

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/333207824>

Review of the Philomidinae Ruschka (Hymenoptera: Chalcidoidea: Perilampidae), with description of three new species

Article in *Arthropod Systematics and Phylogeny* · June 2019

DOI: 10.26049/ASPT77-1-2019-03

CITATIONS

11

READS

854

3 authors:



John M. Heraty

University of California, Riverside

178 PUBLICATIONS 4,148 CITATIONS

SEE PROFILE



Hossein Ali Derafshan

University of Zabol

9 PUBLICATIONS 69 CITATIONS

SEE PROFILE



Mostafa Ghafouri Moghaddam

Chulalongkorn University

52 PUBLICATIONS 202 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



Chalcids 101 - Outreach Program for High School Students [View project](#)



Taxonomy of selected families of the parasitic wasps (Hymenoptera) from Iran [View project](#)

Review of the Philomidinae Ruschka (Hymenoptera: Chalcidoidea: Perilampidae), with description of three new species

JOHN M. HERATY^{*,1}, HOSSEIN ALI DERAFFSHAN² & MOSTAFA GHAFOURI MOGHADDAM²

¹ Department of Entomology, University of California, Riverside, CA, USA; John M. Heraty [john.heraty@ucr.edu] — ² Department of Plant Protection, College of Agriculture, University of Zabol, Zabol, P.O. Box: 98615–538, I. R. Iran — * Corresponding author

Accepted on February 02, 2019.

Published online at www.senckenberg.de/arthropod-systematics on May 17, 2019.

Published in print on June 03, 2019.

Editors in charge: Christian Schmidt & Klaus-Dieter Klass.

Abstract. The subfamily Philomidinae is an odd group of Chalcidoidea currently placed in Perilampidae, although their bizarre morphology has suggested placement in a variety of other chalcidoid families. The genera of Philomidinae are reviewed, and a phylogenetic hypothesis proposed using an analysis of 22 morphological characters. Based on these results, a new genus is proposed, *Vidlinus* **n.gen.**, with two resulting new combinations, *Vidlinus abercornensis* (Risbec) **n.comb.** and *Vidlinus metallicus* (Risbec) **n.comb.** Three new species are described, *Aperilampus rabeharisoae* Heraty, **n.sp.** (Madagascar), *Philomides hamooniae* Heraty, Derafshan, & Ghafouri Moghaddam **n.sp.** (Iran), and *Philomides lasallei* Heraty, **n.sp.** (Madagascar). *Chalcura niayensis* Risbec, 1957, is transferred to *Aperilampus* **n.comb.** An identification key and catalog to the known species of Philomidinae is provided. The first record of *Philomides* potentially ovipositing onto flowerbuds of *Solanum* is recorded.

Key words. Philomidinae, Perilampidae, parasitoid, phylogeny, Halictidae.

1. Introduction

Chalcidoidea are quite likely one of the most diverse insect superfamilies, with 23 extant families and more than 500,000 estimated species (HERATY et al. 2013). More recent phylogenetic analyses of the group have not yet resolved a strong phylogenetic backbone across the phylogeny of the superfamily (HERATY et al. 2013; MUNRO et al. 2011; PETERS et al. 2018), and many of the family group relationships will need to be revisited as more complete data become available.

Philomidinae is a rarely collected and morphologically odd group of chalcidoid wasps. Two genera have been recognized, *Philomides* Haliday, 1862 and *Aperilampus* Walker, 1871. Based on the results of this study, we create a new genus for two of these described species, *Philomides metallicus* Risbec and *Philomides abercornensis* Risbec in Africa. Beyond a key to the species of *Philomides* provided by RISBEC (1953), no revision of the group has been undertaken. It is likely that numerous species remain to be discovered, however the number of

specimens is meager, which makes it difficult to examine variation across the proposed species. Notably, at least some of the four species currently in *Aperilampus* may be color variants of the same species.

Philomides were first placed in Perilampidae (as Perilampini) by HALIDAY (1862), which was followed by WESTWOOD (1874), ASHMEAD (1904), RUSCHKA (1924), and PECK et al. (1956). DALLA TORRE (1898) treated them as Eucharitidae (as Eucharitidinae), which was followed by BOUČEK (1978, 1988) and GIBSON et al. (1999). DARLING (1992) was the first to review the phylogenetic placement of Philomidinae as based on morphological evidence from both adults and larvae, with a focus on the newly discovered planidial larvae of *Aperilampus varians* Strand. He proposed that Philomidinae are nested within the perilampid-eucharitid clade between Chrysolampinae and Perilampinae, although he did not make a firm recommendation on their family level placement. In an analysis of ribosomal data, MUNRO et al. (2011) had

variable results for the placement of Philomidinae, but treated them as Perilampidae. In the combined molecular and morphological analysis of HERATY et al. (2013), Philomidinae were treated as Perilampidae, which was resolved as a paraphyletic family with Philomidinae sister to Perilampidae + Eucharitidae, similar to the results of DARLING (1992). It is clear that Philomidinae are part of a planidial-larva clade that includes Perilampidae, Eucharitidae and Eutrichosomatinae (Pteromalidae) (HERATY et al. 2013). As relationships become resolved with new and ongoing molecular and morphological studies, we may be able to better define the higher level relationships within this planidial-larva clade.

Molecular analyses that included Philomidinae (MUNRO et al. 2011; HERATY et al. 2013) dealt with three species: *Aperilampus* sp. D0900 (= *A. rabeharisoae* **n.sp.**), *Philomides* sp. D1269 (= *P. lasallei* **n.sp.**) and Philomidinae **n.gen.** D0903 (= *Vidlinus metallicus* (Risbec) **n.gen.** and **n.comb.**). MUNRO et al. (2011) supported *Philomides* as sister to *Aperilampus* + *Vidlinus*. When combined morphological and molecular data were used (HERATY et al. 2013), *Vidlinus* were sister to (*Philomides* + *Aperilampus*). Other than their monophyly and placement within the planidial-larva clade, relationships among genera remain poorly resolved.

Life history information for Philomidinae is limited. DARLING (1992) reported that the first-instar planidial larva of *Aperilampus varians* Strand is a parasitoid of the pupa of *Halictus africanus* Friese (Halictidae). *Philomides* and *Vidlinus* likely are also parasitoids of ground-nesting bees. From web-based images, we were able to discover two separate records of *Philomides* apparently ovipositing into flowerbuds of *Solanum* (Solanaceae).

Herein we take the opportunity to propose a phylogenetic hypothesis for the subfamily based on morphological data, describe three new species of *Aperilampus* and *Philomides*, and provide an identification key to the known species.

2. Materials and methods

Morphology and its documentation. Morphological terms follow HERATY et al. (2013) and BURKS et al. (2015). All terms were verified using the Hymenoptera Anatomy Ontology (<http://portal.hymao.org/>) when they are represented in that resource. Following EADY (1968), the sculpture of the mesosoma in *Philomides* is referred to as punctate with hairs (each puncture with its own central seta), with cases of fine or coarse parallel ridges as strigose, striate or strigate, respectively. Color may fade in ethanol; however, the slight yellowish brown color in the mounted specimens after DNA extraction and drying using hexamethyldisilazane (HERATY & HAWKS 1998) is similar to that of the specimen after initial preservation in ethanol. Morphological structures discussed herein were compared across several species of *Philomides* and *Aperilampus*, including a series of scanning electron mi-

crographs of *Aperilampus discolor*. Photographs presented herein were taken using a Leica Imaging System with a Z16 APO A microscope and stacked using Zerene Stacker (version 1.04, © Zerene Systems, LLC), or using the Philips FEI XL30-FEG Scanning Electron Microscope, and then optimized in Photoshop CS4. A map with the distribution of all recorded species was generated using SimpleMappr (SHORTHOUSE 2010). Holotypes for new species are deposited in the Entomology Research Museum, University of California, Riverside, CA (UCRC) and the California Academy of Sciences, San Francisco, CA (CAS). Additional material was examined from the Museum Zoologicum Bogoriense, Cibinong, Indonesia (MBBJ), the Iziko Museum of South Africa, Cape Town, South Africa (SAMC) and the ICAR-National Bureau of Agricultural Insect Resources, Bangalore, India (NBAIR). Specimens examined were given unique specimen identification numbers prefaced by UCRCENT and indicating the museum of deposition on the plasticized label. Images of types listed in the catalog as “image examined” are available at Figshare (<https://figshare.com/s/67356f2595ce91f36db5>).

Abbreviations: **acs** = antecostal sulcus; **acst** = acrosternum; **aed** = aedeagus; **anl** = anellus; **ax** = axilla; **axls** = axillular sulcus; **clv** = clava; **cly** = clypeus; **cal** = callus; **cer** = cercus; **ex** = coxa; **dig** = digitus; **dor scp** = dorsal scape; **Fu₇** = funicular 7; **Fu₉** = funicular 9; **Gs** = gastral sternum; **Gt** = gastral tergum; **lbr** = labrum; **llm** = lateral lobe of mesoscutum; **lpp** = lateral projection on petiole; **mem** = membrane; **mml** = middle lobe of mesoscutum; **mts** = mesoscutellum; **mv** = marginal vein; **no₁** = pronotum; **no₃** = metanotum; **not** = notaulus; **par** = paramere; **pet** = petiole; **pl₁** = propleuron; **pl₃** = metepisternum; **pmv** = postmarginal vein; **pre** = prepectus; **prm** = paramere; **prp** = propodeum; **psa** = parascrobal area; **psl** = parapsidal line; **ptl** = petiole; **ptla** = petiolar lamina; **rma** = raised medial area of Gt₁; **s₁** = probasisternum; **sal** = sub-antennal line; **smv** = submarginal vein; **sp** = spiracular opening; **sss** = scutoscuteellar sulcus; **tgl** = tegula; **unc** = uncus; **ven scp** = ventral scape; **vte** = vertexal carina; **?** = possible process of third axillary sclerite.

Phylogenetic analysis. We scored 22 characters for four Philomidinae and two outgroup genera, *Eutrichosoma mirabile* Ashmead (Pteromalidae: Eutrichosomatinae) and *Chrysomalla hesperis* Darling (Perilampidae: Chrysolampinae) (section 3.1. and Table 1). While the outgroup sampling is limited, it is representative of the placement of Philomidinae in our recent molecular analyses, which further treat Chrysolampinae and Philomidinae as sister groups, and HERATY et al. (2013). Notably, all included genera have the petiole unfused (membranous) ventrally, and possess paired posterior petiolar lamina that extend over the first gastral sternum (character/character states 207-0 and 208-1 in HERATY et al. 2013), both conditions that are likely plesiomorphic within the planidial clade. Similarly, all have an enlarged elliptical propodeal spiracle, which is also likely plesiomorphic. The selection of characters is focused on defining features of importance within Philomidinae that are considered relevant across Chalcidoidea, and often ignoring the plethora of other characters that can be used to distinguish the subfamily or included genera. The matrix was analyzed using par-

simony in PAUP 4.0a (test version) using 100 random starting trees. Characters were mapped using MacClade v.4 (MADDISON & MADDISON 2011).

