

STUDIES ON *ISOETES SAHYADRII* MAHABALE : II—MORPHOLOGY

A. R. RAO* AND TARA BAI PATANKAR**

*"Guru Charana", No. 2, XI Main Road, 3rd Block East, Jayanagar, Bangalore-560 011

**Department of Botany, Central College, Bangalore University, Bangalore-560 011

ABSTRACT

The morphology of *Isoetes sahyadrii* Mahabale has been described. Velum almost completely covers the sporangium except for a small semi-circular basal opening. The membranous wing-like expansions at the base of the leaf show marginal glandular cells. Megaspores are dimorphic.

INTRODUCTION

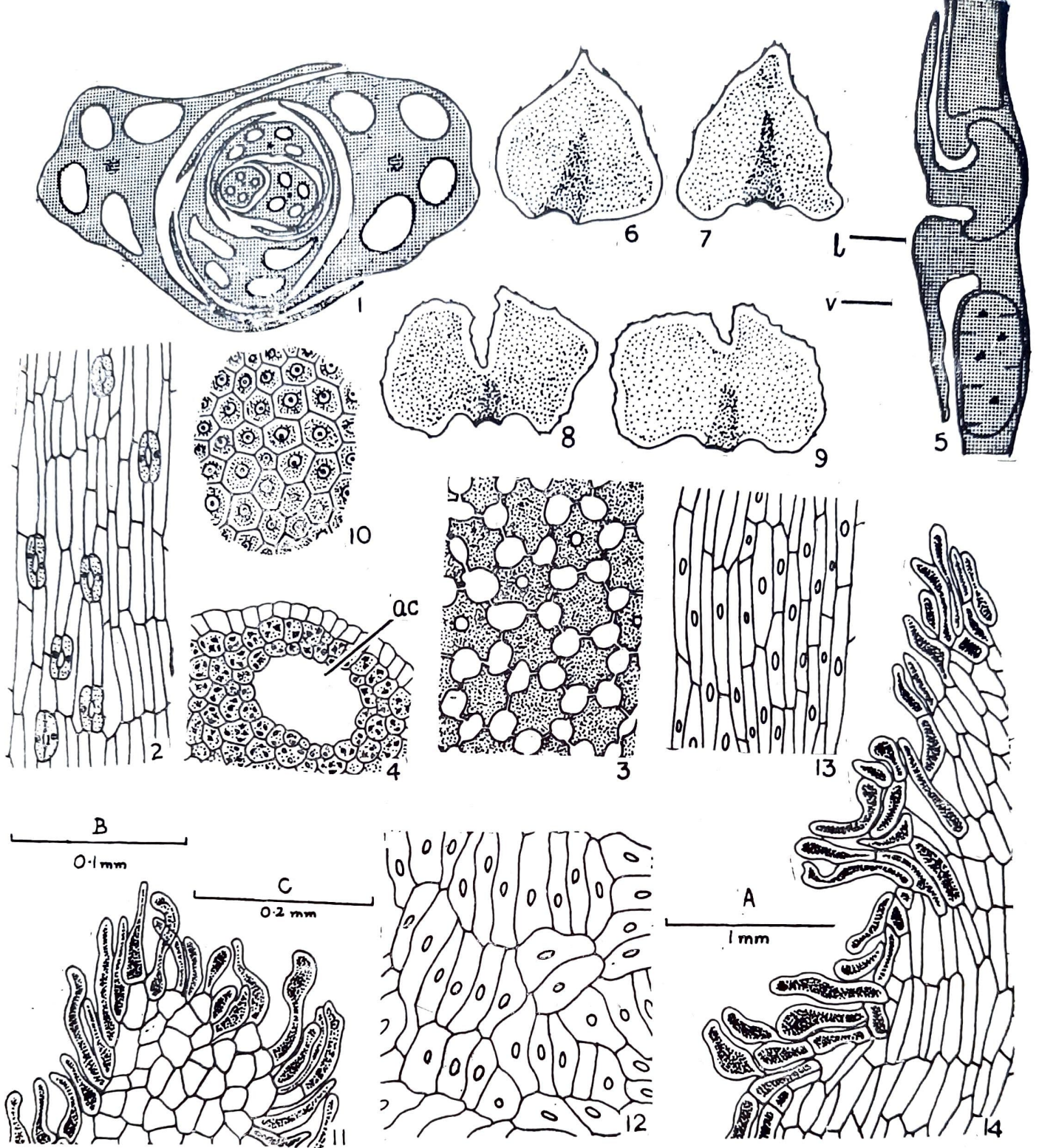
Genus *Isoetes* is represented in South India by three species. *I. coromandelina* L. has been investigated by several authors (EKAMBARAM & VENKATANATHAN, 1933 ; BHAMBIE, 1957, 1962, 1963 ; NINAN, 1958 ; PANT & SRIVASTAVA, 1962). SHARMA (1958, 1959, 1961) has made a detailed study of *I. sampathkumaranii* Rao. *I. sahyadrii* Mahabale was reported by MAHABALE (1938) from Kalhatgiri, Kemmangundi, Karnataka State. PANT AND SRIVASTAVA (1962) compared *I. dixitei* and *I. sahyadrii*. GOSWAMI AND ARYA (1970) have compared the megaspores of *I. sahyadrii* with those of other Indian species, but, unfortunately, information on the morphology of *I. sahyadrii* is not available. Hence, a detailed study of this species has been undertaken. Ontogeny of stomata is already described by RAO AND PATANKAR (1980). The present paper describes the morphology of this species.

