

Research Article

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***Cystoidosoma hermaphroditus* sp. n., the first representative of the quill mite family Ascouracaridae (Acari: Astigmata: Pterolichoidea) from an owl (Aves: Strigiformes)**

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Abstract: The mite family Ascouracaridae Gaud et Atyeo, 1976 contains large-sized mites (mostly > 1 mm) which live inside the quills of birds of several orders. To date, no representative of this family has been found associated with the order Strigiformes (owls). In this paper, a new species of this family, *Cystoidosoma hermaphroditus* sp. n., is described from the tropical screech owl, *Megascops choliba* (Vieillot) (Aves: Strigiformes) from Brazil. This species is unique in having an external spermaduct, a primary duct and a rudimentary *bursa copulatrix* present in males. This is the first astigmatan feather mite described from the order Strigiformes in this country. A key to adults of the genus *Cystoidosoma* Gaud et Atyeo, 1976 of the world is presented.

Keywords: feather mites, *Megascops choliba*, hermaphroditism, taxonomy, systematics, identification key

The family Ascouracaridae Gaud et Atyeo, 1976 (Acari: Astigmata) contains large-sized mites (> 1 mm) that inhabit the quills of several bird orders (Gaud and Atyeo 1996, Mironov and Fain 2003). This taxon was first proposed as a subfamily of the Syringobiidae Trouessart, 1897 by Gaud and Atyeo (1976) and later was elevated to family by Gaud et al. (1989). Twenty-two species in seven genera have been described (Gaud and Kolebinova 1973, Gaud and Atyeo 1976, d'Souza and Jagannath 1982, Dabert and Ehrnsberger 1992, 1995, Proctor 1999, Mironov and Fain 2003). The larva is the dispersal stage and is strongly heteromorphic in relation to subsequent stages, being elongate and highly sclerotised, in contrast to the bulky and relatively poorly sclerotised body – especially the hysterosoma – of adults (Dabert and Ehrnsberger 1992, Proctor 1999).

Mironov and Fain (2003) summarised the known host associations for species of this family, reporting associations with the avian orders: Accipitriformes, Apodiformes, Caprimulgiformes, Galliformes, Passeriformes, Piciiformes and Psittaciformes. The order Strigiformes (owls) has a poor record of mites in Brazil, with only *Ornithonyssus bursa* (Berlese, 1888) (Mesostigmata: Macronyssidae) having been reported from *Megascops choliba* (Vieillot) (Mascarenhas et al. 2009). As for the feather mites (Astigmata), only three ascouracarid species have been reported

from Brazil (Valim et al. 2011): *Ascouracarus chordeili* Mironov et Fain, 2003 from *Chordeiles rupestris* (Spix) (Caprimulgiformes), *Cystoidosoma psittacivora* Dabert et Ehrnsberger, 1992 from *Aratinga aurea* (Gmelin), and *Cystoidosoma aratingae* Mironov et Fain, 2003 from *Aratinga jandaya* (Gmelin) (Psittaciformes).

In the present paper a new species of the genus *Cystoidosoma* Gaud et Atyeo, 1976 is described from *M. choliba* (Strigiformes: Strigidae) in Brazil. This is the first representative of the family Ascouracaridae described from the avian order Strigiformes and also the first astigmatid mite described from this bird order in Brazil. A key to adults of the genus *Cystoidosoma* of the world is presented.

MATERIALS AND METHODS

Mites were collected from a tropical screech owl (Fig. 1A) captured in a mist-net. A few wing feathers were removed and stored in ziploc plastic bags, and the owl was released back into the wild. Mites were cleared in 30% lactic acid and mounted in Hoyer's medium (Krantz and Walter 2009). Measurements and descriptive method follow recent publications on the taxonomy of Ascouracaridae – see Dabert and Ehrnsberger (1992), Mironov and Fain (2003). The chaetotaxy of idiosoma and legs follows that of Griffiths et al. (1990) and Atyeo and Gaud (1966), respectively.

