EPPO Datasheet: *Myriophyllum heterophyllum*

Last updated: 2024-01-02

IDENTITY

Preferred name: *Myriophyllum heterophyllum*
Authority: Michaux
Taxonomic position: Plantae: Magnoliophyta: Angiospermae: Basal core eudicots: Saxifragales: Haloragaceae
Common names: broad-leaf water milfoil (US), variable water milfoil (US), variable-leaf water milfoil
view more common names online...
EPPO Categorization: A2 list, Alert list (formerly)
view more categorizations online...
EU Categorization: IAS of Union concern
EPPO Code: MYPHE



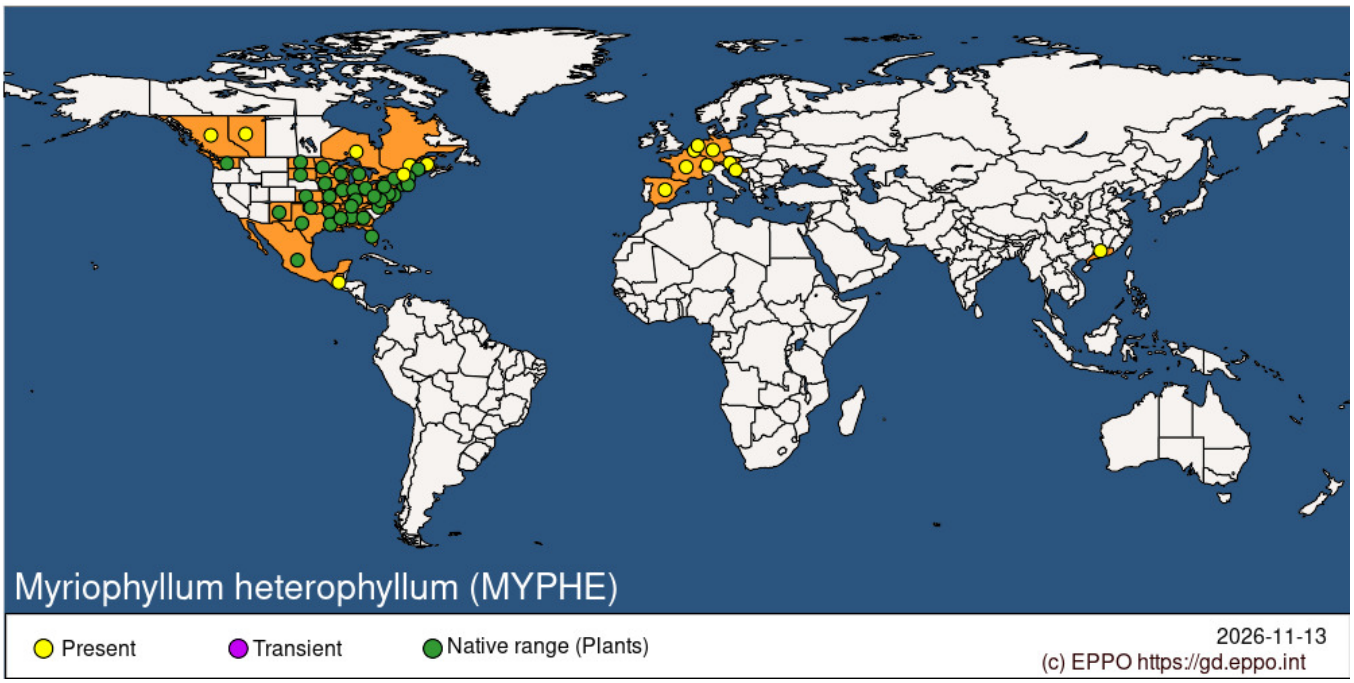
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GEOGRAPHICAL DISTRIBUTION

History of introduction and spread

It is generally regarded that in North America, *M. heterophyllum* is native to the Eastern United States with a distribution throughout the southern region, and in the north, westwards to North Dakota (ENSR International, 2005). The species is considered invasive in much of the north-east (New England region) (http://www.invasive.org/).

