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Notes on morphology of the reproductive stage of two species of the genus *Schaefferia* ABSOLON, 1900 (*Collembola*: *Hypogastruridae*)

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ABSTRACT. Morphological changes associated with the reproductive period of *Schaefferia emucronata* ABSOLON, 1900 and *Schaefferia willemi* (BONET, 1930) are described and illustrated. Phylogenetic context of epitokous changes is discussed.

Key words: entomology, morphology, reproductive stage, *Collembola*, *Hypogastruridae*, *Schaefferia*.

During taxonomic studies on Polish populations of *Schaefferia emucronata* ABSOLON, 1900 and *Schaefferia willemi* (BONET, 1930), I observed strong epitokous changes in the morphology of reproductive individuals. Since there are no reports in the literature on epitoky in *Schaefferia* ABSOLON, 1900 I present a description of the observed morphological changes.

MATERIAL AND METHODS

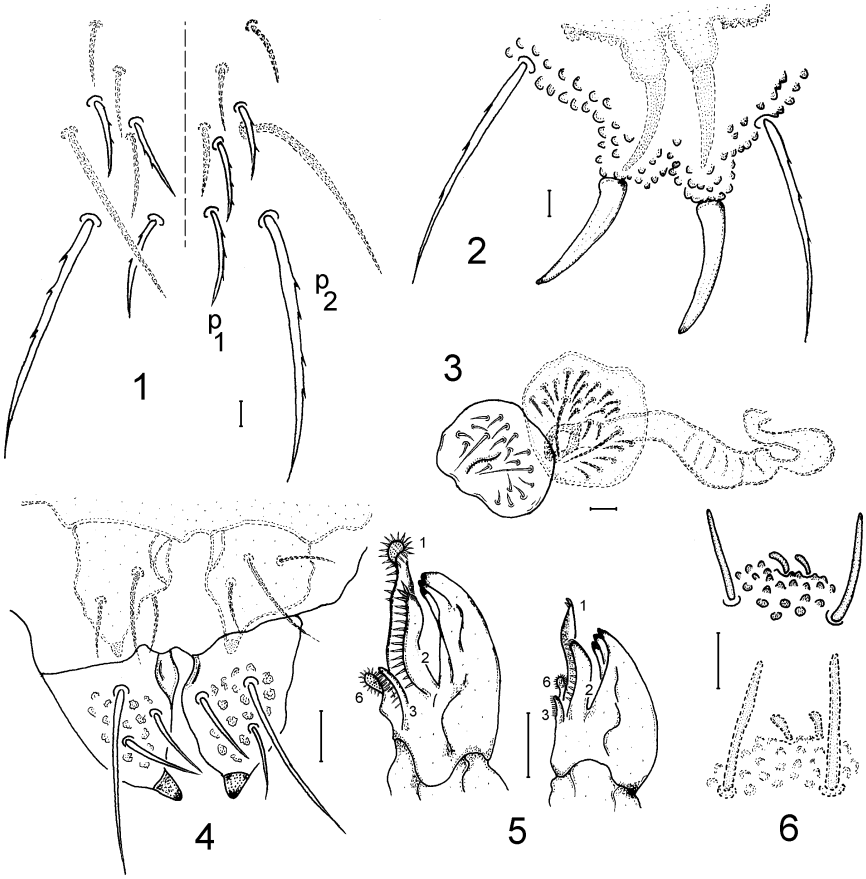
S. emucronata – 24 non-reproductive and 21 reproductive males, 26 non-reproductive and 22 reproductive females collected by the author from April 1999 to November 2000 in the cave Solna Jama, (Góry Bystrzyckie MTS., Sudetes, SW Poland).

S. willemi – 22 non-reproductive and 23 reproductive males, 30 non-reproductive and 20 reproductive females collected by the author from April 1999 to November 2000 on a gravel bed of the Kamienna river (Karkonosze Mts., Sudetes, SW Poland).

