



A NEW SPECIES OF SUCKING LOUSE FROM THE MANDRILL FROM GABON WITH A REVIEW OF HOST ASSOCIATIONS AND GEOGRAPHICAL DISTRIBUTIONS, AND IDENTIFICATION KEYS TO MEMBERS OF THE GENUS *PEDICINUS* (PHTHIRAPTERA: ANOPLURA: PEDICINIDAE)

Lance A. Durden¹, Sharon E. Kessler^{2,3}, Larson Boundenga⁴, Barthélemy Ngoubangoye⁴, Thierry A. Tsombou⁴, Cyr I. Moussadji-Kinga⁴, Michel Halbwx^{4,5}, Joanna M. Setchell³, Jennifer Nichols³, and Stephen E. Greiman¹

¹ Department of Biology, Georgia Southern University, Statesboro, Georgia 30458.

² University of Stirling, Department of Psychology, Faculty of Natural Sciences, Stirling FK9 4LA, Scotland.

³ Durham University, Department of Anthropology, Durham, DH1 3LE, U.K.

⁴ Centre de Primatologie, Centre International de Recherches Médicales de Franceville (CIRMF), B.P. 769 Franceville, Gabon.

⁵ Agence Nationale des Parcs Nationaux, B.P. 20379, Libreville, Gabon.

Correspondence should be sent to Lance A. Durden at: ldurden@georgiasouthern.edu

KEY WORDS ABSTRACT

Phthiraptera	Members of the sucking louse genus <i>Pedicinus</i> are ectoparasites of cercopithecoid primates in Africa, Asia, and Gibraltar. <i>Pedicinus gabonensis</i> n. sp. is described on the basis of adult male and female specimens collected from the mandrill (<i>Mandrillus sphinx</i>) in Gabon. The new species is compared morphologically with other members of the genus <i>Pedicinus</i> , and a nuclear elongation factor 1 alpha gene sequence is provided. Host associations and geographical distributions of the 18 previously recognized species of the genus and of <i>P. gabonensis</i> n. sp. are reviewed. Updated identification keys are provided for males and females of all known valid species of <i>Pedicinus</i> .
Anoplura	
<i>Pedicinus</i>	
New Species	
Gabon	
Dichotomous Key	
Host Associations	
Geographical Distributions	

The sucking louse genus, *Pedicinus* Gervais, is the only genus in the family Pedicinidae Enderlein as designated by Kim and Ludwig (1978), Ledger (1980), and Pajot (1996, 2000). All known members of the genus are ectoparasites of cercopithecoid monkeys in the Old World (Africa, southern Asia, and Gibraltar). To date, 18 valid species of *Pedicinus* have been recognized (Kuhn and Ludwig, 1967; Durden and Musser, 1994; Mey, 1994, 2010; Pajot, 1996) and subgenera and subspecies have been designated for some species (Kuhn and Ludwig, 1967; Mey, 1994, 2010).

In this paper, a new species of *Pedicinus* is described from the mandrill, *Mandrillus sphinx* (Linnaeus) (Primates: Cercopithecidae) in Gabon. Host associations and geographical distributions are reviewed for all known species of *Pedicinus*. We also provide identification keys for males and females of all currently recognized species of *Pedicinus*, including the new species.

The mandrill is a large, sexually dimorphic cercopithecoid primate with a restricted central African distribution that includes parts of Cameroon, Republic of Congo, Gabon, and Equatorial Guinea (Grubb, 1973). It is currently listed as vulnerable (IUCN,

2019). Male mandrills are significantly larger than females (Setchell et al., 2001).

Morphologically, members of the genus *Pedicinus* are characterized within the suborder Anoplura (sucking lice) as having the following morphological characters as designated by Kim and Ludwig (1978): (1) medium-sized sucking lice (adult lengths ~1.1–3.0 mm); (2) head suboval with distinct eyes; antennae 5-segmented and sexually dimorphic (male antennae with a stout dorsal seta on each of the last 3 segments); (3) thoracic sternal plate absent; (4) legs usually large, each with a distinct tibiotarsal claw; (5) abdomen membranous and lacking sternal and tergal plates except those associated with genitalia in adults; (6) abdominal segments 4–6 or 5–6 each with a pair of subtriangular paratergal plates (note: this character is here amended to “additional paratergal sclerotizations present on segments 7 or 8 in some species”); (7) abdominal segments 3–8 each with a pair of spiracles; (8) dorsal and ventral abdominal setae very short and arranged in segmental rows (usually 1 row per segment); (9) male genitalia with basal apodeme apically emarginate, and well-developed parameres, sclerotized endomeres, and a distinct subgenital plate; (10) female genitalia with a small associated subgenital plate and poorly developed gonopods.

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MATERIALS AND METHODS

Louse collections

During annual captures for veterinary health checks, we collected ectoparasites from 7 semifree-ranging mandrills (1 male, 6 females) living at the International Center for Medical Research in Franceville, Gabon on 14 and 15 June 2017. The mandrills live in large, multimale, multifemale groups in forested outdoor enclosures (enclosure 1: ~40 mandrills in 4.7 ha; enclosure 3: ~30 mandrills in 0.7 ha). The mandrills forage in the forest in their enclosures and are provisioned daily with fruit and monkey chow (Setchell, 2016). Some individuals were trapped and treated with antiparasite medication in 2015 (IVOMEC 1% [10 mg/ml]: Ivermectin, 400 µg/kg). This study took advantage of a larger study of mandrill health and cognition during which we trapped and anesthetized (ketamine®: Imalgene 1000, 0.1 mg/kg) the mandrills. If time permitted during the capture, we parted the hair down to the skin and looked for ectoparasites during other data collection procedures. Thus, not all animals or body areas were inspected. Ectoparasites were preserved in 96% ethanol and shipped to Georgia Southern University at ambient temperature.

These ectoparasite collections were authorized by the Durham University Animal Welfare Ethical Review Board (Project: Selection to Outsmart the Germs). All methods were approved by B.N., the head veterinarian and director of the Centre International de Recherches Médicales de Franceville (CIRMF) Primate Center in Franceville, Gabon, who is accredited by the Federation of European Laboratory Animal Science Association (no. 2011-38).

DNA extraction and gene sequencing

We used deoxyribonucleic acid (DNA) sequences to provide a phylogenetic context for *Pedicinus gabonensis* n. sp. Sample DNA was extracted from 4 adult female lice as follows: louse specimens stored in 96% ethanol were transferred to ultrapure water. A small hole was made in the abdomen using a 0.155-mm minuten insect pin (Bioquip Products, Rancho Dominguez, California) and each louse was transferred to a 1.5-ml microcentrifuge tube along with 10 µl of 20 mg/ml proteinase K, 95 µl of ultrapure water, and 95 µl of 2× digestion buffer (Zymo Research, Irvine, California), followed by incubation at 58 C overnight. After incubation, the lysate was transferred to a new 1.5-ml microcentrifuge tube, quickly followed by the addition of 80% ethanol to the original tube with the louse exoskeleton, which was retained and later slide-mounted (see below). Two hundred microliters of isopropanol were added to the new tube with the DNA lysate, vortexed, and maintained at -20 C for at least 2 hr to precipitate DNA. After DNA precipitation, vials were centrifuged at 16,700 g for 15 min; the supernatant was removed and 70% ethanol wash centrifuged at 16,700 g for 5 min (×2). The supernatant was then removed, and the DNA pellet was dried for 15 min at 58 C and then resuspended in 45 µl of ultrapure water and left to sit for 2 hr at room temperature before polymerase chain reaction (PCR) amplification. PCR amplification and sequencing of a 345-base pair portion of the nuclear elongation factor 1 alpha (EF-1α) was performed using the primers For3 and Cho10 (Dansforth and Ji, 1998). Amplified fragments were purified using ExoSAP-it (Affimetrix, Santa

