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Morphological variability and evaluation of taxonomic characters  
in the genus *Erythemis* Hagen, 1861  
(Odonata: Libellulidae: Sympetrinae)

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**Abstract.** *Erythemis* Hagen, 1861 (Odonata: Libellulidae: Sympetrinae) is a Neotropical genus with ten species in which morphological characters vary widely. The aim of this paper is to study the taxonomic diversity of the genus *Erythemis* and to test the diagnostic value of morphological characters used to discriminate species. The diagnostic value of the morphometric characters is tested using discriminant function analysis, principal component analysis, and graphical exploration of the data. A total of 134 characters were studied; of those, 53 are recoded and 81 are proposed in this work. Discrete characters such as color, genitalia, ventral teeth of male cercus, extension of dark basal area in hind wing, and morphometric characters of abdominal carinae and antenodal wing venation are the most useful for species determination. In contrast, abdomen length/HW length ratio, vulvar lamina length, and spines of femoral structure are highly variable. A **lectotype** is designated for *Diplax credula* Hagen, 1861. Taxonomic keys for males and females are included, and variation in several characters is presented.

**Key words.** *Erythemis*, morphometry, morphological characters

## Introduction

The subfamily Sympetrinae includes over 200 species in 22 genera and is the largest Libellulidae subfamily (Pilgrim and von Dohlen 2008). This subfamily was defined by Fraser (1957) based on wing venation characters, but according to Pilgrim and von Dohlen (2008), these characters are problematic, because they are present in other libellulid subfamilies and thus are not synapomorphies that clearly define the subfamily. *Erythemis* is one of its genera and was described by Hagen (1861) based on characters such as the shape of posterior lobe of prothorax, wing venation, genitalia, and the ratio between abdomen and wing length. Later on, Williamson (1923) provided a key to the ten described species of the genus and included characters of coloration, size of spines on the hind femur, genitalia, wing venation, size of carinae on the third abdominal segments, vulvar lamina length, and abdomen and wing length ratio.

The species of *Erythemis* are easy to recognize, but some problems arise when using the key provided by Williamson (1923). For example, he indicated that the width of the first three abdominal segments is different between species but offered no specific values for these limits; he also distinguished species based on coloration and wing venation, which according to our examination of specimens show high intraspecific variability that is not acknowledged in his publication, e.g. *E. peruviana* (Rambur, 1842), *E. simplicollis* (Say, 1840), *E. collocata* (Hagen, 1861), and *E. plebeja* (Burmeister, 1839). Williamson (1923) stated that vulvar lamina length is “specifically different,” but our examination of specimens showed overlap of this length. Sexual dimorphism in the species also causes problems in identification because some characters show different patterns of variation in the two sexes.

Some authors have highlighted the need to analyze the morphological information of organisms through rigorous multivariate methods to delimit taxa and to provide accurate morphological differentiation (Longino 1993; Heraty and Polaszek 2000; Kipling and Rubinoff 2004; MacLeod et al. 2007; Aguirre et al. 2011). Oliver and Beattie (1996), for example, found that a qualitative evaluation of characters is not enough to sort species as it usually overestimates species richness. On the other hand, the alternative approach of conducting morphometric analyses as done with damselflies such as *Calopteryx splendens* (Harris) (Calopterygidae) and the genus *Ischnura* Charpentier (Coenagrionidae) rigorously validated the status of the subspecies and species respectively (Monetti et al. 2002; Sadeghi et al. 2009). Likewise, Landwer and Sites (2006) found it necessary to perform morphometric analysis to differentiate *Pantala* Hagen (Libellulidae) larvae, because most of the previously suggested characters led to misidentifications. These statistical analyses are a logical consequence of understanding species as populations and thus as entities with variability, this study is central to species determination (de Queiroz 2005; Dayrat 2005).

Not only are the explicit statistical analyses important to provide an academically defensible use of morphological characters in any biological research, but the delimitation of morphological characters must also generate comparable information as a result of an objective process that allows repetition (Vogt et al. 2010). For this reason, it is necessary to use explicit language to present characters standardized in terminology and structure (Kennedy et al. 2006; Ramírez et al. 2007; Edgecombe 2008). Sereno (2007) collected previous proposals (Farris et al. 1970; Kluge 2003) and presented a methodology to standardize the definition and description of characters for phylogenetic studies that may also work for characters used in taxonomy because it involves the widely accepted principles of clarity and precision.

The aim of this study is to examine the diagnostic value of morphological characters used to discriminate *Erythemis* species. A standardized structure for the description of characters for the morphological definition of species in the genus is used, and separate diagnostic keys for males and females are provided. A summary of available information on biology, larvae and additional remarks is also provided.

## Materials and Methods

Abbreviations for structures used throughout the text are as follows:

AA	— Anal anterior vein.
Ax	— Antenodal crossvein.
Bha	— Anal bifurcation keel
Bl	— Basal lobe.
C	— Costa vein.
CA	— MP crossvein.
Cu-A	— Cubitus anterior vein.
F	— Female.
FAV	— First antenodal vein.
FW	— Fore wing.
HW	— Hind wing.
M	— Male.
MP	— Media posterior vein.
MRA	— Marginal row in anal field
PRA	— Penultimate row in anal field;
RA	— Radius anterior vein.
RP <sub>1</sub>	— Radius posterior first branch.
RP <sub>2</sub>	— Radius posterior second branch.
S1,S2,S3...	— Abdominal segments 1,2,3....
T	— Triangle.
VL	— Vulvar lamina.

Abbreviations for lengths, widths or counts are as follows:

Acđ	— Discoidal field posterior border width (Fig. 9).
Anas	— Anterolateral width of cercus.
Anb	— HW base width (Fig. 9).
AndFW	— FW width at nodus region.
AndHW	— HW width at nodus region.
AnptFW	— FW pterostigma width (Fig. 8).
AnptHW	— HW pterostigma width.
AnsbtFW	— FWsubtriangle width (Fig. 8).
AntrFW	— FW triangle width (Fig. 8).
As-MP	— Supplementary anal vein-MP length.
At-MP	— Anal angle triangle-MP length.
AvFW	— FW number of antenodal veins.
AvHW	— HW number of antenodal veins.
Cal	— Number of cells in anal loop.
CdfHW	— Arrangement of cells in HW discoidal field from basal to distal region.
Crp	— Number of cells in radial planate.
Csub	— Number of cells in FW subtriangle.
Dat-lsbt	— Distal angle triangle-subtriangle length.
Ddas	— Distal reach of ventral teeth on male cercus.
Dshf	— Distribution of spines of external row of ventral surface of hind femur from base to apex.
DfwHW	— Discoidal field posterior border width.
Dlvc	— Distance between lateral and ventral carinae.
Epl	— Epiproct length.
Fbsd	— Femur base-first spine distance.
Hfl	— Hind femur length.
Hl	— Head length in dorsal view.
Hwd	— Head width in dorsal view.
Lab	— Abdomen length, excluding the abdominal appendages (Fig. 5).
Lal	— Female lamina length from base of basal lobe to apex.
LarFW	— FW arculus-second antenodal length (Fig. 8).
LarHW	— HW arculus-second antenodal length.
Las	— Cercus length.
Lasa	— Supplementary anal vein length (Fig. 26).
Lasa-ca	— Supplementary anal vein-Cu-A crossvein length (Fig. 9).
LbaFW	— FW wing base-arculus length (Fig. 8).
LbaHW	— HW wing base-arculus length.
LbanFW	— FW wing base-nodus length.
LbanHW	— HW wing base-nodus length.
LcaS3	— Apical carina length $S_3$ .
LclS3	— Lateral carina length.
Lecv-clS3	— Length from basal area between ventral-lateral $s_3$ carinae.
LFW	— FW length (Fig. 8).
LHW	— HW length.
Ll	— Labrum length.
Lmt	— Meeting point of lateral and medial transverse carinae on $S_3$ .
LnptFW	— FW nodus-pterostigma length (Fig. 8).
LnptHW	— HW nodus-pterostigma length.
LoptFW	— FW pterostigma length (Fig. 8).
LoptHW	— HW pterostigma length.
Lw	— Labrum width.
Mfl	— Medial femur length.

Nsmf	— Number of short spines on outer surface of medial femur.
Nshf	— Number of short spines on ventral surface of hind femur.
PC-RA-RP1	— Number of postnodal veins between C and RA veins prior to the first Postnodal vein between RA and RP1 veins.
Poas	— Posterolateral width of cercus length.
RP2-loptFW	— FW RP2-proximal side in pterostigma length.
RP2-loptHW	— HW RP2-proximal side in pterostigma length.
Antr	— Triangle width.
Vt	— Number of crossveins in triangle.
Wb	— Wing base width.

Abbreviations for ratios are as follows:

Acd/Lban	— Discoidal field posterior border width/wing base-nodus length.
And/Lban	— Width at nodus region/wing base-nodus length.
AnptFW/LoptFW	— FW Pterostigma width/FWpterostigma length.
AnptHW/LoptHW	— HW Pterostigma width/HWpterostigma length.
Ansbt/Antr	— Subtriangle width/triangle width.
Antr/Lar	— Triangle width/arculus-second antenodal length.
Bl/Vl	— Lateral lobe length/vulvar lamina length ratio (Fig. 27).
Lab/Las	— Abdomen length/cercus length.
Lab/LcaS3	— Abdomen length/apical carina length.
Lab/LclS3	— Abdomen length/lateral carina length.
Lab/Lecv-clS3	— Abdominal length/basal space ventral-lateral carinae length ratio
Lar/Lba	— Arculus-second antenodal length/wing base-arculus length.
Las/Anas	— Cercus length/Anterolateral width of cercus.
Las/Ddas	— Cercus length/reach of teeth on ventral region of cercus (Fig. 6).
Lba/Lban	— Wing base-arculus length/wing base-nodus length.
Lban/Anb	— Wing base-nodus length/HW base width.
Lban/Lasa-ca	— Wing base-nodus length/supplementary anal vein-Cu-A crossvein length.
LcaS4/LclS4	— Apical carina length S4/lateral carina on sternum of S4.
LclS3/Lecv-clS3	— Lateral carina length/Basal area between ventral-lateral $s_3$ carinae.
LclS3/LcaS3	— Lateral carina length/apical carina length.
Lecv-clS3/LcaS3	— Basal area between ventral-lateral carinae/apical carina.
LFW/Lnpt	— FW length/nodus-pterostigma length.
LHW/Acd	— HW length/HW discoidal field posterior border width.
LHW/Lab	— HW length/abdomen length.
LHW/LFW	— HW length/FW length.
Lnpt/Anb	— Nodus-pterostigma length/HW wing base width.
WmS2/LcaS5	— Width of medial region of male on S2/apical carina length on S5 ratio.
WssS2/WfsS4	— Width transverse carina region on S2/width transverse carina region on S4 ratio.

A total of 3,300 specimens of *Erythemis* from the following entomological collections were studied (acronyms according to Evenhuis and Samuelson 2004). A list of specimens showing the geographic range of the genus are show in the material examined and maps.

<b>ANDES</b>	— Entomologic Collection University of the Andes, Bogotá, Colombia
<b>CEUA</b>	— Laboratorio de Colecciones Entomológicas de la Universidad de Antioquia, Antioquia, Colombia.
<b>CNIN</b>	— Colección Nacional de Insectos, Universidad Nacional Autónoma de México, México D. F., Mexico

<b>FSCA</b>	— Florida State Collection of Arthropods, Gainesville, Florida, USA
<b>ICN</b>	— Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá D.C., Colombia.
<b>MCZ</b>	— Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
<b>MEFLG</b>	— Museo de Entomología Francisco Luis Gallego, Universidad Nacional de Colombia, Medellín, Colombia
<b>MLUH</b>	— Halle A.S, Martin-Luther-Universität, Wissenschaftsbereich Zoologie, Germany
<b>MNRJ</b>	— Museu Nacional, Universidade do Rio Janeiro, Rio de Janeiro, Brazil
<b>MEUV</b>	— Museo de Entomología de la Universidad del Valle, Cali, Colombia
<b>RWG</b>	— Rosser W. Garrison personal collection, Sacramento, California, USA
<b>UARC</b>	— Museo de Colecciones Biológicas-Universidad del Atlántico Región Caribe, Barranquilla, Colombia.
<b>UMMZ</b>	— Museum of Zoology, University of Michigan, Ann Arbor, Michigan, USA

Morphological terminology follows Borror (1942), Riek and Kukalová-Peck (1984), and Garrison et al. (2006). Body color was described qualitatively. To observe characters of the vesica spermalis, the structure was extracted from the genital fossa after applying 7% ammonia for ten minutes. Character states were recorded in a DELTA software matrix, based on which diagnoses and keys were constructed (Dallwitz 1974, 1980). Definition of characters follows parameters of Edgecombe (2008) and Vogt et al. (2010), and fundamental and functional components of the structure proposed by Sereno (2007) were used.

Diagnoses, keys, and descriptions were made using DELTA 1.04 software (Dallwitz et al. 1999). Photographs were produced with a 3Mp Leica DCM 300 camera attached to a Leica S8APO stereomicroscope. Focal depth problems in the images were corrected using the software COMBINE Z5.3 (Hadley 2010), which takes multiple pictures of a structure at different focal points, selects the parts that are in focus from each picture and combines them into a single image. Maps represent distribution registers from collections and other reliable records (von Ellenrieder and Muzón 2008; [www.odonatacentral.org](http://www.odonatacentral.org)), and were created electronically from the Digital Chart of the World (1:75,000,000) using ArcView 9.1. Longitude/latitude coordinates were culled from the Fallingrain global gazeteer website <<http://www.fallingrain.com/world/>> and Google maps <<http://maps.google.com/>>.

### Morphometric Analysis

A subsample of 111 female specimens and 443 male specimens of *Erythemis* were studied for the morphometric evaluation of characters. These specimens cover the range of distribution of each species. Specimens were measured using a calibrated ocular scale attached to a Leica S8APO stereomicroscope. Measurements in microns ( $\mu$ ) of males and females were recorded separately to control the effect of sexual dimorphism. Differences in magnitude of body size among species were controlled by using proportions in all lineal measurements.

The diagnostic value of the 134 characters studied was evaluated using two criteria: the existence of clear limits between the states proposed and independence among characters. To define discontinuities in quantitative characters proposed in the literature, to adjust the suggested limits or to proffer new character states, variation was analyzed using scatterplots (Quinn and Keough 2002). Redundancy among metric characters was examined with a Principal Component Analysis (PCA). The discriminant power of each taxonomic character and the status of the species were assessed using Discriminant and Canonical Correlation Analysis (MacLeod et al. 2007), with the Wilk's lambda, which presents an advantage, because it expresses a portion of the total variability, and is not related to the difference among the species, which excludes those characters that vary widely and focus in those that aid to avoid the overlap, despite they show some level of difference (Wilks 1932). Considering that Donnelly (2004) pointed the extensive overlapping of these values between two of the species, a specific ANOVA test was conducted for the character ratio between the apical carina length and the lateral carina length of

S4 in *E. simplicicollis* and *E. collocata*. Analyses were carried out with SPSS version 18.0 (SPSS 2004) and Statistica version 7 (StatSoft Inc. 2004).

## Results

A total of 134 characters were analyzed, 53 recoded and 81 proposed here (Tables 1–3), 31 continuous and 103 discrete as follows: three on the abdomen, 32 on the genitalia (including the cerci), seven on the legs, 18 on the wings and 43 of body color. Another 23 characters proposed in the literature were either found to be redundant (10) or do not vary among species (13). The color information in Tables 1–4 includes variation observed in dead and live individuals. A high variation of the body proportion (Table 5) was found, which prevented us from getting gaps among them. However, Wilk's lambda significant values were found ( $<<0,01$ ) for the proportions shown in Table 6, which are unable to express overlap or continuity in morphology. The total wing length, wing venation characters of the prenodal region (LHW/Lab; LHW/LFW; Lban/Anb; Antr/lar; Lnpt/Anb; LHW/and), the ratio cercus length/epiproct length, color patterns of thorax, abdomen, and basal area of the HW (new characters 88–90, Table 2), the extension of teeth on the ventral region of the cercus, and the shape of the lobes and cornua (recoded characters 28, 29 and 32, Table 1) were used to differentiate *Erythemis* species.

### The status of *E. simplicicollis* and *E. collocata*

The status of *E. simplicicollis* and *E. collocata* and the characters that support the designation of each species have been debated by several authors. Needham and Westfall (1955) mentioned that *E. simplicicollis* has a green face and ivory white or yellow caudal appendages while *E. collocata* has a black face and blackish caudal appendages. Gloyd (1958) used the width of the black stripes on the abdominal dorsum and the ratio between the width and the length of ventral tergum of the S4 to separate these species; *E. simplicicollis* has a 0.16 ratio while *E. collocata* has 0.33 to 0.25 ratios. Later, Needham et al. (2000) reformulated that ratio to 0.25 for *E. simplicicollis* and 0.33 for *E. collocata*. Donnelly (2004) suggested that these species must be synonymized due to the extensive overlapping of those ratio values. Given that Williamson (1923), Gloyd (1958), and Needham et al. (2000) did not describe the specific places where the measurements must be taken, Donnelly (2004) proposed to measure the length of the ventral tergum across the lateral carina, and the ventral tergum width at approximately midlength of the segment. We coded the fourth abdominal tergum as a ratio between the length of apical and lateral carinae and this character was measured in 569 individuals. According to D. Paulson (pers. comm.) in most of the range of the species, this proportion easily distinguishes the two species, and they appear to intergrade in parts of North America, where they cannot be distinguished. Our results are consistent with those of Donnelly (2004) because the analysis of variance ( $p=0.32$ ) shows that there are no significant differences between these two species, suggesting that this character does not help to diagnose them.

During the current study several similarities were found between *E. simplicicollis* and *E. collocata*:  $LclS3/LcaS3 < 2.10$ ;  $Lcv-clS3/LcaS3 < 1.50$ ;  $Lban/Anb < 1.90$ ; M:  $LHW/Acd < 3.60$ ;  $LHW/LFW < 0.97$ ;  $Lab/LclS3 < 1.50$ ;  $Lab/LcaS3 < 3.00$ ;  $Antr/Lar < 7.00$ ; the absence of the basal spot on HW, the coloration of the thorax, vertex, frons, and cercus, vulvar lamina shape, and the cornua of vesica spermalis is exposed and has lobes fused to the apex. On the other hand, several differences in color between *E. simplicicollis* and *E. collocata* (characters 12 and 24, Table 1; characters 66, 67, 70–72, 75, 82; Table 2) reported by Needham and Westfall (1955) were confirmed in our study. Additionally, we found differences in color of cercus (white for *E. simplicicollis*; black for *E. collocata*) and in abdomen and wing ratios (characters 4, Table 1; characters 3, 4, 10, 11 -F-Table 2). According to our results, we consider *E. collocata* and *E. simplicicollis* as valid species. Peculiarities of male behavior in *E. simplicicollis* described by Williamson (1900) and McVey (1985), which are not present in *E. collocata* (D. Paulson, pers. comm.), provided additional support for considering both as separate entities.



**Taxonomy**

Photographs of characteristics and the reference places for several measurements are presented to facilitate the use of the following keys (Fig. 4–26).

**Key to Males of *Erythemis***

1. Dark basal spot on HW absent ..... **2**  
 — Dark basal spot on HW present (in some specimens very pale and small) ..... **3**
- 2(1). White abdominal appendages ..... ***Erythemis simplicicollis* (Say)**  
 — Black abdominal appendages ..... ***Erythemis collocata* (Hagen)**
- 3(1). Dark basal spot on HW not reaching the MP crossvein or AA (Fig. 26); lateral lobe of vesica spermalis extended into posterior region less than medial lobe (Fig. 20 and 21) ..... **4**  
 — Dark basal spot on HW reaching the MP crossvein and AA or beyond (Fig. 26); lateral lobe of vesica spermalis extended into posterior region more than medial lobe ..... **5**
- 4(3). Thorax and first two or three abdominal segments green; S4-7 green with black or brown stripes in dorsal region; S8-10 all black or brown; radial planate with double cells (Fig. 28) ..... ***Erythemis vesiculosa* (Fabricius)**  
 — Thorax, dorsum of abdomen, and basal spot on HW brown (sexually immature M); or thorax and abdominal S1-3 blue and abdominal S4-10 red (mature M); no double cells on radial planate ..... ***Erythemis peruviana* (Rambur)**
- 5(3). Posterior lobe of vesica spermalis covered by lateral lobe ..... **6**  
 — Posterior lobe of vesica spermalis not covered by lateral lobe (Fig. 21) ..... **7**
- 6(5). Thorax and dorsum of abdomen red or reddish-brown; cornua diagonal respect to transverse axis of vesica spermalis (Fig. 22 and 23) ..... ***Erythemis mithroides* (Brauer)**  
 — Abdominal dorsum black or black and yellow; cornua parallel respect to transverse axis of vesica spermalis (Fig. 20) ..... ***Erythemis attala* (Selys)**
- 7(5). Dark basal spot on HW reaching the row of marginal cells of the anal angle ..... **8**  
 — Dark basal spot on HW not reaching the row of marginal cells of the anal angle (Fig. 26) ..... **9**
- 8(7). Dark basal spot on HW reaching the penultimate row of cells of the anal angle (Fig. 26); body black; in lateral view, cornua of vesica spermalis exposed (Fig. 20); vesica spermalis without bilobed hook, instead there are two lobes separated and perpendicular to vesica spermalis longitudinal axis (Fig. 22 and 24) ..... ***Erythemis credula* (Hagen)**  
 — Dark basal spot on HW reaching the row of marginal cells of the anal angle (Fig. 26); body brilliant scarlet red or reddish-brown; in lateral view, cornua of vesica spermalis not exposed (Fig. 19); vesica spermalis with bilobed hook (Fig. 18) .. ***Erythemis carmelita* Williamson**
- 9(7). Thorax, dorsum of abdomen, and dark basal spot on HW reddish brown; posterior extension of ventral teeth on cercus about the same level as apex of epiproct or less (Fig. 13), Antr/Lar  $\geq 7.41$  ..... ***Erythemis haematogastra* (Burmeister)**  
 — Thorax brown on sides and black on front, dorsum of abdomen brown and black with pale yellow crossbands in S3 and S4-7 (immature male); or thorax and dorsum of abdomen black (mature male); posterior extension of ventral teeth on cercus reaching beyond the apex of epiproct (Fig. 12), Antr/Lar  $\leq 6.21$  ..... ***Erythemis plebeja* (Burmeister)**

Key to Females of *Erythemis*

1. Dark basal spot on HW absent ..... 2  
 — Dark basal spot on HW present ..... 3
- 2(1). White abdominal appendages, Lab/Lecv-clS3  $\leq 2.00$ , LFW/Lnpt  $\leq 2.86$ , Lnpt/Anb  $\geq 1.22$ , LHW/Acd  $\geq 0.51$  ..... *Erythemis simplicicollis* (Say)  
 — Black abdominal appendages, Lab/Lecv-clS3  $\leq 1.90$ , LFW/Lnpt  $\geq 2.92$ , Lnpt/Anb  $\leq 1.13$ , LHW/Acd  $\leq 0.50$  ..... *Erythemis collocata* (Hagen)
- 3(1). Dark basal spot on HW not reaching the AA vein (Fig. 26) ..... 4  
 — Dark basal spot on HW reaching the AA or beyond (Fig. 26) ..... 5
- 4(3). Thorax and abdomen brown, sometimes with purple overtones on thorax; pale medio-dorsal thoracic stripe 2.50 wider, or more, than the dark antehumeral stripes in the dorsal region on thorax (Fig. 15); radial planate without double cells ... *Erythemis peruviana* (Rambur)  
 — Thorax green, dorsum of abdomen green with black; thorax and S1-3 the same color as the thorax, S4-7 with black stripes on dorsal region, S8-10 with spots or all black or dark brown; thorax without pale medio-dorsal thoracic stripe (Fig. 14); radial planate with double cells (Fig. 28) ..... *Erythemis vesiculosa* (Fabricius)
- 5(3). Dark basal spot on HW not reaching the row of marginal cells of the anal angle (Fig. 26) ..... 6  
 — Dark basal spot on HW reaching the row of marginal cells of the anal angle (Fig. 26) ..... 7
- 6(5). Thorax and S1-3 reddish brown or brown, in some individuals these may be red as the remaining abdominal segments, S4-10 reddish-brown, all red, or red with brown spots on dorsal region of S4-8; vulvar lamina suboval in antero-ventral view (Fig. 10) .....  
 ..... *Erythemis haematogastra* (Burmeister)  
 — Thorax brown on sides and pale brown with darker stripes on front, dorsum of abdomen brown and black with pale yellow crossbands in S3-7; vulvar lamina triangular in antero-ventral view (Fig. 11) ..... *Erythemis plebeja* (Burmeister)
- 7(5). Thorax, dorsum of abdomen, and dark basal spot ochreous or brown, dorsum of thorax pale with dark antehumeral stripes, the width of the three stripes is similar. Dark basal spot on HW not reaching the first antenodal vein (Fig. 26); two or alternating two and three cell rows in the basal region of the FW discoidal field ..... *Erythemis credula* (Hagen)  
 — Dark basal spot on HW reaching the first antenodal vein (Fig. 26), thorax black and yellow, red, reddish-brown or black; three cell rows in the basal region of the FW discoidal field ..... 8
- 8(7). Thorax reddish-brown or thorax and abdomen scarlet red. *Erythemis carmelita* Williamson  
 — Thorax black, red or reddish-brown, abdomen black, black with yellow, red or reddish-brown. .... 9
- 9(8). Dorsum of abdomen black or black and yellow, and with yellow spots in several segments; thorax black, maximum extension of dark basal spot in HW to base of the triangle (Fig. 26) ..... *Erythemis attala* (Selys)  
 — Thorax and dorsum of abdomen red or reddish-brown; maximum extension of dark basal spot in HW to supplementary anal vein (Fig. 26) ..... *Erythemis mithroides* (Brauer)

*Erythemis* Hagen, 1861

*Erythemis* Hagen, 1861: 168 [male p. 184, couplet 41; female p. 204, couplet 14] Type species: *Libellula peruviana* Rambur, 1842 [by Kirby 1889, subsequent designation] [NOTE: Kirby (1889: 305) gives

*Libellula peruviana* Rambur, 1842 as type species, but this name was not among the original three names (*E. furcata* Hagen, 1861; *E. bicolor* Erichson, 1848; *E. longipes* Hagen, 1861) included under *Erythemis*. Hagen (1861: 169), under *E. bicolor* did state "Is it different from *Libellula peruviana* Rambur?"-perhaps suggesting synonymy between these two names]. Garrison et al. (2006).

