

STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA —
5. GENERIC STATUS OF *GLOSSOPTERIS*, *GANGAMOPTERIS*
AND *PALAEOVITTARIA*

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THOUGH the *Glossopteris* flora has been known for more than a hundred years from now, yet our knowledge of this flora does not extend beyond the gross features of the plants comprising it. Its three well-known fronds, viz. *Glossopteris*, *Gangamopteris* and *Palaeovittaria*, are more or less similar in external form and usually distinguished from one another by the presence or absence of a midrib and anastomosing of the secondary veins. *Glossopteris* possesses a distinct midrib and a freely anastomosing secondary vein, forming meshes of great variety. In *Gangamopteris* there is no midrib but there is a free anastomosing in the secondary veins. *Palaeovittaria* possesses a midrib which is seen only in the lower part of the frond and shows no anastomosing in the secondary veins.

EXTERNAL CHARACTERS

The above characters are, however, seen in the typical forms of the three genera. But many a time the characters of one genus merge into another and then it becomes difficult to refer such forms to *Glossopteris*, *Gangamopteris* or *Palaeovittaria*. For example, *Glossopteris decipiens* and *Glossopteris longicaulis* possess midrib which is seen only in the lower portion of the frond and disappears in the upper part. In *Gangamopteris angustifolia* and *Gangamopteris whittiana*, a groove is seen in the median portion of the frond which looks very much like a midrib (ARBER, 1905, pp. 114, 115). Again, in some fronds of *Gangamopteris cyclopteroides* and *Gangamopteris indica* the median veins, occupying the position of midrib, become so prominent that the fronds may easily be confused with *Glossopteris*. And such confusion had arisen in the past. Zalessky's (1918) specimen of *Glossopteris angarica* from Russia was considered by Sahni (1926, p. 241) to be a *Gangamopteris*, very similar to *Gangamopteris kashmirensis*.

Similarly, there is sometimes a confusion between *Palaeovittaria* on the one hand and *Glossopteris* and *Gangamopteris* on the other. Several fronds like *Glossopteris mitchelli*, *Glossopteris intermittens*, *Gangamopteris rosica* and *Glossopteris flexuosa* are characterized by rarity of anastomoses and doubts arise as to which genus they should be referred to. Some *Palaeovittaria*-like leaves showing complete absence of anastomosing in the secondary veins were referred to different genera by some authors but later they were included under either *Glossopteris* or *Gangamopteris*. One such example is that of the leaf described as *Zamiopteris glossopteroides* by Schmalhausen, which was later transferred to *Gangamopteris* by Zalessky. Another example is that of the leaf referred to the genus *Linguifolium* by Arber (1913), which is considered by Sahni (1926, p. 245) to be, if not identical, at least closely related to *Glossopteris*.

On account of such confusion and variation in the external characters, which are supposed to distinguish the three genera, doubts have been raised in the past with regard to the desirability of maintaining the genera *Gangamopteris* and *Palaeovittaria*. Some authors have in fact suggested merger of the three. As for *Gangamopteris*, Feistmantel (1890, p. 130) remarked that "a *Gangamopteris* is a *Glossopteris* without a midrib". Etheridge (Jun.) (ETHERIDGE & DAVID, 1894, pp. 240, 241) has also drawn attention to this fact and has pointed out that certain forms of these two genera closely resemble each other and there are no good critical characters to distinguish them. Doubts have also been raised on the importance to be attached to the midrib and the secondary veins. Seward (1914), Gothan (1924) and Sahni (1926) considered the anastomosing of the secondary veins to be only a minor character, not worthy of generic importance. Arber stated (1902, p. 14) "that since the discovery of the scale leaves of *Glossopteris* the presence of a midrib is no longer a neces-

sary characteristic of the genus". He further remarked that in the absence of our knowledge of their fructifications, the two genera *Glossopteris* and *Gangamopteris* should be merged.

In case of *Palaeovittaria* also Sahni (1926, p. 245) showed a close relationship of this leaf with *Zamiopteris glossopteroides* Schmalhausen (later transferred to *Gangamopteris* by ZALESSKY). He further stated that on re-examination of the type specimen of *Palaeovittaria kurzi*, he found that the several leaves figured by Feistmantel as separate, in fact radiate out from the apex of a stem showing characteristic signs of *Vertebraria* [since then one of us (SRIVASTAVA) has confirmed this observation]. The mode of attachment of the leaves is suggestive of *Glossopteris* leaves. In the end he stated "the question now arises whether even *Palaeovittaria* is to be respected as a new genus". Walkom (1928, p. 560) also came to the same conclusion. He pointed out similarities between *Glossopteris? mitchelli* and *Palaeovittaria kurzi* and remarked: "In specimens such as the one described here, it is difficult to know where to draw the line between *Glossopteris* and the other genera. *Glossopteris? mitchelli* seems very close to *Palaeovittaria kurzi* and it may be that the two are representative of a single genus."

From the above it is evident that in the three genera *Glossopteris*, *Gangamopteris* and *Palaeovittaria*, there are no distinguishing characters which can be sharply defined, and the criteria like absence or presence of a midrib and the anastomosing of the secondary veins are too inconsistent to be relied upon as of generic value. The conclusion is almost forced upon us that *Glossopteris* type of leaf perhaps represented a generalized pattern borne on diverse plants which dominated the vegetation of that period.