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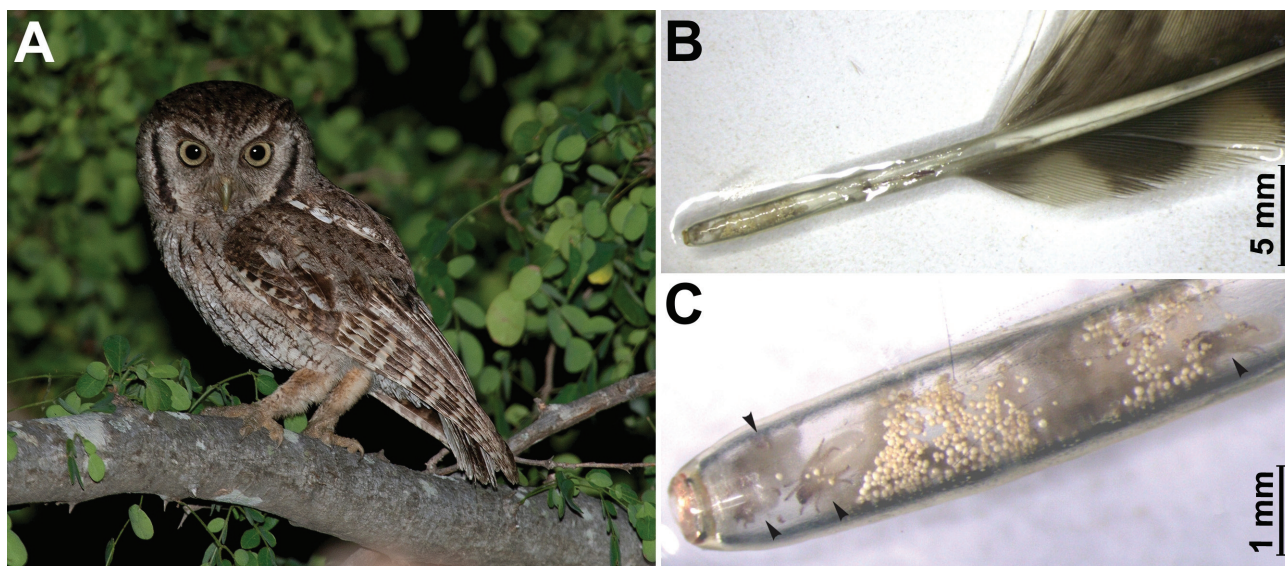


Fig. 1. **A** – Tropical screech owl, *Megascops choliba* (Vieillot); **B** – detail of wing feather; **C** – quill containing *Cystoidosoma hermaphroditus* sp. n. inside (arrows) (photo of *M. choliba* by Arthur Macarrão).

RESULTS

Superfamily **Pterolichoidea** Trouessart et Mégnin, 1884

Family **Ascouracaridae** Gaud et Atyeo, 1976

Genus ***Cystoidosoma*** Gaud et Atyeo, 1976

Type species: *Cystoidosoma labidostoma* Gaud et Atyeo, 1976, by original designation.

Species of the genus *Cystoidosoma* are characterised by lacking trochanteral setae on legs III, seta *kT* present on tibia IV and dorsal setae *c1* shorter than the gnathosoma (Gaud and Atyeo 1996). The genus currently includes six species associated with the Psittaciformes, Piciformes and Accipitriformes (Gaud and Atyeo 1976, Dabert and Ehrnsberger 1992, Mironov and Fain 2003).

***Cystoidosoma hermaphroditus* sp. n.** Figs. 2–6

ZooBank number for species:

