

## ISOETES IN RAJASTHAN—A SYSTEMATIC STUDY

B. D. SHARMA, R. SINGH AND M. S. VYAS

*Department of Botany, University of Jodhpur, Jodhpur*

## ABSTRACT

On the basis of the study of anatomy and morphology of spores, the systematics of the three species of *Isoetes* found in Rajasthan is discussed. *I. tuberculata* Gena & Bhardwaja is not distinct from *I. coromandelina* L. f. Similarly *I. rajasthanensis* Gena & Bhardwaja and *I. reticulata* Gena & Bhardwaja are not based on satisfactory and complete descriptions.

## INTRODUCTION

The taxonomy of *Isoetes* is a ticklish problem as the spores both, mega and microspores show wide variations in shape, size and nature even in the same sporangium. Similarly, the number of lobes in a rhizomorph may increase with the age of the plant, as in *I. coromandelina* Linn. f. described in this paper. In bigger sized plants the velum is absent e.g. *I. coromandelina* L. f., *I. unicularis* Smith (Panigrahi, Biol. Mem. 6 : 129-138, for *I. indica* Pant and Srivastava, Proc. nat. Inst. Sci. India 29 B : 242-280, 1962), *I. pantii* Goswami and Arya (Journ. Indian Bot. Soc. 49 : 32-37) and its place is taken by the upper labium. But the size of the velum is not related with reduction in the length of the sporophyll e.g. in *I. sahyadriensis* Mahabale (Curr. Sci. 7 : 62-63, 1938) the velum is almost complete while in *I. dixitii* Shende (Journ. Univ. Bombay 14B : 50-52, 1945) it is rudimentary. Sharma and Singh (1984) suggested that the structure of glossopodium might be a tool in the taxonomy of *Isoetes*. It is complicated and elaborate in large sized plants of *I. coromandelina* L. f. and becomes simpler in *I. reticulata* Gena and Bhardwaja (Journ. Bombay nat. Hist. Soc.

81 : 165-168, 1954) which hardly exceeds 10 cm in length.

The history of *Isoetes* in Rajasthan is not very old. Mital (1969) reported its occurrence for the first time from Mt. Abu. However, during the past decade, in addition to its collections from a number of places in the state e.g. Atru, Dausa, Jhalawar, Bharatpur, Salpura, Bhanwargarh (Gena *et al.*, 1976 ; Misra and Bhardwaja, 1978 ; Gena and Bhardwaja, 1984), many papers have been published on anatomy (Sharma and Bohra, 1978 ; Sharma *et al.*, 1980 ; Singh, *et al.*, 1982) morphology of ligule (Sharma and Singh, 1984) and study of spores (Bohra *et al.*, 1980 ; Singh *et al.*, 1983). Gena and Bhardwaja (1984) have described three new species of *Isoetes* from Rajasthan i. e. *I. rajasthanensis* (from Mt. Abu), *I. reticulata* (from Atru—small sized plants) and *I. tuberculata* (from Atru—bigger sized plants, and also from Dausa, Jhalawar and Bharatpur, etc.). This material was identified earlier by Sharma and Bohra (1978), Singh *et al.* (1982, 1983) as *I. coromandelina* L. f.

In the present paper on the basis of the study of anatomy and morphology of spores the systematics of the different species of *Isoetes* found in Rajasthan is discussed.

The material has been collected from

Dausa, Atru, Jhalawar, Bharatpur and Mt. Abu. Microtome sections were cut of different plant parts and stained with safranin and Haemotoxylin (Johansen, 1940). Spores taken out by bursting were studied by mounting in water.

1. *Isoetes coromandelina* L. f. Suppl. Pl. Syst. Veg. ed. 13 : 447, 1782 ; Panigrahi, Bio-Mem. 6 (2) : 131, Plate 1, figs. 1, 2. 1981.  
Synonym : *I. tuberculata* Gena and Bhardwaja, Journ Bombay nat. Hist. Soc. 81 : 165-168. 1984.

The material was collected from Dausa, Atru, Jhalawar and Bharatpur. Plants 30-60 cm or more tall (Fig. 1), rhizomorph 2-4 lobed (Figs. 4, 4a, 5), 15-35 leaves are produced per plant. Sporangium oval to circular, 0.9 to 1.4 cm in diameter. The velum is absent. Upper labium present, 1.5 to 1.8 mm in length, and covers the ligule. The ligule is 3.6 to 5.00 mm long with a complicated, well developed glossopodium.

Stele anchor shaped. The meristem cut off secondary cortex with starch grains in its cells ; while the prismatic tissue is differentiated into secondary xylem, sieve elements and the parenchyma (Fig. 7), 2-3 successive rings of secondary xylem could be seen in an old rhizomorph of this species (Fig. 6). Transfusion tissue make a distinct zone surrounding the glossopodium (Sharma *et al.*, 1980).