Syn *Mesothemis* Hagen, 1861: 170. Type species: *Libellula simplicicollis* Say, 1840 [by Kirby 1889, subsequent designation].

Syn *Leptthemis* Hagen, 1861: 160. Type species: *Libellula vesiculosa* Fabricius, 1775 [by Kirby 1889, subsequent designation].

**Diagnosis.** Hind femur thickened with numerous and distally directed short spines on its basal half, followed by 3–5 long robust spines on its distal half. In many specimens some spines of intermediate size may be observed (Fig. 16). Thorax either brown, reddish-brown, black, green or blue. Abdominal dorsum either brown, reddish-brown, red, black, green and black or blue. Prothorax with a small, decumbent posterior lobe constricted at base and upright. Abdomen: S1-3 swollen and S4-10 narrow, the genus species have either slender and elongate or shaped abdomen. HW entirely hyaline or with a dark basal spot, last antenodal incomplete, Mspl and Rspl distinct, radial planates with one or two rows of cells throughout; median planate with one row of cells. Other characters useful in recognizing *Erythemis* proposed by Garrison et al. (2006) are: MP in HW arising at or near anal angle of triangle or distinctly separated from anal angle of triangle; anterior lamina complete; posterior hamule bifid with inner branch smaller than outer branch; vulvar lamina scoop shaped and projecting ventrally.

**Remarks.** Hagen (1861) established three genera for new and previously described species of dragonflies. The first, *Leptthemis* (p. 160), the second, *Erythemis* (p. 168) and the third, *Mesothemis* (p. 170). Gloyd (1980) discussed the dual use of the generic names *Leptthemis* (monotypic genus) and *Erythemis*, and discussed that page priority was not sufficient reason to choose *Leptthemis* over *Erythemis*. Thus, although the nominal genus *Leptthemis* Hagen, 1861, can be selected to take precedence by the First Reviser action (Article 24.2, International Code of Zoological Nomenclature 1999), Pinto et al. (2012) proposed to conserve the widespread usage of the generic name *Erythemis* Hagen, 1861, under Articles 23.9.3 and 81.1 of the Code (ICZN 1999).

### ***Erythemis attala* (Selys, 1857)**

(Fig. 1a, 2a,c, 17, 29)

*Libellula attala* Selys in Sagra, 1857:445.

*Libellula annulata* nec Palisot (Rambur, 1842: 78). Misidentification.

*Libellula annulosa* Selys in Sagra, 1857: 445.

*Libellula mithra* Selys in Sagra, 1857: 445.

**Type material.** Not examined.

**Diagnosis.** Abdominal dorsum black or black and yellow, and with yellow spots in several segments. In some cases, the yellow color completely covering the dorsal region of the segment (F). Thorax and basal area on HW black; basal area on HW reaching the media posterior vein (MP) or beyond, covering a small basal region or the row of marginal cells to the anal angle (MRA, Fig. 26), and extending to the base of the triangle to the posterior region. Posterior extension of ventral teeth of male cercus about the same length as the apex of epiproct or less (Fig. 13). Posterior lobe of vesica spermalis covered by lateral lobe (Fig. 19), which extends more posteriorly than the medial lobe. Hook bilobed, triangular, and not perpendicular to the longitudinal axis of vesica spermalis (Fig. 18). Cornua parallel to the transversal axis of vesica spermalis (Fig. 20), with lobes separate apically, and covered by lateral lobes in lateral view. Vulvar lamina suboval with round posterior border (Fig. 10). Lab  $\leq 30$ mm. LcaS4/lcS4 ratio  $>2.10$ ; WmS2/LcaS5 ratio  $<3$ .

**Morphometric ratios of males.** Acd/Lban<4.10; And/Lban<4.10; Lba/Lban<2.00; Lban/Anb>1.90; LHW/Acd<3.60; LHW/LFW>0.90; Las/Ddas<4.00; LclS3/LcaS3<2.10; AnptFW/LoptFW>0.10; LclS3/Lecv-clS3<4.00; Lecv-clS3/LcaS3<1.50; Lab/LclS3<1.50; Lab/LcaS3<3.00; Ansbt/Antr>2.70; LFW/Lnpt<3.00; Antr/Lar>8.00; Lnpt/Anb>1.50; Lban/Lasa-ca>3.00; Lar/Lba<0.20.

**Morphometric ratios of females.** Lnpt/Anb>1.20 AnptFW/LoptFW>0.20; Lban/Anb<1.50; LHW/Acd<0.50; LHW/Lab>1.20; Lab/Las>2.50; LclS3/LcaS3<3.00; Lecv-clS3/LcaS3<1.60; Lab/LclS3<1.40; Lab/LcaS3<3.00; Ansbt/Antr>2.40; LFW/Lnpt<2.90; Lar/Lba<0.14.

**Head.** Ll: 0.012–0.014mm (M); 0.013–0.015mm (F). Lw: 0.0031–0.0035mm (M); 0.0033–0.0035mm (F). Hwd: 0.0059–0.0070mm (M); 0.0063–0.0065mm (F). Hl: 0.0027–0.0040mm (M); 0.0033–0.0037mm (F).

**Legs.** Nsmf: 8.0–13 (M); 5.0–7.0 (F). Nshf: 20.0–25.0 (M); 6.0–8.0 (F). Hfl: 0.0060–0.0066mm (M); 0.0057–0.0061mm (F). Fbsd: 0.0024.00–0.0025mm (M); 0.0022–0.0030mm (F). Mfl: 0.0037–0.0041mm (M); 0.0038–0.0046mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-1 to 3 median spines-3 long spines (MF, Fig. 17), short spines-3 long spines (M).

**Wings.** LoptFW: 0.0030–0.0034mm (M); 0.0029–0.0033mm (F). AnptFW: 0.006–0.008mm (M); 0.0006–0.001mm (F). LoptHW: 0.0030–0.0035mm (M); 0.0030–0.0038mm (F). AnptHW: 0.006–0.009mm (M); 0.007–0.009mm (F). DfwHW: 0.0056–0.0070mm (M); 0.0063–0.0066mm (F). LbanFW: 15.00–19.00mm (M); 15.00–17.00mm (F). LbanHW: 13.00–17.00mm (M); 13.00–15.00mm (F). AndFW: 7.37–8.31mm (M); 7.23–7.95mm (F). AndHW: 9.90–11.00mm (M); 9.00–10.16mm (F). LFW: 31.00–37.40mm (M); 33.90–36.0mm (F). LHW: 35–38mm (M); 32–35mm (F). AnsbtFW: 0.0020–0.0025mm (M); 0.0022–0.0025mm (F). AntrFW: 0.006–0.009mm (M); 0.004–0.008mm (F). LarFW: 0.001–0.003mm (M); 0.0025–0.0037mm (F). LarHW: 0.0009–0.003mm (M); 0.002–0.003mm (F). LnptFW: 11.68–13.76mm (M); 12.24–12.66mm (F). LnptHW: 13.08–15.07mm (M); 13.73–14.05mm (F). At-MP: 0.002–0.006mm (M); 0.002–0.004mm (F). LbaFW: 0.0029–0.0032mm (M); 0.0028–0.0030mm (F). LbaHW: 0.0031–0.0034mm (M); 0.0028–0.0033mm (F). RP2-loptFW: 0.001–0.006 mm (M); 0.001–0.004mm (F). RP2-loptHW: 0.0006–0.004mm (M); 0.0006–0.005mm (F). Dat-lsbt: 0.0009–0.001mm (M); 0.0012–0.0018mm (F). Lasa-ca: 0.003–0.008mm (M); 0.002–0.007mm (F). Crp: 7–8. Cal: 3–7. PC-RA-RP1: 2–3. CdfFW: only 3 rows, one cell divided into four sections -3 rows of cells. Vt: 1–2. Csub: 3.

**Abdomen.** Lab: 25.00–30.00mm (M); 23.00–30.00mm (F). LcaS3: 0.00087–0.0011mm (M); 0.0010–0.0012mm (F). LclS3: 19.37–21.87mm (M); 0.0019–0.0025mm (F). Lecv-clS3: 0.0012–0.0016mm (M); 0.0011–0.0013mm (F).

**Caudal appendages.** Las: 0.0015–0.0019mm (M); 0.0008–0.0011mm (F). Poas: 0.001–0.003mm (M); 0.0012–0.0018mm (F). Anas: 0.002–0.006mm (M); 0.0025–0.0031mm (F). Ddas: 0.004–0.005mm (M). Epl: 0.0011–0.0014mm (M); 0.0037–0.0043mm (F).

**Larva.** Thirteen preimaginal states were described by Rodrigues-Capítulo (1983) from Punta Indio and Los Talas (Buenos Aires, Argentina). Rodrigues-Capítulo (1983) described the last instar as follows: larvae greenish with a yellowish band on mid-dorsal region of the mesothorax surrounded by two brown spots, mask with whitish and brown irregular spots, seven meridional black and violet stripes on the eyes. Average total length 13.70 mm (live specimens) 15.90–16.50 mm (preserved specimens), this measurement differs from that of Klots (1932) who recorded between 14.50 and 15.00 mm. Head width 4.8–5.0 mm, head length 2.75 mm, head width-length ratio 1.78 mm, antenna length 1.92 mm and 4.60 mm respectively. Anterior, medial and posterior tibial length 2.9, 3.6 and 6.1 mm respectively. Mouth parts with thirteen to fourteen mental setae, small teeth on the distal region of the medial lobe of the mentum, eight to nine palpal setae, outer region of maxillary palp with numerous axial and lateral hairs. Mandibles with 4 + 1 incisive and three molar teeth. Lab 5.60 mm, superior caudal appendage 1.17 mm, lateral 0.67 mm and inferior 1.19 mm. According to Costa and Pujol-Luz (1993), the larva of *E. attala* bears twelve premental setae, and the cercus exceeds by 1/2 the length of the epiproct.

**Material examined.** ARGENTINA, Prov. Jujuy, Laguna Calilegua, 23°46'60" 64°46'60", 675m, 21-22.iii.2006, R. W. Garrison and N. v. Ellenrieder leg., 1 male (RWG). BOLIVIA, Santa Cruz, Ichilo, Amboró, 30 km South-Southeast of Buena Vista, 16.iii.1960, R. Steinbach leg., 2 females (FSCA); Same, but Buena Vista, 400m, 12.v.1960, R. Steinbach leg., 3 males (FSCA); the same data as before except collected on the following dates: i.1936; ii.1937, 1 male, 4 females; same, but Santiesteban, 4 km. north of

Mineros, 25.iii.1960, R.B. Cumming leg., 1 male (FSCA); same, but Ñufflo de Chávez, San Ramón, 4 km SW on Hwy 9, Río San Julián, 16.38° 42.3' S 62.30° 31.6' N, B. Mauffray leg., 1 male (FSCA); **Velasco**, La Estrella, 24 km N on hwy to la Florida, Río San Martín, 15.23.616S 61.29.770W, B. Mauffray leg., 1 male (FSCA). **BRAZIL**, **Amapá**, Macapá, Fazendinha, IEPA, Parque Zoobotánico, ix.1997, P. Magno, 1 male (MNRJ); same, but ix.1997, P. Magno, 11 males, 3 females (MNRJ); **Amazonas**, Benjamin Constant, 20.ii.1942, 1 male (MNRJ); same, but Manaus, N. Santos leg., 27.x.1959, 1 male (MNRJ); same, but Río Negro, 11.vii.1941, Parko leg., 1 male (MNRJ); same, but 23.vii.1941, 1 female; same, but 23.vii.1941, 1 female; same, but 27.x.1959, 1 female; same, but Igarapé, Itacotiarae Rio Branco, N. Santos leg., 21.x.1959, 2 males (MNRJ); same, but Igarapé do Mariano, Elias leg., xi.1959, 3F (MNRJ); same, but Km. 38, Elias leg., xi.1959, 4M (MNRJ); same, but Poraquequara, i.1973, N. Tangerini leg., 5M, 2 females (MNRJ); same, but Parintins, 18.i.1973, N. Tangerini leg., 5 females (MNRJ); **Espírito Santo**, Baixo Guandu, Estr. B. Guandu á Hituba km. 13, 01-07.xi.1970, Elias, Paulo leg., 1 male (MNRJ); same, but Linhares, v.1973, Elias, Paulo leg., 1 male (MNRJ); **Mato Grosso**, Salobra, 21-23.i.1955, A. Passarelli leg., 3 females (MNRJ); **Pará**, Belém, Parque Museu, 03.xi.1963, Arlé leg., 1 male (MNRJ); same, but Utinga, 12.ii.1963, Roppa, Mielke leg., 1 male (MNRJ); **Paraná**, Curitiba, 01.ii.1966, O. Mielke leg., 2 males (MNRJ); same data as before except collected on: 04.xii.1966, 1 female; **Rio Grande do Sul**, Pelotas, 18.v.1943, C. Biezanko leg., 1 male (MNRJ); same data as before except collected on following dates: 01.iv.1945, 1 male; 15.ii.1949, 1 female; 05.v.1943, 1 female; 02.ii.1970, 1 male; same data as before except deposited in FSCA and collected on following dates: 29.i.1956, 1 female; 24.xii.1956, 1 male; 04.i.1957, 1 male; 09.i.1957, 1 male, 2 females; 10.i.1957, 1 male, 1 female; 23.i.1957, 1 male; 24.i.1957, 1 male, 1 female; 25.i.1957, 2 males; 26.i.1957, 1 male, 1 female; 27.i.1957, 1 female; 29.i.1957, 1 female; 01.ii.1957, 1 female; 24.xi.1957, 1 male, 1 female; 01.i.1958, 1 male; 02.i.1958, 1 male; 05.i.1958, 1 male; 07.i.1958, 2 males; 10.i.1958, 1 female; 13.i.1958, 1 female; 18.i.1958, 1 female; 01.ii.1958, 2 males, 3 females; 02.ii.1958, 1 male; 04.ii.1958, 1 male; 02.iii.1958, 1 female; 28.iii.1958, 1 male; 02.iv.1958, 1 male; 03.iv.1958, 1 female; **Rondônia**, Fazenda Rancho Grande, 62 km SW of Ariquenes, 10°31'48" 62°48'0", 165 m, 2-11.xi.1989, R. W. Garrison leg., 1 female (RWG); same, but Porto Velho, Guaporé cachocina do Samuel, Río Yamarý, Pauro leg., x.1944, 1 female (MNRJ); **Roraima**, Ariquenes, viii.1980, Bento leg., 1 male (MNRJ); **São Paulo**, Rio Paraná, 27.i.1971, Castilho leg., MNRJ; 33 males Sem procedência, 1 male (MNRJ). **COLOMBIA**, **Atlántico**, Ciénaga La Larga, Palmar de Varela, 3.xi.2007, M. Lobo leg., 2 males 1 female (UARC); **Bolívar**, Mompós, Hda La Sebastiana, 27.ii.2000, M. Wolff leg., 1 male (CEUA); **Meta**, Villavicencio, Corpoica, "Estación la Libertad", 385m, 1.iii.2008, E. Realpe leg., 1 male (ANDES); same, but Puerto López, 220 m, 01.x.2002, S. Remolino leg., 1 male (ANDES); No data, 2 males, 1 female (UARC); **Valle**, Cali, 1000 msnm, 15.ii.1999, G. Vargas leg., 1 male (MUSENUV); same, but pasto, 19.ii.1999, N. Tigreros, 1 male (MUSENUV); same, but 05.iii.1998, M. Albarracín, 1 male (MUSENUV); same, but, 23.ii.1999, A. Barona leg., 1 male (MUSENUV); same, but Universidad del Valle, 1000 msnm, 01.iii.2000, P. Agudelo leg., 1 male (MUSENUV); same, but Tulua, 1100msnm, 17.xi.2001, A. Ramírez leg., 2 males (MUSENUV); same, but Jardín Botánico Mateguadua, 4°1'42"N 76°10'0,7"W, 1200msnm, 13.viii.2003, C. Bermúdez leg., 1 male (MUSENUV); same, but Jardín Botánico Mateguadua, 4°1'42"N 76°10'0,7"W, 1107msnm, 18.ix.2009, J. Mendivil leg., 1 male (MUSENUV). **ECUADOR**, **Guayas**, Cantón Durán, 02.17S 79.83W, 30 ft, S.N. Rhoads leg., 12.ii.2011, 1 female (FSCA). **GUATEMALA**, Quirigua, 16.ix.1915-18, W. Schaus and J. T. Barnes leg., 1 female (FSCA). **MÉXICO**, **Morelos**, Las Estacas, i.1984, R. Novelo leg., 1 male (CNIN); **Veracruz**, Catemaco, 15.ix.1958, 1 male (CNIN); same, but Río Otapa, 8 Km. S of La Tinaja, 18°45'0" 96°26'24", 90m, 13.viii.1976, R.W. and J.A. Garrison leg., 1 male (RWG). **NICARAGUA**, **Matagalpa**, Moyua, 12.36.09N 86.03.18W, 1420 ft., 28.viii.2003, F.C. Sibley leg., 1 male (FSCA). **PARAGUAY**, **Asunción**, iv.1944, Mis. Cient. Brazil leg., 1 male (MNRJ). **PERÚ**, **Loreto**, Iquitos, xii.1977, RWG; 1 female same, but Explorama Lodge, 50 mi. NE Iquitos, on Amazon River at junction with Yanamono River, 24.viii.1989, S.W. Dunkle leg., 1 male, 2 females (FSCA); same, but Amazon River, 50 miles NE @ Explorama Lodge, 24.vii.1989, H.V. Weems Jr. Leg., 1 male (FSCA); same, but Maynas, Yanamono river at Explorama Lodge, 11.ii.1987, J. Castner leg., 1 male (FSCA); same data as before except collected on: 10.ii.1987, 1 female; same, but Muenacaño, Río Amazonas cerca Iquitos, viii.1839; J. Schunke leg., 1 male (FSCA); same, but Pucallpa, 600 ft., 09.xi.1946, J.C. Pallister leg., 1 male (FSCA); **San Martín**, Bella Vista, 1500 ft., 09.xii.1946, J.C. Pallister leg., 1 male (FSCA).

**Remarks.** Calvert (1928) provides data for larvae of this species, but he also warns of the potential for misidentification. This concern also is shared by Klots (1932) for the key she proposed for this species. Later Rodrigues-Capítulo (1983) redescribed the immature stages of *E. plebeja* clarifying the diagnostic characters proposed by the previous authors.

**Biology.** Larvae have been shown to dwell in a habitat where *Azolla filiculoides* Lam. and various species of Lemnaceae were present. Rodrigues-Capítulo (1983) described color variations in larvae, which vary depending on the substrate they use, and explains that rotifers, protozoans, oligochaetes, and filamentous algae are present due to the relative inactivity of the larva. There are reports of univoltine or semivoltine lifecycles with a facultative diapause that probably regulates the populations of both larvae and adults (Rodrigues-Capítulo 2000). Adults may be associated to ponds and lakes in forests, agricultural regions and sugar cane fields. *E. attala* perches on dead branches very close to the ground and it is common to find males of this species attacking those of *E. plebeja* (F. Palacino, pers. obs.).

**Distribution.** From U.S.A. to Argentina (Fig. 29), between 4–2000 m.asl. De Abenante and Philippi (1982) report *E. attala* from Uruguay, however, without indicating any locality.

### *Erythemis carmelita* Williamson, 1923

(Fig. 1a,b, 2a, 4, 19, 30)

*Erythemis carmelita* Williamson, 1923: 10.

**Type material.** (1 male, 1 female). COLOMBIA. Río Nuevo: between Magangué and El Banco-Magdalena, 22.i.1917, J. H. and E. B. Williamson leg., 1 male **holotype** (UMMZ). COLOMBIA. Magdalena: El Banco, 25.i.1917, J. H. and E. B. Williamson leg., 1 female **allotype** (UMMZ). Examined.

**Diagnosis.** Thorax, dorsum of abdomen, and basal area on HW brown or reddish-brown (male) or S1-3 brown-greenish with darker brown spots, S4-7 pale brown with dark brown spots on dorsal and lateral regions, S8-10 dark brown in the dorsal and lateral regions, ventral region with greenish spots (female). Dark basal spot on HW reaching the following regions: first antenodal vein, beyond the MP crossvein, the penultimate (pra, Fig. 26) or the entire row of marginal cells, at least to the AA or most of the base of the triangle. Posterior extension of ventral teeth on male cercus about to the same level as the apex of epiproct or less (Fig. 13). Posterior lobe of vesica spermalis not covered by lateral lobe (Fig. 21), which extends more posteriorly than medial lobe. Hook bilobed, rectangular (Fig. 25), and not perpendicular to the longitudinal axis of the vesica spermalis (Fig. 18). Cornua perpendicular to the transversal axis of vesica spermalis, with lobes separated to apex, and covered by lateral lobes in lateral view (Fig. 19). Vulvar lamina suboval with round posterior border (Fig. 10). Lab  $\leq$ 30mm, lcaS4/lclS4  $<$ 2.10; WmS2/LcaS5  $<$ 3.

**Morphometric ratios in the male.** AnptHW/LoptHW  $>$ 0.19; Acd/Lban  $<$  4.10; And/Lban  $<$  4.10;4.10; Lban/Anb  $>$ 1.90; LHW/Acd  $<$ 3.60; LHW/LFW  $>$ 0.97; Lab/LclS3  $<$ 1.50; Lnpt/Anb  $>$ 1.50; Lba/Lban  $<$ 2.00; Lar/Lba  $>$ 0.20.

**Head.** Ll: 0.0011–0.0015mm (M). Lw: 0.0033–0.0039mm (M). Hwd: 0.0065–0.0068mm (M). Hl: 0.0037–0.0043mm (M).

**Legs.** Nsmf: 9–19 (M); 5–12 (F). Nshf: 23–36 (M); 11 (F). Hfl: 0.0065–0.0070mm (M). Fbsd: 0.0025–0.0027mm (M). Mfl: 0.0040–0.0043mm (M). Dshf: short spines-1 (MF) or 2 (F) median spines-3 long spines.

