

**Paleobotany.** — *Some remarks concerning the Palaeozoic Flora of Djambi, Sumatra.* By O. POSTHUMUS. (Communicated by Prof. J. C. SCHOUTE.)

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During the geological exploration of the residency Djambi by Dr. A. TOBLER and his collaborators, Ir. GÖLLNER discovered remains of fossil land-plants in palaeozoic strata at Moeara Ketidoeran Siamang, near the Soengei (river) Merangin in the district Bangko in the interior of the residency. As this part of Sumatra is situated about midway between British India and Australia, where a well-developed *Glossopteris* flora is found, one should expect to find plants of this type here too; especially as similar forms have been recorded from Serawak <sup>1)</sup>. The fossil plants from Djambi, however, were more similar to those of Western Europe. The specimens collected at that occasion were first mentioned by JONGMANS in the report on the geological explorations in Djambi <sup>2)</sup>, and in 1925 a detailed description of them was published by JONGMANS and GOTHAN <sup>3)</sup>.

Because of the great importance of this locality for the study of the relationship between the *Glossopteris* flora and that of the Arctocarbonic type, further collecting was planned. Some scientific societies and private persons, a few years ago, put funds at the disposal of Dr. JONGMANS, who, however, was prevented by circumstances to make the voyage. In 1925 these funds were transmitted to me and during an expedition into the interior of Djambi, which was made in combination with a geological re-investigation by the Geological Survey of the Netherland East Indies, a collection of these fossil plants was made. A preliminary report has already been published <sup>4)</sup>.

I hoped to have occasion to study at least part of the material, which I had collected, as a compensation for the time and trouble, necessary for the collecting of the materials. Instead of going to Java directly, I returned to the Netherlands with the intention to work out the results, and though the specimens had already arrived in Holland long ago and I often requested to have put them at my disposal for study, I never saw back any of the fossils, which are now in the hands of Dr. JONGMANS.

The following remarks are based upon some observations during the

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<sup>1)</sup> TENNISON—WOODS, 1885, p. 583.

<sup>2)</sup> JONGMANS in TOBLER, 1923, p. 193, 308, 541.

<sup>3)</sup> JONGMANS und GOTHAN 1925.

<sup>4)</sup> ZWIERZYCKI and POSTHUMUS 1926.

collecting-work, and on some notes and sketches, then made. They are to be considered only as an addition to the preliminary report; the publication by JONGMANS and GOTHAN is now also quoted; it was then not yet known to me.

The species, which have been found, are given in the following list :

	Djambi		Stéph.			Perm.		OA
	J	P	Ct	Bc	Py	B	P	
1. <i>Pecopteris Verbeeki</i> J. et G. . . . .	—							
2. <i>P. polymorpha</i> Brongn. . . . .	—		—	—	—	—	—	
3. <i>P. hemitelioides</i> Brongn. . . . .	—		—	—	—	—	—	
4. <i>P. arborescens</i> Brongn. . . . .	—		—	—			—	
5. <i>P. cf. Miltoni</i> Brongn. . . . .		—						—
6. <i>Cyclopteris spec.</i> . . . . .	—	—						
7. <i>Callipteridium cf. gigas</i> (Schlotheim) Weiss . .		—	—	—	—	—	—	
8. <i>Taeniopteris multinervis</i> Weiss . . . . .		—				—	—	—
9. <i>Gigantopteris americana</i> White . . . . .		—					—	
10. <i>Calamites Suckowi</i> Brongn. . . . .	—	—	—	—		—	—	—
11. <i>Sigillaria Brardi</i> Brongn. . . . .		—	—	—	—	—	—	1)
12. <i>Lepidodendron cf. Gaudryi</i> B. Ren. . . . .		—	—				—	—
13. <i>L. felis oculus</i> (Abbado) Zeiller . . . . .		—						—
14. <i>Stigmaria ficoides</i> Brongn. . . . .	—	—	—	—		—		— 2)
15. <i>Sphenophyllum oblongifolium</i> Germar . . . .	—	—	—	—	—	—	—	—
16. <i>Cordaites borassifolius</i> Stbg. . . . .	—	—		—				
17. <i>Tobleria bicuspis</i> J. et G. . . . .	—							
18. <i>Dadoxylon spec.</i> . . . . .	—	—						

Abbreviations :

J = JONGMANS and GOTHAN 1925.	Py = Basin of Perrecy.
P = Observation of the author.	B = Basin of Bert.
Ct = Basin of Commentry.	P = Other Permian strata.
Bc = Basin of Blanz and Creusot.	OA = Upper Palaeozoic strata of East-Asia.

On these specimens the following remarks may be made :

1—5. The fronds of *Pecopteris* belong to a group, which is known from

1) RENAULT 1896, p. 193.

2) GOTHAN 1915, p. 268.

the Stephanian and Permian of Europe, and also from China and Malakka <sup>1)</sup>).

