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FEATHER MITES OF THE GENUS *PANDALURA* HULL (ASTIGMATA: PSOROPTOIDIDAE) FROM OWLS AND CAPRIMULGIFORMS

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ABSTRACT

Two new species of the feather mite genus *Pandalura* Hull, 1934 (Psoroptoididae: Pandalurinae) are described for the first time from birds of the order Caprimulgiformes: *Pandalura oconnori* sp. n. from *Steatornis caripensis* Humboldt, 1817 (Steatornithidae), and *Pandalura podargi* sp. nov. from *Podargus strigoides* (Latham, 1802) (Podargidae). Two previously described species of this genus from owls (Strigiformes: Strigidae) are redescribed based on materials from corresponding type hosts: *P. strigisoti* (Buchholz, 1869) from *Asio otus* (Linnaeus, 1758), and *P. cirrata* (Müller, 1860) comb nov. from *Bubo bubo* (Linnaeus, 1758). An improved diagnosis of the genus *Pandalura* and a key to known species are provided.

Key words: feather mites, *Pandalura*, Psoroptoididae, systematics, host associations, Strigiformes, Caprimulgiformes

ПЕРЬЕВЫЕ КЛЕЩИ РОДА *PANDALURA* HULL (ASTIGMATA: PSOROPTOIDIDAE) С СОВ И КОЗОДОЕОБРАЗНЫХ

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РЕЗЮМЕ

Два новых вида перьевых клещей рода *Pandalura* Hull, 1934 (Psoroptoididae: Pandalurinae) впервые описаны с птиц отряда Caprimulgiformes: *Pandalura oconnori* sp. nov. с *Steatornis caripensis* Humboldt, 1817 (Steatornithidae) и *P. podargi* sp. n. с *Podargus strigoides* (Latham, 1802) (Podargidae). Два ранее известных вида этого рода с сов (Strigiformes: Strigidae) переописаны с использование материала с соответствующих типовых хозяева: *P. strigisoti* (Buchholz, 1869) с *Asio otus* (Linnaeus, 1758) и *P. cirrata* (Müller, 1860) comb nov. с *Bubo bubo* (Linnaeus, 1758). Предложены новый диагноз рода *Pandalura* и ключ для всех известных видов.

Ключевые слова: перьевые клещи, *Pandalura*, Psoroptoididae, систематика, связи с хозяевами, Strigiformes, Caprimulgiformes

INTRODUCTION

The feather mite genus *Pandalura* Hull, 1934 (Psoroptoididae) is one of eight genera recently recognized of the subfamily Pandalurinae (Gaud and Atyeo 1982, 1996; Mironov 2004, 2007). Mites of this genus, as for all representatives of the family Psoroptoididae, have the typical appearance of inhabitants of downy feathers, which are characterized by the following features: a flattened and moderately widened idiosoma, relatively long lateral and caudal setae of the body, and well developed two anterior pairs of

legs provided with spine- and hook-like processes for attaching to thread-like barbs (Mironov 1987; Dabert and Mironov 1999). Mites of the genus *Pandalura* mostly live on downy parts of the covert feathers of the body. Nevertheless, representatives of this genus as well as other pandalurines very often can be found on firm vanes of the flight and tail feathers of their hosts (personal field observations).

According to the current taxonomic concept (Gaud and Till 1961; Gaud and Atyeo 1982) the genus *Pandalura* included to date a single species *Pandalura strigisoti* (Buchholz, 1869). This species was originally described from the Long-eared Owl *Asio otus* (Linnaeus, 1758) in Europe (Buchholz 1869). Since then, mites referred to this species have been recorded from 17 species of seven genera of owls from the families Strigidae and Tytonidae (Strigiformes) (Canestrini and Kramer 1899; Hull 1934; Lonnfors 1937; Gaud 1958, 1980; Gaud and Till 1961; Atyeo and Philips 1984; Philips 2000). Therefore, it was reasonably assumed for a long time that this genus is restricted to hosts from the order Strigiformes. Nevertheless, in past thirty years findings of unnamed *Pandalura* species were reported from caprimulgiform birds by Gaud and Atyeo (1982, 1996) and OConnor (University of Michigan, USA, personal com.). Unfortunately, all these records were undescribed.

In the present paper I describe two new species of the genus *Pandalura* from caprimulgiform birds of the families Podargidae and Steatornithidae and redescribe two species from owls: the type species *P. strigisoti* and one more species transferred from the genus *Dimorphus* Haller, 1878. Additionally, an improved diagnosis of the genus *Pandalura* and a key to all known species are proposed.

It is important to note that the occurrence of mites of the genus *Pandalura* both on Strigiformes and Caprimulgiformes, used as a parasitological criterion, supports the hypothesis of a close relationship between these orders, or at least of the lineages of Podargidae and Steatornithidae with owls as was recently shown by Barrowclough e*t al.* (2006) (see Livezey and Zusi 2007 for various alternative hypotheses on phylogeny of Caprimulgiformes).

MATERIAL AND METHODS

The material from owls belongs to the mite collection (UFC ZIN No. 2-2.20) of the Zoological Institute of the Russian Academy of Sciences; these specimens were collected from living or accidentally killed birds by the author and colleagues from different institutions. Mites were stored in 70% ethanol and mounted in slides in Faure medium according to standard technique (Evans 1992). Samples from caprimulgiform birds (mites mounted on slides) were granted to the named collection by the late Prof. W.T. Atyeo (University of Georgia, Athens, USA).

The species description is given in the modern format proposed for mites of the family Psoroptoididae (Mironov and Pérez 2002; Mironov 2004, 2007; Mironov and Proctor 2005). General morphological terms and the leg and idiosomal chaetotaxy follow Gaud and Atyeo (1996). The measuring technique for opithosomal lobe structures is as proposed by Mironov (2004) specifically for psoroptoidid mites. All measurements are in micrometers (μm). Latin names and systematics of birds follow Dickinson (2003).

Measuring techniques for particular structures:

(i) length of idiosoma is measured from the anterior margin to bases of setae *h3* on the lobar apices (in males) and to posterior margin of opisthosoma (in females), width of idiosoma is measured at level of the humeral shields;

(ii) hysterosoma is measured from the level of sejugal furrow noticeable on the lateral margin of the body to the bases of setae *h3*;

(iii) distance between different pairs of setae is the shortest distance between the transverse levels formed by setae of respective pairs;

(iv) prodorsal shield length is measured along the midline, and width is the greatest width at the level of the postero-lateral extensions;

(v) hysteronotal shield length in males is the greatest length from the anterior margin to bases of setae *h3*; width is measured at the anterior margin;

(vi) hysteronotal shield length in females is the greatest length from the anterior margin to the posterior one; width is measured at anterior and posterior margins;

(vii) length of terminal lobar digit in males is measured along its lateral margin.

Abbreviations indicating depositories of type and other materials: UMMZ – the Museum of Zoology of the University of Michigan (Ann Arbor, USA); ZIN– the Zoological Institute of the Russian Academy of Sciences (Saint Petersburg, Russia), MBUCV – Colección de Parasitología, Museo de Biología, Universidad Central de Venezuela (Caracas, Venezuela).

SYSTEMATICS

Family Psoroptoididae Gaud et Atyeo, 1982

Subfamily Pandalurinae Gaud et Atyeo, 1982

Genus *Pandalura* Hull, 1934

Type species: *Dermaleichus strigisoti* Buchholz, 1869, by original designation.

Diagnosis. *Both sexes.* Pandalurine mites of medium or large size. Palpal setae *dTi* bifurcate with unequal branches. Prodorsal shield narrow, occupying median part of prodorsum, with or without longitudinal crests, with short postero-lateral extensions bearing setae *se, si* (Figs. 1A, 2A). Vertical setae *vi* present, setae *ve* absent. Median hysteronotal setae *c1, d1, h1* present or absent, setae *e1* present. Epimerites I fused into a Y. Supracoxal setae *scx* absent. Tarsi I, II without ventral process, with or without acute apical extension (Figs. 3A, B, 7A, B). Tibiae I, II with pair of large and usually acute ventral processes. Femora I, II with rounded lateral margin or with large hook-like process. Legs I–IV with full set of setae characteristic for Analgoidea.

Male. Opisthosomal lobes of complicated configuration: outer margin of each lobe with 2 incisions between 3 finger-like extensions: anterior extension bearing seta *f2* (corresponding to postero-lateral angle of opisthosoma in other Pandalurinae), lateral lobar digit carrying seta *h2,* and terminal lobar digit bearing seta *h3* (narrowed apical part of lobe) (Figs. 1A, B). Setae *ps2* situated anterior to bases of setae *f2*. Terminal cleft large, parallel-sided or with poorly expressed blunt-angular ledge bearing seta *ps1*. Interlobar membrane situated in anterior part of terminal cleft (Fig. 8A) or spreading to lobar apices (Fig. 1A, 4A) and forming short terminal lamellae (Fig. 5A). Epimerites II and III free from epimerites IV (actually fused epimerites IIIa and IV), coxal fields II, III open. Setae *3a* on inner tips of epimerites IV, setae *3b* on inner tips of long and strongly curved epimerites III. Genital apparatus small, situated at level of trochanters III, aedeagus shorter than genital arch. Paragenital apodemes well developed, long and wide, forming a long inverted U and encompassing genital field (Fig. 1B), or their posterior ends completely fused forming large entire plate between genital and anal fields and genital apparatus appears completely encircled (Fig. 8B). Adanal apodeme present, represented by entire long bow-shaped sclerite, with setae *ps3* on its posterior margin and with adanal membrane on anterior margin.

