HOKKAIDO UNIVERSITY

Title	On the Fossil Dipteridaceae
Author(s)	Ôishi, Saburô; Yamasita, Kazuo
Citation	Journal of the Faculty of Science, Hokkaido Imperial University. Ser. 4, Geology and mineralogy, 3(2), 135-184
Issue Date	1936-07
Doc URL	https://hdl.handle.net/2115/35769
Type	departmental bulletin paper
File Information	3(2)_135-184.pdf

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

ON THE FOSSIL DIPTERIDACEAE[1]

By

Saburô ÔISHI and Kazuo YAMASITA

With 8 Tables and 6 Text-figures

Contribution from the Department of Geology and Mineralogy, Hokkaidô Imperial University, Sapporo; No. 138.

CONTENTS

I. Morphology and Restoration 135
II. Classification 144
Subfamily Camptopteroideae 144
Genus *Camptopteris* 144
Subfamily Goeppertelloideae 146
Genus *Goeppertella* 146
Subfamily Dipteroideae 147
Genus *Thaumatopteris* 147
Genus *Dictyophyllum* 154
Genus *Clathropteris* 158
Genus *Hausmannia* 158
Subgenus *Protorhipis* 160
Subgenus *Hausmannia* 166
III. Geological and Geographical Distribution of Fossil Dipteridaceae. 167
IV. Summary 175
Addendum 176
Literature 177
Palaeontological Index 181

I. MORPHOLOGY AND RESTORATION

The family Dipteridaceae was instituted by SEWARD and DALE[2] in 1901 for the tropical fern *Dipteris* which had been included in Polypodiaceae. With it were included also some Mesozoic ferns known

(1) A revised and enlarged note of the senior author's "On the Fossil Dipteridaceae". Acta Phytotax. et Geobot., Vol. I, No. 2, 1932, pp. 132–139.

(2) A. C. SEWARD and E. DALE: On the Structure and Affinities of *Dipteris*, with Notes on the Geological History of the Dipteridinae. Phil. Trans. Roy. Soc. London, Vol. CXCIV, 1901.

under the names *Dictyophyllum, Clathropteris, Camptopteris, Hausmannia* and *Thaumatopteris*. Fortunately, the present authors could examine a very large number of specimens belonging to the above mentioned fossil genera with the exception of *Camptopteris,* yielded exhaustively from the Japanese Mesozoic strata, especially from the Nariwa Series. The following is the result of the investigation, bearing chiefly upon the morphology and classification of the fossil Dipteridaceae. The phyllogeny is another task of the first importance to be considered. But it may be discussed in another occasion awaiting still more evidence in regard to the soral characters.

The history of *Dipteris* has already been mentioned in SEWARD and DALE's paper, so it does not need to be described again at this place.

As to the classification of the fossil Dipteridaceae, there is a considerable divergence in the opinions expressed by several authors. A. G. NATHORST(1), who investigated Swedish *Dictyophyllum* and *Camptopteris,* recognised some differences in soral characters between *Dipteris* and the above named fossil genera excepting *Hausmannia* and *Thaumatopteris* (NATHORST makes no mention in his paper about the last two genera), and included the fossil genera in a subfamily Camptopteridinae.

NATHORST's classification was recently followed by M. HIRMER(2) and T. M. HARRIS(3) with some modifications: HIRMER raised NATHORST's subfamily to the rank of family, and instituted a family Camptopteridaceae which cover also *Thaumatopteris* besides two genera as originally included by NATHORST, while *Hausmannia* was included together with the living genus in Dipterideae. HARRIS included *Hausmannia* in Camptopterideae.

HIRMER's arguments on the generic classification are based on the twisting of the pinna-base. On the contrary, HARRIS considered that the pinna base is essentially similar in all the genera. Thus he showed a diagram of the pinna-base with a vertial rachis dividing into two arms which curve and branch in the horizontal plane (HARRIS, 1931, p. 79, fig. 28). He says "such a leaf base may be preserved without distortion; or it may be flattened into one plane,

(1) A. G. NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLI, No. 5, 1906.

(2) M. HIRMER: Handbuch der Palaeobotanik, Bd. I, 1927, pp. 642–656.

(3) T. M. HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. Medd. om Grønland, Bd. LXXXV, No. 2, 1931, p. 78.

and this can happen in several ways. The rachis may be bent backwards (as in *D. exile*) or forwards (*Clathropteris* and small leaves of *D. Nathorsti*), or sideways under one of the arms (*D. Nilssoni*) or both arms may be bent upwards (*Camptopteris* and some specimens of *Thaumatopteris*). Combinations of these distortions are also seen as in a specimen of *D. exile* described here."

As far as the Japanese specimens are concerned which the present authors examined belonging to the genera *Dictyophyllum, Clathropteris, Thaumatopteris,* and *Hausmannia,* the consideration of the nature of the pinna-base seems to be in favour of HARRIS's restoration, though there is need of some modification.

The present authors' consideration is that the nature of the pinna-base at the top of the petiole is similar in all the fossil genera in Dipteroideae, though distinctive to each genus in the degree of dissection of the lamina of pinnae or in the length of arms to which the top of the petiole is divided. These types are often connected by intermediate forms.

Camptopteris and *Goeppertella*[1] gen. nov. (=*Woodwardites* GOEPPERT) are not represented in the Japanese Mesozoic rocks. The habit of *Camptopteris spiralis* NATH. is clearly shown by NATHORST's restoration[2]. Each of the forked arms of the petiole bears many long and narrow pinnae disposed spirally from the pinna-rachis. This genus differs considerably from the other genera of Dipteridaceae in the spiral disposition of the pinnae, if NATHORST's restoration is a natural one. Moreover there seems to be no bending of the arms.

Goeppertella, as may be mentioned later again, seems to have a bipinnate frond at least, and morphologically it has quite different aspect than the rest of the genera.

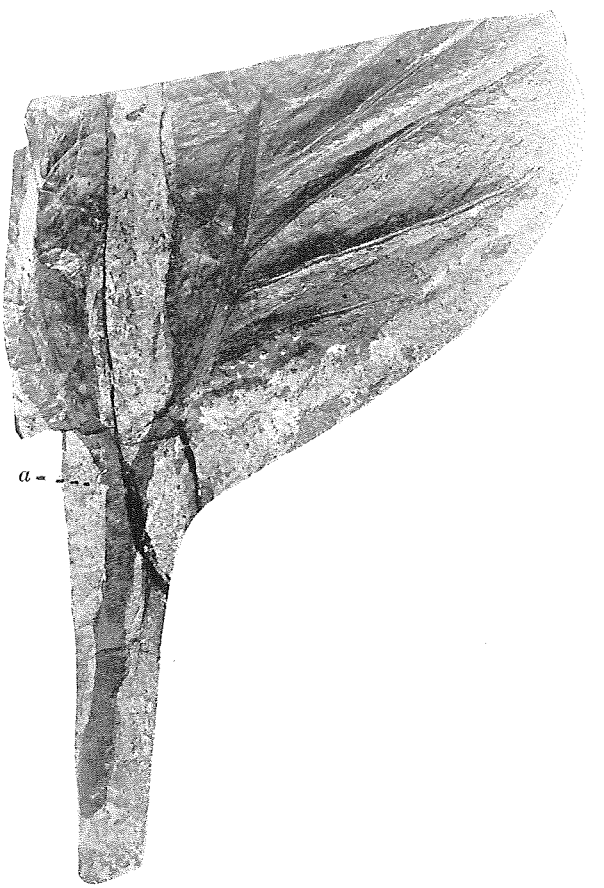
Clathropteris and *Dictyophyllum* possess a similar mode of disposition of pinnae, which are disposed outwards from more or less long arms (pinna-rachis) into which the top of the petiole is divided and bent in a horizontal plane. Of two distinct forms of *Clathropteris,* namely, *C. obovata* and *C. meniscoides* var. *elegans*[3], derived from

(1) A new generic name *Goeppertella* was here proposed for *Goeppertia* ÔISHI and YAMASITA (Journ. Geol. Soc., Tôkyô, Vol. XLII, No. 501, 1935, p. 369), as the latter name was already used by PRESL in 1833 (Versuch, II, p. 121, Pl. L. fig. 1).

(2) A. G. NATHORST: Op. cit., 1906, p. 15, fig. 4.

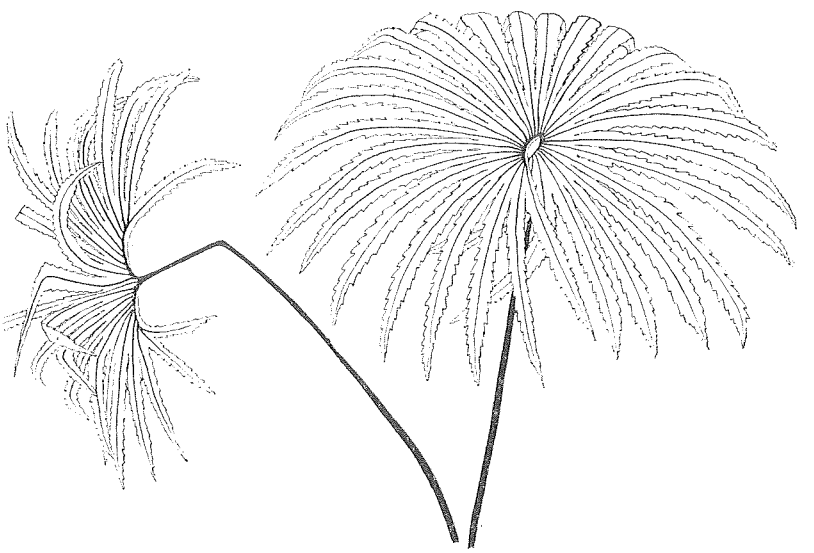
(3) S. ÔISHI: The Rhaetic Plants from the Nariwa District, Prov. Bitchû (Okayama Prefecture). This Journal, Ser. IV, Vol. I, Nos. 3–4, 1932, pp. 289–291.

the Nariwa bed, the latter alone shows the top of the petiole where it forks into two arms which send off pinnae outwards. It is illustrated in Text-fig. 1. It shows that the arms are twisted so as to be brought into one plane with the petiole. The restoration of *C. meniscoides* (BRONGN.) var. *elegans* ÔISHI is shown in Text-fig. 2.



Text-fig. 1. *Clathropteris meniscoides* (BRONGN.) var. *elegans* ÔISHI, showing top of the petiole where it forks into two arms. Loc. Eda (1) in the Nariwa district. ×1. The petiole is twisted at *a*.

Dictyophyllum is a genus very closely related to *Clathropteris*, differing only in the nervation. NATHORST thought that the lamina of *D. exile* (BRAUNS) are spread out in one plane with the petiole, and reproduced a restored figure of this species (NATHORST, op. cit., 1906. p. 13). At the same time he believed that the laminae in *D. acuti-*



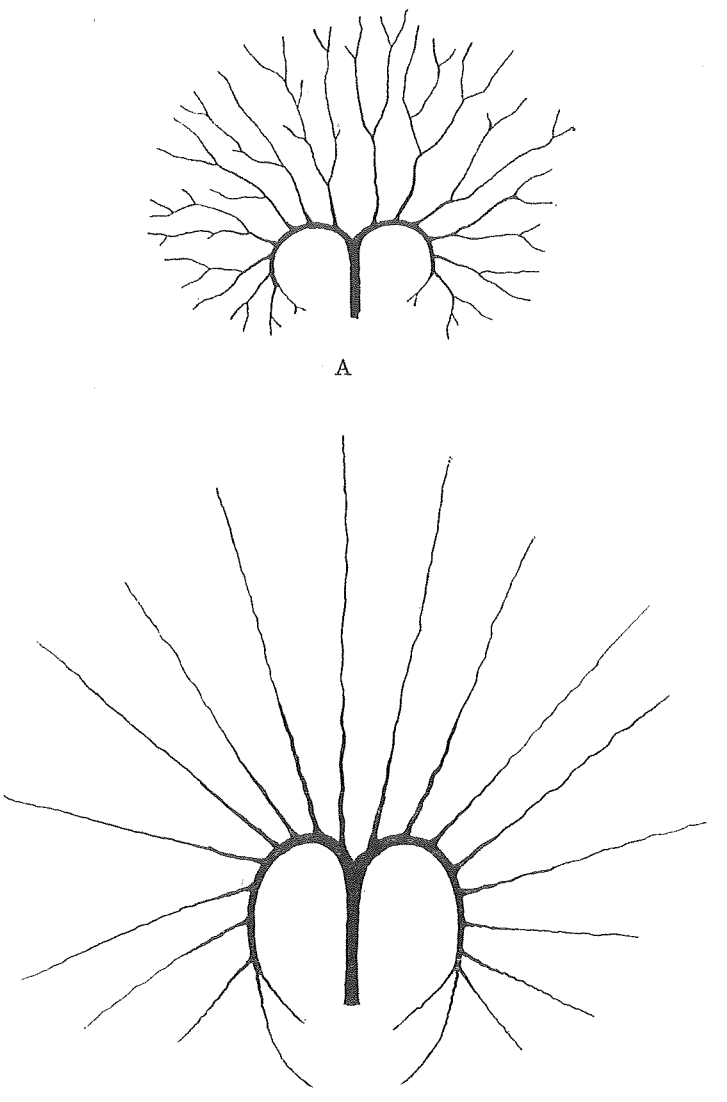
Text-fig. 2. A restoration of *Clathropteris meniscoides* (BRONGN.) var. *elegans* ÔISHI.

lobum, D. Nilssoni, D. Muensteri, and *D. spectabile* are spread nearly in a horizontal plane. He said also that *D. Nathorsti* and *D. exile* together with *Camptopteris spiralis* have long arms which, however, are very short in *D. acutilobum, D. Nilssoni, D. Muensteri* and *D. spectabile.* Japanese specimens referred to *D. Nilssoni, D. Muensteri* and *D. Nathorsti* show the pinna-base according well with NATHORST's view. Though NATHORST thought that the lamina was vertical in *D. exile* as his restored figure shows, his fig. 2 in Pl. V (1906) shows that the petiole is actually twisted at the top where it is divided into two arms spread in a plane making some angles with the rachis. The usual absence of the petiole in the specimens of *Dictyophyllum*-fronds so beautifully preserved (NATHORST, 1906, Pl. II; Pl. III, fig. 6; Pl. V, fig. 1; and some other specimens figured by several other authors) may indicate that the arms or laminae of pinnae are not originally in the same plane with the petiole. In most favourable cases the arms represent direct connection with the petiole in the same bedding-plane (NATHORST, 1906, p. 8, fig. 1).

