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External morphology of postembrionic stages of *Lutrilichus javanicus* (Acariformes: Chirodiscidae) from *Melogale moschata* (Carnivora: Mustelidae) from Vietnam

Andre V. Bochkov

*Zoological Institute, Russian Academy of Sciences, Universitetskaya emb. 1, 199034 St. Petersburg, Russia.*

*Museum of Zoology, University of Michigan, 1109 Geddes Ave., Ann Arbor, Michigan 48109, USA.*

*Tyumen State University, 10 Semakova Str., 625003, Tyumen, Russia.*

**ABSTRACT**

Mites of the family Chirodiscidae (Acariformes: Sarcoptoidea) are permanent mono- or stenoxenous symbionts of mammals living in the fur of their hosts. Among three genera included in the tribe Schizocarpini (Labidocarpinae), members of the genus *Lutrilichus* Fain inhabit small carnivores of the families Mustelidae and Viverridae (Carnivora). The external morphology of postembrionic stages of *Lutrilichus javanicus* Fain, 1970 (Acariformes: Chirodiscidae), collected from *Melogale moschata* (Gray, 1831) (Mustelidae) in Vietnam, is described. This is the second report of this mite species, previously known from a single female specimen from *Melogale orientalis* Blanford, 1888 in Java, and the first description of the immature stages in the genus *Lutrilichus*.

**Keywords** Acari, fur mites, Schizocarpini, parasites, systematics

**Zoobank** http://zoobank.org/9BA16FB7-71A7-4A07-8BBF-7083E5021B41

**Introduction**

The family Chirodiscidae (Acariformes: Sarcoptoidea) includes approximately 230 species in 26 genera and four subfamilies (Bochkov 2010). These mites are permanent mono- or stenoxenous symbionts of mammals that live in the fur of their hosts. The tribe Schizocarpini (Labidocarpinae) includes three genera, *Schizocarpus* Trouessart from beavers (Rodentia: Castoridae) (60 species), *Soricilichus* Fain (3 species) from African shrews of the subfamily Crocidurinae (Soricomorpha: Soricidae), and *Lutrilichus* Fain (5 species) from small carnivores of the families Mustelidae and Viverridae (Carnivora) (Fain 1970, 1971, 1981; Fain et al. 1974; Bochkov et al. 2016). In mites of this tribe, the external morphology of immature instars strongly differs in male and female lines of development. Larvae are hexapode with well-developed legs III having a full set of setae typical for this stage in chirodiscids. Male protonymphs and tritonymphs also bear the full set of setae and have well-developed legs III and IV. All these preimaginal stages of the male line live independently. At the same time, female proto- and tritonymphs are saciform, the number of their idiosomal setae is strongly reduced compared to those of the male line, and their legs III and IV are primordial or absent. They are apparently not able to live independently and are always found attached to males with the posterior end of the opisthosoma (Fain 1971).

The external morphology of the immature stages in chirodiscid genera *Schizocarpus* and *Soricilichus* was studied in detail by Dubinin (1964) and Bochkov et al. (2016), respectively. At the same time, the immature stages of *Lutrilichus* have never been studied specifically.

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In this paper, the external morphology of all postembryonic stages of *Lutrilichus javanicus* Fain, 1970 collected from fur of *Melogale moschata* (Gray) (Carnivora: Mustelidae) in Vietnam is described. This mite species was previously known from a single female specimen (holotype, housed in the Natural History Museum, London, UK) from *Melogale orientalis* Blanford, from Java (Fain 1970; 1981).

**Materials and methods**

The host of mite specimens used in the present study, the Chinese ferret badger, *Melogale moschata*, was collected by my colleague, A.V. Abramov (Zoological Institute of the Russian Academy of Sciences, Saint-Petersburg, Russia), in the zoological survey in northern Vietnam carried out by the Vietnam-Russia Tropical Center (Ho Chi Minh City — Moscow) in 2013. Mites were gathered by AB from the ethanol-preserved host with fine forceps under dissection microscope, placed in 96% ethanol, and then mounted in Hoyer’s medium according to standard methods (Evans 1992). Drawings were made with a Leica microscope equipped with differential interference contrast optics and a camera lucida.

In the description below, the idiosomal setation follows Griffiths et al. (1990) with modifications for coxal setae by Norton (1998), and leg setation follows Grandjean (1939). All measurements are in micrometers (μm) and were taken as follows: body length = length from the palpal apices line to the posterior margin of the body; idiosomal width = lateral width at the level of setae **cp**; length of dorsal shields = maximum length, measured along the median line of the shields; length of the posterior legs = length from the most proximal point of the trochanter to the apex of the tarsus, excluding the pretarsus.

