



## A new species of *Cladochaeta* Coquillett, 1900 (Diptera: Drosophilidae) associated with *Sphodroscarta trivirgata* (Amyot & Serville, 1843) (Auchenorrhyncha: Aphrophoridae) from the Brazilian Amazon rainforest

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## A new species of *Cladochaeta* Coquillett, 1900 (Diptera: Drosophilidae) associated with *Sphodroscarta trivirgata* (Amyot & Serville, 1843) (Auchenorrhyncha: Aphrophoridae) from the Brazilian Amazon rainforest

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### ABSTRACT

A new species of *Cladochaeta* Coquillett, 1900 (Diptera: Drosophilidae) is described, *C. amorimi* **nov. sp.** based on a series obtained from pupae associated with nymphs of *Sphodroscarta trivirgata* (Amyot & Serville, 1843) (Auchenorrhyncha: Aphrophoridae) collected on the National Forest of Caxiuanã in the Brazilian Amazon, State of Pará. The new species belong so the *dykra* species group, being closely related to *Cladochaeta erecta* Grimaldi & Nguyen, 1999.

<http://www.zoobank.org/urn:lsid:zoobank.org:act:39052AE8-3C55-4C92-A78E-3AB46C9D3C8A>

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Spittlebug; Spittlebug fly;  
host record

## Introduction

The Brazilian Amazon is one of the largest and most biodiverse tropical rain forests of the planet. Despite the efforts of scientists to know the Amazon biodiversity, many species remain undescribed. Furthermore, many regions of this ecosystem remain poorly sampled and, as a consequence, only a few specimens of some taxa are available in entomological collections. Given that, even in the taxonomic studies dealing with the Neotropical fauna, Amazonian species are often poorly or not at all represented.

One practical example of this situation is the genus *Cladochaeta*, with 136 valid species and many more undescribed (Grimaldi and Nguyen 1999; Pirani and Amorim 2016). It is mostly restricted to the neotropics, occurring in Central and South America, with only 10 species recorded from the Nearctic region. This genus can be classified as an ‘open-ended’ taxon, since several of its species are known only by the type series and many areas of the Neotropical region are undersampled for this taxon (*i.e.* Colombia, Bolivia, Venezuela and Brazil) (Bickel 2009). Furthermore, estimations for the actual *Cladochaeta* diversity give astonishing numbers, such 645 species for Central America and 1,700 for South America alone (Bickel 2009).

These flies present a relatively uniform external morphology, concerning its colours and shapes, but the male terminalia are extremely complex and different between species in a level that makes the interpretation of homologies between the sclerites difficult. Four classic papers deal in detail with the description and

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understanding of these structures (Frota-Pessoa 1947; Wheeler and Takada 1971; Vilela and Bachli 1990; Grimaldi and Nguyen 1999) giving the bases for its understanding. More recently, Pirani and Amorim (2016) made a discussion about the male terminalia in *Cladochaeta*, standardising the nomenclature with the currently used for Diptera and providing more accurate homology, an effort that still needs to be increased.

Most of the species of this genus have been found in association with nymphs of spittlebugs and froghoppers (Auchenorrhyncha: Aphrophoridae and Clastopteridae) (Grimaldi and Nguyen 1999), but there is one species associated with spider eggs and another with the silk cocoon of a spider wasp (Pompilidae) (Carvalho-Filho et al. 2018) as well as two that have been obtained from flowers (Grimaldi and Nguyen 1999; Santos and Vilela 2005). However, the natural history of most of the species remains undocumented.

In an inventory of flies from the National Forest of Caxiuanã, in the Brazilian Amazon, a new species of *Cladochaeta* was obtained from nymphs of *Sphodroscarta trivirgata* Amyot & Serville, 1843, which is described in this paper.

## Material & methods

Specimens were collected in the Scientific Station Ferreira Penna (1°44'13.67"S; 51° 27'20.46"W), located in the National Forest of Caxiuanã, in the municipality of Melgaço, ca. 400 Km west of Belém, State of Pará, Northeast Amazon. This region is composed mainly of primary upland ('terra-firme') forest.

The specimens were obtained by collecting the fly puparium associated with nymphs of *Sphodroscarta trivirgata* at a trail inside the forest. A host plant stem with the fly pupa was maintained in a plastic bowl at room temperature. The emerged specimens were killed by freezing after being aged for 3 days after emergence and it was glued on pinned card triangles.

Male terminalia, wing and antennae preparation follows Pirani and Amorim (2016). Specimen was photographed under a Leica DC 500 camera coupled to a Leica M16 stereoscope and to Leica DM2500 scope for the structures prepared in slides, like wing and antennae. The Z-stacking of photos was done using the Helicon Focus 6. The illustrations were drawn under a *camara lucida* coupled to the Leica DM2500 scope and then vectorised in Adobe Illustrator CS6. The life history photographs were taken with a Nikon D90 with 18–105 mm Nikon lens and a 105 mm Sigma macro lens with a flash Nikon SB900. Scanning Electron Microscopes (SEM) images were produced with Tescan Mira3 after gold-palladium coating.

