



1



2



4



3



A



B



- A 勘離附近波瀾洶湧之狀, 其後山爲志留紀頁岩, 向北照。  
Hsin Tan Rapid shows the foaming current. The hill in the back ground is composed of Silurian Shale. Looking N.
- B 香溪東之米倉峽, 其地質爲巫山石灰岩之上部。  
The Mi Tsan gorge east of Hsin Chi is developed in the upper part of the Wushan limestone. Looking W.

A



B



- A. 雙輪灘揚子江北岸之剖面, 示片岩與震旦層之不整合。南沱砂岩呈層次甚清, 燈影灰岩則成峭壁位於圖之頂部。  
View of the northern bank of the Yangtze near Kunglingtan, east of Hsin Tan, shows clearly the unconformity between Pre-Sinian schist and Nanton formation. The Nanton Sandstone exhibits here a distinct stratification in contrast with its underlying massive schist while the cliff-forming Tongying limestone is shown in the upper part of the picture.
- B. 歸州系所成之地形, 山勢雖高, 而因岩質軟弱, 故山坡尚平緩。秭歸縣沙鎮溪附近。  
A typical view of the Kweichow series shows its bold topography but rather gentle slope due to the soft nature of its constituents. Looking N.W. Near Shih Cheng Chi, Tze Kwei district.

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**EXPLANATION OF  
PLATE III.**

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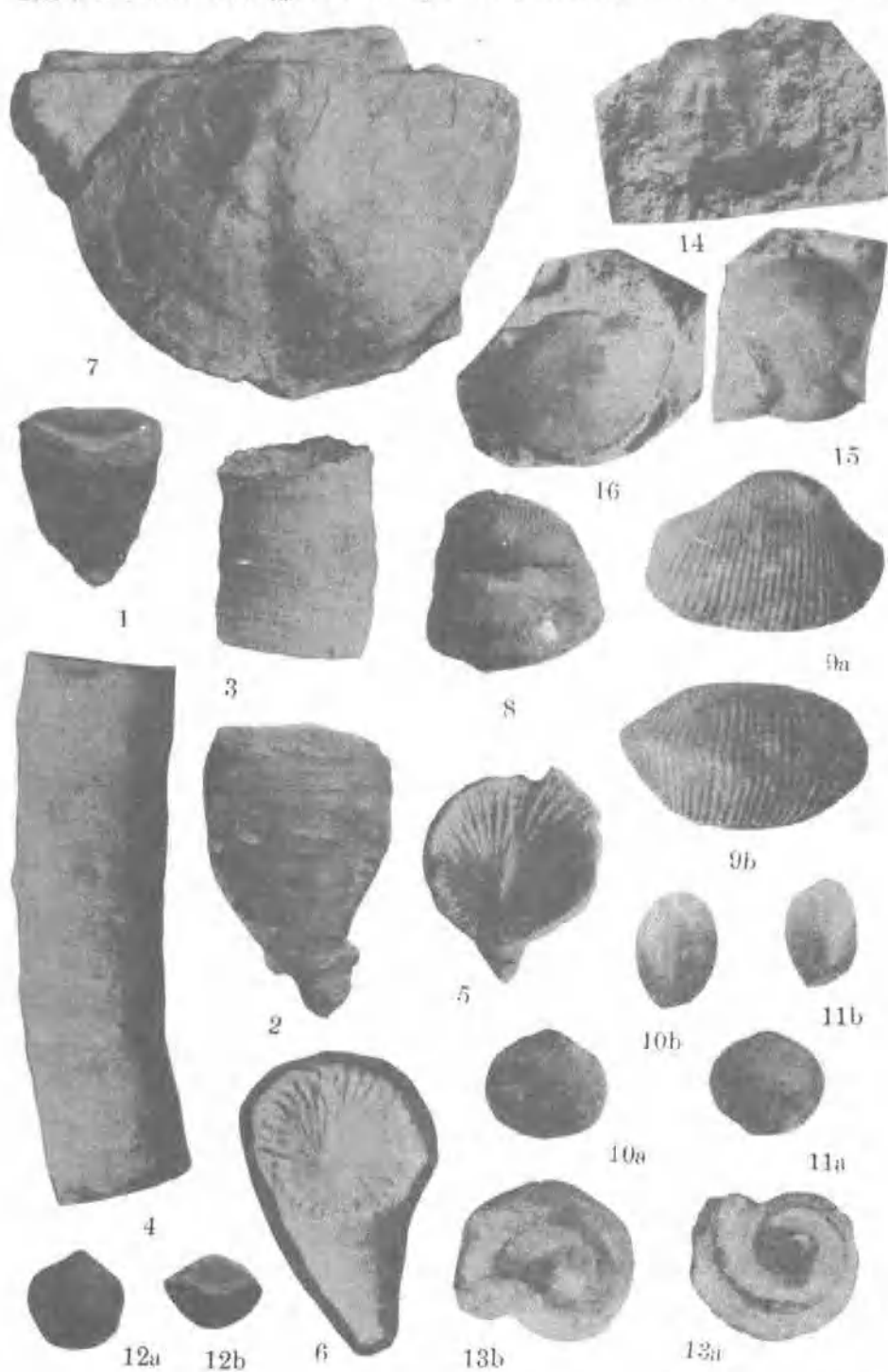
PLATE III.