8. The specimens of *Taeniopteris* from Djambi probably belong to several species.

9. Some of the specimens show a distinct nervation.

11. Several specimens with the leaves still adhering were found at the Moeara Ketidoeran Siamang.

12. The specimens much resemble the fossil, figured by JONGMANS and GOTHAN on pl. IV, fig. 5. It does not seem probable that the twigs, which are mentioned in the preliminary report as *Walchia* spec. <sup>2)</sup> belong to the same plant.

13. From this species some specimens were found at the Soengei Maroes.

14. This species is rather frequent in some localities; some basal stumps of the stem in situ showed by their position that the strata, in which they occurred, were not turned upside down.

The strata, which contain the fossil plants, belong to a series of concordant layers in which banks of vulcanic material and other ones containing marine fossils were intercalated. On some places they had the character of a *Stigmaria*-bank, covered by a bed of lava; on other places they were developed as a shale, containing much *Cordaites*, or as a rather coarse sandstone with much impressions of *Cordaites*, *Taeniopteris* and *Pecopteris*; the locality at the Moeara Ketidoeran Siamang was especially interesting, because the plants were found imbedded in a white clay, which was still plastic; numerous leaves and seeds of *Cordaites*, leaves of *Pecopteris*, *Taeniopteris* and leaves and stems of *Sigillaria* occurred in it.

When collecting the fossils, I did not get the impression, that the flora at the different localities was much different. The marine fossils, which formerly were considered to be of Permian age, occurred in strata, belonging to the same series as the plant-bearing strata and occurring at different height, sometimes alternating with the latter; hence both kinds may be considered to be of the same age.

When discussing the age of strata, situated at the boundary of two formations, i.e. the Carboniferous and Permian, one should bear in mind that the criteria, used by the authors, may differ largely.

The olders of the series quoted here for comparison, that of Comentry, was by RENAULT and ZEILLER <sup>3)</sup>, later by ZEILLER <sup>4)</sup>, taken to be of Carboniferous age; but STERZEL <sup>5)</sup> included it in the Permian formation, because of a number of species, which are known elsewhere from Lower Permian strata only. Though most species may be found both in upper Carboniferous and in Permian beds, some species of *Sigillaria* and *Spheno-*

<sup>1)</sup> EDWARDS 1926, p. 171.

<sup>2)</sup> POSTHUMUS 1926, p. 215.

<sup>3)</sup> RENAULT et ZEILLER 1890, p. 713.

<sup>4)</sup> ZEILLER 1894, p. 275.

<sup>5)</sup> STERZEL 1895, p. 340.

teris, which are characteristic for deposits of the upper Carboniferous, were wholly absent.

In KAYSER, *Lehrbuch der Formationskunde*, these strata are mentioned to be of Permian age; in the French handbook of de LAPPARENT and HAUG, they are included in the upper Carboniferous.

From the East Asiatic regions T. G. HALLE<sup>1)</sup> draws about the same distinction as STERZEL: The upper Shibotse series is, according to him, doubtless of Permian age, as indicated by the occurrence of *Sphenophyllum Thoni* "one of the most distinctive species of the Permian". This species also occurs in the basin of Commentry<sup>2)</sup>.

ZALESSKY<sup>3)</sup> however thinks this species not be decisive of Permian age; his opinion agrees with that of the French palaeobotanists: the beginning of the Permian is indicated by the appearance of *Callipteris conferta*, *Taeniopteris multinervis* and *Walchia filiciformis*. The first species, however, already occurs in the beds of Perrecy<sup>4)</sup>, which are considered by ZEILLER to be of Carboniferous age. Those of Bert are mentioned by all authors as belonging to the Permian formation<sup>5)</sup>, because of the occurrence of *Taeniopteris multinervis*, *Walchia linaeriaefolis*, and the abundance of *Callipteris conferta*. Most of the other species occur in Permian and upper Carboniferous strata.

The same difficulty arises for the localities of Chan-Si; ZEILLER<sup>6)</sup> mentions the occurrence of *Stigmaria ficoides*, *Lepidodendron* cf. *Gaudryi* from there, together with *Taeniopteris multinervis*. The first two species may be used as an argument for Stephanian age; the latter for Permian age, because, according to ZEILLER, it is found elsewhere in Permian strata only. But as a criterion for the age this argument is of relative value only: GOTHAN<sup>7)</sup> thinks these grounds to be insufficient for considering these strata to be of Permian age.

The localities in Djambi are mentioned by JONGMANS and GOTHAN<sup>8)</sup> as being of Carboniferous age,<sup>10)</sup> because *Stigmaria* and *Lepidodendron* are found,<sup>20)</sup> because species characteristic of the Permian do not occur. Of *Stigmaria* good specimens are found in Djambi. In the Saarbasin and in Thuringia they do not occur in the lower Permian (*Rotliegendes*); from Bert, however, which is considered to be of Permian age by all authors, its occurrence is mentioned by GRAND'EURY<sup>9)</sup> and ZEILLER<sup>10)</sup>, and from

1) HALLE 1924, p. 23.

