

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

# *Prosopis juliflora* (Sw.) DC.

### Identity

**Scientific name:** *Prosopis juliflora* (Sw.) DC.

**Synonyms:** *Acacia cumanensis* Willd., *Acacia juliflora* (Sw.) Willd., *Acacia salinarum* (Vahl) DC., *Algarobia juliflora* (Sw.) Heynh., *Algarobia juliflora* (Sw.) Benth., *Desmanthus salinarum* (Vahl) Steud., *Mimosa juliflora* Sw., *Mimosa piliflora* Sw., *Mimosa salinarum* Vahl, *Neltuma bakeri* Britton & Rose, *Neltuma juliflora* (Sw.) Raf., *Neltuma occidenatlis* Britton & Rose, *Neltuma pallescens* Britton & Rose, *Prosopis bracteolata* DC., *Prosopis cumanensis* (Willd.) Kunth, *Prosopis domingensis* DC., *Prosopis dulcis* var. *domingensis* (DC.) Benth., *Prosopis vidaliana* Fern.-Vill.

**Taxonomic position:** phylum Spermatophyta; class Dicotyledonae; order Fabales; family Fabaceae/Leguminosae, subfam. Mimosoideae

**Common names:** English: mesquite

**EPPO Code:** PRCJU

**Phytosanitary categorization:** EPPO A2 List no. 428

### Geographical distribution

#### Native range

**North America:** Mexico

**Central America:** Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama

**Caribbean:** Antigua and Barbuda, Aruba, British Virgin Islands, Cuba, Curacao, Dominican Republic, Haiti, Montserrat, Puerto Rico, Trinidad and Tobago, US Virgin Islands

**South America:** Colombia, Venezuela

#### Introduced range

**EPPO region:** Algeria, Israel, Jordan, Morocco, Spain (Mainland and Gran Canaria), Tunisia

**Africa:** Botswana, Burkina Faso, Cape Verde, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Ghana, Guinea-Bissau, Kenya, Liberia, Libya, Madagascar, Mali, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Réunion, Senegal, Somalia, South Africa, Sudan, Tanzania, Uganda, Zanzibar, Zimbabwe

**Asia:** Bahrain, Bangladesh, Brunei Darussalam, Cambodia, China (Guangdong, Hainan), India, Indonesia, Iran, Iraq,

Kuwait, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Taiwan, Thailand, United Arab Emirates, Vietnam West Bank, Yemen

**North America:** USA (Hawaii)

**Caribbean:** Martinique

**South America:** Brazil

**Oceania:** Australia (New South Wales, Queensland, Western Australia), French Polynesia, Papua New Guinea

### History of introduction and spread

*Prosopis juliflora* is often quoted as being native to the Caribbean where it is found in coastal areas, but several authors have suggested that it was introduced (Little & Wadsworth, 1964; Burkart, 1976), possibly with the arrival of the first human settlers from Venezuela (approximately AD 0–1000) (Timyan, 1996). It is possible that trade between the Caribbean and Brazil may have led to the introduction of *P. juliflora* to the dry coastal areas of Ceará and Rio Grande do Norte in North-East Brazil from Venezuela or the Caribbean (Pasicznik *et al.*, 2001) where it was definitely recorded in 1879 (Burkart, 1976) and still exists.

Pacific islands have naturalized populations of both *P. juliflora* and *Prosopis pallida* recorded for Hawaii and the Marquesa Islands (Burkart, 1976), and it might be assumed that they were introduced from Pacific coastal areas of Peru and Central America where they are native (Pasicznik *et al.*, 2001). The first introduction into Hawaii is thought to have been in 1828 (Perry, 1998) or 1838 (Esbenshade, 1980) (probably being *P. pallida*), and it is from here that introductions to other Pacific islands such as the Marquesas were probably made. The distinction between *P. pallida* and *P. juliflora* is apparently clear in Hawaii but much less so elsewhere in the Pacific, Brazil, Cape Verde and coastal West Africa.

