

Sieve Elements in *Ophioglossum* Linn. (Eusporangiate Fern) from Rajasthan, India

B. D. Sharma

Kath Mandi, Narnaul-123001, India

*Corresponding author's e-mail: bdsharma14@yahoo.com

Manuscript received: 16 October 2017

Accepted for Publication: 4 May 2018

ABSTRACT

Ophioglossum (Adder's tongue) grows at several places during the rainy season in the Aravalli Hills, Chambal ravines, Harauti area and along the canals in Sri Ganganagar District and is represented by nine species. Vascular system has been studied both in cross and longisections. Tracheary elements including vessels (in *O. reticulatum* and *O. costatum*) have various kinds of secondary thickenings. Sieve elements are of different shapes and sizes bearing sieve plates (areas) on lateral walls, arranged in uni to biseriate manners. Young sieve elements have distinct dark coloured nuclei but with maturation the nuclei become thin and elongated and ultimately disappear. Photographs, illustrations and descriptions of the longisections of the phloem of *Ophioglossum* are not available in the literature and is provided for the first time in this contribution.

Key-words: Longisections, *Ophioglossum*, Sieve elements, Vascular system.

INTRODUCTION

In a broad sense the ferns are divided into Protoferns (fossils), Eusporangiatae and Leptosporangiatae (Gifford & Foster 1988). Eusporangiatae includes Ophioglossales and Marattiales. The former has three extant taxa (fossils rare) *Ophioglossum* Linn., *Botrychium* Swartz and *Helminthostachys* Kaulfuss. The genus *Ophioglossum* has approximately 14 species in India (Mahabale 1962; Panigrahi & Dixit 1969; Pant et al. 1993; Goswami 2007; Yadav & Goswami 2010) out of which nine species are found in Rajasthan (Sharma & Singh 1984; Sharma et al. 2007; Yadav & Goswami 2010). These are *O. reticulatum*, *O. petiolatum*, *O. nudicaule*, *O. vulgatum*, *O. gramineum*, *O. lusitanicum*, *O. polyphyllum*, *O. costatum* and *O. indicum*.

In India, Vashistha (1927) studied the anatomy of *O. aitchisonii* (= *O. polyphyllum*) and *O. vulgatum*. Maheshwari and Singh (1934) described the anatomy

of *O. fibrosum* (= *O. costatum*) in detail. Pant et al. (1993) studied tracheary elements of some of the members of Ophioglossales by maceration technique and reported the presence of vessel members in *O. reticulatum* and *O. costatum*. The present work confirms their findings. Anatomy of the *Ophioglossum* species of Rajasthan has been studied by Sharma & Singh (1984, 1986), Sharma & Vangani (1988) and Singh & Sharma (2008). Nair & Shah (1980) published an account of sieve elements of a number of ferns and photographed longisections showing sieve areas bearing sieve pores but not of *Ophioglossum*. Anatomy of ophioglossaceous taxa have been described by a number of earlier botanists like Bower (1907, 1911), Campbell (1911), Petry (1914), Nozu (1956) and others. Evert (1976, 1977, 1984) studied sieve elements of *Botrychium virgigianum* and paid more attention on the histo-chemistry of phloem. Earlier workers have not provided the photographs,

