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Two new stick insect genera from Vietnam, *Nuichua* gen. nov. and *Pterohirasea* gen. nov. with two new species (Phasmida: Diapheromeridae: Necrosciinae)

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Front cover: Left: *Nuichua rabayae* sp. nov., female in Nui Chua National Park, Vietnam, on 7.VIII.2014; right: *Pterohirasea nigrolineata* sp. nov., male in Bach Ma National Park, Vietnam, 12.VII.2011 (photographs by J. Constant).

Two new stick insect genera from Vietnam, *Nuichua* gen. nov. and *Pterohirasea* gen. nov. with two new species (Phasmida: Diapheromeridae: Necrosiinae)

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Abstract

Two new genera of stick insects are described from Vietnam. The new genus *Nuichua* gen. nov. is described to accommodate one new species, *N. rabaeyae* sp. nov. from Nui Chua National Park in southern Central Vietnam and the new genus *Pterohirasea* gen. nov. is described to accommodate *P. nigrolineata* sp. nov. from coastal mountains of Central Vietnam. The new taxa are described from males, females, nymphs and eggs. Comprehensive illustrations, data on biology and captive rearing and a distribution map are provided. Male genitalia inflation was conducted in *N. rabaeyae* sp. nov., based on the technique used for caterpillars. Unusual mating behaviour of adult males with subadult females is reported in *N. rabaeyae* sp. nov. The relevance of a resurrection of the tribe Neohiraseini Hennemann & Conle, 2008 is discussed, as well as the importance of the presence of specialised sensory areas on the prosternum and profurcasternum for classification. A hypothesis based on sexual selection to explain the strong sexual dimorphism in size in *N. rabaeyae* sp. nov. is proposed.

Keywords: Phasmatodea, Necrosiini, *Neohirasea*, *Oxyartes*, vomer, sensory organs, evolution

Introduction

The stick insect subfamily Necrosiinae Brunner von Wattenwyl, 1893 currently contains about 700 species distributed in tropical and subtropical regions of Australasia, with one species also present in Madagascar but probably introduced on that island (BRADLER *et al.*, 2014; BROCK *et al.*, 2018; CLIQUENNOIS, 2012). The tribe Neohiraseini Hennemann & Conle, 2008 was recently synonymised under the Necrosiini Brunner von Wattenwyl, 1893 by BRADLER *et al.* (2014). Twenty one genera of Necrosiinae have currently been recorded from Vietnam, which contain 58 species (BROCK *et al.*, 2018).

The identification of stick insect material collected in the framework of the Global Taxonomic Initiative project “A step further in the entomodiversity of Vietnam” (2010–) allowed us to discover two undescribed species of Necrosiinae that could not be attributed to any existing genus. Furthermore, the two species, although obviously rather closely related, represent two distinct genera.

The first genus is here described as *Nuichua* gen. nov. to include a new species that was collected in Nui Chua National Park (Ninh Thuan Province) along the coast of southern Central Vietnam. The park covers about 24,500 ha and ranges from sea level to 1,039m on Mount Nui Chua. It also protects a marine area with several beaches where different species

of sea turtles have their nesting grounds. The higher portion (400m+) of the park is covered in evergreen tropical rainforest, while the lower portion is used for agricultural purposes by local tribes or has vegetation dominated by thorny trees and bushes. This latter habitat is generated by a hot and dry microclimate and is completely different compared to most areas in Vietnam. This isolates the rainforests on the mountain of Nui Chua N.P. from other rainforest areas.

The second genus, *Pterohirasea* gen. nov., is described to accommodate a new species from moderately high altitude evergreen tropical rainforest in three mountainous or hilly areas along the coast of Central Vietnam: Bach Ma National Park, Phong Dien VNMN station and Ba Na-Nui Chua Nature Reserve. Older additional specimens from the same area were found in the collections of the MNHN.

Both species were reared in captivity, allowing the documentation of nymphal stages and of interesting mating behaviour in the genus *Nuichua* gen. nov.

The present paper aims to describe the new taxa from their male, female, nymphs and eggs, and to provide corresponding comprehensive illustrations, biological data and a distribution map.

Material and methods

The specimens of the treated taxa are nocturnal and were collected at night with the help of light-weight and water-proof head torches: Petzl MYO RXP. The females were kept alive in a mesh pop up cage (exo terra explorarium™) for producing eggs. First generation hatchlings were reared to adulthood by the authors, Mrs Kristien Rabaey, Mr Rob Simoens and later generations by Dr Bruno Kneubühler and Mr Tim Bollens. The wild caught specimens were euthanized by ethylacetate fumes, then stored in airtight plastic “zip”-bags in wood chips (used in rodent cages) and sprinkled with ethylacetate (EtOAc) to prevent rotting, mould and to keep the specimens flexible. The bags were frozen on arrival and the specimens mounted later on.

For each picture of collection specimens, a number of photographs were taken with a Canon 700D camera equipped with a Sigma 50 mm Macro lens (adult specimens) or a Tamron 90 mm Macro lens (eggs), stacked with CombineZ software and optimized with Adobe Photoshop CS3. Observations were done with a Leica MZ8 stereo-microscope. Measurements were done with an electronic calliper. The distribution map was produced with SimpleMapper (SHORTHOUSE, 2010).

The inflation of the phallus was done following the method used by lepidopterists for the caterpillar inflation (HAMMOND, 1960) with the terminal part of the abdomen of a freshly euthanized specimen.

The nomenclature for the morphological characters follows BRAGG (2001); the egg morphology follows that of CLARK SELICK (1997; 1998). The description of the colouration is based on live specimens.

Acronyms used for the collections:

NHMW	=	Naturhistorisches Museum, Vienna, Austria.
RBINS	=	Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
VNMN	=	Vietnam National Museum of Nature, Hanoi, Vietnam.

Abbreviations:

N.P.:	National Park
HT:	holotype
PT:	paratype

Taxonomy

Family **Phasmatidae** Gray, 1835
Subfamily **Necrosiinae** Brunner von Wattenwyl, 1893
Tribe **Necrosiini** Brunner von Wattenwyl, 1893

Genus ***Nuichua*** gen. nov.

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Type species: *Nuichua rabaeyae* sp. nov. by present designation and monotypy.

ETYMOLOGY. The genus name is derived from the beautiful Nui Chua National Park in southeast Vietnam. The gender is feminine.

DIAGNOSIS

Differing from all other known genera of Necrosiinae Brunner von Wattenwyl, 1893 by the following combination of characters:

- 1) Relatively broad with all abdominal terga less than two times longer than wide and smooth (Figs 1 A, 3 A).
- 2) Head with few dark tubercles, otherwise smooth (Fig. 5 I).
- 3) Thorax and abdominal terga smooth (Figs 1 A, 3 A).
- 4) Tegmina absent and alae reduced to scales (Fig. 5 H, J).
- 5) Femora short, subapically armed with few minute spines on the outer ventral carinae, mesofemora swollen (Figs 1 B, 3 B).
- 6) Female praeopercular organ present (Fig. 3 F).
- 7) Vomer well developed and notched apically with two acute terminal hooks (Fig. 1 F).
- 8) Subgenital plate in females spoon shaped, tapering posteriorly, not reaching apex of abdomen (Fig. 3 F–G).
- 9) Eggs slightly oval. Micropylar plate rounded, with a mediolongitudinal carina (Fig. 5 K–N).

DESCRIPTION

MALE AND FEMALE (Figs 1, 3)

Head: longer than wide, with an irregular amount of distinct black granules dorsally and on the genae; area between granules smooth. Dorsal surface slightly flattened with distinct mediolongitudinal groove. Vertex rounded, posterolaterally with a shallow impression or groove. Eyes circular and strongly projecting hemispherically. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob like and round in cross-section.

Thorax: pronotum slightly shorter than head; anterior margin strongly incurved with anterolateral angles extended and rounded apically; posterior portion with lateral margins parallel-sided. Mediolongitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral margins; posterior margin rounded. Mesonotum smooth and parallel-sided. Metanotum smooth and laterally with anterolateral angles slightly extended and rounded apically. Pro-, meso- and metasterna smooth.

Wings: tegmina absent; alae reduced to small but distinct whitish scale-like remnants.

Legs: femora relatively short, profemora compressed and curved basally. Carinae present, antero- and posteroventral carinae armed with few minute saw-like teeth subapically.

Mesofemora laterally swollen; carinae and armature as in profemora. Metafemora as mesofemora. Protibiae rectangular in cross-section; carinae with small setae. Probasitarsus longer than all following tarsomeres combined. Meso- and metatibiae as protibiae. Meso and metatarsi with claws small when compared to body size; tarsomeres with a small posteromedian extension; ventrally with posterior portion smooth and strongly notched.

Abdomen: median segment shorter than metanotum, smooth and trapezoidal. All abdominal terga less than two times longer than wide and smooth. Anal segment in females broad and apically gently rounded; abdominal sternum VII with praeopercular organ present; subgenital plate not reaching apex of abdomen, spoon-shaped and tapering posteriorly; posterior portion with a definite median longitudinal carina. Males with tergum X apically notched. Outer margin of inner portion of tergum X swollen and armed with several short, black spines. Posterolateral angles rounded. Poculum not reaching base of vomer; apex broad and slightly rounded, almost straight. Vomer well developed, represented as a broad triangular sclerite, strongly notched posteriorly and with two apices. Apices blackish and tapering towards the posterior. Other abdominal sterna smooth with a small posteromedian black marking.

