Mapping Plant-Invader Integration into Plant-Pollinator Networks

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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 (Memmott & Waser 2002, Traveset & Richardson 2006, Bjerknes et al. 2007).

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 affine acinaciformis, Opuntia stricta, Rhododendron ponticum, Impatiens glandulifera* and *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 increases the visit of pollinators to some native species (Bartomeus et al. 2008). However, in some cases, pollinators might prefer to visit the invader and reduce the number and duration of visits 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 lure pollinators away from native plants.

Little is known about the impact of alien flowers on native 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, the presence of bumblebees increases in sites invaded by *Impatiens*. Similarly, sites invaded by *Rhododendron* 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 community 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

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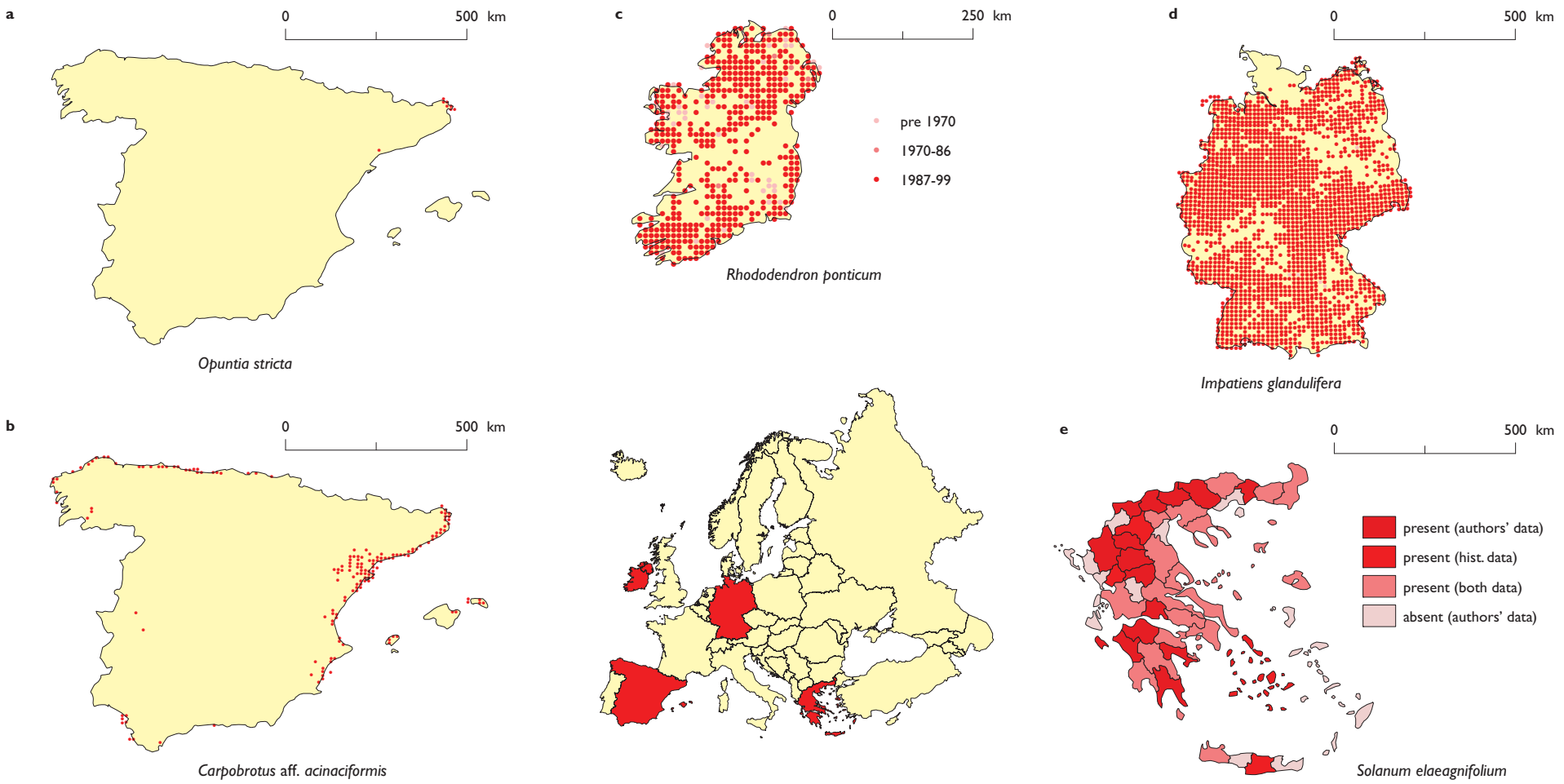

Figure 1. The location of the 5 cases studied is shown on the map of Europe. Small country maps show the degree of invasion for each invasive plant in the European country where the study was carried out. a) and b) distribution map of Spain according to Sanz-Elorza et al. (2004); c) distribution map of Ireland according to Preston et al. 2002; d) distribution map of Germany according to www.floraweb.de; e) distribution map of Greece per prefecture based on authors' research and historical data adapted from Boratynski et al. (1992).

