



***Paracorethrura* Melichar, 1915 (Hemiptera: Lophopidae): two distinct species or sexual dimorphism in a species?**

Adeline Soulier-Perkins^{a*} & Adam Stroiński^b

^aMuséum national d'Histoire naturelle, Mécanismes adaptatifs et évolution, MECADEV-UMR 7179 MNHN-CNRS, 57 rue Cuvier, CP 50, F-75005 Paris, France; ^bMuseum and Institute of Zoology, Polish Academy of Sciences, 64 Wilcza Street, PL00-679 Warsaw, Poland

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Summary. A taxonomic update is provided for *Paracorethrura* Melichar, 1915. *P. arrhen* n. sp. is described from Vietnam and brings up the number of species to two for the genus: *P. iocnemis* (Jacobi, 1905) being known only by female specimens and *P. arrhen* only by males, CO1 sequences are provided in order to check if they are truly two different species or if we are witnessing some sexual dimorphism.

Résumé. *Paracorethrura* Melichar, 1915 (Hemiptera : Lophopidae) : deux espèces distinctes ou dimorphisme sexuel chez une espèce ? La taxonomie de *Paracorethrura* Melichar, 1915, est mise à jour. *P. arrhen* n. sp. est décrite du Vietnam et amène à deux le nombre d'espèces du genre. *P. iocnemis* (Jacobi, 1905) étant connue seulement par des spécimens femelles et *P. arrhen* uniquement par des males, les séquences CO1 sont fournies afin de vérifier s'il s'agit vraiment de deux espèces ou si nous sommes en présence de dimorphisme sexuel.

<http://zoobank.org/urn:lsid:zoobank.org:pub:6EA0E7F9-E594-44E2-8121-50C6650D2B34>

Keywords: new species; Fulgoromorpha; Vietnam; COI

The monotypic genus *Paracorethrura* Melichar, 1915, belongs to the Lophopidae and is placed in the monophyletic group Sarebasa⁺ (Amorim 1982; Soulier-Perkins 2001). This group is characterised by a pad of microsetae present on the first metathoracic tarsal segment and is represented by 11 genera (Soulier-Perkins & Stroiński 2015; Wang et al. 2016b). It is placed in the Lophopini Stål, 1866. Jacobi (1905) described the type species from a specimen he identified as a male. However, from the illustration on the plate he provided, it is obvious that the specimen illustrated is a female. *Paracorethrura iocnemis* (Jacobi, 1905) is the only described species for the genus and is known from North Vietnam and the province of Guanxi in China (Soulier-Perkins 2000) from females. After examination of all the specimens available in diverse collections, the male remains unknown for this large, colourful and easy to recognise species. Within the last 30 years, specimens with characteristics of the genus were collected in Vietnam, all males with the same colour pattern but completely different from the already known species. The absence of the complementary sex raised the following question: are we witnessing sexual dimorphism or are we observing two distinct species? Sequencing and comparing the mitochondrial gene CO1 was undertaken in order to answer this question.

Material and methods

Material

Labels reported verbatim with square brackets “[]” indicating individual labels separated by commas. Terminology follows Bourgoin (1988, 1993) and Soulier-Perkins (1998, 2001) for male and female genitalia, and Bourgoin et al. (2015) for the forewing venation.