Clara, California) and sequenced in both directions using the original PCR primers. Sequence chromatograms were trimmed, assembled, edited, and aligned using Geneious version 11.0.4 (Biomatters, Ltd., Auckland, New Zealand). The EF-1α sequence was aligned with additional Anoplura EF-1α sequences downloaded from GenBank using the Geneious alignment tool implemented in the Geneious software. Phylogenetic analysis was carried out using Bayesian inference in MrBayes version 2.01 (Huelsenbeck and Ronquist, 2001). The following nucleotide substitution parameters were used: lset nst = 6, rates = gamma, ngammacat = 4, prset (prior assumptions) brlenspr = unconstrained:gamma (1.0,0.1,1.0,1.0) shapepr = exponential (0.308), which corresponds to the GTR + G model. The analysis was run for 1,000,000 generations and log-likelihood scores were examined to ensure convergence. The final 75% of trees were used to produce the consensus tree. The GTR + G model was used for the analysis on the basis of results obtained from jModel test version 2.1.10 (Posada, 2008). *Polyplax serrata* was designated as the outgroup on the basis of the phylogenetic analysis of Light et al. (2010).

Louse description

Lice from which DNA had been extracted were already cleared for microscopical analyses as a result of the extraction process. Therefore, after DNA extraction, each louse specimen was transferred to 70% ethanol for 10 min and then slide-mounted in polyvinyl alcohol (Bioquip Products). Prepared slides were oven-dried at 45 C for 2 wk before microscopical examination. Specimens were drawn while examining them with an Olympus BH-2 phase-contrast high-power microscope (Olympus Corporation of the Americas, Center Valley, Pennsylvania) connected to an Ikegami MTV-3 video camera attachment and monitor (Ikegami Electronics, Neuss, Germany). Measurements were made from slide-mounted specimens using a calibrated ocular micrometer. Standardized descriptive format for sucking lice follows Kim and Ludwig (1978) and Durden et al. (2019).

Names of anopluran morphological structures, including setae, follow Kim and Ludwig (1978) and Durden et al. (2019). Host taxonomy and common names follow Groves (2005) and IUCN (2019).

DESCRIPTION

Pedicinus gabonensis Durden, Kessler, and Greiman n. sp. Male (Fig. 1A–C; n = 1)

Total body length of holotype, 1.675 mm. Head, thorax, and abdomen moderately sclerotized.

Head (Fig. 1A): Maximum width, 0.255 mm. Much longer than wide with pair of distinct but nonbulging eyes situated about halfway along lateral sides of head. Head widest centrally, narrowest posteriorly, and broadly rounded anteriorly. One long dorsal principal head seta situated posteriorly, 2 dorsal posterior head setae, 1 dorsal anterior head seta, 3 dorsal marginal head setae, 4–5 apical head setae, 1 ventral preantennal head seta, 1 supra-antennal head seta, and 2 ventral lateral head setae on each side. Antennae 5-segmented; first segment very large, slightly wider than long; second and third segments elongate, much longer than wide; fourth and fifth segments small, about as wide as long.

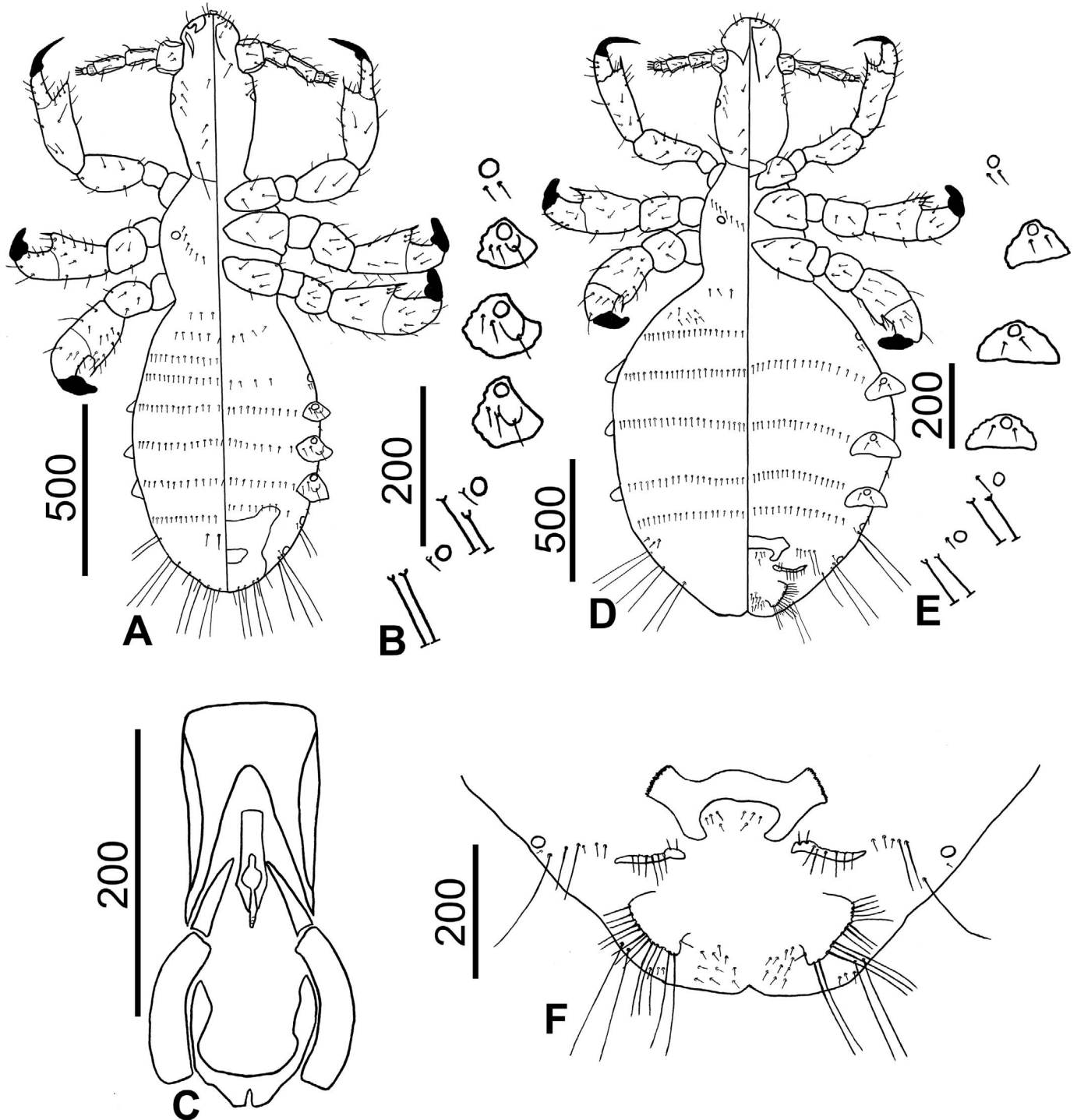


Figure 1. *Pedicinus gabonensis* n. sp., male (A–C) and female (D–F). (A) Dorsoventral drawing of entire adult male (dorsal features on left side, ventral features on right). (B) Male paratergites, abdominal spiracles, and associated setae. (C) Male genitalia. (D) Dorsoventral drawing of entire adult female (dorsal features on left side, ventral features on right). (E) Female paratergites, abdominal spiracles, and associated setae. (F) Female genitalia and posterior, ventral abdomen (scale bars are in microns).

