

## Original papers

# The morphology of juvenile stages of *Bubophilus aluconis* Nattress and Skoracki, 2009 (Acari: Syringophilidae) with a description of a male

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**ABSTRACT.** The morphology of juvenile and adult stages of the quill mite *Bubophilus aluconis* Nattress and Skoracki, 2009 parasitizing the Long-eared Owl *Asio otus* (Linnaeus) (Aves: Strigiformes) in Poland is described and illustrated. Poland is a new location and *A. otus* is a new host species for *B. aluconis*. A description of the male is presented for the first time for this quill mite species.

**Key words:** Acari, Syringophilidae, ectoparasites, *Bubophilus*, *Asio otus*

## Introduction

The quill mites of the family Syringophilidae (Acari: Prostigmata: Cheyletoidea) are diverse group of permanent and highly specialized bird ectoparasites inhabiting the feather quills. They live and reproduce inside the flight, rectrices and covert feathers feeding on soft tissue fluids of their hosts by piercing the calamus wall with their long and flexible chelicerae [1]. Transmission of these mites is mainly vertical, from parents to their offspring. The horizontal transfer, from one adult host to another during molt is also possible. Although, we have little data about pathogenicity and negative impact on condition of birds, some authors suggest that they may be potential enzootic vectors for pathogens [2].

These mites are mono- or oligoxenous parasites associated with birds of different orders throughout the World. To date this family includes more than 240 species of 52 genera described from all zoogeographical regions [3]. This number of syringophilid species is only a small part of their actual biodiversity, because the wide spectrum of

the avian hosts are still largely unexplored. The actual number of the extant syringophilid species is at least 5000 as it was estimated based on species numbers of their potential hosts [4].

The biodiversity of syringophilid mites of the genus *Bubophilus* Philips and Norton, 1978 is still poorly known and presently only three species are known: *B. ascalaphus*, *B. asiobius* and *B. aluconis* [5,7,8]. All members of this genus are associated exclusively with owls (Strigiformes) (Table 1).

In this paper, we describe of all juvenile stages of *Bubophilus aluconis* parasitising the Long-eared Owl *Asio otus* (Aves: Strigiformes) in Poland. Additionally, Poland is a new location, and the avian species *A. otus* is a new host for *B. aluconis*. A description of the male is presented for the first time for this species.

## Materials and methods

The description of *Bubophilus aluconis* presented in this paper is based on the material collected from quills of the Long-eared Owl *Asio otus* (Strigiformes: Strigidae). This bird specimen

Table 1. Distribution of *Bubophilus* spp. on hosts

Mite species	Host species	Host family	Distribution	References
<i>B. ascalaphus</i> Philips and Norton, 1978	<i>Bubo virginianus</i> (Gmelin, 1788)*	Strigidae	USA	[5]
	<i>Bubo africanus</i> (Temminck, 1821)	Strigidae	South Africa	[6]
	<i>Tyto alba affinis</i> (Blyth, 1862)	Tytonidae	Cameroon	[6]
<i>B. asiobius</i>	<i>Asio otus</i> (Linnaeus, 1758)	Strigidae	Poland	[7]
<i>B. aluconis</i> Nattress and Skoracki, 2009	<i>Strix aluco</i> Linnaeus, 1758*	Strigidae	England	[8]
	<i>Asio otus</i> (Linnaeus, 1758)	Strigidae	Poland	Present study

\* – type host

was found dead in Szczecin City (Poland) in September 2010. All wing feathers and most of body feathers have been examined. Quills of feathers were examined using a dissecting microscope, and opened with a fine scalpel. All mite specimens of this species studied derive from 4 samples of great coverts and 7 samples of body feathers, and of the 12 eggs and 108 individuals: 7 were larvae, 10 protonymphs, 16 tritonymphs, 68 females and 7 males. All mite material is deposited in the collection of M. Skoracki (Department of Animal Morphology, Adam Mickiewicz University, Poznan, Poland).

Mite specimens were mounted in the Faure's medium. Examination was done under Nomarsky interference-contrast with an Olympus BH2 microscope. Drawings were made with a camera lucida. All measurements are given in micrometers ( $\mu\text{m}$ ).

**Terminology.** The idiosomal setation follows Grandjean [9] as adapted for Prostigmata by Kethley [10]. The system of nomenclature for leg chaetotaxy follows that proposed by Grandjean [11]. The application of these chaetotaxic schemes to Syringophilidae was recently provided by Bochkov et al. [12] and Skoracki [3].

## Results

### Description

The morphology of juvenile and adult stages of the *B. aluconis* are described below and illustrated in Figures 1–33.

**Egg** (Fig. 1).

Oval in shape (length 250–265; width 160–180), whitish in color and with smooth surface.

**Larva** (Figs. 2–7).

Total body length 305–335. *Gnathosoma*. Hypostomal apex rounded without protuberances. Lateral hypostomal teeth absent. Stylophore with striae ornamentation slightly constricted posteriorly, not reaching anterior margin of propodonal shield, 120–125 long. Movable cheliceral digit edentate, 115–120 long. Each medial branch of peritremes with 1 chamber, each lateral branch with 4 chambers (Fig. 4). Decompression opening visible. *Chaetotaxy of gnathosoma: ao1, ao2, elcp*. *Chaetotaxy and solenidiotaxy of palps: tibiotarsus: dTi, sul, l'Ti, l''Ti, acm, ul', ul'',  $\omega$ ; genu: dG; femur: dF; trochanter: setae absent* (Figs. 6,7).

