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Taxonomy of the Brazilian firefly *Cladodes illigeri* (Coleoptera, Lampyridae): morphology and new records

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ABSTRACT. *Cladodes illigeri* (Kirby, 1818) is redescribed, and can be distinguished by the following features: color pattern overall black, paired spots and elytral margins pale yellow; pygidium bisinuate, posterior angles rounded, as long as median margin; and aedeagus with phallus 1/3 shorter than the parameres, which are sinuated apically. *Cladodes lamellicornis* (Motschulsky, 1854) is proposed as a junior synomym of *C. illigeri*. New records from the Atlantic Rainforest and illustrations for structural features are provided.

KEYWORDS. Amydetinae, Vestina, Neotropical, synonymy.

RESUMO. Taxonomia de *Cladodes illigeri* (Coleoptera, Lampyridae): morfologia e novos registros. *Cladodes illigeri* (Kirby, 1818) é redescrito, o qual pode ser diagnosticado pelos seguintes caracteres: padrão do colorido negro, com par de faixas amarelo-pálidas nas margens elitrais; pigídio bisinuoso, ângulos posteriores arredondados, tão longo quanto a margem mediana; e edeago com falo 1/3 mais curto que os parâmeros, os quais são sinuosos apicalmente. *Cladodes lamellicornis* (Motschulsky, 1854) é sinonimizado com *C. illigeri*. Novos registros da Mata Atlântica e ilustrações das características estruturais são fornecidos.

PALAVRAS-CHAVE. Amydetinae, Vestina, Neotropical, sinonímia.

Cladodes Solier, 1849 (Amydetinae, Vestina) are small to very large-sized diurnal fireflies, distributed in South America (McDermott, 1964), which share the following common characters: an outline narrowly to broadly elliptic; antennae 11-jointed, flabellate and sometimes fan-folded, shorter than body half, antennomeres short, flabellae very long; eyes mediocre; elytra widest at, ahead of, or posterior to midlenght; abdomen strongly lobed; terminal sternum with a median triangular point; male luminous organs rudimentary. The genus has 21 species (McDermott, 1966) in two subgenera: *Cladodes s. str.*, and *Fenestratocladodes* Pic, 1935, monotypic. The genus still lacks taxonomic revision, and this study is the first attempt towards it. In this paper, we present a redescription of *Cladodes illigeri* (Kirby, 1818) based on study of holotype, and provide illustrations of structural features.

MATERIAL AND METHODS

Dissection techniques and terminology follows Silveira & Mermudes (2013, 2014a,b). We dissected and boiled in 10% KOH the specimens. Wing and abdominal sclerites were mounted under glass before illustration. The material was analyzed under stereomicroscope and photographs were made with the Leica Application Suite CV3 Auto-montage Software. Photographs were adjusted in Adobe Photoshop CS5 software. Specimens studied belong to the following collections: The National History Museum, London, United Kingdom (BMNH), Muséum National d'Histoire Naturelle, Paris, France (MNHN), Zoological Museum of the Lomonosov, University of Moscow, Russia (ZMLM), Museu Nacional, Rio de Janeiro, Brazil (MNRJ) and Coleção Entomológica Prof. José Alfredo Pinheiro Dutra, Rio de Janeiro, Brazil (DZRJ). Diagnosis was provided based on the comparison with co-generic species compared with type-material whenever possible.

RESULTS

Cladodes illigeri (Kirby, 1818)

(Figs 1-32)

Lampyris illigeri Kirby, 1818:387
Megalophthalmus (?) *illigeri* Motschulsky, 1854:25
Lucernuta illigeri Olivier, 1911:65
Cladodes illigeri McDermott, 1966: 82
Nyctocrepis lamellicornis Motschulsky, 1854:10; Lacordaire, 1857:314; Olivier, 1885:139; Gorham, 1880:7 **Syn. nov**.
Cladodes lamellicornis McDermott, 1966:82.