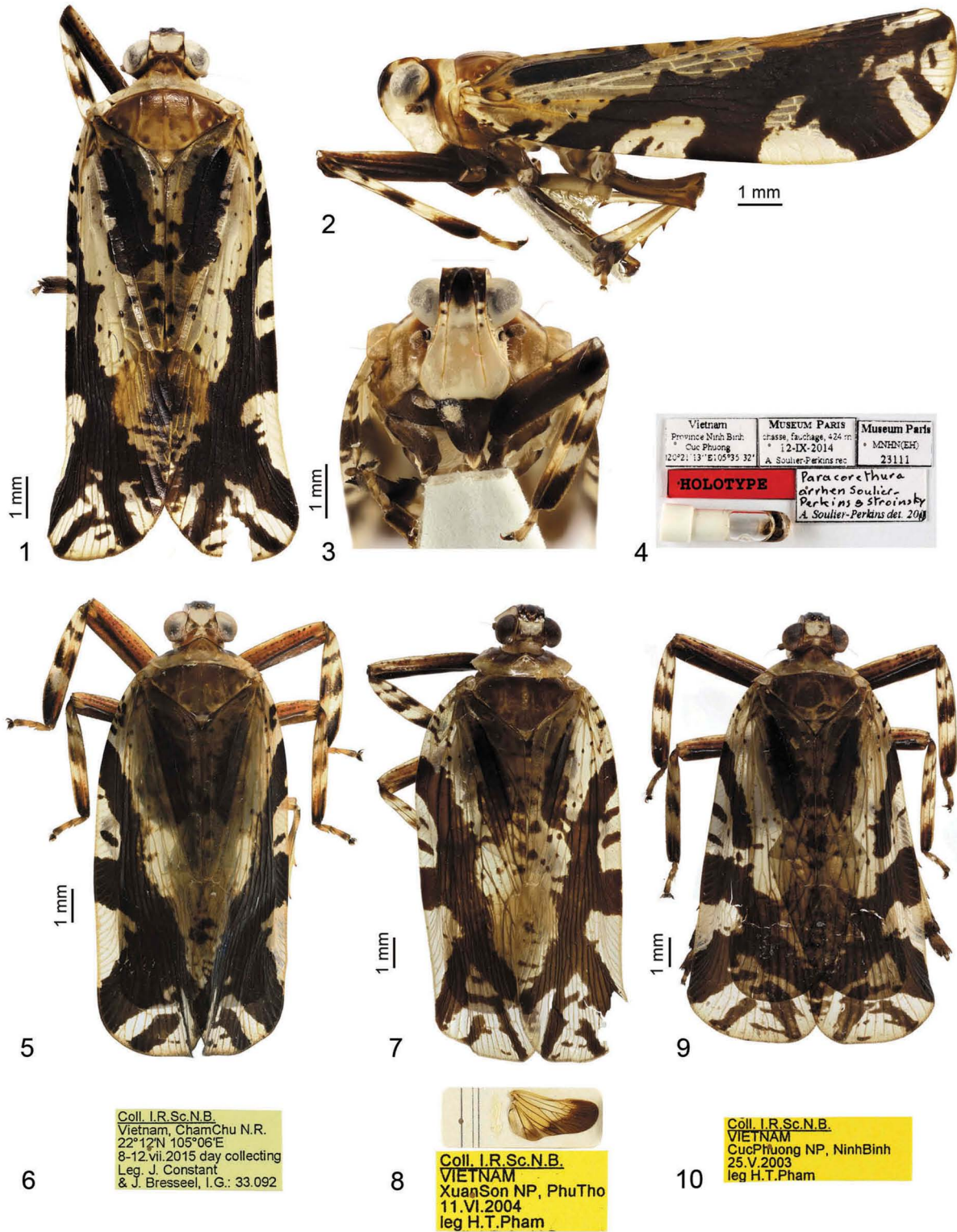
Preparation and observation

The abdomens of each specimen examined were cut off and cleared for 20 min in warm (50°C) 10% KOH. Dissections and cleaning of genital structures were performed in distilled water. Final observations and drawings were made in glycerine, using a camera lucida attached to a microscope. A few drops of blue paragon for dyeing the ectodermic genital ducts were used in order to ease the observation and drawing. This coloration is not permanent. Photos for Figures 1–10 were taken in the MNHN (Paris, France), using a Canon EOS 6D with a Canon lens EB 65 mm (Tokyo, Japan). The camera is motorised and controlled with Helicon remote software and the images were produced using Helicon Focus 5.0 software (<http://www.heliconsoft.com/software-downloads/>). The photos for Figures 11–15 and 31–49 were taken in the MIIZ (Warsaw, Poland), using a Leica MZ 16 stereomicroscope with IC3D digital camera (Wetzlar, Germany); final images were produced using Helicon Focus 5.0 software. The SEM photographs of uncoated specimens for Figures 16–27 were taken

*Corresponding author. Email: adeline.soulier@mnhn.fr

Adeline Soulier-Perkins, urn:lsid:zoobank.org:author:780D689B-DAD3-4115-9C34-97C27B580EB9.

Adam Stroiński, urn:lsid:zoobank.org:author:EB925C2B-94A6-41A7-949E-9CAE10FD5624.

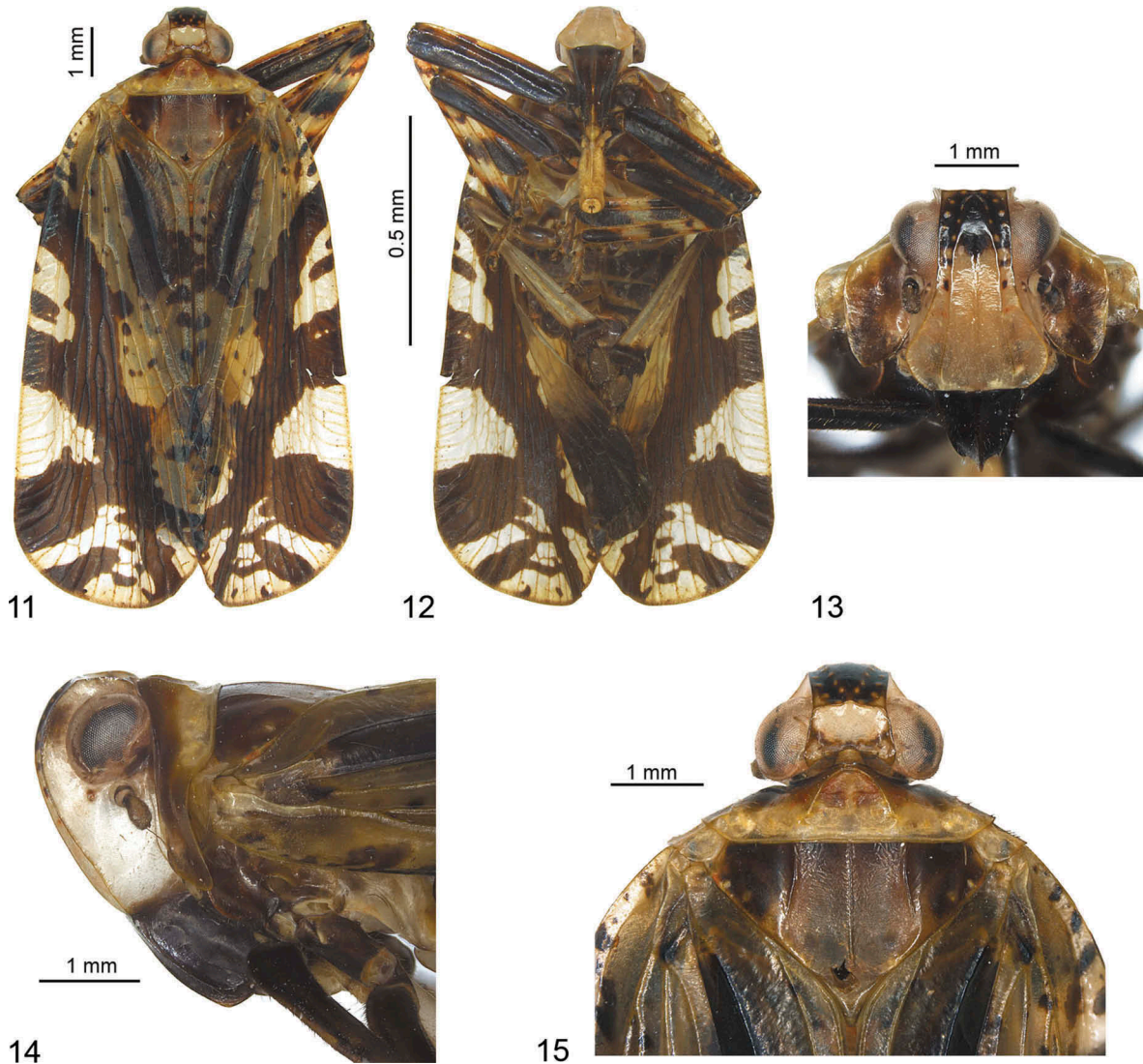


Figures 1–10. *Paracorethura arrhen* n. sp., males. 1–4, Holotype. 5–10, Paratypes. 1, 5, 7, 9, Habitus, dorsal view. 2, Habitus, lateral view. 3, Frons and clypeus, anterior view. 4, 6, 8, 10, Labels.

in the Laboratory of Scanning Microscopy (MIIZ), using a HITACHI S-3400N scanning microscope (Tokyo, Japan) under low vacuum conditions.

Molecular extraction, amplification and sequencing

The whole genomic DNA was extracted from muscle tissue with a DNeasy Tissue kit (Qiagen; Venlo, Netherlands) from two



Figures 11–15. *Paracorethrura arrhen* n. sp., male paratype, Tam Dao. **11**, Dorsal view. **12**, Ventral view. **13**, Frons and clypeus, anterior view. **14**, Anterior part of body, lateral view. **15**, Same, dorsal view.

individuals, the holotype of the new species described here and a female belonging to *P. iocnemis*. A leg from each specimen is used for the extraction. Both specimens (MNHN(EH)23111 and 23136) were collected respectively in Cuc Phong and Tam Dao in north Vietnam in 2014. CO1 was amplified using a mix of different Hemiptera specific primers: LCO1490 puc_t1 and LCO1490 hem1_t1 (forward) and HCO2198 puc_t1, HCO2198 hem1_t1 and HCO2198 hem2_t1 (reverse) (CBGP, INRA Montpellier). The resulting sequences have been assembled using CodonCode aligner version 5.1.4 (CodonCode Corporation 2014) and deposited in GenBank under the registration numbers KY995168 and KY995169.