CUTICULAR EVIDENCE

Srivastava's studies of fourteen species of *Glossopteris*, six species of *Gangamopteris* and *Palaeovittaria kurzi* show that it is again not possible to delimit the three genera as defined at present on the basis of epidermal characters, because there are species in two genera which show very similar epidermal characters and some species of a single genus show such diversity which cannot be regarded as only of specific importance. For example, the cuticles of *Glossop-*

teris arberi and *Gangamopteris flexuosa* are very similar and so is the case with *Glossopteris intermittens* and *Palaeovittaria kurzi*. Similarly, the cuticles of *Glossopteris arberi*, *Glossopteris damudica* and *Glossopteris intermittens* are so widely different from each other that each of them represents a group of at least generic rank. Florin (1940, p. 6) pointed out the same on the evidence of epidermal structures of two species, viz. *Glossopteris indica* and *Glossopteris angustifolia*.

Thus *Glossopteris*, *Gangamopteris* and *Palaeovittaria* cannot be regarded as natural genera. On the other hand, they seem to include leaves belonging at least to different genera but possessing more or less similar external form. Several such examples of leaves having almost similar external forms but belonging to different genera and families as revealed by the epidermal characters are cited by Florin among the conifers.

The three genera, therefore, should be broken up into different genera by adopting new criteria for defining groups of species of generic ranks. The best course will be to take into consideration external as well as the epidermal characters together. However, for the present at least this does not seem to be possible. Arber (1905) on the basis of venation merged several species of *Glossopteris* and retained only thirteen. However, this arrangement is not supported by cuticular evidence.

If only epidermal characters are taken into consideration, the various species of the three genera studied by one of us (SRIVASTAVA) fall into six groups which may provisionally be considered as of generic rank (see TABLE 1).

However, before the three genera are broken up, one important fact has to be taken into consideration. Recently some fructifications have been described as borne on the leaves of certain species of *Glossopteris* and it is possible that similar discoveries will be made in the case of other related genera. When such organs are found in connection, it is natural to connect them together and define more precisely the taxonomic limits of the plant to which they belong. But before doing so in the case of *Glossopteris* and other related genera it would be desirable if the true identity of the leaves is first established on the basis of cuticular study (provided, of course, the material is suitable for cuticular studies). Otherwise, as Srivastava's work has shown, the identification

TABLE 1 — SHOWING PROVISIONAL SPECIES GROUPS OF GENERIC RANK
HAVING BROADLY SIMILAR EPIDERMAL CHARACTERS

EPIDERMAL CHARACTERS	SPECIES INCLUDED
Group 1	
Cuticles thin, stomata confined to the lower surface, epidermal cell walls sinuous and sometimes papillate. Stomata irregular in distribution and orientation. Stomatal apparatuses monocyclic, guard cells not much cutinized. Subsidiary cells 4-6, sometimes papillate.	<ol style="list-style-type: none"> 1. <i>Glossopteris angustifolia</i> 2. <i>Glossopteris retifera</i> 3. <i>Glossopteris arberi</i> *4. <i>Glossopteris sahnii</i> ?5. <i>Gangamopteris flexuosa</i> ?6. <i>Gangamopteris</i> sp. A
Group 2	
Cuticles moderately thick, network marked as a rule, stomata present on both the surfaces, cell walls thin and straight, stomata crowded and irregularly oriented, stomatal apparatuses monocyclic, occasionally partly amphicyclic, guard cells more or less thickened, subsidiary cells 4-7.	<ol style="list-style-type: none"> 1. <i>Glossopteris browniana</i> 2. <i>Glossopteris</i> cf. <i>divergens</i> 3. <i>Glossopteris formosa</i> 4. <i>Glossopteris communis</i>, also including var. <i>stenoneura</i> 5. <i>Glossopteris longicaulis</i>
Group 3	
Cuticles very thick, network not marked. Stomata confined to the lower surface, stomatal apparatuses monocyclic, guard cells thickened and probably sunken, orientation of the stomata longitudinal.	<ol style="list-style-type: none"> 1. <i>Glossopteris indica</i> 2. <i>Glossopteris conspicua</i> *?3. <i>Gangamopteris</i> sp. B
Group 4	
Upper cuticle more or less thick, lower thin, stomata confined to the lower, cell walls straight, stomata sparse, monocyclic, guard cells slightly thickened. Subsidiary cells 4-5, non-papillate.	<ol style="list-style-type: none"> 1. <i>Glossopteris damudica</i> 2. <i>Glossopteris taenioides</i> 3. <i>Glossopteris taeniopteroides</i> ?4. <i>Gangamopteris</i> cf. <i>cyclopteroides</i>
Group 5	
Upper cuticle thin with sinuous cells, lower cuticle comparatively thicker having straight-walled cells, stomata present on one or both the surfaces, orientation oblique or irregular, stomata completely or partly amphicyclic, guard cells more or less thickened, subsidiary cells 5-6, non-papillate.	<ol style="list-style-type: none"> 1. <i>Gangamopteris indica</i> 2. <i>Gangamopteris</i> cf. <i>hughesi</i>
Group 6	
Cuticles moderately thick, areas of meshes and veins well marked, stomata confined to the lower surface, crowded, irregular in orientation and distribution, guard cells dumb-bell-shaped in surface view with characteristic thickening round the aperture and the polar ends.	<ol style="list-style-type: none"> 1. <i>Glossopteris intermittens</i> 2. <i>Palaeovittaria kurzi</i>

*All the details not known.

of a fructification bearing leaf, based on external features alone may be wrong to start with and consequently lead to wrong conclusion regarding the definition of the plant represented by these organs.

The arrangement proposed here (see TABLE 1) is tentative and perhaps will have to be changed or modified later when more forms

are studied. We have, therefore, desisted from giving new generic names for the present. But it seems certain that all these tongue-shaped leaves in the *Glossopteris* flora cannot be accommodated in only one, two or even three genera. They represent a number of genera, perhaps closely related to one another.

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