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The *Knautia* feeding species of *Aphis* (Insecta: Hemiptera: Aphididae) with notes on *Aphis knautiae* Holman nomen nudum

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Abstract. Here we present a review of *Knautia* feeding aphid species of the genus *Aphis* Linnaeus, 1758 (Insecta: Hemiptera: Aphididae). A new European species *Aphis holmani* sp. nov. is described from specimens collected in the Czech Republic, Bulgaria and Romania by the late Jaroslav Holman, who already recognized this new species, but never published its description. It has previously been referred to as *Aphis knautiae* Holman nomen nudum. Morphological characters of apterous and alate viviparous females as well as the sexual generation (oviparous females and males) are described and figured. The new species is associated with *Knautia drymeia* and its affinities with other related species living on species of *Knautia* are presented. Morphological characteristics of known morphs of other *Knautia* feeding species *A. confusa* Walker, 1849, *A. longini* Huculak, 1968 and *A. thomasi* (Börner, 1950) are given and figured. Additionally hitherto unknown sexual forms of *A. thomasi* are described from specimens collected in the Czech Republic and Poland. A key to known aphid species living on species of *Knautia* is also provided.

Key words. Aphidini, Aphidoidea, description, Europe, taxonomy, *Aphis holmani* sp. nov.

INTRODUCTION

Aphis Linnaeus, 1758 with 589 valid species is the most speciose genus within the Aphidoidea as a whole (Favret 2019; Blackman & Eastop 2019). Species belonging to this genus are known mostly from the northern hemisphere with small number of taxa which are native for the southern part of the globe. Most of species form groups of similar or very similar species whose elucidation may be difficult, but mostly all they are characterized by terminal process which is no longer than the fourfold of the basal part length, relatively short siphunculi and a subtriangular or tongue-shaped cauda. Viviparous and sexual generations of *Aphis* are furthermore characterized by undeveloped or low antennal tubercles with a little convex frons, marginal tubercles on prothorax, abdominal segments I and VII and occasionally on other segments of the abdomen, which although lack in some species (Heie 1986).

The plant genus *Knautia* L. (Dipsacaceae) comprises about 50–55 species distributed in western Eurasia and northwestern Africa, with the highest species diversity is in southern and southeastern Europe, especially the Alps and the Balkan Peninsula. Species from this genus can be found dry grasslands, wet meadows, alpine grasslands,

forests, and ruderal communities (Ehrendorfer 1976; Rešetnik et al. 2014). So far 11 aphids species have been described or recorded from ten *Knautia* species of which three species belong to genus *Aphis*: *A. confusa* Walker, 1849, *A. longini* Huculak, 1968 and *A. thomasi* (Börner, 1950) are associated with *Knautia arvensis* (L.) Coult., *K. dinarica* (Murb.) Borbás, *K. dipsacifolia* Kreutzer and *K. integrifolia* Ehrend. Only *A. confusa* feeds on all four species (both, *A. longini* and *A. thomasi* are known only from *K. arvensis*) (Holman 2009; Blackman & Eastop 2019).

Knautia drymeia Heuff. has a native distribution range from South-eastern Germany to Northern Greece (Albania, Austria, Bulgaria, Czech Republic, Croatia, Greece, Hungary, Montenegro, Romania, Serbia and Slovakia) (Rešetnik et al. 2016). It is a perennial herb, usually with a monopodial stalk bearing a terminal leaf rosette and lateral flowering stems. Its habitats are forests and forest margins, especially deciduous and hard-wood floodplain forests, but it also reaches into subalpine habitats (Ehrendorfer 1962; Fischer et al. 2008). Only four aphid species from the tribe Macrosiphini have been reported from this species to date: *Aulacorthum knautiae* Heie, 1960, *Macrosiphum knautiae* Holman, 1972, *M. rosae* (Linnaeus,

1758) and *Ovatomyzus boraginacearum* Eastop, 1952 (Holman 2009).

Another nominal species associated with *K. drymeia* is *Aphis knautiae* Holman which was for the first time mentioned in 1981 in the list of aphids of Romania (Holman & Pintera 1981) but recognized as a nomen nudum (ICZN 1999; Remaudière & Remaudière 1997; Favret 2019). During the work in the Aphidoidea collection of the late Jaroslav Holman (now deposited in the Biology Centre of the Czech Academy of Sciences, Institute of Entomology, České Budějovice, Czech Republic) specimens collected in the Czech Republic, Bulgaria and Romania from *K. drymeia* and labeled as “*Aphis knautiae* Holman” have been found and recognized as *A. knautiae* Holman nomen nudum. A careful examination and comparison with other *Aphis* species associated with *Knautia* revealed that the specimens represent an undescribed species; its diagnosis and detailed description is given in this paper which makes this name available.

MATERIAL AND METHODS

The specimens were examined using light microscope Leica DM 3000 led with Leica MC 190 HD camera and Nikon Eclipse E600 with Nikon DS-Fi camera. The measurements were done according to Ilharco & van Harten (1987) and Blackman & Eastop (2006). Measurements are given in millimeters (Supplementary tables 1–4).

Abbreviations

ANT	= antennae or their lengths
ANT I–VI	= antennal segments I, II, III, IV, V, VI or their lengths (ratios between antennal segments are simply given as e.g. ‘VI: III’)
BASE	= basal part of last antennal segment or its length
BD III	= basal articular diameter of ANT III
BL	= body length (from anterior border of the head to the end of cauda)
FEMORA III	= hind femora length
FEMORA III LS	= longest setae on hind femora
GP	= genital plate
PHT	= posterior seta (hair) of hind trochanter
HW	= greatest head width across compound eyes
HT II	= second segment of hind tarsus or its length
LS ANT III	= length of longest setae of ANT III
MAX W	= maximal width of abdomen
PT	= processus terminalis of last antennal segment or its length
MTu	= marginal tubercles

SIPH L	= siphunculi length
SIPH W	= maximum width of siphunculus
TIBIAE III	= hind tibiae length
URS	= ultimate segments of rostrum (IV + V) or their length
apt.	= apterous viviparous female
al.	= alate viviparous female
♀	= oviparous female
♂	= male

Depositories of the material examined

DZUS	= Hemiptera Collection of the Department of Zoology, University of Silesia in Katowice, Poland
IECA	= Biology Centre of the Czech Academy of Sciences, Institute of Entomology, České Budějovice, Czech Republic;
ZMPA	= Zoological Institute, Polish Academy of Sciences, Warsaw, Poland

RESULTS

Shared characters of *Aphis* species feeding on *Knautia* spp.

Body egg or pear-shaped. Head slightly sclerotized with very small and slightly visible ANT tubercles and sub-convex frons. Head and body sclerotization often with microsculpture. ANT 5 or 6-segmented. ANT III without secondary rhinaria, ANT V with small ciliated rhinarium. ANT VI with small ciliated major rhinarium, 5–6 visible additional rhinaria and 4 apical setae. Ultimate rostral segment with 2 (sometimes 4) accessory setae. First segments of tarsi with 3–3–2 ventral setae. Dorsum of thorax membranous, sometimes with more or less visible sclerotic plates on marginal areas. Dorsum of thorax and abdomen covered by a few short, rigid setae with blunt apices. Abdomen membranous. ABD I and VII always with MTu. Siphunculi short, cylindrical, slightly tapering. Cauda short, tongue-shaped. Alate viviparous females with small number of secondary rhinaria on ANT III and IV. Abdomen with marginal sclerotic plates on ABD II–IV. ABD VI with wide postsiphuncular sclerites. Oviparous females with more or less swollen hind tibiae with rounded or slightly oval pseudosensoria on almost whole length and genital plate divided into two separated sclerotic parts. Males apterous with small number of secondary rhinaria on ANT III–V. They are small, rounded with sclerotic rings. Male genitalia with wide and lobate parameres with a large number of long and pointed setae. Basal part of the phallus short and hooked-shaped.

Morphological characteristics of species

Aphis (Aphis) confusa Walker, 1849

Walker, 1849: XLV

Figs 1–7; Supplementary tables 1–4; Tables 1–2

Apterous viviparous female (n=27).

Colour in life: apterae are pale yellow, yellowish green, green or dark green, depending on location on host (Blackman & Eastop 2019); pigmentation on slide: head sclerotized, brown. Antennae light brown with lighter ANT and basal part of ANT IV or ANT III, and basal part of ANT IV and V. Legs yellow to pale brown with brown distal parts of tibiae and tarsi (sometimes only slightly visible). Abdomen yellow with brown to dark brown SIPH and light brown cauda and anal plate (Fig. 1a).

HW 0.36–0.40 × ANT. Head setae 0.015–0.025 mm long, 0.75–0.90 × BD III. ANT 0.51–0.58 × BL. ANT IV slightly shorter, as long as or slightly longer than ANT V. ANT VI with PT 2.45–3.00 × BASE. Other antennal ratios: VI:III 1.28–1.52, V:III 0.56–0.69, IV:III 0.56–0.76, PT:III 0.87–0.91, PT:IV 1.42–1.71, PT:V 1.55–1.80. ANT bearing very short and blunt setae (Fig. 5a). ANT III setae shorter than the width of the segment, 0.010–0.015 mm long, LS III 0.50–0.75 × BD III. ANT I with 4–5, ANT II with 3–5, ANT III with 4–9, ANT IV with 2–4, ANT V with 2–5, ANT VI with 2–3 basal setae. Rostrum reaching hind coxae. URS 0.37–0.50 × ANT III, 0.27–0.34 × ANT VI, 0.37–0.46 × PT, 1.09–1.37 × BASE and 1.00–1.22 × HT II. Mesosternal furca wide, fused basally. III FEMORA bearing long, slightly rigid setae with blunt or slightly expanded apices (Fig. 5b), 0.015–0.032 mm long, III FEMORA LS 0.63–0.76 ×