3. Results

3.1. Character list

1. Facial setae: **(0)** fine or spatulate relatively sparse setae (Figs. 2, 3, 11, 24); **(1)** thick dense setae (Figs. 30, 36). — State 1 refers to the dense, thickened setae as they occur on the face of *Vidlinus* (Figs. 30, 36). State 0 is variable, with most species having fine relatively sparse setae. *Eutrichosoma mirabile* Ashmead have a very different form of sparse but strongly spatulate setae that we simply scored as state 0 rather than introducing an uninformative autapomorphy; other species of Eutrichosomatinae all have sparse fine setae.
2. Number of antennal funiculars in female: **actual number** of flagellomeres between anellus (flagellomere 1) and clava (terminal cluster of partially or completely fused flagellomeres). — Seven funiculars, as found in the outgroup taxa, is likely plesiomorphic for the planidial clade (character 8 in HERATY et al. 2013).
3. Number of antennal funiculars in male: **actual number** of flagellomeres between anellus and clava. — The male antenna is unknown for *V. abercornensis*. (character 18 in HERATY et al. 2013).
4. Funicular shape in males: **(0)** cylindrical (cf. figs. 3, 8 in BOUČEK 1974); **(1)** ventrally or ventrolaterally with a ramus (thus antenna pectinate) (Figs. 3, 12, 13). — While dorsal rami in males are common in Chalcidoidea, ventral rami are unique to Philomidinae. The shape and occurrence of rami is variable and diagnostic for the genera. Two undescribed males of *Vidlinus* (close to *V. metallicus*) have double-branched ventral rami on each of the 9 funiculars, which are similar to the dorsal rami of some *Saccharissa* Kirby (Eucharitidae: Eucharitinae). The outgroup taxa have cylindrical flagellomeres, with the exception of *Eutrichosoma flabellatum* Bouček, which has dorsal rami (BOUČEK 1974).
5. Clavomeres of female antenna: **(0)** not all fully fused, 1 or more borders between clavomeres visible (2- or more-segmented clava; cf. fig. 2g in HERATY et al. 2013); **(1)** fully fused, no vestiges of borders between clavomeres visible (unsegmented clava; Figs. 2, 11, 30, 36, clv). — Clavomeres are defined as the terminal flagellomeres that are fused along most or all of the connection between each flagellomere, and immobile. The clava is preceded by the funicle, which consists of loosely articulated flagellomeres. Philomidinae all have an unsegmented clava, usually with no discernible segmentation (state 1). *Philomides lasallei* has two vague sulci that indicate 3 clavomeres as being present (Fig. 24), but there is no clear separation of segments. Both outgroup taxa have a 4-segmented clava (3 plus a terminal button), which is plesiomorphic for the planidial clade (character 9 in HERATY et al. 2013).
6. Structure of labrum: **(0)** lightly sclerotized and retracted under the clypeus (cf. fig. 7 in BOUČEK 1974 and fig. 3 in DARLING 1986); **(1)** strongly sclerotized, plate-like, and abutting the clypeal margin (Figs. 2, 3, 11 inset, 25, 30, 36). — In the outgroup taxa, the labrum shows state 0. The plate-like labrum is unique in the planidial clade, and convergent with a similarly structured labrum in Chalcididae (character 52 but with states reversed in HERATY et al. 2013).
7. Extension of lateral clypeal margin: **(0)** absent, no extension beyond ventral genal margin, with the lateral margin of the clypeus sinuate (cf. fig. 7 in BOUČEK 1974 and fig. 2 in DARLING 1986); **(1)** distinct, extending beyond the genal margin, with the lateral clypeal margin straight and abruptly angled to the medial section of the clypeus which is transverse or broadly emarginate (Figs. 2, 3, 11, 25, 30, 36). — Some Perilampinae have a protruding clypeal margin, but the lateral margins of the clypeus are rounded and continuous with the medial section, which is transverse or broadly rounded, and the ventral clypeal margin does not extend beyond the mandibular base.
8. Number of mandibular teeth: **(0)** mandibles asymmetric, right with 3–4 teeth (cf. fig. 7 in BOUČEK 1974 and fig. 3b in HERATY et al. 2013); **(1)** mandibles symmetric, each with 2 teeth (Figs. 2, 11, 36). — Within the planidial clade, Eucharitinae and Perilampinae usually have asymmetric mandibles, with the right mandible usually having 3 teeth and the left 2, and rarely symmetric but with 3 teeth on each mandible. In *Eutrichosoma*, the mandible is asymmetric with the right mandible having 4 teeth and the left 3, which is not uncommon in Pteromalidae. For all Chrysolampinae and Philomidinae, the mandibles are symmetric, each having 2 apically projecting teeth (state 1, Figs. 2, 11, 36) (characters 56 and 57, but coded as actual number of teeth on each mandible, in HERATY et al. 2013).
9. Prepectus shape: **(0)** flat lateral panel that is posterior to the pronotum (cf. fig. 4f–i in HERATY et al. 2013); **(1)** expanded laterally and anteriorly forming a broad shoulder projecting anteriorly beyond the pronotum (Figs. 4, 5, 14, 32, 37). — The expanded prepectus of Philomidinae is unique within Chalcidoidea (character 81 state 4 in HERATY et al. 2013).
10. Probasisternum shape: **(0)** trapezoidal, dividing proepisterna medially (cf. figs. 4c and 5c in HERATY et al. 2013); **(1)** rectangular, projecting posterior to proepisterna (Fig. 28, s₁), with the proepisterna appressed medially along their entire length.
11. Frenal arm and frenum: **(0)** present (cf. fig. 4i in HERATY et al. 2013); **(1)** absent (Fig. 27). — Laterally

Table 1. Morphological character matrix for Philomidinae.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
<i>Eutrichosoma</i>	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Chrysomalla</i>	0	7	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Philomides</i>	0	7	7	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	1	1	1
<i>Aperilampus</i>	0	6	6 & 7	1	1	1	1	1	1	1	1	1	1	0 & 1	1	1	1	1	1	0	1	1
<i>Vidlinus abercornensis</i>	1	7	?	?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
<i>Vidlinus metallicus</i>	1	9	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

the mesoscutellum is rounded and undifferentiated in *Philomides* and *Vidlinus*, but with *Aperilampus* having a clearly differentiated axillula. Philomidinae all lack a frenal arm. *Chrysomalla* have a typical frenal arm and dorsally differentiated frenum, which is likely plesiomorphic for the planidial clade (state 0). *Eutrichosoma* have a very different mesoscutellar structure, but we consider them to have a frenum and frenal arm (characters 104 and 105 in HERATY et al. 2013).

12. Mesoscutellum posterior margin: **(0)** rounded (cf. fig. 4f–i in HERATY et al. 2013); **(1)** with a truncate or emarginate projection from apex of mesoscutellum (Figs. 5, 16, 26, 38). — The projection is most extreme in *V. abercornensis* (Fig. 31). The posterior margin is not projecting in the outgroup taxa (character 102 state 0 in HERATY et al. 2013).
13. Medial part of metanotum differentiated as a raised metascutellum: **(0)** present (cf. fig. 4f in HERATY et al. 2013); **(1)** absent (Figs. 33, 39). — In *Vidlinus* and *Philomides*, the metanotum is evenly sculptured or smooth, without a raised medial area that would be recognized as a metascutellum. In some species of *Aperilampus*, the medial area has a vague indication of a metascutellum, but in most species it is undifferentiated. The outgroup taxa have a clearly differentiated metascutellum that is raised medially and demarked laterally by the metascutellar arms (HERATY et al. 2013).
14. Callus setation: **(0)** sparse (Fig. 15); **(1)** dense (Figs. 4, 27, 37).
15. Metepisternum setation: **(0)** sparse (Figs. 15, 27); **(1)** dense (Figs. 4, 37).
16. Petiolar scale: **(0)** absent; **(1)** present (Figs. 4, 35, 39). — The scale is a transverse lamina that projects dorsally from the medial surface of the petiole (Figs. 4, 35, 39). A scale is found in all *Aperilampus* and *Vidlinus*, but may be reduced in some *Philomides* with a small petiole. A similar scale is found in Perilampinae, but not in Chrysolampinae. *Chrysolampus* do have a raised transverse lamina along the anterior margin of the petiole that projects over the posterior margin of the propodeum, however any positional or morphological similarity, and hence homology, is not supported.
17. Petiolar spines: **(0)** absent; **(1)** present (Fig. 34, lpp). — A pair of prominent blunt or sharp dorsolateral spines on the petiole (Fig. 34). — The lateral surface of the petiole generally lacks any ornamentation across Chalcidoidea.
18. Gastral tergum 1 spiracle: **(0)** absent; **(1)** present (Figs. 8, 35). — Some Philomidinae have a distinct spiracular opening on the lateral surface of the first gastral tergum (metasomal segment 2). As far as we know, this does not occur in any other Chalcidoidea. A trachea connecting to the opening can be observed in some taxa, suggesting that it is a functional structure. The presence or absence of a spiracle on Gt_1 is variable across Apocrita and within Proctotrupomorpha, but it appears to be absent (state 0) also in the proposed sister groups of Chalcidoidea, the Diaprioidea and Mymarommatoidea.
19. Gastral tergum 1 with medial raised area: **(0)** absent; **(1)** present, dorsal surface with a raised, lightly sculptured semicircular area just posterior to the basal attachment (Figs. 34–35, 39, rma). — In all Philomidinae the gaster is triquetrous, with the basal terga distinctly three sided and having a flattened and concave medial surface and a sharply declivous lateral surface. Within the planidial clade, a triquetrous gaster occurs only in the genus *Ancylotropus* Cameron (Eucharitidae: Eucharitinae), but these lack any raised medial area. This appears to be a unique structure in Chalcidoidea.
20. Wing fringe: **(0)** present; **(1)** absent (Figs. 1, 15, 27, 29, 32, 37).
21. Pretarsal claw ornamentation: **(0)** none, simple claw without additional spines; **(1)** pectinate, with 2–3 sharp or blunt spines along the inner surface (Fig. 23). — Within Chalcidoidea, state (1) occurs only in Leucospidae and Philomidinae.
22. Cerci: **(0)** present (Fig. 7); **(1)** absent. — The cerci are small in *Aperilampus* and *Vidlinus*, but completely absent in species of *Philomides*. As far as we know, cerci are present in all other Chalcidoidea.

3.2. Results of phylogenetic analyses

Only a single most parsimonious tree was recovered, which had 23 steps and a retention index of 1.0 (no observed homoplasy along branches) (Fig. 41). The results were the same as reported using ribosomal data alone (*Philomides* + *Aperilampus* + *Vidlinus*) (MUNRO et al. 2011), but differed from those using the combined data (*Vidlinus* + *Aperilampus* + *Philomides*) (HERATY et al. 2013). In either case, *V. metallicus* does not group with *Philomides*.

In HERATY et al. (2013), Philomidinae were supported as monophyletic in the combined analyses by 18 unam-

biguous synapomorphies, with additional notable characters including the setose prepectus (character 82-1; HERATY et al. 2013), the large number and clustered grouping of the uncal sensilla (characters 161-0 & 162-6), and presence of more than 5 hamuli with the first hamulus curved (characters 171-5 & 172-0). No unambiguous characters supported the monophyly of *Aperilampus* and *Philomides* in that study, and any potential synapomorphies were highly homoplastic across Chalcidoidea. Our current analysis proposes 4 unambiguous characters that support the monophyly of *Aperilampus* and *Vidlinus* within Philomidinae, of which the lateral spiracle on metasomal tergum 1 (character state 18-1) is unique within Chalcidoidea. Based on these new morphological results, we feel comfortable with justifying the new genus, and proposing that *Philomides* are sister to *Aperilampus* + *Vidlinus*.

3.3. Descriptive taxonomy

3.3.1. Philomidinae Ruschka (Perilampidae)

included in Perilampini: HALIDAY 1862: 115. Type species: *Philomides paphius* Haliday.

included in Perilampides: WESTWOOD 1874: 138.

included in Eucharidinae: DALLA TORRE 1898: 359.

included in Perilampidae: ASHMEAD 1904: 266; PECK et al. 1964: 26.

included in Perilampinae as Philomidini: RUSCHKA 1924: 90–91.

subfamily in Eucharitidae: BOUČEK 1978: 299, 1988: 514; GIBSON et al. 1999: 89.

subfamily in Perilampidae: MUNRO et al. 2011: 6; HERATY et al. 2013: 471.

Phylogeny and character evolution. The phylogenetic placement of Philomidinae within the planidial clade of Chalcidoidea is relatively clear based on recent unpublished data, and with the earlier studies of MUNRO et al. (2011) and HERATY et al. (2013). There is no reason to consider any close placement to Chalcididae, which share the flap-like labrum, strongly sclerotized body, and similar fore wing shape and pattern of venation. Within the planidial clade, Philomidinae share the presence of the petiolar lamina and a first gastral sternum divided by the antecostal sulcus (Fig. 18), but as they are shared with other chalcidoid taxa such as Torymidae, this feature is likely plesiomorphic. The enlarged ellipsoid propodeal spiracles are shared with some but not all Chrysolampinae, whereas the bidentate mandibles are shared with all Chrysolampinae; however, the male scape lacks the deeply recessed pores in pits on the male scale found in all Chrysolampinae and Perilampinae. Lastly, the antennal flagellum is compressed with dense multiporous plate sensilla as in many Perilampidae, but there is no defined homology of the antennal features to unite them. Overall, adult Philomidinae stand as a morphologically unique group within Chalcidoidea. The monophyly of Chrysolampinae and Philomidinae can be justified only by having both mandibles with two teeth. Other features, including the unfused petiole, petiolar lamina and elliptical propodeal spiracles

are likely plesiomorphic for the planidial clade.

Monophyly of Philomidinae is justified by a number of unambiguous synapomorphies (Fig. 41), at least three of which (states 4-1, 9-1 and 10-1) are potentially unique within Chalcidoidea. Philomidinae all have a strongly sclerotized, flap-like labrum that articulates with the ventral margin of the clypeus (otherwise found only in Chalcididae). Philomidinae have both mandibles bidentate with two long medially directed teeth (Figs. 2, 11, 36). The mouthparts are large, with a maximum of 4 maxillary and 3 labial palpi, and the glossa is enlarged and bilobate apically, although in *P. hamooniae* the mouthparts are very reduced and the palpi buttonlike. Of the taxa examined, females of Philomidinae have the clavomeres fused into a single claval segment (state 5-1), with only *P. lasallei* having 2 vague annuli that suggest a fusion of 3 clavomeres (and a total of 11 flagellomeres). The scape is ventrally concave, and positioned within a deeply recessed scrobal cavity. The male flagellum is broader than in females, with some or all of the funiculars ventrally pectinate (Figs. 3, 12, 13). In males of *Philomides*, the funicular projections are tightly appressed, slightly concave, and with a dense covering of multiporous plate sensilla (MPS) (Figs. 12, 13); laterally, the funicular rami are more loosely articulated (Fig. 13). Male *Aperilampus* have stout, independent, ventrolateral rami on funiculars 1–4 (Fig. 3). Male *Vidlinus* have long, thin, ventral rami on all of the funiculars, with the rami beyond the first funicular double and strongly curved outward and then inward. The ventral surface of the male scape is smooth and appears to lack any pores, although minute pores are visible using SEM on the male scape of *Aperilampus*, suggesting that the scape is able to produce a contact sex-recognition pheromone (cf. ISIDORO et al. 1999).