The terminology used in the description follows Cumming and Wood (2017), except for the enumeration of dorsal branches of the arista which follows Grimaldi and Nguyen (1999) and Pirani and Amorim (2016).

Label data of type specimens are presented in verbatim quotation with individual lines separated by a forward slash (/) and individual labels separated by a double forward slash (//).

The type series is deposited in the entomological collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, State of Pará, Brazil, and in the Museu de Zoologia da Universidade de São Paulo (MZUSP), state of São Paulo, Brazil (check the section 'material examined' bellow for specification).

## Results

### *Systematic description*

Family **DROSOPHILIDAE** Rondani, 1856

Genus ***Cladochaeta*** Coquillett, 1900

***Cladochaeta amorimi*** sp. nov. (Figures 1–6)

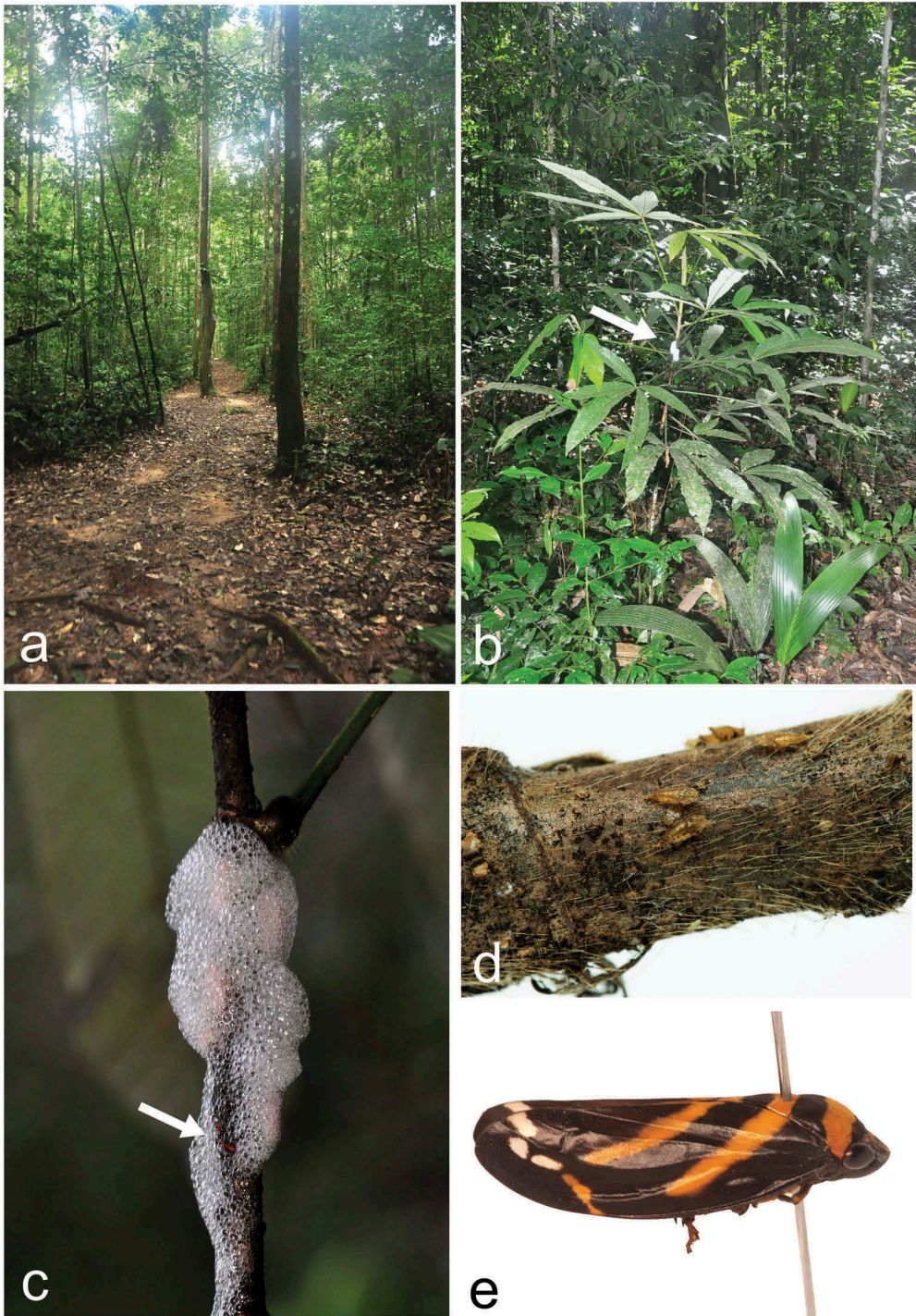
### *Material examined*

Holotype male labelled as follows: Melgaço, PA [= State of Pará], Brasil [= Brazil]/ECFPn [= Ferreira Penna Scientific Station]-Flona Caxiuanã [= National Forest of Caxiuanã]/Trilha do Esecaflores [= Esecaflores trail]/17.iii.2017/F.S. Carvalho Filho [collector]/Criação de pupas/ associadas à *Sphodroscarta trivirgata* [= Reared from pupae associated with *Sphodroscarta trivirgata*]. Left wing and right antenna double mounted, and terminalia in a microvial, both pinned below the source specimen. Deposited at the Museu Paraense Emílio Goeldi (MPEG). Paratypes: five males (three deposited in MPEG and two deposited in MZUSP) and three females (two deposited in MPEG and one deposited in MZUSP) with same data as holotype, except 15–20.iii.2018.

