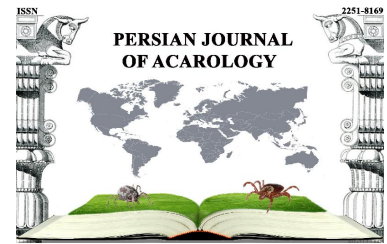




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Article

***Promyialges italicus* sp. nov. (Astigmata: Epidermoptidae) with redescriptions of mites of the families Epidermoptidae and Cheyletidae (Prostigmata) associated with *Pseudolynchia canariensis* (Diptera: Hippoboscidae) from Iran and Italy**

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ABSTRACT

Pseudolynchia canariensis (Diptera: Hippoboscidae) is a parasite of pigeons but also a host for hyperparasitic mites living on the same avian hosts. Four species and subspecies of mites found on this louse fly, *Myialges anchora*, *Promyialges italicus* sp. nov., *Promyialges lophortyx* (Astigmata: Epidermoptidae), and *Ornithocheyletia hallae hallae* (Prostigmata: Cheyletidae), are described or redescribed. One new species of feather mites is described from Tuscany, Pisa, Italy, from *Pseudolynchia canariensis* (Mcquart, 1840) from *Columba livia* (Gmelin, 1789). This is the first report of the genera *Myialges* and *Ornithocheyletia* for the Iranian fauna, while the subspecies *Ornithocheyletia hallae hallae* represents a new report for Asia. Specimens of *O. hallae* from populations in Italy and in Iran differ morphologically. According to these findings, we recognized two subspecies, *Ornithocheyletia hallae hallae* and *O. hallae similis*.

KEY WORDS: Description; hyperparasites; louse flies; *Myialges*; *Ornithocheyletia*; parasites; phoresy.

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INTRODUCTION

Parasitic skin mites of the family Epidermoptidae (Astigmata, Analgoidea), such as the genera *Promyialges* and *Myialges*, and some taxa of the family Cheyletidae (Prostigmata, Cheyletoidea) such as *Ornithocheyletia* species are found on birds, but some epidermoptids and cheyletids are characterized by an unusual mode of dispersal and infecting new host individuals. Some mite species of the genus *Microlichus* Trouessart, 1906 and *Ornithocheyletia* Volgin, 1964, use phoretic transportation by ectoparasitic louse flies (Diptera: Hippoboscidae) (Rettenmund *et al.* 2015). Epidermoptid mites inhabit the upper layer of the skin of the bird host, sometimes causing skin

diseases and eliciting an immune response, which can cause intense itching and may even lead to the death of the host (Evans *et al.* 1963; Fain 1965; Greve 1984; Gilardi *et al.* 2001). The phylogenetically most derived mite genera in the family are characterized by the unusual life-strategy of hyperparasitism by adult females. Fertilized females of the genus *Myialges* Trouessart, 1906 embed into soft regions of the cuticle of their hippoboscoid fly or chewing louse hosts by using specifically elongated mouthparts allowing them to feed on host hemolymph. They strongly attach to these hosts using large, anchor-like hooks on the anterior tarsi (Dubinin 1950; Hill *et al.* 1967; Buttiker and Cerny 1974; Fain and Grootaert 1996; Rettenmund *et al.* 2015).

The host ranges of both families include multiple families of birds. Parasitic cheyletid species are associated with a particular family of birds, where they feed on blood and tissue fluid. Because most species of *Promyialges* and *Myialges* are additionally associated with louse flies (Philips 2000), their bird host range tends to correspond to that of their dipteran hosts (Alekseev and Dubinina 1999; Philips 2000). However, the mechanisms of transmission among hosts are not yet fully understood. There is evidence that feather mites of other families occasionally attach to louse flies (Diptera: Hippoboscidae) and might also use these flies for phoretic transmission among birds Jovani *et al.* (2001). The family Epidermoptidae belongs to the clade Analgoidea and includes more than 100 species in 23 genera (Mironov 1999; Mironov and Dabert 1999; Fain and Bochkov 2003). Also, the bird-mite associations might be based on a host specificity. These assumptions are mostly based on morphological characters of for instance chewing lice (Fain 1965; Mironov *et al.* 2005). Switching over to a new host species can be result of a low vector specificity, whereas the high specificity of vectors may reduce the host range of the parasite and favor specialization (Whiteman *et al.* 2006). However, these correlations are not well understood especially in non-human systems (Fonseca *et al.* 2004). Although many evaluations about the frequency of parasites and as vectors for pathogens in birds have expressed their findings in the light of the presence or absence of the corresponding parasites and in the relative degree of the host specificity, there is an indication that parasites show a more conservative behavior compared to their parasitic hosts (Sehgal *et al.* 2001, 2005; Fallon *et al.* 2003; Ishtiaq *et al.* 2006). Generally, such conservatism leads to host relations as limitations for the numbers of parasite species per host (Eichler 1948).

For successful reproduction, females in species of the genus *Myialges* and *Promyialges* need to attach to insects as external parasites (Fain 1965). Gravid females of *Promyialges* and *Myialges* species have most commonly been found on dipterans and less frequently associated with chewing lice or on the birds themselves (Fain 1965). After mating, fertilized mite females go from birds onto insects and remain permanently attached to them. Female mites attach to insects and attach their eggs to the insect host's cuticle. After hatching, immature mites switch to the host bird and feed on its skin texture and interstitial fluid (Evans *et al.* 1963). Adult male mites and non-mated females live in the skin of the bird host. These mite stages are rarely found on insects (Fain 1965). Insects then transmit the new offspring of mites to new bird hosts.

The aim of this paper is to present records of phoretic and hyperparasitic mite species of the Cheyletidae and Epidermoptidae from *Pseudolynchia canariensis* on pigeons from two localities in Iran and Italy. Specimens of the cheyletid, *Ornithocheyletia hallae*, and the epidermoptid, *Myialges anchora* from both localities were compared morphologically with each other to test geographic differences. Finally, a new species of *Promyialges* similar to *Pr. lophortyx* (Furman & Tarshis, 1953) is described found on the wings of *Pseudolynchia canariensis*.

Myialges anchora was originally described by Trouessart (1907), and Sergent and Trouessart (1907) from a "cold-blooded host", *Pseudolynchia canariensis*. Because the Russian description by Dubinin (1951) including its figures is not detailed enough, relative to modern standards, we herewith redescribe the species based on new drawings and photographs.

Fain's (1965) redescription based on the original type material is satisfactory. However, some characters such as length of *si*, *se*, *d2*, *e2*, *ps1*, *f2* and *h2* are different from Iranian and Italian specimens (Table 2). Also, there is apparent confusion as to the original description of *M. anchora*. The first valid description is by Trouessart (1907 - dated 1906) in the 13 November 1906 minutes of the meeting of the Zoological Society of France. The description is authored by Sergent and Trouessart (1907). Nonetheless, all these descriptions lack photographic images. For comparison, this redescription has been used. Because *M. anchora* and *M. trinotoni* are greatly similar, the photographic picture can be a great help in differentiating these species.

MATERIALS AND METHODS

Mites were removed from the louse fly, *Pseudolynchia canariensis*, which appears as a common parasite of domestic pigeons. Flies were collected using different methods, such as light traps and nets, from Alborz, Karaj, Iran, 35° 48' N, 50° 59' E, alt. 1550 m and Tuscany, Pisa, Italy, 43° 42' N, 10° 24' E, alt. 6 m. The samples were then transferred into 70% ethanol and stored for two weeks at 23 °C. Mites associated with Hippoboscidae were isolated by using a stereomicroscope and then cleared in 85% lactic acid at 27 °C for 72 hours. Afterwards, the samples were mounted on microscope slides in Hoyer's medium (Evans 1992). The main morphological terminology, including idiosomal and leg chaetotaxy, followed Gaud and Atyeo (1996), Bochkov (2008), and Mironov *et al.* (2010). Redescriptions of *Myialges anchora* and *Ornithocheyletia hallae hallae* are based on specimens collected in Iran, while specimens of *Pr. lophortyx* and *Pr. italicus* **sp. nov.** originated in Italy.

The voucher specimens of the three species treated in this paper are deposited in the Acarological Laboratory of Shiraz Branch, Islamic Azad University (ACSIAU) and Jalal Afshar Zoological Museum (JAZM), Faculty of Agriculture, University of Tehran, Karaj, Iran. Measurements were made with a differential interference microscope (Leica DML, Amscope T490-A and B) and illustrations were prepared using an Amscope camera. Measurements are given in micrometers (µm).

RESULTS

Family Cheyletidae Leach, 1815

Genus *Ornithocheyletia* Volgin, 1964

Type species: *Ornithocheyletia dubinini* Volgin, 1964;
Syn.: *Ornithocheyletia barri* Smiley, 1977

For generic diagnosis see Fain (1981).

Ornithocheyletia hallae hallae Smiley, 1970 (Figs. 1–4)

Ornithocheyletia hallae – Smiley (1970), Fain (1981), Macchioni (2003), Macchioni *et al.* (2005), Valim and Gazêta (2007), Marcelino *et al.* (2009), Bilal (2012).

