European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Data sheets on quarantine pests
Fiches informatives sur les organismes de quarantaine

Hydrocotyle ranunculoides

Identity

Scientific name: *Hydrocotyle ranunculoides* C. Linnaeus.
Synonym: *Hydrocotyle natans* Cirillo.
Taxonomic position: *Apiaceae*.
Common names: floating pennywort, marsh pennywort, greater water pennywort (English), hydrocotyle flottante (French), grote waternavel (Dutch), grosser Wassernabel (German), sombrerito de agua (Spanish).
Notes on taxonomy and nomenclature: the plants which have been reported as invasive in northern Europe are believed to originate in North America. However, there are also EPPO – region records in southern Italy, Palestine and Caucasus, which were referred to as *H. natans* Cirillo in the 19th century. This species has since been synonymized with *H. ranunculoides* (e.g. in *Flora Europaea*; Tutin *et al*., 1968), or referred to its var. *natans* (Cirillo) Urban. The present status of these forms is not clear, and there is no indication that they have ever been invasive. The *European Garden Flora* (Cullen, 1997) synonymizes *H. ranunculoides* with *Hydrocotyle americana* Linnaeus, implying that this species is distinct from the Mediterranean *H. natans*. Since *H. ranunculoides* also occurs in sub-Saharan Africa, more information is needed on the similarities or differences between New World and Old World populations.
EPPO code: HYDRA.
Phytosanitary categorization: EPPO A2 Action list no. 334.

Morphology

Plant type

H. ranunculoides is a stoloniferous, perennial, aquatic plant, with floating and emergent leaves. It is both vegetatively and seed-propagated.

Description

H. ranunculoides is entirely glabrous, with stems floating in water or creeping onto shorelines. Stems are slender and root freely from nodes at about 4–6 cm intervals. Roots are profuse and hair-like. Leaves are alternate, emergent and held above the horizontal stem on long fleshy petioles, non-peltate, suborbicular to reniform with a cordate base, and frequently broader than long, shallowly or deeply 3–7-lobed, the lobes rounded, crenate or lobulate and subequal. They reach a diameter of 18 cm in suitable habitats in the United Kingdom. Petioles grow up to 35 cm. Flowers hermaphrodite, white, 5–10 grouped together in a small umbel, borne on a leafless stalk, shorter than the petiole. No sepals, 5 unconnected petals, 5 stamens: ovary inferior, two-lobed, 2 styles. Fruits are nearly round and flat, brownish, with faint ribs and divided into two halves, each with a small persistent stalk (Mathias & Constance, 1976; Northern Prairie Wildlife Research Center, 1999; Huckle, 2002; Washington State Department of Ecology, 2004).

Similarities to other species

In Europe, plants are sometimes falsely identified as the native *Hydrocotyle vulgaris*.

Biology and ecology

General

H. ranunculoides is a stoloniferous aquatic perennial plant with floating and emergent leaves. It roots in the shallow margins of slow-flowing waters. In the UK, the Netherlands and Australia, it forms dense interwoven vegetation mats, rapidly covering the water surface. It has been observed to grow 20 cm per day in the UK under appropriate conditions and it is very competitive, forming monospecific stands. Leaf matter can grow up to 40 cm above the water surface and roots and stems can sink up to 50 cm into the water (Huckle, 2002).

The plant reproduces primarily by vegetative reproduction, though spread by seed has been observed through sewage treatment works. It can regenerate even from small root fragments. It flowers in July–October in its native range.

Chromosome number: $2n = 24$. There is a wide range of polyploids within the genus *Hydrocotyle*, with up to 15-ploidy (Moore, 1971, Federov, 1974). Newman (unpubl.) found four distinct groups of *H. ranunculoides* in the UK population which can be separated by AFLP analysis. There is uncertainty about the extent to which different levels of ploidy between populations influences invasiveness.

Habitat

The plant is native to North America. Intended habitats in areas where the species is intentionally imported are aquaria and

garden ponds. Unintended habitats are slow-flowing and eutrophic water bodies, especially ponds, ditches, dykes and streams. *H. ranunculoides* also colonizes marshes, lake margins and other wet ground and mesotrophic water bodies, e.g. fenland pools. The species prefers high concentrations of nitrate and phosphate, and/or organic matter. The high content of fertilizers in many European waterways due to agricultural practice therefore favours the establishment of this species. It grows below 1500 m (Washington State Department of Ecology, 2004; Newman & Dawson, 1999; van der Krabben & Rotteveel, 2003).

