

F. N Ě M E J C:

The morphology and the systematic relations of the carboniferous *Noeggerathia* with regard to the „genera“ *Tingia* and *Plagiozamites* of Eastern Asia.

In the palaeozoic floras we may state a whole series of vascular plants, which differ essentially as to their organisation from all known groups of recent plants. That is the reason, why their morphology as well as their systematical position among the known recent genera and families are not always easy to be understood. One of such groups is without any doubt also the family of the *Noeggerathia* (*Noeggerathia foliosa* and *N. intermedia*) from the Westphalian series of Central Bohemia. I have described and figured sterile as well as fertile specimens of two various species in the first volume of my monograph »A revision of the Carboniferous and Permian flora of the coal districts of Central Bohemia« (Palaeontographica Bohemiae. Nr. XII. Prague 1928.), where all respective older bibliography is cited. There I supposed, — just as Štúr and Zeiller-, the once pinnate fronds of those plants to be true once pinnate leaves. This idea seemed to be supported by the following facts: 1. The arrangement of the leaflets in two very distinct rows on a strong midrib. 2. The diminishing size of the leaflets in the downward and upward direction. 3. The terminal leaflet at the top of the rhachis, as mentioned by some of the authors.

As long as we did not know in detail any other similar plants, there was no serious objection against the mentioned Štúr-Zeiller's interpretation. Of course we knew, just as at present, nothing of the anatomy of the strong midrib. It was but professor A. C. Seward, Cambridge, who expressed some doubts as to this theory (see »Fossil plants« Vol. II. pp. 431, 1910), evidently on account of the more or less oblique attachment of the leaflets to the strong rhachis.

As seen in the chapter about the *Noeggerathia* in my mentioned monograph, it is impossible to deduce any definite position of the plant-remains in question in the system of plants, basing on the mentioned Štúr-Zeiller's theory. From this point of view they seem to stand near to the heterosporous ferns as perhaps a parallel group having some relations to the Cycads. At the time, when my I. Volume of the mono-

graph of the Carboniferous flora of Central Bohemia was already in print I received Halle's monograph of the Eastern Asiatic Carboniferous flora, where some new *Plagiozamites* leaves and the very interesting genus of *Tingia* are described in detail. (T. G. Halle: Palaeozoic plants from Central Shan-Si. Palaeontographica Sinica. Ser. A. Vol. II, fasc. 1. 1927. pp. 226—239.)

The so called *Tingiae* have been described for the first time by Schenk (Pflanzen aus der Steinkohlenformation in Richthofen: China Bd. 4, pp. 214.) as *Pterophylla*. Halle stated, that those *Tingiae* have not only two rows of leaflets, but beside those still two another rows of smaller leaflets, which are more or less hidden, by the two first mentioned rows of normal leaves. The rhachis of *Tingia* fronds bears therefore 4 rows of leaflets, which means, that it represents a true axis and no leaf rhachis (see Halle l. c.). The arrangement of leaves of two different dimensions on the *Tingia* axis corresponds evidently from the biological point of view to the conditions known in many plagiotropic shoots of the genus *Selaginella*. But according to the general character of the *Tingia* remains it is very probable, that their growth was limited as f. inst. in the plagiotropic shoots of the *Taxodiae*.

The attachement of the leaves in the *Tingiae* is oblique, just as in the *Plagiozamites* and *Noeggerathiae* leaves, with which they correspond also by the character of the unique leaflets and their nervation. In both last named genera — the *Plagiozamites*, the *Noeggerathiae* — the leaflets are arranged on the respective rhachises only in two rows, which is of course a great difference. But as to the leaves of the Eastern Asiatic *Plagiozamites oblongifolius*, Halle mentions (l. c.) a very interesting moment, which allows to understand the mutual relations between the morphology of the *Tingia* »fronds« and those of *Plagiozamites* resp. *Noeggerathiae*. Halle observed, that the leaflets in his Eastern Asiatic *Plagiozamites* are not arranged in two straight rows, but that these rows have slightly undulated course. This may be explained as an originally spiral arrangement of leaves, which was modified by the plagiotropic growth. The fronds of *Plagiozamites* are therefore no leaves but shoots with simple leaves, just as in the *Tingiae*. It is evident, that in the *Noeggerathiae* the once pinnate fronds are built according to the same morphological scheme as in *Plagiozamites*, because their leaflets are joined to the rhachises in the same way. That means, that they represent also plagiotropic shoots with limited growth bearing two rows of undivided leaves. The unique difference between both genera lays perhaps only in the fact, that the leaf rows of the *Noeggerathiae* had a far straighter course, than in Halle's Asiatic *Plagiozamites oblongifolius*, as with absolute objectivity it is impossible to state, whether they are on the impressions straight or slightly undulated. But newly I gained from the mine Krimich in Nýřany (near Plzeň) some specimens (from the hanging shales of the seam nr. II.) of *Noeggerathia foliosa* impressions, which according to the big axis may represent parts near to the base of the shoots and on which the single leaves are declined at rather unequal angles. I suppose it to be the

result of the arrangement of leaves in two rows, which are not quite straight.