Photo: T. Petanidou.

Photo: M. Vilà.

Photo: I. Bartomeus.

Photo: A. Dietzsch.

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Solanum elaeagnifolium **Cav. (Solanaceae)**

Common name. Silverleaf Nightshade

Plant with woody lower stems and extensive 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). Arable land and market gardens (I1), Trampled areas (H5.6), Dry grasslands (E1), Mesic grasslands (E2), Anthropogenic forb-rich habitats (E5.6).
Introduction pathway. Imported fodder, seeds, soil and fertilizer.
Impacts. Competes with native plant species, interferes with crop production, toxic to livestock.

Description summarized from DAISIE (http://www.europe-aliens.org).

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 as fencing.
Impacts. The spines can cause injuries; interferes with livestock grazing. Invaded woodlands are misperceived as typical Mediterranean landscapes.

Description summarized from DAISIE (http://www.europe-aliens.org).

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

Common name. Iceplant

Succulent plant forming large mats. In the Mediterranean basin, *C. edulis* hybridizes with *C. acinaciformis* forming a hybrid complex known as *C. affine acinaciformis*. 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
Impacts. Competes with native plant species. Increases soil N and organic C and reduces soil pH. In dune habitats it hinders the disturbance regime.

Description summarized from DAISIE (http://www.europe-aliens.org).

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.

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. Competes with native plant species, constributes to litter accumulation, interferes with refuges for gamebirds; tissues contain grayanotoxins, toxic to humans and animals.

Description summarized from DAISIE (http://www.europe-aliens.org).

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. Competes with native plant species, can promote riverbank erosion when dominant.
Description summarized from DAISIE (http://www.europe-aliens.org).

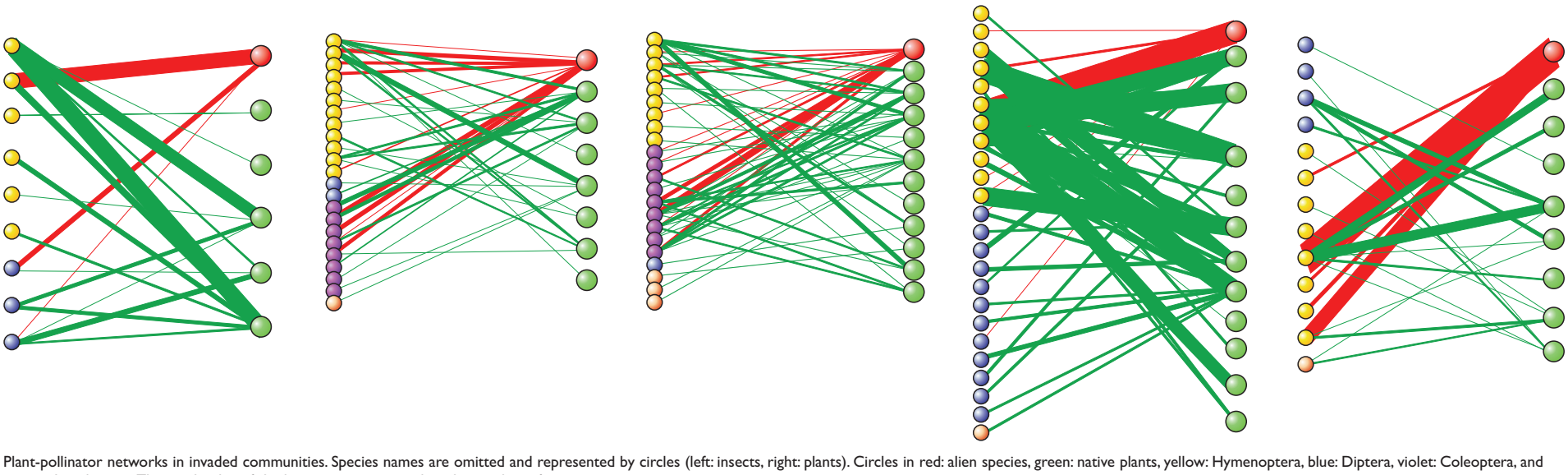
Solanum elaeagnifolium invading cultivated fields west of the city of Thessaloniki, Northern Greece. Photo: T. Petanidou.

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

Carpobrotus affine acinaciformis invading a coastal shrubland in Catalonia-Spain. Photo: I. Bartomeus.

Rhododendron ponticum invading a mixed decidous open forest in Ireland. Photo: A. Dietzsch.

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 (left: insects, right: plants). 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.