EPPO data sheet on Invasive Plants

Fallopia japonica

IDENTITY

Preferred Scientific Name : *Fallopia japonica* Houtt. Ronse Decr.
Other Scientific Names: *Reynoutria japonica* Houtt., *Polygonum cuspidatum* Sieb. & Zucc.
Taxonomic position: Polygonaceae.
Common Names: Japanese knotweed (English), renouée du Japon (French), Japan-knöterich (German), kridlatka japonska (Czech), Japan-pileurt (Danish), rdesh sachalinski (Polish).
EPPO computer code: POLCU
Notes on taxonomy and nomenclature:
Fallopia japonica was independently classified as *Reynoutria japonica* by Houttuyn in 1777 and as *Polygonum cuspidatum* by Siebold in 1846. It was not until the early 1900s that these were discovered to be the same species (Bailey, 1990). This is generally referred to as *Polygonum cuspidatum* by Japanese and American authors, though recent evidence vindicates Meissner's 1856 classification as *Fallopia japonica* var. *japonica* (Bailey, 1990). The two most common introduced varieties are var. *japonica* and var. *compacta* and it is the former that is the main problematic weed. The closely related *Fallopia sachalinensis* can hybridize with *F. japonica* to form *Fallopia* x *bohemica*, first described in 1983, which is proving to be more problematic than *F. japonica* var. *japonica* in the UK.

MORPHOLOGY
F. japonica is a vigorous growing herbaceous perennial with annual tubular, glabrous stems up to 3 m in height that ascend from an erect base, branched and light green in colour often with reddish flecks (Beerling et al., 1994). Where introduced, *F. japonica* is generally taller than in its native range in Japan (Holzner and Numata, 1982) where it is recorded as being 0.3-1.5 m tall (Makino, 1997). Stems arise from strong rhizomes to form a dense thicket, rhizomes being thick and woody when old, and have been recorded as spreading 5-7 m laterally (Pridham et al., 1966). The rhizome snaps like a carrot when fresh to reveal a yellow/orange colour, and acts as a carbohydrate store in the winter months when it represents the complete live biomass of the plant. A number of radial penetrating rhizomes twist together to form a sizeable and considerable penetrating force. The leaves are 5-12 cm x 5-8 cm, broadly ovate, cuspidate at the tip and truncate at the base. The flowers are off-white and borne in clusters of 3 to 6 on terminal and axillary panicles, with the main axis up to 10 cm long and slender branches 5-9 cm long, initially erect but drooping at maturity. Achenes (or nuts) 2-4 mm long, 2 mm wide, dark brown and glossy. Male fertile plants are not known from the introduced range.

SIMILARITIES TO OTHER SPECIES
F. sachalinensis, or giant knotweed, a closely related species which is not normally as much of a problem weed as *F. japonica*, is similar in many respects but is generally a much larger plant, 4-5 m tall and with much larger leaves 20-40 cm long. Another distinguishing characteristic is at the base of the leaf, which in *F. sachalinensis* is rounded acuminate forming a heart shape. The hybrid between *F. japonica* and *F. sachalinensis* is called *Fallopia* x *bohemica* and is very similar to *F. japonica*, though it can be distinguished from its parents by having an intermediate leaf base shape similar in size to *F. japonica*. The closely related *Polygonum polystachyum*, or Himalayan knotweed, can be distinguished from *F. japonica* by its slightly hairy stems and longer, more slender leaf shape. It grows up to 1.8 m tall and can cause localized problems itself in similar habitats to *F. japonica*.

PLANT TYPE
F. japonica is a perennial, succulent, geophytic shrub, which propagates vegetatively or by seed.

