A supplementary study on Protoblechnum Lesquereux from China

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ABSTRACT


The frond structure of Protoblechnum and the other similar plants is examined. These plants are like the neuropterids of the Late Palaeozoic Era, with forked or unforked rachides, whose fronds are simple pinnate or pinnately compound leaf and unequally or equally pinnate fronds. Based on the new materials of the bipinnatifid fronds of Protoblechnum contractum (Gu & Zhi) from Henan in China, it may be seen that other species of Protoblechnum besides Protoblechnum wongii Halle may also be bipinnatifid fronds. The discovery provides important materials for making a clear distinction among Protoblechnum and similar plants.

Key-words—China, Shihhotze Formation, Plant megafossils. Protoblechnum, Compsopferis.

INTRODUCTION

A dispute exists since long over the relationship between Protoblechnum and other similar plants, such as, Compsopferis, Glenopteris and Supaia in Permian floras of China, but it has not been completely solved up to now. The difference of opinion as how to choose suitable generic name still exists because of obvious form variation in the fossils collected by researchers.

BACKGROUND OF PROTOBLECHNUM

Halle (1927) while studying the fossil plants from the Late Palaeozoic strata in Shanxi, China placed a few simple pinnate fronds from the Shihhotze Formation in the genus Protoblechnum and named them Protoblechnum wongii Halle. Lesquereux (1880) had erected the genus Protoblechnum for specimens of Alethopteris holdeni described by Andrews (1875), which are simple pinnate fronds with unforked ra-
chides. Halle (1927) while discussing the distinction between *Protoblechnum* and other relative fossils pointed out that it would also be necessary to place forked *Danaeopsis hughesi* Feistmantel from the Indian Triassic under the genus *Protoblechnum*. Thus it can be seen that he did not think forked or unforked fronds as an important condition to distinguish genera. Yabe and Oishi (1928a, b) accepted Halle’s opinion and put under the genus *Protoblechnum* a few similar specimens from Permian strata of Shandong Province that were also simple pinnate fronds and did not have forked rachides.

White (1929), on the other hand, while researching the fossil plants collected from the Permian Hermit shale of Grand Canyon, America did not agree with views of Halle and Yabe and Oishi. He expressed the opinion that he would prefer to refer the Chinese species, which had simple pinnate fronds and unforked rachis, to the genus *Glenopteris* Sellards (1900), and the Indian species *Danaeopsis hughesi* Feistmantel, whose rachis is forked, to his new genus *Supaia*. Zalesky (1934, 1935) also found some specimens in the Permian of Russia similar to Chinese *Protoblechnum*. He did not approve of using the genus *Protoblechnum*, either. He grouped some specimens with forked rachides into *Supaia* White and the others showing simple pinnate fronds and without forked rachides to his new genus *Compsopteris*.

After the People’s Republic of China was founded, the fossil plants of this type have often been recorded in the Permian strata of China and their form structure is also different. Sze (1955) first reported a forked frond from Permian System of southeast Shanxi. He did not adopt the name *Supaia* White and supported Halle’s view and used the name *Protoblechnum*, which obtained support of many scholars such as Zhou Zhiyan and Li Xingxue. Towrow (1957) pointed out that the original *Protoblechnum* and *Supaia* of forked rachides from China and America, respectively should be placed in the genus *Dicroidium* with Indian *Danaeopsis hughesi*.

**PROToblechnum and Compsopteris from China**

Gu & Zhi (in Li Xingxue *et al.*, 1974) considered that Chinese *Protoblechnum* was quite similar to *Compsopteris*, and thus the former should be transferred to the latter. According to their opinion, *Protoblechnum* wongii Halle including *Protoblechnum* hallei Yabe & Oishi described in China should be merged as *Compsopteris* wongii (Halle) Zalesksy. They also set up two new species, that is, *Compsopteris impars* Gu & Zhi and *Compsopteris contracta* Gu & Zhi. The above mentioned three fossils were all simple pinnate fronds and the rachides forked once or not at all. Many scholars agreed with the opinion and the name *Compsopteris* has been gradually accepted in China since then (Feng Shaonan *et al.*, 1977; Chen Ye & Duan Shuyin, 1978; Zhang Jihui, 1978; Yang Guanxiu & Chen Feng, 1979; Zhao Xiugu *et al.*, 1980; Chen Lizhu, 1982; Wang Guoping *et al.*, 1986; Li Peijuan & He Yuaniang, 1986; Yang Guangrong *et al.*, 1986; Huang Lienneng *et al.*, 1987; Zhu Tong, 1990; Kong Xianzheng *et al.*, 1990).