*Prosopis* species were introduced into Australia around 1900, though no exact records of the first introductions exist. Major planting and possibly further introductions were made in the 1920s and 1930s (Csurhes, 1996). Later introductions may have come from the Americas, for example Mexico (Panetta and Carstairs, 1989) or possibly from India or South Africa where *Prosopis* species had already become naturalized. No information on the dates and sources of seed introduced to South-East Asia can be

located, but it is assumed that seed was introduced from the Americas via Australia and the Pacific, although it may also have been introduced from the Indian Subcontinent.

There appear to be several competing histories of the introduction of *P. juliflora* into the Indian Subcontinent, but no doubt that it first occurred in the 1800s. Whichever account is preferred, *P. juliflora* was certainly widespread throughout present-day India, Pakistan and Sri Lanka by 1900.

*Prosopis juliflora* was introduced into the Middle East in the 1950s, although there is one very large *P. juliflora* tree in Bahrain that is said to be 500 years old (Ahmad *et al.*, 1996). Although possibly not so old, it may show that there was some limited introduction of *Prosopis* by merchant and colonial traders long before the trees were intentionally introduced for other perceived benefits. However, the source of most of the invasions of *P. juliflora* in tropical (Sahelian and Eastern) Africa and the Arabian Peninsula is very likely to have been material planted by or sourced from the FAO via their DANIDA-managed seed bank in the 1970s, 1980 and 1990s (some of it also being incorrectly labelled as *Prosopis chilensis*), or planted by non-governmental organizations, some of whom sourced seed from commercial suppliers such as Setropa. The escape of *P. juliflora* from trial plots was first noted in the late 1990s (Choge *et al.*, 2012).

Early introductions of *Prosopis* into Africa are poorly documented, but appear to have begun in 1822 in Richard Toll, in the north of modern-day Senegal at the mouth of the River Senegal. This introduction was identified as *P. juliflora* but appears very likely to have been *P. pallida* (Harris *et al.*, 2003). *Prosopis juliflora* had been introduced from Senegal to Mauritania before 1960 (Diagne, 1992) but had certainly been introduced elsewhere in the Sahel before then. It appears that *P. juliflora* was already present in Egypt by the early 1900s, and was introduced into Sudan by R. E. Massey from the Egyptian Department of Agriculture at Giza and from South Africa, both in 1917 (Broun and Massey, 1929; in El Fadl, 1997). The exact origins of *P. juliflora* and its subsequent introductions in East Africa remain unknown, but it was possibly introduced in the 1930s (Choge *et al.*, 2012) by livestock from Sudan or Southern Africa, or by traders from India or Southern Africa, and it was also planted along the new railway from Mombasa to Nairobi and beyond. For details of its recent spread in Kenya and areas at risk of invasion see Maundu *et al.* (2009).

*Prosopis juliflora* currently has a very limited naturalized distribution in the EPPO region. It is currently reported as naturalized only in low-lying areas in Israel, the West Bank and Jordan (Dufour-Dror & Shmida, 2017), although records of *P. juliflora* outside the Jordan Valley are considered by the Expert Working Group (EWG) to be possible mis-identifications. *Prosopis juliflora* was first confirmed as present in Jordan by Harris *et al.* (2003), in Almeria, South-Eastern Spain (two planted trees only,

planted in 1988; Pasiecznik & Peñalvo López, 2016) and naturalized in a very limited area in Gran Canaria (Canary Islands, Spain) (Verloove, 2013, 2017). Here, the species has been known since 2011 as an escapee from cultivation in the drier, southernmost parts of Gran Canaria. In 2015 it was recorded in several additional localities, all in ravines. In one of these, in the estuary of Barranco del Polvo in Arinaga, it is present in relative abundance and in various stages of development, in a natural coastal vegetation. At least in this locality it can be considered naturalized.

