Genus	Vol. 17(4): 477-481	Wrocław, 28 XII 2006

New polymorphism in *Ceratophysella bengtssoni* (ÅGREN, 1904) (Collembola: Hypogastruridae)

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ABSTRACT. A new polymorphism in *Ceratophysella bengtssoni* (ÅGREN, 1904) is reported. Untypical morphology of populations from SW Poland is described and illustrated. Nature of this phenomenon is discussed basing on field and laboratory studies.

Key words: entomology, morphology, polymorphism, *Ceratophysella bengtssoni*, Collembola, Hypogastruridae, Poland.

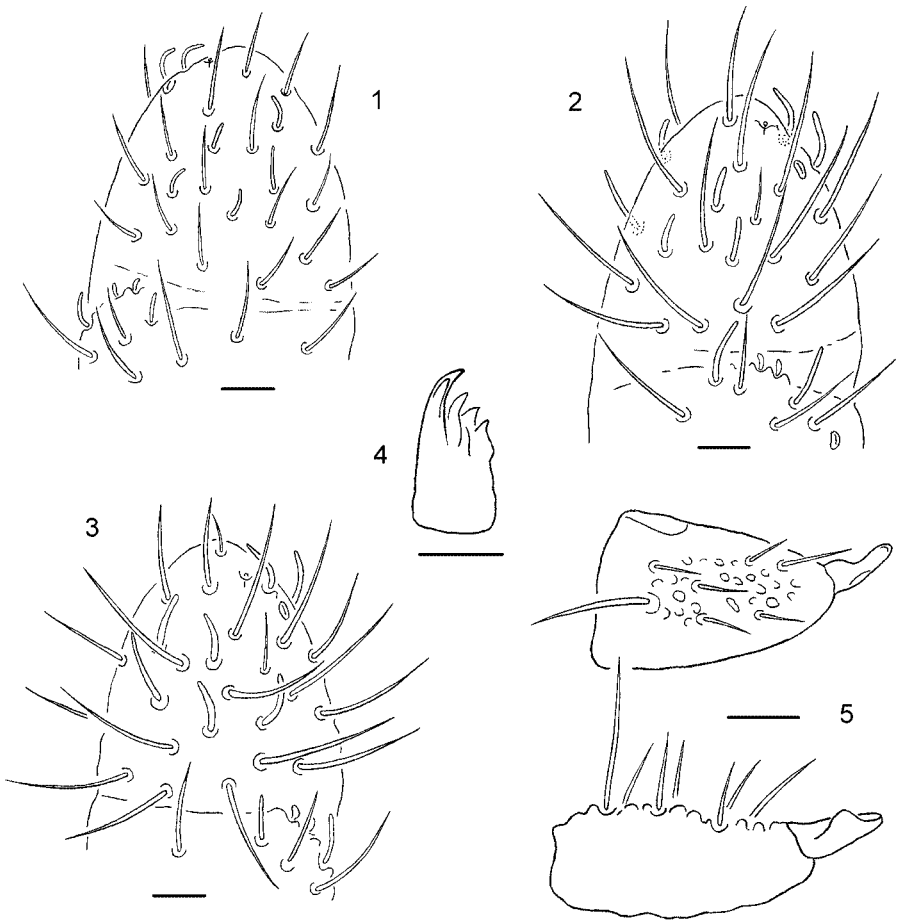
INTRODUCTION

Ceratophysella bengtssoni (ÅGREN, 1904) is a widely distributed species (Europe, N America) common in both natural and anthropogenic habitats (CHRISTIANSEN & BELLINGER 1980, BABENKO et al. 1994). It prefers habitats rich in nitrogen: generous soils, litter of mesic forests, mosses, caves, dunghills, composts a. s. o. (THIBAUD 1970, BABENKO et al. 1994). Biology and morphology of this species are comparatively well recognized (THIBAUD 1967, 1970, BOURGEOIS 1981, BABENKO et al. 1994, JORDANA et al. 1997, FJELLBERG 1998). *C. bengtssoni* has a special status within the genus based on chaetotaxy composed of short setae, the presence of setae m_2 on thoracic tergum II, short sensilla p_4 on thoracic terga II-III, clavate tibiotarsal hairs, small postantennal organ with subequal lobes, dens with large ventro-apical swelling and short anal spines (BABENKO et al. 1994). Such characteristics place this species close to the genus *Hypogastrura* BOURLET, 1839 (BABENKO et al. 1994, FJELLBERG 1998) and *Mucrella* FJELLBERG, 1985 (JORDANA et al. 1997). Up to now reproductional polymorphism (epitoky) was the