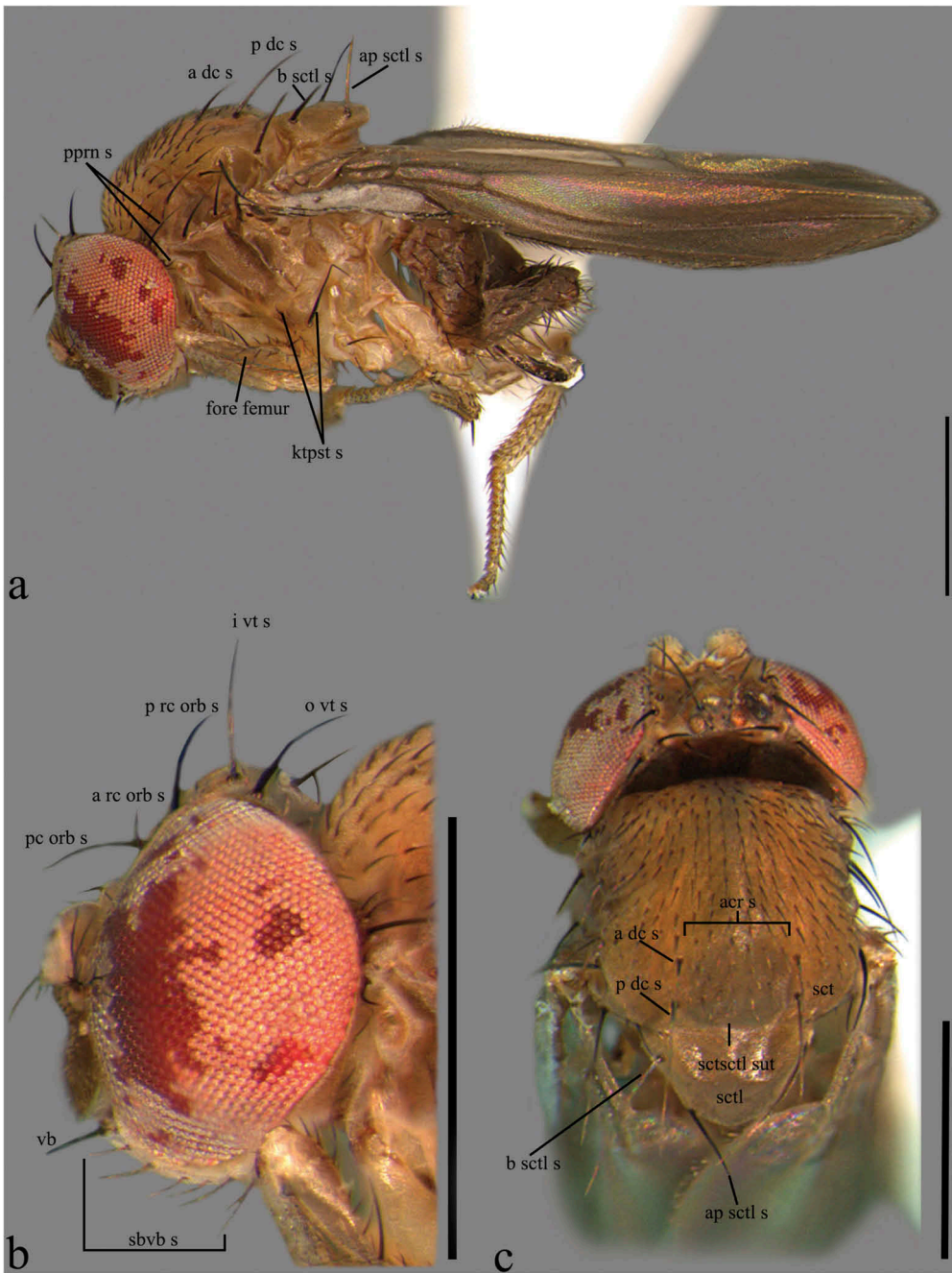
### *Diagnosis*

Fore femur with a row of 10 dorsal setae, the most basal one and the sixth (counting from base to apex) longer than others; six dorsolateral, three lateral and three apical setae of similar length. Male terminalia very distinctive: phallus cylindrical and exceedingly long, with two medioventral rows of strong spines (Figure 4).