The form of the mesosoma is one of the most unusual features of Philomidinae, and is like no other chalcidoid. In all species, the pronotum is vertical and hidden in dorsal view (Fig. 14, no₁). The mesothoracic spiracle occurs at the juncture of the pronotum, mesoscutum and prepectus. In *Philomides* and *Vidlinus*, the prepectus is swollen, laterally rounded, and continues onto the anterior face of the mesosoma (Figs. 14, 15, 27, 32, 37, pre). In *Aperilampus*, the prepectus is similar in structure, but more angulate along the anterior lateral margin (Figs. 4, 5). In all Philomidinae, the prepectus does not reach the tegula (Figs. 4, 15, 19, 32, 37) and ventrally the prepectus is broadly separated (Fig. 28). Notauli dividing the middle and lateral lobes of the mesoscutum may be present as distinct sulci (Figs. 16, 26), vague impressions, subsurface lines or completely absent (Fig. 5). The notauli are distinct and parallel in *Philomides*, with parapsidal lines (psl) found in some species (Fig. 16), whereas both are absent in *Aperilampus* (Fig. 5). The axillae range from transverse and indistinctly separated from the mesoscutellar disc to transverse but divided medially. In most *Philomides*, the axillae are complete, transverse and fused medially, often only indicated by a transverse band of color (Figs. 16, 26); however, the axillae are medially separated in *Philomides aethiopicus* Masi, 1939 (plate 1

therein). In *Aperilampus* and *Vidlinus*, the axillae appear to be small and broadly separated by the apparent track of the scutoscuteellar sulcus (sss) medially (Figs. 5, 31, 38). While *Philomides* and *Vidlinus* lack any lateral differentiation of the mesoscutellum (Figs. 15, 27), *Aperilampus* have a differentiated axillula as a flattened lateral surface delimited by a dorsal carina (Fig. 4). There is also no discernible frenum or frenal bar in Philomidinae, and a frenum is thus considered absent, with the posterior mesoscutellar process arising from an extension of the mesoscutellar disc (Figs. 5, 16, 26, 31, 38). The propodeal spiracle is oblique and elliptical, and separated from the anterior propodeal margin (Figs. 6, 21, 27, 33, 39). Some *Philomides* have a dorsal projection at the base of the wing that appears to arise from the first axillary sclerite (Fig. 19, first axillary?). The calcar is robust, curved and can be bifid, acute or truncate apically. The hind tibia has 2 robust apical spurs. The pretarsal claws are distinctly pectinate in all species (Fig. 23).

Wings are similar in all Philomidinae. The fore wing venation is thick with a short marginal vein, distinct postmarginal vein, and an enlarged stigmal vein (Figs. 20, 29). Placoid sensilla are present on the parastigma (Fig. 29) or absent (Fig. 20). The stigmal vein has a dense cluster of minute placoid sensilla in the swollen posterior region. A projection of the r-m vein may be present (Fig. 20) or absent (Fig. 29). The costal cell is generally long in relation to the marginal vein, but extraordinarily so in *V. abercornensis* (Fig. 32). Wing folds on the fore wing clearly demark the r-m, M and Cu_{1a} tracks (Fig. 19 inset). The hind wing has a series of 6 or more prominent hamuli (Fig. 21).

The petiole of Philomidinae is short and broad, and primarily membranous ventrally but with a narrow encircling ventral band of cuticle posteriorly. Dorsally the petiole has a thin transverse projecting scale (as found in some Perilampinae), and in some species there is a pronounced dorsolateral projection that can be peg-like and several times longer than broad. The ventrolateral margins of the petiole are extended as paired thin lamina (ptla) that extend over the acrosternum (acst₁) of the first gastral sternum (Gs₁) (Figs. 17, 18, 35), which is a feature shared with Perilampidae, Eutrichosomatinae (Pteromalidae) and some Torymidae. The gaster is broad, strongly sclerotized and triquetrous (three-sided), with at least the anterior terga broadly concave dorsally, and with the lateral margins sharply reflexed towards the midline; the terga are more broadly impressed and laterally angulate in *Aperilampus*. Both sexes have 7 terga, with Gt₇₊₈ fused and transverse. The cercus can be tuberculate with three long setae and surrounded by cuticle, or in *Philomides* completely absent. The first gastral sternum (Gs₁) is semicircular and smooth, with a transverse semicircular antecostal sulcus (acs) (Fig. 18). The acrosternum (anterior to the acs) is subdivided by another semicircular sulcus that can be either shallow and indistinct medially (*Philomides*), or pronounced and sulcate in some *Aperilampus*. This secondary subdivision of the acrosternum is unknown in other Chalcidoidea. Females

have 5 gastral sterna, whereas males have 8. The ovipositor valvulae are aciculate (Fig. 27). The genitalia of Philomidinae are typical of most Chalcidoidea and have elongate parameres, a strong medial process on the phallobase, and the digitus is flattened with a row of marginal spines (Figs. 9, 22).

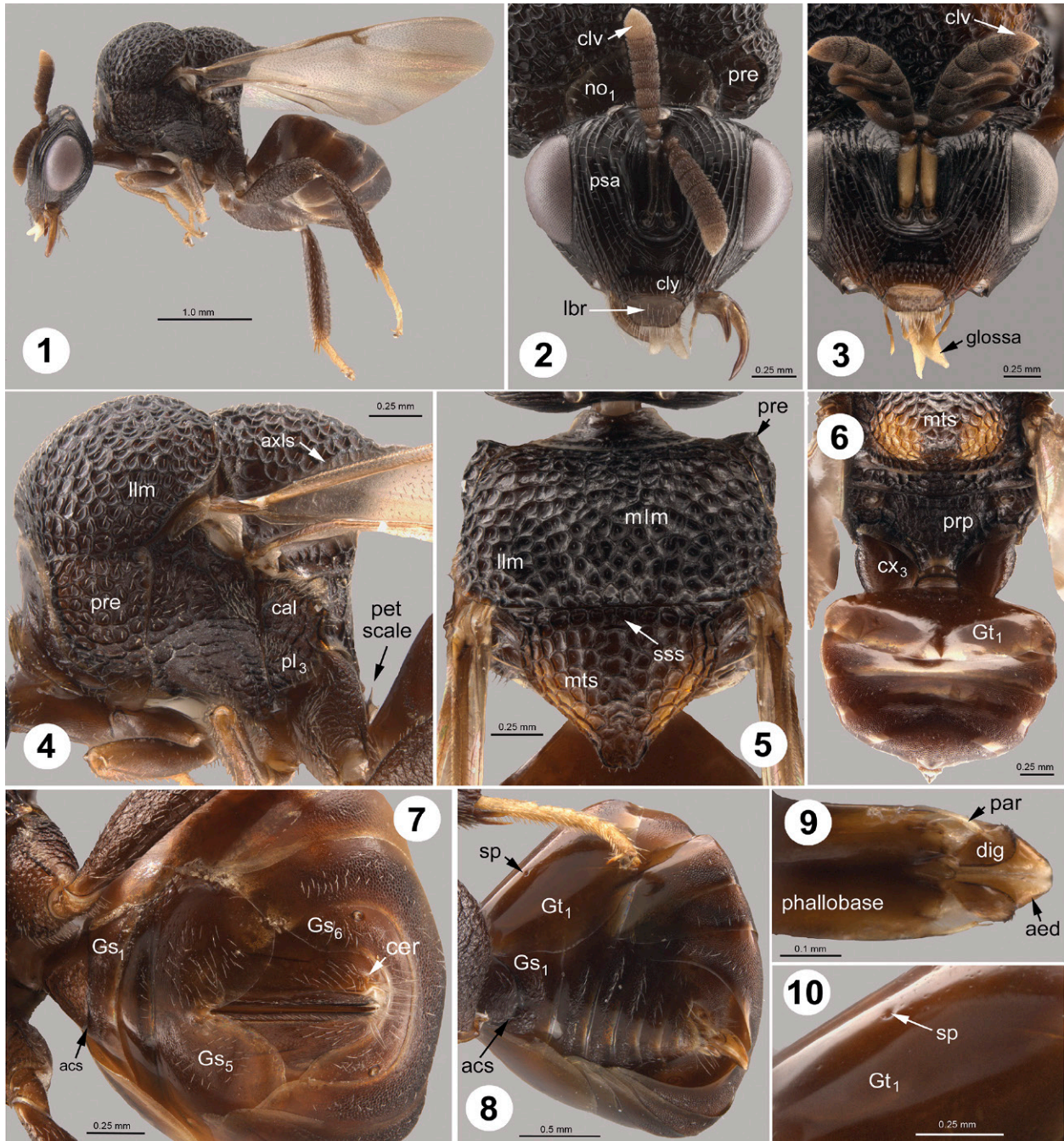
Distribution. Southern Palearctic and Paleotropical (Fig. 42). *Philomides* has the most widespread distribution, including Madagascar and the Oriental Region, but with an eastern distribution that reaches only to the Philippines and Java (Indonesia). *Aperilampus* and *Vidlinus* are both found in sub-Saharan Africa, and only *Aperilampus* and *Philomides* have established in Madagascar. Undescribed species of *Vidlinus* are known from Tunisia and Egypt, which also extends their range into the southern Palearctic.

Biogeography. The outgroup taxa within the plandial clade have a worldwide distribution. This makes it difficult to assign polarity to any distributional shift within Philomidinae. There is a clear bifurcation between the widespread Paleotropical *Philomides*, and the Afrotropical-southern Mediterranean clade of *Aperilampus* and *Vidlinus*. It is likely that Madagascar was colonized from Africa by *Aperilampus* and *Philomides*, but the data are lacking, such as including Oriental species in a molecular phylogenetic study, that could accurately address such a hypothesis (cf. FORTHMAN & WEIRAUCH 2016).

3.3.2. Key to genera and species of Philomidinae

The identification key is rudimentary and only works for described species. Several new species are known from Madagascar, the southern Palearctic, and southeast Asia. Importantly the range in color variation and morphology needs to be more broadly surveyed to better assess species limits.

- 1 Frons and lower face with strong parallel vertical carinae (Figs. 2, 3) ***Aperilampus* Walker** [the four described species from Africa are not diagnosed, but comments on recognition are included below]
- 1' Frons and lower face granulate or pilose, lacking distinct vertical carinae 2
- 2 Mesosoma completely blue or bluish-black; dorsally with prominent, stout, white setae associated with umbilicate puncturation (Fig. 37–39). Both sexes with 9 funiculars (Fig. 36). Face with thick silvery ventrally appressed setae (Fig. 36). Apex of mesoscutellum not strongly projecting and apically emarginate (Fig. 38) [sub-Saharan Africa] ***Vidlinus metallicus* (Risbec)**
- 2' Mesosoma with yellow or brown patches. Mesosomal setae similarly placed in punctures but small, fine and generally indistinct (Figs. 5, 16, 32). Both sexes with 7 funiculars (Fig. 12). Face with or without distinctive setae. Apex of mesoscutellum otherwise 3
- 3 Apical process of mesoscutellum strongly projecting and as long as mesoscutellar disc (Fig. 31); apically bifurcate with sharp spines that are broadly separated



Figs. 1–10. *Aperilampus*. 1, 2, 4, 7: *A. rabecharisoae*, female (holotype; CASENT2212474): 1, habitus; 2, head, frontal view; 4, mesosoma, lateral view; 7, metasoma, ventral view. 6, *A. rabecharisoae*, female (paratype; CASENT023227): posterior mesosoma and dorsal metasoma. 3, 5, 8, 10: *Aperilampus* sp., male (CASENT2212827): 3, head, frontal view; 5, mesosoma, dorsal view; 8, metasoma ventral view; 10, gastral tergum 1, lateral view. 9: *Aperilampus* sp., male (CASENT022341), genitalia, ventral view.

- by deep emargination. Face with thick silvery ventrally appressed setae (Fig. 30) [Zimbabwe and Nigeria] ***Vidlinus abercornensis* (Risbec)**
- 3' Apical process of mesoscutellum truncate, rounded or with only a weak emargination (Figs. 16, 26) and with projection much shorter than mesoscutellar disc. Face with very fine setae (Fig. 11) ***Philomides* Haliday, 4**
- 4 Mesosoma yellow with reddish-brown patches dorsomedially on lateral lobes of mesoscutum, centrally on the middle lobe and axillar band, and on apical pro-

- jection of mesoscutellum (cf. fig. 150, RISBEC 1951). Apical process of mesoscutellum truncate [Senegal] ***Philomides gigantea* (Risbec)**
- 4' Mesosoma yellow with black patches. Apical process of mesoscutellum variable in shape **5**
- 5 Metasoma entirely black [Ethiopia] ***Philomides aethiopicus* Masi**
- 5' Metasoma yellow or yellow and black **6**
- 6 Mesoscutum mostly black dorsally; mesoscutellum with complete medial longitudinal band of black (Figs. 16, 26) **7**

- 6' Mesoscutum with isolated black patches, lateral lobes with patches restricted to dorsomedial area; mesoscutellum mostly yellow and lacking a continuous longitudinal black band 9
- 7 Metasoma entirely yellow (Figs. 15, 17). Midlobe of mesoscutellum mostly black with anterior lateral margins yellow [Iran] ... *Philomides hamooniae* n.sp.
- 7' Metasoma with black patches medially and laterally (Fig. 27) 8
- 8 Middle lobe of mesoscutum a mixture of black and yellow, with longitudinal black band constricted medially; mesoscutellum yellow laterally (Fig. 26) [Madagascar] *Philomides lasallei* n.sp.
- 8' Mesoscutum almost entirely black dorsally, midlobe entirely black; mesoscutellum black laterally [India] ... *Philomides indicus* Girish Kumar & Narendran
- 9 Mesoscutellar disc (excluding axillae and projection) with isolated medial black patch. Mesoscutum with midlobe and dorsomedial areas of lateral lobes black, patches not reaching notauli (cf. Plate XXVI, fig. 1, WESTWOOD 1874) [India and Algeria; Palearctic] *Philomides paphius* Haliday
- 9' Mesoscutellar disc between axillae and mesoscutellar projection yellow. Mesoscutum color pattern variable 10
- 10 Middle lobe of mesoscutum with anterior region black; transverse axillae entirely black (cf. fig. 3, ISHII 1956) [southeast Asia] *Philomides frater* Masi
- 10' Middle lobe of mesoscutum with only posterior region black; axillar band black medially and yellow laterally (cf. fig. 1, FERRIÈRE 1968) *Philomides flavicollis* Cameron [Gibraltar] or *Philomides hogariensis* Ferrière [Algeria; this is likely a synonym, but the types need to be compared]

3.3.3. *Aperilampus* Walker (Figs. 1–10)

Aperilampus Walker, 1871. Type species: *Perilampus discolor* Walker, by monotypy.