Generally the plants possess megasporophylla and microsporangia are rare (Fig. 9). However, some abnormal sporophylls i.e. bisporangiate sporophylls and mixed sporangia (Fig. 8) i.e. mega and microspores in a common sporangium have also been reported in this species. Megaspores show wide variations in shape and size (Figs. 10, 11) ranging from 330 to 560  $\mu$ m in diameter. The distal face has numerous tubercles (Fig. 12) while the each proximal face has one large tubercle (Fig. 13). Sterile cells occur frequently in megasporangia on all

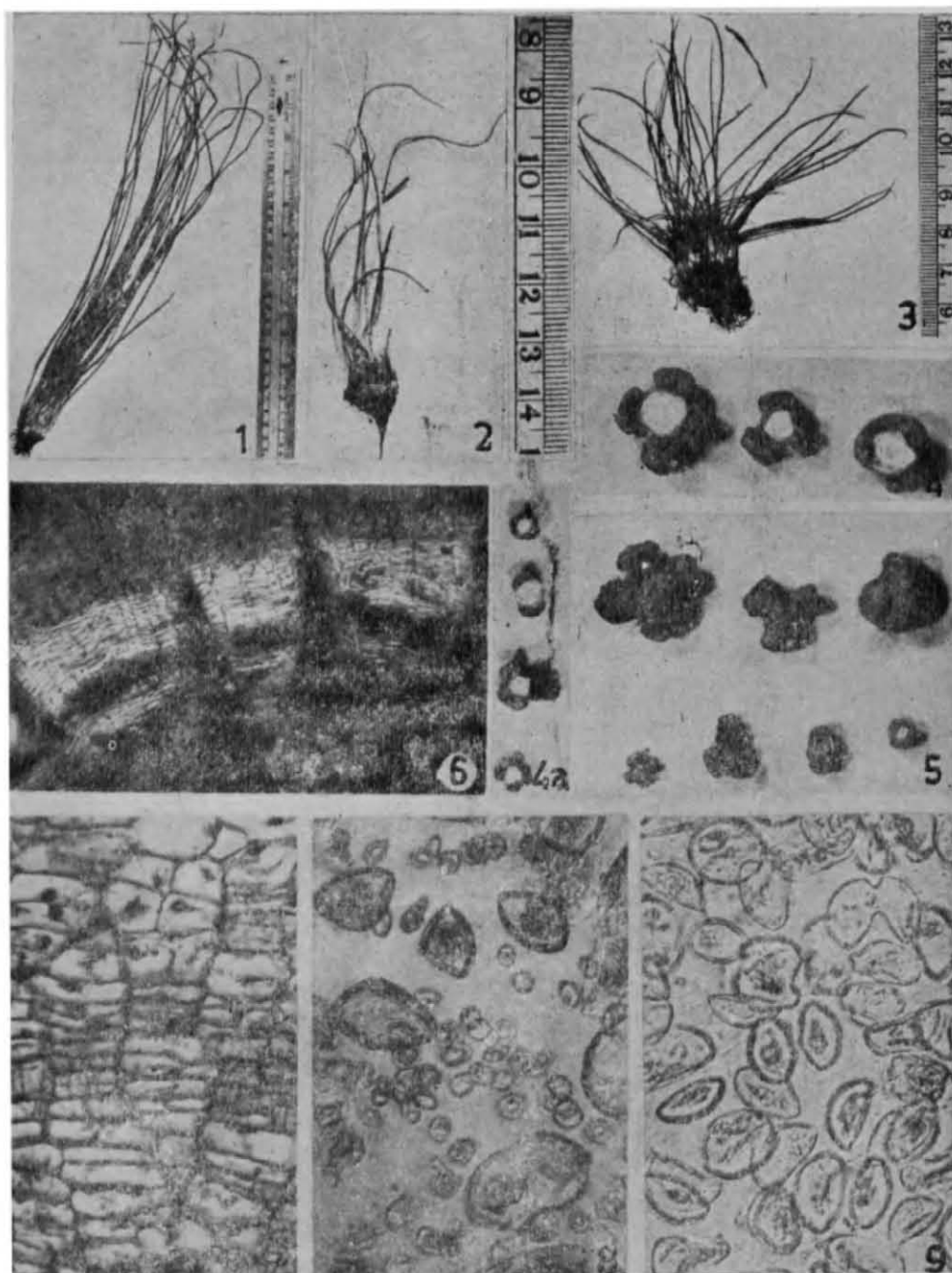
the sporophylls (Figs. 10, 10a, 11, 14, 17, 18) although Pant and Srivastava (1962) stated that sterile cells are absent in the outer megasporangium. These are circular, elliptical, non-nucleated or jointed spores.

