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Population decline of Galapagos endemic Lepidoptera on Volcán Alcedo (Isabela Island, Galapagos Islands, Ecuador): An effect of the introduction of the cottony cushion scale?

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Summary

By eliminating its food plant, *Darwiniothamnus tenuifolius* (HOOK. *f.*, Asteraceae), the cottony cushion scale, *Icerya purchasi* MASKELL (Insecta, Homoptera, Margarodidae), may have extirpated three Lepidoptera species from the east slope of Volcán Alcedo, Isabela Island, Galapagos Archipelago, Ecuador.

Key words: Lepidoptera, exotic species, competition, local extinction.

Résumé

En éliminant sa plante hôte, *Darwiniothamnus tenuifolius* (HOOK. *f.*, Asteraceae), la cochenille australienne, *Icerya purchasi* MASKELL (Insecta, Homoptera, Margarodidae), a causé la disparition de trois espèces de Lépidoptères de la pente ouest du volcan Alcedo, île d'Isabela, archipel des Galapagos, Equateur.

Mots-clefs: Lepidoptera, espèces introduites, compétition interspécifique, extinction locale.

Introduction

Exotic species introduced into habitats with suitable resources and few native competitors often find conditions conducive to rapid population growth. A dramatic example of an exotic phytophagous insect which has invaded and impacted native ecosystems is *Icerya purchasi* MASKELL (Homoptera: Margarodidae) on the Galapagos Islands. Commonly known as the cottony cushion scale, *I. purchasi* is native to Australia but has been introduced accidentally to many parts of the world (CALTAGIRONE & DOUTT, 1989). Since its introduction to the Galapagos archipelago in 1982, this species has invaded at least 15 islands causing damage to at least 82 plant species (ROQUE-ALBELO & CAUSTON, 2000, CAUSTON, 2001).

Icerya purchasi causes direct damage to its host plants by sucking phloem sap, which in turn depletes resources intended for new plant growth. Damage can include branch deformation and plant death (BLUMBERG *et al.*, 1992). *Icerya purchasi* also produces large quantities of honeydew, which encourages the growth of sooty moulds that often cover the leaves, blocking the stomata and thus preventing both respiration and photosynthesis (JOHNSON et al. in prep.).

Nutrient and plant resource loss from the impact of *I. purchasi* may also have a direct effect on other insect species, in particular those that have a narrow host range that are restricted to plants that are heavily infested by this introduced scale insect. However, no studies have been published on the impact of *I. purchasi* on others insect populations in the Galapagos archipelago.

In this paper I present data showing the decline of three species of endemic Lepidoptera whose host plant is the endemic composite *Darwiniothamnus tenuifolius* (HOOK. *f.*) a species highly affected by *I. purchasi*.

Material and methods

The study was conducted on the east slope of Volcán Alcedo on Isabela Island from October 1998 to April 2001. Sampling was carried out in the wet (April) and dry seasons (October) at three localities in three different vegetation zones: Arid Zone (300 m) (dry season deciduous forest), Transition Zone (500 m) (evergreen steppe scrub) and Humid Zone (900 m) (evergreen forest).

In each altitudinal zone, ultraviolet light traps were used for 3 hours (1900 h to 2200 h). Moths attracted to the light were collected or counted. Reference specimens are deposited in the Invertebrate collection of the Charles Darwin Research Station, Santa Cruz Island, Galapagos.

Following the arrival of *I. purchasi* to this area, the percentage of infested plants was recorded.

To evaluate the occurrence of *I. purchasi* on *D. tenuifolius* qualitative measures were taken using a value scale from 0 (no occurrence) to 3 (very common and plant mortality observed).

Results

A reduction of population numbers of three species of Lepidoptera associated with *D. tenuifolius* was observed between 1998 and 2001 (Table 1).