In 1977, Huang Benhong found a great number of fossils of this type from Xiao Xin’an Mountains in Northeast China, too. He considered that the forked or unforked nature of rachis should be an important basis for generic distinction. He, therefore, put the forked fronds into *Supaia* and the unforked specimens into *Compsopteris*. Shen Guanglong (1995), however, included Chinese specimens of *Protoblechnum* wongii Halle with forked rachides in *Supaia* and for those with unforked rachides and simple pinnate he still reserved the name *Protoblechnum* as a form genus. *Compsopteris* has not been used until it has been confirmed as the same kind of plants as in the Angara flora on the basis of cuticular studies.

Liu Lujun (1989) discovered a lot of fossil plants from southeast Shanxi, among which were some bipinnatifid fronds. After reading relative references, he expressed the views to use *Protoblechnum* in the Cathaysian flora and limit *Compsopteris* in the Angaran flora. In conformity with his view, it is clearly seen that the formerly described specimens of *Protoblechnum* type from China may be placed in the genus *Protoblechnum* no matter simple pinnae or bipinnae they are; no matter forked or unforked rachides they have.

Wang (1996) has recently pointed out that *Supaia* which had simple pinnate fronds and forked rachis might have evolved from *Protoblechnum* wongii Halle which had bipinnatifid fronds and unforked rachis. It is a result of palaeoclimatic changes, which can be well explained by Asama’s Growth Retardation Theory (1960). According to Wang’s study, there are two types of the pinnule base in *Supaia* from the Upper Shihhotze Formation in Shanxi, China. One has a decurrent base as in *Protoblechnum* wongii and the other has a contracted base like *Protoblechnum* contractum. Among published records from China, the specimens of *Protoblechnum* contractum are all simple pinnate fronds, contracted bases of pinnule and unforked rachides. It is of vital significance to get a specimen of bipinnatifid fronds of *Protoblechnum* contractum from Permian strata in China if Wang’s guess is correct about the origin of *Supaia* from the Upper Shihhotze Formation of Shanxi, China. Furthermore, it may show that both *Protoblechnum* wongii and *Protoblechnum* contractum, which are all bipinnatifid fronds but whose bases of pinnules are different (one decurrent, the other contracted), possibly represent two directions of the evolution from *Protoblechnum* to *Supaia*.

Kapoor *et al.* (1992) considered that *Kashmiropteris meyenii* Kapoor, a possible cycadalean leaf from the Early Permian Maml Formation in the Kashmir Himalaya, showed a certain resemblance to *Protoblechnum* Lesquereux 1880 and *Compsopteris* Zalesksy 1934, but leaves of both these genera...
differ from that of _Kashniropteris meyenii_ in the venation pattern of the pinnae. It is very interesting that _Kashnirop­teris meyenii_ has also two type bases of pinnae or pinnules, one contracted (Kapoor et al., p. 143, pl. 1, figs 1-3), the other decurrent (p. 145, pl. 2, figs 1-2).

**DISCUSSION**

According to present materials, the rachides of both _Protoblechnum_ and _Glenopteris_ in North America are unforked and their leaves are simple pinnate fronds. They are almost showing no difference in other shape features and may be merged. The former should be kept and used because of its priority. As to the similar fossils with a forked rachis, the genus _Supaia_ erected by White can be applied because the forked or unforked rachides is an important basis for generic segregation. The leaf of _Compsopteris_ is simple frond. Although the appearance of the genus is the same as that of _Protoblechnum_, the cuticular structure of _Compsopteris_ ascertained by Meyen & Migdissova (1969) is different from that of _Protoblechnum_. And the former with an unforked rachis, which differs from the _Supaia_, ought to be reserved and limited in the Angara area. As for Indian species _Danaeopsis hughesi_ with a forked rachis, it has been transferred to another genus because the reproductive organ and the cuticular structure of _Danaeopsis hughesi_ have been clearly studied.