MATERIAL AND METHODS

I. sahyadrii, an amphibious species, was collected from the ponds at Kalhatgiri, Kemmangundi Hills (1887m), and fixed in FAA. Plant parts were processed through the usual dehydration-infiltration-series and sectioned at 8-12 μ m. Sections were stained with iron-alum-haematoxylin. Free-hand-sections, epidermal peels and cleared whole-mounts were stained with one per cent aqueous safranin. Megaspore counts were made by releasing all spores from a sporangium in a watch glass. Spore descriptions are based on acetolysed preparations (ERDTMAN, 1956). Fresh spores were mounted in glycerine jelly. Spores were also treated with 45 per cent hydrofluoric acid.

OBSERVATIONS

Plants are 16 cm in height (Pl. 1, Fig. 1), the tri-lobed rhizomorph is short. Roots are borne on the region between the lobes of the rhizomorph. A root is branched, 4.5 cm long and 0.7 mm in diameter. About 8-15 leaves are spirally arranged on the rhizomorph (Text-fig. 1). A leaf is 10 cm long, cylindrical, ligulate, light-green, with a pointed tip. The non-chlorophyllous basal portion lodges a sporangium adaxially. The leaf here is extended into two wing-like membranous expansions. Epidermal cells are colourless, straight, thin-walled and longitudinally elongated. Stomata are confined to the upper 2/3 portion of the leaf. They are oriented in longitudinal rows (Text-fig. 2).



Text-figs. 1. T. S. of a plant above the axis. 2. Surface view of epidermis with rows of stomata. 3. Armed cells of the leaf diaphragm. 4. T. S. of a portion of a leaf showing the mesophyll. 5. V. S. of the base of the leaf showing glossopodium, ligule and velum. 6-9. Different forms of the ligule. 6. Cordate. 7. Triangular. 8. Bi-lobed. 9. Broad with a bifid tip. 10. Isodiametric cells in the central portion of the ligular lamina. 11. Peripheral portion of the ligular lamina showing finger-like processes. 12. Sporangial epidermis. 13. Cells of the membranous wing-like expansions above the base of the leaf. 14. Marginal cells of the wing-like expansions on either side of the sporangium showing blunt, finger-like, glandular cells: l—ligule; v—velum; ac—air chambers. Scale—A. Figs. 1, 5-9; B—Fig. 2, C—3-4, 10-14.

A stoma is $14 \times 8 \mu\text{m}$ with the pore $6 \times 3 \mu\text{m}$. Partially or completely degenerated stomata are common. They are indiscriminately mixed with healthy, functional stomata.

