Gayana 67(1): 39-44, 2003 ISSN 0717-652X

LARVAL MORPHOLOGICAL VARIATION AND ITS RELATION TO HOST PLANTS IN *SYNCIRSODES PRIMATA* (LEPIDOPTERA: GEOMETRIDAE)

VARIACION MORFOLOGICA LARVAL Y SU RELACION CON PLANTAS HOSPEDERAS EN SYNCIRSODES PRIMATA *(LEPIDOPTERA: GEOMETRIDAE)*

Patricia Bocaz[1], Luis E. Parra[2] & Pedro F. Victoriano[2]

[1]Programa Magíster en Ciencias mención Zoología. Universidad de Concepción. Casilla 160-C. Concepción. Chile. Email: pabocaz@udec.cl
[2]Departamento de Zoología. Facultad de Cs. Naturales y Oceanográficas. Universidad de Concepción. Casilla 160-C. Concepción. Chile.

ABSTRACT

Morphological variations in larvae of *Syncirsodes primata* (Walker 1862) from different hosts were studied. Three different morphs, varying in the number of dorsal tubercles and color, were detected. It appears that these variations depend upon the species of host plant on which the larvae inhabit. The results suggest that the selection of host plants may determine the color, indicating phenotypic plasticity. However, constancy in tubercle number, independent of a change of host plant, suggests genetic differences among morphs.

KEYWORDS: Morphological variation, phenotypic plasticity, *Syncirsodes primata*, Geometridae, Lepidoptera.

RESUMEN

Se estudió la variación morfológica en larvas de *Syncirsodes primata* (Walker 1862) provenientes de distintos hospedadores. Se detectaron tres morfos diferentes que varían en número de tubérculos dorsales y color, dependiendo de la especie hospedero en que se encuentran. Los resultados sugieren preliminarmente que las plantas hospederas determinan el color, respondiendo a un fenómeno de plasticidad fenotípica. En cambio, la constancia del número de tubérculos, independientemente del cambio de hospederos, sugeriría diferencias genéticas entre morfos.

PALABRAS CLAVES: Variación morfológica, plasticidad fenotípica, *Syncirsodes primata*, Geometridae, Lepidoptera.

INTRODUCTION

Phenotypic variation in immature stages of phytophagous insects is frequent (Ayres & Maclean 1987; Greene 1999, 1996, 1989; Nylin 1994; Tikkanen *et al*, 2000), and may be due to the local environmental conditions or biotic factors (Evans & Wheeler 2001). These variations are known as the "phenotypic plasticity" phenomenon (Gotthard & Nylin 1995, Nylin 1998). An opposing theory suggests that they may be due to genetic differences or polymorphism (Nylin 1998). Some studies of Lepidoptera indicate that seasonal variations (Nylin 1994), climatic gradients (Iwasa *et al*, 1994) and latitudinal gradients (Scriber 1994), among others, generates phenotypic changes within a species, and within genetically similar individuals. The phenotypic variation of color or shape in species of chilean lepidopterans has received little attention. Within the Geometridae, Izquierdo (1895) mentions that very similar larvae may, through distinct metamorphoses, give very different adults. Herrera (1987 a y b) describes the color variation in *Phoebis sennae amphitrite* (Feisthamel) (Pieridae) larvae, indicating the presence of an accentuated color difference coming from the host. This supports the notion that these coloration differences are due to the different substrates (flowers or leaves) on which the caterpillars feed. The same author indicates that in the larval stages of the species *Cynthia carye* (Hübner), there are variation in the coloration of the individuals, however in the adults there are no variations.

The genus *Syncirsodes* is endemic to the template forests of southern Chile and Argentina. In Chile this genus is distributed from Coquimbo, northern Chile, to Patagonia. *Syncirsodes* has four species: *S. distictaria* (Mabille 1885), *S. primata* Butler 1882, *S. hyadesi* (Mabille 1885), and *S. straminea* Butler 1882 (Bocaz Torres & Parra, not published data). The adults of *Syncirsodes* are large moths (35 to 45 mm) of thin body and wide wings, with a marked sexual dimorphism. The dorsal surface of the wings has many colour variations, from pale yellow to dark gray.

Besides presenting sexual dimorphism, the different species of *Syncirsodes* have a high intra specific phenotypic variation, expressed as different maculation patterns in the adults. The existence of polychrome makes it necessary to resort to an analysis of the genital armor for a reliable identification of the species of the genus. The species of the genus that presents the biggest variation of coloration is *Syncirsodes primata,* whose adults exhibit five different varieties in the pattern of maculation of the wings. This has caused many naturalists and scientists to mistake identifications of these varieties for different species (e. g. Butler 1882, Angulo & Casanueva 1981).

