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Morphological variability within *Anoecia furcata* Theobald 1915 /Hemiptera, Aphididae, Anoeciinae/

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Abstract

The paper presents the data on the morphological variability of *Anoecia furcata* Theobald 1915 specimens collected in Upper Silesia (Southern Poland). The data are compared to the morphological variability of neighbouring populations of closely related *Anoecia nemoralis* Boerner 1950. It is concluded, that the range of morphological variability of both species overlaps, yet some features (number of ommatidia and the length of antennal segment VI) are characteristic for each species. The results are discussed with reference to the taxonomic situation of both species.

Introduction

The genus *Anoecia* comprises a total of slightly over 20 palaearctic and nearctic species (HEIE, 1980; REMAUDIERE & REMAUDIERE, 1997). BOERNER (1950) described six new species within the genus from Central Europe, followed by ZWÖLFER (1957) who further studied their ecology and life cycles. All central-european *Anoecia* species are either dioecious with *Cornus* sp. as a primary host and grasses (Poacae) as the secondary hosts, or monoecious on Poaceae or Cyperaceae. Most species are visited by ants either on *Cornus* sp. or on secondary hosts (ZWÖLFER, 1957; GODSKE, 1991; DEPA & WOJCIECHOWSKI,

2008). In Poland 8 species of the genus were recorded so far (SZELEGIEWICZ, 1968) including examined species.

This is a very difficult group of aphids due to their wide range of intraspecific morphological diversity and still lack of comprehensive knowledge about their ecology and life cycles (HEIE, 1980; WIECZOREK, 2008). It seems that not always ecological requirements are followed by morphology. It results in extend synonymy in some cases (e.g. *A. corni*, *A. cornicola*, *A. vagans* – for lists of synonyms see: REMAUDIERE & REMAUDIERE, 1997).

Anoecia furcata Theobald 1915 and *A. nemoralis* Boerner 1950 are considered to be the good species. Following ZWÖLFER (1957) it was accepted that both species belong to *A. nemoralis* group, with lack of marginal tubercles on abdominal segments V and VI and spatulate hairs present on abdominal segments I – VII, predominantly anholocyclic. The presence of spatulate hairs on thorax and head was regarded as characteristic for *A. furcata*. Yet both species strongly overlap their morphologic characters and ZWÖLFER (1957) additionally distinguished within *A. nemoralis* winter – and summerforms, on the basis of spatulate hairs distribution pattern. He also stated, that the question of separateness of *A. furcata* from *A. nemoralis* was open. Thus the question of morphological differentiation of both species (as also of whole group) still suffers from deficiency of detailed studies.

Material and methods

The criterion of determination specimens as *A. furcata* was ZWÖLFER's (1957) key, and only specimens form series, where at least one specimen possessed a spatulate hair on head, were regarded as *A. furcata*. BLACKMAN & EASTOP'S (2007) differentiation feature was not applied to appoint specimens to examination as *A. furcata* in order to check the possible overlapping this feature with *A. nemoralis* (*sensu* ZWÖLFER, 1957). The material was collected by applying hand collecting method with careful tearing out grasses from the ground and browsing roots in search for aphids.

A. The following material of the total number of 14 specimens of *A. furcata* was examined:

1. 5 XII 2005 Piekary Śląskie CA58, housing estate meadow, roots of *Poa annua*, nest of *Formica cinerea*, 8 apterous viviparous females; further called series "R"
2. 3 X 2009 Bobrowniki – Namiarki CA58, edge of xerothermic grassland, roots of *Dactylis glomerata*, nest of *Lasius flavus*, 3 apterous viviparous females; further called series "A_1"

3. 8 X 2009 Piekary Śląskie CA58, *Agropyron repens*, housing estate meadow, roots of *Calamagrostis epigejos*, nest of *Lasius niger*, 3 apterous viviparous females; further called series "K_1"

B. The examined *A. nemoralis* material comprised 26 specimens from 12 series, collected on the same area [CA58] between 2003 and 2009, and collected between 16th September and 12th November.

During the study one of the examined series, called further series "G", revealed to be more similar to examined *A. furcata* specimens than to what was considered to be *A. nemoralis*. Those were two apterous viviparous females of following collection data:

23 IX 2003 Piekary Śląskie CA58, moist meadow *Molinietum caeruleae*, roots of *Agropyron repens*, unattended by ants.

All measurements were applied only to the mature apterous viviparous females on secondary host. The following measurements were applied: number of ommatidia, number of secondary rhinaria, length of antennal segments VI-III, body length, minimum and maximum diameter of marginal tubercle, minimum and maximum length of spatulate hairs, the pattern of settlement of spatulate hairs.

In case of marginal tubercles the diameter of the smallest and the largest tubercle within the whole specimen was measured. The same refers to the shortest and longest spatulate hair within the whole specimen. All measurements are given in mm.

