

ISOETES FOUND ON TAIWAN<sup>(1)</sup>CHARLES E. DEVOL<sup>(2)</sup>

On August 22, 1971 two of our graduate students, K.S. Hsu (徐國士) and H.J. Chang (張惠珠) found *Isoetes* growing in a shallow pond on Seven Star Mountain, Chih-hsin-shan (七星山).

For many years our collectors have searched the ponds and lakes of Taiwan in the hope of finding *Isoetes*. Since *Isoetes japonica* A. Br. and *I. asiatica* Makino grow in Japan, *I. sinensis* Palmer grows in an eastern coastal province of Mainland China (Kiangsu), and *I. philippinensis* Merr. and Perry grows in the Philippines (Mindanao) it has seemed likely that we might find *Isoetes* in Taiwan.

The pond in which *Isoetes* was found is near the northern tip of Taiwan in Taipei County. It lies near the top of an extinct volcano at an altitude of about 1000 m. This pond is seldom visited except by a few hunters and mountain climbers. It is small and shallow and during the long dry seasons the water level becomes very low but the peaty soil retains the moisture very well.

In this secluded pond *Isoetes* grows abundantly and is the dominant aquatic plant. Associated with it are:

*Blyxa echinosperma* (Clarke) Hook.

*Eriocaulon formosanum* Hay.

*Sphaerocarum malaccense* (Trin.) Pilger

*Monochoria vaginalis* Presl

*Fimbristylis monostachya* (L.) Hassk.

*Juncus effusus* Linn.

*Scripus triangulatus* Roxb.

*Nymphoides cristata* (Roxb.) O.K.

The water in this pond is not used for irrigation as there are no farm homes in the vicinity. However most ponds on Taiwan are not so conducive for *Isoetes*, being near farms they are used for all kinds of purposes and are frequented by ducks, geese and water buffaloes.

We were not greatly surprised to find *Isoetes* growing on Taiwan, but we were surprised that it seems to be different from any other known species, so we are naming it *I. taiwanensis*. Chart No. 1 shows the known species of *Isoetes* growing on the ring of islands lying off the coast of Asia.

Our whole staff has taken a great interest in the discovery of *Isoetes* on Taiwan.

Dr. Tseng-chiang Huang (黃增泉), Head of our Botany Department, and his assistant T.F. Chung (鍾天福) have made studies and prepared permanent mounts of the megaspores and microspores.

Dr. Chien-chang Hsu (許建昌), Professor of Taxonomy, who has been studying the chromosomes of Taiwan plants, together with his assistants have made a study of the chromosomes in the root tip.

Dr. Su-hwa Tsai Chiang (江蔡淑華), Professor of Plant Anatomy, decided to make sections of the sporangia so as to have them for her classes in plant morphology never expecting to find a sporangium containing two kinds of spores.

Dr. Chiang took the photos shown on Plate II.

The discovery of an *Isoetes* having sporangia containing both megaspores and microspores (Plate 2, fig. c) came as a big surprise to us. Alston in his description

(1) This study was supported in part by a grant from the Biological Research Center of Academic Sinica.

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Chart 1. Geographical Distribution of Isoetes growing on the Pacific Islands bordering Eastern Asia

Species	Section	Distribution	
<i>I. beringensis</i> Komarov	Tuberculatae	Commander Island (Off east coast of Kamchatka)	North of Taiwan
<i>I. asiatica</i> Makino	Echinatae	Southern Sakhalin, Kamchatka, Kurile Islands, Hokkaido, Northern Honshu	
<i>I. japonica</i> A. Br.	Reticulatae	Honshu, Shikoku, Kyushu, Korea	
<i>I. sinensis</i> Palmer	Cristatae	Mainland China: Kiangsu	
<i>I. taiwanensis</i> DeVol	Tuberculatae	Taiwan	
<i>I. philippinensis</i> Merr. and Perry	Reticulatae	Philippines: Mindanao	South of Taiwan
<i>I. neoguineensis</i> Baker	Reticulatae	New Guinea: Papua	
<i>I. habbemensis</i> Alston	(Psilatae) Smooth	New Guinea: Western New Guinea	

of Isoetaceae in Flora Malesiana (1959: 63) stated that "sporangia with both megaspores and microspores have been reported" but he gave no details and did not state what species showed this character. We had also seen Goswami's report (Goswami, 1968: 39-40) of sporangia containing two kinds of spores but thought of that as a freak occurrence.

