

# Mapping plant-invader integration into the plant-pollinator network

MONTERRAT VILÀ, IGNASI BARTOMEUS, ANKE DIETZSCH, THEODORA PETANIDOU, INGOLF STEFFAN-DEWENTER, JANE STOUT, THOMAS TSCHUELIN



Invasions by alien species are causing major problems to biodiversity worldwide and many of the impacts result from disruptions of interspecific interactions. The success of an introduced species often depends largely on how it interacts with the species in the recipient community; including whether it competes with native species, whether there are new natural enemies to cope with and whether they form new mutualistic relationships to fulfil basic life history needs.

If an introduced plant species is entomophilous and self-incompatible it will require the service of resident pollinators to transfer pollen among flowers and plants and to ultimately set seed. Pollinators are often observed visiting invasive plants but little is known about the impact of these new interactions on the whole plant-pollinator network (Bjerknes et al., 2007; Memmott & Waser, 2002, Traveset & Richardson, 2006).

Many introduced flowering plants are pollen- and nectar-rich species attracting a wide range of native pollinators. Within ALARM we surveyed areas invaded by 5 different alien plant species (*Carpobrotus* aff. *acinaciformis*, *Opuntia stric-*

*ta*, *Rhododendron ponticum*, *Impatiens glandulifera*, *Solanum elaeagnifolium*) across Europe to investigate their impact on the plant-pollinator networks. In general, invaders receive a high proportion of visits even at an early stage of invasion, suggesting that they play a central role in plant-pollinator networks. While some invasive plants have a generalist pollination syndrome, attracting a wide variety of pollinator guilds (e.g. *Carpobrotus*), other invasive plants have more specialized flowers, attracting few guilds such as bumblebees, but in large quantities (e.g. *Impatiens*).

Does the high attraction of pollinators to invasive plants interfere with the pollination of native plant species? Few plant-pollinator interactions are exclusive to the invader, i.e. many pollinators visit both the invasive and native plant species. Some alien plants, such as *Carpobrotus* and *Rhododendron* can be considered “magnet species” in some sites because their presence facilitates the visit of pollinators to some native species (Bartomeus et al. 2008). However, in some cases pollinators might prefer visiting the invader and reduce the number and duration of vis-

its to native plant species. This is the case in sites invaded by *Opuntia* and *Solanum* where the total number of visits to the community does not decrease, but most of the visits are to the invader. In this case, the invasive plants hire pollinators away from native plants.

Little is known about the impact of alien flowers on pollinators. What are the consequences of adding new nectar and pollen resources to the diet of the pollinators apart from changes in foraging behaviour? The consequences for pollinator population of foraging on a new species are very difficult to study because in general we know little about pollinator life history cycles. In invaded areas the diversity of pollinator species may not decrease, but relative abundances of pollinators might change. For example, increasing the presence of bumblebees in sites invaded by *Impatiens glandulifera*. Similarly, sites invaded by *R. ponticum* support a higher number of bumblebee colonies.

Overall, invasive plants are very well integrated in the recipient communities and attract a wide range of pollinators, some in large numbers, but the consequences for the native communi-

ty is very much dependent on the context. Some invaders attract pollinators to the entire plant community, but others compete for them, reducing visitation to native plants and probably reducing their fitness.



## References

- BARTOMEUS N, VILÀ M, SANTAMARÍA L (2008) Contrasting effects of invasive plants in plant-pollinator networks. *Oecologia* **155**:761–770
- BJERKNES A L, TOTLAND Ø, HEGLAND S J, NIELSEN A (2007) Do alien plant invasions really affect pollination success in native plant species? *Biological Conservation* **138**: 1–12.
- BORATYNSKI A, BROWICZ K, ZIELINSKI J (1992) *Chorology of Trees and Shrubs in Greece*. Polish Academy of Sciences, Sorus, Poznan/Kornik.
- MEMMOTT J, WASER NM (2002) Integration of alien plants into a native flower-pollinator visitation web. *Proc. R. Soc. Lond. B* **269**: 2395–2399.
- ELORZA M, DANA E D, SOBRINO E (2004) *Atlas de las plantas alóctonas invasoras de España*. Dirección General para la Biodiversidad, Madrid.
- TRAVESSET, A. & RICHARDSON, D. M. (2006) Biological invasions as disruptors of plant reproductive mutualisms. *Trends in Ecology and Evolution*, **21**, 208–216.

