

OBSERVATIONS ON HELMINTHOSTACHYS KAULFUSS (OPHIOGLOSSALES)

H. K. GOSWAMI¹ and SHARDA KHANDELWAL²

Department of Botany, Government Science College, Gwalior, M. P. India

SUMMARY

New observations on the fern genus *Helminthostachys* Kaulfuss (Ophioglossales) are presented. Tetrarchy of the stele in the root is confirmed. The stomata in *Helminthostachys* are similar to those in *Ophioglossum palmatum*. The unusual structure of the vegetative laciniae found at the distal end of each sporangiophore is again emphasized. In the rhizomes the presence of a periderm could be demonstrated.

1. INTRODUCTION

Helminthostachys Kaulfuss is a monotypic genus of the Ophioglossales in the eusporangiate ferns. *H. zeylanica* is found in Ceylon, India, Malay Peninsula, Indonesia, China, Japan, Australia, Philippines, New Caledonia, New Guinea and the Solomon Islands (BEDDOME 1892, EAMES 1936, PANIGRAHI & DIXIT 1969). Numerous workers have made morphological and anatomical studies on the genus (PRANTL 1883, BOODLE 1899, FARMER & FREEMAN 1899, GWYNNE-VAUGHAN 1902, LANG 1915, BOWER 1926, 1935, OGURA 1938, 1972, NISHIDA 1956); they have mostly emphasized its similarity to *Botrychum* Schwarz and *Ophioglossum* L., despite the significant differences in the fertile spikes of the three genera.

It is difficult as yet to offer a morphological explanation of the rosette of vegetative laciniae produced by the sporangiophore, a structure which is unique in the entire plant kingdom (SCOTT 1923, BOWER 1926, 1935) although they are believed to be comparable to growths found in the carboniferous fern *Botryopteris* (SPORNE 1970, BIERHORST 1971).

In this paper, based on morphological and anatomical studies on the genus, its uniqueness is reemphasized and the suggestion is made that an extensive comparative study is needed of specimens of this monotypic pteridophyte genus from different localities, particularly because some phenotypic variables may be suggestive of genetic and/or adaptive changes.

2. MATERIALS AND METHODS

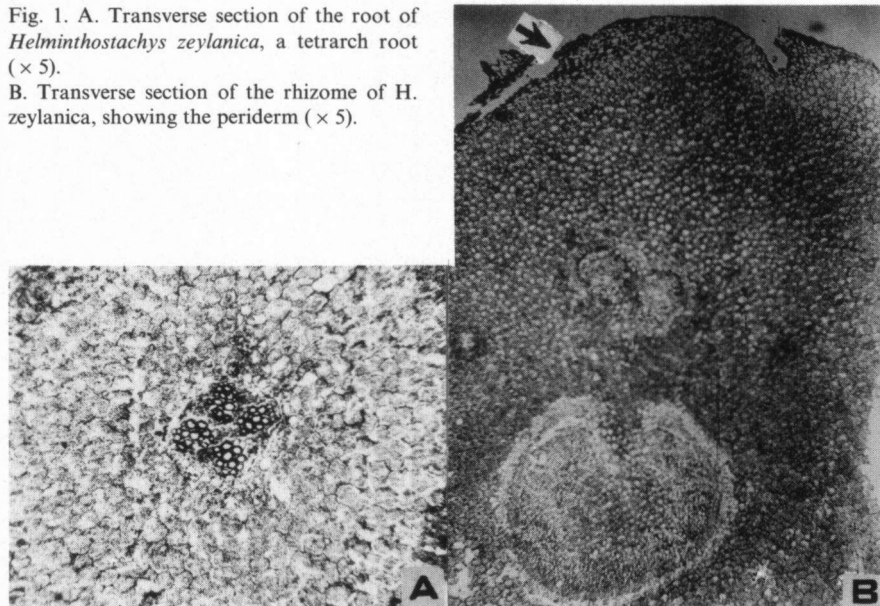
Fixed (acetic acid + abs. alcohol 1:3) and living plants were obtained from Trivandrum and Gorakhpur. Roots and rhizome pieces were processed through an alcohol-xylol series and embedded in paraffin wax (56°C). Microtome sections 8–10 µm thick were stained with fast green and safranin or with Sudan IV. Spores were released on slides by puncturing sporangia and sporangiophore flaps were detached and mounted in glycerine after staining with safranin.

