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Polymorphism in *Ceratophysella armata* (NICOLET, 1841) from the Tatra Mountains (Poland) (Collembola: Hypogastruridae)

DARIUSZ SKARŻYŃSKI
Zoological Institute, Wrocław University, Sienkiewicza 21, 50-335 Wrocław, Poland, e-mail: hypogast@biol.uni.wroc.pl

ABSTRACT. Polymorphism was detected in *Ceratophysella armata* (NICOLET, 1841) from the Tatra Mountains (Polish Carpathians). In the subalpine zone *C. armata* exists as two chaetotactic forms. The form with normal chaetotaxy seems to be more common, whereas the form with spine-like setae occurs only occasionally. Probably fast and significant decrease in temperature and increase in humidity during the reproductive period may affect the appearance of this last form.

Key words. entomology, taxonomy, polymorphism, Collembola, Hypogastruridae, *Ceratophysella armata*, Tatra Mountains, Poland.

INTRODUCTION

In spite of many years of studies the taxonomic status of *Ceratophysella armata* (NICOLET, 1841) still remains unclear. This wide-spread species comprises numerous populations, which differ in subtle characters of unclear diagnostic value (BABENKO et al. 1994, JORDANA et al. 1997). Moreover some of these populations are polymorphic (CASSAGNAU & IZARRA 1969, JORDANA et al. 1997).

In the material collected on the slopes of the Gładkie Upłaziańskie (Tatra Mountains, Carpathians, S Poland) in 29.08.1991 I found two chaetotactic forms of *C. armata*. Specimens collected in the litter and on mushrooms in the spruce forest growing at an altitude of 1000-1400 m a.s.l. had normal chaetotaxy (form N) (Figs 1-3, Tab. 1), whereas specimens extracted from the same kind of samples collected in dwarf mountain pine shrubs at an altitude of 1600 m a.s.l. had a

peculiar chaetotaxy (form S). The head, thoracic and abdominal terga were furnished with comparatively short, erect, spine-like setae (macrochaetae mostly), long body sensilla and on abdominal tergum IV setae p_3 were missing (Figs 4-6, Tab. 1).

The observed differentiation of *C. armata* chaetotactic forms could be regarded as a manifestation of polymorphism of the *Ceratophysella tuberculata*-type (BOURGEOIS 1973) and a sign of its different taxonomic status as well. To solve this problem I carried out field and laboratory culture studies.

MATERIAL AND METHODS

FIELD STUDIES

Mushrooms and numerous litter samples from dwarf mountain pine shrubs and the spruce forest were collected during 2001 (1.06, 10.07, 26.08, 20.09) and 2002 (28.09, 20.10) in the same area as in 29.08.1991. All the samples were extracted with a Tullgren apparatus. Morphology of collected *Ceratophysella* specimens was examined using a microscope with phase contrast lighting.

LABORATORY CULTURE STUDIES

On 14.07.2001 c. 200 juvenile individuals extracted from the field samples from dwarf mountain pine shrubs were placed in two tightly closed plastic containers (60 x 65 mm) filled in half with a mixture of plaster of Paris and activated charcoal (9:1). The culture vessels were kept in the light freezer, at average temperature 6^0C (culture I) and 12^0C (culture II). A few drops of distilled water were added once a week to maintain high air humidity. Yeast were used as food. The culture vessels were inspected once a week, the specimens were observed under stereomicroscope (magnification x 45). Twice a month 3 specimens with the shortest setae from each container were killed and their morphology was examined using a microscope with phase contrast lighting.