EGG (Fig. 5 K–N)

Capsule oval; colouration cream with black markings; cream areas on capsule surface covered with minute whitish granules. Polar area black. Operculum convex. Micropylar plate positioned almost centrally on capsule, slightly displaced towards the polar area and oval. Micropylar cup black and distinct, followed anteriorly by a definite mediolongitudinal carina, and posteriorly by an elongated, black median line.

DISTRIBUTION. Southern Central Vietnam (Fig. 8).

Nuichua rabaeyae sp. nov.

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Figs 1–8

ETYMOLOGY. The species is named after Mrs Kristien Rabaey in acknowledgement for breeding the F1 generation of this species after the authors' material (except one male) was lost in an accidental domestic fire.

TYPE MATERIAL. VIETNAM: holotype ♂ (Fig. 1): Ninh Thuan prov., Nui Chua N. P., 11°42'N 109°09'E, 3-9.VII.2014, night coll. Leg. J. Constant & J. Bresseel, GTI project I.G.:32.779 (RBINS).

Paratypes [25♂♂, 27♀♀]: 18♂♂, 20♀♀: ex breeding J. Bresseel, 2015, origin: Vietnam, Ninh Thuan prov., Nui Chua N.P., 11°42'N 109°09'E, 3-9.VII.2014, night coll. Leg. J. Constant & J. Bresseel, GTI project, I.G.: 32.779 (14♂♂, 16♀♀: RBINS; 3♂♂, 3♀♀: VNMN; 1♂, 1♀: NHMW); 1♂: ex breeding Bruno Kneubühler, origin: Vietnam, Ninh Thuan prov., Nui Chua N. P., 11°42'N 109°09'E, 3-9.VII.2014, night coll. Leg. J. Constant & J. Bresseel, GTI project, I.G.: 32.779, DNA 16-65 BK (RBINS); 1♂: idem, DNA 16-45 BK (RBINS); 1♀: idem, DNA 16-64 BK (RBINS); 1♀: idem, DNA 16-44 BK (RBINS); 5♂♂, 5♀♀: ex breeding F. Hennemann, 2016, origin: Vietnam, Ninh Thuan prov., Nui Chua N.P., 11°42'N 109°09'E, 3-9.VII.2014, night coll. Leg. J. Constant & J. Bresseel, GTI project (Coll. Frank Hennemann, No's FH 0899-1 to -10).

ADDITIONAL MATERIAL. VIETNAM: 150 eggs: ex breeding J. Bresseel, 2015, Origin: Vietnam, Ninh Thuan prov., Nui Chua N. P., 11°42'N 109°09'E, 3-9.VII.2014, night coll., leg. J. Constant & J. Bresseel, GTI project, I.G.: 32.779 (100 eggs: RBINS; 50 eggs: VNMN).



Fig. 1. *Nuichua rabaeyae* sp. nov., holotype ♂. A, habitus, dorsal view. B, habitus, lateral view. C, habitus, ventral view. D, head and thorax, dorsal view. E, terminalia, dorsal view. F, terminalia, ventral view. G, head and thorax, lateral view. H, terminalia, lateral view.

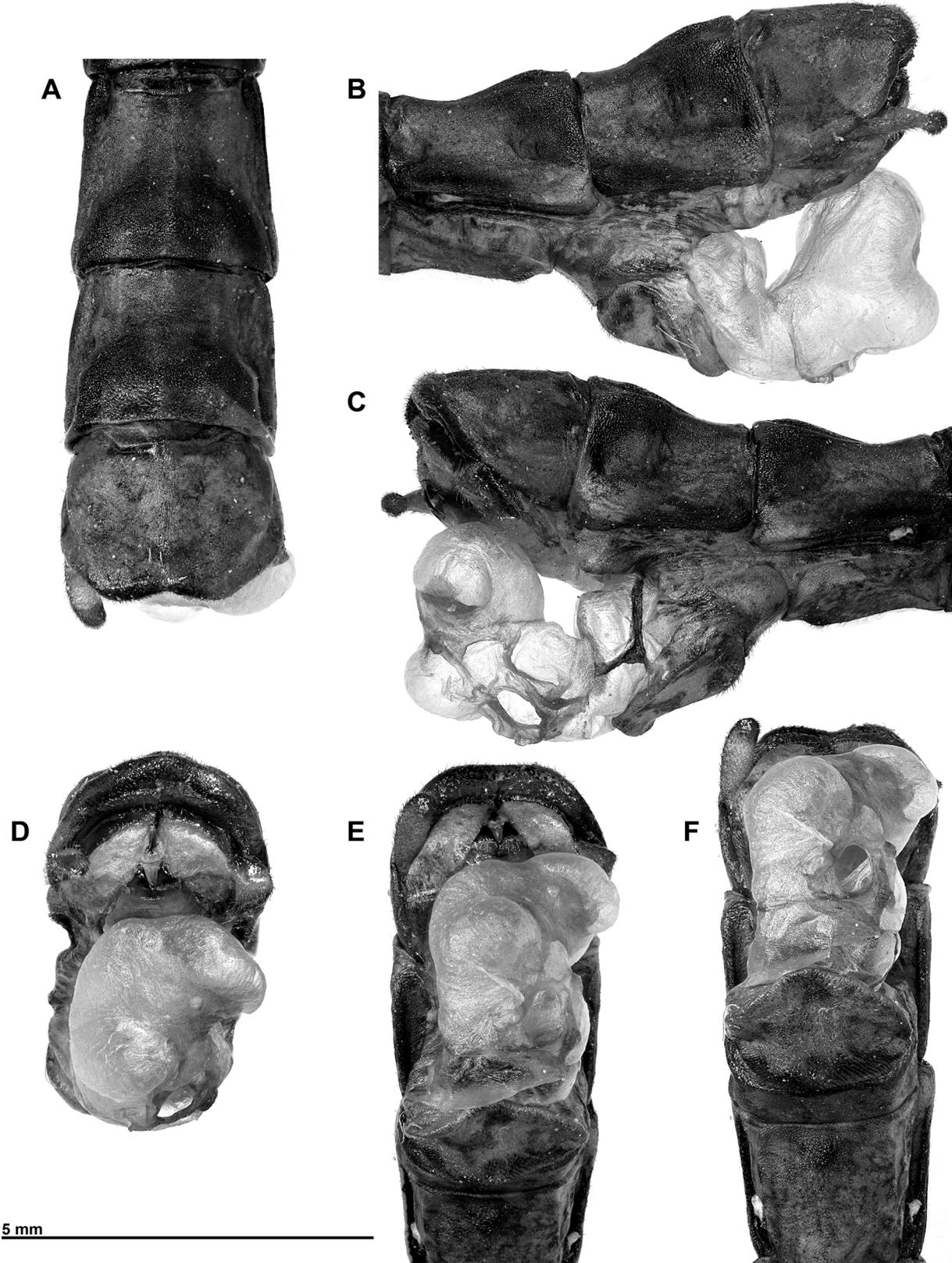


Fig. 2. *Nuichua rabaeyae* sp. nov., ♂ genitalia. A, dorsal view. B, left lateral view. C, right lateral view. D, posterior view. E, ventral view. F, anteroventral view.

DESCRIPTION

MALE (Figs 1–2, 5 A–B, E–G, 6 A, C, 7)

Measurements: see table 1.

Body: (Fig. 1 A–C) head, scapus and pedicellus greyish blue with black granules. Pro-, meso and metanotum mahogany red with a mediolongitudinal greyish blue marking, marking widening near the posterior margin of each segment. Abdominal terga as metanotum, but with black markings posteriorly. Legs with coxae coloured as head; femora grass green, slightly darkening distally. Other portions of legs grass green.

Head: (Fig. 1 D, G) longer than wide and mainly smooth, apart from few distinct granules posteriorly and on genae. Dorsal surface slightly flattened with distinct mediolongitudinal groove. Vertex rounded, posterolaterally also with a groove. Eyes circular and strongly projecting hemispherically. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob-like and round in cross-section.

Thorax: (Fig. 1 D, G) pronotum slightly shorter than head; anterior margin strongly incurved with anterolateral angles extended and apically rounded; posterior portion with lateral margins parallel-sided. Median longitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral edges. Posterior margin rounded. Mesonotum longer than mesofemora, smooth and parallel-sided. Metanotum smooth, longer than head. Anterolateral angles as in pronotum, but not as strongly pronounced. Pro-, meso- and metasterna smooth.

Wings: (Figs 1 G, 5 H) tegmina absent; alae reduced, scale-like and whitish.

Legs: (Fig. 1 A–C) profemora slightly longer than mesonotum; compressed and curved basally. Dorsal carinae present, but unarmed; all ventral carinae present. Antero- and posteroventral carinae armed with three to four minute saw-like teeth subapically. Mesofemora distinctly shorter than mesonotum and slightly swollen laterally; carinae and armature as in profemora. Metafemora about as long as profemora, armature as in mesofemora. Protibiae slightly longer than profemora, rectangular in cross-section with outer ventral and dorsal carinae developed; carinae with small setae. Probasitarsus longer than all following tarsomeres combined. Mesotibiae about as long as mesofemora; carinae as in protibiae. Metatibiae slightly longer than metafemora. All carinae present, but unarmed with medioventral carina raised and laterally flattened. Meso- and metatarsi with claws small when compared to body size; tarsomeres with a small posteromedian extension ventrally with posterior portion smooth and deeply notched.