3. OBSERVATIONS AND DISCUSSION

Root and rhizome: The stele in the root is normally hexarch or heptarch (BOWER 1926) but also tetrarch roots have been found (OGURA 1972); in *fig. 1A* a cross section through a tetrarch root is depicted. Tetrarch roots are normal in *Botrychium virginianum* and *B. ternatum*, the other species of *Botrychium* and *Ophioglossum* usually have monarch or diarch roots (BOWER 1926). The rhizomes of the three genera are similar in possessing an ectophloic siphonostele and a mesarch xylem.

Staining of rhizome sections with Sudan IV (PETERSON 1971) shows the presence of a periderm, which has apparently been overlooked by previous workers. Periderm production is a normal feature of progymnosperms and gymnosperms: among pteridophytes it has been observed in woody lycopods, sphenopsids and in *Botrychium* and *Ophioglossum* (KHANDELWAL & GOSWAMI 1977b).

Fig. 1. A. Transverse section of the root of *Helminthostachys zeylanica*, a tetrarch root ($\times 5$).
B. Transverse section of the rhizome of *H. zeylanica*, showing the periderm ($\times 5$).



Ophioglossaceous genera are different from other ferns in this respect. Our observations indicate that the tissue may be present in some populations and absent in others of the same species.

Epidermis: The epidermal structures and the mode of development of the stomata were described by PANT & KHARE (1969). Contrary to their description in our material the marginal cells of the lower epidermis did not bulge or form small dome-shaped papillae. The stomata of *Helminthostachys zeylanica* closely resemble those of *Ophioglossum palmatum* with the exception of the "lipped projections" we found between the guard cells of some of the stomata of *O. palmatum* (KHANDELWAL & GOSWAMI 1977a).

Spike and sporangia: The spike of *Helminthostachys* is occasionally branched, either dichotomously or by the outgrowth of normally diminutive sporangia-bearing appendages. The sporangia are borne on lateral branches symmetrically placed around the spike axis. The extensions of the flaps of the sporangiophores are spongy and fleshy structures with smooth margins, their outer portion parenchymatous and the central portion containing spongy cells. This is in contrast with the figure as given by, among others, BOWER (1926), showing these flaps as dentate and leafy structures with stiff margins. At maturity the distal end of each sporangiophore produces a rosette of vegetative laciniae comparable with the growths noted in the carboniferous fern *Botryopteris antiqua* (SCOTT 1923).

Cytology: The chromosome number $n = 94$, found by NINAN (1958) and MAHABALE & NAIR (1972) was confirmed for our material: at early diakinesis in spore mother cells 92 bivalents and 3–4 small univalents were observed.

Spores: The spore-size in our material was 19–24 μm , whereas 32–38 μm was reported by PANIGRAHI & DIXIT (1969) and PANT & KHARE (1971), who also describe the exine in their material as verrucate and the ornamentation of the area of contact as equal to that of the rest, whereas in our material the exine is chagrenate and the area of contact only faintly ornamented. These differences may be due to shrinkage of the spores in preservation.

The small inconsistencies between the observations of different authors mentioned above invite a comparative investigation of plant populations from different centres.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. J. K. Ladha and others for sending the living material of *Helminthostachys*. Thanks are also due to the Principal, Shri S. D. Misra, for laboratory facilities at the Botany Department, Government Science College, Gwalior.