The genus has nothing to do with _Supaia_ and is also one of local plant members in the Angara area.

It may be seen from the foregoing review that the frond structure of _Protoblechnum_ and the other similar taxa is rather complex. Based on accumulated materials, these plants may be like neuropterids of the Late Palaeozoic Era, whose rachides were forked or unforked, fronds were simple pinnate or pinnately compound leaf and unequally or equally pinnate fronds. All of these will depend on further field work and study so that the kind of plant can be identified reasonably. Therefore, it is very important that a new specimen which can reveal detailed structure of the plant is discovered.

**NEW MATERIALS**

In the Summer of 1994, one of the authors (Sun Bainian) collected many good specimens of _Protoblechnum_ from the Upper Shihhotze Formation at Dengfeng Coalfield in Henan, among which there are several specimens of bipinnatifid fronds. The authors of present paper think that these bipinnate should be _Protoblechnum contractum_ (Gu & Zhi). This discovery not only indicates that other species of _Protoblechnum_ besides _Protoblechnum wongii_ Halle can be bipinnatifid fronds but also provides important materials for making a deep dis-
tinction between Protoblechnum and similar plants. In accordance with the new materials from Henan, an emended diagnosis of Protoblechnum contractum (Gu & Zhi) is given.

**PROTOBLECHNUM CONTRACTUM**

(Gu & Zhi) Sun Keqin emend

*(Fig. 1; Text-figure 1)*

1974 *Compsopelis contracta*, Gu & Zhi (in Li Xingxue et al.), p.115, pl. 82, figs 4-6; pl. 83, figs 1-3, Text-figure 79.


1979 *Compsopelis contracta*, Yang Guanxiu & Chen Feng, p. 126, pl. 35, figs 7-8.

1980 *Compsopelis contracta*, Zhao Xiugu et al., p. 82.

1982 *Compsopelis contracta*, Chen Lizhu, p. 517, pl. 331, fig. 8.

1982 *Compsopelis contracta*, Wang Guoping et al., p. 366, pl. 153, fig. 10.

1986 *Compsopelis contracta*, Yang Guangrong et al., p. 11, 32, pl. 18, fig. 10.

1987 *Compsopelis contracta*, Huang Lianmeng et al., p. 44, pl. 22, fig. 5; pl. 23, fig. 1-2.

1990 *Compsopelis contracta*, Zhu Tong, p. 96, pl. 3, 6, pp. 34, figs 1-3.

1991 *Protoblechnum contractum*, Sun Keqin, p. 40-41, pl.13, fig. 2.


1996 *Protoblechnum contractum*, He Xilin, Liang Dunshi & Shen Shuzhong, p. 59, pl. 45, fig. 4.

1996 *Compsopelis contracta*, Kong Xianzheng et al., p. 188-189, pl. 13, fig. 1, 1a.

*Description*—Frond very large, bipinnate, rachis thick, attaining 2.8 cm in width, obviously thin drops on the surface of rachis; ultimate pinnae 8 cm in width and unknown in length; ultimate rachis thick, 5-7 mm broad; pinnule 9 mm wide, scattered in arrangement, long linear or strap-shaped, margin entire, base contracted; midrib strong, 1-1.5 mm in width, nearly reaching to the apex, at a right angle extended from the rachis; lateral veins fine and close, curving outside at a small angle from the midrib, dichotomizing twice or thrice, 20-25 veins per cm on the margin.

*Comparison*—The present specimen with unforked rachis, bipinnate frond, shape and veins of ultimate pinnules like *Protoblechnum wongii* Halle, but the distinction lies in the obviously contracted base of pinnules in the former.

*Locality and Horizon*—Dengfeng, Henan; Upper Shihitote Formation.

*Specimen No. and Repository*—PB93174; Palaeontologic laboratory of Geological Department, Lanzhou University.

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REFERENCES