Diagnosis. Colour pattern: body overall dark brown, pronotum black, with paired lateral pale yellow vittae, elytra black, basal 1/2 of lateral margins pale yellow, abdominal sternum VIII with 1/3 lateral translucent, rudimentary larval lanterns conspicuous pygidium black, with anterolateral vittae, trochanters and basal 1/4-1/3 of femora pale yellow. Pronotum semicircular, almost 2x wider than long; posterior angles rounded, slightly projected posteriad. Elytra almost 2.75x longer than wide, widest at basal 1/3, then narrowing towards the apex. Phallobase symmetric; parameres

Fig. 1. *Cladodes illigeri* (Kirby, 1818). Holotype, *habitus* and labels.

symmetric, widest in the basal 2/5, then tapering to distal third, distal portion sinuate and projected internally; phallus 1/3 shorter than the parameres, constricted subapically, ventrodistally clefted, dorsoventrally membranous in apical 1/4; endophallus projected beyond the phallus.

Redescription, male. Body overall dark brown. Pronotum black with paired lateral pale yellow vittae. Elytra black, basal 1/2 of lateral margins pale yellow. Abdominal sternum VIII with 1/3 lateral translucent, rudimentary larval lanterns conspicuous. Pygidium black with anterolateral vittae. Trochanters and basal 1/4-1/3 of femora pale yellow.

Body shape elliptic (Figs 1, 2). Head (Figs 1−13) completely covered by pronotum (Figs 3−4), 2x wider than long. Eye (Figs 5−9) as long as 3/5 head width in dorsal and ventral view; 1/4 as wide as head width, almost as wide in dorsal as in ventral view; internal margin divergent posteriad in dorsal view, almost parallel ventrally; posteroventral margin slightly beveled in lateral view; posterior margin somewhat truncate in ventral view. Frons prominent. Vertex (Figs 5−9) somewhat plane, with two discrete posterior parasagittal indentations. Antennal sockets (Figs 7−8) elliptic, separated by 1/3 labral width; 1/3 longer than wide; antennifer process conspicuous. Antennae(Figs 1−4,12) 11-jointed, flabellate, scape constricted in basal 1/2, pedicel slightly wider than long, antennomeres III-XI increasingly longer towards apex, basal flabellae slightly longer than 1/2 antenna length, flabellae slightly decreasing in size towards apex, antenommere XI 5x longer than X. Frontoclypeus curved. Labrum rectangular, slightly longer than wide, connate to frontoclypeus. Mandibles (Fig 13) abruptly arcuate almost right-angled, apex acute, tooth absent; external margin sparsely setose in basal 1/3; internal margin strongly sulcate, with a wisp of bristles, basally. Hypopharynx bilobed, with dense, minute bristles. Maxillary palpus (Figs 5−6) 4-jointed, IV>III>II=I, palpomere IV securiform with internal margin rounded; cardo weakly-sclerotized, posterior margins truncate, stipe triangular, well-sclerotized, lacinia with dense, minute bristles. Labial palpus (Figs 5−6) 3-jointed, III>II=I, palpomere III securiform with internal margin straight; praementum well-sclerotized and bristled, sagittally divided; mentum U-shaped sclerotized and bristled. Gular sutures divergent posteriad, lesser width as wide as cardo width; gular bar straight, as long as 1/2 cardo length, as wide as 1/2 cardo width. Occiput (Fig 9) oblong, 1/3 longer than wide. Tentorium (Figs 10−11) long and slender, almost as high as head high, projected internally on the half of its length, strongly curved backwards.

