Summer 2001

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Original Publication Citation

Musselman, L. J., Taylor, W. C., & Bray, B. D. (2001). *Isoetes mattaponica* (Isoetaceae), a new diploid quillwort from freshwater tidal marshes of Virginia. *Novon, 11*(2), 200-204. doi:10.2307/3393059

Isoetes mattaponica (Isoetaceae), a New Diploid Quillwort from Freshwater Tidal Marshes of Virginia

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ABSTRACT. *Isoetes mattaponica* is a rare quillwort of freshwater tidal rivers of eastern Virginia with a somatic chromosome number of $2n = 22$. Megaspores have low rugulate muri on both the proximal and distal surfaces; the girdle is broad. Microspores are echinate-spinose with ornamented spines. *Isoetes mattaponica* may be one of the parents of several polyploids in the Southeastern United States.

Key words: Isoetaceae, *Isoetes*, North America, quillwort, United States, Virginia.

Chesapeake Bay quillworts have been extensively studied (reviewed in Musselman & Knepper, 1997, and Caplen & Werth, 2000a) but largely extirpated due to pollution and urbanization. The following taxa are known from the southern parts of the Chesapeake Bay (Musselman & Knepper, 1997): *Isoetes engelmannii* A. Braun ($2n = 22$); *I. saccharata* Engelmann [$2n = 44$, including *I. hyemalis* Brunton ($2n = 44$)]; and *I. acadiensis* Kott ($2n = 44$). For a clear understanding of relationships among these polyploids, knowledge of the basic diploids is essential. A new diploid species from the freshwater tidal marshes of Virginia is described.

Isoetes mattaponica L. J. Musselman & W. C. Taylor, sp. nov. TYPE: U.S.A. Virginia: King William County, Mattaponi River, plants in *Pontederia cordata-Nuphar luteum* marsh, along a tidal shore of the Mattaponi River, ca. 0.75 km S of Aylett, 7 Aug. 1997, *W. C. Taylor 6052* (holotype, MIL). Figures 1–6.

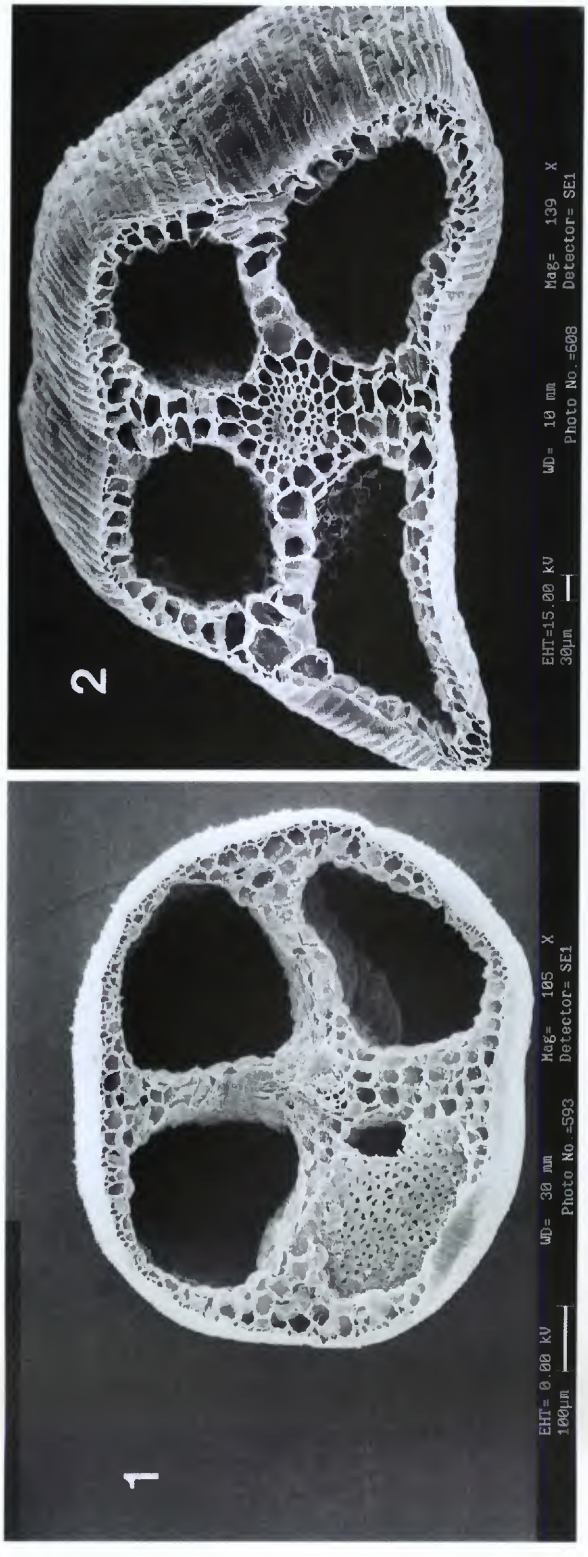
Planta aquatica, emergens, amphibia aestus zonam habitans; caudice subgloboso, bilobo. Folia vivide viridia, basin versus pallida, in spiram disposita, usque ad ca. 25 cm longa, ca. 1 mm lata ad medium longitudinis, flexibilia. Sporangium basale, obovatum ad late ellipticum, ca. 2.5–3.5 mm longum; pariete fasciculis sparsis linearibus ad oblongis cellularum brunnearum unius ad quattuor maculato, velo incompleto membranaceo pro parte 25–75% tecto; megasporis albis, 280–360 μm diametro ($x = 330$ μm), inconspicue verrucato-rugatis, cingulo lato; microsporae pallide canis in massa, 22–28 μm ($x = 25$ μm), echinatis. Chromosomatum numerus $2n = 22$.