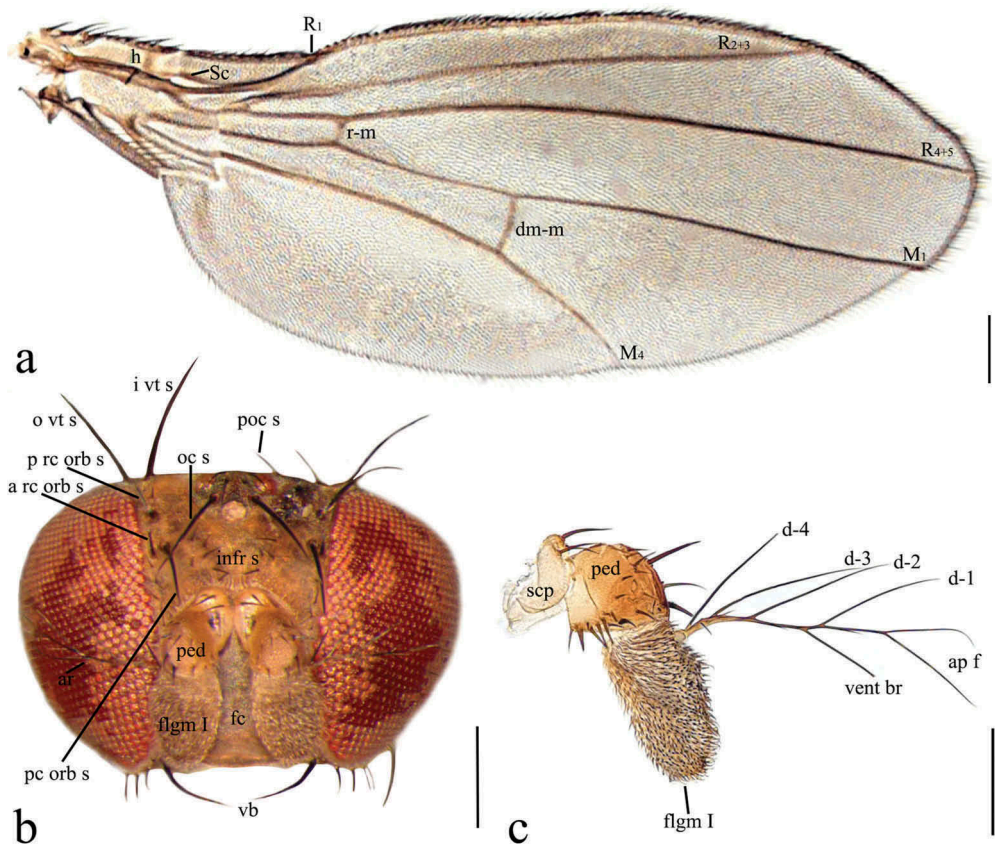
**Description of the adult male.** Body length: 1.4 mm. **Head** (Figures 2(b)–(c) and 3(b)). Higher than wide; wider than thorax. Eye bare, light red. Antenna 0.41 mm long; scape light yellow with three median setae, dorsal one longer than ventral ones; pedicel light brown with three large median setae, plus ca. 20 smaller ones distributed on pedicel as fig. 2C; first flagellomere greyish yellow with dense and long setulae; arista with four dorsal and one ventral branches, plus long apical fork ventral branch between third and fourth dorsal branch, but closer to fourth (Figure 3(c)). Frons light brown, ocellar triangle bearing four setulae plus the ocellar setae; 10 interfrontal setulae present. Anterior reclinate orbital seta ca. 1/3 the length of posterior reclinate orbital seta and anterolateral to proclinate orbital seta; posterior reclinate orbital seta as long as proclinate orbital seta and midway between proclinate orbital seta and outer vertical seta; five fronto-orbital setulae present. Post-ocellar small, ca. 1/2 of inner vertical setae; outer vertical and inner vertical setae about the same length. Face ventrally very slightly elevated, light greyish brown; parafacial, oral margin and gena whitish yellow; a row of seven sub-vibrissal setae present. Proboscis light yellow, palpus light yellow with brown apex. **Thorax** (Figure 2(c)). Length: 0.72 mm. Mostly light brown; scutum light brown, with a longitudinal darker band medially, larger between the dorsocentrals. Anterior dorsocentral ca. 2/3 length of posterior dorsocentral. Posterior dorsocentral midway between scutoscutellar suture and anterior dorsocentral. Acrostichal setulae in six straight rows. Scutellum light brown; basal scutellar setae convergent, apical scutellar setae cruciate.



**Figure 1.** (a) Upland forest of the scientific station Ferreira Penna (ECFPn) in the national forest of Caxiuana, Brazil. (b) Young plant *Cecropia sciadophylla* with an arrow pointing to the spittle mass produced by nymphs of *Sphodroscarta trivirgata*. (c) Spittle mass produced by nymphs of *Sphodroscarta trivirgata* with an arrow pointing to the pupae of *Cladochaeta amorimi* sp. nov. (d) Twig of *Cecropia sciadophylla* with pupal cases of *Cladochaeta amorimi* sp. nov. (e) Adult of *Sphodroscarta trivirgata*.