Legs III strongly hypertrophied. Tibia III with short antaxial and paraxial processes (spurs), membranous ventral spur present or absent (Figs. 3C, D). Tarsus III elongate, attenuate apically, with acute and flattened apical extension; seta *w* situated basally, blade-like or lanceolate; other setae of this segment filiform. Tarsus IV elongate, subequal in length to corresponding tibia, without any processes; seta *d*, *e* barrel-shaped with well-developed apical discoid cap situated apically; seta *r* short spiculiform, situated apically (Fig. 3E).

Female. Hysteronotal shield as longitudinal plate slightly enlarged posteriorly or rectangular. Posterior end of opisthosoma with two pairs of macrochaetae, *h2, h3*. Epigynium semicircular or horseshoe-shaped, free from epimerites (Fig. 2B). Setae *d* of tarsi III, IV shorter than corresponding segments.

Hosts. Strigiformes: Strigidae and Tytonidae; Caprimulgiformes: Podargidae and Steatornithidae.

The genus includes 4 species.

Remarks. 1. The unique male features of the genus *Pandalura* discriminating it from other seven genera of the subfamily Pandalurinae are as follows: idiosomal setae *ps2* are situated anterior to setae *f2*; setae *h2* are situated on the lateral lobar digit (Figs. 1A–C); tarsus IV is normally developed, elongate and subequal in length to corresponding tibia (Figs. 3E, 10D); seta *r* of tarsus IV is short and spiculiform; seta *w* of tarsus III is blade-like, straight or curved (Figs. 3C, D, 7C). These features put the genus *Pandalura* in a quite separate position within the subfamily. In other pandalurine genera, setae *ps2* are situated much posteriorly, i.e. on the lateral lobar digits, while setae *h2* sit near the postero-lateral angles of opisthosoma bearing setae *f2*, (Mironov 2004, 2007). Thus, the lateral lobar digits in *Pandalura* males appear to be not homologous to those in other pandalurines. In contrast to *Pandalura*, tarsus IV in males of all other genera of Psoroptoididae is strongly shortened, half as long as the tibia, or even shorter. Within the family Psoroptoididae, the blade like seta *w*III is observed only in males of the genus *Hexacaudalges* Mironov et Proctor, 2005, but that genus has seta *r*III also blade-like and occupies quite separate position in the subfamily Psoroptoidinae owing to a number of its own unique features (Mironov and Proctor 2005). Females of *Pandalura* are rather similar to those of other pandalurine genera and can be clearly differentiate only by having setae *d* of tarsi III, IV noticeably shorter than corresponding segments, and narrow prodorsal and hysteronotal shields.

2. When Hull (1934) established the genus *Pandalura*, it included eight species, which according to modern taxonomic concepts now belong to different genera of the families Analgidae and Psoroptoididae. Gaud and Till (1961) reduced the species content of *Pandalura* to the type species, *Pandalura strigisoti*, although these authors did not propose any renewed diagnosis for this genus. Since this time to the present day, it has been considered that the genus includes only this species widely distributed on Strigiformes. Almost all researchers working after 1870s missed one more closely related species, *Dermaleichus cirratus* Müller, 1860, which was described from the Eurasian Eagle Owl *Bubo bubo* (Linnaeus, 1758) from Europe (Müller 1860). Only Oudemans (1939) noticed this publication and even synonymized *D. strigisoti* with *D. cirratus*, but his work was also missed by subsequent experts.

3. Although most records of *Pandalura* species have been from owls (see Philips 2000), unnamed representatives of this genus were detected on caprimulgiform birds of the families Podargidae (Gaud and Atyeo 1982, 1996) and Steatornithidae (OConnor, University of Michigan, USA, personal communication). Unfortunately, these quite interesting records essentially enlarging the host range of the genus and giving important evidence regarding relationships of owls and caprimulgiforms remained undescribed. The present paper tries to fill this gap in knowledge.

Key to species of the genus *Pandalura* Hull, 1934

1. *In both sexes*, lateral margins of femora I, II with large hook-like process (Figs. 10A, B). Hysteronotal setae *c1, d1* and *h1* absent. *In male*, posterior parts of paragenital apodemes fused forming entire plate between genital and anal fields (Figs. 8, 9A) . . . . . *P. podargi* sp. n.
– *In both sexes*, lateral margins of femora I, II without hook-like processes (Figs. 3A, B). Hysteronotal setae *d1* and *h1* present, setae *c1* present or absent. *In male*, posterior parts of paragenital apodemes not fused each other and genital field remains open posteriorly (Fig. 1B) 2
2. *In male*, length of idiosoma about 700, supranal concavity not opening into terminal cleft, incision in interlobar membrane with angular anterior end, seta *w* of tarsus III lanceolate, straight (Figs. 5A, B, 7C). *In female*, hysteronotal shield roughly rectangular, setae *d2, e2* situated on lateral margins of this shield (Fig. 6A) . . . . . *P. oconnori* sp. n.
– *In male*, length of idiosoma less than 450, supranal concavity opening into terminal cleft, incision in interlobar membrane with rounded anterior end, seta *w* of tarsus III blade-like and curved (Figs. 1A, 3D, E). *In female*, hysteronotal shield slightly enlarged posteriorly, its posterior part 1.5–2 times wider than anterior one, setae *d2, e2* situated on striated tegument (Figs. 2A, 4E) 3
3. *In male*, width of terminal cleft in anterior part 30–35, setae *ps1* situated at midlevel of terminal lobar digits, paragenital apodemes extending well past midlevel of anal suckers (Figs. 1A, B). *In female*, setae *h1* situated in posterior angles of hysteronotal shield or near them (Fig. 2B). *In both sexes,* setae *c1* absent . . . . . *P. strigisoti* (Buchholz, 1869)
– *In male*, width of terminal cleft in anterior part 45–50, setae *ps1* in basal part of terminal lobar digit, paragenital apodemes usually not extending past the anterior margin of anal suckers (Figs. 4A, B, E). *In female*, setae *h1* situated closer to each other than width of hysteronotal shield at posterior margin. Setae *c1* in male present, in females present or absent . . . . . *P. cirratus* (Müller, 1860) comb. n.

***Pandalura strigisoti* (Buchholz, 1869)**
(Figs. 1–3)

Dermaleichus strigisoti Buchholz, 1869: 45, t. 5, fig. 31.
Dimorphus strigisoti, Haller 1878: 558, t. 33, figs. C, 2, 20; t. 34, fig. E, t. 35, fig. H.
Megninia strigisoti, Berlese 1886: fasc. 25, No. 9; Canestrini and Kramer 1899: 97; Bonnet 1924: 156, fig. 8.
Pandalura strigisoti, Hull 1934: 203, 205; Gaud and Mouchet 1958: 40 (part.); Gaud and Till 1961: 202, fig. 117 (part.); Gaud 1980: 55 (part.).
Analges sunuosus Mégnin 1977 in: Robin and Mégnin 1877: 516, t. 28, fig. 5.

Material examined. 5 males, 5 females (ZIN 4528-4543, 10 slides) from *Asio otus* (Linnaeus, 1758) (Strigidae), RUSSIA: Kaliningrad Province, Rybachy village, 55°05´N, 20°44´E, 7 October 1979, coll. S.V. Mironov.

Description. *Male* (5 specimens from *A. otus*). Length of idiosoma 390–405, width of idiosoma 245–255, length of hysterosoma 303–316. Prodorsal shield: longitudinal plate with almost parallel-sided lateral margins, postero-lateral extension bearing scapular setae *se, si* small and rounded, posterior margin convex, 102–106 in length, 70–75 in width at posterior margin, surface with pair of longitudinal grooves, distance between setae *se* 60–66. Hysteronotal shield: slightly narrowed in anterior part, anterior margin slightly convex, anterior angles rounded, greatest length 265–275, width at anterior margin 78–85. Setae *c1* absent, setae *d1–h1* present.

