

# The Ecology of the Waterwheel Plant, *Aldrovanda vesiculosa*



Chris Doyle, CLM

Allied Biological, Inc. 580 Rockport Road Hackettstown, NJ 07840  
908-850-0303 doyle@alliedbiological.com

## Introduction

*Aldrovanda vesiculosa*, the waterwheel plant, is a fascinating free-floating carnivorous aquatic plant. Although similar to a bladderwort (*Utricularia* spp.), it is most closely related to the well-known terrestrial plant Venus flytrap (*Dionaea muscipula*). *Aldrovanda* has been studied for over 300 years, by some of the most influential scientists. Charles Darwin himself called *Aldrovanda*, "a miniature aquatic *Dionaea*".



In 2012, Allied Biological, Inc. discovered an established population of *Aldrovanda* in the inlet stream of Lake Owassa, located in Sussex County, New Jersey. This population was previously undocumented, but several introduced populations have been reported from New Jersey, New York, and coastal Virginia. World-wide only about 50 extant populations of *Aldrovanda* have been confirmed, although many unverified and extinct sites are documented. In May, 2012, Adam Cross, a Ph. D. student from Perth, Australia, published a comprehensive book on the ecology and life history of *Aldrovanda*. That text was heavily referenced during the creation of this poster, an introduction to the fascinating traits and ecology of *Aldrovanda*.

## Nomenclature



- Plantae
- Angiosperms
- Eudicots (core eudicots)
- Caryophyllales
- Droseraceae
- *Aldrovanda*
- *vesiculosa* L.



## Etymology

***Aldrovanda***, after the founder of the Bologna Botanic Garden, Ulisse Aldrovandi  
***vesiculosa***, from the Latin vesicula (meaning small bladder), and the suffix *-osus* (meaning abundant)

**Fun Fact:** Due to an orthographic error by Linnaeus, the "i" was dropped from *Aldrovanda* in 1753. Yet the spelling *Aldrovanda* (without the "i") is still accepted today (Duval-Jouve, 1861).

## Description

- **Perennial, Free-floating, Rootless Herbaceous Aquatic Plant**
- **Simple or Sparsely-branched Stem**
  - Stem is air-filled to aid in floatation
  - Stem length varies between six to 20 centimeters
  - Influenced by water quality, prey abundance and irradiance
- **Plant Growth is Strictly Directional**
  - Terminal apical bud at anterior
  - Continual senescence of older whorls at posterior end
  - Maintains near constant length during active growth
- **Whorls Consist of Four to Nine Leaves**
  - Up to 23 mm in diameter
  - Petioles tipped with a single trap (Lamina)



## Lamina (trap) Morphology

- **Adapted Foliage Designed to Capture and Digest Prey**
  - Twisted orientation opens away from stem to open water
  - Increased prey capture efficiency
- **Two Lobes of Translucent Tissue**
  - Inside studded with trigger hairs (30-40) and digestive glands
  - Margin has delicate flexible membranous "teeth"
  - Possible passive selective feeding
    - Interior hairs mimic algae filaments (Schell, 2003)
    - Mosquito larvae always captured head first
- **Lamina Snaps Shut in 0.01 seconds**
  - Fastest recorded plant movement in the world
  - Open again in 2-3 hours if no prey inside
- **Carnivory**
  - Lamina size dictates prey size
  - Typical prey includes ostracods, amphipods, *Daphnia*, waterbears, midge larvae
  - Occasionally, *Gammarus* shrimp, tadpoles, and juvenile fish



