**Research Article**

**Lemuralges propithecus** sp. n. (Acariformes: Psoroptidae), an ectoparasite of the diademed sifaka *Propithecus diadema* (Primates: Indriidae)

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Abstract: A new species of the genus *Lemuralges Fain, 1963* (Acariformes: Psoroptidae: Makialginae) is described from the Malagasy lemur *Propithecus diadema* (Bennett) (Primates: Indriidae) based on all postembryonic instars. This new species differs from the only known species in this genus, *Lemuralges intermedius* Fain, 1963, by the following features: both sexes of *L. propithecus* sp. n. show a pair of medioventral projections of the subcapitulum (vs without projections in *L. intermedius*) and the propropodonotal shield is slightly ornamented (vs unornamented); in males the hysteronotal shield is completely covered by longitudinal striae (vs median part without striae), setae c2 are 120–140 µm long (vs 200–210 µm long), and femur III has a short transverse furrow dorsally (vs a longitudinal furrow); in females, setae h2 are, at least, 2 times shorter than h3 (vs slightly longer, or subequal to, h3), tibia IV has a ventro-apical projection (vs without projection). Larvae and protonymphs of the new species show some unique developmental delays. Female and male tritonymphs differ by their external morphology.

Keywords: acari, parasites, lemurs, Madagascar, systematics

Mites of the subfamily Makialginae (Acariformes: Psoroptidae) are permanent mono- or stenoxenous ectoparasites known from all families of strepsirrhine primates (Primates: Strepsirrhini) except Lorisidae. A taxonomic revision, phylogenetic reconstruction and analysis of host-parasite relationships of this group were published recently (Bochkov et al. 2010, 2011).

To date, this subfamily includes 11 species in six genera. Most makialgines are associated with Malagasy lemurs (infraorders Lemuriformes and Chiromyiformes) being re-

Makialgine species, known from continental Africa is *Galagalges congolensis* Fain, 1963 parasitising *Galago moholi* Smith (Lorisiformes: Galagidae). The hosts from which makialgines have been recovered constitute only a small fraction of the extant Malagasy lemur biodiversity, currently listed as at least 59 species in 14 genera (Groves 2005).

New makialgine records are relatively rare events because collection of these mites requires special approaches and their hosts are in protected species. As part of the Prosimian Biomedical Survey Project, a project surveying health conditions of lemurs in their natural environment, two of the authors (R.E.J. and C.V.W.) collected ectopara-

Previously, the genus *Lemuralges* included only a single species, *L. intermedius* Fain, 1963, which was recorded from the following Malagasy lemur species, including a series of Makialginae from the diademed sifaka *Propithecus diadema* (Bennett) (Primates: Indriidae) that revealed a new species in the genus *Lemuralges* Fain, 1963.

In this paper, the new species *L. propithecus* sp. n. is described based on all postembryonic instars.

**MATERIALS AND METHODS**

All lemurs were examined under Research permit No. 200/12/MEF/SG/DFG/DCP SAP/SCB, issued by the Secretary General, Department of Water and Forests, Republic of Madagascar. All animals underwent medical evaluations following the standard...
protocol used by the Prosimian Biomedical Survey Project while under anesthesia (see Junge et al. 2011). Some hosts showed 4–5 cm diameter regions of matted fur and thick, irregular scabs and crusts. Samples of the scabs and adjacent debris were collected and preserved in 90% ethanol. These samples revealed large numbers of Lemuralges. All hosts were released after examination. Mites were mounted in Hoyer’s medium. Drawings were made with a Leica microscope equipped with Nomarski differential interference contrast optics and a camera lucida. The idiosomal setation follows Griffiths et al. (1990) with modifications of Norton (1998) concerning coxal setae. The leg setation follows Grandjean (1941). All measurements are given in micrometres (μm) and were taken as follows: body length – the total length from the anterior extremity of the distal end of the palps to the posterior border of the body, including lobar membranes in males; body width – width at the level of setae cp; length of dorsal shields – maximal length, measured along the median line of the shields; length of the posterior legs – length from the most basal point of the trochanter to the apex of the tarsus, excluding pretarsus. Host systematics follows Groves (2005).