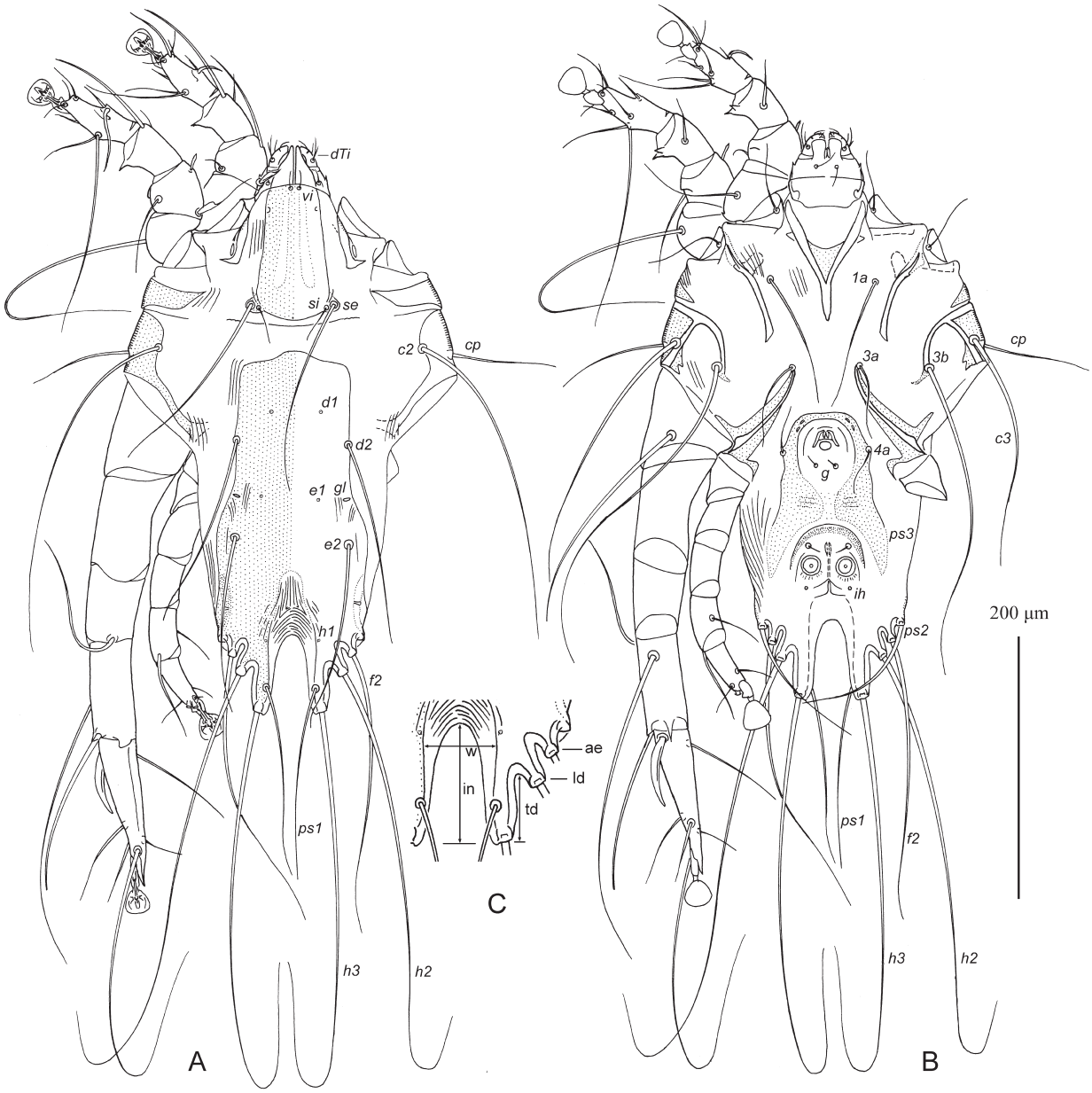

Fig. 1. *Pandalura strigisoti* (Buchholz, 1869), male. A – dorsal view; B – ventral view; C – details and measuring technique for some structures of opisthosomal lobes.

Abbreviations: ae – anterior extension of opisthosomal lobe, dt – length of terminal lobar digit, in – length of incision in interlobar membrane, ld – lateral lobar digit, w – width of terminal cleft.

Supranal concavity widely open into terminal cleft, border line between concavity and cleft indistinct. Terminal cleft with lateral margins parallel-sided in anterior part and slightly divergent posteriorly; interlobar membrane occupying anterior part of cleft and stretching by narrow bands to lobar apices, anterior end of incision in interlobar membrane rounded (Fig. 1A). Terminal lobar digit of opisthosomal lobes straight, with setae *ps1* situated approximately at its midlevel. Measurements of opisthosoma: length

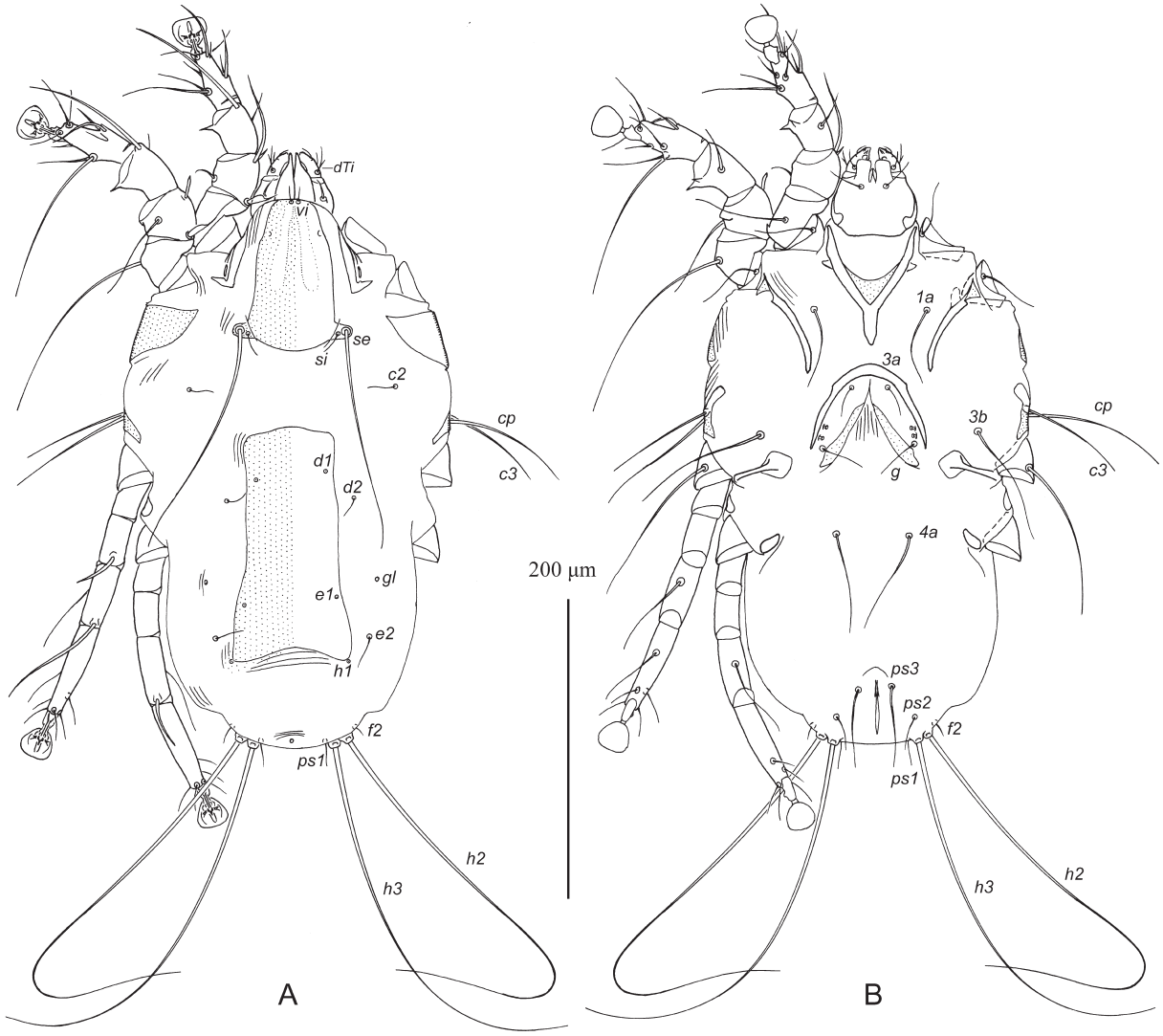

Fig. 2. *Pandalura strigisoti* (Buchholz, 1869), female. A – dorsal view, B – ventral view.

of terminal cleft including supranal concavity (from anterior end of concavity to lobar apices) 102–110, length of incision (from anterior end of incision to lobar apices) 57–62, length of terminal lobar digit 30–35, width of cleft in anterior part (excluding interlobar membrane) 30–35, width of lobe at base (at level of setae *ps2*), width of terminal lobar digit in distal part 13–15. Distance between setae: *c2:d2* 66–75. *d2:e2* 74–77 *e2:h3* 125–130, *h2:h2* 72–78, *h3:h3* 48–53, *ps2:ps2* 105–110, *ps1:ps1* 38–40, *d1:d2* 22–24, *e1:e2* 32–35, *ps1:h3* 15–18.

Length of sternum including sclerotized area between branches of epimerites I 35–40. Setae *3a* and *3b* approximately at same transverse level. Coxal fields IV with narrow sclerotized areas at bases of trochanters. Genital apparatus 12–13 long, 17–20 wide, aedeagus minute. Posterior ends of paragenital apodemes not fused with each other posterior to genital apparatus area, extending past the anterior margins of anal suckers (Fig. 1B). Setae *g* posterior to level of setae *4a*. Adanal apodeme semicircular, thin, with narrow membrane along anterior margin. Anal suck-

ers 13–15 in diameter. Distance between setae: *3a:4a* 62–65, *4a: g* 9–13, *g: ps3* 65–68, *ps3:h3* 112–118.

Lateral margin of femur I with small acute indentation lateral margin of femur II rounded (Figs. 3A, B). Tarsi I, II without acute apical extension. Tibiae I, II each with pair of ventral spines of subequal size. Ventral setae of tarsi and tibiae I, II not thickened. Tibia III with short and acute antiaxial spine at base of solenidion φ and with rounded paraxial spine, both about 4–6 long, and with acute membranous ventral spine (Figs. 3D, E). Tarsus III with acute apical extension, length of this segment 115–117, width at base 25–28; setae *w* blade-like, curved, 52–58 long. Tarsus IV 40–42 long, two times longer than wide at base, setae *d, e* barrel-shaped, with clear discoid caps, setae *r* short spiculiform (Fig. 3E).

Female (5 specimens from *A. otus*). Length of idiosoma 365–385, width of idiosoma 220–230, length of hysterosoma 255–268. Prodorsal shield shaped as in male, slightly narrowed anteriorly, 100–108 long, 80–85 wide, setae *se* separated by 72–75. Scapular shields large. Setae *cp* slightly longer than setae *c3* approximately equal to summed length of trochanter, femur and genu III. Hysteronotal shield shaped as narrow trapezium, anterior margin slightly convex, posterior margin slightly concave, length 153–165, width at anterior margin 62–66, width at posterior margin 82–90 (Fig. 2A). Setae *d1, e1* on hysteronotal shield near its lateral margins, setae *h1* in posterior angles of this shield or near them, setae *d2* and *e2* on striated tegument. Distance between setae: *c2:d2* 75–78, *d2:e2* 97–105, *e2:h3* 74–78, *h2:h2* 74–77, *h3:h3* 55–60, *d1:d2* 20–22, *e1:e2* 31–38.

