the apex. Moreover, a great similarity is observed in the assymetrical leaflets of both specimens from these two localities so very distant from each other. The identification of this plant by VELENOVSKY with *Thinnfeldia Lesquereuxiana* was cancelled in 1889 by himself as quite unfounded.

I also can confirm the total difference of these two genera *Protophyllocladus* (*Thinnfeldia*) and *Sagenopteris*, both represented in my collections from Russian Sakhalin.

The genus *Sagenopteris* occurs first in the Triassic and is very prominent in the Rhaetic as well as the Jurassic; while the Lower Cretaceous species are mainly American, except *S. Mantellii*, which is widely spread in Europe. *S. neocomiensis* H. and M.,[5] of the same type, has been recorded from Westphalia, but its specimens were too fragmental. In the upper Cretaceous, we have only *S. variabilis*

1) FONTAINE (1889), p. 148, pl. XXVII, f. 10.
2) FONTAINE (1889), p. 150, pl. CXXXVIII, f. 13; CXXXIX, f. 1.
3) BERRY (1911 c), p. 287, fig. 4.
4) BERRY (1911 c), p. 289.
5) HOSIUS and MARCK (1880), p. 210, pl. XLIV, f. 194.

from Bohemia, recorded by HOLLICK also from Chappaquidick in New England, together with true *Marsilea*. The last locality appeared doubtful to HOLLICK himself, for the state of preservation was too poor. The resemblance of our species, especially with the typical form in the Cenomanian, greatly emphasizes the age of the bed containing it in Sakhalin.

Many other ferns now in our collection in Tōkyō, too badly preserved for identification, contain among them some species of *Gleichenia*, segments of ferns resembling *Sphenopteris Miertschingii* HR.,[1] a soriferous frond, resembling those of *Thyrsopteris capsulifera* VELEN.[2] (*Onychiopsis capsulifera* NAT.) The study of the whole material now lying in Petrograd, will perhaps add to the present list about fifteen other species.

CYCADALES.

11. *Cycas* aff. *Steenstrupii* HEER.

1882. HEER, Die fossile Flora Grönlands, part I., p. 40, pl. V, f. 1 a, 1 b.
1907. *Pseudocycas Steenstrupii*, NATHORST, Paleobotanische Mitteilungen, No. 1, p. 8, pl. II, f. 10, 11.

Localities: Near Cape Tangi and in some other places, always in the Gyliakian.

Our specimens of *Cycas* are very probably identical with the Cenomanian species of Greenland. *Zamites borealis* HR.[3] of Kome, which is very similar in form, has 4 veins running along each segment. Though Prof. NATHORST[4] has expressed doubt about the position of *C. Steenstrupii* in the true *Cycas*, on account of

---

1) HEER (1868), p. 87, pl. XLV, f. 9.
2) VELENOVSKY (1888), p. 10, pl. I, f. 6–12.
3) HEER (1874 b), p. 66, pl. XIV, f. 13, 14; XV, f. 1, 2; id. (1882), p. 13.
4) NATHORST (1907).

his observation of two closely disposed nerves instead of one, thus establishing the new genus *Pseudocycas*. The representatives of the genus *Cycas* (*Pseudocycas*) were found in the Senonian and older strata of Europe as well as Greenland. The present species has been recorded in the Atane bed.

12. *Glossozamites* aff. *Schenkii* Heer.

1874. Heer, Die Kreideflora der arctischen Zone, F. F. A., vol. III, part 2, p. 69, pl. XVI, f. 5–8.

1882. Heer, Die foss. Flora Grönlands, F. F. A., vol. VI, part 2, p. 13.

Locality: Near Petrovsky's coal mine, on the tributary of the Kozulinkina river.

The genus *Glossozamites* is a typical representative of the Wealden and Lower Cretaceous, but has not yet been found in the Cenomanian. *G. Schenkii* from Kome differs from *G. Hoheneggeri*[1] Schenk by having broader segments and more numerous and richly forking veins, but shows a close resemblance to our species. *G. Hoheneggeri*, figured by Prof. Yokoyama[2] from the Cretaceous of China, is identical with its original type and thus essentially differs from our specimens. The lack of material prevents our making any more detailed comparison.

13. *Nilssonia serotina* Heer.

1878. Heer, Miocene Flora der Insel Sakhalin, F. F. A., vol. V, part 3, p. 19, pl. II, fig. 1–5.

1878. *Nilssonia pigmœa*, Heer, ibidem, p. 21, pl. II, f. 6, 6 b.

Localities: Sea-shore at Mgach; mouth of Myngidai; environs of Cape Tangi; Petrovsky's Coal mine.

This species, originally described from Sakahlin incorrectly as

1) Schenck (1869), p. 9, pl. II, f. 3–6, sub *Podozamites Hoheneggeri*.

2) Yokoyama (1906), p. 37, pl. XII, f. 1, 1 a, 5 a (6 ?).

a Tertiary form, has not yet been mentioned anywhere by another name. However, with this form *N. Jonstrupii* HR.[1] in the Atane bed is surely closely allied, differing only by a larger size and a more entire lamina; this species has also been recorded from the Ryōseki Series of Japan by YOKOYAMA.[2] Another affinite type, *Nilssonia bohemica* VEL.[3] from the Peruc clays is not so large, but has a more entire lamina. A more distant resemblance is shown in the common Wealden and Neocomian species, *N. schaumburgensis* (DUNK.)[4] NATH., bearing a narrow and poorly segmented lamina. To the same genus may belong the plant, described by DAWSON from Nanaimo, as *Macrotæniopteris vancouverensis* DAWS.[5] The genus *Nilssonia*, taking its origin in the Lower Mesozoic, is still quite common in both the Lower and Middle Cretaceous; but its occurrence in younger formations is more scanty and belongs often to regions which are geologically not well studied.[6] Although its occurrence, confirmed anatomically in the Upper Cretaceous of Japan, is beyond any doubt, some leaf impressions, very similar to our Sakhalin species, were kindly shown me by Prof. YABE from his collection, made long ago, near the Yūbari Coal mine in the province of Ishikari, Hokkaidō; it is from the Lower Division of the "Freshwater Tertiary," which is also Uppermost Cretaceous.

Records of Tertiary *Nilssonia* seem to be always without foundation. But the great authority of the famous paleobotanist HEER caused some botanists to believe, that *Nilssonia*, occurring so late as in the "Tertiary" of Sakhalin, may have still found asylum somewhere in the wilderness of south-western China, as have many

1) HEER (1882), p. 44, pl. VI, f. 1-6. also *N. Gibbsii* NEWBERRY (1898), p. 16, pl. XV, f. 2.
2) YOKOYAMA (1894), p. 226, pl. XXV, f. 1-4.
3) VELENOVSKY (1885), p. 11, pl. II, f. 25-28.
4) DUNKER (1846), p. 15, pl. I, f. 7; II, f. 1; VI, f. 5-10.
5) DAWSON (1893), p. 55, pl. V, f. 1, 2, 3.
6) DAWSON (1883), p. 24, pl. IV, f. 15 bis, 15 a.

"fossil" species like *Eucommia*, *Liriodendron*, *Cercidiphyllum*, etc. Having now at hand, in Tōkyō, only very poor specimens out of our rich collection, I postpone a full description of this species.

Nilssonia in Sakhalin is a type fossil of Gyliakian, but has not yet been actually observed in any other horizon, though in Hokkaidō the position of this or allied species is probably somewhat higher.

GYNKGOALES.

14 and **15.** ***Ginkgo*** sp. A. and B.

Localities: Sea-shore at Mgach and to the north of it.

Impressions of *Ginkgo* occur in Sakhalin in the Gyliakian Series, as well as in the real Tertiary. HEER has mentioned *Ginkgo*[1] only from a bed in Mgach, which has now been proved to be Cretaceous, but not from the true Tertiary at Dui, as I did. Some of our Cretaceous specimens are similar to the entire leaves described by HEER, but several others have a more fissed lamina. The latter therefore may be compared with *G. multinervis* HR.[2] and the former rather with *G. primordialis*,[3] both species being from Atane.

Mr. SHIMOTOMAI-TANAKADATE recorded, *in litteris*, two species of this genus from the Lower and Upper Divisions of the Cretaceous of Makai in Japanese Sakhalin, comparing one of them with *G. multinervis* HR., and the other with *G. adiantoides* HR., which is probably identical with *G. primordialis*.

Besides this *Ginkgo*, a full description of which I must postpone until a complete study of our materials can be made, there are found among Ginkgoales from the Gyliakian some plants like *Baiera* and *Ginkgodium*.

1) HEER (1878 c), p. 21, pl. II, f. 7–10.
2) HEER (1882), p. 46, pl. V, f. c; VIII, f. 2 b, 3, 4; IX, f. 3 b.
3) HEER (1874), p. 100, pl. XXVII, f. 1–3; (1882), p, 47.

CONIFERALES.

16. *Protophyllocladus subintegrifolius* (Lesq.) BERRY.

1868. *Phyllocladus subintegrifolius*, LESQUEREUX, On some Cretaceous Fossil Plants from Nebraska, p. 92.

1874. *P. subintegrifolius*, LESQUEREUX, The Cretaceous Flora, p. 54, pl. I, fig. 12.

1882. *Thinnfeldia Lesquereuxiana*, HEER, Die fossile Flora Grönlands, part I. F. F. A. vol. VI, part 2. p. 37, pl. XLIV, f. 9, 10; XLVI, f. 11, 12, 12 b.

1892. *Phyllocladus subintegrifolius*, LESQUEREUX, The Flora of the Dakota Group, p. 34, pl. I, f. 12.

—— *Thinnfeldia Lesquereuxiana*, HOLLICK, The Paleontology of the Cretaceous Formation on Staten Island, p. 99, pl. III, fig. 6.