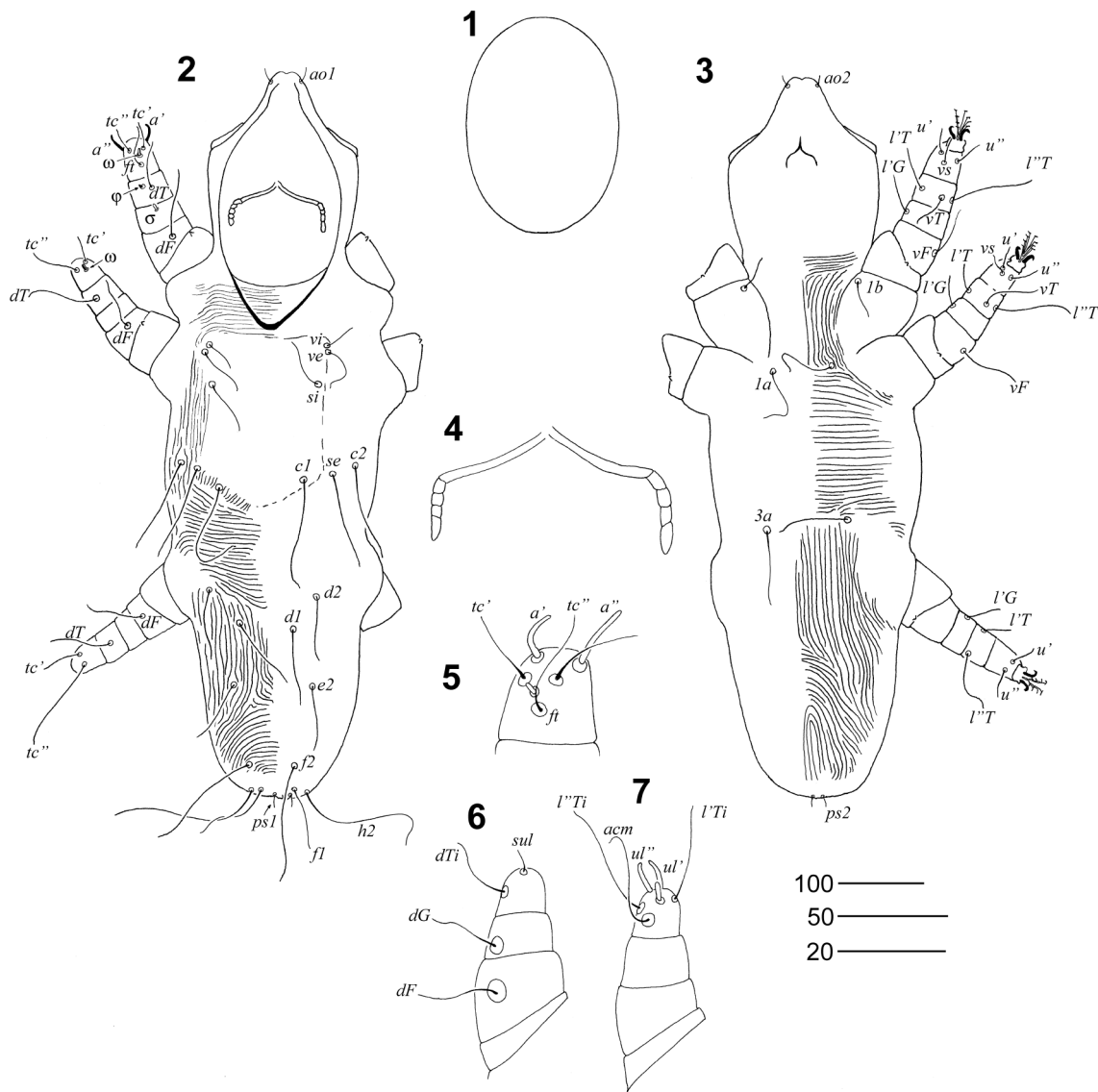
*Idiosoma*. Propodonal shield weakly sclerotized, bearing setae *vi, ve, si* and *c1*; setae *se* on or near this shield. Setae *se* situated anterior to level of setae *c1*. Hysteronotal and pygidial shields absent. Cuticular striations as in Figs. 2 and 3. *Chaetotaxy of idiosoma: vi, ve, si, se, c1, c2, d1, d2, e2, f1, f2, h2, ps1, ps2, 1a, 3a*. *Lengths of idiosomal setae: vi* 15–20, *ve* 15–20, *si* 30–35, *se* 60–70, *c1* 70–75, *c2* 55–65, *d1* 40–55, *d2* 35–40, *e2* 60–65, *f1* 35–45, *f2* 40–45, *h2* 100, *ps1* 10, *ps2* 10.

*Legs*. All three pairs of legs subequal in thickness. All legs consist of, apart from the coxal fields (CF), five articulated segments: trochanter (R), femur (F), genu (G), tibia (T), and tarsus (TA). All tarsi with paired claws and rayed empodium. Tarsal setae of legs I: *a'* and *a''* as eupathidia, setae *tc'* and *tc''* filiform. Chaetotaxy and solenidiotaxy of legs:

**leg I:** (CF) – *1b*; (R) – without setae; (F) – *vF, dF*; (G) – *l'G,  $\sigma$* ; (T) – *l'T, l''T, vT, dT,  $\phi$* ; (TA) – *u'', u''', vs, a'', a''', tc'', tc''', ft,  $\omega$* ;

**leg II:** (CF) and (R) – without setae; (F) – *vF, dF*; (G) – *l'G*; (T) – *l'T, l''T, vT, dT*; (TA) – *u'', u''', vs, tc'', tc''',  $\omega$* ;

**leg III:** (CF) and (R) – without setae; (F) – *dF*; (G)



Figs. 1–7. *Bubophilus aluconis* Nattress and Skoracki. (1) egg; (2–7) larva; (2) dorsal view; (3) ventral view; (4) peritremes; (5) tarsus I in dorsal view; (6) palpa in dorsal view; (7) palpa in ventral view. Scale bar: Fig. 1=100µm; Figs. (2, 3)=50µm; Figs. (4–7)=20µm

– l’G; (T) – l’T, l’’T, dT; (TA) – u’, u’’, tc’, tc’’.

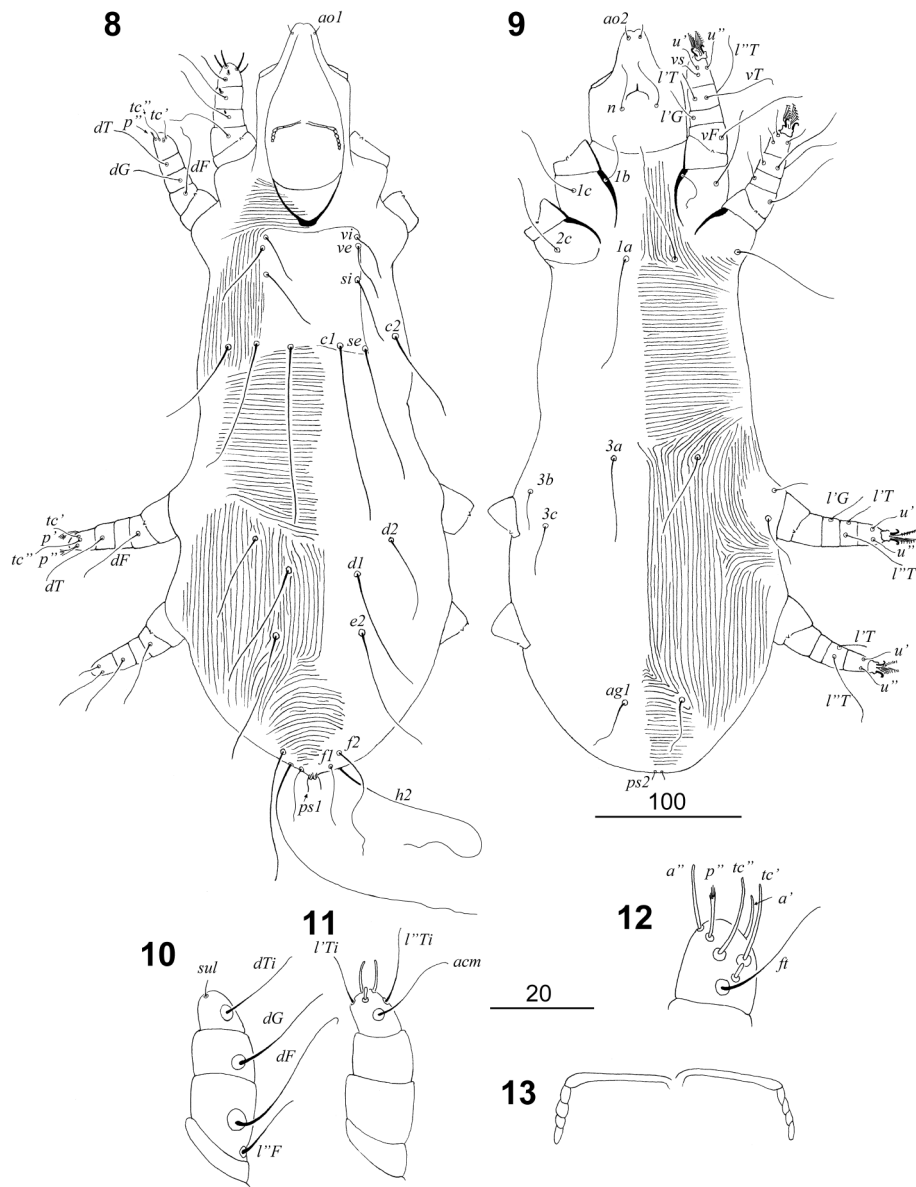
**Protonymph** (Figs. 8–13).