In a young leaf, air-chambers are absent and the mesophyllous cells are compactly arranged. The four air-chambers of an adult leaf are partitioned by transverse diaphragms. Cells of the diaphragm are armed with abundant intercellular spaces (Text-fig. 3). Mesophyll is undifferentiated and made up of thin-walled globular chlorophyllous cells (Text-fig. 4). BHAMBIE (1963) reported hair-like projections arising from the mesophyll tissue of *I. coromandelina*. These have not been observed in this species. Glossopodium in a vertical section appears crescent-shaped. Velum is a colourless, delicate membranous flap. It covers the sporangium almost completely, except for a small, semi-circular, basal opening (Text-fig. 5). Ligule is persistent. It is flat, several cells thick at the base and gradually thins out towards the periphery. A ligule may be cordate (Text-fig. 6), triangular (Text-fig. 7), bi-lobed (Text-fig. 8) or broad with a bifid tip (Text-fig. 9). Cells in the central portion of the ligular lamina are isodiametric with dense cell contents (Text-fig. 10). Surrounding this is a layer of irregularly arranged cells. Peripheral cells of the ligular lamina are elongated into blunt finger-like processes (Text-fig. 11).

All the leaves are potential sporophylls. Outer leaves have small non-functional sporangia, which contain small whitish aborted spores. Megasporangium is oval and $15 \times 10 \text{ mm}$ in size. Sporangial epidermis is delicate consisting of thin-walled, colourless cells (Text-fig. 12).

Basal portion of the leaf is extended into two wing-like membranous expansions. Marginal cells of these, a little above the sporangium, consist of thin-walled elongated cells (Text-fig. 13). But marginal cells of membranous, wing-like expansions on either side of the sporangium are produced into blunt, finger-like processes. These are glandular (Text-fig. 14).

A megasporangium contains 80-356 dimorphic megaspores (Pl. 1, Fig. 6). Both larger and smaller megaspores occur in the same sporangium but differ in their relative size, and external and internal structure. Larger megaspore is triangular and $330-380 \mu\text{m}$ in diameter. Triradiate ridge is sinuous. Laesura arm is $80 \mu\text{m}$ long and lips are $4 \mu\text{m}$ wide. Commisural ridge is straight. Spore wall is four-layered. Perispore and epispore on the distal surface are distinctly reticulate. The polygonal meshes (lumina) of the reticulum are bound by more-or-less even ridges, i.e. muri (Pl. 1, Figs. 2, 3, 5). Proximal surface is verrucose. Mesospore is finely granular. Endospore is round, thin and smooth. Smaller megaspore is $240-250 \mu\text{m}$ in diameter and triangular in shape. Triradiate ridge is straight, often bifurcated. Laesura arm measures $50 \mu\text{m}$ and lips are $3 \mu\text{m}$ wide. Commissural ridge is slightly sinuous. Distal and proximal surfaces of perispore and exospore are verrucose (Pl. 1, Fig. 4). Mesospore is thin and granulose. Endospore is absent. Joined spores are rare. Sterile cells are absent in the megasporangium. Mature megaspores are chalky-white when dry and brown when wet.

DISCUSSION

Plants of *I. sahyadrii* collected from Kemmangundi are all megasporangiate. Though the genus *Isoetes* is reported to be heterosporous, microspores are rarely observed. ABRAHAM AND NINAN (1958) and NINAN (1958) reported only one bisporangiate plant of *I. coromandelina* from South India. Microspores produced by this plant were non-

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functional. RAO (1944) and SHARMA (1949) did not observe microsporangia in *I. sampathkumaranii*. BHAMBIE (1951, 1963) reported only megasporangiate plants of *I. coromandelina* from Meerut. In the present species also, microsporangia have not been observed so far.