Thorax (Fig. 1A): Maximum width, 0.355 mm; wider than head, longer than broad; 1 mesothoracic spiracle (diameter, 0.031 mm) on each side; oblique row of 6 small setae medial to spiracle on each side. Legs large, each ending in acuminate claw; leg I slightly narrower than legs II and III and with much narrower

claw; legs II and III about equal in size; coxae subtriangular, especially coxa II.

Abdomen (Fig. 1A): Slightly wider than thorax. No tergal or sternal plates (as characteristic for genus) other than subgenital plate. Eight rows of transverse small dorsal setae: row 1 with 6

setae, row 2 with 10 setae, rows 3–8 each with 18–24 setae. Four longer dorsal central setae posterior to eighth row of dorsal transverse setae. Eight long setae and 8 very long setae near posterior apex of abdomen. Six rows of transverse small ventral setae; row 1 with 8 irregularly positioned setae; row 2 with 8 setae, rows 3–6 each with 17–22 setae. Six pairs of moderately sized lateral spiracles; second through fourth spiracles each associated with paratergal plates; 2 tiny setae near lateral margin posterior to first spiracle; 1 tiny seta along lateral margin posterior to each of second through sixth spiracles; 2 long setae posterior to fifth spiracle; 2 very long setae posterior to sixth spiracle.

Paratergal plates (Fig. 1B): Subtriangular, present on abdominal segments 4–6, differentially sclerotized, each with anterior spiracle and central protuberance bearing seta; 2 additional setae medial to protuberance on each plate.

Genitalia (Fig. 1A, C): Subgenital plate (Fig. 1A) extending anteriorly to level of spiracles on seventh abdominal segment, with anterolateral extension on each side and central lacuna, wider than long, in posterior half of plate. Basal apodeme (Fig. 1C) differentially sclerotized, longer than parameres; parameres broadly curved around central pseudopenis; pseudopenis partly U shaped, with broadly rounded posterior lobe bearing central notch; 2 lateral subtriangular endomeres and 1 elongate middle endomere near junction of basal apodeme and parameres; middle endomere with subcircular structure bearing small anterior process and longer posterior aedeagus; aedeagus pointed apically, not quite extending posteriorly to anterior margins of parameres.

Female (Fig. 1 D–F; n = 6)

Total body length of allotype 2.400 mm; mean, 2.225 mm; range, 1.950–2.455 mm. Head, thorax, and abdomen as in male unless stated otherwise.

Head (Fig. 1D): Maximum head width of allotype, 0.290 mm; mean, 0.258 mm; range, 0.243–0.290 mm. Head slightly wider posteriorly than in male, especially in allotype; first antennal segment not as enlarged as in male.

Thorax (Fig. 1D): Maximum thorax width of allotype, 0.370 mm; mean, 0.388 mm; range, 0.370–0.405 mm. Diameter of mesothoracic spiracle of allotype, 0.031 mm; mean, 0.031 mm; range, 0.030–0.032 mm. Oblique row of 7 small setae medial to spiracle on each side. First pair of legs slightly narrower than in male.

Abdomen (Fig. 1D): Much wider than thorax. Seven rows of small transverse dorsal setae; row 1 with 6 setae, row 2 extremely irregular with patches of ~8 setae on each side; rows 3–7 each with 24–36 setae. Three short dorsal lateral setae on each side posterior to seventh row of dorsal transverse setae. Three pairs of very long lateral setae posteriorly. Four rows of small transverse ventral setae each with 24–36 setae. Six pairs of moderately sized lateral spiracles; second through fourth spiracles each associated with paratergal plates; 2 very long setae posterior to both fifth and sixth spiracles.

Paratergal plates (Fig. 1E): Subtriangular but broader and shaped slightly differently from those in male; each plate with 2 small central setae and lacking protuberance.

Genitalia (Fig. 1F): Subgenital plate wider than long with squarish anterolateral extension on each side and inwardly curving medial extension on each side posteriorly; margin of each anterolateral extension heavily sclerotized with jagged

appearance; anteromedial margin of subgenital plate broadly curved as distinct hump. Two patches of ~4 small setae on each side between posteriomedial extensions of subgenital plate. Gonopods VIII narrow, much wider than long, each with slightly expanded medial portion; 2 small medial setae and 6 longer setae along remainder of gonopod VIII on each side. Three small setae and 2 longer setae inserted anterolaterally to each gonopod VIII. Gonopods IX distinctly lobed, situated posterolaterally, with 8 long setae on each lateral margin anteriorly, then 5 very long setae posteriorly and 1 small seta along posterointerlateral margin; lateral setae on gonopod IX in patches of 5, 3, 3, and 2 in some specimens. Three small setae posterolateral to each gonopod IX; patches of 9–11 small setae posteromedial to gonopods IX on each side near abdominal apex.

Taxonomic summary

Type and only known host: Mandrill, *M. sphinx* (Linnaeus) (Primates: Cercopithecidae).

Specimens deposited: One male holotype, 1 female allotype, and 1 female paratype deposited in U.S. National Museum of Natural History (NMNH), Smithsonian Institution, Department of Entomology, Washington, D.C., accession barcode numbers USNM0098195 (holotype), USNM0098196 (allotype), and USNM0098199 (paratype). Two voucher specimens (females) deposited in Gabon. Both specimens are housed at the CIRMF Primate Center in Franceville, Gabon waiting for the opening of a national museum. Two voucher specimens (females) in the collection of the senior author (specimens willed to NMNH).

Type locality: Gabon: Franceville, Centre de Primatologie, CIRMF (1°36'55"S, 13°35'50"E). The population is semifree.

Site of infestation: Skin surface and fur.

Zoobank registration: urn:lsid:zoobank.org:act:01362848-A536-4854-B2D9-7659300FF98A.

Etymology: The specific epithet is derived from the country of origin, Gabon.

DNA sequence data: Nuclear EF-1 α sequences were generated from 4 female lice, each from a different host individual, from which DNA was extracted (100% sequence similarity among all 4 specimens) (GenBank accession numbers MN725045 to MN725048). On the basis of a phylogenetic analysis, *P. gabonensis* forms a clade with 2 other species, *Pedicinus badii* and *Pedicinus hamadryas*, with the new species being closer to *P. badii* than to *P. hamadryas* (Fig. 2). This clustering with other Afrotropical species of *Pedicinus* would be expected. However, it should be emphasized that EF-1 α sequences are not yet available for other species of *Pedicinus* and that a more refined phylogeny of the genus can be constructed when sequences are available for additional species.