Length of sternum including sclerotized area between epimerites I 46–50. Epigynum usually extending to level of setae *g*, 55–58 long, 74–78 wide (Fig. 2B). Epimerites IIIa narrow, with strongly enlarged inner tips. Epimerites IVa present, short. Copulatory opening dorso-terminal. Distance between setae: *3a:3b* 33–36, *3a:g* 42–48, *g:4a* 56–62.

Legs I, II as in male, legs IV extending by distal half of tarsus beyond posterior margin of the body; tarsus III 62–64, tarsus IV 64–66 long (Figs. 3F, G).

Remarks. 1. *Deramaleichus strigisoti*, the type species of the genus *Pandalura*, was originally described by Buchholz (1869) from the Long-eared Owl *Asio otus*. Later, Haller (1878) moved this species to the genus *Dimorphus* 1878. Approximately at that time, Mégnin (in: Robin and Mégnin 1877) described *Analges sinuosus* Mégnin, 1877 from a few species of owls. Although this author gave only French names of two owl species, the first host was "Moyen-Duc", which corresponds to *A. otus*. Berlese (1886) synonymized *A. sinuosus* with *D. strigisoti* apparently based on sufficiently informative illustrations of the male opisthosoma and coincidence of hosts and placed this species into the genus *Megninia* Berlese, 1881, which for a long time incorporated most analgid and psoroptoidid mites with well developed opisthosomal lobes (Canestrini and Kramer 1899; Bonnet 1924). Hull (1934) established a new genus *Pandalura* with the type species *D. strigisoti*. Not knowing about that publication, Oudemans (1939) continued to treat *D. strigisoti* in the content of the genus *Dimorphus* and synonymized it with *D. cirratus* (Müller, 1860) (see remarks for the next species) described from the Eurasian Eagle Owl *B. bubo*. This taxonomic decision as well as the existence of *D. cirratus* (Müller, 1860) remained unnoticed for subsequent researchers.

2. Reducing the species content of the genus *Pandalura*, Gaud and Till (1961) for reasons unclear indicated "*Strix flammea* (=*Tyto alba*)" as the type host of *P. strigisoti*. This was quite strange, because these Latin names are not synonyms; each of them corresponds to a valid owl species, in recent sense the Short-eared Owl *Asio flammeus* (Pantoppidan, 1763) and the Barn Owl *T. alba* (Scopoli, 1869). It is only possible to suggest that Gaud and Till (1961) based these wrong data on the paper of Bonnet (1924), who started the host list with *A. flammeus*, rather on the original description of *P. strigisoti*. In a subsequent publication Gaud (1980) corrected the name of type host and provided a large list of hosts recorded in Africa.

3. Host records of *P. strigisoti* during past 150 years were summarized by Philips (2000). It appeared that this species was reported from 17 owl species of seven genera, mainly from the Old World: *Asio capensis* (Smith, 1834), *A. flammeus* (Pontoppidan, 1763), *A. otus* (Linnaeus, 1758), *Athene noctua* (Scopoli, 1769), *Bubo africanus* (Temminck, 1821), *B. bubo* (Linnaeus, 1758), *B. lacteus* (Temminck, 1820), *B. leucostictus* Hartlaub, 1855, *B. poensis* Fraser 1853, *B. shelleyi* (Sharpe et Ussher, 1872), *B. virginianus* (Gmelin, 1788), *Ptilopsis leucotis* (Temminck, 1820), *Scotopelia peli* (Bonaparte, 1850), *Strix aluco* Linnaeus, 1758, *S. nebulosa* Forster, 1772, *S. varia* Barton, 1799, and *Tyto alba* (Scopoli, 1769). Distribution of one species among such a large number of hosts belonging to different genera seems to be questionable. Also, *B.*

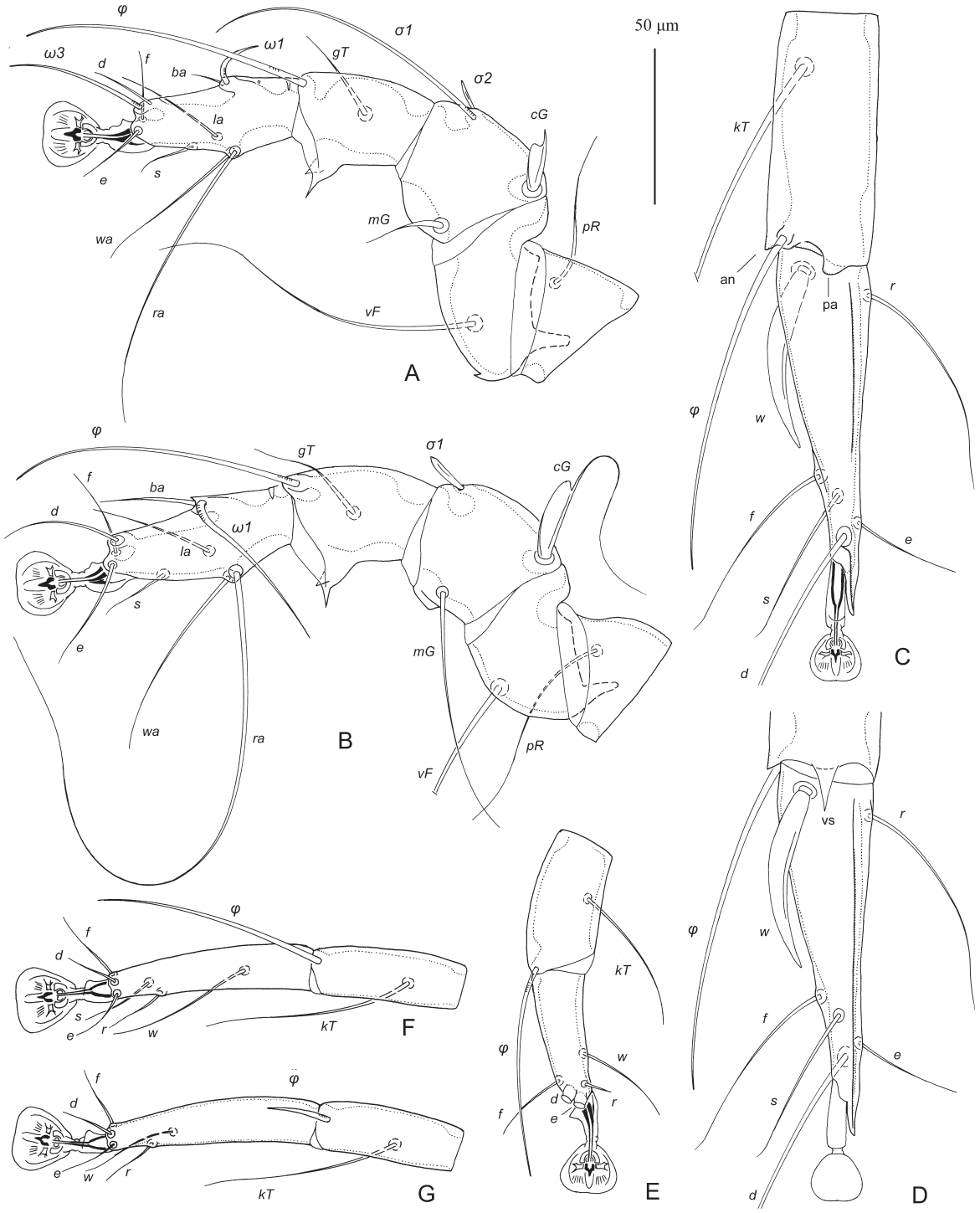

Fig. 3. *Pandalura strigisoti* (Buchholz, 1869), details of legs. A – E – male, F, G – female. A – leg I, dorsal view; B – leg II, dorsal view; C – tarsus and tibia III, dorsal view; D – tarsus and distal part of tibia III, ventral view; E – tarsus and tibia IV, dorsal view; F – tarsus III, G – tarsus IV.

Abbreviations: an – antiaxial spine, pa – paraxial spine, vs – ventral spine.

bubo and *B. virginianus* bear a separate although very closely related species (see below). Therefore confirmation of host associations of *P. strigisoti* with owls other than *A. otus* requires recollecting and precise re-investigation.

Pandalura cirrata **(Müller, 1860) comb. nov.**
(Fig. 4)

Dermaleichus cirratus J. Müller, 1860: 52, t. II, figs. 1a, 1b.
Dimorphus cirratus, Oudemans 1939: 187.
Pandalura strigisoti, Mumcouglu and Müller 1974: 290, fig. 1 (misidentification).

Material examined. 5 males and 5 females (ZIN 4544-553, 10 slides) from *Bubo bubo* (Linnaeus, 1758) (Strigidae), SPAIN: Murcia, Alhama, 16 January 2001, coll. J. Delgado. 1 male and 2 females (SM 25 GHOW/1014/CEN/98) from *B. virginianus* (Gmelin, 1788) (Strigidae), CANADA: Manitoba, Starbuck, 12 July 1998, coll. T.D. Galloway. All specimens – ZIN.

