APHIDS AND OTHER HEMIPTEROUS INSECTS	VOL. 13 151-155

Developmental stages of *Cinara tujafilina* (*Hemiptera, Aphidoidea*)

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Introduction

From about 30 European aphid species of the Cinara genus, 27 are registered in Poland (SZELEGIEWICZ, 1978). This species is connected with trees and coniferous shrubs. In Poland only 2 species connected with the genus. *Thuja* sp. in terms of hostplant nutrient are registered. The presence of *Cinara cupressi* (Buckton 1881) on *Thuja occidentalis* was recorded by SOIKA & ŁABANOWSKI (2001), and DURAK *et al.* (2007). *Cinara tujafilina* (del Guercio 1909) is a species connected with *Thuja orientalis*. So far in Poland only three sites of this species have been registered (DURAK *et al.*, 2006). The aim of this paper is to determine the number of larvae stages and their morphometrical analysis of C. *tujafilina.*

Material and methods

The material was constituted by the larvae and wingless viviparous of *C. tujafilina* collected from the host plant *T. orientalis* from September to November of 2005 and 2006 in the city of Rzeszów. Microscope samples were made from the collected material. Five morphological features were analysed. The following parameters were measured: body length (BL), tibia length (TL), the length of third segment of antennae (Ant. Seg. III), antennae length (Total Ant.), and rostrum length (R).

The relation between average lengths of BL, TL, Ant. Seg. III, Total Ant., R, between subsequent larvae stages (the so called interinstar ratio) was determined by the Dyar rule (DYAR, 1890). It presupposes that insects grow after each moulting and every larvae is bigger by constant factor. The ratio of insect size after moulting to its size prior to the moulting is constant (DYAR, 1890; WHARTON *et al.*, 2004).

A single-factor analysis of variation (ANOVA) and the Kruskal-Wallis test were used to show differences between average lengths of all the measured parameters of larvae and adults. The t-student test was used to point out the statistical differences between average numbers measured by means of parameters of colour forms of the studied species.

Results

Three larval stages of development, which preceded *C. tujafilina* adults, were recorded. Subsequent larval stages differed in terms of different number of antanae segments. The first larva had IV antennae segments, the second one – V, and the third one had VI antennae segments respectively. The extent of the features' morphological parameters of each larval stage is presented in Table 1. Single-factor ANOVA analysis pointed out to significant statistical differences between mean numbers of all the measured parameters for particular larvae BL ($F=168.51$; $p<0.001$), TL ($F=136.23$; $p<0.001$), Ant. Segm. III ($F=26.58$; $p<0.001$), Total Ant. ($F=151.81$; $p<0.001$), R ($F=9.04$; $p<0.001$). The following features clearly enabled to differentiate between particular larval stages: body length (BL) and tilia length (TL) (Tab. 1.). The length of rostrum seems to be an insufficient feature that would differentiate between larval stages. An average ratio of siphon length to the body length was 0.94 and 0.52, respectively for the first larvae and an adult specimen. No proportional increase in larvae size, which remained constant according to the Dyar rule was recorded (Tab. 1.). Subsequent larval stages increased along with different inter-larval factors, with the highest factor usually taking place between 1 and 2 larval stage.

The presence of dark and light colour forms of this species was also registered. The dark form fed on wooded parts of a host plant, from the end of August until the end of February, when only individual specimens are registered. At the end of October and the end of November the light form was registered to settle the main trunk of the plant near the root as well as the root itself. Particular colour forms differed in terms of morphological parameters (Tab. 1.). The t-student test pointed out to significant statistical differences between average parameters of the colour forms of the studied species, i.e. the body length, the tibia length, the length of III segment, the antennae

segment and the antennae length ($p<0.05$). The dark form is significantly different from the light form by means of body length and tibia length of the second and third larvae stages and adults ($p<0.01$). The length of Ant. Seg. III differentiates only between adult specimens ($p<0.05$). The total antennae length distinguishes significantly between the third larvae stage and adults of both colour forms ($p<0.05$). No significant differences between the rostrum length of both colour forms were registered.