1896. NEWBERRY, The Flora of Amboy Clays, p. 59, pl. XI, fig. 1-17.

1898. *Thinnfeldia subintegrifolia*, KNOWLTON, A Catalogue of the Cretaceous and Tertiary Plants of North America, p. 228.

—— *T. subintegrifolia*, HOLLICK, Additions to the Paleobotany of the Cretaceous Formation on Staten Island, p. 58 and 519, pl. III, f. 4, 5; XXXVI, f. 6.

1902. *T. subintegrifolia*, HOLLICK, Geol. and Botan. notes: Cape Cod and Chappaquidick Island, Mass. p. 403, pl. XLI, f. 13, 14.

1903. *Protophyllocladus subintegrifolius*, BERRY, The American species, referred to *Thinnfeldia*, p. 440.

1904. BERRY, Additions to the Flora of the Matawan Formation, p. 69, pl. I, f. 5.

1906. BERRY, The Flora of the Cliffwood Clays, p. 139.

1907. BERRY, Cretaceous Floras in North and South Carolina, New species of Plants from the Magothy Formation, p. 89–91, fig. 6.

1906. HOLLICK, The Cretaceous Flora of Southern New York and New England, p. 36, pl. V, f. 1–6.

1911. BERRY, Flora of the Raritan Formation, p. 88, pl. IX.

Our collection contains many fine impressions of cladodies, which measure from 10 to 12 cm. in length and 5 cm. in width in

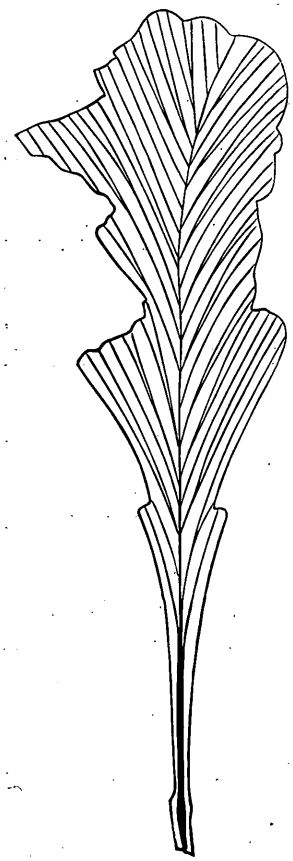

Fig. 6.
Protophyllocladus subintegrifolius (Lesq.) Berry.

the upper part, and show the base decidedly cuneate towards the short petiole. The true nature of this typical form is still somewhat problematical, though Gymnosperm in any case. The plant now in question was described originally as *Phyllocladus* (l. c.) by Lesquereux who afterwards put it into the genus *Thinnfeldia*, whose systematic position is also doubtful. Recently Berry, and after him other authors, have put the same plant in a new genus *Protophyllocladus*, supposed to be closely allied to *Phyllocladus*.

The cladodies of *Protophyllocladus* are cuneate below and fan-shaped above, being either dentate or dentate-fissed on edge. The midrib disappears below the apex, while the secondary veins are numerous but indistinct on account of the coriaceous consistence of lamina. The apex is usually obtuse. Some more dissected specimens of my collection, perhaps, are still more closely allied to *P. lobatus* Berry[1] from the Magothy and the Black Creek, but for this identification I need more complete and numerous specimens, although no essential difference in general appearance can be seen.

The species, which is indeed a type fossil of Gyliakian in Sakhalin, is considerably limited in its vertical distribution, being abundantly represented in the lower part of the Upper Cretaceous in North America, as in the Dakota Group of Kansas and Nebraska, the Raritan Formation of New-Jersey and Magothy of Maryland

1) Berry (1914), p. 17, pl. II, f. 9–13.

and N. Jersey, also in the Raritan and possibly the Magothy too of Black Island and Staten Island of the Atlantic Coast. In Greenland, this species has been found in an equivalent of the Gyliakian series, that is Atane. Though abundantly found in the Upper Cretaceous of America and of Greenland, this species is entirely wanting in Europe as well as in the Lower Cretaceous of its home. This species has therefore found its end in Magothy. But *P. lanceolata* KNOWL.[1] was recognized in the Laramie Group of Montana. The abundant occurrence of *P. subintegrifolius* in Russian Sakhalin as a type fossil of the Gyliakian, together with *Nilssonia serotina*, gives us indication of the closest relation of our flora to those in N. America and in Greenland, but not to any in Europe. This shows very well the contemporaneity of our flora partly with the European Cenomanian and partly with its Turonian.

17. *Dammara borealis* HEER.

1841. "Seed vessels of Coniferous plants," HITCHCOCK, Final report Geol. Massachusetts, p. 430, pl. XIX, f. 4, 5.

1882. *Dammara borealis*, HEER, Fossile Flora Grönlands, part I., p. 54, pl. XXYVII, f. 5.

1882. *Dammara microlepis*, HEER, Fossile Flora Grönlands, part I., p. 55, pl. XL, f. 5.

1882. *Eucalyptus Geinitzii*, HEER, ibidem, p. 93, pl. XLV, f. 4–9; pl. XLVI, f. 12d.

1889. *Dammara borealis*, VELENOVSKY, Kvetena českeho Cenomanu, p. 7, pl. I, f. 28, 29.

1890. *Eucalyptus Geinitzii*, WHITE, On Cretaceous Plants from Martha's Vineyard.

1892. *Dammara borealis*, HOLLICK, The Paleontology of the Cretaceous Formation on Staten Island, p. 31, pl. I. f. 17.

1896. NEWBERRY, Flora of Amboy Clays, p. 46, pl. X, f. 8.

1) WEED and KNOWLTON (1893), p. 49, pl. V, f. 5.

1902. HOLLICK, Geol. and Botan. Notes: Cape Cod and Chappaquidick Island, p. 402, pl. XLI, f. 6.

1903. HOLLICK, Fifty fifth annual report of New York State Museum, for 1901. p. 249.

—— *Dammara Cliffordiensis*, BERRY, The Flora of the Matawan Formation. p. 61, pl. XLVIII, f. 8–11.

1904. *Dammara microlepis*, HOLLICK, Additions to the Paleobotany of the Cretaceous Formation of Long Island, No. 2, p. 410, pl. LXXI, fig. 9, 10.

1904. *Dammara Cliffordiensis*, BERRY, Additions to the Flora of the Matawan Formation, p. 69, pl. I, f. 11.

1906. *Dammara borealis*, HOLLICK, Cretaceous Flora of Southern New York, p. 37, pl. II, fig. 2–11, 12–26, 27 a.

1910. BERRY, Contributions to the Mesozoic Fl. of the Atlantic Coastal Plain, V. N. Carolina, p. 185.

1911. BERRY, The Flora of the Raritan Formation, p. 80.

Locality: Sea-shore at Mgach and to the north of it, also near Arkovo.

Claviculoid scales of this plant, measuring about 1 cm. in length, and very typical of the Middle Cretaceous of Europe, Greenland and America, were collected in many places on the Western Coast. Their form and size well coincide with those of the species from the above mentioned countries. Some authors were of opinion, that the plant with those scales should be put into *Eucalyptus*. Others, as HOLLICK and BERRY, have recently insisted, that it belongs to Coniferæ, probably *Araucariaceæ*, though perhaps not quite identical with the living genus *Dammara*. This species was found first by HITCHCOCK in the Dakota bed and afterwards in the Atane, together with *D. microlepis*. The latter has been recorded with *D. macrosperma*, also from Patoot of Greenland; being recognized by HEER in Atane, under the name of *Eucalyptus*, together with *Pr. subintegrifolius;* and by KRASSER, VELENOVSKY

and BEYER in the Cenomanian of Bohemia. In the Raritan flora, so closely allied with the Gyliakian of Sakhalin, this species is also abundantly represented.

18. *Sequoia fastigiata* (STERNB.) HEER.

1821. *Caulerpites fastigiatus*, STERNBERG, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, part II, p. 23.
1825. *Thuites alienus*, STERNBERG, ibidem, p. XXXVIII, pl. XLV, f. 1.
1869. *Sequoia fastigiata*, HEER, Flora von Moletein in Mähren, p. 11, pl. I, f. 10–13.
1874. HEER, Kreide-Flora der arctischen Zone, p. 102, 128, pl. XXVII, f. 5, 6; XXXVIII, f. 12, 13.
1882. HEER, Fossile Flora Grönlands, p. 53, pl. III, f. 7–9; XVII, f. 4; XXVIII, f. 6.
1883. HEER, ibidem, part II, p. 15, pl. LI, f. 11, 12; LIII, f. 3, 4.

Locality: Sea-shore at Mgach.

To this very species of the Middle and Upper Cretaceous of Europe and Greenland belong some small slender twigs found in our collection. The same species was recorded also, in manuscript, by Dr. TANAKADATE at Makai in Japanese Sakhalin, from the upper part of the Lower Division of the Cretaceous.

19. *Sequoia Reichenbachii* (GEIN.) HEER.

1842. *Araucarites Reichenbachii*, GEINITZ, Characteristik der Schichten und Petrefacten des sächsisch-böhmischen Kreidegebirges, p. 98, pl. XXIV, f. 4.
1846. *Cryptomeria primæva*, CORDA, in REUSS's Versteinerungen der böhm. Kreideformation, p. 89, pl. XLVIII· f. 1–11.
1847. *Geinitzia cretacea*, ENDLICHER, Synopsis Coniferarum, p. 281.
1868. *Sequoia Reichenbachii*, HEER, Die fossile Flora der Polarländer, p. 83, pl. XLIII, fig. 1 d, 2 b, 5 a.
1869. HEER, Kreideflora von Quedlinburg, p. 9, pl. I, f. 2.

1874. HEER, Die Kreideflora der arctischen Zone, pp. 77, 101, 126, pl. XII, f. 7 c, 7 d; XX, f. 1–8; XXVIII, f. 2; XXXIV, f. 1; XXXVI, f. 1–8.