Description. *Male* (5 specimens from *B. bubo*). Length of idiosoma 420–430, width of idiosoma 250–270, length of hysterosoma 300–320. Prodorsal shield: a longitudinal plate with almost parallel-sided lateral margins, postero-lateral extension bearing setae *se, si* rounded, posterior margin convex, 108–112 in length, 70–75 in width, surface with pair of longitudinal grooves, distance between setae *se* 62–68. Hysteronotal shield: anterior margin slightly convex, anterior angles rounded, anterior angles roughly right-angular, greatest length 275–300, width at anterior margin 80–98. Median hysteronotal setae *c1–h1* present. Supranal concavity opens into terminal cleft, border line between concavity and cleft indistinct. Terminal cleft with lateral margins noticeably concave in anterior part and slightly divergent posteriorly; interlobar membrane occupying anterior part of cleft and stretching by narrow bands to lobar apices, anterior end of incision in interlobar membrane rounded (Fig. 4A). Terminal lobar digit of opisthosomal lobes straight, with setae *ps1* situated near its base. Measurements of opisthosoma: length of terminal cleft including supranal concavity (from anterior end of concavity to lobar apices) 100–106, length of incision (from anterior end of incision to lobar apices) 60–66, length of terminal lobar digit 30–35, width of cleft in anterior part (excluding interlobar membrane) 46–50, width of terminal lobar digit 13–15. Distance between setae: *c2:d2* 64–70. *d2:e2* 85–88, *e2:h3* 125–144, *h2:h2* 85–90, *h3:h3* 55–65, *ps2:ps2* 113–120, *ps1:ps1* 44–52, *d1:d2* 20–24, *e1:e2* 40–45, *ps1:h3* 25–28.

Length of sternum including sclerotization between branches of epimerites I 52–55. Setae *3a* and *3b* approximately at same transverse level. Coxal fields IV with narrow sclerotized areas at bases of trochanters. Genital apparatus 15–17 × 20–24, aedeagus minute. Posterior ends of paragenital apodemes not fused with each other posterior to genital apparatus area, and usually not extending past the anterior margin of anal suckers (Fig. 4B). Setae *g* posterior to level of setae *4a*. Adanal apodeme semicircular, thin, with narrow membrane along anterior margin. Anal suckers 13–15 in diameter. Distance between setae: *3a:4a* 62–65, *4a: g* 12–15, *g: ps3* 66–68, *ps3:h3* 117–122.

Lateral margin of femur I with a small acute tooth, lateral margin of femur II rounded. Tarsi I, II without acute apical extension. Tibiae I, II each with pair of ventral spines of subequal size. Ventral setae of tarsi and tibiae I, II not thickened. Tibia III with short and acute antaxial spine at base of solenidion *φ* and with rounded paraxial extensions about long, both about 4–6 long, and with acute membranous ventral spine (Figs. 4C).Tarsus III with acute apical extension, length of tarsus 113–115, width at base 22–27; setae *w* blade-like, curved, 48–57 long. Tarsus IV cylindrical 40–44 long, two times longer than wide at base, setae *d, e* barrel-shaped with clear discoid caps, setae *r* short spiculiform (Fig. 4D).

Female (5 specimens from *B. bubo*). Length of idiosoma 365–385, width of idiosoma 220–230, length of hysterosoma 255–268. Prodorsal shield shaped as in male, slightly narrowed anteriorly, 100–108 long, 80–85 wide, setae *se* separated by 72–75 (Fig. 4E). Scapular shields large. Setae *cp* slightly longer than setae *c3* and approximately equal to summed length of trochanter, femur and genu III. Hysteronotal shield shaped as longitudinal plate slightly enlarged posteriorly, anterior margin straight, posterior margin slightly concave, length 153–165, width at anterior margin 52–55, width at posterior margin 73–85. Setae *d1, e1* on hysteronotal shield near its lateral margins, setae *c1*, *d2* and *e2* on striated tegument (in 2 specimens setae *c1* on one side absent), setae *h1* situated on posterior margin, noticeably closer to each other than width of hysteronotal shield at posterior margin. Distance between setae: *c2:d2* 75–80, *d2:e2* 95–105, *e2:h3* 77–88, *h2:h2* 82–93, *h3:h3* 64–75, *d1:d2* 7–15, *e1:e2* 42–45.

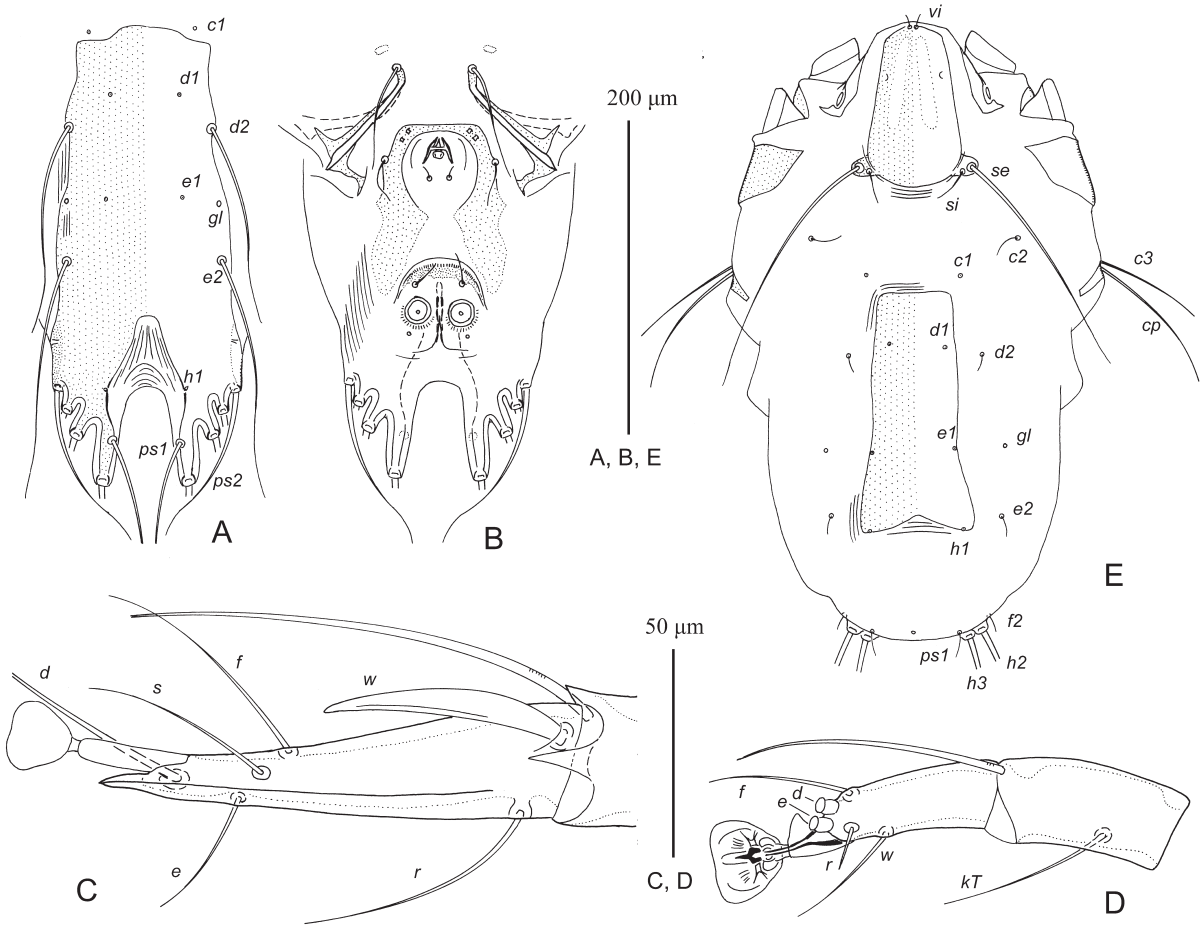

Fig. 4. *Pandalura cirrata* (Müller, 1860) comb.n. A – opisthosoma of male, dorsal view; B –opisthosoma of male, ventral view; C – tarsus and distal part of tibia III of male, ventral view; D – tarsus and tibia IV of male, dorsal view E – idiosoma of female, dorsal view.

Length of sternum including sclerotization between branches of epimerites I 44–51. Epigynum extending to posterior pair of genital papillae or to setae *g*, 57–60 long, 84–93 wide. Epimerites IIIa narrow, with strongly enlarged inner tips. Epimerites IVa present, short. Distance between setae: *3a:3b* 26–37, *3a:g* 42–45, *g:4a* 84–66. Legs I, II as in male, legs IV extending by distal half of tarsus beyond posterior margin of opisthosoma; tarsus III 62–64, tarsus IV 64–69 long.

Remarks. *Dermaleichus cirratus* was originally described by J. Müller (1860) from the Eurasian Eagle Owl *Bubo bubo*. The original descriptions and figures of this species were sufficient to allow the mite to be recognized as a representative of the family Psoroptoididae in recent sense. Unfortunately this publication remained unknown to the majority of subsequent acarologists, including top experts on the systematics of feather mites. Only Oudemans (1939) noticed this species and considered it in the content of the genus *Dimorphus*. This author also declared *D. strigisoti* as a junior synonym of *D. cirratus*. The paper of Oudemans also remained unnoticed by researchers of the second part of 20th Century. Mumcuoglu and Müller (1974) reported "*P. strigisoti*" from *B. bubo* and even gave figures of the male and female. Although figures of "*P. strigisoti*" given by these authors contain a number of obvious errors (for instance, seta *w* of tarsus III in male is given as two separate setae, and anterior legs bear several nonexistent setae), the paragenital apodemes extending only to the level of adanal apodemes in males and the epigynum not

extending to setae *g* in females allow the conclusion that these authors apparently dealt with *P. cirrata*.