Diagnosis. In *Aperilampus*, the parascrobal area (frons lateral to scrobal depression) has multiple vertical carinae with an otherwise smooth surface and at most very few setae (Figs. 2, 3). In contrast, *Philomides* and *Vidlinus* lack vertical carinae except around the scrobes (Figs. 11, 24, 30, 36, psa). Clypeus flat, labrum articulating with its ventral margin. Females with 8 flagellomeres: 1 anellus – 6 funiculars – unsegmented clava, and males with 8 flagellomeres (1–6–1). Males with thick ventrolateral rami on funiculars 1–4 (Fig. 3), whereas *Philomides* and *Vidlinus* have ventral rami on all funiculars. The anterior lateral margin of the prepectus is sharply angled (Figs. 4, 5). Mesoscutellum with a lateral triangular axillula demarcated dorsally by an irregular carina that slopes downward and just below the apical projection (Fig. 4, axls). Posterior margin of mesoscutellum extended as a truncate or slightly emarginate process (Fig. 5). Petiole with strong dorsal scale (Fig. 6) and short blunt dorsolateral process just anterior to scale. First gastral tergum with a

lateral spiracle (Figs. 8, 10). Cercus small and pustulate, with 4 long setae.

Comments. The four previously described species all appear to be variants of the *A. discolor* color pattern, with varying degrees of testaceous and black patterning of the mesosoma. Whether these are different species will require examination of all of the types and making comparisons to more extensive material. “*Aperilampus aurantiacus*” has a distinctive reddish-brown coloration, without any pattern, but is an unavailable name. The color variation among several undescribed species is much greater, ranging from entirely black to almost entirely yellow, and the morphological variation within the genus is much greater than represented by the currently described species.

Biology. A host association for *Aperilampus varians* Strand with a ground-nesting *Halictus* (*Seladonia*) *afrikanus* Friese (Halictidae) and a description of the planidium was provided by DARLING (1992). RISBEC (1957a) stated that a specimen of *Aperilampus brevicornis tapiae* issued from a stem gall of *Uapaca* (Phyllanthaceae), but based on the biology this is likely a specimen of *Perilampus* and not relevant to the biology of *Aperilampus*.

Distribution. *Afrotropical*: Sub-Saharan Africa (at least 7 undescribed species) and Madagascar (6 undescribed species).

“*Aperilampus aurantiacus* Biró” (unavailable name)

Aperilampus aurantiacus nigripes Strand, 1911: 9. Type data: “I.O Afr. Eritrea Jensen-H.V.” [Ethiopia] (Jensen-Haarup leg.). Type depository: Museum für Naturkunde, Berlin, Germany. Female (image examined).

Comments. STRAND (1911) based his description of the subspecies *nigripes* as a variant of *A. aurantiacus* Biró, with *aurantiacus* cited as “in litt.” and *nigripes* as a “n.var.” of *aurantiacus*. The *nigripes* variant was a specimen labelled as such by Biró. NOYES (2017) correctly states that *A. aurantiacus* is a nomen nudum as it was never described by Biró, and *A. nigripes* is unavailable as it is attached to a name that is unavailable. This potential species is recognized by the reddish brown mesonotum and prepectus, with the rest of the body either black or dark brown.

Aperilampus brevicornis (Risbec)

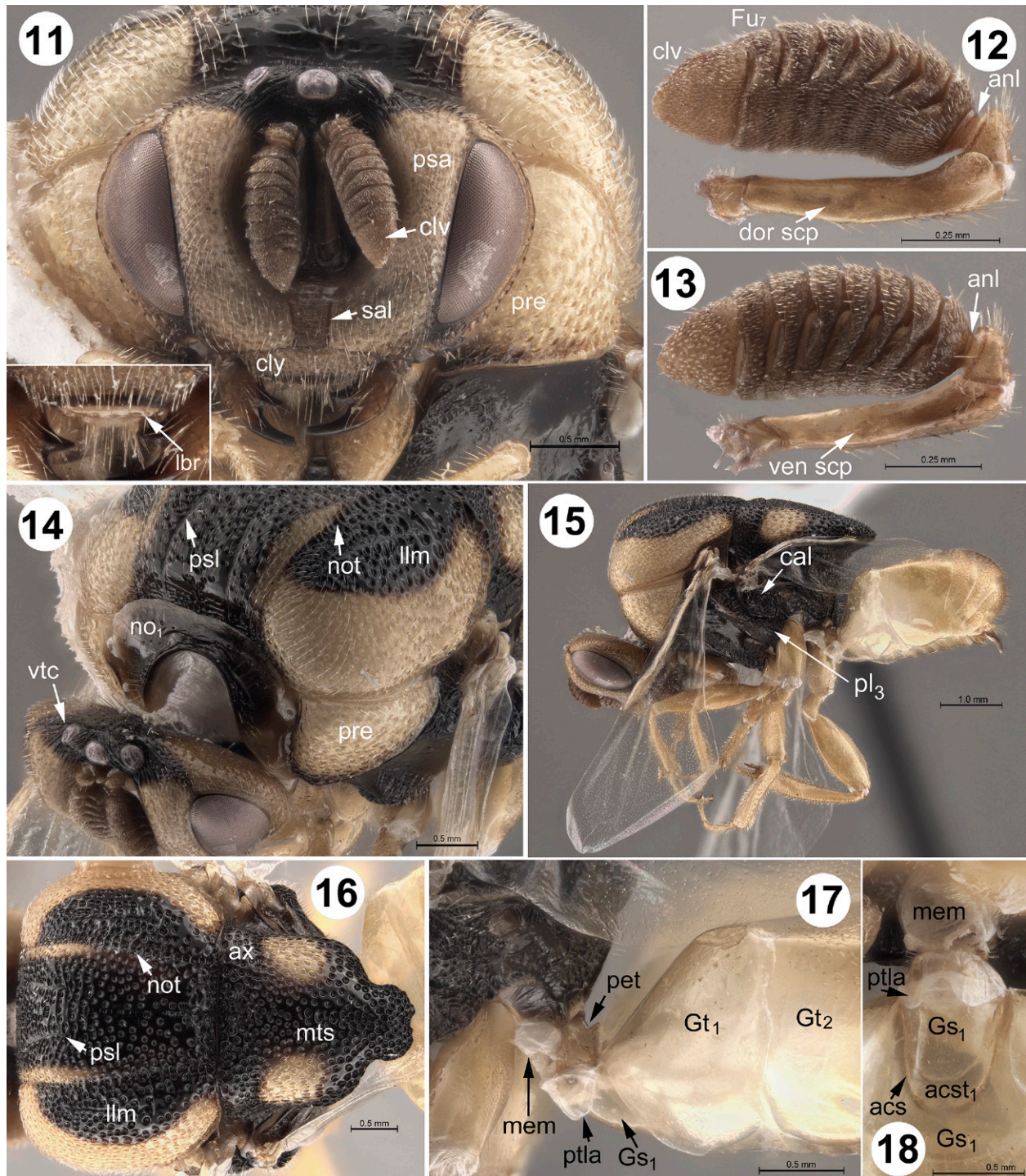
Perilampus brevicornis Risbec, 1951: 371–373, fig. 167b,c,d. Type data: M'Bambey, Senegal. Holotype female, by monotypy (image examined). Type depository: Paris: Museum National d'Histoire naturelle (MNHN), France.

Aperilampus brevicornis; KERRICH 1954: 122. Change of combination.

Perilampus brevicornis var. *tapiae* Risbec, 1957a: 184. Specimen not found in the MNHN. Likely a true *Perilampus*. Unavailable name: nomen dubium.

Distribution. *Afrotropical*: Senegal.

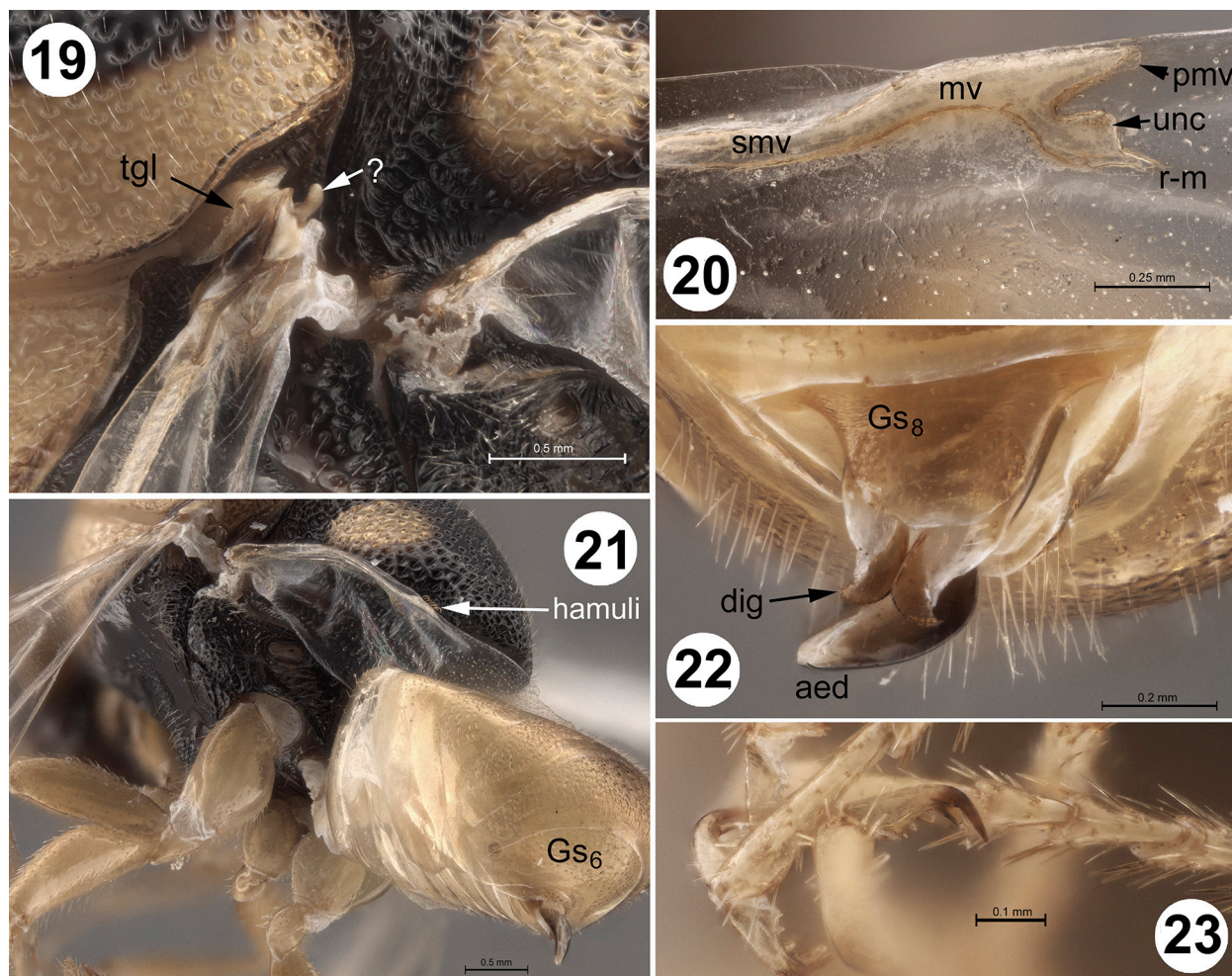
Comments. RISBEC (1951) refers to figure 167 [mistakenly referred to as fig. 161], which illustrates the maxillary palp, labial palp and antenna. As described, the



Figs. 11–18. *Philomides hamooniae*, male (holotype; UCRCENT00491418). 11, head and anterior mesosoma (inset anteroventral view of clypeus and labrum); 12, right antenna, lateral view; 13, right antenna, medial view; 14, head and mesosoma, anterolateral view; 15, habitus, lateral view; 16, mesosoma, dorsal view; 17, mesosoma and gaster, lateral view; 18, petiole and anterior gaster, ventral view.

species has a similar yellow and dark brown coloration of the mesosoma to *A. discolor*, but the yellow coloration on the mesosoma is more extensive on the mesoscutum and mesoscutellum, with the mesoscutellar disc almost entirely yellow and only the midline and apex dark brown. KERRICH (1954) does not provide a description or diagnosis, merely providing the new combination and stating that both *Aperilampus* and *Perilampus* are short-petiolate.

Perilampus brevicornis var. *tapiæ* was listed as a variety and Risbec specifically states that there is no justification for a new species; male from central Madagascar. This ‘variant’ has the head and mesosoma entirely black with bluish reflections, and perhaps more importantly the right mandible is stated as being tridentate, which has not been observed in other Philomidinae, and that the wings have no color. Risbec also states that the specimen emerged from a stem gall of *Tapia* (*Uapaca*



Figs. 19–23. *Philomides hamooniae*, male (holotype; UCRCENT00491418). 19, mesosoma, lateral view; 20, fore wing venation, dorsal view; 21, mesosoma and metasoma, posterolateral view; 22, apex of gaster and genitalia, subventral view; 23, tarsi.

bojeri Baill., Phyllanthaceae). These attributes suggest that this is actually a specimen of *Perilampus*, and the combination with *Aperilampus* inaccurate. As an identified specimen was not found at the MNHN, and the identification uncertain, we consider this as an unavailable name.