Current studies, that examine the life cycle of species of the *Syncirsodes* genus, have indicated certain variation in the pattern of coloration and morphology in the larva of *S. primata*, according to the host plant on which they feed. These leads one to think that different larva, should become different adults. However, that is not what happens. As a result of these observations and considering Izquierdo's studies (1895), the objective of the present study is to describe the morphologic pattern observed in the larva of the *Syncirsodes* genus in the Península of Hualpén (36º 45´S - 73º 9´W / 36º 49´S - 73º 13´W) and to determine an eventual association with different host plants.

MATERIALS AND METHODS

Between spring 1998, and summer, 2002, larvae of *S. primata* were gathered from vegetation (Península of Hualpén, VIII Region, 36º45'S - 73º9'W / 36º49'S - 73º13'W) and taken to a temperate controlled rearing chamber with constant humidity and constant light. The objective was to observe coloration throughout metamorphosis. For each individual captured the species of the host plant was registered, with the purpose of associating them with the different morphologic forms. Once emerged, the adult (n = 10 males, 10 females) genital armor was analyzed to check the conspecific nature of the individuals. The eggs (n = 70) were also morphologically analyzed. They were obtained from females in the laboratory and from gravid females captured in the field, in order to examine whether the observed characters would remain the same. For the comparison of the different larval morphs the chaetotaxia, anatomy of the mandibles, and the number of tubercles present, morph 1 (n=1); morph 2 (n=8); morph 3 (n=11), were examined. The specimens were fed with their host plants. We observed that each larva ate from its host plant species, especially those with morph 1. Furthermore, the genital armor and the morphology of the eggs of *Syncirsodes distictaria* (n = 70), a species that also inhabits the study area, were compared to determine the differences of the morphologic characters analyzed, and to rule out any doubts or errors in regards to *S. primata*.

We observed a high incidence of parasitism. Parasitoids emerging from the larvae were recorded during the all rearing period throughout the year. This explains the low number of larvae examined in this study.

RESULTS

While studying the feeding preferences (host plants) of the *Syncirsodes* larvae, it was observed that the larva presents polyphagous habits, and can be found on 10 different host plants. During the observation period different morphological patterns and larval colorations were detected, *a priori*, which seem to be associated with the different species of host plants.

The morphological analyses (of genitalia and eggs), of mature individuals emerged in the laboratory and coming from larva that varied in form and color, indicate that *S. primata* is one species, presenting three different larval types. In addition, comparison to *S. distictaria*, confirmed that both species of *Syncirsodes,* that inhabit the same

Figures 1-6: Larvae morphs. 1-3 According to tubercle number: 1) morph 1; 2) morph 2; and 3) morph 3. 4-6 Color patterns. Scale 10 mm.

Figuras 1-6: Morfos larvales. 1-3 Número de tubérculos larvales: 1) morfo 1; 2) morfo 2; and 3) morfo 3. 4-6 Patrón de colores. escala 10 mm.

TABLE I. Distribution patterns of the morphs of *S. primata* on the host plants.

TABLA I. Patrones de distribución de morfos en *S. primata* sobre sus plantas hospederas.

MORPH	HOST PLANTS									
	Tubercle number	*L.sempervirens*	*M. obtusa*	*M. planipes*	*L.apiculata*	*R. spinosus*	*P. boldus*	*C.alba*	*L. caustica*	*A. chilensis*
Morph 1	6	Rosy dark								
Morph 2	2	Rosy dark	Reddish chestnut	Greenish chestnut	Reddish chestnut	Chestnut				
Morph 3	0	Rosy dark	Reddish chestnut	Greenish chestnut	Reddish chestnut	Chestnut	Green	Dark chestnut	Chestnut	Chestnut

area, are indeed two distinct species.

The morphologic pattern is related with the presence or absence of dorsal tubercles in the abdominal segments. Based on this, three different morphs can be distinguished: Morph 1 (Fig. 1) with 6 dorsal tubercles, from segment A1 to A5 and in A8; morph 2 (Fig. 2) with two tubercles in A1 and A8; and morph 3 (Fig. 3) without dorsal tubercles. The presence or absence of dorsal tubercles (morph 2 and morph3, respectively) on the abdominal segments of the larva are observed indistinctly in males and females. From the 100% (N=20) of observed larvae, 55% were recorded as belonging to morph 3, 45% to morph 2 and 5% to morph 1.

