

New Examples of the Moonwort Hybrid, *Botrychium matricariifolium* $\times$ *simplex* (Ophioglossaceae)

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Known previously from only two localities in Michigan, two new specimens of the moonwort hybrid, *Botrychium matricariifolium* $\times$ *simplex*, are reported in herbarium collections from Gaspé Co., Quebec. These are of special interest for representing only the third locality reported, 1930 km northeast of the previous ones, the plants themselves much larger and better developed than the earlier ones. A detailed key separates the hybrid from both its parents, as well as from *B. lanceolatum*, the orthospecies with which it is most likely to be associated.

Key Words: Moonworts, *Botrychium matricariifolium*, *B. simplex*, Ophioglossaceae, hybridization, hybrid characters.

Moonworts are mostly minute ferns that occur in disturbed sites. Because of their inconspicuousness, rarity, often brief seasonal appearance, few and often subtle characters, and commonly poorly-preserved herbarium specimens, the moonworts have been until recently a neglected and poorly understood group. Intensive field studies over the past decade have revealed a number of previously unrecognized divergent species (orthospecies), as well as interspecific hybrids (nothospecies). Hybridization is promoted by the commonly close proximity of the parents in *Botrychium* communities, where a number of taxa may grow together. The nothospecies can be determined by (a) association with the parents, (b) intermediate leaf morphology, (c) abortive spores, and (d) irregular meiosis. The first three of these sources of evidence for a hybrid hypothesis are considered to provide strong support, especially leaf morphology.

The first presumed hybrid moonwort from the New World was described only a decade ago (Wagner 1980). Two collections from central Michigan were reported of the cross between Matricary Moonwort, *B. matricariifolium* A. Br., and Least Moonwort, *B. simplex* E. Hitchc., the two commonest moonworts in eastern North America. Subsequently other hybrids have been described, many of them from the west. In the Lake Superior region, we now have reported five hybrid combinations (Wagner and Wagner 1988). As in a number of other fern genera, e.g., *Asplenium*, *Dryopteris*, and *Woodsia*, congeneric species tend to occur together in the same habitats, forming genus communities. In *Botrychium* and *Ophioglossum*, this tendency reaches an extreme, and we have discovered as many as 11 species co-occurring (Wagner and Wagner 1985), making it possible to delineate the basic species and detect

occasional hybrids. The actual number of hybrids we have found is, however, exceedingly small; indeed, most are from only a single specimen. The outstanding exception is the Waterton Lakes hybrid moonwort, *Botrychium* $\times$ *watertonense* W. Wagner, the nothospecies that combines the very different characteristics of the fertile orthospecies, Western Moonwort, *B. hesperium* (Maxon and Clausen) Wagner and Lellinger, and Paradox Moonwort, *B. paradoxum* W. Wagner, that grow with it. There are probably hundreds of plants of the Waterton hybrid at the locality, which we have not yet thoroughly censused; of the three taxa in our sample, nearly one-fourth were the hybrid (Wagner et al. 1984).

The Matricary $\times$ Least Moonwort hybrid is here reported from a new locality. This is of interest for several reasons: (a) the locality is only the third one reported; (b) it is nearly 1930 km to the northeast of the previous ones; (c) the plants themselves are far better developed and larger than those already described; and (d) it is now possible to provide a key to separate out the hybrids using fully mature individuals.

The data on the new collection are as follows: Canada, Quebec, Gaspé Co., St. Ann des Monts. On flat, sandy summit of partly wooded hill, growing with *B. simplex* and *B. [lanceolatum* var.] *angustisegmentum*. 29 June 1929. L. McI. Terrill 1621 (CAN). Of the six plants on the sheet (Figure 1), one is *B. lanceolatum* (C), three are *B. matricariifolium* (B, D, F), and two are the hybrid discussed here (A and E). An enlargement (Figure 2) of plants D, E, and F is presented to show the characters of the hybrid (2). All of the specimens are large and well-developed. The hybrids have leaves that average 22.2 cm tall, the trophophores average 7.6 cm long. The previously reported hybrids had leaves that average 16.5 cm