Abbreviations

IRSNB: Institut Royal des Sciences naturelles de Belgique, Bruxelles, Belgium
 MIIZ: Muzeum i Instytut Zoologii, Warsaw, Poland
 MNHN: Muséum national d’Histoire naturelle, Paris, France

Results

Suborder Auchenorrhyncha Duméril, 1806

Infraorder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Lophopidae Stål, 1866

Subfamily Lophopinae Stål, 1866

Tribe Lophopini Stål, 1866

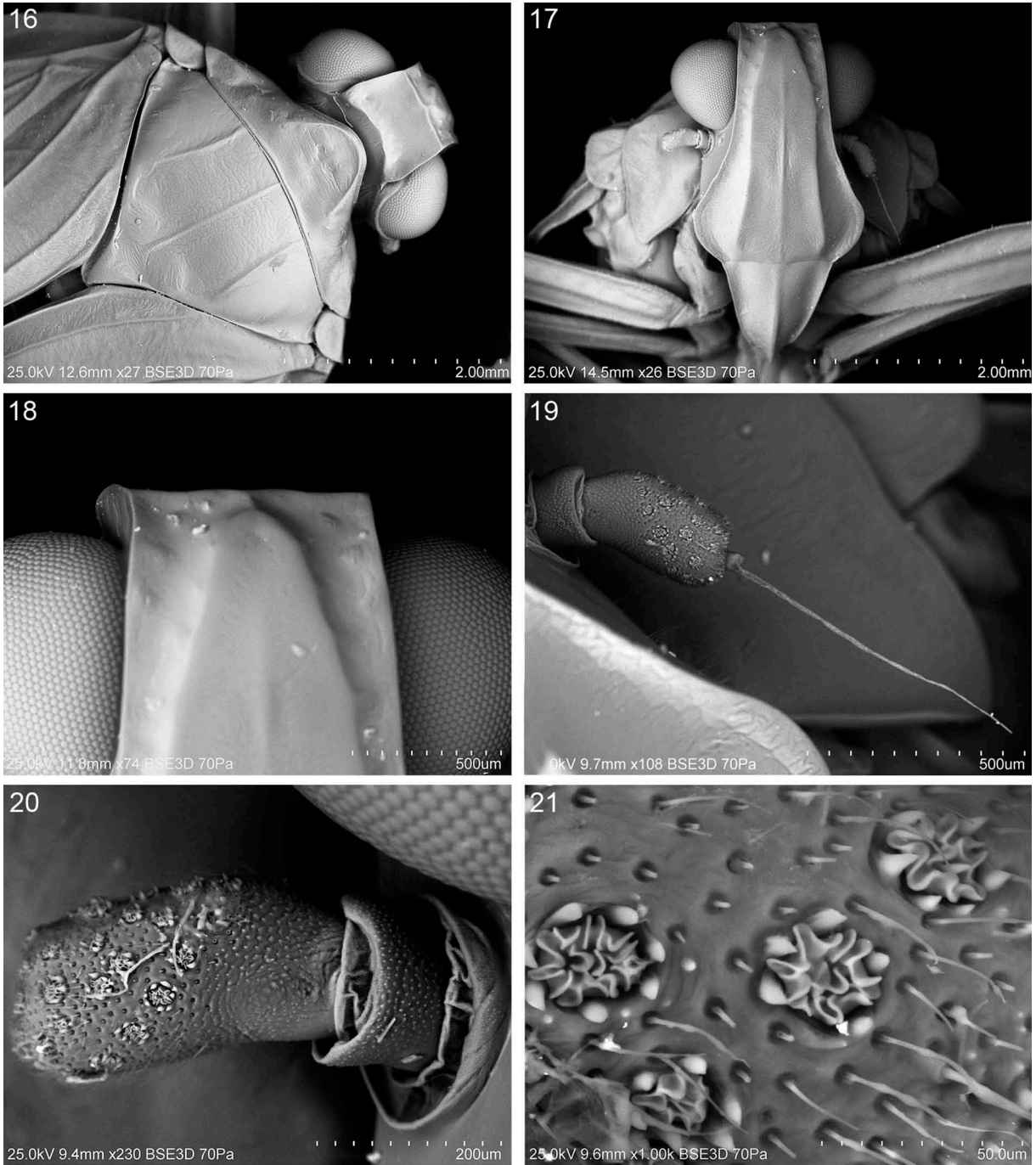
Genus *Paracorethrura* Melichar, 1915

Paracorethrura Melichar 1915: 352.

Type species. *Corethrura iocnemis* Jacobi, 1905, designated by Melichar (1915). Original designation for the genus.

***Paracorethrura arrhen* n. sp. (Figures 1–38, 55)**

Type material. Holotype: ♂, [Vietnam, Province Ninh Binh, Cuc Phong, from Cuc Phong, 20°21’12,7”N, 105°