Plant aquatic, emergent, tidal-amphibian. Rootstock subglobose, bilobed. Leaves bright green, pale toward base, spirally arranged, ca. 25 cm long, ca. 1 mm wide at mid length, pliant. Labium absent. No peripheral strands present. Central intrastelar canal one. Velum incomplete, membranous, covering ± 25–75% of sporangium wall. Sporangia basal, obovate to widely elliptic, ca. 2.5–3.5 mm long, walls spotted with scattered, linear to oblong clusters of 1 to 4 brown-colored cells. Megaspores white, ca. 280–360 μm diam. ($x = 330$ μm), obscurely verrucate-rugate, girdle wide, ornamentation obscure. Microspores light gray in mass, ca. 22–28 μm long ($x = 25$ μm), echinate. Chromosomes: $2n = 22$.

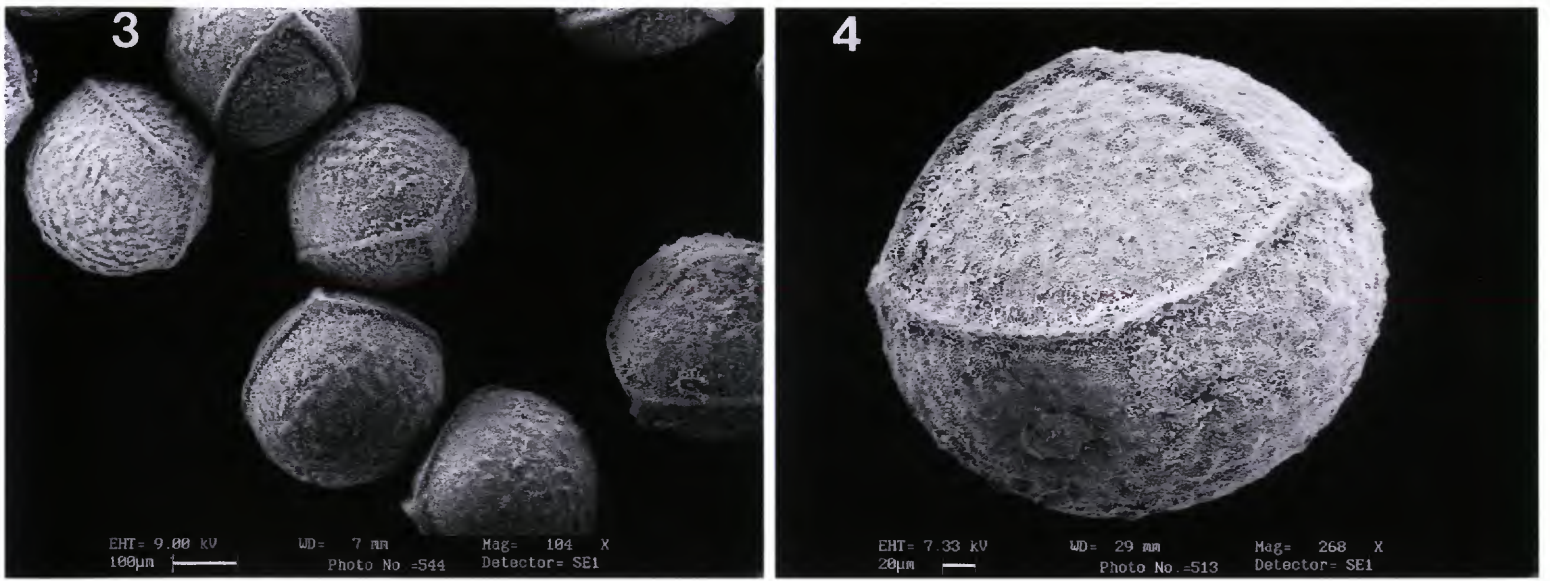
Distribution. Chickahominy, Pamunkey, and Mattaponi Rivers of eastern Virginia.