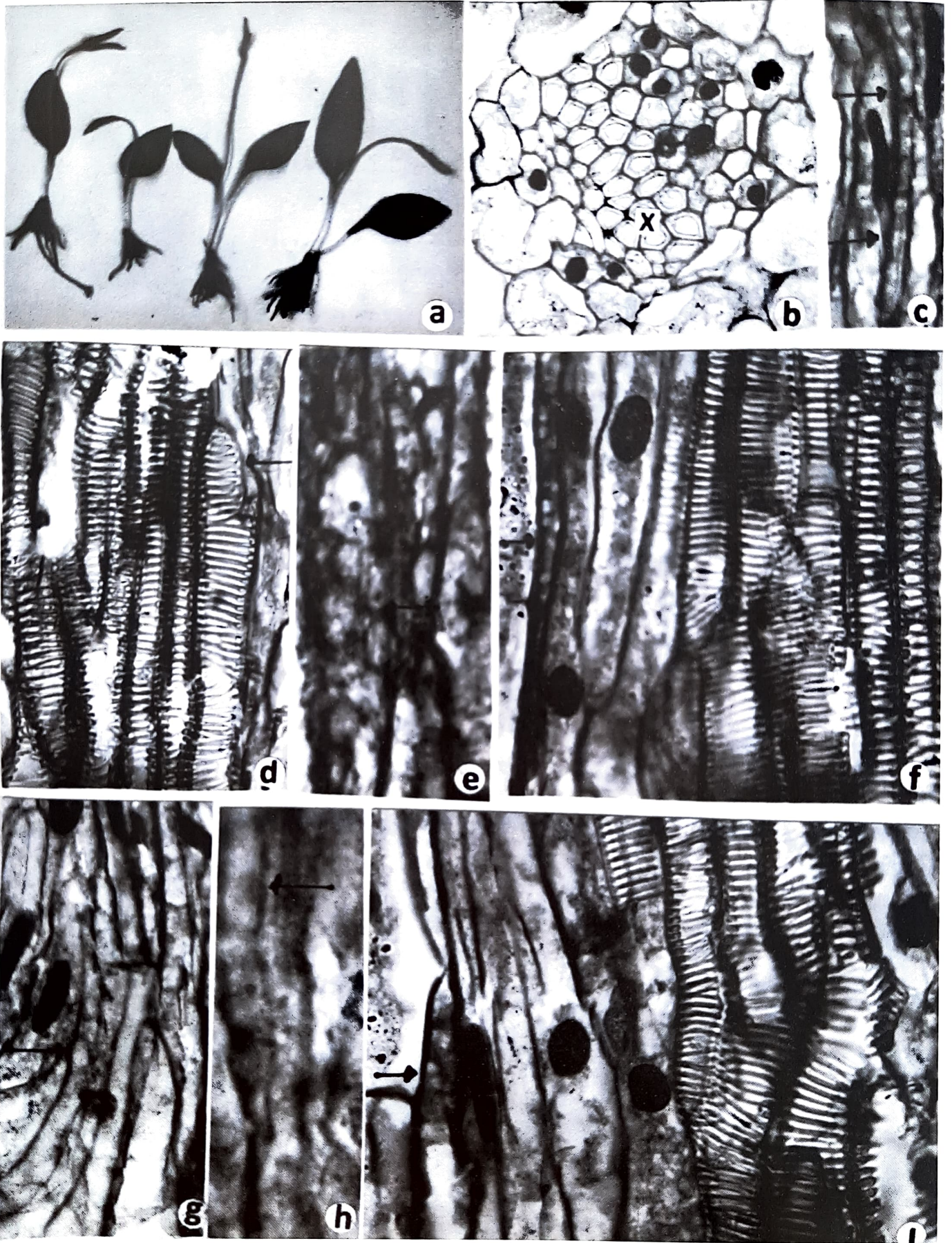
