

DOES RESOURCE CONCENTRATION AFFECT ATTACK BY GALLING AND FOLIVOROUS INSECTS ON *SCHINUS POLYGAMUS* (CAV.) CABR. (ANACARDIACEAE)?¹

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ABSTRACT

The resource concentration hypothesis states that the concentration or dispersion of host resources has a direct influence on herbivore insect populations. Plant consumers tend to concentrate at places in which the plant resources are abundant and easy to find. Results with *Schinus polygamus* (Cav.) Cabr. (Anacardiaceae), a shrub showing high levels of attack by different herbivorous insects, suggest that the concentration of resources influences the level of attack by galling insects, but not in the case of folivorous insects. This difference could be related with the biological features of the species involved, such as size, searching behaviour and flight capacity. Different degrees of specialization could also explain the differences between attack of galling and folivorous insects.

Keywords: concentration of resources, gall makers, folivory insects, specialization degree.

RESUMEN

La hipótesis de concentración de recursos plantea que la concentración o dispersión de recursos influye directamente en las poblaciones de insectos herbívoros que los utilizan. Los consumidores de plantas tienden a concentrarse en lugares donde el recurso es abundante y fácil de encontrar. En este estudio se trabajó con *Schinus polygamus* (Cav.) Cabr., un arbusto que presenta un alto nivel de ataque por diferentes insectos herbívoros. Los resultados sugieren que la concentración de recursos puede influenciar el nivel de ataque por insectos agalladores, mientras que no lo hace para insectos defoliadores. Esta diferencia puede estar relacionada con la diferencias en la biología de las especies involucradas tales como tamaño, conducta de búsqueda de hospederos o capacidad de vuelo. Diferencias en el grado de especialización también podrían explicar las diferencias entre el ataque de insectos agalladores y defoliadores.

Palabras claves: concentración de recursos, insectos agalladores, insectos defoliadores, grado de especialización.

INTRODUCTION

Several studies indicate that the concentration or dispersion of food resources has a direct influence

on insect populations (Price, 1997). Thus, consumers tend to concentrate at places where resources are abundant and easy to find. Root (1973) formalized this phenomenon as the resource concentration hypothesis. This lies on the assumptions that herbivores, particularly specialists, 1) are more likely to find hosts that are spatially concentrated, 2) once arrived, are likely to remain there; and 3) reproductive success is likely to be greater (Price, 1997). According to Root (1973), the concentration of the resource could benefit the development of some specialized herbivores, but the situation could be different with respect to non-specialized ones. Adults of these latter species may find adequate oviposition sites, but these sites may constitute

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inadequate larval food (Price, 1997). Thus, members of these species may tend to emigrate from the patch.

Schinus polygamus (Cav.) Cabr. (Anacardiaceae) is an abundant shrub in the semi-arid matorral of Central Chile. High levels of attack by different herbivorous insects have been reported in this species (Hoffmann, 1998; Navas, 1976). In addition, the family Anacardiaceae concentrates 9.2 % of all types of galls described in the Chilean flora (Nuñez & Sáiz, 1994). In particular, in *S. polygamus* seven types of galls have been reported, five of which are rather common (Nuñez & Sáiz, 1994, 1997). The aim of this study was to examine the effect of the degree of aggregation of resources on the number of leaves showing herbivory and the number of galls present in plants of *S. polygamus*.

MATERIALS AND METHODS

Data were collected between December 5 and 10, 1999 at the Río Clarillo National Reserve (33°51'S, 70°29'W, 45 km southeast of Santiago, Chile). *Schinus polygamus* is an abundant, polymorphic evergreen shrub of 1–2.5 m high, with high to low aggregated distribution. Twenty-one patches with different degrees of aggregation of *S. polygamus* individuals were defined. Each patch was identified as a focal plant surrounded (or not) by other conspecifics in the centre of a circle with 10 m radius. The height and approximate cover of each individual in the experimental unit was measured. The number of neighbouring individuals and the distance between each of them and the focal plant were also assessed.

To analyze the effect of the aggregation degree on the abundance of galls and incidence of folivory, standardized samples of 100 g of fresh biomass (branches, leaves, etc), were randomly collected

from the focal plant of each patch. Samples were stored in plastic bags until analyzed. The following parameters were recorded for each sample: number of galls, type of galls, number of damaged leaves (chewed, sucked, etc.) and number of undamaged leaves.

