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

Data sheets on pests recommended for regulation
Fiches informatives sur les organismes recommandés pour réglementation

Lygodium japonicum (Thunb.) Sw

Identity

Scientific name: *Lygodium japonicum* (Thunb.) Sw.
Synonyms: *Ophioglossum japonicum* Thunb. (basionym) – *Adiantum scandens* Lour.
Taxonomic position: phylum Pteridophyta; class Polypodiopsida (ITIS)/Filicopsida (USDA); order Schizaeales; family Lygodiaceae
Common names: English: Japanese climbing fern; French: fougère grimpante du Japon; German: Japanischer Kletterfarn; Japanese: kani-kusa; Chinese: hǎi jīn shā; Russian: лигодий японский
EPPO Code: LYFJA
Phytosanitary categorization: EPPO A1 List no. 427

Geographical distribution

Native range

Asia: Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, North and South Korea, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam
Oceania: Papua New Guinea

Introduced range

EPPO region: absent from the natural environment
Africa: South Africa
North America: USA (Alabama, Arkansas, Florida, Georgia, Hawaii, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas), Mexico, Puerto Rico
Oceania: Australia (Northern Territory, New South Wales, Queensland)

History of introduction and spread

Lygodium japonicum is considered native in a number of Asian countries including Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Korea (North and South), Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand and Vietnam (Garrison, 1998; Chang *et al.*, 2014; Ferns of Thailand, 2014; Flora of China Editorial Committee, 2014; Flora of Japan, 2015). In China, it is primarily found south of the Yangtze River (Zheng *et al.*, 2006). *Lygodium japonicum* is considered native to Papua New Guinea.

Lygodium japonicum is described as being sparingly established as a 'casual alien' in South Africa (MacDonald *et al.*, 2003; Henderson, 2007), and this is the only known documented location for the species on the African continent. The oldest confirmed naturalized record of *L. japonicum* is from 1985.

In Australia, *L. japonicum* has been documented as escaped from cultivation in the Northern Territory from the early 1900s. It was suggested that it was introduced during that period as an ornamental and as a specimen in botanical gardens, from which it escaped. Most records of this species becoming naturalized have been reported in South-Eastern Queensland since the mid-1990s. In Queensland, it is currently considered to be an environmental weed (Queensland Government, 2015). Hosking *et al.* (2011) also reported *L. japonicum* to be naturalized in New South Wales. In particular, there are several records from the Sunshine Coast and Brisbane areas in the last 10 years (K. Bohn, pers. comm. 2017). In Western Australia, Orchard & McCarthy (1998) considered previous reports of *L. japonicum* to be mistaken identifications of the native *Lygodium flexuosum*.

In the USA, *L. japonicum* has been introduced as an ornamental plant (Ferriter, 2001); *L. japonicum* individuals have been recorded near greenhouses (Anderson, 1921; Diddell, 1941) and in yards and gardens (Graves, 1920; Anderson, 1921). Regionally, the species was sold commercially as trailing or running maidenhair (Brown & Correll, 1942). The earliest record of *L. japonicum* as a garden escapee is from 1903 in Thomasville, Georgia, USA where it was observed near the site of a greenhouse that had been destroyed in a fire (Harper,1905; *Thomasville Times-Enterprise*, 1903). In the early 1920s, it was recorded as escaped from cultivation in Alabama (Graves, 1920) and South Carolina (Anderson, 1921). In the late 1930s, *L. japonicum* was recorded in Florida; this record also indicated that the species was already known in Alabama, Georgia and South Carolina and was expected to spread further in the southern states (Correll, 1938). Thorne (1949) reported the species as naturalized

from Florida to Louisiana and North Carolina. It is currently found as far west as Texas and Arkansas, throughout Louisiana, Mississippi, Alabama and Florida, as far north as North Carolina and Kentucky. In Florida, it is primarily found in the panhandle and through the central part of the peninsula, although a few observations have been noted as far south as the southern tip of the peninsula. Its southern expansion may be limited by competition with its congener *Lygodium microphyllum* or climatic conditions. It has also been introduced in Puerto Rico and Mexico but is not widely established or invasive.

In the EPPO region, *L. japonicum* is not present in the natural environment. It may be present in cultivation in private collections (within confined greenhouses) and botanical gardens in Europe (often inside dedicated greenhouses).

Morphology

Plant type

Broadleaved, herbaceous perennial climbing fern.

Description

Lygodium japonicum is a rhizomatous vine, with a twining rachis (Fig. 1) climbing to 30 m. Belowground rhizomes are creeping, with black to reddish-brown hairs. Stipes are spaced to 1 cm apart on the rhizome. Stems remain underground, but send up long vine-like indeterminate fronds that have numerous compound pinnae. Pinnae on frondlets are triangular to deltoid-shaped, with short stalks, about 3–5 cm long. The mid-ribs (costae) have scattered hairs, and veins and pinnae surfaces are typically glabrous. Each pinnule on the pinnae is pinnate to lobed and stalked often with dissected terminal lobes. Pinnules are pubescent below and margins are variously dentate. Spore diameters range in size from 64 to 80 μm, averaging 76 μm. Japanese climbing fern sporangia are borne on narrow, fingerlike segments of the pinnae.