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Description. Male (holotype) (Figs. 2, 3, 6B,D) (measurements of holotype followed by range for three paratypes in parentheses). Idiosoma length and width 1106×582 ($898\text{--}1003 \times 540\text{--}545$). Subcapitulum length and width 164×172 ($161\text{--}172 \times 163\text{--}168$). Prodorsal shield length along midline 245 ($242\text{--}251$), width at base 377 ($363\text{--}382$). Seta *vi* 80 ($74\text{--}83$) in length, their bases coalescent, setae *se* 346 ($357\text{--}376$) in length, distance *se-se* 222 ($200\text{--}226$), setae *si* 130 ($107\text{--}120$) in length, distance *si-si* 153 ($136\text{--}160$). Humeral shields present ventrally, bearing setae *cp* and *c3*. Setae *ps1*, *h2*, *h3* inserted on soft tegument, without surrounding sclerotisation. Cupules *ia*, *im* and *ip* present dorsally, cupules *ih* present ventrally flank-

ing posterior part of anal opening. Gland opening *gl* situated dorsally midway between bases of setae *d2* and *e2*. Male unique in possessing external spermaduct similar to that of female, as short cone 17 ($14\text{--}15$) in length, situated dorsally between bases of setae *e1* and *h1*. Leading from opening to rudimentary *bursa copulatrix* (or spermatheca) similar to that of female but lacking sclerotised termini of ducts leading to ovaries in female. Length of dorsal setae: *c1* 80 ($60\text{--}85$), *c2* 104 ($90\text{--}106$), *c3* 89 ($91\text{--}108$), *cp* 354 ($328\text{--}364$), *d1* 36 ($38\text{--}47$), *d2* 89 ($70\text{--}91$), *e1* 46 ($43\text{--}46$), *e2* 86 ($84\text{--}94$), *f2* 81 ($59\text{--}76$), *h1* 28 (36), *h2* 444 ($386\text{--}430$), *h3* 440 ($378\text{--}486$), *ps1* 458 ($412\text{--}421$), *ps2* 90 ($87\text{--}106$), *ps3* 44 ($41\text{--}51$).

Anterior coxal apodemes I united as Y with short sternum, sclerotised coxal fields I with incision toward setae *1a*. Genital arch horseshoe-shaped bearing pregenital sclerites with setae *g* and genital papillae. Setae *3b* inserted on anterior coxal apodemes III, setae *4a* inserted on soft tegument posterolateral to bases of genital arch. Leg segments without spurs or apophyses. Distal tarsal seta *s* lanceolate and enlarged, abruptly bent on anterior legs (Fig. 3B,D).

Female (measurements of four paratypes in parentheses) (Figs. 4, 5, 6A,C). Idiosoma length and width $997\text{--}1154 \times 520\text{--}629$. Subcapitulum length and width $164\text{--}172 \times 164\text{--}173$. Prodorsal shield length along midline $239\text{--}267$, width at base $349\text{--}399$. Seta *vi* $72\text{--}76$ in length, their bases coalescent, setae *se* $354\text{--}374$ in length, distance *se-se* $225\text{--}236$, setae *si* $106\text{--}138$ in length, distance *si-si* $154\text{--}168$. Prodorsal and hysteronotal areas as in male. External spermaduct as short cone $12\text{--}16$ in length, situated dorsally between bases of setae *e1* and *h1*. Spermathecal duct leading to sac-like spermatheca with sclerotised openings to ovarian ducts at base. Length of dorsal setae: *c1* $73\text{--}88$, *c2* $92\text{--}129$, *c3* $74\text{--}92$, *cp* $322\text{--}391$, *d1* $34\text{--}40$, *d2* $72\text{--}87$, *e1* $26\text{--}45$, *e2* $68\text{--}73$, *f2* $55\text{--}66$, *h1* $11\text{--}15$, *h2* $303\text{--}413$, *h3* $392\text{--}473$, *ps1* $298\text{--}360$, *ps2* $59\text{--}77$, *ps3* $34\text{--}54$.

