A NEW SPECIES OF *ISOETES* FROM NARSINGHGARH, MADHYA PRADESH

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During our collections of different genera and species of pteridophytes from Narsinghgarh (unpublished data) we have come across plants of *Isoetes* which differ from all the six species so far recorded from India (*see* Pant and Srivastava, 1962, 1965). In addition, these plants are unique in having a tilted rhizomorph and in showing a regular occurrence of large megaspore-like structures towards the ligular end of its microsporangia (Goswami and Arya, 1968; occasional occurrence of different sizes of spores is already recorded in *Isoetes* by Smith, 1900). Therefore these plants are being assigned to a new species which is described hereunder:

***Isoetes pantii* sp. nov.**

Rhizomorpha typtce inclinata, 3-loba, 2 lobis tertio maioribus. Folia 15–39, singula 15–33 cm longa, viridia, gracilia, alata ad basin gradatim vel subito evadentia angularia ad medium, desinentia in apicem cylindricum attenatum, expansa ad basin, complanata, marginibus membranaceis. Ligula triangularis, latior quam longa, 2–3-cellulis crassa ad basin, subito desinens in margines crassos unicellulares monstrantes cellulas epidermales longas, immersas in substantiam mucosam. Velum nullum. Megasporangium cinereum exoblongo elongatum, 3–7 mm longum, 2–4 mm latum. Sporophylla exteriora possident sporangia circularia. Microsporangia ex ovato oblonga, 5–9 mm longa, vulgo in septimo vel superiore verticillo sporophyllorum. Megasporae trimorphae; megasporae triplicis sortis inveniuntur in uno eodemque sporangio, sed diversae magnitudine, structura interna et externa. Magasporae maiores 480–600 diam. (512 μ mediet. e 100), 4-seriatae, superficie distali perisporii pulchre granulosa, ornata tuberculis pluribus rotundis adjacentibus, quorum bases saepe junguntur; exosporium crassum, tumescentiis minutis ornatum operientibus trientem tuberculi perisporialis; mesosporium pulchre granulare, fortiter axosporio fixum; endosporium leve, gracile, et triradiatum cristis rectis, numquam furcatis (sporis haud normalibus exceptis). Cristae commissurales etiam rectae. Una area pyramidalis continet plus quam 5 tuberculos. Megasporae mediae 280–312 μ diam. (294 μ mediet, e 100), 4-seriatae, superficie distali perisporii pulchre granulosa, ornata

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pluribus tuberculis basi rotundae insidentibus, saepe confluentibus, multo propioribus quam in magaspora maiore; superficies tuberculi pulchre granularis; exosporium, crassum, sed leve, tumescentiis non-monstratis. Mesosporium et endosporium eis in sporis maioribus similia; cristae triradiatae rectae, raro undulatae, marginibus rectis vel undulatis, marginibus divisis valde raris; 5 vel plures tuberculi in area pyramydali. Megasporae minores 70–110 μ (87·5 μ mediet e 100), 3-seriatae. Perisporium granulare, distinctum tantum prope cristas commisuriales; episporium tuberculatum; mesosporium crassum endosporium non visum; cristae triradiatae vulgo sinuosae; tuberculi in superficie distali plures, vulgo minores; superficies proximales sporarum monstrant tuberculos numero minore quam 5, si 1–3 tunc hi sunt magni et fere centraliter positi. Microsporae trimorphae, sporae triplicis sortis in uno eodemque sporangio sed diversae magnitudinis et structurae internae et externae, siccae albae, cinereae cum madidae. Microsporae maiores typice rotundae 24–54 μ diam. (32·5 μ mediet e 100) 4-seriatae. Perisporium 2-seriatum (fibrosum), uniformiter distributum; exosporium hyalinum et crassum; mesosporium crassum, chitinosum, uniforme, pulchre spinulosum in sectione transversa, in superficie distali sed vulgo leve versus apicem proximalem; endosporium uniformiter tenue, hyalinum et leve. Microsporae mediae bilaterales, monoletae, 24 μ latae, 48 μ longae (mediet. e 100). Perisporium uniseriatum, efformans laciniae instar projection—em ad medium, latius ad superficem distalem; exosporium hyalinum et crassius in superficie distali; mesosporium crassum et chitinosum, endosporio nullo. Sporae unitae raro visae. Microsporae, minutae 15–39 μ (26·2 μ mediet. e 100), triletae, tumescentiis papillosis ornatae; perisporium uniseriatum (fibrosum), latius ad superficiem distalem; exosporium hyalinum,, incrassatum in superficie distali; mesosporium crassum et chitinosum; endosporium nullum.

Praeter tres sortes microsporarum, corpora magna tuberculata triradiatim cristata (ad 200 μ) megasporis similia constanter inveniuntur in microsporangiis versus ligulam.