Remarks

Pedicinus gabonensis can be separated morphologically from all other species of *Pedicinus* most easily by examination of the genitalia and associated morphological structures of both sexes. Females of *P. gabonensis* are unique in having a distinctly lobed (almost “ear”-shaped) gonopod IX on each side; females of all other described species of *Pedicinus* have a fairly straight, indistinct gonopod IX on each side. Males of *P. gabonensis* can be distinguished from all other species of *Pedicinus* by a combination of the following genital characters: (1) anterior

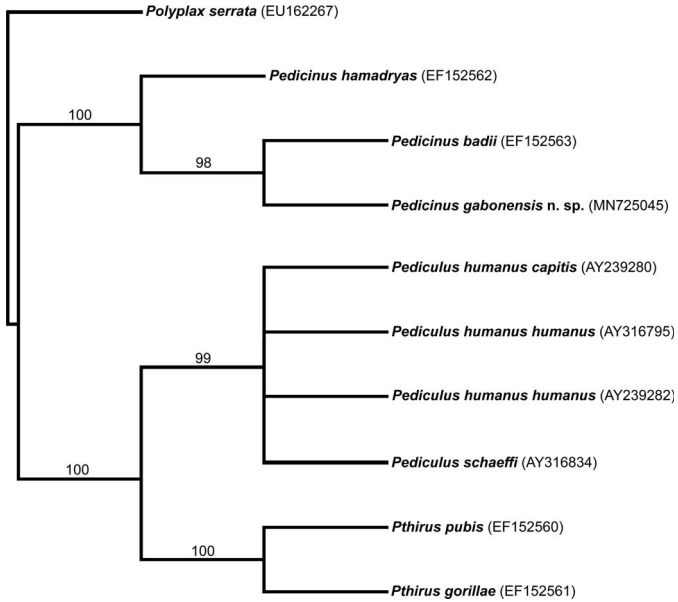


Figure 2. Consensus phylogenetic tree of *Pedicinus* spp., *Pediculus* spp., and *Pthirus* spp. lice on the basis of nuclear elongation factor 1 alpha gene sequences. *Pedicinus gabonensis* sequences were generated for this study; sequences for other species of lice shown are from GenBank. (Note: accession number AY316795 is entered in GenBank as *Pediculus humanus corporis*, which is an invalid name according to rules of the International Code of Zoological Nomenclature [ICZN]; we have therefore used the ICZN compliant name, *Pediculus humanus humanus*).

margin of basal apodeme straight (not curved); (2) parameres distinctly shorter than basal apodeme; (3) parameres broad throughout and lacking lobes or protrusions; (4) pseudopenis barely extending beyond posterior confluence of parameres, broadly rounded apically (posteriorly), with distinct apical notch; (5) aedeagus small and pointed, not quite extending to anterior margin of parameres; (6) small lacuna immediately anterior to aedeagus subcircular with anterior extension. Males of some other species of *Pedicinus* share 1 or 2 of these characters but this combination of characters is unique to *P. gabonensis*. Like the majority of its congeners, both sexes of *P. gabonensis* have 3 pairs of distinct paratergal plates (on abdominal segments 4–6); only *Pedicinus eurygaster* has 2 pairs of distinct paratergal plates (on abdominal segments 4 and 5). However, 2 additional species, *Pedicinus nadleri* and *Pedicinus pictus*, also have distinct paratergal sclerotizations on abdominal segments 7 or 8 (or both). Illustrations of both sexes of all described, valid species of *Pedicinus* can be seen by consulting the following publications in addition to this paper: Kuhn and Ludwig (1967, 1970), Mey (1994, 2010), and Pajot (2000).

The following dichotomous keys allow adult males and females, respectively, of all known, valid species of *Pedicinus* to be identified on the basis of morphological characters.

Key to species of *Pedicinus*—males

- 1A. 3 pairs of paratergal plates on abdomen (on segments 4–6)..... 2
- 1B. 2 pairs of paratergal plates on abdomen (on segments 4 and 5); mainly on macaques, Asia
..... *Pedicinus eurygaster*

- 2A. 3 pairs of paratergal plates on abdomen (on segments 4–6) plus smaller paratergal sclerotizations (on segments 7 or 8 [or both])..... 3
- 2B. 3 pairs of paratergal plates on abdomen (on segments 4–6) and lacking smaller paratergal sclerotizations (on segments 7 or 8 [or both]) 4
- 3A. Parameres much shorter than basal apodeme; on *Colobus* and *Ptilocolobus*; Afrotropical Region ...
..... *Pedicinus pictus*
- 3B. Parameres distinctly longer than basal apodeme; mainly on *Trachypithecus delacouri*, Asia (Vietnam)
..... *Pedicinus nadleri*
- 4A. First pair of legs more slender than second and third pairs with very long, slender, slightly curved, pointed tarsal claw; mainly on *Papio hamadryas*, Afrotropical Region *Pedicinus hamadryas*
- 4B. All 3 pairs of legs about equal in size; tarsal claw on first legs distinctly curved, broader, and not pointed.. 5
- 5A. Paratergal plates on abdominal segment 4 much smaller than paratergal plates on abdominal segments 5 and 6 6
- 5B. Paratergal plates on abdominal segment 4 about equal in size to paratergal plates on abdominal segments 5 and 6..... 7
- 6A. Anterior arms of pseudopenis bulbous terminally, almost subcircular; on *Pygathrix nigripes*, Asia (Vietnam)..... *Pedicinus atratulus*
- 6B. Anterior arms of pseudopenis each tapering to distinct apex; on *Pygathrix cinerea*, Asia (Vietnam)
..... *Pedicinus curtippennis*
- 7A. Posterior apex of aedeagus concave 8
- 7B. Posterior apex of aedeagus of various shapes but not concave..... 10
- 8A. Posterior apex of aedeagus concave and much wider than central portion of aedeagus; on *Macaca sylvanus*, Gibraltar and Morocco.... *Pedicinus albidus*
- 8B. Posterior apex of aedeagus concave and distinctly narrower than central portion of aedeagus..... 9
- 9A. Posterior apices of parameres squarish, not notched; small bump never present in center of concavity of posterior apex of aedeagus; on *Macaca hecki*, Asia (Indonesia: Sulawesi) *Pedicinus cynopithecii*
- 9B. Posterior apices of parameres acuminate and notched; small bump sometimes present in center of concavity of posterior apex of aedeagus (in some subspecies); mainly on *Macaca* spp., Asia
..... *Pedicinus obtusus*
- 10A. Aedeagus with distinct lateral protuberance on each side subapically 11
- 10B. Aedeagus smooth throughout length, lacking lateral protuberance on each side subapically 13
- 11A. Aedeagus hugely expanded posteriorly (more than twice width of central aedeagus), almost heart shaped; mainly on *Cercopithecus* spp., Afrotropical Region *Pedicinus patas*
- 11B. Aedeagus appearing trifid apically with distinct subapical lateral tapering protuberance on each side 12
- 12A. Parameres each with large, distinct medial flangelike extension; on *Trachypithecus* spp., *Presbytis rubi-*

cunda, and *Semnopithecus entellus*, Asia
 *Pedicinus ancoratus*

12B. Parameres smooth, lacking medial flangelike extensions; mainly on *Pygathrix nemaeus*, Asia (Vietnam)
 *Pedicinus tongkinensis*

13A. Apex of aedeagus rounded 14

13B. Apex of aedeagus pointed 16

14A. Posterior lobe of pseudopenis barely extending beyond parameres; pseudopenis with large apical notch; mainly on *Cercopithecus* spp., Afrotropical Region
 *Pedicinus ferrisi*

14B. Posterior lobe of pseudopenis extending well beyond parameres; pseudopenis without large apical notch 15

15A. Small subapical pointed projection on each side of pseudopenis; on *Cercocebus torquatus* and *Lophocebus albigena*, Afrotropical Region (Democratic Republic of the Congo and Uganda)
 *Pedicinus cercocebi*

15B. Lacking subapical pointed projection on each side of pseudopenis; host unknown, Afrotropical Region (Senegal)
 *Pedicinus senegalensis*

16A. Medial margin of each paramere smooth, lacking a protuberance; on *Mandrillus sphinx*, Afrotropical Region (Gabon)
 *Pedicinus gabonensis*

16B. Medial margin of each paramere with a distinct protuberance 17

17A. Parameres closely appressed to lateral margins of pseudopenis for entire, or almost entire, length of pseudopenis 18

17B. Parameres widely separated from lateral margins of pseudopenis for almost entire length of pseudopenis; on *Miopithecus talapoin*, Afrotropical Region (Equatorial Guinea, Gabon)
 *Pedicinus miopithecii*