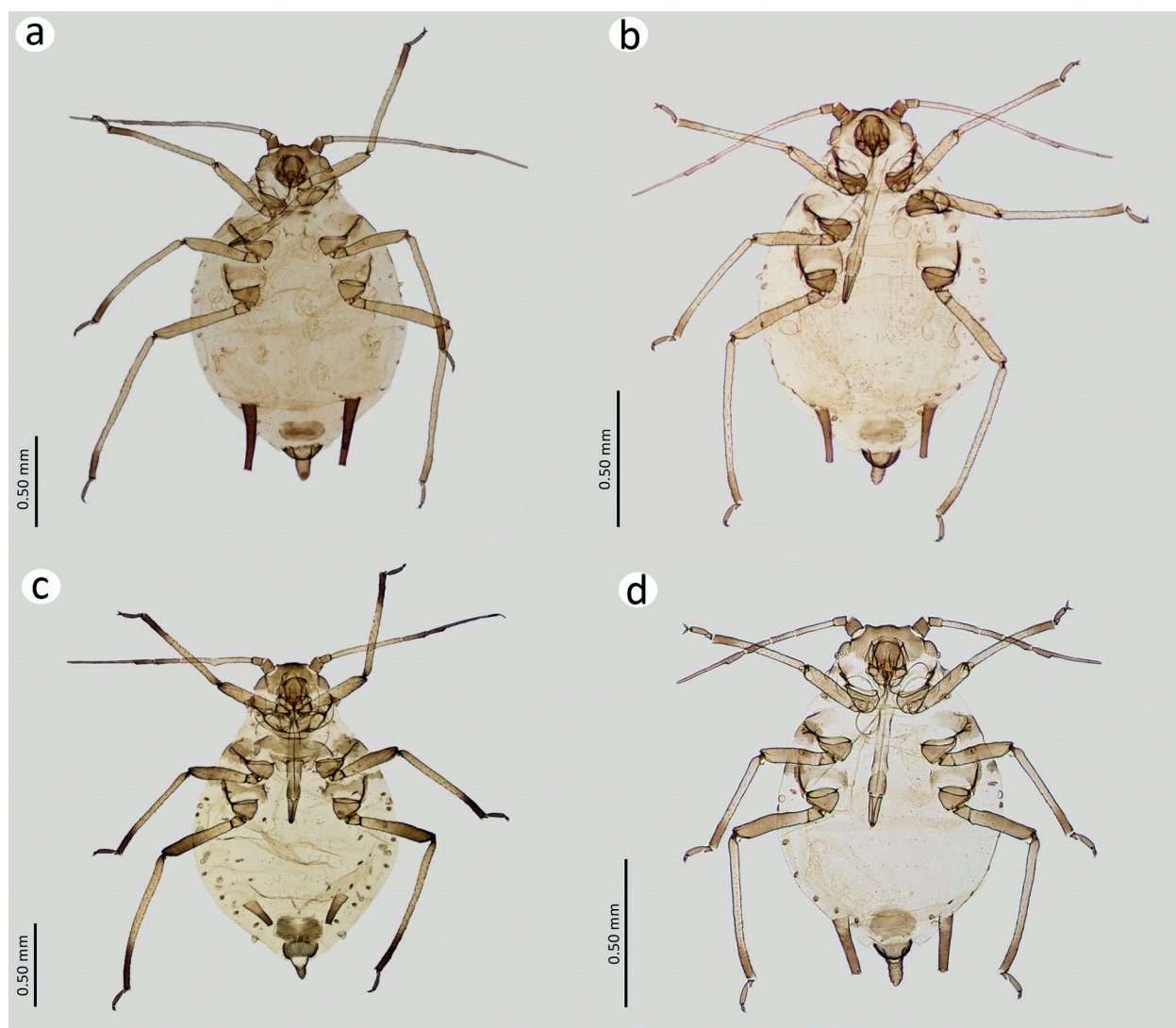


Fig. 1. *Apterous viviparous* females of *Knautia* feeding *Aphis* species. (a) *A. confusa*; (b) *A. holmani* sp. nov.; (c) *A. longini*; (d) *A. thomasi*.

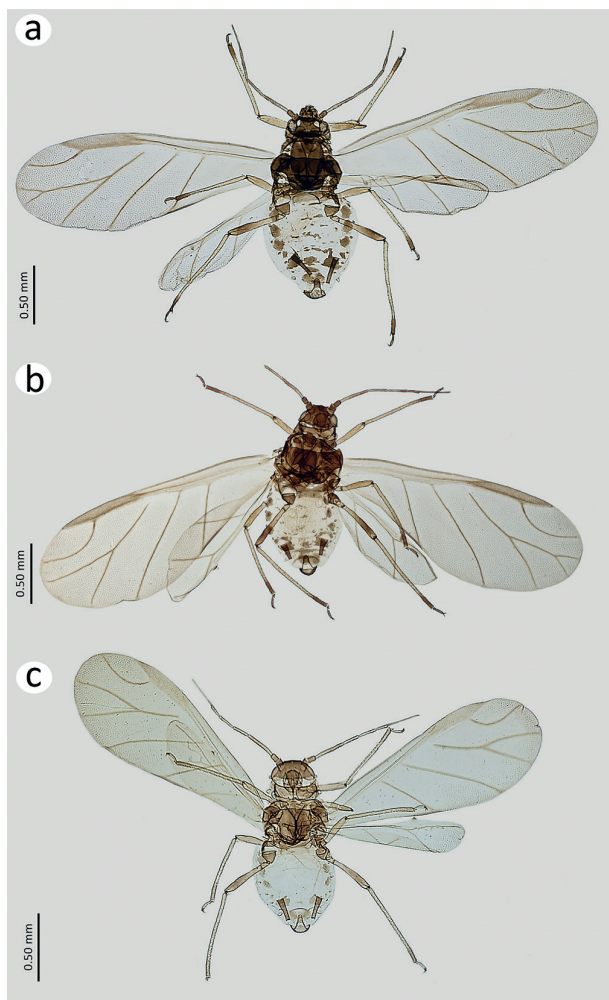


Fig. 2. Known alate viviparous females of *Knautia* feeding *Aphis* species. (a) *A. confusa*; (b) *A. holmani* sp. nov.; (c) *A. thomasi*.

trochantero-femoral suture length. Posterior seta on hind trochanter $0.76\text{--}1.00 \times$ trochantero-femoral suture length (Fig. 5c). III TIBIAE bearing long and rigid setae with slightly blunt apices, $0.017\text{--}0.030$ mm long. HT II $0.37\text{--}0.44 \times$ ANT III, $0.27\text{--}0.30 \times$ ANT VI, $0.37\text{--}0.42 \times$ PT and $1.00\text{--}1.12 \times$ BASE. Abdomen with very small MTu on ABD IV. SIPH $1.60\text{--}1.88 \times$ cauda, $0.13\text{--}0.18 \times$ BL, and $1.09\text{--}1.30 \times$ ANT III. Setae on ABD I–V $0.015\text{--}0.020$ mm long, about $0.85 \times$ BD III. Setae on ABD VI–VIII $0.017\text{--}0.025$ mm long, $0.85\text{--}1.13 \times$ BD III. Genital plate anterior setae $0.035\text{--}0.042$ mm long, $1.75\text{--}2.00 \times$ BD III. Cauda with 5–8 setae (Fig. 6a, b).

Alate viviparous female (n=4).

Colour in life: unknown; *pigmentation on slide*: head and thorax sclerotized, brown to dark brown. Antennae brown to light brown with paler basal half of ANT III, IV and V. Wings light brown with darker venation. Fore

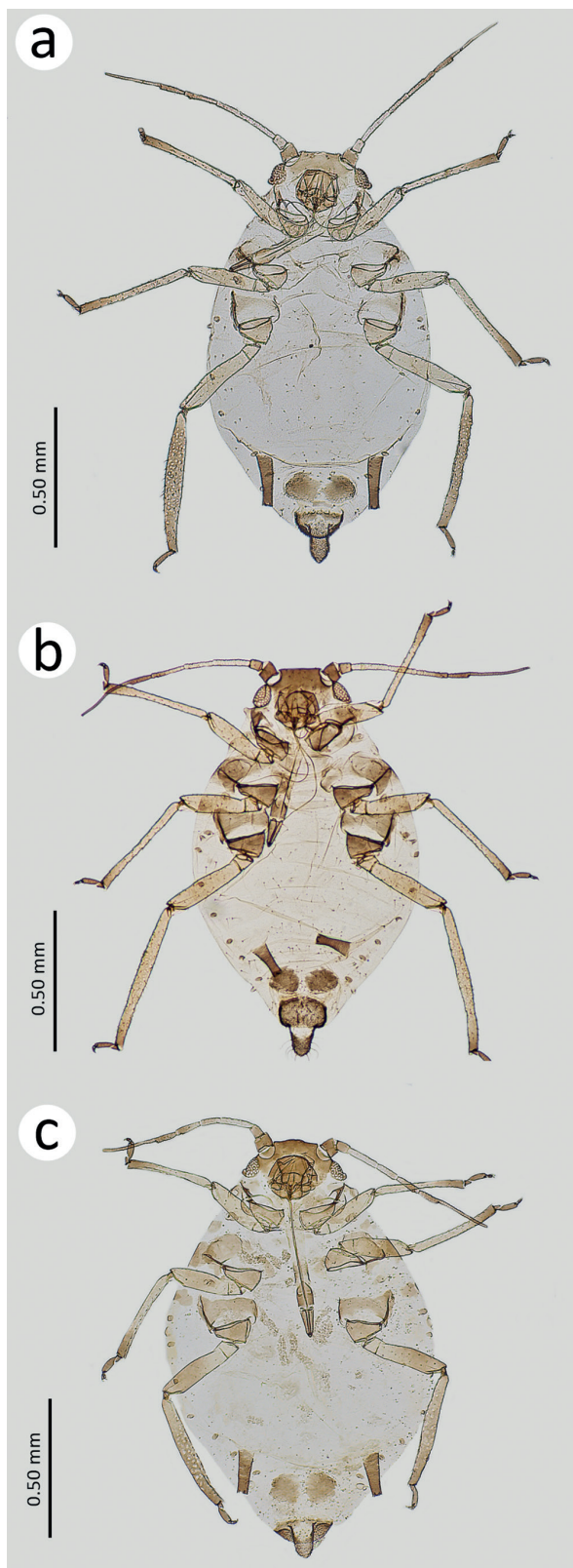


Fig. 3. Known oviparous females of *Knautia* feeding *Aphis* species. (a) *A. confusa*; (b) *A. holmani* sp. nov.; (c) *A. thomasi*.

and middle femora uniformly yellow to light brown, hind femora yellow to light brown with darker distal half. Tibiae yellow to light brown with brown distal ends and tarsi. Abdomen pale with brown sclerite, plates, SIPH, cauda and anal plate (Fig. 2a). HW $0.34\text{--}0.36 \times \text{ANT}$. Head setae $0.012\text{--}0.015$ mm long, $0.76\text{--}0.88 \times \text{BD III}$. ANT $0.62\text{--}0.67 \times \text{BL}$. ANT III with 4–5 secondary rhinaria, ANT IV slightly shorter or slightly longer than ANT V. ANT VI with PT $2.28\text{--}2.90 \times \text{BASE}$. Other antennal ratios: VI:III $1.32\text{--}1.70$, V:III $0.57\text{--}0.77$, IV:III $0.62\text{--}0.69$, PT:III $0.92\text{--}1.20$, PT:IV $1.33\text{--}1.93$, PT:V $1.55\text{--}1.70$. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, $0.010\text{--}0.012$ mm long, LS III $0.58\text{--}0.83 \times \text{BD III}$. ANT I with 4–5, ANT II with 4–5, ANT III with 5–7, ANT IV with 4–6, ANT V with 4–6, ANT VI with 2–3 basal setae. Rostrum reaching mesosternum. URS $0.42\text{--}0.45 \times \text{ANT III}$, $0.26\text{--}0.31 \times \text{ANT VI}$, $0.37\text{--}0.45 \times \text{PT}$, $0.90\text{--}1.10 \times \text{BASE}$ and $1.10\text{--}1.17 \times \text{HT II}$. III FEMORA bearing medium sized to long, slightly rigid setae with blunt apices, $0.017\text{--}0.027$ mm long, III FEMORA LS $0.59\text{--}0.67 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter $0.40\text{--}0.81 \times \text{trochantero-femoral suture length}$. III TIBIAE bearing long and rigid setae with blunt apices, $0.017\text{--}0.027$ mm long. HT II $0.38\text{--}0.39 \times \text{ANT III}$, $0.22\text{--}0.28 \times \text{ANT VI}$, $0.32\text{--}0.41 \times \text{PT}$ and $0.77\text{--}0.95 \times \text{BASE}$. Abdomen with solid sclerotic bar on ABD I, small spinal and spinopleural sclerites on ABD ABD II–V. ABD V without presiphuncular sclerites. ABD VI with large spinal plate. ABD VII with small spinal plate (Fig. 7a). SIPH $1.50\text{--}1.61 \times \text{cauda}$, about $0.13 \times \text{BL}$, and $0.87\text{--}0.95 \times \text{ANT III}$. Setae on ABD I–V $0.010\text{--}0.015$ mm long, $0.66\text{--}0.88 \times \text{BD III}$. Setae on ABD VI–VIII $0.015\text{--}0.020$ mm long, $0.88\text{--}1.17 \times \text{BD III}$. Genital plate anterior setae $0.020\text{--}0.040$ mm long, $1.47\text{--}2.35 \times \text{BD III}$. Cauda with 5–7 setae.