***Isoetes pantii* sp. nov.**

Diagnosis.— Rhizomorph.—Typically tilted, 3-lobed, 2 lobes larger than third. *Leaves*: 15 to 39, 15 to 33 cm long, green, slender, limb winged at the base, gradually or abruptly becoming broadly angular in middle, ending in attenuating cylindrical apex; base expanded, flattened showing membraneous margins. *Ligule*: Broader than longer, 2–3-celled thick at the base, abruptly ending; one celled thick margins showing long epidermal cells, glandular cell embedded in a mucilaginous substance. *Velum* absent.

Megasporangia.—Ash-coloured showing varying shapes from circular to oblong elongate, 3–7 mm long, 2–4 mm broad. Outer sporophylls have circular sporangia. *Microsporangia* ovate to oblong, 5–9 mm long, generally found in 7th or later whorls of sporophylls.

TABLE

Comparison of megaspores of velumless

Name of the plant	Colour	Sterile cells	Surface	Type	Size (μ)
I. coromandelina	White when dry, grey when wet	Absent	Tuberculate (short blunt and rounded)	Dimorphic (*a*) Large	466-660
				(*b*) Small	356-458
I. indica Pant and Srivastava	White when dry, grey when wet	Present	Tuberculate, more or less uniform in size, tubercles larger and gradually tapering	Polymorphic (*a*) Large	458-636
				(*b*) Medium	407-509
				(*c*) Small	89-380
I. dixitei Shrends	White when dry, ash-coloured when wet	Present	Tuberculate	Dimorphic (*a*) Large	483-660
				(*b*) Small	320-458
I. sahyadriensis Mahabale	Creamy when dry, dark brown when wet	Absent	Tuberculate	One type	325-430
I. pantii n. sp.	White when dry, ash-coloured when wet	Absent	Tuberculate, large and small intermixed, tubercles rounded	Polymorphic *Large*	(*a*) 480-600
				Medium	(*b*) 280-312
				Small	(*c*) 70-110

Indian species of Isoetes

No.	Wall layers perispore and exospore	Ridges				No. of tubercles on a pyramidal area
		Mesospore	Endospore	Triradiate	Commissural	
4	Tubercles having rounded ends	Thin granulose attached to exospore	Thin, translucent and smooth	Straight and simple	Straight	Too many
3	Numerous tubercles on distal surface with rounded ends	Granular, 2 μ thick	Absent or inseparable	Straight and simple	Straight	One
4	Tubercles tapering with pointed ends	Thin, finely granulose attached to exospore	Round, thin, translucent and smooth	Sinuous, often bifurcated	Sinuous	Many
3	Proximal surfaces showing mostly pointed tubercles	Rounded, triangular, thin and granulose	Inseparable	Sinuous, often bifurcated		One
3	Distal surface shows one or more tubercles	Thin, granulose	None	Sinuous		
4	Show uneven tubercles on both sides	Thin, reticulately pitted and adherent to the exospore	Round, thin, translucent and smooth	Straight	Straight	
3	Tuberculate showing tubercles uneven	Granular	Absent	Sinuous	Straight	

Description not available

4	Granular; tuberculate	Thick chitinous, thickest below the tubercle (mamillate)	Transparent	Straight	Straight	More than five
4	Grannular, tuberculate	Thick chitinous and smooth	Transparent	Straight	Rarely sinuous	More than five
3	Granular, distinct near the commissural ridges only; tuberculate	Thick, chitinous	Absent	Generally sinuous	Rarely sinuous	Generally less than five, when 1–3, they are large and almost centrally placed on a pyramidal area

Megaspores.—Trimorphic (3 types of megaspores occurring inside the same sporangium and differing in size and external and internal structures). Larger megaspores are 480-600 μ in diameter (512 μ average of 100). 4-layered distal surface of perispore finely granulose, bearing numerous close rounded tubercles, bases of which often joined; exospore thick showing minute protuberance traversing one-third of tubercle of perispore; mesospore finely granular, firmly attached to the exospore on proximal side and free elsewhere, endospore smooth, thin, Triradiate ridges straight, never bifurcated. Commissural ridges also straight. One pyramidal area contains more than 5 tubercles. The medium-sized megaspores are 280–312 μ in diameter (294 μ average of 100) 4 distal surface of perispore finely granulose, bearing numerous close tubercles of rounded base, often confluent, much closer than those in the large megaspores, surface of the tubercle finely granular: exospore thick but smooth not showing protuberances, mesospore and endospore similar to that of large spores. Triradiate ridges straight, rarely wavy, margins straight or undulating divided margins extremely rare; 5 or more tubercles on a pyramidal area. The smaller megaspores are 70–110 μ (87·5 μ average of 100). 3-layered. Perispore granular distinct near commissural ridges only; exospore tuberculate; mesospore thick, endospore not seen. Triradiate ridges generally sinuous; tubercles on distal surface, many, generally smaller; proximal surfaces of spores showing less than 5 tubercles. When 1–3 they are large and almost centrally placed.