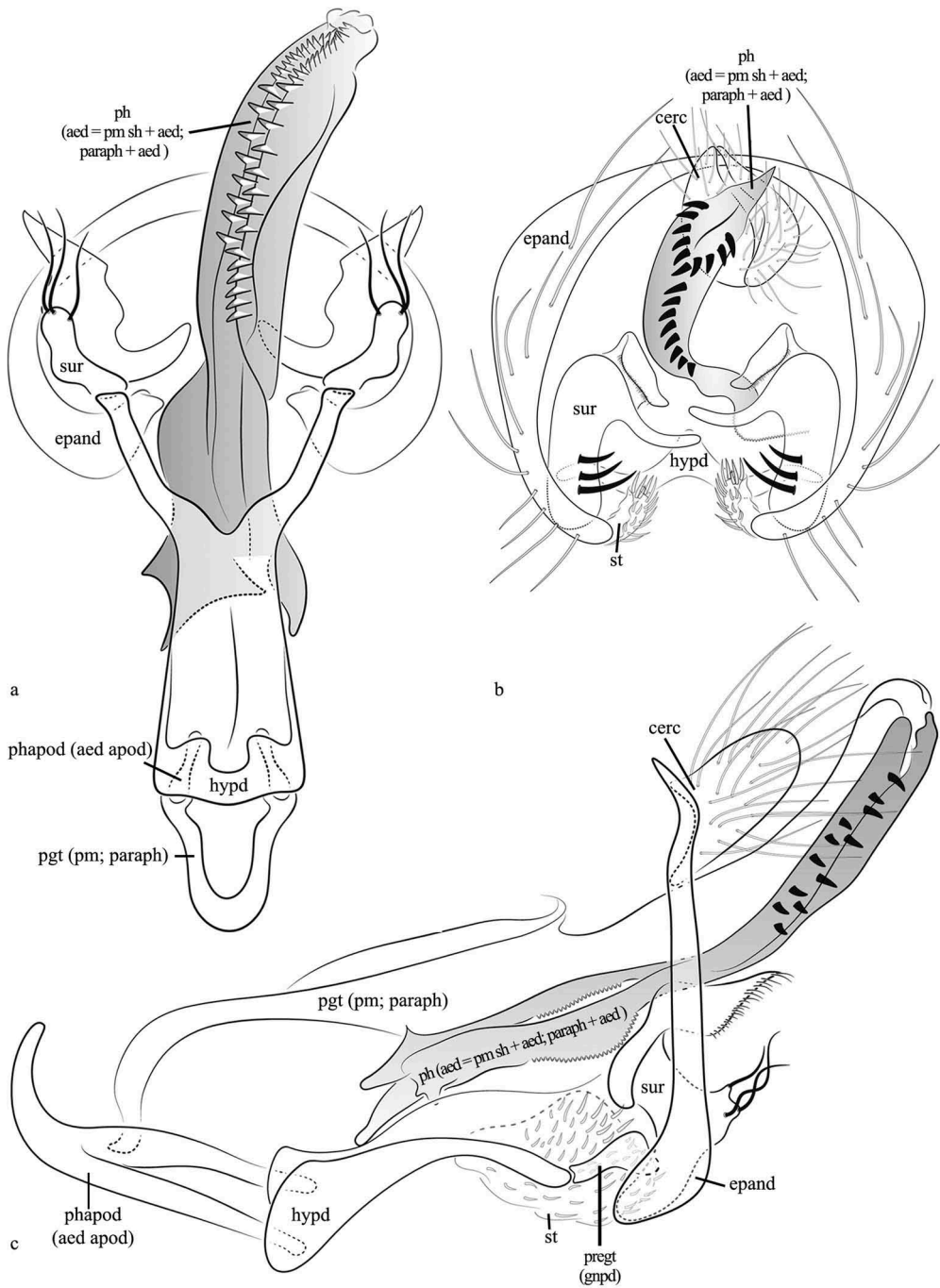


**Figure 2.** *Cladochaeta amorimi* nov. sp., holotype. (a) Lateral habitus. (b) Head, lateral view. (c) Head and thorax, dorsal view. Abbreviations. a dc s: anterior dorcentral seta; a rc orb s: anterior reclinate orbital seta; acr s: acrostichal setulae; ap sctl s: apical scutellar seta; b sctl s: basal scutellar seta; i vt s: inner vertical seta; ktpst s: Katepisternal setae; o vt s: outer vertical seta; p dc s: posterior dorsocentral seta; pc orb s: proclinate orbital seta; pprn s: postpronotum setae; sbvb s: subvibrissal setae; sct: scutum; sctscutl sut: scutuscutellar suture; scutl: scutellum; vb: vibrissa. Scale bars: 0.5 mm.