Oviparous female (n=4).

Colour in life: unknown; *pigmentation on slide*: head slightly sclerotized, yellow to light brown. Antennae yellow or pale with ANT I, ANT II, apical part of ANT V, BASE and PT light brown. Legs yellow with light brown distal parts of tibiae and tarsi. Hind tibiae uniformly light brown. Abdomen yellow with brown SIPH, cauda and anal plate (Fig. 3a). HW $0.47\text{--}0.50 \times \text{ANT}$. Head setae $0.010\text{--}0.012$ mm long, $0.58\text{--}0.62 \times \text{BD III}$. ANT about $0.48 \times \text{BL}$. ANT IV slightly shorter than ANT V. ANT VI with PT about $2.50 \times \text{BASE}$. Other antennal ratios: VI:III $2.00\text{--}2.33$, V:III $0.85\text{--}0.91$, IV:III $0.64\text{--}0.83$, PT:III $1.42\text{--}1.66$, PT:IV $2.20\text{--}2.22$, PT:V $1.66\text{--}1.81$. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, $0.007\text{--}0.010$ mm long, LS III $0.58\text{--}0.62 \times \text{BD III}$. ANT I with 5, ANT II with 3, ANT III with 5–6, ANT IV with 2, ANT V with 3–4, ANT VI with 2–3 basal setae. Rostrum reaching hind coxae. URS $0.67\text{--}0.83 \times \text{ANT III}$, $0.33\text{--}0.35 \times \text{ANT VI}$, $0.47\text{--}0.50 \times \text{PT}$, $1.18\text{--}1.25 \times \text{BASE}$ and $1.18\text{--}1.33$

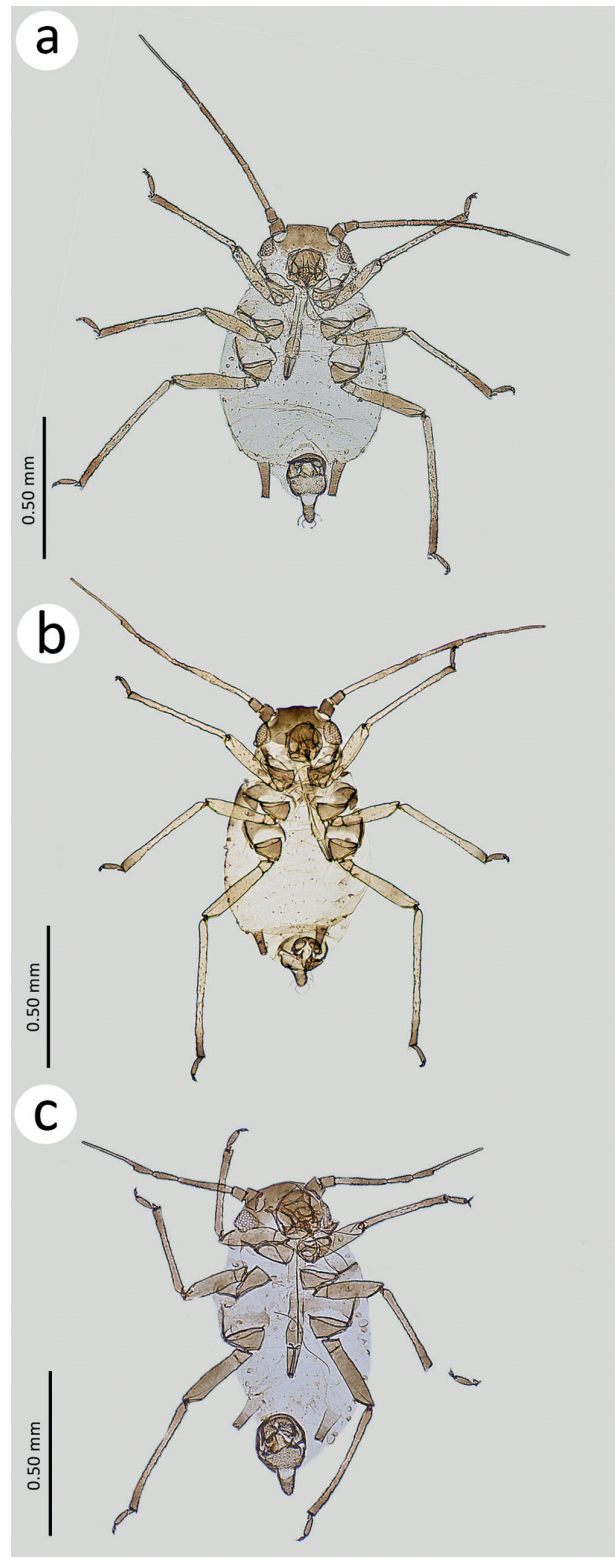


Fig. 4. Known males of *Knautia* feeding *Aphis* species. (a) *A. confusa*; (b) *A. holmani* sp. nov.; (c) *A. thomasi*.

Table 1. Morphological differences between apterous and alate viviparous females of *Aphis holmani* sp. nov. and *A. confusa*.

Character	Apterous viviparous females	
	<i>Aphis holmani</i> sp. nov.	<i>Aphis confusa</i>
Femora setae	pointed	with blunt apices
Head setae	pointed	with blunt apices
URS	0.13–0.16	0.10–0.12
III FEMUR LS	0.045–0.050	0.030–0.045
Head LS	0.030–0.035	0.015–0.025
Frontal setae	0.030–0.035	0.017–0.025
ABD VIII setae	0.025–0.030	0.017–0.025
GP anterior setae L	0.045–0.050	0.035–0.042
PT/BASE	1.75–2.20	2.45–3.00
URS/HT II	1.40–1.52	1.00–1.22
URS/ANT VI	0.40–0.43	0.27–0.34
URS/PT	0.59–0.66	0.37–0.45
HT II/ANT III	0.26–0.35	0.37–0.44
HT II/BASE	0.83–0.90	1.00–1.25
SIPH/CAUDA	1.05–1.50	1.60–1.88
SIPH/ANT III	0.59–0.91	1.09–1.30
III FEMUR LS/TFS	0.90–1.11	0.63–0.76
GP anterior seta/ BD III	2.25–2.94	1.75–2.00
ABD VIII setae/BD III	1.11–1.76	0.85–0.90
	Alate viviparous females	
	<i>Aphis holmani</i> sp. nov.	<i>Aphis confusa</i>
URS	0.125–0.135	0.100–0.110
III FEMUR LS	0.032–0.035	0.022–0.025
ABD I–V setae	0.020–0.025	0.010–0.015
ABD VI–VIII setae	0.025–0.040	0.015–0.020
HW/ANT	0.32–0.33	0.34–0.36
URS/HT II	1.50–1.56	1.10–1.17
URS/ANT III	0.51–0.59	0.42–0.45
URS/ANT VI	0.36–0.37	0.26–0.31
URS/PT	0.51–0.52	0.37–0.45
URS/BASE	1.25–1.28	0.90–1.10
SIPH/CAUDA	1.14–1.36	1.50–1.61
SIPH/BL	0.090–0.010	0.13
SIPH/ANT III	0.57–0.58	0.87–0.95
III FEMU LS/TFS	0.80–0.86	0.59–0.67
Head setae/BD III	0.11–0.14	0.08–0.09
Frontal setae/BD III	0.13–0.16	0.07–0.10
ABD I–V setae/BD III	0.13	0.006–0.008
ABD VI–VIII setae/BD III	0.16	0.08–0.11

× HT II. Mesosternal furca separated or slightly fused, wide. Posterior seta on hind trochanter 0.64–1.00 × trochantero-femoral suture length. III FEMORA with 60–89 pseudosensoria, bearing medium sized to long, slightly rigid setae with slightly blunt apices which are mostly pointed on the dorsal side, 0.010–0.075 mm long, III FEMORA LS 0.59–0.77 × trochantero-femoral suture length. III TIBIAE with 60–89 mostly circular, different in size pseudosensoria and with long and rigid setae with blunt apices, 0.010–0.030 mm long. HT II 0.57–0.62 × ANT III, 0.26–0.28 × ANT VI, 0.37–0.40 × PT and 0.93–

1.00 × BASE. Abdomen with small marginal tubercles on ABD I, V and VII. SIPH 1.23–1.28 × cauda, about 0.11 × BL, and 1.28–1.33 × ANT III. Setae on ABD I–V 0.010–0.015 mm long, about 0.62–0.88 × BD III. Setae on ABD VI–VIII 0.015–0.025 mm long, 0.93–1.00 × BD III. Genital plate anterior setae 0.026–0.035 mm long, 1.52–2.18 × BD III. Cauda with 6–7 setae.

Male (n=5).

Colour in life: unknown; pigmentation on slide: head sclerotized, light brown. Antennae light brown with

Table 2. Morphological differences between sexual morphs of *Aphis holmani* sp. nov. and *A. confusa*.