—— LESQUEREUX, Cretaceous Flora, p. 51, pl. I, f. 10, 10 a, 10 b.

1882. HEER, Die fossile Flora Grönlands, part I, p. 52, pl. XXVIII, f. 7.

1890. FONTAINE, The Potomac Flora, p. 243, pl. CXVIII, f. 1, 4; CXIX. f. 1–5; etc.

1896. KRASSER, Kreideflora von Kundstadt in Mähren, p. 124.

—— NEWBERRY, Flora of Amboy Clays, p. 49, pl. IX, f. 19.

1903. The Flora of the Matawan Formation, p. 59, pl. XLVIII, f. 15–18.

1906. HOLLICK, The Cretaceous Flora of Southern New York, p. 42, pl. II, f. 40, III, f. 4, 5.

1911. BERRY, Lower Cretaceous of Maryland, p. 444, pl. LXXVII, f. 7. (see here the full list of literature).

1914. BERRY, the Upper Cretaceous and Eocene Floras of South Carolina and Georgia p. 23, pl. IV, fig. 1–4; p. 107.

Localities: Sea-shore, from Mgach to Cape Tangi.

A good number of impressions of Coniferæ from the Gyliakian belongs to this very typically Cretaceous species, broadly distributed from the lowest to the upper horizons of the Cretaceous, both in Europe and in America.

The same species was recognized by SHIMOTOMAI-TANAKADATE in Onennai in Japanese Sakhalin, in the lower part of the upper division of the Cretaceous.

Probably some other species of the genus will be found in the other part of our collection, now lying in Petrograd.

20. *Sequoia Smittiana* HEER.

1871. HEER, Förutskickade anmärkningar öfver Nordgrönlands Kritflora, p. 1181.

1874. HEER, Die Kreideflora der arctischen Zone, p. 82, pl. XII, f. 10 b; XVII, f. 3, 4; XVIII, f. 1 b; XX f. 5 b, 7 c; XXIII, f. 1–6.

1886. DAWSON, On the Mesozoic Floras of the Rocky Mountain Region of Canada, p. 9, pl. II, f. 7, 7 a.

Locality: Cape de la Jonquière; sea-shore at Mgach.

This species has been found before mostly in the Lower Cretaceous of Greenland and of the Rocky Mountains (Kootanie) of Canada. DAWSON referred to the same species, specimens of *Sequoia*, recorded from Vancouver under the name *S. Langsdorfii*, though differing from the latter by a much more luxuriant habitus. Thus the occurrence of this species, as high up as Orokkian in Sakhalin is very probable. Postponing any full discussion about this species as well, I must remark, that *Sequoia Smittiana*, when found without any leading species, may cause a misunderstanding of geological age, on account of its great similarity to the Tertiary *Sequoia Langsdorfii*.

21. *Thuja cretacea* (HEER) NEWBERRY.

1882. *Libocedrus cretacea*, HEER, Die fossile Flora Grönlands, part I, p. 49, pl. XXIX, f. 1–3; XLIII, f. 1 d.

1896. *Thuja cretacea*, NEWBERRY, Flora of Amboy Clays, p. 53, pl. X, fig. 1, 1 a.

1905. KNOWLTON, Fossil Plants of the Judith River Beds, p. 133, pl. XVI, fig. 3 a.

1906. BERRY, Contributions to the Mesozoic Flora of the Atlantic Coastal Plain, p. 169.

1911. BERRY, The Flora of the Raritan Formation, p. 83.

Localities: Sea-shore at Mgach; Tymovskaya river; Erikson's coal mine; on the north of Cape Tangi.

Fragments of small twigs in our collection, with four rows of scaly leaves, belong either to this very species or one closely allied to it. *T. cretacea* was recorded before from several Cenomanian beds, as the Atane in Greenland, the Judith river Bed of Montana,

the Magothy Formation of Delaware and Maryland and also the Raritan and Dakota.

Monocotyledones.

On some plates of shale from several localities of different horizons remains are seen, which are either grasses or sedges, all too badly preserved for determination.

Dicotyledones.

22. *Populus arctica* Heer.

1868. Heer, Miocene Flora von Nordgrönland, F. F. A. vol. I, p. 100, pl. IV, f. 6 a, 7; V; VI, f. 5, 6; VIII, f. 5, 6; XVII, f. 5 b, c; p. 137, pl. pl. XXI, f. 14, 15.

1869. Heer, Contributions to the fossil flora of North Greenland, F. F. A. vol. II, p. 469, pl. XLIII, f. 14; L, f. 8 b; LIII, f. 4 b.

1870. Heer, Die Miocene Flora und Fauna Spitzbergens, ibidem, p. 55, pl. X, f. 2–7; XI, f. 1; XII, f. 6c.

1871. Lesquereux, Annual report, p. 289, 300. Supplement, p. 9.

1872. Idem, Annual report, p. 358, 401.

1873. Idem, Annual report, p. 406.

1874. Heer, Nachträge zur Miocenen Flora Grönlands, F. F. A., vol. III, part 3, p. 15, 17, 20, pl. II, f. 20; III, f. 9.

1876. Heer, Beiträge zu foss. Flora Spitzbergens, F. F. A., vol. IV, p. 68, pl. XXXI, f. 2.

1878. Lesquereux, Contributions to the fossil flora of the western Territories, The Tertiary Flora, p. 178, pl. XXIII, f. 1–6.

1878. Heer, Die Miocene Flora des Grinnell-Landes, F. F. A., vol. V, p. 30, pl. V, f. 1.

1878. Heer, Primitæ floræ fossilis sachalinensis, F. F. A., vol. V, p. 26, pl. II, f. 1b, III, f. 3a.

1878. Heer, Beiträge zur miocenen Flora von Sachalin, F. F. A., vol. V, part 4, p. 4, pl. I, f. 3, 4.

1878. HEER, Beiträge zur fossilen Flora Sibiriens und des Amurlandes, F. F. A., vol. V, part 2, p. 35, 49, pl. IX, f. 3?; XV, f. 3–5.

1880. HEER, Nachträge zur fossilen Flora Grönlands, F. F. A,, vol. VI, part 1, p. 9, pl. IV, f. 1.

1880. HEER, Beiträge zur miocenen Flora von Nord-Canada, F. F. A., vol. VI, part 3, p. 13, pl. I, f. 2c; II, f. 6, 7.

1883. HEER, Die Tertiäre Flora von Grönland, F. F. A., vol. II, p. 74, pl. LXVII, f. 2, 3; XCVI, f. 1.

Localities: Cape de la Jonquière; near Cape Rogatyi; sea-shore at Mgach; the Tymovskaya river.

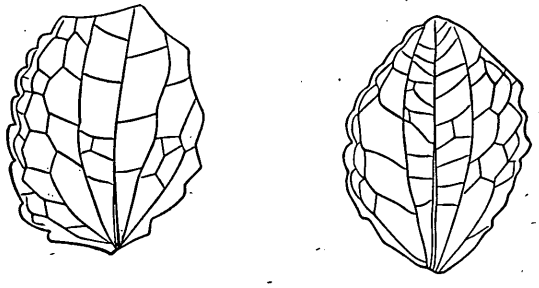

Fig. 7.
Populus arctica HEER.

This characteristic species, found in many arctic floras, is very abundantly represented in Sakhalin, not only in the Orokkian, but in the older horizon—Gyliakian. This same species was recorded by HEER from Mgach, and as a fact of special interest, he found it on a plate of shale with impressions of *Nilssonia*. He, however, believed, that *Populus arctica* is a typical Tertiary species, and that was the reason why he neglected the testimony of *Nilssonia*, in favour of the greater antiquity of the flora. He thus put the whole flora of Sakhalin in the rank of other Arctic Floras, described by him as "Tertiary" and properly "Miocene." No representative of this species has been recognized in the floras of Atane and Patoot, but the very similar *Populus amissa* HR,[1] that was compared by HEER himself with *P. arctica*, was recorded from the Cretaceous of Atane. We must, however, bear in mind, that the first representative of *Populus* is found already in the Kome flora.

1) HEER (1883), p. 65, pl. XXVIII, f. 18.

The true *Populus arctica* has been found in Atanekerdluk and in Arctic Canada, both being Tertiary according to HEER. But already at that time, Marquis SAPORTA expressed the opinion about an older age of the Canadian floras, which was strongly supported by DAWSON against HEER. SAPORTA'S opinion is in full agreement with our recent condition of knowledge and was moreover partly confirmed by the occurrence of animal fossils. It is very probable, that *P. arctica* has already been observed in the Cretaceous of America, but treated under some other names, for instance, by DAWSON and NEWBERRY (1898). But there is no question, about the true Cretaceous age of this fossil in Mgach. Another and younger horizon, at Cape de la Jonquière, well characterized by its fauna, also bears well preserved specimens of *Populus arctica*. Consequently, this species, formerly regarded as decidedly Tertiary, must now be introduced into the list of Cretaceous plants. In Sakhalin, namely, it occurs in a flora, older than those elsewhere; though the age of many other floras believed as Tertiary must be revised. In the Dakota flora, the genus *Populus* is represented by some other, but allied, species. *Populus arctica* passes from the Upper Cretaceous of Arctic, right through into the Laramie of America and the Lower Tertiary of the high North. It is very important to remark here in favour of its Cretaceous age rather than the Tertiary, its total absence in the really Tertiary floras of Dui and Mgach (the latter contains *Castanea Kubinyi*, *Comptoniphyllum* cf. *japonicum*, *Populus latior*, *Carpinus*, *Alnus* etc., which are all characteristic Tertiary species). Under this condition, we can well explain the solitary position of this species among the recent sections of the genus *Populus*, while all the other sections of this genus are well represented in really Tertiary floras. The position and distribution of this species among the extinct floras of the whole Holarctic Province deserves great attention.