Ornithocheyletia hallae hallae – Smiley (1970), Fain (1981).

Material examined

Nine females from two countries, four females, Iran, Alborz, Karaj, 35° 48' N, 50° 59' E, alt. 1550 m a.s.l., O. Joharchi coll., on *Pseudolynchia canariensis* collected from domestic pigeons *Columba livia*, deposited in JAZM and ACSIAU. Five females, Italy, Tuscany, Pisa, 43° 42' N, 10° 24' E, alt. 6 m, F. Macchioni coll., on *P. canariensis*, deposited in JAZM and ACSIAU.

Amended diagnosis

Dorsal idiosoma (Fig. 1, A) – Body short and wide, Width/Length > 1. Cuticle striated, bearing three sclerotized plates: two large sclerotizations, one located anteriorly (propodonotal) and one medially (hysteronotal), and a much smaller subterminal (pygidial) plate. In some species these plates are very poorly or not sclerotized and bear very fine striations. Ventral surface clearly striated. Coxae strongly sclerotized and in some species their internal parts striated. Vulva located subtermino-ventrally. Anus generally terminal. Gnathosoma small with unusually long palps; palpfemur distinctly longer than all other articles of the pedipalps. Palptibia short, ending in a curved "claw". Palptarsus without combs. Peritremes short, with three or four pairs of segments.

Description

Female (Fig. 1, A, B) – Body length, including gnathosoma (390–420), width (200–210). Gnathosoma (Fig. 4, A) (72–80) long, (55–60) wide. Female with the following setae: *vi*, *ve*, *sci*, *sce*, *c1*, *c2*, *d1*, *d2*, *e1*, *fl*, *h2*, *la*, *3a*, *4a*, *ag1*, *ag2*, *ag3*, *gl*, *g2*, *ps1*, *ps2*, *ps3*. Setae: *sci* 178, *sce* 48, *vi* 33, *ve* 42, *c1* 182, *c2* 172, *d1* 23, *d2* 36, *e1* 41, *fl* 25, *h2* 177. Palpal femur about 18 long. Palpal tibial claw without teeth. Peritremes slightly arched; with 6–7 pairs of transverse striated segments. Rostrum (protegmen) and rostral shield weakly ornamented. A few tubercles and striations present in anterior part of peritremes. Idiosoma (270–295) long; idiosomal length/ width ratio 1.3, distance *2c*–*3b* about 25, more than 1/8 of body width. Remnants of propodonotal and hysteronotal shields as distinct weak spots (ultrafine spots with periodically). Propodonotum with 5 pairs of setae, setae *c4* absent. All propodonotal setae setiform. Setae *d2* about 160 long. Hysteronotum with 2 pairs of setiform setae (*e1*, *e2*), sizes and shapes similar to propodonotal setae; setae *f2* inserted significantly on pygidial plate. Two pairs of genital setae, 2 pairs of pseudogenital setae, and 3 pairs of aggenital setae present. Setae *ag4* and *ag5* are barbed (Fig. 4, B). The pygidial plate is 42–45 wide. Setae *sci*, *c1*, *c2* and *h2* smooth and 180 long (Fig. 1, A) Setae *vi*, *ve*, *sce*, *d1* 45–60 long (Fig. 1, A). Setae *h2* 157. Tibia III-IV with 3 setae. Tarsus IV with at least one branched setae (at the base of two branches) (Fig. 3, C). Solenidion of tibia I inflated in its middle part and about 5 long (Fig. 3, A). Solenidion genu I without a stalk (Fig. 2, B).

Legs (Fig. 3, A–D) – All usual leg setae of *Ornithocheyletia* present. Leg I–IV setation: tarsi 7 (*tc'*, *tc''*, *a''*, *u'*, *u''*, *vs* smooth, *p'* and *p''*) -7 + solenidion $\omega 1$ (*tc'*, *tc''*, *u'*, *u''*, *vs* smooth, *p'* and *p''*) -7-7, tibiae 4 + solenidion ϕ + (*d*, *v'*, *v''* smooth, *l'* serrate)-3 + solenidion ϕ -3-3, genua 2 + solenidion σ (*d* serrate, *l'* smooth)-2-2-1, femora 2 (*d* serrate, *v* smooth)-2-1-1, trochanters 1 (*v* serrate)-1-0-0, coxae 2 (*1b* and *1c* smooth)-1 (*2b* smooth)-2 (*3b* and *3c* smooth)-1 (*4b* smooth). Coxae forming two sections separated by striated cuticle, an anterior with coxae I-II and a posterior smaller area with coxae III-IV. Tarsi with a dorsal preapical protuberance and ending in paired claws and a multi-rayed empodium.

Remarks

Ornithocheyletia hallae Smiley, 1970 was originally described from a pigeon (*Columba livia*) in Brownsville, Texas, USA (Smiley 1970). Fain (1972) described *O. similis* from a common emerald dove, *Chalcophaps indica* that had been imported into Belgium from Asia. In 1981, Fain published a revision of *Ornithocheyletia* and reduced *O. similis* to a subspecies of *O. hallae* and distinguished *O. hallae hallae* and *O. hallae similis* on measurements of the setae *sci*, *c1*, *c2*, and *h2* and the width of the pygidial plate. The first description was based female (Smiley 1970). In 1978, Smiley described the two male forms and a "nymph" (clearly the nymph II), in which males appeared in two different forms, "normal and heteromorphic males". Our redescription and studies are based on females instead and their different morphologies at different collection sites. Our figures and photographs are herewith presented with more morphological details and will support the identification of subspecies.

Females of *O. hallae hallae* Smiley, 1970 and *O. hallae similis* Fain, 1972 are similar, but differ in the lengths of setae *sci*, *c1*, *c2* and *h2* (180 long in *O. hallae hallae* versus 140–150 in *O. hallae similis*) and the pygidial plate width (45 in *O. hallae hallae* versus 32 in *O. hallae similis*).

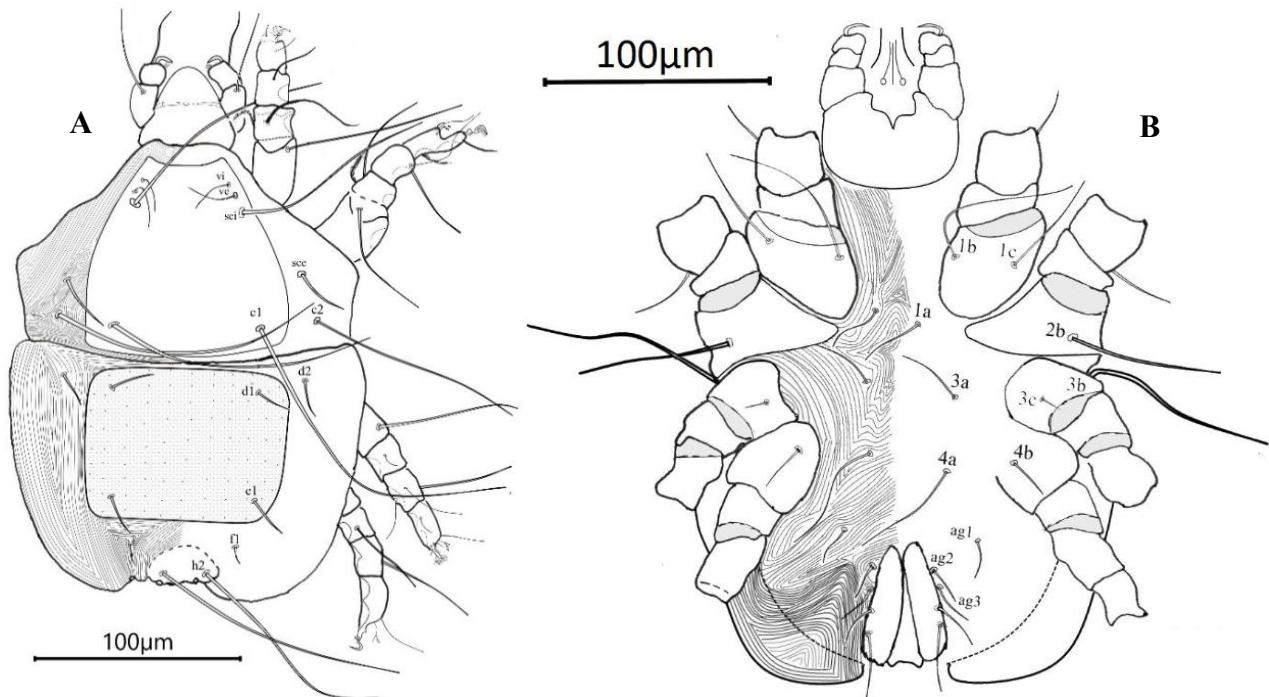


Figure 1. *Ornithocheyletia hallae hallae* Smiley, 1970 (female) – A. Dorsal mite in total view with idiosomatal setation. Left side: Cuticula sculpture; B. Ventral idiosoma.