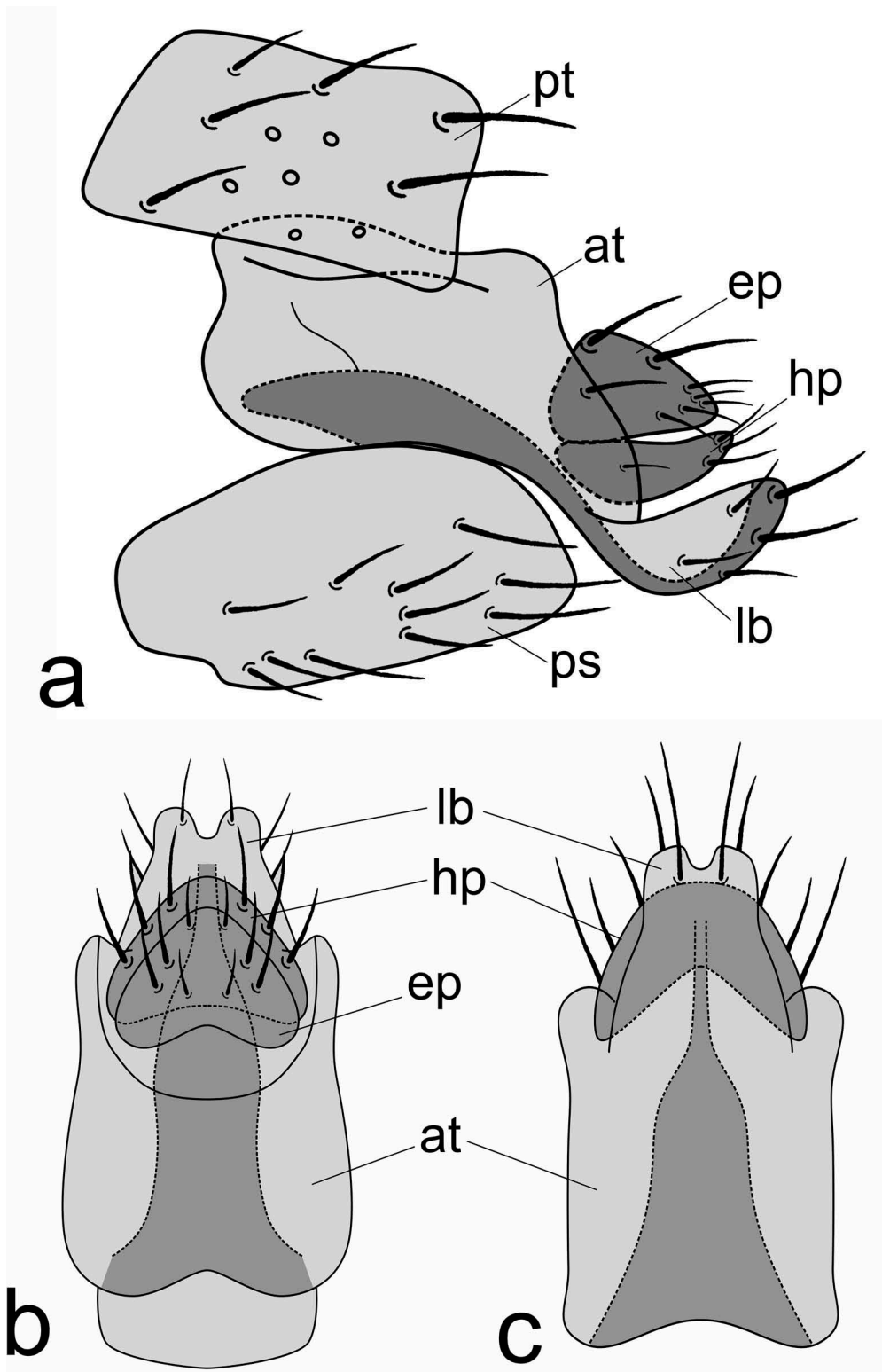


**Figure 3.** *Cladochaeta amorimi* nov. sp., holotype. (a) Wing. (b) Head, frontal view. (c) Antenna. Abbreviations: a rc orb s: anterior reclinate orbital seta; ap. f: apical fork; ar: arista; r-m: basal medial-cubital crossvein; d-1: first dorsal branch; d-2: second dorsal branch; d-3: third dorsal branch; d-4: forth dorsal branch; dm-m: discal medialcrossvein; fc: face; flgm 1: first flagellomere; h: humeral crossvein; i vt s: inner vertical seta; infr s: interfrontal setulae; M<sub>1</sub>: medial vein; M<sub>4</sub>: fourth medial vein; o vt s: outer vertical seta; oc s: ocellar seta; p rc orb s: posterior reclinate orbital seta; pc orb s: proclinate orbital seta; ped: pedicel; poc s: postocellar seta; R<sub>1</sub>: anterior branch of radius; R<sub>2+3</sub>: second longitudinal vein; R<sub>4+5</sub>: third longitudinal vein; sc: subcostal vein; scp: scape; vb: vibrissa; vent. br: ventral branch. Scale bars: 0.1 mm.