The species was reported from Cyprus in 1915 (Bovill, 1915) and in 1923 (Frangos, 1923); both reports are referenced in Meikle (1977), but has not been detected in recent years. According to Maniero (2000), *P. juliflora* was introduced into Italy in 1813 as an ornamental species. It is likely that all of these reports refer to species other than *P. juliflora (sensu stricto)*. For example, Bovill (1915) notes that seeds of *P. juliflora* were received from Southern California where *P. juliflora* does not exist, and the material was almost certainly *Prosopis glandulosa* var. *torreyana*. However, at the time of introduction, this taxon was also referred to as *P. juliflora* var. *torreyana*, from where the confusion would have arisen. In addition, Bovill (1915) also noted that ‘The following [taxa] have been tried, but without any marked success, some of them are alive but that is all.’ Frangos (1923) merely notes the species as being present in another nursery. As such, it is considered that *P. juliflora* was probably never introduced to Cyprus and probably not to Italy, and in the absence of any subsequent reports is certainly not present in either country (conclusions of the EWG, 2018).

## Morphology

### Plant type

Evergreen, broadleaved, perennial, seed-propagated, woody shrub or tree.

### Description

*Prosopis juliflora* is a tree 3–12 m tall, sometimes shrubby with spreading branches; wood hard; branches cylindrical, green, more or less round- or flat-topped, somewhat spiny with persistent, green (sometimes glaucous or greyish, not reddish) foliage, glabrous or somewhat pubescent or ciliate on the leaflets; spines axillary, uninodal, divergent, paired, or solitary and paired on the same branches, sometimes absent, not on all branchlets, measuring 0.5–5.0 cm long, being largest on strong, basal shoots. Leaves bipinnate, glabrous or pubescent, 1–3 pairs of pinnae, rarely 4 pairs; petiole plus rachis (when present) 0.5–7.5 cm long; pinnae 3–11 cm long; leaflets 6 to 29, generally 11 to 15 pairs per pinna, elliptic-oblong, glabrous or ciliate, rarely pubescent, approximate on the rachis or distant a little more than their

own width, herbaceous to submembranous (not sub-coriaceous as in more xerophilous species and therefore often corrugated or curved when dried), emarginated or obtuse, pinnate-reticulately curved; leaflets 6–23 mm long  $\times$  1.6–5.5 mm wide. Racemes cylindric, 7–15 cm long, rachis puberulent; florets as usual, greenish-white, turning light yellow. Legume straight with incurved apex, sometimes falcate, straw-yellow to brown, compressed, linear with parallel margins, stalked and acuminate, 8–29 cm long  $\times$  9–17 mm broad  $\times$  4–8 mm thick; stipe to 2 cm; endocarp segments up to 25, rectangular to subquadrate, mostly broader than long; seeds oval, brown, transverse. Within the EPPO region there are three close congeners (*Prosopis chilensis*, *Prosopis velutina* and *P. glandulosa*) that can be easily confused for *P. juliflora* (Pasiecznik *et al.*, 2004; EPPO, 2018). All three species are included on the EPPO Alert List.

## Biology and ecology

### General

*Prosopis juliflora* usually begins to flower and fruit after 2–3 years (see Fig. 1), but this is highly dependent upon site conditions, as trees as young as 12 months old have been observed to flower in the Sahel and trees 15 years old or more on poor exposed sites have never been seen to flower (Pasiecznik *et al.*, 2001). Almost continuous year-round flowering of *P. juliflora* is seen in India (Goel & Behl, 1995) and Haiti (Timyan, 1996) but there is always a period of maximum fruit production. In parts of India, one or two fruiting periods occur, depending on site and the ‘form’ of *P. juliflora* present (Luna, 1996). With continuous flowering, periods of major fruit production may correspond to periods of increased pollinator activity and not necessarily to genetic controls, particularly with introduced material.