23. *Populus* cf. *potomacensis* WARD.

1895. *Populus potomacensis*, WARD, 15th Ann. Report U. S. Geol. Surv., p. pl. IN. f. 1–3.
—— *Populus auriculata*, ibidem, p. 356, pl. IV, f. 4.
1906. *Populus potomacensis*, WARD, in Fontaine, Monogr. U. S. Geol. Surv., vol. XLVIII, (1905), p. 500.
—— *P. auriculata*, ibidem, p. 499, pl. CX, f. 5.
—— *P. menispermoides*, ibidem, p. 498, pl. CX, f. 2 (non 3, 4).
1911. *P. potomacensis*, BERRY, Lower Cretaceous, p. 458, pl. LXXXI, f. 1–1e.

Locality: Erikson's coal mine; the Pilenga Pass.

Among our collections, we observe together with remains of ferns, small leaf impressions with a tender consistence, orbicular or ovate in outline and cordate at the base. The margin of the leaves is slightly crenulate. Our leaf may be compared with *Populus potomacensis* WARD from the Patapsco Formation.

This species seems to extend in Russian Sakhalin from the lower Series into the Gyliakian.

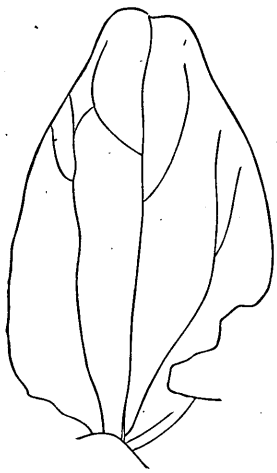

Fig. 8.
Cocculus aff. extinctus VELEN.

24. *Cocculus* aff. *extinctus* VELENOVSKY.

1887. VELENOVSKY, Die Flora der böhmischen Kreideformation, 4. Theil, p. 3, pl. VI (XXXIX), fig. 1, 3.

Locality: Sea-shore at Mgach.

To this species, recorded orginally from the Cenomanian of Bohemia, some leaves are very closely allied, about 6 cm. in length and $3\frac{1}{2}$ cm. in width, ovate in outline and showing thin basal nerves. *Ficus ovatifolia* BERRY,[1] which is also similar in general

1) BERRY (1911), p. 123, pl. XII, f. 3.

outline and nervation with our species, is at once distinguished, however, by the Tertiary veins making network with rectangular meshes, instead of the only tender polygonal ones in ours.

25. *Credneria* aff. *integerrima* Zenker.

1833. Zenker, Beiträge zur Naturgeschichte der Urwelt, p. 17, pl. II, fig. 1.
1858. Stiehler, Beiträge zur Kenntniss der vorweltlichen Flora, p. 64, t. IX, f. 2, 3.
1874. Heer, Kreideflora der arctischen Zone, p. 711, t. XXXII, f. 20, 21.
1882. Heer, Die fossile Flora Grönlands, p. 78, pl. XXXVI, f. 4.

Locality: Sea-shore at Mgach.

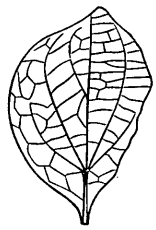

Fig. 9.
Credneria aff. integerrima Zenk.

Of this species there is a single leaf, only 2.5 cm. in length and 20 cm. in width, and with the midrib stout enough below the point of origin of the basal secondary nerves. These nerves are found two on each side of the midrib. The margin of the leaf is quite entire and the outline broadly ovate. The lamina is a little decurrent. The original European species shows very large leaves, but smaller specimens were figured by Heer, especially in his fig. 21 (l. c.), though our leaf is still smaller. The species was recorded from the Atane in Greenland and the Senonian of Europe.

26. *Credneria* sp.

Locality: Near Petrovsky's coal mine.

Some perfectly preserved impressions of exceedingly large leaves, found here in abundance, may be referred either to the species above described or one closely allied to it.

27. *Platanus* sp.

Locality: Sea-shore to the north of Mgach, besides other places.

Some of the large leaves in our collections seem to be allied to *Platanus Heeri*[1] which is quite common in the Arctic Cretaceous (Atane) and in the Dakota Formation. *Platanus rhomboidea* VELEN.[2] and *Pl. Velenovskyana* KRASSER[3] of the European Cenomanian are similar to this species. *Platanus Velenovskyana* was recorded by me from the Southern Ural.[4] *P. Heeri* was mentioned by ROMANOWSKY,[5] as the single representative of the Cretaceous flora in the Semipalatinsk Province, Turkestan, and also determined by me in the Upper Cretaceous of the Amur river.

28. *Bauhinia cretacea* NEWBERRY.

1886. NEWBERRY, Bauhinia cretacea, nov. sp., p. 77, pl. LVI, f. 5.
1895. NEWBERRY, the Flora of Amboy Clays, p. 91, pl. XLIII, f. 1–4; XLIV, f. 1–3.
1911. BERRY, Flora of Raritan Formation, p. 162, t. XIX, f. 3.

Locality: Sea-shore at Mgach.

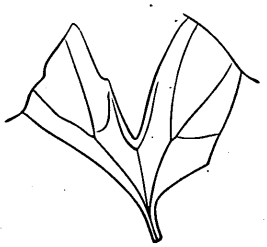

Fig. 10.
Bauhinia cretacea NEWB.

There is only one impression of this leaf, showing a peculiar character. The leaf is circular in general outline, deeply bilobate with the sinus surpassing $^2/_3$ of its length. The midrib is slender and runs in the direction of the median sinus, the lateral nerves are stronger than the midrib, and fork several times. NEWBERRY speaks of the great similarity of this form with

1) LESQUEREUX (1874), p. 70, pl. VIII, f. 4; IX, f. 1, 2.
2) VELENOVSKY (1889), p. 17, pl. II, f. 10; VI. f. 2, 3.
3) KRASSER (1896), p. 138, pl. XV, f. 2.
4) KRYSHTOFOVICH (1914), p. 607, pl. I, f. 5, 6.
5) ROMANOWSKY (1890), p. 139.

some living species of the same genus. This and another species are common in the Raritan Formation.[1] A few other species were recorded by BERRY in the Magothy and in the Tuscaloosa Formation of Alabama.[2] Excluding the Tertiary species, this genus was recognized in Europe as *Phyllites bipartitus* VELEN. from the Cenomanian of Bohemia.[3] A leaf of similar shape but quite different nervation was described by HEER as *Diphyllites membranaceus*,[4] from the Patoot Beds of Greenland.

29. *Celastrophyllum Yokoyamai* n. sp.

Locality: Sea coast of Mgach.

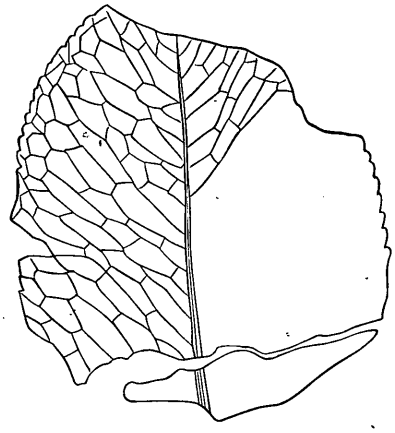

Fig. 11.
Celastrophyllum Yokoyamai n. sp.

Only a middle part of an elliptic leaf of considerable size was found, not less than 10 cm. in length and 5–5½ cm. in width. The midrib is stout, but the most characteristic feature of the leaf is a fine obtuse-serrate margin and a very slender homogeneous network of nerves, without a clear distinction of the secondary and minor veins.

Of the three species, *C. grandifolium*,[5] *C. decurrens*[6] and *C. undulatum*[7] of the Dakota Group, which seem allied to one another, our species is first of all quite different from *C. decurrens*, showing similarly serrate leaves with a

1) BERRY (1911), p. 163.
2) BERRY (1908), p. 218, f. 3.
3) VELENOVSKY (1885), p. 12, pl. VI, f. 4.
4) HEER (1883), p. 45, pl. LX, f. 4 a.
5) NEWBERRY (1895), p. 104, pl. XXI, f. 1–4 etc.
6) Idem, p. 100, pl. XIV, f. 8–17, sub. *C. angustifolium*; BERRY (1911), p. 176, pl. XXII, f. 8.
7) NEWBERRY (1895), p. 102, pl. XXXVIII, f. 1–3.

network of slender veins, but distinguished by its narrow lanceolate outline. The other two species are more similar to ours in outline and size of leaf; but *C. undulatum* is distinguished from ours by bigger teeth of the undulate margin, and *C. grandifolium* by showing a coarse quadrangular reticulation of tertiary veins between the laterals. Converging with some species of *Celastrophyllum* in several features, our specimen possesses an essential difference to warrant the establishment of a new species. But the real generic position of it and of all allied types is still a broad question, because, for instance, a quite similar leaf was described as *Ternstroemia crassipes* Vel. by VELENOVSKY[1], mentioning the close resemblance of it with *Camellia japonica* (tsubaki), and still more with *Ternstroemia dentata* Sw. (the same family) from Guyana. For lack of sufficient specimens of our type, I must limit myself to the above comparison. I must also mention here, that some impressions, described as *Myrica*, have several features in common with ours and with those described as *Celastrophyllum*.

30. *Aralia Polevoii* n. sp.

Locality: Sea-shore at Mgach; Petrovsky's coal mine.

Leaves broadly cordate or orbicular, attaining 8 cm. in length and 8 cm. in width in broadest part. Base of the leaf slightly cordate, sinus broadly open, lamina a little decurrent. The limb palmately trilobate, without any subordinate lobes. Median lobe elliptic, with pointed top and sometimes strictly contracted at the base. The lateral lobes are separated from the median by sinuses with rounded bottom, and are curved outward. Primary nerves three, diverging radially, from one point at the base of leaf, running directly into the summit of each lobe. From each of the

1) VELENOVSKY (1886), p. 54, pl. XVIII, f. 3, 4; reported also by TOULA (1889), p. 33, in Balkans.