Character	Oviparous females	
	<i>Aphis holmani</i> sp.nov.	<i>Aphis confusa</i>
Tibiae setae	pointed	with blunt apices
Pseudosensoria	25–42	60–89
ABD VIII setae	8–10	3–5
ANT	0.77–0.85	0.70–0.73
III FEMUR LS	0.04–0.05	0.025–0.035
TIBIAE LS	0.035–0.045	0.01–0.03
Head setae	0.017–0.040	0.010–0.012
Frontal setae	0.030–0.040	0.015–0.025
ABD I–V setae	0.032–0.075	0.010–0.015
ABD VIII setae	0.025–0.030	0.015–0.025
ANT/BL	0.51–0.56	0.48
HW/ANT	0.44–0.46	0.47–0.50
PT/BASE	2.68–3.06	2.50
URS/BASE	1.37–1.43	1.18–1.25
SIPH/CAUDA	1.07–1.12	1.23–1.28
SIPH/BL	0.08–0.09	0.11
SIPH/ANT III	0.87–0.96	1.28–1.33
III FEMUR LS/TFS	0.84–1.00	0.57–0.77
GP anterior seta/ BD III	2.50–3.23	1.52–2.18
Head setae/BD III	0.85–1.47	0.58–0.62
ABD I–V setae/BD III	1.10–1.29	0.62–0.88
ABD VI–VIII setae/BD III	1.88–2.00	0.93–1.00
	Males	
	<i>Aphis holmani</i> sp. nov.	<i>Aphis confusa</i>
ANT IV rhinaria	12–18	2–12
ANT V rhinaria	11–13	4–10
TFS	0.032–0.037	0.040–0.045
ABD I–V setae	0.022–0.027	0.010–0.013
ABD VI–VIII setae	0.030–0.052	0.015–0.030
ANT/BL	0.87–1.06	0.76–0.80
HW/ANT	0.31–0.36	0.39–0.40
PT/BASE	2.94–3.28	2.64–2.73
ANT V/ANT III	0.82–0.83	0.76–0.80
ANT IV/ANT III	0.82–0.88	0.61–0.71
ANT IV/ANT V	1.00–1.06	0.80–0.89
URS/HT II	1.33–1.35	1.21–1.30
URS/ANT III	0.55	0.48–0.50
HT II/BASE	0.88–1.00	0.82–0.86
SIPH/CAUDA	0.88–0.90	1.00–1.20
SIPH/ANT III	0.47–0.50	0.57–0.64
III FEMUR LS/TFS	1.06–1.08	0.78–0.80
Head setae/BD III	1.11–1.33	0.50–0.76
Frontal setae/BD III	1.33	0.60–0.96
ABD I–V setae/BD III	1.46–1.80	0.50–0.076
ABD VI–VIII setae/BD III	2.00–2.46	0.75–1.15

slightly paler basal part of ANT III. Legs with yellow or light brown femora and pale to yellow tibiae with brown distal parts and tarsi. Abdomen pale with light brown SIPH, cauda and genitalia (Fig. 4a). HW 0.39–0.40 ×

ANT. Head setae 0.010–0.017 mm long, 0.50–0.76 × BD III. ANT 0.76–0.80 × BL. ANT III with 0 (on one segment)–14, ANT IV shorter, than ANT V with 2–12, ANT V with 1–11 secondary rhinaria. ANT VI with PT

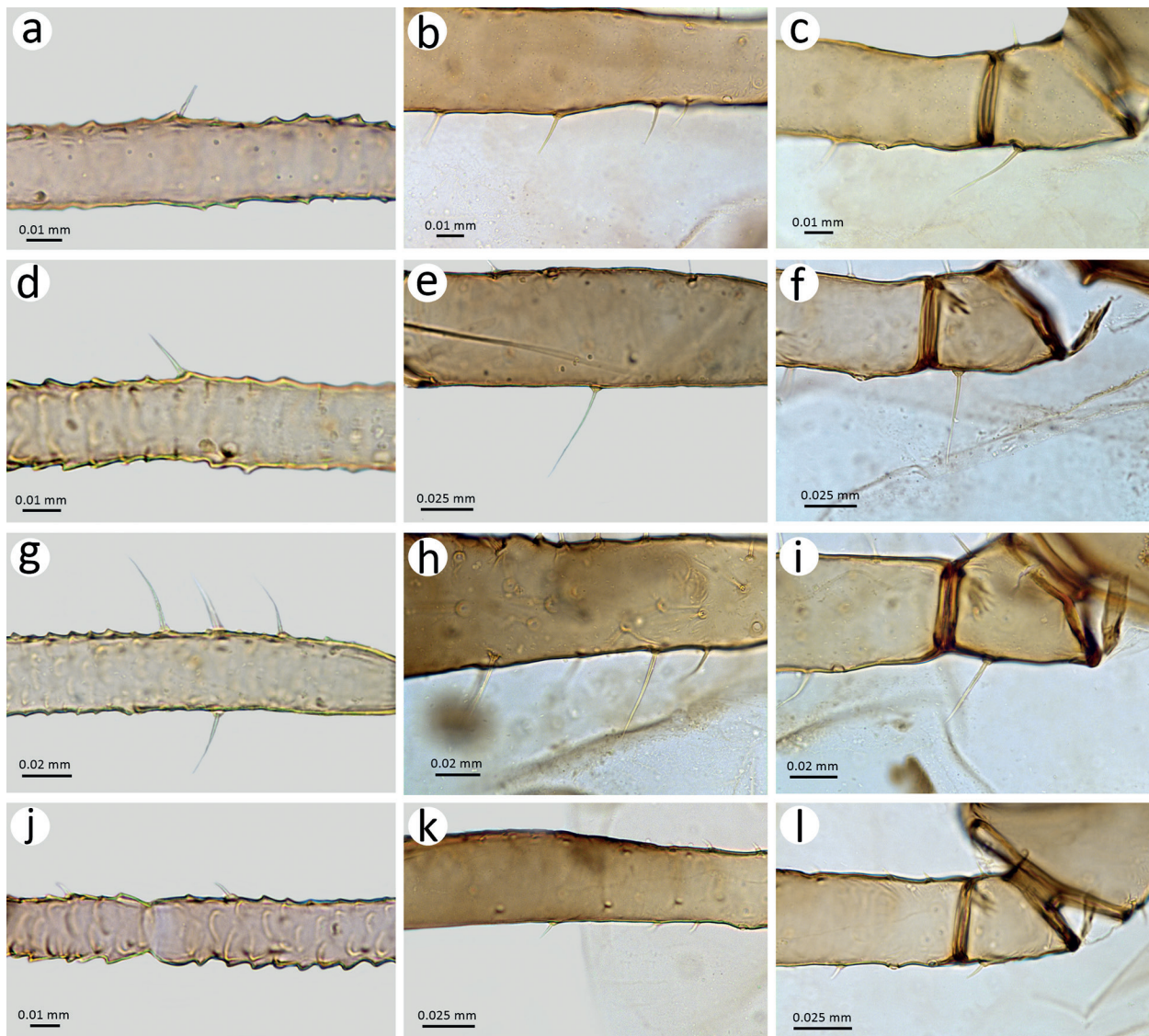


Fig. 5. Key morphological differences between apterous viviparous females of *Knautia* feeding *Aphis* species. *A. confusa*. (a) ANT III seta with blunt apex; (b) hind femora inner setae with blunt apices; (c) long hind trochanter seta; *A. holmani* sp. nov.: (d) ANT III seta with pointed apex; (e) hind femora inner setae with pointed apices; (f) very long hind trochanter seta; *A. longini*: (g) ANT III long and pointed setae; (h) hind femora inner setae with pointed apices; (i) long hind trochanter seta; *A. thomasi*: (j) ANT III and IV very short setae with blunt apices; (k) very short hind trochanter inner setae with blunt apices; (l) very short hind trochanter seta.

2.64–2.73 × BASE. Other antennal ratios: VI:III 1.64–1.77, V:III 0.76–0.80, IV:III 0.61–0.71, PT:III 1.20–1.28, PT:IV 1.80–1.95, PT:V 1.57–1.60. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, about 0.010 mm long, LS III 0.50–0.76 × BD III. ANT I with 4–5, ANT II with 3, ANT III with 4–5, ANT IV with 3, ANT V with 1–3, ANT VI with 1–2 basal setae. Rostrum reaching from hind coxae to ABD I. URS 0.48–0.50 × ANT III, 0.27–0.30 × ANT VI, 0.37–0.41 × PT, 1.00–1.33 × BASE and 1.21–1.30 × HT II. Mesosternal furca separated. Posterior seta on hind trochanter 1.00–1.40 × trochantero-femoral suture

length. III FEMORA bearing short to medium sized and rigid setae with mostly blunt apices which are pointed on the dorsal side, 0.015–0.032 mm long, III FEMORA LS 0.78–0.80 × trochantero-femoral suture length. III TIBIAE bearing short to medium sized and rigid setae with blunt apices, 0.010–0.025 mm long. HT II 0.38–0.40 × ANT III, 0.22–0.23 × ANT VI, aout 0.31 × PT and 0.82–0.86 × BASE. Abdomen with small marginal tubercles on ABD IV. SIPH 1.00–1.22 × cauda, 0.09–0.11 × BL, and 0.57–0.64 × ANT III. Setae on ABD I–V 0.010–0.013 mm long, 0.50–0.76 × BD III. Setae on ABD VI–

VIII 0.015–0.030 mm long, $0.75\text{--}1.15 \times \text{BD III}$. Cauda with 4–6 setae.

Material examined. CZECH REPUBLIC: Český Krumlov-Vyšné, 27 May 1987, on *Knautia arvensis*, J. Holman leg., 2 al, 19705, IECA; Karlštejn, 10 October 1971, on *K. arvensis*, J. Holman leg., 4 ♀, 5 ♂, 13289, IECA; FRANCE: Nevache (1600m), dépt. Hautes-Alpes, 25 June 1969, on *K. arvensis*, F. Leclant leg., 2 apt, L3120, IECA; HUNGARY: Nagykovácsi: Nagyszénás, 17 June 1964, on *Scabiosa* sp., H. Szelegiewicz leg., 6 apt, 2225, R344, ZMPA; on *S. ochroleuca*, H. Szelegiewicz leg., 6 apt, 2782, R434, ZMPA; POLAND: Ługwald near Olsztyn, 27 June 1964, on *K. arvensis*, S. Huculak leg., 3 apt (per one on each slide), 189, R341, ZMPA; Kaletnik near Suwałki, 09 July 1955, on *K. arvensis*, H. Szelegiewicz leg., 4 apt, 32 R348, 1 al, 32 R439, ZMPA; SLOVAKIA: Vrbovce, 20 May 1967, on *K. arvensis*, J. Holman leg., 4 apt, 10879 (apt. 33–36), IECA; SWEDEN: Växjö, S. Åreda, 06 June 1981, R. Danielsson leg., 2 apt, 1 al, 5132: 24, IECA.

Host plants. *Dipsacus* sp. *D. fullonum*, *Knautia arvensis*, *K. integrifolia*, *K. dinarica*, *K. dipsacifolia*, *K. longifolia*, *Scabiosa* sp., *S. argentea*, *S. atropurpurea*, *S. canescens*, *S. columbaria*, *S. comosa*, *S. ochroleuca*, *S. sosnowskyi*, *S. pratensis* (Holman 2009)

Biology. This is a monoecious and holocyclic species with sexuales in September and October. The aphids occur on upper parts of stems and inflorescences or on undersides of leaves and at base of stems or on roots (Heie 1986).

Distribution. *Aphis confusa* is a common and widely distributed species in Europe (except Balkans).

Aphis (Aphis) holmani sp. nov.

Aphis knautiae Holman in Holman & Pintera, 1981: 50 (nomen nudum)
Figs 1–7, Supplementary tables 1–4; Tables 1–2

Description

Apterous viviparous female (n=63).