The following institutional abbreviations are used: IRSNB – Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium; OSAL – Acarology Laboratory, the Ohio State University, Columbus, OH, USA; UMMZ–Museum of Zoology, the University of Michigan, Ann Arbor, MI, USA; ZISP – Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia.

RESULTS

Family Psoroptidae Canestrini, 1892
Subfamily Makialginae Gaud and Till, 1957
Genus Lemuralges Fain, 1963

Lemuralges propithecus sp. n. (Figs. 1–8)


Lengths of setae: vi 10 (9–10), si 35 (35–40), se 250 (220–250), c1 150 (140–150), c2 120 (120–135), cp 570 (550–575), c3 175 (150–175), dl 125 (125–140), d2 180 (180–190), e1 200 (180–200), e2 330 (300–340), f2 55 (50–60), h2 475 (470–520), h3 520 (490–520), la 80 (80–100), 3a 185 (185–200), 4a 70 (60–70), db 60 (60–65), g 12 (12–14), ps3 about 20, ps2 220 (220–240), ps1 375 (350–375).

Legs. Tibia and genua I, II each with 1 short ventral projection. Legs III 620 long (580–630); legs IV about 270 long (260–270). Dorso-apical spur of tibia III about 15 long. Tarsi III about 140 long without pretarsus. Femur III with short transverse furrow dorsally. Setae sIII about 350 long; kTIII about 380 long, and dIII about 350 long. Lengths of solenidia: wIII about 45, wI, II 20–30, φI, II 90–110, φIII about 90, φIV about 90, φI about 90, φII about 25, and φIII about 50.


Lengths of setae: vi about 10, si about 30, se 180–190; cl, c1, d1, e2, and e2 30–40, c3 55–60, cp 110–120, h2 130–160, h3 380–400, la 40–45, 3a about 60, 4a, 4b, and g 30–40, ps1 and f2 10–15, ps3 and ps2 19–20.


Idiosoma. Propodonal shield about 100 long and 40 wide, without ornamentation, bearing setae vi and 1 pair of small unsclerotised spots (probable remnants of setal alveoli ve) at level of openings of coxal organ. Hysteronotal shield absent. Openings of hysteronal glands (gL) distinct. Opisthosomal margin widely rounded. Idiosomal dorsum slightly punctate.

Idiosomal setae: vi, si, se, cl, c2, cp, c3, d1, d2, e1, e2, h2, 3a, and 3a. Setae sxs absent. Setae si and se situated off propodonal shield; si located close, but distinctly anterior to se. Setae d1 located slightly anterior to level of setae d2, e1 located distinctly anterior to level of setae e2, distance between levels of setae e1 and e2 about 50. Setae se about 80 long, located on small sclerotised plates; setae cp about 40 long, setae h2 whip-like, about 200 long, other dorsal setae short, 10–15 long, ventral setae 1a, 3a, and c3 20–30 long. Apodemus Ia free.

Legs. Tarsi I and II each bearing dorsoapical spur and widely rounded ventral subapical projection. Tibiae I and II each bearing upwardly directed ventroantiaxial projection and weakly developed ventral projection. Genua I and II each bearing weakly developed ventral projection. Legs III with 5 articulated segments. Pretarsi I and II normally developed. Pretarsus III half as long as its respective tar-
Fig. 1. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, male. A – dorsal view; B – ventral view.

Fig. 2. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, female. A – dorsal view; B – ventral view.
Fig. 3. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, adult legs. **A** – leg I of male in ventral view; **B** – same, leg II; **C** – tarsus III of male in ventral view; **D** – seta sIII of male; **E** – tibia and tarsus IV of male in ventral view; **F** – leg III of female in ventral view; **G** – tibia and tarsus IV of female in ventral view. Scale bars: A, B, E–G = 100 µm; C = 50 µm; D = 25 µm.

Fig. 4. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, larva. **A** – dorsal view; **B** – ventral view.
Fig. 5. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, legs of larva. A – leg I in ventral view; B – tibia and tarsus III in ventral view; C – leg II in ventral view.