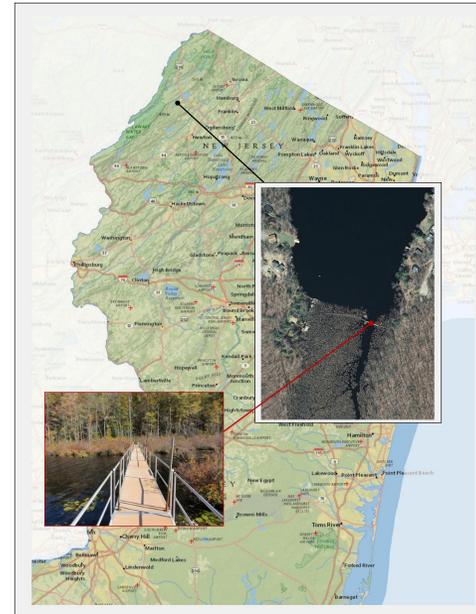
## New Jersey Location

- Discovered on 10/11/12**
- Southern inlet stream of Lake Owassa
  - Bear Swamp Wildlife Management Area
    - Owned by NJDEP
    - 2,925.39 acres
      - Part of the Kittatinny Forest
        - Oak, beech and maple
      - Freshwater wetlands
      - Open water



**GPS Coordinates**  
41° 08'27.08" N  
74° 49'09.31" W

**Associated Aquatic Vegetation on Site**  
Common bladderwort (*Utricularia vulgaris*)  
Spiny hornwort (*Ceratophyllum echinatum*)  
Ribbon-leaf pondweed (*Potamogeton ephedrus*)  
Slender naiad (*Najas flexilis*)  
White water lily (*Nymphaea odorata*)  
Slender riccia (*Riccia fluitans*)  
Small duckweed (*Lemna minor*)  
Great duckweed (*Spirodela polyrrhiza*)  
Common bur-reed (*Sparganium eurycarpum*)



## Habitat and Worldwide Distribution

### *Aldrovanda* Inhabits:

Wetlands, fens, billabongs, streams, and lake littoral zones

- Prefers (but not limited to) nutrient impoverished oligo-mesotrophic sites and dystrophic (humic) sites
- Habitat suitability linked to abiotic and biotic factors

### Abiotic Factors

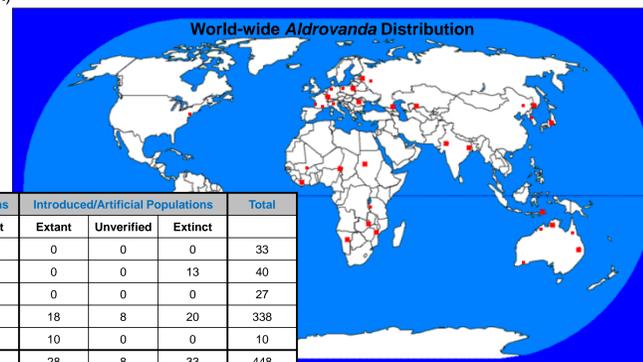
Water Temperature  
Water Depth  
Irradiance (20% to 60% total sunlight)  
pH (5.0 to 6.8)  
Nutrient Loading  
Water Chemistry

### Biotic Factors

Assoc. Vegetation (30-70% cover)  
Prey Abundance  
Predation

### Critical Habitat Factors

- High Summer Water Temperatures
- Minimum Maintained Water Depth (3-5 cm)
- High Free CO<sub>2</sub> Concentration
  - 0.5 to 2.0 mM
- Prey Abundance
  - 6,000 to 20,000+ zooplankton per L



Continent	Natural and Restored Populations			Introduced/Artificial Populations			Total
	Extant	Unverified	Extinct	Extant	Unverified	Extinct	
Africa	7	26	0	0	0	0	33
Australia	5	22	0	0	0	13	40
Asia	0	7	20	0	0	0	27
Europe	38	90	164	18	8	20	338
North America	0	0	0	10	0	0	10
<b>Total</b>	<b>50</b>	<b>145</b>	<b>184</b>	<b>28</b>	<b>8</b>	<b>33</b>	<b>448</b>

Table 1: Summary of World-wide Population Status of *Aldrovanda* (modified from Cross, 2012)

Map Modified from Cross, 2012

### Natural *Aldrovanda* Populations<sup>1</sup>

(# of sites; E=extant, U=unverified, X=extinct)