**Wings.** AvFW: 12–14 (M). AvHW: 9–10 (M). LoptFW: 0.0028–0.0031mm (M). AnptFW: 0.0068–0.0075 $\mu$  (M). LoptHW: 0.0028–0.0031mm (M). AnptHW: 0.0068–0.0075mm (M). DfwHW: 0.0056–0.0067mm (M). LbanFW: 16.50–17.63mm (M); 17.00mm (F). LbanHW: 14.09–15.37mm (M); 14.25mm (F). AndFW: 7.05–7.44mm (M); 8.07mm (F). AndHW: 7.05–7.38mm (M). Wb: 10.08–10.79mm (M); 9.80mm (F). LFW: 32.72–35.23mm (M); 34.42mm (F). LHW: 32.79–35.18mm (M); 33.16mm (F). AnsbtFW: 0.0021–0.0024mm (M). AntrFW: 0.0081–0.0093mm (M). LarFW: 0.003–0.005mm (M). LarHW: 0.0037–0.0043mm (M). LnptFW: 11.08–12.16mm (M); 11.72mm (F). LnptHW: 12.59–13.76mm (M);

13.01mm (F). At-MP: 0.0025–0.0037mm (M). LbaFW: 0.0030–0.0031mm (M). LbaHW: 0.0031–0.0032mm (M). RP2-loptFW: 0.0003–0.0010mm (M). RP2-loptHW: 0.003–0.007mm (M). Dat-lsbt: 0.0006–0.001mm (M). Lasa-ca: 0.004–0.005mm (M). Crp: 7. Crp: 5–7 (FW), 5–6 (HW). Cal: 3–6. PC-RA-RP1: 2–3 (FW), 1–3 (HW). CdfFW: only 3 rows of cells; 2 triple cells-2 double cells-3 rows of cells. CdfHW: 1 cell-2 rows of cells. Vt: 1–2, in some cases 1 (left), 2(right).

**Abdomen.** Lab: 26.99–29.26mm (M); 30.09mm (F). LcaS3: 0.0007–0.0010mm (M). LclS3: 0.0021–0.0023mm (M). Lecv-clS3: 0.0012–0.0015mm (M).

**Caudal appendages.** Las: 0.0014–0.0018mm (M). Poas: 0.003–0.004mm (M). Anas: 0.003–0.006mm (M). Ddas: 0.003–0.005mm (M). Epl: 0.0012–0.0013mm (M).

**Biology.** This species inhabits ponds, marshes and lakes, where major of males constantly change perches, but keep sites very close to water (F. Palacino, pers. obs.). *E. carmelita* is commonly found on sunny days between 10:00 and 15:00 hours, when they perch, fly quickly around their territories, copulate and lay eggs. Males are territorial and display continuous intra and interspecific aggression.

**Larva.** Unknown.

**Material examined.** BRAZIL, Sem procedência, 7 males, 1 female (MNRJ). COLOMBIA, El Banco (Magdalena), 22.I.1917, 4 males; no data, 1 male (UARC); Magdalena, La Peña, 16.xii.2009, F. Palacino leg., 3 males. PERU, Loreto Dept., Explorama Lodge, 50 mi NE Iquitos on Amazon River at junction with Yanamono River, 3°21'59" 72°47'56", 30.viii.1989, S. W. Dunkle leg., 1 male (RWG).

**Remarks.** Specimens of *E. carmelita* are very rare in collections.

**Distribution.** From Panama to Brazil (Fig. 30), from 10 to 300 m. asl.

### *Erythemis collocata* (Hagen, 1861)

(Fig. 1a, 2a–c, 31)

*Mesothemis collocata* Hagen, 1861: 171.

**Type material.** (1 male). USA. Texas: Pecos River, no more data, 1 male (MCZ). Examined.

**Diagnosis.** Thorax green (female and sexually immature male) or pruinose blue (mature male), dorsum of abdomen green with narrow stripes black on lateral, transversal and dorsal carinae on S2-9, stripes wider in S7-9 (female and sexually immature male), or pruinose blue (mature male). Abdominal appendages black. Basal area hyaline. Posterior extension of ventral teeth on male cercus beyond level of apex of epiproct (Fig. 12). Posterior lobe of vesica spermalis absent, lateral lobe extended more posteriorly than medial lobe. Hook bilobed and not perpendicular to the longitudinal axis of vesica spermalis (Fig. 18). Cornua parallel to vesica spermalis transversal axis, with lobes fused to apex, and not covered by lateral lobes in lateral view (Fig. 20). In ventral view vulvar lamina triangular, not projected to the posterior region and with the posterior border acute. Lab  $\leq$  30mm, LcaS4/LclS4  $>$  2.10; WmS2/LcaS5  $<$  3.

**Morphometric ratios of males.** Lban/Anb  $<$  1.90; LHW/Acd  $<$  3.60; LHW/LFW  $<$  0.97; LclS3/LcaS3  $<$  2.10; AnptHW/LoptHW  $>$  0.19; LclS3/Lecv-clS3  $>$  4.00; Lab/LcaS3  $<$  3.00; Ansbt/Antr  $<$  2.70; Antr/Lar  $<$  8.00.

**Morphometric ratios of females.** Lban/Anb  $<$  1.55; LHW/Acd  $<$  0.54; LHW/Lab  $<$  1.20; Lab/Las  $>$  2.50; LclS3/LcaS3  $<$  3.00; Lecv-clS3/LcaS3  $<$  1.60; Lab/LclS3  $<$  1.40; Lab/LcaS3  $<$  3.00; Ansbt/Antr  $<$  2.40; LFW/Lnpt  $>$  2.9; Lnpt/Anb  $<$  1.20.

**Head.** Ll: 0.0009–0.0014mm (M); 0.0013–0.0014mm (F). Lw: 0.0031–0.0033mm (M); 0.0031–0.0035mm (F). Hwd: 0.0055–0.0062mm (M); 0.0059–0.0061mm (F). Hl: 0.0031–0.0036mm (M); 0.0032–0.0036mm (F).

**Legs.** Nsmf: 7–10 (M); 6–7 (F). Nshf: 16–24 (M); 11–17 (F). Hfl: 0.0058–0.0063mm (M); 0.0058–0.0061mm (F). Fbsd: 0.0022–0.0025mm (M); 0.0022mm (F). Mfl: 0.0035–0.0041mm (M); 0.0035–

0.0038mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-3 long spines, short spines-1 median spine-3 long spines.

**Wings.** LoptFW: 0.0028–0.0031mm (M); 0.0031–0.0034mm (F). AnptFW: 0.0050–0.0068mm (M); 0.0068–0.0075mm (F). LoptHW: 0.0030–0.0033mm (M); 0.0033–0.0035mm (F). AnptHW: 0.0062–0.0068mm (M); 0.005–0.008mm (F). Dfwhw: 0.0057–0.0066mm (M); 0.0058–0.0061mm (F). LbanFW: 14.47–16.42mm (M); 14.00–15.74mm (F). LbanHW: 12.24–13.87mm (M); 11.94–13.17mm (F). and FW: 6.92–7.61mm (M); 7.65–7.77mm (F). Wb: 9.11–10.19mm (M); 9.00–9.73mm (F). LFW: 30.54–32.11mm (M); 30.00–32.00mm (F). LHW: 30.00–31.24mm (M); 27.97–30.71mm (F). AnsbtFW: 0.0016–0.0020mm (M); 0.0015–0.0020mm (F). AntrFW: 0.0080–0.0093mm (M); 0.0081–0.0093mm (F). LarFW : 0.003–0.006mm (M); 0.001–0.006mm (F). LarHW : 0.003–0.005mm (M); 0.002–0.006mm (F). LnptFW: 10.00–11.11mm (M); 10.00–11.00mm (F). LnptHW: 11.00–12.33mm (M); 10.70–12.24mm (F). At-MP: 0.0006–0.005mm (M); 0.0003–0.0012 mm (F). LbaFW: 0.0028–0.0032 (M); 0.0028–0.0030mm(F). LbaHW: 0.0029–0.0034mm (M); 0.0028–0.0030mm (F). RP2-loptFW: 0.000–0.003mm (M); 0.000–0.006mm (F). RP2-loptHW: 0.000–0.004mm (M); 0.001–0.004mm (F). Dat-lsbt: 0.0006–0.0020mm (M); 0.001–0.003mm (F). As-MP: 0.0008–0.0012mm (M); 0.0010–0.0013mm (F). Crp: 9–10 (FW), 9–11 (HW). Cal: 3–6. PC-RA-RP1: 2–3. Cdffw: only 3 rows of cells; 1 triple cell-1 double cell-3 rows of cells. Vt: 1–2.

**Abdomen.** Lab: 24.00–27.00mm (M); 24.52–25.88mm (F). LcaS3: 0.0008–0.0011mm (M); 0.0009–0.0012mm (F). LclS3: 0.0014–0.0022mm (M); 0.0019–0.0021mm (F). Lecv-clS3: 0.0014–0.0019mm (M); 0.0013–0.0015mm (F).

**Caudal appendages.** Las: 0.0014–0.0018mm (M); 0.0006–0.0011mm (F). Poas: 0.0009–0.003mm (M); 0.0015–0.0018mm (F). Anas: 0.003–0.006mm (M); 0.003–0.005mm (F). Ddas: 0.002–0.005mm (M). Epl: 0.0009–0.0012mm (M); 0.003–0.006mm (F). Pritchard and Smith (1956) used the caudal appendage length to differentiate the *E. collocata* and *E. simplicicollis* larvae. Costa and Pujol-Luz (1993) found that the cercus length exceeds half of the epiproct length.

**Larva.** Pritchard and Smith (1956) mention the character “lateral anal appendages two-thirds as long as superior appendage”, to differentiate the species. According to Costa and Pujol-Luz (1993) the number of premental or palpal setae has not been recorded, and the cercus is between 1/2 and 2/3 of the length of the epiproct.

**Material examined.** USA, Arizona, Cochise Co., pond at Slaughter Ranch, 26 km E of Douglas, 31°20'11" 109°16'44", 1160 m, 9.viii.1995, R. W. Garrison leg., 1 female (RWG); same, but Muleshoe Ranch, Bass Creek, Hot Springs, 32°21'10" 110°15'26", 1196 m, R. W. Garrison, N. v. Ellenrieder leg., 1 male (RWG); same, but Yavapai, Santa María River at Ariz. Hwy., 96, 8.x.1990, R. W. Garrison leg., 1 male (RWG); same, but Yuma Co., Mohawk, Gila River at Mohawk Valley Blvd., 32°42'52" 114°0'52", 80m, 30.ix.2002, R. W. Garrison, N. v. Ellenrieder leg., 1 mle (RWG); **California**, Fresno Co., Avocado Lake, 12.ix.1977, S.W. Dunkle leg., 1 male, 1 female (CNIN); same, but Riverside Co., Dos Palmas Nature Preserve, NE corner of Salton Sea, ca 2 mi E Salton. Sea recreation area, 33°29'50" 115°49'54", 60 m, 12–13.v.2001, R. W. Garrison leg., 1 female (RWG); **Nuevo México**, Cháves Co., Bottomless Lakes State Park, 32°3'45" 104°28'18", 1129 m, 2.viii.1984, R. W. and J. A. Garrison leg., 1 male (RWG).

**Remarks.** The label attached to the holotype says “TYPE 1871”, however the species description was published in 1861.

**Biology.** In Sutter Co. (California), *E. collocata* adults feeds on *Anopheles freeborni* Aitken (Diptera: Culicidae) mosquitoes in rice crops (Yuval and Bouskila 1993). A high percentage of attacks on mosquitoes were documented at sunset when mosquitoes gathered in copulatory or postcopulatory swarms (Yuval and Bouskila 1993). Collection labels indicate that *E. collocata* also feeds on specimens of Syrphidae (Diptera), antlions (Neuroptera) and *Hetaerina vulnerata* Hagen in Selys (Odonata: Calopterygidae). Manolis (2003) mentioned that *E. collocata* exhibit a territorial mating system, which was corroborated by Wong-Muñoz et al. (2011) who also found that emergence of the largest individuals occur at the end of the mating season.

**Distribution.** Canada to Mexico (Fig. 31), between 30–2286 m. asl.



***Erythemis credula* (Hagen, 1861)**

(Fig. 1a, 2a, 22, 24, 32)

*Diplax credula* Hagen, 1861: 184.

**Type material.** (2 male). BRAZIL. Minas Gerais: St. Thomas, 1877, no more data, 1 male lectotype, 1 male paralectotype (MCZ). We examined two adult specimens labeled as types (MCZ), in the type 1 the abdomen is lost (from the mid region of second segment). The specimen labeled as type 2 is here designed as the lectotype because it has all its parts.

**Diagnosis.** Thorax, dorsum of abdomen, and dark basal spot ochreous or brown (in female and immature male), or black (mature male). Dorsum of the thorax pale with dark antehumeral stripes, the width of the three stripes is similar (female and sexually immature male). Dark basal spot on HW does not reach the first antenodal vein, but reaches the following regions: beyond the MP crossvein, the penultimate row of cells or the row of marginal cells, and maximum the supplementary anal vein. Posterior lobe of vesica spermalis not covered by lateral lobe (Fig. 20 and 21), which extends more posteriorly than medial lobe is more extended into posterior region than the medial lobe. Hook not bilobed, instead two finger-shaped structures are oriented perpendicular to the longitudinal axis of the vesica spermalis (Fig. 22 and 24). Cornua diagonal with respect to vesica spermalis transversal axis, with lobes separate to apex, and not covered by lateral lobes (Fig. 20). Vulvar lamina suboval in ventral view, not projected to posterior region and with posterior border rounded (Fig. 10).  $Lab \leq 30mm$ ,  $LcaS4/LclS4 > 2.1$ .

**Morphometric ratios of males.**  $AnptFW/LoptFW$  ratio on HW ( $AnptHW/LoptHW < 0.19$ );  $LHW/Lab > 1.2$ ;  $AnptFW/LoptFW > 0.22$ ;  $Acid/Lban > 4.10$ ;  $And/Lban > 4.10$ ;  $Lban/Anb > 1.90$ ;  $LHW/Acd > 3.60$ ;  $LHW/LFW > 0.97$ ;  $LclS3/LcaS3 > 2.10$ ;  $LclS3/Lecv-clS3 > 4.00$ ;  $Lecv-clS3/LcaS3 > 1.50$ ;  $Lab/LclS3 < 1.50$ ;  $Lab/LcaS3 > 3.00$ ;  $Ansbt/Antr < 2.70$ ;  $LFW/Lnpt > 3.00$ ;  $Lnpt/Anb > 1.50$ ;  $Lba/Lban > 2.00$ ;  $Lban/Lasa-ca < 3.00$ .

**Head.** Ll: 0.0009–0.0011mm (M); 0.0013mm (F). Lw: 0.0027–0.0031mm (M); 0.0031mm (F). Hwd: 0.0050–0.0053mm (M); 0.0055mm (F). Hl: 0.0026–0.0028mm (M); 0.0028mm (F).

**Legs.** Nsmf: 9–22 (M); 6–12 (F). Nshf: 21–54 (M); 7–17 (F). Hfl: 0.0056–0.0060mm (M); 0.0062mm (F). Fbsd: 0.0020–0.0021mm (M); 0.0023mm (F). Mfl: 0.0034–0.0036mm (M); 0.0038mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-3 long spines (MF), short spines-1 (F) or 2 median spines (MF)-3 long spines (M).

**Wings.** AvFW: 10–12 (M); 10–12 (F). AvHW: 8–10 (M); 8–9 (F). LoptFW: 0.0030–0.0033mm (M); 0.0031mm (F). AnptFW: 0.005–0.007mm (M); 0.006mm (F). LoptHW: 0.0031–0.0033mm (M); 0.0032mm (F). AnptHW: 0.0053–0.0068mm (M); 0.006mm (F). Dfwhw: 0.004–0.006mm (M); 0.0053mm (F). LbanFW: 11.85–14.58mm (M); 13.24–14.58mm (F). LbanHW: 10.25–13.35mm (M); 10.91–12.89mm (F). AndFW: 5.33–6.74mm (M); 5.55–6.62mm (F). Wb: 6.38–8.16mm (M); 7.47–7.91mm (F). LFW: 24.19–30.35mm (M); 27.24–29.94mm (F). LHW: 24.46–29.00mm (M); 25.67–29.05mm (F). AnsbtFW: 0.0015–0.0018mm (M); 0.0013mm (F). AntrFW: 0.0062–0.0075mm (M); 0.007mm (F). LarFW: 0.000–0.0002mm (M); 0.0006mm (F). LarHW: 0.000–0.002mm (M); 0.0006mm (F). LnptFW: 7.86–9.75mm (M); 8.30–9.81mm (F). LnptHW: 7.56–10.95mm (M); 9.00–10.90mm (F). At-MP: 0.004–0.008mm (M); 0.009mm (F). LbaFW: 0.0025–0.0029mm (M); 0.002mm (F). LbaHW: 0.0025–0.0029mm (M); 0.0025mm (F). RP2-loptFW: 0.0009–0.0015mm (M); 0.008mm (F). RP2-loptHW: 0.0011–0.0016mm (M); 0.008 (F). Dat-lsbt: 0.0012–0.0018mm (M); 0.0018mm (F). Lasa-ca: 0.003–0.008mm (M); 0.006mm (F). Crp: 6–9 (FW), 5–10 (HW). Crp: 4–6 (FW), 5 (HWF). Cal: 2–4. PC-RA-RP1: 2–3 (FW), 1–3 (HW). CdfFW: only 2 rows, only 3 rows, 1–3 triple cells-2 rows, 1 double cell-1-2 triple cells-2 rows, 1 double cell-1 triple cell-2 rows. CdfHW: 1–4 individual cells-2 double cells, 1 cell-1 double cell-1 cell-2-3 rows. Vt: 0–1, in some cases 0 (left), 1(right). Csub: 2–3. FW arculus approaching or beyond the second antenodal vein.

**Abdomen.** Lab: 21.16–24.94mm (M); 22.97–24.65mm (F). LcaS3: 0.005–0.008mm (M); 0.008mm (F). LclS3: 0.0016–0.0018mm (M); 0.0019mm (F). Lecv-clS3: 0.0011–0.0013mm (M); 0.001mm (F).

**Caudal appendages.** Las: 0.0013–0.0015mm (M); 0.009mm (F). Poas: 0.001–0.003mm (M); 0.001mm (F). Anas: 0.003–0.005mm (M); 0.002mm (F). Ddas: 0.002–0.004mm (M). Epl: 0.0008–0.0014mm (M); 0.004mm (F).

**Larva.** Dias dos Santos (1969) provides the following characters for the last larval stage: larva ochre and spider-shaped, with white eyes and long metathoracic legs. Head short and wide. Total length 15 mm, width of the head 5 mm, head length 2 mm, ll 3 mm, lw 3.50 mm, thorax length 4 mm, wing teca 6.00 mm, femur anterior, medial and posterior length 2.30; 3.00 and 5.50 mm respectively. Tibia anterior, medial and posterior length 2.50; 3.50 and 7.00 mm respectively. Lab 9.00 mm, caudal appendage mid-dorsal 1.20 x 1.10 mm, lateral superior 0.70 mm, lateral inferior 1.20 mm. According to Costa and Pujol-Luz (1993), *E. credula* larvae show 11 premental setae, six palpal setae, cercus exceeds 1/2 the length of the epiproct.

**Material examined.** **BRAZIL, Amapá,** Ressurreição, ii.1964, J.C.M. Carvalho, Dirce leg., 1 male (MNRJ); **Espírito Santo,** Reserva Nova Lombardia, 4Km. do Sta. Tereza, 15.i.1967, N. Santos leg., 1 male (MNRJ); **Minas Gerais,** Cataguases, 20.ii.1958, N. Santos leg., 2 males (MNRJ); same, but Lagoa Santa, Lagoa olho d' agua, 20.iv.1949, Machado e N. Dias dos Santos leg., 4 males, 6 females (MNRJ); same data as before except collected on following dates: 23.x.1983, N. Santos, Ulisses leg., 1 male; same, but ii.1942, Berla leg., 1 male (MNRJ); same data as before except collected on following dates: ii.1947, Santos, Berla, Machado leg., 4 males, 1 female, 13.i.1951, N. Dias dos Santos e Machado leg. 2 males, 2 females; same, but Pirapora, ii.1947, Santos, Machado leg., 1 male (MNRJ); **Pará,** Belém, Utinga, 20.ii.1963, Roppa, Mielke leg., 4 males 1 female (MNRJ); **Pernambuco,** Igarapu, Usina S. José, 2 males (MNRJ); same, but Recife, Reserva Florestal do Açude do Prata, Parque Dois irmãos, 08°-09°S e 34°-35°W, 08.ii.2001, 5 males; same data as before except collected on following dates: 09.ii.2001, 1 male; same, but Dois irmãos, 12.xii.1944, Berla leg., 1 male (MNRJ); same data as before except collected on following dates: 27.vii.1944, 1 male; same, but São Lourenço, Brejo dos Macacos, 18.ii.1963, N. Santos, Dardano Lima leg., 1 male (MNRJ); Sem procedência, 2 males, 3 females (MNRJ); **São Paulo,** Emas, i.1939, Santos leg., 1 male (MNRJ); same, but Pirassununga, Ribeirão S. Vicente, 15.xii.1948, Machado, N. Dias dos Santos leg., 2 males (MNRJ); same, but Laranja Azeda, iii.1944, N. Santos leg., 1 male, 2 females (MNRJ); same, but E. E. Casa e Pesca, 09.xii.1948, Machado, N. Dias dos Santos leg., 2 males (MNRJ); same, but Lagoa do Carrinho, xii.1948, Machado, N. Dias dos Santos leg., 1 male (MNRJ). **COLOMBIA, Amazonas,** Leticia. km. 2 vía Tarapacá, 1 male (ICN); **Meta,** San Juan de Arama, Hda. La Macarena, 1 male (ICN). **GUYANA, Demerara,** Lama creek, tributary of Mahaica River, 6°48' 58"10', 0 m, T. W. and A. J. Donnelly leg., 1 female (RWG). **FRENCH GUYANA,** small canal 17 km S of Tonate on route D5, 4°52'15" 52°31'9", 18 m, 18.ii.1988, R. W. Garrison leg., 2 males (RWG); marsh by Piste de Kaw, just E of N2, 4°23'53" 52°18'30", 71 m, 17.ii.1988, R. W. Garrison leg., 1 male (RWG). **VENEZUELA, Bolívar State,** Canaima at Río Carrao, 6°14'30" 62°50'53", 415 m, 12-14.viii.1990, R. W. and J. A. Garrison, 1 male (RWG).

**Remarks.** The larva of *E. credula* was described by Calvert (1928) based on material from Antigua and Barbados, but Dias dos Santos (1969) remarks that both the description and the figures provided by Calvert (1928) do not correspond to this species, so he provided a new description.

**Biology.** Larvae of *Erythemis credula* show low mobility in water, but walk rapidly on dry surfaces (Dias dos Santos 1969) and have been observed preying on larvae of *Buenoa platynemis* Fieber (Heteroptera: Notonectidae) in acidic water ponds with temperatures between 22 and 24°C (Nessimian and Ribeiro 2000). Likewise, larvae and adults have been found in swamps where the primary vegetation was *Sphagnum* (Sphagnaceae) (Dias dos Santos 1969).

**Distribution.** From Belize to Argentina (Fig. 32), between 0–1870 m. asl.

### *Erythemis haematogastra* (Burmeister, 1839)

(Fig. 1a, 2a–c, 23, 33)

*Libellula haematogastra* Burmeister, 1839: 857.

*Lepthemis hamatogastra* Kirby, 1890: 39. Incorrect spelling.

**Type material.** Not examined.

**Diagnosis.** Thorax, dorsum of abdomen, and dark basal spot on HW reddish brown (female and sexually immature male), or thorax and first three abdominal segments brown and abdominal segments 4–10 red (mature male). Basal area on HW does not reach the first antenodal vein or the last rows of cells to anal angle, but reaches beyond the MP crossvein, and the AA (Fig. 4). Posterior extension of ventral teeth on male cercus about the same level as the apex of epiproct or less (Fig. 13). Posterior lobe of the vesica spermalis is not covered by lateral lobe (Fig. 20), which extends more posteriorly than the medial lobe. Hook bilobed, rectangular (Fig. 25) and not perpendicular to the longitudinal axis of vesica spermalis (Fig. 18). Cornua diagonal with respect to vesica spermalis transversal axis, with lobes separate to apex, and covered by lateral lobes in lateral view (Fig. 19). Lab >30mm, LcaS4/LclS4 >2.1.

**Morphometric ratios of males.** AnptFW/LoptFW>0.22; LHW/Acd>3.60; LHW/LFW>0.97; Las/Anas>4.00; LclS3/LcaS3>2.10; LHW/Lab>1.2.00; Lecv-clS3/LcaS3>1.50; Lab/LcaS3>3.00; Lba/Lban<2.00; Lar/Lba<0.20.

**Morphometric ratios of females.** Lban/Anb>1.55; LHW/Acd>0.54; LHW/Lab<1.20; Lab/Las>2.50; LclS3/LcaS3>3.00; Lecv-clS3/LcaS3>1.60; Lab/LcaS3>3.00; Antr/Lar>3.00; LFW/Lnpt<2.90; Lar/Lba<0.14; Lnpt/Anb>1.20.