Abdomen: (Fig. 1 A–C, E–F, H) median segment longer than wide, shorter than metanotum, smooth and trapezoidal. All abdominal terga with indistinct median line, less than two times longer than wide and smooth. Terga II–VI about the same, or slightly decreasing in length; tergum VII distinctly shorter than VI; VII about as wide as long; VIII distinctly wider than long; VII and VIII with posterolateral angles expanded and rounded; tergum X about as long and wide as IX and with a mediolongitudinal line, apically notched with outer rim slightly setose. Outer margin of inner portion of tergum X swollen and armed with several short, black spines. Posterolateral angles rounded. Poculum slightly rounded, not reaching base of vomer; apex broad and slightly rounded, almost straight. Cerci reaching about apex of abdomen, with apices knob-like, slightly incurving and distinctly setose. Vomer well developed, represented as a broad triangular sclerite, strongly notched posteriorly and with two terminal hooks; apices blackish and tapering towards the posterior. Other abdominal sterna smooth with a small black posteromedian marking.



Fig. 3. *Nuichua rabaeyae* sp. nov., paratype ♀. A, habitus, dorsal view. B, habitus, lateral view. C, habitus, ventral view. D, head and thorax, dorsal view. E, terminalia, dorsal view. F, terminalia, ventral view. G, terminalia, lateral view. H, head and thorax, lateral view.



Fig. 4. *Nuichua rabaeyae* sp. nov., nymphs. A–B, second instar. C–D, third instar. E–F, fourth instar.

Genitalia: (Fig. 2) phallus entirely membranous; when inflated, strongly curved dorsally with distal portion more strongly swollen and bearing a medioventral round opening; one posteroventral inflated hump and one apicolateral inflated hump on right side.

FEMALE (Figs 3, 5 B, E–G, I–J, 6 B–C, 7)

Measurements: see table 1.

Body: (Figs 3 A–C, 6 B–C) coloured more or less like male, but less contrasted. Head and mediolongitudinal dorsal marking on body with a greenish tinge.

Head: (Figs 3 D, H, 5 I) longer than wide, with an irregular amount of distinct black tubercles dorsally and on genae; area between granules smooth. Dorsal surface slightly flattened with distinct mediolongitudinal groove. Posteriorly of groove, a distinct black triangular marking. Vertex rounded, posterolaterally with a shallow impression. Eyes circular and strongly projecting hemispherically. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob-like and round in cross-section.

Thorax: (Fig. 3 D, H) pronotum slightly shorter than head; anterior margin strongly incurved with anterolateral angles extended and apically rounded; posterior portion with lateral margins parallel-sided. Mediolongitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral edges; posterior margin rounded. Mesonotum about as long as median segment and terga II–IV combined, smooth and parallel-sided. Metanotum smooth. Pro-, meso- and metasterna smooth.

Wings: (Figs 3 H, 5 J) tegmina absent; alae small, whitish and scale-like.

Legs: (Fig. 3 A–C) profemora shorter than mesonotum, compressed and curved basally; dorsal carinae present, but unarmed; all ventral carinae present; antero- and posteroventral carinae armed with three minute saw-like teeth subapically. Mesofemora about 2/3 as long as mesonotum and distinctly swollen laterally; carinae and armature as in profemora. Metafemora about as long as profemora, with armature as in mesofemora, but with four spines subapically on outer ventral carinae. Protibiae slightly longer than profemora, rectangular in cross-section with all carinae developed; carinae with small setae. Probasitarsus longer than all following tarsomeres combined. Mesotibiae about as long as mesofemora, with carinae as in protibiae. Metatibiae slightly longer than metafemora. Meso- and metatarsi with claws small when compared to body size; tarsomeres with a small posteromedian extension, ventrally with posterior portion smooth and strongly notched.

Abdomen: (Fig. 3 A–C, E–G) median segment about as wide as long, shorter than metanotum, smooth and trapezoidal. All abdominal terga smooth and less than two times longer than wide. Terga II–V slightly increasing in length; terga VI and VII decreasing in length; tergum VII about as wide as long; VIII slightly wider than long; IX about as long and wide as X, rounded posteriorly. Anal segment broad and apically gently rounded. Abdominal sternum VII with praeopercular organ represented by a carina followed by a single, dorsoventrally flattened spine. Subgenital plate just not reaching halfway along anal segment, spoon-shaped and tapering posteriorly; posterior portion with a definite median longitudinal carina. Other abdominal sterna smooth with a small posteromedian black marking.

NYMPH (Figs 4, 5 C–D)

Newly hatched nymphs mostly mottled pale yellowish brown and black. Head reddish brown with yellowish granules. Antennae black and white. Profemora coloured as head. Meso- and metafemora with a greenish tinge in basal half, a whitish ring in middle, and distal portion black.



Fig. 5. *Nuichua rabaeyae* sp. nov., captive reared, from Nui Chua N.P. (photographs by B. Kneubühler). A, ♂ lateral view. B, mating pair dorsal view. C–D, newly hatched nymph. C, dorsal view. D, lateral view. E, mating pair lateral view. F, abdomen ♀ with adult ♂ mating. G, apices of abdomen mating pair. H, ♂ metanotum and median segment; arrow indicates scale-like wings. I, ♀ head and pronotum. J, ♀ metanotum and median segment; arrow indicates scale-like wings. K–N, eggs. K, lateral view. L, operculum. M, dorsal view. N, polar area.



Fig. 6. *Nuichua rabaeyae* sp. nov. A–B, wild specimens (photographs by J. Constant). A, ♂, Nui Chua N.P., 8.VIII.2014. B, ♀, Nui Chua N.P., 7.VIII.2014. C, adult pair, captive reared (photograph by M. Duytschaever).



Fig. 7. *Nuichua rabaeyae* sp. nov., male mating with subadult moulting female. A, adult male showing mating behaviour with subadult female starting her final moult. B, detail of male with subadult female. C, female in final phase of moulting with male still attached to exuvia. D, adult female drying after final moult with male still attached to exuvia. E, detail of male attached to exuvia. F, male moving to female after drying process. G, male attached to adult female.

EGG (Fig. 5 K–N)

Measurements (in mm). Length: 2.7; width: 1.9; height: 2.2.

Capsule oval, colouration cream with black markings; cream areas on capsule surface covered with minute whitish granules. Polar area black. Black marking on polar area tapering towards and reaching micropylar plate. Operculum convex; central portion cream coloured with outer margin black; cream coloured area covered with minute white granules except centrally. Micropylar plate positioned almost centrally on capsule but very slightly displaced towards polar area; oval, slightly darker than capsule; surface smooth, except for outer margin with minute whitish granules. Micropylar cup black and distinct, followed anteriorly by a definite mediolongitudinal carina and posteriorly by an elongated, black median line covered with minute black granules and reaching polar area.

BIOLOGY.

The species was collected in secondary evergreen rainforest, at low altitude (400m). The specimens were found foraging on low vegetation and bushes (Fig. 6 A–B).

The species is easy to rear in captivity and accepts a wide variety of alternative foodplants including *Hypericum* spp. (Hypericaceae), *Hedera helix* L. (Araliaceae) and different species of *Rubus* spp. (Rosaceae). Eggs are dropped to the ground and have a relatively short incubation time (2–4 months). Nymphs can react hectically when disturbed, but older nymphs often feign dead. Males mature 4 to 6 weeks earlier than females and are considerably smaller in size than the latter, reaching only about half their length. As soon as they are adult, males already occupy the larger female nymphs and stay with the same female for the rest of their life. Subadult females moult with males still attached to the old skin (Fig. 7 A–E). Once the moulting process is completed, the male moves from the old skin to the freshly moulted adult female (Fig. 7 F–G). When a lone male comes close to an occupied female or even when two mating males come close to one another, they become agitated and instantly try to fend off the contender with their legs (B. Kneubühler pers. comm., IV.2016).

Table 1. Measurements [mm] of *Nuichua rabaeyae* gen. et sp. nov.

<i>Length of</i>	HT ♂	PT ♂♂	PT ♀♀
Body	60.6	53.7–65.2	98.6–113.6
Head	4.5	3.5–4.1	7.1–7.9
Pronotum	3.8	3.1–3.9	6.3–6.9
Mesonotum	15.2	12.4–15.0	24.0–28.1
Metanotum	4.8	4.3–5.1	7.3–8.9
Median segment	3.2	3.2–3.6	5.6–6.4
Profemora	16.3	13.7–17.1	20.9–25.8
Mesofemora	12.1	10.2–11.9	15.9–19.5
Metafemora	15.6	13.8–16.5	20.7–26.5
Protibiae	18.5	14.7–18.8	22.6–27.4
Mesotibiae	12.3	10.3–12.5	16.3–19.0
Metatibiae	18.8	15.6–18.9	23.7–29.1

DISTRIBUTION. Southern Central Vietnam, Ninh Thuan Province (Fig. 8).