BIOLOGY AND ECOLOGY

Vegetative spread is normally through tiny pieces of rhizome, stems and even internodal sections of stem capable of establishing roots (Locandro, 1978; Palmer, 1990), even in water (Figueroa, 1989). Rhizome fragments weighing as little as 0.7 g are capable of regenerating into a new plant, whilst rhizome pieces with a mean weight of 4.39 g generated shoots 70% of the time in controlled greenhouse experiments, giving a conservative estimate that a 1 m² stand could produce 238 new shoots (Brock and Wade, 1992). In its native range, *F. japonica* spreads both by seed and vegetatively, and the small winged seeds enable the plant to colonize recently exposed land such as that resulting from recent volcanic activity, where it may colonize within 20 years when it is often the sole pioneer species, being replaced by other herbaceous species after 50 years or so. It is often found in association with *Miscanthus sinensis* grassland on active volcanic fumaroles and stands often give way to grass species from the centre after die-back (Adachi et al., 1996). *F. japonica* is functionally dioecious, but in the UK and the USA, the plants are female with male sterile flowers and that the primary regeneration strategy is asexual. The most important aspect of *F. japonica* in its introduced range is that it has spread solely by vegetative means and from a very small number of initial introductions. Thus, much of the invasive *F. japonica* in the world may be clonal as is the case in the UK, where only females occur (Hollingsworth and Bailey, 2000). However, recent research in the USA has shown that wild *F. japonica* can produce large quantities of viable seed and seedlings have been found in the field (Forman and Kesseli, 2003).

Genetics

Hybridization and relative chromosome numbers are important in differentiating *F. japonica* varieties and related species. *F. japonica* var. *japonica* is octoploid (2n=88); *F. japonica* var. *compacta* and *F. sachalinensis* are tetraploid (2n=44) and *F. baldshuanica* is diploid (2n=20). F *japonica* var. *compacta* and *F. japonica* var. *japonica* only rarely produce tetraploid offspring (2n=44) which are able to interbreed with either of their parents. The most commonly observed hybrid is between *F. japonica* var. *japonica* and *F. baldshuanica*, a commonly planted and invasive climber called Russian vine, though seed from this hybrid very rarely survives in the wild and possesses none of the aggressive attributes of either of its parents (Bailey, 1988). *F. japonica* var. *japonica* and *F. sachalinensis* can cross to produce the hexaploid *F.* x *bohemica* (2n=66), which are reasonably common but only partly fertile, and any pollen produced usually contains between 30 and 66 chromosomes. If a pollen grain with 66 chromosomes were to pollinate a *F. sachalinensis* flower in Europe, a fertile octoploid *F.* x *bohemica* would be produced. Such plants would be able to cross-pollinate the all-female *F. japonica* and potentially be a replacement for the absent male *F. japonica*, allowing *F. japonica* to reproduce by seed again.

Environmental requirements

F. japonica is generally a temperate species, found in areas with a mean annual rainfall of 580-2200 mm, and mean annual temperature of 5-17°C, and will tolerate absolute minimum temperatures of –17°C, and a mean monthly temperatures up to 32°C. *F. japonica* requires high light environments. It grows from sea level in its native and introduced ranges up to altitudes of 2400 m in Japan (Maruta, 1983) and to 2400-3800 m in Taiwan. *F. japonica* is found on many soil types, and can survive very acidic soils (pH as low as 3; Beerling et al., 1994), waterlogging, extreme heavy metal and salt pollution and low available nitrogen.

Climatic and vegetational categorization

F. japonica is associated with areas with a warm to hot wet summer and a cool to cold wet winter. It is not favoured by drier conditions. It is hardy to zone 4 (-34 to –29°C). It is associated with the vegetation zones: temperate deciduous forests and mixed conifer forests (extending to temperate steppes?).

HABITAT

In its native range of Japan, Taiwan and Korea, *F. japonica* is found growing in sunny places on hills, high mountains and along road verges and ditches. Other typical habitats are gravel riversides and managed pastures where high levels of nitrogen fertilizer are applied (Child and Wade, 2000). In its introduced range, the plant can be found as a riparian weed as well as an invader of man-made environments such as spoil heaps, wasteland, road and railway verges and gardens. There is a clear association with disturbed sites and urban areas thanks to its use as a horticultural plant. It is found primarily in open sites, and its growth and abundance are depressed in shady sites (Beerling, 1991; Seiger, 1993) and it is consequently unable to invade forests, though may be a weed in plantation crops such as orchards or vineyards and in agricultural land.