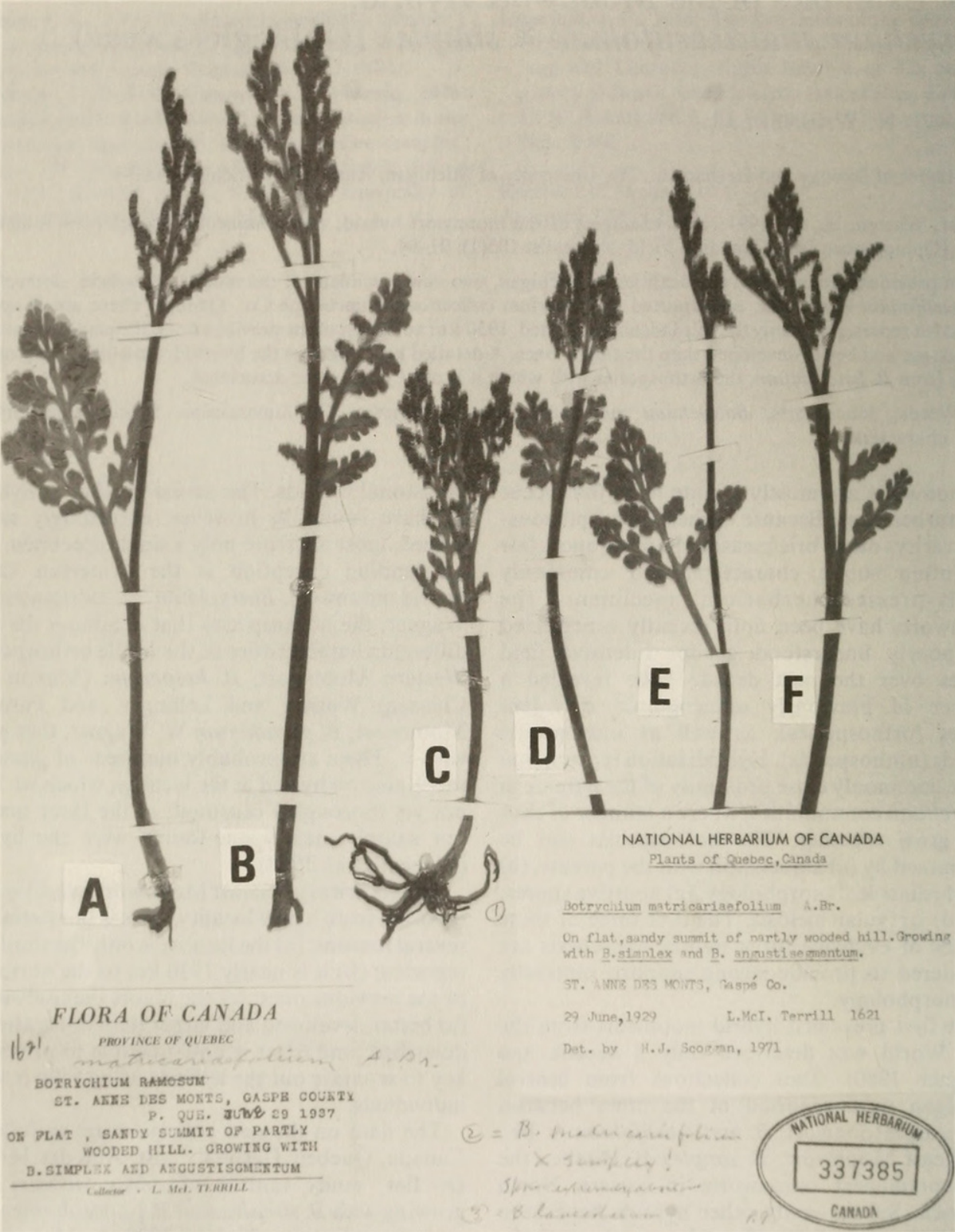


FIGURE 1. Herbarium sheet showing three taxa: *B. matricariifolium* (B,D,F), *B. lanceolatum* ssp. *angustisegmentum* (C), and *B. matricariifolium* $\times$ *simplex* (A,E).