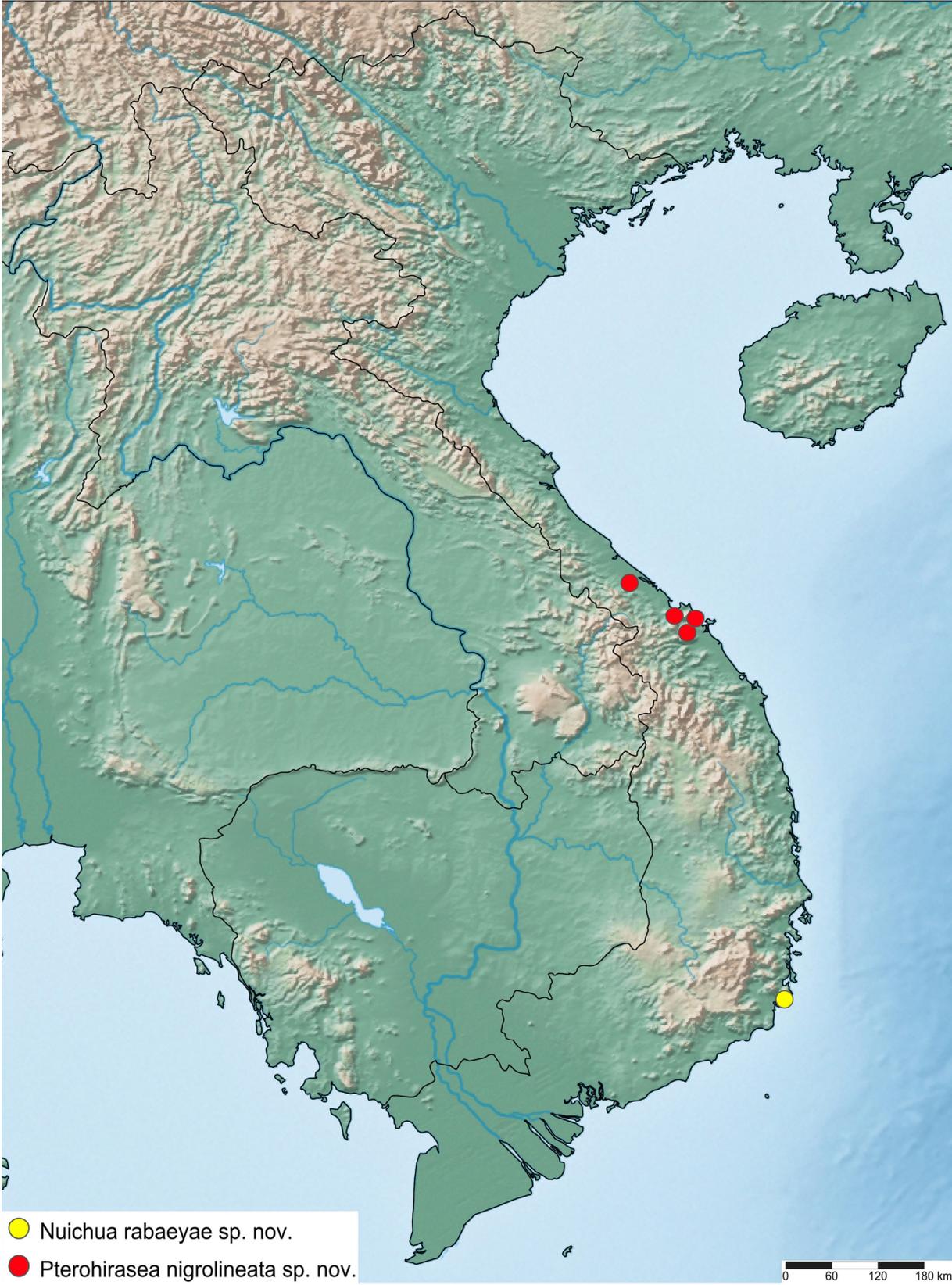


Fig. 8. *Nuichua rabaeyae* sp. nov. and *Pterohirasea nigrolineata* sp. nov., distribution map.

Genus *Pterohirasea* gen. nov.

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Type species: *Pterohirasea nigrolineata* sp. nov. by present designation and monotypy.

ETYMOLOGY. The genus name is the combination of *ptero-*, from the Greek word *pteron* meaning wing, and *-hirasea*, the ending of *Neohirasea* Rehn, 1904, illustrating the close relationship between the two genera.

DIAGNOSIS

The genus is closely related to *Nuichua* gen. nov. but can be distinguished by the following characters:

- 1) Comparatively longer legs; legs completely unarmed and mesofemora not swollen (Figs 10A–C, 12 A–C).
- 2) Posternum with rough paired, almost circular sensory areas (Fig. 9).
- 3) Tegmina absent; small alae present (Figs 10 D, G, 12 D, H, 13 H, L).
- 4) Poculum strongly rounded with outer margin curving downwards (Fig. 10 F, H–I).
- 5) Vomer with basal portion very broad, flattened and almost semicircular; posterior portion tapering, strongly upcurving and with two blunt terminal hooks (Fig. 11).
- 6) Subgenital plate in females slightly projecting over apex of abdomen (Fig. 12 E–G).

DESCRIPTION

MALE AND FEMALE (Figs 10, 12)

Head: longer than wide and mainly smooth, except few distinct, pale granules dorsally and on genae. Dorsal surface slightly flattened with distinct mediolongitudinal groove. Vertex rounded, posterolaterally also with a groove. Eyes circular and strongly projecting hemispherically followed by a broad dark postocular line. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob-like and round in cross-section.

Thorax: pronotum slightly shorter than head with few pale granules. Anterior margin strongly incurved with anterolateral angles extended and apically rounded. Base of anterolateral extensions with a minute pseudoforamen. Median longitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral edges. Posterior margin rounded. Mesonotum with few pale granules and parallel-sided. Metanotum with few pale granules, slightly longer than median segment, subapically with a small hump, followed by a short transverse furrow medially. Prosternum with anterior margin straight, widening toward the posterior; posterior margin concave. Posternum with rough, paired, almost circular sensory organs; longitudinally divided by a median furrow.

Wings: tegmina absent. Alae small, reduced, not reaching median segment; costal area blackish with reddish margin; anal area bright red.

Legs: profemora compressed and curved basally. All carinae present and unarmed; medioventral carina indistinct. Meso- and metafemora with carinae and armature as in profemora (female) or ventral carinae indistinct (male). Protibiae subrectangular in cross-section with outer ventral and dorsal carinae developed. Meso- and metatibiae with carinae as in protibiae, with medioventral carinae present but indistinct. Meso- and metatarsi with claws small when compared to body size; tarsomeres with a small posteromedian extension.

Abdomen: median segment longer than wide, slightly trapezoidal and subapically with a small, black transverse hump medially. All abdominal terga less than two times longer than wide (males) or transverse (females), with few pale granules. Terga II–IX with a small

posteromedian hump. Males with anal segment shorter than IX, tectiform with mediolongitudinal carina; slightly concave apically with outer margin slightly setose; ventral portion of outer margin of anal segment slightly swollen and armed with several black tubercles; posterolateral angles rounded. Poculum rounded; posterior margin flattened with outer rim curving downwards; reaching about base of vomer. Cerci reaching about apex of abdomen, laterally flattened with apices rounded, slightly incurving and distinctly setose. Vomer well developed and large; basal portion broad, flattened and almost semicircular; posterior portion tapering, strongly upcurving and notched apically, forming two blunt apices. Apices blackish and tapering towards the posterior. Females with anal segment about as long as tergum IX, tectiform with mediolongitudinal carina and broadly rounded apically; abdominal sternum VII with definite praeopercular organ; broadened at base, later tapering and resulting in a single spine. Subgenital plate reaching about apex of abdomen; laterally flattened basally, later spoon-shaped and tapering posteriorly; posterior portion with a definite median longitudinal carina.

EGG (Fig. 13 O–Q).

Capsule oval, brownish with darker markings and a reticulate structure; reticulum on capsule surface covered with minute stalked granules. Polar area with dark marking. Operculum oval and convex; coloured as capsule with several mushroom-shaped, stalked granules, more densely grouped in the central portion. Micropylar plate positioned almost centrally on capsule, slightly displaced towards polar area and almost circular. Micropylar cup black and distinct, followed anteriorly by a definite mediolongitudinal carina.

DISTRIBUTION. Central Vietnam.

Pterohirasea nigrolineata sp. nov.

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Figs 8–14

ETYMOLOGY. The species name is derived from *niger* (adj., Latin) meaning black, and *lineatus* (adj., Latin) meaning striped. It refers to the black longitudinal stripe marking the body of the species.

TYPE MATERIAL. VIETNAM: holotype ♂ (Fig. 10): C Vietnam, Bach Ma N. P., 16°12'N 107°52'E, 12–17.VII.2011, leg. J. Constant & J. Bresseel, I.G.: 31.933 (RBINS).