Results

All the measurements of *A. furcata* specimens are presented in Table 1. while the measurments of *A. nemoralis* and series G are presented in Table 2. In both tables parenthesis in case of spatulate hairs arrangement means that not all specimens possessed spatulate hairs on particular body parts. As may be observed, specimens from series determined as *A. furcata sensu* Zwölfer (1957) definitely differ from *A. nemoralis* with lower number of ommatidia. They also differ possessing only one secondary rhinarium on antennal segment I while in *A. nemoralis* there may be present two secondary rhinaria. And also on antennal segment III *A. furcata* may have up to two secondary rhinaria while *A. nemoralis* possessed at least one and up to three. There was also the notable difference in length of antennal segment III, which in case of *A. nemoralis* was longer, although the range of variability overlaps with *A. furcata*. The key feature by Zwölfer (1957) – the arrangement of spatulate hairs, revealed that all specimens with spatulate hairs on head, determined in this study as *A. furcata*, always possessed them on I abdominal segment while the *A. nemoralis* specimens were sometimes lacking them

from that segment. The other examined features strongly overlap between all series.

Discussion

In the view of obtained results, the correspondence between ZWÖLFER's (1957) features of *A. furcata* and BLACKMAN & EASTOP's (2007) seems to be interesting. The proposed features were the length ratio of antennal segments V, IV and III. In this study the number of ommatidia and, to some extent, also the body length differed between studied species. In order to emphasize their importance they were deliberately multiplied and presented in Figure 1. Although the range of variability of obtained indices still overlap, there is some sort of separation between species. It would confirm ZWÖLFER's (1957) key feature of *A. furcata* to be valuable as a species determinant. Yet there appeared series "G", which according to ZWÖLFER (1957) must have been determined as *A. nemoralis*, but after examination it revealed other morphological features accordant to *A. furcata*. Specimens of series "G" did not possess any spatulate hairs on head or thorax (Tab. 2) so it was determined as *A. nemoralis*. But the length of III antennal segment, body length and the number of ommatidia made it very similar to *A. furcata*. Thus it weakened the value of ZWÖLFER's (1957) determination feature. Similarly series "A_1", determined as *A. furcata*, was very close to *A. nemoralis*, although the range of variability in number of ommatidia and length of antennal segment VI overlaps with features of series "R" and "K_1", belonging to *A. furcata* (accordant with ZWÖLFER's and BLACKMAN & EASTOP's features). BLACKMAN & EASTOP (2007) mention both species in their work, yet they do not make distinction between them, taking into account only *A. furcata* in their key (treating *A. nemoralis* as a synonym of *A. furcata*). As a result of this analysis it may be concluded, that the morphological separation of both species is possible. Further studies of both species should scope on connection of habitat requirements and life cycles with morphological variability. As far as now, determination of both species should reflect the morphological variability and be based on determination at least a few specimens from one colony. Obtained range of variability of distinctive features may then be compared to the diagram of variability of those features (Fig. 1) and then the degree of overlapping with one of both species may be evaluated. The mean value for colony series and distinctive feature revealed in this study should allow to apply the following key (to apterous viviparous females on secondary host, referring only to species present in polish fauna):

1. – number of marginal tubercules > 10 .....*A. corni* group, *A. vagans*
   – number of marginal tubercules = 10 2
2. – spatulate hairs absent or very sparse .....*A. haupti*
   – spatulate hairs present at least on abdominal segments II-VII 3
3. – number of ommatidia x length of antennal segment VI > 7.5 ..*A. nemoralis*
   – number of ommatidia x length of antennal segment VI < 7.5 .....*A. furcata*