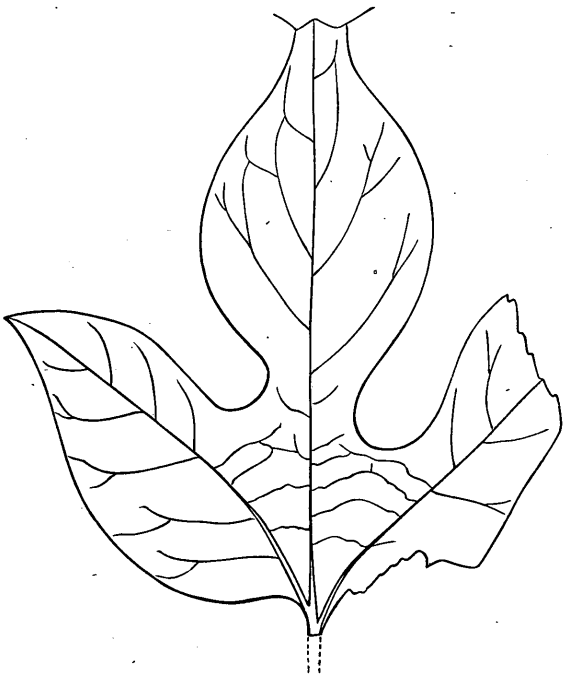

Fig. 12.
Aralia Polevoii n. sp.

lateral nerves, a strong branch goes off from a very short distance above the origin of the nerve. Lateral basal nerves starting from the midrib under an angle of about 30°, but running afterwards more outward, under an angle of about 45°. These lateral nerves run in the lobes nearer to their internal edge; the chief external secondary veins, produced by basal nerves, run nearly at a right angle to the midrib. The secondaries of the median lobe proceed strictly upward, forming a camptodrome network near the margin. Petiole long, reaching the whole length of the limb.

The genus *Aralia*[1] is chiefly Cretaceous, though some of the species still survive now in tropical and subtropical countries. On account of polymorphy of leaves, *Aralia* is very often confused with *Sassafras* and *Cissites*, both being also mainly Cretaceous. The present species, *A. Polevoii*, is most closely allied to the following species in the Potomac (Patapsco) Flora: *Araliœphyllum magnifolium* Font.,[2] *A. aceroides* Font.,[3] *Aceriphyllum aralioides*

1) Berry (1903 b), p. 421.
2) Fontaine (1889), p. 318, pl. CLIX, f. 9, 10; Berry (1911 c) p. 491, pl. XCVI, f. 1–5.
3) Fontaine (1889), p. 319, pl. XCVI, f. 11; CLXII, f. 2.

FONT,[1] and *Hederæphyllum angulatum* FONT.[2] All those species must, according to BERRY,[3] be united into the single species *A. magnifolium* FONT. The most important coincidence of the Potomac and Sakhalin leaves is the strictly contracted median lobe and the broadly cordate form of the base of the limb. But the entire absence of additional lobes and the more outwardly stretched lateral lobes, in contrast to the upward ones of the American species, are the characteristic differences. *Aralia grœnlandica* HEER,[4] represented in Atane and in Dakota, appears not so closely allied to our species, but a leaf impression described from Dakota as *Lindera venusta Lesq.*[5] shows a great resemblance to ours, differing only in having lateral nerves and lobes running more strictly upward. May it not be regarded as a synonym of *A. magnifolia* FONT.? From the above mentioned, our species seems to be good enough to be separated under the new name, *A. Polevoii* m.

A greater part of the collection of the Mgach flora consists of its leaves, which is therefore one of the most important type fossil of the Gyliakian.

Besides *A. groenlandica*, *A. Ravniana* HR.[6] was recorded from the Atane and *A. waigathensis* HR. from the Patoot[7] Beds, both being far distant from our Sakhalin type.

31. *Aralia Tikhonovichii* n. sp.

Locality: The sea coast at Mgach.

Leaves palmately decompound, with five leaflets; leaflets 6,0 cm. to 10.0 cm. in length, and 1.5 cm. to 2.0 cm. in width, shortly

1) FONTAINE (1889), p. 321, pl. CLXXIII, f. 8.
2) FONTAINE (1889), p. 324, pl. CLXII, f. 1.
3) BERRY (1911 c), p. 491, pl. XCVI, f. 1–5.
4) HEER (1882), p. 84, pl. XXXVIII, f. 3; XXXIX, f. 1; XLVI, f. 16, 17.
5) LESQUEREUX (1892), p. 95, pl. XVI, f. 1, 2.
6) HEER (1882), p. 84, pl. XXXVIII, f. 1, 2.
7) HEER (1883), p. 36, pl. LX, f. 5.

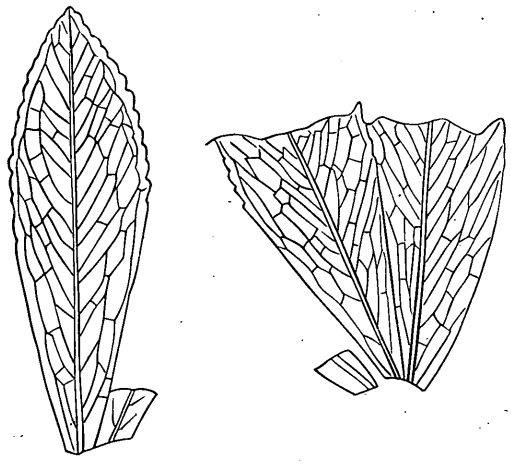

Fig. 13.
Aralia Tikhonovichii n. sp.

petiolate, oblanceolate, tapering to the apex more abruptly than to the base. Margin shortly obtuse-crenate-serrate, more evidently in the upper half and a little below, becoming quite entire on the base. The number of teeth about 10–14 on each side. Midrib stout, secondaries slender and very slightly evident among the general network of veins of lower ranks, rising steeply upward, camptodrome near the edge.

Our species shows closest resemblance with the two Cenomanian species of Bohemia: *A. coriacea* Vel.[1] and *A.* (*Panax*) *dentifera* Vel.[2] The most important difference between them and ours is in the form of the teeth of margin, which are in ours fine and well prominent below the middle of leaflet, but in *A. coriacea* dentate only at the upper half. In *A. dentifera*, the teeth descend almost down to the base, but are longer and less numerous than in ours. On account of the above mentioned divergence from the European forms, a separate species *A. Tikhonovichii* m. was established. *A. coriacea* is very abundant in the Bohemian flora, and our new species in the Mgach, although the latter never plays so important a rôle in the bed as *A. Polevoii.*

As more or less similar to the *Aralia* of our type, we may point out some impressions, figured sometimes under quite different

1) Velenovsky (1886), p. 11, pl. I (XVI), f. 1–9; II (XVIII) f. 2; also found in Balkans, Toula (1889) p. 33.

2) Velenovsky (1886), p. 13, pl. II (XVII), f. 3–5.

generic names, as *Dryandroides* or *Myrica*, which may be quite identical with *Aralia*, according to Marquis SAPORTA.[1] Less closely allied species of *Aralia* were recorded mostly from the Cenomanian in Europe, America and Greenland, and partly from the Senonian in Europe.

32. *Hedera McClurii* HEER.

1868. HEER, Miocene Flora von Nordgrönland, F. F. A., I, p. 119, pl. XVII, f. 1 a, 2 c, 3, 4, 5 a.

1869. HEER, Contributions to the fossil flora of North Greenland, p. 476, pl. LII, f. 8 e.

1870. HEER, Die Miocene Flora und Fauna Spitzbergens, p. 60, pl. XIII, f. 29–33.

1876. HEER, Beiträge zur fossilen Flora Spitzbergens, p. 78, pl. XVIII, f. 1,2.

1878. HEER, Miocene Flora der Insel Sachalin, p. 44, pl. VII, f. 9 b.

1880. HEER, Beiträge zur Miocenen Flora von Nord-Canada, p. 16, pl. III, f. 5.

1883. HEER, Die tertiäre Flora von Grönland, p. 117, pl. LXVI, f. 2.

Locality: Cape de la Jonquière.

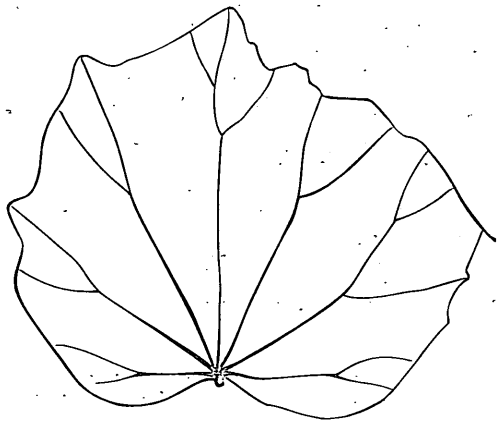

Fig. 14.
Hedera McClurii HEER.

This Arctic species, which was regarded before as Tertiary, can be identified with one of our species, occurring in the Mgach, just as I have treated *Populus arctica* in a foregoing page. Most of the described floras which contain the present species are of doubtful age; but the Mgach flora, from which HEER has

1) SAPORTA (1866), p. 114, pl. VI, f. 1.

mentioned it, is no doubt Cretaceous. However, I myself found it only at Cape de la Jonquière, a little below its *Inoceramus* horizon. The basal nerves, which count five or more, run radially upwards altogether from the same point at the top of the petiole. The midrib does not differ essentially from the laterals, and forks sometimes soon after the origin. The Cretaceous *Hedera cuneata* HR.[1] and *H. primordialis* SAP.[2] is also not far distant from our species. *H. McClurii* HR. has until now only been found in Greenland, Spitzbergen, and on the McKenzie river in Canada.

33. *Viburnum Schmidtianum* HEER.