Thaumatopteris is a type of *Dictyophyllum* in which the arms are extremely reduced. Therefore, in this genus the pinnae are disposed almost in a funnel-shape from the top of the petiole (NATHORST, 1907, Pl. I, fig. 1; see also *Thaumatopteris nipponica*

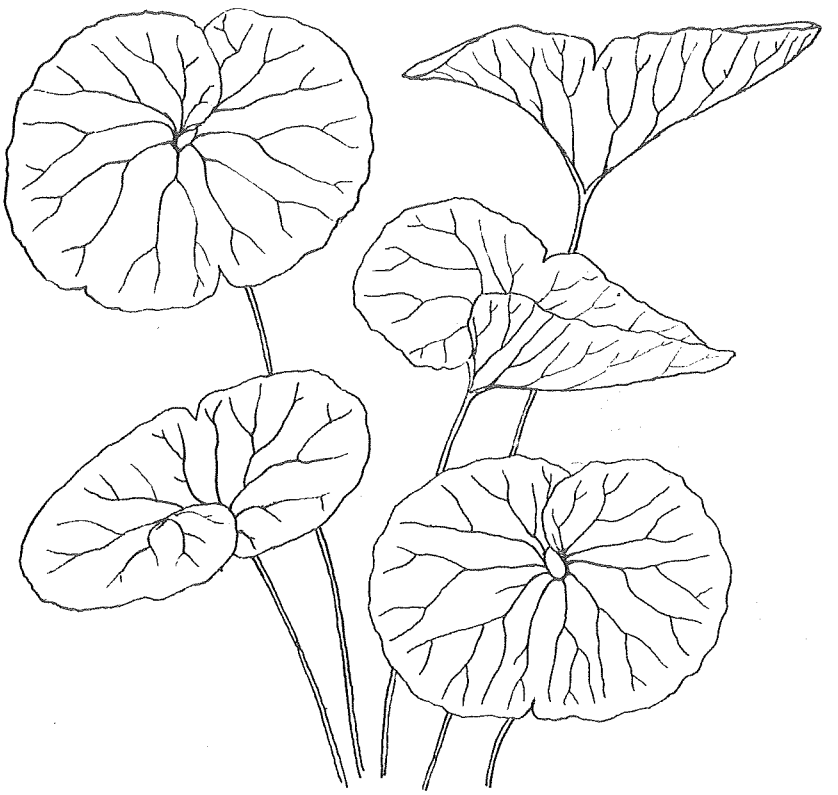
ÔISHI (ÔISHI, 1932b, Pl. XII, fig. 6; Pl. XV, fig. 2; Pl. XXI, fig. 5B and a restoration on p. 294).

Hausmannia appears morphologically quite different from other genera mentioned above, but it is essentially the same in habit with



Text-fig. 3. A comparison of primary nerves; A, *Hausmannia nariwaensis* ÔISHI and B, *H. dentata* ÔISHI. ×1.

them. It is quite beyond doubt that the lamina of *Protorhipis*-type is in a horizontal plane, and this fact is amply proved by the great number of specimens derived from the Nariwa bed. Text-figs. 3–5 show the distribution of the primary nerves and the restorations of *Hausmannia* (*Protorhipis*) *nariwaensis* ÔISHI and *H.* (*P.*) *dentata* ÔISHI.



Text-fig. 4. A restoration of *Hausmannia* (*Protorhipis*) *nariwaensis* ÔISHI. ×1.

At any rate, *Dictyophyllum* and *Clathropteris* are merely the more dissected type of the lamina in *Hausmannia*; thus the primary division of the petiole in *Hausmannia* corresponds to the arms in *Dictyophyllum* and *Clathropteris*. In other words, if in Text-fig. 6 the lamina is entire or nearly so the specimen belongs to *Hausmannia* (*Protorhipis*), while if it is deeply dissected it is *Dictyophyllum* or

Clathropteris. If the primary division of the petiole does not go so far it is *Thaumatopteris*.

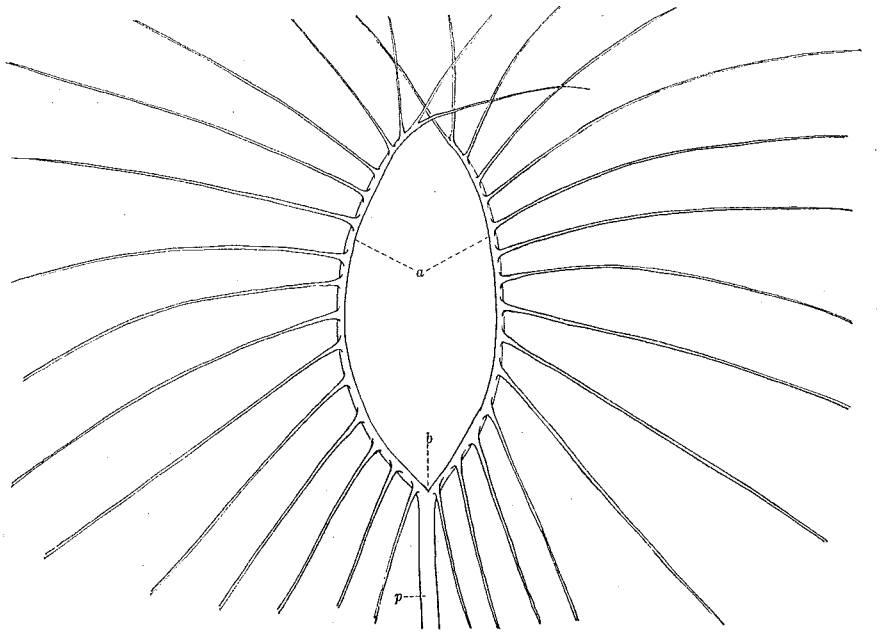
Text-fig. 5. A restoration of *Hausmannia* (*Protorhipis*) *dentata* ÔISHI. Slightly reduced.

The soral characters:—The fertile fronds are very unsatisfactorily represented in the Japanese specimens. The following table is a summary of the soral characters previously given by several authors, added to which is the meagle information obtained from some Japanese specimens. *Goeppertella* is omitted from the table, as its sporangia are not yet satisfactorily investigated.

TABLE I.

	Sori			Sporangia				Spores			Sources
	Shape	Diameter (mm.)	Distribution	Shape	Number in a sorus	Diameter (mm.)	Annulus	Shape	Number	Diameter (μ)	
Hausmannia dentata ÔISHI	Circular	1	Whole under surface		6–12 ?	0.18–0.2	Almost complete ; 15 cells in semi-circle				ÔISHI (1932 b)
H. nariwaensis ÔISHI	Circular	0.5	Whole under surface								ÔISHI (1932 b)
H. Forchammeri BARTH. var. *dentata* MOELLER			Whole under surface	Roundly obovoid		0.18–0.24	Somewhat twisted ; 10–12 cells in semi-circle		64 or 128		HALLE (1921)
H. cracoviensis RACIB.	Round			Circular	3–5	0.25	Oblique ?			70–90	RACIBORSKI (1894)
Thaumatopteris Brauniana POPP	Round	0.8	Whole under surface	Pear-shaped	15	0.3	Conspicuous	Round		40	HARRIS (1931)
T. Schenki NATHORST	Variable		Near the rachis		3–30 (HARRIS) ; 8–10 (NATHORST)	0.3 (HALLE) ; 0.2–0.25 (NATHORST)	Somewhat twisted ; probably not quite complete		64, 128		HALLE (1921) ; NATHORST (1907) ; HARRIS (1931)
Dictyophyllum rugosum L. and H.	Non-soral		Whole under surface	More or less lenticular ; short stalked		0.35–0.5	Developed ; oblique ; more than 8–10 cells in semi-circle	Tetrahedral	128	36	THOMAS (1922)
**D. Muensteri* (GOEPP.)	Variable		Whole under surface	Round ; short stalked	3–4	0.39	Complete ; 25–28	Triangular	201, 215	65	HARRIS (1931)
D. Nilssoni BRONGN.			Whole under surface			0.32		Round	164, 177, 191		HARRIS (1931)
D. Nathorsti ZEILLER	Round or variable		Whole under surface	Ovate	5–8	0.15–0.2	Oblique ?				ZEILLER (1903)
D. exile (BRAUNS)			Whole under surface	Globular ; lenticular	4–7	0.5–0.6 (HALLE) ; 0.4–0.6 (NATHORST)	Complete (GOEPPERT ; SCHENK) ; Imcomplete (NATHORST ; ZEILLER ; HALLE)		512, 256		ZEILLER (1893) ; NATHORST (1906) ; HALLE (1921)
Clathropteris meniscoides (BRONGN.)	Round		Near the rachis	Nearly spherical ; short stalked	7–9 (SCHENK) ; 10–15 (HARRIS) ; 5–12 (ZEILLER)	0.25	Complete ; 30 cells	Round or triangular			HARRIS (1931) ; SCHENK (1867) ; THOMAS (1922) ; ZEILLER (1903)
Camptopteris spiralis NATHORST	Non-soral ?			Circular	6–7 ?	0.44–0.5	Incomplete				NATHORST (1906)

* The description of a Japanese specimen of a fertile pinna of *D. muensteri* can be seen in ÔISHI and YAMASITA : The Rhaetic Plants from the Nariwa District. A Supplement (in preparation).



Text-fig. 6. A diagram showing the mode of disposition of pinnae in Dipteroideae. As the arms (*a*) are not in the same plane with the petiole (*p*) in the life time, the frond receives distortion usually at (*b*) when it was embedded.

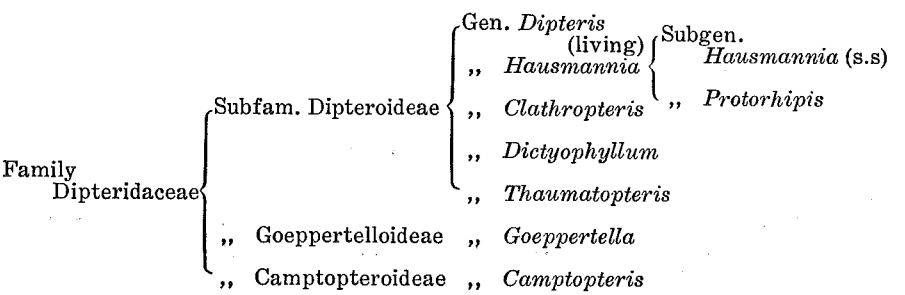
So far as the above information about the soral characters is concerned, unsatisfactory though it is, we can find that the following facts seem to be roughly true:

1. The shape of the sori is mostly the same, being circular or rounded.
2. The size of the sori decreases in the following order of the genera: *Hausmannia*>*Thaumatopteris*>*Dictyophyllum*.
3. The number of sporangia is not constant, even in one species; however, it decreases according to rough estimation in the following order: *Thaumatopteris*>*Clathropteris*>*Hausmannia*>*Dictyophyllum*>*Camptopteris*.
4. The size of the sporangia decreases according to the increase of the size of sori.
5. The annulus is sometimes oblique and mostly complete.
6. Each annulus generally has 30 cells.
7. The number of spores in a sporangium is less in *Hausmannia* and *Thaumatopteris* than in *Dictyophyllum*; the number of spores

increases according to the decreases of size of sori. Judging from the number of spores only, *Hausmannia* and *Thaumatopteris* are types of Filicales leptosporangiatae, while *Dictyophyllum* is a type intermediate between this and Filicales eusporangiatae, comparable to Gleicheniaceae.

II. CLASSIFICATION

The present authors propose tentatively the following classification of Dipteridaceae, chiefly based upon the manner of division of fronds, mode of disposition of pinnae, degree of dissection of laminae, taking also into consideration the soral characters available:



SUBFAMILY Camptopteroideae Subf. nov.

GENUS *Camptopteris* PRESL em. NATHORST

PRESL's genus *Camptopteris* was emended by NATHORST[1] in 1878 based upon some Rhaetic fronds from Sweden resembling those of *Clathropteris* and *Dictyophyllum*, but differing in the form of the pinnae and in their mode of disposition on the arms. This genus differs considerably in habit from all other genera of Dipteridaceae, and may possibly be grouped separately as Camptopterideae, which has already been done by NATHORST[2] and HIRMER[3].

Camptopteris is essentially an Upper Triassic plant, and two valid species are known to us, namely, *C. lunzensis* STUR from the

(1) A. G. NATHORST: Floran vid Bjuf, I, 1878b, p. 33.
(2) A. G. NATHORST: Op. cit., 1906, p. 19.
(3) M. HIRMER: Op. cit., p. 643.

Lettenkohle of Austria[1] and *C. spiralis* NATHORST from the Rhaetic of Sweden[2]. There are two more species referred to this genus, namely, *C. jurassica* GOEPPERT figured by ZIGNO[3] and *C. incissa* NATHORST from the Rhaetic of Sweden[4], but they were founded on very unsatisfactory specimens. *C. serrata* KURR[5] from the upper Triassic strata of Würllemberg has little claim to be included in this genus; this species has been included in *Dictyophyllum* in this paper, as already done by FRENTZEN[6] and HIRMER[7].

Camptopteris incissa NATHORST

1878b. *Camptopteris incissa* NATHORST: Op. cit., p. 35, Pl. IV, figs. 7–8.

This species was founded on some fragmental pinnae derived from the Rhaetic bed of Bjuf. NATHORST distinguished this species from *C. spiralis* in having deeper incision of the lamina, each lobe bearing acute apex. As the mode of disposition of pinnae is obscure it is not clear just how certainly these specimens should be included in the genus *Camptopteris*. As far as the sterile pinnae figured by NATHORST are concerned, they closely resemble *Dictyophyllum japonicum* YOK.

Camptopteris lunzensis STUR

1909. *Camptopteris lunzensis* STUR: Op. cit., p. 111 (no figure).

As there is no reproduction of any figure of this species, the present authors can not form an opinion on this species. The pinnae seem to be entire all round, instead of being lobed or serrated as is usually the case in this genus and allied genera.

---

(1) D. STUR: Zur Kenntnis der fossilen Flora der Lunzer Schichten. Jahrb. d. k. k. geol. Reichsanst., Bd. LIX, Heft 1, 1909, p. 111 (no figure).

(2) A. G. NATHORST: Op. cit., 1906, p. 14.

(3) A. DE ZIGNO: Flora Fossilis Formationis Oolithicae, Vol. I, 1856, p. 181.

(4) A. G. NATHORST: Op. cit., 1878b, p. 35, Pl. IV, figs. 7, 8.

(5) W. PH. SCHIMPER: Traité des paléontologie végétale, I, p. 632, Pl. XLII, fig. 4.

(6) K. FRENTZEN: Die Keuperflora Badens. Verh. naturwiss. Vereins in Karlsruhe, Bd. XXVIII, p. 35.

(7) M. HIRMER: Op. cit., 1927, p. 652.

Camptopteris spiralis NATHORST

1878a. *Camptopteris spiralis* NATHORST: Bidrag till Sveriges Fossila Flora, II, Floran vid Höganas och Helsingborg, Kgl. Svensk. Vet.-Akad. Handl., Bd. XVI, No. 17, p. 13.