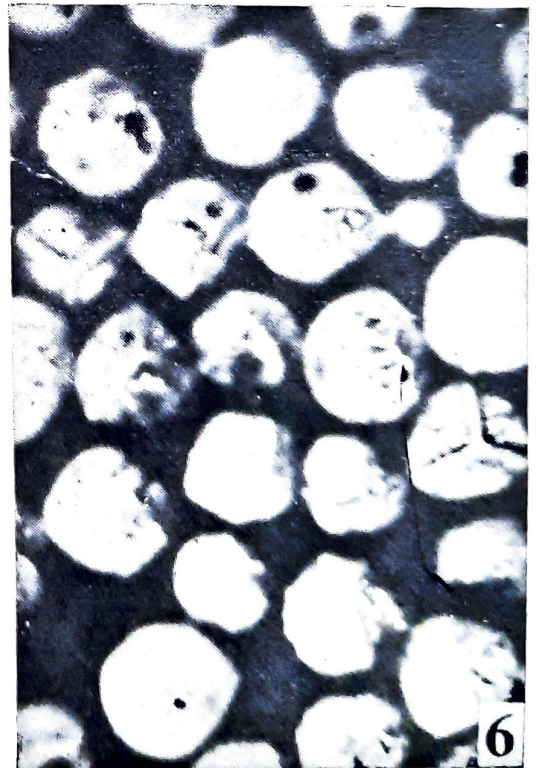
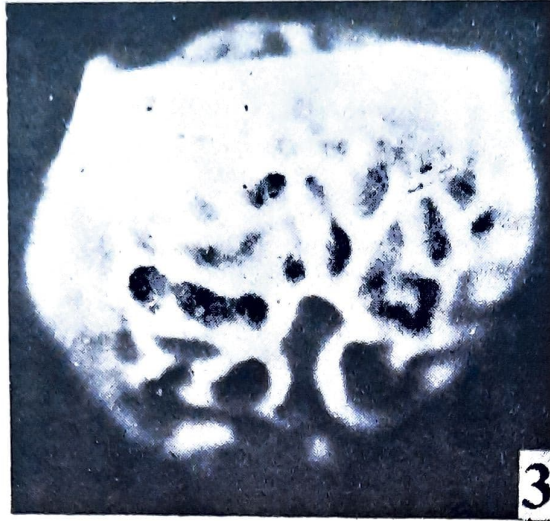
Rhizomorph of Indian species of *Isoetes* consists of 2, 3 and 4 lobes. *I. coromandelina* shows typically 3-lobed rhizomorph, often 4 or 5-lobed. Rhizomorph of *I. sampathkumaranii* is typically bilobed, rarely 3 or 4-lobed (SHARMA, 1958), *I. panchananii* has a bilobed rhizomorph. *I. sahyadrii* and *I. dixitei* have a three lobed rhizomorph although bilobed rhizomorph has also been reported in *I. sahyadrii*. *I. sahyadrii* resembles *I. coromandelina* and *I. panchananii* in its stomatal ontogeny. *I. sampathkumaranii*, *I. panchananii* and *I. sahyadrii* show relatively low frequency of stomata (PANT & SRIVASTAVA, 1962 ; RAO & PATANKAR, 1980). Peripheral strands reported in *I. coromandelina*, *I. dixitei* and *I. indica* have not been observed in *I. sahyadrii*. They are also absent in *I. sampathkumaranii* (SHARMA, 1958).

The velum in *I. sahyadrii* covers the sporangium except for a small semi-circular basal opening. A complete velum has also been reported in *I. hystrix*. According to SCOTT AND HILL (1900) presence of a complete velum is a characteristic of terrestrial species, but the present species, curiously enough, is amphibious. In *I. coromandelina* marginal cells of the velum are glandular (BHAMBIE, 1963 ; EKAMBARAM & VENKATANATHAN, 1933) ; in *I. sahyadrii* marginal cells of the membranous lateral wing-like expansions at the basal portion of the leaf show glandular cells.

Dimorphism of megaspores of *I. sahyadrii* was not reported by MAHABALE (1938), but PANT AND SRIVASTAVA (1962) have remarked (p. 255): "as in the case of the dimorphic megaspores of *I. coromandelina* it is possible that this character has remained unnoticed in *I. sahyadrii*." In the present work we have observed two types of megaspores occurring in the same sporangium. Larger megaspore of *I. sahyadrii* shows distinct reticulation on the distal surface. MAHABALE (1938) described the megaspores as tuberculate. PANT AND SRIVASTAVA (1962) have also included *I. sahyadrii* in the Tuberculatae of PFEIFFER (1922). According to them (p. 245): "*I. panchananii* falls under the section Reticulatae. Strictly speaking, no other Indian species could be referred to this section of the genus". However, we observed that the larger megaspores of *I. sahyadrii* have reticulate pattern on the distal surface; therefore, we are inclined to refer this species to the Reticulatae of PFEIFFER (1922).

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EXPLANATION OF PLATE I

1. Plant of *I. sahyadrii* Mahabale.
2. Proximal surface of larger megaspore showing verrucate pattern.
3. Distal surface of larger megaspore showing reticulate pattern.
4. Proximal surface of smaller megaspore showing verrucate pattern.
5. Proximal and distal surfaces of larger megaspores.
6. Larger and smaller megaspores from a sporangium.