Total body length 390–505. *Gnathosoma*. Hypostomal apex rounded without protuberances. Lateral hypostomal teeth absent. Stylophore with striae ornamentation, rounded or slightly constricted posteriorly, not reaching anterior margin of propodonal shield, 130–135 long. Movable cheliceral digit edentate, 115–120 long. Each medial branch of peritremes with 1 chamber, each lateral branch with 4 chambers (Fig. 13). Decompression opening visible. *Chaetotaxy of gnathosoma*: ao1, ao2, elcp, n. *Chaetotaxy and solenidiotaxy of palps*: tibiotarsus: dTi, sul, l’Ti, l’’Ti, acm, ul’, ul’’, ω; genu: dG; femur: dF, l’F;

trochanter: without setae (Figs. 10,11).

*Idiosoma*. Propodonal shield weakly sclerotized, bearing setae vi, ve, si and c1; setae se on or near this shield. Setae se situated posterior to level of setae c1 or both setae at same transverse level. Hysteronotal and pygidial shields absent. Cuticular striations as in figs. 8 and 9. *Chaetotaxy of idiosoma*: vi, ve, si, se, c1, c2, d1, d2, e2, f1, f2, h2, ps1, ps2, ag1. *Lengths of idiosomal setae*: vi 20–25, ve 30–35, si 55–70, se 90–120, c1 100–130, c2 75–95, d1 75–80, d2 45–55, e2 75–80, f1 40–45, f2 80–100, h2 165–170, ps1 15–20, ps2 15–20, ag1 30–35.

*Legs*. All four pairs of legs subequal in thickness. Tarsal setae a’, a’’, tc’ and tc’’ of legs I as



Figs. 8–13. *Bubophilus aluconis* Nattress and Skoracki, protonymph. (8) dorsal view; (9) ventral view; (10) palpa in dorsal view; (11) palpa in ventral view; (12) tarsus I in dorsal view; (13) peritremes. Scale bar: Figs. (8, 9)=100 $\mu$ m; Figs. (10–13)=20 $\mu$ m

eupathidia. *Chaetotaxy and solenidiotaxy of legs:*

**leg I:** (CF) – 1b; (R) – without setae; (F) – vF, dF; (G) – l'G, dG,  $\sigma$ ; (T) – l'T, l''T, vT, dT,  $\varphi$ ; (TA) – u'', u'', vs, a'', a'', tc'', tc'', ft, p'',  $\omega$ ;

**leg II:** (CF) and (R) – without setae; (F) – vF, dF; (G) – l'G, dG; (T) – l'T, l''T, vT, dT; (TA) – u', u'', vs, tc', tc'', p'',  $\omega$ ;

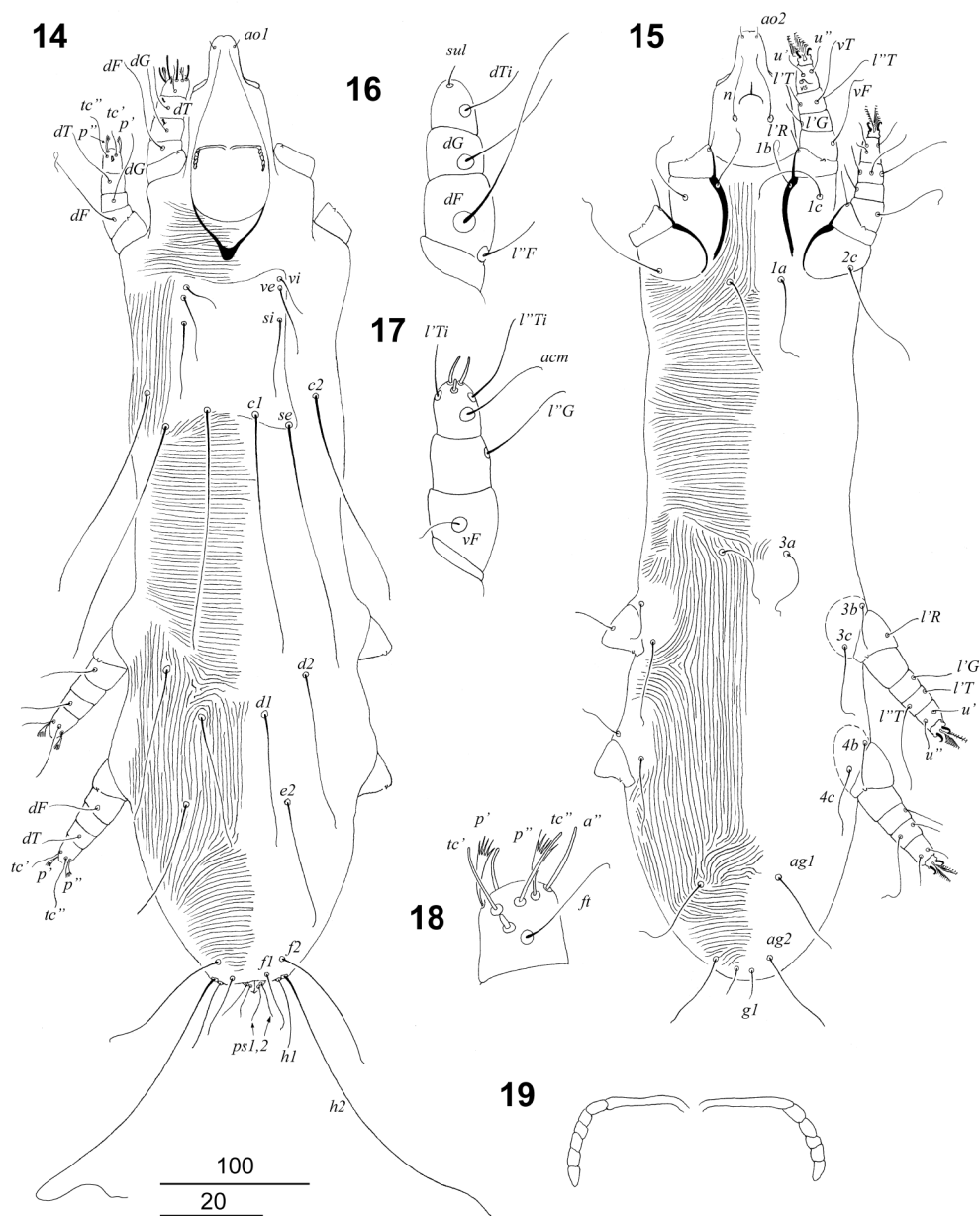
**leg III:** (CF) – 3b, 3c; (R) – without setae; (F) – dF; (G) – l'G; (T) – l'T, l''T, dT; (TA) – u', u'', tc', tc'', p', p'';