Paratypes [20♂♂, 20♀♀, 4♀♀ penultimate stage, 2 nymphs]: 1♂, 3♀♀, 4♀♀ nymphs penultimate stage: C Vietnam, Bach Ma N. P., 16°12'N 107°52'E, 12–17.VII.2011, leg. J. Constant & J. Bresseel, I.G.: 31.933 (2♀♀, 2♀♀ nymphs penultimate stage: RBINS; 1♂, 1♀, 2♀♀ nymphs penultimate stage: VNMN); 1♂, 2♀♀: Vietnam, Thua Thiên-Huê Prov., Phong Dien near VNMN station, 16°35'12"N 107°20'31"E, 8-9.IV.2017, leg. J. Constant & J. Bresseel, I.G.: 33.447 (RBINS); 1♂ Vietnam, Thua Thiên-Huê Prov., Bach Ma N.P., 16°12'N 107°52'E 10-16.IV.2017, leg. J. Constant & J. Bresseel, I.G.: 33.447 (RBINS); 15♂♂, 15♀♀: ex breeding Tim Bollens 2018, origin: Vietnam, Thua Thiên-Huê Prov., Phong Dien near VNMN station, 16°35'12"N 107°20'31"E, 8-9.IV.2017, leg. J. Constant & J. Bresseel, I.G.: 33.447 (11♂♂, 11♀♀: RBINS; 4♂♂, 4♀♀: VNMN); 3♂♂: Annam, Lién Chién près Tourane, 0 à 1000 M d'alt., Mme Poilane, 1923 (MNHN).

NOTE

Tourane is the older name of Da Nang, hence the location name “Lién Chién” is most probably a misspelling of Liên Chiểu (coordinates: 16°07'26"N 108°07'4"E)

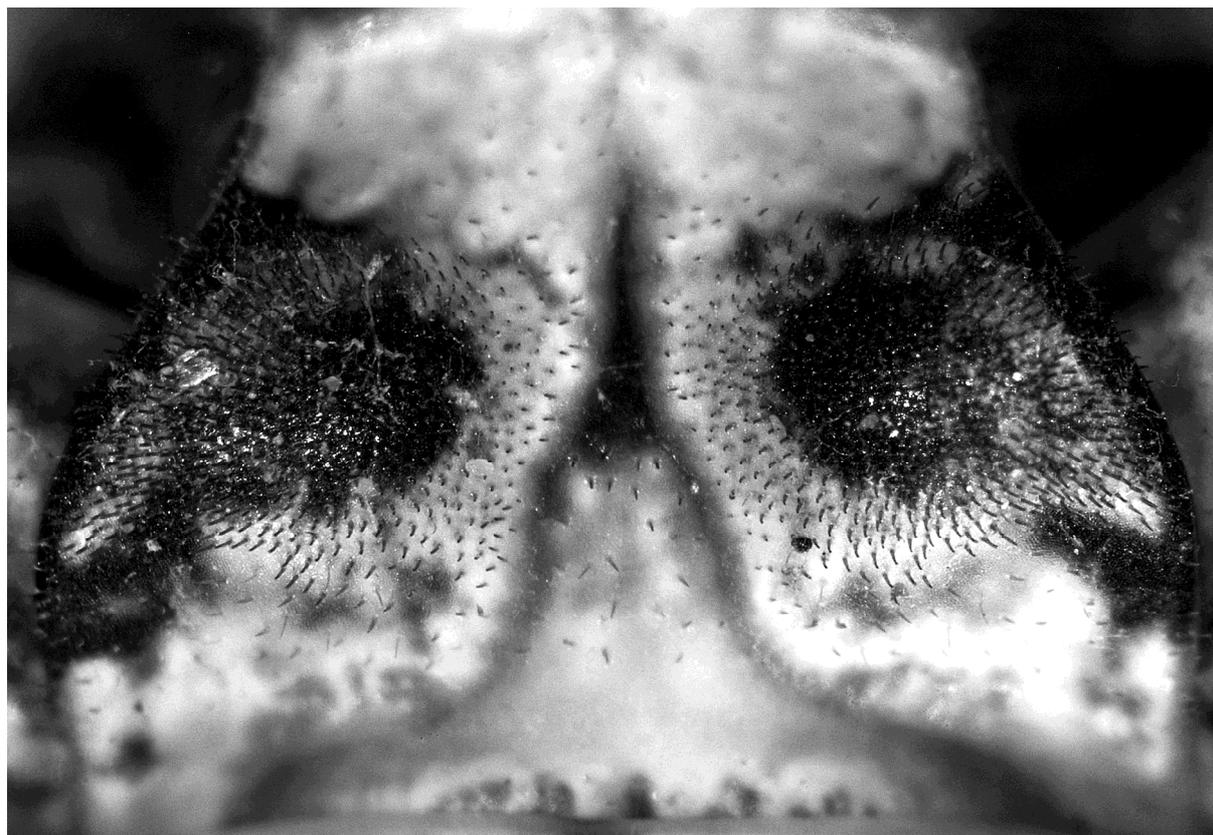


Fig. 9. *Pterohirasea nigrolineata* sp. nov., prosternal sensory organs.

ADDITIONAL MATERIAL. VIETNAM: 75 eggs: ex breeding J. Bresseel, 2017, origin: Vietnam, Thua Thiên-Huê Prov., Phong Dien near VNMN station, 16°35'12"N 107°20'31"E, 8-9.IV.2017, leg. J. Constant & J. Bresseel, I.G.: 33.447 (50 eggs: RBINS; 25 eggs: VNMN).

ADDITIONAL DATA. VIETNAM: several nymphs (not collected): Da Nang Province, Ba Na-Nui Chua Nat. Res., 16°00'N 108°01'E, 16-19.VII.2017, J. Constant & J. Bresseel.

DESCRIPTION

MALE (Figs 10–11, 13 C–I, 14 A–C)

Measurements: see table 2.

Body: (Fig. 10 A–C) head orange- to dark brown with paler granules; broad black postocular line and a dark marking dorsally. Antennae black with white rings. Pro-, meso and metanotum orange- to dark brown with paler granules and a broad black mediolongitudinal line. Median segment and abdominal terga II–VII brown with a broad, black longitudinal line; sometimes present on all segment excluding anal segment. Terga II–IX with a pale marking anterolaterally. Legs orange- to dark brown. Coxae with a yellowish marking posteriorly, femora and tibiae with minute pale markings. Meso- and metapleura with a definite yellow marking. Thoracical and abdominal sterna cream to light brown with posteromedian black marking.

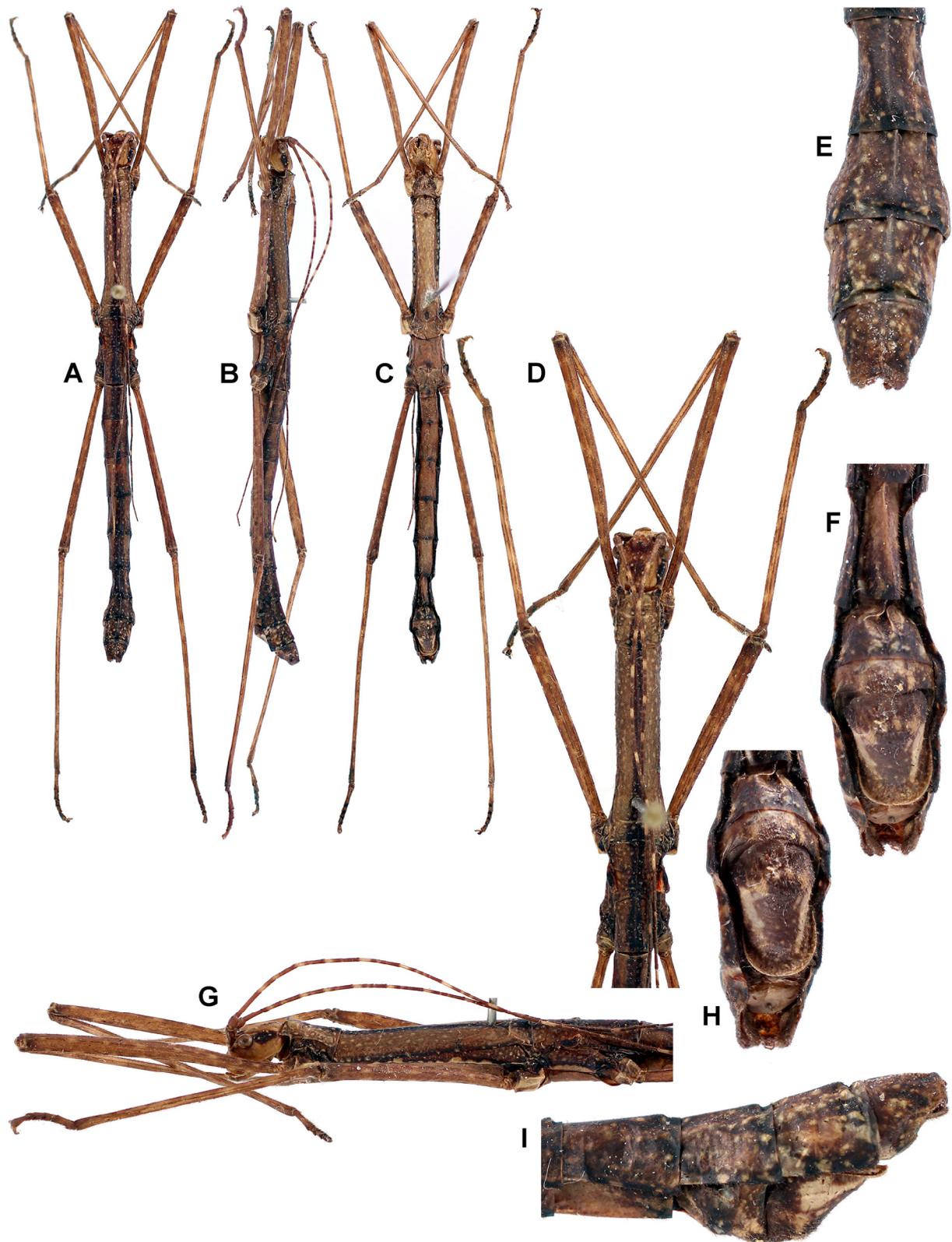


Fig. 10. *Pterohirasea nigrolineata* sp. nov., holotype ♂. A, habitus, dorsal view. B, habitus, lateral view. C, habitus, ventral view. D, head and thorax, dorsal view. E, terminalia, dorsal view. F, terminalia, ventral view. G, head and thorax, lateral view. H, terminalia, ventral view. I, terminalia, lateral view.