Colour in life: unknown; pigmentation on slide: head slightly sclerotized, light brown. Antennae yellow or light yellow with ANT I and ANT II and light brown, apical part of ANT V and BASE and PT pale brown. Legs yellow with light brown distal parts of tibiae and tarsi. Abdomen yellow with light brown to brown SIPH, cauda and anal plate (Fig. 1b). HW $0.36\text{--}0.45 \times \text{ANT}$. Head setae $0.015\text{--}0.035$ mm long, $0.83\text{--}1.25 \times \text{BD III}$. ANT $0.46\text{--}0.52 \times \text{BL}$ in 5-segmented specimens and $0.60\text{--}0.62 \times \text{BL}$ in 6-segmented specimens. In 6-segmented speci-

mens ANT IV slightly shorter or as long as ANT V. ANT VI with PT $1.75\text{--}2.20 \times \text{BASE}$. Other antennal ratios: VI:III $0.86\text{--}1.33$, V:III $0.45\text{--}0.62$, IV:III $0.54\text{--}0.57$ (in 6-segmented specimens), PT:III $0.55\text{--}0.91$, PT:IV $1.26\text{--}1.69$, PT:V $1.16\text{--}1.57$. ANT bearing very short and pointed setae (Fig. 5d). ANT III setae shorter than the width of the segment, $0.010\text{--}0.125$ mm long, LS III $0.50\text{--}1.00 \times \text{BD III}$. ANT I with 4–6, ANT II with 3–5, ANT III with 5–11, ANT IV with 3–5, ANT V with 2–4, ANT VI with 1–2 basal and 4 apical setae. Rostrum reaching from hind coxae to ABD I. URS $0.36\text{--}0.54 \times \text{ANT III}$, $0.40\text{--}0.43 \times \text{ANT VI}$, $0.59\text{--}0.66 \times \text{PT}$, $1.16\text{--}1.30 \times \text{BASE}$ and $1.40\text{--}1.52 \times \text{HT II}$ with 2–4 accessory setae. Mesosternal furca separated or slightly fused, wide. III FEMORA bearing long, fine, hair-like setae with pointed apices (Fig. 5e), $0.015\text{--}0.050$ mm long, III FEMORA LS $0.045\text{--}0.050$ mm long, $0.90\text{--}1.11 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter, $1.00\text{--}1.22 \times \text{trochantero-femoral suture length}$ (Fig. 5f). III TIBIAE bearing long setae with pointed apices, $0.010\text{--}0.040$ mm long. HT I with 3–3–2 ventral setae, HT II $0.26\text{--}0.35 \times \text{ANT III}$, $0.26\text{--}0.30 \times \text{ANT VI}$, $0.38\text{--}0.47 \times \text{PT}$ and $0.83\text{--}0.90 \times \text{BASE}$. Abdomen membranous, with well-developed marginal tubercles on ABD I and ABD VII and sometimes small marginal tubercles on ABD IV. SIPH tubular, very slightly tapering towards apex, $1.05\text{--}1.50 \times \text{cauda}$, $0.09\text{--}0.14 \times \text{BL}$, and $0.59\text{--}0.91 \times \text{ANT III}$. Dorsal setae very short and pointed, $0.015\text{--}0.030$ mm long, $0.83\text{--}1.25 \times \text{BD III}$ on ABD I–V and $0.020\text{--}0.055$ mm long, $1.11\text{--}1.76 \times \text{BD III}$ on ABD VI–VIII. Anterior setae on genital plate $0.045\text{--}0.050$ mm long, $2.25\text{--}2.94 \times \text{BD III}$. Cauda with 6–9 setae (Fig. 6c, d).

Alate viviparous female (n=5).

Colour in life: unknown; pigmentation on slide: head and thorax sclerotized, brown. ANT light brown with brown ANT I and ANT II and slightly paler basal half of ANT III–V. Fore and middle legs light brown with slightly darker distal parts of tibiae. Hind legs with brown femora with paler proximal parts and light brown tibiae with darker distal part of tibiae and tarsi. Wings with light brown pterostigma and veins. Abdomen pale with light brown sclerotization, brown SIPH and cauda (Fig. 2b). HW about $0.32 \times \text{ANT}$. Head setae $0.017\text{--}0.027$ mm long, $0.11\text{--}0.14 \times \text{BD III}$. ANT $0.65\text{--}0.76 \times \text{BL}$. ANT III with 4–6 secondary rhinaria. ANT IV as long as or slightly shorter, as long as than ANT V with 0–1 secondary rhinaria. ANT VI with PT $2.40\text{--}2.47 \times \text{BASE}$. Other antennal ratios: VI:III $1.40\text{--}1.61$, V:III $0.57\text{--}0.66$, IV:III $0.51\text{--}0.61$, PT:III $1.00\text{--}1.14$, PT:IV $1.73\text{--}1.84$, PT:V $1.71\text{--}1.73$. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, $0.012\text{--}0.015$ mm long, LS III $0.80\text{--}1.00 \times \text{BD III}$. ANT I with 4–5, ANT II with 3–5, ANT III with 6–10, ANT IV with 3–6, ANT V with 4–6, ANT VI with 2 basal setae. Rostrum reaching from hind coxae to ABD I. URS 0.51--

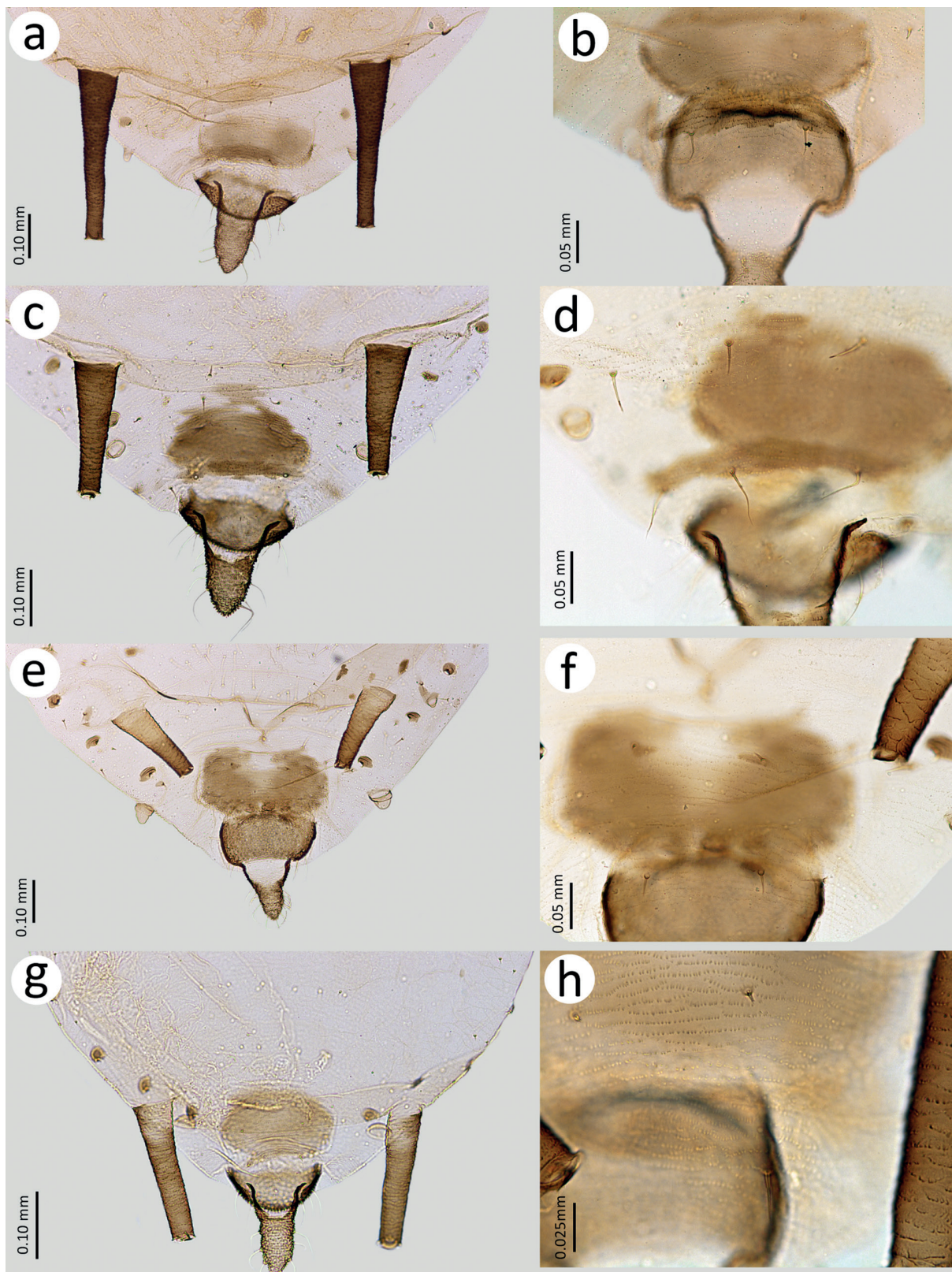


Fig. 6. End of abdomen (left column) and ABD VIII setae (right column) of *Knautia* feeding *Aphis* species. (a–b) *A. confusa*, (c–d) *A. holmani* sp. nov.; (e–f) *A. longini*; (g–h) *A. thomasi*.

0.59 × ANT III, about 0.36 × ANT VI, 0.51–0.52 × PT, 1.25–1.28 × BASE and 1.50–1.56 × HT II. III FEMORA bearing long, fine and pointed setae, 0.012–0.032 mm long, III FEMORA LS 0.80–0.86 × trochantero-femoral suture length. Posterior seta on hind trochanter 0.80–1.00 × trochantero-femoral suture length. III TIBIAE bearing long, fine and pointed setae, 0.012–0.032 mm long. HT II 0.34–0.38 × ANT III, 0.23–0.26 × ANT VI, 0.33–0.34 × PT and 0.80–1.00 × BASE. Abdomen with sclerite on ABD I, small spinal sclerites on ABD II–IV. ABD V with solid or broken presiphuncular sclerites. ABD VI with large spinal plate. ABD VII with wide spino-pleural plate. ABD IV and VI with small MTu (Fig. 7b). SIPH 1.14–1.636 × cauda, 0.09–0.10 × BL, and about 0.57 × ANT III. Setae on ABD I–V 0.020–0.025 mm long, about 1.33 × BD III. Setae on ABD VI–VIII 0.025–0.040 mm long, about 1.66 × BD III. Genital plate anterior setae 0.030–0.040 mm long, 2.00–2.66 × BD III. Cauda with 8 setae.

Oviparous female (n=47).

Colour in life: unknown; pigmentation on slide: head sclerotized, brown. Antennae pale with ANT I, ANT II, apical part of ANT V and ANT VI brown. Legs yellow with slightly darker very apical parts and tarsi. Abdomen yellow with brown SIPH, cauda and anal plate (Fig. 3b). HW 0.44–0.46 × ANT. Head setae 0.017–0.040 mm long, 0.85–1.47 × BD III. ANT 0.51–0.56 × BL. ANT IV shorter than ANT V. ANT VI with PT 2.68–3.06 × BASE. Other antennal ratios: VI:III 2.00–2.18, V:III 0.87–0.92, IV:III 0.70–0.85, PT:III 1.48–1.51, PT:IV 1.86–2.09, PT:V 1.64–1.75. ANT bearing very short and pointed setae. ANT III setae shorter than the width of the segment, 0.011–0.015 mm long, LS III 0.60–0.88 × BD III. ANT I with 4–5, ANT II with 4, ANT III with 3–4, ANT IV with 2–3, ANT V with 2–3, ANT VI with 2–3 basal setae. Rostrum reaching hind coxae. URS 0.70–0.81 × ANT III, 0.35–0.37 × ANT VI, 0.35–0.37 × PT, 1.37–1.43 × BASE and 1.22–1.43 × HT II. Mesosternal furca fused and wide. III FEMORA with 25–42 pseudosensoria, bearing long, fine and pointed setae, 0.015–0.050 mm long, III FEMORA LS 0.84–1.00 × trochantero-femoral suture length. Posterior seta on hind trochanter 0.74–1.11 × trochantero-femoral suture length. III TIBIAE bearing long, fine and pointed setae, 0.017–0.045 mm long. HT II 0.50–0.62 × ANT III, 0.24–0.29 × ANT VI, 0.32–0.39 × PT and 1.00–1.12 × BASE. SIPH 1.07–1.12 × cauda, 0.08–0.09 × BL, and 0.87–0.96 × ANT III. Setae on ABD I–V 0.022–0.027 mm long, 1.10–1.29 × BD III. Setae on ABD VI–VIII 0.032–0.075 mm long, 1.88–2.00 × BD III. Genital plate anterior setae 0.050–0.055 mm long, 2.50–3.23 × BD III. Cauda with 6–10 setae.