Thorax (Figs 14−24) with pronotum (Figs 14−15) semicircular, almost 2x wider than long; posterior angles rounded, slightly projected posteriad; disc overall trapezoidal, regularly, finely punctured, medially elevated, anterior margin projected, recurved anteriad, posterior margin straight, lateral margins divergent posteriad and depressed; with a line of deep marginal punctures; expanded all over, expansions irregularly, deep punctured, punctures separated by less than puncture diameter, anterior and lateral expansions well-developed, as wide as 1/2 disc posterior margin, lateral expansions (Fig 16) rather straight in posterior view, posterior expansions short, discreetly bisinuate; 1/3 wider than elytra major width. Hypomeron (Fig 16) 2x longer than high, discreetly projected posteriad, anterior and posterior margins beveled, ventral margin somewhat emarginate. Prosternum (Fig 15) 8-9x wider than long, anterior margin curved, posterior margin projected, prosternal process wide, truncate, entirely bristled. Proendosternite (Fig 17) slender, slightly shorther than 3x distance between proendosternites. Mesoscutellum (Fig 22) bristled, finely punctured, posterior margin rounded. Elytra (Fig 20) almost 2,75x longer than wide, widening up to basal 1/3, then narrowing towards apex, pubescent, secondary pubescence present, with four costae, plus the marginal one, epipleura distinct up to 1/2 elytra length, with a line of conspicuous punctures all over