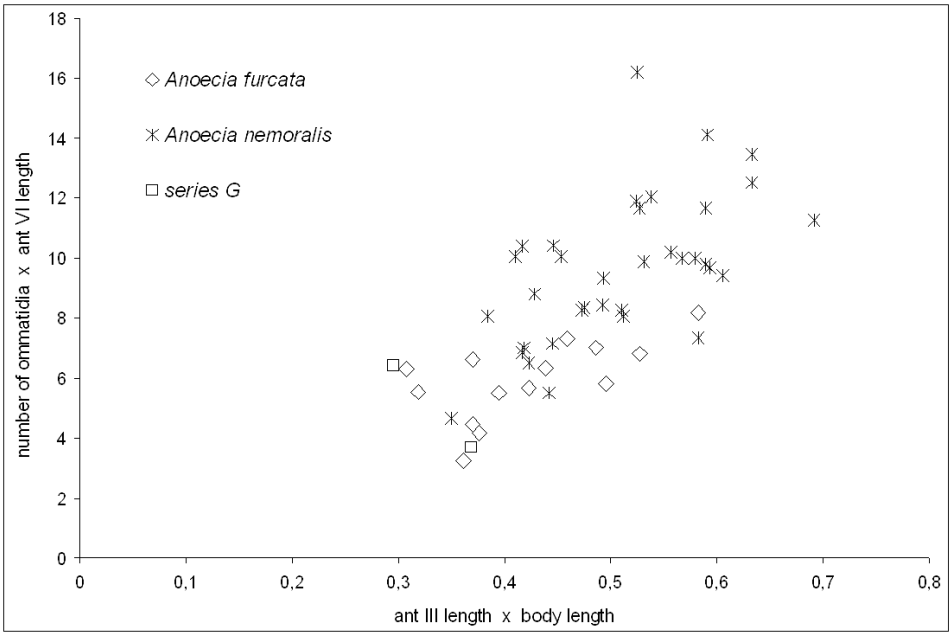

Figure 1. The correspondence between distinctive examined features of studied specimens.

Table 1. The measurements and spatulate hairs pattern of examined *Anoecia furcata* specimens

sample		number of ommatidia	number of secondary rhinaria VI	V	IV	III	length of antennal segments VI	V	IV	III	body length	marginal tubercle minimum diameter	marginal tubercle maximum diameter	minimum length of spatulate hair	maximum length of spatulate hairs	spatulate hairs distribution pattern abdVII	abdVI	abdV	abdIV	abdIII	abdII	abdI	thorax	head
series R n=8	mean	34	0.57	1.13	1.56	0.25	0.162	0.115	0.099	0.232	1.664	0.041	0.052	0.051	0.142									
	max	43	1	2	2	1	0.179	0.122	0.115	0.282	1.894	0.055	0.069	0.087	0.174	X	X	X	X	(X)	X	X	(X)	(X)
	min	21	0	0	1	0	0.154	0.103	0.077	0.205	1.500	0.028	0.034	0.034	0.101									
series A_1 n=3	mean	43	0.17	0.67	2.17	0.83	0.167	0.115	0.111	0.273	1.868	0.029	0.044	0.051	0.134									
	max	49	1	2	3	2	0.167	0.128	0.115	0.295	1.973	0.034	0.048	0.067	0.147	X	X	X	X	X	X	X	(X)	(X)
	min	36	0	0	2	0	0.167	0.103	0.103	0.256	1.789	0.024	0.041	0.040	0.121									
series K_1 n=3	mean	36	0.17	1.50	2.00	1.00	0.162	0.111	0.103	0.244	1.719	0.048	0.064	0.047	0.114									
	max	38	1	2	3	2	0.167	0.115	0.103	0.256	1.736	0.055	0.069	0.054	0.134	X	X	X	X	X	X	X	(X)	(X)
	min	33	0	1	1	0	0.154	0.103	0.103	0.231	1.710	0.041	0.055	0.034	0.080									

Table 2. The measurements and spatulate hairs pattern of examined *Anoecia nemoralis* and series "G" specimens

		number of ommatidia	number of secondary rhinaria VI	V	IV	III	length of antennal segments VI	V	IV	III	body length	marginal tubercle minimum diameter	marginal tubercle maximum diameter	minimum length of spatulate hair	maximum length of spatulate hairs	spatulate hairs distribution pattern abdVII	abdVI	abdV	abdIV	abdIII	abdII	abdI	thorax	head
Anoecia nemoralis n=24	mean	53	0.56	1.26	1.91	0.51	0.176	0.124	0.113	0.274	1.845	0.042	0.054	0.056	0.123									
	max	75	2	2	4	3	0.205	0.141	0.128	0.321	2.157	0.062	0.076	0.101	0.201	X	X	X	X	X	X	(X)	(X)	
	min	33	0	0	1	1	0.154	0.115	0.103	0.244	1.631	0.031	0.038	0.027	0.067									
series G n=2	mean	33	0.75	1.25	1.75	0	0.154	0.115	0.103	0.224	1.434	0.038	0.058	0.044	0.127									
	max	40	1	2	2					0.231	1.553	0.041	0.062	0.054	0.134	X	X	X	X	X	X	X		
	min	25	0	1	1					0.218	1.315	0.034	0.055	0.034	0.121									

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Zmienność morfologiczna w obrębie *Anoecia furcata* Theobald 1915 /Hemiptera, Aphididae, Anoeciinae/

Streszczenie

Praca przedstawia dane o zmienności morfologicznej wśród osobników *Anoecia furcata* Theobald 1915, zebranych na Górnym Śląsku (południowa Polska). Dane zostały porównane ze zmiennością morfologiczną występującej na tym samym obszarze populacji blisko spokrewnionego gatunku *Anoecia nemoralis*. Stwierdzono, że zakres zmienności obu gatunków pokrywa się, jednak pewne cechy (liczba ommatidiów i długość VI członu czułków) są charakterystyczne dla każdego z gatunków. Wyniki zostały omówione w odniesieniu do pozycji systematycznej obydwu gatunków.