Male (n=16).

Colour in life: unknown; pigmentation on slide: head slightly sclerotized, brown. Antennae light brown to

brown with yellow ANT III, basal part of ANT IV and ANT V. Legs yellow with light brown very distal parts of tibiae and tarsi. Abdomen pale with light brown to brown SIPH, cauda and anal plate (Fig. 4b). HW 0.31–0.36 × ANT. Head setae 0.017–0.025 mm long, 1.11–1.33 × BD III. ANT 0.87–1.06 × BL. ANT III with 10–16 secondary rhinaria. ANT IV as long as or slightly longer than ANT V with 12–18 secondary rhinaria. ANT V with 11–13 secondary rhinaria. ANT VI with PT 2.94–3.28 × BASE. Other antennal ratios: VI:III 1.76–1.86, V:III 0.82–0.83, IV:III 0.82–0.88, PT:III 1.35–1.38, PT:IV 1.56–1.64, PT:V 1.64–1.66. ANT bearing very short and pointed setae. ANT III setae shorter than the width of the segment, 0.011–0.012 mm long, LS III about 0.83 × BD III. ANT I with 4–5, ANT II with 4, ANT III with 4–5, ANT IV with 3, ANT V with 2–3, ANT VI with 2 basal setae. Rostrum reaching from hind coxae to ABD I. URS about 0.55 × ANT III, 0.29–0.31 × ANT VI, 0.40–0.41 × PT, 1.17–1.35 × BASE and 1.33–1.35 × HT II. III FEMORA bearing long, fine and pointed setae, 0.017–0.040 mm long, III FEMORA LS 1.06–1.08 × trochantero-femoral suture length. Posterior seta on hind trochanter 1.00–1.06 × trochantero-femoral suture length. III TIBIAE bearing long, fine and pointed setae, 0.012–0.032 mm long. HT II about 0.41 × ANT III, 0.22–0.23 × ANT VI, about 0.30 × PT and 0.88–1.00 × BASE. Abdomen with small marginal tubercles on ABD VI. SIPH 0.88–0.90 × cauda, 0.08–0.10 × BL, and 0.47–0.50 × ANT III. Setae on ABD I–V 0.022–0.027 mm long, 1.46–1.80 × BD III. Setae on ABD VI–VIII 0.030–0.052 mm long, 2.00–2.46 × BD III. Cauda with 5–6 setae.

Diagnosis

From so far known *Aphis* species feeding on *Knautia*, apterous viviparous females of *A. holmani* sp. nov. are most similar to *A. confusa* by hind femora and hind trochanter setae lengths (which are longer than 0.50 × trochantero-femoral suture length) and genital plate anterior setae lengths (which are longer than 1.00 × BD III). Both species differ from *A. thomasi* in those characters (0.20–0.50 × trochantero-femoral suture setae length and 0.20–0.50 × BD III respectively). The new species differ from *A. confusa* by:

- Pointed setae on femora, head and antennae (setae with blunt apices in *A. confusa*)
- longer anterior setae on the genital plate, 2.25–2.94 × BD III (1.00–2.00 in *A. confusa*)
- higher ratio of URS/HT II, 1.40–1.52 (1.00–1.22 in *A. confusa*)
- lower ratio of PT/BASE, 1.75–2.20 (2.45–3.00 in *A. confusa*)
- lower ratio of SIPH/cauda, 1.05–1.50 (1.60–1.88 in *A. confusa*)



Fig. 7. Key morphological differences between known alate viviparous females of *Knautia* feeding *Aphis* species. **(a)** abdomen of *A. confusa* without presiphuncular sclerites; **(b)** abdomen of *A. holmani* sp. nov. with presiphuncular sclerites; **(c)** abdomen of *A. thomasi* without presiphuncular and spino-pleural sclerites.

Detailed morphological differences between particular morphs of both species are given in Tables 1 and 2.

Etymology. The authors have the pleasure to give the name to honour the late Jaroslav Holman (1931–2014) – an outstanding European aphidologist and a long-time employee of the Biology Centre CAS in České Budějovice, Czech Republic.

Biology and distribution. The new aphid species is associated with *Knautia drymeia* Heuff., from which it was collected in Central (the Czech Republic) and South-Eastern Europe (Bulgaria and Romania). It is a holocyclic aphid with the sexual phase in September.

Material examined. HOLOTYPE: CZECH REPUBLIC, Jihomoravský kraj, Pustý žleb, Moravský kras, 20 June 1967, on *Knautia drymeia*, J. Holman leg., 1 apt, 10838 B (apt. 8), IECA. PARATYPES: CZECH REPUBLIC, the same data as in the holotype, 11 slides (1 apt on each slide), 10838 B (apt. 1–7, 9–12); Macocha, 19 May 1967, on *K. drymeia*, J. Holman leg., 1 apt, 10877 (apt. 1), 16 apt (two on each slide), 10877 (apt. 2–17), IECA, slide no apt.2 DZUS; Pustý žleb, 22 September 1970, on *K. drymeia*, J. Holman leg., 40 ♀ (four on each slide), 12885 (♀ 21–48, ♀ 61–68) 6 ♀, 10877 (73–78); 12 ♂ (four on each slide), 12885 (♂ 1–12), 1 ♀, 4 ♂ (♂ 13–16, ♀ 49), IECA; BULGARIA, Mt. Vitoša nr. Simenovo, 22 May 1990, on *K. drymeia*, J. Holman leg., 2 apt, 21725 A (apt. 1–2), 4 apt, 21725 (apt. 3–6), 16 apt (four on each slide), 21722 B (apt. 1–16), 2 al, 21722 B (al. 1–2), 3 al, 21722 B (al. 3–5), IECA; ROMANIA, Băile Herculane jud. Caraș-Sev, 20 July 1976, on *K. drymeia*, J. Holman leg., 12 apt (six per each slide), 16309 (apt. 1–12), IECA.

Aphis (Aphis) longini Huculak, 1968

Huculak, 1968: 333

Figs 1, 5, 6; Supplementary table 1

Apterous viviparous female (n=5).

Colour in life: matt dirty green to olive brown (Huculak, 1968); pigmentation on slide; head sclerotized, brown. Antennae brown with yellow ANT III and basal part of ANT IV. Femora of legs brown with lighter basal parts, tibiae light brown to yellow with brown to dark brown distal and apical parts and tarsi. Abdomen yellow to light brown SIPH brown with lighter basal part, cauda and anal plate brown to dark brown (Fig. 1c). HW $0.34\text{--}0.35 \times \text{ANT}$. Head setae $0.015\text{--}0.045$ mm long, $0.60\text{--}1.00 \times \text{BD III}$. ANT $0.65\text{--}0.67 \times \text{BL}$. ANT IV as long as or longer than ANT V. ANT VI with PT $3.58\text{--}4.27 \times \text{BASE}$. Other antennal ratios: VI:III $2.07\text{--}2.11$, V:III $0.61\text{--}0.67$, IV:III $0.67\text{--}0.80$, PT:III $1.65\text{--}1.67$, PT:IV $2.04\text{--}2.47$, PT:V $2.47\text{--}2.68$. ANT bearing long, fine and pointed. ANT III setae as long as and longer than the width of the segment (Fig. 5g), $0.030\text{--}0.040$ mm long, LS III $1.20\text{--}2.00 \times \text{BD III}$. ANT I with 4–5, ANT II with 5, ANT III with 1417, ANT IV with 11–12, ANT V with 7, ANT VI with 2 basal setae. Rostrum reaching from hind coxae to ABD I. URS $0.57\text{--}0.59 \times \text{ANT III}$, $0.27\text{--}0.28 \times \text{ANT VI}$, $0.34\text{--}0.36 \times \text{PT}$, $1.29\text{--}1.45 \times \text{BASE}$ and $1.14\text{--}1.19 \times \text{HT II}$. Mesosternal furca robust, fused and wide. III FEMORA bearing long, fine and pointed setae (Fig. 5h), $0.025\text{--}0.055$ mm long, III FEMORA LS $1.00\text{--}1.10 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter about $0.90 \times \text{trochantero-femoral suture length}$ (Fig. 5i). III TIBIAE bearing long, fine and pointed setae, $0.050\text{--}0.055$ mm long. HT II about $0.50 \times \text{ANT III}$, $0.23\text{--}0.24 \times \text{ANT VI}$, $0.29\text{--}0.30 \times \text{PT}$ and $1.08\text{--}1.27 \times \text{BASE}$. Abdomen with small marginal tubercles on ABD IV. SIPH about $1.33 \times \text{cauda}$, $0.09\text{--}0.10 \times \text{BL}$, and $0.76\text{--}0.78 \times \text{ANT III}$. Setae on ABD I–V 0.010--

0.015 mm long, $0.40\text{--}0.62 \times \text{BD III}$. Setae on ABD VI–VIII $0.015\text{--}0.032$ mm long, $0.70\text{--}0.75 \times \text{BD III}$. Genital plate anterior setae $0.060\text{--}0.070$ mm long, about $3.50 \times \text{BD III}$. Cauda with 16–17 setae (Fig. 6e, f).

Remarks: Despite Huculak (1968) gave short descriptions of oviparous females and males in the original description, no material has been found in the ZMPA collection. The alate viviparous females are unknown. Measurements of the specimens examined in this study vary from those given by Huculak in the original description (1968) and in Blackman & Eastop (2019). The differences are maybe due to the fact that Huculak measured more specimens which were not available for us.

Material examined. Holotype: POLAND: Trzebinia, 26 August 1967, on *Knautia arvensis*, L. Olesiński leg., 1 apt, APH-1469, ZMPA; Paratype: the same data as holotype, 1 apt, APH-1479, ZMPA, 1 apt, APH-1477; other material: Trzebinia, 01 October 1967, on *K. arvensis*, L. Olesiński leg., 1 apt. 2651, R621, ZMPA;

Host plants. The species is known only from *K. arvensis* (Holman 2009).

Biology. It is a monoecious and holocyclic species with sexual generation in October. The aphids form large, ant-attended colonies on the bases of stems on the plant (Huculak 1968).

Distribution. Poland, Russia (Holman, 2009). Olesiński & Szelegiewicz (1974) provided that this species was also found in “Czechoslovakia” but without existing material it was impossible to determine if it was the Czech Republic or Slovakia.

Aphis (Aphis) thomasi (Börner, 1950)

Doralina thomasi Börner, 1950: 7
Figs 1–7; Supplementary tables 1–4

Apterous viviparous female (n=12).