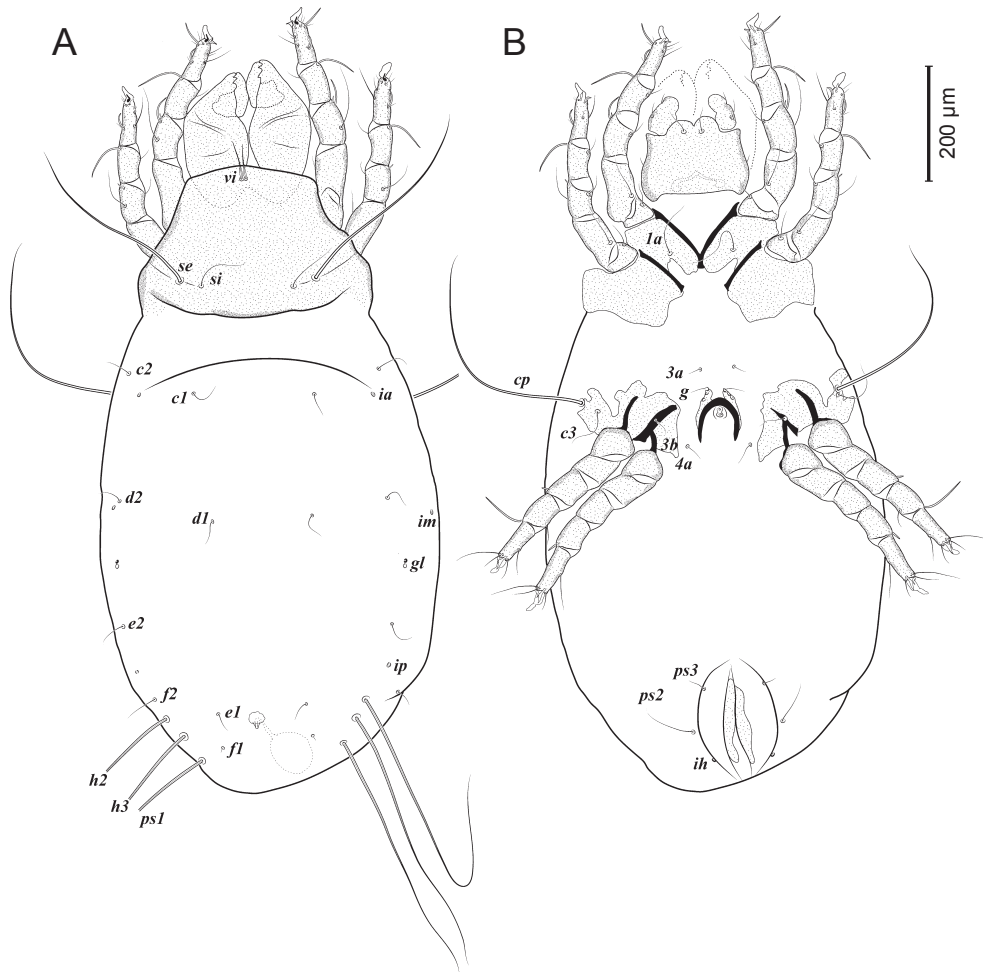


Fig. 2. *Cystoidosoma hermaphroditus* sp. n. from *Megascops choliba* (Vieillot), male habitus. **A** – dorsal view; **B** – ventral view.