Besides detecting morphologic differences, the existence of different patterns of coloration was observed (Table I). The larva corresponding to morph 1 is of a dark rose color. The individuals of morph 2 present four different colorations: dark rose, chestnut tree greenish, chestnut tree and reddish chestnut tree depending on the host plant on which they fed. Morph 3 presents the same colors as morph 2, plus a dark chestnut tree color. The patterns of coloration are associated with the color of the shafts and petioles of the host plants (Fig. 4, 5 and 6).

The patterns of coloration also present a correspondence with the presence or absence of tubercles (Table I). Morph 1 was only observed on *Laurelia sempervirens* (R. *et* P.), Tulle. Morph 2 is also associated to *L. sempervirens*. It was also found on *Myrceugenya obtusa* (DC) Berg, *Myrceugenya planipes* (H. *et* A.) Berg, *Luma apiculata* (AD) Burret and to *Raphitamnus spinosus* (A. L. Juss) Mold. Morph 3 shares the host plant species of morphs 1 and 2, which is also found on *Peumus boldus* Mol.; *Cryptocarya alba* (Mol.) Looser; *Lithrea caustica* (Mol.) H. *et* A.; *Aristotelia chilensis* (Mol.) Stuntz and *Ribes punctatum* Ruiz *et* Pavón.

The distribution of the morphs on the different species of host plants suggests that morph 3 is the most generalist in its food consumption, compared to the other two morphs. Morph 2, on the other hand, is more associated with the plants of the Myrtaceae family, and morph 1 is the most specialist.

DISCUSSION

According to the observations, the individuals of *S. primata* present morphologic and color variations in the larval state, reflected in three morphs, which are added to those observed in the mature state. It is possible that these variations in the larval states are related to variations in the patterns of the maculation of the wings of *S. primata*. Now, because of the low sample size (N=20) it was not possible to ensure that the adults are specifically related to the morphs, especially specimens of morph 3. According to Holloway *et al*. (1993) these variations may represent phenotypic differences in the duration of the pupa period, however, the life cycle of these moths is univoltine (Bocaz Torres 2001), there by discarding the seasonal variation.

According to the analyses, the only character that separates the morphs is the presence or absence of dorsal tubercles in the abdominal segments. However, all the variable characters to an intra specific level would not follow the same criteria, as the number of tubercles is constant for each one of the morphs, but the color isn't. These results suggest that the host plant may determine the color, probably responding to a phenotypic plasticity phenomenon, like the one observed in the three morphs related to the *L. sempervirens*. Greene (1996) elucidated some examples of this mechanism. In *Nemoria arizonaria* (Geometridae) rearing experiments showed that only larval diet induced different developmental responses (Greene 1999). Although experiment for this species have not examined if the different morphs provide protection from predators, it is possible that the apparently strong selection pressure by visually searching predators has favored the evolution of this polyphenism (Greene 1996). In the same way, the larval color in *S. primata* may be related to a cryptic mechanism determined by the host plant to avoid predators. On the other hand the persistence of the number of tubercles, independent of the change of host, may indicate genetic differences in between morphs (Danks 1994; Evans & Wheeler 2001).

The distribution patterns of each morph in relation to the host plants suggest that there is overlapping microhabitat among morphs. However, this could be due to differentiation in the feeding habits among them. In the case of morph 1, it is not possible to infer anything, since only a single individual was observed. All of the morphs share the species *L. sempervirens* as food source, and between morph 2 and 3 there is a habitat overlapping on host plants of the Myrtaceae family.

This is a descriptive work. Finer analysis with molecular techniques would allow future studies to supplement the described observations. These techniques would allow us to respond with more security, as to whether the observed phenomenon corresponds to a phenotypic expression different from the species, when faced with different host plants. Experimenting with translocations of larvae between host plants and more detailed observations of oviposition of the females may also help understand the mechanisms that generate the different varieties of larval morphology.

ACKNOWLEDGMENTS

Financial support was obtained from the Dirección de Investigación, Universidad de Concepción, grants 200.113.056-1.0, 200.113.056-1.3 and "Proyecto Instrumental Científico año 2001". The authors acknowledge to T. Heath Ogden and Enrique Mundaca for translation of this paper to English.

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Fecha de recepción: 19/03/03
Fecha de aceptación: 13/05/03