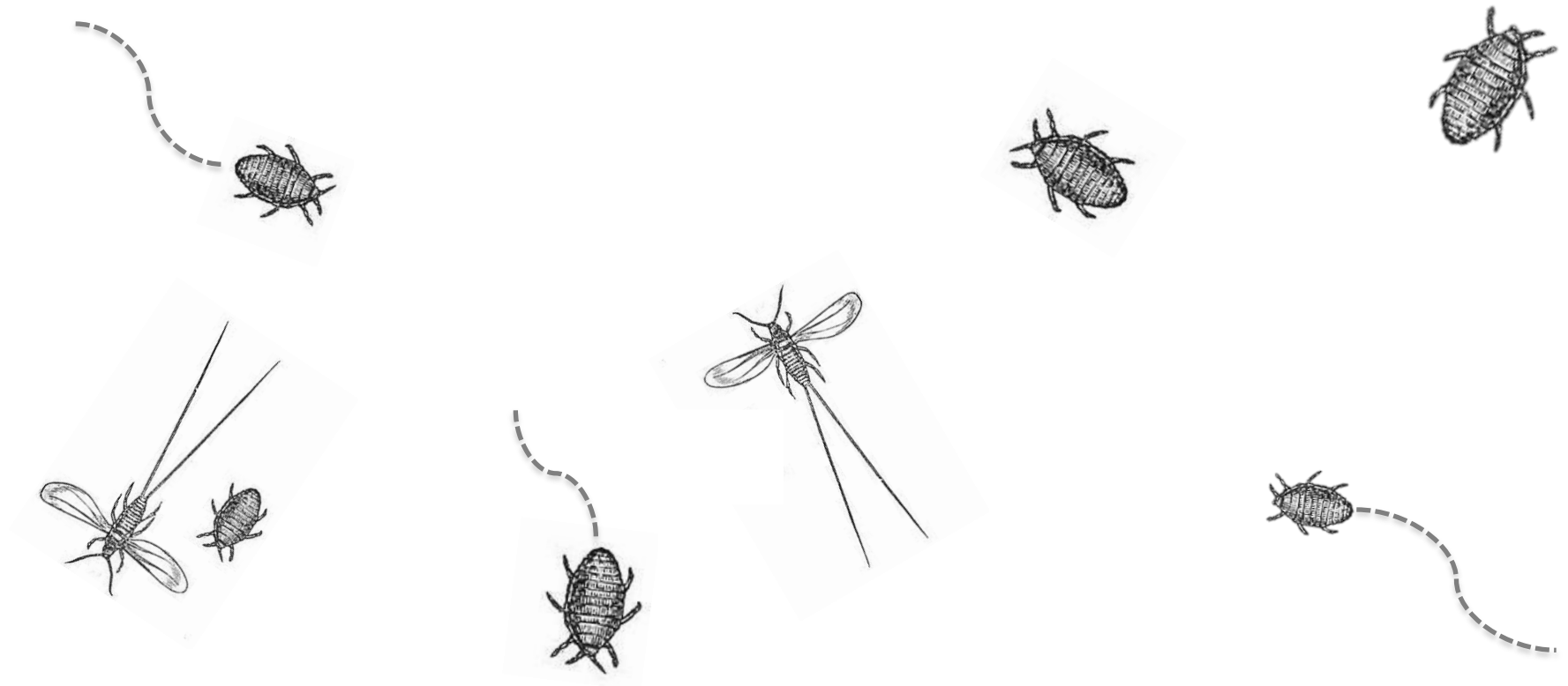


Potential use of the fortuitously-arrived parasite *Dactylopius opuntiae* (Hemiptera; Dactylopidae) as a biological control agent for the invasive cacti *Opuntia ficus-indica* in the Valencia region (East Spain).