1878. HEER, Miocene Flora der Insel Sachalin, p. 43, pl. XI, f. 4–8.

1883. HEER, Die foss. Flora Grönlands, II. Th. II: F. Foss. Arct., vol. VII, p. 114, pl. LXXXIX, f. 10; XCIV, f. 4 (? A. K.)

Locality: Cape de la Jonquière; Petrovsky's coal mine.

Impressions, very similar to those described by HEER from Mgach and Dui, have now been found in several places. Having not now at my disposal all I collected, I simply follow the nomenclature of HEER. His specimen from Mgach is doubtless Cretaceous; but the locality at Dui is very difficult to identify owing to the indefinite use of this place name. HEER has determined the geological position as the lowermost Tertiary. Perhaps his locality "Dui" (only in this case; because in other cases he called by this name a locality near Cape Khoinju) here corresponds to the modern "Cape de la Jonquière," that is the place of the "inverted series" of SCHMIDT.

HEER himself compares the present species with *V. Whimperi*[3]

1) SAPORTA (1869), p. 200, text-fig. 29–1 and 2; HEER (1882), p. 82, pl. XV, f. 9, 10; XXIV, f. 6, 7 a; XXVIII, f. 13, 14.

2) HEER (1882), p. 81, pl. XXVIII, f. 12; XLV, f. 2.

3) HEER (1869 c), p. 475, pl. XLVI, f. 1 b; id. (1883), p. 115, pl. CII, f. 13.

and *V. Nordenskioldii* HR.[1] from Greenland. *V. Schmidtianum* was also recorded from the Hasel Islands.

LESQUEREUX has shown the close resemblance of his *Viburnum inequilaterale*[2] from the Dakota Group with the present species.

INCERTÆ SEDIS.

34. *MacClintockia sachalinensis* n. sp.

Locality: Tymovskaya Padj near Niklewicz's coal mine.

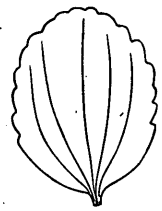

Fig. 15.
McClintockia sachalinensis n. sp.

Leaf small, 2 cm. in length and 1.5 cm. in width, broadly ovate or nearly orbicular, margin serrate, more distinctly towards the top. From a point of the base arise the slightly prominent midrib and basal nerves, forming a slender network with irregular meshes.

The genus *MacClintockia* represents one of the most wonderful types in the Arctic Flora. HEER described from Greenland *McClintockia cretacea* HR. in the Patoot Beds,[3] and *M. appendiculata* HR. in the Atane.[4] The leaves of both have a quite entire margin, and the latter has besides auriculate appendices at the base. Our leaves are, however, dentate on the upper two thirds of the margin. A more close affinity with our fossil is shown by some Arctic species, treated by HEER as Tertiary. These are *M. Lyellii* HR.[5] with narrow lanceolate leaves and *M. dentata* HR.[6] with broader leaves; from both of which our species differs by an evidently smaller size and a more circular outline, thus separating ours as a

1) HEER (1883), p. 115, pl. XCLL, f. 11; XCVI, f. 2.
2) LESQUEREUX (1892), p. 120, pl. XXI, f. 2, 3.
3) HEER (1882), p. 70, pl. XXXVI, f. 1, 2; XXXVIII, f. 2, 3, 4; id. (1883), p. 27, pl. LV, f. 14.
4) HEER (1882), p. 71, pl. XXXVII, f. 1.
5) HEER (1868), p. 115, pl. XV, f. 1 a, 2; XVI, f. 7 a b; XVII 2 a etc.; (1883), p. 95.
6) HEER (1868), p. 115, pl. XV, f. 34; (1869 c), p. 479, pl. LII, f. 4–7; (1883) p. 95.

distinct species. I have mentioned above, that the connection of our Cretaceous fossils with the Arctic Tertiary is not at all surprising. For instance, *M. trinervis* Hr.,[1] having been previously observed together with *Populus arctica* and *Hedera McClurii* in the so-called Tertiary of Atanekerdluk, was afterwards recognized by Dawson in the Upper Cretaceous Bed of Port McNeil of Vancouver,[2] which corresponds to the Nanaimo Group and overlies the Beds of Quatsino.[3]

Dawson has also recorded *M. cretacea* of Patoot from the Mill-Creek Series in the Cenomanian,[4] if his determination is correct. We must also throw a glance upon the "Miocene" *M. tenera* Hr. from Spitzbergen,[5] similar with our specimens in size and form.

There are in our collection still very many other dicotyledonous leaves, which represent different species not above mentioned. But not having the greater part of our collection at my disposal, where these leaves are represented by far more perfect specimens, I must postpone their determination.

Geological Institute
Imperial University
Jan. 22nd, 1918. Tōkyō.

---

1) Heer (1868), p. 115, pl. XV, f. 7–13; (1869 c) p. 480, pl. L, f. 12; LII, f. 8 a.
2) Dawson (1893), p. 64, pl. X, f. 38.
3) Id. (1890), p. 180.
4) Dawson (1889), p. 13, pl. IV, f. 3.
5) Heer (1876 a), p. 83, pl. XXI, f. 6.

Literature.

AUERBACH, J.—1844. Notiz über einige Pflanzen-Versteinerungen aus einem Sandsteine des Moskovischen Gouvernements: Bull. Soc. Imp. Natur. de Moscou, vol. XVII, pp. 145–148.

BERRY, E.—1903. The Flora of the Matawan Formation: Bull. New York Botan. Garden, vol. III.

—— 1903 a. The American Species referred to *Thinnfeldia*: Bull. Torr. Botan. Club, Aug. 1903, vol. 30.

—— 1903 b. *Aralia* in American Paleobotany: Bot. Gaz., vol. XXXVI, p. 421–428.

—— 1904. Addition to the Flora of the Matawan Formation: Bull. Torr. Botan. Club, vol. XXXI.

—— 1905. Addition to the Flora of Cliffwood, New Jersey: Bull. Torr. Botan. Club, vol. XXXII.

—— 1906 a. The Flora of Cliffwood Clays: Annual Report Geolog. Survey New Jersey, for year 1905.

—— 1906 b. Contributions to the Flora of the Atlantic Coastal Plain: Bull. Torr. Bot. Club, vol. XXXIII.

—— 1907. Paleobotanical notes: Cretaceous Floras in North and South Carolina; New species of Plants from the Magothy Formation: Johns Hopkins University Circular 1906–7, new series No. 7.

—— 1910. Contributions to the Mesozoic Flora of the Atlantic Coastal Plain. V. North Carolina: Bull. Torr. Bot. Club, vol. XXXVII.

—— 1911 a. The Flora of the Raritan Formation: Bull. of the Geological Survey of New Jersey, No. 3.

—— 1911 b. A revision of the fossil Ferns from Potomac: Proceed. U. S. Nat. Mus., vol. XLI, p. 307.

—— 1911 c. Lower Cretaceous: Maryland Geological Survey, Baltimore, Md.

—— 1914. The Upper Cretaceous and Eocene Floras of South Carolina and Georgia: U. S. Geol. Surv. Profess. Paper, No. 84.

—— 1916. Upper Cretaceous Floras of the World: Proceed. Nation Acad. of Sci., vol. II, March, p. 186.

CORDA, A. J.—1846. Pflanzen-Versteinerungen in der böhmischen Kreideformation: in REUSS, Versteinerungen der böhmischen Kreideformation, pp. 81–96. Stuttgart.

DAWSON, J. W.—1883. On the Cretaceous and Tertiary Floras of British Columbia and the North-West Territory: Proc. and Trans. Roy. Soc. Canada, vol. I, sect. IV.

—— 1886 a. On the Mesozoic Floras of the Rocky Mountains Region of Canada: Proc. and Trans. Roy. Soc. Canada, vol. III (1885) Sect. IV.

—— 1886 b. Geological Surv. of Canada: Annual Report, vol. I.

—— 1890. Notes on the Cretaceous of the British Columbia Reg. The Nanaimo group: The American Journal of Science, vol. XXXIX, p. 180–183.

—— 1893 a. On the Correlations of early Cretaceous Floras in Canada and the U. S. and on some new plants of this period: Proc. and Trans. Roy. Soc. Canada, vol. X (1892), sect. IV, p. 79.

—— 1893 b. On new Species of Cretaceous Plants from Vancouver Island: Proc. and Trans. Roy. Soc. Canada, vol. XI, sect. IV, p. 53.

DAWSON, J. W. and G. M.—1889. On Cretaceous Plants from Port McNeill, Vancouver Island: Proc. and Trans. Roy. Soc. Canada, vol. VI, (1888), sect. IV, p. 71.

DUNKER, W.—1846. Monographie der Norddeutschen Wealdenbildung. Braunschweig.

EICHWALD, E.—1862. Die vorweltliche Fauna und Flora des Grünsandes der Gegend von Moskwa: Bull. Soc. Imp. Nat. Moscou, vol. XXV, No. 2, p. 355.

—— 1865. Lethaea Rossica, vol. II.

ENDLICHER, S.—1847. Synopsis Coniferarum. Sangalli.

FONTAINE, M.—1889. Potomac or Younger Mesozoic Flora: Monographs of the U. S. Geol. Survey, vol. XV, part 1 and 2.

—— 1899. Notes on Lower Cretaceous Plants from the Hay Creek Coalfield, Crook County, Wyoming: Ann. Report (19th) U. S. Geol. Surv., p. 645–702.

—— 1906. Report on various collections of Fossil Plants from the Older Potomac of Virginia and Maryland: in Ward's Status of Mesozoic Floras, Monogr. U. S. Geol. Surv., vol. XLVIII (year 1905).

GARDNER, J. S.—1884. On the Relative Ages of the American and the English Cretaceous and Eocene Series: Geol. Magaz., vol. I, Dec. 3, p. 492–506.