sutural and lateral margins. Hind wing (Fig 21) well-developed, radial cell well developed, 4x wider than long, almost reaching anterior margin, costal row of setae absent, ScP juxtaposed to RA up to basal 1/4 radial cell length, where they fuse with C; CuA_2 and mp-cu crossveinpresent; $RP + MP_{1+2}$ slightly shorter than R4, almost reaching distal margin; J absent. Allinotum (Figs 22) 1/4 wider than long, lateral margins slightly convergent posteriad, posterior margin emarginate; prescutum (Figs 22−23) extending up to 1/2 metascutum length; rounded area of scutum weakly sclerotized, posterior margin membranous; scutum-prescutal plate well-developed, sclerotized, extending ridges up to posterior margin; metascutellum glabrous; postnotal plate emarginate. Mesosternum (Fig 24) membranous anteriad, pointed posteriad. Metasternum (Fig 24) depressed by the mesocoxae, anterior medial keel absent; discrimen almost as long as 2/5 sternum length; lateral margins enlarging towards lateral-most part of metacoxa, then convergent posteriad; with a pair of parasagittal indentations. Mesosternum/mesanepisternum suture indistinct. Mesanepisternum/mesepimeron suture conspicuous. Mesepimeron attachment to metasternum membranous. Mesendosternum with two parasagittal projections, irregularly allate, turned outwards.

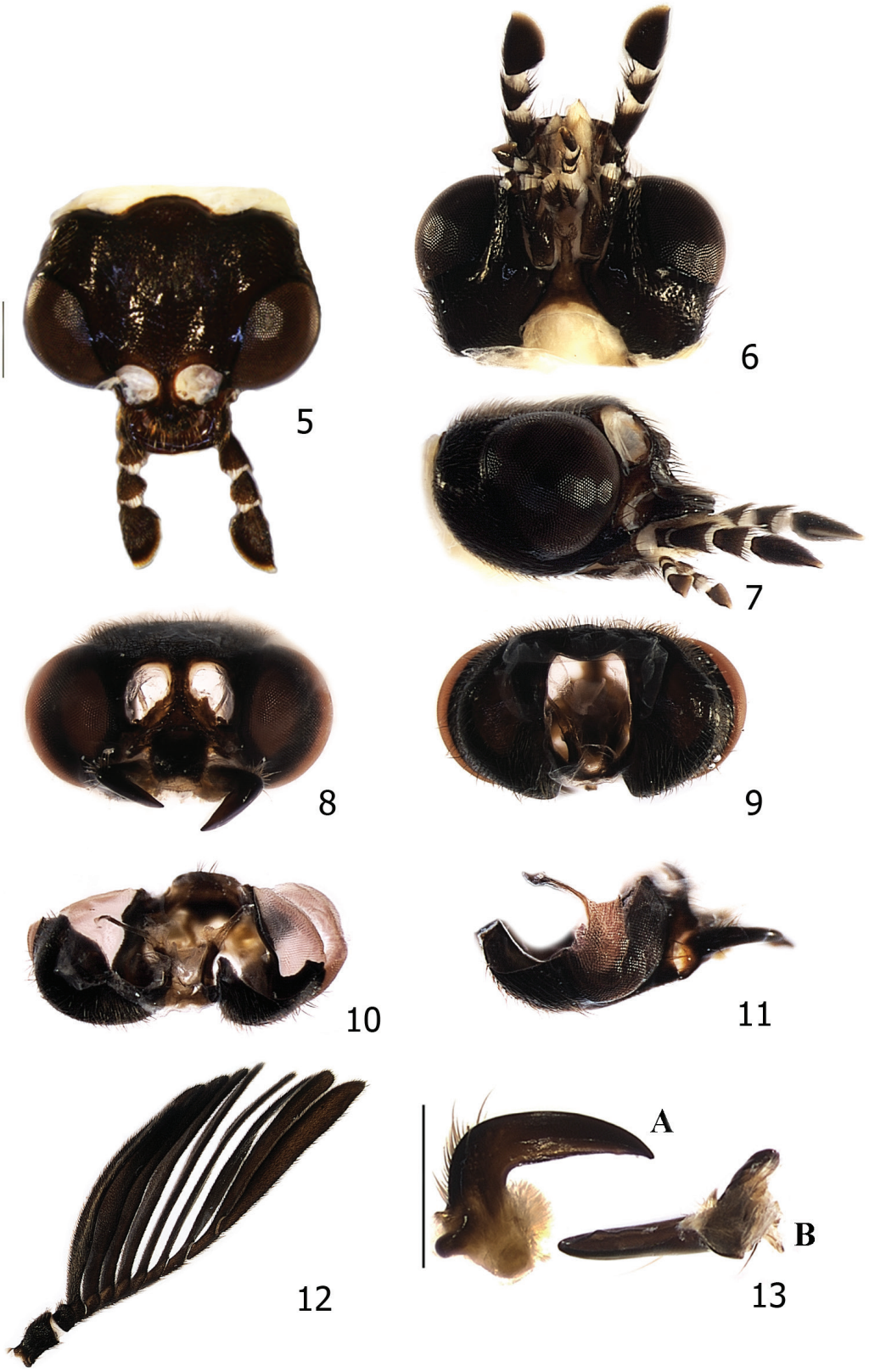
Figs 2-4. *Cladodes illigeri* (Kirby, 1818): 2, dorsal; 3, ventral; 4, lateral *habitus*. Scale bar: 10 mm.

