APOGAMY IN PTERIS BIAURITA LINN.

BY P. N. MEHRA.

(Kashyap Research Laboratory, Panjab University, Lahore.)

Received June 25, 1938.

[Communicated by Dr. H. Chaudhuri, n.sc. (Lond.), Ph.D., D.I.C.]

_Pteris biaurita_ belongs to the Pteroid section of the Leptosporangiate ferns. The species is common in India in the Eastern Himalayas from Garhwal to Bhotan and Khasia ascending upto 6000 ft. The spores were collected in Sikkim where they ripen in the month of October.

The spores are tetrahedral, dark brown and possess a tri-radiate mark. As in other members of Pteridaceae, the spore wall consists of a thin intine and a thick outer exine. There is a band of thickening developed on the periphery of the spore running along its three corners.

The spores were germinated on sterilized soil in pots kept in troughs of water and covered over with glass plates to avoid foreign contamination and in sterilized Petri-dishes on Knop's solution. The initial stages of germination in the latter medium are secured earlier in about 12 days than on soil which takes about 23 days. Drawings of the early germination stages were made from the living material from cultures from both the sources and these are specified. The later stages, after the protonema were, drawn exclusively from the soil culture.

The spores do not lose their viability even after an year.

![Diagram](From soil culture) $\times 533.$

**Text-Fig. 1.**
Apogamy in Pteris biaurita Linn.

The spore swells in size and the exine ruptures at the tri-radiate mark (Text-Fig. 1 a, b) showing a number of oil globules and other food grains enclosed within the intine. The protuberance or the protonema initial gradually develops chlorophyll granules. At the same time primary rhizoid is cut off by a longitudinal or oblique wall (Text-Fig. 1 c, d). In the protuberance the food material and the chloroplasts collect in the upper region so that the lower part within the spore coat becomes empty and hyaline (Text-Fig. 1 e). Successive transverse walls are laid forming a protonema of variable length which in Knop's solution may be upto 13 cells long (Text-Fig. 2 a, b, c). In the meantime another rhizoid may be formed from

Text-Fig. 2. (From Knop's solution) × 95.
the lowermost cell or the one just above it. The growth of the rhizoids
is much pronounced and smooth in Knop's solution than on soil. In the
former medium the rhizoids develop a few small chloroplasts probably be-
cause of their being exposed to diffused light in the aquatic medium.

Frequently the protonema may branch (Text-Fig. 2 g). Sometimes
in Knop's solution it forms a rather narrow elongated cell in front
in which the chlorophyll grains become aggregated in the apical region
(Text-Fig. 2 f).

**Flattening of the gametophyte:**

The prothallus in *Pteris biaurita* does not expand by a two-sided apical
cell.

The filament grows out in its anterior region into a spatula-shaped
structure, one layer of cells thick, by the formation of vertical walls in the
marginal and surface cells. One of the cells on the lateral margin divides
into a number of smaller cells by periclinal, anticlinal and oblique walls
(Text-Fig. 3 a). During this procedure a two-sided cell is differentiated which,
as will be seen later, marks the position of the notch (Text-Fig. 3 b). It cuts
off a few segments alternately on the right and left. These segments divide
by both periclinal and anticlinal walls and grow outwards both above and
below the two-sided lateral cell where a notch is formed (Text-Fig. 3 c).
Later the segments below this two-sided cell begin to grow vigorously
with the result that a second small lobe is differentiated. The
prothallus at this stage is lop-sided with two lobes of unequal size (Text-
Fig. 3 d). At the same time two-sided cell becomes dissected into more or
less rectangular cells, by the formation of anticlinal walls, forming a short-
celled meristem at the notch. The growth of the secondary smaller lobe is
now more rapid compared to the big primary lobe. Ultimately the prothallus
assumes a cordate appearance (Pt. VIII, Figs. 5, 6) with two lobes equal in
size. It must be noted, however, that the two lobes are not of the same age.

This type of prothallial development resembles with that described by
Goebel (1930) for *Pteris longifolia* and by Schumann (1915) for *Acrostichum
aureum* both belonging to Pteridaceae. In *Pteris flabellata* probably a similar
thing happens as indicated by the figures of the apogamous prothalli
drawn by Steil (1933). Similar development of the prothallus has been
observed by the writer in a Gymnogrammoid fern *Ceropeteris calomelanos*
(unpublished).

Frequently the lateral meristem arises very late. In such cases the
prothallus forms a flat plate of cells of considerable size, one layer thick, and
may commonly become lobed simply by the greater growth of cells on one
side than on the other (Text-Fig. 4). Also the two-sided cell and later the meristem in these cases may arise obliquely anteriorly so that the second lobe is not formed entirely de novo, but is also to a certain extent a part of the original plate like thallus (Pt. VII, Fig. 1, Text-Fig. 5).
These irregularities, however, are not very common. They serve to point out the plastic nature of fern prothalli.

In a few cases, a highly irregularly lobed prothallus was found to develop. One of the peculiar features in these is the formation of an elongated narrow cell separating two of the lobes, while on both of its sides smaller cells are present (Text-Fig. 6).

The mature cordate prothalli in the present culture on soil are, as a rule, a single layer of cells thick throughout, the typical well-developed cushion
Apogamy in Pteris biaurita Linn.

between the wings being absent. In *Pteris longifolia* a cushion is present. The fully developed cells of the wings do not possess any collenchymatous thickenings on their corners or along the walls such as have been observed by the writer in *Adiantum lunulatum* (1938) and *Cheilanthes farinosa* (unpublished) and described by Horvat in *Adiantum cuneatum* and Bauke in *Anemia phyllitidis* (quoted by Bower, 1928).