SILURIAN FOSSILS FROM LO JO PING, I CHIANG.

(All figures are in natural size)

宜昌羅惹坪之志留紀化石

- Figs. 1-2. *Platyphyllum minor*, Grabau.  
1, a median-sized specimen; 2, a large individual. Lojoping series (Loc. 826 B).
- Fig. 3. *Cyathophyllum chaoui*, Grabau.  
Lojoping series (Loc. 826).
- Fig. 4. *Microplasma pailou*, Grabau.  
*Cystiphyllum* bed, Lojoping series (Loc. 826 C).
- Figs. 5-6. *Pselophyllum zaphrentiforme*, Grabau.  
*Pselophyllum* bed, Lojoping series (Loc. 826 B).
- Fig. 7. *Strincklandinia transversa*, Grabau.  
A large pedicle valve from the *Cystiphyllum* bed, Lojoping series (Loc. 826 C).
- Figs. 8-9. *Conchidium tenuiplicatus*, Grabau.  
8, top view; 9a, pedicle and 9b, bottom views of another individual. *Cystiphyllum* bed, Lojoping series (Loc. 826 C).
- Figs. 10-12. *Glassia obovata* Sow. var. *magna*, Grabau.  
10a pedicle view, 10b side view; 11a brachial view, 11b side view; 12a pedicle view, 12b bottom view. *Pselophyllum* bed, Lojoping series (Loc. 826 B).
- Fig. 13. *Trochonema depressa*, Grabau.  
13a top view, 13b umbilical view. *Pselophyllum* bed, Lojoping series (Loc. 826 B).
- Fig. 14. *Harpes veneulosa* Curd var. *sinensis*, Grabau.  
A cranidium from the upper Trilobite bed in the Lungma shale, Sha Mao Shan, Lo Jo Ping (Loc. 825).
- Figs. 15-16. *Illænus asaphoides*, Grabau.  
15, glabella; 16, pygidium. Upper Trilobite bed, Lungma shale (Loc. 825).



Silurian Fossils.

Photo. by Y. T. Chao.

# BULLETIN OF THE GEOLOGICAL SURVEY OF CHINA

NUMBER 7.

DECEMBER 1925.

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PEKING  
THE GEOLOGICAL SURVEY OF CHINA  
MINISTRY OF AGRICULTURE AND COMMERCE

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THE COMMERCIAL PRESS, PEKING BRANCH WORKS  
1926.