CROPS / OTHER PLANTS AFFECTED

F. japonica is not generally considered a weed of agriculture or of forests but is sometimes known to occur in these habitats as well as in managed pastures.

PATHWAYS FOR MOVEMENT AND DISPERSAL

Natural dispersal

Flooding events can facilitate the spread of *F. japonica* as whole plants and/or stem parts can be dislodged and transported to new areas downstream where they can establish easily.

Vector transmission

There are no reports of animals disseminating propagules in the introduced range, though means of seed dispersal in the native range has not been investigated.

Agricultural practices

Flail mowing of road verges often facilitates local spread and contaminates equipment that could promote spread over longer distances. Accidental dissemination is the most common pathway for the establishment of populations, often as a result of inappropriate control measures such as mowing riverbanks.

Movement in trade

Some gardeners still consider *F. japonica* to be attractive ornamental plant and could plant it in ignorance. It was also promoted in the past for soil stabilisation. Contamination of imported growing medium and failure to kill rhizomes by adequate heat treatment or composting is another common means of accidental introduction by gardeners. Contaminated soil imported to development sites or for use in trench filling causes new introductions as well as allowing the spread of previously contained infestations. It is virtually impossible to remove it from soil and composting is not effective at killing large rhizomes or crown material. It is also possible that the import of viable seed from its area of origin by gardening enthusiasts could produce a sexual partner in the areas where male-fertile plants do not yet exist, which would have a major impact on its ability to spread without human intervention.

USES AND BENEFITS

F. japonica has been introduced principally as an ornamental plant, and has also sometimes been used for soil stabilisation. In its native range is believed to have medicinal properties, with its Japanese common name ‘Itadori’ meaning ‘take away pain’. It is used in Japan and China as a traditional medicine for ailments such as schistosomiasis, hyperlipemia, gonorrhoea, dermatitis and athlete’s foot. The roots of *F. japonica* and *F. sachaline*nsis contain relatively high levels of resveratrol, an anti-cancer drug, and are the source for most of the resveratrol sold in nutritional supplements. Leaf extracts from the closely related giant knotweed, *F. sachalinensis*, have been shown to inhibit the performance of common fungal pathogens of crops (Paik, 1989; Herger and Klinghauf, 1990).

GEOGRAPHICAL DISTRIBUTION

EPPO region: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia (Southern Russia), Serbia and Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

Asia: China (Anhui, Fujian, Guangdong, Henan, Hubei, Jiangsu, Jiangxi, Taiwan, Zhejiang), Japan (Hokkaido, Honshu, Kyushu, Shikoku), Korea DPR, Korea Republic.

North America: Canada (British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, Quebec), USA (Alaska, Arkansas, California, Colorado, Connecticut, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin).

Oceania: Australia (New South Wales, Tasmania, Victoria), New Zealand.

HISTORY OF INTRODUCTION / SPREAD

F. japonica is native to Japan, China, Taiwan and the Korean peninsula. The most likely date of its introduction to Europe was 1849, at the nursery of Philip Von Siebold, who later sent it to the Royal Botanical Gardens at Kew, UK, in 1850 (Conolly, 1977). That was also the first year that *F. japonica* var. *japonica* was made available to the public by Von Siebold as an ornamental, and later promoted as a potential source of forage. *F. japonica* was sent to the Royal Botanical Gardens at Edinburgh, UK in 1854, where it was then further distributed across the UK and most likely into the USA also. It had certainly become naturalized in the UK by the late 1880s, and was intentionally introduced as an ornamental into the Czech Republic as early as 1892 (Pysek and Prach, 1993). Early in the 1900s the number of reports of naturalizations increased rapidly. These establishments were most likely to have been escapes from gardens as it was a popular exotic plant whose rapid growth made an ideal natural screen for the privy house in the garden (which lead it to be called the ‘outhouse plant’ in the USA). Introduction and spread in other countries followed a similar exponential pattern as that in the UK.