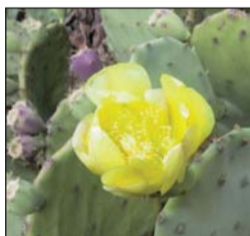


Photo: M. Vilà

*Solanum elaeagnifolium* Cav. (Solanaceae)

**Common name:** Silverleaf Nightshade  
Branched, perennial plant with woody lower stems and extensive spreading root system. Deeply lobed, star-shaped bright blue to purple (and rarely white) corolla with long yellow anthers. Flowering from May to September. Fruits are berries containing up to 150 seeds dispersed by water, wind, machinery, agricultural produce and livestock.

**Native range:** South and Central America.

**Introduced range in Europe:** Mediterranean countries.

**Invaded habitats (EUNIS code):** Disturbed land, in general: Arable land and market gardens (I1), Trampled areas (H5.6), Dry grasslands (E1), Mesic grasslands (E2), Anthropogenic forb-rich habitats (E5.6), building sites and waste land.

**Introduction pathway:** Imported fodder, seeds, soil and fertilizer.

**Impacts:** Competition with native plant species, interferes with crop production, toxic to livestock.



Photo: A. Dietzsch

*Opuntia stricta* (Haw.) Haw. (Cactaceae)

**Common name:** Prickly-pear cactus  
Tall cactus with succulent flat, oval and segmented stems. Plants produce large regular yellow flowers and purple fig shaped fruits. Flowering from June to July. Seeds are dispersed by birds, feral pigs and lizards that feed upon fruits.

**Native range:** tropical America from Mexico to Colombia

**Introduced range in Europe:** Mediterranean countries and Macaronesian islands.

**Invaded habitats (EUNIS code):** Coastal dune and sand habitats (B1), Rock cliffs, ledges and shores, including the supralittoral (B3), Spiny Mediterranean heaths (F7), Thermo-Atlantic xerophytic habitats (F8), Coniferous woodland (G3), Waste deposits (J6).

**Introduction pathway:** ornamental and planted as wind protection fencing and land restoration

**Impacts:** the spines can cause injuries to animals and humans; interferes with livestock grazing. Invaded woodlands are misperceived as typical Mediterranean landscapes.



Photo: T. Petanidou

*Carpobrotus edulis* (L.) N.E.Br. (Aizoaceae)

**Common name:** Iceplant  
Succulent, trailing perennial plant forming large, dense mats. In the Mediterranean basin, *C. edulis* hybridizes with *C. acinaciformis* forming a hybrid complex known as *C. affine acinaciformis*, therefore flower colour (yellow, pinkish or purple) is very variable. Flowers have regular large corollas with many petals. Flowering from March to May. The fleshy, indehiscent fig-like fruits are eaten by wild mammals.

**Native range:** Cape region of South Africa

**Introduced range in Europe:** Mediterranean countries and Macaronesian islands.

**Invaded habitats (EUNIS code):** Coastal dune and sand habitats (B1), Coastal shingle habitats (B2), Rock cliffs, ledges and shores, including the supralittoral (B3), Inland cliffs, rock pavements and outcrops (H3), Miscellaneous inland habitats with very sparse or no vegetation (H5), Littoral zone of inland surface waterbodies (C3), Garrigue (F6), Constructed, industrial and other artificial habitats (J).

**Introduction pathway:** ornamental and landscaping for erosion control and land restoration

**Impacts:** competes aggressively with native plant species, threatening rare and endangered coastal species. Increases soil N and organic C and reduces soil pH. In dune habitats it hinders the disturbance regime.



Photo: I. Bartomeus

*Rhododendron ponticum* L. (Ericaceae)

**Common name:** Rhododendron  
Evergreen large multistemmed shrub with pink-purple flowers held in dense inflorescences. Main flowering season from May to July. Each flower produces several hundred tiny, wind-dispersed seeds in woody capsules. Large plants can produce millions of seeds each season.

**Native range:** Disjunct with *R. ponticum* ssp. *baeticum* in SW Spain and S Portugal; ssp. *ponticum* is found in Turkey, Lebanon, Bulgaria and the Caucasus.