# TINGIA, A NEW GENUS OF FOSSIL PLANTS FROM THE PERMIAN OF CHINA.

Preliminary note.

By T. G. HALLE.

(With one text-figure and two plates)

In June 1869 v. RICHTHOFEN collected a small number of fossil plants in the coal-bearing deposits at pönn-hsi-hu (本溪湖) in Shengking. The fossils were described by SCHENK (v. RICHTHOFEN: China, vol. 4, p. 211), who remarked that the flora was mainly characterized by a *Taeniopteris* and a *Pterophyllum*, both, according to him, exclusively Permian types.

The form referred to *Pterophyllum* has proved to be of considerable interest, though it was represented by only one rather fragmentary specimen. It was described by SCHENK (l.c., p.214; pl.44, figs.4,5) as a new species, *P. carbonicum*. (In the explanation of SCHENK's plate 44 the name is given as *P. carbonarium*.) The preservation of the type-specimen left much to be desired, and SCHENK was evidently far from sure that it was really a *Pterophyllum*. He compares the plant also with the genus *Noeggerathia* and concludes his description by saying that the preservation was not sufficiently good to permit him to decide whether the specimen represents a pinnate frond or a branch.

Later on SCHENK seems to have re-examined the material and arrived at a different opinion, for in the copy of his work which he presented to the late Prof. A. G. NATHORST and which is kept in the palaeobotanical department of the State Museum of Natural History at Stockholm, there is a pencil note in SCHENK's own hand substituting *Cordaites* sp. for *Pterophyllum carbonicum*. I find that ZEILLER<sup>1</sup> has already mentioned a similar correction in the copy received by him from SCHENK.

Better specimens, which it has now been possible to identify with this form, were later obtained from different localities in the Permian of China. This new material, and finally a re-examination of the type-specimen in Berlin, has convinced me that SCHENK's critical attitude towards his own deter-

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1. R. ZEILLER. Note sur la flore houillère du Chanéi. Annales des Mines, 1901, p.25.

mination was justified. *Pterophyllum carbonicum*, however, belongs neither to *Cordaitea* nor to *Noeggerathia*, but is a distinct generic type which, in the light of our present knowledge, seems to be characteristic of the Permian of eastern Asia.

I have named this new genus *Tingia* in honour of Dr. V. K. TING, Honorary Director of the Geological Survey of China, who has done so much to further the study of palaeobotany in China, not least through organizing the splendid field work carried out by the geologists of the survey. Dr. TING has a special connection with the present genus, since he had collected some of the first specimens of it that were examined by the author.

The history of the material which finally led to the institution of the new genus is rather interesting and will be briefly told. In December 1916 I found on the dumps of the Tong-shan mine in Chihli a single specimen of a fossil plant which at first sight strongly recalled *Pterophyllum carbonicum* but had pinnae with the apex dissected into lobes. On a close examination of SCHENK's figure of the type-specimen it was found that in the lowermost pinna to the right there is in the drawing a slight indication of what might be similar apical lobes. This feature is very indistinct, however, and appeared more probably to be accidental or due to incorrect drawing. A short time afterwards I had an opportunity of examining, at the Geological Survey in Peking, a collection of Palaeozoic plants which had been made in Honan by Dr. V. K. TING. Among this material were a couple of specimens which greatly resembled the one from Tong-shan, except that the pinnae were longer. While the author was travelling in Hunan with Mr. T. C. CHOW in the spring of 1917 for the purpose of studying the fossil plants of the anthracite field of that province, we found specimens evidently identical with the Tong-shan plant in at least two localities on the Lei-ho (莱河), in both cases associated with *Gigantopteris nicotianaefolia* SCHENK. The same new type of plant had thus been recognized in a very short time among material from no less than three different provinces, and it was evident that it represented a peculiar type widely distributed in the Upper Palaeozoic of China. Unfortunately all specimens of the plant collected before 1919 were lost in September that year through the wreck of the steamer "Peking" while they were being conveyed to Stockholm for further examination.