Fig. 1 Japanese climbing fern (*Lygodium japonicum*). Photo: K. Bohn.

Biology and ecology

General

Lygodium japonicum is a true fern that reproduces by spores (homosporous fern) which germinate and develop through gametophyte and sporophyte stages. It reproduces sexually by intragametophytic selfing (Lott *et al.*, 2003), meaning it is self-fertilizing. Spores develop only on frondlets (sorophores) of the new season's growth.

Habitats

Where introduced in the USA, *L. japonicum* occupies a broad range of natural and disturbed habitats (K. Bohn, pers. obs.). While *L. japonicum* has a strong preference for moist soils it can sometimes occupy xeric sites (Van Loan, 2006). It is invasive in diverse habitats throughout the South-Eastern USA, ranging from floodplain forests, swamps, marshes, river and stream banks to pine flatwoods, hardwood hammocks and upland woodlands (Wunderlin *et al.*, 2000; Diggs & George, 2006; Van Loan, 2006; Langeland *et al.*, 2008; Miller *et al.*, 2010). Floodplain swamps are comparatively uninfested due to lower elevations and resultant regular flooding and inundation (Ferriter, 2001). Infestations also occur in xeric sites, but do not appear to expand as rapidly as in more mesic sites, possibly due to the infrequency of appropriate conditions for gametophyte establishment or fertilization. The species is a common invader of pine plantations (Ferriter, 2001; Zeller & Leslie, 2004; Van Loan, 2006; Miller *et al.*, 2010) and often invades disturbed areas, including alongside roads and particularly ditches and culverts.

In South Africa, it has been found in moist forest, scrub and road edges, and in Australia, it has been documented in wet forests and riparian areas (CABI, 2017).

Environmental requirements

In its native range, the species mostly prefers warm climates with average year-round temperatures over 10°C (CABI 2017), and with clearly defined wet and dry seasons. In the South-Eastern USA, peak growth periods occur between mid-May and late July and have been associated with average monthly temperatures ranging from lows of 22°C to highs of 32°C. The above-ground foliage of *L. japonicum* dies back after frost and temperatures at or near 0°C; however, belowground root and rhizomes will remain dormant through the winter and re-sprout when temperatures reach at least 18°C. Hutchinson & Langeland (2014) found that freezing temperatures do not affect the viability of spores. Gametophytes were sensitive to freezing temperatures but could survive when exposed for several hours.

In North Florida, spore development begins around late June to July and spores become mature in late August and disperse throughout mid-September to late October. In a controlled setting, spores have been observed to be viable for up to 5 years (K. Bohn, pers. obs.). Spore germination is triggered by exposure to temperatures of at least 15°C for at least 2–3 weeks, and may be enhanced by being protected by leaf litter rather than exposed to bare soil (Ulrich, 2012).

Lygodium japonicum may have a preference for soils with a circumneutral pH (Diggs & George, 2006; Langeland *et al.*, 2008).

Natural enemies

To date, no biological control agents have been released specifically for *L. japonicum* in the South-Eastern USA, primarily because of the potential impact on a sympatric, native species *Lygodium palmatum*.

Uses and benefits

Lygodium japonicum is currently sold as an ornamental plant in the USA. There are some recent indications that the species is available in the pest risk analysis (PRA) area but to a low extent. One supplier in Ireland has been highlighted as supplying the species in the past. The species is also listed on the Royal Horticultural Society (GB) website, where one supplier is detailed.

Lygodium japonicum is recorded as having medicinal value in its native range. CABI (2017) gives the following details. In China, it is used as a diuretic (Puri, 1970) and to treat colds, inflammation, kidney stones and renal ailments (Eisenberg *et al.*, 2009). In India, it is used as an expectorant and to treat snakebites (Reutter, 1923; Puri, 1970) and to treat diabetes, wounds and ulcers (Yumkham & Singh, 2011). In Nepal, a paste is used to treat scabies, the juice is used to treat herpes and wounds (Manandhar, 1995) and its juice is applied for boils, wounds, whitlow and scabies (Mall *et al.*, 2015). In Pakistan, a powder is used on wounds to help healing and a root extract is used to reduce body aches and swelling (Khan *et al.*, 2010). Spores are sold on the Internet for use in traditional Chinese medicine as 'Spora Lygodii' (Ferriter, 2001). Formal studies have been conducted to determine the medicinal benefits of *L. japonicum.* Duan *et al.* (2012) showed that this species has compounds with strong antioxidant properties. Cho *et al.* (2014) found it to be useful as a preventive and therapeutic agent against the formation of oxalate kidney stones, supporting one of the primary traditional uses. It has also been studied, with potentially positive results, for the regrowth of hair (Matsuda *et al.*, 2002).