**Introduced range in Europe:** UK, Ireland, Belgium, France, Netherlands, Germany and Austria.

**Invaded habitats (EUNIS code):** Mixed deciduous forest (G1), temperate heaths (F4), raised and blanket bogs (D1).

**Introduction pathway:** Ornamental  
**Impacts:** Competition with native plant species, litter accumulation, interferes with refuges for gamebirds, tissues contain grayanotoxins (toxic to humans and other animals)



Photo: I. Bartomeus

*Impatiens glandulifera* Royle (Balsaminaceae)

**Common name:** Himalayan balsam  
Tall annual plant with pale pink-purple zygomorphic flowers and green fruits. Flowering from June to October. The seeds are ejected from the fruits via ballochory.

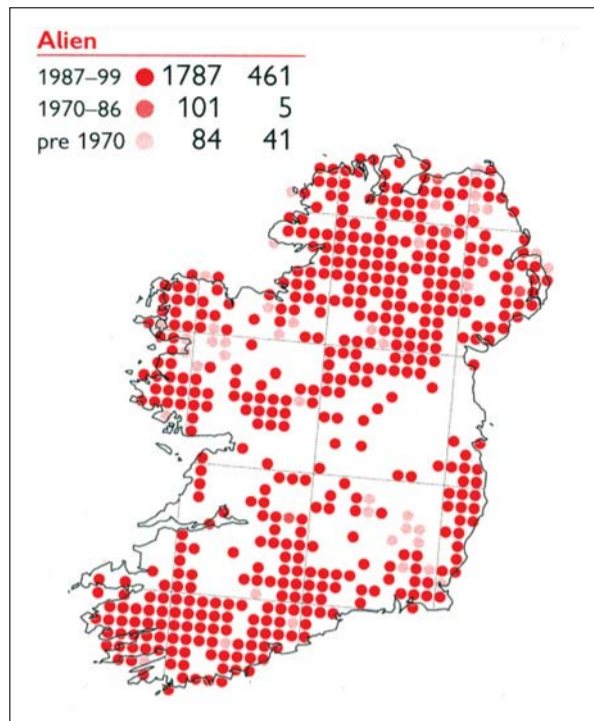
**Native range:** Himalayas

**Introduced range in Europe:** Temperate countries

**Invaded habitats (EUNIS code):** Riverine and fen scrubs (F9), transport networks and other constructed hard-surfaced areas (J4), highly artificial man-made waters and associated structures (J5).

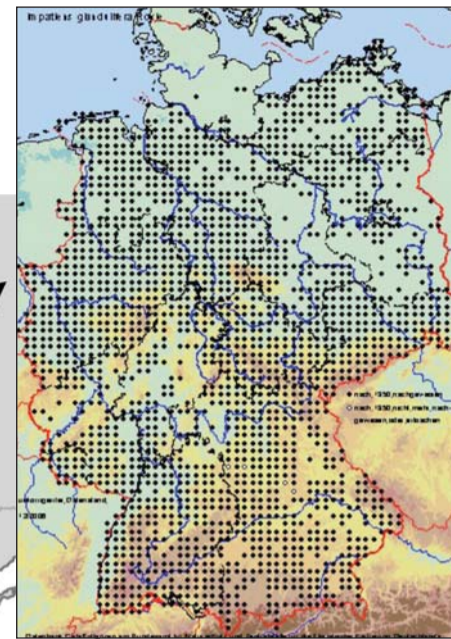
**Introduction pathway:** Ornamental and planted by bee keepers for nectar production

**Impacts:** Competition with native plant species, can promote riverbank erosion when dominant.

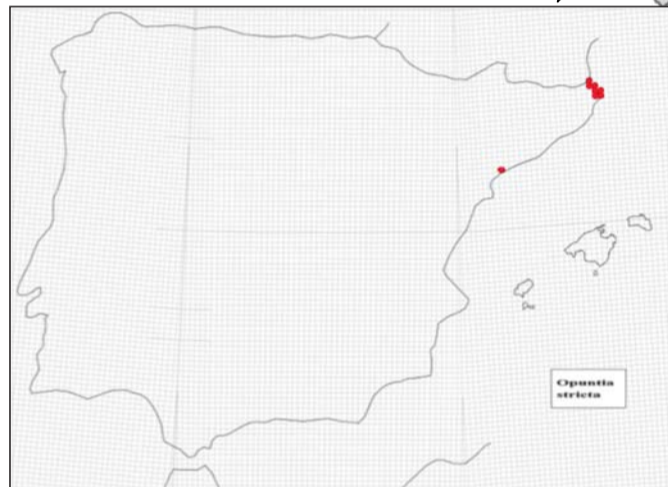


a) *Rhododendron ponticum* distribution map of Ireland according to [citation]

Maps. The location of the 5 study cases is shown in the map of Europe. Small country maps show the degree of invasion of each invaded plant in the European country where the study was carried out.