Environmental requirements

The areas *H. ranunculoides* currently invades differ strongly in humidity and temperature, indicating that the species is very adaptable. Low frost tolerance seems to be a limiting factor for the distribution of this plant, though other plants (e.g. *Glyceria maxima*) provide shelter from frost for *H. ranunculoides* in margins and on non-mown banks.

Climatic and vegetational categorization

H. ranunculoides is typically associated with climates Af, Cf and Dfa in Köppen's classification, i.e. warm to hot summer, cool to hot winter, wet year round. It may also survive in climate Cs (hot dry summer, cool wet winter). It is hardy to zone 7 (–15°C). It is associated with the vegetation zones: temperate to tropical deciduous forests, temperate steppes, Mediterranean sclerophyllous forests.

Natural enemies

There is no information on natural enemies in areas where *H. ranunculoides* has invaded.

Geographical distribution

EPPO region: confirmed presence in Belgium, France, Italy, the Netherlands, Portugal, Spain, the UK. In Italy, present from Toscana southwards, including Sardegna and Sicilia (Pignatti, 1982). Old records in Palestine and Caucasus, originally under the name *H. natans* (see Notes on taxonomy and nomenclature).
Asia: Israel (old record), Yemen (Wood, 1997).
Africa: Angola, Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zaire (Gonçalves, 1978); Rwanda (Troupin, 1978). Possibly also Sudan and Zimbabwe (untraced records).
North America: Canada, Mexico, the USA (Alabama, Arizona, Arkansas, California, Delaware, Florida, Georgia, Illinois, Kansas, Louisiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, West Virginia). In some States (Illinois, New Jersey, New York) it is considered as an endangered species. Further details on American records can be found on the USDA website http://plants.usda.gov and http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl (USDA, 2004; USDA-ARS, 2004).
Central America and Caribbean: Costa Rica, Cuba, Guatemala, Nicaragua, Panama. Martin & Hutchins (1981) indicate presence in Tropical America generally.
South America: Argentina, Bolivia, Brazil, Chile, Ecuador, Paraguay, Peru, Uruguay.
Oceania: Australia (Western Australia) (Ruiz Avila & Klemm, 1996).

History of introduction and spread

The main pathway of introduction is via the aquatic nursery trade. *H. ranunculoides* was first recorded in the wild in the UK in 1990. According to Newman & Dawson (1999), it was present at 29 sites in the south-east of England and in southern Wales, in a wide range of water body types and had increased to 71 recorded observations by 2001–01 (Huckle, 2002). A first infestation in the Netherlands was detected and controlled in 1995 (Baas & Duistermaat, 1999). In France, *H. ranunculoides* has been reported in pools in the Essonne valley south of Paris and in the Dombes area (near Lyon); invaded pools are completely covered by the end of the season, but there is currently no spread to other water bodies. The species has been present in some southern European countries since at least the 1970s.

The infestation in the UK is assumed to have originated from a single clone which was sold by aquatic garden centres and nurseries (Newman & Dawson, 1999). In the Netherlands, the spread of this plant is now regarded as unstoppable, because it is already flowering and fruiting there in May (van der Meijden *et al*., 2001).

In 1983, the plant was observed for the first time in the urban drainage network in the Canning River Regional Park in Western Australia. Eight years later, it had spread throughout the drainage system into the river and nearby wetlands (Ruiz Avila & Klemm, 1996).

Pathways of movement

Fragments of plants are transported by flowing water to new locations. Waterfowl can spread viable fragments of the plant (Huckle, 2002), and this is also suggested as a pathway for spread in France. The main pathway of movement is, however, distribution and sale by the aquatic nursery trade. This may also involve contamination of other aquatic plants with fragments of *H. ranunculoides*. Spread from the intended to the unintended habitat then occurs primarily as a result of cleaning aquaria and garden ponds where *H. ranunculoides* has been grown.

Impact

Effects on plants

The potential of *H. ranunculoides* to become a weed was first stated in a publication dating from 1936 (Huckle, 2002). Due to its vigorous growth, *H. ranunculoides* causes loss of light and reduction in dissolved oxygen content. The native aquatic flora

can be outcompeted and ecosystem functions can be altered. As a consequence, keystone species, endangered species and biodiversity can be reduced. In the EPPO region, where present, *H. ranunculoides* competes with many plant species in the habitats it invades. These may include water-edge plants such as species of *Carex*, *Juncus*, *Myosotis*, *Rorippa* and also submerged aquatic plants shaded out by the capability of *H. ranunculoides* to build floating carpets.