1878b. *Camptopteris spiralis* NATHORST: Op. cit., p. 33, Pl. II, fig. 8; Pl. III; Pl. IV, figs. 1–6; Pl. VIII, fig. 1.

1886. *Camptopteris spiralis* NATHORST: Floran vid Bjuf, III, p. 118.

1906. *Camptopteris spiralis* NATHORST: Op. cit., p. 14, Pl. VI, figs. 25–31; Pl. VII, figs. 12–14.

1932. *Camptopteris spiralis* KRYSHTOFOVICH and PRYNADA: Contribution to the Mesozoic Flora of Ussuriland. Bull. U. Geol. Prosp. Serv. U. S. S. R., Vol. LI, Fasc. 22, p. 367.

The occurrence of this species from the Mongugay Series of Ussuriland[1] is somewhat doubtful, because it is reported without any accompanying description or figure.

SUBFAMILY Goeppertelloideae Subf. nov.

GENUS *Goeppertella* gen. nov.

A new generic designation *Goeppertella* is here proposed for the Mesozoic fern which has been called under the name *Woodwardites microlobus* SCHENK[2] in order to avoid confusion with the Tertiary *Woodwardia* which has closer affinity with the living *Woodwardia*. SCHENK's species was derived from the Rhaeto-liassic strata of Franconia and is characterised by fronds which are apparently at least bipinnate(?) and not like those of the *Dipteris*-type. *W. microlobus* SCHNEK was later studied in detail by ZEILLER[3] based on beautiful specimens from the Rhaetic of Tonkin. He recognised the close affinity of this species with Dipteridaceae. Unfortunately, the present authors have not yet met with specimens belonging to this genus. Therefore they follow ZEILLER in including SCHENK's species in Dipteridaceae. The bipinnate habit of the frond of *W. microlobus* seems to warrant its placement in a different group other than Dipteroideae. For this group the present authors wish to propose

(1) A. KRYSHTOFOVICH and V. PRYNADA: Op. cit., p. 367.

(2) A. SCHENK: Die fossile Flora der Grenzschichten des Keupers und Lias Frankens, p. 68, Pl. XIII, figs. 11–13.

(3) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, 1903, p. 91, Pl. XVII, figs. 1–5.

provisionally a subfamily name "Goeppertelloideae", retaining the generic name *Woodwardia* or *Woodwardites* for those fronds from the Tertiary strata which have still closer affinity with the living *Woodwardia*. True *Woodwardia* has not yet been found from strata older than the Tertiary.

Goeppertella microloba (SCHENK) n. comb.

1867. *Woodwardites microlobus* SCHENK: Die fossile Flora der Grenzschichten des Keupers und Lias Frankens, p. 68, Pl. XIII, figs. 11–13.
1869. *Woodwardites microlobus* SCHIMPER: Traité de paléontologie végétale, I, p. 638, Pl. XXXIX, figs. 7–9.
1882. *Woodwardites microlobus* ZEILLER: Examen de la flore fossile des couches de charbon du Tonking, p. 12, Pl. XII, figs. 3–4.
1892. *Woodwardites microlobus* RACIBORSKI: Flory Retyskiej Polski, p. 3, Pl. II, fig. 17.
1903. *Woodwardites microlobus* ZEILLER: Op. cit., p. 91, Pl. XVIII, figs. 1–5.
1913. *Woodwardites microlobus* MOELLER and HALLE: The Fossil Flora of the Coal-bearing Deposits of South-Eastern Scania. Ark. f. Botanik, Bd. XIII, No. 7, p. 9, Pl. I, figs. 7–16.
1919. *Woodwardites microlobus* ANTEVS: Die liassische Flora des Hoersandsteins. Kgl. Svensk. Vet.-Akad. Handl., Bd. LIX, No. 8, p. 14, Pl. I, figs. 5–6.

SUBFAMILY Dipteroideae Subf. nov.

GENUS *Thaumatopteris* GOEPPERT

The genus *Thaumatopteris* was instituted by GOEPPERT[1] in 1841, taking *T. Muensteri* GOEPP. as its genotype. However, this species was later transferred to *Dictyophyllum* by NATHORST[2], who retained GOEPPERT's generic name for POPP's *Thaumatopteris Brauniana*. *Thaumatopteris* is often confused with *Dictyophyllum* in the habit of the frond, but it has the following characters distinct from *Dictyophyllum*:

1. The typical pinnae are disposed in funnel-shape at the top of the petiole, while in *Dictyophyllum*, they are disposed from two arms into which the top of the petiole is branched. In young fonds, the mode of disposition of the pinnae seems to exhibit the *Dictyophyllum*-habit (NATHORST, 1907, Pl. I, fig. 11).

(1) H. R. GOEPPERT: Les genre des plantes fossiles, 1841.
(2) A. G. NATHORST: Ueber *Thaumatopteris Schenki* NATH. Kgl. Svensk. Vet.-Akd. Handl., Bd. XLII, No. 3, p. 3.

2. The pinnae are deeply dissected up to the pinna-rachis at their margin into long and narrow, linear pinnules, while in *Dictyophyllum* the dissection is shallow.

3. The size of sporangia is generally smaller than in *Dictyophyllum*, while the number of sporangia in a single sorus is more in *Thaumatopteris* (table I).

4. The number of spores in a sporangium is less in this genus than in *Dictyophyllum* (table I).

a) The following species are known showing the mode of disposition of pinnae characteristic to the genus *Thaumatopteris*:

Thaumatopteris Gollioni (PELOURDE) n. comb.

1913. *Dictyophyllum Gollioni* PELOURDE: Sur quelques végétaux fossiles du Tonkin. Bull. Serv. Géol. l'Indochine, Vol. I, fasc. 1, p. 2, Pl. I.

PELOURDE[1] reproduced photographs of very beautifully preserved specimens of this species. The funnel-shape disposition of the pinnae is clearly seen in the figures.

Thaumatopteris nipponica ÔISHI

1932b. *Thaumatopteris nipponica* OISHI: Op. cit., p. 293, Pl. XII, figs. 5–6; Pl. XV, figs. 2–3, Pl. XVI, fig. 1; Pl. XXI, fig. 5B; Text-fig. 1 (restoration).

Thaumatopteris Schenki NATHORST

For references of this species, see HARRIS, 1931, p. 93; ÔISHI, 1931, p. 241; ÔISHI, 1932b, p. 296. CHOW[2] figured an indefinite specimen from Scania under the name Cfr. *T. Schenki*.

Thaumatopteris Vieillardi (PELOURDE) n. comb.

1913. *Dictyophyllum Vieillardi* PELOURDE: Op. cit., p. 6, Pl. II.

b) The following species are not yet known to have the characteristic mode of disposition of pinnae of *Thaumatopteris*. However, the present authors, from the general habit of the pinnae or some-

(1) F. PELOURDE: Op. cit., 1913.

(2) T. C. CHOW: The Lower Liassic Flora of Sofiero and Dompäng in Scania. Ark. f. Bot., Bd. X, No. 4, 1924, p. 2, Pl. I, fig. 6.

times from the soral characters available, regard that they belong to this genus rather than to any other genera of Dipteridaceae.

Thaumatopteris Brauniana POPP

An imperfect specimen of this species has been described by the senior author[1] from the Rhaetic bed of Nariwa. For references of this species, see HARRIS, 1931, p. 94.

Thaumatopteris Dunkeri (NATHORST) n. comb.

1878a. *Dictyophyllum Dunkeri* NATHORST: Bidrag till Sveriges Fossila Flora, II, p. 45, Pl. V, fig. 17.
1892. *Dictyophyllum* aff. *Dunkeri* RACIBORSKI: Op. cit., p. 5, Pl. II, fig. 14.
1909. *Dictyophyllum Dunkeri* SALFELD: Beitraege zur Kenntnis jurassischer Pflanzenreste aus Norddeutschland. Palaeontogr. Bd. LVI, p. 15, Pl. I, fig. 7.

This species has been provisionally substituted to the genus *Thaumatopteris.* It is a type resembling *T. Brauniana,* as NATHORST[2] suggested. *Dictyophyllum* aff. *Dunkeri* figured by RACIBORSKI[3] resembles also *T. pusilla* (NATH.) which may be described below.

Thaumatopteris elongata ÔISHI

1932b. *Thaumatopteris elongata* ÔISHI: Op. cit., p. 295, Pl. XVI, fig. 2; Pl. XVII, figs. 1–2.

Thaumatopteris Fuchsi (ZEILLER) n. comb.

1903. *Dictyophyllum Fuchsi* ZEILLER: Op. cit., p. 98, Pl. XVIII, figs. 1–2.

This species is closely allied to *T. Brauniana,* but the pinnules are longer and narrower than those in the latter species. HARRIS[4] mentioned that the base of the pinnules of this species is expanded, while this is not the case in *T. Brauniana.*

Thaumatopteris gracilis (SCHENK)

1867. *Polypodites gracilis* SCHENK: Die fossile Flora der Grenzschichten des Keupers und Lias Frankens, p. 67, Pl. XV, figs. 7–9.

(1) S. ÔISHI: Op. cit., 1932b, p. 297, Pl. XXXV, fig. 4.
(2) A. G. NATHORST: Op. cit., 1878a, p. 45.
(3) M. RACIBORSKI: Op. cit., 1892, p. 5, Pl. II, fig. 14.
(4) T. M. HARRIS: Op. cit., 1931, p. 96.

1869. *Thaumatopteris gracilis* SCHIMPER: Traité de paléontologie végétale, I, p. 630.
1892. *Thaumatopteris gracilis*? BARTHOLIN: Nogle i den bornholmske Jura-formation forekommende Planteforsteninger. Bot. Tidskr., Bd. XVIII, p. 25, Pl. IX, fig. 8.
1910. *Dictyophyllum* (*Thaumatopteris*) *gracile* BARTHOLIN: Planteforsteninger fra Holsterhus paa Bornholm. Danm. geol. Unders., Bd. II, No. 24, p. 9.

This species resembles *T. Schenki* in several characters, but differs from it in the smaller habit of the frond.

Thaumatopteris Kochibei (YOKOYAMA) n. comb.

1891. *Dictyophyllum Kochibei* YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. IV, Art. 2, p. 244, Pl. XXXIV, figs. 1, 1a.
1896. *Dictyophyllum Kochibei* INOUYE: On the Mesozoic Formation in the Southern Part of Nagato. Journ. Geol. Soc. Tôkyô, Vol. III, No. 3, p. 363, Pl. XII, figs. 5, 7.
1905. *Dictyophyllum Kochibei* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XX, Art. 5, p. 6, Pl. I, figs. 5, 7; Pl. II, figs. 1–2.
1932c. *Dictyophyllum Kochibei* ÔISHI: Rhaetic Plants from Province Nagato (Yamaguchi Prefecture), Japan. This Journal, Ser. IV, Vol. II, No. 1, p. 59, Pl. I, figs. 4–6.

This species is certainly very closely related to *Thaumatopteris* in respect to the linear pinnules shallowly lobed at the margin, as YOKOYAMA[1] already compared the species to *Thaumatopteris Schenki* NATH. Though there is no evidence of a characteristic mode of disposition of pinnae, the general features, especially the long and narrow pinnules, seem to warrant the inclusion of the genus of this plant under *Thaumatopteris*. The presence of a small lamina between two adjacent pinnules is one of the characteristic features of this species.

Thaumatopteris lunzensis STUR

1909. *Thaumatopteris lunzensis* KRASSER: Op. cit., p. 113.

KRASSER[2] described *T. lunzensis* as follows, without illustration: "*Thaumatopteris lunzensis* besitzt ziemlich kurze Fieldersegmente, die in geringem Masse anadrom orientiert sind, sie sind parallel-

(1) M. YOKOYAMA: Op. cit., p. 245.
(2) F. KRASSER: Op. cit., 1909, p. 113.

wandig, an der Spitze abgerundet, am Grunde hängen sie zusammen. Von den basalen und apikalen abgesehen, sind sie meist viermal so lang als breit (gewöhnlich 4 mm. Breite, 16 mm. Länge). Die Nerven treten scharf hervor. Der Mittelnerv der Segmente hebt sich ungeachtet dessen, dass er nicht kräftiger als die netzbildenden Sekundärnerven ist—deutlich ab, geht aber in der Spitze in das Sekundärnervennetz ueber, das sich beiderseits vom Mittelnerv in je zwei Reihen aufbaut. Im Zusammenhalt mit den Fiedersegmenten erscheint die 2 mm. breite Spindel recht kraftig. Auch fruktifizierende Exemplare mit den in den Nervenmaschen der Spreitenunterseite stehenden Sori sind zum Vorschein gekommen."

Thaumatopteris pusilla (NATHORST) n. comb.

1878a. *Dictyophyllum Muensteri* GOEPP. var. *pusillum* NATHORST: Op. cit., p. 45, Pl. V, figs. 14–16; Pl. VIII, figs. 8–10.
1932b. *Dictyophyllum Muensteri* (GOEPP.) var. *pusillum* ÔISHI: Op. cit., p. 303, Pl. XVIII, fig. 7; Pl. XIX, figs. 4–7.

This species was described originally by NATHORST[1] as *Dictyophyllum Muensteri* var. *pusillum*, and the senior author[2] also figured similar pinnae from Nariwa. The description of this species may be given in detail in ÔISHI and YAMASITA's paper in preparation[3].

Thaumatopteris Remauryi (ZEILLER) n. comb.

1903. *Dictyophyllum Remauryi* ZEILLER: Op. cit., p. 101, Pl. XIX, figs. 1–2; Pl. XX, figs. 1, 3–4, ?2; Pl. XXI, figs. 1–2.

The present authors included provisionally ZEILLER's *Dictyophyllum Remauryi*[4] from the Rhaetic of Kebao (Tonkin) in *Thaumatopteris*, taking into consideration the long and narrow pinnules resembling *T. nipponica* ÔISHI. ZEILLER figured a specimen of a basal portion of pinnae agreeing in the mode of disposition to that of *Dictyophyllum* (ZEILLER's Pl. XX, fig. 2). This specimen led him to believe that it belongs to the genus *Dictyophyllum*. However, the above named specimen is derived from Hongay, while other speci-

(1) A. G. NATHORST: Op. cit., 1878a, p. 45.
(2) S. ÔISHI: Op. cit., 1932b, p. 303.
(3) S. ÔISHI and K. YAMASITA: Rhaetic Plants from the Nariwa District. A Supplement (in preparation).
(4) R. ZEILLER: Op. cit., 1903, p. 101.

mens with long and narrow pinnules are all derived from Kebao. Therefore, there exist some doubts whether such pinnae as figured in ZEILLER's Pl. XIX, fig. 2 and Pl. XX, figs. 3–4 actually bore the basal character of *Dictyophyllum*-type. The presence of a small lobe between two adjacent pinnules is a feature seen also in *T. Kochibei* (YOK.) as mentioned above.

Thaumatopteris rugosa (L. and H.) n. comb.