Pandalura cirrata is indeed very close to *P. strigisoti* and most clearly differs from the latter by having shorter paragenital apodemes and wider terminal cleft in males (see the key above).

Pandalura cirrata is definitely associated with the two species of eagle owls, *B. bubo* and *B. virginianus*, but it is possible to expect that this species also inhabits other representatives of the genus *Bubo* Dumeril, 1806.

***Pandalura oconnori* sp. nov.**
(Figs. 5–7)

Type material. Holotype male (NU 11794, AMNH 476 836) from *Steatornis caripensis* Humboldt, 1817 (Steatornithidae), TRINIDAD: Mt. Aripo, 15 May 1903, coll. E. Andre; paratype female (NU 11637, USNM 133052), same host species, TRINIDAD, no other data. Holotype and paratype – UMMZ.

Additional material. 1 male and 1 female (№ 6112) from *S. caripensis,* VENEZUELA: Bolivar State,

Fig. 5. *Pandalura oconnori* sp. nov., male. A – dorsal view; B – ventral view.

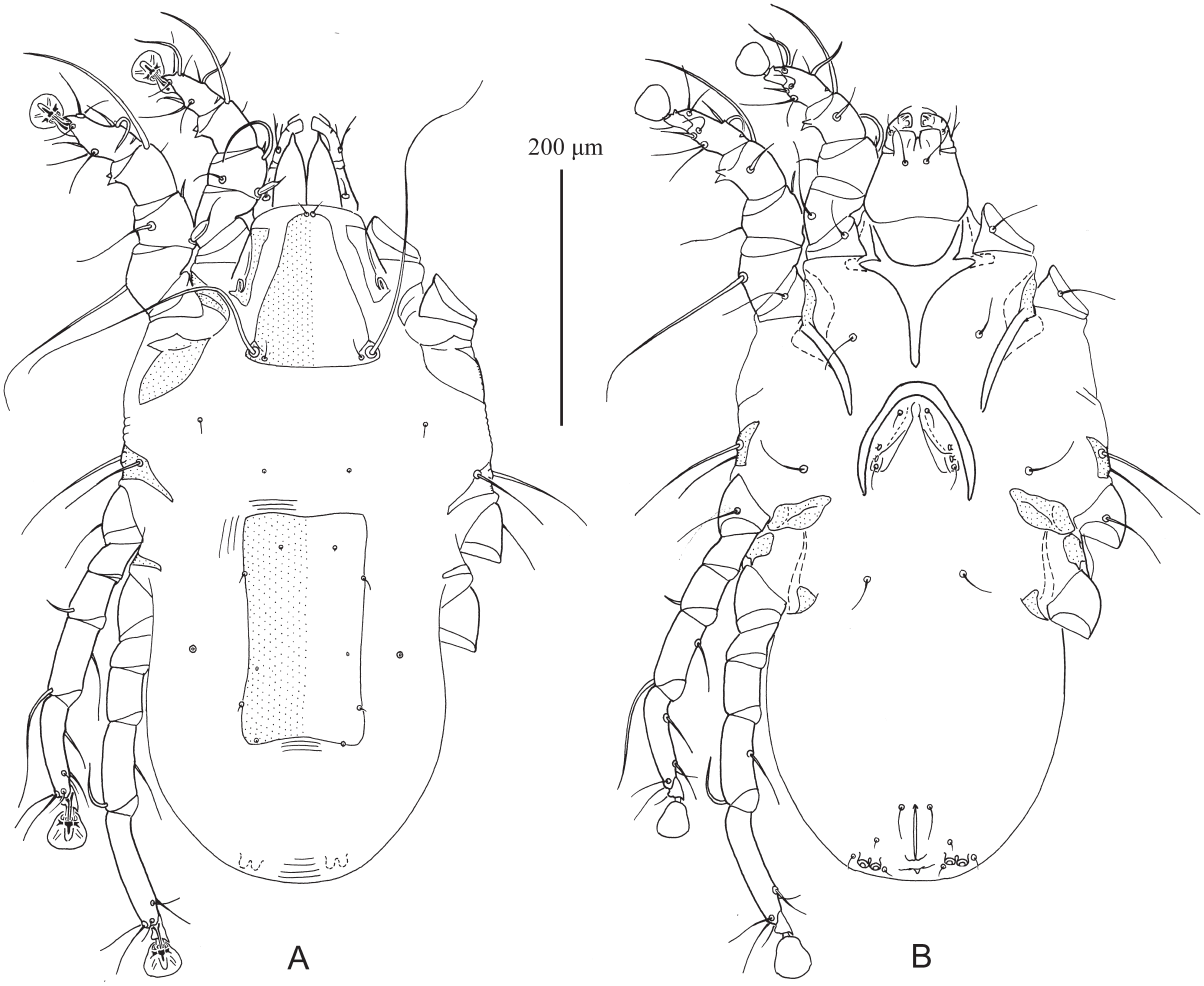

Fig. 6. *Pandalura oconnori* sp. nov., female. A – dorsal view; B – ventral view.

Cerro Auyantepuy, 5°54´N, 62°29´W, 1750 m, 13 February1994, coll. D. Guerrero. Material – MBUCV.

Description. *Male* (holotype). Length of idiosoma 700, width of idiosoma 405, length of hysterosoma 550. Prodorsal shield: longitudinal plate with strongly narrowed anterior third, posterolateral extension bearing scapular setae *se, si* small and rounded, posterior margin convex, 150 in length, 95 in width at posterior margin, surface with pair of longitudinal crests, distance between setae *se* 80. Hysteronotal shield: anterior margin slightly convex, anterior angles rounded, greatest length 505, width at anterior margin 142. Hysteronotal setae *c1–h1* present. Supranal concavity present, not fused with terminal cleft. Anterior end of terminal cleft widely rounded, lateral margins of terminal cleft with blunt-angular extensions bearing bases of setae *ps1*. Interlobar membrane occupying anterior part of cleft and stretching by narrow bands to lobar apices and forming short and acute terminal lamellae, anterior end of incision in interlobar membrane angular (Fig. 5A). Terminal lobar digits of opisthosomal lobes long, slightly divergent posteriorly, with setae *ps1* situated near their bases. Measurements: total length of terminal cleft (from bottom of terminal cleft to base of setae *h3*) 150, length of incision (from anterior end of incision to lobar apices) 142, length of terminal lobar digit 95, greatest width of cleft in anterior part (level of setae *ps2*) 82, width of lobar digit in apical part 27, length of terminal lamellae 11–13. Distance

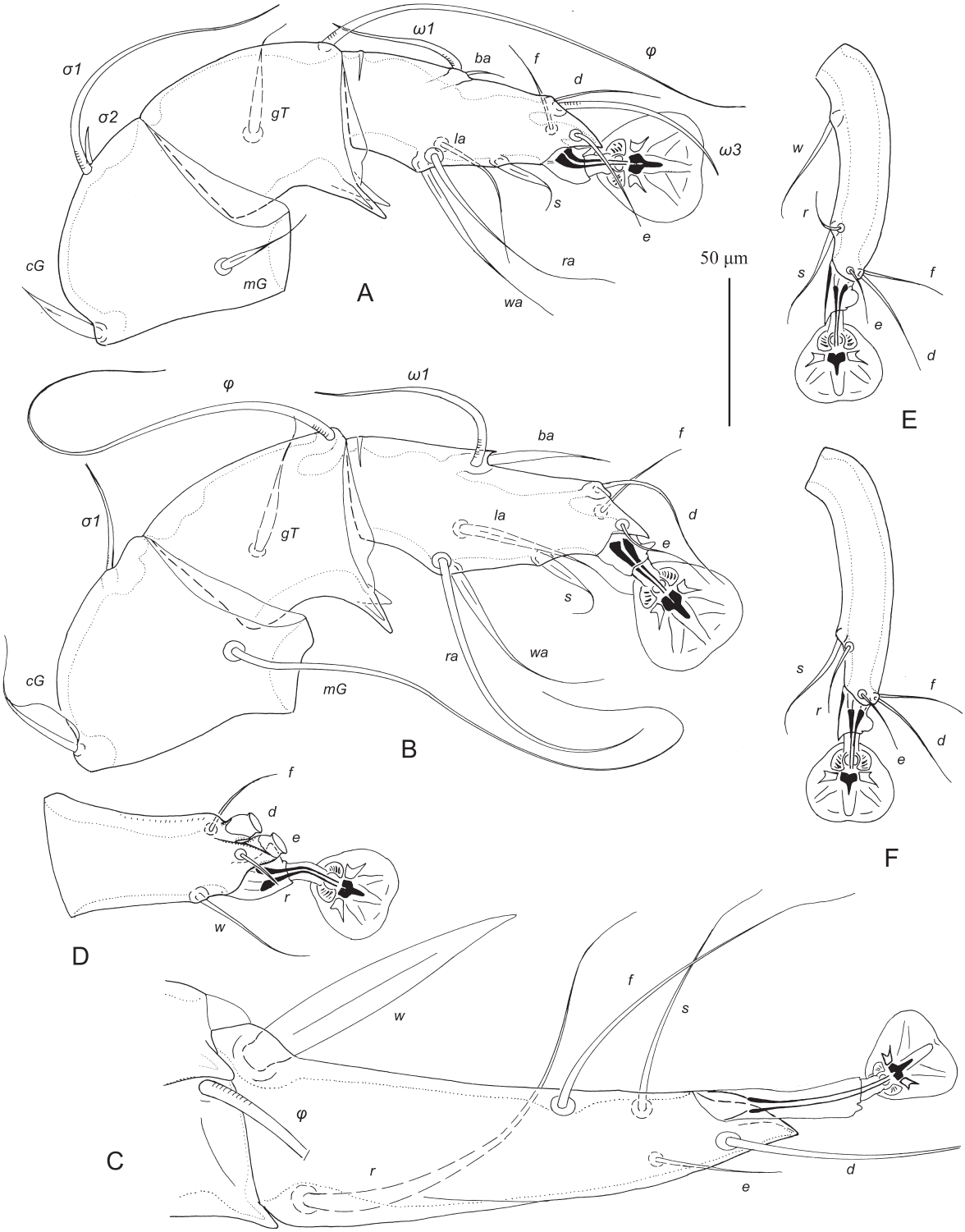

Fig. 7. *Pandalura oconnori* sp. nov., details of legs. A – D – male, E, F – female. A – tarsus, tibia and genu I, dorsal view; B – tarsus, tibia and genu II, dorsal view; C – tarsus and tibia III, dorsal view; D – tarsus and tibia IV, dorsal view; E – tarsus III, F – tarsus IV.

between setae: *c2:d2* 93. *d2:e2* 98, *e2:h3* 126, *h2:h2* 156, *h3:h3* 107, *ps2:ps2* 223, *ps1:ps1* 58, *d1:d2* 32, *e1:e2* 66, *ps1: h3* 80.

