

ISOETES PROTOTYPUS (ISOETACEAE) IN
THE UNITED STATES

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ABSTRACT

Isoetes prototypus Britton, an endemic of the Atlantic Maritime Ecozone of Northeastern North America, is reported for the first time in the United States from Acadia National Park, Maine. It is a rare species throughout its range, being known elsewhere (in Atlantic Canada) from only five populations. For reasons of site requirements and possibly dispersal limitations, *Isoetes prototypus* is unlikely to be found in the United States away from the coastal region of Maine. It warrants designation as Critically Imperiled (G1S1) throughout its range.

Key Words: *Isoetes prototypus*, Isoetaceae, Maine, Acadia National Park, distribution, conservation

INTRODUCTION

The rarest member of the pteridophyte genus *Isoetes* in northeastern North America is the Prototype Quillwort, *I. prototypus* Britton (Britton and Goltz, 1991). It is one of the few northeastern North American diploid *Isoetes* species ($2n = 22$), increasing its value for evolutionary investigations of a group in which allopolyploidy and autopolyploidy are considered to be important for speciation (Taylor and Hickey, 1992). *Isoetes prototypus* also has a variety of morphological characteristics which are rare and in some cases, unique in North American *Isoetes* (Britton and Goltz, 1991) (Figures 2 and 3).

Isoetes prototypus has been previously reported from only four lakes, all in Atlantic Canada.¹ A specimen representing an additional locality and constituting the first record from outside Canada was discovered in material taken in Acadia National Park, Maine. The following describes that population and considers aspects of the ecology, geography and conservation significance of the species.

¹ A fifth Canadian population has recently been rediscovered at Sandy Lake, Annapolis Co., Nova Scotia (D. M. Britton, A. Anderson and R. Newell 12,506, 23 August 1990, OAC).

METHODS

A recent review of a set of *Isoetes* specimens collected in Acadia National Park, Maine resulted in the discovery of a specimen of *I. prototypus*. The site was subsequently visited and investigations of *Isoetes* population size and site ecology were undertaken. Comparison of these data with those gathered in earlier studies (e.g., Britton and Goltz, 1991) was undertaken in order to assess ecological and geographical similarities between American and Canadian populations.

RESULTS

Despite recent surveys of most northeastern *Isoetes* material for several studies (including Kott and Britton, 1983; Taylor et al., 1993 and pers. obs. (1989–1992) in maritime Canada and New England), *I. prototypus* remained unrecorded in the United States until we identified a collection from the north end of Bubble Pond, Acadia National Park, Maine (*C. W. Greene 1782*, 18 August 1987, HCOA, OAC). A subsequent search of the site uncovered a large population of *I. prototypus* there (*D. F. Brunton and K. L. McIntosh 11,347*, 19 September 1992, OAC, DFB, CAN, DAO, MIL, BM).

Bubble Pond is a small, spring-fed lake at 101 m asl—a relatively high elevation along the coastal plain. The lake is situated in a broad Palaeozoic volcanic and intrusive bedrock trough. Its profile is characterized by a broad, shallow shelf of silty-sand/coarse sand extending 4 to 40 m out from shore which pitches steeply into much deeper, noticeably darker water (Figure 1). *Isoetes prototypus* was found growing through dense *Eriocaulon septangulare* mats in a 20–30 cm thick layer of loose, silty ooze over sand in deep cool, oligotrophic water at the top of the steep slope to deeper water. The plants were not observed in water less than 1.5–> 2.0 m deep, although label data from the 1987 collection reports that those plants were collected in water ca. 1.0 m deep.

Bubble Pond *I. prototypus* has unusually long leaves—12.5 cm (average of 15 plants)—compared to Canadian material—6.4 cm (average for 22 plants from Nova Scotia and New Brunswick). It is otherwise typical of the species (cf. Britton and Goltz, 1991) viz, extremely straight, stiff, sharp-pointed, lustrous, dark-green



Figure 1. North end of Bubble Pond, Acadia National Park, Maine. *Isoetes prototypus* is abundant well out from shore, from the point where water depth > 1.5 m is achieved (dark area).

leaves with mahogany-coloured bases and a velum completely covering the sporangium. Megaspores are small ($< 500 \mu\text{m}$) and ornamented by an obscure, reticulate network of low, broad, 'meandiform,' mound-like markings on an essentially smooth surface. These are typical of the megaspores of *I. prototypus* (Figure 2).