Up to that time nothing definite was known of the relation of the new form to SCHENK's *Pterophyllum carbonicum*, except the general resemblance in habit which was noted in the case of the first specimen found at Tong-shan. As SCHENK's type-specimen had been repeatedly examined by him, it did not seem probable that it would throw any additional light on the question. All the material having been lost, a comparison of the new form with SCHENK's specimen was not possible, but during a visit to Berlin in January 1922 the author made a careful examination of the type. It was found that the slight indication of apical lobes in SCHENK's figure was correct, while his description was wrong. The pinnae are not entire as stated by him but distinctly lobed or dentate at the truncate apex. Through the kind assistance of Professor W. GÖTTAN I was able to obtain photographs of the type in natural size and twice enlarged. These photographs which had to be somewhat retouched will be published, together with a more extensive account of the new genus, in a memoir on the Upper Palaeozoic flora near Tai-yuan fu now under preparation for the *Palaeontologia Sinica*. Drawings of these photographs are shown in text-fig. 1.

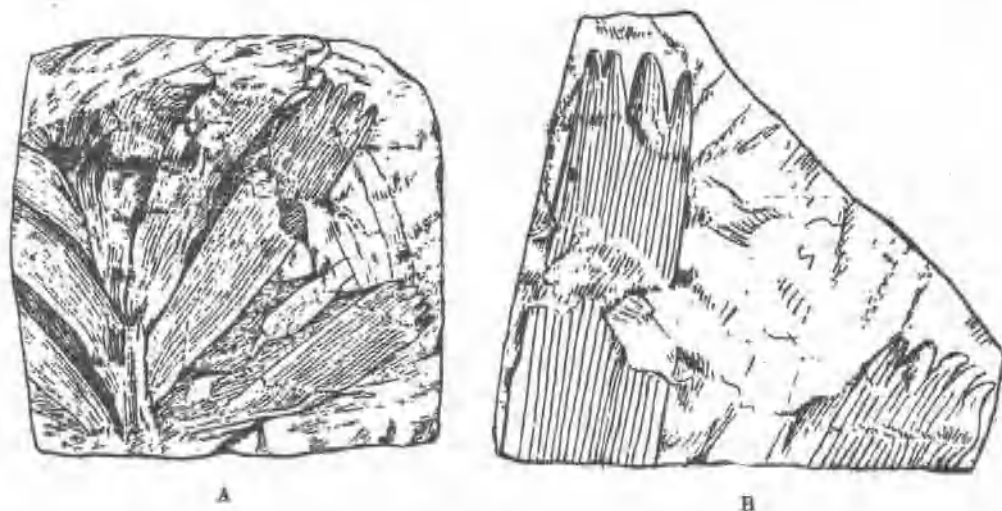


Fig. 1. SCHENK's type specimen of *Pterophyllum carbonicum* (RICHTHOFFEN: China, Vol. 4. pl. 41. fig. 4).

A. Natural size. B. Upper parts of two leaves, showing apical lobes, in twice the natural size.

While the type-specimen clearly showed that *Pterophyllum carbonicum* must be removed from that genus, it did not give sufficient information on the morphology of the species or its relation to some other genera. A short time after the examination of the type-specimen in Berlin, however, the author had the great pleasure to receive new material of the type first recognized at the Tong-shan colliery. These new specimens, which had been collected in the coal-bearing deposits east of Tai-yuan-fu by Dr. E. NORIN, were obviously identical also with SCHENK's type-specimen of *Pterophyllum carbonicum* and made it possible to gain a better idea of this species than before. Because of the fragmentary nature of the type-specimen, which is only just sufficiently well preserved to prove the identity with the new specimens, the description given below of *Tingia carbonica* is based chiefly on the latter.