GEINITZ, H. B.—1842. Charakteristik der Schichten und der Petrefakten des sächsisch-böhmischen Kreidegebirges, Abth. 3. Leipzig und Dresden. (2nd ed. in 1850).

GRAY, ASA.—1859. Diagnostic characters of new species of phaenogamic plants, collected in Japan: Memoirs of the American Academy, new series, vol. VI, part 2.

HARADA, T.—1890. Die Japanischen Inseln. Eine topographisch geologische Uebersicht.

HEER, O.—1867. Ueber einige fossile Pflanzen von Vancouver und Britisch Columbia: Neue Denksch. d. schweiz. naturforsch. Gesellschaft, Bd. XXI.

—— 1868. Die fossile Flora der Polarländer, enthaltend die in Nordgrönland, Melville Insel, Banksland, am Mackenzie, in Island und Spitzbergen entdeckten fossilen Pflanzen: F. F. A., vol. I.

—— 1869 a. Beiträge zur Kreideflora. I. Flora von Moletein in Mähren: Neue Denksch. allgem. schweiz. Gesellschaft gesam. Naturwissenschaft, vol. XXIII, p. 1–24.

—— 1869 b. Flora fossilis Alaskana: Fl. Foss. Arct., vol. II, part 2; Kongl. Svenska Vetensk. Akadem. Handlingar, bd. 8, No. 4.

—— 1869 c. Contributions to the fossil Flora of North Greenland, being a description of the Plants collected by Mr. E. WHYMPER during the summer of 1867; Philosoph. Transactions. Roy. Soc., vol. CLIX, p. 445.

—— 1870. Die miocene Flora und Fauna Spitzbergens: Fl. Foss. Arct., vol. II, part 3; Kongl. Sven. Vetensk. Akad. Handl., bd. 8, No. 7.

—— 1871 a. Beiträge zur Kreideflora. II. Zur Kreideflora von Quedlinburg: Neue Denkschr. allg. schweiz. Gesellsch. gesam. Naturwiss., Bd. XXIV, p. 1–15.

—— 1871 b. Forutskickade anmärkningar öfver Nordgrönlands Kritflora: Öfvers. K. Svensk. Vetensk. Akad. Handl., bd. XXVIII, year 1870, p. 1175.

—— 1871 c. Om nogle fossile Blade fra Öen Sachalin: Vitens. Meddel. fra den nat. Forening i Kjöbenhavn, No. 23–25.

HEER, O.—1874 a. Om några fossila växter från ön Sachalin: Öfvers. af Kongl. Vetensk. Akad. Förhandl., No. 10.

—— 1884 b. Die Kreideflora der arktischen Zone: Fl. Foss. Arct, vol. III, part 2; Kong. Sv. Vet. Akad. Handl., bd. 12, No. 6.

—— 1874 c. Nachträge zur miocenen Flora Nordgrönlands, enthaltend die von der schwedischen Expedition im Sommer 1870 gesammelten miocenen Pflanzen: Fl. Foss. Arct., vol. III, part 3; Kongl. Sv. Vet. Akad. Handl., bd. 13, No. 2.

—— 1874 d. Uebersicht der miocenen Flora der arktischen Zone: Fl. Foss. Arct., vol. III, part 4.

—— 1876 a. Beiträge zur fossilen Flora Spitzbergens: Fl. Foss. Arct., vol. IV, part 1; Kong. Sv. Vet. Akad. Handl., bd. 14, No. 5.

—— 1876 b. Beiträge zur Juraflora Ostsibiriens und des Amurlandes: Fl. Foss. Arct., vol. IV, part 2; Mém. de l'Acad. Imp. de Sci. de St.-Pétersbourg, Série VII-e, tome XXII, No. 12.

—— 1878 a. Die miocene Flora des Grinnellandes gegründet auf die von Capitän H. W. FEILDEN und Dr. E. Moss in der Nähe des Kap Murchison gesammelten fossilen Pflanzen: Fl. Foss. Arct., vol. V, part 1.

—— 1878 b. Beiträge zur fossilen Flora Sibiriens und des Amurlandes: Fl. Foss. Arct., vol. V, part 2; Mém. de l'Acad. Impér. des Sci. de St. Pétersbourg, VII série, tome XXV, No. 6.

—— 1878 c. Primitiæ floræ fossilis sachalinensis. Miocene Flora der Insel Sachalin: Fl. Foss. Arct., vol. V, part 3; Mém. de l'Acad. Impér. Sci. de St.-Pétersbourg, VII-e série, vol. XXV, No. 7.

—— 1878 d. Beiträge zur miocenen Flora von Sachalin: Fl. Foss. Arct., vol. V, part 4; Kongl. Sv. Veten. Akad. Handl., bd. 15, No. 4.

—— 1880 b. Beiträge zur miocenen Flora von Nord Canada: Fl. Foss. Arct., vol. VI, part 3.

—— 1880 a. Nachträge zur fossilen Flora Grönlands: Fl. Foss. Arct., vol. VI, 1. Abth., part 2; Kongl. Sv. Vet. Akad. Handl. bd. 18, No. 2.

—— 1882. Die fossile Flora Grönlands. I. Theil.: Fl. Foss. Arct., vol. VI, 2. Abth. (Flora von Kome- und Atanschichten).

—— 1883. Die fossile Flora Grönlands. II. Theil (Die Flora der Patoot-

schichten, die tertiäre Flora von Grönland, allgem. Bemerkungen, über die Lagerungsverhältnisse d. Westküste von Grönland etc.): Fl. Foss. Arct., vol. VII.

HITCHCOCK, E.—1841. Final report Geol. Massachusetts: Vol. II, p. 429–433.

HOLLICK, A.—1892. The Paleontology of the Cretaceous Formation on Staten Island: Trans. New York Acad. Sci., vol. XI, p. 96.

—— 1893. Additions to the Paleobotany of the Cretaceous Formation on Staten Island. Trans. New York Acad. Sci., vol. XII, p. 28.

—— 1898. Additions to the Paleobotany of the Cretaceous Formation on Staten Island (New York): Ann. New York Acad. Sci., vol. XI, p. 415.

—— 1902. Geological and botanical notes: Cape Cod and Chappaquidick Island, Mass.: Bull. New York Botan. Garden, vol. II, p. 381.

—— 1902 b. Fossil Forms of Laramie Group of Colorado: Torreya, vol. II, p. 145.

—— 1903. Fifty-fifth annual report New York State Museum for 1901.

—— 1905. Additions to the Paleobotany of the Cretaceous Formation of Long Island, No. II: Bull. New York Bot. Gard., vol. III, p. 403.

—— 1906. The Cretaceous Flora of Southern New York and New England: Monogr. U. S. Geol. Surv., vol. L.

HOSIUS A. UND MARCK, W. VON DER.—1880. Die Flora der westfälischen Kreideformation: Palæontographica, vol. XXVI, p. 126.

JAPAN.—1902. Outlines of the geology of Japan: Descriptive text to accompany the geological map of the Empire on the scale 1: 1000000. Tōkyō.

JIMBŌ, K.—1892. General Geological Sketch of Hokkaidō, with special reference to the petrography: published by Hokkaidōchō, Satporo.

—— 1908. Preliminary notes on the geology of Japanese Sakhalin, with a geol. map: Trans. of the Sapporo Natural History Society, vol. II, parts I and II, p. 1.

KNOWLTON, F. H.—1898. A Catalogue of the Cretaceous and Tertiary Plants of North America: Bull. U. S. Geol. Survey, No. 152.

—— 1905. Fossil Plants of the Judith-River beds: Bull. U. S. Geol. Surv., No. 257, p. 129.

KNOWLTON, F. H.—1907. Description of a collection of Kootanie Plants from the Great Falls Coal Field of Montana: Smithsonian Misc. Coll. Quart. Issue, vol. L, p. 105.

KONSTANTOW, S. W.—1914. Die tertiäre Flora des Bjelogorje Aufschlusses am Unterlauf des Fl. Bureja: Mem. Comité Géologique, Russie, Livr. 113. [Константовъ, Третичная флора Бѣлогорскаго обнаженія въ низовьѣ р. Буреи: Труды Геолог. Комитета, нов. сер., вып. 113].

KRASSER, FR.—1896. Beiträge zur Kenntniss der fossilen Kreide-Flora von Kunstadt in Mähren: Beitr. zur Geologie and Palaeontologie Oesterreich-Ungarns und des Orients, vol. X, Heft III, p. 113.

KRENDOWSKIJ, M.—1880. Beschreibung fossiler Bäume hauptsächlich aus dem Süden Russlands, I and II: Trudy Obshchestva Ispytateley Prirody Imperat. Kharkov. Universiteta, vol. XIII, p. 263. [Крендовскій, Описаніе ископаемыхъ древесинъ преимущественно изъ Южной Россіи: Труды Общества Испытателей Природы Императорскаго Харьковскаго Университета, томъ 13, стр. 263].

KRYSHTOFOVICH, A.—1914. The discovery of the Angiosperm Flora in the Cretaceous of the Ural Province: Bull. de l'Acad. Impér. de St.-Pétersbourg (1914), p. 603. [Криштофовичъ, Открытіе остатковъ покрытосѣменныхъ въ мѣловыхъ отложеніяхъ Уральской области: Извѣстія Императорской Академіи Наукъ (1914 г.), стр. 603].

—— 1917. Cretaceous Plants in Russian Sakhalin: The Journal of the Geological Society of Tōkyō, vol. XXIV, No. 291, Dec. 20th, p. 624 (Summary of communication).

KURTZ, K.—1902. Contributiones a la Palæophytologia Argentina.-III: Sobre la existencia de una Dakota-Flora en la Patagonia Austro-Occidental: Revista Museo de La Plata, vol. X, p. 43–59.

LESQUEREUX, L.—1868. On some Cretaceous Fossil Plants from Nebraska: Americ. Journ. Sci., ser. 2, vol. XLVI.