All the specimens were obtained by extraction with Tullgren apparatus. They were examined morphologically using a microscope with phase contrast lighting. Measurements were taken with a calibrated eyepiece and presented in the Table as ratio d/ (after BOURGEOIS 1974). Some individuals in ecdysis from the pre-reproductive to the reproductive stage were also examined.

RESULTS

The following morphological changes were manifest in the studied reproductive specimens of *S. emucronata* and *S. willemi*:



1-6. *Schaefferia willemi*, male in ecdysis from the pre-reproductive to the reproductive stage (specimen with "double" skin and mouth parts): 1 – axial chaetotaxy of abd. 4, 2 – anal spines, 3 – genital plate and ejaculatory duct, 4 – mucrodens, 5 – head of maxilla, left – non-reproductive stage, right - reproductive stage, 6 – antennal III-organ. Scale bar – 10 µm

1. The genital plates became swollen, the number of setae on the genital plates increased, “pre-genital lobes” in females and a swollen ejaculatory duct in males became visible (fig. 3).

2. Sensilla (especially lateral) in the antennal III-organ of males became enlarged (the mean d/AO3 ratio decreased from 2.88 to 2.31 in *S. emucronata* and from 2.76 to 2.14 in *S. willemi*) (Tab.) (fig. 6).

3. The postantennal organ decreased in size in females (the mean d/PAO ratio increased from 1.85 to 2.05 in *S. emucronata* and from 1.62 to 1.91 in *S. willemi*), while in males it became slightly enlarged (the mean d/PAO ratio decreased from 1.91 to 1.74 in *S. emucronata* and from 1.71 to 1.59 in *S. willemi*) (Tab.).

4. The head of maxilla diminished, lamella 1 became narrower at the tip, slightly shortener and devoid of marginal filaments. Marginal filaments of lamellae 2-6 became shorter than in non-reproductive individuals (fig. 5).

5. The claws decreased in size, but in each species in a different way. In *S. emucronata* the mean d/cl3 ratio increased from c. 1 to c. 1.18 in both sexes, while in *S. willemi* the mean d/cl3 ratio increased from 0.95 to 1.02 in males and from 1.01 to 1.38 in females (Tab.).

6. The mucrodens (dens) became shorter in females of *S. emucronata* (the mean d/md ratio increased from 1.73 to 2.05) and in males of *S. willemi* (the mean d/md ratio increased from 1.65 to 2.01) (Tab.) (fig. 4).

7. The anal spines distinctly decreased in size (the mean d/as ratio increased from 0.97 to 2.3 in females and from 0.98 to 1.38 in males of *S. emucronata*,

Table. Extreme and mean (in parentheses) body length (l) and values of d/ ratio of non-reproductive (A) and reproductive (E) individuals (F - female, M - male) of *S. emucronata* (Se) and *S. willemi* (Sw). Other abbreviations: d - distance between setae a_1 and p_1 on th.2, AO3 – length of lateral sensilla in antennal III-organ, PAO – size of postantennal organ, cl3– length of claws 3, md – length of mucrodens (dens), as – length of anal spines, p_1 – length of microchaeta p_1 on abd. 4, p_2 – length of macrochaeta p_2 on abd. 4, s – length of sensillum p_5 on abd. 4.