IMPACT

Economic impact

The estimated annual control costs for one county council in Wales, UK, in 1994 was approximately Euro 500,000, and to control *F. japonica* on a national scale in the UK would cost an extrapolated Euro 2.5 billion, as reported by the UK Department of Environment, Food and Rural Affairs in a recent non-native species policy review. An accepted estimate of control costs is Euro 15,000 per hectare for a 3-year spraying regime with two sprays per year, but this is probably an underestimate if revegetation costs are taken into account. Its presence can add around 10% to the costs of a development project, especially if soil is considered contaminated and subject to additional removal fees. Indeed, a spraying programme on a development site is estimated to be approximately Euro 45 per m^2 and including finance costs this almost doubles to approximately Euro 85 per m^2 if soil has to be removed and clean soil imported and compacted (Child and Wade, 2000). *F. japonica* also has an impact via an increased risk of flooding, as dense stands can impede water flow and exacerbate flooding, dead stems can be swept away and cause blockages downstream, and rapidly growing *F. japonica* can disrupt the integrity of flood defence structures.

Social impact

F. japonica infestations are often a sign of poverty in Wales and Cornwall, UK, a factor compounded by the extra cost of development associated with *F. japonica* infestations. Stands become litter traps that become evident in winter once the leaves fall, and plants create a fire hazard in the dormant season (Ahrens, 1975).

Impact on biodiversity

As is often the case with invasive species, the impact that *F. japonica* has on biodiversity is often referred to but little studied. A riverbank that used to support a wide range of native species but now supports a monoclonal stand of *F. japonica* certainly has less biodiversity. Its early emergence and great height combine to shade out other vegetation and prohibit regeneration of other species (Sukopp and Sukopp, 1988), thus it reduces species diversity and damages wildlife habitat (Scott and Mars, 1984; Palmer, 1990). Dead *F. japonica* stems can persist for 2-3 years producing large quantities of debris and slowly decomposing litter that also leads to a reduced floristic diversity (Child and Wade, 2000).

RISK AND IMPACT FACTORS

F. japonica is noted to have a negative effect on native flora and fauna, biodiversity and the environment in general, and some negative effects on forestry production, transport and tourism have also been recorded.

SUMMARY OF INVASIVENESS

F. japonica is an extremely invasive weed despite its lack of sexual reproduction in most of its introduced range. It is included on various lists of invasive weeds and is one of the 100 worst invasive species as identified by the IUCN. It is a potential contaminant of soil, and its ability to tolerate a remarkable range of soil types and climates means that it has the potential to spread much further than it has to date.

	CHARACTERISTIC	(Y)es, (N)o
	Invasiveness	
1	Is the species invasive in its native range?	N
2	Has it proved invasive outside its native range? (i.e. is it an invasive alien species)?	Y
3	Is it highly adaptable to different environments?	Y
4	Does it have high reproductive potential? (e.g. for weeds; prolific seed production, high germination rate, reproduction by rhizomes, tubers, stolons or root/stem fragments).	Y
5	Is it highly mobile locally? (i.e. for weeds, propagules capable of moving long distances by wind, water, attachment to machinery, animals or humans).	N
6	Can its propagules remain viable for more than one year?	Y
7	Does it tolerate, or benefit from, cultivation, browsing pressure, mutilation, fire etc?	Y
	Impacts	
8	Is it competitive to agricultural and plantation crops or pasture plants?	N
9	Does it cause impacts on ecosystem processes? (e.g. hydrology, sedimentation, fire risk, nutrient cycling etc.).	Y
10	Does it adversely affect natural communities? (biodiversity, native populations, endangered or threatened species) by competition or hybridization (underline one or both).	Y
11	Does it adversely affect community structure? (e.g. effects on the food chain, elimination or creation of a canopy).	Y
12	Does it adversely affect human health? (e.g. allergies, effects on water or air quality).	N
13	Does it have sociological impacts on recreational patterns, aesthetics, property values?	Y
14	Is it harmful to animals? (e.g. poisonous plant parts or vector of animal diseases).	N
15	Does it produce spines, thorns or burrs (or other discomfort)?	N
16	Is it a host or vector to recognised pests and pathogens of agriculture or forestry etc?	N
	Likelihood of entry/control	
17	Is it highly likely to be transported internationally (a) accidentally? (e.g. as a contaminant).	N
18	Is it highly likely to be transported internationally (b) deliberately? (e.g. as an ornamental)	N
19	Is it difficult to identify / detect as a commodity contaminant? (e.g. due to small seed size)	Y
20	Is it difficult to identify / detect in the field? (e.g. similarities to other species, inconspicuousness)	N
21	Is it difficult / costly to control? (e.g. resistance to pesticides)	Y