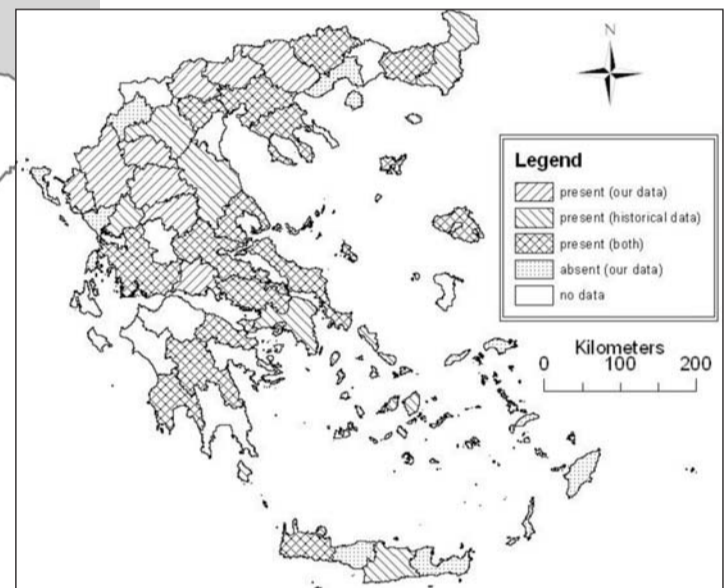
e) *Impatiens glandulifera* distribution map of Germany according to www.floraweb.de



b) *Opuntia stricta* distribution map of Spain according to Sanz-Elorza et al. (2004).



c) *Carpobrotus aff. acinaciformis* distribution map of Spain according to Sanz-Elorza et al. (2004).



d) *Solanum elaeagnifolium* distribution map of Greece per prefecture; historical data adapted from Boratynski et al. (1992).



*Carpobrotus aff. acinaciformis* invading a coastal shrubland in Catalonia-Spain (Photo: I. Bartomeus)



*Opuntia stricta* invading abandoned vineyards in Catalonia-Spain (Photo: M. Vilà)



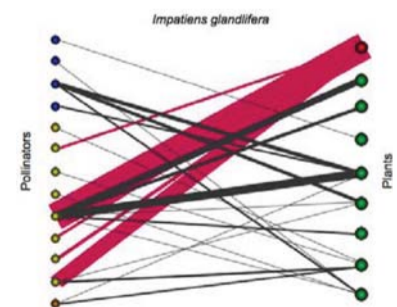
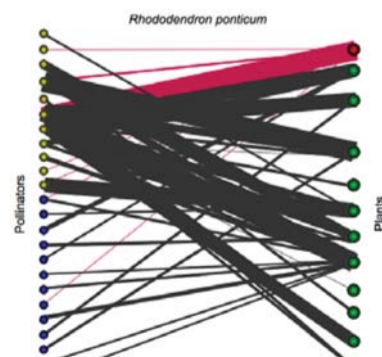
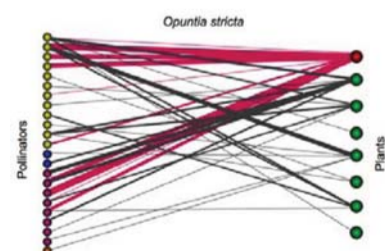
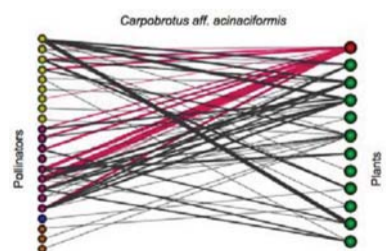
*Rhododendron ponticum* invading a mixed deciduous open forest in Ireland (Photo: A. Dietzsch)



*Solanum elaeagnifolium* invading cultivated fields west of the town of Thessaloniki, Northern Greece (Photo: T. Petanidou)



*Impatiens glandulifera* invading riparian areas in Central Germany. (Photo: I. Bartomeus)



Plant-pollinator networks in invaded communities. Species names are omitted and represented by circles. Circles in red: alien species, green: native plants, yellow: Hymenoptera, blue: Diptera, violet: Coleoptera, and orange: Lepidoptera. The amplitudes of the lines are proportional to the number of visits.