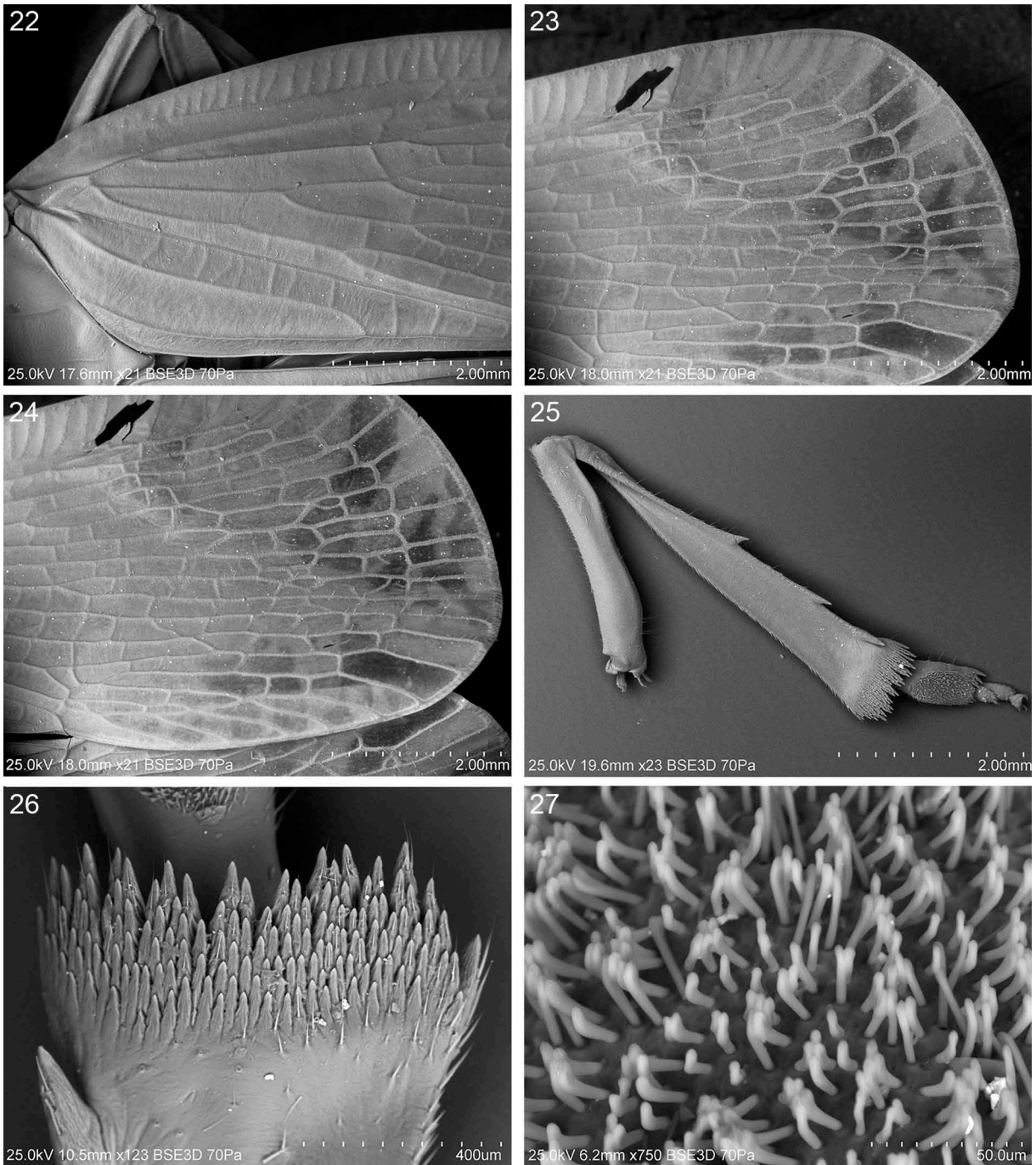


Figures 16–21. *Paracorethrura arrhen* n. sp., male paratype, Tam Dao, SEM photographs. **16**, Anterior part of body, dorsal view. **17**, Head, anterior view. **18**, Upper part of frons, anterior view. **19–20**, Antenna, frontal view. **21**, Antennal plate organs.

35°32'E], [Museum Paris, chasse, fauchage, 424 m, 12. IX.2014, A. Soulier-Perkins rec], [Museum Paris, MNHN (EH) 23111] – deposited in MNHN.

Paratypes: 12 ♂: [Vietnam, Tam Dao Mts., VI.1991, V. Novotny], [386 SP], [for 91/tr], [Museum Paris, MNHN(EH) 19242] – 1 ex. MNHN; [Vietnam, Tam Dao

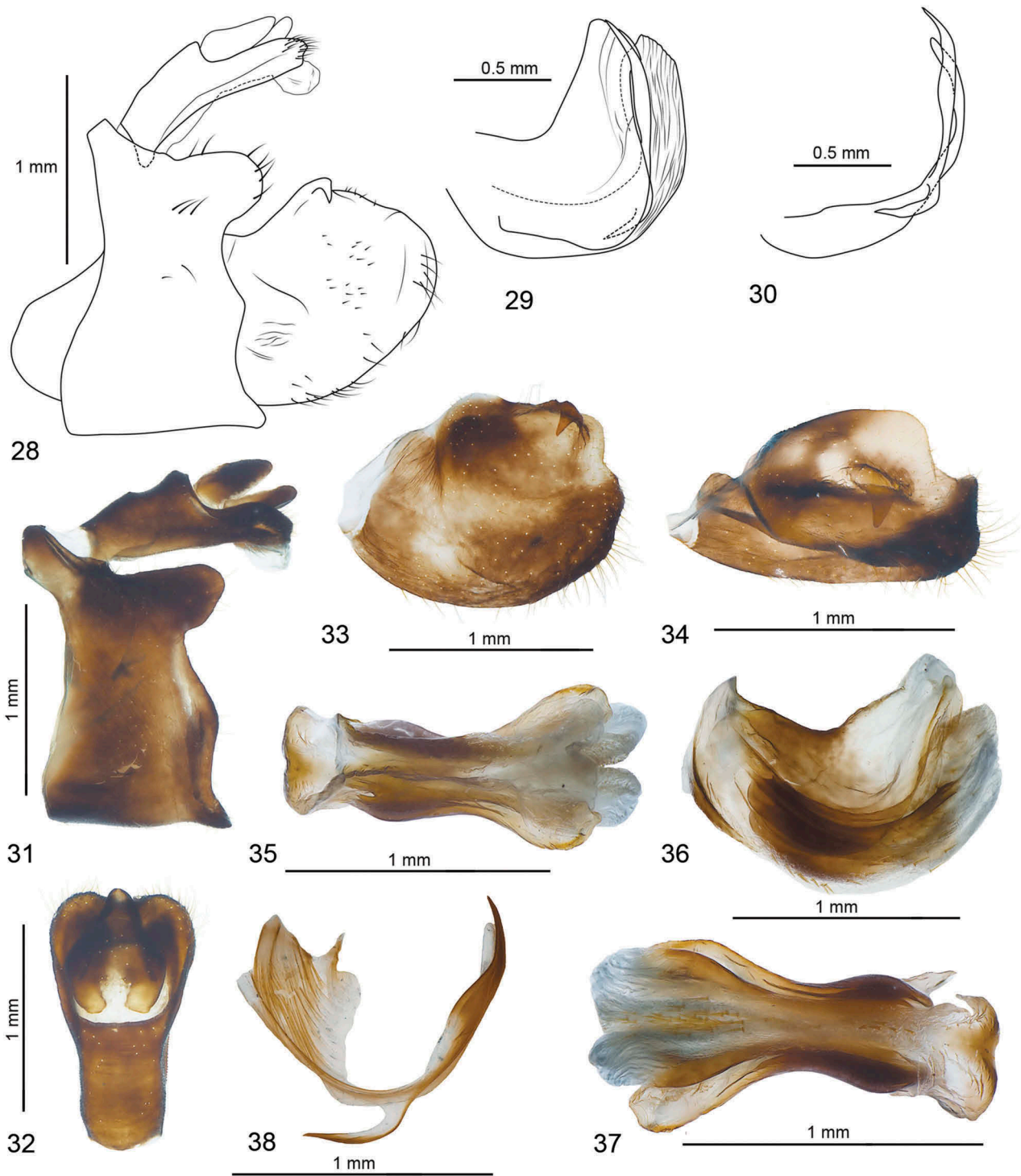
Mts., VI.1991, V. Novotny], [386 SP], [for 91/tr], [Museum Paris] – 2 ex. MNHN; [Vietnam, Tam Dao Mts., 10.VIII–5.IX.1993, V. Novotny], [GS4], [GS33] – 1 ex. MNHN; [Vietnam: Tam Dao National Parc, prov. Vinh Phu, 06–08.VI.2000, leg. A. Stroiński and P. Węgrzynowicz] – 2 ex MIIZ; [Coll. I.R.Sc.N.B., C.



