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Individual Trail Marking by Larvae of the Scarce Swallowtail *Iphiclides podalirius* L. (Lepidoptera; Papilionidae)

R. Weyh and U. Maschwitz

Fachbereich Biologie/Zoologie der Universität Frankfurt, Siesmayerstr. 70, D-6000 Frankfurt/Main, Federal Republic of Germany

Summary. Starting from permanent resting sites covered with silk, the solitary and territorial larvae of *I. podalirius* spin silk trails leading to feeding sites. It is shown that the silk contains a volatile trail marker. The larvae recognize their own trails and prefer them to those laid by conspecific caterpillars. Trail marking appears to be widespread among larvae of Lepidoptera.

Individuelle Spurung bei Raupen des Segelfalters *Iphiclides podalirius* L. (Lepidoptera; Papilionidae)

Zusammenfassung. Die solitär lebenden, territorialen Raupen von *I. podalirius* spinnen, ausgehend von festen, mit Seide besponnenen Ruheplätzen, Seidespuren zu ihren Futterstellen. Es wird gezeigt, daß die Seide einen flüchtigen Spurmarkierungsstoff enthält. Die Raupen erkennen ihre eigenen Spuren und ziehen sie den Spuren von Artgenossen vor. Die Möglichkeit, daß Spurmarkierung unter den Entwicklungsstadien von Schmetterlingen weiter verbreitet sein könnte, wird diskutiert.

Introduction

The Scarce Swallowtail *Iphiclides podalirius* L. is a butterfly characteristic of open bushland and hot, south-exposed slopes covered with poor, mainly xeromorph vegetation in central and mediterranean Europe and Eurasia. Its larvae are strictly solitary, living on several *Prunus* species and other Rosaceae, mainly on small, poor shrubs of *P. spinosa*. When not feeding, they rest on dense white silk bolsters spun on thin branches or on the upper surface of a leaf. Strands of silk, which are reinforced by the larvae during each feeding period, lead to the feeding sites on surrounding leaves. When meeting another larva, they are very aggressive. Fatal injuries may occur during the fights. Sometimes weaker larvae are totally covered by silk spun by the stronger ones and thus fastened to the branch. Such aggressive meetings with conspecific larvae, however, are not very common because the female butterflies lay only a few eggs on each shrub. Observations in the field have indicated that egg-laying females are territorial.

The establishment of relatively permanent resting sites and the continuous reinforcement of the silk strands leading to the feeding sites led us to suspect trail marking behaviour in these solitary larvae.

Material and Methods

Eggs and larvae were collected in the vicinity of Pula (Istria, Yugoslavia) in August 1979 and 1980. They were reared on branches of *P. domestica* and *P. avium*, which were installed in bottles filled with water.

We allowed hungry larvae (3rd and 4th instar) to lay silk strands on the two stems and one branch of cardboard double-Y bridges (—◇—), one larva on each bridge only. Then performing repeated 180° rotations of the bridge to exclude side-preferences, we tested the trail-following response. We used simple Y-mazes with a neutral stem (strips of cardboard or fresh pieces of cherry branches) and silk bolsters on the branches (one side fresh silk, the other 5 days old and additionally washed in acetone p.a.) to test the volatility of the marker. A similar arrangement, but with silk bolsters of two different larvae, was used to test the reactions of larvae on alien trails.

Results

Trail Marking

In three test series the larvae clearly preferred the silk-covered branch of the double-Y. The results are given in Table 1.

Each of the larvae in this test series was tested only on its own silk

Volatility of Trail Marker

Three test series showed that the mechanical constituent of the trail (silk) does not influence the trail-following response of the larvae. Fresh silk was clearly preferred to old silk washed in acetone, even when the old silk bolster was larger than the fresh one (Table 2).

Individual Marking

A preliminary test for the trail-following response of larvae of *I. podalirius* on fresh silk strands laid by other conspecific larvae showed that nine of ten larvae preferred the silkless branch of a double-Y bridge. This indicated individual marking, which we investigated in a series of six tests using simple Y-mazes.

Table 1. Trail following on partly silk-covered double-Y bridges by larvae of *Iphiclides podalirius* L

Larva on silk	Larva on silkless branch	Total	P(%)
7	1	8	3.4
22	4	26	<0.1
9	2	11	3.4
38	7	45	<0.1

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Table 2. Evidence of volatility of the trail marker of *I. podalirius* larvae

Larva on fresh silk	Larva on old silk	Total	*P* (%)
9	1	10	1.14
12	2	14	0.75
10	2	12	2.1
31	5	36	<0.1

Table 3. Recognition and preference of own trail marker by larvae of *I. podalirius*

Larva on own silk	Larva on alien silk	Total	*P* (%)
7	3	10	
11	4	15	
10	2	12	
7	2	9	
6	4	10	
11	4	15	
52	19	71	< 0.1

Table 4. Spinning activity of larvae of *I. podalirius* on own and alien silk bolsters

	Intensive spinning	No marked spinning	Total
Own	12	40	52
Alien	17	2	19
	$P \ll 0.1\%$		

The larvae clearly preferred their own silk bolsters to those laid by others (Table 3).

Larval Behaviour on Silk of Conspecifics

Larvae walking on silk of conspecifics often showed a very conspicuous behaviour: they intensively began to cover the alien silk with their own. In comparison with the spinning behaviour on their own silk bolsters, the spinning activity was significantly higher on the markings of other caterpillars (Table 4).

Discussion

In the last five years, pheromonal trail marking has been demonstrated in several gregariously living lepidopteran larvae (Fitzgerald and Gallagher 1976; Weyh and Maschwitz 1978; Capinera 1980). In all species investigated, the trail pheromone was extracted from silk produced by the labial glands. Fitzgerald (1976), however, indicates that an additional gland might be involved in trail marking. The production of volatile trail factors by larvae of Lepidoptera is seen, though this is not clearly expressed, as an evolutionary consequence of larval aggregation.

Spinning of silk during the first stages of larval life is common among the Lepidoptera, especially in oligophagous and monophagous species. The basic function of the silk produced by larvae is to give a better hold on the substrate (Forster 1977). In some cases, silk spinning by solitary larvae is described as (mechanical) trail marking (Friedrich 1977).

Considering our results, we suppose that trail marking based on the primary capability of spinning silk may occur commonly among larvae within the order Lepidoptera, providing better orientation in their environment. Production of marking pheromones may lead to two different developments. On the one hand, the volatile marker may be the basis of aggregation behaviour, keeping the groups together and guiding them to common feeding places. On the other, individual variation in the composition of the pheromone may enable solitary larvae to establish a territory that may lead to a homogeneous distribution within the feeding site. Such territoriality has been found in several Lepidoptera (e.g. Kahlheber 1976; Friedrich 1977).

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