Environmental and social impact

H. ranunculoides is a useful plant in aquaria and garden ponds, but other species could adequately replace it. When it spreads to unintended habitats, it presents a lasting threat to the native recreational flora. Though Baas & Holverda (1996) initially stated that *H. ranunculoides* would cause no significant harm in the Netherlands, this statement had to be retracted only three years later by Baas & Duistermaat (1999), as they then expected this plant to cause major impact on plants in nature reserves and recreation areas. *H. ranunculoides* can damage waterworks and, as well as displacing native flora through competition, can affect fauna by habitat modification (van der Krabben & Rotteveel, 2003). Dense mats reduce penetration of light to the water below and oxygen shortage may induce high fish mortality. Strongly invaded waters loose their attractiveness and safety for recreation. Flooding may be caused by heavy infestations chocking drainage systems and sluices. Plants accumulate heavy metals, making disposal of plant material problematic.

Summary of invasiveness

H. ranunculoides is an American aquatic plant which has been on sale in Europe as a garden or aquarium plant for at least 20–30 years and has become established in non-contained conditions in several western European countries. In the UK and Netherlands, it has shown its capacity to invade water courses by forming extensive floating mats of vegetation, excluding native floating and submerged aquatic plant species, and interfering with human use of the water courses. Its potential spread to other water bodies and catchments is almost entirely dependent on human agency. *H. ranunculoides* has negative impacts principally on biodiversity and the environment, tourism and transport. *H. ranunculoides* is included in the EPPO Alert List and is considered as invasive by the PRA conducted by Schrader *et al*. (2005).

Control

Mechanical control

In the case of mechanical removal, the areas of concern should be fenced or netted off, to reduce the risk that water downstream is infested. Also, all cut plant material should be removed from the water, otherwise spread and impact can even be increased due to the high regeneration capability of the species. The first infestation in Dutch urban waterways in 1995 was apparently controlled successfully by mechanical removal of plant material and a severe winter. Now the situation has changed and the plant proved to be hardy to severe frosts when protected by surrounding vegetation. Baas & Duistermaat (1999) conclude that *H. ranunculoides* in the Netherlands is now very unlikely to be controlled by man.

Chemical control

According to Newman & Dawson (1999), *H. ranunculoides* is most susceptible to the herbicide 2,4-D amine applied at 4.23 kg/ha active substance, and is resistant to glyphosate applied at 2.16 kg/ha active substance, probably due to insufficient uptake through the leaf cuticle. The treatment with 2,4-D amine should be done at the end of the growing season when submerged apical stem tips are no longer present, as these are unaffected by the herbicide. To guarantee that all plant material is treated, a follow-up spot treatment or mechanical removal 2–4 weeks after the first treatment is very important. In some countries (e.g. Germany), treatment of water bodies with herbicides is prohibited.

Biological control

Up to now, there are no biological control measures applicable in Europe. *Lixellus elongatus* (*Curculionidae*) has been found to feed exclusively on *Hydrocotyle* species in Argentina. Further research on this potential biological control agent is necessary (Newman, 2003).

Possibilities for eradication

Eradication is possible in the very early stage of invasion. Central organization and funding are crucially important, and so is legislation. In later stages, eradication becomes very difficult and its success partly depends whether legislation allows herbicides to be applied.

An example of control costs is the investment by the Western Australian government to control *H. ranunculoides* in the Canning River. The species became a serious problem in 1992 and after declaration as a P2 plant (a plant to be eradicated), a program costing over 200 000 AUD in the first year was implemented (AFFA, 2003). In the Netherlands, some waterboards faced a doubling of costs each year during the 1990s, and, in 2000, the total control costs were around 1 million EUR. A significant rise of waterboard taxes is expected (van der Krabben & Rotteveel, 2003).

Regulatory status

In 2001–01, the Dutch Ministry van Landbouw, Natuurbeheer en Visserij prohibited the sale and possession of *H. ranunculoides*. Due to its high invasiveness, the Royal Horticultural Society in the UK prohibited this plant at its shows and gardens (Shaw, 2003). In 2005, EPPO added this plant to its A2 action list, and

endangered EPPO member countries are thus recommended to regulate it. Suggested measures are related to EPPO Standard PM 3/67 (OEPP/EPPO, 2007), with emphasis in particular on: prohibition of import, sale, holding, planting and movement; the obligation to report findings; publicity; surveillance; establishment of an action plan for eradication when the plant is found.

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