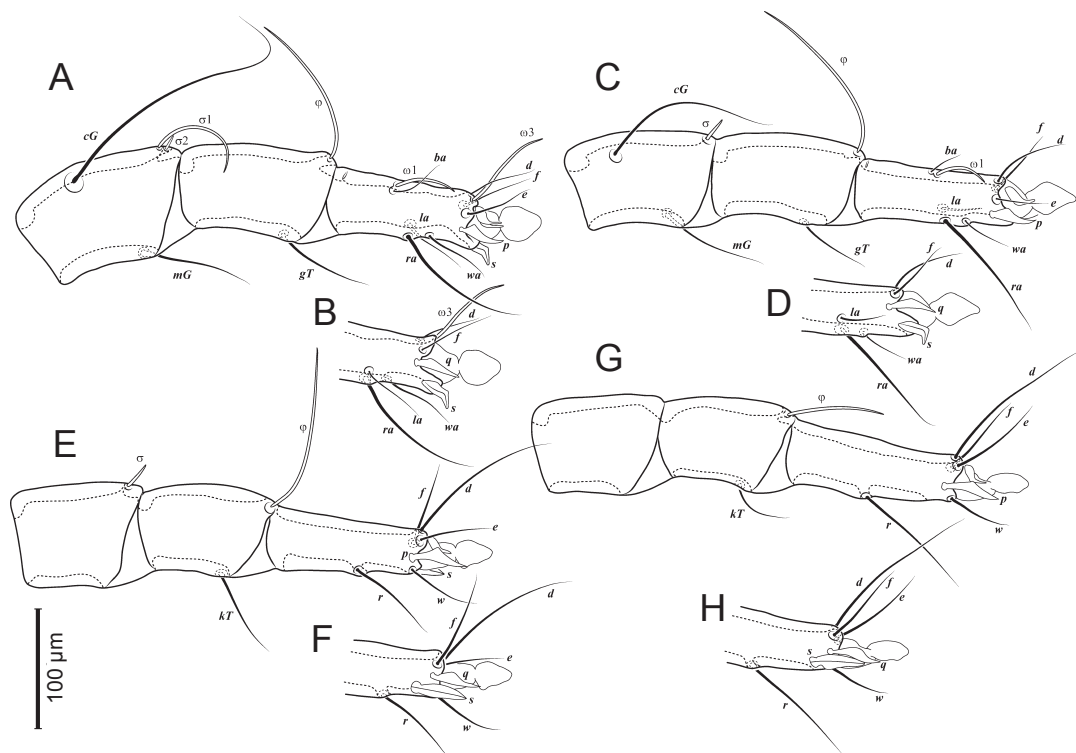


Fig. 3. *Cystoidosoma hermaphroditus* sp. n. from *Megascops choliba* (Vieillot), genua, tibiae and tarsus of male. **A, B** – leg I; **C, D** – leg II; **E, F** – leg III; **G, H** – leg IV (**A, C, E, G** – dorsal view; **B, D, F, H** – ventral view).

