# AZOLLACEAE MOSQUITO FERN FAMILY

George Yatskievych
Missouri Botanical Garden
P.O. Box 299
Saint Louis, MO 63166-0299

and

Michael D. Windham
Department of Biology
Duke University
Box 90338
Durham, NC 27708

Annual or perennial floating aquatic herbs, sometimes stranded on mud, heterosporous. ROOTS adventitious, appearing fascicled from the stem nodes, unbranched. STEMS more or less dichotomously branched, sometimes breaking apart with age. LEAVES alternate, 2-ranked, slightly overlapping, sessile, deeply 2-lobed, the lobes lacking apparent venation, one lobe floating and green, the other submerged, translucent, and nonphotosynthetic. FLOATING LEAF LOBES oblong-ovate to obovate, the adaxial (emergent) surface with moderate to dense, minute, papilla-like hairs, with narrow thin entire margins. SUBMERSED LEAF LOBES slightly larger than the floating lobes, oblong-ovate to obovate, thin, membranous. SORI borne in sporocarps. SPOROCARPS of 2 types, usually on the same plant, globose or nearly so, each containing 1 sorus, some with 1 megasporangium containing 1 megaspore, others with numerous microsporangia, each containing 32 or 64 microspores, produced infrequently, in pairs on short submerged stem branches (Fig. 2). SPORANGIA thin-walled, lacking an annulus, breaking open irregularly through decay. MEGASPORES large (0.2–0.6 mm), more or less ovoid, differentiated into a basal hemispheric portion, a medial ring-like collar, and 3 apical sac-like floats, these covered by a more or less conical, cap (the remains of an indusium). MICROSPORES dust-like (10–27 µm), trilete, globose, imbedded in 3 or 4 amorphous translucent masses of cells (massulae), these with the outer surface usually bearing apically barbed trichomes. GAMETOPHYTES reduced, developing inside the spores, the archegonia and antheridia protruding from the spore wall. X = 22. —1 genus, ca. 7 spp., nearly worldwide.

**Azolla** Lam. Mosquito Fern

Characters of the family. (Greek for “to dry” and “to kill”).

The megaspores of *Azolla* species are structurally the most complex of any fern and have an extensive fossil record dating back to the Cretaceous Era. This complex morphology involving differentiation of floats and an indusial cap, as well as the

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barbed microsporangial massulae, presumably is adaptive in bringing the spore types into proximity after their release into the aquatic environment. However, spores are produced only rarely, and spread is more often accomplished by fragmentation of stems and dispersal of plants by waterfowl or other vectors.

Classification of species in the genus depends heavily on megaspore morphology, as well as that of the trichomes on the floating leaf lobes and the barbs covering the massulae. The ca. 5 New World species are included in section *Azolla* and differ from the Old World section *Rhizosperma* (Meyen) Mett. in having apparently dichotomous (vs. pinnate) stem branching, megaspores with three (vs. 9) floats, and barbed (vs. acicular or no) trichomes on the microsporangial massulae. One member of sect. *Rhizosperma*, *A. pinnata* R. Br., is considered a noxious weed in the United States and appears sporadically as a contaminant in commercially grown aquatic plants imported from other regions. It has not been documented yet as an escape in Arizona, but may eventually be found. In addition to the spore and sporangial characters mentioned above, *A. pinnata* is also notable for the pinnate (vs. more or less dichotomous) branching pattern of its stems.

*Azolla* is the most important fern genus in world agriculture. For centuries, farmers in southeastern Asia added *A. pinnata* to rice paddies after the rice was planted as a kind of fertilizer. *Azolla* plants have chambers in the floating leaf lobes that contain a symbiotic filamentous cyanobacterium, *Anabaena azollae* Strasb. The bacteria are capable of fixing atmospheric nitrogen into a nitrate form that can be utilized by other plants as a fertilizer when released from decaying *Azolla* plant remains. Recently, efficient, fast-growing strains of *A. filiculoides* have been among those developed for this purpose.

**Azolla filiculoides** Lam. (diminutive, fern-like). Western Mosquito Fern. —PLANTS 0.7–3.0 cm long, sometimes to 5 cm in cultivation (Fig. 3). STEMS glabrous. FLOATING LEAF LOBES 0.5–0.8 mm long, somewhat convex, usually with hyaline or reddish margins (turning entirely dull reddish brown in the autumn), the minute adaxial trichomes 1-celled. MEGASPORES with the hemispherical portion having irregularly confluent, angular papillae, sometimes appearing irregularly pitted, also sparsely to moderately tomentose with long, loosely curled trichomes; the collar somewhat concave, glabrous, the cap appearing fibrous. GLOCHIDIA with an average of 3–5 crosswalls. $2n = 44, 66$. —Ponds, lakes, and backwaters of rivers, in still or sluggish water, sometimes stranded on mud: Cochise, Coconino, Graham, Greenlee, La Paz, Maricopa, Mohave, Pima, Pinal, Santa Cruz cos. (Fig. 1; also reported, but not vouchered, from Yuma Co.); 600–1200 m (2000–4000 ft); WA to CA and AZ, w Can., Mex., s to S. Amer.; introduced in HI and the Old World.

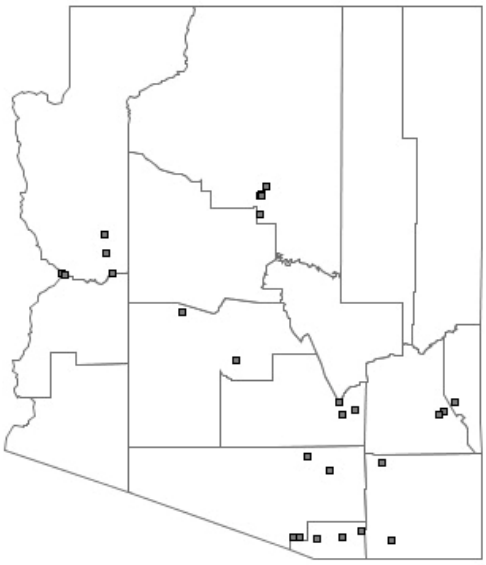
Populations of *A. filiculoides* in Arizona are uncommon and sporadic. Waterfowl move the plants around and eventually it may be discovered at other sites in the state.

## LITERATURE CITED

LUMPKIN, T.A. 1993. *Azollaceae*. Pp. 338–342. *In:* Flora of North America Editorial Committee (eds.). *Flora of North America North of Mexico.* Vol. 2. Oxford University Press, New York.

LUMPKIN, T.A. and D.L. PLUCKNETT (eds.). 1982. *Azolla as a Green Manure: Use and Management in Crop Production*. Westview Press, Boulder.

SVENSON, H.K. 1944. The New World species of *Azolla*. *American Fern Journal* 34: 69–84.



**Azollaceae** Figure 1. Distribution of: *Azolla filiculoides.*


**Azollaceae** Figure 2. *Azolla filiculoides*, closeup of abaxial side with microsporocarps.

**Azollaceae** Figure 3. *Azolla filiculoides*, group of plants adaxial side.