**Head.** Ll: 0.0011–0.0015mm (M); 0.0014–0.0015mm (F). Lw: 0.0030–0.0036mm (M); 0.0034–0.0038mm (F). Hwd: 0.006–0.007mm (M); 0.0067–0.0071mm (F). Hl: 0.0033–0.0040mm (M); 0.0031–0.0041mm (F).

**Legs.** Nsmf: 14–19 (M); 8–10 (F). Nshf: 29–37 (M); 10–18 (F). Hfl: 0.0065–0.0072mm (M); 0.0065–0.0070mm (F). Fbsd: 0.0024–0.0027mm (M); 0.0026–0.0040mm (F). Mfl: 0.0042–0.0054mm (M); 0.0041–0.0046mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-3 long spines (M), short spines-1 to 3 median spines-3 to 5 long spines (F).

**Wings.** LoptFW: 0.0034–0.0038mm (M); 0.0035–0.0042mm (F). AnptFW: 0.006–0.008mm (M); 0.007–0.009mm (F). LoptHW: 0.0034–0.0038mm (M); 0.0036–0.0040mm (F). AnptHW: 0.006–0.008mm (M); 0.007–0.008mm (F). DfwHW: 0.0061–0.0069mm (M); 0.0063–0.0068mm (F). LbanFW: 16.46–18.49mm (M); 17.49–19.19mm (F). LbanHW: 14.33–16.12mm (M); 14.96–16.45mm (F). AndFW: 6.87–8.48mm (M); 7.85–9.03mm (F). Wb: 8.58–10.29mm (M); 9.02–10.00mm (F). LFW: 35.40–37.53mm (M); 36.92–38.9mm (F). LHW: 34.82–37.05mm (M); 36.38–38.56mm (F). AnsbFW: 0.0023–0.0025mm (M); 0.0023–0.0025mm (F). AntrFW: 0.006–0.009mm (M); 0.0008–0.0010mm (F). LarFW: 0.001–0.003mm (M); 0.000–0.002mm (F). LarHW: 0.0006–0.0030mm (M); 0.0006–0.0025mm (F). LnptFW: 12.00–12.62mm (M); 13.27–13.89mm (F). LnptHW: 13.71–14.69mm (M); 13.68–15.5mm (F). At-MP: 0.0031–0.0043mm (M); 0.0025–0.0043mm (F). LbaFW: 0.0031–0.0034mm (M); 0.0030–0.0033mm (F). LbaHW: 0.0031–0.0034mm (M); 0.0031–0.0033mm (F). RP2-loptFW: 0.0009–0.0030mm (M); 0.001–0.005mm (F). RP2-loptHW: 0.0009–0.0070mm (M); 0.0062–0.0065mm (F). Dat-lsbt: 0.001–0.006mm (M); 0.0012–0.002mm (F). Lasa-ca: 0.005–0.007mm (M); 0.005–0.007mm (F). Crp: 9–10. Cal: 3–8. PC-RA-RP1: 2–3. CdfFW: only 3 rows of cells. Vt: 1. Csub: 3.

**Abdomen.** Lab: 31.63–40.60mm (M); 33.09–35.60mm (F). LcaS3: 0.0075–0.0087mm (M); 0.006–0.008mm (F). LclS3: 0.0020–0.0022mm (M); 0.0023–0.0029mm (F). Lecv-clS3: 0.0013–0.0017mm (M); 0.0013–0.0016mm (F).

**Caudal appendages.** Las: 0.0018–0.0021mm (M); 0.0011–0.0013mm (F). Poas: 0.001–0.004mm (M); 0.001–0.005mm (F). Anas: 0.002–0.004mm (M); 0.001–0.004mm (F). Ddas: 0.0043–0.0059mm (M). Epl: 0.0012–0.0015mm (M); 0.003–0.005mm (F).

**Larva.** Unknown.

**Material examined.** BRAZIL, Amapá, Porto Santana, ICOMI, 06.xii.1961, J.C.M. Carvalho, Mielke leg., 1 male, 1 female (MNRJ); same, but 26-27.ii.1963, Roppa, Mielke leg., 1 male (MNRJ); same, but Serra do Navío, 18.ix.1963, H. Berla leg., 2 males (MNRJ); Amazonas, Manaus, km. 38, Elias leg., xi.1959, 2 females (MNRJ); same, but Igarapé, adiante do bifurcais da estrada, Hacotiana e Rio Branco, N. Santos leg., 21.x.1959, 1 male, 1 female (MNRJ); same, but Parintis, 18.i.1973, N. Tangerini leg., 1 male (MNRJ); same, but Poraquequara, i.1973, N. Tangerini leg., 2 males, 1 female (MNRJ); same, but Rio Negro, Pauro leg., 25.vii.1941, 1 female (MNRJ); same, but Manicoré, Rio Madeira, Parko leg.,

x.1941, 1 male, 2 females (MNRJ); same, but Médio Javari, iii.1963, J.C.M. Carvalho leg., 3 males (MNRJ); same, but Rio Paranari, iv.1937, 1 female (MNRJ); no data, 1 female (MNRJ); **Bahia**, Itamaraju, monte Pascoal Km. 5, 10-15.i.1972, Elias leg., 6 males, 18 females (MNRJ); **Espírito Santo**, Conceição da Barra, Cohaire, 16-21.ix.1968, Paulo Elias leg., 1 female (MNRJ); same data as before except collected on: 08.iv.1969; 1 female; same, but vii.1971, Elias, Paulo leg., 1 male (MNRJ); same, but Linhares, Estr. Linhares - Regência km. 4, iii.1944, Elias leg., 1 male, 4 females (MNRJ); same, but Estr. nova para Regência km. 6, 10-15.iii.1972, Elias, Paulo leg., 2 males, 6 females (MNRJ); same data as before except collected on: 21-26.ii.1972; 5 males; same, but, Estr. nova para Regência km. 7, 01-08. iv.1972, Elias, Paulo leg., 10 males, 9 females (MNRJ); same, but Estrada nova para Regência Km. 8, 10-15.iv.1972, Elias, Paulo leg., 1 male, 4 females (MNRJ); same, but Estr. Linhares a Colatina, parte Norte km. 5, 24-31.v.1972, Elias, Paulo leg., 3 males 4 females (MNRJ); same, but 01-07.ii.1972, Elias, Paulo leg., 2 males, 5 females (MNRJ); same data as before except collected on following dates: 08-14. ii.1972, 3 males 4 females; 15-19.ii.1972, 3 males, 2 females; 10-15.iii.1972, 12 males, 14 females; 17-22. iii.1972, 13 males, 9 females; 24-25.iii.1972, 6 males; 22-27.v.1972, ; 5 males, 6 females; 01-10.vii.1972, 10 females; xii.1972, 6 males; v.1973, 12 males, 11 female; same, but Rib. Do Engano, Vale do Itaúna, Travassos Santos, 1 male 1 female (MNRJ); same, but Santa Cruz, Estação de Biologia Marinha, 15-i.1973, N. Santos leg., 1 male (MNRJ); same, but Santa Tereza, 16.i.1973, J.M. C leg., 1 male (MNRJ); **Mato Grosso**, Rio São Lourenço, 02.xi.1983, N. Santos, Ulisses leg., 1 male (MNRJ); **Pernambuco**, Represa Gurjau, Cabo, 08°-09°S e 35°-36°W, 14.ii.2001, J.M. C e L.D.R. Borges leg., 2 males, 1 female (MNRJ); same, but Mun. do São Lourenço, Brejo dos Macacos, 18.ii.1963, N. Santos, D. Lima leg., 1 male (MNRJ); sem procedência, 4 males (MNRJ). **COLOMBIA, Antioquia**, Caucasia, Hacienda la Candelaria, 26.iv.2000, Clase de Entomología, 1 male (CEUA); same, but Santa Fé de Antioquia, Finca Cotove, 6.5530683° -75.8240600°, 540m, 12.iii.2008, M. Altamiranda leg., 1 male (MEFLG); **Cesar**, Chimichagua, 22.x.2006, N.C. Rojas leg., 1 male (ICN); **Córdoba**, Pueblo Nuevo, 20.iii.2006, N.C. Rojas leg., 4 females (ICN); **Meta**, San Martín, 16.v.2006, G. Beltrán leg., 1 male (ICN); **Valle**, El Medio, 14.ii.2004, 3 females (MUSENUV). **COSTA RICA, Guanacaste Prov.**, Hda. Taboga, 15.vi.1976, D. R. Paulson leg., 1 female (RWG). **ECUADOR, Napo Prov.**, Taracoa, 20 Km E of Puerto Francisco de Orellana, Napo River, 9.vii.1983, T. H. and P. S. Gantenbein leg., 1 male (RWG). **PERU, Loreto**, Aguas Negras, 0°31'22" 75°15'24", 145 m, 3.iii.1994, J. Louton leg., 1 male (RWG). **MEXICO, Tamaulipas**, Río Guayalejo, Km 170.5 ruta 85 a 1 km. al NE de Llera, 400 m, 26.x.1985, E. González leg., 1 male (CNIN).

**Biology.** *Erythemis haematogastra* adults are common at small lakes in both conserved and disturbed environments where rest on *Eleocharis* Brown, *Nymphaea* Linnaeus, and *Eichhornia crassipes* (Mart.) Solms (Ferreira and Fonseca 2003; Palacino-Rodríguez and Millán 2010). The period of greatest activity of *E. haematogastra* in rice fields has been registered from 12:00 to 16:00 hrs (Palacino-Rodríguez and Millán 2010).

**Distribution.** From Mexico to Brazil (Fig. 33), between 3–1000 m.asl.

### *Erythemis mithroides* (Brauer in Therese, 1900)

(Fig. 1a, 2a,b, 13, 18, 27, 34)

*Mesothemis mithroides* Brauer in Therese, 1900: 266, pl. 3, f 5.

*Mesothemis bicolor* Hagen, 1861: :169. Misidentification.

**Type Material.** Not examined.

**Diagnosis.** Thorax and dorsum of abdomen red or reddish-brown. Dark basal area on HW dark brown, and reaching beyond the MP crossvein, sometimes reaching the anal supplementary vein. Posterior extension of ventral teeth on male cercus about the same level as the apex of epiproct or less (Fig. 13). Posterior lobe of the vesica spermalis is covered by lateral lobe, which extends more posteriorly than medial lobe. Hook bilobed, triangular, and not perpendicular to the longitudinal axis of vesica spermalis

(Fig. 18). Cornua diagonal with respect to vesica spermalis transversal axis, with lobes separate to apex, and covered by lateral lobes in lateral view (Fig. 19).  $LclS4/LcaS4 < 2.10$ ;  $WmS2/LcaS5 < 3$ .

**Morphometric ratios of males.**  $Las/Anas < 4.00$ ;  $Acid/Lban < 4.10$ ;  $And/Lban < 4.10$ ;  $LHW/Acd < 3.60$ ;  $LHW/LFW > 0.97$ ;  $Las/Ddas < 4.00$ ;  $LclS3/LcaS3 < 2.10$ ;  $AnptHW/LoptHW < 0.19$ ;  $LHW/Lab < 1.2$ ;  $Lab/LcaS3 < 3.00$ ;  $LFW/Lnpt < 3.00$ ;  $Lba/Lban < 2$ .

**Head.** Ll: 0.0011–0.0015mm (M). Lw: 0.0020–0.0036mm (M). Hwd: 0.0061–0.0068mm (M). Hl: 0.0031–0.0037mm (M).

**Legs.** Nsmf: 3–15 (M). Nshf: 7–32 (M). Hfl: 0.0056–0.0063mm (M). Fbsd: 0.0020–0.0025mm (M). Mfl: 0.0034–0.0043mm (M). Dshf (the conditions separated by commas are present in different specimens): short spines-1 or 2 median spines-3 or 4 long spines, short spines-3 long spines.

**Wings.**  $LoptFW: 0.0023–0.0035$ mm (M).  $AnptFW: 0.004–0.006$ mm (M).  $LoptHW: 0.0023–0.0036$ mm (M).  $AnptHW: 0.005–0.006$ mm (M).  $DfwHW: 0.005–0.007$ mm (M).  $LbanFW: 14.60–18.56$ mm (M).  $LbanHW: 12.61–15.87$ mm (M).  $AndFW: 6.35–8.19$ mm (M).  $Wb: 8.77–11.41$ mm (M).  $LFW: 29.9–36.19$ mm (M).  $LHW: 29.33–35.94$ mm (M).  $AnsbtFW: 17.50–23.12\mu$  (M).  $AntrFW: 6.25–8.75\mu$  (M). Lar: 0.0006–0.0050mm (M).  $LnptFW: 10.91–12.38$ mm (M).  $LnptHW: 12.24–13.70$ mm (M). At-MP: 0.002–0.005mm (M).  $LbaFW: 0.0027–0.0030$ mm (M).  $LbaHW: 0.0027–0.0031$ mm (M).  $RP2-loptFW: 0.00620–0.00625$ mm (M).  $Dat-lsbt: 0.0006–0.0018$ mm (M).  $Lasa-ca: 0.004–0.008$ mm (M). Crp: 7. Cal: 3–6. PC-RA-RP1: 2–3. CdfFW: only 3 rows of cells. Vt: 1. Csub: 3.

**Abdomen.** Lab: 24.00–36.18mm (M); 21.00–23.5 mm (F).  $LcaS3: 0.0008–0.0013$ mm (M).  $LclS3: 0.0014–0.0022$  (M).  $Lecv-clS3: 0.0013–0.0015$ mm (M).

**Caudal appendages.** Las: 0.0009–0.0018mm (M). Poas: 0.002–0.004mm (M). Anas: 0.002–0.006mm (M). Ddas: 0.002–0.005mm (M). Epl: 0.0008–0.0014mm (M).

**Larva.** Costa and Pujol-Luz (1993) described the ochre colored larva from Rio São João (Rio de Janeiro, Brazil). According to Costa and Pujol-Luz (1993) the larva of *E. mithroides* is the smallest of the genus. However, this proposal is hard to accept in view of *E. credula* having the smallest adults (J. De Marmels, pers. comm.). Likewise, Costa and Pujol-Luz (1993) provided the following diagnostic characters: larva ochre. Head wide. Incisors and molars obtuse, mandibular formula L 1234 abb' R 123 +4 xy abd. Labrum with small dark spots, 13 premental setae, eight palpal setae, cercus exceeds between 2/3 up to half the length of epiproct. Outer margin of the palp with 13 small spines, inner margin slightly crenulated and presenting 24 large spines. Thorax with prothoracic apophyses. Supracoxa round, surrounded by spines. Wing sheaths reaching the level of the sixth abdominal segment, femur 1 and 2 with a distal dark brown circular band, the third pair of legs larger. Abdomen with the sixth segment widest. Epiproct triangular; paraproct pyramidal and divergent. Total length 11.25 mm; head length 3.7 mm; labial palp length 2 mm; prementum width 2,7 mm; teca anterior length 4.62 mm; teca posterior: 4.12 mm; femur I: 1.87 mm; Tibia 1: 2.5 mm; Femur 2: 2.75 mm; Tibia 2: 3.12 mm; Femur 3: 3.75 mm; Tibia 3: 5.12 mm; lab: 5.62 mm; epl: 0.8 mm; las: 0.5 mm; paraproct length 0.7 mm.

**Material examined.** BRAZIL, Amapá, Mazagão, Rio Purcacá, ii.1961, J.C.M. Carvalho leg., 1 male (MNRJ); Amazonas, Parintins, 18.i.1973, N. Tangerini leg., 2 females (MNRJ); Mato Grosso, Salobra, 05.vi.1942, C.I.O. Cruz leg., 1 female (MNRJ); same, but Entre Cuiabá e Guia, 15.iv.1963, N. Santos, Machado leg., 1 female (MNRJ); same, but Manaus, km. 38, Elias leg., xi.1959, 3 males, 1 female (MNRJ); Espírito Santo, Rib. Do Engano, Vale do Itaúna, Travassos Santos, 1 female (MNRJ); same, but Linhares, Estr. nova para Regência km. 7, 01-08.iv.1972, Elias, Paulo leg., 1 male, 3 females (MNRJ); same, but 22.i.1973, N. Santos, Sandim, Vicente leg., 1 male (MNRJ); same, but Santa Tereza, Rio Timluci, Reserva do Museu Nacional, 15.i.1967, N. Santos leg., 1 male (MNRJ); Maranhão, Carutapera, 10.i.1959, C. Simões, O. Fontana leg., 1 male (MNRJ); Minas Gerais, Januária, vii.1949, Machado, Berla leg., 1 male (MNRJ); Pará, Belém, Jardim Museu Goeldi, 06.ii.1956, Candido leg., 1 male (MNRJ); same data as before except collected on following dates: 04.viii.1959, 4 males; 1956, 1 male; São Paulo, Luis Antônio, Lagoa do Diogo, 14.i.2001, P.S.F. Peruquetti leg., 1 male (MNRJ); same, but Luis Antônio, Represa Beija-Flor, 14.i.2001, P.S.F. Peruquetti leg., 1 male (MNRJ); Sem procedência, 3 males, 4 females (MNRJ). COLOMBIA, Atlántico, Ciénaga La Larga, Palmar de Varela, 7.ii.2008, M. Lobo y M. Moreno leg., 2 males (UARC); Bolívar, Regidor, Finca Las Brisas, Corredor de vegetación alrededor de caño, 8° 45' 39.5"N 73° 52' 02.2" W, i.2009, M. Moreno leg., 2 males (UARC);

same, but Finca Las Pavas ó Labrador, Bosque Montaña de Toronto, 8° 46' 43.7 N 73° 54' 53.8" W, i.2009, M. Moreno leg., 1 male (UARC); same, but Finca Puerto Libre, Bosque, 8° 46' 4.4" N 73° 51' 44.5 " W, i.2009, M. Moreno leg., 1 male (UARC); same, but Santa Catalina, 8.x.1999, 1 male (ICN); same, but 3.x.1999, 1 male (ICN); **Boyacá**, Puerto Boyacá, 22.vi.1981, C. Bohórquez leg., 1 male (ICN); **Córdoba**, Pueblo Nuevo, 20.iii.2006, N.C. Rojas leg., 1 female (ICN). **MEXICO, Jalisco**, La Huerta. Estación de Biología Chamela, 1.xi.1994, E. González-Soriano leg., 1 male (CNIN); **Veracruz**, pond 13 km S of la Tinaja, 18°45'0" 96°26'24", 90 m, 13.viii.1976, R. W. and J. A. Garrison leg., 1 male (RWG); **PERU, Dept. Loreto**, Yarinacocha, forest pond at La Cabaña, 10.vii.1977, Dennis Paulson leg., 1 male (RWG).

**Remarks.** We studied some large adult specimens from Mexico and Guatemala labeled as “new species”, but our analyses showed that these are only size variations of the species. A molecular analyses may help to clarify the identity of these specimens.

**Biology.** *Erythemis mithroides* adults inhabits cane fields where they feed and males display interspecific aggression, especially in the presence of their own females (F. Palacino pers. obs.).

**Distribution.** From U.S.A. to Argentina (Fig. 34), between 4–970 m.asl.

### *Erythemis peruviana* (Rambur, 1842)

(Fig. 1a, 2a–c, 7, 10, 15, 21, 35)

*Libellula peruviana* Rambur, 1842: 81

*Libellula rubriventris* Blanchard, 1845: 217, pl. 28.

*Libellula bicolor* Erichson, 1848: 583.

**Type Material.** Not examined.

**Diagnosis.** Thorax, dorsum of abdomen, and basal spot on HW brown (female and sexually immature male); or thorax and abdominal S1-3 blue and abdominal S4-10 red (mature male). In females and sexually immature males, the dorsum of pterothorax is pale with dark antehumeral stripes and the central one is two or more times wider than lateral ones (Fig. 15). Dark basal spot on HW does not reach the first antenodal vein or the AA vein, only extends to the penultimate row of cells of anal angle. Posterior lobe of vesica spermalis is not covered by the lateral lobe, which extends less posteriorly than the medial lobe (Fig. 21). Hook is bilobed (Fig. 18), fingerlike and not perpendicular to the longitudinal axis of vesica spermalis (Fig. 21). Cornua is perpendicular to vesica spermalis transversal axis, with lobes separate at apex, and covered by lateral lobes in lateral view (Fig. 21). Lab  $\leq$ 30mm, LcaS4/LclS4  $<$ 2.1 (Fig. 4).

**Morphometric ratios of males.** LHW/Acd  $<$ 3.60; LclS3/LcaS3  $<$ 2.10; Lab/LcaS3  $<$ 3.00; Lban/Lasca  $<$ 3.00.

**Morphometric ratios of females.** AnptFW/LoptFW  $<$ 0.22; Lab/Las  $>$ 2.50; LclS3/LcaS3  $<$ 3.00; Lecv-clS3/LcaS3  $<$ 1.6; Lab/LcaS3  $<$ 3.00; Ansbt/Antr  $>$ 2.40; Antr/Lar  $<$ 3.00; LFW/Lnpt  $>$ 2.90.

**Head.** Ll: 0.0011–0.0014mm (M); 0.0011–0.0014mm (F). Lw: 0.0030–0.0037mm (M); 0.0030–0.0045mm (F). Hwd: 0.0054–0.0061mm (M); 0.0058–0.0061mm (F). Hl: 0.0028–0.0035mm (M); 0.0027–0.0037mm (F).

**Legs.** Nsmf: 5–13 (M); 6–9 (F). Nshf: 14–24 (M); 6–15 (F). Hfl: 0.0031–0.0059mm (M); 0.0053–0.0061mm (F). Fbsd: 0.0018–0.0023mm (M); 0.0021–0.0022mm (F). Mfl: 0.0032–0.0039mm (M); 0.0033–0.0041mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-1 to 3 median spines-3 long spines, short spines-3 long spines.

**Wings.** LoptFW: 0.0027–0.0036mm (M); 0.0032–0.0039mm (F). AnptFW: 0.004–0.007mm (M); 0.005–0.008mm (F). LoptHW: 0.0026–0.0038mm (M); 0.0032–0.0039mm (F). AnptHW: 0.004–0.007mm (M); 0.006–0.008mm (F). DfwHW: 0.005–0.006mm (M); 0.005–0.006mm (F). LbanFW: 13.11–14.95mm (M); 13.73–15.89mm (F). LbanHW: 11.04–13.50mm (M); 11.15–14.17mm (F). AndFW: 5.00–7.54mm (M); 6.53–8.20mm (F). Wb: 7.93–9.28mm (M); 6.96–9.69mm (F). LFW: 27.15–30.61mm (M); 28.42–33.27mm (F). LHW: 26.66–29.79mm (M); 26.70–32.22mm (F). AnsbtFW: 0.0017–0.0020mm (M);

0.0015–0.0020mm (F). AntrFW: 0.005–0.008mm (M); 0.005–0.008mm (F). LarFW: 0.001–0.004mm (M); 0.003–0.005mm (F). LarHW: 0.0003–0.0043mm (M); 0.001–0.003mm (F). LnptFW: 0.0008–0.0010mm (M); 9.30–11.27mm (F). LnptHW: 9.89–11.75mm (M); 10.02–12.25mm (F). At-MP: 0.002–0.005mm (M); 0.0002–0.0011mm (F). LbaFW: 0.0023–0.0028mm (M); 0.0025–0.0030mm (F). LbaHW: 0.0024–0.0030mm (M); 0.0027–0.0031mm (F). RP2-loptFW: 0.0006–0.0010mm (M); 0.0062–0.0068mm (F). RP2-loptHW: 0.0009–0.0070mm (M). Dat-lsbt: 0.0006–0.0019mm (M); 0.0006–0.0015mm (F). Lasa-ca: 0.004–0.011mm (M); 0.0006–0.0010mm (F). Crp: 7–8. Cal: 3–6. PC-RA-RP1: 2–3 (FW), 2 (HW). CdffFW: only 2 rows of cells; only 3 rows of cells. Vt: 1. Csub: 3.

**Abdomen.** Lab: 20.56–26.86mm (M); 22.62–27.53mm (F). LcaS3: 0.010–0.015mm (M); 0.010–0.014mm (F). LclS3: 0.015–0.020mm (M); 0.016–0.020mm (F). Lecv-clS3: 0.010–0.018mm (M); 0.010–0.019mm (F).

**Caudal appendages.** Las: 0.009–0.018mm (M); 0.009–0.010mm (F). Poas: 0.006–0.03mm (M); 0.012–0.025mm (F). Anas: 0.025–0.050mm (M); 0.025–0.037mm (F). Ddas: 0.0018–0.0110mm (M). Epl: 0.08–0.013mm (M); 0.050–0.062mm (F).