Length of sternum including hard sclerotization between branches of epimerites I 150. Setae *3a* anterior to level of setae *3b*. Coxal fields IV with large sclerotized areas at bases of trochanters. Genital apparatus 15 × 11, aedeagus minute. Posterior ends of paragenital apodemes not fused with each other, their tips extending to level of anal suckers. Setae *g* anterior to level of setae *4a*. Adanal apodeme semicircular, thick, with radial striation, with wide adanal membrane along anterior margin (Fig. 5B). Anal suckers 31 in diameter. Distance between setae: *3a:3b* 31, *3a:4a* 130, *g: 4a* 14, *g: ps3* 95, *ps3:h3* 240.

Lateral margin of femora I, II rounded (Fig 7A, B). Tarsi I, II with acute apical extension. Tibiae I, II with pair of large ventral spines of subequal size. Ventral setae *la, wa* and *s* of tarsi I, II and setae *gT* tibiae I, II thickened basally, with filiform apex. Tibia III with short spine-like paraxial and antaxial extensions about 10 long. Tarsus III with acute and flattened apical extension, length of tarsus 200, wide at base 65; setae *w* blade-like, straight, 105 long (Fig. 7C). Tarsus IV 65 long, subequal to corresponding tibia, two times longer than wide at base, setae *d, e* barrel-shaped, with clear discoid caps, setae *r* short spiculiform (Fig. 7D).

Female (paratype). Length of idiosoma 530, width of idiosoma 275, length of hysterosoma 380. Prodorsal shield: shaped as narrow trapezium, posterior margin slightly convex, setae *se, si* in posterior angles, 122 long, 120 wide, surface without crests and grooves, setae *se* separated by 93. Scapular shields large. Setae *cp* slightly shorter than setae *c3* and approximately equal to summed length of trochanter, femur III. Hysteronotal shield roughly rectangular, anterior and posterior margins slightly concave, length 165, width at anterior margin 93 (Fig. 6A). Setae *d1, e1* on hysteronotal shield near its lateral margins, setae *h1* on posterior margin, and setae *d2* and *e2* on lateral margins. Distance between setae: *c2:d2* 122, *d2:e2* 100, *e2:h3* 98, *h2:h2* 78, *h3:h3* 56, *d1:d2* 17, *e1:e2* 42.

Length of sternum including hard sclerotization between branches of epimerites I 70. Epigynum extending slightly beyond level of setae *g*, 88 long, 86 wide (Fig. 6B). Epimerites IIIa wide. Epimerites IVa present, short. Copulatory opening ventro-terminal. Distance between setae: *3a:3b* 48, *3a:g* 48, *g:4a* 82.

Legs I, II as in male, legs IV extending by distal half of tarsus beyond posterior margin of the body; tarsus III 75, tarsus IV 86.

Differential diagnosis. The new species *P. oconnori* sp. n. clearly differs from other known species of the genus (including new ones described in the present paper) by the presence of apical spines on tarsi I, II and by having a significantly larger idiosoma. In other known species, the idiosoma is 390–410 in males and 360–400 in females. Among known species, *P. oconnori* is similar to *P. cirrata* by having the full set of median hysteronotal setae (*c1–h1*). Males of *P. oconnori* differ from *P. cirrata* by the following features: lateral margins of terminal cleft with blunt-angular extension, lobar apices with short terminal membrane, seta *w* of tarsus III is straight, tibia III without ventral acute spine. Females of this species are distinguished by rectangular hysteronotal shield. In males of *P. cirrata*, lateral margins of terminal cleft are straight, lobar apices are without terminal membrane, seta *w* of tarsus III is curved, tibia III with membranous ventral spine; in females, hysteronotal shield is trapezoidal, enlarged posteriorly.

Etymology. The species is named after Dr. B.M. OConnor (University of Michigan, Ann Arbor, USA), prominent acarologist and top expert on Astigmata.

***Pandalura podargi* sp. nov.**
(Figs. 8–10)

Type material. Holotype male and paratype female (UGA 9211) from *Podargus strigoides* (Latham, 1802) (Podargidae), AUSTRALIA: N.W. Australia, Beagle Bay, 24 August 1976, coll. F.S. Lukoschus. Holotype and paratype – UMMZ.

Male (holotype). Length of idiosoma 400, width of idiosoma 235, width of hysterosoma 290. Prodorsal shield: longitudinal plate, slightly attenuate anteriorly, posterior margin straight, 92 in length, 60 in width, surface with two longitudinal ridges, scapular setae *se, si* on small rounded postero-lateral extensions, distance between setae *se* 52. Hysteronotal shield: narrowed in anterior part, anterior margin slightly concave, anterior angles acute, greatest length 240, width at anterior margin 55. Hysteronotal setae *c1, d1, h1* absent, setae *e1* present.

Supranal concavity open into terminal cleft, border line between concavity and cleft indistinct. Terminal cleft with lateral margins slightly concave in anterior

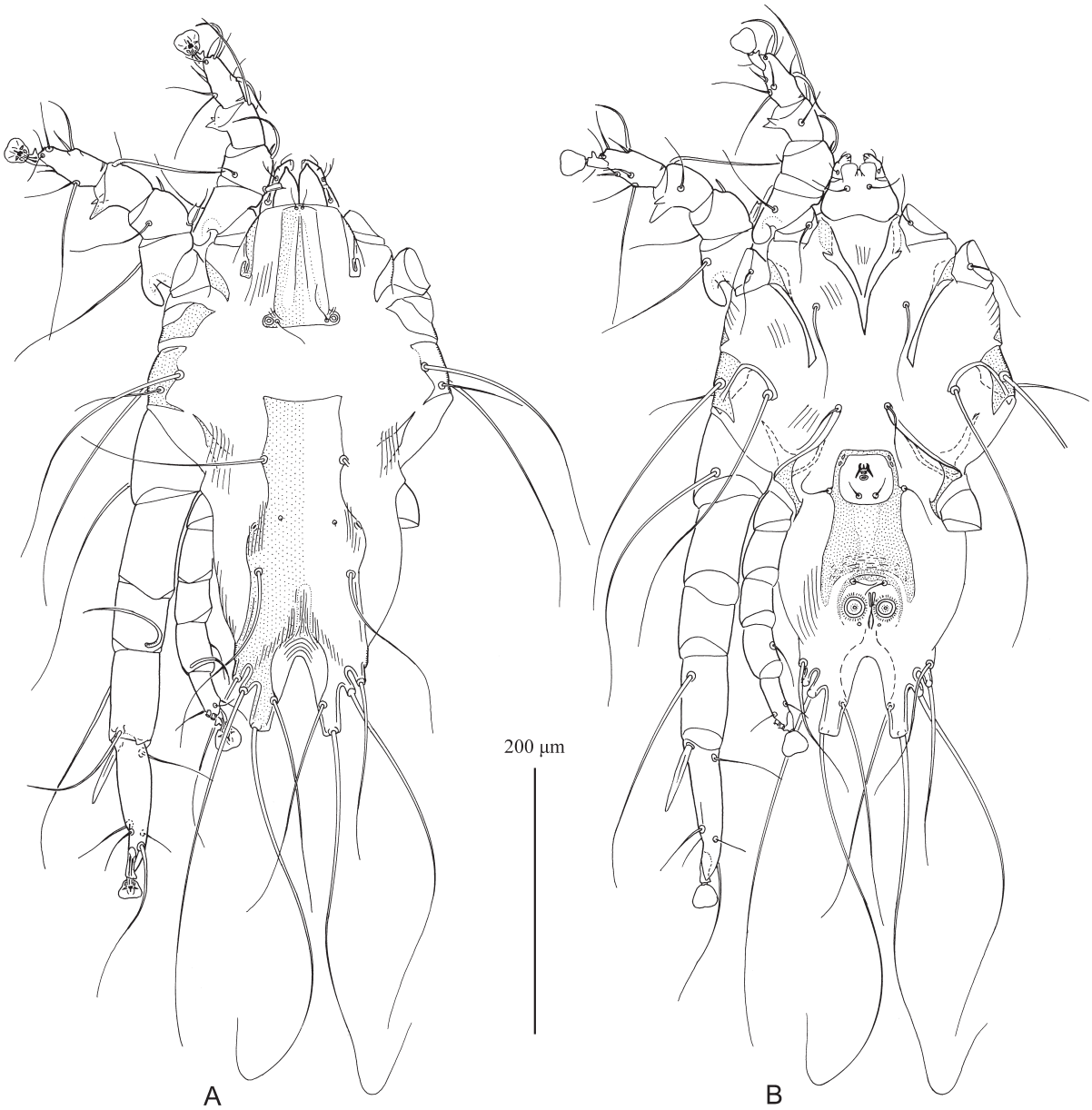

Fig. 8. *Pandalura podargi* sp. nov., male. A – dorsal view; B – ventral view.