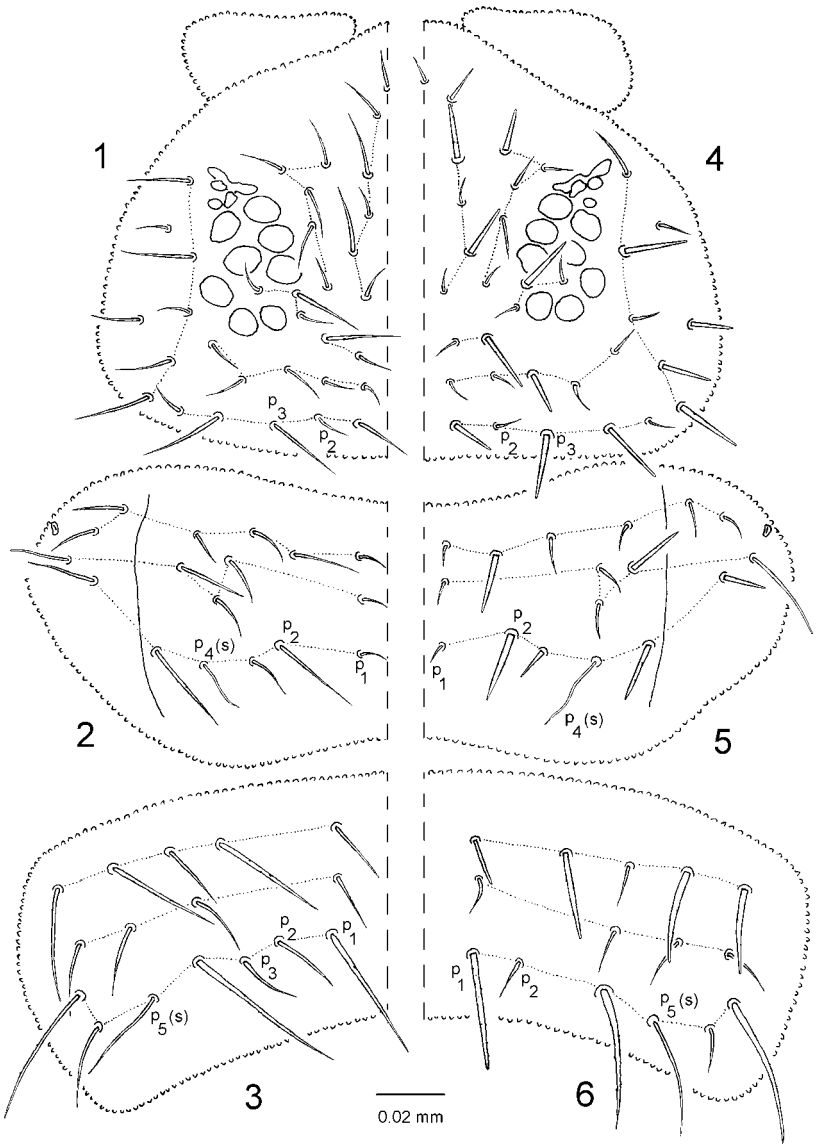
From the beginning of October 2001 to the end of March 2002 (culture II) and August 2002 (culture I) reproductive specimens and eggs batches were observed. Unfortunately, successive generations were not obtained because all eggs failed to develop.

RESULTS AND DISCUSSION

The material of *C. armata* collected during 2001 and 2002 in the spruce forest and dwarf mountain pine shrubs was almost homogeneous. The form N (Figs 1-3, Tab. 1) strongly dominated in the studied habitats (Tab. 2); only one specimen of form S (Figs 4-6, Tab. 1) was found in dwarf mountain pine shrubs (Tab. 2). Specimens cultured in laboratory had normal chaetotaxy.

Comparison of data obtained in 1991 and 2001-2002 (Tab. 2) showed that in the spruce forest only form N occurred, whereas in dwarf mountain pine shrubs both forms N and S were detected. The form S dominated in 1991, while the form N dominated in 2001-2002; it can be said that these forms replaced one another in different periods of investigations.

A close morphological similarity and alternate occurrence in the same area suggest that these forms are conspecific. Consequently, population of *C. armata* from the subalpine zone should be regarded as polymorphic. The form with normal chaetotaxy seems to be more common, whereas the form with spine-like setae occurs only occasionally. Probably fast and significant decrease in temperature



1-6. Dorsal chaetotaxy of *Ceratophysella armata*: 1-3: form N, 1 - head, 2 - thoracic tergum II, 3 - abdominal tergum IV, 4-6: form S, 4 - head, 5 - thoracic tergum II, 6 - abdominal tergum IV

and increase in humidity during the reproductive period may affect appearance of this last form. It is indicated by the following observations:

- A week before sampling in August 1991 the day temperature in subalpine zone of the Tatra Mts suddenly dropped below 10 ^{0}C and it was raining for c. 10 days; instead weather in August and September 2001 and 2002 was warm and dry.