**Larva.** According to Calvert (1928) the larva of this species shows the following characters: Total length 13.00–13.50 mm, six palpal setae, the lateral spine on ninth segment is strongly decurved and measures 0.43 mm. Additional characters are provided by Costa and Pujol-Luz (1993) as follows: the cercus exceeds between 1/3 to half the length of epiproct, and there are eight palpal setae.

**Material Examined.** ARGENTINA, **Formosa Prov.**, ditch by road, 12 km E from route 11 on route 2 to Mojón de Fierro, 25°59'6" 58°2'18", 0 m, 5.xi.2007, R. W. Garrison and N. v. Ellenrieder leg., 1 male (RWG); same, but Banado La Estrella, 42 km N of Las Lomitas on road 28, 24°27'32" 60°23'17", 0 m, 18.ii.2008, R. W. Garrison and N. v. Ellenrieder leg., 1 female (RWG). BOLIVIA, **El Carmen**, 02.ii.1955, 1 male, 1 female (MNRJ). BRAZIL, **Amazonas**, Barreira da Ribeira, 18.viii.1936, 3 males, 4 females (MNRJ); same, but Rio Amazonas, 1936, Almeida leg., 1 female (MNRJ); same, but B. Constant, Rio Itecoahy, iii.1942, Parko leg., 2 males (MNRJ); same, but Rio Itecoahy, vi.1942, Parko leg., 1 male (MNRJ); same, but Manaus, N. Santos leg., 27.x.1959, 1 male (MNRJ); same, but Igarapé do Passarinho, Elias leg., xi.1959, 1 male (MNRJ); same, but Ponte de Bolívia, 20.xi.1960, E. Ferreira leg., 1 female (MNRJ); same, but Poraquequara, i.1973, N. Tangerini leg., 1 male 1 female (MNRJ); same, but Río Negro, 05.vii.1941, Parko leg., 1 male (MNRJ); same data as before except collected on following dates: 06.vii.1941, 2 males; 11.vii.1941, 2 males, 4 females, 12.vii.1941, 3 females, 13.vii.1941, 1 male; 19.vii.1941, 1 male; 20.vii.1941, 1 female; 22.vii.1941, 1 female; 23.vii.1941, 2 males; 25.vii.1941, 3 females, vii.1941, 3 males; xii.1941, 1 female; 23.x.1959, N. Santos leg., 8 males, 5 females, same, but Santo Antonio, Elias leg., iii.1960, 1 male (MNRJ); same, but Turislandia, x.1977, Sandim leg., 1 female (MNRJ); same, but Xiborene, 04.xii.1960, E. Ferreira leg., 5 males, 3 females (MNRJ); same data as before except collected on: 03.xii.1960, 2 males, 2 females; same, but Parintins, 18.i.1973, N. Tangerini leg., 8 males, 5 females (MNRJ); **Bahia**, Caravelas, vi.1908, Garbe leg., 1 female (MNRJ); same data as before except collected on: xi.1908, 1 male; same, but Camarajipe, Salvador, 18.vii.1951, N. Santos leg., 1 female (MNRJ); same, but Rep. da Bolandreira, Rio Yituamir, Salvador, 15.vii.1951, N Santos leg., 1 male (MNRJ); **Ceará**, Fortaleza, Pacatula, vi.1946, F. Pessoa leg., 4 males, 9 females (MNRJ); same, but Pacatula, ii.1962, N. Santos leg., 1 male (MNRJ); **Espirito Santo**, Anchieta, litoral do Espírito Santo, ii.1949, Berla leg., 1 male (MNRJ); same, but Baixo Guandú, 07-12.xii.1970, Elias leg., 1 female (MNRJ); same, but Conceição da Barra, 27.iii.1968, Paulo Elias leg., 1 female (MNRJ); same data as before except collected on: 24.ii.1972, 1 male; same, but Linhares, 08-14.ii.1972, Elias, Paulo leg., 1 male (MNRJ); same, but 22-27.v.1972, Elias e Paulo leg., 2 females (MNRJ); same data as before except collected on: 10-15.iii.1972, 1 male; same, but Linhares, Estr. Linhares - Regência km. 4, iii.1944, Elias leg., 1 male, 1 female (MNRJ); same, but Estr. Linhares a Colatina, parte Norte km. 5, 24-31.v.1972, Elias, Paulo leg., 2 females (MNRJ); same, but Sooretama, lago de Macuez 07.xi.1960, Dimitro leg., 1 male (MNRJ); **Goiás**, Formosa-Soiós, Lagoa Feia, 24.xi.1963, N. Santos, Machado e Dozjes leg., 1 female (MNRJ); **Maranhão**, Porto Gonçalves Dias, Medio Pindaré, 1942-1943, R. Meanda leg., 2 males (MNRJ); same, but Timon, Fazenda Cruzeiro, 17-18.viii.2004, J.M. C leg., 1 female (MNRJ); **Mato Grosso**, Bodoquena, 12-xii.1941, C.J.O. Cruz leg., 1 male (MNRJ); same, but Corumbá, 01-ii.1955, 1 male (MNRJ); same, but Miranda, 15-17.1941, C.J.O. Cruz leg., 2 males, 4 females (MNRJ); same, but Sa-

lobra, 21-23.i.1955, 1 male, 1 female (MNRJ); same, but C.I.O. Cruz leg., 4 males, 8 females (MNRJ); same, but Rio Paraguay, Corumbá-P. Esperanis, xi.1943, 1 male (MNRJ); same, but Tabatinga, Raul Soares, 10.v.1950, 2 males, 1 female (MNRJ); **Minas Gerais**, Lagoa Santa, 13.i.1951, Santos and Machado leg., 2 males, 3 females (MNRJ); same data as before except collected on: ii.1947, Santos, Berla y Machado leg.; 1 male iv.1949, 1 female; xii.1949, 13 males, 2 females; 15.i.1951, 1 male; same, but olho d' agua, 20.iv.1949, Machado e N. Dias dos Santos leg., 1 female (MNRJ); same, but lagoa olho d' agua, 08.iv.1979, N. Santos e L. F. Neto leg., 1 male (MNRJ); same, but 23.x.1983, N. Santos e Ulisses leg., 2 males, 6 females (MNRJ); same, but Lagoa do Palmital, governador, Valadares, 9.ii.1955, N. Santos e Machado leg., 4 males (MNRJ); same, but Pirapora, 11.ii.1942, A. Passarelli leg., 1 male, 1 female (MNRJ); same data as before except collected on: 19.v.1941, Bayley leg., 1 male; **Pará**, Belém, x.1980, Otero leg., 1 male, 1 female (MNRJ); same, but Santarém, v.1920, Garbe leg., 2 males, 1 female (MNRJ); same, but alter do Chão, 24.1.1971, N. Tangerini leg., 2 males (MNRJ); **Pernambuco**, Igarassu, Refugio Ecológico Charles Darwin, 12.ii.2001, J.M. C e L. Borges leg., 1 male (MNRJ); same, but Recife, Dois irmãos, 12.vii.1944, Berla leg., 1 female (MNRJ); same, but 07.x.1944, 1 male (MNRJ); same, but Parque Zoobotánico (Lago), 18.xi.1965, 2 males (MNRJ); same, but Florestal do Açude do Prata, 08°-09°S e 34°-35°W, 09.ii.2001, J.M. C e L. Borges leg., 1 male, 1 female (MNRJ); same, but Represa Gurjau, N. Santos, D. Lima leg., 1 male (MNRJ); same, but 08°-09°S e 35°-36°W, 14.ii.2001, J.M. C e L. Borges leg., 7 females (MNRJ); **Rio Grande do Sul**, Porto Alegre, Rio Capivara, 16.i.1958, N. Santos leg., 1 male, 2 females (MNRJ); **Rio de Janeiro**, Santa Cruz da Serra, 01.iv.1986, 1 female (MNRJ); **Roraima**, Ariquemes, viii.1980, Bento leg., 3 males (MNRJ); **Santa Catarina**, Brejo, entre Blumenau e Guará-Mirim, 13.ii.1982, N. Santos, L. F. Netto e M. C leg., 5 males, 1 female (MNRJ); **São Paulo**, Horto, Rio Claro, 04.ii.1975, N. Santos leg., 1 male (MNRJ); **Sergipe**, Santo Amaro, Aruari, xi.1961, J.C.M.C. leg., 4 males, 3 females (MNRJ); no data, 20 males, 11 females (MNRJ). **COLOMBIA**, **Amazonas**, Leticia, 15.iv.1990, 1 male (ICN). **Antioquia**, El Bagre, Ciénaga Mocholo, 11.iii.2005, J.A. Posada, leg., 1 male, 1 female (CEUA); same, but Carepa, Finca Augura, Estación Experimental Tulenapa, 48 m, 6.ii.2009, N. Uribe leg., 1 male (CEUA); same, but Caucasia, Hacienda La Candelaria, 80 m, 23.xi.2007, Grupo Entomología, 4 males (CEUA); **Bolívar**, Regidor, Finca Las Brisas, Corredor de vegetación alrededor de caño, 8° 45' 39.5"N 73° 52' 02.2" W, i.2009, M. Moreno leg., 2 males, 1 female (UARC); same, but Finca Las Pavas o Labrador, Bosque Montaña de Toronto, 8° 46' 43.7 N 73° 54' 53.8" W, i.2009, M. Moreno leg., 1 female (UARC); same, but Finca La Herradura (Amiagro), Cultivo de palma de aceite, 8° 41' 6.6" N 73° 53' 45,7" W, i.2009, M. Moreno leg., 1 male, 1 female (UARC); same, but Santa Catalina, 3-9.x.1999, G. Andrade leg., 4 males, 4 females (ICN); same, but 23.x.1946, 1 female (ICN); **Boyacá**, Puerto Boyacá, 18.vi.1981, C. Bohórquez leg., 1 female (ICN); **Cesar**, Chimichagua, 22-23.x.2006, N.C. Rojas leg., 1 male, 1 female (ICN); same, but El Paso, 25.x.2006-4.iv.2007, N.C. Rojas leg., 3 males, 1 female (ICN); **Córdoba**, Pueblo Nuevo, 18-20.iii.2006, N.C. Rojas leg., 3 males, 1 female (ICN); same, but Santa Cruz de Lorica, 22-24.iii-18.vii.2006, N.C. Rojas leg., 1 male, 4 females (ICN); **Meta**, Puerto López 15.iv.1984-3.vii.1986, R. Restrepo leg., 3 males, 1 female (ICN); same, but 9.iv.1984, 1 male (ICN); **Santander**, Sabana de Torres, Pozo Ecopetrol, 7°22'36"N 73°27'34"W, 133 males, 16.xii.2007, C. Garzón leg., 2 males (ANDES); **Sucre**, San Onofre, Reserva Sanguaré, 31.iii.2004, Grupo Entomología leg., 1 male (CEUA); same, but Bosque Tapón, 30.iii.2004, Grupo Entomología leg., 1 male (CEUA); **Valle del Cauca**, Laguna del Sonso, iv.1991, G. Medina y C. Rodríguez leg., (ICN); 2 males same, but CIAT, ii.2004, 1 male (MUSENUV). **MEXICO**, **Veracruz**, La Pera, Los Tux., 5.VII.1980, e. González, leg., 1 male (CNIN); same, but cerca de Cuichapa, 5.VII.1980, E. González, leg., 1 female (CNIN). **PANAMA**, **Canal Zone**, Pipeline Road, 25 km NW of Gamboa, 9°6' 79'42', 29.vii.1979, R. W. Garrison leg., 2 males (RWG). **PARAGUAY**, **San Bernardino**, i.1944, Mis. Cient. Brasil leg., 1 female (MNRJ); **Asunción**, iv.1944, Mis. Cient. Brasil leg., 1 female (MNRJ); **Puerto General Díaz**, iv.1944, Mis. Cient. Brasil leg., 7 males, 4 females (MNRJ).

**Biology.** Larvae and adults of *Erythemis peruviana* inhabits ponds, swamps, backwaters of rivers, and rice field canals, where the period of greatest activity for the adults is from 10:00 to 16:00 hrs. The males perch on low vegetation branches or directly on the ground, folding their wings forward, changing perches constantly and showing intraspecific aggression, as well as interspecific aggression with males of *E. vesiculosa* and *Erythrodiplax* sp. (Palacino-Rodríguez and Millán 2010). *Erythemis*



*peruviana* females have been observed perching or ovipositing over long periods in territories that are shared with non-territorial species such as *Brachymesia furcata* (Hagen) (De Marco et al. 2005).

**Distribution.** From U.S.A. to Argentina (Fig. 35), between 0–1500 m.asl.

***Erythemis plebeja* (Burmeister, 1839)**

(Fig. 1a, 2a–c, 11, 25, 36)

*Libellula plebeja* Burmeister, 1839: 856.

*Lepthemis verbenata* Hagen, 1861: 162.

**Type material.** (5 males, 1 female). BRAZIL, no more data, **holotype** 1 male (MLUH). CUBA. 1858, no more data, **paratypes** 2 males (MCZ). SURINAM, no more data, **paratype** 1 male (MCZ). VENEZUELA, no more data, **paratypes** 1 male, 1 female (MCZ). Examined.

**Diagnosis.** Thorax brown on sides and pale brown with darker stripes on front (female) or black (sexually immature male). Dorsum of the abdomen is brown and black with pale yellow crossbands in S3 and S4-7 (female and immature male). Thorax and dorsum of abdomen black (mature male). Dark basal area on HW brown. Dark basal spot on HW reaches beyond of the MP crossvein, and the AA. Ventral teeth on male cerci extending beyond the level of the apex of epiproct (Fig. 12). Posterior lobe of the vesica spermalis is not covered by lateral lobe, which extends more posteriorly than medial lobe (Fig. 19). Hook bilobed, triangular and is not perpendicular to the longitudinal axis of the vesica spermalis (Fig. 18). Cornua is diagonal with respect to vesica spermalis transversal axis, with lobes separate to apex and covered by lateral lobes in lateral view (Fig. 23 and 25).

**Morphometric ratio of male.** Lab/LcaS3>3.00.

**Morphometric ratios of female.** LHW/Lab<1.20; Lab/Las>2.50; Ansbt/Antr>2.40.

**Head.** Ll: 0.011–0.014mm (M); 0.011–0.013mm (F). Lw: 0.030–0.036mm (M); 0.030–0.041mm (F). Hwd: 0.060–0.068mm (M); 0.054–0.070mm (F). Hl: 0.029–0.038mm (M); 0.031–0.046mm (F).

**Legs.** Nsmf: 9–14 (M); 5–8 (F). Nshf: 21–30 (M); 6–14 (F). Hfl: 0.054–0.063mm (M); 0.053–0.060mm (F). Fbsd: 0.019–0.023mm (M); 0.021–0.030mm (F). Mfl: 0.036–0.041mm (M); 0.034–0.044mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-3 long spines (M), short spines-1 to 4 median spines-3 long spines (F).

**Wings.** LoptFW: 0.032–0.038mm (M); 0.034–0.041mm (F). AnptFW: 0.006–0.008mm (M); 0.005–0.008mm (F). LoptHW: 0.031–0.041mm (M); 0.033–0.040 (F). AnptHW: 0.005–0.008mm (M); 0.006–0.008mm (F). DfwHW: 0.055–0.074mm (M); 0.054–0.070mm (F). LbanFW: 15.69–17.66mm (M); 15.1–18.43mm (F). LbanHW: 12.92–15.57mm (M); 13.70–15.40mm (F). AndFW: 6.68–8.03mm (M); 6.66–8.20mm (F). Wb: 8.56–9.87mm (M); 8.68–10.47mm (F). LFW: 31.33–35.99mm (M); 30.93–36.72mm (F). LHW: 30.62–35.21mm (M); 30.87–35.32mm (F). AnsbtFW: 0.018–0.025mm (M); 0.017–0.024mm (F). AntrFW: 0.007–0.008mm (M); 0.006–0.009mm (F). LarFW: 0.003–0.006 (M); 0.0019–0.0060mm (F). LarHW: 0.0018–0.0068mm (M); 0.0098–0.0560mm (F). LnptFW: 10.50–12.31mm (M); 10.46–12.16mm (F). LnptHW: 10.62–13.57mm (M); 11.01–13.58mm (F). At-MP: 0.0018–0.0043mm (M); 0.0018–0.003mm (F). LbaFW: 0.026–0.032mm (M); 0.026–0.031mm (F). LbaHW: 0.026–0.035mm (M); 0.028–0.034mm (F). RP2-loptFW: 0.0006–0.0068mm (M); 0.0018–0.0056mm (F). RP2-loptHW: 0.0012–0.0062mm (M); 0.0006–0.0810mm (F). Dat-lsbt: 0.0006–0.0031mm (M); 0.001–0.003mm (F). Lasa-ca: 0.004–0.008mm (M); 0.004–0.009mm (F). Crp: 7–10 (FW), 7–11 (HW). Cal: 3–6. Number of postnodal veins between C and RA veins previous to first postnodal vein between RA and RP1 veins: 2–3 (FW), 1–3 (HW). CdfFW: only 2 rows of cells; only 3 rows of cells; 1 triple cell-1 double cell-3 rows of cells; 1 triple cell-2 double cells-1 triple cell. Vt: 1. Csub: 3.

**Abdomen.** Lab: 25.02–35.79mm (M); 26.10–32.38mm (F). LcaS3: 0.005–0.010mm (M); 0.005–0.012mm (F). LclS3: 0.016–0.025mm (M); 0.015–0.026mm (F). Lecv-clS3: 0.012–0.016mm (M); 0.011–0.015mm (F).

**Caudal appendages.** Las: 0.018–0.027mm (M); 0.006–0.011mm (F). Poas: 0.001–0.006mm (M); 0.0004–0.0025mm (F). Anas: 0.003–0.015mm (M); 0.002–0.003mm (F). Ddas: 0.003–0.006mm (M). Epl:

0.011–0.016mm (M); 0.003–0.006mm (F).

**Larva.** The following characters for the larvae were described by Calvert (1928): total length 14.50–15.50 mm, eight palpal setae. The midgut runs caudad as far as S7, leading into the hindgut it contracts to a narrow pylorus. Ampulla is small and is connected to anterior region of the latter, by a small pore in the midventral line. The subintestinal transverse muscle is attached to the ventral surface of the rectum, to the body wall and runs transversely along the long axis of the body. 30 lamellae in the dorsal hemibranch of gill I, which measured 3.68 mm. No pigment in gills V and VII, but some pigmentation in the axial and antaxial edges of I and XI, antaxial edge of III and IX gills, and on lamellae of the posterior half of the ventral hemibranchs of III and IX gills. The six dorsal hemibranchs of the rectum contain more pigment than the six ventral. Prothoracic ganglia length 0.45 mm, Prothoracic ganglia width 0.46 mm, Mesothoracic ganglia length 0.41 mm, Mesothoracic ganglia width 45.00 mm, Metathoracic ganglia length 0.27 mm, Metathoracic ganglia width 0.36 mm. Distance between Prothoracic and Mesothoracic ganglia 1.56 mm, distance between Mesothoracic and Metathoracic ganglia 0.17 mm. Eighth palpal setae (Costa and Pujol-Luz 1993).

**Material examined.** **ARGENTINA, Salta Prov.**, pond 1 km E of Embarcación, on road to Misión Chaqueña, 23°12'18" 64°4'44", 392 m, 25.viii.2008, R. W. Garrison and N. v. Ellenrieder leg., 1 male (RWG); **Buenos Aires Prov.**, Ensenada: Punta Lara, selva, 34°49'0" 57°58'60", 4 m, 5.iii.1997, 1 male (RWG); **Entre Ríos**, 17.iii.1951, 1 male (MNRJ). **BRAZIL, Amazonas**, Ilha no Solimões abaixo da confluência do Rio Negro, 23.x.1959, N. Santos leg., 2 males (MNRJ); same, but Manaus, Rio Negro, Pauro leg., 23.vii.1941, 1 female (MNRJ); same data as before except collected on following dates: 1941, 1 female (MNRJ); xi.1941, 3 females (MNRJ); **Bahia**, Açenda da Bambo do Serrinha, 05.vii.1951, N. Santos leg., 1 male (MNRJ); same, but Caravelas, vi.1908, Garbe leg., 1 female (MNRJ); same, but Rep. da Balandecia, rio Viluasri, Salvador, 15.vii.1951, N Santos leg., 1 female (MNRJ); same, but Rio Vasa, Barro Canudos, 08.vii.1951, N. Santos leg., 3 males (MNRJ); same, but Senhor do Boufui, 16.vii.1978, 1 male (MNRJ); same, but Vila Nova, 1908, E. Garbe leg., 1 male (MNRJ); **Ceará**, Fortaleza, vi.1946, Frota Penôa leg., 1 male (MNRJ); **Espirito Santo**, Baixo Guandú, borrego do Duvo, 04-09.v.1970, Elias e Paulo leg., 1 male (MNRJ); same, but Conceição da Barra, vii.1971, Elias, Paulo leg., 1 female (MNRJ); same, but Linhares, 22-27.v.1972, Elias e Paulo leg., 1 male (MNRJ); same data as before except collected on following date: 10-15.iii.1972, 1 male; same, but Estr. Linhares - Regência km. 4, iii.1944, Elias leg., 1 male, 3 females (MNRJ); same, but São Mateus, 15-20.iv.1968, Paulo, Elias leg., 1 female (MNRJ); **Maranhão**, Timon, Sitio Boa Vista, Riacho da Ivone, 21.viii.2004, J.M. C leg., 1 male, 2 females (MNRJ); **Mato Grosso**, Bodoquena, xii.1941, C.I.O. Cruz leg., 1 female (MNRJ); same, but Miranda, 15-17.1941. C.J.O. Cruz leg., 1 male (MNRJ); same data as before except collected on: 07.x.1944, 1 female, same, but Raul Soares, La ejerai, vi.1949, Machado e Berla leg., 2 males (MNRJ); **Minas Gerais**, Janaúba, vii.1949, N. Dias dos Santos, Machado e Berla leg., 6 males, 8 females (MNRJ); same, but Pirapora, 19.v.1941, Bayley leg., 1 female (MNRJ); same, but ii.1947, Santos, Machado leg., 2 males, 1 female (MNRJ); same, but Lagoa do Palmital, Governador, Valadares, 9.ii.1955, N. Santos e Machado leg., 2 males (MNRJ); **Pará**, Belém, Museu Soeldi, 04.viii.1955, N. Santos leg., 1 male, 1 female (MNRJ); same, but Parque Museu, 03.xi.1963, N. Santos leg., 1 male (MNRJ); **Pernambuco**, Recife, Dois irmãos, 09.vii.1944, Berla leg., 1 female (MNRJ); same data as before except collected on following dates: 11.vii.1944, 2 females; 12.vii.1944, 1 female; 1 female, 26.vii.1944, 1 male; 27.vii.1944, 1 male, 1 female; 07.x.1944, 4 males, 1 female; same, but Açude Dois irmãos, 30.vii.1944, Berla leg., 1 male (MNRJ); same, but Reserva Florestal do Açude do Prata, Parque Dois irmãos, 08°-09°S e 34°-35°W, 08.ii.2001, J.M. C e L. Borges leg., 1 male (MNRJ); same, but São Lourenço, Brejo do Macaco, 18.ii.1963, N. Santos e Dardano Lima leg., 1 female (MNRJ); **Rio de Janeiro**, Tinguá, Haroldo, E. Rio, N. Santos e H. Sandim, 04.iv.1970, 1 male (MNRJ); same, but São Cristóvão, Museu Nacional, J. C. Machado, 18.ix.1965, 1 male (MNRJ); same data as before except collected on: 25.ix.1965, 1 female; same, but São Cristóvão, Museu Nacional, horto do Museu, Heber, 30.x.1961, 1 male (MNRJ); same, but Iguabinha, 26.i.1972, 1 male (MNRJ); same, but Itaipu, D. Lacombe, ii.1961, 1 female (MNRJ); same, but Jacarepaguá, próximo ao Mono do Rangel, J.M. C, 03.x.1991, 2 males, 1 female (MNRJ); same, but Represa do Camorim, N. Santos, 26.v.1963, 1 male (MNRJ); **Rio Grande do Sul**, Pelotas, 02.i.1944, C. Biezanko leg., 1 male (MNRJ); **Santa Catarina**, Brejo, entre Blumenau e Guará-Mirim, 13.ii.1982, N. Santos, L. F. Netto e M.M. C leg., 2 males (MNRJ); **São Paulo**, Emas, Tanques de Piscicultura,

Represa de Promissas, 07.x.1985, N. Santos, L. Fernandes e José Roberto leg., 1 male (MNRJ); **Sergipe**, Aruari, Santo Amaro, xi.1961, J.b.m.b. leg., 1 male (MNRJ); no data, 14 males, 7 females (MNRJ). **COLOMBIA**, **Antioquia**, Caucasia, Hacienda la Candelaria, 80 m, 23.xi.2007, Grupo Entomología leg., 1 male (CEUA); **Atlántico**, Ciénaga La Larga, Palmar de Varela, 3.ix.2006 - 15.x.2007 - 7.ii.2008, M. Lobo y M. Moreno leg., 3 males, 3 females (UARC); same, but Repelón Bijibana, 3.vii.2006, M. Lobo y M. Moreno leg., 1 male (UARC); **Bolívar**, Regidor, Finca Las Pavas ó Labrador, Bosque Montaña de Toronto, 8° 46' 43.7 N 73° 54' 53.8" W, i.2009, M. Moreno leg., 1 female (UARC); same, but Finca La Herradura (Amiagro), Cultivo de palma de aceite, 8° 41' 6.6" N 73° 53' 45.7" W, i.2009, M. Moreno leg., 8° 46' 43.7 N 73° 54' 53.8" W, i.2009, M. Moreno leg., 3 females (UARC); same, but Finca Las Brisas, Corredor de vegetación alrededor de caño, 8° 45' 39.5"N 73° 52' 02.2" W, i.2009, M. Moreno leg., 1 male (UARC); same, but Cartagena, viii.1981, H. Stocker leg., 1 male (ICN); same, but Santa Catalina, 3-4,x.1999, 2 males, 2 females (ICN); **Magdalena**, Santa Ana, 4.i.1978, P.A. Jiménez, 1 male (ICN); **Córdoba**, Montería, Tres Palmas, 18 m, ix.1972, R. Velez leg., 3 females (MEFLG); same, but Santa Cruz de Lorica, 16.vii.2006, N.C. Rojas leg., 1 male (ICN); **Meta**, Puerto López, 220 m, 01.x.2002, S. Remolino leg., 1 male (ANDES); same, but San Juan de Arama, 23.ix.2005, N.C. Rojas leg., 1 male (ICN); **Santander**, Bucaramanga, Quebrada "La Grande", Barro Blanco, 435 m, 17.iii.2006, C. Garzón leg., 1 female (ANDES); **Sucre**, San Onofre, Reserva Sanguaré, 0 m, 11.x-23.xi.2003 - 20.iii-29.iv.2004, Grupo Entomología leg., 3 males, 4 females (CEUA); **Valle del Cauca**, 13.ix.2003, 1 male (MUSENUV); no data, 1 male, 1 female (UARC); **MEXICO**, **Nayarit**, Arroyo poblado Las Piedras Km. 67 carretera Tepic - Pto. Vallarta, 16.iii.1981, E. González, R. López leg., 1 male (CNIN). **PANAMA**, **Canal Zone**, Pipeline Road, 25 km NW of Gamboa, 9°6' 79°42', 29.vii.1979, R. W. and J. A. Garrison leg., 1 female (RWG); **Panama Prov.**, Reserva Sobrina Pipeline Rd., 9 km mark, 25.vi.1994, N. Smith y R. Kasabian leg., 1 male (RWG). **PERU**, **Tacna Dept.**, Humedales de Ite, 17°55'32" 70°56'11", 68 m, 2005, N. Flores leg., 1 female (RWG). **PARAGUAY**, **Puerto General Díaz**, iv.1944, Mis. Cient. Brazil leg., 2 males, 2 females (MNRJ). **PUERTO RICO**, **Lajas**, Hwy 306 just W of Laguna Cartagena S of Hwy 101, 18°0'49" 67°2'2", 14 m, 14.ii.1982, R. W. and J. A. Garrison leg., 1 male (RWG).