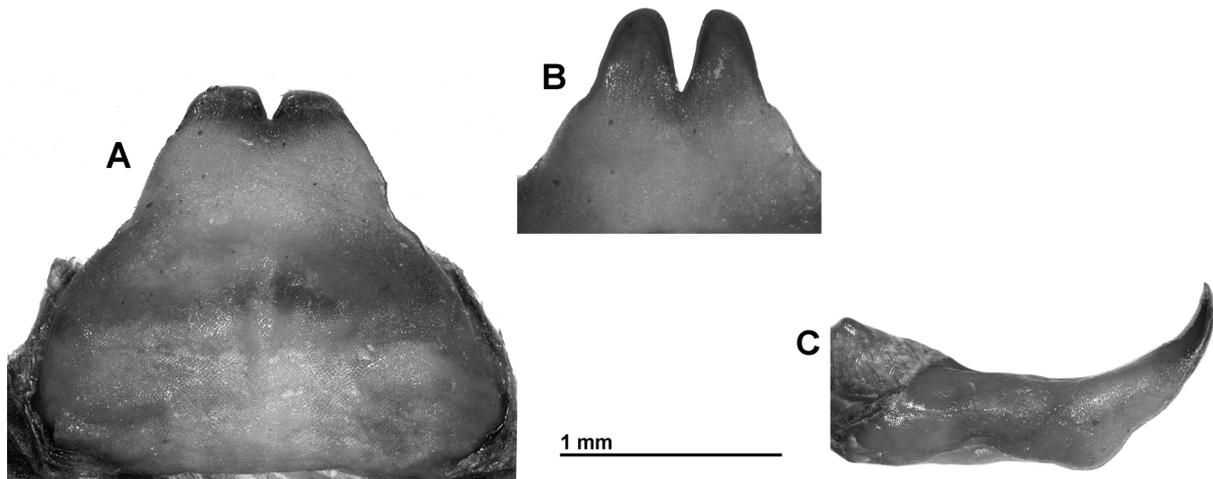


Fig. 11. *Pterohirasea nigrolineata* sp. nov., ♂ vomer. A, ventral view. B, detail of apex. C, lateral view.

Head: (Figs 10 D, G, 14 C) longer than wide and mainly smooth, with few distinct, pale granules dorsally and on genae; dorsal surface slightly flattened with distinct mediolongitudinal groove. Vertex rounded, posterolaterally also with a groove. Between eyes, a small raised area; anteriorly of raised area a shallow indentation. Eyes circular and strongly projecting hemispherically. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob like and round in cross-section.

Thorax: (Figs 10 D, G, 13 H, 14 C) pronotum slightly shorter than head with few pale granules; anterior margin strongly incurved with anterolateral angles extended and apically rounded. Base of anterolateral extensions with a minute pseudoforamen. Posterior portion slightly widening towards posterior margin. Median longitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral edges. Posterior margin rounded. Mesonotum about as long as mesofemora, with few pale granules and parallel-sided. Metanotum with few pale granules, slightly longer than median segment, subapically with a small hump followed by a short transverse median furrow. Prosternum with anterior margin straight, widening towards the posterior; posterior margin concave. Prosternum with rough paired, almost circular sensory organs; longitudinally divided by a median furrow (Fig. 9). Mesosternum with few, minute pale tubercles laterally. Meso- and metasternum with a small, black elevation posteriorly.

Wings: (Figs 10 D, G, 13 H, 14 C) tegmina absent. Alae small, not reaching median segment; costal area blackish with inner margin reddish; anal area bright red.

Legs: (Fig. 10 A–C) profemora slightly longer than pro- and mesonotum combined; compressed and curved basally; outer dorsal and ventral carinae present and unarmed; medioventral carina indistinct. Mesofemora about as long as mesonotum; ventral carinae indistinct. Metafemora slightly longer than profemora, armature as in mesofemora. Protibiae slightly longer than head, pro- and mesonotum combined; subrectangular in cross-section with outer ventral and dorsal carinae developed; carinae with small setae. Probasitarsus longer than all following tarsomeres combined. Mesotibiae slightly longer than mesofemora; carinae as in protibiae, with medioventral carinae present, but indistinct. Metatibiae distinctly longer than metafemora; carinae as in mesotibiae. Meso- and metatarsi with claws small when compared to body size; tarsomeres with a small posteromedian extension.

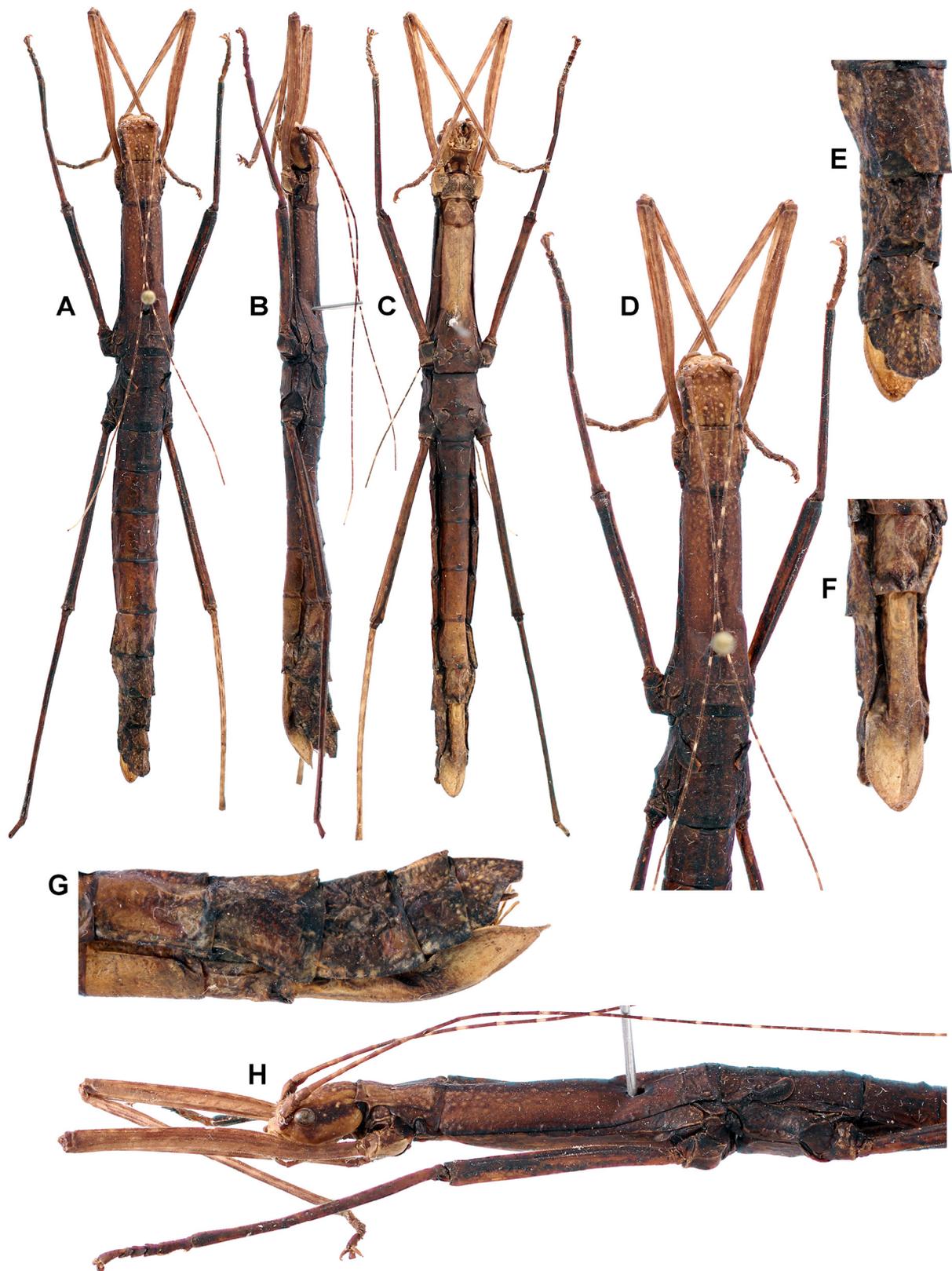


Fig. 12. *Pterohirasea nigrolineata* sp. nov., paratype ♀. A, habitus, dorsal view. B, habitus, lateral view. C, habitus, ventral view. D, head and thorax, dorsal view. E, terminalia, dorsal view. F, terminalia, ventral view. G, terminalia, lateral view. H, head and thorax, lateral view.