Fig. 6. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, protonymph. A – dorsal view; B – ventral view.
Fig. 7. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, legs of protonymph. A – leg I in ventral view; B – leg II in ventral view; C – tibia and tarsus III in ventral view; D – tarsus IV in ventral view.

Fig. 8. *Lemuralges propithecus* sp. n. from *Propithecus diadema*, tritonymph. A – leg III of form A in ventral view; B – form B in ventral view; C – leg III of form B in ventral view. Scale bars: A, C = 50 µm; B = 100 µm.
sus with strongly reduced ambulacral disc. Setation of legs I–III: I – tarsus  d, e, f, ra, wa, la, s, ba, o1, e, tibia gT, φ, genu cG, mG, femur vF, trochanter without seta; II – tarsus d, e, f, ra, wa, la, s, ba, o1, tibia gT, φ, genu cG, mG, femur vF, trochanter without seta; III – tarsus d, e, f, s, w, r, tibia kTIII and φ; other segments of leg III without setae. Famulus ε trirfurcated, setae ba spur-like, solenidia o1 I and II about 15 long, located slightly posterior to respective setae ba, φ I and II 70–80 long, setae dIII whip-like, about 400 long.  

Protonymph (3 paratypes, Figs. 6, 7). Body 630–700 long and 360–400 wide. Subcapitulum ventrally with pair of median triangular retrograde projections. Propodonotal shield about 160 long and 100 wide, slightly ornamented, with transverse fold in anterior part. One pair of genital papillae, setae f2, h3, ps1, ps2, ps3 and g added on idiosoma. Setae f2 located near bases of h2. Setae se about 300 long, setae cp about 70 long, setae h3 560–600 long, 5–6 times longer than h2; other dorsal setae 8–15 long; ventral setae l1a about 65 long, 3a and c3 about 50 long, other ventral setae and setae f2 6–12 long. Distances between setal levels of d1–d2 and e1–e2 about 45 and 85, respectively. Solenidia σ1I, σII, and σIII added. Solenidion σ1I about 130 long, 8 times longer than σII; solenidion σIII shorter than respective genu. Ventroaxial projections of tibiae I, II and ventral projections of genua I, II distinct. Legs IV added, with 5 segments. Setae d, w, r present on tarsus IV. Setae dIII and dIV whip-like, about 1000 long and 650 long, respectively. Pretarsus III well developed, two times longer than respective tarsus; pretarsus IV absent.  

Tritonymph A (2 paratypes, Fig. 8A). Body 700–800 long and 425–475 wide. Propodonotal shield about 160 long and 125 wide. Second pair of genital papillae, setae 4a and 4b added on idiosoma. Setae se about 230 long, cp 50, h3 about 250 long, in 2.5 times longer than setae h2, other dorsal setae 12–20 long, l1a and 3a 30–35 long, other ventral setae and f2 10–15 long. Solenidion o3 added on tarsus I, setae pRI and pRII added on trochanters I and II, respectively, and setae sRIII added on trochanter III. Tibia III with anteroventral projection. Setae dV and dIV added on tarsus IV and kTIV and pIV added on tibia IV. Setae dIII and dIV whip-like, about 1000 long and 700 long, respectively. Pretarsi III and IV about 1.5 times longer than respective tarsi.  

Tritonymph B (5 paratypes, Fig. 8B, C). Body 500–650 long and 250–300 wide. Tibia III without anteroventral projection. Other structures as in tritonymph A, but proportionally smaller.

**Type host:** Diademid sifaca Propithecus diadema (Bennett) (Primates: Indriidae).

**Type Locality:** Madagascar, Antananarivo, Tsinoarivo, 19°37′59″S; 47°40′59″E.

**Other locality:** Madagascar (no other data).

**Type material:** Male holotype, 5 male, 7 female, 2 tritonymph of form A, 5 tritonymph of form B, 3 protonymph and 6 larva paratypes (OSAL 0104569), 1 male and 1 female paratypes (UMMZ BMOC 14-0813-001, No. 1, 2), 1 male and 1 female paratypes (ZISP AVB 14-0810-001, No. 1, 2) (several unmounted ethanol-preserved specimens present at OSAL), host No. TSN 8.14, June–July 2008, coll. R.E. Junge and C.V. Williams.