- Specimens originating from dwarf mountain pine shrubs and cultured for several months at constant low temperatures and high humidity had normal chaetotaxy.

- The material of *C. armata* collected in dwarf mountain pine shrubs in August 1991 comprised some reproductive specimens with short and fine setae and specimens in ecdysis from the form S to the reproductive one.

Such a polymorphism can be cautiously considered as an adaptation to reproduction in harsh climatic conditions of high mountains.

As it was mentioned in the introduction polymorphism of that type was detected in some populations of related species *Ceratophysella tuberculata* CASSAGNAU, 1958 from Pyrenees (BOURGEOIS 1973); other species of the *C. armata*-group with numerous spine-like setae living in high mountains – *Ceratophysella armatissima* GISIN, 1958 (Alps), *Ceratophysella kolchidica* (BABENKO, 1994) (Caucasus Mts) and *Ceratophysella sibirica* (MARTYNOVA, 1974) (Altai Mts) are suspected to be polymorphic.

Particular attention should be paid to the morphological similarity of *C. armatissima* and the form S of *C. armata*. The holotype and paratypes of this species (which I have seen thanks to the kindness of Dr. CHARLES LIENHARD) have spine-like setae, long body sensilla and setae p_3 on abdominal tergum IV missing. However, spine-like setae especially on the head are much thicker than in the form S of *C. armata* (see GISIN 1960) and apical bulb is simple (*versus* trilobed). This

Table 1. Extreme and mean (in parentheses) values of d/ ratio (after BOURGEOIS 1974) of non-reproductive individuals of the form S (S) and the form N (N) of *C. armata* collected in 29.08.1991 in dwarf mountain pine shrubs and the spruce forest respectively. Other abbreviations: d - distance between setae a_1 and p_1 on thoracic tergum II, p_1-5 - length of setae in row p (see Figs 1-6).

	Head		Thorax II			Abdomen I			Abdomen IV		
	d/p_2	d/p_3	d/p_1	d/p_2	d/p_4	d/p_1	d/p_2	d/p_5	d/p_1	d/p_2	d/p_5
S n=20	3.28-4.6 (4.02)	1.22-1.62 (1.41)	2.75-4.2 (3.51)	1-1.5 (1.19)	1.1-1.4 (1.26)	2.44-4.2 (3.11)	0.83-1.11 (0.96)	0.95-1.23 (1.07)	0.73-1 (0.84)	1.91-2.63 (2.16)	0.74-0.82 (0.8)
N n=20	2.75-3.38 (3.16)	0.88-1.25 (1.04)	2-2.55 (2.26)	0.76-0.96 (0.89)	1.38-1.8 (1.64)	1.67-2 (1.87)	0.63-0.8 (0.74)	1.22-1.47 (1.32)	0.57-0.75 (0.65)	1.18-1.53 (1.32)	0.81-1.04 (0.91)
S-N (%)	(21.4)	(26.2)	(35.6)	(25.2)	(23.17)	(39.9)	(22.9)	(18.9)	(22.62)	(38.9)	(12.1)

Table 2. Approximate numbers of non-reproductive specimens of form S (S) and form N (N) of *C. armata* collected in the spruce forest (F) and dwarf mountain pine shrubs (D).

Data	29.08.1991		1.06.2001*		10.07.2001*		26.08.2001		20.09.2001		28.09.2002		20.10.2002	
Habitat	F	D	F	D	F	D	F	D	F	D	F	D	F	D
S	-	600	-	-	-	-	-	1	-	-	-	-	-	-
N	500	3	150	160	250	300	220	200	220	250	180	160	120	80

* juveniles dominated

comparison suggests that *C. armatissima* can be a form of polymorphic alpine population of *C. armata* and as it was stated by JORDANA et al. (1997) is synonymous with this species.

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