**Remarks.** The paratypes deposited in MCZ are labeled as Types 1–5. The abdomen of the specimen number four is missing from the fourth segment, and the abdomen attached to the specimen number five does not belong to this species, it instead belongs to *E. vesiculosa*.

**Biology.** *Erythemis plebeja* inhabits lakes and other lentic water habitats where multiple males may engage in interspecific aggression for territory (De Marco 2008). It is common to see males perched on dead branches close to the ground or near the water. This species is aggressive and may use up to 10% of its time in territorial disputes due to their high thermoregulatory capacity (May 1979). Males are commonly observed simulating oviposition, which apparently is an altruistic behavior to increase the chance of survival of females and their offspring by attracting the attention of predators such as toads (De Marco et al. 2002).

**Distribution.** From U.S.A. to Argentina (Fig. 36), between 0–1676 m. asl.

### ***Erythemis simplicicollis* (Say, 1840)**

(Fig.1, 2a–c, 5, 6, 9, 12, 26, 37)

*Libellula simplicicollis* Say, 1840: 28.

*Libellula imbuta* Say, 1840: 32.

*Libellula caerulans* Rambur, 1842: 64.

*Libellula maculiventris* Rambur, 1842: 87.

*Mesothemis simplicicollis* Hagen, 1861: 170

*Mesothemis gundlachii* Scudder, 1866: 195.

*Mesothemis simplicicollis* Calvert, 1893: 265 (Diagnosis).

**Type material.** Not examined.

**Diagnosis.** Thorax green, and dorsum of abdomen green with black dorsal bands (female and sexually immature male), or thorax and abdomen pruinose blue (mature male). McVey (1985) provides information about rates of color maturation in relation to age, diet, and temperature in males of this species. Abdominal appendages are white. Basal area hyaline. Posterior lobe of vesica spermalis absent. Hook is bilobed and not perpendicular to the longitudinal axis of the vesica spermalis (Fig. 18), and the lateral lobe is extended more posteriorly than the medial lobe. Cornua is parallel with respect to the transversal axis of the vesica spermalis, with lobes fused to apex, and not covered by lateral lobes in lateral view (Fig. 20). Lab  $\leq$  30mm.

**Morphometric ratios of males.** Acd/Lban < 4.10; And/Lban < 4.10; Lban/Anb < 1.90; LHW/Acd < 3.60; LHW/LFW < 0.97; Las/Ddas > 4.00; Las/Anas < 4.00; LclS3/LcaS3 < 2.10; LHW/Lab > 1.20; Lecv-clS3/LcaS3 < 1.50; Lab/LclS3 < 1.50; Lab/LcaS3 < 3.00; Antr/Lar < 8.00; LFW/Lnpt > 3.00; Lnpt/Anb < 1.50; Lba/Lban > 2.00; Lban/Lasa-ca < 3.00.

**Morphometric ratios of females.** AnptFW/LoptFW < 0.22; Lban/Anb < 1.55; LHW/Acd < 0.54; LHW/Lab < 1.20; Lab/Las < 2.50; LclS3/LcaS3 < 3.00; Lecv-clS3/LcaS3 < 1.60; Lab/LclS3 < 1.40; Lab/LcaS3 < 3.00; Ansbt/Antr > 2.40; Antr/Lar < 3.00; LFW/Lnpt < 2.90; Lar/Lba < 0.14; Lnpt/Anb > 1.20.

**Head.** Ll: 0.0132–0.0137mm (M); 0.012–0.013mm (F). Lw: 0.033–0.038mm (M); 0.031–0.034mm (F). Hwd: 0.057–0.065mm (M); 0.058–0.063mm (F). Hl: 0.030–0.038mm (M); 0.032–0.034mm (F).

**Legs.** Nsmf: 8–12 (M); 7–9 (F). Nshf: 18–30 (M); 10–18 (F). Hfl: 0.060–0.070mm (M); 0.056–0.067mm (F). Fbsd: 0.022–0.024mm (M); 0.021–0.027mm (F). Mfl: 0.038–0.043mm (M); 0.034–0.041mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-1 or 2 median spines-3 long spines, short spines-3 long spines.

**Wings.** LoptFW: 0.030–0.034mm (M); 0.034–0.035mm (F). AnptFW: 0.005–0.007mm (M); 0.006–0.007mm (F). LoptHW: 0.031–0.035mm (M); 0.036mm (F). AnptHW: 0.005–0.007mm (M); 0.0062–0.0068mm (F). DfwHW: 0.057–0.062mm (M); 0.057–0.063 (F). LbanFW: 14.99–16.24mm (M); 15.75–16.20mm (F). LbanHW: 12.73–13.75mm (M); 12.06–13.53mm (F). AndFW: 6.86–7.83mm (M); 8.28–8.88mm (F). Wb: 8.52–9.60mm (M); 8.93–9.60mm (F). LFW: 30.00–34.10mm (M); 33.38–34.54mm (F). LHW: 29.27–33.73mm (M); 31.00–32.76mm (F). AnsbtFW: 0.018–0.024mm (M); 0.020–0.021mm (F). AntrFW: 0.005–0.009mm (M); 0.006–0.008mm (F). LarFW: 0.003–0.009mm (M); 0.0043–0.0056mm (F). LarHW: 0.0012–0.0025mm (M); 0.0006–0.0018mm (F). LnptFW: 10.08–12.20mm (M); 11.12–12.28mm (F). LnptHW: 10.91–13.36mm (M); 12.22–13.31mm (F). At-MP: 0.0031–0.0043mm (M); 0.003–0.013mm (F). LbaFW: 0.030–0.032mm (M); 0.028–0.032mm (F). LbaHW: 0.033–0.033mm (M); 0.030–0.034mm (F). RP2-loptFW: 0.000–0.002mm (M); 0.006–0.012mm (F). RP2-loptHW: 0.0000–0.0018mm (M); 0.0018–0.0056mm (F). Dat-lsbt: 0.0012–0.0018mm (M); 0.0012–0.0018mm (F). Lasa-ca: 0.0068–0.0112mm (M); 0.008–0.012mm (F). Crp: 0.008–0.011mm. Crp: 5–8 (FW), 4–7 (HW). Cal: 3–6. pC-RA-RP1: 2–3. CdfFW: only 3 rows of cells. CdfHW: 1–2 individual cells-2 to 4 double cells. Vt: 1. Csub: 3.

**Abdomen.** Lab: 25.55–29.80mm (M); 25.16–30.61mm (F). LcaS3: 0.010–0.011mm (M); 0.0100–0.0106mm (F). LclS3: 0.020–0.025mm (M); 0.021–0.028mm (F). Lecv-clS3: 0.013–0.016mm (M); 0.012–0.014mm (F).

**Caudal appendages.** Las: 0.015–0.018mm (M); 0.010–0.011mm (F). Poas: 0.0018–0.0037mm (M); 0.0018mm (F). Anas: 0.004–0.005mm (M); 0.003–0.004mm (F). Ddas: 0.0025–0.0043mm (M). Epl: 0.009–0.013mm (M); 0.004–0.005mm (F).

**Larva.** Bick (1941) mentions 13 larval instars, a total larval period of 113 days, and an average hatching time as 11.6 days. The small and robust larvae of *Erythemis simplicicollis* are habitat generalists. They can inhabit swamps, marshes, ponds, lakes, reservoirs and small pools of creeks where they live under the detritus, feeding on tadpoles (May and Baird 2002; Relyea 2003). Osburn (1906) listed *E. simplicicollis* larvae living in “slightly salt water”, Wright (1943) reported *E. simplicicollis* larvae in Mississippi River delta and central Gulf Coast salt marshes in brackish areas of varying salinities (14–57% seawater), Bick et al. (1953) found *E. simplicicollis* larvae associated with naturally acid streams in southern Louisiana, and Smith and Smith (1995) exposed larvae to six salinities (0–80% seawater) and found that larvae survived for at least 24 h. However, survival time and eclosion significantly decreased at salinities above 20% with only 50% of the larvae emerging at that those higher concentrations (Smith and Smith 1995). Also, little development occurred at salinities of 60% and 80%, suggesting that increasing salt concentration could produce physiological stress on the larvae. Catling (2005) found *E. simplicicollis*

as indicator of higher water quality. Both temperature and time of day influence the occurrences and frequencies of ventilation in larvae of this species, under constant temperature conditions, the vertical migration has its highest peak during photophase and its lowest during dark phase (Cofrancesco and Howell 1982). According to Morin (1984), the larvae are eaten by fish, compete for food with larvae of *Tramea lacerata* Hagen (Libellulidae) (Wissingner and McGrady 1993). Larger larvae of *E. simplicicollis* attack and predate on *Hyaella* (Crustacea) amphipods (Cothran 2008).

**Material examined.** HAITI, Samana, Frazar, no data, 1 male. MEXICO, Jalisco, La Huerta. Arroyo Chamela, 1.ix.2001, E. González-Soriano leg., 1 male (CNIN); Coahuila, Puente San Rodrigo II bridge, c. 64 km S of Ciudad Acuña, elev. c. 28°44'01.0" 100°54'45.8", 320 m, 23.vi.2007, R.A. Behrstock leg., 2 females (CNIN). U.S.A., Nebraska, Cherry Co., Boardman Creek at Rd. 16C, Merritt Reservoir State Recreation Area, W of Nebr. Hwy 97, about 26 mi SW of Valentine, 42°34'57" 100°54'56", 18.vii.1998, R. W. Garrison leg., 1 male (RWG); California, Cumberland Co., Texas Pond by Honeycutt Road, Fort Bragg Military Reservation, 35°8'34" 78°55'56", 53 m, 16.vii.1967, R. W. Garrison leg., 1 male (RWG); Texas, Williamson Co., Mustang Creek, by Carlos G. Parker Blvd. (= Loop 427), Taylor, 30°34'37" 97°27'18", 25.viii.1976, J. E. Hafernik, Jr. leg., 1 male (RWG); same, but Field near road to Manor, Taylor, 30°34'37" 97°27'18", 16.viii.1975, J. E. Hafernik, Jr. leg., 1 female (RWG).

**Remarks.** The paratypes of *E. simplicicollis* were included in the Say's paratypes collection, but most of his collection is known to have been lost.

**Biology.** *Erythemis simplicicollis* adults has been sight in swarms (Paulson 1966), trapped from light traps (Wright 1944; Frost 1975), and Harrison and Lighton (1998) found that, under laboratory conditions, they are even able to fly with low concentrations of oxygen. *E. simplicicollis* may have one, two or several generations per year depending of the climatic conditions (Montgomery 1980; Harrison and Lighton 1998). This species usually prefer to perch on exposed logs or rocks (Robey 1975) and their sexual recognition is based on visual cues of body coloration (Andrew 1966). Males are territorial, exhibiting intraspecific flight pattern when two males are in the same area (Currie 1963), and showing interspecific aggression toward males of *Pachydiplax longipennis* (Burmeister) (Baird and May 2003). McVey (1988) found that lifetime reproductive success was highly variable, suggesting that this variation is important for selection between both sexes, especially when males are territorial (Koenig and Albano 1987). After mating (which is not preceded by courtship behavior), the male tries to prevent other males from mating with his female or female may mate with different males in one day and store sperm to fertilize their eggs for several days, however, McVey and Smittle (1984) found that the last male in copulate fertilizes the up to 95% of the eggs.

According to collection labels, adults of *E. simplicicollis* feeds on females of the same species, as well as other Libellulidae (Odonata) such as *Celithemis ornata* (Rambur), *Perithemis tenera* (Say), and *Orthemis ferruginea* (Fabricius), Coenagrionidae (Odonata) such as *Enallagma weewa* Byers, and Araneae (Arachnida) such as *Leucauge argyra* (Walckenaer). *E. simplicicollis* also hunts *Diceroprocta delicata* (Osborn) (Hemiptera: Cicadidae) (Sanborn 1996), caterpillars of the noctuid moth *Helicoverpa zea* (Boddie) (Bell and Whitcomb 1961) and *Phidippus pulcherrimus* Keyserling (Araneae: Salticidae) (Edwards 1980; 1987). In New York (USA), Olberg et al. (2000) found that 97% of prey-capture flights by *E. simplicicollis* males ended in successful captures. On the other hand, some birds (Calvert 1893), fish and Asilidae (Diptera) such as *Promachus hinei* Bromley (Chatfield 2011) may feed on *E. simplicicollis*. Adults of *E. simplicicollis* are parasitized by *Actinocephalus* (Koern.) and *Geneiorhynchus* Schneider (Eugregarinorida: Actinocephalidae) (Locklin and Vodopich 2010), the presence and abundance of these parasites appear to be independent of season and do not affect the host fitness characters (Locklin and Vodopich 2009; 2010), but in central Texas (USA), the same authors found that parasite prevalence was biased towards males because of behavioral and environmental aspects that influenced them. Painter et al. (1996) found that repeated applications of *Bacillus thuringiensis israelensis* on *E. simplicicollis*, did not affect development, morphology or their flight capability. Recently, a novel adipokinetic hormone (neuropeptide) of corpora cardiaca (Gäde and Kellner 1999; Gäde et al. 2011), and one *Cyclovirus* new species, were found in *E. simplicicollis* adults (Rosario et al. 2012).

**Distribution.** From U.S.A. to Costa Rica (Fig. 37), from 0 to 1825 m. asl.

***Erythemis vesiculosa* (Fabricius, 1775)**

(Fig. 1a, 2a,c, 8, 14, 16, 20, 28, 38)

*Libellula vesiculosa* Fabricius, 1775: 421.

*Libellula acuta* Say, 1840: 24

*Lepthemis vesiculosa* Hagen, 1861: 161.

**Type Material.** Not examined.

**Diagnosis.** Thorax green, dorsum abdomen green with dark brown (sexually immature male) or black (mature male), S8-10 with spots or all black or dark brown, and the basal area on HW is yellow or brown. Radial planate with double cells (Fig. 28). Dark basal spot on HW does not reach the first antenodal vein, the MP crossvein, the AA (Fig. 26) or the last rows of cells to anal angle. Ventral teeth on male cercus is beyond the apex of epiproct (Fig. 12). Posterior lobe of vesica spermalis absent. Hook bilobed (Fig. 18), triangular or trapezoidal, and not perpendicular to the longitudinal axis of vesica spermalis (Fig. 20). Cornua parallel to transversal axis of vesica spermalis, with lobes fused to apex, and not covered by lateral lobes in lateral view (Fig. 20). Lab >30mm.

**Morphometric ratios of males.** LHW/Lab >1.20; Lab/LclS3 >1.50.

**Morphometric ratios of females.** LHW/Lab <1.20; Lab/Las <2.50; LclS3/LcaS3 <3.00; Lab/LclS3 >1.40; Lnpt/Anb >1.20.

**Head.** Ll: 0.013–0.017mm (M); 0.014–0.017mm (F). Lw: 0.035–0.043mm (M); 0.038–0.041mm (F). Hwd: 0.070–0.079mm (M); 0.072–0.076mm (F). Hl: 0.036–0.050mm (M); 0.040–0.046mm (F).

**Legs.** Nsmf: 8–16 (M); 5–9 (F). Nshf: 11–42 (M); 8–17 (F). Hfl: 0.053–0.092mm (M); 0.067–0.086mm (F). Fbsd: 0.024–0.035mm (M); 0.030–0.035mm (F). Mfl: 0.042–0.054mm (M); 0.046–0.052mm (F). Dshf (the conditions separated by commas are present in different specimens): short spines-1 to 3 median spines-3 long spines, short spines-3 to 5 long spines.

**Wings.** LoptFW: 0.039–0.050mm (M); 0.043–0.048mm (F). AnptFW: 0.005–0.010mm (M); 0.008–0.010mm (F). LoptHW: 0.038–0.046mm (M); 0.041–0.046mm (F). AnptHW: 0.006–0.010mm (M); 0.008–0.010mm (F). Dfwhw: 0.068–0.081mm (M); 0.071–0.082mm (F). LbanFW: 17.23–21.23mm (M); 18.81–20.91mm (F). LbanHW: 15.18–18.41mm (M); 14.91–17.76mm (F). AndFW: 7.74–9.34mm (M); 8.43–9.46mm (F). Wb: 9.28–11.57mm (M); 10.90–11.02mm (F). LFW: 36.44–41.34mm (M); 40.26–42.17mm (F). LHW: 36.78–41.52mm (M); 36.52–40.72mm (F). AnsbtFW: 0.020–0.031mm (M); 0.021–0.026mm (F). AntrFW: 0.005–0.010mm (M); 0.007–0.010mm (F). LarFW: 0.0018–0.0056mm (M); 0.002–0.005mm (F). LarHW: 0.000–0.006mm (M); 0.0019–0.0062mm (F). LnptFW: 12.33–14.45mm (M); 12.90–14.53mm (F). LnptHW: 12.28–16.79mm (M); 14.42–16.21mm (F). At-MP: 0.0021–0.0050mm (M); 0.0028–0.0043mm (F). LbaFW: 0.029–0.038mm (M); 0.031–0.035mm (F). LbaHW: 0.028–0.038mm (M); 0.032–0.037mm (F). RP2-loptFW: 0.00–0.09mm (M); 0.018–0.093mm (F). RP2-loptHW: 0.0006–0.0062mm (M); 0.0006–0.0110 (F). Dat-lsbt: 0.0006–0.0025mm (M); 0.0009–0.0031mm (F). Lasa-ca: 0.0021–0.0081mm (M); 0.003–0.009mm (F). Crp: 9–11 (FW), 10–13 (HW). Cal: 3–7. pC-RA-RP1: 2–3. CdfFW: only 3 rows of cells. Vt: 1. Csub: 3.

**Abdomen.** Lab: 35.70–43.09mm (M); 37.86–42.47mm (F). LcaS3: 0.006–0.021mm (M); 0.008–0.017mm (F). LclS3: 0.015–0.023mm (M); 0.021–0.028mm (F). Lecv-clS3: 0.012–0.017mm (M); 0.014–0.019mm (F).

**Caudal appendages.** Las: 0.021–0.027mm (M); 0.018–0.022mm (F). Poas: 0.0006–0.0056mm (M); 0.001–0.004mm (F). Anas: 0.004–0.008mm (M); 0.003–0.006mm (F). Ddas: 0.003–0.010mm (M). Epl: 0.011–0.023mm (M); 0.005–0.008mm (F).

**Larva.** The following characters were found by Klots (1932): Total length 18.5 mm, Hfl 7 mm, head width 5.2 mm, abdomen width 6 mm. Head widest across the front, and narrowed behind the eyes. Ocellar region paler, with a black spot at the anterior end of each side lateral ocellus, diffuse at the base of the antennae. Rear of head has 8 paler bands. Labium with 15–16 mental setae and 11–12

lateral setae. Wing pads reach to the 8<sup>th</sup> segment. Tarsi with an apical ring. Dorsal hooks with long hair on the apex 7–9. Larvae additional characters are provided by Needham and Westfall (1955) as follows: minute lateral spine on S9, several more setae on the labium than other species. According to Costa and Pujol-Luz (1993) *E. vesiculosa* larvae is the longest of the genus, and shows 16 premental setae, 12 palpal setae, the lateral spine on ninth segment is reduced, cercus exceeds 2/3 the length of the epiproct. Paulson (1966) found *Anax junius* and *Ischnura ramburi* larvae simultaneously with *E. vesiculosa* larvae in a temporary ditch with vegetation and about 8 inches deep in Marco Island (Collier Co., Florida).