In Europe *M. heterophyllum* is established in Austria, Belgium, France, Germany, Hungary, the Netherlands, Spain and Switzerland. *Myriophyllum heterophyllum* has not been recorded in the UK since 1969 (BSBI, 2012); efforts were made to confirm the absence in 2015. In Belgium, the species was first observed in 1993 (Bouxin & Lambinon, 1996). The species appears to be established in several localities but does not seem to spread in an invasive way. Its current distribution is the Kempen region of Belgium (http://ias.biodiversity.be/, 2015). In France *M. heterophyllum* was found in 2011 in a large covered private pond in Saint-Sylvestre in the HauteVienne Department (Lebreton, 2013) and it is also known from the Landes, Rhone and Pyrénées-Atlantiques Departments (Lebreton, 2013) . *M. heterophyllum* was found in East Germany in 1960s (Stricker, 1962) and it arrived in West Germany (Nordrhein-Westfalen) in 1979 (Spangehl & Scharrenberg, 1985). In Germany there has been little spread but the current populations are stable and dominant within the submerged vegetation. The first record of *M. heterophyllum* in the Netherlands was in 1999 (van Valkenburg, 2011). In 2007, *M. heterophyllum* was observed dominating a canal in Orvelte. In 2008, the plant was found in Loosdrecht and Maasbracht (an inland harbour). In 2010, it was recorded in Leeuwarden, again in urban canals. At present the species can be found throughout the south-east and central parts of the Netherlands (http://www.verspreidingsatlas.nl/5500).



EPPO Region: Austria, Belgium, Croatia, France (mainland), Germany, Netherlands, Spain (mainland), Switzerland
Asia: China (Guangdong)
North America: Canada (Alberta, British Columbia, New Brunswick, Ontario, Québec), Mexico, United States of America (Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, Wisconsin)
Central America and Caribbean: Guatemala

MORPHOLOGY

Plant type

An aquatic evergreen perennial (submerged species).

Description

Myriophyllum heterophyllum is a perennial evergreen submerged aquatic herb, having both submerged and emergent leaf forms. Submerged leaves are feather-like and pinnate (2–5 cm long and 2–4 cm wide). Each leaf has 4– 10 pinnae. Emergent leaves can take two forms, either a terrestrial form (pinnately dissected), which is expressed when growing on damp mud, or an emergent leaf form (entire toothed) on a stem on which flowers are produced. Emergent leaves are variable in both shape and structure, 4–30 mm long, 1.5–3 mm wide and stiff in texture. Flowering is rarely observed throughout its native and invasive range (Global Invasive Species Database, 2011), but when it does flower, female flowers are small, red in colour and appear from the nodes along the stems of specialized emergent leaves from May to October (Brown *et al.*, 2014). Flowers are only produced on the emergent part of the stem which can often be exposed 10–15 cm above the water surface. Like other submerged aquatic plants, *M. heterophyllum* readily produces fragments that are capable of dispersal and regeneration (Hussner & Krause, 2007). Molecular DNA barcoding has been developed for *M. heterophyllum* (Ghahramanzadeh *et al.*, 2013) to detect the presence of the species in trade and to separate it from unidentified wild populations. The spread of *M. heterophyllum* occurs predominately via clonal reproduction and fragmentation.

BIOLOGY AND ECOLOGY

General

There is no seed production within the EPPO region, thus there is no likelihood of dispersal by seed. Small stem fragments (<1 cm) that contain at least one node have a high capacity to regenerate new plants and thus could initiate new infestations. Regeneration is even possible from single leaves, though this is generally unlikely. Compared with most other submerged macrophytes, stems of *M. heterophyllum* are more robust and tend to remain intact all year round, resulting in a low incidence of autofragment production. However, physical disturbance caused by human, fish and water-bird activity can lead to the production of allofragments.

Habitats

Myriophyllum heterophyllum grows in slow-moving rivers, irrigation channels, ponds, lakes, canals and damp ditches (Peters, 2004; Hussner *et al.*, 2005; De Beer & De Vlaeminck, 2008; Valkenburg, 2011; Brown *et al.*, 2014). A semi-terrestrial form can be found between the interface of the aquatic and terrestrial environment on mudflats and boggy land (CABI, 2015), but this is a survival strategy rather than a preferred growth form when water levels drop. It is able to grow in water up to 9.5 m deep (Hussner *et al.*, 2005; Hussner, pers. comm., 2015).

Environmental requirements

Myriophyllum heterophyllum can grow in a wide range of physical and chemical conditions (Brown *et al.*, 2014). It can tolerate high summer temperatures as well as cold winter temperatures, when it can be covered by ice during the winter months (Brunel *et al.*, 2010). There are few data on the exact temperature requirements for this species within the EPPO region. The optimum temperature for *M. heterophyllum* is about 20°C and plants grow best under high availability of carbon dioxide, even though the species can use bicarbonate as an additional carbon source for photosynthesis (Hussner & Jahns, 2015). The light saturation point for *M. heterophyllum* is between 200 and 300 micromole m^2 s^{-1} (Hussner, 2008), which is quite low but in the normal range for submerged aquatic plants, indicating shade tolerance.

Natural enemies

The following insects have been observed to feed on emergent or submerged leaves, petioles and stems of *M. heterophyllum* in the USA: *Donacia cincticornis* Newman, *Perenthis vestitus* Dietz, *Mystacoides longicornis* L., *Oecetis cinerascens* Hagen, *Triaenodes injusta* Hagen, *Triaenodes marginata* Sibley, Triaenodes spp (McGaha, 1952). As the species is non-native within the EPPO region there are no co-evolved natural enemies that would significantly impact on the invasive population.