18A. Aedeagus with curved margins and extremely broad subapically (about as wide as widest part of pseudopenis); on *Piliocolobus* spp. and *Colobus polykomi*, Afrotropical Region
 *Pedicinus badii*

18B. Aedeagus with straight margins and less broad subapically (less than half the width of the widest part of pseudopenis); on *Procolobus verus*, Afrotropical Region (Liberia, Sierra Leone)
 *Pedicinus veri*

Key to species of *Pedicinus*—females

1A. 3 pairs of paratergal plates on abdomen (on segments 4–6) 2

1B. 2 pairs of paratergal plates on abdomen (on segments 4 and 5); mainly on macaques, Asia
 *Pedicinus eurygaster*

2A. 3 pairs of paratergal plates on abdomen (on segments 4–6) plus smaller paratergal sclerotizations (on segments 7 or 8 [or both]) 3

2B. 3 pairs of paratergal plates on abdomen (on segments 4–6) and lacking smaller paratergal sclerotizations (on segments 7 or 8 [or both]) 4

3A. Anterior margin of subgenital plate straight to slightly concave; posterior margin with distinct

central hump; mainly on *Trachypithecus delacouri*, Asia (Vietnam)
 *Pedicinus nadleri*

3B. Anterior margin of subgenital plate with distinct central hump; posterior margin concave; on *Colobus* and *Piliocolobus*; Afrotropical Region
 *Pedicinus pictus*

4A. Subgenital plate large and distinct 5

4B. Subgenital plate as 2 tiny, well separated, sclerotized plates; host unknown, Afrotropical Region (Senegal)
 *Pedicinus senegalensis*

5A. Gonopods IX indistinct and more or less straight ... 6

5B. Gonopods IX as distinct curved (ear-shaped) lobes; on *Mandrillus sphinx*, Afrotropical Region (Gabon)
 *Pedicinus gabonensis*

6A. Anterior margin of subgenital plate with distinct medial rounded hump 7

6B. Anterior margin of subgenital plate lacking medial curved hump; either straight or concave 12

7A. Anterior margin of subgenital plate jagged 8

7B. Anterior margin of subgenital plate smooth, not jagged 9

8A. Spiracle on abdominal segment IV medial to corresponding paratergal plate; on *Pygathrix nigripes*, Asia (Vietnam)
 *Pedicinus atratulus*

8B. Spiracle on abdominal segment IV anterolateral to corresponding paratergal plate; on *Pygathrix cinerea*, Asia (Vietnam)
 *Pedicinus curtipeinitus*

9A. Anterior margin of subgenital plate broadly convex (with central hump); on *Piliocolobus* spp. and *Colobus polykomi*, Afrotropical Region
 *Pedicinus badii*

9B. Anterior margin of subgenital plate straight or with concave margins on either side of central hump.... 10

10A. Anterior margin of subgenital plate distinctly concave on either side of central hump; on *Cercocebus torquatus* and *Lophocebus albigena*, Afrotropical Region (Democratic Republic of the Congo and Uganda)
 *Pedicinus cercocebi*

10B. Anterior margin of subgenital plate straight on either side of central hump 11

11A. Subgenital plate at least 3 times wider than long, with outwardly curving posterior extension laterally on each side; on *Procolobus verus*, Afrotropical Region (Liberia, Sierra Leone)
 *Pedicinus veri*

11B. Subgenital plate less than 2 times wider than long, with 2 posterior medial inwardly curving extensions; on *Trachypithecus* spp., *Presbytis rubicunda* and *Semnopithecus entellus*, Asia
 *Pedicinus ancoratus*

12A. Anterior margin of subgenital plate convexly curved; on *Macaca sylvanus*, Gibraltar and Morocco
 *Pedicinus albidus*

12B. Anterior margin of subgenital plate straight or concave 13

13A. Gonopods VIII each with 8–9 setae 14

13B. Gonopods VIII each with 6–7 setae 16

14A. Gonopods IX each with 9–10 setae; on *Macaca hecki*, Asia (Indonesia: Sulawesi) *Pedicinus cynopithecii*

14B. Gonopods IX each with 14–15 setae 15

(15A) Sclerotized lateral margin of subgenital plate longer than posteromedial extensions; mainly on

- Cercopithecus* spp., Afrotropical Region
 *Pedicinus ferrisi*
- 15B. Sclerotized lateral margin of subgenital plate shorter than posteromedial extensions; mainly on *Pygathrix nemaeus*, Asia (Vietnam) *Pedicinus tongkinensis*
- 16A. First pair of legs more slender than second and third pairs with very long slender slightly curved pointed tarsal claws; mainly on *Papio hamadryas*, Afrotropical Region *Pedicinus hamadryas*
- 16B. All 3 pairs of legs about equal in size; tarsal claw on first legs distinctly curved, broader, and not pointed 17
- 17A. 6 small setae between posterior extensions of subgenital plate 18
- 17B. 9 small setae between posterior extensions of subgenital plate; mainly on *Macaca* spp., Asia *Pedicinus obtusus*
- 18A. Setae on gonopods IX all about equal in length; mainly on *Cercopithecus* spp., Afrotropical Region *Pedicinus patas*
- 18B. Setae on gonopods IX of distinctly different lengths; on *Miopithecus talapoin*, Afrotropical Region (Equatorial Guinea, Gabon) *Pedicinus miopithecii*

Known host associations and geographical distributions of lice belonging to the genus *Pedicinus* including current International Union for Conservation of Nature (IUCN) host status

***Pedicinus albidus* (Rudow, 1869)**

Host: Macaca sylvanus (Linnaeus) (Barbary macaque)—vulnerable (IUCN, 2019).

Known distribution of louse: Gibraltar, Morocco (Kuhn and Ludwig, 1967; Durden and Musser, 1994; Cohn et al., 2007).

Taxonomic notes: Rudow (1869) placed this louse in the genus *Haematopinus*. *Pedicinus vulgaris* Fahrenholz, 1916 (partim) is a synonym. Ferris (1934) illustrated the male and female. Kuhn and Ludwig (1967) also illustrated both sexes, assigned this taxon to the subgenus *Parapedicinus*, and designated a neotype that was collected from a host in the Zoological Gardens in London, U.K.

***Pedicinus ancoratus* Ferris, 1934**

Hosts: Trachypithecus cristatus (Raffles) (silvery lutung) (type host)—near threatened (IUCN, 2019), *Presbytis rubicunda* (Muller) (maroon leaf monkey)—species of least concern (IUCN, 2019), *Trachypithecus auratus* (Geoffroy) (Javan lutung)—vulnerable (IUCN, 2019), *Trachypithecus francoisi* (Pouargues) (François' langur)—endangered (IUCN, 2019), *Semnopithecus entellus* (Dufresne) (northern plains gray langur)—species of least concern (IUCN, 2019).

Known distribution of louse: Borneo, China (Jiangsu Province), India (Jammua and Kashmir State), Indonesia (Sumatra), Malaysia, Sri Lanka, Thailand (Ferris, 1934; Kuhn and Ludwig, 1967; Chin, 1983; Adhikary and Ghosh, 1994; Durden and Musser, 1994).

Taxonomic notes: Ferris (1934) described and illustrated both sexes. Kuhn and Ludwig (1967) also illustrated both sexes and assigned this species to the subgenus *Neopedicinus*.

***Pedicinus atratulus* Mey, 2010**

Host: Pygathrix nigripes (Milne-Edwards) (black-shanked douc)—endangered (IUCN, 2019).