Gena and Bhardwaja (1984) distinguished the new species *I. tuberculata* Gena and Bhardwaja from *I. coromandelina* L. f. on the basis that in the former the plants are smaller in size, glandular hairs are present on ligule margins, megaspores and microspores show more variations than known in the latter. However, the mature plants collected from Dausa generally exceed 60 cm in length and glandular hairs occur on the ligule in majority of the species of *Isoetes* as, secretory function has been assigned to this structure (Sharma and Singh, 1984). Megaspores show wide variations in size and morphology and have tuberculate exine. Thus *I. tuberculata* Gena and Bhardwaja (1984) is not different from *I. coromandelina* L. f.

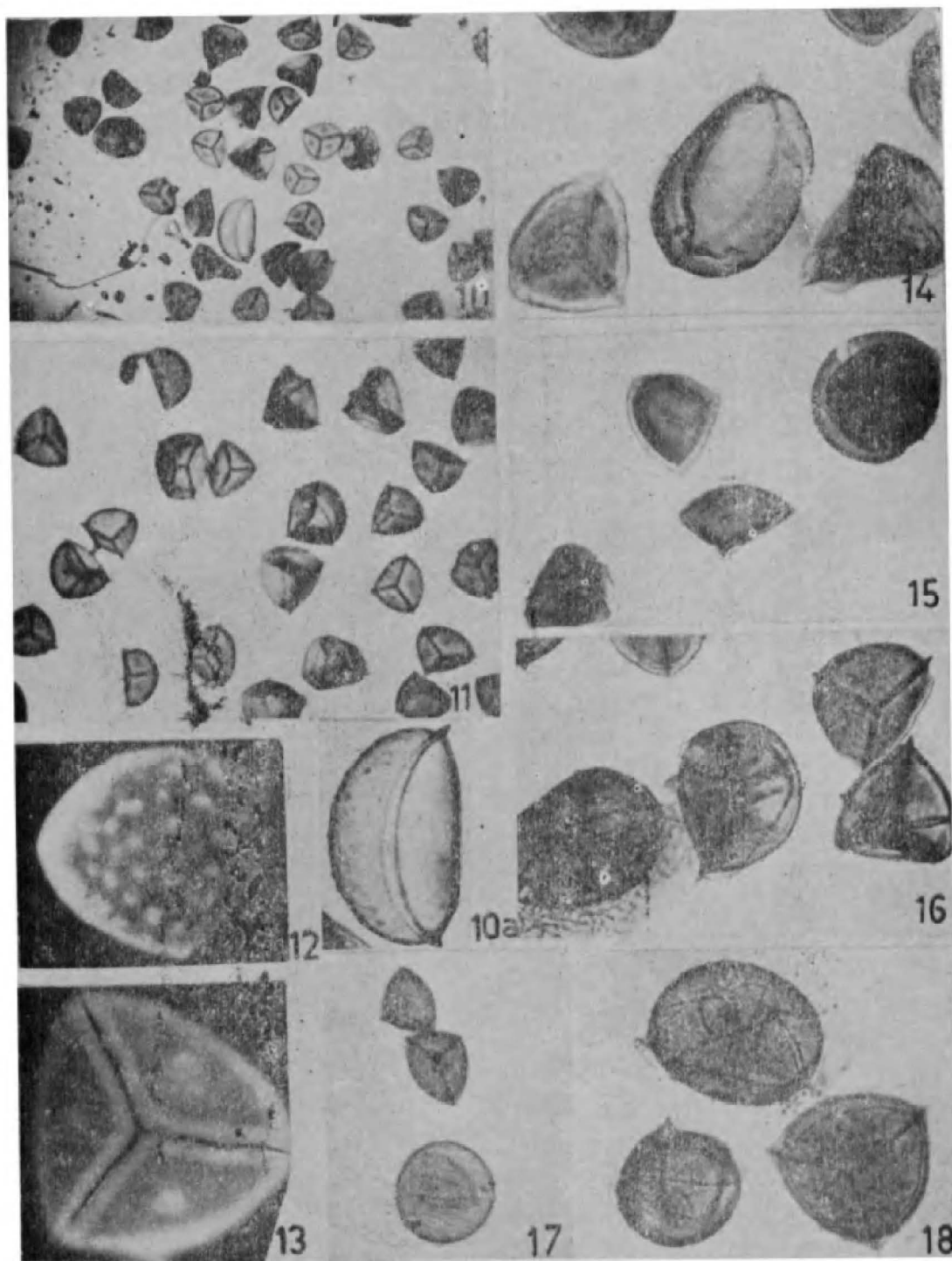
2. *I. rajasthanensis* Gena and Bhardwaja, Journ. Bombay nat. Hist. Soc. 81 : 165-168, 1984.