**Fig. 1** *Prosopis juliflora* flowers and leaves, Djibouti. Photo courtesy of Nick Pasiecznik.

### Habitats

In the native and introduced ranges, *P. juliflora* is found in a number of different habitats including: wasteland, forest, managed and natural grassland, coastal areas (including coastal dunes), wetlands, abandoned fields and urban areas (e.g. roadsides). In particular, in the introduced range, *P. juliflora* invades rangeland, where it can form impenetrable thickets over hundreds or thousands of hectares and encroaches upon agricultural and abandoned land and can quickly invade uncultivated fields.

### Environmental requirements

*Prosopis juliflora* thrives in a wide range of rainfall zones, from 100 mm mean annual rainfall or less in dry coastal zones to 1500 mm at higher altitudes, and the ability to tolerate very low annual rainfall is well known. Mean annual air temperature in the shade where *P. juliflora* is found is generally above 20°C, with optimum temperatures for growth in the range 20–30°C. There appears to be no natural upper limit to temperature, and introduced *P. juliflora* is known to tolerate day-time shade temperatures of over 50°C (Pasiecznik *et al.*, 2001).

A major limitation to the distribution of *P. juliflora* is mean minimum temperature and the frequency and duration of frost events. Light frosts cause dieback of the branches, harder frosts may cause complete stem mortality, and more severe or longer-lasting frosts can cause complete death of the plant (Felker *et al.*, 1982). Frost damage is more severe on seedlings and younger trees of *P. juliflora* and on trees in inter-dunal or other low-lying areas (Muthana, 1974). Hyde *et al.* (1990) found that *P. juliflora* seedlings were killed by a –2°C frost in Spain, whereas *P. juliflora* was noted to suffer frost damage but survive when temperatures fell below 0°C in India (Muthana, 1974).

*Prosopis juliflora* has a broad ecological amplitude and is adapted to a very wide range of soils and habitat types, from sand dunes and coastal flats to cracking clays. It is often found in areas where water, soil fertility and salt are the principal agents limiting plant growth, and it is able to survive and even thrive on some of the poorest land unsuitable for any other plant species. *Prosopis juliflora* has a deep taproot, and can become dominant in dry, or seasonally dry, watercourses or depressions, around wells or water points and, commonly, along canal sides, irrigation ditches and around lakes and other water bodies. It is also salt tolerant, so can also be found on beaches growing right up to the shoreline, as well as salt flats and coastal areas where the water table is saline, and is even seen growing a few metres from mangroves in Sri Lanka (Pasiecznik & Weerawardane, 2011). However, although it will survive periods of flooding, it tends to suffer dieback or plant mortality when areas are waterlogged for extended periods of time.

### Natural enemies

There are no known natural enemies in the EPPO region.

### Uses and benefits

*Prosopis juliflora* is a very valuable multi-purpose tree, but much more so where introduced than where native. Principal uses are wood for fuel, posts, poles and sawn timber, and pods for fodder and human food sources (Pasicznik *et al.*, 2001). There are numerous other tree products, including wood as a biofuel for electricity generation, honey from the flowers, medicines from various plant parts, exudate gums, fibres, tannins, leaf compost and chemical extracts from the wood or pods. It has also been widely planted for soil conservation, in hedgerows and as an urban and general amenity tree, and continues to be planted as such in some countries (e.g. Chad, Mauritania, Niger, India, Iran, Pakistan). For a comprehensive review of the uses of *P. juliflora*, refer to Pasicznik *et al.* (2001).

As with many other invasive species, it is mostly developing countries that obtain economic benefits from the species (Shackleton *et al.*, 2014). For example, in Kenya, trade in *Prosopis* goods and services was worth 2122 USD per household per year in some villages in 2002, and in 10 years was estimated to exceed 1.5 million USD in four selected areas (Choge *et al.*, 2012).

Within the EPPO region including European Union Member States, there are no known socio-economic benefits reported.