Aperilampus discolor (Walker)

Perilampus discolor Walker, 1862. Type data: South Africa (Natal).

Syntype (likely only type), female (examined). Type depository: London: Natural History Museum, England; type no. 5.641.

Aperilampus discolor; WALKER 1871: 67. Change of combination.

Aperilampus discolor; STRAND 1911: 9. Compared to *A. varians*.

Citations. DARLING (1988, anatomy); DARLING (1992, nomenclature).

New material. YEMEN: 12 km NW of Manakhah, 15°08'39"N 43°42'46"E, 3 July–21 August 2001, A. van Harten, malaise trap, 6512 (1♀, UCR: UCRCENT00184055; UCR DNA voucher code D0900).

Distribution. *Afrotropical*: South Africa (WALKER 1862), and Cameroon, Nigeria, Uganda, Yemen (new records).

Comments. The type has a patterned coloration of yellowish brown and dark brown, with the midlobe of the mesoscutum including the notaular area entirely black,

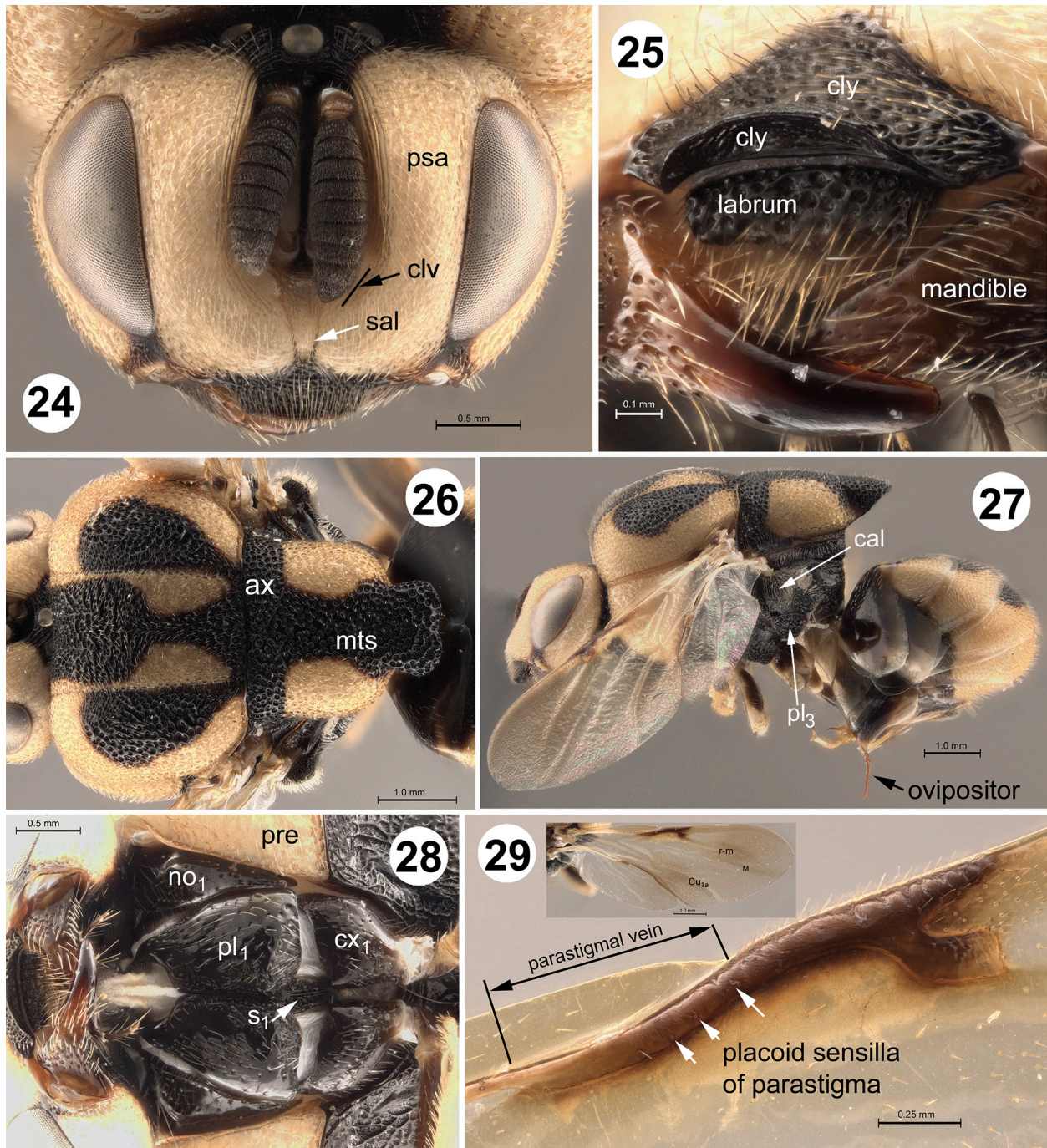
and the apex and medial area of the mesoscutellum mostly black.

Aperilampus niayensis (Risbec) n.comb.

Chalcura niayensis Risbec, 1957b: 260, fig. 8. Type data: Senegal: Station de Niayes. Holotype female, by monotypy (image examined). Type depository: Paris: Museum National d'Histoire naturelle, France.

Distribution. *Afrotropical*: Senegal (RISBEC 1957b).

Comments. The new combination is based on Risbec's detailed illustrations and examination of a photo of the type. Risbec states "Tout la tête a de fortes crêtes qui passent, transversalement, devant les antennes, puis entre les yeux et la depression faciale" [The whole head has strong ridges that pass transversely in front of the antennae, then between the eyes and the facial depression]. While the illustration appears close to *Philomides metallicus*, the presence of transverse curved carinae below the antenna (as illustrated in his fig. 8d) clearly place this species in *Aperilampus*. The color description by Risbec suggests that the body is black, with testaceous spots dorsolaterally on the mesoscutum, laterally on the pronotum, and dorsolaterally on the mesoscutellum. Examination of



Figs. 24–29. *Philomides lasallei*, female (holotype; CASENT008299). **24**, head, anterior view; **25**, clypeus and labrum, ventrolateral view; **26**, mesosoma, dorsal view; **27**, habitus, lateral view; **28**, anterior mesosoma, ventral view; **29**, fore wing venation, dorsal view (inset, entire wings, dorsal view).

the type reveals that the color is intermediate between *A. discolor* and *A. brevicornis*, with the majority of the middle lobe and medial mesoscutellum dark brown, but with yellow patches on the mesoscutal lateral lobes, dorsolateral prepectus and lateral mesoscutellum.

***Aperilampus rabeharisoae* Heraty, n.sp.**

(Figs. 1–10)

Material. *Holotype*: female. MADAGASCAR, ANTIRANANA: SAVA Region, Vohemar Dist., Antsahabelela rainforest, 9 km SW Daraina

Binara, 182 m, 13°15'02"S 49°37'00"E, 9–16.iii.2011, M. Irwin, R.Harin'Hala, humid forest, malaise trap, MG-58-23. Deposited in the California Academy of Sciences, CASENT2212474; UCR DNA voucher code D3762]. **Paratypes**: MADAGASCAR, FIANARANTSOA: Fianarantsoa Parc. Ranomafanae radio tower at forest edge, MT, 1130 m, 21°15'05"S 47°24'43"E, 15–21.xii.2001, M. Irwin, R. Harin'Hala, mixed tropical forest, MT, MA-02-098-07 [1♀, CASC: CASENT02022344]; Parc National Ranomafana Belle Vue at Talatamy, 1020 m, 21°15'59"S 47°25'13"E, 26.ii–10.iii.2003, R. Harin'Hala, secondary tropical forest, malaise trap, MA-02-09C-55 [1♀, CASC: CASENT02022343]. **Additional material** (potentially same species, but scale yellowish brown and Gt₁₋₃ shagreened dorsally): MADAGASCAR, FIANARANTSOA: near Isalo NP, in dry wash

south of interpretive center, 885 m, 22°38'00"S 45°21'49"E, 17–28. iii.2003, M. Irwin, Harin'Hala, open area, MT, MA-02-11B-59 [1 ♂, CASC: CASENT02022341]. near Isalo NP, in dry wash south of interpretive center, 885 m, 22°38'00"S 45°21'49"E, 22–29. xi.2002, M. Irwin, Harin'Hala, open area, MT, MA-02-11B-47 [1 ♂, CASC: CASENT02022342].

Etymology. Named in honor of a woman who makes a difference: Saraha Georget Rabeharisoa for her work in the politics of Madagascar as president of the Green Party and a previous presidential candidate.

Species diagnosis. Holotype evenly dark brown, paratypes both with a lateral yellow patch laterally above axilla, with one paratype having a yellowish brown patch dorsolaterally on the prepectus. Wings slightly infusate.

Description. Female (male unknown). Length 3.7–4.3 mm. **Color:** Dark brown, clava, mouthparts and tarsi yellowish brown (Figs. 1, 2). Scape dark brown. Labrum pale brown. Mesosoma entirely dark brown (holotype) or with yellowish brown patch dorsolaterally on prepectus or lateral spot on mesoscutellum above axillula. Metasoma dark brown. Wings infusate apically and faintly along posterior margin. **Head:** Head width : head height 1.15–1.16. Gena length : eye height 0.3–0.42. Subtorular lines nearly vertical but barely discernible; lateral margins of supraclypeal area shallowly impressed (Fig. 2). Vertex with a transverse vertexal carina just posterior to ocelli. Mandibles each with 2 elongate teeth. Mouthparts well developed; elongate with 4/3 palpal formula; maxillae of holotype broad and discoidal, laterally with dense long setae. Antenna with 8 flagellomeres: 1 anellus – 6 funiculars and an unsegmented clava (Fig. 2). **Mesosoma:** Parapsidal lines absent, notauli shallowly impressed and very slightly angled to midline. Axillae broadly separated medially, SSS meeting TSA. Hind femur length:width 3.17–3.22. Fore wing (Fig. 1) length : width 2.79–2.86; juncture of submarginal and parastigmal vein indistinct, parastigmal sensilla absent, stigmal vein with r-m vein prominent, 8 sensilla; wings pilose. **Metasoma:** Gt_{1–3} smooth medially. Cerci small and buttonlike with 3 long hairs.

Distribution. *Afrotropical:* Madagascar.

Aperilampus varians Strand

Aperilampus discolor varians Strand, 1911: 9. Type data: Tanzania: "Nyassa-See, Langenburg [= Tukuyu] VI.98 Fülleborn S.". Holotype female, by monotypy (image examined). Type Depository: Museum für Naturkunde, Berlin, Germany
Aperilampus varians; DARLING 1992: 333. Change of status.

Citation. DARLING (1992: description of planidium, host record, nomenclature).

Biology. Associated with *Halictus (Seladonia) africanus* Friese (Halictidae) (DARLING 1992).

Distribution. *Afrotropical:* South Africa (DARLING 1992), Tanzania (STRAND 1911).

Comments. STRAND (1911) described this as a variant of *Aperilampus discolor* that was labelled as a variant (*variens*) by Biró, which was not previously published. The

type has a patterned coloration of yellowish brown and dark brown, with the mesoscutellum dark medially, centrally and at the apex. Similar to *A. discolor*, but the prepectus is evenly yellowish brown and the notaular area and the posterior margin of the middle lobe yellowish brown.

3.3.4. *Philomides* Haliday (Figs. 11–29)

Philomides Haliday, 1862: 138. Type species: *Philomides paphius*, by monotypy.

Sternodes De Stefani, 1891: 118. Type species: *Sternodes pusateri* Stefani (= *Philomides paphius* Haliday), by original designation. Homonym; discovered by DALLA TORRE 1898: 88.

Destefania Dalla Torre, 1898: 88. Replacement name, preoccupied by *Sternodes* Fischer 1837 (Tenebrionidae), RUSCHKA 1924: 91. *Destefania*; ASHMEAD 1904[238]: 268, 269 (in key).

Philomides; RUSCHKA 1924: 91–92. Subsequent description.