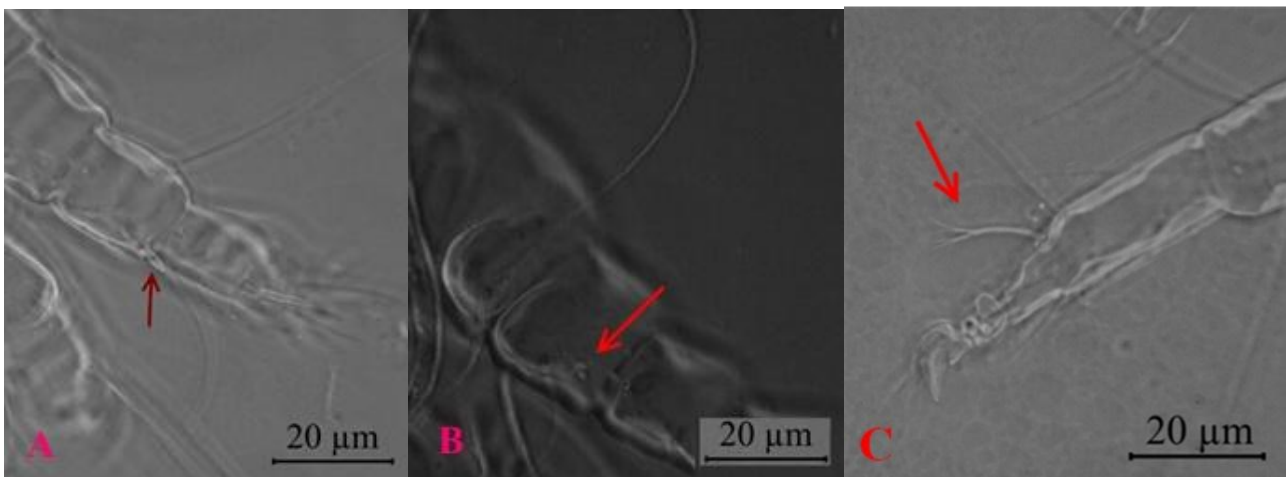


Figure 2. *Ornithocheyletia hallae hallae* Smiley, 1970 – A. Solenidion of Ti I; B. Solenidion of Ge I (dorsal view); C. Ta IV.

Male – not found.

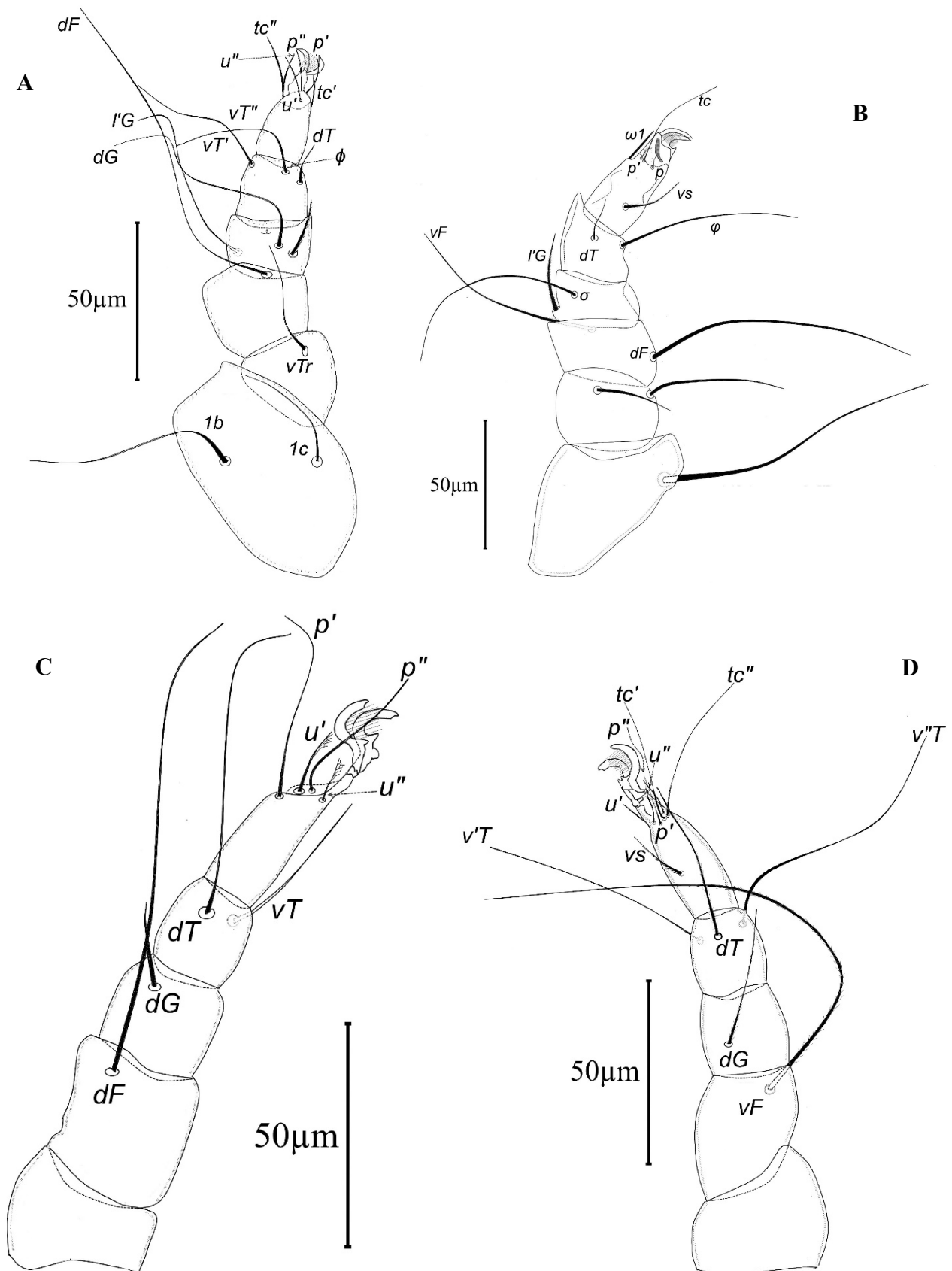


Figure 3. *Ornithocheyletia hallae hallae* Smiley, 1970 – A. Leg I; B. Leg II; C. Leg III; D. Leg IV.

Family Epidermoptidae Trouessart, 1892
Subfamily Myialginae Trouessart, 1906

Type genus: *Myialges* Trouessart, 1906.

***Myialges anchora* Trouessart, 1907 (Figs. 5–8)**

Myialges anchora – Furman and Tarshis (1953), Fain (1965), Macchioni *et al.* (2005), Mironov *et al.* (2005), Valim and Gazêta (2007), Marcelino *et al.* (2009), Bilal (2012).

Type host – *Pseudolynchia canariensis* (Diptera: Hippoboscidae) from domestic pigeons *Columba livia*.

Material examined

Ten females (JAZM and ACSIAU) from two locations in Iran, Alborz, Karaj, 35° 48' N, 50° 59' E, alt. 1550 m, collected by O. Joharchi. Six females (JAZM and ACSIAU) Italy, Tuscany, Pisa, 43° 42' N, 10° 24' E, alt. 6 m, collected by F. Macchioni

Redescription

Female (Figs. 5, A, B) (n = 10, all specimens ovigerous) – Idiosomal length × width, 665 × 373 (635–665 × 365–392). Gnathosoma: subcapitulum trapezoidal, strongly attenuated anteriorly, not reach to anterior of apex of Leg I. Length including palps 64 (62–65), width at base 51 (50–58), length/width ratio 1.1–1.2; pseudorutellar membrane not extends laterally; distal part of palps simple; length of chelicerae 75 (58–77). Dorsum (Fig. 5, A): with striated lines. Idiosoma ovoid, without sejugal furrow, dorsal setae smooth, *si* 41, *se* 135, *cl* 35, *d2* 38, *1a* 30, *3a* 60, *4b* 35, *g* 47, *4a* 48, *f2* 290, *h1* 130, *h2* 62, *ps1* 52. Prodorsal shields: triangular in shape with compact spot, postero-lateral extensions blunt, not reach to beyond bases of scapular setae *se* and *si* or maybe reach to basis of *si*; antero-lateral curved and extensions to lateral margins of prodorsum and fuse with bases of epimerites Ia; median part of posterior margin slightly concave (Fig. 8 A); greatest length of shield 95 (84–100), width in widest level 126 (120–139). Distance between scapular setae: *se:se* 103 (103–113), *si:si* 69 (67–75); setae *si* postero-mesal to corresponding setae *se*; distance between transverse levels of these setae 25 (22–26). Scapular shields well developed. Humeral shields present, moderate. Setae *c2* on humeral shields. Length of hysterosoma 524 (501–641). Setae *h2* located on posterior margin of opisthosoma with short extension. Setae *h3* ventral, at level of bases of *h2*. Distance between hysteronotal setae: *c2:d2* 110 (103–153), *d2:e2* 152 (147–196), *e2:h2* 272 (272–318), *h2:h2* 61 (61–69). Epimerites I fused in Y-shape, surrounded with narrow sclerotized area; lateral margins of this area surrounded by irregular lines (Fig. 5, 8B). Epimerites II slightly curved. Coxal fields II with sclerotized area of triangular form. Coxal fields III and IV ovoid and completely sclerotized. Epimerites IVa absent. Epigynum at level of anterior of epimerites I, thick anchor-shaped, posterior margin with straight line, maximum thickness (at mid-line) 21 (17–23), width 77 (75–85). Genital papillae at level of setae *3a*, close to their bases. Folds of ovipore sclerotized in posterior of (*g*) setae and at mid-line of coxa IV. Setae *3b* on sclerotized areas of coxal fields III (Fig. 8B), and with two pairs of genital papillae covered by genital valves and a pair of genital setae (Fig. 13A). Distance between ventral setae: *3a: g* 28 (18–28), *g: 4a* 72 (72–90). Spermathecal duct with the same size than diameter of copulatory opening, spermathecal sac shaped like a bubble. Pretarsi of all legs bilobate. Claw of tarsus I with two arms, anchor shaped. Length of transverse piece of this extension 45 (42–49) (Fig. 6). Tibia II sharp, reflexed apophysis; Caruncles bilobed.