Metendosternum spatulate, projected and acute anteriad, with two lateral laminae, of the same width in anterior and posterior half. Trochantins sparsely setose in pro and mesolegs; protrochantin as wide as 1/2 procoxal width, touching procoxa medially; mesotrochantin as wide as 2/3 mesocoxal width, touching mesocoxa at internal 1/3. Procoxae tapering distally. Trochanters discreetly divided. Femur as long as tibia in pro and mesolegs; tibia slightly longer than femur in metaleg. Tarsi I>V>IV>II>III; II bilobed, dense and finely bristled, lobes as long as 2/3 V lenght.

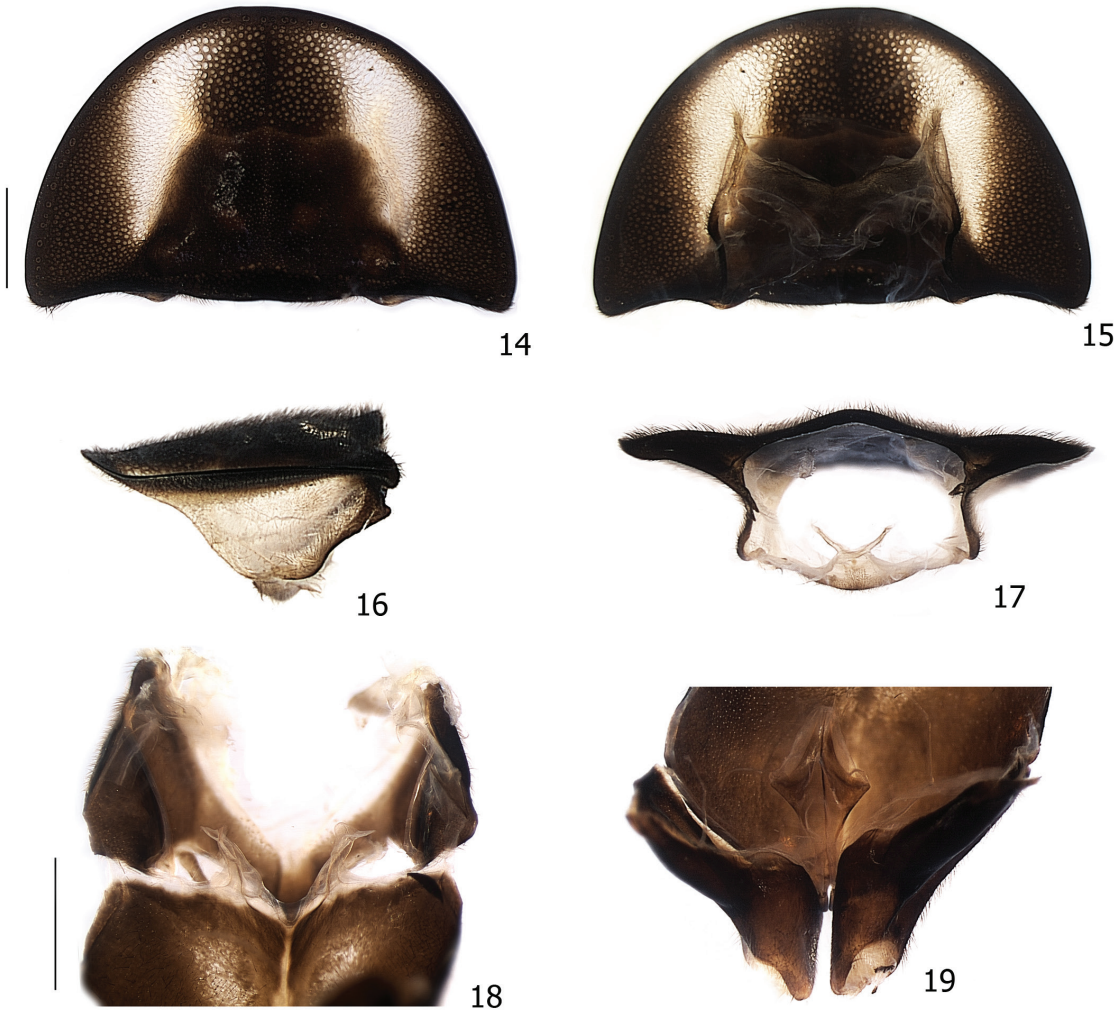
Abdomen (Figs 25−32) with sterna II-IX visible. Spiracles dorsal in anterior 1/3. Abdominal tergum (Fig 25) I with anterior margin membranous, laterotergite well-developed, internally projected; spiracle obliquely attached to thorax, more horizontally. Abdominal terga (Fig 25) II-XII with acute posterior angles projected posteriad, increasingly arcuate posteriad. Abdominal sternum (Fig 26) VII slightly projected medio-distally, projection discreetly emarginate; VIII projected posteriad in median 1/3, slightly longer than posterolateral margins. Pygidium (Fig 27) with lateral and posterior margins rounded, lateral angles projected posteriad, acute, as long as posterior margin. Syntergite (Figs 28−29) slightly shorter than abdominal sternite IX, acuminate posteriad, emarginate anteriad, median suture conspicuous, symmetric, with median cross membranous. Abdominal sternite IX assymetric, setose in posterior 1/2, left margin slightly beveled. Aedeagus (Figs 30−32) well-sclerotized, phallobase symmetric, projected dorsally; paramerae symmetric, widest in basal 2/5, then tapering to distal third, distal portion sinuate and projected internally, 1/3 shorter than phallus; phallus constricted subapically, ventrodistally clefted, dorsoventrally membranous in apical 1/4; endophallus projected beyond phallus.

Biology. Diurnal species, active especially on hot, moist days, abundant in moist broadleaf forests. They fly heavily, relatively slowly, all-day long, up to dusk. Female and immature stages remain unknown.

Remarks. *Lampyris illigeri* was described by Rev. William Kirby, an English priest of the Anglican church, co-founder of the Linnean Society and a fellow of the Royal Society of London for Improving Natural Knowledge. He quoted that the name was "*In honorem viri doctissimo, et*



Figs 5-13. *Cladodes illigeri* (Kirby, 1818). Head: 5, dorsal; 6, ventral; 7, lateral; 8, frontal; 9, posterior views. Tentoria: 10, posterior; 11, lateral views.12, antenna; 13, mandibles: A, dorsal; B, internal view. Scale bars 5-12: 1 mm, 13: 500 µm.



