



# RHODORA

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*HYDRILLA VERTICILLATA* (HYDROCHARITACEAE):  
AN UNDESIRABLE ADDITION TO INDIANA'S  
AQUATIC FLORA

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NOTE

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*Hydrilla verticillata*, hereafter referred to as hydrilla, is a submerged freshwater angiosperm, having a cosmopolitan distribution across Africa, Eurasia, the Americas, and Oceania (Cook and Lüönd 1982; Madeira et al. 2000). Its native distribution likely includes Asia, portions of Australia, and perhaps localized areas in central Africa and Europe (Cook and Lüönd 1982; Madeira et al. 2007; Verkleij et al. 1983). In the United States, hydrilla has become naturalized and occurs as a dioecious, pistillate biotype and as a monoecious biotype, each representing a separate introduction (Langeland 1996; Verkleij et al. 1983).

Since its introduction to Florida in the late 1950s (for a detailed account, see Schmitz et al. 1991), the dioecious biotype has expanded its range throughout the southern and southeastern United States, occurring in Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia, and extending westward into Oklahoma, Texas, Arizona (where it has since been eradicated), and California (Madeira et al. 2000). It has recently been discovered in a 10 km stretch of the Bruneau River, which runs through southwestern Idaho (T. Woolf, Idaho Dept. Agriculture, pers. comm.).

The monoecious biotype was first collected from Delaware in 1976 (Steward et al. 1984). Shortly thereafter, it was observed in North Carolina (Langeland and Schiller 1983), Maryland, and Virginia (Steward et al. 1984). As of 2000, it had extended its range

along the Northeast coast and into the Mid-Atlantic region, ranging from Georgia to Connecticut, including sites in Pennsylvania and Tennessee (Madeira et al. 2000). Disjunct populations are located in California and Washington (Madeira et al. 2000). States with recent introductions of the monoecious biotype include Maine, Massachusetts, New Jersey (Jacono and Richerson 2007), and Wisconsin (C. Schaal, Wisconsin Dept. Natural Resources, pers. comm.). Both dioecious and monoecious biotypes occur in California, Tennessee, Georgia, North and South Carolina, and Virginia (Madeira et al. 2000).

In Indiana, plants suspected to be hydrilla were collected on August 7, 2006 by fisheries biologists Jeremy Price and Gwen White of the Indiana Department of Natural Resources (IDNR) during a routine aquatic vegetation survey of Lake Manitou, a 297.5 ha man-made impoundment located in the city limits of Rochester, Fulton County. Samples of putative hydrilla were sent to the two senior authors who were asked to verify the initial identifications. Due to the fragmented condition of the samples, additional material was requested and the specimens were verified as hydrilla on August 22, 2006.

During the aforementioned survey of Lake Manitou, hydrilla was collected from only three of 90 sampling stations scattered across the littoral zone. Two of the collection sites were located in the northeastern portion of the lake near the public boat launch maintained by IDNR. The third locality was approximately 0.5 km directly north of Treasure Island, which is located near the central portion of the lake. The low frequency of occurrence (ca. 3.3%) of this species, the small area from which this species was collected, and the relatively low number of plants retrieved from each site suggest a recent and local infestation confined to discrete patches. However, the senior authors visited Lake Manitou on September 26, 2006 and conducted a qualitative survey to assess the extent of the hydrilla population. During this survey, 15 additional sites were located along both islands and along the eastern and western portions of the littoral zone where hydrilla was found growing as monospecific stands and in mixed patches with *Vallisneria americana* and *Najas flexilis*. Subterranean turions (often reported as stem tubers) were present on plants collected from all of the survey sites. These observations indicate that hydrilla is widespread throughout the lake and may have become established at Lake Manitou earlier than 2006. It is potentially relevant that we did not

observe any species of *Elodea* during our September survey and that an unidentified *Elodea* species was recorded from three of 100 sample points at Lake Manitou in the fall of 2005 (Donahoe and Keister 2005). Unfortunately, voucher specimens were not prepared from the 2005 survey (J. Donahoe, Aquatic Weed Control, Syracuse, IN, pers. comm.), and thus we could not confirm the identity of these plants, which may have been hydrilla.

Since hydrilla is morphologically similar to *Egeria densa* and *Elodea canadensis* and has been misidentified as the aforementioned species in other states (e.g., see Les et al. 1997; Schmitz et al. 1991; Steward et al. 1984), a thorough examination of Indiana collections of Hydrocharitaceae from BUT, IND, and PUL was conducted to determine if an introduction of hydrilla to Indiana prior to Lake Manitou might have gone unnoticed. No specimens of hydrilla were discovered in those collections, and thus the specimens from Lake Manitou represent the first authenticated records of this species from Indiana.

Contrary to reports that have circulated throughout Indiana and neighboring states, the occurrence of hydrilla in Indiana is not the first report of this species from the Midwest. In 1972, hydrilla was introduced into Iowa (Cook and Lüönd 1982) where it was discovered in an ornamental pond located in Pleasant Valley, Scott County (Phillips 2000) and later eradicated before it became a serious threat (Haller 1982, p. 7, Table 1; Phillips 2000).

In the United States, it is widely recognized that both biotypes of hydrilla have become a nuisance, displacing native taxa, clogging waterways, and reducing recreational activities (for a review, see Langeland 1996). In brief, Langeland (1996) described this species as “the perfect aquatic weed,” due to its (1) capacity to prolifically reproduce from vegetative fragments and subterranean and axillary turions, (2) ability to outcompete other species because of its high rate of growth, and (3) broad ecological amplitude with respect to either the tolerance or utilization of nutrients, pH, light, and dissolved carbon.