**leg IV:** (CF) and (R) – without setae; (F) – dF; (G)

– without setae; (T) – l'T, l''T, dT; (TA) – u', u'', tc', tc''.

**Tritonymph** (Figs. 14–19).

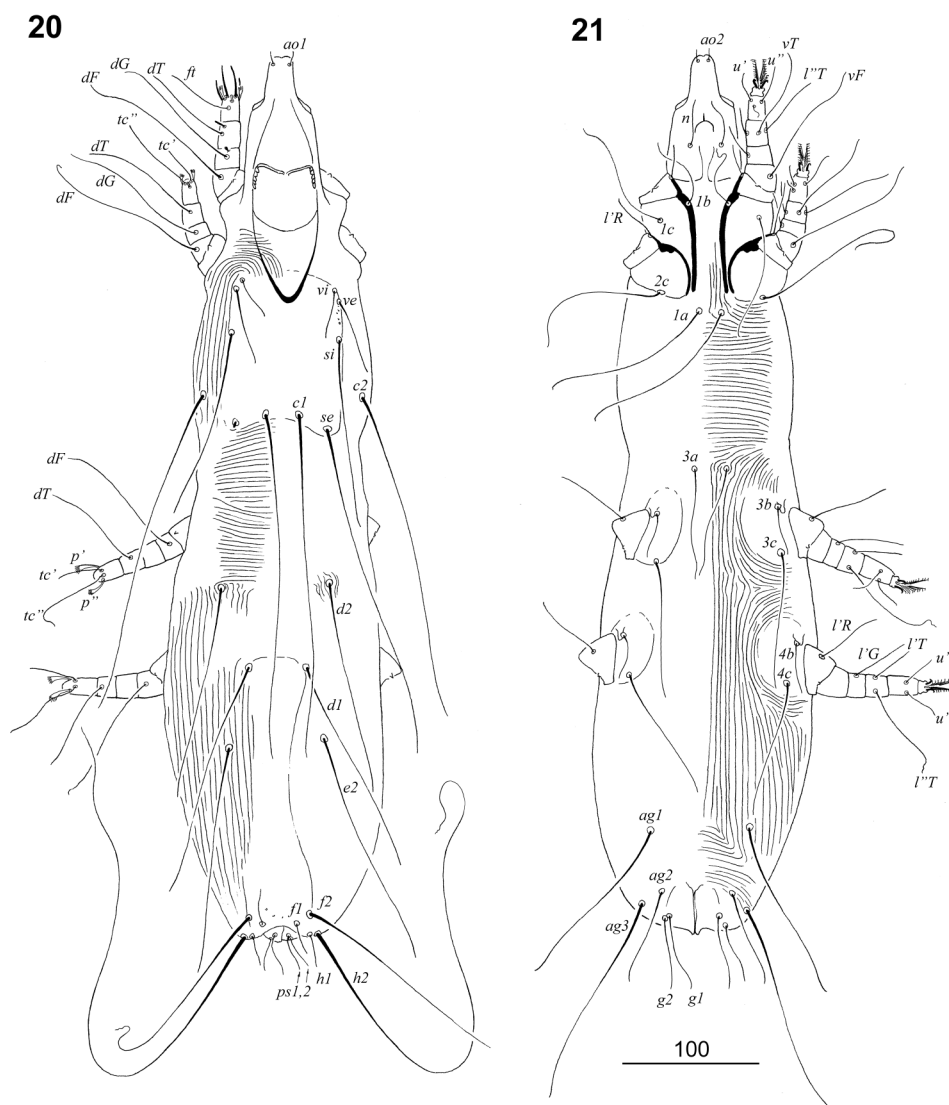
Total body length 555–605. *Gnathosoma.* Hypostomal apex rounded without protuberances. Lateral hypostomal teeth absent. Stylophore with weakly visible striae ornamentation, slightly constricted posteriorly, not reaching anterior margin of propodonal shield, 150–155 long. Movable cheliceral digit edentate, 120–130 long. Each medial branch of peritremes with 1 chamber, each



Figs. 14–19. *Bubophilus aluconis* Nattress and Skoracki, tritonymph. (14) dorsal view; (15) ventral view; (16) palpa in dorsal view; (17) palpa in ventral view; (18) tarsus I in dorsal view; (19) peritremes. Scale bar: Figs. (14, 15)=100µm; Figs. (16–19)=20µm

lateral branch with 4–5 chambers (Fig. 19). Decompression opening visible. *Chaetotaxy of gnathosoma*: *ao1*, *ao2*, *elcp*, *n*. *Chaetotaxy and solenidiotaxy of palps*: tibiotarsus: *dTi*, *sul*, *l'Ti*, *l''Ti*, *acm*, *ul'*, *ul''*,  $\omega$ ; genu: *dG*; femur: *dFl*, *l'F*, *vF*; trochanter: without setae (Figs. 16,17). *Idiosoma*. Propodonal shield well sclerotized, bearing setae *vi*, *ve*, *si*, *se* and *c1*; all propodonal setae on margins of this shield. Setae *se* situated posterior to level of setae *c1* or both setae at same transverse level. Hysteronotal and pygidial shields

absent. Cuticular striations as in Figs. 14 and 15. *Chaetotaxy of idiosoma*: *vi*, *ve*, *si*, *se*, *c1*, *c2*, *d1*, *d2*, *e2*, *f1*, *f2*, ***h1***, *h2*, *ps1*, *ps2*, *ag1*, ***ag2***, ***g1***. Lengths of idiosomal setae: *vi* 20–25, *ve* 40–50, *si* 60–85, *se* 160–170, *c1* 160–170, *c2* 150–165, *d1* 85–90, *d2* 90–105, *e2* 90–100, *f1* 30–40, *f2* 90–100, *h1* 40–50, *h2* 230–250, *ps1* 20–30, *ps2* 20–30, *ag1* 60–75, *ag2* 60–70, *g1* 20–25. *Legs*. All four pairs of legs subequal in thickness. Tarsal setae *a'*, *a''*, *tc'* and *tc''* of legs I as eupathidia. *Chaetotaxy and solenidiotaxy of legs*:



Figs. 20–21. *Bubophilus aluconis* Nattress and Skoracki, female. (20) dorsal view; (21) ventral view

**leg I: (CF) – 1b; (R) –  $P'$ ; (F) –  $vF$ ,  $dF$ ; (G) –  $l'G$ ,  $dG$ ,  $\sigma$ ; (T) –  $l'T$ ,  $l''T$ ,  $vT$ ,  $dT$ ,  $\phi$ ; (TA) –  $u'$ ,  $u''$ ,  $vs$ ,  $a'$ ,  $a''$ ,  $tc'$ ,  $tc''$ ,  $ft$ ,  $p'$ ,  $p''$ ,  $\omega$ ;**

**leg II: (CF) and (R) –  $P'$ ; (F) –  $vF$ ,  $dF$ ; (G) –  $l'G$ ,  $dG$ ; (T) –  $l'T$ ,  $l''T$ ,  $vT$ ,  $dT$ ; (TA) –  $u'$ ,  $u''$ ,  $vs$ ,  $tc'$ ,  $tc''$ ,  $p'$ ,  $p''$ ,  $\omega$ ;**

**leg III: (CF) – 3b, 3c; (R) –  $P'$ ; (F) –  $dF$ ; (G) –  $l'G$ ; (T) –  $l'T$ ,  $l''T$ ,  $dT$ ; (TA) –  $u'$ ,  $u''$ ,  $tc'$ ,  $tc''$ ,  $p'$ ,  $p''$ ;**

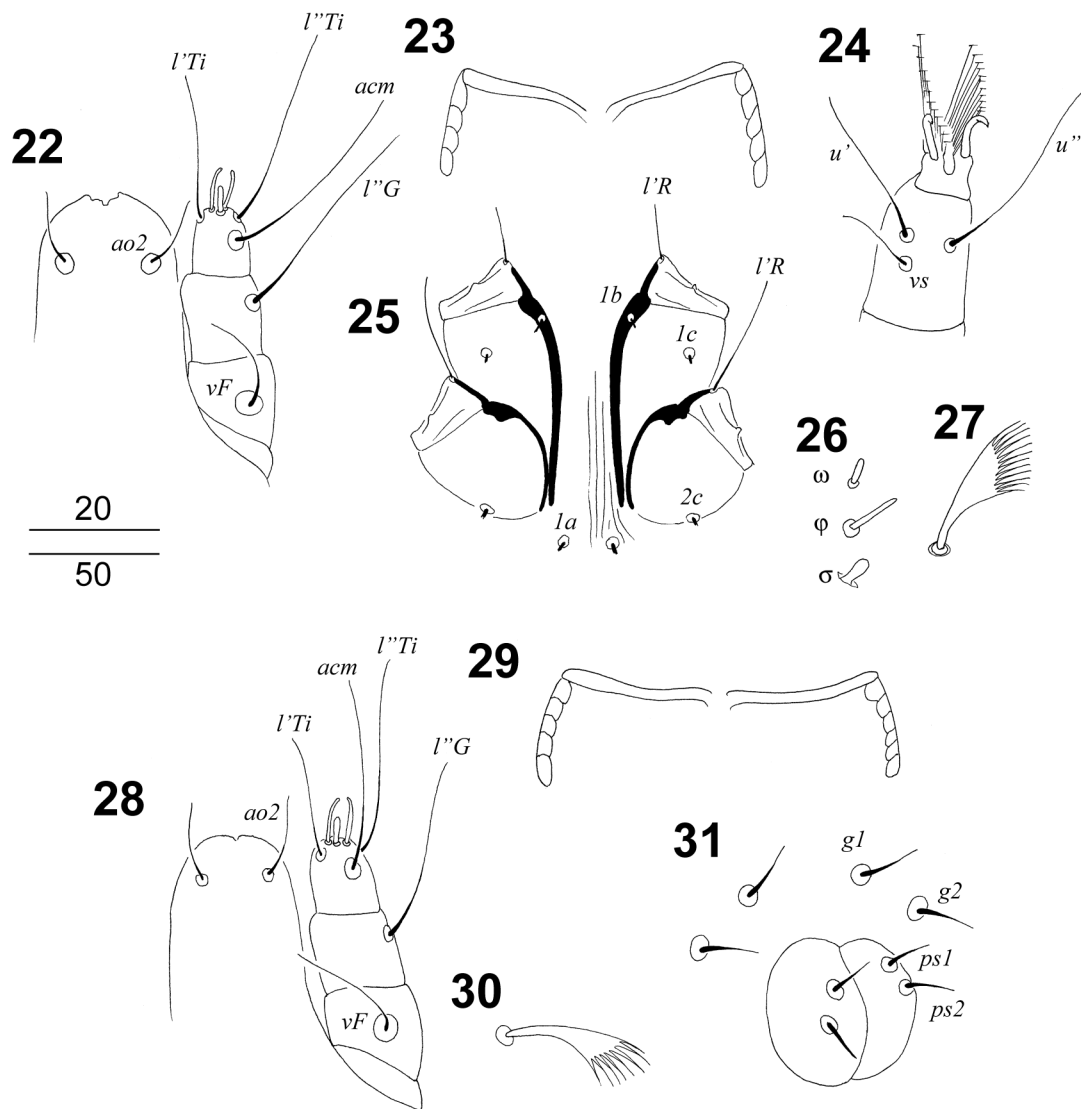
**leg IV: (CF) – 4b, 4c; (R) – without setae; (F) –  $dF$ ; (G) –  $P'$ ; (T) –  $l'T$ ,  $l''T$ ,  $dT$ ; (TA) –  $u'$ ,  $u''$ ,  $tc'$ ,  $tc''$ ,  $p'$ ,  $p''$ .**

**Female** (Figs. 20–27).

Total body length 590–630. *Gnathosoma*. Hypostomal apex rounded without protuberances. Lateral hypostomal teeth absent. Stylophore without striae ornament, constricted posteriorly, reaching anterior margin of propodonotal shield, 175–180

long. Movable cheliceral digit edentate, 135–140 long. Each medial branch of peritremes with 1 chamber, each lateral branch with 4 chambers (Fig. 23). Decompression opening visible. *Chaetotaxy of gnathosoma*:  $ao1$ ,  $ao2$ ,  $elcp$ ,  $n$ . *Chaetotaxy and solenidiotaxy of palps*: tibiotarsus:  $dTi$ ,  $sul$ ,  $l'Ti$ ,  $l''Ti$ ,  $acm$ ,  $ul'$ ,  $ul''$ ,  $\omega$ ; genu:  $dG$ ; femur:  $dFl$ ,  $l''F$ ,  $vF$ ; trochanter: without setae (Fig. 22).