**Results**

**Family Chirodiscidae Trouessart, 1892**

**Subfamily Labidocarpinae Gunther, 1942**

**Tribe Schizocarpini Fain, 1971**

**Genus Lutrilichus Fain, 1970**

*Lutrilichus javanicus* Fain, 1970 (Figures 1-7)


Material examined — 10 males, 10 females, 10 male larvae, 10 female larvae, 5 male protonymphs, 10 female protonymphs, 10 male tritonymphs, 10 female tritonymphs, and numerous specimens retained in ethanol (ZISP, AVB 17-1103-001) from the Chinese ferret badger *Melogale moschata* (Gray) (Carnivora: Mustelidae) (ZISP, AVA 13-169), VIETNAM: Son La Province, Phu Yen District, Suoi To Commune, Suoi Khang Village, ca. 10 km NW of Phu Yen, 21°20′13.2″N, 104°36′29.7″E, alt 1100 m, 31 May 2013, coll. A.V. Abramov. Mites are deposited in the Museum of Zoology, the University of Michigan, Ann Arbor, USA (UMMZ), and Zoological Institute of the Russian Academy of Sciences, Saint-Petersburg, Russia (ZISP).

Figure 1 *Lutrilichus javanicus* Fain, 1970, male larva. A – Lateral view; B – Leg III in ventral view. Scale bars: A = 100 μm; B = 50 μm.
absent. Anal opening situated ventrally. Lengths of setae: \(si\) 50–88, \(se\) 60–80, \(c1\) 55–63, \(c2\) 48–58, \(cp\) 45–50, \(c3\) 40–65, \(d1\) 33–45, \(d2\) 40–60, \(e1\) 50–65, \(e2\) 58–78, \(h2\) 150–210, \(l1\) and \(3a\) 15–20. Each pair of coxal apodemes \(Ia\) and \(IIa\), fused in \(Y\)-shaped structures. Coxal apodemes \(IIIa\) fused medially in \(arch-like\) structure.

**Legs.** Legs I and II with 5 segments: trochanter without setae, femur with seta \(vF\), genu with setae \(cG\) and \(mG\), tibia with seta \(gT\) and solenidion \(\varphi\), tarsus with paired tarsal flaps and solenidion \(\omega 1\). Legs III well developed, with full set of articulated segments: trochanter, femur, genu, tibia and tarsus with pretarsus. Ambulacral disc of pretarsus III with acute terminal protrusion. Leg III setation: genu: solenidion \(\sigma\), tibia: seta \(kT\) and solenidion \(\varphi\), tarsus: setae \(w, r, s, f, e, d\). Setae \(sIII\) and \(wIII\) shaped as longitudinally striated spurs.

**Male protonymph — (5 specimens, Figure 2A, B) —** Body 310–390 long and 210–265 wide. **Idiosoma.** Propodonotal shield about 10 long. One pair of genital papillae, setae \(f2\), \(h3\), \(ps1\), \(ps2\), \(ps3\), and \(g\) added on idiosoma. Setae \(f2\) situated closer to bases of \(h2\) than \(ps2\). Lengths of setae: \(si\) 70–90, \(se\) 80–100, \(c1\), \(c2\), \(cp\), \(c3\), \(d1\), \(d2\), \(e1\), and \(e2\) 70–100; \(f2\), \(ps1\), \(ps2\), and \(ps3\) 10–20; \(h2\) 100–120; \(h3\) 80–100. Coxal apodemes \(IVA\) fused medially into \(arch-like\)

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**Figure 2** *Lutrilichus javanicus* Fain, 1970, male nymphs. (A, B) protonymph: A – Lateral view; B – Leg IV in ventral view. (C–F) deutonymph: C – Lateral view; D – Coxal fields III, E – Tarsus and tibia IV in dorsal view; F – Tarsus IV in ventral view. Scale bars: A, C = 100 μm; B, D – F = 50 μm.
structure. Legs. Legs IV with five articulated segments added. Pretarsus IV present. Setae d, w, and r of tarsus IV present, other segments of legs IV without setae. Seta wIV shaped as longitudinally striated spur.

Male tritonymph — (10 specimens, Figure 2C–F) — Body 410–450 long and 250–300 wide. Idiosoma. Propodonotal shield 10–15 long. Second pair of genital papillae, coxal setae 4a and 4b added on idiosoma. Lengths of setae: si 78–90, se 80–100, c1 50–70, c2 70–90, cp 45–70, c3 60–65, d1 45–50, d2 70–90, e1 and e2 60–70, f2 18–25, h2 140–180, h3 80–100, ps1 5–10, ps2 23–28, ps3 38–53. Legs. Seta sRIII on trochanter III, seta kTIII on tibia III, and setae eIV and fIV on tarsus IV added.