I. tuckermanii A. Br. occurs commonly at the north end outlet of Bubble Pond in 2 to 10 cm deep fresh, warm water on silty-sand/coarse sand flats; none was observed in deeper water. The presence of a third *Isoetes* species in Bubble Pond, *I. macrospora* Dur., is indicated by the single up-rooted plant of the hybrid *Isoetes* \times *harveyi* A. A. Eat. (= *I. macrospora* \times *tuckermanii*). It is a common sterile hybrid within mixed populations of the parent species and always occurs in the company of both parents (Britton, 1991). Both of these species (and their hybrid) can be readily separated from *I. prototypus* by their more delicate, recurved, reddish-green leaves and larger, intricately ornamented megaspores (high-walled, densely reticulate pattern with a band of small, more or less distinct spines along the equator—cf. Kott and Britton, 1983).

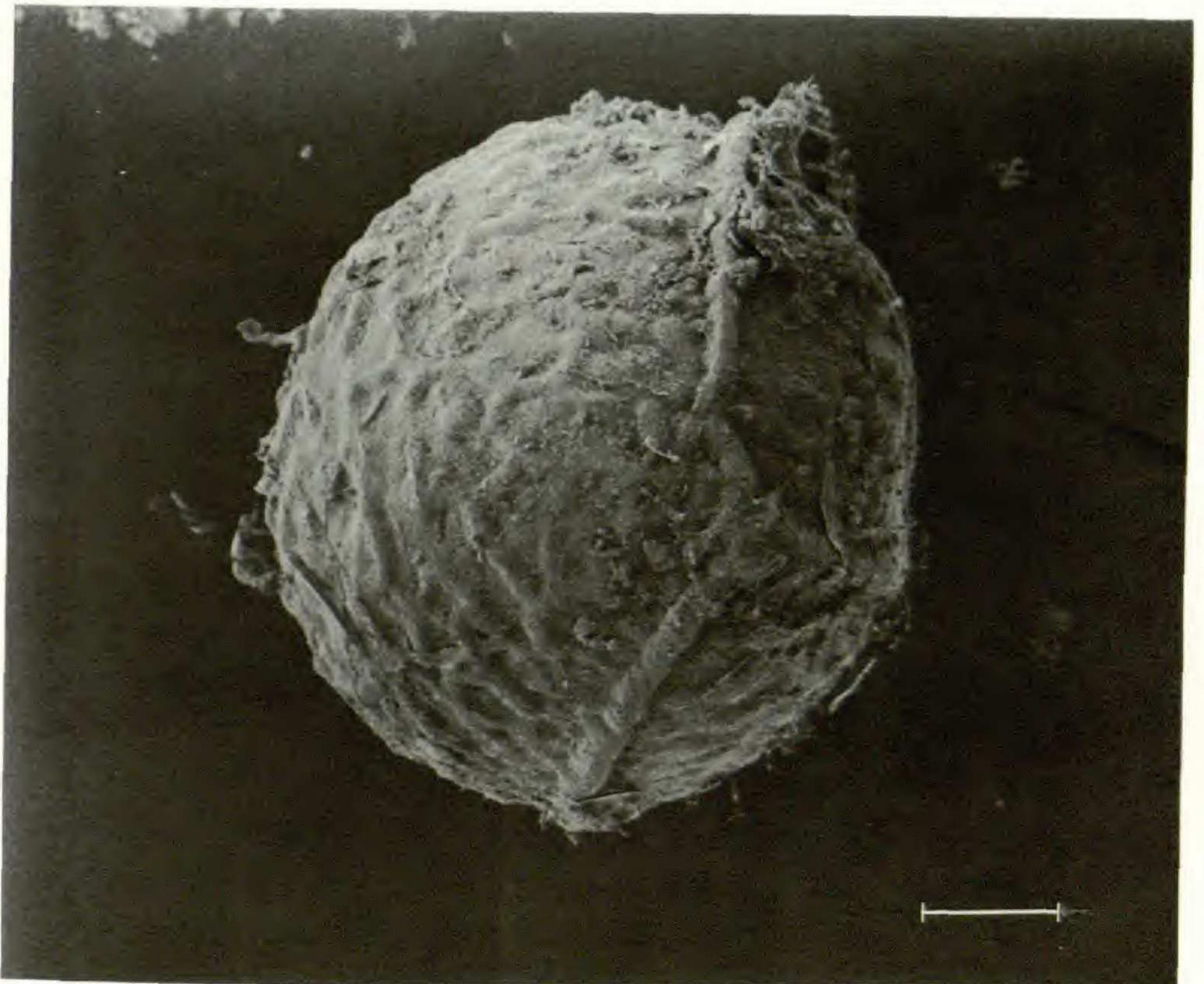


Figure 2. *Isoetes prototypus* megaspore with irregular pattern of tubercles and low, meandiform ridges (TOPOTYPE/PARATYPE, York Co., New Brunswick; Hinds 77-41 UNB 28537) (bar = 100 μ m).

This habitat is comparable to Canadian sites. First evidence of *I. prototypus* is usually offered by plants washed up on shore because the typically abundant deep water populations are not readily apparent from the surface (Britton and Goltz, 1991). Similarly, *I. prototypus* was not apparent during an unaided search from the surface of Bubble Pond. We examined that population with the aid of a glass-bottomed box to improve underwater viewing and by swimming down to the plants. We have had success in obtaining plants at other sites by dragging an anchor across the lake bottom and collecting the dislodged plants which readily float to the surface thereafter.

Evidence of *I. prototypus* was not detected in a brief survey of other apparently suitable lakes in Acadia National Park in September 1992; nearby Jordan Pond appears to be a particularly likely candidate but has received considerable botanical attention for over a century without providing evidence of this species.