1828. *Phlebopteris Phillipsii* BRONGNIART: Histoire des végétaux fossile, p. 377, Pl. CXXXII, fig. 3; Pl. CXXXIII, fig. 1.
1834. *Dictyophyllum rugosum* LINDLEY and HUTTON: Fossil Flora of Great Britain, Vol. II, Pl. CIV.
1835. *Phyllites nervulosus* PHILLIPS: Geology of Yorkshire, sec. edit., Pt. I, Pl. VIII, fig. 9.
1856. *Dictyophyllum rugosum* ZIGNO: Flora Fossilis Formationis Oolithicae, Vol. I, p. 176, Pl. XXIII, figs. 2, 2a.
1856. *Dictyophyllum Leckenbyi* ZIGNO: Ibid., p. 178, Pl. XXIII, fig. 11a.
1900. *Dictyophyllum rugosum* SEWARD: Jurassic Flora, Part I, p. 122, Pl. XIII, fig. 3 (non Pl. XVIII, fig. 1; text-figs. 17–19; these may be distinct species).
1923. *Dictyophyllum rugosum* THOMAS: On Some New and Rare Jurassic Plants from Yorkshire. V. Fertile Specimens of *Dictyophyllum rugosum*. Proc. Camb. Phil. Soc., Vol. XXI, p. 110, Pl. I, figs. 1–5.

This species has long been known under the name *Dictyophyllum rugosum*. However, it displays two types in respect to the shape of pinnae. The original specimens figured by BRONGNIART[1] as *Phlebopteris Phillipsi* have imperfect pinnae with long and narrow, linear pinnules. Later, PHILLIPS[2], LINDLEY and HUTTON[3] and ZIGNO[4] also figured similar pinnae under the same name, while there is another type of pinnae as figured by SEWARD[5] from Yorkshire. They differ greatly from the first type in having less dissected lamina. The pinnae of the first type, though the basal character is not known, are morphologically similar to *Thaumatopteris Kochibei* (YOK.). THOMAS' study[6] of the soral character of *Dictyophyllum rugosum*

(1) A. BRONGNIART: Op. cit., 1828, p. 377, Pl. CXXXVII, fig. 3; Pl. CXXXIII, fig. 1.
(2) J. PHILLIPS: Op. cit., 1835, Pl. VIII, fig. 9.
(3) J. LINDLEY and W. HUTTON: Op. cit., 1831, Pl. CIV.
(4) A. de ZIGNO: Op. cit., 1856, p. 176, Pl. XXIII, figs. 2, 2a.
(5) A. C. SEWARD: Jurassic Flora, Pt. I, 1900, Pl. XVIII, fig. 1; text-figs. 17, 18, 19.
(6) H. H. THOMAS: Op. cit., 1923, p. 113.

from Yorkshire (pinnae of the first type) shows that the number of spores is the same as that of *Thaumatopteris Schenki,* and far less than that of *D. exile, D. Muensteri* and *D. Nilssoni* (see table I). Therefore, the provisional substitution of the generic name *Thaumatopteris* for such pinnae seems to be more appropriate. The present authors wish to call specimens with the pinnae of the first type only under the name *Thaumatopteris rugosa.*

The pinnae of the second type exhibit the base close to *Thaumatopteris* (see, SEWARD, 1906, p. 128, fig. 19; in this specimen the arm is represented as being short just like *D. Muensteri* figured by GOEPPERT)[1]. Therefore, present authors think that they belong to a distinct species of *Thaumatopteris;* outside Europe, the specimens of the second type have been reported from Australia by WALKOM[2] who considered SHIRLEY's species *D. bremerense* as a synonym of it.

Thaumatopteris Sturi KRASSER

1922. *Thaumatopteris Sturi* KRASSER: Zur Kenntnis einiger fossiler Floren des unteren Lias der Sukzessionsstaten von Oesterreich-Ungarn. Sitzungsb. k. Akad. Wiss. Wien, Math.-naturwiss. Kl., Abth. I, Bd. CXXX, Heft 10, p. 354.

1927. *Dictyophyllum Sturi* HIRMER: Op. cit., p. 652.

This species has not yet been figured, but KRASSER[3] described it as follows: "Typische *Thaumatopteris*-Nervatur. Fiedern letzter Ordnung linealisch parallelseitig, 2 mm. breit und ueber 20 mm. lang, ganzrandig mit deutlichem Mittelnerv, der Spinder von Fiederbreite wagrecht oder unter einem Winkel bis 45° entspringend, und zwar in Entfernungen von mehr oder weniger 10 mm., fast gegenstaendig. Die Spindel ist durch einen die Fiederchen verbindenden Laminarsaum schwach gefluegelt". KRASSER compared this species with *Polypodites? Angelini* NATH.[4] from the Rhaetic of Helsingborg, *Dictyophyllum exile* and *Dictyophyllum* (*Thaumatopteris*) *Dunkerianum.*

---

(1) H. R. GOEPPERT: Les genres des plantes fossiles, Liv. I and II, 1841, Pl. I, fig. 1; Pl. II, fig. 1.

(2) A. B. WALKOM: Mesozoic Floras of Queensland. Pt. 1 Cont. The Flora of the Ipswich and Walloon Series. Queensl. Geol. Surv., Publ. No. 257, 1917, p. 9. On Fossil Plants from Bellevue, Near Esk. Mem. Queensl. Mus., Vol. III, Pt. 1, p. 82, Pl. XXI, fig. 1.

(3) F. KRASSER: Op. cit., 1922, p. 354.

(4) A. G. NATHORST: Op. cit., 1878a, p. 43, Pl. VIII, figs. 5–7.

GENUS *Dictyophyllum* LINDLEY and HUTTON

This genus was founded by LINDLEY and HUTTON in 1834 for some fronds from the Jurassic strata of Yorkshire which they regarded as probably dicotyledonous. Some additional material of this genus revealed that it was a fern which demonstrates a close similarity to the recent fern *Dipteris*. *Dictyophyllum* is now a large group comprising more than twenty different forms recorded from various countries. *Dictyophyllum* agrees very closely with *Clathropteris*, but it is convenient to retain both genera in view of the following differences:

1. In *Dictyophyllum*, the tertiary nerves make a reticulum filled with polygonal meshes, while in *Clathropteris* the reticulum made by the tertiary nerves is rectangular.

2. The number of sporangia in a single sorus is less in *Dictyophyllum* than in *Clathropteris*, and the size of sporangia is larger in *Dictyophyllum* than in the other (see table I).

a) Species belonging actually, or to a considerable degree of certainty, to *Dictyophyllum*.

Dictyophyllum acutilobum (F. BRAUN)

For references, see GOTHAN, 1914, p. 17; ARBER, 1917, p. 34; and HARRIS, 1931, p. 81, in "*D. Nilssoni*".

The specimens figured by GOTHAN[1] as *D. acutilobum* are, as HARRIS[2] considered, closely allied to *D. Muensteri* (GOEPP.).

Dictyophyllum Bartholini MOELLER

1902. *Dictyophyllum Bartholini* MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. Lunds Univ. Arsskr., Bd. XXXVIII, Afd. 2, No. 5, p. 44, Pl. IV, figs. 10–12.

1922. *Dictyophyllum Bartholini* KRASSER: Op. cit., p. 350.

The long and narrow pinnules with waved margin of this species remind one of *Dictyophyllum Nilssoni* (BRONGN.) or *Thaumatopteris nipponica* ÔISHI.

(1) W. GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. Abhandl. naturhist. Gesell. Nürnberg, Bd. XIX, 1914, p. 17, Pl. XVIII, fig. 4.

(2) T. M. HARRIS: Op. cit. 1931, p. 82.

Dictyophyllum Carlsoni NATHORST

1878a. *Dictyophyllum Carlsoni* NATHORST: Op. cit., p. 14.
1878b. *Dictyophyllum Carlsoni* NATHORST: Op. cit., p. 38, Pl. V, figs. 8–9.
1899. *Dictyophyllum Carlsoni* SOLMS-LAUBACH: Beschreibung der Pflanzenreste von La Ternera. N. Jahrb. f. Min. etc., B.–B., Bd. XII, p. 598.
1927. *Dictyophyllum Carlsoni* HIRMER: Op. cit., p. 649.

Dictyophyllum Davidi WALKOM

1917. *Dictyophyllum Davidi* WALKOM: Op. cit., p. 10, Pl. III, fig. 2.

This is a species very closely allied to British specimens which SEWARD assigned to *Dictyophyllum rugosum* (L. and H.) (see SEWARD: Jurassic Flora, Pt. I, p. 122, Pl. XVIII, fig. 1; Text-figs. 17–19), differing slightly from them in the smaller type of the frond.

Dictyophyllum exile (BRAUNS)

For references, see HARRIS, 1931, p. 80.

This species resembles *D. Nathorsti* ZEILLER, but differs from it in the complete reduction of lamina towards the base of the pinnae.

Dictyophyllum japonicum YOKOYAMA

1891. *Dictyophyllum japonicum* YOKOYAMA: Op. cit., p. 243, Pl. XXXIII.
1932c. *Dictyophyllum japonicum* ÔISHI: Op. cit., p. 58, Pl. I, figs. 2–3.
1932. *Dictyophyllum japonicum* KRYSHTOFOVICH and PRYNADA: Op. cit., p. 367.
1936. *Dictyophyllum japonicum* ÔISHI and TAKAHASI: Rhaetic Plants from Province Nagato. A Supplement. This Journal, Ser. IV, Vol. III, No. 2, p. 124, Pl. X (II), fig. 3.

One of the characteristic features of this species is the complete reduction of lamina towards the basal portion of the pinnae recalling strongly *Camptopteris spiralis*. However, the discovery of pinna-bases disposed from arms proved its belonging to the genus *Dictyophyllum*[1]. This is a species closely allied to *Dictyophyllum exile*.

Dictyophyllum Muensteri (GOEPPERT)

Dictyophyllum Muensteri mentioned in this place does not contain such a reduced form which NATHORST named *D. Muensteri* var.

(1) S. ÔISHI and E. TAKAHASI: Op. cit., p. 124.

pusillum. This variety was described in the present paper under the name *Thaumatopteris pusilla*. *D. Muensteri* is an intermediate form between *Dictyophyllum* and *Thaumatopteris*, the arms being very short. SEWARD[1] figured a beautiful specimen showing funnel-shape disposition of pinnae under the name *Thaumatopteris Muensteri*.

Dictyophyllum Nathorsti ZEILLER

For references, see ÔISHI and TAKAHASI, op. cit., 1936, p. 122.

Dictyophylluma Nilssoni (BRONGNIART)

For references, see HARRIS, 1931, op. cit. p. 81.

Some Bornholm specimens figured by BARTHOLIN[2] as *Dictyophyllum Nilssoni* may be *Thaumatopteris;* especially the specimen in Pl. X, fig. 5, exhibits the characteristic mode of disposition of pinnae of the *Thaumatopteris*-type.

Dictyophyllum obsoletum NATHORST

1878b. *Dictyophyllum obsoletum* NATHORST: Op. cit., p. 39, Pl. VI, fig. 5, Pl. VIII, fig. 4.
1878a. *Dictyophyllum obsoletum*? NATHORST: Op. cit., p. 14.

Dictyophyllum obtusilobum (BRAUN)

For references, see ARBER: The Earlier Mesozoic Floras of New Zealand. New Zeal. Geol. Surv., Pal. Bull. No. 6, 1917, p. 34.

The New Zealand specimens figured by ARBER are too fragmentary to admit specific determination.

Dictyophyllum Sarrani ZEILLER

1903. *Dictyophyllum Sarrani* ZEILLER: Op. cit., p. 107, Pl. XXII, fig. 1.

Dictyophyllum serratum (KURR)

1869. *Camptopteris serrata* SCHIMPER: Traité des paléontologie végétale, I, p. 632, Pl. XLII, fig. 4.

---

(1) A. C. SEWARD: Fossil Plants, Vol. II, 1910, p. 386, fig. 284.
(2) C. T. BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planteforsteninger. I. Bot. Tidskr., Bd. XVIII, Pl. X, figs. 5–7.

1877. *Camptopteris serrata* HEER: Flora Fossilis Helvetiae, p. 72, Pl. XXV, fig. 3.
1878b. *Camptopteris serrata* NATHORST: Op. cit., p. 36, Pl. V, figs. 3–5.
1922. *Dictyophyllum serratum* FRENTZEN: Op. cit., p. 35, Pl. III, fig. 1.
1927. *Dictyophyllum serratum* HIRMER: Op. cit., p. 652.

This species was originally described as *Camptopteris serrata*. But the present authors follow Frentzen[1] in substituting the generic designation *Dictyophyllum* of this species for *Camptopteris*. The illustration of *C. serrata* given by SCHIMPER[2] shows in all respects the *Dictyophyllum*-habit of the frond.

Dictyophyllum spectabile NATHORST

1906. *Dictyophyllum spectabile* NATHORST: Op. cit., p. 4, Pl. I; ?Pl. VII, fig. 1.
1919. *Dictyophyllum spectabile* ANTEVS: Op. cit., p. 15.
1932b. *Dictyophyllum spectabile* ÔISHI: Op. cit., p. 298, Pl. XVII, figs. 5–6.

A Franconian specimen figured by NATHORST[3] as *D. spectabile* shows a great similarity in habit to *Thaumatopteris*, especially in bearing "Zwischensegment". It is a type close to *T. Kochibei* (YOK.).

b) Specimens determined as *Dictyophyllum* sp.

1910. BARTHOLIN: Planteforsteninger fra Holsterhus paa Bornholm. Danm. Geol. Unders., II, No. 24, p. 17, Pl. III, fig. 2.
1932. CARPENTIER: Végétaux fossiles du Yemen. Bull. Soc. Géol. France, Ser. V, Vol. II, p. 89, Pl. VII, figs. 1–4.
1914. GOTHAN: Op. cit., p. 106, Pl. XIX, fig. 1; Pl. XX, figs. 1.
1913. HALLE: The Mesozoic Flora of Graham Land. Wiss. Ergeb. Schwed. Suedpolarexpedit., 1901–1903, Bd. III, Lief. 14, p. 9.
*1927. HALLE: Fossil Plants from South-Western China. Pal. Sinica, Ser. A, Vol. I, Fasc. 2, p. 12, Pl. IV, fig. 10.
1892. RACIBORSKI: Op. cit., p. 5, Pl. II, fig. 11.
1907. SALFELD: Fossile Landpflanzen der Rhaet- und Juraformation Suedwestdeutschland. Palaeontogr., Vol. LIV, Lief. 4, p. 171, Pl. XIV, fig. 2.
1904. SEWARD: Jurassic Flora, Pt. II, p. 90, fig. 8.
1912. SEWARD: Mesozoic Plants from Afghanistan and Afghan-Turkistan. Pal. Indica, N. S., Vol. IV, Mem. No. 3, p. 14, Pl. III, figs. 14, 14a.