Colour in life: straw yellow (Blackman & Eastop, 2019); **pigmentation on slide:** head sclerotized, light brown. Antennae light brown with pale basal half of ANT III and base of ANT IV. Tibiae of legs light brown with slightly paler basal distal parts, tibiae light brown to pale with light brown apical parts, tarsi light brown. Abdomen yellow with light brown SIPH, cauda and anal plate (Fig. 1d). HW $0.47\text{--}0.58 \times \text{ANT}$. Head setae $0.005\text{--}0.010$ mm long, $0.25\text{--}0.29 \times \text{BD III}$. ANT $0.49\text{--}0.54 \times \text{BL}$. ANT IV as long as or shorter than ANT V. ANT VI with PT $2.00\text{--}3.20 \times \text{BASE}$. Other antennal ratios: VI:III $1.42\text{--}2.10$, V:III $0.50\text{--}0.69$, IV:III $0.46\text{--}0.60$, PT:III $1.00\text{--}1.60$, PT:IV $1.90\text{--}2.66$, PT:V $1.66\text{--}2.26$. ANT bearing very short and blunt setae (Fig. 5j). ANT III setae shorter than the width of the segment, 0.003--

0.007 mm long, LS III $0.25\text{--}0.65 \times \text{BD III}$. ANT I with 3–6, ANT II with 3–5, ANT III with 4–6, ANT IV with 2–3, ANT V with 1–4, ANT VI with 1–2 basal setae. Rostrum reaching to ABD I. URS $0.65\text{--}0.80 \times \text{ANT III}$, $0.38\text{--}0.46 \times \text{ANT VI}$, $0.50\text{--}0.70 \times \text{PT}$, $1.40\text{--}1.60 \times \text{BASE}$ and $1.31\text{--}1.66 \times \text{HT II}$. Mesosternal furca slightly fused, wide. III FEMORA bearing very short, rigid and blunt setae (Fig. 5k), $0.005\text{--}0.007$ mm long, III FEMORA LS $0.12\text{--}0.25 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter $0.18\text{--}0.25 \times \text{trochantero-femoral suture length}$ (Fig. 5l). III TIBIAE bearing short rigid and blunt setae, $0.005\text{--}0.025$ mm long. HT II $0.43\text{--}0.60 \times \text{ANT III}$, $0.25\text{--}0.35 \times \text{ANT VI}$, $0.37\text{--}0.50 \times \text{PT}$ and $0.92\text{--}1.20 \times \text{BASE}$. SIPH $1.09\text{--}1.60 \times \text{cauda}$, $0.11\text{--}0.16 \times \text{BL}$, and $0.80\text{--}1.53 \times \text{ANT III}$. Setae on ABD I–V $0.006\text{--}0.010$ mm long, $0.30\text{--}0.44 \times \text{BD III}$. Setae on ABD VI–VIII $0.007\text{--}0.025$ mm long, $0.37\text{--}0.73 \times \text{BD III}$. Genital plate anterior setae $0.010\text{--}0.035$ mm long, $0.50\text{--}1.47 \times \text{BD III}$. Cauda with 6–8 setae.

Alate viviparous female (n=2).

Colour in life: unknown; **pigmentation on slide:** head sclerotized, brown. Antennae yellow or light brown with paler basal parts of ANT III–VI BASE. Femora of legs uniformly light brown with pale distal parts. Tibiae pale with light brown distal parts of tibiae and light brown tarsi. Abdomen pale with light brown SIPH, cauda and anal plate (Fig. 2c). HW $0.35\text{--}0.36 \times \text{ANT}$. Head setae $0.008\text{--}0.010$ mm long, about $0.66 \times \text{BD III}$. ANT $0.62\text{--}0.65 \times \text{BL}$. ANT III with 8–10 secondary rhinaria. ANT IV as long as or shorter than ANT V, with 2–4 secondary rhinaria. ANT V sometimes with one secondary rhinarium. ANT VI with PT $2.30\text{--}2.53 \times \text{BASE}$. Other antennal ratios: VI:III $1.43\text{--}1.52$, V:III $0.59\text{--}0.65$, IV:III $0.56\text{--}0.59$, PT:III $1.00\text{--}1.09$, PT:IV $1.76\text{--}1.84$, PT:V $1.53\text{--}1.84$. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, $0.005\text{--}0.010$ mm long, LS III $0.60\text{--}0.66 \times \text{BD III}$. ANT I with 4–5, ANT II with 4, ANT III with 5–6, ANT IV with 3–4, ANT V with 3–4, ANT VI with 1–3 basal setae. Rostrum reaching hind coxae. URS $0.45\text{--}0.50 \times \text{ANT III}$, $0.31\text{--}0.32 \times \text{ANT VI}$, about $0.45 \times \text{PT}$, $1.05\text{--}1.15 \times \text{BASE}$ and $1.22\text{--}1.23 \times \text{HT II}$. III FEMORA bearing short, rigid and blunt setae, $0.007\text{--}0.012$ mm long, III FEMORA LS $0.31\text{--}0.35 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter $0.31\text{--}0.39 \times \text{trochantero-femoral suture length}$. III TIBIAE bearing short rigid and blunt setae, $0.010\text{--}0.022$ mm long. HT II $0.36\text{--}0.40 \times \text{ANT III}$, $0.25\text{--}0.26 \times \text{ANT VI}$, $0.36\text{--}0.37 \times \text{PT}$ and $0.85\text{--}0.94 \times \text{BASE}$. Abdomen with sclerite on ABD I, large marginal plates on ABD II–IV and small ones on ABD V, which is without presiphuncular sclerites. ABD VI with large postsiphuncular sclerites and very small spinal sclerite. ABD VII with wide spino-pleural plate. ABD I and VII with visible marginal tubercles (Fig. 7c). SIPH $1.09\text{--}1.61 \times \text{cauda}$, $0.08\text{--}0.11 \times \text{BL}$, and $0.54\text{--}0.73 \times \text{ANT III}$. Setae

on ABD I–V 0.007–0.012 mm long, $0.50\text{--}0.66 \times \text{BD III}$. Setae on ABD VI–VIII 0.010–0.017 mm long, about $0.66 \times \text{BD III}$. Genital plate anterior setae 0.012–0.015 mm long, $0.83\text{--}1.00 \times \text{BD III}$. Cauda with 5–8 setae (Fig. 7c).

Oviparous female. Description (n=9).

Colour in life: unknown; pigmentation on slide: head sclerotized, light brown. Antennae yellow or light yellow with ANT I, ANT II, ANT V and ANT VI light brown. Femora yellow or light brown with paler proximal parts. Fore and middle tibiae yellow or light brown with darker distal parts and tarsi. Hind tibiae light uniformly light brown or with slightly darker apical half. Abdomen yellow with light brown SIPH, cauda and anal plate (Fig. 3c). HW $0.51\text{--}0.56 \times \text{ANT}$. Head setae 0.005–0.011 mm long, $0.28\text{--}0.37 \times \text{BD III}$. ANT $0.44\text{--}0.48 \times \text{BL}$. ANT IV as long as or slightly shorter than ANT V. ANT VI with PT $2.13\text{--}2.56 \times \text{BASE}$. Other antennal ratios: VI:III 2.35–2.59, V:III 0.75–0.81, IV:III 0.60–0.81, PT:III 1.60–1.86, PT:IV 2.27–2.66, PT:V 2.00–2.27. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, 0.005–0.075 mm long, LS III $0.28\text{--}0.58 \times \text{BD III}$. ANT I with 4–6, ANT II with 3–5, ANT III with 3–5, ANT IV with 3, ANT V with 3–4, ANT VI with 2–3 basal setae. Rostrum reaching hind coxae. URS $0.91\text{--}1.10 \times \text{ANT III}$, $0.36\text{--}0.46 \times \text{ANT VI}$, $0.51\text{--}0.68 \times \text{PT}$, $1.29\text{--}1.46 \times \text{BASE}$ and $1.31\text{--}1.46 \times \text{HT II}$. Mesosternal poorly visible almost separated. III FEMORA bearing very short, rigid and blunt setae, 0.005–0.010 mm long, III FEMORA LS $0.15\text{--}0.23 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter about $0.17 \times \text{trochantero-femoral suture length}$. III TIBIAE with 27–53 pseudosensoria, bearing short to medium in length, rigid and blunt setae, 0.007–0.022 mm long. HT II $0.66\text{--}0.75 \times \text{ANT III}$, $0.28\text{--}0.31 \times \text{ANT VI}$, $0.39\text{--}0.46 \times \text{PT}$ and $0.94\text{--}1.00 \times \text{BASE}$. SIPH $1.13\text{--}1.33 \times \text{cauda}$, $0.10\text{--}0.11 \times \text{BL}$, and $1.25\text{--}1.50 \times \text{ANT III}$. Setae on ABD I–V 0.005–0.008 mm long, about $0.25\text{--}0.42 \times \text{BD III}$. Setae on ABD VI–VIII 0.010–0.017 mm long, $0.50\text{--}0.80 \times \text{BD III}$. Genital plate anterior setae 0.017–0.020 mm long, $0.87\text{--}1.14 \times \text{BD III}$. Cauda with 6–10 setae.

Male. Description (n=1).

Colour in life: unknown; pigmentation on slide: head sclerotized, light brown. Antennae light brown with paler basal part of ANT III. Legs yellow with lighter central parts of tibiae. Abdomen pale, SIPH light brown with paler basal parts, cauda and anal genitalia light brown (Fig. 4c). HW $0.49\text{--}0.52 \times \text{ANT}$. Head setae 0.008–0.010 mm long, about $0.40 \times \text{BD III}$. ANT 5-segmented, $0.57\text{--}0.60 \times \text{BL}$. ANT III with 10, ANT IV with 1–3 secondary rhinaria. ANT V with PT $2.28\text{--}3.00 \times \text{BASE}$. Other antennal ratios: V:III 1.45–1.48, IV:III 0.48–0.51, PT:III 1.03–1.09, PT:IV 2.00–2.25. ANT bearing very short and blunt setae. ANT III setae shorter than the width of the segment, 0.005–0.006 mm long, LS III

$0.30\text{--}0.50 \times \text{BD III}$. ANT I with 5, ANT II with 4, ANT III with 5–6, ANT IV with 3–4, ANT V with 1–2 basal setae. Rostrum reaching ABD III. URS $0.60\text{--}0.64 \times \text{ANT III}$, $0.41\text{--}0.43 \times \text{ANT VI}$, $0.55\text{--}0.62 \times \text{PT}$, $1.42\text{--}1.66 \times \text{BASE}$ and about $1.42 \times \text{HT II}$. Mesosternal furca poorly visible, separated. III FEMORA bearing very short, rigid and blunt setae, 0.005–0.007 mm long, III FEMORA LS about $0.16 \times \text{trochantero-femoral suture length}$. Posterior seta on hind trochanter about $0.22 \times \text{trochantero-femoral suture length}$. III TIBIAE bearing short, rigid and blunt setae, 0.005–0.017 mm long. HT II $0.42\text{--}0.45 \times \text{ANT III}$, $0.29\text{--}0.30 \times \text{ANT V}$, $0.38\text{--}0.43 \times \text{PT}$ and $1.00\text{--}1.16 \times \text{BASE}$. Abdomen with small marginal tubercles on ABD IV. SIPH $1.00\text{--}1.10 \times \text{cauda}$, $0.10\text{--}0.11 \times \text{BL}$, and $0.64\text{--}0.66 \times \text{ANT III}$. Setae on ABD I–V 0.007–0.010 mm long, $0.37\text{--}0.50 \times \text{BD III}$. Setae on ABD VI–VIII 0.010–0.015 mm long, $0.50\text{--}0.75 \times \text{BD III}$. Cauda with 6 setae.