Pathways for movement

The pathway plants for planting is considered the main entry pathway into the EPPO region (EPPO, 2018). In North America, *L. japonicum* was introduced as an ornamental plant for homeowners and landscapers and then it escaped into the wild (Ferriter, 2001). *Lygodium japonicum* is currently sold as an ornamental plant in the USA, and there is some evidence that the species is sold within the EPPO region. The plant can be purchased via the Internet, and thus imports into the EPPO region from outside are possible.

In the Netherlands, gametophytes have been detected in growing media of bonsai plants imported from China (J. van Valkenburg, pers. comm. 2017). Following inspection, of the bonsai consignments, young plants were found in the growing medium and subsequently identified as *L. japonicum*.

Other potential pathways include contamination of machinery and equipment, contamination of leisure equipment (e.g. hiking boots and clothes) and contamination of timber and wood material (see EPPO, 2018).

Impact

Effects on plants

Lygodium japonicum can grow in sun or shade, damp, disturbed or undisturbed areas in the USA. It can grow so dense that it forms a living 'wall' (Fig. 2), leading to the elimination of seedlings and other native vegetation. No long-term studies have been completed to assess the impact of *L. japonicum* on biodiversity. In upland and mesic pine forests of the South-Eastern USA, a negative correlation was found between native plant richness and increasing percentage fern cover (Ulrich, 2012). Similar correlations were found with decreases in plant diversity and increasing fern cover. There may be less impact on species diversity on drier upland soils where *L. japonicum* is more likely to co-occur with native vegetation, at least during early periods of the infestation. Leichty *et al.* (2011) also found that

Fig. 2 Smothering habit of *Lygodium japonicum* growing over native vegetation in North America. Photo: K. Bohn.

L. japonicum is likely to compete with mesic pine savannah species in Louisiana, particularly with other native ferns or vines. On wetter sites, such as near rivers and wetlands, heavily infested areas have been observed to create dense mats over ground layer herbaceous vegetation. On those sites, both species abundance and richness are likely to decrease more significantly over time.

Environmental and social impact

In the South-Eastern USA the most important impact of *L. japonicum* on the ecosystem is its ability to alter fire regimes in both natural areas and managed plantations. In both settings, surface fires with low flame lengths are used to limit wildfire fuels. In unmanaged longleaf pine ecosystems, surface fires as a result of lighting naturally occur every 2–3 years. However, where the fern climbs vertically around shrubs and trees, fires can easily spread into canopy trees from the ground. This has implications for commodity production of timber as well as primary productivity of mature trees in unmanaged ecosystems. The dense mats created by *L. japonicum* may also facilitate the movement of fires into wetland areas that might otherwise be barriers (Munger, 2005). Another important negative impact of *L. japonicum* on ecosystem services is the impact on cultural services by reducing access to forests for recreation and leisure (Rowe, 2008).

The greatest economic impact of *L. japonicum* is on timber losses due to fire. In the USA, final harvest values for plantation forest range from about USD 1000–1200 per acre, so a crown fire that might be caused by an invasion of climbing fern could result in an economic loss of that scale (Georgia Forestry Commission, 2011).

In addition, the species negatively affects the pine straw (fallen pine needles) industry in the South-Eastern USA. In Alabama and Florida, movement of *L. japonicum* spores through the distribution of pine straw for the landscaping industry is highly regulated. If discovered, fines can be levied, and regulatory action can be taken against such products and potentially lower the product value.

Control

Because of the ability of *L. japonicum* to resprout vegetatively, mechanical methods are not effective. Small plants could potentially be pulled, as long as the entire root system is removed. Fire also stimulates vegetative regrowth and will not control this species.

From operational experience in the USA best results are obtained with the application of herbicides in late season, from July to early October (Bohn *et al.*, 2011). However, to better control spore dissemination and reproduction, some results suggest applying herbicides no later than mid-September (Bohn & Thetford, 2014). In a preliminary study in the USA, spore germination was reduced when individual plants were treated between July and early September.

Regulatory status

Europe (overall): in 2016, *L. japonicum* was identified as a priority for risk assessment within the requirements of Regulation 1143/2014 (Branquart *et al.*, 2016; Tanner *et al.*, 2017). A subsequent PRA concluded that *L. japonicum* posed a moderate phytosanitary risk to the endangered area (EPPO, 2018) and was added to the EPPO A1 List of pests recommended for regulation as quarantine pests. At the time of publishing, *L. japonicum* is being considered for inclusion on the list of (European) Union concern.

In the USA, *L. japonicum* does not have federal 'noxious weed' status, but is listed as a Class B noxious weed in Alabama, and was added to the Florida Noxious Weed List in 1999 (USDA, 2017).

In Australia, Japanese climbing fern is 'regarded' as an environmental weed in New South Wales and South-Eastern Queensland and is a potential environmental weed in Northern Australia; however, no laws or regulations exist to regulate its distribution and spread (Queensland Government, 2015).

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