**Material examined.** ARGENTINA, Formosa Prov., Banado La Estrella, 42 km N of Las Lomitas on road 28, 24°27'32" 60°23'17", 0 m, 18.ii.2008, R. W. Garrison and N von Ellenrieder leg., 1 male (RWG); same, but Parque Nacional Pilcomayo, Laguna Blanca marshes by pond, 25°10'29"S 58°7'44"N, 74 m, 16.ii.2008, N. von Ellenrieder and R. W. Garrison leg., 1 female (RWG). BOLIVIA, Dept. Beni, Ciudad Reyes, 02-20.xii.1956, 1 male (MNRJ). BRAZIL, Amapá, Porto Santana, ICOMI, 26-27.ii.1963, Roppa, Mielke leg., 2 females (MNRJ); Amazonas, Barreiras da Ribeira, 18.viii.1936, 1 male, 2 females (MNRJ); same, but B. Constant, Río Itocoahy, v.1942, Parko leg., 1 male, 3 females (MNRJ); same, but 17.v.1950, 1 female (MNRJ); same, but Lagadiço de baixo, 22.iv.1942, (MNRJ); same data as before except collected on following dates: 2 M, 20.ii.1942, 1 male, 1 female; 22.ii.1942, 1 male; same, but Manaus, Parko leg., 1 male (MNRJ); same, but Rio Negro, 20.vii.1941, 1 male (MNRJ); same data as before except collected on following dates: 22.vii.1941, 1 male; 11.vii.1941, 1 male; 12.vii.1941, 1 male; 23.vii.1941 1 female, 1 male; 25.vii.1941, 3 males, 3 females; 25.vii.1942, 1 female, same, but Xiborene, 02.xii.1960, E. Ferreira leg., 1 male, 2 females (MNRJ); same, but Manicoré, Rio Madeira, Parko leg., x.1941, 1 male, 2 females (MNRJ); Bahia, Açenda da Bambo do Serrinha, 05.vii.1951, N. Santos leg., 1 male (MNRJ); same, but Camarajipe, Salvador (Mata), 18.vii.1951, N. Santos leg., 1 female (MNRJ); same, but Itamaraju, monte Pascoal km. 5, 10-15.i.1972, Elias, leg., 1 female (MNRJ); same, but Lençóis (atraído por luz, noite), 24.iv.2002, J. Glauber leg., 1 female (MNRJ); Mucuri (Mata), ii.1971, Elias, leg., 2 males (MNRJ); Periperi, Baerour, 19.vii.1951, N. Santos leg., 1 female (MNRJ); Brasília D.F., Coquinho, Reserva Ecológica do IBGE, 06.ii.1981, N. Santos, L.F. Netto, H. Mezquita leg., 1 female, 1 male (MNRJ); Espírito Santo, Baixo Guandu, Estr. B. Guandu á Hituba km. 13, 01-07.xi.1970, Elias, Paulo leg., 1 female (MNRJ); same, but Cariacica, iii.1981, Bento leg., 1 female (MNRJ); same, but Conceição da Barra, 15-20.iv.1968, Paulo, Elias leg., 2 males (MNRJ); same data as before except collected on following dates: 18-23.iii.1968, 1 male; 17.ii.1968, 1 female; 25-30.i.1971, 2 females; Goitacazes, 22.i.1973, N Santos leg., 1 female (MNRJ); same, but Jacareípe, 11-28.ii.1967, Paulo Elias leg., 3 males, 5 females (MNRJ); same, but Linhares, 10-15.iii.1972, Elias leg., 1 male, 2 females (MNRJ); same data as before except collected on following dates: 01-07.ii.1972, 2 females, 17-22.iii.1972, 2 males; 08-14.ii.1972, 1 male; same, but Estr. Linhares-Regência km. 4, iii.1944, Elias leg., 8 males, 6 females (MNRJ); same, but Linhares, v.1973, Elias, Paulo leg., 1 male (MNRJ); same, but Parque Sooretama, 20.i.1973, N. Santos, Sandim, Vicente leg., 2 males (MNRJ); same, but Parque Sooretama, xii.1981, Bento leg., 1 male, 1 female (MNRJ); same, but São Mateus, 15-20.iv.1968, Paulo, Elias leg., 1 male (MNRJ); same, but Vitória, Morro Moscoso, iii.1981, Bento leg., 2 males (MNRJ); same data as before except collected on: i.1981, 2 females; same, but Santa Tereza, xii.1967, Elias leg., 1 female (MNRJ); same data as before except collected on: 08.ii.1967, 1 male; 02.i.1967, 1 female; 11.i.1968, 1 female; 8-13.vi.1968, 2 males; Goiás, Itumbiara, 11.xii.1975, Inácio leg., 1 male, 1 female (MNRJ); same, but Mineiros, xi.1994, P.R. Magno leg., 1 female (MNRJ); Maranhão, Imperatriz, 20.vii.1974, O. Mielke leg., 1 female (MNRJ); Mato Grosso, Judiavai, Km. 3 de Rondonia Judiavai, 01.iii.2002, O.I. Souza leg., 1 male (MNRJ); same, but Porto Estrela, 06.ii.2002, O.I. Souza leg., 1 male (MNRJ); same, but Río Salobra, 26.i.2002, 1 male (MNRJ); same data as before except collected on following dates: 21-23.i.1955, 5 males, 6 females; 21.i.1955, 1 male; 01.ii.1941, 2 females; same, but Afluente do Río Casca, cerca de 20 km., 13.iv.1963, N. Santos, Machado leg., 1 male, 2 females (MNRJ); same, but Bodoquena, xii.1941, C.I.O. Cruz leg., 1 male (MNRJ); same data as before except collected on: 15-17.1941, 1 female; same, but entre Cuiabá e Guia, 15.iv.1963, N. Santos, Machado leg., 1 male (MNRJ); same, but entre Cuiabá e Jaciara, 08.iv.1963, N. Santos, Machado leg., 1 male (MNRJ); same, but Buriti Chapada dos Guimarães, 21.ii.1967, Nestor leg., 1 male (MNRJ); same data as before except collected on: 20.i.1970, N. Tangerini leg., 2 males; same, but Urucum, 28-30.i.1955, 1 female (MNRJ); Minas Gerais, Estr. B.

Horizonte-Serra do Cipó, Río Cipó, Km. 02, 01.xii.1963, N Santos, Machado, Borjes leg., 1 male (MNRJ); same, but Lagoa Santa, Lagoa Vermelha, 21.iv.1949, M.G. Machado, N. Dias dos Santos leg., 3 females (MNRJ); same, but ii.1947, Santos, Berla, Machado, leg., 1 male (MNRJ); same, but Lagoa do Palmital, Governador, Valadares, 9.ii.1955, N. Santos, Machado leg., 3 males, 1 female (MNRJ); same, but Rio Claro, 22.ii.1958, D. Lacombe leg., 1 male (MNRJ); same, but São João del Rey, Cascata na Serra do Tiradentes, 03.iii.1957, Santos, A.C. Pires leg., 1 male (MNRJ); **Pará**, Belém, Jardim do M. Goeldi, 21.i.1956, 1 female (MNRJ); same, but Utinga, 12.ii.1963, Roppa, Mielke leg., 1 female (MNRJ); same, but 23.viii.1936, 1 male (MNRJ); same, but Japérica, 06.02.1959, C. Simón, O. Fontana leg., 1 female (MNRJ); same, but Santarém, v.1920, Garbe leg., 1 male, 1 female (MNRJ); **Paraná**, Curitiba, 01.xii.1972, O. Mielke leg., 1 male (MNRJ); same, but Guaíra, 13.ii.1957, D. Lacombe leg., 1 male (MNRJ); same, but Salto das Sete Quedas, 09.ii.1957, D. Lacombe leg., 1 male (MNRJ); **Pernambuco**, Recife, Dois irmãos, 11.vii.1944, Berla leg., 1 female (MNRJ); **Rio Grande do Norte**, Natal, 20.vi.1941, 1 female (MNRJ); **Rio de Janeiro**, iii.1975, 1 male (MNRJ); same, but Horto da quinta da Boavista, 25.i.1983, 1 male (MNRJ); same data as before except collected on following dates: 20.x.1994, 1 male; same, but Itatiaia, Parque Nacional do Itatiaia (lago azul) perto do Museu. E.F. Ramos, 30.iii.1997, 1 female (MNRJ); same, but Lagoa das Tachas, i.1961, 2 males (MNRJ); same data as before except collected on: 19.ix.1964, 1 male 2 females, (MNRJ); 12.xii.1965, N. Santos leg., 8 males; 21.ii.1966, N. Santos e Martins leg., 1 male; 25.i.1969, N. Santos leg., 1 male, 1 female; same, but Ihada Marambaia, Poça heliponto, J. M. C, 25.ix.2003, 1 male (MNRJ); same, but Represa São Pedro, Machado, 09.ii.1943, 1 male (MNRJ); same, but Rio das Flores, Fazenda da Forquilha, B. Mascarenhas, 10.vii.1997, 1 male (MNRJ); same, but Valença, Faz. Sta. Rosa (Faz. Pau-D'Alho) Represa da Usina. B. Mascarenhas, 24.x.1997, 1 male (MNRJ); **Roraima**, Ariquemes, viii.1980, Bento leg., 1 male, 1 female (MNRJ); **São Paulo**, Caraguatatuba, 16.ii.1980, 1 female (MNRJ). **COLOMBIA**, **Amazonas**, Leticia, 2.v.1946, 1 female (ICN); **Antioquia**, Caucasia, Hacienda la Candelaria, 80 m, 13.vii.2002 – 2-3.ix.2004 – 1-2.ix.2006 – 23.xi.2007, Grupo Entomología leg., 10 males, 1 female (CEUA); same, but Universidad de Antioquia, 1450 m, 16.i.2008, D. Osorio leg., 1 male (CEUA); same, but Puerto Berrío, Casco urbano, Barrio La Malena, xii.2008, A. Bustamante leg., 1 female (CEUA); same Puerto Berrío, 6.5°-74°, 17.xi.2007, G. Ochoa leg., 1 male (MEFLG); same, but 6.5° -74.4°, 20.xi.2007, J. Alvarez leg., 1 female (MEFLG); same, but Turbo, 8.000000° -76.5833000°, 4.iii.2005, M. Pérez leg., 1 male (MEFLG); same, but Yolombó, Vereda El Bosque, 7.00110° 75.9636000°, 1475 m, G. Ochoa leg., 1 male (MEFLG); **Atlántico**, Barranquilla, 9.v.1970, G. Zambrano leg., 1 male (ICN); same, but Ciénaga La Larga, Palmar de Varela, 6.vii.2006 - 15.x.2007, M. Lobo y M. Moreno leg., 1 male, 1 female (UARC); same, but Piojó, Guaibaná, 6.vii.2006, 1 male (UARC); **Bolívar**, Regidor, Finca Las Brisas, Corredor de vegetación alrededor de caño, 8° 45' 39.5"N 73° 52' 02.2" W, i.2009, M. Moreno leg., 1 male (UARC); same, but Las Pavas ó Labrador, Cuerpos de agua, 8° 46' 43.7 N 73° 54' 53.8" W, i.2009, M. Moreno leg., 1 male (UARC); same, but Santa Catalina, 5-7.x.1999, 2 males (ICN); **Caldas**, La Dorada, 13.ix.1980, L. Cruz leg., 1 female (ICN); same, but 19.iv.1974, A.B. Lotero leg., 1 male (ICN); same, but 11.iv.1974, L. Agudelo leg., 1 male (ICN); **Casanare**, Agua Azul, 12.x.1976-11.x.1978, P. Franco leg., 1 male, 1 female (ICN); same, but Finca San Luís, 4°59'18"N 72°23'59"W, 200 m, 21.iii.2005, V. Sánchez leg., 1 male (ANDES); **Cesar**, Chimichagua, 22.x. 2006-iv.2007, N.C. Rojas leg., 1 male, 2 females (ICN); same, but El Paso, 25.x.2006, N.C. Rojas leg., 3 males (ICN); **Chocó**, Acandí, Camino El Aguacate-Pinorroa, 24.vi.2007, C. Bota leg., 1 male (CEUA); same, but Vereda Rufino, 8°34'46.7"N 77°18'47.5"W, 34 m, 2-5.vi.2005, C. Botero leg., 2 males (ANDES); same, but Vereda Rufino, Finca El Paraiso, 8°35'14.6"N 77°18'38.7"W, 13 m, 24.vi.2005, C. Botero leg., 1 male (ANDES); same, but Quibdó, 10.xii.1985 J.M. Idrobo leg., 1 male (ICN); **Córdoba**, Pueblo Nuevo, 15-21.vii-15.viii.2006, N.C. Rojas leg., 4 males, 2 females (ICN); same, but Santa Cruz de Lorica, 15.vii.2006, N.C. Rojas leg., 1 female (ICN); **Cundinamarca**, Fusagasugá, iv.1969, Arias leg., 1 male (ICN); **Huila**, Villa Vieja, 1.iv.1982, 1 male (ICN); **Magdalena**, La Gaira, 20 msnm, xii.1975, 1 male (MUSENUV); same, but Santa Ana, 4.i.1978, A. Jiménez leg., 1 female (ICN); **Meta**, Acacías, 25-26.iv.2004, 1 male, 1 female (ICN); same, but 17.iv.2004, G. Flórez y estudiantes leg., 1 female (ICN); same, but Sector Brisas de Ortoy, 555 m, 1.iv.2004, L. Pérez y E. Realpe leg., 1 male (ANDES); same, but Cumaral, 3.ix.1981, R. Restrepo leg., 1 male (ICN); same, but Macarena, i-ii.1950, L. Richter leg., 1 male (ICN); same, but PNN La Macarena, 21.xii.1986, X. Martínez leg., 1 male (ICN); same, but 27.xii.1986, Estudiantes UN leg., 1 male (ICN); same, but Puerto Gaitán, 3.ix.2005, N. Rojas leg., 1 female (ICN); same, but Puerto López, 13.x.1984, R. Restrepo leg., 1 male (ICN);



same, but 6.vi.1970, M.A. Santoyo leg., 1 male (ICN); same, but Puerto López, 6.vi.1970, O.M. Santo leg., 1 female (ICN); same, but Puerto Lleras, 22.x.2005, D. Gaitán leg., 1 female (ICN); same, but Restrepo, 11.ix.1976, A. Bernal leg., 1 male (ICN); same, but San Juan de Arama, 21-22.ix.2005, N.C. Rojas leg., 2 males, 1 female (ICN); Villavicencio, 20.iv.2005, 1 male (ICN); same, but Bosque Bavaria, 525 m, 5.xi.2006, J. Dumar leg., 1 male (ANDES); same, but Corpoica, estación "La Libertad", 4°3'43"N 73°28'9"W, 445 m, 11.xii.2004, L. Pérez y E. Realpe leg., 3 males (ANDES); same, but 385 m, 11.xii.2006, T. Ramírez leg., 1 male (ANDES); same, but 385 m, 1.iii.2008, E. Realpe leg., 1 male (ANDES); **San Andrés, Providencia y Santa Catalina**, San Andrés, Laguna "Big Pond", 100 m, 1.iv.2004, E. Realpe leg., 1 male (ANDES); same data as before except collected on: x.2006, L. Pérez y E. Realpe leg., 3 males; **San Andrés**, El Cove, 5.xii.1980, C. Bohórquez leg., 1 male (ICN); same, but San Andrés, 5-15.xii.1980, 10.iv.1984, C. Bohórquez leg., 2 males (ICN); **Sucré**, Coveñas, vii.2008, J. Vélez leg., 1 female (CEUA); same, but San Marcos, 16-18.x.2004, Sist. Animal UN leg., 2 males, 1 female (ICN); same, but San Onofre, Reserva Sanguaré, 0 m, 17.x.2003, Grupo Entomología leg., 1 male (CEUA); **Tolima**, Ambalema, 22.viii.1977, H. Aristizabal leg., 1 male (ICN); same, but Guamo, 28.xi.1970, F. Torres leg., 1 male (ICN); same, but Espinal, vii.1984, L.P. Moreno leg., 1 female (ICN); same, but Melgar, 28.iv., L.E. Aguirre leg., 1 male (ICN); **Valle del Cauca**, Buenaventura, 7.vii.1980, C. Bohórquez leg., 1 male (ICN); same, but Bajo Calima, 600msnm, 02.xii.2001, Curso Ecología leg., 1 male (MUSENUV); same, but 70msnm, 08.vi.2002, M. Cadavid leg., 1 male (MUSENUV); same, but Palmira, CIAT, 13.ix.2003, C. Bermúdez leg., 1 male (MUSENUV); same, but ii.2004, 1 male, 1 female (MUSENUV); same, but 1000 msnm, 30.x.1986, J. Zapata, leg., 1 female (MUSENUV); same data as before except collected on: 05.x.1986, G. Banquero leg., 1 female; no data, 2 males (UARC); same, but colectado en arroz, 980msnm, 23.ii.2001, A. Morales leg., 1 female (MUSENUV); same, but 980msnm, 23.ii.2001, J.M. Bueno leg., 1 female (MUSENUV); same, but Cali, Univalle, 1000 msnm, 22.x.1982, E. Valencia leg., 1 female (MUSENUV); same data as before except collected on: 30.iii.2000, M. Barrera leg., 1 male; same, but Tuluá, Jardín Botánico Mateguadua, 4°1'42"N 76°10'0,7"W, 1200msnm, 13.viii.2003, C. Bermúdez leg., 1 female (MUSENUV). **MEXICO, Jalisco**, La Huerta, Estación de Biología Chamela, 12.vii-19.x.1988, E. Ramírez y R. Ayala leg., 1 female (CNIN); **Veracruz**, Playa Escondida, 18.viii.1979, G. Jiménez leg., 1 male (CNIN). **PUERTO RICO, Mun. Cavey**, pond and river at milepost 0.6, 0.6 km. from jct Hwy 175, NE of Cayey, 18°7'59" 66°10'6", 386 m, J. A. and R. W. Garrison leg., 1 male, 1 female (RWG).

**Biology.** *Erythemis vesiculosa* exhibit large and unidirectional flights (Rácenis 1953; Paulson 1966), showing his abundance peak in late fall and early winter (Florida, Paulson, 1966). This species inhabit lakes, ponds, swamps, backwaters in streams, and rice field canals, where his peak activity is from 9:00 to 16:00 hrs and include aspects as the aggressive defense of territories by males against other males of their own species or from other Libellulidae such as *Orthemis discolor* (Burmeister), *Erythemis peruviana* (Rambur) and *Erythrodiplax umbrata* (Linnaeus) (Palacino-Rodríguez and Millán 2010). Males visit various perches, especially in the lower branches of vegetation or on the ground and it is common to see them with their wings inclined forward to counteract the heat while watching females lay eggs in the water. *E. vesiculosa* individuals are voracious predators, show cannibalism, and may feed on butterflies (Needham and Westfall 1955) and Libellulidae such as *Dasythemis esmeralda* Ris (information of collection labels). Females lay eggs by giving quick taps with the apex of the abdomen on the water surface (Taber and Fleenor 2005). *E. vesiculosa* is parasitized by *Forcipomyia incubans* Mcfie (Diptera: Ceratopogonidae), which feeds on hemolymph taken from wing veins (Johannsen 1951), and in adults of this species from an agricultural field in Puerto Rico, was discovered the first mastrevirus probably transmitted by some of their diverse insect prey (Rosario et al. 2013).

**Distribution.** From U.S.A. to Argentina (Fig. 38), between 0–1870 m.asl.

### Morphometric Analysis - Continuous characters

Of the 31 continuous characters proposed in this work; 12 are only present in males, five just in females, and 14 are found in both male and female (Tables 1–3). Three of the characters analyzed do not show morphological gaps using Williamson (1923) coding nor with our recoding (characters 4 and 5 Table 1; 23 Table 2; Fig. 1). The first six functions of the discriminant function analysis explains

83% of the total variance in males (Fig. 2a,b), and 93% in females (Table 7, Fig. 2c). The discriminant function analysis ( $p \ll 0.01$ ) indicates that 100% of the 111 female specimens and 95% of the 238 male specimens are correctly separated (Fig. 2a), the remaining 5% of males were not properly assigned due to overlapping among *E. peruviana*, *E. simplicicollis*, and *E. collocata* (Fig. 2b). *Erythemis peruviana* is clearly different from the other two species given discrete characters of coloration and genitalia; likewise *E. simplicicollis* and *E. collocata* differ in some coloration characters and body ratios; the status of these two species will be discussed below.

Principal Component Analysis shows that the six first components explain 58% of the variation in males (Table 6, Fig. 3a) and 79% of the variation in females (Table 6, Fig. 3b). The ratio characters related to the wing and to the abdomen were strongly correlated with the first six functions of the discriminant function analysis as it is shown by the Wilk's lambda values (Table 6), and these characters have capacity to discriminate among male *Erythemis* species, and among female *Erythemis* species (Tables 6 and 7). Redundant information in males was detected between following characters (Table 2): Lar/Lba ratio (character 12), Las/Ddas ratio (character 16), and Lnpt/Anb ratio (character 11), and between LFW/Lnpt ratio (character 10), and LHW/LFW ratio (character 7). Redundant information in F was detected among Lab/LclS3 ratio (character 15) and Lab/Las ratio (character 17) (Table 2). Given that, the Lnpt/Anb ratio, LFW/nodus-pt length ratio, and Lab/Las ratio are easier to measure, we propose to keep using them as characters to differentiate some *Erythemis* species. The females of *E. credula*, *E. mithroides*, and *E. carmelita* were excluded because fewer than two specimens were available for the analysis.

Several ratio characters should not be used to separate species because no gaps were found, some ratios need to be recoded or their gaps require redefinition as previous discontinuities show strong overlapping. These are, the LHW/Lab ratio, the postero-ventral edge length/apex of the internal branch length ratio, the postero-ventral edge length/antero-ventral angle of the external branch length ratio, the genital lobes length/ventral hamules length ratio, the ventral region on the external branch of the hamules length/genital lobes length ratio, the carinae on third abdominal segment ratio, and the length of the vulvar lamina. We carefully explore the variation in the last character, analyzing measures in two opposite points on  $S_3$  in the following ratio: measure of distance between lateral and ventral carinae (dlvc), divided by the measure of distance between meeting point of lateral and medial transverse carinae and ventral carinae (lmt). Our analysis found that this ratio shows overlaps among species (Fig. 1a,b). A revised redefinition of these gaps indicated that is not possible to use it to separate all of the *Erythemis* species due to the high variation found.

The analysis showed that 20 proportions are useful to discriminate *Erythemis* species. The characters and percentage of species (male and female separately) that are separated by each variable is shown in Table 5. In general, the proportions associated to  $S_3$  carinae and the relationship HW length and abdomen length (Fig. 5) provided several information in this analysis, allowing separation from 70 to 100% of the species. Consistently with Williamson (1923), the usage of these characters aids to separate *Erythemis* species. However the gaps had to be reformulated, because the morphometric analysis showed that the character states proposed by him do not present discontinuity. The proportions obtained from the wing venation and the abdominal appendages discriminate a lower percentage of males and females (Table 7). A greater number of wing venation characters of the antenodal portion were obtained compared to those in the postnodal portion. Nonetheless, the width of HW discoidal field posterior border (acd) from the postnodal portion was one of the most informative characters in the analysis, when using the HW length proportion (LHW).

### Discrete characters

For the discrete characters, polymorphism was a common phenomenon, especially in characteristics such as color of labrum, frons, vertex, thorax, femur, and posterior tibia, and in morphological characters of cercus, abdomen, and wing venation (Table 3). While character 5 (Table 1) was recoded, and characters 2, 4, 5, 7, 8, 10–13, 16, 18, 19, 22, 36 (Table 2) were proposed in this work, our general results are consistent with those found by Williamson (1923) regarding the diagnostic importance of thorax and abdomen color and the dark basal spot on hind wing. Genitalia characters (Table 4) and morphometric characters of abdomen were found to be the most useful for separating *Erythemis* spe-

cies, while LHW/Lab ratio, and vulvar lamina length (Fig. 7) were not found to be reliable to separate species.

## Discussion

In recent decades new sources of information such as molecular, ecological, physiological, behavioral, developmental and morphometric data have been explored for taxonomic purposes (Avisé and Ball 1990; Sites and Marshall 2003). Important characteristics such as morphological measurements, color and wing venation patterns show extensive intra and interspecific variation in Odonata (Dijkstra and Pilgrim 2007). Despite this, few investigations focus on studying the variability of these characters and evaluating their diagnostic properties in Odonata (Johnson 1964, 1969; Cordero 1992; Garrison and von Ellenrieder 2006). To our knowledge this is the first study that evaluates the informative value of morphometric characters using explicit statistical analyses for the genus *Erythemis*.

### Continuous characters

Some authors have approached to the variation and complexity of Odonata morphology (i.e., Pilgrim and Von Dohlen 2008), and they have included wing venation along with many autapomorphies (Rehn 2003), showing a high individual variation due to the developmental process as larvae (Martynov 1930). This variation might apparently respond to the high difference in the capability of wing flexion among some odonates, i.e., *Aeshna* Fabricius, and *Pachydiplax* Brauer (Combes and Daniel 2003). In other odonate groups (i.e., *Coenagrion* Kirby, *Calopteryx* Leach), wing venation and some quantitative wing characters do not vary significantly among individuals of a species, becoming in useful characters for taxonomy (Hassall et al. 2008; Sadeghi et al. 2009).

We found few papers that included wing proportions for Odonata, and some of those show that the usefulness of this characters depends on the taxa to which they are associated. Kenner (2000) recognizes that some quantitative wing venation characters in *Somatochlora kennedyi* (Walker) have a high variation and therefore are not appropriate for the species taxonomy. Likewise, Sadeghi et al. (2009), in a morphometric analysis of *Calopteryx splendens* (Harris), had difficulty locating landmarks due to the variability shown by the wing venation and states that the wing shape may change when several populations of the species are compared.

Our results are consistent with those of Hassall et al. (2008) who found that *Coenagrion puella* (Linnaeus) vary little in size and shape in the prenodal portion, but shows a high variation in the postnodal portion as a consequence of the general elongation shown by this portion. In addition, other odonates have demonstrated considerable variability in the size of their wing bases and size of the spots on the wings (Outomuro et al. 2013). In *Erythemis*, discrete characters associated to the size of the basal spot are used successfully in this paper to determine species, which suggests that the interspecific variations in the size of the spots are associated to variation in the wing width, which may be used as continuous characters to separate species. However, the characters  $Ac/Lb$ ;  $LFW/Lnpt$ ;  $AnptFW/LoptFW$  include lengths of the postnodal portion of the wings. We consider that these characters might be among those parts of the postnodal portion that do not represent a significant variation, but we did not find data to support our proposal. Unfortunately, Hassall et al. (2008) did not provide information about which parts of the wing venation might or might not vary in this region.