Figures 22–27. *Paracorethrura arrhen* n. sp., male paratype, Tam Dao, SEM photographs. **22**, Tegmen, basal part. **23–24**, Same, apical part. **25**, Hind leg, ventral view. **26**, Hind tibia, apical part, ventral view. **27**, Club-like setae on the first segment of tarsus, ventral view.

Vietnam, Tam Dao N.P., 21°31'N 105°23'E, 25–30.VII.2011, Malaise trap, leg. J. Constant & J. Bresseel, I. G.:31.933, GTI project] – 1 ex. IRSNB; [Coll. I.R.Sc.N.B., Vietnam, Tam Dao N. P., 25–30.VII.2011, day collecting, leg. J. Constant & J. Bresseel, I. G.: 31.933] – 2 ex IRSNB; [Coll. I.R.Sc.N.B., Vietnam, Cuc Phong NP, Ninh

Binh, 25.V.2003, leg. H.T. Pham] – 1 ex. IRSNB; [Coll. I. R.Sc.N.B., Vietnam, Xuan Son NP, Phu Tho, 11.VI.2004, leg. H.T. Pham] – 1ex. IRSNB; [Coll. I.R.Sc.N.B., Vietnam, Cham Chu N.R., 22°12'N 105°06'E, 8–12.VII.2015 day collecting, leg. J. Constant & J. Bresseel, I.G.: 33.092] – 1 ex. IRSNB.



Figures 28–38. *Paracorethrura arrhen* n. sp., male. 28–30, Holotype. 31–38, Paratype, Tam Dao. 28, 31, Terminalia, lateral view. 29, 36, Perianthrium, lateral view. 30, 38, Aedeagus, lateral view. 32, Anal tube, dorsal view. 33, Gonostylus, lateral view. 34, Same, dorsal view. 35, Perianthrium dorsal view. 37, Same, ventral view.

Etymology. The species here described is known only by male specimens and *arrhen*, in Greek, means male. The genus name *Paracorethrura* finds its origin in the Greek *korethron* meaning cleaning device, broom and *oura*

meaning tail of an animal; the genus name is then feminine, which is why we place the name *arrhen* in apposition.

Diagnosis. Pro and mesothoracic femora almost black; red for *P. iocnemis*.

Description. Head with compound eyes narrower than prothorax. Vertex in dorsal view, trapezoid, wider than long, all margins carinate with the lateral ones elevated, discal vertex flat without any median carina (Figures 1, 16). Frons tulip shaped, lateral margin with continuous carinate, three carinate with short common stem reaching the upper margin (Figure 18). Median frontal disc of frons relatively flat, carinae almost reaching the fronto-clypeal suture, which is straight. Postclypeus with median carina keel shaped and lateral carinae elevated (Figures 3, 17). In lateral view, rounded compound eye with posteroventral callus (Figure 2), ocellus present, ocellar and genal carinae absent, base of antenna clearly separated from base of eye. Small elevation of lateral frontal carina visible on lateral view. Pedicel of antenna bearing plate organs, which are absent on the first basal third and up to a second third on the ventral part (Figures 19, 20). Sensory plates organs multi-petal shaped and surrounded by strong denticules (Figure 21). Trichoid sensilla of type 1 present. Rostrum reaching level of metathoracic coxa, apical segment clearly shorter than sub-apical.

Thorax. Pronotum longer than vertex in midline, median disc largely rounded anteriorly, bearing two carinae joining anteriorly before the limit of anterior margin of pronotum and not reaching posterior margin, which is straight. Lateral part of pronotum without any carina (Figure 16). Mesonotum triangular shaped and bearing three parallel carinae, median carina almost reaching the scutellum, lateral carinae present only in the posterior part. In lateral view, vertex, pro and mesonotum almost at same level (Figure 2). Pro and mesothoracic legs slightly flattened, with femur rectangular shaped, femur and tibia of same length (Figures 2, 3). Metathoracic legs with tibia clearly longer than femur, tibia widening apicad with numerous small apical teeth and bearing three lateral spines (Figures 25, 26). First metathoracic tarsal segment longer than second and third segments together, bearing a pad of microsetae typical of *Sarebasa*⁺ (Amorim 1982). Microsetae club shaped (Figure 27).

Female unknown

Male terminalia. Pygofer on lateral view with anterior margin cut out in its median part, dorsal margin higher anteriorly than posteriorly, posterior margin protruding posteriorly on its upper part, rounded in its middle and with a small protrusion basally (Figures 28, 31). Anal tube, in lateral view, extending beyond posterior margin

of pygofer with a small membranous lobe at the apex, in dorsal view median part of posterior margin concave (Figure 32). Gonostyli, in lateral view rounded with a hook shaped process on the posterodorsal area (Figure 34), below the dorsal margin (Figures 28, 33). Periandrium, bearing setae ventrally (Figure 37), regularly rounded ventrally and gently cut on its dorsal margin, without any special extension (Figures 35, 36). Aedeagus with ventral anterior process curved anteriorly, ventral posterior process distinctly longer and oriented dorsally (Figures 30, 38). For some specimens the ventral anterior process can be a little longer than drawn for the holotype.

Coloration. Vertex whitish with brownish patch along the posterior margin, frons yellowish with black upper part punctuated with yellow dots. Postclypeus black. Rostrum yellowish. Lateral part of head whitish except for a brown patch between compound eyes and anterior margin. Pronotum with anterior part brown to dark brown and posteriorly dark yellow. Mesonotum brown, tegulae yellowish. Tegminae hyaline with large area dark brown, two main brown lines, one on clavus between Cua and PCu and the second starting on anterior costal margin and reaching the claval suture. From second line, one brown patch extends to middle of costal margin and a second to apex of costal margin, irregular patches extends to posterior margin. Some variations in the pattern can be observed as shown on Figures 5, 7, 9, 11 and 12. Pro and mesothoracic femora black with a lighter anterior margin, pro and mesothoracic tibiae yellowish with four black bands, with biggest black patch at apex. Metathoracic femora brown, tibiae whitish with apex dark brown, small teeth dark brown. Tarsal segment brownish. Tergites and sternites brown with small yellow dots located mostly on lateral part, last two sternites with yellow band along the posterior margins. Genital capsule dark brown, ventral part of pygofer yellowish except for a narrow dark brown stripe along the posterior margin.

