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Aphid species of genus *Macrosiphum* Passerini, 1860 (Hemiptera, Sternorrhyncha: Aphididae) inhabiting *Knautia* L. in Belarus

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A morphological analysis of extensive material from Belarus (45 localities, 117 samples, 2002–2010) confirms that *Macrosiphum silvaticum* Meier, 1985 is a junior synonym of *Macrosiphum knautiae* Holman, 1972. Two species of the genus *Macrosiphum* were found on *Knautia arvensis* in Belarus in 2002–2010: *M. rosae* (Linnaeus, 1758), and *M. knautiae* Holman, 1972, the latter species being predominant. In addition to common key characters, a canonical discrimination function (Rakauskas 2003) is necessary to ensure exact morphological discrimination between the two species.

2002–2010 m. Baltarusijoje keturiasdešimt penkiose vietovėse surinktų 117 amarų mėginių morfologinė analizė patvirtino, jog amarų rūšies pavadinimas *Macrosiphum silvaticum* Meier, 1985 yra jaunesnysis pavadinimo *Macrosiphum knautiae* Holman, 1972 sinonimas. Tyrimų metu Baltarusijoje ant *Knautia arvensis* aptiktos dvi *Macrosiphum* genties amarų rūšys: *M. rosae* (Linnaeus, 1758) ir *M. knautiae* Holman, 1972, pastaroji rūšis randama dažniausiai. Norint atskirti šias dvi rūšis, be įprastinių apibūdinimo raktuose taikomų morfologinių požymių reikia naudoti dar ir kanoninę atskyrimo funkciją (Rakauskas 2003).

Keywords: *Macrosiphum rosae*; *Macrosiphum knautiae*; *Macrosiphum silvaticum*; *Knautia*; morphometry; Belarus

Introduction

Three species of the genus *Macrosiphum* Passerini, 1860 (Hemiptera, Sternorrhyncha: Aphididae) have been reported as inhabiting plant hosts of the genus *Knautia* Linnaeus, 1753 (Dipsacales: Dipsacaceae) in Europe (Holman 1972, 2009; Meier 1985; Heie 1994; Blackman and Eastop 2006): *Macrosiphum rosae* (Linnaeus, 1758), *Macrosiphum knautiae* Holman, 1972, and *Macrosiphum silvaticum* Meier, 1985. *M. rosae* is a widespread and abundant pest aphid species in Belarus, endangering cultivated roses (Sautkin and Buga 2007). *M. silvaticum* has been registered on *Knautia arvensis* (Linnaeus, 1753) Coulter 1823 in three areas of Belarus: Lakeland, Prepolessie, and western Belarus (Buga and Rakauskas 2003). *M. rosae* is facultatively heteroecious between *Rosa* spp. and various Dipsacaceae, Valerianaceae and Onagraceae; the hosts of the genus *Knautia* are not obligatory for this species (Rakauskas and Zajanckauskas 1985). Whilst the two remaining species, *M. knautiae* and *M. silvaticum*, are holocyclic monoecious on *Knautia* spp., which was shown experimentally for *M. knautiae* in Moravia (Holman 1972) and for *M. silvaticum* in Lithuania (Rakauskas 1985).

Rakauskas (2001, 2003) discussed the host specificity, life cycles, morphological features and distribution of these species in some European territories (Lithuania, Poland, Czech Republic, Slovakia, Switzerland) and established the synonymy between *M. silvaticum* and *M. knautiae*, which was subsequently confirmed by molecular data (Turčinavičienė and Rakauskas 2009). Therefore, only two valid species of the genus *Macrosiphum (M. rosae* and *M. knautiae*) inhabiting *Knautia* are presented in the Fauna Europaea list of aphids to date (Nieto Nafría et al. 2004; Lampel and Meier 2007). Nonetheless, such a synonymy is not accepted in some widely used aphid identification and information volumes (Blackman and Eastop 2006; Holman 2009). Such a situation generates the need for a thorough study of the *M. rosae–knautiae–silvaticum* complex in other parts of its distribution area.

The aim of this study is to identify the *Macrosiphum* species inhabiting *Knautia* in Belarus and to evaluate their morphological peculiarities.