Microspores.—Trimorphic, 3 types occurring inside same sporangium and differing in size and in external and internal structures. White when dry, ash-coloured when wet. The large microspores are characteristically round, 24–54 μ in diameter (32·5 μ average of 100), 4-layered. Perispore double-layered (fibrillar), distributed uniformly; exospore hyaline and thick; mesospore thick, chitinous, uniform, finely spinulose in transverse section, on the distal surface but generally smooth towards the proximal end; endospore uniformly thin, hyaline and smooth. The medium microspores are bilateral, monolete 24 μ broad and 48 μ long (average of 100). Perispore one-layered forming a flap-like projection at the centre, wider on the distal surface; exospore, hyaline and thicker on the distal surface; mesospore thick and chitinous, endospore none. Joined spored are rarely seen. The small microspores are 15–39 μ (26·2 μ average of 100), trilete having papillate protuberance; perispore one-layered (fibrillar); wider on the distal surface, exospore hyaline; thickened on the distal surface; mesospore thick and chitinous; endospore none.

Beside three types of microspores large tuberculate triradiately ridged bodies (upto 200 μ) resembling megaspores are constantly found inside the microsporangia towards the ligular side.

Occurrence.—Narsinghgarh, Rajgarh, Madhya Pradesh (India) Plants grow along the margin of a pond intermixed with *I. coromandelina* and *I. sampathkumaranii. Rao. Holotype* (GA: I A) deposited

in Herbarium, Pteridophyte Section, British Museum Natural History, London, *Isotypes* (GA: IB–E) deposited in Herbarium, Botany Department, Allahabad University; Herbarium Research Institute, Dehra Dun; Herbarium, Botany Department, Government Degree College, Narsinghgarh and Herbarium, Botany Department, Government Science College, Gwalior.

Description and Comparison

The plants of *Isoetes pantii* sp. nov. (Fig. 1) seem to be more robust (15–33 cms high) than *I. indica* and *I. panchanannii* Pant and Srivastava but smaller than *I. coromandelina* L. On comparison with other velumless Indian species (Table I), we find that *I. pantii* resembles *I. coromandelina* in having rounded tubercles on its megaspores but differs from it in other details; it resembles *I. indica*, *e.g.*, in showing a three-lobed rhizomorph, elongate sporangia, and white microspores (ash-coloured when wet). This species, however, differs from *I. indica* also in a number of features, *e.g.*, tilted rhizomorph (observed in 82% plants), colour of megaspores white when dry, ash-coloured when wet, size ranges of trimorphic megaspores, and nature of tubercles (always round, Figs. 2, 3, 4 and 5). The triradiate rays of large megaspores of *I. dixitei*, *I. panchanannii*, *I. indica* and I. *pantii* are straight while those of smaller megaspores are sinuous (Figs. 4 and 5). However, unlike megaspores of *I. pantii*, triradiate ridges of *I. indica* are often bifurcated and commissural ridges sinuous (*see* Pant and Srivastava, 1962, Pl. XIV, Figs. 18, 19; Text-Fig. 6 D, E). Also the presence of occasional multicellular hair-like outgrowths in the trabaculae, and quadrangular megaspores characteristic of sporangia of *I. indica* are not recorded in this species. *I. dixitei* resembles in colour of spores but differs in having dimorphic megaspores, uneven tubercles and texture of spore layers (Table I).