### Pathways for movement

Plants for planting is a potential pathway for the entry of *P. juliflora* into the EPPO region. Seeds are widely available via numerous online global mail order suppliers. The two reported introductions into the EPPO region (Pasicznik & Peñalvo López, 2016; Dufour-Dror & Shmida, 2017), as with most global introductions, have been as seed for reforestation (Pasicznik *et al.*, 2001). However, this is highly unlikely to happen now.

## Impact

### Effects on plants

*Prosopis juliflora* is a very aggressive invader with the potential to outcompete and replace native vegetation. *Prosopis juliflora* has been noted as invasive in protected areas in South Asia, notably grasslands in Gujarat and native xerophytic woodlands in Rajasthan (Kaur *et al.*, 2012), as well as a national park in Sri Lanka (Pasicznik and Weerwadane, 2011). Even amongst the protected and undisturbed sites, dominance of late successional species, for example *Acacia senegal*, *Maytenus emarginata*,



**Fig. 2** *Prosopis juliflora* invading native *Acacia tortillis*-dominated savannah scrub, Djibouti. Photo courtesy of Nick Pasicznik.

*Ziziphus nummularia* and *Acacia nilotica*, was less at sites with *P. juliflora* present than at sites without it (Kumar & Mathur, 2014). The density of *Commiphora wightii*, an endangered species, decreased with increasing density of *P. juliflora*. Invasion of *P. juliflora* thus has demonstrable adverse impacts on plant communities in arid grazing lands (Kumar & Mathur, 2014).

Some plant species are suppressed when *P. juliflora* forms dense stands, and Maundu *et al.* (2009) showed plant biodiversity was reduced in *P. juliflora* thickets in Kenya compared with uninvaded areas. In India and Hawaii, USA, where *P. juliflora* is an aggressive invader, canopy effects on species richness were consistently and strongly negative (Kaur *et al.*, 2012). In the United Arab Emirates, *Malva parviflora* attained only 600 individuals/100 m<sup>2</sup> under the canopy of *P. juliflora* compared with 4289 individuals/100 m<sup>2</sup> from outside canopies (El-Keblawy & Al-Rawai, 2007; Fig. 2).

### Environmental and social impact

*Prosopis* species have large impacts upon water resources, nutrient cycling, the successional process and soil conservation (Shackleton *et al.*, 2014). Negative effects of *Prosopis* invasions also include complete loss of native pasture and rangelands, transforming natural grasslands into thorn woodland (i.e. encroachment). *Prosopis* rapidly form dense thorny thickets that reduce biodiversity and can also block irrigation channels, obstruct roads and block smaller trails completely, affecting access to pasture, croplands, water sources and fishing areas (Weber, 2003). Loss of grass cover under canopies may also promote soil erosion.

*Prosopis* species are amongst a range of invasive woody plants being eradicated in South Africa under the Work for Water programme, due to their noted effect in exploiting soil water and lowering water tables (Zachariades *et al.*, 2011): stands of *Prosopis* species were estimated to be using water equivalent to four times the mean annual

rainfall. *Prosopis* are known to possess very deep roots which will use subterranean water when no surface water is available. However, there is some debate as to the extent of the effects of *Prosopis* on water tables. In India, Cape Verde and elsewhere in the Sahel, *Prosopis* species have been blamed by farmers for the lowering of water tables, while some researchers suggest that this is due to the increase in the number of boreholes and the amounts of water being extracted for irrigation by these very same farmers (Pasicznik, 1998).

Invasion of *P. juliflora* was also blamed for limiting transhumance by occupying settlement areas and affecting the availability of multipurpose trees/bushes and grass. All these effects put pressure on livestock assets, with livestock ill-health reported in Kenya (Choge *et al.*, 2002; Mwangi & Swallow, 2005) and Brazil (Tabosa *et al.*, 2006).