Figs 14-19. *Cladodes illigeri* (Kirby, 1818). Pronotum: 14, dorsal; 15, ventral; 16, lateral; 17, posterior. 18, mesendosternite, posterior view; 19, metendosternite dorsal view. Scale bars 14-17, 18-19: 1 mm.

in Entomologia heu desideratissimi, D. Illigeri, *Borussi*", which means that the name is in honor to the prussian entomologist, D. Illiger. Later on, Ernst Olivier placed the species in *Lucernuta* Laporte, 1833. Viktor Motschulsky placed the species in *Megalophthalmus* Gray (=*Magnoculus* McDermott, 1964). Then, McDermott (1966) finally placed the species in *Cladodes* Solier, 1849.

Based on study of the types, we propose *Cladodes lamellicornis* (Motschulsky, 1854) to be junior synonym of *Cladodes illigeri* (Kirby, 1818), which has precedence.

We also dissected genitalia of at least two specimens from three different areas (Serra dos Órgãos and Serra do Mar ranges, and Tijuca Forest), to account for phenotypic cohesion among populations, as an operational criterion of species delimitation (Sites & Marshall, 2004; De Queiroz, 2007).

Type-Material. Holotype (Fig. 1): BRAZIL, without other provenance data (BMNH). Labels: *Lampyris illigeri* Type Kirby (handwritten); Illigeri K. L. Jr Brazil (handwritten); 6340 (handwritten); Type (typewritten). Lectotype of *Nyctocrepis lamellicornis* Motsch., male (ZMLM), "Brasil", without other data.

Material-examined, pinned. BRAZIL, **Minas Gerais**: ♂, Mar de Hespanha, 27.VIII.1908, J. F. Zilán col. (MNRJ); **Rio de Janeiro**: ♂, Rio de Janeiro (Tijuca) without other data. (MNRJ); ♂, (E[strada] das Paineiras), 22.XII.1996, A. Pimenta col. (MNRJ); *idem* locality and date, J. R. I. Ribeiro, col.; ♂, (P. N. Floresta da Tijuca, Açude da Solidão), 02.X.1959, Newton Santos col. (MNRJ); ♂, (Corcovado), XII.1957, Alvarenga & Seabra, col. (MNRJ); ♂, (Bom Retiro), 08.01.1957, Newton Santos col. (MNRJ); **Santa Catarina**: 2♂, without other data, *Cladodes lamellicornis*, det. Olivier (MNHN). Alcoholed. BRAZIL: **Minas Gerais**: ♂, (Itamonte, Parque Nacional do Itatiaia, Aiuruoca), 24.XI.2011, Silveira & Ávila col. (DZRJ); **Rio de Janeiro**: ♂, Nova Friburgo (Rio Cascatinha), 22-23.X.2011, Takiya, Santos Souza & Cruz col. (DZRJ); ♂, Rio de Janeiro (Estrada Pedra Branca/ Pau da Fome), XI.2001 R. Baptista col. (DZRJ); 2♂, Teresópolis (PAR[que] NA[cional da] S[erra dos] O[rgãos]), 12.XII.2010, Silveira col. (DZRJ); **São Paulo**: 2♂, Ubatuba (Parque Estadual da Serra do Mar, Picinguaba, Praia da Fazenda), 27.VI.2013, E. Matos col. (DZRJ).