**Voucher material:** Additional samples of mites in ethanol (same locality as for type series) – host No. TSN 8.01 (OSAL 0102386), host No. TSN 8.02 (OSAL0102385), host No. TSN 8.05 (OSAL0102383), host No. TSN 8.06 (OSAL0102384), host No. TSN 8.08 (OSAL0102392), host No. TSN 8.09 (OSAL0102388), host No. TSN 8.10 (OSAL0102378), host No. TSN 8.11 (OSAL0102377), host No. TSN 8.12 (OSAL0102376); host No. TSN 8.13 (OSAL0102374), host No. TSN 8.16 (OSAL0102379), host No. TSN 8.17 (OSAL0102390), host No. TSN 8.22 (OSAL0102387); 5 males, 5 females and 3 tritonymphs A (IRSNB), date unknown, coll. Robaux.

**Site:** Skin.

**Prevalence:** 23 hosts examined, 15 were parasitized by *Propithecus diadema* (~65%) (at Tsinoarivo).

**Etymology:** The name of this new species refers to the generic name of the host and is a noun in apposition.

**Remarks.** A pair of ventromedian retrograde projections is present on the subcapitulum in all postlarval instars (absent in larva) of *L. propithecus* sp. n., and the propodonotal shield is slightly ornamented (not ornamented in larva); in females and immatures, setae h2 are at most half as long as h3; in males, the hysteronotal shield is completely covered by striae, setae c2 are 120–140 long, femur III has a short transverse furrow dorsally; in females, tibia IV shows a ventro-apical projection; in protonymphs, tarsus IV has no pretarsus; in larvae, pretarsus III is strongly reduced, shorter than the tarsus.

In all instars of *L. intermedius*, the ventromedian projections of the subcapitulum are absent and the propodonotal shield is devoid of ornamentation; in females and immaturity stages, setae h2 are slightly longer or subequal to h3; in males, the hysteronotal shield is devoid of striae in the median part, setae c2 are 200–210 long, femur III shows a short longitudinal furrow dorsally; in females, tibia IV lacks a ventro-apical projection; in protonymphs, tarsus IV has a well developed pretarsus; in larvae, pretarsus III is longer than the tarsus.

**DISCUSSION**

As in other psoroptids, the life-cycle of *Lemuralges* includes the following postembryonic immature stages: larva, protonymph and tritonymph (Fain 1963). The female and male lines probably are not distinguishable in the larval or protonymphal stages. In contrast, we found two morphologically different forms of tritonymphs of *L. propithecus* sp. n. In tritonymphs of *L. intermedius* (12 specimens examined), such different forms were not observed. In our material of *L. propithecus*, there were no pharate adults inside of tritonymphal skins. Therefore, the direct association of these tritonymphal forms with female or male lines of development is currently impossible, but we assume that the bigger ones (form A) represent male tritonymphs.

In *Lemuralges*, the ontogenetic pattern of morphological characters is similar to that recorded for other Psoroptidae (see Fain 1963). One important deviation from the
A general scheme is observed in the larvae: solenidion σ1I, normally present in most psoroptid larvae, is delayed to the protonymph. According to our observations, the same apomorphy characterises larvae of three other makialgine genera (Bochkov et al. 2011), i.e. Daubentonialges Fain, 1972, Gaudalges Fain, 1963, and Makialges Gaud et Till, 1957, but is absent in all other psoroptid subfamilies (A.V.B. – unpubl. data). Larvae of the two remaining early derivative makialgine genera, Galagalges Fain, 1963 and Cheirogalalges Fain, 1963 are unknown, and so it is unclear whether this apomorphy characterises the entire subfamily or only the clade uniting these four genera. In addition, Lemuralges propithecus sp. n. demonstrates delay of pretarsal development on the posterior legs. In larvae of this species, pretarsi III are weakly developed, and protonymphs completely lack pretarsi IV. In other makialgines of this clade, larval legs III have well developed pretarsi and protonymphs have pretarsi IV.

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REFERENCES


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