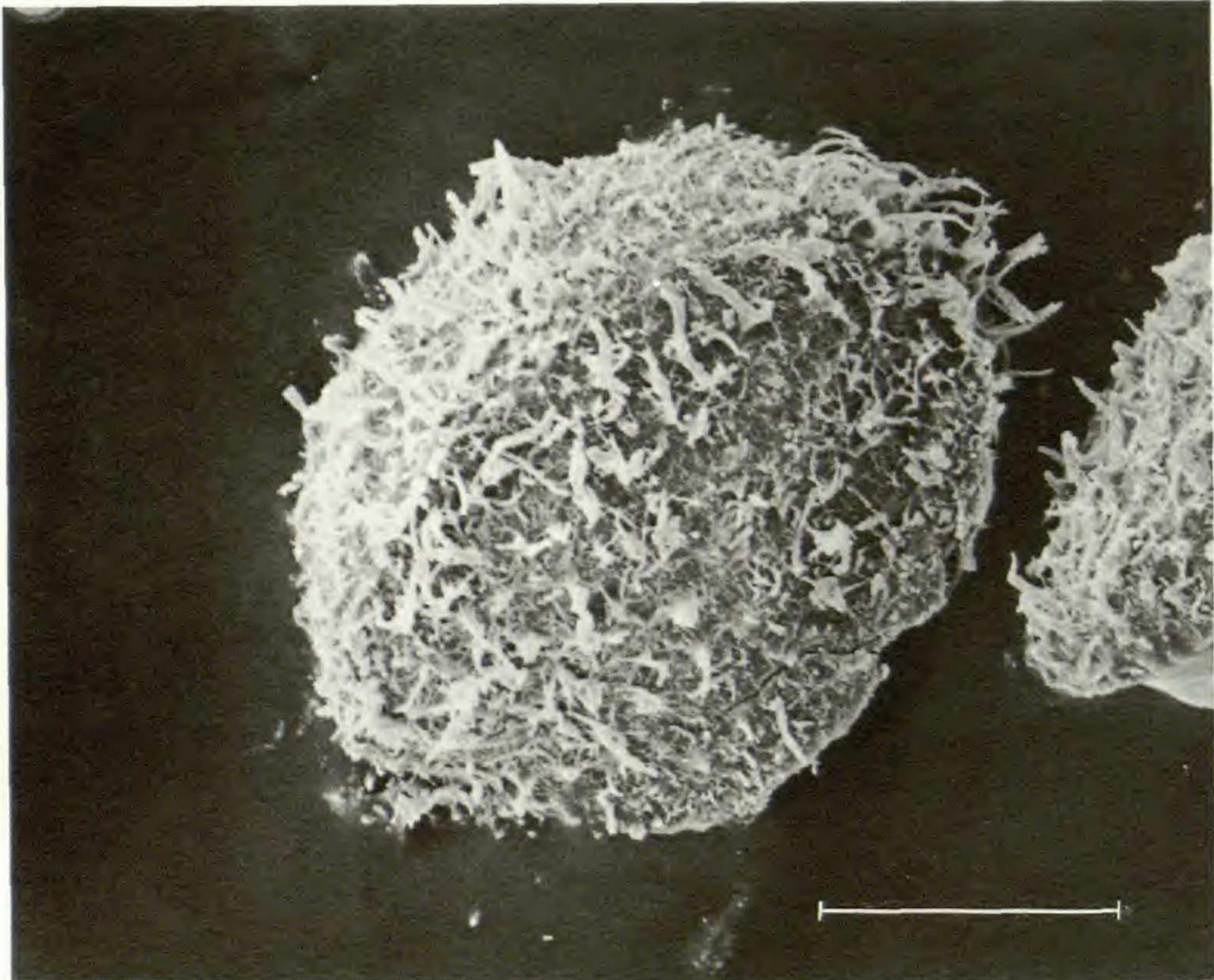


Figure 3. Densely fine-spinulose *Isoetes prototypus* microspore (TOPOTYPE/PARATYPE, York Co., New Brunswick; *Hinds 77-41 UNB 28537*) (bar = 10 μm).

DISCUSSION

Few washed-up plants were evident at Bubble Pond, in contrast to other *I. prototypus* lakes we have examined. Boating and swimming are prohibited in this lake, perhaps lessening the disturbance to the bottom by motors, fishing lines and swimmers. We also suspect that bottom-feeding waterfowl and Muskrats, wintering reptiles and amphibians, and/or spawning fish may be responsible for producing massive shore 'wracks' (accumulations of washed-up vegetation) consisting of various species of *Isoetes* plants, but this has not been confirmed. Such *Isoetes* wracks are regularly encountered along the Atlantic coast and in western North American cordillera—pers. obs.

The Bubble Pond station of *I. prototypus* constitutes the southernmost population for this endemic of the Atlantic Maritime Ecozone (cf. Wiken, 1986). Its occurrence in a deep, cold, nutrient-poor lake may reflect a particularly strict set of site requirements and/or the species' inability to tolerate significant competition.

We typically find *Isoetes prototypus* in such sites either growing alone or with very few associates (such as *Eriocaulon septangulare* With., *Isoetes macrospora* or *Isoetes* × *heterospora* A. A. Eat.).