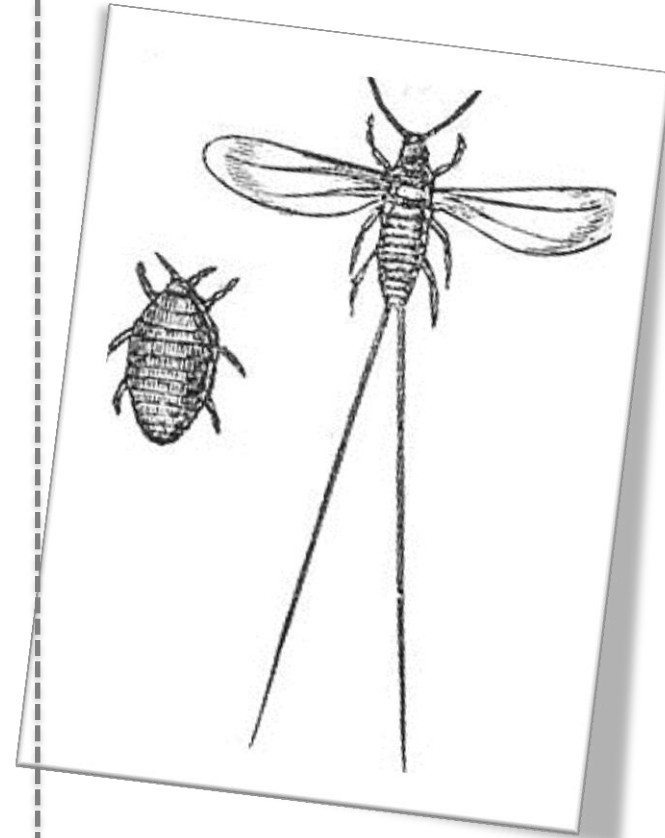
V. Deltoro, C. Torres, MA Gómez-Serrano, P. Pérez, J. Jiménez



GENERALITAT VALENCIANA

CONSELLERIA DE INFRAESTRUCTURAS, TERRITORIO Y MEDIO AMBIENTE

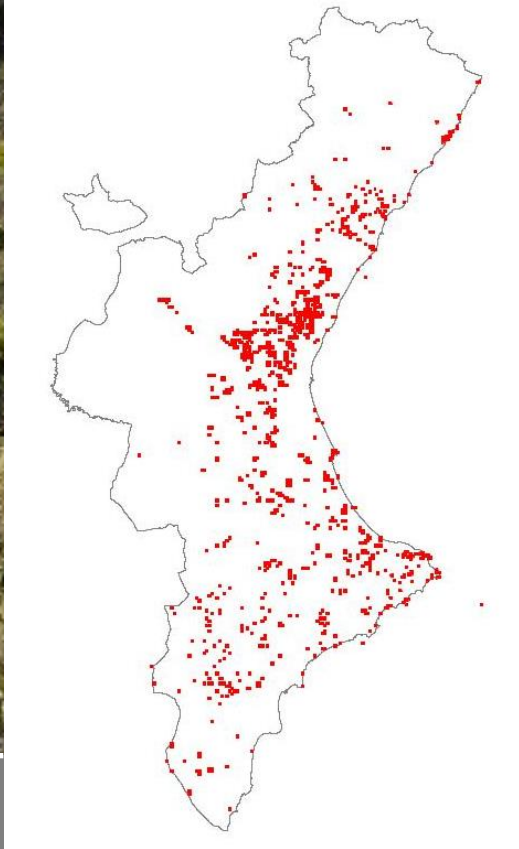




Opuntia ficus-indica is a highly invasive species in sandstone coastal ranges in the Valencia region. It is included in the Spanish national catalogue of invasive sp.