In the new collection made by Dr. NORIN there were also several specimens of another somewhat similar species which should evidently be referred to the same genus. This species, which will also be described below, is important because it shows more clearly than *Tingia carbonica* the morphological nature of the specimens included in the new genus. A diagnosis of the genus and descriptions of the two species known at present will be given below.

#### TINGIA NOV. GEN.

Dorsiventral, frond-like anisophyllous shoots with thick axis. Leaves apparently arranged in four rows, two on the upper and two on the lower side of the axis. Leaves of the two rows on one (the upper?) side smaller, directed forward at narrow angles to the axis, those of the other two rows (on the lower side?) larger, spread out in one plane and forming a more open angle to the axis; each lateral half of the shoot thus provided with two rows of dissimilar leaves. Leaves of the larger (normal) type varying from broadly cuneate-obovate to oblong or linear, with entire lateral margins but more or less deeply lobed at the apex. Several veins entering each leaf, dichotomizing mostly in the lower part of the leaf, all branches continuing to the apex.

At present the genus comprises only two species, *Tingia carbonica*

(SCHENK) *n. comb.* (= *Pterophyllum carbonicum* SCHENK, the genotype) and *Tingia crassinervis n. sp.* The general characters and relationship of the genus will be discussed after the description of the species.

TINGIA CARBONICA (SCHENK) *N. comb.*

Pl. 1, figs. 1-4.

*Pterophyllum carbonicum* SCHENK 1883, in v. RICHTHOFFEN: China, Vol. 4, p. 214; Pl. 44, figs. 4, 5.

Shoot dorsiventral, frond-like, anisophyllous, with rather thick axis (3-8 mm. broad on the impression). Leaves apparently arranged in four rows, two on the upper, two on the lower side of the rachis. Leaves of the two rows on one (the lower?) side large, spread out in one plane, forming an angle of (30) 40 60° to the axis, varying on the same shoot in ascending order from short cuneate-obovate to oblong-linear, attaining a maximum length of almost 10 cm., their base broad, somewhat oblique. Apex of these leaves somewhat truncate, dissected through sharp, narrow incisions into a varying number (mostly 3-5) of irregular, narrow, triangular to linear, obtuse lobes which may attain a maximum length of 8-10 mm. and are often once more dissected at the apex; leaves of the other (upper?) side, smaller, directed towards the top of the shoot, less markedly truncate, with shorter triangular lobes. Veins fine, bifurcating mostly in the lower part of the leaf, two or more branches entering into each of the larger lobes.

The photographs in pl. 1 give a general idea of the great variation in regard to the shape and size of the leaves in this species. It is difficult to imagine, for instance, that the specimens in fig. 3 and fig. 4 can both belong to the same species. The leaves vary, however, within rather wide limits even in one and the same specimen, the general rule being that they grow longer and narrower towards the top of the shoot. While there is a great difference, for instance, between the leaves in the lower part of fig. 3 and in the upper part of fig. 1, a greater resemblance is found if the top of fig. 3 is compared with the base of fig. 1. There is a similar resemblance between the uppermost leaves of the specimen in fig. 1 (not shown in the figure) and the basal ones of fig. 2, and also between the top of the specimen in fig. 2 and the large specimen in fig. 4. Thus all the specimens figured in pl. 1 are doubtless specifically identical.

The marked and regular variation in size and shape of the leaves in the same vertical rows, according to their position on the shoot, seems to indicate that the shoots were rather short, of limited growth, and were possibly shed entire.

The disposition of the leaves is not so well shown in this species as in *Tingia crassinervis* and will be more fully discussed in connexion with the latter species. In the figures only the two vertical rows of larger leaves, suggesting pinnae of a compound frond, are seen, but after removing a part of the matrix which bears the impression of the axis, it was found that other somewhat smaller leaves, apparently also in two vertical rows, occur on the other side of the axis.