#### Latin description:

##### *Isoetes taiwanensis* sp. nov. TUBERCULATAE Pfeiffer.

Planta aquatica submersa; cormo vulgo 3-loba, nonnumquam 4-5 loba; folia numero 15-90, viridia, 7-17 cm longa, patentissima, basi dilata et complanata, marginibus membranaceis, apice fastigiato; stomata adsunt in parte apicali, ad basim desunt; ligula elongato-triangulari; velum brevissimum; fibris periphericis destituta; megasporangia exteriora ovalia 2.5 mm longa, 2 mm lata, interiora magnioris; megasporae 310-390 $\mu$  diam., griseae colores cum madidae, albae cum siccae, exosporii tuberculatis; microsporae griseae, ellipticae, 25 $\times$ 15 $\mu$ , minutissime spinulosae.

**Description of species:** Aquatic plants, usually growing submersed, but can live on in the damp soil when ponds become nearly dry; stem 3-lobed or occasionally 4 or 5 lobed; leaves widely spreading, 7 to 24 cm long, in tufts of 15 to 90 or more, flattened on upper side, rounded on lower side, base expanded with membranous margins, septa appearing on the upper surface as broken white lines, with a few scattered stomata near the tips, the stomata opening into the air spaces; (no stomata observed on middle and lower portions of cleared leaves); stomata range in size from 27.5 to 30 $\mu$  $\times$ 20 to 22.5 $\mu$ ; peripheral fibers absent; ligule elongate, triangular; velum rudimentary, very short, only covering the top of the sporangium; megasporangium oval, those on outer sporophylls 2.5 $\times$ 2 mm, inner ones longer, megaspores gray when wet, white when dry, tuberculate on basal side, sides adjoining the other

megaspores smooth, 310 to 390 microns in diameter; microspores gray, elliptic, with small spines,  $25 \times 15$  microns; some sporangia contain both megaspores and microspores, the megaspores in these mixed sporangia are slightly smaller than those in sporangia containing only megaspores, and the microspores in these mixed sporangia are much smaller than in sporangia containing only microspores (these measure  $13 \times 11.5 \mu$  rather than  $23 \times 15 \mu$ ); chromosomes  $2n =$  about 22.

**Collections:** Taipei County, Chong Hu (中湖), Seven Star Mt. (七星山) K. S. Hsu and H. J. Chang 1715, M. T. Kao 7935, DeVol 8005, C. C. Hsu 11261.

**Type:** The specimens collected by K. S. Hsu and H. J. Chang on Aug. 22, 1971 were the first to be collected, so one of them has arbitrarily been chosen as the holotype (Hsu and Chang 1715) and is deposited in the herbarium of the National Taiwan University (TAI). We know of no other locality where this species grows so any specimen from this pond can be considered as a topotype.

**Fruiting period:** All plants collected last year between August and October were fruiting. Some specimens collected in November had ripe sporangia, but no specimens were found with sporangia after that date until about the middle of April and none of the specimens examined in April had mature spores.

Chart No. 2 compares the important characters of species known from the Pacific islands as well as from Eastern China and India. The reason for considering Indian species in this paper is because the Taiwan species is somewhat like them.

The velum of our new species is very small and would have been overlooked, had we not seen it in the sectioned material, since it does not hang down over the sporangia. (Plate 2, Figs. a, b.)