*Idiosoma*. Propodonotal shield well sclerotized, bearing setae  $vi$ ,  $ve$ ,  $si$ ,  $se$  and  $c1$ ; all propodonotal setae on margins of this shield. Setae  $se$  situated posterior to level of setae  $c1$ . Hysteronotal shield narrow and apunctate, fused to pygidial shield, bearing bases of setae  $d1$  and terminal setae  $f1$ ,  $f2$ ,  $h1$  and  $h2$ . Cuticular striations as in Figs. 20 and 21. *Chaetotaxy of idiosoma*:  $vi$ ,  $ve$ ,  $si$ ,  $se$ ,  $c1$ ,  $c2$ ,  $d1$ ,  $d2$ ,



Figs. 22–31. *Bubophilus aluconis* Nattress and Skoracki, Figs. (22–27) female, (28–31) male. (22) gnathosoma in ventral view; (23) peritremes; (24) tarsus II in ventral view; (25) coxal fields of legs I and II; (26) solenidia of leg I; (27) fan-like seta *p'* of leg III; (28) gnathosoma in ventral view; (29) peritremes; (30) fan-like seta *p'* of leg III; (31) genitor-anal region. Scale bar: Figs. (22–24, 26–31)=20µm; Figs. (25)=100µm

*e2*, *f1*, *f2*, *h1*, *h2*, *ps1*, *ps2*, *ag1*, *ag2*, **ag3**, *g1*, *g2*.  
 Lengths of idiosomal setae: *vi* 30–35, *ve* 50–55, *si* 120–140, *se* 240–250, *c1* 245–250, *c2* 220–240, *d1* 170–190, *d2* 175–210, *e2* 180–190, *f1* 35–45, *f2* 180–190, *h1* 40–50, *h2* 395–400, *ps1* 25–35, *ps2* 30–40, *ag1* 130–145, *ag2* 65–70, *ag3* 170–180, *g1* 50–55, *g2* 50–60.

**Legs.** All four pairs of legs subequal in thickness. Tarsal setae *a'*, *a''*, *tc'* and *tc''* of legs I as eupathidia. **Chaetotaxy and solenidiotaxy of legs:**

**leg I:** (CF) - *1b*; (R) - *l'*; (F) - *vF*, *dF*; (G) - *l'G*, *dG*,  $\sigma$ ; (T) - *l'T*, *l''T*, *vT*, *dT*,  $\phi$ ; (TA) - *u''*, *u''*, *vs*, *a''*, *a''*, *tc''*, *tc''*, *ft*, *p''*, *p''*,  $\omega$ ;

**leg II:** (CF) and (R) - *l''*; (F) - *vF*, *dF*; (G) - *l'G*, *dG*; (T) - *l'T*, *l''T*, *vT*, *dT*; (TA) - *u''*, *u''*, *vs*, *tc''*,

*tc''*, *p''*, *p''*,  $\omega$ ;

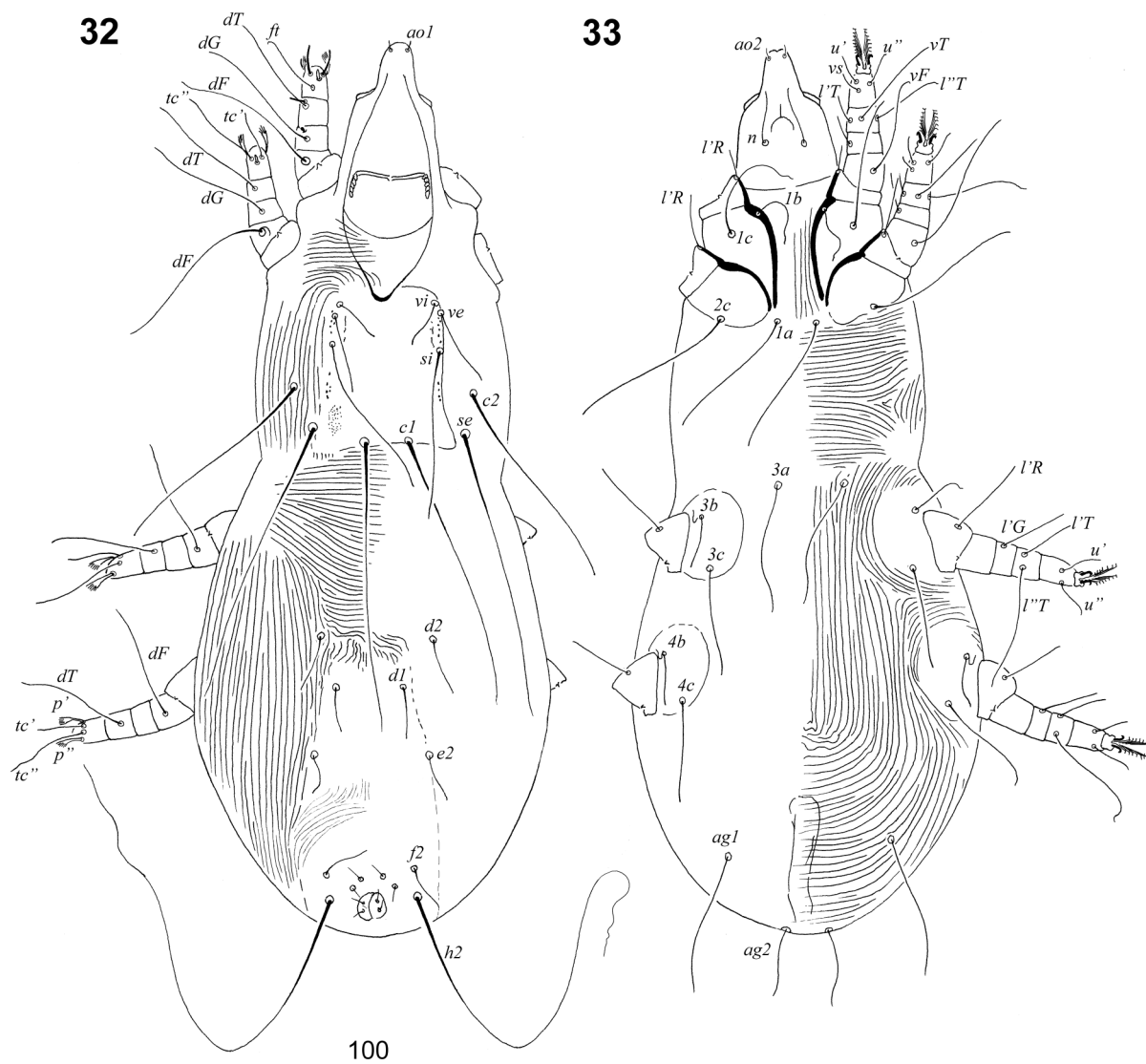
**leg III:** (CF) - *3b*, *3c*; (R) - *l''*; (F) - *dF*; (G) - *l'G*; (T) - *l'T*, *l''T*, *dT*; (TA) - *u'*, *u''*, *tc'*, *tc''*, *p'*, *p''*;

**leg IV:** (CF) - *4b*, *4c*; (R) - *l'*; (F) - *dF*; (G) - *l'*; (T) - *l'T*, *l''T*, *dT*; (TA) - *u'*, *u''*, *tc'*, *tc''*, *p'*, *p''*.