---

(1) K. FRENTZEN: Op. cit., 1922, p. 35.
(2) W. PH. SCHIMPER: Op. cit., 1869, Pl. XLII, fig. 4.
(3) A. G. NATHORST: Op. cit., 1906, Pl. VII, fig. 1.

* The specimen is named as *Dictyophyllum*? It is particularly worthy of note that *Dictyophyllum*? is here described from the rock which is regarded as Permian. If this be truly a *Dictyophyllum*, it is the oldest record of this genus.

1919. WALKOM: Mesozoic Floras of Queensland. Pats. III and IV. The Floras of the Burrum and Styx River Series. Queensl. Geol. Surv., Publ. No. 263, p. 15, Pl. I, fig. 13.

GENUS *Clathropteris* BRONGNIART

This genus agrees essentially with *Dictyophyllum*, though there are slight differences in the nervation and in some points of soral character (see table I). This genus comprises three species(1) and one variety.

Clathropteris meniscoides (BRONGNIART)*

For references, see HARRIS, 1931, p. 88.

Clathropteris meniscoides (BRONGN.) var. *elegans* ÔISHI

1932b. *Clathropteris meniscoides* (BRONGN.) var. *elegans* ÔISHI: Op. cit., p. 289, Pl. XI, fig. 8; Pl. XII, figs. 3–4; Pl. XIII, figs. 1–2; Pl. XV, fig. 1.

Clathropteris obovata ÔISHI

1932b. *Clathropteris obovata* ÔISHI: Op. cit., p. 291, Pl. XII, fig. 2; Pl. XIV, fig. 1.
1936. *Clathropteris obovata*? ÔISHI and TAKAHASI: Op. cit., p. 121, Pl. X (II), fig. 4.

Clathropteris reticulata KURR

1877. *Clathropteris reticulata* HEER: Op. cit., p. 73, Pl. XXV, figs. 4–6.
1922. *Clathropteris reticulata* FRENTZEN: Op. cit., p. 34, Pl. III, fig. 2.

GENUS *Hausmannia* DUNKER

The genus *Hausmannia* was instituted by DUNKER in 1846 on some Wealden specimens from North Germany, and he gave the

(1) *Clathropteris egyptiaca* SEW. described by SEWARD from the Nubian Sandstone of Egypt has been excluded from the list of *Clathropteris* in this paper, because it was later revealed by FRITEL that SEWARD's *C. egyptiaca* was a fragment of *Nulumbium Schweinfurchi* FRITEL (BARTHOUX and FRITEL: Flore Crétacée du grès de Nubie, 1925, p. 106).

* After the manuscript was completed, the authors obtained a specimen of *Clathropteris meniscoides* (BRONGN.) derived from the Nariwa district. The specimen may be figured and described in ÔISHI and YAMASITA: The Rhaetic Plants from the Nariwa District. A supplement (in preparation).

following diagnosis taking *H. dichotoma* as its genotype: "*Hausmannia* fronde irregulariter flabellata, dichotoma, lobis seu lacinis inaequalibus cuneatis obtusis integris vel apice incisis; nervis medianis pluries furcatis crassis costaeformibus, secundaris in areas irregulares subquadratas confluentibus". This diagnosis was later somewhat modified by SCHENK and RICHTER[1] according to some additional material.

In 1853, ANDRAE[2] established the genus *Protorhipis* on Liassic material from the Banat of Hungary, and gave the following diagnosis, taking *P. Buchii* as its genotype: "*Protorhipis* fronds semi-orbiculata?, venae primarial flabellatae, pluries dichotomae, venae secondariae transversales cum priolibus maculas parallelogrammas formantes, venulae in areolas subquadratas confluentes."

These two genera, *Hausmannia* and *Protorhipis*, have been used by several authors following each the original sense until RICHTER[3] mentioned their generic identity in 1906. Thus he proposed to use DUNKER's designation which was established earlier than the other for all the forms of fronds which had been called under DUNKER and ANDRAE's names, together with certain specimens which had been also included in the genera, such as *Asplenium, Platyceriphyllum, Dictyophyllum, Jeanpauria*, etc.

It is indeed true that the fern-fronds which had been called under the genera *Hausmannia* and *Protorhips* are extremely variable in the manner of dissection of laminae even in a single species, and this morphological evidence led RICHTER to the connection of both genera. This view was followed by several authors. Also the present authors believe to some extent the heterophylly of these ferns.

The present authors noticed an interesting contrast as to the geological occurrence of ferns of *Hausmannia* and *Protorhipis* types respectively. That is, the fronds of *Hausmannia* type occur generally from the younger Mesozoic rocks, while on the contrary the appearances of the *Protorhipis* type are geologically older than the former and are yielded generally from the Older Mesozoic rocks, though there are some exceptional cases. The geological distribution

(1) P. B. RICHTER: Beitraege zur Flora der unteren Kreide Quedlinburgs. Theil 1. Die Gattung *Hausmannia* DUNKER und einige seltenere Pflanzenreste, 1906.

(2) K. T. ANDRAE: Die fossile Flora Siebenburgens und des Banates. Abh. k. k. Geol. Reichsanst., Bd. II, Abth. 3, No. 4, 1853, p. 35.

(3) P. B. RICHTER: Op. cit., 1906.

of these genera showing the contrast of their occurrence will be shown by tables in the next chapter.

This contrast of the geological occurrence may be accidental, but it can be considered that fronds of *Hausmannia* type are a more advanced type of *Protorhipis* with less dissected or entire laminae, the former thus approaching the living genus. Therefore, the present authors considered it appropriate to retain both names, *Hausmannia* and *Protorhipis*, in their original senses, placing them in the subgeneric rank under *Hausmannia* in the modern usage.

SUBGENUS *Protorhipis* ANDRAE

For the diagnosis of *Protorhipis*, see that of ANDRAE cited on p. 159 in this paper. Under this subgeneric designation, are comprised the following species.

Hausmannia (*Protorhipis*) *acutidens* MOELLER

1902. *Hausmannia acutidens* MOELLER: Op. cit., p. 51, Pl. V, fig. 7 (also figs. 1 and 3 are similar type).

Hausmannia (*Protorhipis*) *asarifolia* (ZIGNO)

1856. *Protorhipis asarifolia* ZIGNO: Op. cit., p. 180, Pl. IX, figs. 2, 2a.
1906. *Hausmannia? asarifolia* RICHTER: Op. cit., p. 23, Pl. VII, figs. 22a and 22b (a reproduction of ZIGNO's figures).
1927. *Hausmannia asarifolia* HIRMER: Op. cit., p. 656.

Hausmannia (*Protorhipis*) *Buchii* (ANDRAE)

1853. *Protorhipis Buchii* ANDRAE: Op. cit., p. 36, Pl. VIII, fig. 1.
1911. *Hausmannia Buchii* SEWARD: The Jurassic Flora Sutherland. Trans. Roy. Soc. Edinburgh, Vol. XLVII, Pt. IV, No. 23, p. 658, Pl. II, fig. 21; Pl. VI, fig. 6; text-fig. 3.
1917. *Hausmannia Buchii?* WALKOM: Op. cit., p. 11, text-fig. 4.
1922. *Hausmannia Buchii* KRASSER: Op. cit., p. 349.

This species is originally an element of the Rhaeto-Liassic flora, but it has also been reported from the Upper Jurassic strata of

Sutherland[1] though it was based on some imperfect specimens. CARPENTIER[2] also figured a fragment of frond under the name *Hausmannia* sp. *H.* aff. *Buchii* ANDRAE.

Hausmannia (*Protorhipis*) *cordata* (HEER)

1882. *Protorhipis cordata* HEER: Flora Fossilis Groenlandica. Flora Fossilis Arctica, Vol. VI, Pl. III, fig. 18.

1906. *Hausmannia? cordata* RICHTER: Op. cit., p. 24, Pl. VII, fig. 19 (a reproduction of HEER's figure).

Hausmannia (*Protorhipis*) *cracoviensis* (RACIBORSKI)

1894. *Dictyophyllum cracoviense* RACIBORSKI: Flora Kopalna ogniotrwalych glinek krakowskich. Pamiet. Mat. przyr. Akad. Umiej., Bd. XVIII, p. 47, Pl. XIV, figs. 5–10.

1927. *Hausmannia cracoviensis* HIRMER: Op. cit., p. 656.

Hausmannia (*Protorhipis*) *crenata* (NATHORST)

1878b. *Protorhipis crenata* NATHORST: Op. cit., p. 57, Pl. XI, fig. 4.

1902. *Hausmannia* (*Protorhipis*) *crenata* MOELLER: Op. cit., p. 51, Pl. V, figs. 5–6.

1906. *Hausmannia crenata* RICHTER: Op. cit., p. 23, Pl. VII, fig. 20 (a reproduction of NATHORST's figure).

1927. *Hausmannia crenata* HIRMER: Op. cit., p. 656.

1927. *Hausmannia crenata* PRYNADA: Sur des restes de plantes des dépots mésozoique de la Samarskaya Louka. Bull. Com. Géol. Leningrad, Tom. XLVI, No. 8, p. 970, Pl. XLVIII, figs. 1–2.

1932b. *Hausmannia crenata* ÔISHI: Op. cit., p. 305, Pl. XIX, fig. 8.

Hausmannia (*Protorhipis*) *dentata* ÔISHI

1932b. *Hausmannia dentata* ÔISHI: Op. cit., p. 306, Pl. XXI, figs. 1–4, 5A; Pl. XXXV, figs. 2–3; text-fig. 2.

---

(1) A. C. SEWARD: Op. cit., 1911, p. 658, Pl. II, fig. 21; Pl. VI, fig. 6; text-fig. 3.

(2) A. CARPENTIER: La flore Wealdienne de Féron-Glageon (Nord). Mém. Soc. Géol. Nord, Tom. X, No. 1, 1927, p. 25, Pl. III, figs. 2, 2bis.

Hausmannia (*Protorhipis*) *Fischeri* (KNOWLTON)

1907. *Protorhipis Fischeri* KNOWLTON: Kootany Plants from the Great Falls Coal Field of Montana. Smith. Misc. Coll., Vol. L, p. 114, Pl. XII, figs. 3-4.

Hausmannia (*Protorhipis*) *Forchammeri* BARTHOLIN

MOELLER[1] divided this species into two subspecies, namely, *dentata* and *laciniata*. With the former are included fronds in which the laminae are orbicular as in *Protorhipis*, while under the latter are included laminae deeply dissected as in *Hausmannia* (s.s.). It is as yet uncertain that this species is actually heterophyllous as it seems, the Bornholm material being not sufficient to connect both extreme types by intermediate forms. However, the present authors provisionally follow MOELLER treating these two types as valid ones.

Subsp. *dentata* MOELLER

1892. *Hausmannia Forchammeri* BARTHOLIN: Op. cit., p. 26, Pl. XI, figs. 4–5 (non fig. 6; it is subsp. *laciniata* MOELLER).
1902. *Hausmannia Forchammeri* BARTHOLIN subsp. *dentata* MOELLER: Op. cit., p. 49, Pl. IV, figs. 15 and 17 (non fig. 16; it is subsp. *laciniata* MOELLER); Pl. V, fig. 2 (?figs. 1 and 3; they may be *acutidens*); Pl. VI, fig. 27.

This form is a type very similar to *P. Buchii* (ANDRAE).

Subsp. *laciniata* MOELLER

1892. *Hausmannia Forchammeri* BARTHOLIN: Op. cit., p. 26, Pl. XI, fig. 6.
1902. *Hausmannia Forchammeri* BARTHOLIN subsp. *laciniata* MOELLER: Op. cit., p. 50, Pl. IV, fig. 16; Pl. V, fig. 4.

This is a type similar to *Hausmannia dichotoma* DUNKER.

Hausmannia (*Protorhipis*) *integrifolia* (NATHORST)

1878b. *Protorhipis Buchii* NATHORST: Op. cit., p. 42, Pl. XI, fig. 2.
1879. *Protorhipis integrifolia* NATHORST: Op. cit., p. 57, Pl. XI, fig. 2.

A small specimen specifically hardly determinable.

---

(1) H. MOELLER: Op. cit., 1902, p. 49.

Hausmannia (Protorhipis) Kohlmanni RICHTER

1906. *Hausmannia Kohlmanni* RICHTER: Op. cit., p. 21, Pl. I, figs. 1–11; Pl. II, figs. 1, 3–6, 8–9; Pl. V, figs. 1–2, 5–7; Pl. VI, figs. 3, 6–7, 9.
1927. *Hausmannia Kohlmanni* HIRMER: Op. cit., p. 656.
1932. *Hausmannia* aff. *Kohlmanni* KRYSHTOFOVICH and PRYNADA: Op. cit., p. 367.

Hausmannia (Protorhipis) Leeiana SZE

1933. *Hausmannia Leeiana* SZE: Beitraege zur mesozoischen Flora von China. Pal. Sinica, Ser. A, Vol. IV, Fasc. I, p. 7, Pl. II, figs. 8–9.
1934. *Hausmannia Leeiana* CARPENTIER: Sur une diptéridacée d'age sécondaire de la province de Jehol (Chine). Ann. Soc. Sci. Bruxelles, Ser. B, Tom. LIV, p. 147, figs. 1–3.

A type allied to *P. Buchii* ANDRAE.

Hausmannia (Protorhipis) nariwaensis ÔISHI

1932b. *Hausmannia nariwaensis* ÔISHI: Op. cit., p. 303, Pl. XX, figs. 1–10.

This species is by far the most abundant in the Nariwa bed of the Nariwa district. *Hausmannia* cf. *ussuriensis* KRYSHTOFOVICH recently described by SZE[1] from Kansu may in all probability be specifically identical with this Japanese species.

Hausmannia (Protorhipis) ? reniformis (HEER)

1880. *Protorhipis reniformis* HEER: Nachtraege zur Jura-Flora Sibiriens. Mém. l'Acad. Imp. Sci. St.-Pétersbourg, Ser. VII, Vol. XXVII, No. 10, p. 8, Pl. I, fig. 4a.
1906. *Hausmannia? reniformis* RICHTER: Op. cit., p. 24, Pl. VII, fig. 18 (a reproduction of HEER's figure).

It is doubtful whether HEER's *Protorhipis reniformis* actually represents a fern. NATHORST[2] expressed the opinion that it might be such as figured by HEER in his Pl. I, fig. 9 as *Zamiostrobus* (HEER: Nachtraege, 1880, op. cit.).

---

(1) H. C. SZE: Mesozoic Plants from Kansu. Acad. Sinica, No. 13, 1932, p. 67, Pl. IX, figs. 1–6.

(2) A. G. NATHORST: Nachtraegliche Bemerkungen ueber die mesozoischen Flora Spitzbergens. Oefver. Kgl. Vet.-Akad. Foerhandl., Vol. LIV, No. 8, 1897, p. 387.

