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Leaf feeding preferences in the monophagous saltbush flea beetle *Nesaecrepida darwini* (Coleoptera: Chrysomelidae)

Peter VERDYCK and Konjev DESENDER

Abstract

In order to test for morphological differences between specimens of host plant (*Cryptocarpus pyriformis*) used for feeding and plants not used for feeding by the salt bush flea beetle (*Nesaecrepida darwini*), we compared five variables (branch length, number of leaves, maximum leaf length, maximum leaf width and digitised leaf surface) between three feeding classes (no, minor and major feeding damage). The results show that there are significant morphological differences between branches and leaves depending on the degree of feeding. Feeding is primarily taking place on smaller plants (with a lower general vitality), an observation supporting the 'environmental stress hypothesis'.

Samenvatting

Om te testen of er morfologische verschillen zijn tussen exemplaren van de waardplant (*Cryptocarpus pyriformis*) waar de "salt bush" vlokever (*Nesaecrepida darwini*) zich op voedt en planten waarop hij zich niet voedt, vergelijken we vijf variabelen (tak lengte, aantal bladeren, grootste blad lengte, grootste blad breedte en bladoppervlakte) tussen drie voedingsklassen (geen, lichte of zware voedingsschade). De resultaten tonen significante morfologische verschillen tussen takken en bladeren afhankelijk van de mate waarin ze gebruikt worden als voedsel. De kevers voeden zich hoofdzakelijk met de kleinste planten (met de laagste algemene vitaliteit) en dit is in overeenstemming met de "omgevingsstress hypothese".

Keywords: leaf feeding, leaf surface, monophagy, Chrysomelidae, Galápagos.

Introduction

With over 37.000 species described (and about 70.000 estimated) the leaf beetle family (Chrysomelidae) constitutes one of the most important herbivorous groups with an enormous impact both in natural and agricultural biotopes. Although feeding preferences and host plant relations have been studied in great detail for a few species, even basic data as food-plant records are only known for less than 30% of the described species (JOLIVET,1988). Adults of almost all chrysomelid species are leaf feeders, and their feeding damage can easily be observed.

Within the Chrysomelidae a huge variation in host plant range exists. On the one hand real specialists only feed on a single plant species or on a few related plants within a single genus (monophagy). On the other hand some species feed on a huge variety of plant species, even from different plant families, and are really polyphagous. The relationships between host plant range and genetic variability has already been studied for several groups and is discussed in detail by VERDYCK (1998). Here we take a look at a highly specialised flea beetle: the salt bush flea beetle *Nesaecrepida darwini* (Mutchler, 1925), a monophagous species, endemic on Galápagos and feeding exclusively on saltbush (*Cryptocarpus pyriformis*). This species is distributed on almost all islands of Galápagos, but it has a very patchy distribution and the populations are always very concentrated (often on a few square metres). Recent genetic work on *N. darwini* (VERDYCK & DESENDER, 1999) revealed a metapopulation structure suggesting regular extinctions and recolonisations, leading to a high degree of genetic differentiation, even within a single island.

Although at first sight the host plant is very abundant, and the beetles seem to have good dispersing capabilities (flying and jumping), the populations remain small and do not move to spots in the close neighbourhood. In order to find out more about the distribution pattern of the beetle, we investigated which characteristics the host plants infested with beetles show. In this paper we therefore study whether morphological or morphometric differences can be observed between plants used to feed upon and those on which beetles apparently do not feed.

Material and methods

Near the Charles Darwin Research Station, a single population of *N. darwini* was detected during our expeditions of 1996 and 1998 (March-April). The exact location is between the meteorological station and the sea, near the directors House at the Charles Darwin Research Station (Academic Bay, Santa Cruz). Although at this part of Academic Bay saltbush is growing almost everywhere, only on a single spot of a few square metres the saltbush flea beetle could be found. Biotope, host plant, beetles and leaves are illustrated in Figs. 1 to 6.

To study whether damaged (by *Nesaecrepida* feeding)

Figs. 1-6 — (from left to right and top to bottom): 1. Academy Bay, Santa Cruz, 2. vegetation in arid zone with *Cryptocarpus* and *Opuntia,* 3. shrub of *Cryptocarpus pyriformis,* 4. flower of *Cryptocarpus pyriformis,* 5. *Nesaecrepida darwini*, female (left) and male (right) 6. leaves of *Cryptocarpus pyriformis*: top: undamaged, bottom: with feeding damage.

and undamaged *Cryptocarpus* plants showed morphological differences, we collected branches of *C. pyriformis* in this location.