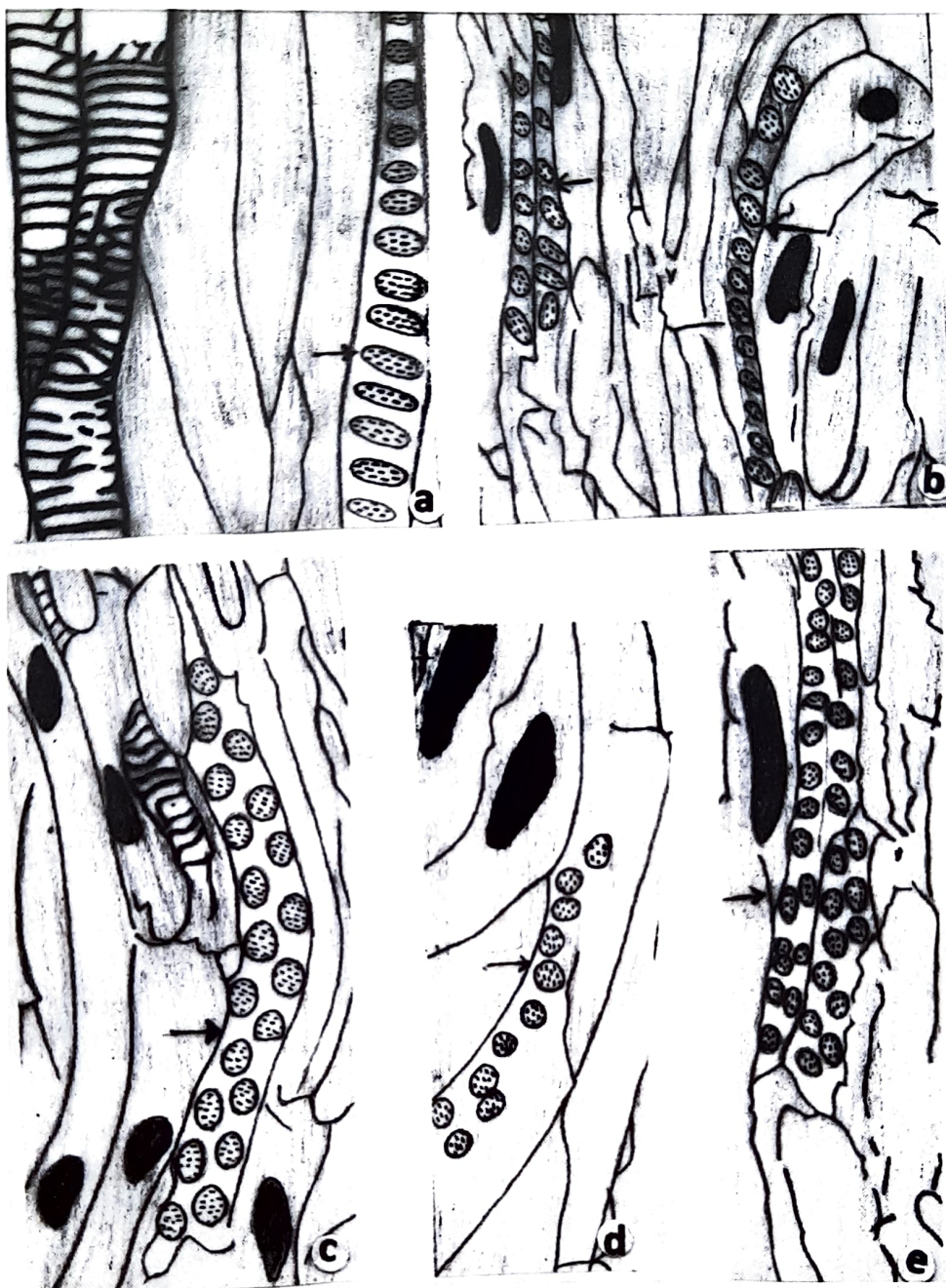