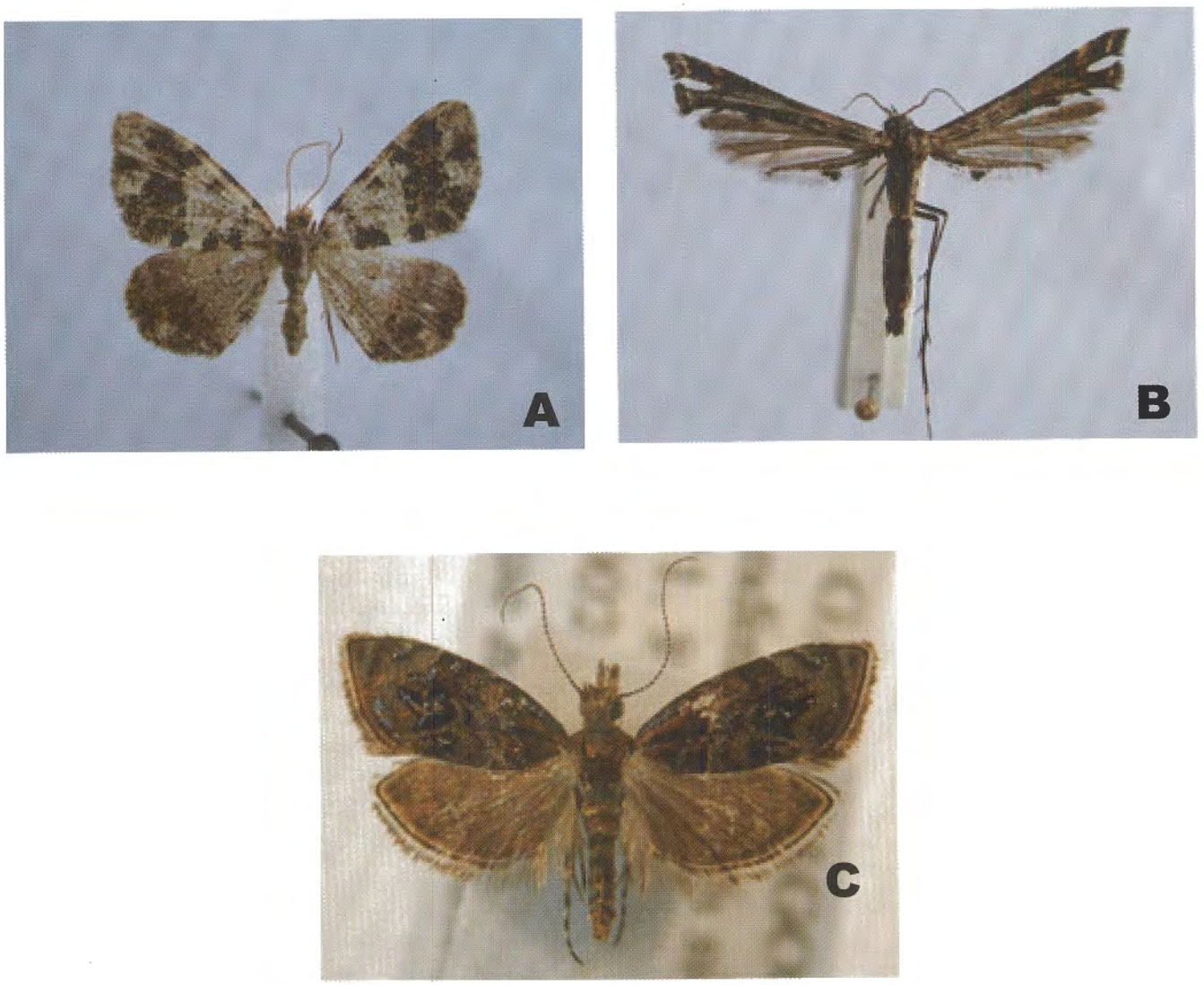

Fig. 1. — Lepidoptera species afected by *Icerya purchasi*. a) *Semiothisa cerussata*, b) *Platyptilia vilema*, c) *Tebenna galapagoensis*.

In contrast, following the discovery of *I. purchasi* on Volcán Alcedo in October 1999, population numbers and *D. tenuifolius* mortality increased markedly from April 2000 onwards.

Semiothisa cerussata HERBULOT, 1970 (Geometridae) (Fig. 1 a) was only collected in April 1999 (19 specimens). It was collected at all three altitudes. This is a new distribution record. The larvae were very abundant on leaves and young branches of *D. tenuifolius* in the Arid Zone (300m). Since this date, the species has not been observed. Previously, this species had been reported only from Santa Cruz and San Cristobal islands where adults had been collected only in the wet season (January to June) (LANDRY & RINDGE, 1995).

The large plume moth *Platyptilia vilema* LANDRY, 1993 (Pterophoridae) (Fig. 1 b) was only collected in small numbers from Volcán Alcedo. In October 1998, five adults were collected and one larva found on leaves of *D. tenuifolius* was reared. Only two adults were collected on alcedo in 1999, and none have been collected since then. This is a new distribution record. This species had been reported only from the volcanoes Darwin and Sierra Negra (Isabela Island) and Pinta in the wet season (LANDRY, 1993).