Abdomen: (Figs 10 A–C, E–F, H–I, 13 I) median segment longer than wide, slightly trapezoidal and subapically with a black transverse hump medially. All abdominal terga less than two times longer than wide with few pale granules. Terga II–IX with a minute posteromedian hump; tergum II slightly longer than median segment; III–V about the same length; tergum VII distinctly shorter than V, widening towards the posterior; VIII distinctly wider than long, widening posteriorly with a mediolongitudinal carina; tergum IX slightly shorter than VIII and tectiform; tergum X shorter than IX with mediolongitudinal carina; slightly concave apically with outer margin slightly setose. Ventral portion of outer margin of anal segment slightly swollen and with several black tubercles. Posterolateral angles rounded. Poculum rounded; posterior margin flattened with outer rim curving downwards; reaching about base of vomer. Cerci reaching about apex of abdomen, laterally flattened with apices rounded, slightly incurving and distinctly setose. Vomer well developed and large; basal portion broad, flattened and almost semicircular; posterior portion tapering, strongly upcurving and notched apically, forming two apices; apices blackish and tapering towards a fairly blunt apex (Fig. 11).

FEMALE (Figs 12, 13 J–N, 14 D–F)

Measurements: see table 2.

Body: (Fig. 12 A–C) colouration as in male, distinctly paler ventrally.

Head: (Figs 12 D, H, 14 D) longer than wide and mainly smooth, with few distinct granules dorsally and on genae. Dorsal surface slightly flattened with distinct mediolongitudinal groove. Vertex rounded, posterolaterally also with a short groove. Eyes circular and strongly projecting hemispherically. Antennae distinctly projecting over front legs. Scapus slightly flattened dorsoventrally and oval in cross-section. Pedicellus short, knob-like and round in cross-section.

Thorax: (Figs 12 D, H, 13 L, 14 D) pronotum slightly shorter than head, slightly widening towards the posterior and sparsely granulose. Anterior margin strongly incurved with anterolateral angles extended and apically rounded. Base of anterolateral extensions with a minute pseudofoamen. Median longitudinal groove starting anteriorly, not reaching posterior edge. Centrally with a short transverse impression not reaching lateral edges. Posterior margin rounded. Mesonotum distinctly longer than mesofemora, with scattered pale granules and parallel-sided. Metanotum with few pale granules, slightly longer than median segment, subapically with a median small hump, followed by a short transverse furrow. Prosternum with anterior margin straight, widening towards the posterior; posterior margin concave. Posternum with rough paired, almost circular sensory organs; longitudinally divided by a median furrow. Meso- and metasternum smooth.

Wings: (Figs 12 D, H, 13 L) tegmina absent. Alae small, not reaching median segment; costal area blackish with inner margin reddish; anal area bright red.

Legs: (Fig. 12 A–C) profemora shorter than mesonotum and half the pronotum combined; compressed and curved basally; all carinae present and unarmed; medioventral carina indistinct. Mesofemora shorter than mesonotum; ventral carinae indistinct. Metafemora slightly longer than profemora and unarmed. Protibiae slightly longer than profemora; subrectangular in cross-section and with outer ventral and dorsal carinae developed; carinae with small setae. Probasitarsus about as long as the following three tarsomeres combined. Mesotibiae about as long as mesofemora, with carinae as in protibiae, but with medioventral carinae present. Metatibiae distinctly longer than protibiae; carinae as in mesotibiae. Claws small when compared to body size; tarsomeres with a small posteromedian extension.

Abdomen: (Figs 12 A–C, E–G, 13 M–N) median segment wider than long, slightly trapezoidal and subapically with a faint transverse hump medially. All abdominal terga transverse with

few minute granules. Terga II–IX with faint median hump subapically, median hump more definite in terga VI–IX; tergum II about as long as median segment; III–VI about the same length; tergum VII slightly shorter than VI, trapezoidal, widening towards the posterior and with a small lobe dorsolaterally; VIII about the same length as VII, trapezoidal and narrowing towards the posterior; tergum IX distinctly shorter than VIII and tectiform. Anal segment about the same length as tergum IX, tectiform with mediolongitudinal carina and truncate apically. Abdominal sternum VII with definite praeopercular organ. Praeopercular organ broad at base, later tapering and resulting in a single spine. Subgenital plate reaching about apex of abdomen; apical half spoon-shaped and tapering posteriorly; posterior portion with a definite median longitudinal carina. Other abdominal sterna smooth with a small black marking posteromedially.

NYMPH (Figs 13 A–B, 14 G)

Head orange with black postocular line. Antennae black and white. Body olivaceous brown with minute white spots; abdominal terga with anterolateral white markings; legs coloured as body with apical portion of femora orange and trochanters and coxae white.

EGG (Fig. 13 O–Q)

Measurements (in mm). Length: 3.2; width: 2.2; height: 2.6.

Capsule oval, coloured brownish with darker markings and a reticulum; reticulum on capsule surface covered with minute stalked, cream granules. Polar area with dark marking; marking tapering towards and reaching and continuing on micropylar plate. Operculum oval and convex; coloured as capsule with several mushroom-like, stalked granules, more densely grouped in central portion. Micropylar plate positioned almost centrally on capsule, slightly displaced towards the polar area; almost circular, slightly darker than capsule; surface smooth; outer margin with few, minute whitish granules. Micropylar cup black and distinct, followed anteriorly by a definite mediolongitudinal carina.

BIOLOGY. Adults (Fig. 14 A–F) and nymphs (Fig. 14 G) were collected in tropical evergreen rainforest (Fig. 14 H), at low to medium altitude (250–800 m). The specimens were observed on lower vegetation. In captivity, eggs are dropped to the ground and a wide variety of alternative foodplants including *Hypericum* spp. (Hypericaceae) and different species of *Rubus* spp. (Rosaceae) were accepted.

When disturbed, they open their wings to show the bright red part of the alae as a defensive behaviour (Fig. 13 G–H).

Table 2. Measurements [mm] of *Pterohirasea nigrolineata* gen. et sp. nov.

Length of	HT ♂	PT ♂♂	PT ♀♀
Body	51.4	62.4–67.0	68.2–81.4
Head	4.0	4.5–4.7	5.3–6.8
Pronotum	4.3	4.5–5.0	5.8–6.2
Mesonotum	11.5	13.5–15.4	15.0–18.3
Metanotum	3.3	4.0–4.6	4.0–5.2
Median segment	3.1	3.5–3.8	3.7–4.6
Profemora	15.1	18.0–18.6	16.2–21.3
Mesofemora	11.9	14.1	12.9–16.2
Metafemora	16.6	20.3–21.7	18.6–24.4
Protibiae	19.0	20.7–22.5	17.8–22.8
Mesotibiae	14.0	15.9–16.7	13.6–18.6
Metatibiae	21.8	24.7–27.3	21.6–28.1

DISTRIBUTION. Central Vietnam, provinces of Thua Thien-Hue and Da Nang (Fig. 8).