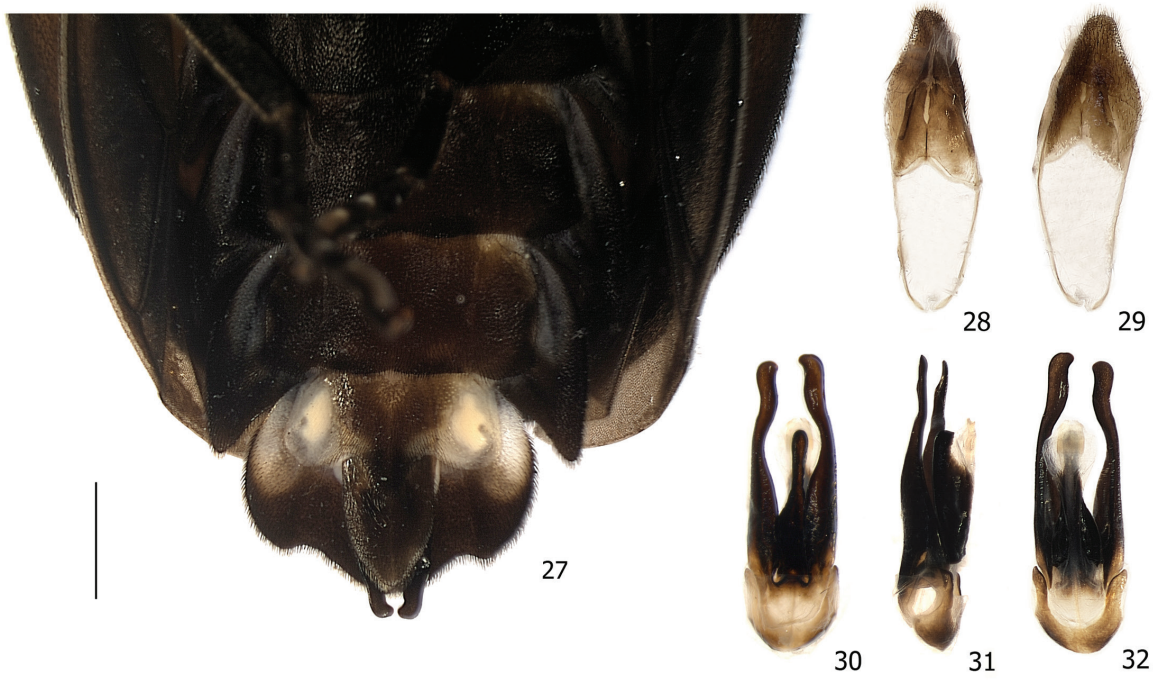
Distribution. Known from Southeastern Brazil. Mar de Hespanha municipality is the northern-most distribution, and Ubatuba municipality (in the Serra do Mar range) southwestern-most distribution.

Figs 20-24. *Cladodes illigeri* (Kirby, 1818). 20, Elytra ventral view (arrow shows elytral ventral line); 21, wing. Pterothorax: 22, dorsal; 23, lateral; 24, ventral. Scale bars 20-21: 2 mm, 22-24: 1 mm.

DISCUSSION

Currently, *Cladodes* is the second largest genus of fireflies in the subtribe Vestina. The type genus *Vesta* Laporte, 1833 has south-east Asiatic and south-American distribution, whilst other genera of the subtribe (*Cladodes*, *Ledocas* Olivier, 1885, *Dodacles* Olivier, 1885, and *Dryptelytra* Laporte, 1833) are exclusively Neotropical. While Asiatic fireflies have recently been studied (SAGEGAMI-OBA *et al.*, 2007; BOCAKOVA *et al.*, 2007), phylogenetic relationships of South-American fireflies are still ambiguous, both at the generic and the species level. This is also true for *Cladodes*, where the majority of the species is known only from the type specimens. Within *Cladodes*, only two subgenera (*Cladodes s. str.* and *Fenestratocladodes*) are currently recognized, while our preliminary research (L. F. L da SILVEIRA *et al.*, in prep.) indicated at least three different lineages of Brazilian *Cladodes*. Therefore, further research will be necessary to elucidate phylogenetic relationships among Neotropical fireflies. After a detailed study of *Amydetes* Hoffmansegg, 1807 (SILVEIRA & MERMUDES, 2014a), this paper represents

Figs 25-26. *Cladodes illigeri* (Kirby, 1818). Abdomen: 25, terga II-VII and pygidium; 26, sterna II-VII (arrows point the spiraculae). Scale bar: 2 mm.



Figs 27-32. *Cladodes illigeri* (Kirby, 1818). Abdomen: 27, ventral posterior half. Aedeagal sheath: 28, dorsal; 29, ventral. *Aedeagus*: 30, dorsal; 31, lateral; 32, ventral. Scale bar: 1 mm.

another contribution on lampyrid systematics providing detailed morphological descriptions for *Cladodes illigeri*, one of the most common Brazilian species in the genus.

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