Legs (Figs. 7, A-C) – coxae 1, 0, 1, 0; trochanters 1, 1, 1, 1; femur 1, 1, 0, 0; genua 2, 2 + 1 σ , 0, 0; tibiae 2 + 1 ϕ , 1 + 1 ϕ , 1 + 1 ϕ , 1 + 1 ϕ ; tarsus 5, 7, 5, 4. Claw like structure absent on some legs or smaller and vestigial. Apophyses of tarsi prominent though modified and anchor like on 1st tarsus, claw absent on tarsus II, claw like of tarsus I with two arms, anchor shaped (Fig. 6), tibia II without apophysis. Legs dark brown pigmented.

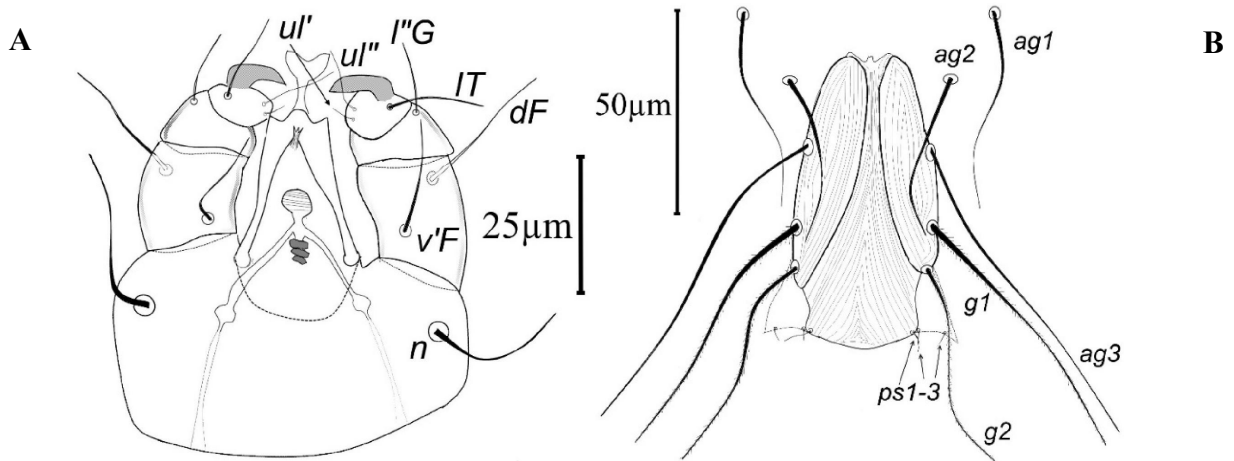
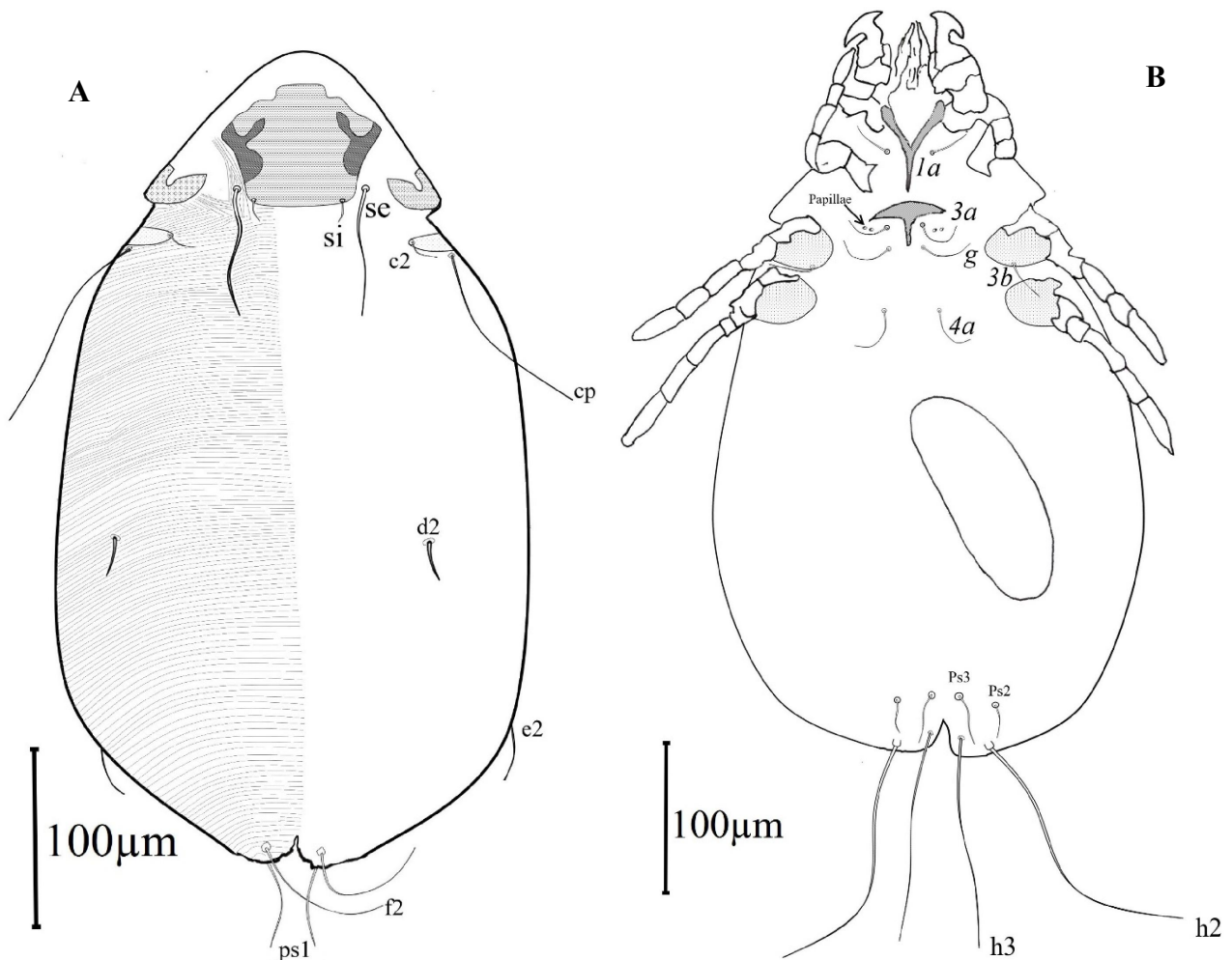


Figure 4. *Ornithocheyletia hallae hallae* Smiley, 1970 – A. Gnathosomal structure; B. Anogenital region.



Figures 5. *Myialges anchora* Trouessart, 1907 (Female) – A. Dorsal view of ofidiosoma, left side in grey colors: detailed sculpture of the dorsal cuticle; B. Ventral view of body.

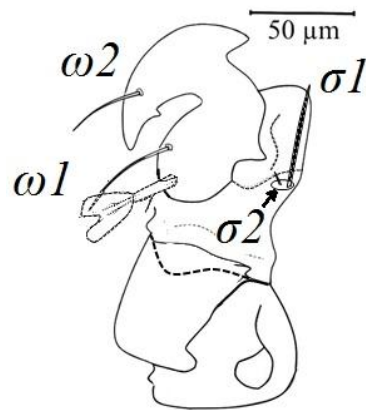


Figure 6. *Myialges anchora* Trouessart, 1907 (female) – Leg I.