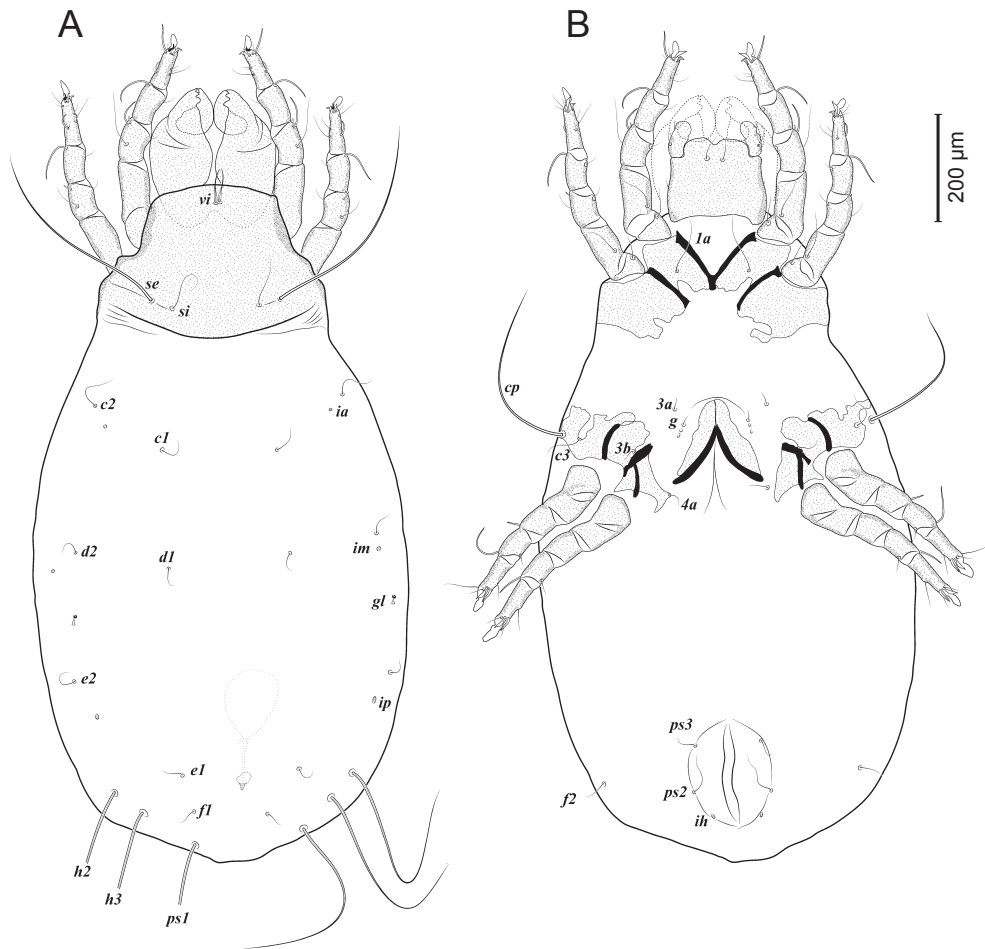


Fig. 4. *Cystoidosoma hermaphroditus* sp. n. from *Megascops choliba* (Vieillot), female habitus. **A** – dorsal view; **B** – ventral view.

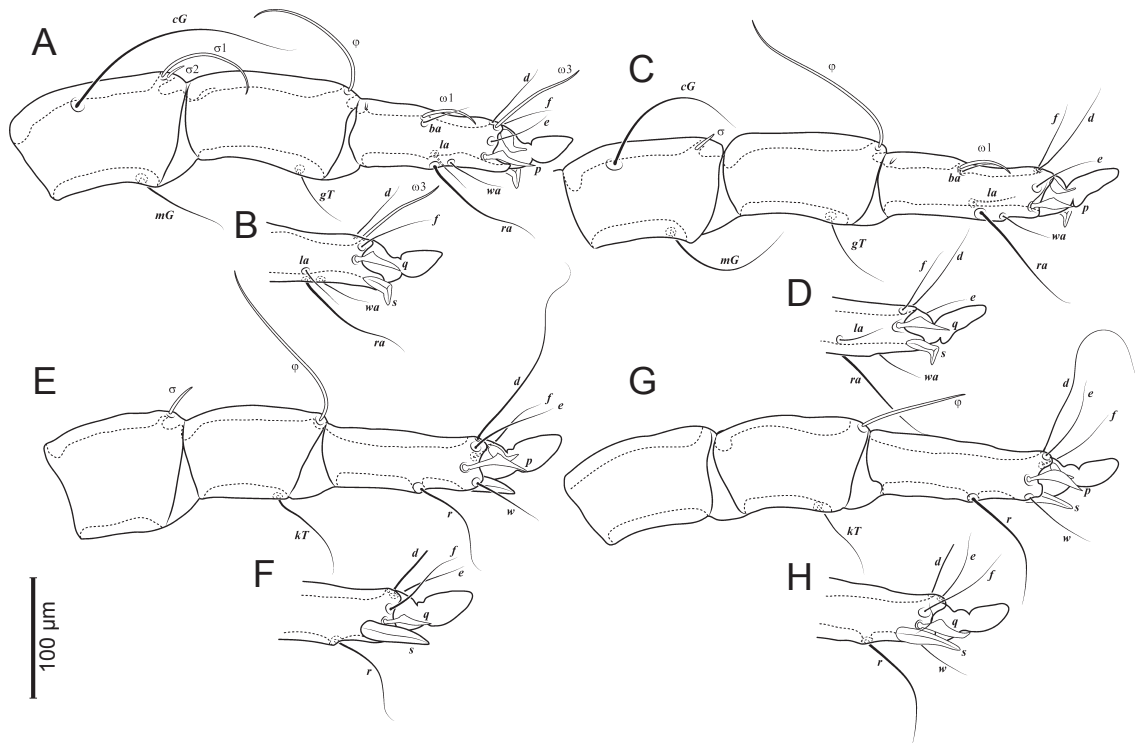


Fig. 5. *Cystoidosoma hermaphroditus* sp. n. from *Megascops choliba* (Vieillot), genua, tibiae and tarsus of female. **A, B** – leg I; **C, D** – leg II; **E, F** – leg III; **G, H** – leg IV (**A, C, E, G** – dorsal view; **B, D, F, H** – ventral view).