Table 1. Morphological parametres of developmental stages *Cinara tujafilina* (mm)

Life stage	n	Colour form					
		Dark			Light		
		Range (mm)	Mean (mm)	Relation between larval stages (after Dyar)	Range	Mean	Relation between larval stages (after Dyar)
Body length (BL)							
1-st larvae	10	0.95-1.36	1.15a		1.03-1.3	1.18	
2-nd larvae	10	1.02-1.69	1.45b	1.26	1.28-1.8	1.69	1.44
3-rd larvae	10	1.65-2.35	1.67c	1.20	1.5-1.88	1.78	1.05
adult	10	2.33-2.73	2.54d	1.46	1.89-1.97	1.95	1.09
Tibia length (TL)							
1-st larvae	10	0.35-0.45	0.42a		0.33-0.45	0.38	
2-nd larvae	10	0.45-0.8	0.51b	1.21	0.45-0.56	0.56	1.46
3-rd larvae	10	0.78-1.23	0.95c	1.87	0.57-0.79	0.76	1.38
adult	10	1.14-1.41	1.31c	1.37	0.75-0.79	0.78	1.02
Length of third antennae segment (Ant.segm.III)							
1-st larvae	10	0.19-0.25	0.23a		0.17-0.23	0.21	
2-nd larvae	10	0.17-0.27	0.19b	0.83	0.18-0.24	0.18	0.84
3-rd larvae	10	0.19-0.28	0.19b	1.02	0.17-0.21	0.18	1.03
adult	10	0.23-0.3	0.28c	1.45	0.18-0.23	0.21	1.12
Antennae length (Total Ant.)							
1-st larvae	10	0.38-0.48	0.43a		0.35-0.45	0.40	
2-nd larvae	10	0.39-0.55	0.47a	1.10	0.42-0.47	0.45	1.11
3-rd larvae	10	0.56-0.65	0.64b	1.35	0.54-0.58	0.56	1.26
adult	10	0.64-0.88	0.82c	1.28	0.52-0.57	0.55	0.98
Rostrum length (R)							
1-st larvae	10	0.92-1.3	1.08a		0.82-1.1	1.01	
2-nd larvae	10	1.0-1.35	1.17ab	1.09	0.95-1.2	1.11	1.11
3-rd larvae	10	1.13-1.29	1.26bc	1.07	1.12-1.3	1.17	1.05
adult	10	1.1-1.45	1.33c	1.06	1.02-1.34	1.23	1.05

Means marked the same letter they are not statisticly significantly differend $p<0.05$

Discussion

The research presented new information on the *C. tujafilina* biology, pointing out to the presence of three larval stages in the development of wingless morphs. Most aphids had four larval stages. A smaller number of larvae was registered in *Cinara thujafoliae* Theob (Takahashi, 1924), *Cinara cupressivora* Watson, Voegtlin (Kairo & Murphy, 1999) and *Essigella californica* Essig (Wharton *et al.*, 2004) among *Lachnidae*, several species from the *Hormaphididae* and *Hydaphis coriandri* Das (Kumar & Sagar, 1996) from the *Aphididae* were registered. The reduction of the first larval stage was considered to be an adjustment that enabled the aphid to take in food from the phloem tissue deep inside the host plant (Kairo & Murphy, 1999). *C. tujafilina* larvae just like *C. cupressivora* had long stylets which enabled them to take in the phloem from the plant's twig. The length of stylet of the first larval stage was usually longer than the body length. In aphids, a positive dependence between the length of stylet and the length of body was recorded (Dixon, 1998). Subsequent larvae took their food in from thicker and thicker veins of the plant which was connected with the growth of rostrum as the insects grew old. The first larvae had a relatively greater ratio of the rostrum length to the body length in comparison with the adults (Dixon, 1998). This phenomenon was confirmed in case of the studied species.

The growth of insects after each moulting was a function of growth tempo, moulting effectiveness and greatest growth of insects in previous moulting. In nature, the size of insects increases along with the declining tendency but exceptions to this rule are often recorded (Hutchinson *et al.*, 1997).

The presence of colour forms was observed in this species also in Great Britain (Carter & Maslen, 1986). So far, no morphological differences between them have been described.

Summary

1. Three developmental stages of *C. tujafilina* were registered.
2. Morphological parameters of subsequent larval stages were determined.
3. The presence of colour forms of this species which differed by morphological parameters and the site of feeding on the host plant were registered.

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Stadia rozwojowe *Cinara tujafilina* (*Hemiptera, Aphidoidea*)

Streszczenie

Cinara tujafilina jest gatunkiem rzadkim w faunie Polski związanym z *Thuja orientalis*. Zbadano jego rozwój i stwierdzono obecność trzech stadiów larwalnych poprzedzających bezskrzydłego osobnika dorosłego. Określono parametry morfologiczne kolejnych stadiów larwalnych (Tab. 1.). Stwierdzono obecność form barwnych tego gatunku (ciemnej i jasnej) różniących się parametrami morfologicznymi oraz miejscem żerowania na roślinie żywicielskiej.