Mattaponi is the name of a tribe of Native Americans living along these coastal rivers.

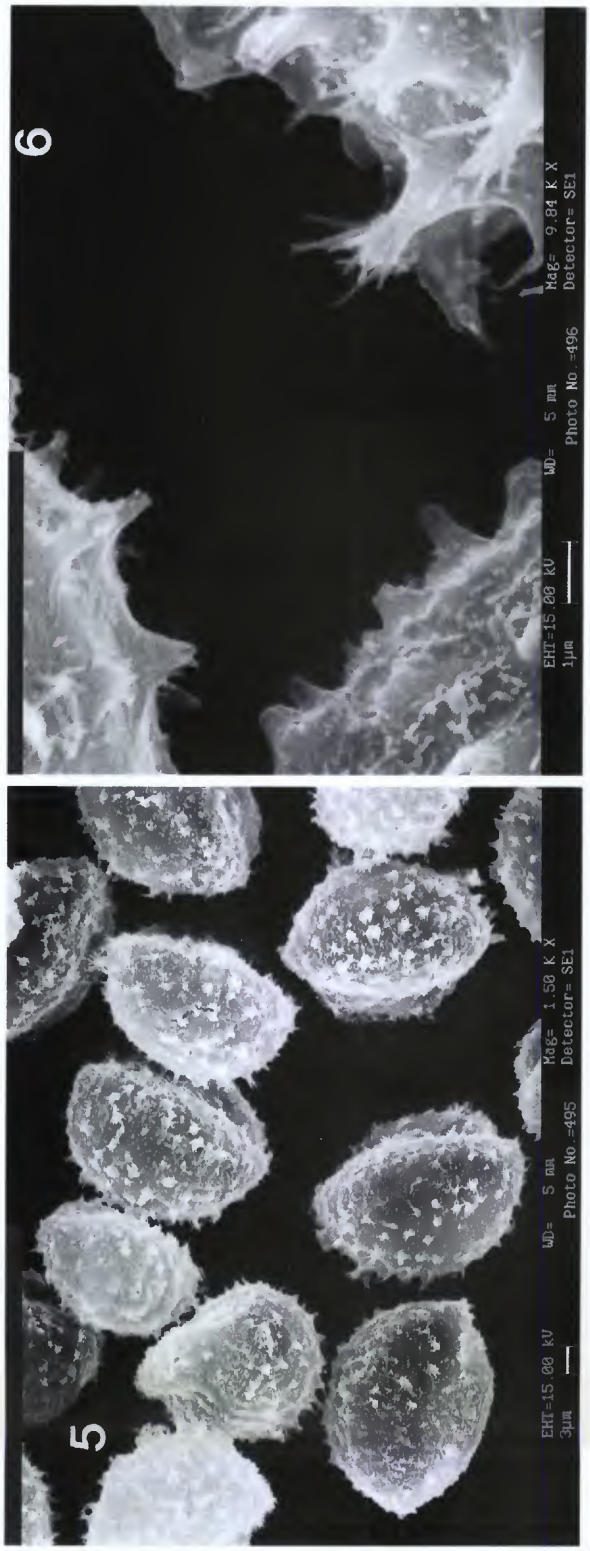
Paratypes. U.S.A. **Virginia:** King William County, Aylett, *Taylor 6052* (MIL), *Musselman 98902* (ODU), *Musselman 99176* (ODU); King and Queen County, 1.5 km S of Aylett, *Musselman 99178* (ODU); New Kent County, 3.0 km N of Pamunkey Indian Reservation, *Musselman 96042* (ODU); Charles City County, 4.5 km S of Walker Dam, *M. Pease s.n.* (ODU); Wilcox Neck, *Musselman 99186* (mixed collection) (ODU).



Figures 1, 2. Leaf cross sections (*Musselman 99178*). —1. Midsection of *I. mattaponica* leaf. No peripheral strands are evident. Note diaphragm with characteristic stellate cells in lower left lacuna. Scale (lower left) 100 µm. —2. Lower portion of leaf with single intrastelar canal. Scale (lower left) 30 µm.



Figures 3, 4. Megaspores of *I. mattaponica*.—3. Spore on upper left exhibits the wide girdle found in this species (*Musselman 99178*). Scale (lower left) 100 µm. —4. The ornamentation is similar on both the proximal and distal surfaces (*Taylor 6052*). Scale (lower left) 20 µm.



Figures 5, 6. Microspores of *I. mattaponica* (*Taylor 6052*). —5. General views of microspores showing echinate pattern. Scale (lower left) 3 µm. —6. Detail of processes at tip of spines. Scale (lower left) 1 µm.