The material was collected from Mt. Abu. Plants 5-16 cm tall (Fig. 3), rhizomorph 2-3 lobed, 6-20 acicular leaves are produced per plant. Sporangium oval 3  $\times$  4.5 to 5  $\times$  6.5 mm, velum covers one-third adaxial portion of the sporangium. Ligule small, 2.1-2.4 mm in length with a well developed glossopodium (Sharma and Singh, 1984).

Stele anchor shaped, vertical column gives rise leaf traces, while the horizontal arms produce traces to roots. Lateral and basal meristems cut off secondary cortex on the outer side and prismatic tissue towards inner side. The latter is differentiated into sieve elements and parenchyma cells. Few transfusion cells could be seen adjacent to the glossopodium. Majority of the sporangia produce megaspores. Microspores are rare. Megaspores are trilete, 300 to 350  $\mu$ m



Figs. 1-9 : 1. *Isoetes coromandelina* morphology of a plant. 2. *I. reticulata*. 3. *I. rajasthanensis*. 4-6. *I. coromandelina* Rhizomorphs of different sizes and lobes (4-4a. apical view, 5. basal view)  $\times 1$ . 6. Same C. S. rhizomorph with successive rings of secondary xylem (black), and secondary phloem (white). Leaf traces originating from primary xylem are also seen  $\times 36$ . 7. Same enlargement of meristematic cells and secondary tissue  $\times 36$ . 8. Same mixed sporangium with micro, mega and sterile spores  $\times 36$ . 9. Same microsporangium with microspores and sterile spores  $\times 150$ .



Figs. 10-18 : 10. *Isoetes coromandelina*—megasporangium with different types of megaspores and sterile spores  $\times 20$ . 10a. A sterile cell enlarged  $\times 60$ . 11. Same jointed megaspores are also seen  $\times 30$ . 12. Same distal tuberculate face of a megaspore  $\times 80$ . 13. Same proximal face with triradiate mark and each face with one large tubercle  $\times 120$ . 14. Same sterile spores and megaspores  $\times 60$ . 15, 16. *I. rajasthanensis*. Triradiate megaspores and circular sterile spores  $\times 60$ . 17, 18. *I. coromandelina*. Triradiate megaspores and sterile spores  $\times 30, 60$ .

in diameter (Figs. 15, 16) with spinulose exine. The rays exceed the size of spore. Sterile, enucleated spores (Figs. 15, 16) and jointed spores are also found in megasporangia. Microspores monolete,  $20 \times 36$  to  $30 \times 50 \mu\text{m}$  in size with smooth exine. Sterile cells occur frequently (Bohra *et al.*, 1980).

**3. *Isoetes reticulata*** Gena and Bhardwaja, Journ. Bombay nat. Hist. Soc. 81 : 165-168, 1984.

The material was collected from Atru. Plants 4-9 cm in length (Fig. 2), rhizomorph 2-3 lobed, and 6-16 leaves are produced per plant. Sporangium oval-circular, 2.5 to 3.5 mm in diameter and the velum covers 2/3 portion of the sporangium. The legule is small, 0.9-1.4 mm in length with a comparatively simpler glossopodium.

The stele looks as in *I. rajasthanensis*. However, the distinction between the primary (old) and newly produced secondary cortex is quite sharp. The former is devoid of starch while in the latter the cells are full of starch grains. Transfusion cells are not seen surrounding the glossopodium.

Only megasporangia are known and microsporangia are yet to be discovered in this species. Megaspores are trilete, 160-200  $\mu\text{m}$  in diameter, and with reticulate thickenings on distal face and many small tubercles on the proximal face. Sterile, enucleated spores also occur in the megasporangia.

*I. rajasthanensis* Gena and Bhardwaja and *I. reticulata* Gena and Bhardwaja are not based on satisfactory and complete descriptions for example, simply suggesting megaspores 'Trimorphic' does not give a clear picture. Morphology of the three different kinds of spores should have been included. The photographs of spores

given, do not help in understanding the differences between the three new species (*I. tuberculata*, *I. rajasthanensis* and *I. reticulata*). Gena and Bhardwaja have shown the absence of sterile cells in all the three species of *Isoetes* from Rajasthan. On the other hand, Bohra *et al.* (1980), Singh *et al.* (1983) and in the present paper occurrence of sterile cells/spores is clearly shown in both mega and microsporangia. However, cytological studies are needed to confirm the validity of the three new species of *Isoetes* described from Rajasthan.

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