A marked reduction of *Tebenna galapagoensis* HEPPNER & LANDRY, 1994 (Choreutidae) (Fig. 1 c) was observed during the sampling period. This species was common until 1998. At that time, adults and immature stages were collected from the transition zone (500 m), *T. galapagoensis*, was not collected from 1999 onwards.

In April 1999, *I. purchasi* was recorded for the first time on the east slope of Volcán Alcedo (from 300 m to 600 m). Several plants such as *D. tenuifolius* and *Rhynchosia minima* (L.) DC. were observed with a few individuals of this scale insect. Between then and April 2001 a progressive increase of infestation was observed. Plant death and high levels of infestation were first observed in April 2000.

Table 1 — Abundance of three species of moth associated with *D. tenuifolius* and *I. purchasi* at three altitudinal sites from 1998- 2001. Numbers associated with moth species indicate numbers of specimens collected or observed on plants. Numbers for *Icerya purchasi* indicate: 0: Not observed; 1: Scarse; 2: Common but no *Darwiniothamnus tenuifolius* mortality observed; 3: very common and *Darwiniothamnus tenuifolius* mortality observed.

Family	1998	1999		2000		2001
Species	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.
Geometridae *Semiothisa cerussata*	0	19	0	0	0	0
Pterophoridae *Platyptilia vilema*	5	1	1	0	0	0
Choreutidae *Tebenna galapagoensis*	17	0	0	0	0	0
Margarodidae *Icerya purchasi*	0	1	2	3	3	3

Discussion

This study suggests that the virtual elimination of *D. tenuifolius* in the study localities may have had a drastic effect on *S. cerussata*, *P. vilema*, and *T. galapagoensis*. These three species of endemic Lepidoptera have not been collected in light traps since 1999, coinciding with the arrival and establishment of *I. purchasi* in the study area. It is postulated that these moths are restricted to feed on *D. tenuifolius* and therefore, they disappear in its absence.

Data obtained for some indigenous plants in Galapagos showed that the scale insect infestation appear to influence the levels of nutrients and the vegetative growth of the plants (CAUSTON, 2001).

Some plants species appear to be less susceptible to *I. purchasi* attack (JOHNSON *et al.*, in prep.). However, *D. tenuifolius* is a highly affected species. The IUCN category for this species has been changed recently from non-threatened to vulnerable as a result of damage by *I. purchasi* (A. Tye, pers comm.).

Studies in the Galapagos have shown that it is very difficult to identify in the field whether *I. purchasi* infestations are entirely responsible for plant mortality (CAUSTON, 2003). However, even if *I. purchasi* is not the sole factor responsible for mortality, its effects can be fatal to susceptible plant species that are already stressed by feral goat damage and prolonged dry periods such as those found on Volcán Alcedo.

Interspecific interactions such as competition is an important factor influencing the distribution and abundance of herbivorous insects (CRAWLEY, 1983; DAMMAN, 1993; DENNO *et al.*, 1995). Most studies of competition have concentrated on a small number of closely related taxa on the assumption that in these cases resource overlap is most likely to occur (MCCLURE, 1980; KARBAN, 1986). However competition between herbivorous insects can occur even between distantly unrelated taxa (BLAKEY & DINGLE, 1978).

Our results on Lepidoptera and *Icerya purchasi* provide the first documented example of delayed, plant–mediated interspecific competition between phytophagous insects in the Galapagos archipelago. The evaluation of the impact of *I. purchasi* on the flora and fauna is no easy matter. The data obtained during our study can only give a glimpse into its effect on the biota. More field sampling is clearly needed before any reasonable predictions can be made about the probable local extinction of the species in the localities investigated. However, evidence from this study suggests that the direct consequence of this competition is an increase in abundance of *I. purchasi* and a significant reduction in abundance of Lepidoptera species associated with *D. tenuifolius*. This reduction is due to the combined effect of habitat destruction and food availability as well as, probably, food quality.

It will be interesting to see if *D. tenuifolius* and its associated lepidopteran fauna will recover in this area now that *Rodolia cardinalis* (MULSANT) (Coleoptera, Coccinellidae) has been purposefully introduced as a biological control agent for *I. purchasi*.

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