part and with blunt-angular ledges carrying setae *ps1* at midlevel (Fig. 8A). Interlobar membrane occupying only anterior part of cleft, anterior end of incision in interlobar membrane rounded. Terminal lobar digits of opisthosomal lobes parallel-sided, slightly divergent posteriorly. Measurements of opisthosoma: length of terminal cleft including supranal concavity (from anterior end of concavity to lobar apices) 100, length of incision (from anterior end of incision to lobar apices) 60, length of terminal lobar digit 36, greatest width of cleft in anterior part (excluding interlobar membrane) 44, width of terminal lobar digit in distal part 12. Distance between setae: *c2:d2* 70. *d2:e2* 88, *e2:h3* 117, *h2:h2* 84, *h3:h3* 62, *ps2:ps2* 104, *ps1:ps1* 27, *e1:e2* 40, *ps1: h3* 20.

Length of sternum 33, sclerotization between branches of epimerites I absent. Setae *3a* slightly posterior to level of setae *3b*. Coxal fields IV with narrow

Fig. 9. *Pandalura podargi* sp. nov., female. A – dorsal view; B – ventral view.

sclerotized areas at bases of trochanters. Genital apparatus 11 long, 15 wide, aedeagus minute. Posterior parts of paragenital apodemes fused with each other forming large plate between genital and anal areas; genital apparatus area appears completely encircled (Fig. 8B). Setae *g* slightly posterior to level of setae *4a*. Adanal apodeme horseshoe-shaped, thin; adanal membrane along its anterior margin indistinct. Anal suckers 14–15 in diameter. Distance between setae: *3a:4a* 62, *4a: g* 4, *g:ps3* 66, *ps3:h3* 117.

Lateral margin of femora I, II with large hook-shaped processes (Figs. 10A, B). Tarsi I, II without acute apical extension. Tibia I with pair of ventral spines of subequal size; tibia II with antaxial ventral process much larger than paraxial one. Ventral setae of tarsi and tibiae I, II not thickened. Tibia III with short and acute antaxial and paraxial spines about 5 long (Fig. 10C). Tarsus III with acute and flattened apical extension, length of this segment 104, wide at base 22; setae *w* blade-like, straight, 55 long. Tarsus IV 40 long, setae *d, e* barrel-shaped, with clear discoid caps, setae *r* short spiculiform (Fig. 10D).

Female (paratype). Length of idiosoma 405, width of idiosoma 178, length of hysterosoma 270. Pro-

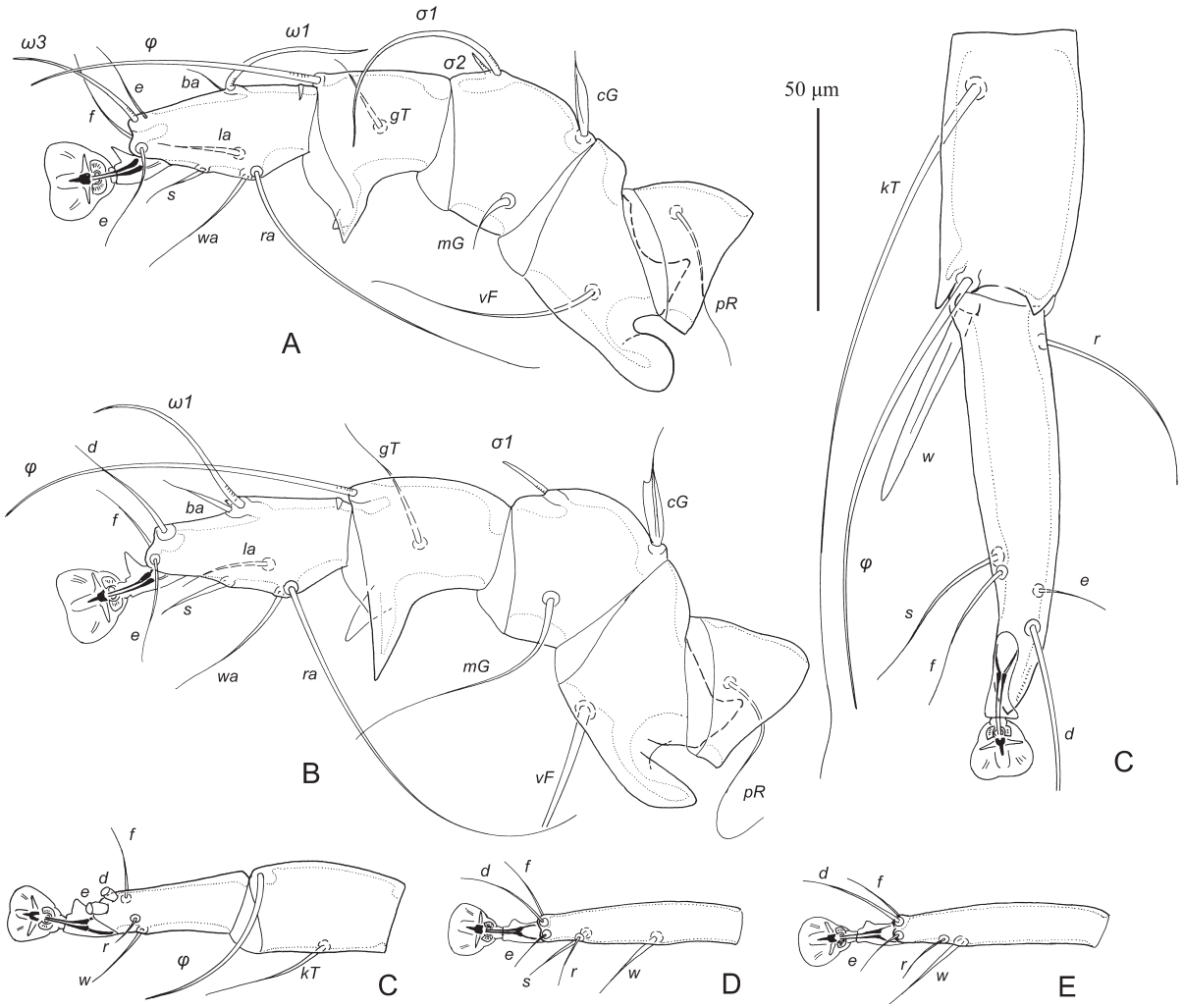

Fig. 10. *Pandalura podargi* sp. nov., details of legs. A – D – male, E, F – female. A – leg I, dorsal view; B – leg II, dorsal view; C – tarsus and tibia III, dorsal view; D – tarsus and tibia IV, dorsal view; E – tarsus III; F – tarsus IV.

dorsal shield generally shaped as in male, except for convex posterior margin, 95 long, 57 wide, setae *se* separated by 51. Scapular shields small, represented by narrow transverse sclerites. Setae *cp* twice as long as setae *c3* and approximately equal to summed length of trochanter – tibia III. Hysteronotal shield shaped as narrow longitudinal plate slightly enlarged posteriorly, anterior margin straight, posterior margin slightly concave, length 120, width at anterior margin 36, width at posterior margin 50 (Fig. 9A). Setae *e1* on lateral margins of hysteronotal shield, setae *d2* and *e2* on striated tegument. Distance between setae: *c2:d2* 77, *d2:e2* 73, *e2:h3* 115, *h2:h2* 73, *h3:h3* 66, *e1:e2* 22.

Sternum as in male, 15 long. Epigynium short, extending to level of anterior genital papillae, 38 long, 66 wide (Fig. 9B). Epimerites IIIa narrow and straight. Epimerites IVa present, small. Copulatory opening terminal. Distance between setae: *3a:3b* 33–36, *3a:g* 42–48, *g:4a* 56–62.

Legs I, II generally as in male; paraxial ventral spine on tibia I, II rounded and much smaller than

in male. Legs IV extending by distal half of tarsus beyond posterior margin of the body; tarsus III 62–64, tarsus IV 64–66 long (Figs. 10E, F).

Differential diagnosis. *Pandalura podargi* sp. n. is similar to *P. oconnori* by having straight lanceolate seta *w* on tarsus III and blunt-angular extension on lateral margins of terminal cleft in males. Nevertheless, this species strongly differs from *P. oconnori* and two other known species by the following features: in both sexes, femora I, II with large hook-like lateral processes, antaxial ventral spine of tibiae I, II is much larger that paraxial one; hysteronotal setae *d1* and *h1*are absent; in males, posterior parts of paragenital apodemes are fused and completely encircle the area of genital apparatus; in females, scapular shields are strongly reduced and represented by narrow transverse sclerites. In both sexes of the three other *Pandalura* species, femora I, II are devoid of hook-like processes, antaxial and paraxial ventral spines of tibiae I, II are subequal in size; hysteronotal setae *d1* and *h1* are present; in males, the posterior parts of paragenital apodemes are not fused and genital area remains open posteriorly; in females, the scapular shields are large, roughly triangular plates on lateral margins of prodorsum.

Etymology. The specific epithet derives from the generic name of the type host and is a noun in the genitive case.

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