Although both biotypes are aggressive aquatic weeds, they exhibit different life-history strategies, which may have important implications for lake management (Madiera et al. 2000). The shoot architecture and horizontal growth pattern found in Indiana hydrilla strongly resemble Van’s (1989) descriptions of the monoecious biotype. In an independent assessment of Indiana plants, Mike Netherland, of the Center for Aquatic and Invasive Plants, observed rhizome and subterranean turion formation under long-day (15 hr.)

photoperiodic conditions (M. Netherland, pers. comm.), which is a characteristic of the monoecious biotype (Steward and Van 1987; Van 1989). Indiana hydrilla should be analyzed by molecular techniques using universal primers (e.g., see Madeira et al. 2004) to provide additional evidence on the identity of the biotype.

Because of concerns about the invasive potential of this species, IDNR has launched an aggressive hydrilla eradication program on Lake Manitou that has been projected to last four to six years, with an estimated cost that may exceed \$2 million (Keller 2007). Private and public boat ramps on the lake were closed on October 11, 2006 in an attempt to stop the spread of this undesirable species to other water bodies. At the end of the 2007 growing season, IDNR and private consulting firms had surveyed over 60 lakes within an approximate 100 km radius of Lake Manitou and no additional populations of hydrilla were discovered in adjacent water bodies. Although this eradication program has only been in force since May 2007, it apparently has been successful enough to allow the temporary reopening of the IDNR public boat launch, which occurred on June 28, 2008 (INDR 2008). Further herbicide treatments and restrictions on boat access to Lake Manitou are likely to occur over subsequent years until the eradication of hydrilla is complete.

The hydrilla population at Lake Manitou may not be the only one in Indiana. On September 9, 2008, floating, unrooted plants identified as hydrilla were collected from the western bank of the Ohio River in Charlestown State Park, Clark County (N. Harby, Purdue University, pers. comm.). After first being sent to PUL, a portion of this specimen was forwarded to the authors at the Aquatic Plant Herbarium of Purdue University North Central, Indiana (indicated below as PUNC), who confirmed the initial identification. Unfortunately, the location of the population from which these plants originated has yet to be determined.

VOUCHER SPECIMENS: U.S.A. Indiana: Fulton Co., City of Rochester, Lake Manitou, 41°03'26"N, 86°10'37"W, approximately 22 m southeast of the northeastern public boat launch, in water 1.8 m deep, associated species include *Chara* sp., *Najas* sp., and *Vallisneria americana*, 7 Aug 2006, *J. Price & G.M. White s.n.* (PUNC); 41°03'39"N, 86°11'03"W, in water 0.3 m deep at the mouth of the channel on the west end of the bay directly north of Poet's Point, 22 Aug 2006, *J. Price & B. Peterson s.n.* (PUNC); UTM NAD 83, Zone 16, 567906.7 mE, 4545623.7 mN, material collected two weeks post Komeen® treatment along the western shoreline of Colonial Drive directly east of the dam, plants necrotic, subterranean turions present, rooted in a sand/marl substratum, water depth 1.0 m, water temperature 18.2°C, pH 8.1, specific

conductance 400.8  $\mu\text{S}/\text{cm}$ , total alkalinity 164.0 mg/l  $\text{CaCO}_3$ , salinity 0.2 ppt, associated species include *Ceratophyllum demersum*, *Chara contraria*, *Stuckenia pectinata*, and *Vallisneria americana*, 26 Sep 2006, *M.S. Alix & R.W. Scribailo s.n.* (BUT, F, IND, PUL, PUNC); UTM NAD 83, Zone 16, 568175.7 mE, 4545611.4 mN, collected from open water zone east of Coney Island, plants occur in distinct patches within eel-grass beds, subterranean turions present, axillary turions absent, flowers absent, rooted in a sand/marl substratum, water depth 1.0 m, water temperature 18.7°C, pH 8.5, specific conductance 393.2  $\mu\text{S}/\text{cm}$ , total alkalinity 160.0 mg/l  $\text{CaCO}_3$ , salinity 0.2 ppt, associated species include *Najas flexilis* and *Vallisneria americana*, 26 Sep 2006, *M.S. Alix & R.W. Scribailo s.n.* (BUT, F, IND, PUL, PUNC); UTM NAD 83, Zone 16, 568145.9 mE, 4545669.2 mN, collected from the mouth of the channel next to the red seawall directly east of Colonial Drive, subterranean turions present, axillary turions absent, flowers absent, rooted in a mixture of sand, marl, and gravel, water depth 0.75 m, water temperature 18.8°C, pH 8.5, specific conductance 377.6  $\mu\text{S}/\text{cm}$ , total alkalinity 156.0 mg/l  $\text{CaCO}_3$ , salinity 0.2 ppt, associated species include *Ceratophyllum demersum*, *Potamogeton amplifolius*, and *Vallisneria americana*, 26 Sep 2006, *M.S. Alix & R.W. Scribailo s.n.* (BUT, F, IND, PUL, PUNC); Clark Co., Charlestown State Park, Ohio River Area, UTM NAD 83, Zone 16, 619287 mE, 4250371 mN, collected from the river bank, plants not rooted and perhaps floated in from elsewhere, 9 Sep 2008, *W.E. Thomas 3097* (JEF, PUL, PUNC).

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