2) RENAULT et ZEILLER 1888, p. 488, pl. 52, fig. 10.

3) ZALESSKY 1907, p. 523.

4) ZEILLER 1906, p. 232.

5) ZEILLER 1906, p. 251.

6) ZEILLER 1901, p. 451.

7) GOTHAN 1915, p. 267.

8) JONGMANS und GOTHAN 1925, p. 296.

9) GRAND'EURY 1877, p. 519.

10) ZEILLER 1906, p. 181.

East Asia by ZEILLER <sup>1)</sup>), where it is found in association with *Taeniopteris multinervis*. If the presence of *Stigmaria* is used as a criterion for Carboniferous age, as is done by GOTHAN, then *Taeniopteris multinervis* may be found in the Carboniferous too. In this respect GOTHAN draws the boundary lower than the other authors.

From Southern Yun-Nan, ZEILLER <sup>2)</sup>), mentions *Stigmaria* from the same locality as *Gigantopteris nicotiaenifolia*, from strata which are doubtless of Permian age. He also mentions the occurrence of similar forms from the Triassic of Baccarat, described by FLICHE <sup>3)</sup> as *Stigmarites*, but which, according to personal observations by ZEILLER <sup>4)</sup>), differ in nothing from *Stigmaria*. Moreover the occurrence of *Stigmaria*, may be called rather probable in the strata which contain *Sigillaria*, as is the case in the Permian formation.

As well as the decisive value of the occurrence of *Taeniopteris multinervis* and *Callipteris conferta*, which even by ZALESSKY are considered to occur in Permian strata only, can be doubted, as has been done by GOTHAN, the same may be the case with that of *Stigmaria* for Carboniferous strata, though GOTHAN considers it to be a rather decisive point.

The only remaining argument against Permian age is the occurrence of the genus *Lepidodendron*. But *L. felis oculis*, which is elsewhere known from the above mentioned East Asian strata only, must be left out of consideration. And also the other specimens, which much resembles *L. Gaudryi* from Commeny and from the East-Asian localities, originates from these transitional strata; as long as no more localities are known, it should be used as an argument against Permian age with at least the same reserve as GOTHAN <sup>5)</sup> expresses for *L. Schmalhauseni* Zal and *L. kirgisca* Zal. <sup>6)</sup>).

If the list, given above, on the preliminary character of which stress should be laid, is considered, it becomes obvious that *Pecopteris Verbeeki* J. et G., *Tobleria bicuspis* J. et G., *Dadoxylon spec.* and *Cyclopteris spec.* are of no value for determining the age. The same is the case with the specimens mentioned as *Pecopteris cf. Miltoni*, as long as they have not been investigated more carefully; but it is interesting to see, that SCHENK <sup>7)</sup> mentions similar forms from Lui-pa-kon in Hu-nan from strata which certainly are not older than those from Djambi. From the remaining forms the three species of *Pecopteris*, *Callipteridium gigas*, *Taeniopteris multinervis*, *Gigantopteris americana*, *Sigillaria Brardi*, *Calamites Suckowil* and *Sphenophyllum oblongifolium* have been found in Permian strata;

1) ZEILLER 1901, p. 438, pl. 7, fig. 8.

2) ZEILLER 1907, p. 492, pl. 14, fig. 18.

3) FLICHE 1906, p. 138, pl. 13, fig. 2.

4) ZEILLER 1907, p. 493.

5) JONGMANS und GOTHAN 1925, p. 298.

6) ZALESSKY 1918, p. 49, pl. 4, fig. 5, 5a; p. 53, pl. 12, fig. 5.

7) SCHENK 1883, p. 230.

*Lepidodendron felis oculis*, L. Caudryi together with *Taeniopteris multinervis* in strata which according to ZEILLER<sup>1)</sup>, are of permo-carboniferous age. The only possible argument against Permian age, except the occurrence of *Stigmaria ficoides*, which has been discussed above, is the occurrence of *Cordaites borassifolius*, which has not yet been mentioned from the Permian. The delimitation of the "species" of *Cordaites*, however, is rather difficult and analogous forms are known from the Permian too.

As a species, characteristic for Permian strata, only *Taeniopteris multinervis* and *Gigantopteris americana*<sup>2)</sup> can be mentioned.

As far as data are available, they indicate that the fossil flora of Djambi shows most resemblance with the *Gigantopteris* flora of Eastern Asia and especially with the lowest part of it. Even if the boundary between Carboniferous and Permian formation is traced as high as possible, even then some arguments are left for a Permian age. Therefore it seems reasonable to indicate these strata as lower Permian or eventually as the transition, carboniferous-permian, as has already been done<sup>3)</sup>. For a more detailed opinion one should also take in account the results of the study of the marine fossils, which occur intercalated between the plant bearing strata.

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