Such a distinctive and restrictive habitat requirement likely also restricts the distributional potential of *I. prototypus*, contributing to its global rarity. Dispersal to such sites may be limited by the existence of its complete sporangial velum which reduces the ease of separation and rupture of the sporangium from the sporophyll, perhaps reducing the availability of free microspores and megaspores for transport by water currents, animal activity or other dispersal agents.

It seems likely that *I. prototypus* will remain a rare species in the United States, found only in the cold, clear Palaeozoic-bedrock based lakes in the Atlantic Maritime Ecozone along and near the Atlantic coastal plain in Maine. Given the greater intensity of botanical investigation in New England than in Atlantic Canada, it seems unlikely that evidence of commonly distributed American populations would have been missed when documentation of comparable Canadian populations dates back to the early years of this century.

The conservation status of *I. prototypus* meets the high priority designation of the Nature Conservancy ranking scheme (Morse, 1987; Argus and Pryer, 1990); the species likely warrants G1 (Critically Imperiled) status. Similarly, it warrants Critically Imperiled Provincial/State status (S1) for Nova Scotia, New Brunswick and Maine.

The rarity of populations of this species and the general vulnerability of aquatic *Isoetes* to water pollution strongly suggests that *I. prototypus* warrants Endangered (or at least Vulnerable) Species designation in both Canada and the United States.

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