The present specimens were found by Dr. NORIN east of Tai-yuan-fu, near the village Chen-chia-yü, in the fine section exposed in the Shih-ho-tse valley. The plant-bearing bed from which they are derived belongs to the "Lower Shih-ho-tse Series" of Dr. NORIN and has the number 16 in his general tabular section of the Upper Palaeozoic east of Tai-yuan-fu<sup>1</sup>. It is about 150 m. above the highest coal-bearing level and 70 m. below the oldest horizon (bed 20) on which *Gigantopteris nicotianaefolia* has been noted with certainty; it is possible, however, that the latter species begins much lower down (in bed 18), or less than 20 m. above the horizon with *Tingia carbonica*.—The horizon of the specimen first collected at Lorg-shan is unknown: all other specimens collected at the same time on the dump indicated a level corresponding to the lowermost part of the Shih-ho-tse series or even to the Yueh-men-kon Series of Dr. NORIN (l.c.).—In Hunan as remarked above, the species was found associated with *Gigantopteris nicotianaefolia*.

TINGIA CRASSINERVIS N. SP.

Pl. 2, figs. 1-3.

Shoot dorsiventral, frond-like, anisophyllous, with very thick axis (attaining a breadth on the impression of 10 mm.). Leaves apparently arranged in four rows, two on each side of the axis. Leaves of the two rows on one

<sup>1</sup> E. NORIN, The late Palaeozoic and early Mesozoic sediments of Central Shansi. Bull. Geol. Surv. China, No. 4. 1922. Pl. 3.

(the lower?) side large, spread out in one plane, and forming an angle of 40-60° to the axis, varying in ascending order from short cuneate-obovate to oblong-oblancoelate, attaining a length of 10 cm.; their base broad, oblique, decurrent; apex of these leaves broadly obtuse or rounded, dissected into a varying number of irregular lobes. Lobes varying from short semicircular, only 1-2 mm. long, to oblong with a length of 5-7 mm, apex of the longer lobes often dissected into two short secondary lobes. Veins numbering 6-8 at the base of the leaf, very thick, bifurcating twice or thrice, the first time very near the base, generally two or more branches passing out into each lobe.

The shoots of this species attain a larger size than those of *Tingia carbonica*. The largest specimen, a part of which is shown in pl. 2, fig. 1, is broken off at both ends; the preserved portion is 25 cm. long with a greatest breadth of 13 cm. The larger leaves, which measure 9 cm. in length at the top of the specimen, diminish downwards, but even at the lower end they are nearly 7 cm. long. In the specimen in pl. 2, fig. 2, which is also broken off both above and below, the leaves are considerably shorter, or a little over 4 cm. at the upper end and a little less than 3 cm. at the lower. In all specimens except a few fragments representing the uppermost part of the shoot, the leaves diminish in a similar way in length, though not in breadth, downwards; and it is evident that the specimens with short and broad leaves, such as the one in fig. 2, represent the basal parts of shoots. A comparison between the specimens in figs. 1 and 2 suggests that the missing basal part of the former must have been of considerable length and that the shoots generally attained very large dimensions. The regular variation in the size of the leaves according to their place on the shoot, and the fact that no case of branching has been observed, seem to indicate that the ultimate lateral shoots were sharply set off, of limited growth and rather frond-like, and were probably shed entire.

The two rows of smaller leaves are more or less distinctly seen in all the figures in pl. 2. In the largest specimen the matrix bearing the impression of the axis has been removed at the lower end, and fragmentary impressions of two smaller leaves are shown on a deeper level. These smaller leaves appear, on the impression, to be directed towards the top of the shoot, and almost parallel with the axis, though it is possible that they were not adpressed

but formed an angle to the plane of the larger leaves. In the specimen in fig. 2 traces of apparently adpressed smaller leaves are found close to the axis, but their shape is not shown. All four rows of leaves are more or less distinctly present in the small fragment in fig. 3.