- Africa**  
Botswana (5E, 2U), Burundi (1U), Cameroon (2U), Chad (4U), Ghana (3U), Malawi (1U), Mozambique (1U), Rwanda (1U), South Africa (2E), South Sudan (2U), Tanzania (4U), Togo (1U), Uganda (1U), Zambia (3U)
- Europe**  
Austria (4X), Belarus (22U), Bulgaria (2E), Croatia (2U), Czech Republic (1X), France (18X), Germany (21X), Greece (1E), Hungary (1E, 2U, 4X), Italy (17X), Lithuania (1E, 2X), Montenegro (1U), Poland (12E, 75X), Romania (1E, 16U), Russia (2E, 37U), Serbia (1E, 8X), Slovakia (1X), Turkey (1U), Ukraine (18E, 8U, 13X)
- Asia**  
Bangladesh (2X), China (2U), India (2X), Japan (12X), Kazakhstan (3U, 2X), Uzbekistan (1X), North Korea (1U), South Korea (1U), East Timor (1X)
- Australia**  
Western Australia (3U), Northern Territory (2E, 13U), Queensland (2U), New South Wales (3E, 4U)
- North America** (Introduced Only)  
New Jersey (2), New York (1), Virginia (8)



1. Cross, 2012

## Reproduction

- **Reduced Capacity to Sexually Reproduce**
  - Typical of most aquatic plants
  - Sporadic and unpredictable flower production
    - *Aldrovanda* in warmer climates tend to produce flowers more often
  - Flowers are borne on pedicels from modified axes lacking traps
  - Five-partite tiny flowers with five green sepals and five white petals
    - Flowers only open for 2-3 hours, usually under high irradiance
  - Plants are self pollinated, but with poor efficiency
  - Fruit development takes 2-4 weeks; only 1 to 10 seeds produced per fruit
- **Vegetative Reproduction More Common**
  - Propagules are abundant and available in 100 to 120 days
    - Stems are brittle and readily fragment (waterfowl)
    - Morphology is resistant to desiccation
- **Over Winter via Turion Production**
  - Turions are extreme condensation of filiform leaves situated on modified whorls
  - Produced in temperate regions before frost
  - Can rise or sink based on water temperature



## Predators, Diseases, Pests

### *Aldrovanda* Predators

- Juvenile fish and tadpoles
- Herbivorous aquatic snails
- Waterfowl (ducks, swans, waders)
  - Indirect damage to *Aldrovanda* while foraging
  - Sometimes *Aldrovanda* is directly consumed



### Cultivated *Aldrovanda* Susceptible to "Aldrovanda Disease"

- Originally thought to be caused by boron deficiency
- Recently linked to a fungal pathogen (genus *Fusarium*)

### Filamentous Algae Inhibits Growth and Feeding of *Aldrovanda*

## Vectors of Spread

- **Waterfowl**
  - Strong correlation between distribution and migratory bird routes
    - Likely only stem fragments or turions via exozoochory
    - Seeds and fruits likely can't survive gut transport
  - Waterfowl foraging activity increases dispersal
- **Water Flow**
  - Streams and rivers attached to wetlands and lakes
- **Flooding**
  - Floodplain dispersal, wind, and increased water flow
  - Hurricane Irene (August 28, 2011)
  - Super Storm Sandy (October 29, 2012)

Loss of wetland habitat (especially in Europe) is limiting natural dispersal



Breckpot, 1997.

## Documentation

### Pressed *Aldrovanda* Samples to be Submitted to:

- Brooklyn Botanic Garden (Brooklyn, New York)
- Chrysler Herbarium (Rutgers University, New Jersey)
- Academy of Natural Sciences (Philadelphia, Pennsylvania)



### References

- Cross, A. 2012. *Aldrovanda The Waterwheel Plant*. Redfern Natural History Productions. 250 pp.
- Breckpot, C. 1997. *Aldrovanda vesiculosa: Description, Distribution, Ecology and Cultivation*. Carnivorous Plant Newsletter 26, p 73-82.
- Darwin, C. 1876. *Insectivorous Plants*. D. Appleton and Company, New York.
- Duval-Jouve, J. 1861. *Letter to Schoenfeldt*. Bulletin de la Societe Botanique de France, 8, p 518-519.
- Schell, C. 2003. *A note of the possible prey selectivity in the Waterwheel Plant (Aldrovanda vesiculosa) and a possible prey attraction*. Carniflora Australis, 1, p 18-19.