Material examined. BULGARIA: Liljanovo (10 km E of Sandenski) reg. Blagoevgrad, 28 May 1990, on *Scabiosa* sp., J. Holman leg., 4 apt, 21840 A (apt. 1–4), IECA; CZECH REPUBLIC: Luka p. Medníkem, 30 September 1964, on *S. canescens*, J. Holman leg., 7 ♀, 8851 (♀ 9–15), IECA; POLAND: Augustów, 05 July 1967, on *S. ochroleuca*, S. Huculak leg., 1 apt, 1248, R838; ZMPA; Warszawa-Bielany, 30 September 1965, on *S. ochroleuca*, H. Szelegiewicz leg., 5 apt, 2991, R839, ZMPA; 2 apt, 2 ♀, 1 ♂, 2991, R839, 363, ZMPA; UKRAINE: Čatyrdag, Krimea, 21 July 1960, on *S. gramuntia* (= *S. trandria*), J. Holman leg., 2 al, 3898 (al. 1–2), IECA.

Host plants. *Knautia arvensis*, *Scabiosa* sp., *S. argentea*, *S. atropurpurea*, *S. canescens*, *S. columbaria*, *S. comosa* (= *S. lachnophylla*), *S. ochroleuca*, *S. triandra* (Holman, 2009), *Pycnocomon rutifolium* (Blackman & Eastop 2019).

Biology. *Aphis thomasi* is a monoecious and holocyclic species with sexual phase in the end of September. The aphids live on basal parts on the host plants.

Distribution. Bulgaria, Czech Republic, Germany, Poland, Romania, Slovakia, Spain, Switzerland, Ukraine, probably Hungary (de Jong et al. 2014).

Key to *Knautia* feeding *Aphis* based on Blackman & Eastop (2019)

- 1 ANT tubercles undeveloped or weakly developed. ABD TERG 1 and 7 with marginal tubercles (MTu) 2
- ANT tubercles well developed. ABD TERG 1 and 7 without MTu..... 4
2. Cauda with 14–24 hairs. Longest hairs on hind femur as long as or longer than diameter of trochantero-femoral suture. Well-developed MTu present on

- ABD TERG 2–4 as well as 1 and 7. ANT PT/BASE 3–4 *Aphis longini*
- Cauda with 4–9 hairs. Longest hairs on hind femur 0.15–0.7 of diameter of trochantero-femoral suture. Small MTu present or absent from ABD TERG 2–4(–5). ANT PT/BASE 1.5–3.3 **3**
 - 3. Posterior hair on hind trochanter 0.2–0.5 × diameter of trochantero-femoral suture. Hairs on anterior half of subgenital plate 0.2–0.5 × ANT BD III *Aphis thomasi*
 - Posterior hair on hind trochanter 0.6–1.1 × diameter of trochantero-femoral suture. Hairs on anterior half of subgenital plate 1.0–3.0 × ANT BD III **4**
 - 4. Hairs on hind femora and antennae pointed. Hairs on anterior half of subgenital plate 2.25–2.94 × Ant BD III, R IV+V 1.40–1.52 × HT II *Aphis holmani* sp. nov.
 - Hairs on hind femora and antennae with blunt apices. Hairs on anterior half of subgenital plate 1.00–2.00 × Ant BD III, R IV+V 0.90–1.10 × HT II *Aphis confusa*
 - 5. Head and SIPH black. ANT III with 7–25 rhinaria. SIPH with polygonal reticulation on distal 0.1–0.2 of length (8 or more rows of closed cells) **5**
 - Head and SIPH pale. ANT III with 0–3 rhinaria. SIPH without polygonal reticulation or with only 1–4 rows of closed cells **6**

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APPENDIX I

(electronic supplement, available at www.bonnzoologicalbulletin.de)

Suppl. table 1. Measurements (in mm) of apterous viviparous females of *Knautia* feeding *Aphis* species; *measurements of ANT III for specimens with 5-segmented antennae. **measurements of ANT III for specimens with 6-segmented antennae.

Suppl. table 2. Measurements (in mm) of known alate viviparous females of *Knautia* feeding *Aphis* species.

Suppl. table 3. Measurements (in mm) of available for examination oviparous females of *Knautia* feeding *Aphis* species.

Suppl. table 4. Measurements (in mm) of available for examination males of *Knautia* feeding *Aphis* species (male of *A. thomasi* with 5-segmented antennae).

APPENDIX 1

Suppl. table 1. Measurements (in mm) of apterous viviparous females of *Knautia* feeding *Aphis* species.

*measurements of ANT III for specimens with 5-segmented antennae; **measurements of ANT III for specimens with 6-segmented antennae.

Character	<i>Aphis confusa</i>	<i>Aphis holmani</i> sp. nov.	<i>Aphis longini</i>	<i>Aphis thomasi</i>
BL	1.75–2.07	1.50–2.00	2.00–2.10	1.20–1.55
MAX W	0.87–1.32	0.85–1.25	1.25–1.32	0.71–0.92
HW	0.36–0.45	0.38–0.44	0.48–0.49	0.35–0.38
ANT	0.94–1.21	0.85–1.20	1.35–1.41	0.59–0.78
ANT III	0.22–0.32	0.29–0.38*	0.17	0.13–0.15*
		0.24–0.33**		0.13–0.19**
ANT IV	0.14–0.19	0.13–0.19	0.19–0.21	0.06–0.10
ANT V	0.14–0.18	0.14–0.19	0.16–0.19	0.09–0.11
ANT VI	0.32–0.39	0.30–0.37	0.55–0.58	0.22–0.31
BASE	0.08–0.11	0.10–0.13	0.11–0.12	0.070–0.080
PT	0.24–0.28	0.20–0.24	0.43–0.47	0.15–0.24
URS	0.10–0.12	0.13–0.16	0.15–0.16	0.105–0.125
III FEMUR	0.37–0.50	0.35–0.49	0.48–0.50	0.23–0.34
III FEMUR LS	0.030–0.035	0.045–0.050	0.050–0.055	0.010–0.011
PHT	0.035–0.050	0.050–0.055	0.050	0.010–0.012
III TIBIA	0.69–0.93	0.64–0.94	0.92–0.95	0.44–0.60
HT II	0.09–0.12	0.085–0.100	0.13–0.14	0.075–0.095
SIPH	0.24–0.38	0.18–0.27	0.20–0.22	0.20–0.24
CAUDA	0.15–0.21	0.15–0.18	0.18–0.18	0.13–0.15
GPL	0.10–0.13	0.11–0.12	0.14–0.16	0.090–0.100
GP W	0.20–0.26	0.22–0.43	0.27–0.29	0.19–0.20

Suppl. table 2. Measurements (in mm) of known alate viviparous females of *Knautia* feeding *Aphis* species.

Character	<i>Aphis confusa</i>	<i>Aphis holmani</i> sp. nov.	<i>Aphis thomasi</i>
BL	1.55–1.70	1.20–1.57	1.42–1.50
MAX W	0.72–0.80	0.50–0.66	0.50–0.60
HW	0.36–0.37	0.30–0.34	0.33–0.35
ANT	1.015–1.055	0.920–1.035	0.92–0.94
ANT III	0.22–0.26	0.21–0.26	0.22–0.23
ANT IV	0.15–0.18	0.13–0.15	0.13
ANT V	0.15–0.17	0.14–0.15	0.13–0.15
ANT VI	0.34–0.39	0.34–0.36	0.33
BASE	0.10–0.11	0.100–0.105	0.095–0.100
PT	0.24–0.29	0.24–0.26	0.23–0.24
URS	0.10–0.11	0.125–0.135	0.105–0.110
III FEMUR	0.38–0.42	0.34–0.40	0.31–0.32
III FEMUR LS	0.022–0.025	0.032–0.035	0.010–0.012
PHT	0.015–0.030	0.032–0.037	0.011–0.012
III TIBIA	0.75–0.81	0.72–0.80	0.61–0.65
HT II	0.085–0.100	0.080–0.090	0.085–0.090
SIPH	0.21–0.23	0.12–0.15	0.12–0.17
CAUDA	0.13–0.15	0.10–0.11	0.105–0.110
GPL	0.09–0.10	0.08–0.10	0.08–0.10
GPW	0.18–0.20	0.18–0.22	0.18–0.20

Suppl. table 3. Measurements (in mm) of available for examination oviparous females of *Knautia* feeding *Aphis* species.

Character	<i>Aphis confusa</i>	<i>Aphis holmani</i> sp. nov.	<i>Aphis thomasi</i>
BL	1.45–1.52	1.45–1.60	1.25–1.52
MAX W	0.70–0.79	0.80–0.92	0.60–1.02
HW	0.33–0.37	0.36–0.38	0.30–0.38
ANT	0.70–0.73	0.77–0.85	0.57–0.68
ANT III	0.12–0.14	0.13–0.16	0.10–0.12
ANT IV	0.09–0.10	0.11–0.13	0.06–0.09
ANT V	0.11–0.12	0.12–0.14	0.08–0.09
ANT VI	0.28	0.29–0.32	0.23–0.28
BASE	0.08	0.08	0.075–0.085
PT	0.20	0.21–0.24	0.16–0.20
URS	0.09–0.10	0.11	0.10–0.11
III FEMUR	0.26–0.30	0.29–0.32	0.20–0.26
III FEMUR LS	0.025–0.035	0.04–0.05	0.007–0.010
PHT	0.027–0.045	0.037–0.050	0.007–0.010
III TIBIA	0.46–0.51	0.54–0.60	0.38–0.46
HT II	0.075–0.080	0.08–0.09	0.075–0.08
SIPH	0.16–0.18	0.13–0.14	0.12–0.16
CAUDA	0.13–0.14	0.12–0.13	0.11–0.13
GPL	0.10–0.11	0.10–0.12	0.12–0.13
GP W	0.23–0.25	0.24–0.28	0.20–0.25

Suppl. table 4. Measurements (in mm) of available for examination males of *Knautia* feeding *Aphis* species (male of *A. thomasi* with 5-segmented antennae).

Character	<i>Aphis confusa</i>	<i>Aphis holmani</i> sp. nov.	<i>Aphis thomasi</i>
BL	1.00–1.05	0.80–1.07	0.97
MAX W	0.46–0.57	0.43–0.55	0.46
HW	0.31–0.33	0.27–0.34	0.29
ANT	0.76–0.84	0.85–0.93	0.55–0.58
ANT III	0.17	0.17–0.18	0.155–0.165
ANT IV	0.10–0.12	0.14–0.16	0.08
ANT V	0.13–0.14	0.14–0.15	–
ANT VI	0.28–0.31	0.30–0.33	0.23–0.24
BASE	0.07–0.08	0.07–0.08	0.06–0.07
PT	0.20–0.22	0.23–0.25	0.16–0.17
URS	0.085	0.09–0.10	0.10
III FEMUR	0.23–0.25	0.26–0.27	0.21
III FEMUR LS	0.025–0.032	0.032–0.040	0.0075
PHT	0.040–0.045	0.032–0.037	0.01
III TIBIA	0.45–0.50	0.52–0.56	0.39
HT II	0.065–0.070	0.070–0.075	0.07
SIPH	0.10–0.11	0.08–0.09	0.10–0.11
CAUDA	0.09–0.10	0.09–0.10	0.10

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