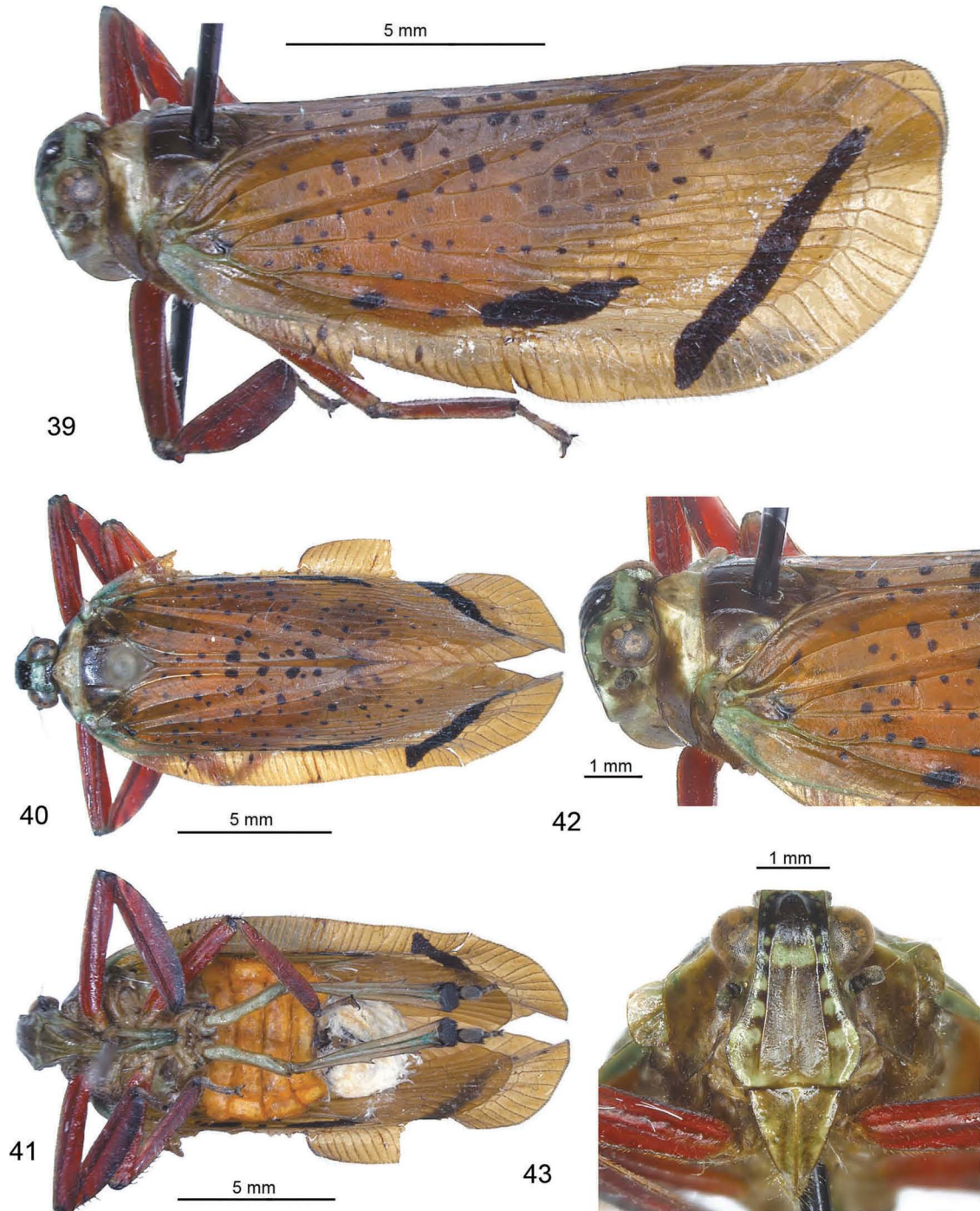
Molecular data. 658 base pairs of CO1 sequence were obtained from the individual, MNHN(EH)23111. The sequence is the following:

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AAATAAGTGTTGGTAAAGGATAGGGTCCCCCCTC
CTGATGGATCAAAGAATGATGTATTAATAATTCGAT
CTATTAATAATATTGTAATTGCTCCAGCTAATACTGG
TAAAGATACAAGAAGAAGAATTGCAGTAATTAGAA
CTGATCAGCAGAATAGGGGTAATTTTTCTATTGATA
TTTTCATTTGCTCGCATATTTATGATTGTTGAAATAAA
ATTGATTGCCCTAAGATTGAACTAACTCCTGCAAT
ATGTAAGGAGAAGATTGTTAAGTCCACTGATGGAC
CTGAGTGGGCAGTTTGTCTTGACAAGGGTGGGTAA
ACTGTTTCAGCCAGTCCCTGAACCACTACCTGCTATT
GATCTCGAAATTAATAGTGAGATTGATATGGGCAGT
AATCAAAATCTTATATTATTTATTCGTGGAAATGCTA
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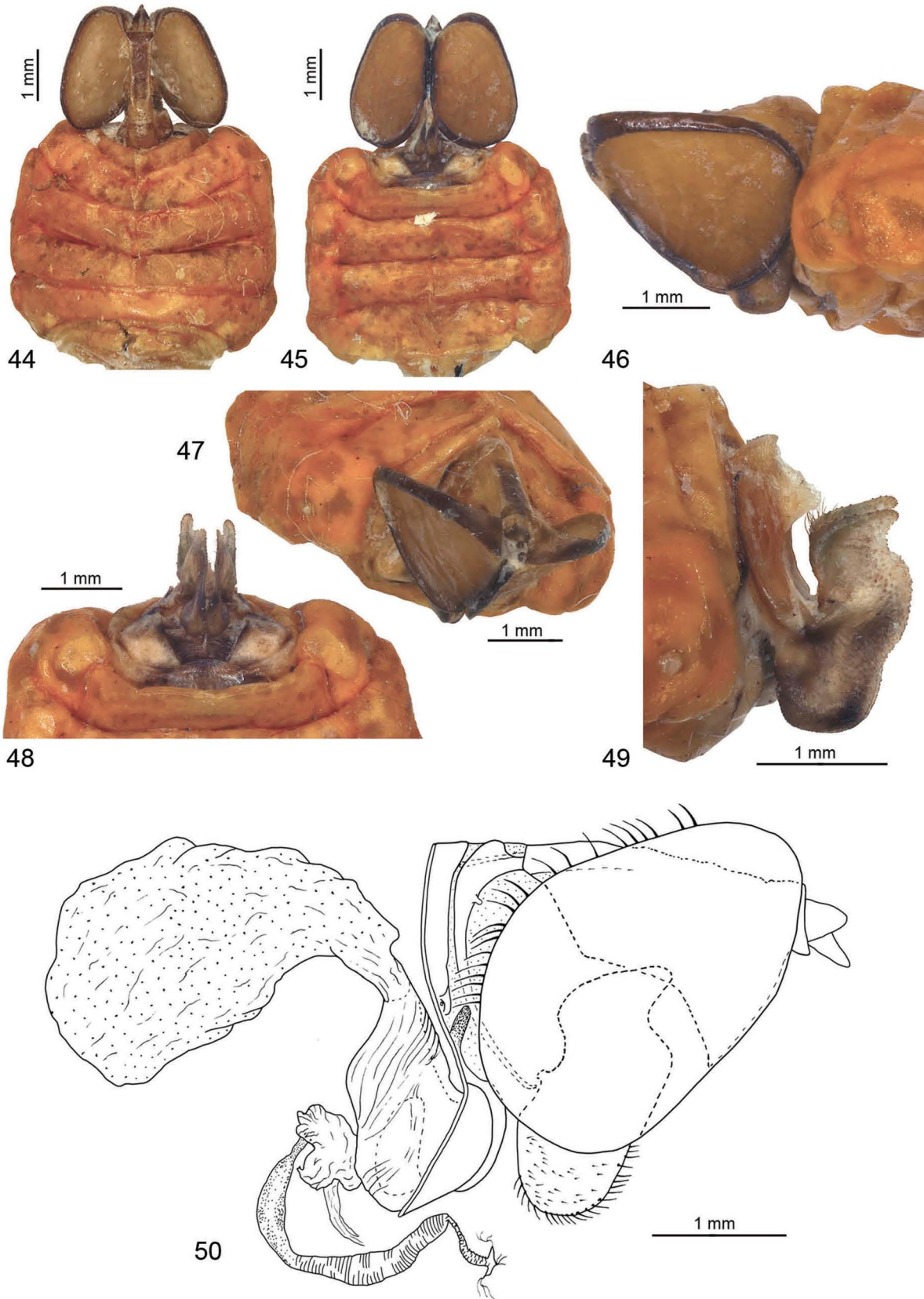