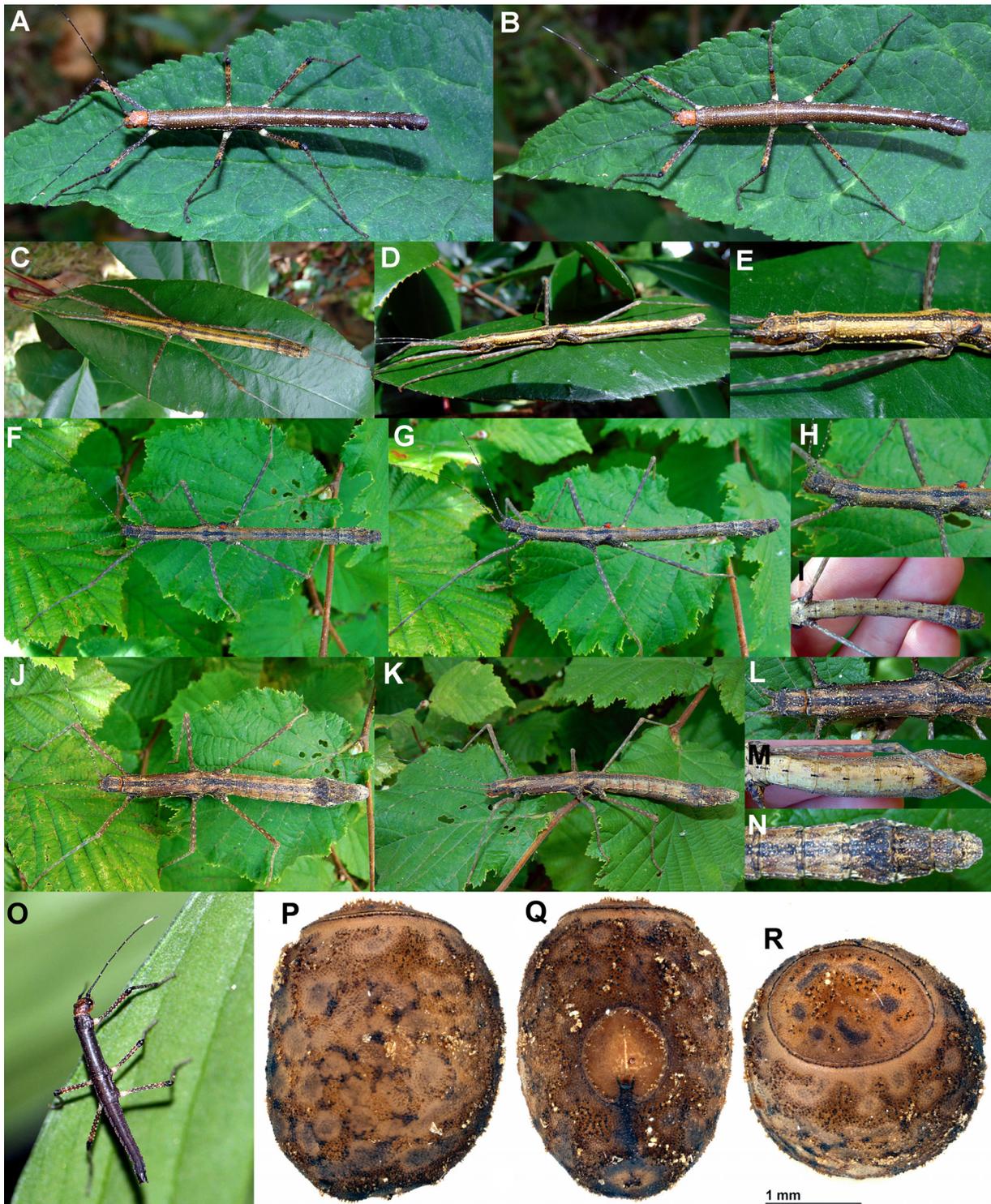


Fig. 13. *Pterohirasea nigrolineata* sp. nov. A–N, captive reared, from Phong Dien VNMN Station (photographs by J. Constant). A–B, nymph. C, ♂, dorsal view. D, ♂, lateral view. E, ♂, head and thorax. F, ♂, dorsal view. G, ♂, lateral view. H, ♂, head and thorax. I, ♂, abdomen ventral view. J, ♀, dorsal view. K, ♀, lateral view. L, ♀, head and thorax dorsal view. M, ♀, abdomen ventral view. N, ♀, terminalia dorsal view. O, newborn nymph (photograph by T. Bollens). P–R, egg. P, lateral view. Q, dorsal view. R, operculum.

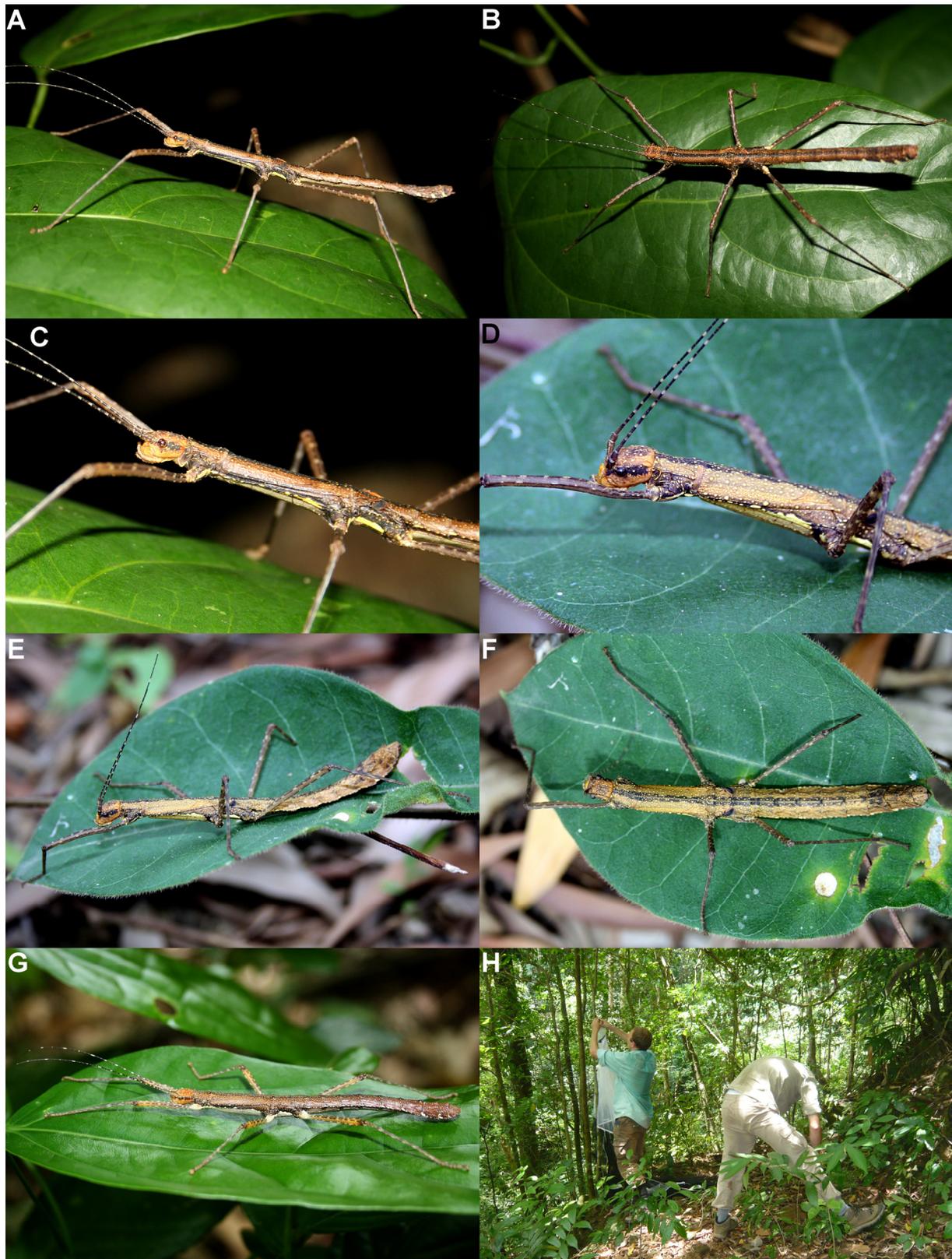


Fig. 14. *Pterohirasea nigrolineata* sp. nov., wild specimens and habitat in Bach Ma N.P. (photographs A–G by J. Constant, H by H.T. Pham). A–C, ♂, 12.VII.2011. D–F, ♀, 17.VII.2011. G, subadult nymph, 12.VII.2011. H, habitat in Bach Ma N.P., 12.VII.2011.

Discussion

Together with the new taxa described herein, the total number of Necroschiinae in Vietnam now reaches 23 genera and 60 species. The two new genera are closely related and share a number of characters e.g. relatively stout body; subgenital plate in females relatively flat, more or less spoon-shaped with a longitudinal median carina in apical half; eggs with capsule more or less round to oval, capitulum rounded to conical, micropylar plate bearing a mediolongitudinal ridge; no specialised egg laying method with eggs dropped to the ground; males with a distinct, often specialised vomer. These common characters of both genera, also place them close to *Oxyartes* Stål, 1875, *Neohirasea* Rehn, 1904 and a number of genera that were grouped in the tribe Neohiraseini Hennemann & Conle, 2008 by HENNEMANN & CONLE (2008) and HO *et al.* (2014). The latter tribe was originally included in the subfamily Lonchodinae following the generic classification at that time. Based on molecular analysis, BRADLER *et al.* (2014) transferred *Neohirasea* to the subfamily Necroschiinae, which comprises only the tribe Necroschiini. Consequently, the tribe Neohiraseini automatically became a junior synonym of Necroschiini. However, the morphological characters as listed above, as well as the phylogenetic trees provided by BRADLER *et al.* (2014) support a consistent clade within the Necroschiinae which includes the Neohiraseini sensu HENNEMANN & CONLE (2008) + *Oxyartes* and some further closely related taxa (e.g. *Phaenopharos* Kirby, 1904, *Paramenexenus* Redtenbacher, 1908, *Phamartes* Bresseel & Constant, 2013 and *Pseudoparamenexenus* Ho, 2016). Further study integrating molecular data of more taxa, morphological characters of adults and eggs and behavioural data needs to be conducted to assess the relevance of the resurrection of the tribe Neohiraseini within the Necroschiinae.

The presence of rough sensory areas on the prosternum and profurcasternum was considered an autapomorphy of Heteropterygidae by HENNEMANN *et al.* (2016). A similar structure has been observed for the first time in Necroschiinae, in *Pterohirasea* gen. nov. Further examination of putatively closely related genera, e.g. *Neohirasea*, *Andropromachus*, *Spinohirasea* and *Brockphasma* has shown that this character cannot be considered an autapomorphy of Neohiraseini sensu HENNEMANN & CONLE (2008) as it is not present in all genera and can even be present or absent in different species of the same genus as observed in *Neohirasea*. Additional study of those structures appears necessary to clarify their function and their relevance as a taxonomically useful character within Necroschiinae.

The sexual dimorphism in terms of size observed in *Nuichua rabaeyae* sp. nov. with the males being almost 50% shorter than females, is very strong compared to that in *Pterohirasea nigrolineata* sp. nov., with males only about 15% shorter than females. A hypothesis for this sexual dimorphism may be related to sexual selection in connection with the behaviour consisting, for the males reaching adulthood as first, to mate with and keep subadult females. This process may have induced the selection of the fastest growing males, i.e. those reaching maturity with the smallest size. This hypothesis is further supported by the fact that the male remains attached to the same female for all his life.

Acknowledgments

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