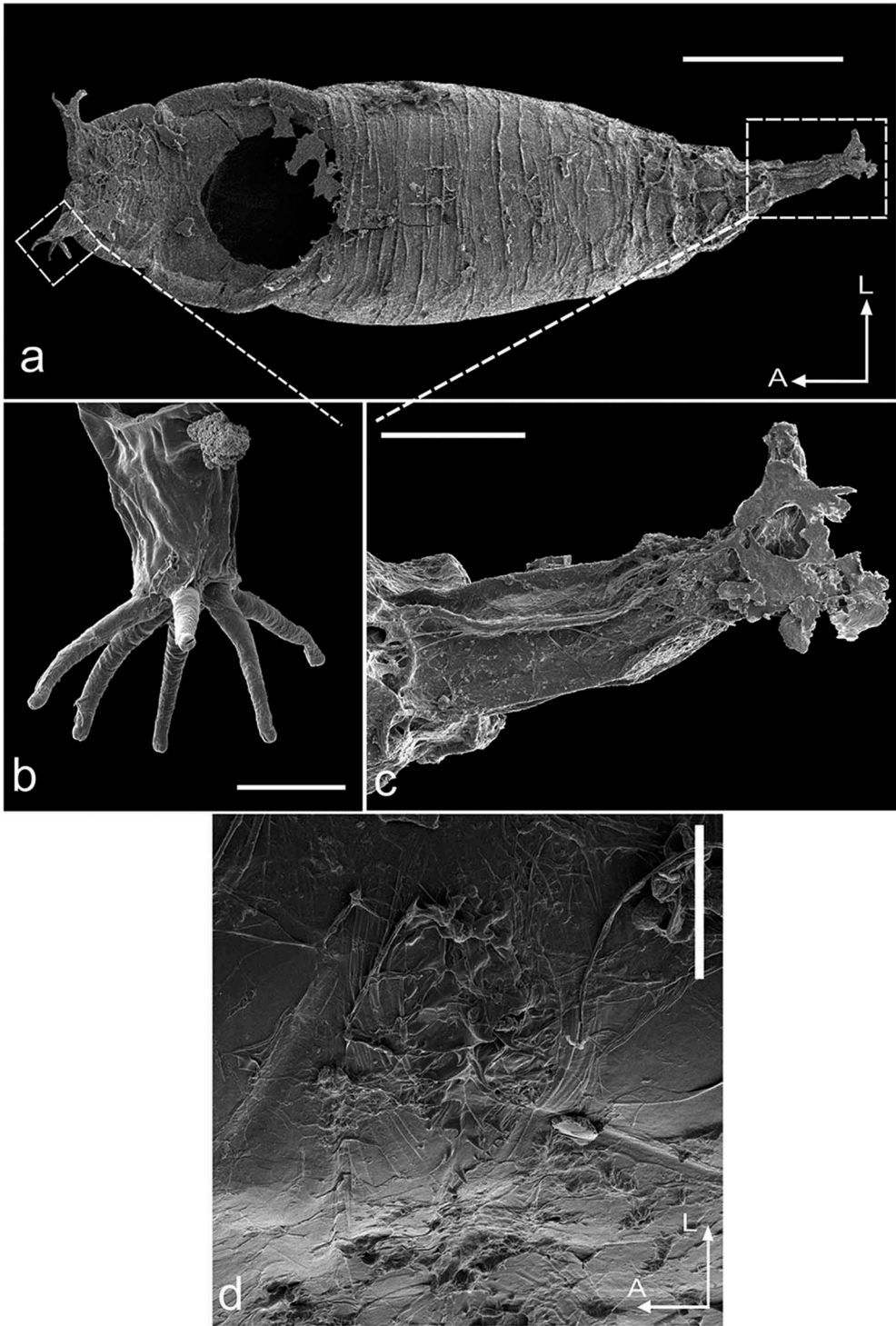
Two postpronotal seta present, ventral ca. 1/3 length of dorsal one; four postpronotal setulae present. Two katepisternal setae of unequal length. Legs homogeneously pale yellow; fore femur with a row of 10 dorsal setae, most basal and the sixth (counted from base to apex) longer than others; six dorsolateral, three lateral and three apical setae of similar length. **Wing** (Figure 3(a)). Length: 1.8 mm. Membrane infuscate, uniformly brownish. C ending at M<sub>1</sub>, with 10 setae of unequal length basally to h vein, and one seta at subcostal break. R<sub>2+3</sub> slightly curved towards anterior wing margin. R<sub>4+5</sub> and M<sub>1</sub> parallel. Crossvein dm-m slightly bent in the middle, perpendicular to M<sub>4</sub>. **Halter** pale yellow. **Abdomen** uniformly brown; apical sternites bearing modified setae and strongly connected with ventral portion of epandrium. **Male terminalia** (Figure 4(a-c)). Epandrium very thin, with inverted U-shape, higher than wide, with 11 setae of different length in a misaligned row on each ventral side. Cercus simple, without ventrolateral



**Figure 4.** *Cladochaeta amorimi* nov. sp., holotype, male terminalia. (a) Ventral view. (b) Terminal view. (c) Lateral view. Abbreviations: aed: aedeagus; aed apod: aedeagal apodeme; cerc: cercus; epan: epandrium; gnpd: gonpod; hypd: hypandrium; paraph: paraphysis; pgt: postgonite; ph: phallus; phapod: phallapodeme; pm sh: parameral sheath; pregt: pregonite; st: sternite; sur: surstylus. Nomenclature follows Cumming and Wood (2017), followed by the traditional drosophilid nomenclature in parentheses (McAlpine 1981; Bächli et al. 2004).