Uses and benefits

Myriophyllum heterophyllum is used within the aquatic ornamental plant trade, though within the EPPO region the species is never sold under its proper name (see Pathways for movement).

PATHWAYS FOR MOVEMENT

Within the EPPO region, *M. heterophyllum* is used in aquaria and as an ornamental plant in outdoor ponds. The plant is sold throughout the EPPO region as an ornamental aquatic species but never under its proper name. van Valkenburg (2011) reports that there are no records of *M. heterophyllum* in the aquatic plant trade in the Netherlands under its proper name. van Valkenburg & Boer (2014) lists *M. hippuroides* Torr. & Gray, *M. propinquum* Cunn. and *M. scabratum* Michx. as mis-applied or mistakenly used names for *M. heterophyllum* in trade in the Netherlands.

IMPACTS

Effects on plants

Dense monospecific growth of any aquatic plant species can have negative impacts on native plant communities and other aquatic organisms such as invertebrates and fish (Carpenter & Lodge, 1986). *M. heterophyllum* has both environmental and economic impacts in the EPPO region.

Dense mats of *M. heterophyllum* reduce light to other submerged plants and can affect water quality by reducing oxygen levels, resulting in avoidance of the infested area by fish. The maximum dry weight recorded for this species is very high, measured at 4 kg m^2 in old infestations (Hussner, pers. comm., 2015). Additionally, the pH within *M. heterophyllum* stands can vary between 7 and 10.5 on a diel basis, increasing stress for fish populations and reducing available habitat for other macrophyte species. In the Oranjekanaal in the province of Drenthe (the Netherlands) the turbidity of the water decreased greatly when *M. heterophyllum* invaded the canal (Matthews *et al.*, 2013). Retention of sediments can act to impede the lifecycle of high trophic levels by smothering spawning grounds for fish.

Many rivers and lakes with the EPPO region are either protected areas or contain protected species that may be adversely affected by dense mats of *M. heterophyllum.* The presence of *M. heterophyllum* in rivers and lakes can act to degrade such habitats, reducing the ecological status of water bodies. In Belgium, the species grows alongside several rare and vulnerable aquatic native species including *Luronium natans* (L.) Raf., a Red List species. In some nature reserves in Germany the species occurs as the dominant species with up to 95% coverage of the whole water body (Hussner, pers. comm., 2015).

Myriophyllum heterophyllum is known to hybridize with *M. laxum* Shuttlew. Ex Chapm. and *M. hippuroides*, both very closely related species (Moody & Les, 2002). However, as detailed by Newman (2014), closely related species from the Spondylium subsection do not occur in the EPPO region and therefore hybridization seems very unlikely. In the USA *M. heterophyllum* has the potential to hybridize with the native *M. pinnatum* (Walter) Britton, Sterns & Poggenb. forming *M. heterophyllum* x *pinnatum* which is a more aggressive hybrid, and considering the number of *Myriophyllum* 'species' in trade, hybridization in future may result in more aggressive invasive species (Moody & Les, 2002; Thum & Lennon, 2006; Tavalire *et al.*, 2012).

Environmental and social impact

Myriophyllum heterophyllum can reduce the aesthetic value of water bodies and restrict water-related recreational activities including fishing, swimming and boating (Hussner, pers. comm., 2015).

The decay of large plant masses results in elevated levels of dissolved and suspended organic matter in the water column (Carpenter & Lodge, 1986). Furthermore, large populations act to increase sedimentation (Carpenter & Lodge, 1986). Monospecific stands can negatively affect wildlife (predator/prey relationship among fish, impede predation, shelter prey fish, cover spawning areas).

In the USA, *M. heterophyllum* has been recorded as reducing house prices by 20–40% when the species grows along lake shores (Halstead *et al.*, 2003). Invasive aquatic weeds can cause high economic impacts to areas they invade, both in terms of management and loss of earnings by degrading the areas (Williams *et al.*, 2010). In drainage and irrigation systems the presence of the species reduces water availability and flow. Hydropower and drinking water resources can be affected as the plant clogs up waterbodies.

CONTROL

In a study in Maine, USA, three physical control methods (hand removal, cutting and benthic mats) were assessed for *M. heterophyllum* (Bailey & Calhoun, 2008). All three methods significantly lowered regrowth, though the cost of both hand pulling and cutting was one-third the cost of benthic mats. Benthic mats can only be applied in small infestations.