Antheridia develop on young prothalli in quite large numbers, particularly on the under surface but also along the margins and on the upper surface. Sometimes every cell of the young prothallus bears an antheridium. These prothalli get exhausted and die. Those which either produce no antheridia or only a few ones grow big, develop the second lobe, become cordate and produce the embryo.

The structure of a ripe antheridium is as usual in highly advanced ferns. There is a basal funnel-shaped cell, a wall cell and an apercular cell, all containing a few chloroplasts in the living condition. Sometimes the basal cell may not be funnel shaped but only slightly depressed. The number of sperm-mother cells vary from 18 to 37, the most common number being about 30. This is the number met within the antheridia of advanced Leptosporangiate ferns. The lesser number of mother cells is perhaps due to the lack of nourishment owing to the formation of a large number of antheridia on young prothalli.

In ripe antheridia the wall cell is so much compressed that at some places its inner wall comes in contact with the outer. With the release of pressure on the discharge of the sperms, the walls bulge inwards almost closing the
cavity. The dehiscence of the antheridium occurs by the bodily lifting of the opercular cell which is thrown out with some force.

The sperm-mother cells are round and when ejected out of the antheridium gelatinise in the water outside. After a few seconds, the coiled sperm inside riggles, at first slowly and then rapidly, ultimately emerging out of it carrying a vesicle at its tail. The sperms apparently seem capable of fertilization.

The archegonia are never developed in the life-history of the gametophyte.

The embryo formation is apogamous. A few cells just behind the notch become meristematically active dividing in all plains transverse, vertical and horizontal giving rise to a short pad-like structure (Pt. VII, Fig. 2). Each of the cells at this stage contains a single nucleus and there is no irregular fusion of the nuclei of adjacent cells as shown in a magnified photograph of such a region in one focus (Pt. VII, Fig. 3). In its interior a few cells loose contents, develop thick walls and become tracheidal cells. They possess scalariform bands which cut one another frequently forming a number of reticulations. From its surface, on the underside of the prothallus, the first leaf which is pinnate with 3 lobes makes its appearance (Pt. VIII, Figs. 5, 6). This is protected in young condition by a number of multiseriate trichomes which are 3–5 cells long with the terminal cell swollen and globular. In the meantime a root apex is visible. The stem apex is the last to be differentiated and becomes protected by multicellular hairs and flattened scales which arise from the surface of the hemispherical cushion.

After producing the embryo, the prothallus stops further growth and the cells in the notch loose their meristematic activity and become more or less elongated anteriorly.

In the genus *Pteris* apogamy is already known to occur in *Pteris cretica* studied by Farlow (1874), in 10 other varieties of *Pteris cretica*, *P. sulcata*, *P. quadri-aurita* var. *argyrea*, *P. parkeri* and *P. flabellata* by Steil (1918, 1933). *Pteris biaurita* adds another to the list of apogamous species of the genus *Pteris*.

**Summary.**

The development of the gametophyte in *Pteris biaurita* is of the *Pteris longifolia* type.

There is no typical cushion which is met with commonly in ferns behind the notch in well-developed prothalli.

Antheridia with motile sperms apparently capable of fertilization are formed but archegonia are eliminated out of the life-cycle of the gametophyte.
Apogamy in Pteris biurita Liun.

The dehiscence of the antheridia occurs by the bodily lifting of the opercular cell which is thrown off with some force.

The embryo formation is by apogamous bud.

BIBLIOGRAPHY.


INDEX TO TEXT-FIGURES AND PLATES.

Text-Fig. 1—(From soil culture).

a, b—Rupture of the spores at tri-radiate mark.
c, d—Protonema protuberance with primary rhizoid cut off by oblique wall.

Text-Fig. 2—(From culture on Knop's solution).
a, b, c, d—Filamentous protonema of different lengths.
e—Beginning of expansion of the protonema.
f—Protonema with terminal cell rather narrow and elongated. Most of the chloroplasts are localised near the apex.
g—Branched protonema.

Text-Fig. 3.—(From soil culture).
a—Spatula-shaped prothallus in one of the lateral cells of which meristematic activity is begun.
b—A slightly more advanced stage with a two-sided lateral cell differentiated.
c—Two-sided lateral cell having cut a few segments on right and left. The position of the notch established.
d—Lop-sided prothallus with the secondary lobe small in size.

Text-Fig. 4.—(From soil culture).
A prothallus with 2 lobes in which the meristem arises rather late and is obliquely anterior. The two-sided cell is differentiated.

Text-Fig. 5.—(From soil culture).
An old prothallus with meristem differentiated rather late in oblique anterior position.

Text-Fig. 6.—(From soil culture).
Highly irregularly lobed prothallus. A peculiar elongated cell between two of the lobes. On either side of this cell there are small cells.
PLATE VII.

Fig. 1.—Prothallus bearing large number of antheridia. Meristem obliquely anterior and developed rather late.

Fig. 2.—Formation of a pad of tissue immediately behind the notch due to meristematic activity of cells in preparation to the formation of apogamous bud.

Fig. 3.—'Pad' region in one focus highly magnified. Each cell contains a single nucleus.

Fig. 4.—Formation of an apogamous bud.

PLATE VIII.

Fig. 5.—The first leaf in process of growth.

Fig. 6.—Later stage than 5. First leaf pinnate with 3 lobes and covered with multiseriate trichomes.