**Figure 5.** *Cladochaeta amorimi* sp. nov., paratype female terminalia. (a) lateral view. (b) dorsal view. (c) ventral view. Abbreviations: at: apical tergite; ep: epiproct; hp: hypoproct; lb: lateral lobe; ps: penultimate sternite; pt: penultimate tergite.



**Figure 6.** *Cladochaeta amorimi* sp. nov., puparium. (a) Entire puparium, dorsal view. Scale bar: 500  $\mu$ m. (b) Anterior spiracle, dorsal view. Scale bar: 50  $\mu$ m. (c) Posterior spiracle, dorsal view. Scale bar: 100  $\mu$ m. (d) Rosettes of abdominal segment, ventral view. Scale bar: 100  $\mu$ m. Arrows pointing A: anterior and L: lateral.

lobes. Phallus very long, ventrally sclerotised, with two medioventral rows of strong spines; postgonite longer than phallus in lateral view, less sclerotised. Surstylus sinuous and complex: ventral portion bearing three long and thick setae, a finger-shaped projection medially and a dorsal fold terminally directed bearing a row of marginal setulae. Hypandrium y-shaped. Pregonites present, small and bare. Phallapodeme thin, higher than wide, with two ventral arms articulating with the anterior portion of hypandrium and a single dorsal portion directed terminally, articulating with postgonites.

**Adult female.** External morphology similar to male. Female terminalia hardly sclerotised and elongated; apical tergite largely fused beneath epiproct and hypoproct, lateral lobes fused with a medial excavation (Figure 5(a–c)).

**Puparium (Figures 1(c–d) and 6(a–d)).** Length: 2.5 mm. Reddish brown. Elongate, with lateral margins and anterior region dorsally flattened anteriorly, slightly narrowed anteriorly and posteriorly, without protuberances and spinulose bands in the intersegmental region. Dorsal surface with vertical parallel wrinkles. Hardly any constrictions at the segmental borders. Abdominal segments with a pair of prolegs composed by elliptical rosettes of creeping welt spinules. Anterior spiracle on an elongated tubular stalk, with six long branches; stalk longer than branches. Caudal segment elongated and dorsally flattened, with two divergent branches where are placed the posterior spiracles.

**Etymology.** The specific name is in honour of the dipterist Dr. Dalton de Souza Amorim, who was essential to the understanding of the very complex male terminalia of this species and who contributed to the hand drawing of the terminal view and helped with homology issues.

**Distribution.** NEOTROPICAL – Brazil (Pará).

**Remarks.** This species belongs to the *dikra* species group (Grimaldi and Nguyen 1999) according to the general shape of phallus and surstyli.

**Biology.** (Figure 1(a–e)) The pupae of *C. amorimi* sp. nov. were found attached to a twin stem of a young *Cecropia sciadophylla* Mart. (Figure 1(b)) inside the spittle mass produced by nymphs of *Sphodroscarta trivirgata* (Auchenorrhyncha: Aphrophoridae) about 80 cm from the ground (Figure 1(c–e)). The plant was on the border of a trail in a pristine upland (*terra-firme*) forest (Figure 1(a)). Most of the species of *Cladochaeta*, in which the biology is known, are associated with nymphs of *Clastoptera* (Clastopteridae). This is the third species that has been recorded in association with species of *Sphodroscarta* (Aphrophoridae), the other being *C. caxiuana* and *C. spectabilis* (Grimaldi and Nguyen 1999; Carvalho-Filho et al. 2018).

## Discussion

*Cladochaeta amorimi* sp. nov. is placed in the *dikra* species group, mostly due to its resemblance to *C. erecta* (Grimaldi and Nguyen 1999) in general body and male terminalia characters.

However, both species (*C. erecta* and *C. amorimi* sp. nov.) differ from the others in this group by a strongly modified phallus, which causes doubt about the proper allocation of both species.

These clearly differ from each other in several characters. The face of *C. erecta* is flat, while in *C. amorimi* sp. nov. it has a subtle elevation ventrally; the setation of the fore femur in *C. amorimi* sp. nov. is: 10 dorsal setae, the basal one and the sixth (counted from base to apex) longer than others; six dorsolateral, three lateral and three apical setae of similar length; while in *C. erecta* the setation is: one dorsolateral and two ventrolateral apical. In the male terminalia, *C. erecta* has a long ventral lobe in the cercus, which is absent in *C. amorimi* sp. nov.; *C. amorimi* sp. nov. has a phallus with two rows of medioventral spines from apex to middle, while *C. erecta* does not have spines in this position, although it has a small, heavily sclerotised hook on ventral surface of its base (Grimaldi and Nguyen 1999). In addition, the dorsal portion of phallapodeme in *C. erecta* is large and flat, while in *C. amorimi* sp. nov. is thinner.

## Acknowledgements

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## Disclosure statement

No potential conflict of interest was reported by the authors.

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