Hausmannia (*Protorhipis*) *Richteri* SEWARD

1911. *Hausmannia Richteri* SEWARD: Op. cit., p. 660, Pl. I, figs. 18, 18a.

Hausmannia (*Protorhipis*) *Sewardi* RICHTER

1906. *Hausmannia Sewardi* RICHTER: Op. cit., p. 22, Pl. I, fig. 12; Pl. V, figs. 3–4; Pl. VI, fig. 8.
1927. *Hausmannia Sewardi* HIRMER: Op. cit., p. 656.

Hausmannia (*Protorhipis*) *spuria* RICHTER

1906. *Hausmannia spuria* RICHTER?: Op. cit., p. 23, Pl. II, fig. 2.

Hausmannia (*Protorhipis*) *ussuriensis* KRYSHTOFOVICH

1923. *Hausmannia ussuriensis* KRYSHTOFOVICH: *Pleuromeia* and *Hausmannia* in Eastern Siberia. Amer. Journ. Sci., Ser. V, Vol. V, p. 207.
1927. *Hausmannia ussuriensis* HIRMER: Op. cit., p. 656.

This species is closely allied to *P. nariwaensis* ÔISHI, but the Siberian specimens are too unsatisfactorily represented in the figures to admit the comparison with the well-preserved Japanese specimens.

Hausmannia (*Protorhipis*) *volgensis* PRYNADA

1927. *Hausmannia volgensis* PRYNADA: Op. cit., p. 971, Pl. XLVIII, figs. 3–6.

A type similar to *H.* (*P.*) *Kohlmanni.*

Hausmannia (*Protorhipis*) *Zeilleri* (RICHTER)

1897. *Protorhipis Buchii* ZEILLER (non ANDRAE): Revue des travaux de paléontologie végétale. Rev. Gén. Bot., Vol. IX, p. 51, Pl. XXI, figs. 1–7.
1906. *Hausmannia Zeilleri* RICHTER: Op. cit., p. 21, Pl. VII, fig. 17 (a restoration of one of ZEILLER's figures).
1927. *Hausmannia Zeilleri* HIRMER: Op. cit., p. 656.

The following species have originally been described under the generic name *Dictyophyllum* founded on very imperfect specimens. In this paper, they were tentatively included in *Hausmannia*, as no characteristic mode of disposition of pinnae of *Dictyophyllum* type is shown in these specimens. The nervation exhibited in these specimens is rather *Hausmannia*-like than *Dictyophyllum*-like.

Hausmannia (*Protorhipis*) ? *Dicksoni* (HEER)

1874. *Dictyophyllum Dicksoni* HEER: Die Kreide-Flora der arctischen Zone. Kgl. Svensk. Vet.-Akad. Handl., Vol. XII, No. 6, p. 55, Pl. III, fig. 9.
1927. *Dictyophyllum Dicksoni* HIRMER: Op. cit., p. 653.

This species was founded on a very fragmentary specimen from the Kome formation of Greenland. It resembles *D. Roemeri* SCHENK from the Wealden of Germany, but the latter is not in itself a valid species. SEWARD[1] suggested that HEER's species may be *Hausmannia* resembling *H. Kohlmanni* RICHTER.

Hausmannia (*Protorhipis*) ? *Roemeri* SCHENK

1871. *Dictyophyllum Roemeri* SCHENK: Die Flora der norddeutschen Wealdenformation. Paleontogr., Bd. XIX, p. 224, Pl. XXXI, fig. 3.
1894. *Dictyophyllum Roemeri* SEWARD: Wealden Flora, Pt. I, p. 140, figs. 16, 17.
1900. *Protorhipis Roemeri* SEWARD: La Flore Wealdienne de Bernissart. Mém. Mus. Roy. d'Hist. Nat. de Belgique, Tom. I, p. 18, Pl. III, fig. 34.
1927. *Dictyophyllum Roemeri* HIRMER: Op. cit., p. 653.

This specific name was given by SCHENK[2] for a fragmental specimen from the Wealden of Germany, belonging certainly in their characteristic reticulate nervation to Dipteridaceae. Later SEWARD also reported the occurrence of this species from the Wealden strata of Ecclesbourne[3] and Bernissart[4]. In a paper on the Bernissart plants, he used the generic name *Protorhipis* for the specimen, while in a subsequent paper[5], he applied the generic name *Hausmannia*, in view of its being a more appropriate designation. The reason why SEWARD was so undecided in the application of the generic name for this Wealden species was chiefly because of the imperfectness of the original specimen as well as the specimen found subsequently.

Also the present authors have no claim for applying any of the generic names above referred to for this Wealden species. But the

(1) A. C. SEWARD: Notes sur la Flore Crétacique du Groenland, 1924, p. 232. The Cretaceous Plant-bearing Rocks of Western Greenland. Phil. Trans. Roy. Soc. London, Ser. B, Vol. CCXV, 1926, p. 82.
(2) A. SCHENK: Op. cit., 1871.
(3) A. C. SEWARD: Op. cit., 1894, p. 140.
(4) A. C. SEWARD: Op. cit., 1900a, p. 18.
(5) A. C. SEWARD: A Contribution to our Knowledge of Wealden Floras, with Special Reference to a Collection of Plants from Sussex. Q. J. G. S., London, Vol. LXIX, 1913, p. 90.

application of the generic name *Hausmannia* seems to be more appropriate for such specimens as hitherto have been known under the name *D. Roemeri.*

SUBGENUS *Hausmannia* (s. s.) DUNKER

For the diagnosis of *Hausmannia,* see that of DUNKER cited on p. 159 in this paper. Under this subgeneric designation, are comprised the following species:

Hausmannia (*Hausmannia* s. s.) *cretacea* (VELENOVSKY)

1889. *Platyceriphyllum cretaceum* VELENOVSKY: Květena Českého Ceno manu, p. 5, Pl. V, fig. 16 (cited from RICHTER's paper, 1906, p. 20).
1906. *Hausmannia cretacea* RICHTER: Op. cit., p. 20, Pl. VII, fig. 24 (a reproduction of VELENOVSKY's figure).
1927. *Hausmannia cretacea* HIRMER: Op. cit., p. 656.

Hausmannia (*Hausmannia* s. s.) *dichotoma* DUNKER

1846. *Hausmannia dichotoma* DUNKER: Monographie der norddeutschen Wealdenbildung, p. 12, Pl. V, fig. 1; Pl. VI, fig. 12.
1871. *Hausmannia dichotoma* SCHENK: Op. cit., p. 223, Pl. XXIX, figs. 8–9.
1906. *Hausmannia dichotoma* RICHTER: Op. cit., p. 18, Pl. I, figs. 1–10; Pl. IV, figs. 1–9; Pl. V, figs. 9–11; Pl. VI, figs. 2, 5.
1911. *Hausmannia dichotoma* SEWARD: Op. cit., p. 657, Pl. I, figs. 14–17; Pl. II, fig. 20.
1927. *Hausmannia dichotoma* CARPENTIER: Op. cit., p. 24, Pl. III, fig. 1.
1927. *Hausmannia dichotoma* HIRMER: Op. cit., p. 656.

This species is one of the characteristic elements of the Lower Cretaceous and Upper Jurassic floras. *Marchantites erectus* described by FONTAINE[1] from the Jurassic of Oregon may, as SEWARD[2] suggested, be *Hausmannia* allied to *H. dichotoma.*

Hausmannia (*Hausmannia* s. s.) *gracillima* RICHTER

1906. *Hausmannia gracillima* RICHTER: Op. cit., p. 19, Pl. III, figs. 12, 12a.
1927. *Hausmannia gracillima* HIRMER: Op. cit., p. 656.

(1) W. M. FONTAINE: Op. cit., 1905, p. 53, Pl. VI, figs. 1–2.
(2) A. C. SEWARD: Op. cit., 1911, p. 660.

Hausmannia (*Hausmannia* s. s.) *Pelletieri* SEWARD

1913. *Hausmannia Pelletieri* SEWARD: Op. cit., p. 89, Pl. XIV, figs. 1–3.
1927. *Hausmannia Pelletieri* HIRMER: Op. cit., p. 656.

Hausmannia (*Hausmannia* s. s.) *Wirkinsi* WALKOM

1928. *Hausmannia Wirkinsi* WALKOM: Fossil Plants from Plutoville, Cape York Peninsula. Proc. Linn. Soc. N. S. Wales, Vol. LIII, Pt. 2, p. 148, Pl. XIII, figs. 3–4.

Among the two specimens figured by WALKOM, one in fig. 3 is of *H. dichotoma* type, while the other in fig. 4 is of the type similar to *H.* (*P.*) *acutidens*.

The following specimens have been assumed to belong to *Hausmannia*, but there still remains some doubt of their generic determination[1]:

1919. ANTEVS: Op. cit., p. 15, Pl. III, fig. 1; Pl. VI, fig. 39; determined as *Hausmannia* sp.
1910. BARTHOLIN: Op. cit., p. 17, Pl. I, figs. 14, 15; determined as *Hausmannia* sp.
1905. FONTAINE: In WARD's Status of the Mesozoic Floras of the United States, U. S. G. S., Mon. Vol. XLVIII, p. 238, Pl. LXV, fig. 47; determined as *Hausmannia*? *californica*.
1859. DEBEY and ETTINGSHAUSEN: Die vorweltlichen Acrobryen der Kreide formation von Aachen. Denksch. k. Ak Wiss Wien, Bd. XVI, p. 35, Pl. II, figs. 1–3; determined as *Asplenium Brongniarti* and later RICHTER provisionally called the plant *Hausmannia*? *Brongniarti*.

III. GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF FOSSIL DIPTERIDACEAE

The geological and geographical distribution of fossil Dipteridaceae are tabulated below (Table II–VIII) to each species and genera.

(1) RICHTER (1906, p. 20) provisionally substituted the generic name *Hausmannia* for some ferns from the Kome formation of Greenland which HEER called under the names *Jeanpaulia arctica* (=*borealis*) and *J. lepida* (HEER: Die Kreide-Flora der arctischen Zone. Kgl. Svensk. Vet.-Akad. Handl., Bd. XII. No. 6, p. 57, Pl. II, figs. 1–16). However, SEWARD referred the majority of HEER's specimens to *Sphenopteris* (*Onychiopsis*) *Johnstrupi* HR. (SEWARD: The Cretaceous Plant-bearing Rocks of Western Greenland, p. 84). Therefore, RICHTER's *Hausmannia*? *arctica* was excluded from the present category.

TABLE II. *Camptopteris* and *Goeppertella*.

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *C. incissa* NATH.		—						Sweden	NATHORST (1878).
2. *C. lunzensis* STUR	—							Austria.	STUR (1909).
3. *C. spiralis* NATH.		—	?					Sweden ; Ussuriland ?	NATHORST (1878 a, 1878 b, 1886, 1906) ; KRYSHTOFOVICH and PRYNADA (1932).
4. *G. microloba* (SCHENK)		—						Sweden ; Poland ; Tonkin.	SCHENK (1866) ; SCHIMPER (1869) ; RACIBORSKI (1892) ; ZEILLER (1882) ; MOELLOR and HALLE (1913) ; ANTEVS (1919).

TABLE III. *Thaumatopteris*.

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *T. Brauniana* POPP		—						Japan ? ; Greenland ; Poland ; Germany ; Hungary.	SCHENK (1867) ; RACIBORSKI (1891, 1892) ; HARRIS (1931) ; KRASSER (1922) ; ÔISHI (1932).

2. *T. Dunkeri* (NATH.)								Sweden ; Poland.	NATHORST (1878) ; RACIBORSKI (1892).
3. *T. elongata* ÔISHI								Japan.	ÔISHI (1932).
4. *T. Fuchsi* (ZEILL.)								Tonkin.	ZEILLER (1903).
5. *T. Gollioni* (PEL.)								Tonkin.	PELOURDE (1913).
6. *T. gracilis* (SCHENK)								Bornholm.	BARTHOLIN (1892, 1910); SCHENK (1867); SCHIMPER (1869).
7. *T. Kochibei* (YOK.)								Japan.	YOKOYAMA (1895, 1905); INOUYE (1896); ÔISHI (1932).
8. *T. lunzensis* STUR								Austria.	KRASSER (1909).
9. *T. nipponica* ÔISHI								Japan.	
10. *T. pusilla* (NATH.)								Sweden ; Japan.	NATHORST (1878 a) ; ÔISHI (1932 b).
11. *T. Remauryi* (ZEILL.)								Tonkin.	ZEILLER (1903).
12. *T. rugasa* (L. and H.)								England.	PHILLIPS (1835) ; BRONGNIART (1828) ; LINDLEY and HUTTON (1834) ; ZIGNO (1856); SEWARD (1900); THOMAS (1923).
13. *T. Schenki* NATH.								Japan ; Greenland ; Bornholm ; Sweden ; Poland ; Hungary ;	HARRIS (1931) ; NATHORST (1878) ; OISHI (1931) ; RACIBORSKI (1891, 1892); GOTHAN (1914) ; ANTEVS (1919) ; SCHENK (1867) ; MOELLER (1902) : MOELLER and HALLE (1913) ; HALLE (1921).
14. *T. Sturi* KRASSER								Hungary.	KRASSER (1922).
15. *T. Vieillardi* (PEL.)								Tonkin.	PELOURDE (1913).

TABLE IV. *Dictyophyllum.*

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *D. acutilobum* (F. BRAUN)		—	—					Bornholm ; Sweden ; Germany ; Persia ; New Zealand.	ARBER (1917); MOELLER (1902); SALFELD (1907) ; GOTHAN (1914) ; SCHENK (1887, 1891) ; FRENTZEN (1932) ; NATHORST (1878 a, 1878 b).
2. *D. Bartholini* MOELLER		—	—					Bornholm ; Hungary.	MOELLER (1902) ; KRASSER (1922).
3. *D. Carlsoni* NATH.		—	—					Sweden ; Chile.	NATHORST (1878 a, 1878 b) ; SOLMS-LAUBACH (1899).
4. *D. Davidi* WALKOM			—?—					Australia.	WALKOM (1917).
5. *D. exile* (BRAUNS)		—	—					Greenland ; Sweden :	HARRIS (1931) ; JOHANSSON (1922) ; NATHORST (1876, 1878 b, 1886).
6. *D. japonicum* YOK.		—	—?					Japan ; Ussuriland ?	YOKOYAMA (1891) ; ÔISHI (1932) ; KRYSHTOFOVICH and PRYNADA (1932) ; ÔISHI and TAKAHASI (1936).
7. *D. Münsteri* (GOEPP.)		—	—					Japan ; Greenland ; Sweden ; Germany ; Rumania.	MOELLER (1902) ; HARRIS (1931) ; SCHENK (1867) ; MOELLER and HALLE (1913) ; KRASSER (1922) ; NATHORST (1876, 1878 a) ; OISHI (1932).
8. *D. Nathorsti* ZEILL.		—	—					Japan ; China ; Ussuriland ; Kamenka ; Tonkin.	ZEILLER (1903) ; THOMAS (1911) ; ÔISHI (1932) ; KRYSHTOFOVICH and PRYNADA (1932) ; SZE (1933 c).