PLATE 1

a-i. Longisections sieve elements of *Ophioglossum* (c-i). **a.** Abnormal spikes of *O. petiolatum* from Nagpahar, Ajmer x 1; **b.** Cross section rhizome showing a bundle with xylem(x) on inner side and phloem (P) on outside. Dark coloured nuclei in phloem portion x 150; **d.** Tracheary elements with a vessel having oblique terminal pore bearing scalariform pits (arrow); **c, g.** Uniseriate sieve areas on sieve cells; **e, h.** Sieve cells with large sized sieve plates (arrow); **f, i.** Tracheary cells with large sized sieve plates (arrow) on sieve cells (c-i x 450).



Text-Figure 1. a-e. Longisection of sieve elements of *Ophioglossum*. **a.** Tracheary elements with reticulate, scalariform thickenings, sieve cell with uniseriate oval sieve plates each bearing many sieve pores; **b.** Narrow elongated dark coloured nuclei of sieve cells and sieve areas (arrow) on lateral walls of sieve elements; **c-e.** Biseriate sieve areas (arrow) on sieve cells and dark coloured distinct nuclei (All figures x 450).

illustrations and description of the longisections of the sieve elements of *Ophioglossum*. It is documented here probably for the first time.

MATERIALS AND METHODS

Materials of the seven species (excluding *O. lusitanicum* and *O. indicum*) found in Rajasthan were collected from different places during the rainy season (July to mid September). After proper washing, the materials were fixed in F.A.A. for 2 to 3 days and then

transferred to 70% alcohol. Microtomy of different organs rhizomes, petiole, trophyll and cone were cut and processed according to Johansen (1940). Staining was done by the combinations of Safranin and Haematoxylin and Safranin and Fast green. Canada balsam was used as mounting medium.

DESCRIPTION

Ophioglossum is a small herbaceous plant, predominantly terrestrial and annual (except *O.*

palmatum, *O. pendulum* and *O. simplex*, which are epiphytic (Sharma et al. 2007). Abnormal cones producing plants occur frequently in a population of *O. petiolatum* at Nagpahar, Ajmer (Plate 1). Rhizome is small, cylindrical or button shaped with VAM association in roots (Nair & Mahabale 1975, 1980; Harsh & Sharma 1995; Sharma & Tripathi 1999). Gametophytes also have association with endomycorrhiza (Pant et al. 1984).

Cross sections of rhizomes in all the seven species were studied. The ground tissue is parenchymatous i.e., no sclerenchyma. Vascular system is protostelic in young rhizome of *O. reticulatum* (Sen 1968; Sharma & Singh 1984), siphonostelic (*O. palmatum*) or an ectophloic dictyoxyllic stele that consists of different sizes of bundles e.g., *O. petiolatum*, *O. costatum* (Maheshwari & Singh 1934). The stellar portion travels upward, horizontal, divides and re-divides and fuses with one another. Origin of traces to roots and petioles make the vascular system further complicated. In the bundles, the xylem (x) portion is distinct and consists of angular thick walled tracheids (Plate 1b), while the phloem is on the outer side and consists of thin walled, angular sieve elements of different thickness (Plate 1b). Dark coloured nuclei are visible in the phloem portion of the bundle.

Longisection – Sen (1968) provided an illustration of the vascular skeleton of *O. reticulatum* and showed bifurcation and fusion of adjoining bundles. He commented that the vascular system of rhizome is cauline and the origin of pith is intrastelar. Sharma and Singh (1984) also supported the interpretation of Sen (1968). Tracheary elements have annular to pitted types of secondary thickenings (Text-Figures 1 a-c, 2 d, f and i). In vessels, the terminal pore is either oblique with scalariform pitting (Plate 1d) in *O. reticulatum* or a single, large circular aperture e.g. *O. costatum*.

Sieve elements – Phloem consists of sieve cells, which are either spindle shaped and narrow or wide cylindrical cells with tapering end walls (Text-Figures 1 a and b, Plate 1 f and i). Distinct dark coloured nuclei are visible in the phloem portion. The lateral walls of sieve cells have sieve plates or areas of different shapes, sizes and arrangements. The sieve areas are circular,

elliptical, oval or little irregular and arranged in one or two rows (Text-Figures 1a-e, Plate 1 c and i). In Text-Figures 1a-e, Plate 1 c and i, dark coloured circular to narrow elliptical nuclei are present in the sieve cells. In Text-Figures 1 a and b the sieve areas (arrow) are oval and uniseriate. Each sieve plate has many small sized sieve pores. In Text-Figures 1 c-e, 2. e, f, i, sieve areas are circular and biseriate, opposite or alternate. In mature sieve elements, sieve area (arrow) is crowded and of irregular shapes and in arrangement (Text-Figures 2. e, f and i).

CONCLUSION

It has been noticed that amongst the studied seven species of *Ophioglossum*, *O. gramineum* and *O. nudicaule* have the simplest and poorly developed phloem. Their sieve cells are long cylindrical and possess only uniseriate sieve plates. In *O. polyphyllum* and *O. costatum*, phloem is well developed and the sieve cells have biseriate, crowded sieve plates. Further investigations are required on the study of sieve elements of other species of *Ophioglossum*. This is a first attempt on some selected species of the genus.

ACKNOWLEDGEMENT

The author is thankful to all his students who helped in making collections of various species of *Ophioglossum* from different places in Rajasthan. Special thanks are also due to Dr. Ravindra Singh for preparation of slides and Dr. O.P. Suthar for making the drawings.

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