TATCTGGTGCTCCGATTATTAGGGGTACTAATCAATT
TCCAAATCCTCCAATTATAATTGGTATAATTATAAAA
AAAATTATAATAAATGCATGTGATGTTACTACTACG
TTATAGATTTGATCATTGATTATTGATCCCGGTT
GGGACAATTCTATACGGATAATTATTCTTAAAAATA

TTCCTATTATTCTGATCAAATACCAATAATGAAGT
ATAAGGAT

Distribution. Figure 55. Vietnam: Province Ninh Binh, Phú Thọ, Tuyên Quang, Vĩnh Phúc.



Figures 39–43. *Paracorethrura iocnemis* (Jacobi, 1905), female. 39, Dorsolateral view. 40, Dorsal view. 41, Ventral view. 42, Anterior part of body, dorsolateral view. 43, Head, anterior view.



Figures 44–50. *Paracorethrura iocnemis* (Jacobi, 1905). 44, Abdomen and terminalia, dorsal view. 45, Same, ventral view. 46, Terminalia, lateral view. 47, Same, posterodorsal view. 48, Genital structures (anal tube removed), ventral view. 49, Same, lateral view. 50, Terminalia and internal genital structures, lateral view.

Paracorethrura iocnemis (Jacobi, 1905)

(Figures 39–54)

Corethrura iocnemis Jacobi, 1905: 437.

Additional material examined. [Museum Paris, Tonkin N., Rég. Ha-Giang, Siebené Olivier 1916], [*Paracorethrura iocnemis* (Jacobi, 1905), det. A. Soulier-Perkins 1998] – 2 ex. MNHN; [Vietnam, Tam Dao Mts., 10. VIII–5.IX.1993, V. Novotny], [GS4], [GS18], [*Paracorethrura iocnemis* (Jacobi, 1905), det. A. Soulier-Perkins 1998] – 2 ex. MNHN; [Vietnam, Tam Dao Mts., VI.1991, V. Novotny], [386 SP], [B7], [Museum Paris,

MNHN(EH) 19239] – 1 ex MNHN; [Vietnam N. Vinh Phu prov. Tam Dao Mts., 950m, 5.VI–8.VII.1991, V. Novotny & M. Tonner lgt.], [for 91], [346 SP], [*Paracorethrura iocnemis* (Jacobi, 1905), det. A. Soulier-Perkins 1998] – 1 ex. MNHN; [Vietnam: Tam Dao National Parc, prov. Vinh Phu, 06–08.VI.2000, leg. A. Stroiński and P. Węgrzynowicz] – 2 ex MIIZ; [Vietnam, Province Vinh Phuc, Tam Dao, 21°26'43"N 105°37'07"E], [Museum Paris, chasse, 450–600 m, 21.IX.2014, Th. Bourgoin rec.], [*Paracorethrura iocnemis* (Jacobi, 1905), A. Soulier-Perkins det. 2015] – 1 ex. MNHN; [Vietnam, Province Vinh Phuc, Tam Dao, 21.IX.2014, A. Soulier-Perkins rec.], [Museum



Figures 51–54. *Paracorethrura iocnemis* (Jacobi, 1905). Live specimens.