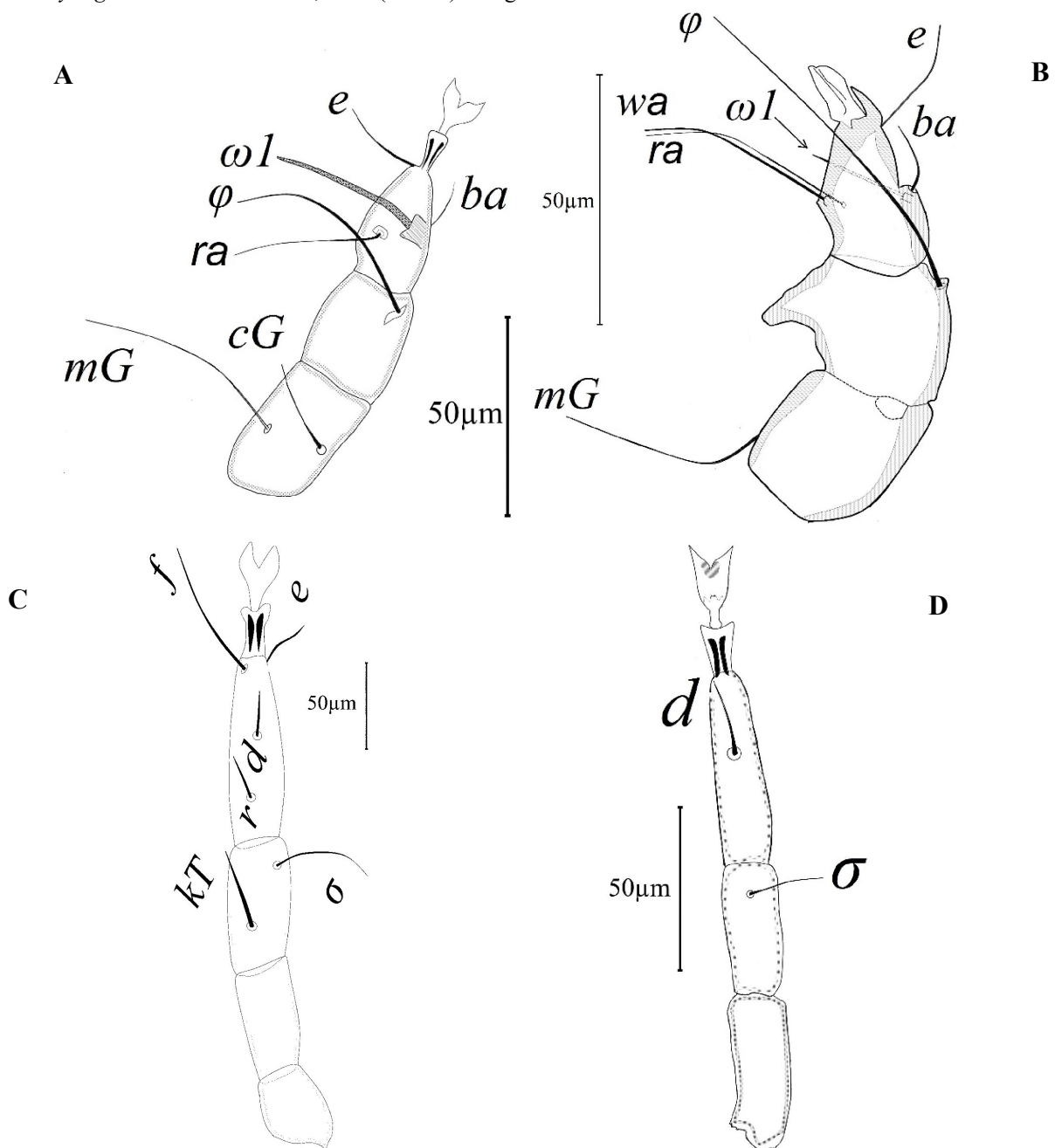


Figure 7. *Myialges anchora* Trouessart, 1907 (female) – A. Leg II; B. Leg II; C. Leg IV.

Remarks

The two species *Myialges anchora* Trouessart, 1907 and *My. trinotoni* Cooreman, 1944 are morphologically most similar to each other, but differ by the shape of tibia II, which bears a reflexed apophysis and bilobed ambulacral disc in *M. anchora* while in *Myialges trinotoni*, the tibia II lacks an apophysis and the ambulacral disc is bell-shaped.

Male – not found.

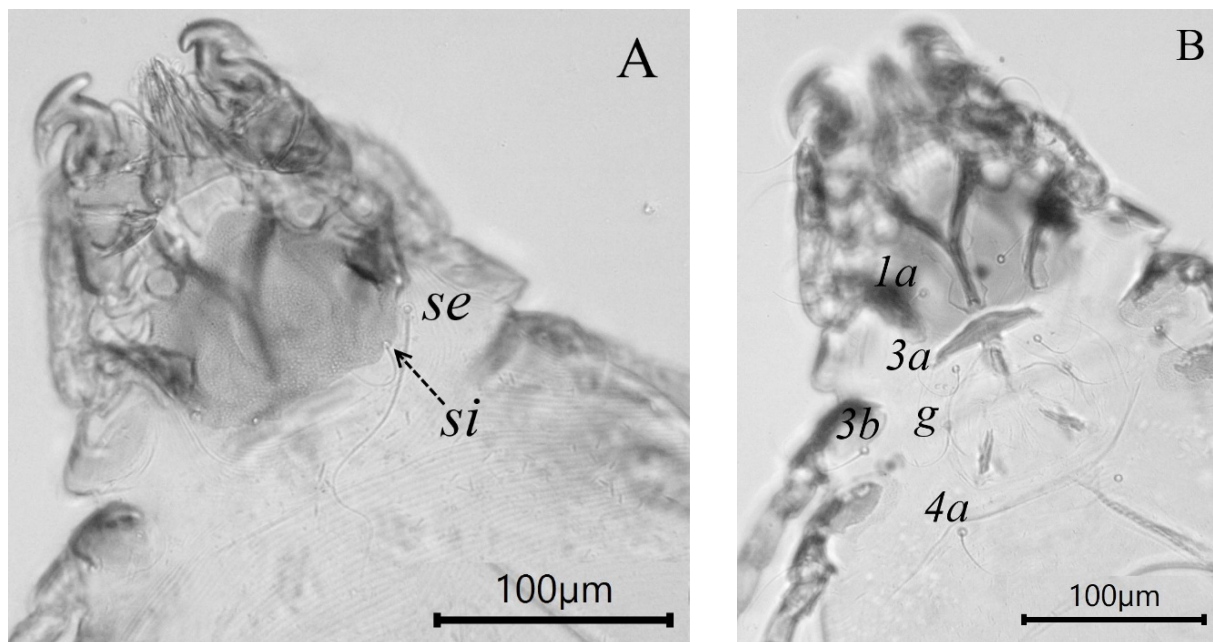


Figure 8. *Myialges anchora* Trouessart, 1907 (female) – A. Dorsal view of propodosoma; B. Ventral view of podosoma.

Subfamily Epidermoptinae Trouessart, 1892

Genus *Promyialges* Fain, 1965

Type species: *Microlichus uncus* Vitzthum, 1934

Promyialges italicus sp. nov. (Figs. 9–12)

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Promyialges lophortyx – Furman and Tarshis (1953), Macchioni *et al.* (2005), Marcelino *et al.* (2009).

Type host – *Pseudolynchia canariensis* (Mcquart, 1840) from *Columba livia* (Gmelin 1789).

Type material

Female holotype and five female paratypes from Tuscany, Pisa, Italy, 43° 42' N, 10° 24' E, alt. 6 m., F. Macchioni collector. Holotype and three paratypes – JAZM, two female paratypes – ACSIAU.

Diagnosis

Dorsum with striated lines. Prodorsal shield triangular and with troughs in the anterior. Idiosoma ovoid, sejugal furrow located between *si* and *c2*, dorsal setae smooth. *d1* and *e1* located on hysterosomal shield. Ornamentation structure with circular pattern. Apodemes of coxae I fused; outer scapular setae delicate, 2/3 as long as propodosomal plate. With anchor-like structure exceeding apodemes of coxa II.