Known distribution of louse: Vietnam.

Taxonomic notes: Mey (2010) described the adult male and female and provided illustrations of the paratergal plates, male genitalia, and variations in the male and female subgenital plates (hypandrium and hypogynium, respectively, of Mey). He assigned this species to the subgenus *Neopedicinus*.

***Pedicinus badii* Kuhn and Ludwig, 1964**

Hosts: Piliocolobus badius (Kerr) (western red colobus) (type host)—endangered (IUCN, 2019), *Colobus polykomos* (Zimmermann) (king colobus)—vulnerable (IUCN, 2019), *Piliocolobus rufomitratu*s (Peters) (Tana River red colobus)—endangered (IUCN, 2019) (Kuhn and Ludwig, 1964; Durden and Musser, 1994).

Known distribution of louse: Republic of Congo, Democratic Republic of the Congo, Gambia, Ghana, Liberia, Sierra Leone (Benoit, 1964; Kuhn and Ludwig, 1964a, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1964a) described and illustrated the male and female. Kuhn and Ludwig (1967) also illustrated the male and female, and placed this species in the subgenus *Neopedicinus*. Benoit (1964) illustrated selected morphological characters in his description of *Pedicinus badiivorus* Benoit, 1964, which is a synonym (Kuhn and Ludwig, 1967).

***Pedicinus cercocebi* Kuhn and Ludwig, 1967**

Hosts: Cercocebus torquatus (Kerr) (collared mangabey) (type host)—endangered (IUCN, 2019); *Lophocebus albigena* (Gray) (gray-cheeked mangabey)—species of least concern (IUCN, 2019).

Known distribution of louse: Democratic Republic of the Congo, Uganda (Kuhn and Ludwig, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1967) described and illustrated both sexes and assigned this species to the subgenus *Neopedicinus*. The type specimens were collected from *C. torquatus* in Stockholm, Sweden, presumably from a zoo (Durden and Musser, 1994).

***Pedicinus curtipenitus* Mey, 2010**

Host: Pygathrix cinerea Nadler (gray-shanked douc)—endangered (IUCN, 2019).

Known distribution of louse: Vietnam.

Taxonomic notes: Mey (2010) described the male and female and provided illustrations of the paratergal plates, male genitalia, and variations in the male and female subgenital plates (hypandrium and hypogynium, respectively, of Mey). He assigned this species to the subgenus *Neopedicinus*.

***Pedicinus cynopithecii* Kuhn & Ludwig, 1967**

Host: Macaca hecki (Matschie) (Heck's macaque)—vulnerable (IUCN, 2019).

Known distribution of louse: Indonesia (Sulawesi) (Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1967) described and illustrated the male and female from specimens collected from *M. hecki* in the National Zoological Park in Washington, D.C.; they assigned this taxon to the subgenus *Parapedicinus*. Durden and Musser (1994) listed the type host as *Macaca tonkeana* (Meyer) (tonkean macaque), following the host taxonomy of Groves (1993) who, at that time, treated *M. hecki* as a junior synonym of *M. tonkeana*. Later, he treated *M. hecki* as a valid, separate species (Groves, 2005).

***Pedicinus eurygaster* (Burmeister, 1838)**

Hosts: *Macaca sinica* (Linnaeus) (type host) (toque macaque)—endangered (IUCN, 2019) *Macaca cyclopis* (Swinhoe) (Formosan rock macaque)—species of least concern (IUCN, 2019), *Macaca fascicularis* (Raffles) (long-tailed macaque)—species of least concern (IUCN, 2019), *Macaca mulatta* (Zimmermann) (rhesus macaque)—species of least concern (IUCN, 2019), *Macaca nemestrina* (Linnaeus) (southern pig-tailed macaque)—vulnerable (IUCN, 2019), *Macaca silenus* (Linnaeus) (lion-tailed macaque)—endangered (IUCN, 2019), (Kuhn and Ludwig, 1967; Durden and Musser, 1994); also recorded as a probable straggler from *Simias concolor* Miller (Simakobou)—critically endangered (IUCN, 2019) (Durden and Musser, 1994).

Known distribution of louse: Borneo, China (Guizhou and Yunnan provinces), India (Andhra Pradesh, Bihar, and Jammu and Kashmir states), Indonesia (Java, Sumatra), Malaysia, Myanmar, Philippines, Thailand (Ferris, 1934; Kuhn and Ludwig, 1967; Chin, 1983; Chin and Li, 1991; Adhikary and Ghosh, 1994; Durden and Musser, 1994).

Taxonomic notes: Ferris (1934) illustrated both sexes and the first instar nymph. The following names are synonyms, subspecies, or previous generic assignments, as documented by Kuhn and Ludwig (1967) and Durden and Musser (1994): *Pediculus eurygaster* Burmeister, 1838; *Phthirpedicinus eurygaster* (Burmeister, 1838); *Pedicinus (Pedicinus) eurygaster eurygaster* (Burmeister, 1838); *Pediculus microps* Nitzsch, 1864; *Phthirpedicinus microps* (Nitzsch, 1864); *Pedicinus breviceps* Piaget, 1880 (partim); *Pedicinus (Pedicinus) eurygaster breviceps* Piaget, 1880; *Pedicinus longiceps* Piaget, 1880 (partim); *Pedicinus piageti* Stroebelt, 1881; *Phthirpedicinus piageti* (Stroebelt, 1881); *Phthirpedicinus micropilosus* Fahrenholz, 1912; *Pedicinus (Pedicinus) eurygaster orientalis* Kuhn and Ludwig, 1967. Kuhn and Ludwig (1967) recognized and illustrated the following 3 subspecies: *P. eurygaster eurygaster* (Burmeister, 1838), *P. e. breviceps* Piaget, 1880, and *P. e. orientalis* Kuhn and Ludwig, 1967.

***Pedicinus ferrisi* Kuhn and Ludwig, 1965**

Hosts: *Cercopithecus mitis* Wolf (blue monkey) (type host)—species of least concern (IUCN, 2019), *Cercopithecus ascanius* (Audebert) (red-tailed monkey)—species of least concern (IUCN, 2019), *Cercopithecus nictitans* (Linnaeus) (greater spot-nosed monkey)—species of least concern (IUCN, 2019), *Chlorocebus aethiops* (Linnaeus) (grivet)—species of least concern (IUCN, 2019) (Kuhn and Ludwig, 1964b, 1967; Durden and Musser, 1994).

Known distribution of louse: Democratic Republic of the Congo, Kenya, Rwanda, South Africa, Tanzania, Uganda (Kuhn and Ludwig, 1964b, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1964b) described and illustrated the male and female. However, that paper was actually published in 1965, so the description bears that date. Kuhn and Ludwig (1967) also illustrated both sexes and placed this taxon in the subgenus *Neopedicinus*.

***Pedicinus gabonensis* Durden, Kessler, and Greiman**

Host: *Mandrillus sphinx* (Linnaeus) (mandrill)—vulnerable (IUCN, 2019).

Known distribution of louse: Gabon.

Taxonomic notes: The male and female are described in this paper with accompanying illustrations and EF-1 α gene sequences.

***Pedicinus hamadryas* Mjöberg, 1910**

Hosts: *Papio hamadryas* (Linnaeus) (hamadryas baboon) (type host)—species of least concern (IUCN, 2019), probable stragglers also reported from *Chlorocebus aethiops* (Linnaeus) (grivet)—species of least concern (IUCN, 2019) (Ferris, 1934; Kuhn and Ludwig, 1967; Ledger, 1980; Durden and Musser, 1994).