	l (mm)	d/AO3	d/PAO	d/cl3	d/md	d/as	d/p_1	d/p_2	d/s
SeA F	1.25-1.6 (1.4)	2.55-3.55 (2.9)	1.68-2 (1.85)	0.93-1.23 (1.02)	1.6-1.87 (1.73)	0.93-1.04 (0.97)	1-1.17 (1.09)	0.45-0.51 (0.48)	0.8-1.03 (0.89)
SeE F	1-1.5 (1.3)	2.5-3.5 (2.88)	1.67-2.54 (2.05)	1.09-1.4 (1.19)	1.77-2.17 (2.05)	1.87-2.88 (2.3)	1.33-1.75 (1.6)	0.66-0.8 (0.72)	1-1.2 (1.08)
SeA M	1.1-1.25 (1.2)	2.67-3.25 (2.88)	1.6-2.08 (1.91)	0.89-1.09 (1)	1.6-2.17 (1.93)	0.87-1.08 (0.98)	0.96-1.3 (1.14)	0.43-0.54 (0.49)	0.76-1.09 (0.82)
SeE M	1.1-1.4 (1.25)	2.14-2.7 (2.31)	1.59-2 (1.74)	1.04-1.28 (1.18)	1.6-2.5 (1.98)	1.14-1.6 (1.38)	1.07-1.35 (1.21)	0.48-0.63 (0.57)	0.69-0.9 (0.83)
SwAF	1.4-1.6 (1.5)	2.73-3.11 (2.94)	1.58-2.33 (1.62)	1-1.04 (1.01)	1.87-2 (1.93)	0.96-1.28 (1.04)	1.2-1.42 (1.28)	0.51-0.6 (0.54)	1.14-1.28 (1.21)
SwE F	1.5-1.75 (1.6)	2.46-4 (3.13)	1.52-2.29 (1.91)	1.13-1.62 (1.38)	1.6-2.27 (1.92)	1.33-1.94 (1.62)	1.52-1.79 (1.64)	0.64-0.86 (0.73)	1.39-1.94 (1.65)
SwA M	1.2-1.4 (1.3)	2.5-2.9 (2.76)	1.5-2 (1.71)	0.91-1.18 (0.95)	1.44-2 (1.65)	0.83-1.26 (0.94)	1.18-1.32 (1.25)	0.43-0.58 (0.5)	1-1.15 (1.05)
SwE M	1.25-1.6 (1.45)	1.87-2.33 (2.14)	1.22-2.13 (1.59)	0.89-1.25 (1.02)	1.78-2.27 (2.01)	1.08-1.36 (1.22)	1.25-1.62 (1.41)	0.55-0.7 (0.65)	0.93-1.21 (1.07)

while it increased from 1.04 to 1.62 in females and from 0.94 to 1.22 in males of *S. willemi*) (Tab.) (fig. 2).

8. The body setae became shorter and finer, but their changes were different in each sex. In females the mean d/p_1,d/p_2,d/s ratios distinctly increased (see Tab.). In males the d/p_1, d/p_2 ratios increased slightly, while the d/s ratio remained unchanged (see Tab.) (fig. 1).

It is noteworthy, that all the studied reproductive individuals had empty gut. This suggests that they did not feed.

DISCUSSION

Within *Hypogastruridae*, morphological changes associated with the reproductive period (epitoky) were observed in the genera *Ceratophysella* BÖRNER, 1932, *Mitchellania* WRAY, 1953 and *Mucrella* FJELLBERG, 1985 (CASSAGNAU 1964, BOURGEOIS 1973, 1974, 1981; BOURGEOIS & CASSAGNAU 1970, 1973; WALTZ & HART 1986; ZETTEL & ZETTEL 1994; SKARŻYŃSKI 2000). The majority of changes listed in the mentioned papers were observed in studied species of *Schaefferia*. Moreover, like in *Ceratophysella*, the intensity of the observed changes varied between species and sexes.

Since the biological sense and taxonomic consequences of this phenomenon have been preliminarily outlined (BOURGEOIS 1974, ZETTEL & ZETTEL 1994, SKARŻYŃSKI 2000), some phylogenetic considerations should be presented. The relatively close similarity of epitokous changes in these four genera points to a common character of the described phenomenon within the ceratophysellan lineage (epitoky in *Bonetogastrura* THIBAUD, 1975 and *Typhlogastrura* BONET, 1930 is expected). This suggests a close phylogenetic relationship between the members of this lineage. Although the knowledge of epitoky in other genera of *Hypogastruridae* is scanty, the complex of epitokous characters can be tentatively regarded as one of synapomorhies of the ceratophysellan lineage.

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