tall, the trophophore 5.2 cm long. The newly recognized individuals are thus over a third again as large. It may be that *B. matricariifolium* $\times$ *simplex* will prove to be more frequent than expected. The parents, together with *B. lanceolatum* ssp. *angustisegmentum* are the most commonly encountered moonworts in eastern North America. Cody and Britton (1989: maps 59,60,64)

show their distributions. Matricary and Least Moonworts often occur side-by-side. (Indeed in our research on botrychiums we have stopped collecting samples of this mixture in nature). The parents are abundantly represented in herbaria, and except for certain peripheral localities, most occurrences are uninteresting. On the other hand, if we actually do search for the hybrid we should be

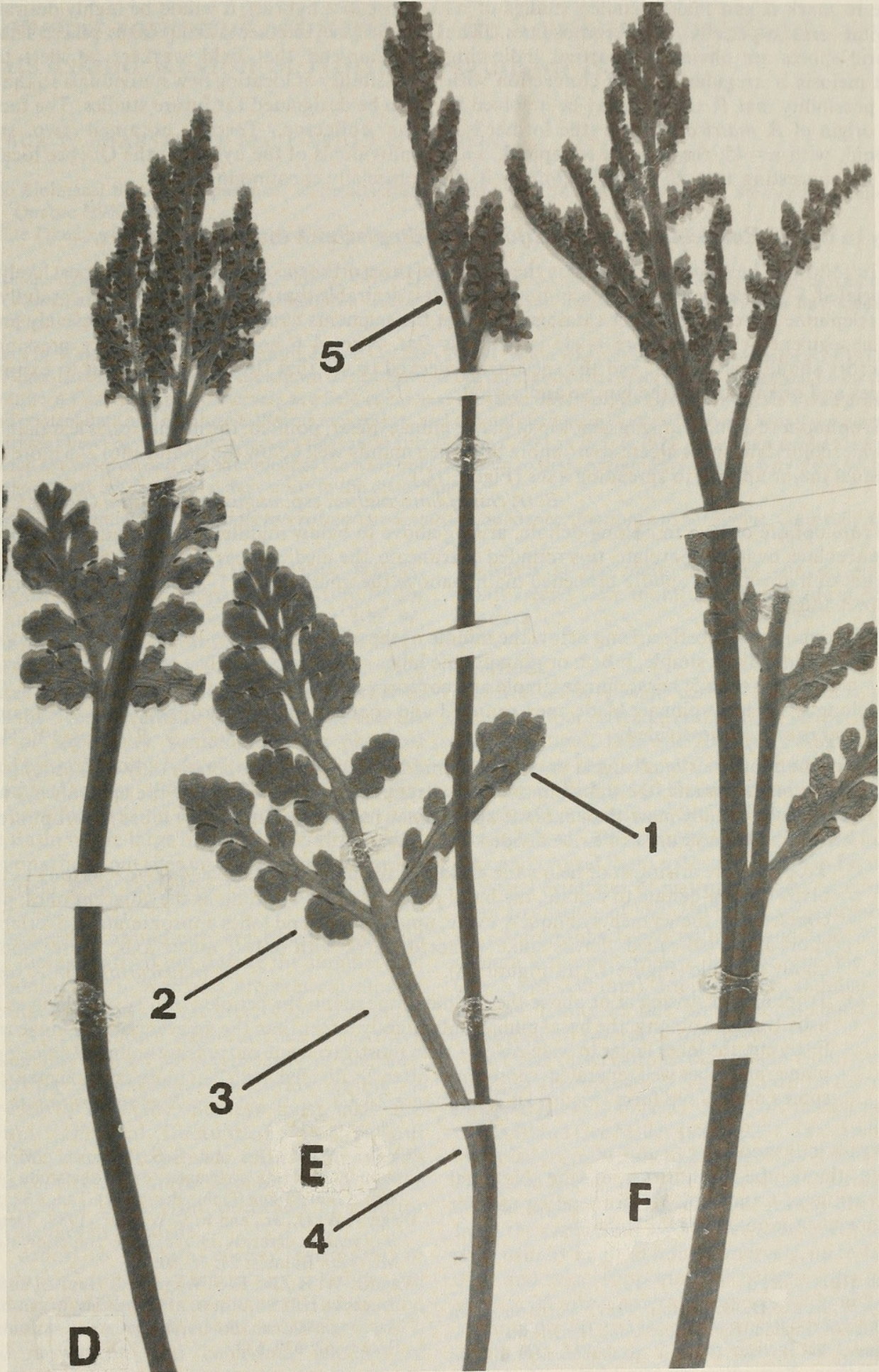


FIGURE 2. Close-up of *B. matricariifolium* $\times$ *simplex* (E). Note (1) large basal pinnae, (2) rounded segments, (3) long petiole, (4) low origin of sporophore, and (5) once-pinnate sporangial cluster.