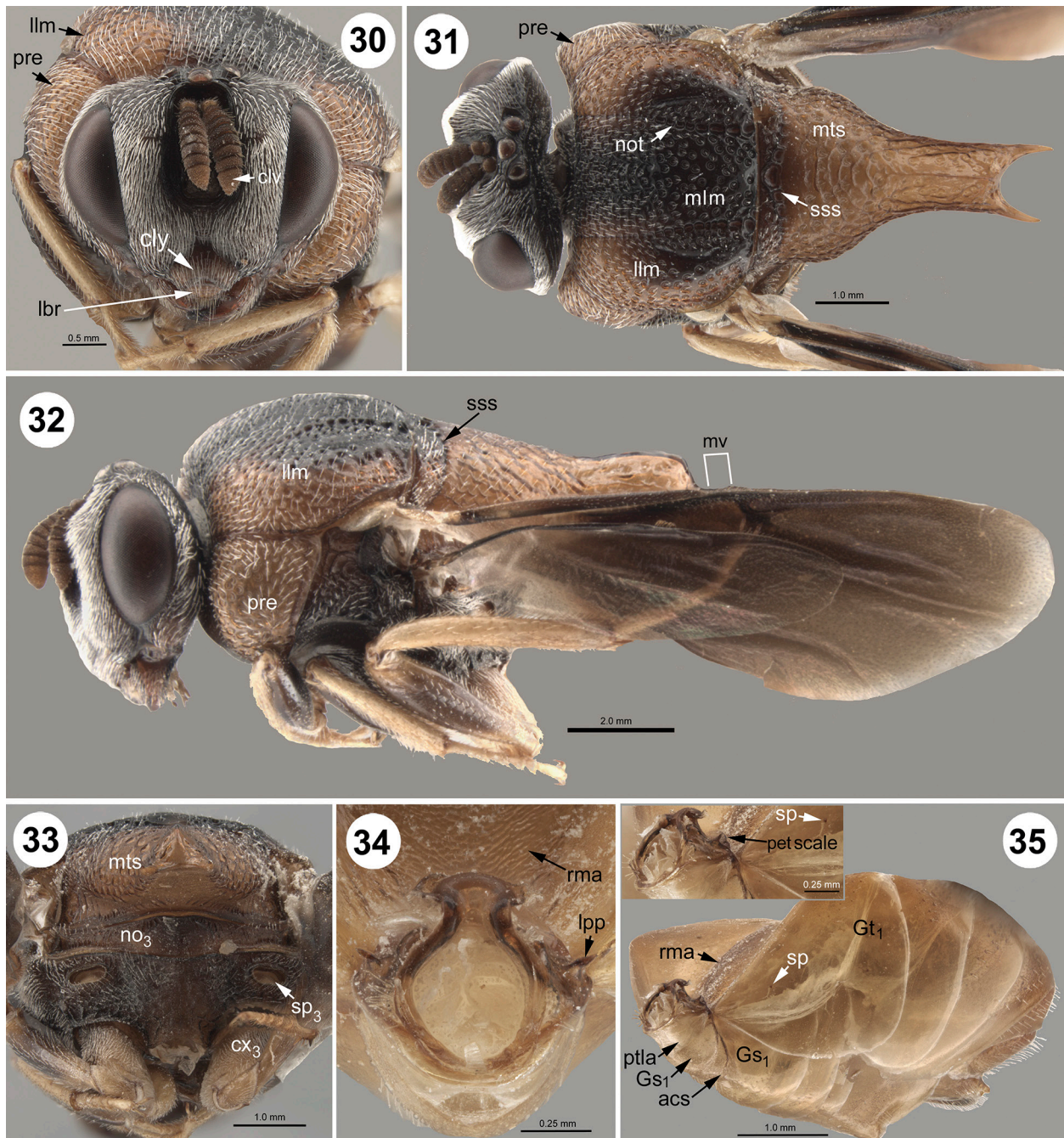
Citations. BOUČEK (1978, catalog); DESANTIS (1950, catalog); MASI (1919, description, nomenclature).

Key. RISBEC (1953: 607).

Diagnosis. *Philomides* can be easily distinguished from *Aperilampus* and *Vidlinus* by a number of features, but in particular *Philomides* all have the parascrobal area punctuate with dense fine setae, with the surface lacking distinctive carinae except around the ocelli and scrobes (Figs. 11, 24, psa). *Philomides* (excluding *Vidlinus*) have the punctuations more broadly spaced with fine semi-erect setae (Figs. 11, 24), whereas in *Vidlinus*, the facial setae are thick, dense, and decumbent forming a silvery sheen across the entire face. *Aperilampus* and *Vidlinus* both have a flat clypeus that directly abuts a broad, semi-circular, flattened labrum, whereas *Philomides* have the ventral margin of the clypeus (cly) strongly reflexed and abutting a strongly transverse labrum (Figs. 11 inset, 25). *Philomides* are the only chalcidoid species known to have distinct vertical subsurface subtorular lines (Figs. 11, 24, sal). These internal ridges may be present in all Philomidinae, but are more clearly evident in *Philomides* because of the yellow, more transparent cuticle. In *Philomides*, the antennal flagellum has 9 flagellomeres: 1 anellus – 7 funiculars – unsegmented clava, that are cylindrical and compressed, with dense minute multiporous plate sensilla (MPS) (Fig. 24). The funiculars of males each have a lobate ventral ramus that are tightly appressed ventrolaterally (Fig. 12) and more openly spaced medially (Fig. 13). Anterior lateral margin of prepectus broadly rounded. Mesoscutellum rounded laterally with no indication of axillula. Posterior margin of mesoscutellum produced as a broad truncate process (Figs. 16, 26). Petiolar scale pronounced or reduced to transverse ridge, petiole smoothly rounded laterally and without a dorsolateral spine. First gastral tergum lacking spiracle. Cercus absent.

Biology. Based on photographic evidence, *Philomides* appear to oviposit into flower buds of *Solanum* (Solana-ceae) (Fig. 41).

Distribution. *Paleotropical* (9 described species) ranging across *Afrotropical* (widespread in subsaharan Africa including Gibraltar and Malagasy) and *Oriental* (west



Figs. 30–35. *Vidlinus abercornensis* (Risbec), female (Nigeria; UCRCENT00412722): **30**, head, frontal view; **31**, head and mesosoma, dorsal view; **32**, head and mesosoma, lateral view; **33**, mesosoma, posterior view; **34**, petiole and Gt₁, anterior view; **35**, metasoma, antero-lateral view; inset is magnification of petiole.

to Taiwan including the Philippines and Indonesia (Java) and India). **Southern Palearctic** (including Algeria, Cyprus, Gibraltar, Iran, Israel).

Philomides aethiopicus Masi

Philomides aethiopicus Masi, 1939: 26, Tav. 1, fig. 1. Type data: S. Abyssinia (= Javello Bora Ethiopia); type label "Missione Zavattari nei Borana", Javello, 15–30.IV.1937". Holotype female, by monotypy. Type depository: Museo Civico di Storia Naturale "Giacomo Doria", Genova, Italy.

Distribution. Afrotropical: Ethiopia.

Philomides flavicollis Cameron

Philomides flavicollis Cameron, 1905: 150. Type data: Gibraltar. Holotype male (examined), by monotypy. Type depository: London: Natural History Museum, England; type no. 5.4635; NHMUK010749113.

Distribution. Palearctic: Gibraltar.

Philomides frater Masi

Philomides frater Masi, 1926: 372–375, fig. 42. Type data: Taiwan: Taihorin. Holotype male, by monotypy. Type depository: Museum für Naturkunde, Berlin, Germany.

Philomides frater; ISHII 1956: 32-33. Described: male. Illustrated. Subsequent description.

New material. **INDONESIA, W. JAVA:** Depok, 6°24'08"S 106°47'39"E, M.A. Lieftinck [1 ♀, MBBJ]; Dungus Iwul, 100 m, 6°27'32"S 106°42'52"E, M.A. Lieftinck [1 ♀, MBBJ]. **PHILIPPINES:** Mt. Montalban, Rizal, Wa-wa Dam, 150–200 m, 14°43'40"N 121°11'30"E, 29.iii.1965, L.M. Torreallas [1 ♀, BPBM: UCRCENT00422377]. **THAILAND:** Doi Inthanon Natn. Park, Mae Klang waterfall area, 900 m, 18°26'12"N 98°35'53"E, 21.x.1979 [1 ♀, UCRC: UCRCENT00496095].

Distribution. Oriental: Widely distributed in southeast Asia, with records from Indonesia (Java), the Philippines (Luzon) and Taiwan.

Philomides gigantea (Risbec)

Fissicrania gigantea Risbec, 1951: 299–301, fig. 150. Type data: Senegal: Niore. Holotype female, by monotypy (image examined). Type depository: Muséum National d'Histoire Naturelle, Paris.

Philomides gigantea; RISBEC 1953: 606. Change of combination.

Distribution. Afrotropical: Senegal.

Philomides hamooniae Heraty, Derafshan & Ghafouri Moghaddam, n.sp.

(Figs. 11–23)

Material. Holotype: Female, UCRC. **IRAN,** Sistan and Baluchestan, Sistan County, Nimrooz, Hamoon International Wetland, 31°05'02"N 61°26'07"E, 461 m, 05.vi.2016, swept on mix vegetation, H.A. Derafshan coll.. Deposited in UCRC, UCRCENT00491418; UCR DNA voucher code D5119. Known from only this specimen.

Etymology. Named after the park where it was collected, and in support of wetland conservation.

Species diagnosis. *Philomides hamooniae* is most similar to *Philomides indicus* as based on the shared color pattern of the mesosoma. It can be readily distinguished by the medial edges of the lateral lobes of the mesoscutum yellow (black in *P. indicus*), and the entire metasoma yellow (black in *P. indicus*). Both species have the mesoscutellum entirely black except for yellow circular areas laterally on the mesoscutellar disc (Figs. 15, 16). Perhaps unique among *Philomides*, this species has very reduced mouthparts with the palpi reduced to buttonlike processes. As well, the parapsidal lines and notauli are clearly indicated.

Description. Male (female unknown). Length 6.6 mm. **Color:** Black and yellow coloration (Figs. 11, 23). Vertex including region of upper face black (Fig. 11). Clypeus mostly yellow. Labrum yellow. Mesosoma mostly black dorsally with the lateral and midlobes separated by a thin yellow line anteriorly and the lateral lobes yellow laterally. Mesoscutellum with sublateral patches of yellow (Fig. 16). Pronotum, mesopleuron and propodeum black (Fig. 15). Prepectus mostly yellow. Legs and gaster yellow. Metasoma yellow. Wings hyaline. **Head:** Head width : head height 1.3. Gena length : eye height 0.14. Subtorular lines broadly spaced and nearly vertical (Fig.

11). Vertex with a transverse vertexal carina just posterior to ocelli (Fig. 14, vtc). Mouthparts very reduced; palpi small and buttonlike. Antenna with 9 flagellomeres: 1 anellus – 7 funiculars – unsegmented clava (Figs. 12, 13). **Mesosoma:** Parapsidal lines distinct (Fig. 16, psl). Axillae transverse and not distinguished posteriorly from mesoscutellar disc. Hind femur length : width 2.25. Fore wing (Fig. 20) length : width 2.63; juncture of submarginal and parastigmal vein indistinct, parastigmal sensilla absent, stigmal vein with r-m vein prominent; wing setae absent.

Distribution. Palearctic: Iran.

Philomides hoggariensis Ferrière

Philomides hoggariensis Ferrière, 1968: 240, fig. 1. Type data: Algeria, Hoggar, Sahara Tamanrasset. Holotype female, by monotypy. Type depository: Muséum d'Histoire Naturelle, Genève.

Distribution. Palearctic: Algeria.

Philomides indicus Girish Kumar & Narendran

Philomides indicus Girish Kumar et al., 2008: 124–127, figs. 2–4. Type data: India: Kerala, Kozhikode Dt. Holotype female, by original designation. Type depository: Calcutta: National Zoological Collection, Zoological Survey of India, India.

Distribution. Oriental: India (Kerala).

Philomides paphius Haliday

Philomides paphius Haliday, 1862: 115. Type data: Cyprus [Ile de Chypre]. Holotype male, by monotypy. Type depository: Muséum National d'Histoire Naturelle, Paris.

Philomides paphius; WESTWOOD 1874: 138, Plate XXVI. Subsequent description, male. Illustrated.

Sternodes Pusateri De Stefani, 1891: 118. Type data: Sicily. Holotype female (one specimen inferred from description). Type depository: unknown, type likely lost (pers. comm. Bruno Massa, Museum of Zoology "P. Doderlein"). Synonymy by RUSCHKA 1924: 92.

Destefania pusateri Dalla Torre, 1898: 359. Unjustified replacement name; discovered by RUSCHKA 1924: 359.

Philomides paphius; RUSCHKA 1924: 92. Subsequent description, both sexes.

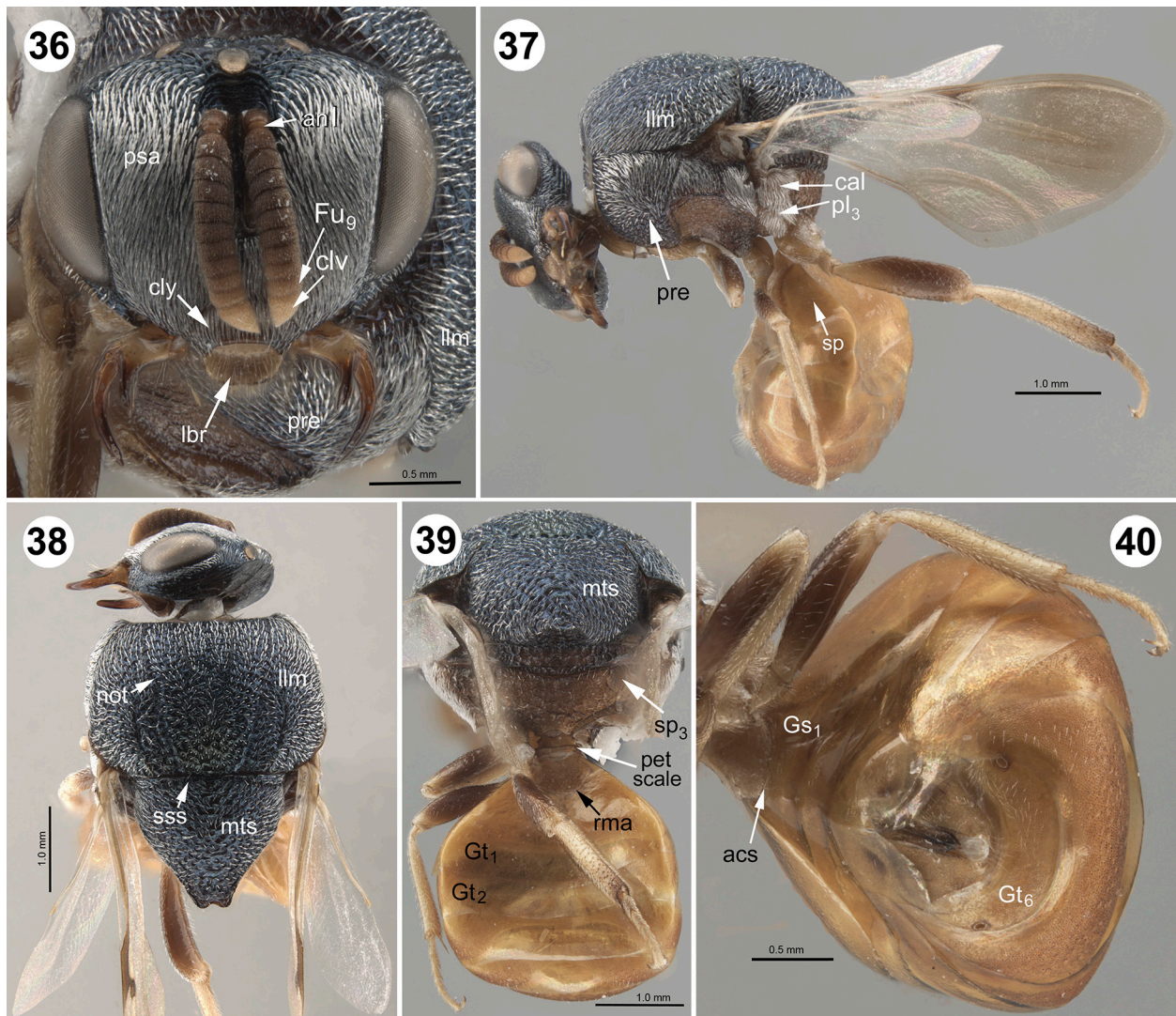
Philomides paphius; MASI 1949: 93–94. Subsequent description, female.