70 branches were collected on the spot described above. Afterwards they were divided into three classes of feeding damage:

— branches of which the leaves were not fed upon by the beetles (n = 32)
— branches of which the leaves showed minor feeding damage (n = 14)
— branches of which the leaves had major feeding damage (n = 24)

The feeding damage caused by *Nesaecrepida* is easy recognisable. The beetles make small holes in the leaves which show brown points in varying densities. The division of the branches in three categories was done after short visual inspection.

For all branches the following measures were taken:

1. total length of the branch (branch length) (in centimetres)
2. number of leaves on the branch (without the top) (number of leaves)
3. length of the largest leaf on the branch (maximum leaf length) (in millimetres)
4. width of the largest leaf on the branch (maximum leaf width) (in millimetres)

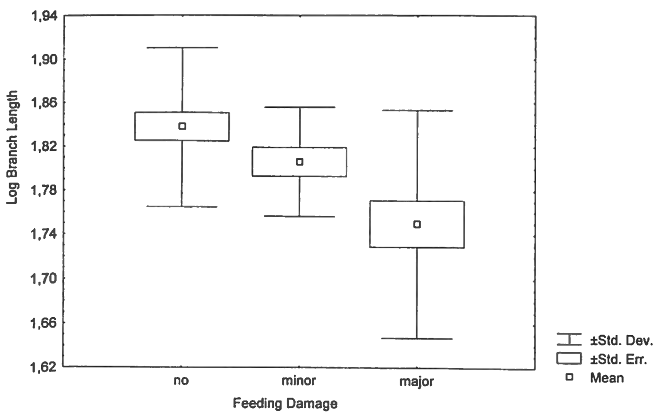
For a random selection of leaves the total surface was measured by drawing the contours on paper and digitising the surface (5. leaf surface) (square millimetres).

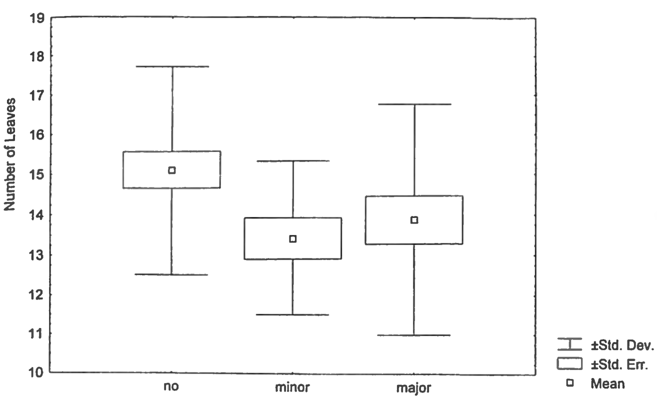
The data were checked for deviations from a normal distribution using Kolmogorov-Smirnov test and for homogeneity of variances and covariances using Levene's test. No significant deviations from normal distribution were detected and only data for the variable "branch length" showed significant deviation for homogeneity of variances and covariances. For this variable the data were log transformed before further analysis.

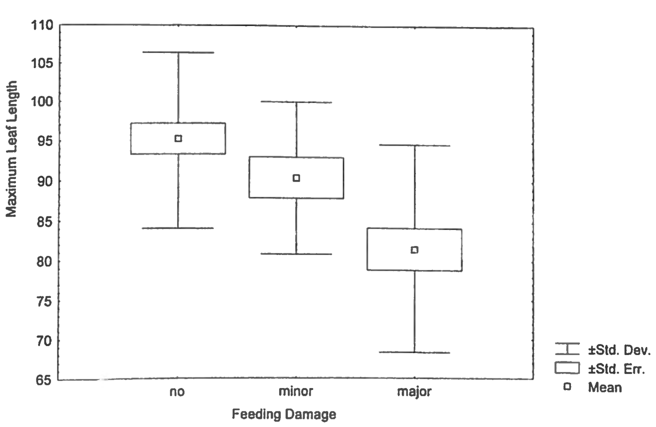
We checked for differences for all five characters using ANOVA and performed post hoc Tukey honest significant difference test (HSD) for unequal sample sizes to find out which of the mean values were significantly different. All analyses were performed using Statistica V 5.0. To correct for multiple testing sequential Bonferroni correction (Holm, 1979; Rice, 1989) was applied.