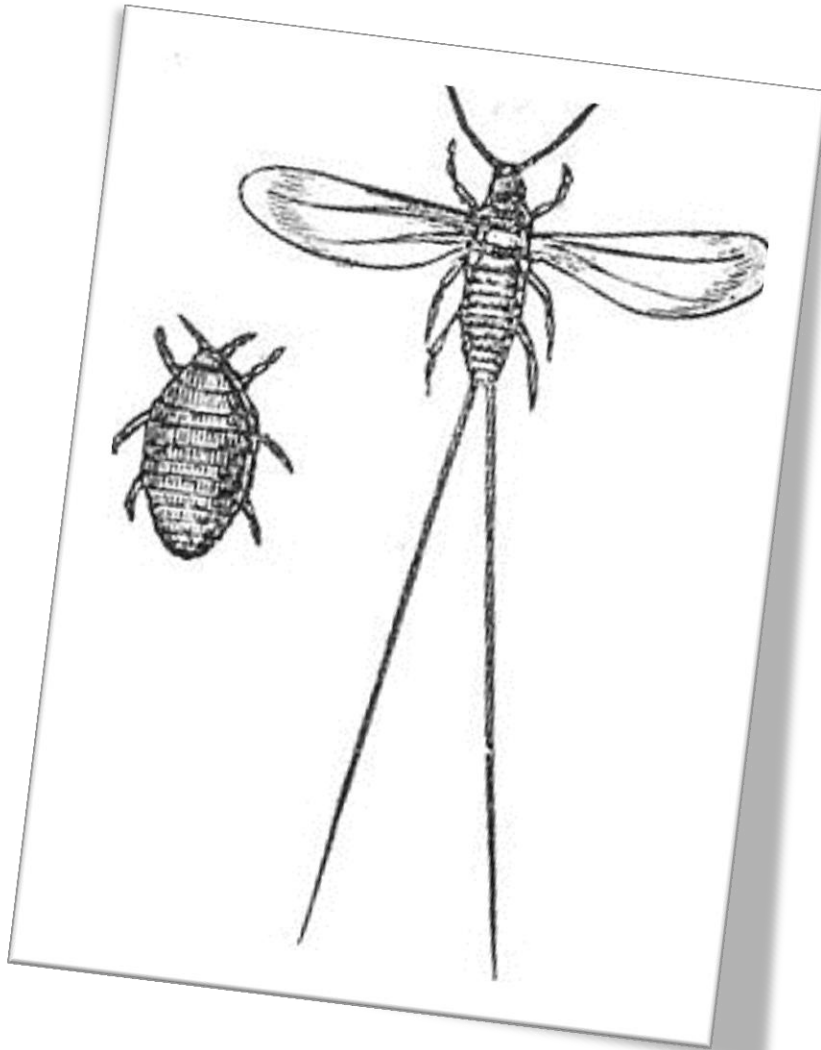
Invasion not restricted to degraded areas. Well preserved thermo-mediterranean shrublands by *O.ficus indica* in Calderona Natural Park heavily colonised (92,5 ha).



O. ficus-indica is fully integrated into the native community, polinised by bees and dispersed by native mammals and birds (i.e. crows)



D. Opuntiae. Genus of sap sucking insects from Mexico. Strong sexual dimorphism. Females sessile, males winged. Passive non-directional dispersal by wind.



Each of the 9 known species of *Dactylopius* lives and feeds **exclusively** on one or a few related cactus species of the genus *Opuntia*, *Cylindropuntia* and *Grusonia*.

They gather in large clumps mainly in shady, sheltered areas on the cactus pads and fruits and feed on the sap . Once larvae attach to a cladode they remain in the same spot throughout their entire lifespan.



A protracted history of use in biological control.



Dactylopius opuntiae

- ✓ Cochineals within *Dactylopius* genus are among the first organisms to be used for biological control (1915), with a history of use by man that exceeds one century.
- ✓ Remarkable record of specificity
- ✓ Extremely damaging to host plants albeit only in dry warm weathers:
- ✓ In wet climates: inefficient process, with dispersal rates in the region of **metres per year** (Hosking et al., 1994; Sullivan and Hosking, 1995; Foxcroft and Hoffmann, 2000).
- ✓ In warm climates: In dry areas or during dry spells, *Dactylopius* dispersal is fast. For instance, Lounsberry (1915) reports a dispersal rate for *Dactylopius* sp of **13 miles year⁻¹ in India**. Likewise, the *Opuntia* cochineal contributed to the clearance of 75% of an infested area of about 900.000 ha in dry regions of the Eastern Cape (Zimmermann, 1981; Zimmermann and Moran, 1991).

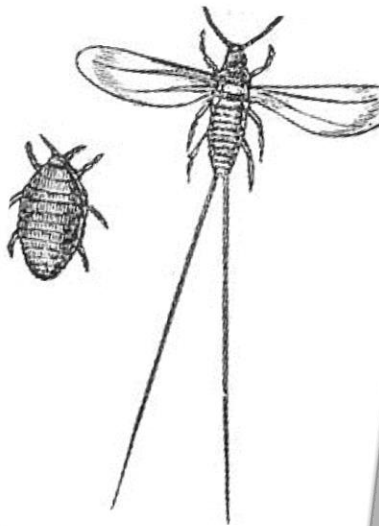
1915. THE AGRICULTURAL JOURNAL OF S.A. 537

PLANT KILLING INSECTS: THE INDIAN COCHINEAL.