Hysteronotal shield shaped of transverse band, situated posterior to setae e1, 25–35 in length along midline. Setae ps3 situated between adanal suckers. Opisthosomal lobes widely rounded. Lengths of idiosomal setae: si 80–100, se 100–115, el 78–93, c2 93–105, cp 70–120, c3 40–65, d1 40–60, d2 80–95, e1 microsetae, e2 70–100, f2 80–85, h2 130–180, h3 130–170, ps1 110–120, and ps2 100–125. Aedeagus about 11 long. Adanal sclerites absent. Legs III 110–140 long, with setation as in male tritonymph. Legs IV 70–90 long, consisting of 4 segments, femur and genu fused. Solenidion σIII added on genu III. Tarsi IV bearing setae d, w, and r, tibia IV with solenidion φIV, other segments of legs IV without setae. Seta wIV shaped as longitudinally striated spur.

Female larva — (10 specimens, Figure 3) — Similar to male larva. Body 250–300 long and 160–205 wide. Idiosomal dorsum posterior to level of setal bases c2 and d1 smooth. Lengths
Lutrilichus javanicus Fain, 1970, adults in lateral view. A – Male; B – Female.

of idiosomal setae: \( si \) 88–120, \( se \) 75–125, \( c1 \) 28–38, \( c2 \) 80–100, \( cp \) 80–120, \( c3 \) 70–85, \( d1 \) 2–3, \( d2 \) 25–30, \( e1 \) 110–125, \( e2 \) 60–90, \( h2 \) 180–240, \( 1a \) 10–20, and \( 3a \) 30–40. Setae \( e1 \) thickened and situated terminally. Live independently or attached to male.

Female protonymph — (10 specimens, Figure 4A, B) — Body 255–265 long and 190–210 wide, slightly elongated sack-like. Coxal fields I smooth; coxal apodemes II–IV absent. Setae \( c3 \), \( e1 \), \( e2 \), \( d1 \), \( d2 \), \( f2 \), \( 3a \), \( g \), \( ps1 \), \( ps2 \), and \( ps3 \) absent. Setae \( h3 \) added. Lengths of setae: \( si \) 88–93, \( se \) 100–110, \( c1 \) 10–15, \( c2 \) 5–8, \( cp \) 30–35, \( 1a \) about 10, \( h2 \) and \( h3 \) 28–35. Posterior end of opisthosoma between levels of setae \( e1 \) and \( h2 \) smooth, anterior margin of this area flanked with a pair of large bow-shaped opisthosomal sclerites and bears pair of rounded tubercles corresponding to male adanal suckers. Legs I strongly shortened compared to female larva, their tibia and tarsus clearly separated. Setation of legs I as in female larva, but all setae shorter. Legs II–IV absent. First pair of genital papillae added.
Figure 6 *Lutrilichus javanicus* Fain, 1970, details of male. A – Palp in ventral view; B – Cheliceral digits in lateral view; C – Coxal fields III; D – Opisthosomal lobes in dorsal view; E – Opisthosomal lobes in ventral view; F – Tarsus, tibia, and genu III in ventral view; G – Leg IV in ventral view.
Female tritonymph — (10 specimens, Figure 4C) — Similar to female protonymph. Body 335–350 long and 245–305 wide. *Idiosoma*. Propodonotal shield 10–15 long. Second pair of genital papillae added. Idiosomal chaetome as in female protonymph. Lengths of idiosomal setae: $si$ 80–135, $se$ 125–155, $c1$ and $c2$ 5–8, $cp$ 25–50, $h2$ and $h3$ 20–35, $1a$ about 10. *Legs*. Legs I as in female protonymph. Legs II strongly reduced, several times shorter and thinner than legs I, consisting of 3 articulated segments, apical segment with 3 short setae. Legs III and IV primordial, shaped as small conical tubercles not split into segments, each bearing 1 apical microseta.

Female — (10 specimens, Figures 5B and 7) — Similar to male tritonymph except oviporus between coxal fields III. Body 440–490 long, 275–330 wide. *Idiosoma*. Propodonotal shield about 10 long. Full set of idiosomal setae occurring in adult chirodiscids excluding setae $h1$ (as in male). Coxal apodemes I–III as in male tritonymph. Lengths of setae: $si$ 100–125, $se$
100–120, c1 75–85, c2 80–105, cp 83–105, c3 75–85, dl 58–80, d2 85–95, e1 95–130, e2 95–125, f2 19–25, h2 135–170, h3 140–160, ps1 10–23, ps2 25–38, and ps3 50–70. Legs I and II as in male. Legs III and IV fully developed as in male tritonymph; setation of legs III and tibia IV as in male, tarsus IV with 5 setae d, e, f, r, and w. Seta wIV shaped as longitudinally striated spur. Ovoviviparous.

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