Multiple regression analysis was performed separately for the dependent variables "number of galls" and "incidence of folivory". First, a basic multiple regression was performed where all the independent variables were tested at the same time, followed by a multiple regression with the forward stepwise form, to identify the most relevant variables. An exploratory analysis indicated the need to $\ln(x + 1)$ - transform some data sets to deal with the assumptions of the parametric statistics.

RESULTS

The results of the multiple regression showed no relation between folivory and different variables related to aggregation ($R = 0.60$, $P = 0.31$). The multiple regression for the number of galls showed a different scenario. There was a significant relationship between the number of galls and variables related to aggregation of resources ($R = 0.82$, $P = 0.006$). The variables with positive significant correlations with number of galls were focal shrub height ($P = 0.030$) and height of highest neighbour ($P = 0.021$), whereas cover area of neighbours had a negative significant correlation ($P = 0.027$).

In order to determine the most important independent variables on the multiple regression, a forward stepwise analysis was performed. The variables that arose as the most important determinants of the increase of the number of galls, were the heights of the highest neighbour and of the focal plant, and the coverage of the neighbouring plants (Table 1).

TABLE 1
FORWARD STEPWISE ANALYSIS FOR INCIDENCE OF GALLING INSECTS IN PATCHES WITH DIFFERENT DEGREES OF AGGREGATION OF *SCHINUS POLYGAMUS*.

	β	Partial correlation	P-level
Height of focal shrub	0.542	0.648	0.0025
Height of highest neighbour	0.891	0.650	0.0024
Area covered by neighbours	-0.634	-0.518	0.022

DISCUSSION

In general, it may be hypothesized that the volume of the plants is the most important cue for the visual finding of the host by the gall makers. At the level of multiple regressions made with the forward stepwise procedure, the height of the neighbours, the height of the focal plant and the coverage of the neighbours inside the experimental units, determine the most significant level of relation with the number of galls.

The presence of galls correlated directly with variables related to the height of shrubs in each patch, and inversely with the area covered by neighbors in the patch. Both types of variables are related to how conspicuous the resource was. On the other hand, field observations showed that in patches with numerous conspecifics, the presence of galls tended to be homogeneous, i.e. all neighbouring plants had galls. Thus, the results suggest that a conspicuous patch, with high plants, is able to recruit a high number of galling insects, but the presence of several conspecifics in the patch results in homogenization of the attack by these insects.

Although the presence of galls showed a significant relation with variables related to concentration of resources, no such relation was found with the incidence of folivory. These differences could be attributed to two major facts: insect-host specialisation and the capacity of the insects for searching and finding the resources.

The insects that are involved in the production of galls in *S. polygamus* are species from the families Psyllidae, Cecidomyiidae and Cecidosidae, generally smaller than 5 mm (Sáiz & Nuñez, 1997; Artigas, 1994). Small insects tend to have restricted capacity to explore distant places. For example, psyllids are jumping homopterans with poor capacity to maintain prolonged flights (Artigas, 1994). Assuming that these incapacities decrease the probability to colonize farther away patches, the correlation encountered in this work supports this fact.

The formation of galls reflects a high level of specificity between plants and galling insects (Dreger - Jauffret & Shorthouse, 1992). In contrast, folivorous insects tend to be relatively polyphagous species, foraging on a wider range of resources. In

this sense, generalist folivorous insects could have less difficulty in finding suitable hosts than could have specialized gall makers. Thus, for small and specialist organisms such as the galling insects present in the system studied, the effect of distance could be a real barrier between the potential host plants, comparable to the presence of other kinds of vegetation or other physical barriers such as rivers, hills, etc. These barriers would decrease the probability of arrival to the host plants, and could be particularly important in explaining the differences of folivorous and galling insects in relation to resource concentration.

Few studies have discussed the biology of galling insects present in the Central Chilean matorral, and none of them has addressed their flight capacities and host searching abilities. These are relevant data to record in the future. The relations found between the presence of galls and variables related to concentration of resources suggest that the dispersion capacity of galling insects in *S. polygamus* are related with the conspicuity of patches, but a high concentration of resources could lead to a dilution of attack by the insect. In other words, those patches containing tall plants could be more attractive to galling insects, but if they are highly dense, this effect would be diluted.

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