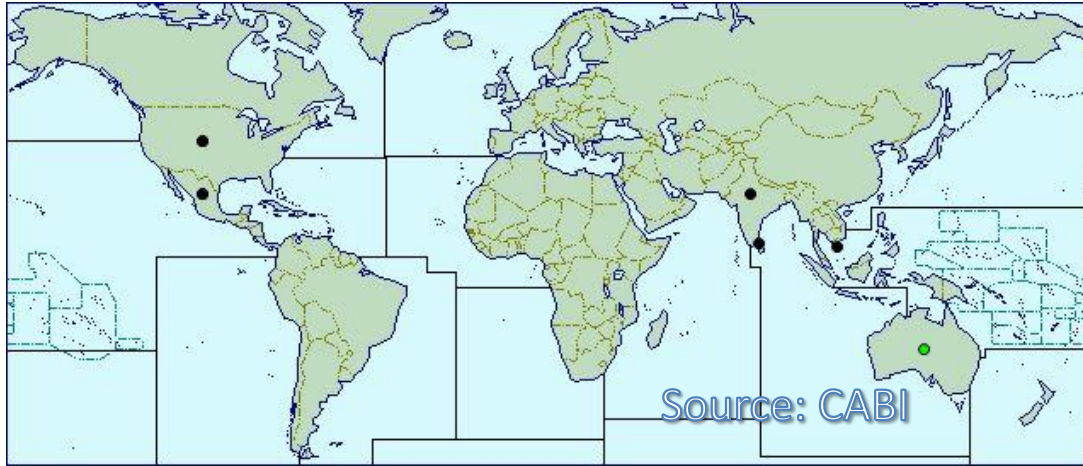
By C. P. LOUNSBURY, Chief, Division of Entomology,
Union Department of Agriculture.

Many sap-sucking insects cause much greater injury to plants than is due to the loss of the extracted juices. There are some very familiar examples of such accessory or incidental injury, as for instance the knotty tumours caused on apple trees both above and below ground by the Woolly Aphis, the distortion of the leaves of peach trees by the common Green Peach Aphis, the pits in the leaves of orange trees by the Citrus Psylla, and the malformations in twig and fruit development that follows the attack of the plant bug, *Antesthia variegata*. In these several cases there is distinct distortion that may be considered to favour the insect in one way or another. In some other cases there is obvious injury without distortion and without any apparent advantage to the insect. A number of scale insects cause discoloration of the plant tissues near the point of their attack. Such an effect is very noticeable in the bark of apple, pear and rose plants in the case of the Red (*Aspidiotus aurantii*) and Pernicious Scale (*A. perniciosus*), and of pear trees at least in the case of Grey Scale (*A. africanus*), and in peach fruits in the case of White Peach Scale (*Aulacaspis pentagona*). It does not appear in these instances that the insect is benefited by the change which, particularly in the case of the first two species, is accompanied by a sickening of the plant far in excess of what appears likely to be due to the mere loss of sap. The scales named, with the possible exception of Grey Scale, are introduced species, but some undoubtedly very severe in their effect on the host plants.

One name
reputed to
Thorn Tree
forty years
The tree
usurping
been at
There
in the

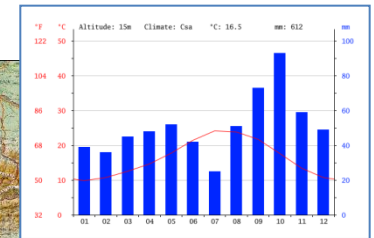


First widespread record of *D.opuntiae* in the western paleartic.



- ✓ Introduced and established in Hawaii, Australia and South Africa.

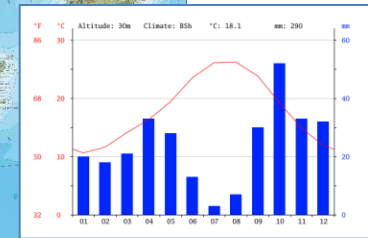
16,5 °C 612mm



- ✓ Fold, 2001: Anecdotal presence in France on an ornamental *Opuntia* spp.
- ✓ Llorens, 2009. First location in Spain in 2007. Currently > 4 million hectares.
- ✓ Spodek et al. 2014: several localities in Israel, within the Hula valley.