Known distribution of louse: Botswana, Democratic Republic of the Congo, Kenya, South Africa, Tanzania, Uganda (Ferris, 1934; Kuhn and Ludwig, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: The type specimens were collected from a host in the Hamburg Zoological Gardens, Germany. Ferris (1934) illustrated the male and female. Kuhn and Ludwig (1967) also illustrated both sexes, placed this species in the subgenus *Parapedicinus*, and recognized the following 3 subspecies: *Pedicinus hamadryas hamadryas* Mjöberg, 1910, *P. h. cercopitheci* Kuhn and Ludwig, 1967, and *P. h. cynocephali* Kuhn and Ludwig, 1967.

***Pedicinus miopitheci* Kuhn and Ludwig, 1970**

Host: *Miopithecus talapoin* (Schreber) (Angolan talapoin)—species of least concern (IUCN, 2019).

Known distribution of louse: Equatorial Guinea, Gabon (Kuhn and Ludwig, 1970; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: The type specimens were collected from captive *M. talapoin* in the San Diego Zoo, California. Kuhn and Ludwig (1970) described and illustrated the male and female and assigned this species to the subgenus *Neopedicinus*.

***Pedicinus nadleri* Mey, 1994**

Hosts: *Trachypithecus delacouri* (Osgood) (Delacour's langur) (type host)—critically endangered (IUCN, 2019). Mey (1994) also reported stragglers from *Hylobates leucogenys* (Ogilby) (northern white-cheeked gibbon)—critically endangered (IUCN, 2019).

Known distribution of louse: Vietnam.

Taxonomic notes: Mey (1994) described and illustrated the male and female; he placed this species in the subgenus *Parapedicinus*.

***Pedicinus obtusus* (Rudow, 1869)**

Hosts: *Macaca maura* (Schinz) (Moor macaque) (type host)—endangered (IUCN, 2019), *Macaca arctoides* (I. Geoffroy) (stump-tailed macaque)—vulnerable (IUCN, 2019), *Macaca cyclopis* (Swinhoe) (Formosan rock macaque)—species of least concern (IUCN, 2019), *Macaca fascicularis* (Raffles) (long-tailed

macaque)—species of least concern (IUCN, 2019), *Macaca fuscata* (Blyth) (Japanese macaque)—species of least concern (IUCN, 2019), *Macaca mulatta* (Zimmerman) (rhesus macaque)—species of least concern (IUCN, 2019), *Macaca nemestrina* (Linnaeus) (southern pig-tailed macaque)—vulnerable (IUCN, 2019), *Macaca nigra* (Desmarest) (Celebes crested macaque)—endangered (IUCN, 2019); *Macaca silenus* (Linnaeus) (lion-tailed macaque)—endangered (IUCN, 2019), *Macaca sinica* (Linnaeus) (toque macaque)—endangered (IUCN, 2019), *Macaca thibetana* (Milne-Edwards) (Milne Edwards macaque)—near threatened (IUCN, 2019); also recorded from the following hosts, possibly representing straggler infestations: *Nasalis larvatus* (Wurmb) (proboscis monkey)—endangered (IUCN, 2019), *Trachypithecus cristatus* (Raffles) (silvery lutung)—near threatened (IUCN, 2019), *Trachypithecus francoisi* (Pousargues) (François' langur)—endangered (IUCN, 2019), *Trachypithecus phayrei* (Blyth) (Phayre's leaf monkey)—endangered (IUCN, 2019).

Known distribution of louse: Borneo, China (Guizhou and Yunnan Provinces), India (Jammu and Kashmir State), Indonesia (Java, Sulawesi, Sumatra), Japan, Myanmar, Philippines, Taiwan, Vietnam (Kuhn and Ludwig, 1967; Chin, 1983; Chin and Li, 1991; Durden and Musser, 1994; Mey, 1994).

Taxonomic notes: Ferris (1934) illustrated the male and female (as *Pedicinus longiceps*). The following names are synonyms or previously published generic assignments: *Haematopinus obtusus* Rudow, 1869, *Pedicinus breviceps* Piaget, 1880 (partim), *Pedicinus longiceps* Piaget, 1880 (partim), *Pedicinus graciliceps* Piaget, 1885, *Pedicinus paralleliceps* Mjöberg, 1910, *Pedicinus rhesi* Fahrenholz, 1912, *Pedicinus vulgaris* Fahrenholz, 1916 (partim) (Kuhn and Ludwig, 1967; Durden and Musser, 1994). Kuhn and Ludwig (1967) illustrated both sexes and the egg (nit), placed this species in the subgenus *Parapedicinus*, and recognized and illustrated the following 5 named subspecies: *Pedicinus* (*P.*) *obtusus obtusus* (Rudow, 1869), *P. o. graciliceps* Piaget, 1885, *P. o. japonicus* Kuhn and Ludwig, 1967, *P. o. longiceps* Piaget, 1880, and *P. o. paralleliceps* Mjöberg, 1910. They also recognized a sixth subspecies that they did not name.

***Pedicinus patas* (Fahrenholz, 1916)**

Hosts: *Erythrocebus patas* (Schreber) (patas monkey) (type host)—species of least concern (IUCN, 2019), *Cercopithecus campbelli* Waterhouse (Campbell's mona monkey)—species of least concern (IUCN, 2019), *Cercopithecus cephus* (Linnaeus) (moustached monkey/guenon)—species of least concern (IUCN, 2019), *Cercopithecus diana* (Linnaeus) (diana monkey)—vulnerable (IUCN, 2019), *Cercopithecus mitis* Wolf (blue monkey)—species of least concern (IUCN, 2019), *Cercopithecus neglectus* Schlegel (De Brazza's monkey)—species of least concern (IUCN, 2019), *Cercopithecus petaurista* (Schreber) (lesser spot-nosed monkey)—species of least concern (IUCN, 2019), *Chlorocebus aethiops* (Linnaeus) (grivet)—species of least concern (IUCN, 2019), *Ptilocolobus badius* (Kerr) (western red colobus)—endangered (IUCN, 2019).

Known distribution of louse: Republic of Congo, Democratic Republic of the Congo, Liberia, South Africa (Ferris, 1934; Benoit, 1962; Kuhn and Ludwig, 1964b, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1964b) redescribed and illustrated the male and female. Benoit (1962) described both

sexes and illustrated selected morphological features under the name *Pedicinus bilobatus*. The following 2 names are synonyms (Kuhn and Ludwig, 1967; Durden and Musser, 1994): *Neopedicinus patas* Fahrenholz, 1916; *Pedicinus bilobatus* Benoit, 1962. Kuhn and Ludwig (1967) placed this species in the subgenus *Neopedicinus*.

***Pedicinus pictus* Ferris, 1934**

Hosts: *Colobus guereza* Ruppell (mantled guereza) (type host)—species of least concern (IUCN, 2019), *Colobus polykomos* (Zimmermann) (king colobus)—vulnerable (IUCN, 2019), *Colobus satanus* Waterhouse (black colobus)—vulnerable (IUCN, 2019), *Ptilocolobus badius* (Kerr) (western red colobus)—endangered (IUCN, 2019).