able to mark it and make detailed studies of its habitat and especially its chromosomes. The hybrid spores are obviously abortive, indicating that meiosis is irregular. But, in connection with the possibility that *B. simplex* may be involved in the origin of *B. matricariifolium* (the former is a diploid, with $n = 45$; the latter a tetraploid, with $n = 90$, suggesting that *B. matricariifolium* itself

arose as a hybrid), it would be highly desirable to determine whether pairing takes place. Thus, we recommend that field workers be alert to the possibility of locating new individuals so that they can be designated for future studies. The fact that the collector, Terrill, obtained two superb individuals of the hybrid at the Quebec locality is especially encouraging.

Key to hybrid *Botrychium matricariifolium* $\times$ *simplex* and three orthospecies.

The following key places the hybrid in the context of three orthospecies with which it is most likely to be associated. For making useful herbarium vouchers, it is desirable that the leaves be pressed carefully in an old telephone directory or other catalogue, so that the segments can be teased out completely and the sterile segment or trophophore blade is perfectly flat. After 4–6 hours of preliminary pressing, the directory should be opened, and the specimens checked to see that they are spread out to expose the shapes and orientation of the pinnae and pinnules.

1. Trophophore deltate, arising near top of plant; pinnae linear, pointed, the median ones less than 3 mm wide; color dark shiny green; sporophore branched mainly well below the middle into 2–5 more or less equal major upright to spreading axes (Figure 1C).

Botrychium lanceolatum ssp. *angustisegmentum* (Fern.) Clausen

1. Trophophore oblong to oblong-deltate, arising above to below middle of the plant; pinnae oblong-lanceolate, ovate to spatulate, tips rounded to truncate, the median ones more than 5 mm wide; color light dull green; sporophore branched mainly above the middle, only 1–3 unequal major upright to spreading axes.

2. Trophophore mostly arising below the middle of the plant, its petiole $\frac{3}{4}$ to 1 or more $\times$ as long as the blade; blade simple, lobed, or pinnate, the lobes or pinnae strongly asymmetrical; pinna pairs usually less than 5; basal pinnae simple and conform or lobed or pinnulate and enlarged, 1–3 $\times$ as long as adjacent pinnae; blade apex rounded and coarsely lobed; sporophore with one main axis and usually once divided.

B. simplex E. Hitchc.

2. Trophophore mostly arising at or above the middle of the plant, its petiole only to $\frac{1}{2}$ as long as the blade; blade pinnate, the pinnae moderately asymmetrical; pinnae below the apex always lobed; pinna pairs usually more than 5; blade apex somewhat pointed and finely lobed; sporophore with 1–3 main axes and once to twice divided.

3. Trophophore arising at or below the middle of the plant, the petiole $\frac{1}{4}$ to $\frac{1}{3}$ $\times$ as long as blade, blade oblong-deltate to deltate, the basal pinnae 2–2 $\frac{1}{2}$ $\times$ as long as the adjacent ones; pinnae coarsely cut, the segments obliquely ovate; upper pinnae and lobes approximate to overlapping; sporophore (so-called "fertile spike") once divided, with only 1 major axis; spores abortive, highly variable (Figure 1A,E; Figure 2B).

B. matricariifolium $\times$ *simplex*

3. Trophophore arising at or above the middle of the plant, the petiole $\frac{1}{10}$ to $\frac{1}{5}$ $\times$ as long as blade usually; blade oblong, the basal pinnae only slightly larger than the adjacent ones; pinnae mostly finely cut, the lobes linear to wide-oblong, with mostly truncate or truncate-rounded apices; upper pinnae and lobes well separated; sporophore often 2 $\times$ divided, with 2 or more unequal major axes; spores normal, uniform (Figure 1B,D,F; Figure 2A,C).

B. matricariifolium A.Br.

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