**Male** (Figs. 28–33).

Total body length 515–565. **Gnathosoma.** Each medial branch of peritremes with 1 chamber, each lateral branch with 5–6 chambers (Fig. 29). Length of stylophore and movable cheliceral digit 160–170 and 135 respectively. **Chaetotaxy of gnathosoma:** as in female.

**Idiosoma.** Propodonotal shield weakly sclerotized, sparsely punctate at lateral margins, bearing bases of setae *vi*, *ve*, *si* and *c1*, setae *se* on or near this



Figs. 32–33. *Bubophilus aluconis* Nattress and Skoracki, male. (32) dorsal view; (33) ventral view

shield. Length ratio of setae *vi:ve:si* 1:2:3.2–4. Hysteronotal shield apunctate, weakly sclerotized in anterior part, striae visible, fused to pygidial shield, bearing bases of setae *d1*, *e2*, *f2* and *h2*. Setae *d2* about twice as long as *d1* and *e2*. Genital setae *g1* situated anterior to level of setae *g2*, both pairs subequal in length. Pseudanal setae *ps1* and *ps2* subequal in length. Length ratios of setae *ag1:ag2* 2:1. *Chaetotaxy of idiosoma*: *vi*, *ve*, *si*, *se*, *c1*, *c2*, *d1*, *d2*, *e2*, *f2*, *h2*, *ps1*, *ps2*, *ag1*, *ag2*, *g1*, *g2*. *Lengths of idiosomal setae*: *vi* 20–30, *ve* 45–55, *si* 80–100, *se* 165, *c1* 180–190, *c2* 130–140, *d1* 20–30, *d2* 40–65, *e2* 20–25, *f2* 30, *h2* 280–320, *ag1* 85–90, *ag2* 45–50.

*Legs*. Coxal fields I–IV apunctate. Setae *3c* 2.3 times longer than *3b*. Fan-like setae *p'* and *p''* of

legs III and IV with 7–8 tines. Length ratio of setae *tc'III–IV:tc''III–IV* 1:2. *Chaetotaxy and solenidiotaxy of legs* as in female.

## Discussion

Quill mite species, *Bubophilus aluconis* has been known only from type host – *Strix aluco* from England and up to now there were no other data. In our studies we unexpectedly recorded this syringophilid species inside quill feathers of *Asio otus* which is a type host for the other *Bubophilus* species – *B. asiobios*. Both quill mite species can be simply distinguished by the lengths of propodonal setae *vi*, *ve* and *si* and by their length ratio [7,8]. The mixed quill mite species on *A. otus*, may be a result



Table 2. Comparison of measurements of morphological characters of all stages of *Bubophilus aluconis* based on material from the Long-eared Owl *Asio otus* from Poland

	larva (n=7)	protonymph (n=10)	tritonymph (n=10)	female (n=10)	male (n=7)
Total body length	305–335	400–505	555–605	590–630	515–565
Length of stylophore	120–125	130–135	150–155	175–180	160–170
Length of chelicerae	115–120	115–120	120–130	135–140	135
Lengths of setae					
<i>vi</i>	15–20	20–25	20–25	30–35	20–30
<i>ve</i>	15–20	30–35	40–50	50–55	45–55
<i>si</i>	30–35	55–70	60–85	120–140	80–100
<i>se</i>	60–70	90–120	160–170	240–250	165–170
<i>c1</i>	70–75	100–130	160–170	245–250	180–190
<i>c2</i>	55–65	75–95	150–165	220–240	130–140
<i>d1</i>	40–55	75–80	85–90	170–190	20–30
<i>d2</i>	35–40	45–55	90–105	175–210	35–65
<i>e2</i>	60–65	75–80	90–100	180–190	20–25
<i>f1</i>	35–45	40–45	30–40	35–45	–
<i>f2</i>	40–45	80–100	90–100	180–190	25–30
<i>h1</i>	–	–	40–50	40–50	–
<i>h2</i>	100	165–170	230–250	395–400	280–320
<i>ps1</i>	10	15–20	20–30	30–35	5
<i>ps2</i>	10	15–20	20–30	30–40	5
<i>g1</i>	–	–	20–25	50–55	5
<i>g2</i>	–	–	–	50–60	5
<i>ag1</i>	–	30–35	60–75	130–145	85–90
<i>ag2</i>	–	–	60–70	65–70	45–50
<i>ag3</i>	–	–	–	170–180	–

of host switching. Both owl species may coexist in the same kind of habitat e.g., simultaneous nesting in the farm building complexes, or territorial occupation during the breeding period [13].

### The scheme of the ontogenesis for the genus *Bubophilus*

Until now, the scheme of ontogenesis has been presented in detail for only *Mironovia lagopus* Bochkov and Skirnisson, 2011. Our studies of the juvenile stages of *B. aluconis* show that the development is similar to the scheme noted for *M. lagopus* [14].

*Gnathosoma*. In all stages the gnathosoma is well developed and represents a compact formation consisting of the acron remnants, palps and the chelicerae. Directed forward the movable cheliceral digits are elongate, retractable and flexible

structures transformed into the stylets. The length of these stylets is subequal in all juvenile and adult stages (Table 2). This functional adaptation permits feeding in all developmental stages [15].

In syringophilids, like in other Cheyletoidea, both the cheliceral bases are completely fused to one another and with the infracapitulum, forming a stylophore capsule. The successive growth of the stylophore capsule in the following immature stages is observed (Table 2). Because the gnathosoma is deeply bounded into the idiosoma, the posterior part of the stylophore is represented by the apodeme. This apodeme is constricted in all developmental stages. The bottom of the gnathosomal tube, termed as infracapitulum has a pair of ventral infracapitular setae (*n*) and a small decompression opening. Setae *n* are absent in the larval stage. Dorsolateral parts of the gnathosoma, at the level of the peritremes, bear small supracoxal setae of palps (*elcp*). The

infracapitulum, as well as the dorsal surface of the stylophore is smooth. The medio-ventral part of the infracapitulum, namely the hypostome, is formed by the gnathocoxal projections. In syringophilids, the hypostome is almost completely fused with the stylophore [16]. The hypostomal apex takes different shapes in various genera. In *Bubophilus* its rounded and devoid lateral sclerites termed the lateral hypostomal teeth in all stages. The mouth is flanked by two pairs of adoral setae (*ao1* and *ao2*). The proper palps are basically similar to leg-like structures. They consist of four segments: trochanter, femur, genu and tibiotarsus, which are provided with mechano- and chemosensory sensilla (Figs. 3A–D and 4A–D). Palps are tactile organs and probably the main appendages determining locality of specific habitat on an avian host [3]. Well defined chaetotaxy is stable for the family, include tigmotactic setae on all free podomers except trochanters, a pair of eupathidia (*ul'* and *ul''*) and one small solenidion omega ( $\omega$ ) on tibiotarsus. In the ontogenesis, palps of larvae have no setae *vF*, *l''F* and *l''G* (Figs. 6,7), in protonymphs setae *vF* and *l''G* are absent (Figs. 10,11), whereas tritonymphs have a full complement of setae (Figs. 16,17). The setae of juveniles (especially dorsal setae) show gradual growth in ensuing stages.