Known distribution of louse: Cameroon, Ethiopia, Gambia, Kenya, Liberia, Uganda (Ferris, 1934; Kuhn and Ludwig, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Ferris (1934) described and illustrated both sexes. Kuhn and Ludwig (1964c) described and illustrated both sexes of *Pedicinus polykomi* and *Pedicinus fastigatus*, which they later (Kuhn and Ludwig, 1967) relegated to subspecies of *Pedicinus pictus*. Kuhn and Ludwig (1967) assigned this species to the subgenus *Neopedicinus* and recognized and illustrated the following 5 subspecies: *Pedicinus pictus pictus* Ferris, 1934 and *P. p. ethiopicus* Kuhn and Ludwig, 1967, both parasitizing *C. guereza*, *P. p. fastigatus* Kuhn and Ludwig, 1964, and *P. p. gambiensis* Kuhn and Ludwig, 1967, both parasitizing different subspecies of *P. badius*, and *P. p. polykomi* Kuhn and Ludwig, 1964, parasitizing both *C. polykomos* and *C. satanus*.

***Pedicinus senegalensis* Pajot, 1996**

Host: Not recorded.

Known distribution of louse: Senegal.

Taxonomic notes: Pajot (1996) described the adult male and female but stated that the collection he examined did not include information on the host or the precise type locality in northern Senegal.

***Pedicinus tongkinensis* Mey, 1994**

Hosts: *Pygathrix nemaes* (Linnaeus) (red-shanked douc) (type host)—endangered (IUCN, 2019). Mey (1994) also reported stragglers from *Hylobates leucogenys* (Ogilby) (northern white-cheeked gibbon)—critically endangered (IUCN, 2019).

Known distribution of louse: Vietnam.

Taxonomic notes: Mey (1994) originally described this taxon as a subspecies of *Pedicinus ancoratus* but later elevated it to full species rank (Mey 2010). The male genitalia, male subgenital plate, and female genitalia and posterior (ventral) abdomen were illustrated by Mey (1994). Variations in the male subgenital plate (= hypandrium of Mey) were illustrated by Mey (2010). Mey (1994, 2010) placed this taxon in the subgenus *Neopedicinus*.

***Pedicinus veri* Kuhn and Ludwig, 1963**

Host: *Procolobus verus* (Van Beneden) (olive colobus)—vulnerable (IUCN, 2019).

Known distribution of louse: Liberia, Sierra Leone (Kuhn and Ludwig, 1963, 1967; Ledger, 1980; Durden and Musser, 1994).

Taxonomic notes: Kuhn and Ludwig (1963) described and illustrated both sexes. Kuhn and Ludwig (1967) also illustrated both sexes, described and illustrated all 3 nymphal instars, and assigned this species to the subgenus *Neopedicinus*.

Pedicinus colobi Fahrenholz, 1917 is excluded from this list of valid species. Although *P. colobi* was recognized as a valid species by Durden and Musser (1994) and Pajot (2000), we do not recognize this species here on the basis of currently available information. Fahrenholz (1917) originally described this taxon as *Pedicinus paralleliceps colobi* based on 2 females reportedly from *Colobus guereza* Ruppell (mantled guereza)—species of least concern (IUCN, 2019). No illustrations or type locality data were included in the 17 lines (2 paragraphs) comprising the description by Fahrenholz (1917). The types were deposited in the Zoological Museum in Hamburg, Germany but have, unfortunately, been destroyed (Kuhn and Ludwig, 1967) and were never illustrated. Nevertheless, Kuhn and Ludwig (1967) placed this taxon in the subgenus *Parapedicinus* on the basis of the Fahrenholz (1917) description. Ferris (1934) saw the types before they were destroyed and treated this taxon as a synonym of *Pedicinus longiceps* Piaget but later, he (Ferris 1951) considered it to be a synonym of *P. obtusus*. Kuhn and Ludwig (1967) synonymized some of the types of *P. longiceps* as *P. eurygaster* and others as *P. obtusus*, actions that are followed here. On the basis of the brief morphological information provided by Fahrenholz (1917), Kuhn and Ludwig (1967) hypothesized that *P. colobi* might be a synonym of either *P. hamadryas* or *P. obtusus* but stated that the true status of this taxon cannot be determined. We agree with that assessment.

DISCUSSION

We provide a description of a new species of *Pedicinus* from central Africa (Gabon), and also provide EF-1 α gene sequences and a dichotomous key for morphologically identifying males and females of all described valid species belonging to this genus. A dichotomous key for identifying the 7 species of *Pedicinus* known at that time was presented by Ferris (1951), but most morphological characters used in that key were for male lice. Kuhn and Ludwig (1963) updated and modified this key to also include *P. veri*, which they described in the same paper. Kuhn and Ludwig (1967) provided a key to adult males of the 12 species of *Pedicinus* that they recognized. Pajot (1996, 2000) provided a key for adult males of 8 Afrotropical species. Following the identification of any species of *Pedicinus* using our keys, we recommend comparing specimens with published descriptions and illustrations of the appropriate species, especially for specimens collected from host species that are not currently known to be parasitized by lice. We state this because there is the possibility that undescribed species could be encountered, which would erroneously key out to a previously described species.

Many of the hosts of *Pedicinus* spp. lice are listed as near threatened, vulnerable, endangered, or critically endangered by the IUCN (IUCN, 2019) (see species accounts). We recommend the conservation of these hosts and their unique parasites. Host conservation efforts are currently in effect for most of these primates. However, to also conserve the parasite biodiversity of these hosts, some of which can be unique for certain host species including *M. sphinx*, we advocate avoiding the treatment of captive or wild hosts with parasiticides unless absolutely

necessary. Some unique parasite species that had no known detrimental effects to their hosts are already extinct because rare hosts such as California condors and black-footed ferrets were captured and treated with parasiticides to purposely kill unique parasites (Dunn et al., 2009; Jørgensen, 2015). However, it is highly likely that most species of *Pedicinus* occur in more countries or regions than those listed in the species accounts we provide, and the distributions of some of these lice may mirror the distributions of their hosts.

It is unknown if any species of *Pedicinus* lice detrimentally affect their hosts by consuming significant volumes of blood or by transmitting parasites or pathogens. Typically, these lice occur in relatively small numbers on their hosts in the wild (Kuhn and Ludwig, 1967), in part because of mutual grooming behaviors (Zamma, 2002) and probably only cause minor occasional host irritation and blood loss. However, there are records of *Pedicinus* spp. lice occurring in fairly large numbers on captive hosts, some of which had no or few opportunities for mutual grooming (Wimsatt et al., 1988; Mader et al., 1989, Argañaraz et al., 2001, Jin et al., 2006).

With respect to the potential for parasite transmission by *Pedicinus* lice, Argañaraz et al. (2001) molecularly detected *Trypanosoma cruzi*, the causative agent of Chagas' disease, in lice stated to be *P. obtusus* parasitizing captive-reared hamadryas baboons at a primate facility in San Antonio, Texas and suggested the possibility that these lice could be vectors of this parasite. Transmission of *T. cruzi* by primate lice seems unlikely in our opinion, but controlled transmission tests would provide a more definitive answer. *Bartonella quintana*, the causative agent of trench fever, including urban trench fever, which is currently emerging in some inner-city human populations around the world, has been detected in some Asian macaques and their lice (*P. eurygaster*) (O'Rourke et al., 2005; Li et al., 2013a, 2013b; Sato et al., 2015). Previously, *B. quintana* had only been recorded in humans and their body lice, *Pediculus humanus humanus* (Linnaeus), so the findings of this pathogen in macaques and their lice may suggest an origin for this pathogen or a zoonotic link. In recent years, *B. quintana* has also been molecularly detected in human head lice, *P. h. capitis* De Geer (Eremeeva et al., 2019), showing that, contrary to historical accounts, this bacterium can occur in multiple taxa of primate-associated lice.

We suspect that additional species of *Pedicinus* lice await discovery on Old World primates and we advocate collections of lice and other ectoparasites from these hosts using techniques that are not harmful to the hosts, many of which are protected.

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