Results

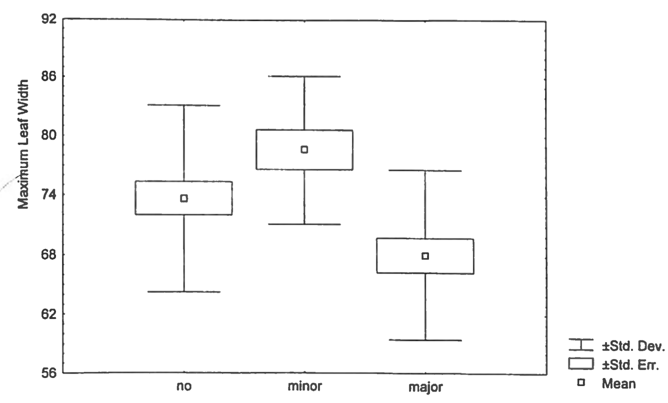
Basic statistics for all branches are shown graphically in box whisker plots (Figs. 7-11). ANOVA showed highly significant differences ($p<0.01$, sequential Bonferroni

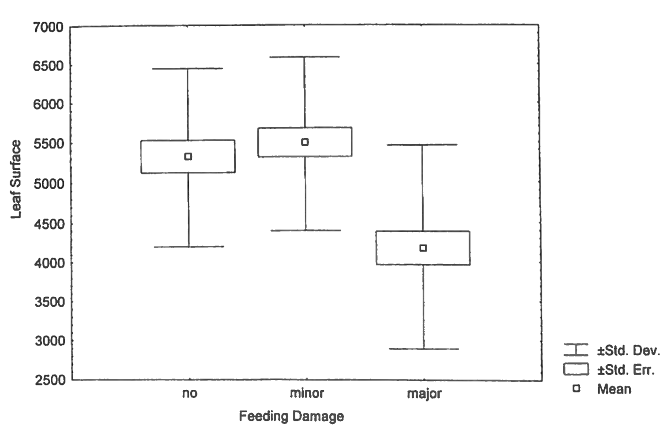






Figs. 7-11 — Box-whisker plots (mean, standard error, standard deviation) for the variables "branch length", "number of leaves", "maximum leaf width", "maximum leaf length" and "leaf surface".





correction) for "branch length", "leaf length", "leaf width" and "leaf surface" but not for number of leaves. The posthoc test showed that differences were significant between strongly attacked and unattacked branches for "branch length" and "maximum leaf length". For "maximum leaf width" there was a significant difference between weakly and strongly attacked branches (but here the unattacked branches did not show a significant difference from both other categories). For "leaf surface" the posthoc test showed that differences are significant between the strongly attacked braches and both other groups.

Discussion

The results clearly show that there are significant morphological differences between branches and leaves that are used for feeding and those that are not touched by *Nesaecrepida* beetles. Beetles always prefer less developed (smallest) leaves and branches. The fact that the beetles seem to feed on smaller plants, might be supporting the environmental stress hypothesis which states that herbivores will prefer weakened or stressed plants for feeding (see Louda & Collinge, 1992).

However, it is not completely sure that plant morphology is the limiting factor for the ability of the beetles to feed. Neither can we exclude that the feeding of the beetles itself may be causing stress to the plants. Although it has been shown for flea beetles of the genus *Phyllotreta* that leaf shape has an impact on feeding preference (Rivero-Lynch et al., 1996), other factors such as leaf epicuticular wax, secondary compounds, nutrient concentration, trichome density etc. can have an influence on the distribution of phytophagous insects on their hosts (Soetens, 1991; Bodnaryk, 1992; Soetens & Pasteels, 1994). Nevertheless this study is a first but convincing indication that variation in host plant characteristics influences the beetle species distribution and thus has an influence on the observed metapopulation structure of *Nesaecrepida darwini*.

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Peter Verdyck
KBIN, Department of Entomology,
Vautierstraat 29,
B-1000 Brussels
Belgium
Evolutionary Biology Group,
Department Biology,
University of Antwerp (RUCA),
Groenenborgerlaan 171, 2020 Antwerpen,
Belgium
e-mail: verdyck@kbinirsnb.be

Konjev Desender
KBIN, Department of Entomology,
Vautierstraat 29, B-1000 Brussels,
Belgium
kdesender@kbinirsnb.be