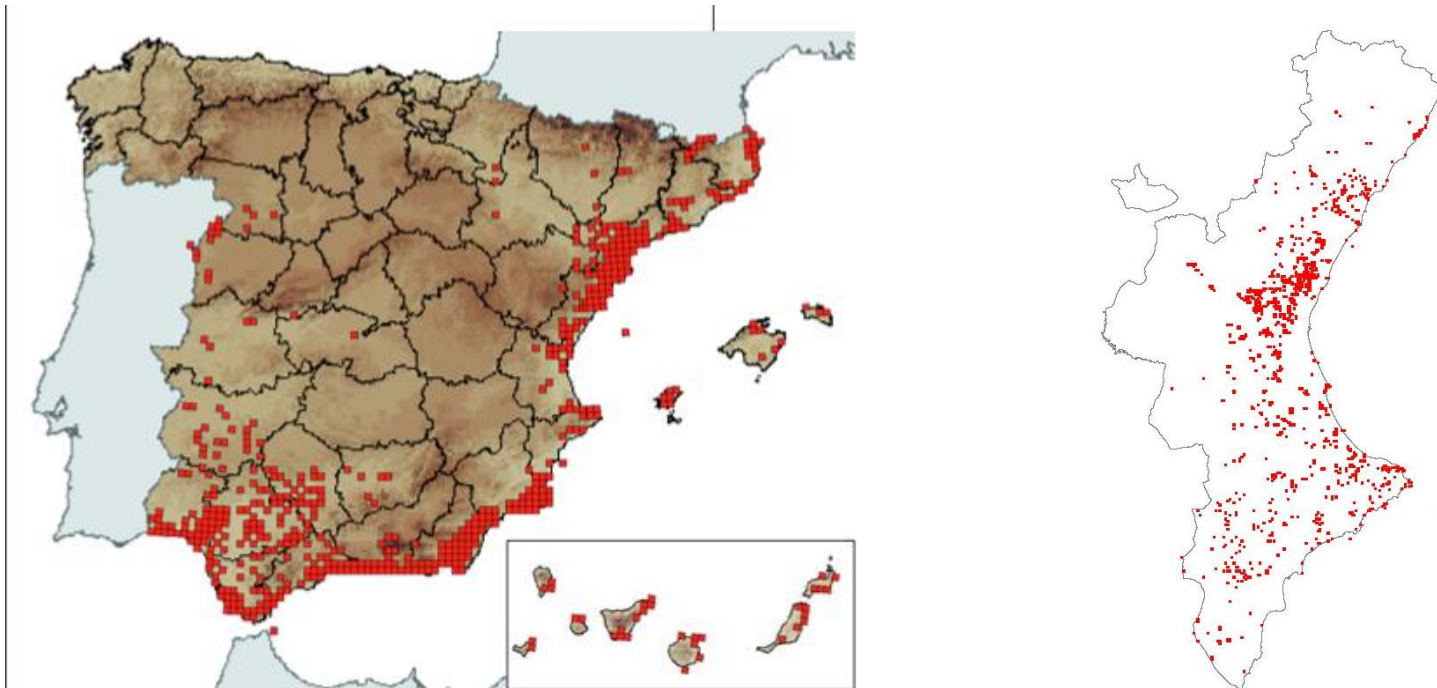
18,1 °C 290 mm



1) Remarkable dispersal rate (ca. 40 km per year) compared to other countries:

- ✓ **Warm+dry** conditions boost colony growth and production of larvae.
- ✓ **Continuous distribution** of host plant along the coastline.

Warm temperatures in the range of 25-30°C are known to be the most favourable for development, survival and reproduction of *Dactylopius* species



2) high incidence and severe injury to plants.

Every single *O. ficus-indica* within the core of the distribution area of *D. opuntiae* is affected, from large clumps through to isolated individuals, no matter how remote.



Sept 2014

Dispersal by *D. Opuntiae* is passive and no directional.

Very high propagule pressure.



Feb 2016

Dispersal to islands located > 3 km off the coast.





Dactylopius introduced on june 13, 2013 at two sites. 18 and 9 infested cladodes were introduced.

Dispersal of crawlers 15 days after initial introduction at mean distance 60cm

First visible damage symptoms observed in november





MAY 2014

Plant nº 1

- ✓ Cladodes collapsed
- ✓ Overall chlorosis
- ✓ Low cladode production in spring



LATE SEPTEMBER 2013

Plant nº 1, 3 months after infection.

Large *Dactylopius* colonies already clearly visible. No evidence of damage.



Conclusions.

- ✓ **Very high incidence of attack and level of damage**, which increases with time and eventually kills plants.
- ✓ *D. Opuntiae* found **across all habitat types** where *O. ficus-indica* grows, reflecting great potential for natural dispersal and wide habitat suitability.
- ✓ *D. opuntiae* will eventually affect (and kill) all *Opuntia* populations in Spain.

Thank you for your attention 😊

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