CONTROL

Mechanical control

Mechanical control is difficult but continual mowing will reduce the resources of the extensive rhizome system if carried out throughout the growing season, with repeated cutting at least every 4 weeks and at least 7 weeks prior to senescence being effective (Seiger and Merchant, 1997). Pulling up plants complete with root systems can eliminate small stands and is appropriate for local eradication in sensitive areas but only if carried out continually over a number of years (Baker, 1988). Digging up roots, however, is even more challenging since they can extend to a depth of 2 m, and 7 m away from the crown, and despite the best efforts, it normally results in an increased stem density.

Chemical control

The use of chemicals to control *F. japonica* will depend on the intended goal and the restrictions in place for the environment invaded. Five herbicides are recommended by Child and Wade (2000): triclopyr and imazapyr can be applied to young, actively growing shoots when grasslands need to be protected; glyphosate is suitable during active growth periods when leaves are fully expanded although larger plants may need to be sprayed using a telescopic/long lance sprayer; picloram can also be used as a soil drench due to its persistence but not where planting is required within 2 years; and 2,4-D amine is used during the active growing period and as a selective translocated herbicide in grasslands, amenity areas and forest situations, although this may depend on which formulation is used in which country. Of these herbicides, only glyphosate and 2,4-D amine can be used near water. In general, cutting and removing dead stems at the end of the season prior to a spraying regime the following season is advisable to aid access. *F. japonica* is a very resilient plant and unless extremely toxic chemicals are appropriate, repeated well-timed applications should be anticipated and follow up spot treatments of regrowth will be required.

Biological control

F. japonica has been identified as one of the best targets for biological control in the UK (Shaw, 2003). *F. japonica* in Japan is attacked by a suite of natural enemies, both arthropod and fungal, not present in its introduced range. As a result of this attack, it is not able to compete with local flora as effectively as it does in the introduced range. Of these natural enemies, some exert significant damage, such as *Gallerucida nigromaculata* which is described as having potential as a biocontrol agent (Zwoelfer, 1973), though this is now thought to be *G. bifasciata* Motchulski and not adequately specific. In its introduced range, *F. japonica* is attacked by the green dock beetle *Gastrophysa viridula*, but this is only when its normal *Rumex* host has been consumed and beetle populations are elevated.

Integrated control

Using a combination of mechanical and chemical techniques can be effective, such as cutting and a follow up spray of new growth, but it is necessary to apply the chemical more than once a season (de Waal, 1995). There are two basic methods: to cut plants to 5 cm height and immediately apply a 25% solution of glyphosate or triclopyr to the cut stems; or cut or mow infestations when the plants reach the early bud stage in the late spring or summer and treat the regrowth in the autumn with glyphosate or triclopyr. If deep digging is used to effectively increase the above ground:below ground biomass ratio, then subsequent chemical application can reduce the time required to achieve effective control (Child et al., 1998).

REGULATORY STATUS

It is illegal to plant *F. japonica* anywhere in the wild in the UK under the Wildlife and Countryside Act 1981, and legislation for its control has been introduced in some states of the USA (Shaw and Seiger, 2002).

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