The publication was made possible by a grant from the DPC-fund of the Royal Netherlands Botanical Society.

REFERENCES

BEDDOME, R. H. (1892): *A handbook to the ferns of British India, Ceylon and Malaya Peninsula*. Thacker, Spink & Co., Calcutta.

- BIERHORST, D. W. (1971): *Morphology of Vascular plants*. McMillan Co. New York; Collier McMillan Ltd. London.
- BOODLE, L. A. (1899): On some points in the anatomy of the Ophioglossaceae. *Ann. Bot.* **13**: 377–394.
- BOWER, F. O. (1926): *The ferns (Filicales)* Vol. I. *The Eusporangiatae and other relatively primitive ferns*. Cambridge University Press.
- (1935): *Primitive Land Plants*. McMillan & Co. London.
- EMES, A. J. (1936): *Morphology of vascular plants*. New York.
- FARMER, J. B. & W. G. FREEMAN (1899): On the structure and affinities of *Helminthostachys zeylanica*. *Ann. Bot.* **13**: 421–445.
- GWYNNE-VAUGHAN, D. T. (1902): On an unexplained point in the anatomy of *Helminthostachys zeylanica*. *Ann. Bot.* **16**: 170–172.
- KHANDELWAL, S. & H. K. GOSWAMI (1977a): Stomata in *Ophioglossum palmatum* L. *Curr. Sci.* **45** (2): 51–54.
- & — (1977b): Periderm in Ophioglossaceae. *Acta Soc. Bot. poloniae* **46**: 641–646.
- LANG, W. H. (1915): Studies in the morphology and anatomy of Ophioglossaceae III. On the anatomy and branching of the rhizome of *Helminthostachys zeylanica*. *Ann. Bot.* **29**: 1–54.
- MAHABALE, T. S. & L. N. NAIR (1972): Cytology of some species of the Ophioglossaceae in India. *Proc. Ind. Ac. Sci.* **55B**: 201–215.
- NINAN, C. A. (1958): Studies on the cytology and phylogeny of the Pteridophytes VI. Observations on the Ophioglossaceae. *Cytologia* **23**: 291–300.
- NISHIDA, M. (1956): Vascular behaviours in the phyllo-mophore of *Helminthostachys zeylanica* Hooker. *Bot. Mag. Tokyo* **69**: 76–83.
- OGURA, Y. (1938): *Anatomie der Vegetationsorgane der Pteridophyten*. Gebr. Borntraeger, Berlin.
- (1972): Comparative anatomy of vegetative organs of the Pteridophytes. In: *Encycl. Plant Anatomy* 7(3), Ed. W. ZIMMERMANN. Borntraeger, Berlin, Stuttgart.
- PANIGRAHI, G. & R. D. DIXIT (1969): Studies in Indian Pteridophytes IV. The family Ophioglossaceae in India. *Proc. Nat. Inst. Sci. India* **35B**(3): 230–266.
- PANT, D. D. & P. K. KHARE (1969): Epidermal structure and stomatal ontogeny in some eusporangiate ferns. *Ann. Bot.* **33**: 795–806.
- & — (1971): Notes on the spore morphology of Ophioglossaceae and the occurrence of *Ophioglossum* and its gametophyte in the Gangetic Valley. *Geophytology* **1**(1): 48–53.
- PETERSON, R. L. (1971): Introduction of a periderm-like tissue in excised roots of the fern *Ophioglossum petiolatum* Hook. *Ann. Bot.* **35**: 165–167.
- PRANTL, K. (1883): *Helminthostachys* und ihre Beziehung zu *Ophioglossum* und *Botrychium*. *Ber. Deutsch. Bot. Ges.* **1**: 155–161.
- SCOTT, O. H. (1923): *Studies in Fossil Botany*. 3rd Ed. London.
- SPORNE, K. R. (1970): *The Morphology of Pteridophytes*. Hutchinson & Co. Ltd. London.