9. *D. Nilssoni* (BRONGN.)			—	—				Japan; China?; Alaska; Greenland; Bornholm; Poland; France; Hungary.	KNOWLTON (1916); CHOW (1924); NATHORST (1876, 1906); ANTEVS (1919); JOHANSSON (1922); HARRIS (1925, 1931); SCHENK (1867); MOELLER (1902); BARTHOLIN (1892); RACIBORSKI (1891); KRASSER (1922); ÔISHI (1932).
10. *D. obsoletum* NATH.			—					Sweden.	NATHORST (1878 a, 1878 b).
11. *D. obtusilobum* (F. BRAUN)			—	?				Sweden; New Zealand?	NATHORST (1878 a, 1878 b); ARBER (1917).
12. *D. Sarrani* ZEILL.			—					Tonkin.	ZEILLER (1903).
13. *D. serratum* (KURR.)		—						Sweden; Switzerland; Germany.	SCHIMPER (1879); NATHORST (1878 b); HEER (1877); FRENTZEN (1922).
14. *D. spectabile* NATH.			—	—				Japan; Sweden.	NATHORST (1906); ANTEVS (1919); ÔISHI (1932).

TABLE V. *Clathropteris.*

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *C. meniscoides* (BRONGN.)		—	—					Japan; Korea; China; Ussuriland; Kamenka; Turkestan; Tonkin; North America; Greenland; Borholm; Sweden; Poland; Germany; France; Hungary; England.	HARRIS (1931).

2. *C. meniscoides* (BRONGN.) var. *elegans* ÔISHI		—						Japan.	ÔISHI (1932).
3. *C. obovata* ÔISHI		—						Japan.	ÔISHI (1932).
4. *C. reticulata* KURR	?...	—						Switzerland; Germany.	HEER (1877); FRENTZEN (1922).

TABLE VI. *Hausmannia* (*Protorhipis*).

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *H.* (*P.*) *acutidens* MOELLER			—					Bornholm.	MOELLER (1902).
2. *H.* (*P.*) *asarifolia* (ZIGNO)				—				Italy.	ZIGNO (1868); RICHTER (1906).
3. *H.* (*P.*) *Buchii* (ANDRAE)			.....		—?—	?—		Scotland; France?; Hungary; Rumania; Australia?	ANDRAE (1853); SEWARD (1911); WALKOM (1917); KRASSER (1922).
4. *H.* (*P.*) *cracoviensis* (RACIB.)			—					Poland.	RACIBORSKI (1894).
5. *H.* (*P.*) *crenata* (NATH.)		——						Japan; Ussuriland; Sweden; Bornholm.	NATHORST (1878 b); MOELLER (1902); RICHTER (1906); PRYNADA (1927); ÔISHI (1932).

6. *H.* (*P.*) *cordata* (HR.)						—		Greenland.	HEER (1882); RICHTER (1906).
7. *H.* (*P.*) *dentata* ÔISHI		—						Japan.	ÔISHI (1932).
8. *H.* (*P.*) ? *Dicksoni* (HR.)						—		Greenland.	HEER (1874).
9. *H.* (*P.*) *Fischeri* (KNOWLTON)						—		North America.	KNOWLTON (1907).
10. *H.* (*P.*) *Forchammeri* BARTH.			—					Bornholm.	BARTHOLIN (1892); MOELLER (1902).
11. *H.* (*P.*) *integrifolia* (NATH.)		—						Sweden.	NATHORST (1878 b, 1879).
12. *H.* (*P.*) *Kohlmanni* RICHTER					—	—		Ussuriland; Germany.	RICHTER (1906); KRYSHTOFOVICH and PRYNADA (1932).
13. *H.* (*P.*) *Leeiana* SZE			—					China.	SZE (1933); CARPENTIER (1934).
14. *H.* (*P.*) *nariwaensis* ÔISHI		—						Japan.	ÔISHI (1932).
15. *H.* (*P.*) *reniformis* (HR.)				—				Siberia.	HEER (1880); RICHTER (1906).
16. *H.* (*P.*) *Richteri* SEWARD					—			Scotland.	SEWARD (1911).
17. *H.* (*P.*) *Roemeri* SCHENK						—		Germany.	SCHENK (1871).
18. *H.* (*P.*) *Sewardi* RICHTER						—		Germany.	RICHTER (1906).
19. *H.* (*P.*) *spuria* RICHTER			—					Ussuriland.	KRYSHTOFOVICH (1927).
20. *H.* (*P.*) *ussuriensis* KRYSHT.			—					Siberia.	PRYNADA (1927).
21. *H.* (*P.*) *volgensis* RICHTER			—					Hungary; Rumania.	ZEILLER (1897); RICHTER (1906).
22. *H.* (*P.*) *Zeilleri* (RICHTER)						—		Germany.	RICHTER (1906).

TABLE VII. *Hausmannia* (*Hausmannia* s.s.)

	Up. Trias		Jurassic			Creta-ceous		Geographical distribution	Sources
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper		
1. *H.* (*H.*) ? *Brongniarti* (D. and E.)							—	Germany.	DEBEY and ETTINGSHAUSEN (1859); RICHTER (1906).
2. *H.* (*H.*) ? *californica* FONT.						—		North America.	FONTAINE (1905).
3. *H.* (*H.*) *cretacea* (VEL.)							—	Germany.	VELENOVSKY (1889); RICHTER (1906).
4. *H.* (*H.*) *dichotoma* DKR.					—	—		Scotland; Germany; France.	DUNKER (1846); SCHENK (1871); RICHTER (1906); SEWARD (1911); CARPENTIER (1927).
5. *H.* (*H.*) *gracillima* RICHTER						—		Germany.	RICHTER (1906).
6. *H.* (*H.*) *Pelletieri* SEWARD						—		England.	SEWARD (1913).
7. *H.* (*H.*) *Wirkinsi* WALKOM						—		Australia.	WALKOM (1928).

TABLE VIII. The geological distribution to each genus.

	Up. Trias		Jurassic			Cretaceous	
	Keuper incl. Lettenkohle	Rhaetic	Lower	Middle	Upper	Lower	Upper
1. *Camptopteris*	———	———					
2. *Goeppertella*		———	?				
3. *Thaumatopteris*	———	———	———	———			
4. *Dictyophyllum*	———	———	———				
5. *Clathropteris*	?———	———	———				
6. *Hausmannia* (*Protorhipis*)		———	———	———	———	———	
7. *Hausmannia* (*Hausmannia* s.s.)					———	———	———

IV. SUMMARY

The conclusion arrived at from the investigation of fossil records of Dipteridaceae is that it forms a conspicuous group of ferns among the Mesozoic flora of the world. It has been known from Europe, Eastern Asia, North and South America, Australia, Greenland and Graham Land but there are no satisfactory examples from India and Africa. Thus the occurrence of fossil Dipteridaceae in these continents is of special interest as indicating that tropical or subtropical condition prevailed in the regions where the fossil forms are now found. The fossil Dipteridaceae reached its maximum development, numerically and possibly biologically also, in the Rhaetic and the Liassic epochs, and it began to wane numerically towards the end of the Mesozoic, though a certain genus, namely, *Hausmannia,* began to flourish in the younger Mesozoic time. The oldest known genera of the Dipteridaceae are *Camptopteris, Thaumatopteris Dictyophyllum* and *Clathropteris,* which are recorded from the Keuper strata of Europe.

Camptopteris has never been found outside Europe, though there is a record of its occurrence in Ussuriland without description or illustration. This genus is known by only three species from the Upper Triassic rocks. *Thaumatopteris* is known by fifteen species

mostly assembled in the Rhaetic rocks, and in a few cases it has been known from the Middle Keuper and the Jurassic strata. At any rate, its maximum development was in the Rhaetic epoch. *Thaumatopteris* has a wide geographical distribution, it having been recorded from Greenland, Europe and Asia.

Dictyophyllum is known nearly as many species as *Thaumatopteris* than which it is geographically more widely distributed. This genus is mostly concentrated in the Rhaetic and lower Liassic rocks of the European and Asiatic continents, but it is also known from South America and New Zealand. *Clathropteris* is known by four distinct forms, of which *C. meniscoides* has a wide geographical distribution, being known from Europe, Asia and Greenland. The remaining forms are local ones. The genus is rather characteristic of Rhaetic than of Jurassic floras, but the above named species seems to be developed beyond the Rhaetic to the Liassic epoch.

Protorhipis shows a wide geological and geographical distribution, but it seems to be more characteristic of the older Mesozoic than of the younger Mesozoic floras. Fronds of typical *Protorhipis* type are developed mostly in the Rhaetic and the Liassic times, while those unsatisfactorily represented or transitional forms to *Hausmannia* (s.s.) seem to be concentrated in the younger horizons. It is interesting to note that *Hausmannia* (s.s.) is essentially of the younger Mesozoic and that it has never been recorded from strata older than the Middle Jurassic excepting once from Bornholm.

September, 1935.

Addendum: After the manuscript of this paper was already sent to press, the present authors received papers by SEWARD and CROOKSHANK. One of the two papers of the former author deals with the description of fossil plants from the Cretaceous strata of western Greenland in which he described an imperfect frond under the name *Hausmannia Dicksoni* (HR.) (A. C. SEWARD: Additional Cretaceous Plants from Western Greenland. Kgl. Svensk. Vet.-Akad. Handl., Bd. XV, No. 3, 1935, p. 6, Pl. I, fig. 7). Another paper of the same author deals with some dicotyledonous leaves from the Nubian Sandstone of Egypt in which the author mentioned that a fossil plant from the Nubian Sandstone which he once named as *Clathropteris egyptiaca* SEWARD was unfortunately not correctly determined but was a *Nelumbium* as was already pointed out by FRITEL. See also p. 158 of this paper. (A. C. SEWARDS Leaves of

Dicotyledons from the Nubian Sandstone of Egypt. Survey of Egypt (Geological Survey), Cairo, 1935, p. 3).

The paper by CROOKSHANK reports the discovery of some specimens resembling *Hausmannia dichotoma* DKR. and *H. Buchii* (ANDRAE) in the Jabalpur Series of India. Although there still remains some doubt as to the specific determination of the Indian specimens which are very fragmentary, yet it is very interesting as they represent actual existence of Dipteridean ferns in the Upper Gondwanas (H. CROOKSHANK: Note on Some Jabalpur Plants from the Satpura Gondwana Basin. Rec. Geol. Surv. India, Vol. LXIX, Pt. 2, 1935, p. 168, Pl. IX, figs. 1–3; Pl. X, fig. 1).

Literature cited

ANDRAE, K. T. (1853) Die fossile Flora Siebenbürgens und des Banates. Abh. k. k. Geol. Reichsanst., Bd. II.

ANTEVS, E. (1919) Die liassische Flora des Hoersandsteins. Kgl. Svensk. Vet.-Akd. Handl., Bd. LIX, No. 8.

ARBER, E. A. N. (1917) The Earlier Mesozoic Floras of New Zealand. New Zeal. Geol. Surv., Pal. Bull. No. 6.

BARTHOLIN, C. T. (1892) Nogle i den bornholmske Juraformation forekommende Planteforsteninger. I. Bot. Tidskr., Bd. XVIII.

——— (1894) Nogle i den bornholmske Juraformation forekommende Planteforsteninger. II. Ibid., Bd. XIX.

——— (1910) Planteforsteninger fra Holsterhus paa Bornholm. Danm. geol. Unders., II Raek., Nr. 24.

BARTHOUX, J. and P. H. FRITEL (1925) Flore crétacée du grès de Nubie. Le Caire.

BRONGNIART, A. (1828) Histoire des végétaux fossile. Paris.

CARPENTIER, A. (1927) La flore Wealdienne de Féron-Glageon (Nord). Mém. Soc. Géol. Nord, Tom. X, No. 1.

——— (1932) Végétaux fossiles du Yemen. Bull. Soc. Géol. France, Ser. 5, Tom. II.

——— (1934) Sur une diptéridacée d'age sécondaire de la Province de Jehol (Chine). Ann. Soc. Sci. Bruxelles, Ser. B, Tom. LIV.

CHOW, T. C. (1924) The Lower Liassic Flora of Sofiero and Dompäng in Scania. Ark. f. Bot., Bd. X, No. 4.

DEBEY, M. H. and C. v. ETTINGSHAUSEN (1859) Die vorweltlichen Acrobryen der Kreideformation von Aachen. Denksch. k. Ak. Wiss. Wien, Bd. XVI.

DUNKER, W. (1846) Monographie der norddeutschen Wealdenbildung. Brauenschweig.

FONTAINE, W. M. (1905) In WARD's Status of the Mesozoic Floras of the United States. U. S. G. S., Mon. Vol. XLVIII.

FRENTZEN, K. (1922) Die Keuperflora Badens. Verh. naturwiss. Vereins in Karlsruhe, Bd. XXVIII.

GOEPPERT, H. R. (1841) Les genres des plantes fossiles. Bonn.

GOTHAN, W. (1914) Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. Abhandl. naturhist. Gesell. Nürnberg, Bd. XIX.

——— (1924) Palaeobiologische Betrachtungen ueber die fossile Pflanzenwelt. Fortsch. Geol. Paleont., Heft 8.

HALLE, T. G. (1913) The Mesozoic Flora of Graham Land. Wiss. Erg. Schwed. Südpolarexped. 1901–1903, Bd. III, Lief. 14.

——— (1921) On the Sporangia of Some Mesozoic Ferns. Ark. f. Bot., Bd. XVII, No. 1.

——— (1927) Fossil Plants from South-Western China. Pal. Sinica, Ser. A, Vol. I, Fasc. 2.

HARRIS, T. M. (1931) The Fossil Flora of Scoresby Sound, East Greenland. Medd. om Grønland, Bd. LXXXV, No. 2.

HEER, O. (1874) Die Kreide-Flora der Arctischen Zone. Kgl. Svensk. Vet.-Akad. Handl., Bd. XII, No. 6.

——— (1877) Flora Fossilis Helvetiae. Zürich.

——— (1880) Nachtraege zur Jura-Flora Sibiriens. Mém. l'Acad. Imp. Sci. St.-Pétersborg, Ser. VII, Tom. XXVII, No. 10.

——— (1882) Flora Fossilis Groenlandica. Flora Fossilis Arctica, Bd. VI.

HIRMER, M. (1927) Handbuch der Palaeobotanik. München.

INOUYE, K. (1896) On the Mesozoic Formation in the Southern Part of Nagato. Journ. Geol. Soc. Tôkyô, Vol. III.

KNOWLTON, F. H. (1907) Kootany Plants from the Great Falls Coal Field of Montana. Smith. Misc. Coll., Vol. L.