Leaf features. The leaves of *Isoetes mattaponica* lack peripheral strands and have a single intrastelar canal (Figs. 1, 2). *Isoetes engelmannii*, *I. acadiensis*, and *I. hyemalis* also possess a single intrastelar canal (Bray, unpublished). More populations and taxa need to be examined to establish the taxonomic value of peripheral strands. Stomata are present on the leaves of *I. mattaponica*. Unlike most southeastern quillworts (Bray & Musselman, unpublished), *I. mattaponica* lacks scales.

Spore morphology and size. *Isoetes acadiensis* also grows in the tidal rivers of southeastern Virginia and superficially resembles *I. mattaponica*. Megaspore size and ornamentation differ between the two taxa, however. Spores of *I. mattaponica* are slightly smaller (x = 330 μm) than *I. acadiensis* (x = 412 μm). *Isoetes mattaponica* megaspores (Figs. 3, 4) have an obscure, low, rugulate sculpturing; those of *I. acadiensis* are boldly rugulate-reticulate. Lastly, the girdle of *I. mattaponica* is wider and less ornamented than that of *I. acadiensis*.

Megaspores of *I. mattaponica* superficially resemble those of the basic diploid *I. melanopoda* Gay & Durieu. However, the rugulate, low (< 5 μm), rounded muri of *I. mattaponica* megaspores differ from the tuberculate ornamentation of *I. melanopoda* (Taylor et al., 1993). They more closely resemble the muri of *I. acadiensis*, a tetraploid that grows with *I. mattaponica*.

Microspores of *I. mattaponica* are strongly echinate (Fig. 5) and have fringed processes at the tips of some spines (Fig. 6). Fringed processes occur on several North American species of *Isoetes* (Musselman, unpublished).

Megaspores mature from the middle of June to the middle of August. Microspores develop from the first of July to the end of August. By October, most sporophylls have decayed and only a few depauperate leaves, lacking sporangia, remain. Like other Chesapeake Bay submergent quillworts, *I. mattaponica* stays green during the winter.

Cytology. *Isoetes mattaponica* has a basic diploid chromosome number of 22. Only two diploid quillworts have been described from North America the past one hundred years—*I. tegetiformans* Rury and *I. prototypus* D. M. Britton (Taylor et al., 1993). Like *I. mattaponica*, these two diploids also have a very restricted range (Taylor et al., 1993).

Field characters. In common with most quillworts, there is little to distinguish *I. mattaponica* from other species. Its general appearance and chromosome number have similarities to *I. melanopoda* ($2n$ = 22), a wide-ranging, variable species of North America with shallowly ornamented megaspores (Taylor et al., 1993).

Molecular characters. Recently, Sarah Hoot (pers. comm.) has used the second intron of the leafy (*lfy*) in her phylogenetic studies of *Isoetes*. Her preliminary sequence data support *I. mattaponica* as a distinct species with about 15 unique substitutions and one indel not found in any other species of *Isoetes*.

In an allozyme study of the *I. riparia* complex—all tetraploids ($2n$ = 44)—Caplen and Werth (2000b) found *I. mattaponica* to be one of the most likely parents for ten different populations of "*I. riparia*" in the Southeast.

Ecology. The rivers in which this quillwort grows are unique freshwater tidal river systems of Chesapeake Bay. At their borders lie extensive and relatively undisturbed marshes. Federally endangered plants found here include *Aeschynomene virginica* (L.) Britton, Sterns & Poggenburg and *Helianthus* (= *Micranthemum*) *micranthemoides* Nuttall. *Isoetes mattaponica* is part of a guild of isoetid plants (plants with rosette leaves, tufted roots, and often CAM photosynthesis). Isoetids in these marshes include *Eriocaulon parkeri* Robinson, *Lilaeopsis chinensis* (L.) Kuntze, and *Sagittaria subulata* (L.) Buchenau. Other species that grow with *I. mattaponica* are *Acorus calamus* L., *Elatine triandra* Schkuhr, *Eleocharis parvula* (Roemer & Schultes) Link, *Nuphar advena* (Aiton) Aiton f., *Orontium aquaticum* L., *Peltandra virginica* (L.) Schott & Endlicher, *Pontederia cordata* L., and *Zizania aquatica* L.

Isoetes mattaponica, like some of its cohorts, apparently is a rare plant. We have seen it at only five sites in four Virginia counties: Charles City, King and Queen, King William, and New Kent. No previous collections are known. Careful searches should be made, however, before populations are adversely affected by marsh disturbance through water withdrawal and urbanization.

Acknowledgments. We have benefited from discussions with C. Caplen, R. J. Hickey, K. Heafner, and D. Knepper. Doug Davis, Davis Environmental, helped locate populations. Plates were made by R. Jones. Michael Adam prepared the materials for electron microscopy. Research was supported, in part, by the Mary Payne Hogan Fund.

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