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 whittitana, 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 cyclopteroideos 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 michelli, 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 Lingulifolium 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 knowl-
edge 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 Ganga-
mopteris by Zalesky). 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 Ve-
tebraia [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 simi-
larities 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 sec-
dary 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 general-
ized 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 epider-
mal 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 im-
portance. For example, the cuticles of Glosso-
pteris arberi and Gangamopteris flexuosa are
very similar and so is the case with Glos-
sopteris intermittens and Palaeovittaria kurzi.
Similarly, the cuticles of Glossopteris arberi,
Glossopteris damudica and Glossopteris inter-
mittens 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 epi-
dermal structures of two species, viz. Glosso-
pteris 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 fructi-
fications 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 desir-
able 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 study). Otherwise, as Srivas-
tava's work has shown, the identification
TABLE 1—SHOWING PROVISIONAL SPECIES GROUPS OF GENERIC RANK HAVING BROADLY SIMILAR EPIDERMAL CHARACTERS

<table>
<thead>
<tr>
<th>EPIDERMAL CHARACTERS</th>
<th>SPECIES INCLUDED</th>
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<td><strong>Group 1</strong></td>
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| 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. | 1. *Glossopteris angustifolia*
2. *Glossopteris retifera*
3. *Glossopteris arberi*
4. *Glossopteris sahnii*
5. *Gangamopteris flexuosa*
6. *Gangamopteris* 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. | 1. *Glossopteris browniana*
2. *Glossopteris cf. divergens*
3. *Glossopteris formosa*
4. *Glossopteris communis*, also including var. *stemonnea*
5. *Glossopteris longicaulis* |
| **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. | 1. *Glossopteris indica*
2. *Glossopteris conspicua*
3. *Gangamopteris* 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. | 1. *Glossopteris damudica*
2. *Glossopteris taenioides*
3. *Glossopteris taeniopteroides*
4. *Gangamopteris cf. cyclopteroides* |
| **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. | 1. *Gangamopteris indica*
2. *Gangamopteris cf. hughesi* |
| **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 dumble-shaped in surface view with characteristic thickening round the aperture and the polar ends. | 1. *Glossopteris intermittens*
2. *Palaeovittaria kurzi* |

*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.

REFERENCES