Since our species has warty projections on the megaspores it differs from all other species occurring on the islands lying off East Asia except *I. beringensis*. In the description Komarov gave of this species (Komarov 1932: 196) he says that the megaspores are about  $270 \mu$  in diameter and echinate; but in his treatment of the Isoetaceae of the U. R. S. S. (Komarov 1934: 127-128) he says the megaspores have thick wartlets. We have not seen any specimens of that plant and Komarov's description is brief and his figures are too small to be of much value. He also says the stomata of that species are numerous; and ours has very few stomata.

All the Indian species discussed by Pant and Srivastava (Pant and Srivastava 1962) except *I. panchananii* belong to the class Tuberculatae.

Our species has a rudimentary velum and so does *I. dixitei* but that species has 4 main peripheral strands with 20-30 subsidiary strands and ours has none. Of the other Indian species: *I. coromandelina*, *I. indica* and *I. pantii* have no velum, and the others have a velum that covers at least half of the sporangium.

Our species is much like *I. pantii* in that it has no peripheral fibers, and has some sporangia which contain both megaspores and microspores but it differs in that the leaves grow erect in *I. pantii* (judging by the illustration given (Goswami and Arya 1970: p. 36 fig. 1). A second difference is that *I. pantii* has no velum and a third difference is that both the megaspores and microspores of *I. pantii* are trimorphic, i.e. in the same sporangia there are 3 kinds of spores which differ not only in size but also in other characters. (Goswami and Arya 1970: 34 and Table on pages 32-23). *I. taiwanensis* has a rudimentary velum and we have not observed megaspores or microspores of different sizes within any of the sporangia containing only megaspores or microspores.

*I. coromandelina* is like our species in having the same number of chromosomes ( $2n=22$ ) at least according to some reports (Pant and Srivastava, 1962 see Chart on

Chart 2

	Corn lobes	Leaf habit	Stomata	Velum	Peripheral fibers	Megas- porangium containing microspores	Megaspore size	Megaspore markings	Microspore size	Microspore markings	Chromo- some no.
<i>I. beringensis</i> Kom.	2	erect	+			-	270 $\mu$	T	21 x 15 $\mu$	muricate	
<i>I. asiatica</i> Mak.	2	spreading	-	covers 2/3-3/4		-	440-540 $\mu$	E	23-35 $\mu$	smooth	2n=22
<i>I. japonica</i> A. Br.	3	erect	-	-	6	-	560-660 $\mu$	R	24-35 $\mu$	smooth	
<i>I. sinensis</i> Palm.	3		+	-	4	-	330-460 $\mu$	C	26-30 $\mu$	spinulose	
<i>I. taiwanensis</i> DeVol	3(4)	spreading	near tips	rudimen- tary		+	310-390 $\mu$	T	15 x 25 $\mu$	spinulose	2n=22
<i>I. philippinensis</i> Merr. and Perry	3(4)	spreading	-	-		-	385-455 $\mu$	R	25-30 x 22 $\mu$	minutely scabrous	
<i>I. neoguineensis</i> Bak.	3(4)	spreading	few	-		-	800 $\mu$	R			
<i>I. habbemensis</i> Alston	2		-	-		-	575 $\mu$	P	43 $\mu$	spinulose	
<i>I. coromandelina</i> Linn.	3(4,5)			-	4 main	-	dimorphic	T	22-33 $\mu$	smooth rugose	2n=44+1 2n=22
<i>I. indica</i> Pant	3(4)	somewhat spreading	near tips	-	4-6 main	-	trimorphic	T	dimorphic 16-48	tuberculate	44+1
<i>I. sahyadrii</i> Mahab.	3			nearly complete		-	uniform	T	30 $\mu$	spinulose	
<i>I. dixitei</i> Shende	3			rudimen- tary	4 main	-	dimorphic	T	27-30 $\mu$	muricate	
<i>I. sampathkumaranii</i> Rao	2			1/2-2/3		-	dimorphic	T			2n=66
<i>I. panchananii</i> Pant	2	erect	near tips	1/2		-	dimorphic 225-400 $\mu$	R			44+1
<i>I. pantii</i> Gosw.	3	erect(?)		-		+	trimorphic 70-110 280-312 450-600	T	trimorphic 15-54 $\mu$	smooth or papillose	