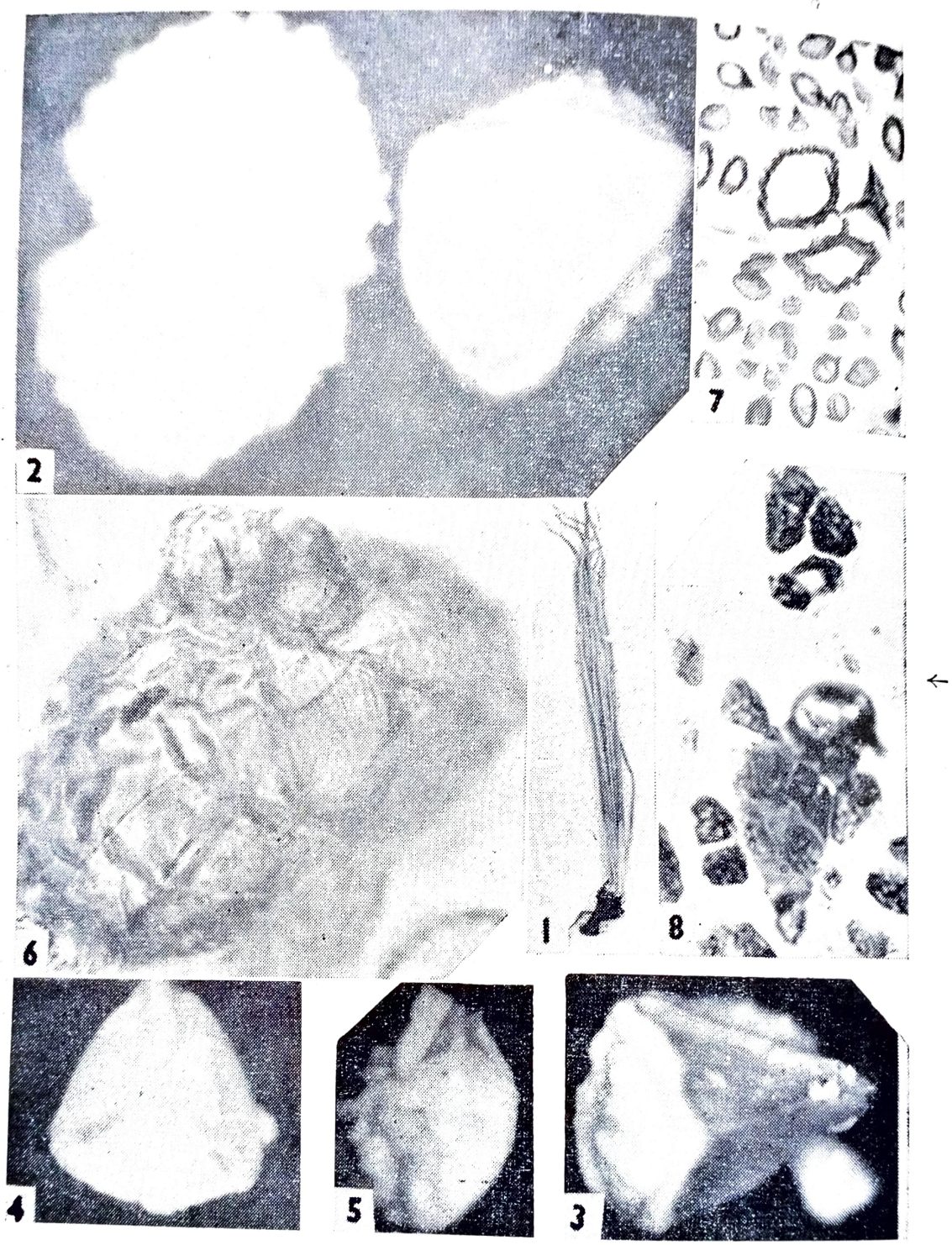
As far as ascertained, comprehensive megaspore morphology of *I. pantii* is not in agreement with either of the known species of *Isoetes*.

When frequency of normal and joined megaspores was taken into account *I. pantii* indicated highest frequency record of joined spores (5 : 1) among Indian species (Table II).

Interesting features of *I. pantii* in microsporangia are as follows:

(1) *Trimorphic microspores*.—The dimorphism of micrspores in *Isoetes* is well known (Pfeiffer, 1922). However, occurrence of large alete spores in addition to the two kinds of pore (mono and trilete), probably, is recorded for the first time (Goswami and Arya, 1968).

(2) *Large spores* (? *megaspores*).—Large tuberculate spores showing triradiate and commissural ridges are found intermixed with the trimorphic microspores (Figs. 6 and 7). The formation of these spores is initiated at a very young stage of microsporangium (Fig. 8).



FIGS. 1–8. Fig. 1. Plant of *Isoetes pantii* n.Sp., × 1/10. Fig. 2. Large megaspores : joined and free, × 75. Fig. 3. Medium-sized megaspore, × 75. Fig. 4, 5. Small megaspores. × 80. Fig. 6. Glycerine mount of a large siamese twin spore from a microsporangium showing attached microspores, × 550. Fig. 7. Portion of a longitudinal section of microsporangium showing microspores and large (?) spores, × 125. Fig. 8. Portion of a longitudinal section of a small microsporangium showing early stages of formation of micro and the large spore (arrowed), × 750.

TABLE II

Counts of megaspores in megasporangia of four species of Isoetes (*Pant and Srivastava*, 1962)

Name of the species	No. of sporangia	No. of megaspores in the sporangia		Ratio
		Normal	Joined	
Isoetes coromandelina ..	9	7773	428	18 : 1
I. indica ..	5	8598	133	64 : 1
I. dixitei ..	5	1032	4	255 : 1
I. pantii ..	5	9458	1990	5 : 1

We take it our privilege in naming the species after Professor Divya Darshan Pant, Allahabad; not only for his authority on Indian *Isoetes* but also for his great inspiration and genuine help during our study.

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