The principal cause for concern arises from the strong and often profuse thorns of *P. juliflora*, which are able to pierce tyres and shoes or hooves. The scratches are said in some parts to cause infection by themselves and even lead to amputations (e.g. Choge *et al.*, 2002), although there is no actual poison in the *P. juliflora* thorns. On the contrary, many plant extracts are used in local medicines as fungicides and bactericides, and a poultice of damp leaves is recommended by some to cure infections.

In the USA, Mexico, Saudi Arabia, Kuwait, United Arab Emirates, India and South Africa the pollen has been identified as a major allergen (e.g. Killian & McMichael, 2004), and Dhyani *et al.* (2008) described *P. juliflora* as an 'important source of respiratory allergens in tropical countries'. Killian & McMichael (2004) identified at least 13 human allergens in the pollen. *Prosopis juliflora* has a close allergenic relationship with *Ailanthus excelsa*, *Cassia siamea* and *Salvadora persica* and the lima bean *Phaseolus lunatus* (Dhyani *et al.*, 2008). As it is a major cause of allergenic disease and has close allergenic relationships with other species, further planting of *P. juliflora* in urban areas is not recommended.

## Control

The following is adapted from Pasicznik *et al.* (2001) and CABI (2017), including those methods used on closely related *Prosopis* species as it is considered that control methods suitable for one species could be successfully applied to others. However, methods of eradication attempted for over half a century in the Americas have proved very expensive and largely unsuccessful in the long term. Total tree kill may be possible with some treatments, but adequate techniques for preventing the reintroduction of seeds and re-establishment of trees have yet to be developed, and it is considered that eradication over large areas is not possible using these techniques; at best, only some form of control is feasible.

Hand clearance is the first method used to deal with *Prosopis* as a weed. Work teams are sent into invaded

stands to fell trees and uproot stumps. Although effective, the operation is labour-intensive and hand clearing remains practical only for small land holdings or where labour is relatively cheap. Hand clearing can also be used in conjunction with mechanical or chemical methods, such as chemical stump treatment.

Fire, probably one of the original management tools used in American grasslands, has undergone limited assessment for controlling *Prosopis*. Young seedlings are fire-sensitive but older trees become increasingly protected by thick bark as they mature and will resprout rapidly after fire. However, fire could be used successfully as a management tool for preventing re-establishment of young *Prosopis* seedlings, while also improving forage production. Fire has been used in Australia in conjunction with other methods in the development of integrated eradication programmes. For example, spraying with herbicides produces dead wood that will ignite and support a sustained fire with more likelihood of killing the remaining trees.

Studies on succession suggest the possibility of 'ecological control', by leaving succession to take its natural course. The invasion of *Prosopis* species into rangeland has been observed and studied in the USA for over a century (e.g. Archer, 1995) and for long periods in South America (e.g. D'Antoni & Solbrig, 1977) and India (e.g. Chinnimani, 1998). Long-term ecological observations and the use of models have indicated that dense thickets associated with the problems of invasion are only a temporary stage in the process of succession. The initial stages of invasion involve the introduction of small numbers of *Prosopis* trees, which eventually produce seed and act as centres of dissemination (Archer, 1995). *Prosopis* stand density increases if land-use systems allow the establishment of seedlings, leading to the formation of dense thickets where conditions allow. However, Chinnimani (1998) showed that *Prosopis* density eventually declines as other species become established and, if left to take a natural course, a new vegetation complex will occur with *Prosopis* as only a minor component. Felker *et al.* (1990) also observed that self-thinning occurred in stands of *P. glandulosa* over time. The dense thickets identified as weedy invasions in many countries may only be indicative of the stage of invasion and, if left alone, ecological control may reduce *Prosopis* numbers.

Mechanical site clearance involves tractor operations developed for removing trees; the roots are severed below ground level to ensure the tree is killed. These operations include root ploughing and chaining, which are often the most effective mechanical means, using a mouldboard plough pulled behind a tractor or a heavy chain pulled between two machines.