Washing out plant stands using a hydro-Venturi system has been practised in the Netherlands for the management of both *M. heterophyllum* and *Cabomba caroliniana* Gray. The system removes both the root system and the foliage, resulting in long-term control (van Valkenburg *et al.*, 2011). The cost of a hydro-Venturi system, when taking into account all preparatory work and aftercare, can be in the region of EUR 1.35–2.05 m^2 (van Valkenburg, pers. comm.,

2015). This depends on the dimensions of the waterways, sediment types, etc. (van Valkenburg *et al.*, 2011).

Small, recently detected infestations may be successfully eradicated through careful and thorough hand-pulling or using a tarpaulin. Great care should be taken with such methods since they cause fragmentation of the plant and therefore increase potential spread. Benthic barriers may be used in small areas (swimming beaches, boating lanes, around docks) to restrict light and upward growth. Nevertheless, barriers can have a negative impact on benthic organisms and need to be properly maintained.

Dense stands occurring in shallow lakes in the vicinity of Dusseldorf (NordRhine Westfalia, Germany) have been regularly cut in summer using a weed cutting boat without any long-term effect (Hussner *et al.*, 2005; Hussner & Krause, 2007). Mechanical control of *M. heterophyllum* in these lakes, where 190 tonnes of fresh weight was removed, cost in the region of EUR 45 000 (Hussner & Krause, 2007). Again, since the 1990s, repeated cutting in a lake in the Ville area has not decreased the population in the long term. However, mechanical control options may be better practised during the winter time, when the plant is less active and regrowth is less likely, to reduce the effect on native vegetation and to reduce the competitive advantage of *M. heterophyllum* in spring.

Drawdown (see http://www.ecy.wa.gov/programs/ wq/plants/management/drawdown.html) can also be used to control *M. heterophyllum* where applicable, if it is extensive enough to prevent regrowth, but this control method could have a negative impact on native plants and animals (fish, reptiles, amphibians, etc.).

Herbicide control (e.g. diquat-dibromide and 2,4-D) is recommended in some US states to manage this species (Getsinger *et al.*, 2003). Triclopyr is effective against *M. heterophyllum* over a wide range of concentrations and exposure times. Carfentrazone-ethyl has been shown to be effective against *M. heterophyllum* (Glomski & Netherland, 2007). Diquat applied at 370 microgram a.s. per L for 30 h provided good control (85%) and carfentrazone significantly reduced *M. heterophyllum* biomass. Fluridone and penoxsulam are also reported to control *M. heterophyllum* at rates as low as 5 and 10 microgram a.s. per L, respectively (Glomski & Nertherlands, 2008). None of the active ingredients are currently approved for use in the EU.

Grass carp (*Ctenopharyngodon idella*) have been used in Dusseldorf after the failure of mechanical control, but they have not eradicated the species. In the USA, Hanlon *et al.* (2000) showed a reduction in cover in 6 years from 54% to 24% when grass carp were present.

REGULATORY STATUS

Myriophyllum heterophyllum is included in the EU Regulation (1143/2014) and listed as a species of Union concern.

Within the EPPO region, as a result of a Code of Conduct in the Netherlands all major growers and retail chains agreed not to sell *M. heterophyllum* after 2013 (Verbrugge *et al.*, 2014). In Belgium, different initiatives regarding regulation are in preparation or being applied. At the federal level there is a Royal Decree in preparation to prohibit the import, export and transit of *M. heterophyllum*. In Wallonia, the Circulaire Wallonne (Version 2013) prohibits the use of *M. heterophyllum*. In a Code of Conduct there is a so-called ‘consensus species list’ that horticulture professionals agreed to withdraw from sales or plantations (Halford *et al.*, 2011). *M. heterophyllum* appears on that list. It is assigned to the Black List and classified as an A1 species (isolated populations but with a high environmental risk). In Germany, *M. heterophyllum* is included on the Black List/Action List of invasive alien plants in Germany. According to paragraph 40 (BNatSchG, 2009), these species that are on the Action List should be targeted by the local authorities. A Pest Risk Assessment was produced specifically for Germany (Ahlburg *et al.*, 2009). A Rapid Risk Assessment has been produced for the GB Non-Native Species Secretariat (Newman, 2014).

PHYTOSANITARY MEASURES

For plants for planting EPPO (2015) recommends:

(1) Prohibition of import into and within the EPPO region. Because many species are imported under incorrect names it is necessary to screen imported aquatic plants for the presence of *M. heterophyllum*. *M. heterophyllum* should be recommended as a quarantine pest within the EPPO region. Techniques for confirmation of exact species identification, including molecular methods are available (Van Valkenburg & Boer, 2015; Ghahramanzadeh *et al.*,

2013).

(2) In addition to the existing requirement for a phytosanitary certificate (PC) by the exporting country, confirmation of the correct identification and labelling of the species should be required (see EPPO Standard PM 1/1(2) Use of phytosanitary certificates).

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