one known in this species (BOURGEOIS 1981). Recently two *C. bengtssoni* populations characterized by a new type of polymorphism were found in SW Poland. The aim of this study was to describe and explain nature of this new polymorphism.

MATERIAL AND METHODS

Three populations, including two characterized by a new type of polymorphism (Muszkowice and Śliwice 1) and one characterised by the typical morphology (Śliwice 2) were studied. The localities of the mentioned populations used in this study are given in Tab. 1. About 100 specimens from each population were killed and mounted on slides (the characteristics of collected specimens are



1-5. *Ceratophysella bengtssoni*: 1 – antennal segments III-IV of U-male, 2 – antennal segments III-IV of E-male, 3 – antennal segments III-IV of A-male, 4 – maxillary head of U-morph, 5 – dens and mucro of U-morph. Scale bar 0.01 mm

presented in Tab. 2) and about 150 specimens from Muszkowice and Śliwice 2 populations were used to set up cultures. Cultures were kept in plastic containers (60 x 65 mm) half filled with a mixture of plaster of Paris and activated charcoal (9:1). Yeast was used as food. The laboratory populations were bred under four types of climatic conditions (see Tab. 3) for 11-12 months. Once a month 5-30 specimens from each culture were killed and mounted on slides to check their morphology. The characteristics of collected specimens are presented in Tab. 4.

Abbreviations used: A, A-morph, A specimen – non-reproductive specimen of typical morphology; U, U-morph, U specimen – non-reproductive specimen of untypical morphology; E, E-morph, E specimen – reproductive (epitokous) specimen; instars 1-4 – juvenile specimens of the 1-4 instars.

RESULTS

Description of U-morph

Antennal segment IV with short and thin setae and cylindrical sensilla (Fig. 1, compare with E and A-morphs Figs 2, 3). Antennal III-organ composed of short and thin sensilla (Fig. 1, compare with E and A-morphs Figs 2, 3). Eversible sac between antennal segments III-IV absent. Ocelli small. Maxillary head with very short lamellae devoid of marginal filaments (Fig. 4, compare with A-morph Jordana et al. 1997: 104, Fig. F). Integumental granulation typical. Body setae, body sensilla and anal spines short. Claws without teeth. Ventral surface of ventral tubus furnished with some small folds, inside pouch-like structures are visible. Mucro small and deformed (Fig. 5, compare with A-morph and E-morph Jordana et al. 1997: 104, Fig. B and Bourgeois 1981: 199, Fig. 2 respectively). Ventro-apical swelling on dens invisible (Fig. 5, compare with A-morph Jordana et al. 1997: 104, Fig. B). Inner apical dental setae not modified. Cuticular skeleton of furca invisible or very delicate. Digestive tract not reduced, specimens with gut

Table 1. Localities of studied *C. bengtssoni* populations.

Muszkowice	Near Ziębice (Niemczańsko-Strzelińskie Hills, Sudetes, SW Poland), beech forest, moderately dry rotting wood from the hollows of old beeches, 28. VIII. 2005, leg. A. Smolis
Śliwice 1	Near Wrocław (Nizina Śląska Lowland, SW Poland), mixed forest, moderately dry rotting wood from the hollow of an old dead oak, 1. X. 2005, leg. D. Skarżyński
Śliwice 2	As above, but wet rotting wood with mushrooms from the hollow of an old poplar situated ca 50 m from Śliwice 1, 1. X. 2005, leg. D. Skarżyński

Table 2. The characteristics of *C. bengtssoni* specimens collected in the field.