For root ploughing, large trees must first be felled by hand, but this treatment has been used to remove stumps up to 50 cm in diameter without difficulty and has a treatment life of 20 years or more (Jacoby & Ansley, 1991). Other advantages are that only a single treatment is required, which can lead to improved soil water conservation and to

the opportunity to reseed with improved forage species. However, this method is one of the most expensive control treatments and is only recommended on deep soils that have a high potential for subsequent increased forage production (Jacoby & Ansley, 1991). The soil should be neither too wet nor too dry for effective root ploughing.

Chaining involves pulling a heavy chain between two slow-moving tractors, with the effect of pulling over larger trees and uprooting them. A second pass in the opposite direction ensures that roots on all sides are severed to ease tree removal (Jacoby & Ansley, 1991). Soil moisture is again important, with soil that is dry on the surface and moist below giving the optimal conditions. If the soil is too dry, the stem breaks leading to coppicing, if too wet, the soil and understorey are damaged (Jacoby & Ansley, 1991). Smaller, unbroken trees have to be removed by other means. Although expensive, this treatment is effective where there are many mature trees. It is most widely used following herbicide application to remove dead standing trees. Clearance with a biomass harvester produces wood chips that can be sold for energy production offsetting the operational costs (e.g. Felker *et al.*, 1999).

Most work on biological control of *Prosopis* to date has been carried out in South Africa, where several programmes are under way. The seed-feeding insects *Mimosetes protractus* and *Neltemius arizonensis* were introduced to eastern South Africa in conjunction with the bruchid beetles *Algarobius prosopis* and *Algarobius bottimeri* for the control of invasive *Prosopis* species. *Neltemius arizonensis* and *A. prosopis* were successful in establishing themselves in large numbers and having a significant effect on *Prosopis* spp., whereas the other species were only found in low numbers (Hoffmann *et al.*, 1993). Maximum damage to seed occurred where grazing was controlled, as the multiplication and progress of the biocontrol agents is hampered by livestock devouring the pods.

The same two bruchid species were also introduced to Ascension Island in an attempt to control *P. juliflora* which is present on 80% of the island, often in dense thickets. Two other species, one a psyllid and the other a mirid, were identified as attacking *P. juliflora* on Ascension Island and were thought to have been introduced accidentally from the Caribbean. The mirid *Rhinocloa* sp. causes widespread damage and is thought to lead to substantial mortality of trees (Fowler, 1998). Insect species continue to be tested for their efficacy and host specificity as possible biological control agents of *Prosopis* species in Australia (e.g. van Klinken, 1999; Van Klinken *et al.*, 2009). In addition to the two *Algarobius* species, the sap-sucking psyllid *Prosopidosylla flava* and the leaf-tying moth *Evippe* sp. have both been found to provide some control in Australia.

Chemical treatments involve the use of herbicides to kill trees, with the most effective being stem or aerial applications of systemic herbicides. Effectiveness is dependent upon chemical uptake, which in *Prosopis* is limited by the

thick bark, woody stems and small leaves with a protective waxy outer layer.

## Regulatory status

In 2016, *P. juliflora*, 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 pest risk analysis concluded that *P. juliflora* had a moderate phytosanitary risk to the endangered area (EPPO, 2018) and was added to the EPPO A2 List of pests recommended for regulation. At the time of publishing, *P. juliflora* is being considered for inclusion on the list of (European) Union concern.

Australia: The genus *Prosopis* is listed as one of the 30 Weeds of National Significance (Australian Government, 2017) and includes *P. juliflora* as one of four naturalized species (the others being *P. glandulosa*, *P. pallida*, *P. velutina* and hybrids).

The US State of Hawaii, includes *P. juliflora* on its list of noxious weeds (Hawaii Invasive Species Council, 2018). The whole genus is listed as a noxious weed in the State of Florida (<https://plants.usda.gov/java/noxious>).

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