The respiratory structures, like stigmata (respiratory openings) and peritremes (external gutter-like structures) are situated in the middle part of the stylophore. The peritremes are similar in shape and number of chambers in each branch in all developmental stages.

*Idiosoma.* The idiosoma of syringophilids is divided into propodosoma and hysterosoma by the remnants of the sejugal furrow. Both shields covering the propodonotal and hysteronotal regions are present in adult stages (Figs. 20,32), whereas immature stages possess only weakly developed propodonotal shield (Figs. 2,8,14).

*Chaetotaxy of dorsal idiosoma.* This species like the most of members of Syringophilinae have filiform smooth setae. It is likely that very long dorsal setae in adult females excepting their tigmotactic function also help to attach them to the host [3]. Dorsal setae show successive growth in length in ensuing immature stages. The propodonotum bears six pairs of setae: *vi*, *ve*, *si*, *se*, *c1* and *c2*. On the hysteronotum three pairs of hysteronotal setae, *d1*, *d2* and *e2*, and four pairs of setae situated on the terminal part of the body, *f1*, *f2*, *h1* and *h2* are present. In males, the terminal setation

is represented by two pairs of setae *f2* and *h2*. In larvae and protonymphs setae *h1* are absent (Figs. 2, 8). Tritonymphs have the full complement of dorsal setae (Fig. 14).

*Venter of the idiosoma.* The ventral side has no sclerites. The intercoxal region comprises two pairs of setae *1a* and *3a* which are present in all stages. *Bubophilus aluconis* is a member of neotrichous species where the opisthogastric region bears three pairs of the aggenital setae (*ag1–3*). In this case, larvae have no aggenital setae, protonymphs possess only setae *ag1*, and tritonymphs bear the two pairs of the aggenital setae, *ag1* and *ag2*. In adult females, setae *ag3* are added (in males, setae *ag3* is absent).

*Genito-anal region.* The anal and genital orifices are coalesced. In females it is situated terminally and covered by a pair of distinct valves, whereas in males, it is placed dorso-terminally, and is covered by a pair of small, oval valves (Fig. 32). In *Bubophilus*, like most genera of syringophilins, the genito-anal region bears two pairs of the pseudanal setae (*ps1–2*) and two pairs of the genital setae (*g1–2*). Larvae and protonymphs possess only pseudanal setae (genital setae are absent). In tritonymphs setae *g1* are added, and in adults, setae *g2* are added.

*Legs.* All legs of all stages are subequal in thickness and consist of, apart from the coxal fields, five articulated segments, well defined in all stages: trochanter, femur, genu, tibia, and tarsus. The first and second pairs of the legs are orientated anteriorly, whilst the other two pairs take a posterior direction. Each tarsus bears an ambulacrum at its distal end. It comprises praetarsus with a pair of lateral claws and an empodium bearing numerous tenent hairs (Fig. 24). The paired claws are similar in the shape and size and without basal angle. The empodium is fleshy with numerous tenent hairs in all stages. The coxae are fused with idiosoma and represented by the coxal fields delineated from the idiosomal surface by the coxal apodemes clearly visible in protonymph-adult stages. External surface of the coxal fields is smooth or sparsely punctate.

*Chaetotaxy and solenidiotaxy of legs.* Leg setae are filiform. Coxal fields (CF). In larval stages only coxal fields I bearing one setae *1b*, the remainder of the coxal fields have no setae. In protonymphs show the following setae *1c*, *2c*, *3b* and *3c*, whereas in tritonymphs setae *4b* and *4c* are added. Trochanters (R): Trochanters of all the legs in the larval and protonymphal stages have no setae. In tritonymphs, the setae *l'R* of legs I–III appear, whilst in adults the

setae *l'RIV* are added. Femur (F): In all post-embryonic stages femur of legs I and II have one dorsal (*dF*) and one ventral setae (*vF*), femur of legs III (in larva and postlarval stages) and IV (in postlarval stages) possess only one dorsal setae (*dF*). Genua (G): Larvae have on the genua of legs I–III only lateral setae *l'G*, in protonymph setae *dGI–II* are added, in tritonymphs setae *l'GIV* are added. In all known species and their all postembryonic stages, genua of first pair of legs bear a bulb-like solenidion *sigma*. Tibiae (T): The typical pattern of tibia chaetotaxy for all stages is one dorsal (*dT*), one ventral (*vT*), two lateral setae (*l'T* and *l''T*) on legs I and II, and the same pattern, except setae *l''* (which is absent) on tibia III–IV. All stages have on the tibiae of legs I a cylindrical solenidion *phi*. Tarsi (TA): On tarsi I and II, cylindrical solenidion *omega* is present in all stages. Chaetotaxy of tarsus I in tritonymphs and adult stages is represented by ten setae: three ventral (*u'*, *u''* and *vs*) and seven dorsal – among them four rod-like euphatidial setae *a'*, *a''*, *tc'* and *tc''*, two fan-like setae *p'* and *p''* with well developed tines and unpaired setiform fastigial setae *ft*. Tarsus I in larval stage lacks the fan-like setae *p*, and tectals setae (*tc*) are hair-like (Fig. 5). In protonymph setae *p''* are added and tectals setae (*tc*) are rod-like. In tritonymph setae *p'* are added. In protonymphs and adult stages tarsus II bears seven setae: three ventral (*u'*, *u''* and *vs*) and four dorsal setae, one pair of fan-like setae *p'*, *p''* and one pair of filiform setae *tc'*, *tc''*. Larvae are devoid fan-like setae, in protonymph setae *p''* are added and in tritonymph setae *p'* are added. Tarsus III and IV in tritonymphs and adults possess two setae on the ventral side (*u'* and *u''*) and four setae on the dorsal side (*tc'*, *tc''*, *p'* and *p''*). In protonymphs, fan-like setae on tarsus IV are absent. They are also lacking on tarsus III in larval stage.

The scheme of chaetotaxy development of *Bubophilus* is similar to genus *Mironovia*. In both genera, the protonymphs possess only setae *p''* on tarsi I and II, compared to genera like *Syringophilus* Haller and *Colinophilus* Kethley, where both setae *p'* and *p''* on tarsi I and II are present [13,17].

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