This specimen evidently represents the basal part of a shoot, to judge from the thickness of the axis and the broad leaves shown in the rows on the right. The corresponding leaves to the left have been slightly deformed and displaced through pressure so that they appear to be directed more upwards than in their natural state. The rows of smaller leaves close to the axis, however, are yet more adpressed and differ from the rows of lateral leaves not only in size but in direction. In this case the smaller leaves are about half the length of the larger ones, and more or less the same proportion seems to prevail also in the other specimens.

The specimens were found in the same locality, near Chen-chia-yü, as *T. carbonica*, but on a higher horizon, Dr. NORIN's plant-bearing bed 20, belonging to the Upper Shih-ho-tse series.

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In the material of *Tingia carbonica* which I examined somewhat superficially in China in 1916-17, and which was afterwards lost, only the larger leaves on one side of the shoot were observed, and there was no reason then to doubt that the specimens represented pinnate fronds. In most specimens of the present material of both species, too, the smaller leaves on the other side of the axis are invisible if not exposed through special preparation. Both *Tingia carbonica* and *T. crassinervis*, therefore, generally show a certain resemblance in habit to pinnate fronds referred to the genera *Noeggerathia* STERNB. and *Plagiozamites* ZEILL. From *Noeggerathia* or at least its geno-type, *N. foliosa* STERNB., *Tingia* differs through the shape of the leaves, which are longer and narrower and taper less to the base than the leaflets of *Noeggerathia*. From both genera it is easily distinguished through the deep apical lobes each of which receives more than one vein. Both in *Noeggerathia* and *Plagiozamites* the margin of the leaflets is finely dentate or fimbriate, but the teeth are generally small, always narrow,



rather hair-like or spine-like and receive only one vein each. Moreover, the venation of *Plagiozamites* and of *Noeggerathia* with dissected margin is more radiating, so that some veins run out into the lateral margins, even in the lower half of the leaflets or almost at the base, whereas in *Tingia* the veins are more nearly parallel and only the truncate or rounded apex of the leaf dissected. The short leaves in the lower part of the *Tingia*-shoot and the basal pinnae of *Plagiozamites* are less different in this respect; and fragmentary specimens may sometimes be difficult to distinguish if the arrangement of the leaves or leaflets is not seen.

While the specimens of *Noeggerathia* and *Plagiozamites* have generally been held to be pinnate fronds, the arrangement of the leaves in four rows proves that *Tingia* represents leaf-bearing shoots. At the same time the *Tingia*-shoots have a very frond-like appearance, and the great resemblance to *Noeggerathia* and *Plagiozamites* suggests that the specimens referred to these genera, too, may actually be shoots rather than fronds. SEWARD<sup>1</sup> has already expressed the view that the segments of *Noeggerathia* are single leaves while ZEILLER<sup>2</sup> held both *Noeggerathia* and *Plagiozamites* to be compound fronds. As reasons for his opinion ZEILLER mentioned that in *Plagiozamites Planchardi* the segments diminish in size downwards, that they are directed more upwards in the upper part of the specimens, and finally that in some cases there seems to be a terminal segment. The first two features, however, are found just as well developed in *Tingia* and, indeed, are frequently seen in ultimate shoots with limited growth. Regarding the occurrence of a terminal segment, it should be remarked that the uppermost leaf, at the suppression of the growing point in a shoot with limited growth, often may be directed upwards and appear as a direct continuation of the axis; it is therefore very difficult to make out the real structure in specimens preserved as impressions. The oblique attachment of the supposed pinnae in *Noeggerathia* and *Plagiozamites* rather suggests that they are of the nature of leaves, and the fructifications assigned to *Noeggerathia* would also be easier of interpretation on the assumption that the specimens represent shoots. While

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1 A. C. SEWARD, *Fossil Plants*, vol. 2, 1910, p. 430-31.

2 R. ZEILLER, *Notes sur la flore des couches permiennees de Trienbach (Alsace)*. Bull. Soc. Géol. France, 3 sér. t.22, 1894, p.176.