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Material and methods

The aphid material was collected on *Knautia arvensis* (L.) Coult. in 45 localities (Fig. 1, Table 1) in all administrative regions (including Minsk city) and landscape provinces of Belarus by S.V. Buga (115 samples) and N.V. Lyashchynskaja (2 samples) in 2002–2010. Several samples of *M. rosae* from *Rosa* spp. were added for comparison. The sampling methods were those commonly used (Eastop and van Emden 1972). The microscope slides were prepared using the Faure-Berlese mounting fluid or Canadian balsam (Blackman and Eastop 1984). After analysis, the aphid material was deposited at the Department of Zoology of Belarusian State University (Minsk, Republic of Belarus) and at the Department of Zoology of Vilnius University (Vilnius, Republic of Lithuania).

The commonly used key morphological character (Holman 1972; Meier 1985; Blackman and Eastop 2006), i.e. the ratio of the ultimate rostral segment length to the second segment of hind tarsus length (urs/htarsII), was applied when identifying 276 apterous viviparous females sampled in Belarus. In addition, the canonical discrimination function (Rakauskas 2003) was used. The Olympus BX 40 microscope and interactive measurement MicroImage software (Olympus Optical Co) was used together with the STATISTICA for WINDOWS 5.5 software (StatSoft 2000).

Results and discussion

The distribution of individual values of the urs/htarsII ratio of apterous viviparous females of the genus *Macrosiphum* collected on *K. arvensis* in Belarus are scatter-plotted against the length of the ultimate rostral segment (urs) in Fig. 2. The values of the urs/htarsII ratio ranged from 1.02 to 1.90. Commonly, apterous viviparous females that have the urs/htarsII ratio less than 1.18 are keyed as *M. rosae*, whilst those whose urs/htarsII exceeds 1.19 belong to the *M. knautiae–silvaticum* complex (Holman 1972; Meier 1985). The key of Blackman and Eastop (2006) reported even a more constricted gap: less than 1.18 urs/htarsII ratio for *M. rosae*, and over 1.18 for *M. knautiae–silvaticum*. Rakauskas (2003) suggested a canonical discrimination function (CDF) for the cases when the urs/htarsII ratio appears between 1.1 and 1.2. The negative values of CDF indicate the *M. knautiae–silvaticum* complex, whilst positive ones characterise *M. rosae*. In our material, seven out of 276 specimens had the urs/htarsII ratio between 1.1 and 1.2. Four of them are attributable to *M. rosae* due to their host specificity because they were collected on *Rosa* spp. (*M. knautiae* and *M. silvaticum* can inhabit *Knautia* spp. only). Morphologically, they also appeared ascribable to *M. rosae* because of having CDF values above zero, the same as three specimen collected on *K. arvensis* (Fig. 2). Thus, the majority of *Macrosiphum* aphids collected on *K. arvensis* in Belarus in 2002–2010 (273 out of 276 specimens) should be ascribed to the *M. knautiae–silvaticum* complex although the morphological gap between *M. rosae* and *M. knautiae–silvaticum* complex is quite slim.

Blackman and Eastop (2006) used the urs/htarsII ratio 1.4 as a margin to separate between *M. knautiae* (urs/htarsII less than 1.4) and *M. silvaticum* (urs/htarsII exceeding 1.4). Our present data show this morphological criterion being unreliable due to the absence of any gap in the area of urs/htarsII value 1.4 (Fig. 2). Together with the earlier published data on morphological characters, host specificity, life cycles, distribution and partial sequences of mitochondrial *COI* and nuclear *EF-1α* genes of *M. knautiae* and *M. silvaticum* (Rakauskas 2003; Turčinavičienė and Rakauskas 2009), this corroborates the nomenclatorical decision (Rakauskas 2003) that *Macrosiphum silvaticum* Meier, 1985 is a junior synonym of *Macrosiphum knautiae* Holman, 1972. The present data show *M. knautiae* being the predominant *Macrosiphum* species inhabiting *K. arvensis* in Belarus. Similar situation has been earlier reported for Lithuania (Rakauskas 1985).

Figure 1. Aphid sampling places in Belarus in 2002–2010, showing landscape provinces according to Martsinkevich and Pirozhnik (2007). Numbers indicate respective sampling sites as numbered in Table 1.

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Table 1. Aphid material used in the present study showing the sampling data and numbers of apterous viviparous females used for morphological analysis.