Philomides paphius; GIRISH KUMAR et al. 2008: 124, fig. 1. Subsequent description, female.

New material. **INDIA:** Karnataka; Hesaraghatta, 13°08'02"S 77°28'43"E, 27.vii.2018, H.M.Yeshwanth, ex *Solanum torvum* (1 ♀, NBAIR).

Biology. A single female was observed in a position on a flower bud of *Solanum torvum* Sw. (Solanaceae) that suggests it is ovipositing into the flower bud (Fig. 41 inset). The habit of flower bud oviposition was also observed on a web image of a *Philomides* (possibly *frater*) from Chiang Mai, Thailand (no specimen available) (<https://www.inaturalist.org/taxa/824746-Philomides>).

Distribution. Oriental: India (Karnataka: GIRISH KUMAR et al. 2008). **Palearctic:** Cyprus; Israel (MASI 1949).



Figs. 36–40. *Vidlinus metallicus* (Risbec) (Yemen, UCRCENT00092160): **36**, head, frontal view; **37**, habitus, lateral view; **38**, head and mesosoma, dorsal view; **39**, mesosoma and metasoma, posterior-dorsal view; **40**, metasoma, ventral view.

***Philomides lasallei* Heraty n.sp.**

(Figs. 24–29)

Material. Holotype. Female, **MADAGASCAR:** Toliara: Forêt de Mite, 20.7 km 29° WNW Tongobory, 75 m, 23°31'27"S 44°07'17"E, 27 Feb–3 Mar 2002, Fisher-Griswold Arthropod Team, gallery forest, malaise trap, BLF 5849. Deposited in CAS, CAsENT008299; UCR DNA voucher code D1269. Known from only this specimen.

Etymology. Named after John LaSalle, a truly unique individual with a determined passion for Chalcidoidea.

Species diagnosis. *Philomides lasallei* has a unique color pattern. In dorsal view, the middle lobe of the mesoscutum has an hourglass shaped black pattern and the lateral lobes are black dorsomedially and reaching to the notauli (Fig. 26). The axillae are evenly black and the mesoscutellum entirely black medially and yellow laterally (Figs. 26, 27). The mouthparts are prominent with the maxillary palpi 4-segmented, labial palpi 2-segmented. The parapsidal lines are present but weakly defined.

Description. Female (male unknown). Length 8.3 mm.

Color: Black and yellow coloration (Figs. 24–29). Vertex black around ocellar triangle, upper parascrobal area

and vertex laterally yellow (Figs. 24, 26). Clypeus and labrum entirely black. Mesosoma black and yellow dorsally with the lateral and middle lobes separated by yellow along entire length, and middle lobe with an hourglass shaped black pattern. Mesoscutellum black medially and mesoscutellar disc laterally yellow (Figs. 26, 27). Pronotum, mesopleuron and propodeum black (Fig. 27). Prepectus yellow. Legs with femora mostly black, and with tibia and tarsi yellow. Gaster Gt₁ black with following three terga black dorsally and laterally (Fig. 27). Sterna beyond acrosternum black. Wings infusate. **Head:** Head width : head height 1.3. Gena length : eye height 0.13. Subtorular lines converging and narrowly spaced ventrally (Fig. 24). Vertex without transverse vertexal carina. Mouthparts large; maxillary palpi 4-segmented, but the basal palpomere short and only partially sclerotized; labial palpi 2 segmented. Antenna with 11 flagellomeres: 1 anellus – 7 funiculars and clava fused but with vague indications of 3 clavomeres (Fig. 24). **Mesosoma:** Parapsidal lines present but weak (Fig. 26). Axillae transverse and not distinguished posteriorly from mesoscutellar

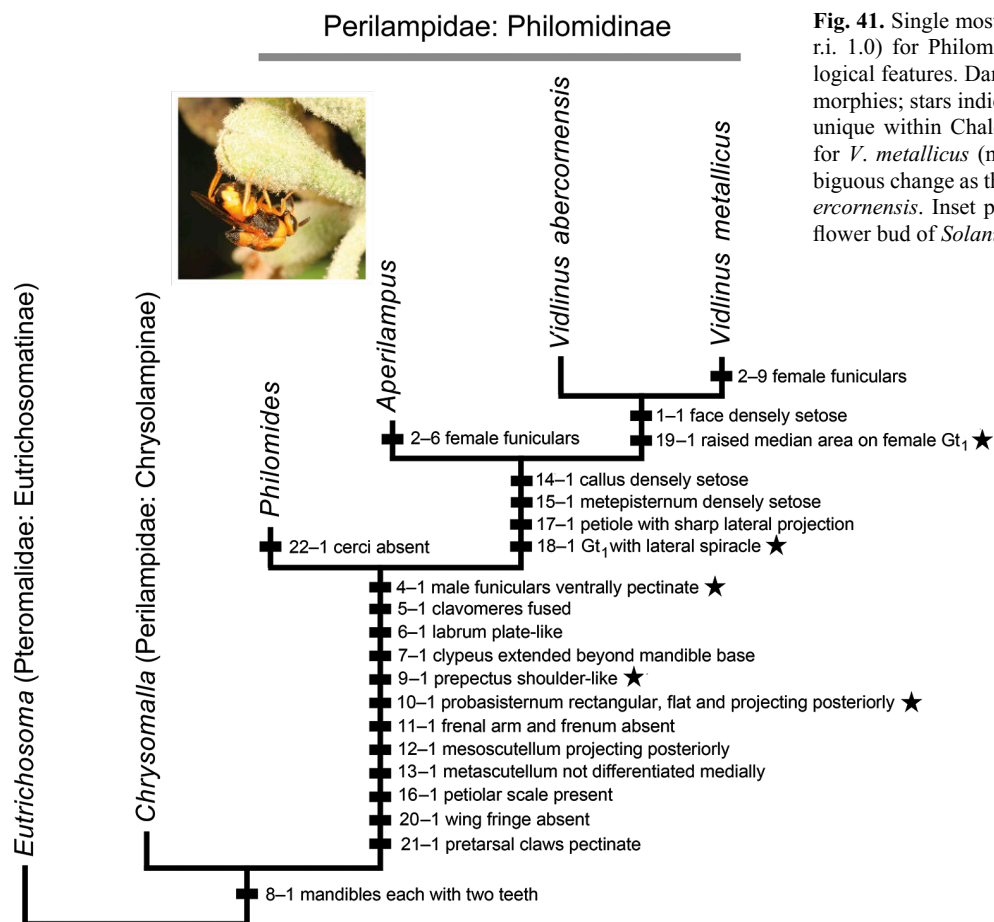


Fig. 41. Single most parsimonious tree (24 steps; r.i. 1.0) for Philomidinae based on 22 morphological features. Dark bars are unambiguous apomorphies; stars indicate states that are potentially unique within Chalcidoidea. Character state 3-9 for *V. metallicus* (not shown) was the only ambiguous change as the male is unknown for *V. abercornensis*. Inset photo: *Philomides paphius* on flower bud of *Solanum torum* (Solanaceae).

disc. Hind femur length : width 2.31. Fore wing (Fig. 29) length : width 2.64, juncture of submarginal and parastigmal vein distinct (Fig. 29), 3 parastigmal sensilla present, stigmal vein with r-m vein absent; fore wing with scattered minute setae on costal cell and fore wing disc, and with denser setae along marginal and postmarginal vein and posterior to stigmal vein (Fig. 29).

Distribution. *Afrotropical*: Madagascar.

3.3.5. *Vidlinus* Heraty n.gen. (Figs. 30–40)

Type species. *Vidlinus metallicus* (Risbec).

Etymology. *Vidlinus* was an arbitrary name invented by Zdenek Bouček and placed as a manuscript name on the holotype; he was right. Gender masculine.

Diagnosis. *Vidlinus* are recognized by the thick, dense, and decumbent facial setae forming a silvery sheen across the entire face (Figs. 30, 36). *Vidlinus* have a flat clypeus that directly abuts a broad, semicircular, flattened labrum (Figs. 30, 36). The female antennal flagellum has 9 flagellomeres: 1 anellus – 7 funiculars – unsegmented clava, that are cylindrical and compressed, with dense minute multiporous plate sensilla (MPS). An undescribed male, close to *V. metallicus*, has 11 (1–9–1) flagellomeres, with the 9 funiculars each with long, paired, outwardly curved ventral rami. Anterior lateral margin of prepectus rounded. Mesoscutellum rounded laterally with no indi-

cation of axillula (Figs. 32, 37). Posterior margin of mesoscutellum produced either as a long apically bifurcate process (Figs. 31, 32), or as a short apically emarginate process (Fig. 38). Petiole with strong dorsal scale (Fig. 39) and an elongate (*V. abercornensis*) or short blunt (*V. metallicus*) dorsolateral spine (Fig. 34, lpp). First gastral tergum with a lateral spiracle (Fig. 35). Cercus small and pustulate, with 4 long setae.

Distribution. *Afrotropical* (Nigeria and Zimbabwe). Undescribed species are known from Egypt (Maasarah), Tunisia (Douz) and Yemen (Manakhah), which extends the distribution into the southern *Palaearctic* region.

Vidlinus abercornensis (Risbec) n.comb. (Figs. 30–35)

Philomides abercornensis Risbec, 1958: 154, fig. 3. Type data: Zimbabwe [N. Rhodesia]: Abercorn. Holotype female, by monotypy (image examined). Type depository: Muséum National d'Histoire Naturelle, Paris; the type bears the labels *Philomides rhodesiensis* by Risbec [which was not used] and *Vidlinus* [manuscript name] *abercornensis* (Risbec) by Bouček in 1993, and the locality “Abercorn, N. Rhodesia, XI. 1943”, which is the same as reported by RISBEC (1958).

New material. NIGERIA: Ondo: Idanre Hills, 465 m, 7°06'0"N 5°07'12"E, 16 July 2008, C. Weirauch (1♀, UCR: UCRCENT 00412722; UCR DNA voucher code D1269 [not successful]) [compared to image of type].

Distribution. *Afrotropical*: Zimbabwe.

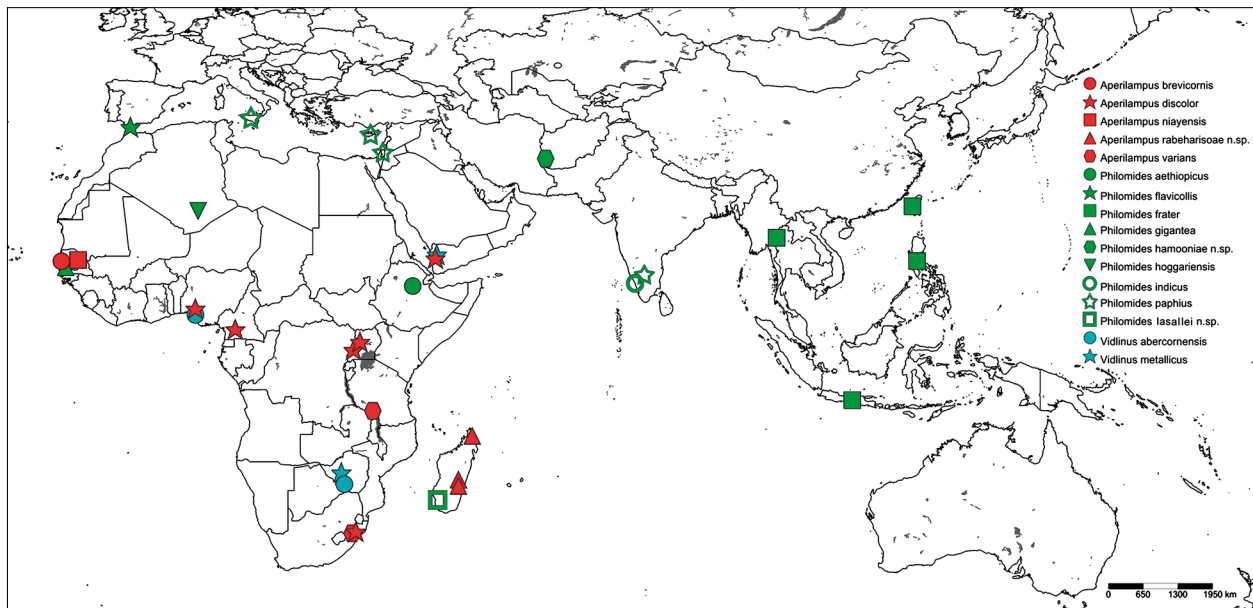


Fig. 42. Worldwide distribution of known Philomidinae.