Description

Female (Figs. 9 A, B; n = 7, all specimens ovigerous) – Idiosoma saccate, Idiosomal length \times width, 467 \times 258 (326–496 \times 193–282) greatest width at level posterior to legs IV 256–260. Gnathosoma: subcapitulum triangular, strongly attenuated anteriorly, moderately elongate (reach to tarsi leg I), length including palps 57 (56–61), width at base 39 (39–42), length/width ratio 1.4; length of chelicerae 53 (51–58). Prodorsal shields: postero-lateral extensions blunt, not extend to bases of scapular setae *se* and *si* (*se* and *si* located out of prodorsal shield). Antero-lateral extensions extend to lateral margins of prodorsum and fuse with bases of epimerites Ia; median part of posterior margin concave; greatest length of shield 88 (85–91), width close to level of scapular setae 110 (107–110). Light yellow to semitransparent. Dorsum with 2 pairs of prodorsal setae (*si* and *se*) and 8 pairs of hysterosomal setae (*c2*, *cp*, *d2*, *e2*, *ps1*, *f2*, *h2* and *h3*), all dorsal setae simple. Distance between scapular setae: *se:se* 112 (108–112), *si:si* 97 (89–97); internal scapular setae shorter than external scapular setae these setae located at same level and distance between transverse levels is 6 (5–8). Scapular shields well developed. Humeral shields present, large. *c2* on humeral shields. Hysterosomal setae *c2* and *d2* and *e2* short (microsetae). Setae *c2* not reaching until the posterior end of their own plate. Length of *d2* and *e2* approximately equal and less than 1/3 distance between these setae. Setae *cp* very long (more than twice as *c2*); *d2* and *e2* located on hysterosomal plate. Length of hysterosoma 364 (227–376). Distance between hysteronotal setae: *c2:d2* 108 (61–108), *d2:e2* 80 (80–89), *e2:h2* 106 (44–107), *h2:h2* 90 (72–92). Epimerites I fused in inverse arc; posterior tip of sternum bifurcate (Fig. 9B). Epimerites II narrow and slightly curved. Coxal fields II with sclerotized area. Coxal fields III and IV completely sclerotized. Epimerites IVa absent. Epigynum at level of sejugal furrow with acute tips and bidentate median extension on posterior margin, maximum thickness (at mid-line) 9 (9–13), width 118 (70–118). Genital opening present between coxae III and IV, with 1 pair of genital setae (*g*). Genital folds present. All around folds of ovipore with sclerotized. Setae *3b* on sclerotized areas of coxal fields III (Fig. 9B). Distance between ventral setae: *3a:g* 58 (44–66), *g:4a* 91 (26–91). Spermatheca and spermducts as in figure 12. Coxal plates I not reaching to posterior extremity of prosternal apodeme; anal opening posteriorad of genital opening, with 2 pairs of setae (*ps3*, *ps2*). Legs light brown. Pretarsi of all legs bilobate. Tarsus I with claw like dorsal extension (round and sickle shaped) (Fig. 10A); length of transverse piece of this extension 25 (25–26); tarsi of legs III with short dorso-apical spine (Fig. 10C). Chaetotaxy of legs (Figure 10A, D): coxae 1, 0, 1, 0; trochanters 1, 1, 1, 0; femur 1, 1, 0, 0; genua 2 + 1 σ , 2 + 1 σ , 0, 0; tibiae 2, 2, 2, 2; tarsus 7, 5 + 1 dorso-apical spine + 1 ω , 5 + 1 dorso-apical spine, 5 + 1 dorso-apical spine.

Differential diagnosis

Promyialges italicus **sp. nov.** most closely resembles *Pr. lophortyx* in the similarity of the prodorsal shield shape and the structure of the membranes of the gnathosoma and shape of hysterosomal shield. Females of *Pr. italicus* **sp. nov.** differ from those of *Pr. lophortyx* by having setae *si* located at the same level as *se*, *c2* short and not reaching the posterior edge of humeral shield, setae *g* at level trochanter IV (vs. setae *g* before coxa IV as in Fig. 13C), *cp* not located on humeral shield, *d2* and *e2* are short and not reach half the distance between each setal pair (Fig. 9A).

In *Pr. lophortyx*, solenidion φ on tibia II is thin, stick-like and equal in length to the segment, the epigynum is thinner (8–9) and the sclerotized area around the sternum attenuates towards. On the other hand, *Pr. italicus* **sp. nov.** is similar to *Pr. pari* Fain, 1965 in the shape of hysterosomal shield; however, it differs from the latter species by having a prodorsal shield bearing a pair of spots antero-lateral in *Pr. pari*. In *Pr. pari*, the prodorsal shield is in the shape of a trapezium, both pairs of scapular setae are situated on the posterolateral margin of the shield.

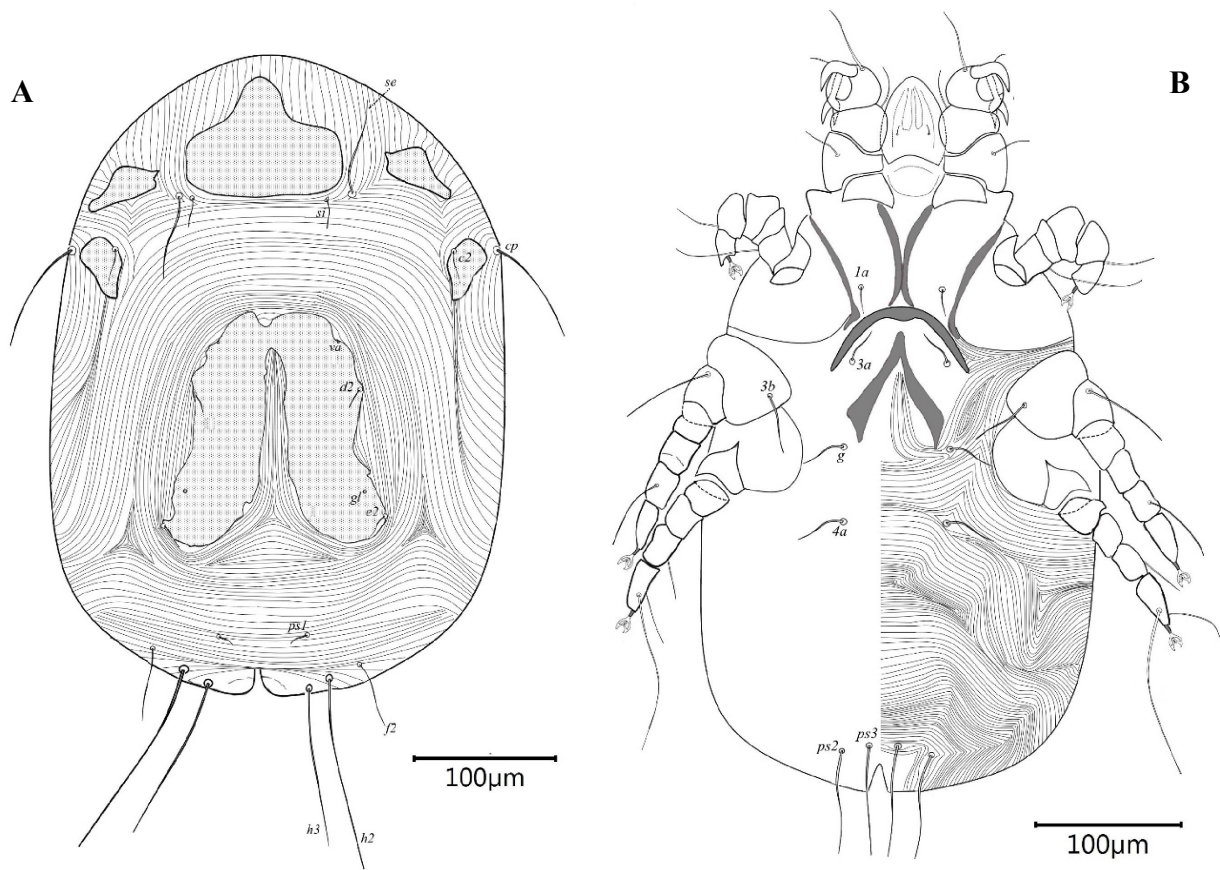


Figure 9. *Promyialges italicus* sp. nov. (female) – A. Dorsal view of idiosoma; B. Ventral view of body.

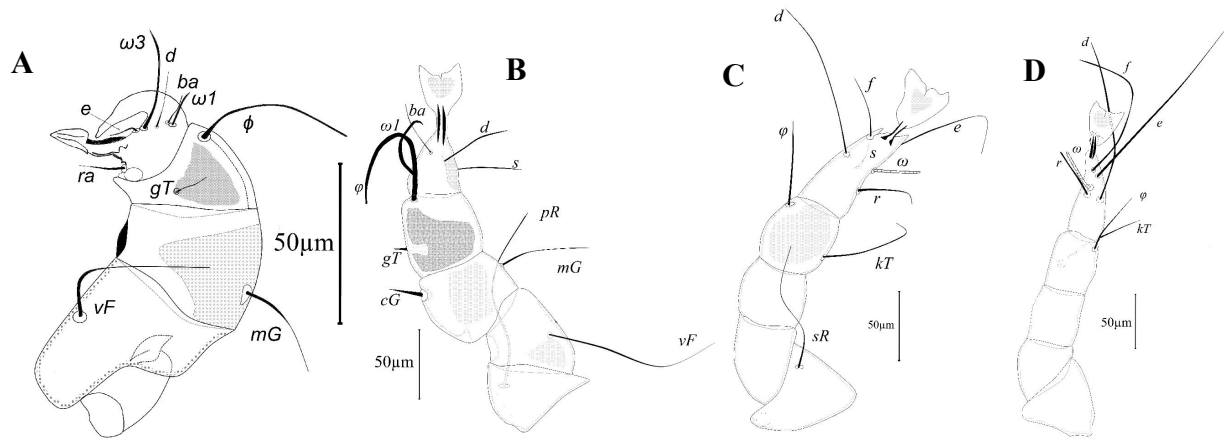


Figure 10. *Promyialges italicus* sp. nov. (female) – A. Leg I; B. Leg II; C. Leg III; D. Leg IV.