KRASSER, F. (1891) Ueber die fossile Flora der rhaetischen Schichten Persiens. Sitzungsb. d. k. Akad. Wiss. Wien, Math.-naturwiss. Kl., Abth. I, Bd. C.

——— (1909) Zur Kenntnis der fossilen Flora der Lunzer Schichten. Jahrb. d. k. k. geol. Reichsanst., Bd. LIX, Heft 1.

——— (1922) Zur Kenntnis einiger fossiler Floren des unteren Lias der Sukzessionsstaaten von Oesterreich-Ungarn. Sitzungsb. d. k. Akad. Wiss. Wien, Math.-naturwiss. Kl., Abth. I, Bd. CXXX, Heft 10.

KRYSHTOFOVICH, A. (1923) *Pleuromeia* and *Hausmannia* in Eastern Siberia, with Summary of Recent Contribution to the Palaeobotany of the Region. Amer. Journ. Sci., Ser. V, Vol. V, No. 27.

——— and V. PRYNADA (1932) Contribution to the Mesozoic Flora of Ussuriland. Bull. U. Geol. Prosp. Serv. U. S. S. R., Bd. LI, fasc. 22.

LINDLEY, J. and W. HUTTON (1831) The Fossil Flora of Great Britain, Vol I. London.

MOELLER, H. (1902) Bidrag till Bornholms Fossila Flora. Pteridofyter. Lunds Univ. Årsskr., Bd. XXXVIII, Afd. 2, No. 5.

——— and T. G. HALLE (1913) The Fossil Flora of the Coal-bearing Deposits of South-Eastern Scania. Ark. f. Bot., Bd. XIII, No. 7.

NATHORST, A. G. (1876) Bidrag till Sveriges Fossila Flora. I. Kgl. Svensk. Vet.-Akad. Handl., Bd. XIV, No. 3.

——— (1878a) Bidrag till Sveriges Fossila Flora. II. Floran vid Höganäs och Helsingborg. Ibid., Bd. XVI, No. 7.

——— (1878b) Floran vid Bjuf. I.

——— (1879) „ II.

——— (1886) „ III.

——— (1897) Nachtraegliche Bemerkungen ueber die mesozoische Flora Spitzbergens. Oef. Kgl. Vet. Akad. Förhand., Arg. LIV, No. 8.

——— (1906) Ueber *Dictyophyllum* und *Camptopteris spiralis*. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLI, No. 5.

——— (1907) Ueber *Thaumatopteris Schenki* NATH. Ibid., Bd. XLII, No. 3.

ÔISHI, S. (1931) Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. This Journal, Ser. IV, Vol. I, No. 2.

——— (1932a) On the Fossil Dipteridaceae. Acta Phytotax. et Geobot., Vol. I, No. 2.

——— (1932b) The Rhaetic Plants from the Nariwa District, Prov. Bitchû (Okayama Prefecture), Japan. This Journal, Ser. IV, Vol. I, Nos. 3–4.

——— (1932c) Rhaetic Plants from Province Nagato (Yamaguchi Prefecture), Japan. This Journal, Ser. IV, Vol. II, No. 1.

——— and E. TAKAHASI (1935) The Rhaetic Plants from Prov. Nagato. A Supplement. This number of this Journal.

PELOURDE, F. (1913) Sur quelque végétaux fossiles du Tonkin. Bull. Serv. Geol. l'Indochine, Vol. I, Fasc. 1.

PHILLIPS, J. (1835) Geology of Yorkshire. Sec. Edit. Pt. I. London.

POPP, P. (1863) Der Sandstein von Jaegersberg bei Forchheim und die in ihm vorkommenden Pflanzen. N. Jahrb. f. Min. etc., p. 399.

POTONIÉ-GOTHAN (1921) Lehrbuch der Palaeobotanik. Berlin.

PRYNADA, V. (1927) Sur des restes de plantes des depots mésozoiques de la Samarskaya Louka. Bull. Com. Géol. Léningrad, Vol. XLVI, No. 8.

RACIBORSKI, M. (1892) Flory Retyckiej Polski. Krakow.

——— (1894) Flora kopalna ogniotrwalych glinek krakowskich. Pamiet. Mat. prezyr. Akad. Umiej., Bd. XVIII.

RICHTER, P. B. (1906) Beitraege zur Flora der unteren Kreide Quedlinburgs. Theil 1. Die Gattung *Hausmannia* DUNKER und einige seltenere Pflanzenreste. Leipzig.

SALFELD, H. (1907) Fossile Land-Pflanzen der Rhaet- und Juraformation Südwestdeutschland. Palaeontogr., Bd. LIV.

——— (1909) Beitraege zur Kenntnis jurassischer Pflanzenreste aus Norddeutschland. Ibid., Bd. LVI.

SCHENK, A. (1867) Die fossile Flora der Grenzschichten der Keuper und Lias Frankens. Wiesbaden.

——— (1871) Beitraege zur Flora der Vorwelt. Die fossile Flora der nordwestdeutschen Wealdenformation. Palaeontogr., Bd. XIX.

——— (1887) Fossile Pflanzen aus der Albourskette. Bib. Bot., Heft No. 6.

SCHIMPER, W. PH. (1869) Traité de paléontologie végétale, Tom. I.

SEWARD, A. C. (1894) Wealden Flora. Pt. 1. London.
——— (1900a) La Flore Wealdienne de Bernissart. Mém. Mus. Roy. d'Hist. Nat. Belgique, Tom. 1.
——— (1900b) Jurassic Flora. Pt. I. London.
——— (1907) Fossil Plants from Egyt. Geol. Mag., Vol. IV (V).
——— (1910) Fossil Plants. II. London.
——— (1911) The Jurassic Flora of Sutherland. Trans. Roy. Soc. Edinburgh, Vol. XLVII, Pt. IV, No. 23.
——— (1913) Contribution to our Knowledge of Wealden Flora, with special Reference of a Collection of Plants from Sussex. Q. J. G. S., Vol. LXIX.
——— (1924) Notes sur la Flore Crétacique du Groenland. Soc. Géol. Belgique, 50me Anniv. Livre Jubilaire, 1874–1924, Tom. I, Fasc. 1.
——— (1926) The Cretaceous Plant-bearing Rocks of Western Greenland. Phil. Trans. Roy. Soc. London, Ser. B, Vol. 215.
——— and E. DALE (1901) On the Structure and Affinities of *Dipteris*, with Notes on the Geological History of the Dipteridinae. Phil. Trans. Roy. Soc. London, Vol. CXCIV.
SOLMS-LAUBACH, GRAF zu (1899) Beschreibung der Pflanzenreste von La Ternera. N. Jahrb. f. Min. etc., B.-B., Bd. XII.
STUR, D. (1909) Zur Kenntnis der fossilen Flora der Lunzer Schichten. Jahrb. d. k. k. geol. Reichsanst., Bd. LIX, Heft 1.
SZE, H. C. (1933a) Mesozoic Plants from Kansu. Acad. Sinica, No. 13.
——— (1933b) Beitraege zur mesozoischen Flora von China. Pal. Sinica, Ser. A, Vol. IV, Fasc. 1.
——— (1933c) Fossile Pflanzen aus Shensi, Szechuan und Kueichow. Ibid., Fasc. 3.
THOMAS, H. H. (1923) On Some New and Rare Jurassic Plants from Yorkshire. V. Fertile specimens of *Dictyophyllum rugosum* L. and H. Proc. Camb. Phil. Soc., Vol. XXI.
VELENOVSKY, J. (1889) Kvetena Ceskeho Cenomanu. The original paper not accessible.
WALKOM, A. B. (1917) Mesozoic Floras of Queensland. Pt. I.-Cont. The Flora of the Ipswich and Walloon Series. Queensl. Geol. Surv., Publ. No. 257.
——— (1924) On Some Fossil Plants from Bellevue, Near Esk. Mem. Queensl. Mus., Vol. VIII, Pt. 1.
——— (1928) Fossil Plants from Plutoville, Cape York. Proc. Linn. Soc. N. S. Wales, Vol. LIII, Pt. 2.
YOKOYAMA, M. (1891) On Some Fossil Plants from the Coal-bearing Series of Nagato. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. IV, Art. 2.
——— (1905) Mesozoic Plants from Nagato and Bitchû. Ibid., Vol. XX, Art. 5.
ZEILLER, R. (1882) Examen de la flore fossile des couches de charbon du Tong-king. Ann. d. Mines, Ser. 8.
——— (1897) Revue des travaux de paléontologie végétale. Rev. Gén. Bot., Vol. IX.
——— (1903) Flore fossile des gîtes de charbon du Tonkin. Paris.
ZIGNO, A. de (1856) Flora Fossilis Formationis Oolithicae, Vol. I. Padova.

PALAEONTOLOGICAL INDEX

(The principal page-references to names of genera and species are printed in heavy type).

A.

PAGE

Asplenium 159
A. Brongniarti 167

C.

Camptopteridaceae 136
Camptopteroideae 136, 144
Camptopteridinae 136
Camptopteris 136, 137, 143, **144**, 145, 157, 168, 175
C. incissa **145**, 168
C. jurassica 145
C. lunzensis 144, **145**, 168
C. serrata 156, 157
C. spiralis 137, 139, 145, **146**, 155, 168
Clathropteris 136, 137, 138, 141, 142, 143, 144, 154, **158**, 171, 175, 176
C. egyptiaca 158
C. meniscoides **158**, 171, 176
C. meniscoides var. *elegans* 137, 138, 139, **158**, 172
C. obovata 137, **158**, 172
C. reticulata **158**, 172

D.

Dictyophyllum 136, 137, 138, 139, 141, 143, 144, 145, 147, 148, 151, 152, **154**, 155, 156, 157, 158, 159, 164, 170, 175, 176
D. acutilobum 138, 139, **154**, 170
D. Bartholini **154**, 170
D. Bremerense 153
D. Carlsoni **155**, 170
D. cracoviensis 161
D. Davidi **155**, 170
D. Dicksoni **165**
D. Dunkeri 149
D. Dunkerianum 153
D. exile 137, 138, 139, 153, **155**, 170
D. Fuchsi 149
D. Gollioni 148
D. Gracilis 150
D. japonicum 145, **155**, 170
D. Kochibei 150
D. Leckenbyi 152
D. Muensteri 139, 153, 154, **155**, 156, 170
D. Muensteri var. *pusillum* 151, 155

PAGE
D. Nathorsti 137, 139, 145, **156**, 170
D. Nilssoni 137, 138, 139, 153, 154, **156**, 171
D. obsoletum **156**, 171
D. obtusilobum **156**, 171
D. Remauryi 151
D. Roemeri **165**
D. rugosum 152, 155
D. Sarrani **156**, 171
D. serratum **156**, 157, 171
D. spectabile 138, **157**, 171
D. Sturi 153
D. Vieillardi 148
Dipteridaceae 135, 136, 137, 144, 146, 149, 167, 175
Dipterideae 136
Camptopteroideae 137, 143, 144, 146
Dipteris 135, 136, 144, 146, 154

G.

Gleicheniaceae 144
Goeppertella 137, 142, 143, 144, **146**, 168, 175
Goeppertelloideae 144, 146, 147
Goeppertella microloba 146, **147**, 168
Goeppertia 137

H.

Hausmannia 136, 140, 141, 143, 144, **158**, 164, 165, **166**, 167, 174, 175, 176
H. acutidens **160**, 167, 172
H. arctica 167
H. asarifolia **160**, 172
H. Brongniarti 167, 174
H. Buchii **160**, 161, 172
H. californica 167, 174
H. cordata **161**, 173
H. cracoviensis **161**, 172
H. crenata **161**
H. cretacea **166**, 172, 174
H. dentata 140, 141, 142, **161**, 172
H. dichotoma 159, 162, **166**, 167, 174
H. Dicksoni **165**, 173
H. Fischeri **162**, 173
H. Forchammeri **162**, 173
H. Forchammeri subsp. *dentata* **162**
H. Forchammeri subsp. *laciniata* **162**
H. gracillima **166**, 174
H. integrifolia **162**, 173
H. Kohlmanni **163**, 164, 165, 173
H. Leeiana **163**, 173
H. nariwaensis 140, 141, **163**, 164, 173

PAGE

H. Pelletieri **167**, 174
H. reniformis **163**, 173
H. Richteri **164**, 173
H. Roemeri **165**, 173
H. Sewardi **164**, 173
H. spuria **164**, 173
H. ussuriensis 163, **146**, 173
H. volgensis **164**, 173
H. Wirkinsi **167**, 174
H. Zeilleri **164**, 173

J.

Jeanpaulia 159
J. arctica 167
J. borealis 167
J. lepide 167

M.

Marchantites erectus 166

N.

Nelumbium Schweinfurchi 158

O.

Onychiopsis Johnstrupi 167

P.

Phillites nervulosus 152
Phlebopteris Phillipsi 152
Platyceriphyllum 159
P. cretaceum 166
Polypodiaceae 135
Polypodites angelini 153
P. gracilis 149
Protorhipis 141, 144, 159, **160**, 165, 172, 175, 176
P. acutidens **160**, 167, 172
P. asarifolia **160**, 172
P. Buchii **160**, 162, 163, 164, 172
P. cordata **161**, 173
P. cracoviensis **161**, 172
P. crenata **161**, 172
P. dentata 141, 142, **161**, 173
P. Dicksoni **165**, 173
P. Fischeri **162**, 173
P. Forchammeri **162**, 173
P. Forchammeri subsp. *dentata* **162**
P. Forchammeri subsp. *laciniata* **162**
P. integrifolia **162**, 173

PAGE
P. Kohlmanni **163**, 164, 173
P. Leeiana **163**, 173
P. nariwaensis 141, **163**, 164, 173
P. reniformis **163**, 173
P. Richteri **164**, 173
P. Roemeri **165**, 173
P. Sewardi **164**, 137
P. spuria **164**, 173
P. ussuriensis **164**, 173
P. volgensis **164**, 173
P. Zeilleri **164**, 173

S.

Sphenopteris Johnstrupi 167

T.

Thaumatopteris 136, 137, 139, 142, 143, 144, **147**, 147, 149, 150, 151, 153, 156, 157, 158, 168, 175, 176
T. Brauniana 147, **149**, 168
T. Dunkeri **149**, 153, 169
T. elongata **149**, 169
T. Fuchsi **149**, 169
T. Gollioni **148**, 169
T. T. gracilis **149**, 150, 166
T. Kochibei **150**, 152, 157, 169
T. lunzensis **150**, 159
T. Muensteri **147**, 156
T. nipponica 139, **148**, 151, 154, 169
T. pusilla 149, **151**, 156, 169
T. Remauryi **151**, 169
T. rugosa **152**, 153, 169
T. Schenki **148**, 150, 153, 169
T. Sturi **153**, 179
T. Vieillardi **148**, 169

W.

Woodwardia 146, 147
Woodwardites 137, 147
W. microlobus 146, 147

Z.

Zamiostrobus 163