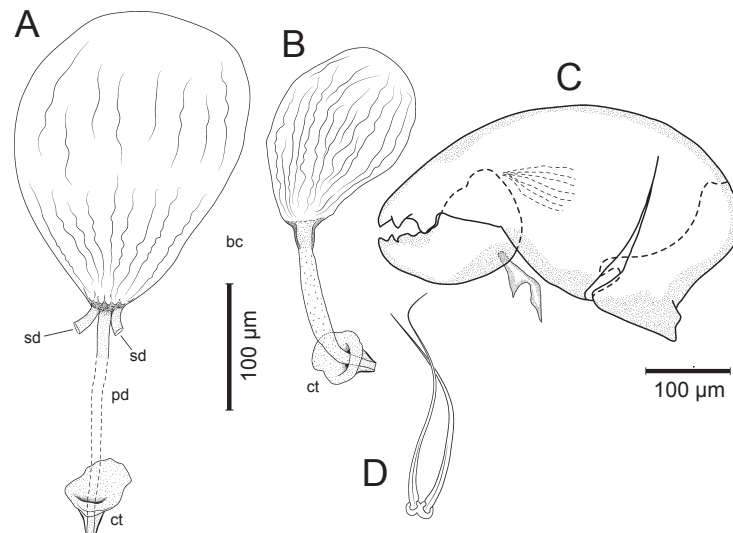


Fig. 6. *Cystoidosoma hermaphroditus* sp. n. from *Megascops choliba* (Vieillot). **A** – copulatory tube (ct) of female; **B** – copulatory tube of male; **C** – lateral view of female chelicera; **D** – prodorsal setae vi of male. Abbreviations: bc – bursa copulatrix; pd – primary duct; sd – secondary ducts.

Ventral surface as in male, except for differences in genital area (Fig. 4). Legs as in male (Fig. 5).

Type material: Holotype male (DZUnespRC-2721), 3 male and 7 female paratypes ex *Megascops choliba* (Vieillot) (Strigiformes: Strigidae), 22°49'52"S; 47°26'08"W, Santa Bárbara d'Oeste, São Paulo State, Brazil, 2 March 2013, collected by Fabio A.F. Jacomassa. Holotype and 6 paratypes deposited in DZUnesp-RC – Collection of Acari of Department of Zoology of the Universidade Estadual Paulista, Rio Claro, São Paulo, Brazil; 2 male and 2 female paratypes in the University of Michigan Museum of Zoology, Ann Arbor, Michigan, USA.

Etymology: The specific name is a noun in apposition and refers to the character in Greek mythology, Hermaphroditos (Latin – Hermaphroditus), offspring of Hermes and Aphrodite, who was classically depicted as a male with some female sexual characteristics.

Differential diagnosis. *Cystoidosoma hermaphroditus* sp. n. resembles *C. centuri* Dabert et Ehrnsberger, 1992 in having setae *c1* short (not reaching prodorsal shield), longitudinal sclerites absent near setae *d2*, bases of terminal setae (*h2*, *h3*, and *ps1*) not supported by sclerotisations, and scapular setae *se* about five times longer than *si*. The new species is clearly different in having an external copulatory tube and rudimentary spermatheca present in males.

Key to species of *Cystoidosoma* Gaud et Atyeo, 1976 of the world (adults)

- 1 Seta *c1* long, reaching prodorsal shield..... 2
- Seta *c1* short, not reaching prodorsal shield..... 3
- 2 Humeral shields not reaching setae *c2*, coxal fields I separated from each other.....
- *C. aratingae* Mironov et Fain, 2003
- Humeral shields reaching setae *c2*, coxal fields I fused..... *C. psittacivora* Dabert et Ehrnsberger, 1992