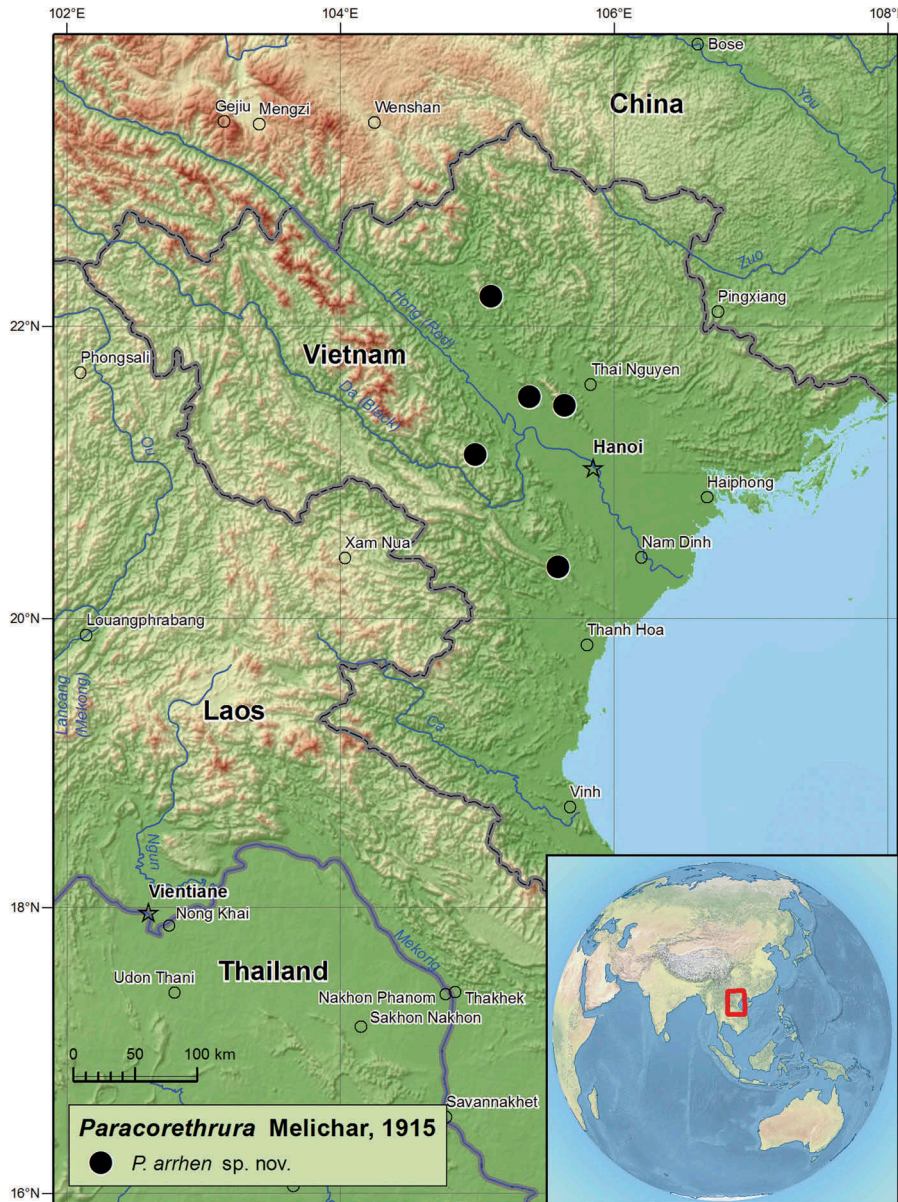


Figure 55. Distribution map of *Paracorethrura arrhen* n. sp.

Paris, MNHN(EH)23136], [*Paracorethrura iocnemis* (Jacobi, 1905), A. Soulier-Perkins det. 2016] – 1 ex. MNHN.

Complement to the original description. Female terminalia (Figure 50). Seventh abdominal segment with middle posterior margin straight. Anal tube bearing apically two large lobes oriented posteriorly and developed dorsoventrally. Dorsal margin of anal tube before anus long in comparison to the length between the anus and the lobes. Bursa copulatrix with a single pouch and without cells, only some small ornamentations. Spermatheca developed with ductus receptaculi and diverticulum ductus of a same length. As for all Lophopidae, gonospiculum absent.

Male unknown

Coloration. Head with a dominant colour of yellowish-light brown or greenish. Vertex yellowish or green with brownish patch along the posterior margin. Frons yellowish or green with brown or black patches, one patch located in the quarter upper part, the second and larger patch located in the lowest two-thirds, stretching from the median area to the lateral margins. Postclypeus and rostrum yellowish or greenish. Lateral part of head yellow-brownish or green, darker next to the ocellus. Pronotum and mesonotum yellowish, getting darker toward their anterior margins. The individuals presenting a green

colour on the head present as well some greenish coloration on the pronotum. Tegulae pale yellow. Tegminae yellow spotted with small brown dots distributed on the anterior two-thirds and between the postclaval margin and the costal area. Two additional brown stripes are present, the first located parallel to the costal margin and the second and longest in the apical third, transverse in the radial and median areas. Pro and mesothoracic femora and tibiae red. Metathoracic femora and tibiae yellowish-brown, small teeth at apex of tibiae dark brown. Tarsal segment brownish. Abdomen yellowish. Genitalia yellowish underlined with brown. A light-coloured powder is generally distributed along the costal margins of tegminae and ascends toward the anterior margin of pronotum. This powder tends to disappear on the old specimens kept in collection.

Molecular data. 658 base pairs of CO1 sequence were obtained from the individual, MNHN(EH)23136. The sequence is the following:

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AAATAAATGTTGATATAAGATGGGGTCTCCCCC
CTGATGGGTCAAAAATGATGTATTAATAATTACGA
TCTATGATTAGTATTGTAATAGCACCTGCTAGAAC
GGTAATGAGAGTAGAAGTAATATTGCAGTAATTA
ACTGACCAACAAAATAATGGGGTAGATTCTAGGGT
TATTCCTTTAGTTCGTATATTTATAATGGTTGAA
AAGTTAATTGCTCCTAAGATAGATCTAATTCCTG
CAATGTGAAGGGAAAAATAGTAAGGTCAACAGAG
GCCCTGAATGAGCGGGTTGACTAGATAATGGGGG
TAAACTGTTCAACCTGTCCCTGTTCTGATCCTGT
ATTGAACTAGATATTAAGAGTGAGATTGATATTG
AGTAGTCAAATCTTATATTGTTTATTCGGGGGA
GCTATATCTGGTGCTCCAATCATAATAGGAATA
CAGTTTCCAAAGCCTCCAATAAGGATTGGCATTG
ATAAAGAAGATTATTATAAATGCATGGGAAGTT
ATGGTATTATAAATTTGGTCGTTTTTAATTAGGT
CTGGTTGAATTAATTCTATACGGATAATTATTCT
GGAGGTTCCAATAATTCCTGATCAAAATCCGAATA
GAAATATAGAGTA
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Distribution. Vietnam: North Vietnam.

Discussion

Little information is available on the genetic distance for the Fulgoromorpha (Soulier-Perkins et al. 2015), but depending on the groups the genetic distance expected for an intra- or interspecific variation can be different. Gopurenko et al. (2013) had 11 families of Auchenorrhyncha represented in their samples and they mentioned an average distance within morphospecies of 0.31%, with a maximum of 4.66% and a distance between nearest neighbour species ranging from 7.20% to 20.87%. Bressan et al. (2009) mentioned for *Pentastiridius*

Kirschbaum, 1868 (Cixiidae) a genetic distance of 0.2% for intraspecific variation that reaches 7.8% for the interspecific DNA divergence. Picciau et al. (2016) mentioned a distance of 9.99% between two Lebanon species of *Cixius* Latreille, 1804 (Cixiidae). Gitau et al. (2011) observed for *Zophiuma* Fennah, 1955 (Lophopidae) a maximum p-distance within *Z. butawengi* (Heller, 1966) of 0.7 and 4.3% within *Z. pupillata* (Stål, 1863). The minimum p-distance between the two species is 14.8%. Here the p-distance between *P. arrhen* n. sp. and *P. iocnemis* is 23.4% (70 transitions and 84 transversions). In the light of that information we have to conclude that *P. arrhen* and *P. iocnemis* are two different species. However, a mystery remains, as for *P. arrhen* only males are known, whereas for *P. iocnemis* only females were ever collected. We checked all the specimens available from all the collections in which we found them. We looked for them in the field in Vietnam and never found any male matching the description of *P. iocnemis* or females corresponding to the coloration and description of *P. arrhen*. This is why, at first, we hypothesised that some kind of sexual dimorphism could be at work within *Paracorethrura*. However, sexual dimorphism is not often reported for the Lophopidae. The most obvious case is *Zophiuma butawengi*, for which the large bright red coloured female can easily be recognized from the smaller and tawny male, both well illustrated in Gitau et al. (2011). Within the lophopid genera, the species are generally distinguished from each other by the morphological characters observed on the male terminalia. It can even become difficult sometimes to attribute female specimens to species, when they are sympatric. However, some discrete characters can sometimes be observed on the VII abdominal segment (Wang et al. 2016a) when confronted with such a dilemma.

Acknowledgements

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