***Vidlinus metallicus* (Risbec) n.comb.**
(Figs. 36–40)

Philomides metallicus Risbec, 1958: 157–159, fig. 4. Type data: Zimbabwe [S. Rhodesia]: Bulawayo. Holotype female, by monotypy (image examined). Type depository: Muséum National d'Histoire Naturelle, Paris.

New material. MOZAMBIQUE, INHAMBANE PROV.: Inhambane, 1 m, 23°51'54"S 35°23'00"E, R.F. Lawrence [1♀, SAMC: UCRCENT00247121]. NIGER, TILLABERI REG.: 13 km N Niamey, 13°32'36"N 2°16'24"E, 14.ix.2005, Madougou Garba and W.J. Pulawski [1♀, CASC: UCRCENT00417591]. YEMEN: 12 km NW of Manakhah, 15°08'39"N 43°42'46"E, 3.vii–21.viii.2001, A. van Harten, malaise trap, 6512 [1♀, UCRCENT00092160; specimen imaged]. ZAMBIA, LUSAKA PROV.: 20 km E Lusaka International Airport, 15°21'00"S 28°29'00"E, 2.iii.1998, W.J. Pulawski [1♀, CASC: UCRCENT00417589].

Variation. The specimens from Mozambique and Zambia are closer to the image of the holotype, with strong blue coloration of the mesosoma and entirely dark antennae and hind legs, whereas the specimens from Niger and Yemen have a generally lighter coloration, brown antennae, and a dark femora with lighter tibia and tarsi. Potentially these could represent two or more species but we cannot discount the artifacts of preservation techniques affecting their color.

Distribution. *Afrotropical*: Mozambique, Zambia, and Zimbabwe (RISBEC 1958).

4. Acknowledgements

We would like to thank Roger Burks, Chris Darling and Chrysalyne Dominguez for insightful comments on earlier drafts of this manuscript. Agnèle Touret-Alby and Claire Villemant provided information on the Risbec specimens in Paris, Michael Ohl and Lukas Kirschev on the Masi types in Berlin, Maria Tavano on the Masi type in Genova, and Sabrina Lo Brutto and Bruno Massa for the De Stefani type information. H.M. Yeshwanth allowed for the use

of his image of *Philomides*. Chris Darling helped with the identification of specimens from Indonesia. Many thanks to Klaus Klass and an anonymous reviewer for their insightful comments. This research was supported by grant NSF-DEB 1555808 to JMH.

5. References

- ASHMEAD W.H. 1904. Classification of the chalcid flies, or the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. Smith. – *Memoirs of the Carnegie Museum* 1: 225–551. doi.org/10.5962/bhl.title.10341
- BOUČEK Z. 1974. The pteromalid subfamily Eutrichosomatinae (Hymenoptera: Chalcidoidea). – *Journal of Entomology (B)* 43: 129–138.
- BOUČEK Z. 1978. A generic key to Perilampinae (Hymenoptera, Chalcidoidea), with a revision of *Krombeinius* n. gen. and *Euperilampus* Walker. – *Entomologica Scandinavica Supplement* 9: 299–307.
- BOUČEK Z. 1988. Australasian Chalcidoidea (Hymenoptera). A Biosystematic Revision of Genera of Fourteen Families, with a Reclassification of Species. – CAB International, 832 pp.
- BURKS R.A., MOTTERN J., HERATY J.M. 2015. Revision of the *Ora-sema festiva* species group (Hymenoptera: Chalcidoidea: Eucharitidae). – *Zootaxa* 3972: 521–534.
- CAMERON P. 1905. Description of a new species of *Philomides* (Chalcididae). (Hym.). – *Zeitschrift für Systematische Hymenopterologie und Dipterologie* 5: 150.
- DALLA TORRE KWV. 1898. *Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus, V. Chalcididae et Proctotrupidae*. Vol. V. – Leipzig, 598 pp.
- DARLING D.C. 1986. Revision of the New World Chrysolampinae (Hymenoptera: Chalcidoidea). – *Canadian Entomologist* 118: 913–940.
- DARLING D.C. 1988. Comparative morphology of the labrum in Hymenoptera: the digitate labrum of Perilampidae and Eucharitidae (Chalcidoidea). – *Canadian Journal of Zoology* 66: 2811–2835.
- DARLING D.C. 1992. The life history and larval morphology of *Aperilampus* (Hymenoptera: Chalcidoidea: Philomidinae), with a discussion of the phylogenetic affinities of the Philomidinae. – *Systematic Entomology* 17: 331–339.

- DE SANTIS L. 1950. Lista de sinonimas establecidas para los generos de Chalcidoidea. – *Revista del Museo de La Plata (Nueva Serie)* **37**: 47–67.
- DE STEFANI T. 1891. De duobus novis Hymenopteris Siciliae. – *Naturalista Siciliano (Nuova Serie)* **10**: 117–119.
- EADY R.D. 1968. Some illustrations of microsculpture in the Hymenoptera. – *Proceedings of the Royal Entomological Society of London (A)* **43**: 66–72.
- FERRIERE C. 1968. Notes sur quelques chalcidiens nouveaux ou peu connus (Hymenoptera). – *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* **40**: 240–248.
- GIBSON G.A.P., HERATY J.M., WOOLLEY J.B. 1999. Phylogenetics and classification of Chalcidoidea and Mymarommatoidea – a review of current concepts (Hymenoptera: Apocrita). – *Zoologica Scripta* **28**: 87–124.
- GIRISH KUMAR P., NARENDHAN T.C., RAJMOHANA K. 2008. A study on the taxonomy of the rare genus *Philomides* Haliday (Hymenoptera: Perilampidae) of Indian subcontinent. – *Record of the Zoological Survey of India* **108**: 123–128.
- FORTHMAN M., WEIRAUCH C. 2016. Phylogenetics and biogeography of the endemic Madagascan millipede assassin bugs (Hemiptera: Reduviidae: Ectrichodiinae). – *Molecular Phylogenetics and Evolution* **100**: 219–233.
- HALIDAY A.H. 1862. Caractères de deux nouveaux genres d'Hyménoptères de la famille des Chalcididae (*Philomides* et *Chirolophus*) de la collection du Docteur Sichel. – *Annales de la Société Entomologique de France* **2**: 115–118.
- HERATY J.M., BURKS B.D., CRUAUD A., GIBSON G., LILJEBLAD J., MUNRO J., RASPLUS J.-Y., DELVARE G., JANŠTA P., GUMOVSKY A.V., HUBER J.T., WOOLLEY J.B., KROGMANN L., HEYDON S., POLASZEK A., SCHMIDT S., DARLING D.C., GATES M.W., MOTTERN J.L., MURRAY E., DAL MOLIN A., TRIAPITSYN S., BAUR H., PINTO J.D., VAN NOORT S., GEORGE J., YODER M. 2013. A phylogenetic analysis of the megadiverse Chalcidoidea (Hymenoptera). – *Cladistics* **29**: 466–542; doi/10.1111/cla.12006.
- HERATY J.M., HAWKS D. 1998. Hexamethyldisilazane: A chemical alternative for drying insects. – *Entomological News* **109**: 369–374.
- ISIDORO N., BIN F., ROMANI R., PUJADE-VILLAR J., ROS-FARRÉ P. 1999. Diversity and function of male antennal glands in Cynipoidea (Hymenoptera). – *Zoologica Scripta* **28**: 165–174.
- KERRICH G.J. 1954. A systematic study of the parasite complex of the karoo caterpillar, *Loxostege frustralis* Zeller: Perilampidae and Ichneumonidae (Hym.). – *Journal of the Entomological Society of Southern Africa* **19**: 118–127.
- MADDISON D.R., MADDISON W.P. 2011. MacClade. Version 4.0. – <http://macclade.org>.
- MASI L. 1919. Chalcids of Tuscan Archipelago, Part 2. Eurytominae, Eucharidinae, [etc.]. Chalcididi del Giglio. – *Annali del Museo Civico di Storia Naturale di Genova* **48**: 277–337.
- MASI L. 1926. H. Sauter's Formosa-Ausbeute Chalcididae (Hymenoptera). – *Konowia* **5**: 325–381.
- MASI L. 1939. Hymenoptera: Chalcididae, Cynipidae, Ichneumonidae, Braconidae, Bethyidae. – *Missione Biologica nel Paese dei Borani*, Rome **3**: 21–24.
- MASI L. 1949. Note su calcididi della Palestina (Chalcididae Ashm. ed Eucharidae Ashm.) (Hymenoptera: Chalcidoidea). – *Bollettino della Società Entomologica Italiana* **79**: 91–94.
- MUNRO J.B., HERATY J., BURKS R.A., HAWKS D., MOTTERN J.L., CRUAUD A., RASPLUS J.-Y., JANŠTA P. 2011. A molecular phylogeny of the Chalcidoidea (Hymenoptera). – *PLoS One* **6**: e27023. doi:10.1371/journal.pone.0027023.
- NOYES J.S. 2017. Universal Chalcidoidea Database. – <http://www.nhm.ac.uk/our-science/data/chalcidoids/>.
- PECK O., BOUČEK Z., HOFFER A. 1956. Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). – *Memoirs of the Entomological Society of Canada* **34**: 120 pp.
- PETERS R.S., NIEHUIS O., GUNKEL S., BLÄSER M., MAYER C., PODSIADŁOWSKI L., KOZLOV A., DONATH A., VAN NOORT S., LIU S., ZHOU X., MISOF B., HERATY J., KROGMANN L. 2018. Transcriptome sequence-based phylogeny of jewel wasps (Hymenoptera: Chalcidoidea) reveals a history of rapid radiations, convergence and evolutionary success. – *Molecular Phylogenetics and Evolution* **120**: 286–296.
- RISBEC J. 1951. Les Chalcidoïdes de l'Afrique occidentale Française. – *Mémoires de l'Institut Français d'Afrique Noire*, Ifan-Dakur **13**: 1–409.
- RISBEC J. 1953. Chalcidoïdes et Proctotrupoïdes de l'Afrique occidentale Française (suppl. 2). – *Bulletin de l'Institut Français d'Afrique Noire* **15**: 549–609.
- RISBEC J. 1957a. Perilampidae africaines et malgaches (Hym.). – *Bulletin de la Société Entomologique de France* **61**: 184–189.
- RISBEC J. 1957b. Chalcidoïdes et Proctotrupoïdes de l'Afrique occidentale française (Suppl. 5 et 6). – *Bulletin de l'Institut français d'Afrique noire* **19**: 228–267.
- RISBEC J. 1958. Chalcidoïdes nouveaux d'Afrique du Sud. – *Occasional Papers of the National Museum of South Rhodesia*, Bulawayo **22B**: 147–162.
- RUSCHKA F. 1924. Die europäisch-mediterranen Eucharidinae und Perilampinae (Hym., Chalc.) [Der Chalcidenstudien IV. und V. Teil]. – *Deutsche Entomologische Zeitschrift* **1924**: 82–96.
- SHORTHOUSE D.P. 2010. SimpleMappr, an online tool to produce publication-quality point maps. – <http://www.simplemappr.net>
- STRAND E. 1911. Neue exotische Chalcididen der Gattungen *Phasgonophora* Westw., *Heptasmicra* Ashm., *Anacryptus* Kby., *Antrocephalus* Kby., *Aperilampus* Wlk. and *Chryseida* Spin. (Schluss). – *Fauna Exotica* **1**: 9–10.
- SWOFFORD D.L. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (* and other methods). Version 4.0a build 164. – Sinauer Associates, Sunderland, Massachusetts.
- WALKER F. 1862. Mr. F. Walker's notes on chalcidites and characters of undescribed species. – *Transactions of the Entomological Society of London* **1**: 380–385.
- WALKER F. 1871. Notes on Chalcididae. Part IV. Chalcididae, Leucospidae, Agaonidae, Eucharidae, Perilampidae, Ormyridae, Encyrtidae. – E.W. Janson, London, 55–70.
- WESTWOOD J.O. 1874. *Thesaurus Entomologicus Oxoniensis*; or illustrations of new, rare, and interesting insects, for the most part contained in the collections presented. – Oxford, 205 pp., 40 pls.

Zoobank Registrations

at <http://zoobank.org>

Present article: <http://zoobank.org/urn:lsid:zoobank.org:pub:60C69898-9CCE-4540-B034-14C6A6603F30>

Aperilampus rabeharisoae Heraty: <http://zoobank.org/urn:lsid:zoobank.org:act:E5A3AE4E-1B84-473A-AB0B-F8A-9E5E855E5>

Philomides hamooniae Heraty, Derafshan & Ghafouri Moghaddam: <http://zoobank.org/urn:lsid:zoobank.org:act:C770384E-ED67-4EFF-BE6A-D4BA48A69A82>

Philomides lasallei Heraty: <http://zoobank.org/urn:lsid:zoobank.org:act:C87D4065-B550-49CF-9B44-F8E22CCDD54F>

Vidlinus Heraty: <http://zoobank.org/urn:lsid:zoobank.org:act:65C37B04-999E-4270-A9AC-AB564BA13176>