Administrative region	Administrative district	Locality (locality number in Fig. 1)	Sample No	Date	Number of specimens
		Macrosiphum ex Knautia			
Brest	Baranovichi	Ivnaya (1)	02–328	9 September 2002	2
	Gancevichi	Polonj (2)	03–409	14 September 2003	1
			03–410	14 September 2003	2
			03–415	14 September 2003	2
			03–416	14 September 2003	1
			03–417	14 September 2003	1
			03–418	14 September 2003	1
			03–419	14 September 2003	1
			03–420	14 September 2003	1
		Gancevichi (3)	07–305	13 September 2007	2
			07–306	13 September 2007	1
			07–308	13 September 2007	2
			07–309	13 September 2007	2
	Ivanovo (Janov)	Jukhnevichi (4)	09–334	16 September 2009	8
			09–335	16 September 2009	3
			09–336	16 September 2009	4
	Ivacevichi	Kholop'ja (5)	04–696	20 September 2004	3
	Luninec	Bostynj (6)	09–341	16 September 2009	3
	Malorita	Mel'niki (7)	09–319	29 August 2009	13
		Malorita (8)	09–325	29 August 2009	9
Gomel	Dobrush	Dobrush (9)	09–299	22 August 2009	12
	Octjabrj	Moshny (10)	09–250	28 July 2009	3
			09–260	28 July 2009	1
			09–261	28 July 2009	1
			09–362	28 September 2009	1
		Moshny (10)	09–369	28 September 2009	1
	Rechitsa	Kopanj (11)	09–266	31 July 2009	1
			09–269	31 July 2009	1
			09–270	31 July 2009	4
Grodno	Iv'e	Naustj (12)	02–294	27 August 2002	1
		RWS Jachimovshchina (13)	10–528	27 August 2010	2
		Jachimovshchina (13)	10–531	27 August 2010	1
	Slonim	Ivnaya (14)	02–326	9 September 2002	3
			02–332	9 September 2002	1
			02–337	9 September 2002	4
		Ivnaya (14)	02–330	9 September 2002	1
			02–335	9 September 2002	4
			02–339	9 September 2002	3
			02–342	9 September 2002	3
			02–347	9 September 2002	1
			02–349	9 September 2002	2
Minsk city		Minsk, central part of the city (15)	380–07	28 June 2007	2

(*Continued*)

Table 1 (*Continued*).

Administrative region	Administrative district	Locality (locality number in Fig. 1)	Sample No	Date	Number of specimens
Minsk	Dzerzhinsk	Asino (16)	02–315	27 August 2002	2
	Kopylj	Pechurany (17)	10–470	10 July 2010	1
	Minsk	Pomyslishche (18)	05–844	15 July 2005	3
		Priluki (19)	05–715	10 October 2005	1
	Molodechno	Udranka (20)	06–017	29 June 2006	4
	Mjadel	Naroch (21)	255–06	28 June 2007	2
	Nesvizh	Lipa (22)	02–304	29 August 2002	2
	Stolbcy	Slobodka (23)	10–451	9 July 2010	2
	Volozhin	Rakov (25)	06–020	26 June 2006	2
			06–021	26 June 2006	2
			06–025	26 June 2006	1
		Pral'niki (26)	10–532	27 August 2010	1
Mogilev	Belynichi	Korytnica (27)	05–935	23 August 2005	2
	Klimovichi	Malashkovichi (28)	05–903	24 August 2005	2
		Cerkovishche (29)	05–914	24 August 2005	1
	Klichev	Dubno (30)	06–053	15 August 2006	3
	Kostjukovichi	Krutoj Rov (31)	05–909	25 August 2005	2
	Krasnopolje	Kholmy (32)	05–895	24 August 2005	2
	Khotimsk	Markovka (33)	05–896	24 August 2005	3
		Juzefovka (33)	05–945	25 August 2005	2
Vitebsk	Gorodock	Bolotnica (34)	02–254	22 August 2002	6
			02–259	22 August 2002	2
			02–260	22 August 2002	2
		Bolotnica (34)	02–255	22 August 2002	1
			02–257	22 August 2002	1
			02–287	20 August 2002	8
			02–289	22 August 2002	1
			02–290	22 August 2002	4
		Bolotnica (34)	07–296	6 August 2007	1
		Bolotnica (34)	02–258	22 August 2002	3
			02–288	20 August 2002	2
		Laptevka (35)	08–463	19 June 2008	3
		Prudok (36)	02–226	20 August 2002	1
			02–227	20 August 2002	3
			02–251	20 August 2002	1
			02–286	20 August 2002	2
		Repishche (37)	02–274	22 August 2002	1
			02–276	22 August 2002	1
			02–277	22 August 2002	3
			02–278	22 August 2002	1
		Repishche (37)	02–267	22 August 2002	3
			02–268	22 August 2002	1
			02–269	22 August 2002	2
			02–270	22 August 2002	1