- 3 Seta *se* only slightly longer than *si*.....
- *C. labidostomma* Gaud et Atyeo, 1976
- Setae *se* at least three times longer than *si*..... 4
- 4 Longitudinal sclerites present near setae *d2*.....
- *C. sacculipyga* Dabert et Ehrnsberger, 1992
- Longitudinal sclerites absent near setae *d2*..... 5
- 5 Bases of setae *h2*, *h3* and *ps1* situated on weakly sclerotised band.....
- *C. myiopsittae* Mironov et Fain, 2003
- Bases of setae *h2*, *h3* and *ps1* situated on soft tegument..... 6
- 6 External copulatory tube present in females only; caudal setae *ps1*, *h2* and *h3* transversely arranged.
- *C. centuri* Dabert et Ehrnsberger 1992
- External copulatory tube present in both sexes; caudal setae *ps1*, *h2* and *h3* obliquely arranged.
- *C. hermaphroditus* sp. n.

DISCUSSION

Cystoidosoma hermaphroditus sp. n. is the first feather mite (Astigmata: Psoroptidia) described from an owl in Brazil (see Valim et al. 2011). It is also the first record of the family Ascouracaridae associated with owls (Strigiformes) in the world. Other quill mites (Prostigmata: Syringophilidae), however, have been found on owls, including the three species of the genus *Bubophilus* Philips et Norton, 1978: *B. ascalaphus* Philips et Norton, 1978, *B. asiobius* Skoracki et Bochkov, 2002, and *B. aluconis* Natress et Skoracki, 2009, associated with *Bubo virginianus* (Gmelin), *Asio otus* (Linnaeus), and *Strix aluco* Linnaeus, respectively (Philips and Norton 1978, Skoracki and Bochkov 2002, Natress and Skoracki 2009). In the

Ascouracaridae, it is typical for a single male and female to inhabit a single feather (OConnor 2009), but 11 adults were found inhabiting the same feather quill in the present study (Fig. 1 B,C).

In female astigmatans, the primary spermathecal duct (or inseminatory canal of Witalinski et al. 1990) sometimes extends outside the opisthosomal margins, forming an external copulatory tube, or external spermaduct (Walter and Proctor 2013), that leads to the *bursa copulatrix* (*receptaculum seminis* of Witalinski et al. 1990) (Fig. 6A) via the primary duct. The external tubes occur in females of many families including Pterolichoidea (Ascouracaridae, Caudiferidae, Crypturoptidae, Eustathiidae, Freyanidae, Pterolichidae, Thoracosathesidae), Analgoidea (Trouessartiidae), Glycyphagoidea (Echimyopodidae, Glycyphagidae, Rosensteiniidae) and Canestrinioidea (Canestriniidae). It is a remarkable and surprising fact of the present study that, males were also found to possess an external cone-like spermaduct, an inseminatory canal and a rudimentary *bursa copulatrix* (Fig. 6B), much similar to those of females. This condition has not been previously reported in mite groups where sperm is introduced into the female reproductive system via a secondary opening (Acariformes: Astigmata) or openings (Parasitiformes: Dermanyssina).

There is some variation in these structures in the two sexes. In slide preparations of females, the primary spermathecal duct is slightly longer, and both the primary and secondary (ovarian) ducts are visible near the base of the

bursa copulatrix; in males there are no traces of secondary ducts visible (Fig. 6B). Because these structures in males are unique, it is difficult to employ standard terminology applied in other organisms where both female and male structures appear in the same individual. Monoecy or hermaphroditism are not appropriate, since these terms imply complete female and male systems in the same individual. Similarly, gynandromorphism seems inappropriate because this term typically refers to aberrant individuals where the body is a mosaic of male and female morphologies (e.g. Buczek 1993). The mode of sex determination in the Ascouracaridae is unknown; in fact, the only psoroptid (Astigmata) family in which it is described is the analgoid family Epidermoptidae Trouessart, 1892, where *Promyalges pari* (Fain, 1965) has a haplo/diploid karyotype, although true arrhenotoky has not been demonstrated (Helle and Wysoki 1983, Norton et al. 1993). It is possible that the small number of males examined from a single feather may represent an aberration resulting from a local mutation, but further collecting will be needed to test this hypothesis. In the meantime, this unique configuration of the male reproductive system will remain enigmatic.

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