—— 1883. See NATHORST (1883), pag. 5 (list of plants determined by L. LESQUEREUX from Hokkaidō now in Sapporo Agricult. College of Tōhoku Imperial University).

—— 1874. The Cretaceous Flora: Reports U. S. Geol. Surv. of Territories, vol. VI.

LESQUEREUX, L.—1892. The Flora of the Dakota Group: Monogr. U. S. Geol. Surv., vol. XVII.

MERCKLIN, C. E. VON.—1855. Palæodendrologicon Rossicum.—Vergleichende anatomisch-microscopische Untersuchungen fossiler Hölzer aus Russland. St.-Petersburg.

MICHAEL.—1899. Ueber Kreidefossilien von der Insel Sachalin: Jahrb. Kgl. Preuss. Geol. Landesanst., Jahrg. 1898, vol. XVIII, p. 164.

NATHORST, A.—1883. Contributions à la flore fossile du Japon: Kongl. Sven. Vet. Akad. Handl., bd. 20, No. 2.

—— 1888. Zur fossilen Flora Japan's: Palæontologische Abhandlungen von Dames und Kayser, Bd. IV, Heft 3.

—— 1907. Paleobotanische Mitteilungen. I. *Pseudocycas*, eine neue Cycadophytengattung aus den cenomanen Kreideablagerungen Grönlands: Kong. Svensk. Vet. Akad. Handl., vol. XLII, No. 5, p. 1.

—— 1908. Paleobot. Mitt. V. Ueber *Nathorstia* HEER: K. Sven. Vet. Akad. Handl., bd. XLIII, No. 1.

NEWBERRY, J. S.—1886. *Bauhinia cretacea* n. sp.: Bull. Torr. Botan. Club, vol. XIII, May, p. 77.

—— 1869. The Flora of the Amboy Clays: Monogr. U. S. Geol. Surv., vol. XXVI.

—— 1898. The later extinct Floras of N. America: Monogr. U. S. G. Surv., vol. XXXV.

REISS, K.—1907. Untersuchungen über fossile Hölzer aus Japan: Inaugural-Dissertation angen. in Leipzig, 22. V. 1906. Rostock.

REUSS, A.—1846. Die Versteinerungen der böhmischen Kreideformation (see CORDA). Stuttgart.

ROMANOWSKY, G.—1890. Materialien zur Geologie von Turkestan, vol. III.

SAPORTA, G. DE.—1866. Etudes sur la végétation du sud-est de la France à l'époque tertiaire, vol. II, part 1: Ann. de Sci. Nat. 5 série, botanique, vol. III.

—— 1872. Revision de la flore des gypses d'Aix. Etudes sur la végétation du sud-est de la France etc.: Ann. Sci. Nat., 5 série, botanique, vol. XV, p. 277.

SAPORTA, G. DE.—1873. Paléontologie Française. Plantes Jurassiques, vol. I. (text et atlas), p. 292, pl. XXXII, f. 1, 2; XXXIII, f. 1.

SAPORTA, G. DE ET MARION.—1876. Rechèrches sur la végétation fossile de Meximieux: Archive du Musée d'Histoire Natur. Lyon, vol. I.

SCHENK, A.—1869. Beiträge zur Flora der Vorwelt. Die fossilen Pflanzen der Wernsdörfer Schichten in den Nordkarpathen: Palæontographica, vol. XIX, Heft 1.

—— 1871. Die fossile Flora der nordwestdeutschen Wealdenformation. Leipzig.

—— 1875. Beiträge zur Flora der Vorwelt. Zur Flora der nordwestdeutschen Wealdenformation: Paläontographica, vol. XXIII, p. 1–57.

SCHMIDT, F.—1873. Ueber die Kreide-Petrefakten von Sachalin: Mém. de l'Acad. Imp. de St.-Pétersbourg, VII serie, vol. XIX, No. 7.

—— 1897. Ueber Kredefossilien von der Insel Sachalin: Jahrb. der Kgl. Geol. Landesanstalt.

SEWARD, A.—1907. Jurassic Plants from Caucasia and Turkestan: Mémoires du Comité Géologique, St. Pétersbourg, livr. 38, vol. XXXVIII.

SHIMOTOMAI, HIDEZÔ.—1908. General Geology of the Southern part of "The Naibuchi Coal Field" on the river Onnenai, Sakhalin: Manuscript in the Geological Institute of Tōkyō Imperial University.

SOKOLOW, D.—1814. Kreideinoceramen des russischen Sakhalin: Mémoires Com. Geol., livr. 83. [Д. Соколовъ. Мѣловые иноцерамы Русскаго Сахалина: Тр. Геол. Ком., нов. сер., вып. 83.]

STIEHLER, A. W.—1858. Beiträge zur Kenntniss der vorweltlichen Flora: Paläontographica, vol. V, Heft 2.

STOPES, M.—1909. Plant containing nodules from Japan, considered structurally in their relation to the "Coal-Balls" and "Roof-Nodules" of the European Carboniferous: Quart. Journ. Geol. Soc., vol. LXV, p. 195.

—— 1910. The internal anatomy of *Nilssonia orientalis*; Ann. Bot., vol. XXIV, pp. 389–393, pl. XXVI.

—— 1913. The Cretaceous Flora. Part I. Bibliography, Algæ and Fungi: Catalogue of the Mesozoic Plants of the British Museum, London.

STOPES and FUJII, K.— 1910. Studies on the Structure and Affinities of

Cretaceous Plants: Phil. Trans. Roy. Soc., Lond., vol. 201 b, pp. 1–90, pls. I–IX.

STUR, D. in TOULA.—1889. Geologische Untersuchungen im Zentral-Balkan: Denkschr. K. K. Akad. Wiss. Wien, vol. LV, p. 25.

TIKHONOVICH, N. AND POLEVOI, P.—1915. Geomorphological sketch of Russian Sakhalien: Mémories du Comité Géologique, nouv. série, livr. 120. [Тихоновичъ и Полевой, Матеріалы по изслѣдованію Русскаго Сахалина. Геоморфолорическій очеркъ Русскаго Сахалина: Труды Геологическаго Комитета, нов. сер., томъ 120.]

TOULA, F.—1889. Geologische Untersuchungen im Zentral-Balkan: Denkschr. K. K. Akad. Wiss. Wien, vol. LV.

TRAUTSCHOLD, H.—1876. Der Klin'sche Sandstein in Russland: Nouv. Mém. de la Soc. Impér. des Natur. de Moscou, vol. XIII, p. 191.

UNGER, F.—1867. Kreidepflanzen aus Oesterreich: Sitzber. d. K. K. Akad. Wiss. Wien, vol. LV, p. 642.

VELENOVSKY, J.—1882–7. Die Flora der böhmischen Kreideformation, Theil I–IV: Beiträge zur Geologie und Paleontologie Oesterreich-Ungarns und des Orients, I–vol. II (1882), Heft I, p. 8; II–vol. III (1884) Heft I, p. 1; III–vol. IV (1886), Heft I–II, p. 1; IV–vol. (1887), Heft I, p. 1.

—— 1885. Die Gymnospermen der böhmischen Kreideformation.

—— 1888. Die Farne der böhmischen Kreideformation: Abhandl. d. K. böhm. Gesellsch. der Wiss. VII. Folge, vol. II, Naturwiss. Classe. No. 8.

—— 1889. Kvetena ceskeho Cenomanu: Abhandl. k. böhm. Gesellsch. Wiss., vol. III.

WARD, L.—1894. The Cretaceous Rim of the Black Hills: Journ. of Geology, vol. II, p. 250.

—— 1895. The Potomac Formation: 15th Annual Report of U. S. Geolog. Surv., p. 313.

—— 1899. The Cretaceous Formation of the Black Hills as indicated by the fossil plants: Annual Report 19th U. S. Geol. Surv.

WEED, W. H. AND KNOWLTON, F. H.—1893. The Laramie and the over-

lying Livingston Formation in Montana, with report on Flora: Bull. U. S. G. S, No. 105, p. 1–68, pl. I–VI.

WHITE, D.—1890. On Cretaceous Plants from Martha's Vineyard: Amer. Journ. Sci., ser. 3, vol. XXXIX, p. 93.

WHITE, D. AND SCHUCHERT, C.—1898. Cretaceous Series of the West Coast of Greenland: Bull. of the Geol. Soc. of America, vol. IX, p. 343.

WHITEAVES.—1893. The Cretaceous System in Canada: Proceed. and Trans. of Royal Soc. Canada, vol. XI, sect. IV. p. 3.

YABE, H.—1903–4. Cretaceous Cephalopoda from Hokkaidō: Journ. Coll. Sci. Tokyo, vol. XVIII, part 2, and vol. XX, part 2.

—— 1909. Zur Stratigraphie und Paläontologie der oberen Kreide von Hokkaidō und Sachalin: Zeitschr. der Deutsch. Geol. Gesellschaft, vol. LXI, p. 402.

—— 1902. サガレンの白聖紀層及其化石に就て (containing list of fossils from Cape Dui): Journ. Geol. Soc. Tōkyō, vol. IX, p. 44.

YOKOYAMA, M.—1894. Mesozoic Plants from Kōzuke, Kii, Awa, and Tosa: Journ. Coll. Sci. Imper. Univ. Tōkyō, vol. VII, pt. 3.

—— 1906. Mesozoic Plants from China: Jour. Coll. Sci. Imper. Univ. Tōkyō, vol. XXI, art. 9 (on Cretaceous plants pp. 11, 12).

ZEILLER, R.—1905. Sur quelques empreintes des végétaux supracrétacée des Balkans: Annales des Mines, ser. X, vol. VII., p. 326.

ZENKER, J. C.—1833. Beiträge zur Naturgeschichte der Urwelt. Jena.

Contents.

Published April 15th, 1918.