			02–271	22 August 2002	3
			02–272	22 August 2002	4
			02–273	22 August 2002	2
			02–275	22 August 2002	1
			02–279	22 August 2002	3
		Rudnia (38)	07–253	2 August 2007	2
			07–254	2 August 2007	1
		Rudnia (38)	02–247	19 August 2002	1
			02–249	19 August 2002	3
			02–283	19 August 2002	3
			02–285	19 August 2002	8
		Rudnia (38)	02–220	19 August 2002	1
		Zadrach'e (39)	02–195	19 August 2002	1
			07–270	31 July 2007	1
	Dokshicy	Dedino (40)	04–620	7 July 2004	1
		Sosnovaja (41)	07–136	3 July 2007	1
	Miory	Lake Vazho (42)	07–219	3 July 2007	2
			07–220	3 July 2007	1
			07–222	3 July 2007	2
			07–224	3 July 2007	1
			07–229	3 July 2007	1
			07–233	3 July 2007	3
			07–235	3 July 2007	1
			07–238	3 July 2007	1
			07–239	3 July 2007	1
			07–241	3 July 2007	1
			07–242	3 July 2007	1
			07–243	3 July 2007	3
	Rossony	Krasnopol'e (43)	07–191	1 July 2007	3
	Ushachi	Zavydrino (44)	04–679	21 July 2004	1
		Pligovki (45)	07–193	1 July 2007	1
		Macrosiphum ex Rosa			
Minsk	Stolbcy	Kletishche (24)	10–512	14 July 2010	5
	Volozhin	Pral'niki (26)	10–527	27 August 2010	3

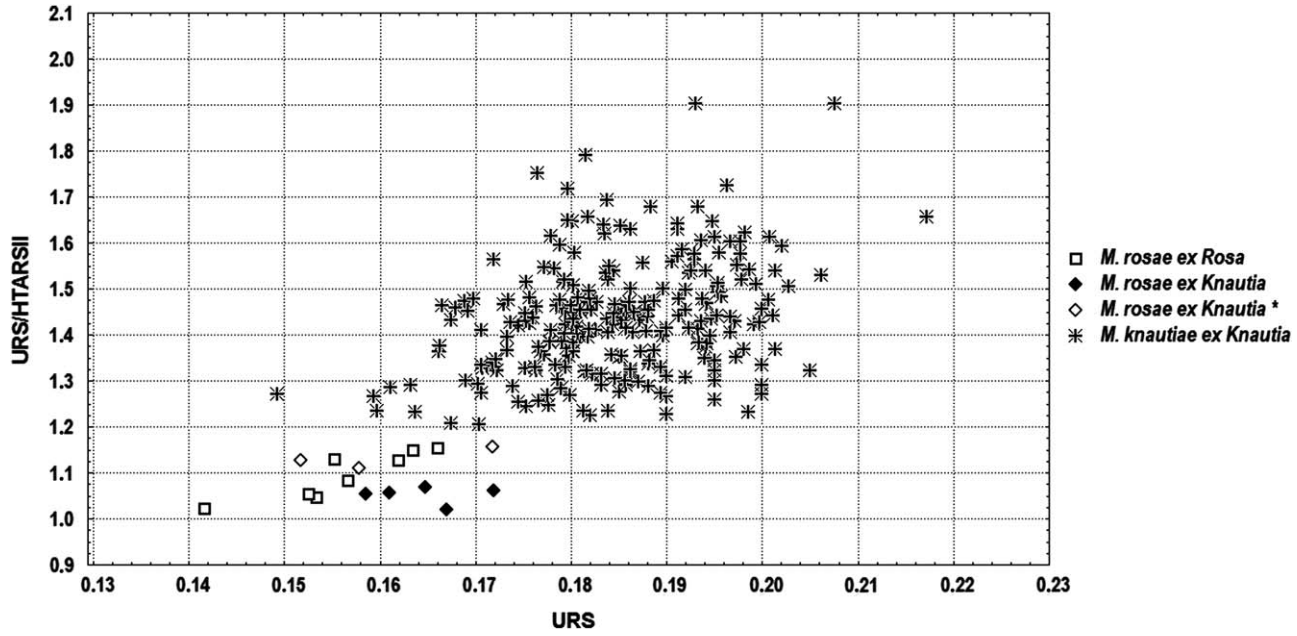

Figure 2. Individual values of the urs/htarsII ratio plotted against the ultimate rostral segment (urs) length of apterous viviparous females of *Macrosiphum* aphids collected on *K. arvensis* and *Rosa* spp. in Belarus in 2002–2010. * – specimens identified by means of CDF (Rakauskas 2003).

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