Etymology

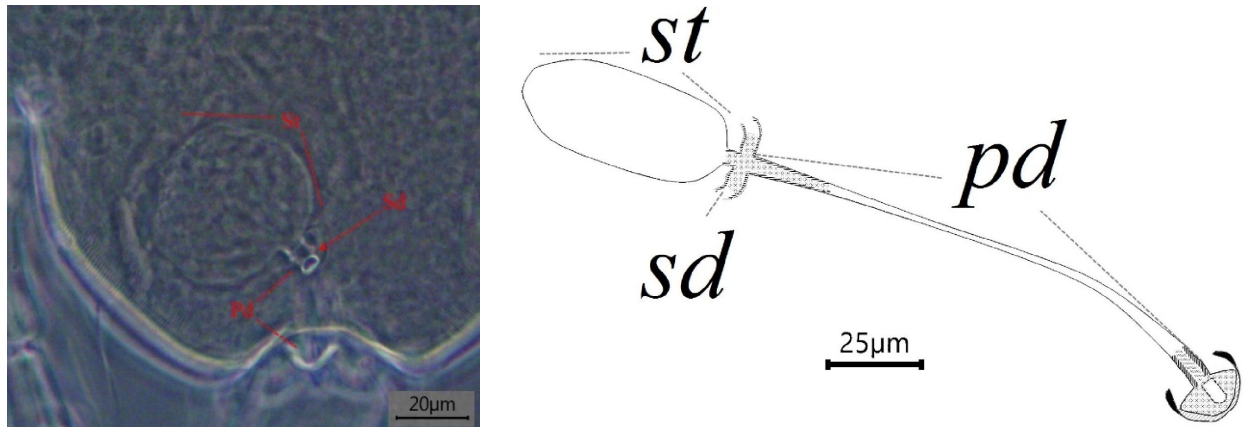
The species is named after Italy country where the new species was found.

Remarks

Mironov *et al.* (2005) studied the phylogeny of four species belonging to *Promyialges* and divided the genus into two groups. Group I included *Pr. pari* and *Pr. uncus* Vitzthum, 1934.

According to *Pr. italicus* **sp. nov.** similar to this group. These are with *Pr. lophortyx* (Furman & Tarshis, 1953) closely similar to *Pr. italicus* **sp. nov.** but differs from it by the shapes apodemes of coxae I (in *Pr. lophortyx* fused versus not fused in *Pr. unicus*) and the length of the outer scapular setae (in *Pr. lophortyx* delicate, 2/3 as long as propodosomal plate versus in *Pr. unicus*). Level of scapular setae in *Pr. lophortyx* differ to *Pr. italicus* **sp. nov.** (in *Pr. lophortyx* *si* posteriorly *se* as in Fig. 13B) *c2*, *d2* and *e2* long and each one reach to posteriorly setae (Fig. 13B).

Male – not found.



Figures 11–12. Spermatheca and spermducts – 11. *Promiyalges lophortyx* (Furman & Tarshis, 1953) (female); 12. *Promiyalges italicus* **sp. nov.** (female). Pd = primary spermduct; sd = secondary spermduct; st = spermatheca.

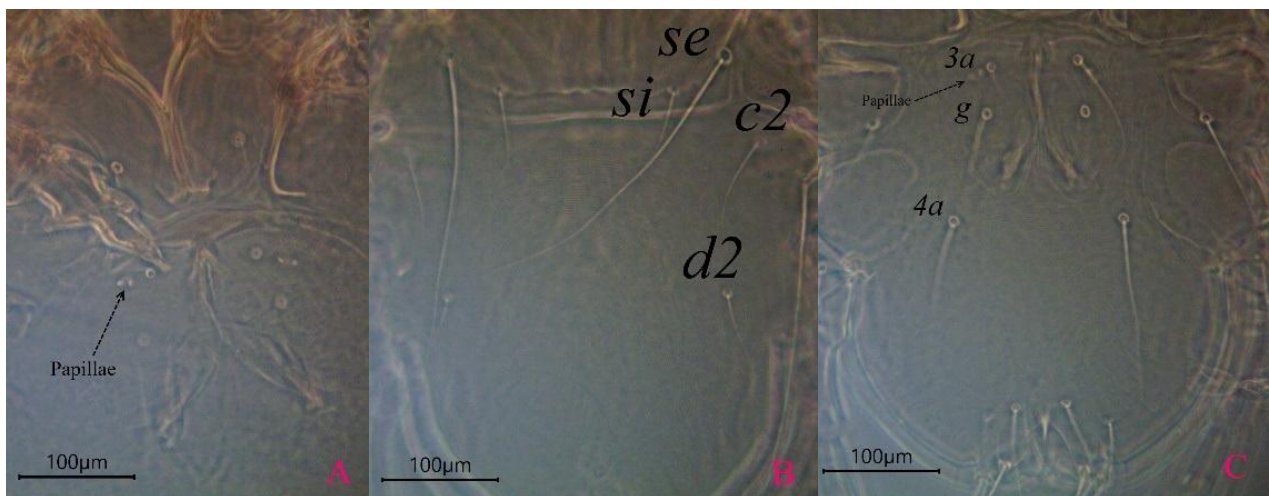


Figure 13. A. *Myialges anchora* Trouessart, 1907 (female) – Genital papillae; B, C. *Promiyalges lophortyx* (Furman & Tarshis, 1953) (female) – B. Dorsal view of podosoma, C. Ventral view of metapodosoma.

Comparative morphological measurements between different populations of species

Some characters among three species within different sites were compared; *Pr. lophortyx* is not found in Iran, but Italian species were surveyed and compared with original descriptions (Furman and Tarshis 1953). Length and width differences are reported. Ratio of length/width were in the original description ≈ 1.4 and in Italian specimens ≈ 1.6 . As a result, the ratio of original specimens is less than Italian specimens (Table 1).

As to *M. anchora*, nine characters in populations from Iran and Italy were compared with each other. A clear difference was observed between their body lengths and widths, so that ratio of

length/width in Iranian specimens is 1.7 and in Italian specimens is 1.6 but show clear differences in comparison with Fain, 1965 as 2.5. The length of *d2*, *f2*, and *h2* setae indicated clear differences between Iranian and Italian specimens (Table 2).

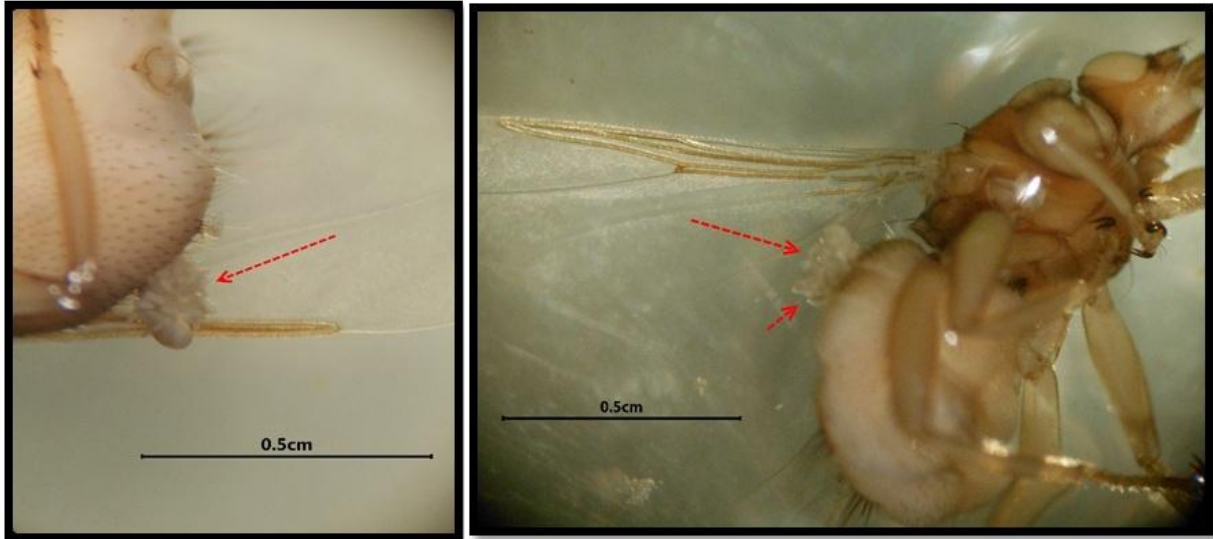


Figure 14. *Pseudolynchia canariensis* (adult) with abundant phoretic mites collected from decedent in the advanced state of decomposition, from Tuscany, Pisa County.

Ornithocheyletia hallae hallae was studied in three geographic regions of Alborz, Iran, Tuscany, Pisa, Italy and the Canoga Park, California (Smiley 1977). Body size, shape of the pygidial plate and also some setae, such as *sci*, *vi*, *c1*, *c2*, *d2*, and *h2* differed regarding their lengths. In the original description and our Italian specimens, the ratio of length/width was ≈ 1.7 , whereas the ratio of length/width in Iranian specimens was 1.8. Some of these variables are different only in subpopulations. To differ subspecies of *O. hallae hallae* and *O. hallae similis*, the width of the pygidial plate and the lengths of setae *sci*, *c1*, *c2* and *h2* long was important. In Italian specimens the pygidial plate was distinctly wider, while setae *sci*, *c1*, *c2* and *h2* were distinctly longer 180 of our Iranian specimens (Table 3).

Table 1. Comparison of some dorsal setal length of females in different population of *Promiyalges lophortyx* (Furman & Tarshis, 1953).