E = Echinatae

P = Psilatae (Smooth)

R = Reticulatae

T = Tuberculatae

C = Cristatae

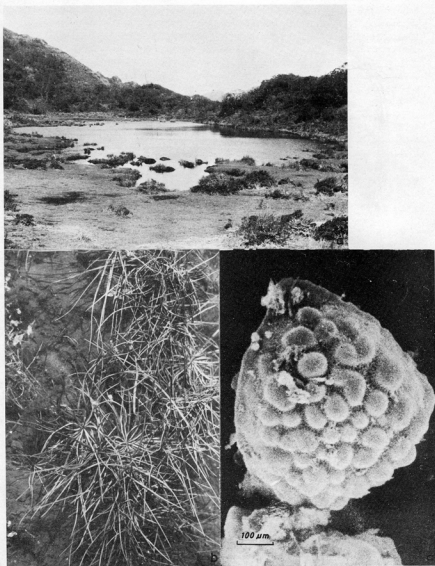


Plate I.

- Fig. a. The pond in which *Isoetes taiwanensis* grows. Photo by Dr. Chien-chang Hsu.  
 Fig. b. Specimens of *Isoetes taiwanensis* growing submersed. Photo by Soon-Hing Chit 威順興  
 Fig. c. A megaspore from isotype showing tubercles. Picture enlarged from photo made by Dr. A. C. Jermy of collection by C. C. Hsu 11261.

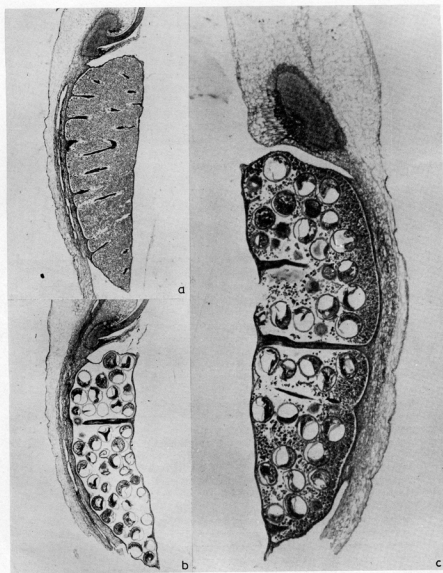


Plate II. All photos made by Dr. Su-hwa Tsai Chiang from collection by  
*K. S. Hsu and H. J. Chang 1715.*

Fig. a. l.s. of microsporangium, showing base of ligule and rudimentary velum, ( $\times 20$ ).

Fig. b. l.s. of a megasporangium containing only megaspores, and showing the ligule and rudimentary velum above the sporangium, ( $\times 20$ ).

Fig. c. l.s. of sporangium containing both megaspores and microspores, ( $\times 34$ ).

page 279) and it is also like our species in that its corm normally has 3 lobes but may occasionally have 4 or 5 lobes. *I. coromandelina* differs from *I. taiwanensis* because it has no velum, and has 4 main peripheral strands and several accessory strands.

We are much indebted to Dr. A. C. Jermy for his help in the study of this species. The photos he took for us of the megaspores of *I. pantii* and *I. taiwanensis* were a very big help us.

We expect to give additional reports concerning this new species in the near future as a number of studies are still in progress.

In listing the species of *Isoetes* of our area and indicating the class to which each belonged we came across *I. habbemensis* Alston from New Guinea which is reported to have smooth megaspores and so does not fit into any of Pfeiffer's four sections so we are suggesting the term PSILATAE for that section of *Isoetes* which has smooth megaspores.

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