According to all these mentioned facts, it is quite clear that the classic Štúr-Zeiller's interpretation of the *Noeggerathiae* fronds, which I have also accepted in my monograph from 1927, is not correct and must be at present refused. The doubts about its correctness expressed by prof. Seward, Cambridge, were certainly just. Thus from the morphological point of view, the fronds of *Noeggerathiae* may be understood as plagiotropic shoots with limited growth and with simple obliquely attached leaves arranged in two most probably not absolutely straight rows.

From this point of view the morphological significance of the *Noeggerathiae* conelike fructifications, called *Noeggerathiostrobus* is also quite different, than stated on the basis of Štúr-Zeiller's interpretation in my named monograph. In this book I have stated as incontestable, that the axis of the conelike fructifications is homologous to the axis of the »once pinnate *Noeggerathiae* fronds« and that the sporophylls are homologous to the *Noeggerathiae* »leaflets«, be their morphological significance whatever. Therefore to day, with regard to the morphology of the Eastern Asiatic *Plagiozamites* and *Tingiae* we must accept, that the axis of the conelike *Noeggerathiostrobi* are true axis and that the sporophylls are homologous to the whole undivided leaves. We have here therefore true cones, which are homologous to the plagiotropic *Noeggerathiae* shoots. The most interesting character of those fructifications is the situation of the sporangia, which — as seen in the figures of my monograph — are placed on the adaxial side of the sporophylls. This is the same fact, as in the groups of the *Articulatales* and *Lycopodiales*.

If we consider the morphology of the *Noeggerathiae* and the *Noeggerathiostrobi* from the just mentioned point of view, we may state also their systematic relations in a more precise and by far clearer way, than I was able to state on the basis of the old Štúr-Zeiller's theory. We may only take in mind the following characters of the fossil remains in question:

1. The leaves are simple, large, ovato-cuneate till oblongo-ovate. Their nervation is radiating and dichotomously divided. Their margin is (at least in its frontpart) denticulated. Just the same character of leaves may be found among the *Pteridophyta* in the *Sphenophyllales* (see f. inst. *Sphenophyllum Thoni*).

2. The sporangia are attached as relatively large oval bodies to the upper or adaxial side of the sporophylls. The arrangement of them is collateral and serial. The same facts may be met with in the group of the *Sphenophylla*, where of course the sporangia (just as in other articulated *Pteridophytes*) are very often provided with special sporangiophori, which are not developed in our *Noeggerathiae*. Something similar may be pointed out also in the *Cheirostrobi*.

3. The sporophylls are composing a conelike fructification, which is a characteristic feature in the *Articulatales* and the *Lycopodiales*.

4. I stated here two kinds of spores (see in my monograph from 1927/8). Therefore the *Noeggerathiae* may be regarded as true *Pteridophyta*.

5. The axis of the shoots is not articulated. It has its analoga not among the *Articulatales*, but among all other Pteridophytic plants with non articulated stems and twigs.

Within the *Noeggerathiae* many features characterising the articulated Pteridophyta are thus joined together to the non articulated character of the *Lycopodiales* and the *Filicales* axis. Therefore it is impossible to range this group, in which are joined the cardinal characters of the various pteridophytic groups in such a curious way, into any of the known groups of Pteridophyta. We cannot join it to the *Articulatales* on account of the unarticulated axis, though many features of that group are here prevailing. It is however also impossible to join them to the *Lycopodiales* on account of the leaf character as well as of the features of the sporophylls. Therefore I suppose, that the *Noeggerathiae* are a member of a perhaps great special palaeozoic pteridophytic group, of which we had not yet any precise knowledge and which may be perhaps best characterised as plants standing between the *Articulatales* and the *Lycopodiales*.

The main characters of this new pteridophytic group are: Leaves simple (— at least never pinnate —), pseudomacrophyllous, with radiating and dichotomously divided nervation. Axis non articulated. Sporangia with a tendency to serial and collateral arrangement, sitting on the adaxial side of the sporophylls. Sporophylls composing conelike fructifications.

I name this group after the best known genus of the Noeggerathiae the group of the Noeggerathiales and suppose it to be of the same cardinal systematic value as f. inst. the Filicales, Lycopodiales etc. Therefore we may now state among the Pteridophyta the following chief divisions:

Psylophytales,
Lycopodiales (incl. the Isoetinae),
Psilotales,
Cladoxylales,
Noeggerathiales,
Articulatales,
Filicales (incl. perhaps the Hydropteridinae).