Population	Instars 1-2		Instars 3-4		Ecdysis	Adults		
	A	U	A	U	U/A 3-4 instar	A	E	U
Muszkowice	-	-	28	42	2	22	-	6
Śliwice 1	-	-	19	38	1	31	-	7
Śliwice 2	11	-	48	-	-	32	7	-

content were quite numerous in material collected. Internal genital organs e.g. pouch-like structures in females and swollen ejaculatory duct in males absent.

NATURE OF U-POLYMORPHISM

Field and laboratory studies showed that the appearance of U specimens in *C. bengtssoni* populations was induced by environmental factors, high temperature and low humidity. U-polymorphism took place only in these natural and laboratory populations which lived in warm and dry conditions (Tabs 1-4). The composition of morphs in polymorphic populations was heterogeneous. U, A and sometimes E specimens occurred together at the same time (Tabs 2, 4). U-polymorphism affected most often 3-4 instars, rarely adults, while 1-2 instars always maintained typical morphology (Tabs 2, 4). Induced U-morphs appearance in "warm/dry" culture Śliwice 2 (typical morphology in the field, compare Tabs 2 and 4), showed that polymorphism of this type is probably an universal property of studied species. However, actual distribution of polymorphic and non-polymorphic populations in nature can have mosaic character due to microclimatic differences. The constant presence of U specimens in laboratory populations bred in "warm/dry" conditions and their constant absence in other cultured populations (Tab. 4) suggest non-cyclic character of studied phenomenon.

DISCUSSION

Three main types of polymorphisms are known in the family Hypogastruridae: ecomorphosis, cyclomorphosis and epitoky (HOPKIN 1997). Phenomena men-

Table 3. Culture conditions.

	Cold/wet	Cold/dry	Warm/wet	Warm/dry
Vessel stored in glass-fronted cooler at 10-12^{0}C.	+	+	-	-
Vessel stored in shaded place in laboratory at 22-28^{0}C.	-	-	+	+
Bottom of vessel filled with distilled water at the start of the study. A few drops of water were added once a week.	+	-	+	-
Bottom of vessel only sprinkled with distilled water at the start of the study.	-	+	-	+

Table 4. The characteristics of *C. bengtssoni* specimens collected in cultures.

Population	Culture conditions	Instars 1-2		Instars 3-4		Ecdysis U/A 3-4 instars	Adults		
		A	U	A	U		A	E	U
Muszkowice	Cold/wet	65	-	128	-	-	98	22	-
	Cold/dry	17	-	67	-	-	48	6	-
	Warm/wet	58	-	156	-	-	88	28	-
	Warm/dry	24	-	37	76	3	33	11	18
Śliwice 2	Cold/wet	41	-	108	-	-	78	16	-
	Cold/dry	23	-	61	-	-	42	8	-
	Warm/wet	47	-	160	-	-	98	22	-
	Warm/dry	28	-	42	82	2	44	13	15

tioned above are associated with accidental and seasonal changes in the environment and with reproduction respectively. Ecomorphosis and U-polymorphism are both induced by environmental factors, however strictly ecomorphic hypogastrurids from the Mediterranean region exhibit specific morphological (hypertrophic anal spines), anatomical (atrophic mesenteron, enlarged fat bodies) and behavioural features (cessation of feeding, inactivity) (CASSAGNAU 1986). Epitokous specimens and U ones are morphologically similar (see BOURGEOIS 1981), but they differ in the presence/absence of internal genital organs and chaetotaxy of antennal segments III-IV. U-morph resembles also C-morph of related cyclomorphic species *C. sigillata* (UZEL, 1891). However this last one is considered as a dormant stage whose change from A-morph is initiated by unknown triggers (ZETTEL & ZETTEL 1994). To precisely define and classify U-polymorphism, knowledge on the biological function of this phenomenon is needed. I suggest adaptive character of studied polymorphism. Undoubtedly energetically favourable reduction of cuticular structures observed in U specimens makes life under unfavourable climatic conditions easier.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr Adrian SMOLIS for supplying material of *C. bengtssoni* from Muszkowice and to Prof. Wanda M. WEINER for insightful comments on the manuscript. Project was sponsored by University of Wrocław (grant 1018/S/IZ/2005).

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