Species origin	length	width	<i>si</i>	<i>se</i>	<i>c1</i>	<i>d2</i>	<i>h1</i>	<i>h2</i>	<i>h3</i>	<i>ps3</i>	<i>ps2</i>	<i>ps3</i>
Original description	316	216	-	-	-	30	-	286	-	-	-	-
Italy (n = 10)	356–493	212–299	11–26	105–137	24–34	24–36	36–65	168–261	113–375	89–125	53–125	20–58

Table 2. Comparison of some setal length of females in different populations of *Myialges anchora* Sergent & Trouessart from Iran and Italy.

Species origin	length	width	<i>si</i>	<i>se</i>	<i>d2</i>	<i>e2</i>	<i>ps1</i>	<i>f2</i>	<i>h2</i>
Iran (n = 7)	635–665	365–392	40–56	118–140	26–55	38–70	27–80	290–329	54–170
Italy (n = 12)	360–786	231–481	46–58	125–155	41–54	42–54	35–48	330–363	186–227
Fain (1965)	650–725	260–290	55–75	160–180	50–65	60	60	350–400	150–200

Table 3. Comparison of some setal length of females in different population of *Ornithocheyletia hallae hallae* Smiley, 1970 with those collected in Iran and Italy.

Species origin	length	width	pygidial plate	vi	ve	sci	sce	c1	c2	d1	d2	e1	f1	h2
Original description	342	199	45	45–60	45–60	180	45–60	180	180	–	45–60	–	–	180
Iran (n = 12)	315–318	162–182	42–45	33–35	42–44	142–152	48–52	150–156	156–160	23–26	36–39	41–43	25–27	157–162
Italy (n = 7)	304–320	166–200	35–42	39–42	45–55	152–185	33–59	169–195	168–196	22–30	42–51	39–48	25–35	163–189

DISCUSSION

In our findings, most species of the subfamilies Epidermoptinae and Myialginae indicated an affiliation to be associated with hippoboscids. Finding a new host depends on the host specificity of the dipteran insects, since most *Microlichus*, *Metamicrolichus* and *Promyialges* species were reported having a wide range of bird taxa as suitable available hosts (Hill *et al.* 1967; Fain and Grootaet 1996).

Another cheyletid mite of the genus *Ornithocheyletia*, can cause severe hyperkeratinosis to their bird hosts and consequently might transfer secondary fungal infections to the common pigeon, *Columba livia* (Haarlov and Morch 1975).

This species has relatively short legs and a well-developed hook in the anterior part of its front legs. It apparently lives with a low growth rate on the bird hosts until being transferred from one host to a new one, which happens through a mite layer of plumage. Females use the family Hippoboscidae as phoretic carriers so that they reach their new host bird via this special dispersal strategy. In the family Epidermoptidae, the phoresy as dispersal model obviously must have had evolved independently in at least three separate clades (Mironov *et al.* 2005). *Myialges* mite species are considered to be specific to a host since they attack Hippoboscidae insects and lice from the same bird host as hyperparasites (Cooreman 1944).

We assume that the mites of *Myialges* and *Promyialges* species have less specialized hosting features apparently reflecting a low level of specificity of their insect vectors. Another explanation for this might be indicated by their morphological conservatism. In short, a lot of information about the species is assigned by birds and insects as the host.

These hyperparasitic mites use insects as a source of food and a suitable habitat for the deposition of their eggs. Their females do not require to be transferred to birds as new hosts because they are not able to pull out their anchor-like organ on their first paw from the skin of their birds.

We found different mite species being attached to hippoboscids. An interesting finding about our 20 studied *Pseudolynchia canariensis* fly species was that the area between abdomen and thorax was the preferred attachment site of *Pr. Lophortyx*; another favored area was the whole posterior abdomen of the dipterans, where they were commonly connected with the ventral denominator (Fig. 14).

We redescribed species of epidermoptid mites collected in Iran and Italy. For the first time, the taxonomic relevance of the shape of spermathecae in *Pr. lophortyx* was pointed out. The morphological differences in specimens of one species from populations of different regions confirmed the findings of former authors that subspecies need to be differed from each other. Louse flies as hyperparasitic vectors play, according to our findings, a more important role than assumed by former authors. We discovered significant morphological differences between populations of *M. anchora*. Body lengths in samples from the West Palearctic had a wider range of variations unlike specimens from the climatically more stable Eastern region. Significant differences between the size of setae *e2*, *ps1*, *f2* and *h2* were pointed out. The ratio of setae *h2* compared between specimens from

Italy and Iran was ≈ 3.4 . The maximum length of setae *ps1* in the Iranian samples was almost twice as long as in the Italian samples (Table 2).

Myialges anchora species were collected on birds, which lived on the hillside in a mountainous region in Iran and birds in significantly warmer plain-areas in Italy. We discovered distinct morphological differences within mite species, which presumably were related to the different ecological circumstances, in which these populations lived. Specimens from Iran were characterized by a significant more stable body shape (with even a low size difference between the samples) and had longer bodies, while specimens from Italy possessed significantly longer setae *d2*, *ps1* and *h2*. We need to survey the intra-specific variation, in order to understand the morphological variability within this species and also to contribute to new ideas about the evolution towards new species in the corresponding mite taxa. The conversion of variation within one species into differences among species can be the result of the evolution of new species. Evolutionary mechanisms, such as the natural selection, influence the balance of mutations and generally can improve the transgression of species' borders. This study aimed to contribute to an understanding of variation among populations (geographic variation) (Ridley 2003). Ecological and morphological studies about *M. anchora* in the future might clarify, whether mite specimens from Italy and Iran indeed represent the same species, whether they represent different subspecies or despite these different characters need to be interpreted as a species with its normal geographic variations.

Also, the setae-sizes in *Pr. lophortyx* were not properly described in the original description, which is why a direct comparison with our findings could not be performed. According to our findings, only specimens collected in the Western region of the Palearctic possess micro-setae in the positions of *d2* and *e2*.

We studied morphological characters of *O. hallae* in more detail due to the fact that mite specimens were collected from different hosts. Differences regarding the lengths of setae *sci*, *c1*, *c2*, *h2* and regarding the width of the pygidial plate appeared in specimens from both hosts. All specimens from domestic pigeons represented *O. hallae hallae*. Other specimens of the same subspecies *O. hallae hallae* were discovered on *Chalcophas indica*. *Ornithocheyletia hallae hallae* were so far only reported from America, Europe and Africa. On the Asian continent, only *O. hallae similis* Fain, 1972 from India was known, while *O. hallae hallae* was overseen until our study. We thus contributed herewith to the knowledge about the distribution of bird related mite species, along with mite subspecies. This is the first record of *O. hallae hallae* from Asia and Iran. Our findings from Asia indicated morphological differences between populations of this subspecies from Italy and Iran. We interpret these slight differences as evolutionary adaptations to the different particular hosts. We nevertheless consider *Ornithocheyletia* specimens from both counties as belonging to the same subspecies.

Morphological differences between specimens of our two different sampling sites, Italy and Iran, and also California (USA) as the original habitat of the subspecies *O. hallae hallae* (Smiley 1977; Fain 1981) were presumably due to ecological differences between these locations; however, all three regions were despite of their great humidity in a sufficient distance to the sea.

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گونه جدید *Promyialges italicus* (Astigmata: Epidermoptidae) به همراه بازتوصیف
کنه‌هایی از خانواده‌های *Epidermoptidae* و *Cheyletidae* (Prostigmata) مرتبط با مگس
Pseudolynchia canariensis (Diptera: Hippoboscidae) از ایران و ایتالیا

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چکیده

گونه *Pseudolynchia canariensis* (Diptera: Hippoboscidae) به عنوان انگل کبوتر شناخته شده است. همچنین به عنوان میزبانی برای کنه‌های هایپرپارازیت که در ارتباط با پرندگان مشابه زندگی می‌کنند، نیز شناخته می‌شود. سه گونه و یک زیر گونه کنه در ارتباط با *Pseudolynchia canariensis* جمع‌آوری شده است. گونه‌های *Promyialges italicus sp. nov.* (Astigmata: *Myialges anchora* Epidermoptidae) و زیرگونه *Ornithocheyletia hallae hallae* (Prostigmata: Cheyletidae) جدیدی از منطقه توسکانی، پیزا در کشور ایتالیا، در ارتباط با دو بالان گونه *Pseudolynchia canariensis* انگل کبوترهای *Columba livia* (Gmelin, 1789) توصیف شده است. این نخستین گزارش از جنس *Myialges* و *Ornithocheyletia* برای فون کنه های ایران است، در حالی که زیرگونه *O. hallae hallae* نخستین گزارش برای فون کنه های آسیا محسوب می‌شود. جمعیت گونه‌های *O. hallae* در ایتالیا و ایران از نظر ریخت‌شناسی مقایسه شدند. با توجه به این یافته‌ها، دو زیرگونه *O. hallae hallae* و *O. hallae similis* را که پیش‌تر توصیف شده بودند، شناسایی شدند.

واژگان کلیدی: توصیف؛ هایپرپارازیت‌ها؛ مگس‌های شپشی؛ *Myialges*؛ *Ornithocheyletia*؛ انگل‌ها؛ هم‌سفری.

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