Although cerci characters are used to differentiate Odonata species, lengths and proportions have been scarcely used. Although Pessacq and Costa (2007) do not provide precise data of the proportion, they used the ratio between cerci length and S10 length to differentiate species of *Peristicta* (Hagen in Selys), providing an important component in the taxonomical key to separate species of this genus. Von Ellenrieder and Costa (2002) used the total length of cerci, the variation in the width and the cercus length and epiproct length ratio as characters to distinguish *Aeshna* species. Our finding is consistent with that of Müller and Schiel (2012) who found that the ratio cerci length/paraproct length is similar in most of the species of Neureclia group (Odonata: Aeshnidae).

It has been found that females odonates recognize and accept conspecific males using tactile signals that express male abdominal appendages shape (Paulson 1974, Robertson and Paterson 1982,

Fincke et al. 2007). The shape of these structures in species of *Enallagma* Selys (McPeck et al. 2009) show morphological and evolutionary correlation to the mesothoracic plates shape in females (Zygoptera). It is possible that in *Erythemis*, similar to that of other Odonata genera (i.e., *Enallagma*), the evolutionary dynamic of these structures enable them to change little in lapse different to speciation periods (Templeton 1979; Paterson 1993) and therefore no intraspecific variation is found, but indeed an interspecific one is (McPeck et al. 2008, 2009; Shen et al. 2009), thus making them useful in species taxonomy.

In *Erythemis*, the intraspecific consistency in the cerci shape due to the stability of certain measurements, such as the length and width of different portions, may be an important character for counteracting the similarity in color patterns and structure of the vulvar lamina in females of *E. collocata*/*E. simplicicollis*; *E. attala*/*E. mithroides* and *E. credula*/*E. peruviana*. The specificity in these structures may be very important for separating species pairs, especially the last two because of their sympatric distribution. However, our findings show that the proportions for these species pairs overlap and therefore do not aid to distinguish them. In addition, it is possible that *Erythemis* males do not discriminate conspecific females from those of other species, which has been reported for males in other species (Paulson 1974; Miller and Fincke 2003; Fincke et al. 2007). According to Klass (2008), the structure of the abdomen is similar among Odonata, with drastic variations in the region associated to female genitalia in Anisoptera. We corroborated that finding in our study because the length of the vulvar lamina showed a high degree of overlap. On the other hand, the interspecific variability present in other continuous characters associated to abdomen (Lab/Lecv-clS3; Lab/LcaS3; Lecv-clS3/LcaS3; Lab/LclS3; Lab/Las; LclS3/LcaS3) is consistent with that proposed by Klass (2008), and is useful to determine *Erythemis* species.

Although we examined specimens of *Erythemis* from throughout its known distribution, an analysis of the geographical character variation has not been done. The high variation in morphometric ratios associated with size in *Erythemis* may show that the characters vary across the geographical distribution of the genus, which is common in Odonata (Mayr 1963). This variations in morphology often reflect adaptations of the populations to environments and local biotic factors (McPeck 1990; Ricklefs and Miles 1994), such as has been proposed for *Erythemis* (Palacino et al. 2014).

### Discrete characters

After careful review some characters did not comply with the independence criterion proposed by some authors (i.e., Sereno 2007) as several qualities and structures are lumped together into a single trait. For example, a thickened hind femur with 3–5 long, robust spines on its distal half followed by numerous short, distally directed spines on its basal half failed this criterion. Thus, the recoding of these characters revealed that they vary widely. In addition, characters of wing venation have little taxonomic value. Several other characters should not be used to separate species of *Erythemis* because they do not vary within the genus or are highly polymorphic. These characters include the distribution of bristles on the apex of ninth sternum, the orientation of the external branch of the hamuli, the shape of the lamina in the antero-ventral view, the shape of the external arm of the hamuli, the presence or absence of the posterior emargination between the basal lobes and the apex on vulvar lamina, the shape of the base of the vulvar lamina, and the color of labrum and face.

Characters of the male genitalia and the color patterns of thorax, abdomen, and basal region of wing are valuable for separating the species of *Erythemis*. Although we recorded extensive variation in several of the discrete color characters, it is important to clarify that polymorphisms and sexual dimorphism were observed (Table 3). The importance of thorax and abdomen color, and genitalia lobes is consistent with literature reports (De Marmels and Rácenis 1982; Belle 1998; von Ellenrieder 2000, 2003; Garrison and von Ellenrieder 2006; Garrison et al. 2006). These characters have proven to be useful to separate Odonata species that are otherwise difficult to distinguish (Gyulavári et al. 2011; Lee and Lin 2012; Monetti et al. 2002).

The analysis of museum specimens (RWGC, CNIN and UMMZ collections) collected from Mexico and Guatemala, which were labeled as new species, revealed that these specimens are probably species such as *E. attala* and *E. mithroides* with strong variations in size and color patterns. The rigorous and accurate definition of the species helps to clarify questions in evolutionary biology, ecology, and

conservation biology, and elucidates the processes that generate and maintain diversity (Masta and Maddison 2002). Addressing the problem of intra- and interspecific morphological variation in complex species, requires that it should be studied from several perspectives, because the confidence in species delimitation is greater when supported by the incorporation of different kinds of data and analyses of these data (Dayrat 2005; Guerra-Gracia et al. 2008).

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**Table 1.** Original description and redefinition of the taxonomic characters from Williamson (1923) and Kennedy (1923). As some characters proposed in the literature were split, the number of newly defined characters listed in the right column totaled 41 characters.\*The original character was split into two or more new characters, °Characters were examined, but were found to be sufficiently variable, and not helpful in distinguishing all the species.

Original description	New definition of the character
1. Abdomen length (less than 30 mm. long, shorter than hind wings; 30 mm long or longer).	a.* Abdomen length excluding caudal appendages (30mm or less; 30mm or longer, Fig. 5). °b. Abdomen length compared to HW length (shorter; equal or longer).
2. Abdomen variable, stout to slender, inflated or not at base.	S4-10 narrower than S1-3 (yes; not).
3. Distribution of bristles at apex of sternum of S9 (patch of sparse bristles; patch of sparse bristles-80%; a single transverse row-20%; a single row of bristles-80%; a patch of sparse bristles-20%; a single, or at most a double row; a patch of bristles; single row of bristles).	°Distribution of setae along ventral carina on sternum 9 (in a single transverse row; in a transverse double row).
4. Lateral and ventral carinae on S3 at apex, measured along apical carina, separated by (0.8 mm or less; 1mm or more).	Lateral carina length S3/apical carina length S3 ratio (F: $LclS3/LcaS3 < 2.50$ ; $LclS3/LcaS3 > 2.50$ ).
5. Distance between lateral and ventral carinae, opposite to meeting point of lateral and medial transverse carinae (equal to more than one and one-half times; one and one-half times or less the distance between them at apex).	Basal space between ventral-lateral S3 carinae/apical carina S3 ratio (M: $Lecv-clS3/LcaS3 < 1.50$ ; $Lecv-clS3/LcaS3 > 1.50$ ; F: $Lecv-clS3/LcaS3 < 1.60$ ; $Lecv-clS3/LcaS3 > 1.60$ ).
6. Lateral and ventral carinae on S4 separated by (less than one-sixth the length of lateral carina; more than one-sixth the length of lateral carina; other states including 0.20; 0.33; equal or less than 0.25; between 0.25 and 0.33).	Apical carina length S4/lateral carina on sternum of S4 (M: $lcaS4/lclS4 < 2.10$ ; $lcaS4/lclS4 > 2.10$ ).
7. Color of abdominal segments (4-10 bright red; 5-10 predominantly pale).	a.*Color of abdominal dorsum (red; yellow-brown; yellow-black; yellow-green; brown; purple-red; green-black; black with pruinescence; dark brown-black; brown-red; all black; yellow-green-brown-black; green-brown-black; yellow-brown-black; red-black; pale brown-black; yellow-red; grey due to pruinescence). b. Black or brown spots on dorsal region of abdomen (present; absent). c. Black or brown stripes on dorsal region of abdomen (present; absent).
8. Male cerci is lightly constricted postbasally, then enlarging to beyond mid-length and then more rapidly reduced to a superior acute apex.	Ratio length of cercus/Anterolateral width of cercus (M: $Las/Anas < 4$ , $Las/Anas > 4$ ).
9. Dorsum of thorax (distinctly patterned, paler above, bordered on either side with antehumeral black stripe; not distinctly patterned paler and darker).	Dorsum of thorax (pale with dark antehumeral stripes; same color as remainder of thorax).

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| 10. Color of thorax (yellowish; greenish; yellow to red or black).  | Color of lateral and dorsal regions of thorax (red; brown-green; pale brown; dark brown; yellow-green; pale green; brown-green-yellow; pale brown-yellow; pale brown-dark brown; dark brown-black; purple; orange; brown-red; black; grey due to pruinescence).       |
| 11. Labrum (pale colored, green and yellow; orange).  | ◊Color of labrum (yellow; black; black with yellow spots; dark brown; orange; black-brown; yellow-brown; yellow, black-brown; yellow-black-brown; yellow-green; pale brown-dark brown).   |
| 12. Frons (pale colored, green and yellow; not orange).   | ◊Color of antefrons (red; red-orange-black; brown; black; green; yellow-orange; yellow; green-yellow; green-red; yellow-brown; yellow-brown with violet overtones; black with violet overtones).  |
| 13. Dark basal spot on hind wings (reduced, not reaching cubito-anal crossvein; reaching beyond cubito-anal crossvein).   | Extension of basal coloration in HW (before or reaching cubito-anal crossvein; reaching beyond cubito-anal crossvein).  |
| 14. Wing bases (unmarked; basally tinged with yellow; distinctly dark).   | Dark basal spot on HW (present; absent).  |
| 15. Basal and apical parts of stigma about the same color, not distinctly bicolored.  | ◊Color of pterostigma (yellow with costal edge brown; yellow or black).   |
| 16. 11-15 antenodals in front wing.   | ◊Number of complete Ax veins in FW (8-16).  |
| 17. Rs and Rspl separated by one row of cells.  | a.*Radial planate (with double cells; without double cells).<br>b. ◊Cells double between IR <sub>2</sub> and R <sub>spl</sub> veins (in FW and HW; in one wing; no double cells in wings).  |
| 18. Normally two crossveins under the stigma.   | ◊Number of crossveins below pt (two; three).  |
| 19. In hind wing three to five cells between Cu <sub>1</sub> , and Cu <sub>2</sub> , from <i>t</i> to distal angle of anal loop.  | ◊Number of cells between AA and the posterior margin of HW (3-7).   |
| 20. In hind wing, <i>t</i> of front wing followed by three cells (rarely two in <i>credula</i> ) followed by three rows (usually but not always by two rows in part of the field in <i>credula</i> ), increasing to more at or distal to the level of the distal cell between M <sub>4</sub> and M <sub>spl</sub> . | ◊Distribution of cells at base of HW discoidal field (one cell followed by two rows of four cells; one cell followed by two rows of three cells; one cell followed by two rows of two cells; one cell followed by two rows of five cells).                            |
| 21. Cu <sub>1</sub> and Cu <sub>2</sub> in hind wing separate at origin.  | ◊MP origin in HW with respect to <i>t</i> (near posterior angle; separate from posterior angle).  |
| 22. Arculus between first and second antenodal.   | ◊Position of arculus with respect to Ax veins (proximal and anterior to first Ax; proximal and posterior to first Ax; distal to second Ax).   |
| 23. <i>t</i> of front wing narrow, the anterior side much shorter than the proximal.  | ◊Ratio of costal side length to proximal side in FW <i>t</i> (half or more; less than 0.33; more than 0.33 and less than 0.50).   |
| 24. Legs (tibiae, and to a lesser extent femora) of adults largely black or dark brown.   | a.*◊Color of outer surface of hind femur (dark brown; black-yellow-green; black; black-brown; yellow-green-dark brown; yellow-green-brown-black; brown; yellow-brown).<br>b. ◊Color of outer surface of posterior tibia (pale brown; black; dark brown; black-brown). |
| 25. Third femur of male with an antero-ventral row of small and regular teeth.  | ◊Number of shorter spines on outer surface of hind femur (8-19).  |
| 26. In F, femur apical third with three or four stout spines the same size in the antero-ventral row.   | ◊Number of longer distal spines on outer surface of female hind femur (3-4).  |
| 27. Second femur with the number of apical spines variable in number, three or four in each row.  | ◊Number of longer distal spines on outer surface of medial femur (3-6).   |
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| 28. The three cornual lobes (fused into a single conspicuous, terminal lobe), Kennedy (1923).                  | Cornual lobes to apex (separate; fused).  |
| 29. Cornual lobe (parallel to axis of vesica spermalis; bent across axis of vesica spermalis), Kennedy (1923). | Cornual orientation with respect to vesica spermalis transversal axis (parallel; perpendicular; diagonal).  |
| 30. Shape of external branch of hamule (triangular; rounded; rounded triangular), Kennedy (1923).              | ◊Edge on hamulus external arm (round; truncated).   |
| 31. Female lamina (projecting ventrad; directed caudad).   | a. *Vulvar lamina projected to posterior region (yes; no).<br>b. ◊Vulvar lamina orientation angle with respect to abdominal longitudinal axis (right; obtuse).<br>c. Vulvar lamina projected ventrally (yes; no). |
| 32. Hook over medial lobes (undeveloped; developed into an arched two-lobed affair), Kennedy (1923).           | a. *Hook posterior region bilobed (yes, no).<br>b. Hook perpendicular to vesica spermalis longitudinal axis (yes; no).  |
| 33. Female lamina in antero-ventral view (semicircular; not semicircular; rounded triangular; trilobed).       | Lamina vulvar in antero-ventral view (suboval; triangular).   |
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**Table 2.** List of discrete and continuous characters used for *Erythemis* species discrimination analysis. Characters with asterisk were proposed by Williamson (1923), and others are proposed in this study.  
<sup>◊</sup>Characters were examined but were found to be sufficiently variable to be of no value in distinguishing all the species.

Character
1. HW length/abdomen length ratio (M and F, LHW/Lab<1.20; LHW/Lab>1.20).
2. Pterostigma width/pterostigma length ratio on FW (M, AnptFW/LoptFW <0.22, >0.22).
3. Pterostigma width/pterostigma length ratio on HW (M and F: AnptHW/LoptHW >0.22, AnptHW/LoptHW<0.22).
4. HW discoidal field posterior border width/wing base-nodus length ratio (M: Acd/Lban; <4.10, >4.10).
5. Wing base-nodus length/HW base width ratio (M: Lban/Anb>1.90, Lban/Anb<1.90; F: Lban/Anb<1.50, Lban/Anb>1.50).
6. HW length/HW discoidal field posterior border width ratio (M: LHW/Acd<3.60, LHW/Acd>3.60, F: LHW/Acd<0.54, LHW/Acd>0.54).
7. HW length/FW length ratio (M: LHW/LFW>0.97, LHW/LFW<0.97).
8. Subtriangle width/triangle width ratio (F: Ansbt/Antr<2.40; Ansbt/Antr>2.40).
9. Triangle width/arculus-second antenodal length ratio (M: Antr/Lar>7.00, Antr/Lar<7.00; F: Antr/Lar<3.00; Antr/Lar>3.00).
10. FW length/nodus-pterostigma length ratio (M: LFW/Lnpt<3.00, LFW/Lnpt>3.00; F: LFW/Lnpt<2.90, LFW/Lnpt>2.90).
11. Nodus-pterostigma length/HW base width ratio (M: Lnpt/Anb>1.50, Lnpt/Anb<1.50; F: Lnpt/Anb>1.20, Lnpt/Anb<1.20).
12. Arculus-second antenodal length/wing base-arculus length ratio (M: Lar/Lba<0.22; Lar/Lba>0.22; F: Lar/Lba<0.14; Lar/Lba>0.14).
13. Wing base-arculus length/wing base-nodus length ratio (M: Lba/Lban<2.00, Lba/Lban>2.00).
14. Wing base-nodus length/supplementary anal vein-Cu-A crossvein length ratio (M: Lban/Lasa-ca>4.00, Lban/Lasa-ca<4.00).
15. Abdomen length/cercus length ratio (F: Lab/Las<2.50, Lab/Las>2.50; Figs. 5 and 6).
16. Cercus length/reach of teeth on the ventral region of cercus ratio (M: Las/Ddas<5.00, Las/Ddas>5.00).
17. Abdomen length/lateral carina length ratio (M: Lab/LclS3<1.50, Lab/LclS3>1.50; F: Lab/LclS3<1.40, Lab/LclS3>1.40).
18. Abdomen length/apical carina length ratio (F: Lab/LcaS3<3.00; Lab/LcaS3>3.00).
19. Abdomen length/basal space ventral-lateral carinae length ratio (M: Lab/Lecv-clS3<1.90, Lab/Lecv-clS3>1.90; F: Lab/Lecv-clS3<2.00, Lab/Lecv-clS3>2.00).
20. Width transverse carina region on S2/width transverse carina region on S4 ratio. (WssS2/WfsS4<3.00; WssS2/WfsS4>3.00).
21. Width medial region on second abdominal segment/apical carina on fifth abdominal segment length ratio (WmS2/LacS5<3.00; WmS2/Lac5>3.00).
22. Length ratio vulvar lamina lateral lobe/vulvar lamina length (Bl/Vl>4.00; Bl/Vl<4.00).
23. Female lamina length from base of basal lobe to apex (0.65mm-1.50mm)*.
24. Width of pale medio-dorsal thoracic stripe with respect to width of dark antehumeral stripe that borders it in the dorsal region of thorax (similar; two or more times wider).
25. <sup>◊</sup> Wing base of HW widened (yes; no).
26. <sup>◊</sup> Number of complete Ax veins in HW (8-12).
27. <sup>◊</sup> Number of cell rows in FW anal field in the region below subtriangle (1-2).
28. <sup>◊</sup> Number of postnodal veins between C and R prior to first postnodal vein between RP1 and M <sub>1</sub> (2-3).
29. <sup>◊</sup> Number of cell rows in HW in the anal field region on distal angle of triangle (less than three; three).
30. Cells rows in FW HW discoidal field basal region (Two; alternating two and three; three).
31. <sup>◊</sup> Medial planate (with double cells; without double cells).
32. <sup>◊</sup> Number of cells in radial planate in FW (7-11).
33. <sup>◊</sup> Number of cells in radial planate in HW (7-13).
34. <sup>◊</sup> Number of cells in HW bifurcation of anal keel (3-7).
35. <sup>◊</sup> First postnodal in HW (inclined with respect to the rest; parallel to the rest).
36. <sup>◊</sup> Arrangement of spines in external margin of hind femur (a series of longer spines followed by one or more medium spines and a series of shorter spines; a series of longer spines followed by a series of shorter spines).



37. ◊Series of shorter spines on hind femur (one or more spines much longer than the rest; all spines of same size).
38. ◊Number of spines on external margin of medial tibia (4-7).
39. ◊Number of shorter spines on external angle of medial femur (5-11).
40. ◊Dorsal carina on abdominal segment 10 (present; absent).
41. ◊Dorsal edge of cercus in lateral view (curved; straight).
42. Teeth in ventral carina on ventral tergum 9 (present; absent).
43. ◊Posterior edge of cercus (curved; truncated).
44. Posterior extension of ventral teeth on male cerci (beyond level of apex of epiproct; about the same level as apex of epiproct or less)\*.
45. ◊Ventral edge of anterior lamina with respect to ventral edge of genital lobe (higher; lower; at the same height).
46. ◊Postero-ventral edge in external branch of the hamule (equal to or slightly shorter than the distance between the apex of the internal branch and the antero-ventral angle of the external branch; about equal to, or slightly more than half the distance between the apex of the internal branch and the antero-ventral angle of the external branch; equal to or shorter than the distance between the apex of the internal branch and the antero-ventral angle of the external branch)\*.
47. ◊External branch of the hamules and the genital lobes (reaching ventrad to about the same level, or the genital lobes very slightly longer; the external branch of the hamules reaching ventrad distinctly beyond the level of the genital lobes)\*.
48. ◊External branch of the hamule (directed ventrad, in posterior view erect; directed more caudad than ventrad, not erect in posterior view; directed ventro-caudad)\*.
49. ◊Hamulus external arm with respect to posterior edge of the genital lobe (narrower; wider).
50. ◊Constriction of genital lobe base (present; absent).
51. Shape of the vesica spermalis hook (triangular; trapezoidal; suboval; finger shaped).
52. Width of hook of vesica spermalis in dorsal view (wide; narrow).
53. Cornua of vesica spermalis in lateral view (covered by lateral lobe; exposed).
54. Posterior edge of vesica spermalis hook (acute; rounded; truncated).
55. Posterior extension of lateral lobe of vesica spermalis respect to medial lobe (less extended into posterior region; more extended into posterior region).
56. ◊Hook of vesica spermalis (short; long).
57. Posterior lobe of vesica spermalis (present; absent), Kennedy (1923).
58. Posterior lobe of vesica spermalis (covered by lateral lobe; not covered by lateral lobe).
59. ◊Genital lobes (reaching ventrad far beyond the level of the hamules; extending ventrad about as far as or farther than the hamules)\*.
60. ◊Color on vertex dorsal region (red; brown-green; black; pale brown; dark brown; yellow-green; yellow-green with brown anterior edge; dark brown-black; purple; pale green; orange; brown-red; brown-yellow; yellow-green with black anterior edge; yellow-brown-black; yellow).
61. ◊Apex of female lamina (bent; not distinctly bent)\*.
62. ◊Base of vulvar lamina (widened; not widened)\*.
63. ◊Posterior emargination between basal lobes and apex of female lamina (present; absent)\*.
64. ◊Female lamina in antero-ventral view (nearly as long as wide; the width about one-half greater than the length)\*.
65. ◊Posterior basal lobe of the female lamina in lateral view (distinct; scarcely evident)\*.
66. ◊Black stripe on anterior margin of vertex (present; absent).
67. ◊Brown stripe on anterior margin of vertex (present; absent).
68. ◊Purple overtones on vertex (present; absent).
69. ◊Anterior region of vertex brown and posterior region green (present; absent).
70. ◊Purple overtones on frons (present; absent).
71. ◊Brown stripes on basal region of antefrons and apical region of postfrons on vertex (present; absent).
72. ◊Brown spots on antefrons (present; absent).
73. ◊Metallic blue overtones on antefrons (present; absent).
74. ◊Yellow-greenish stripe on antefrons (present; absent).
75. ◊Brown stripe on postfrons (present; absent).
76. ◊Yellow spots on dorsal region of labrum (present; absent).
77. ◊Dark longitudinal stripe in medial region of labrum (present; absent).
78. Color on S1 and 2 or S1-3 with respect to thorax color (similar; different).
79. Pruinescence on dorsal region of abdomen (present; absent).

80. Color on first two or three abdominal segments (similar to rest of abdominal segments; different from rest of abdominal segments).
  81. Color in lateral view, dorsal and ventral regions of cercus (red; brown; yellow with brown apex; yellow with black apex; green on superior region and pale brown on inferior region; yellow-brown; brown with posterior half black, white, black).
  82. <sup>◊</sup>Ventral and dorsal surfaces of male cercus of different colors (yes; no).
  83. <sup>◊</sup>Anterior and posterior regions of cercus of different colors (yes; no).
  84. Pruinescence on lateral and dorsal regions of thorax (present; absent).
  85. Pale stripe on dorsal region of thorax (present; absent).
  86. <sup>◊</sup>Color of internal surface of femur with respect to color of external region (similar; different).
  87. <sup>◊</sup>Color on anterior and posterior regions of the hind femur (similar; different).
  88. Extension of dark basal spot on HW to posterior region (to supplementary anal vein; to anal anterior; to base of the triangle).
  89. Dark basal spot on HW reaching the first antenodal vein (yes; no).
  90. Extension of dark basal spot on HW to anal angle (reaching the penultimate row of cells; reaching the row of marginal cells in anal angle; not reaching penultimate row or marginal cells).
  91. Dark basal spot on HW (no; yes).
  92. Color of basal spot in HW (dark brown; pale brown; yellow; black).
  93. <sup>◊</sup>Wing apex color (hyaline; tinged with brown)\*.
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Table 3. Polymorphism and sexual dimorphism observed in *Erythemis* species.

Character number	<i>E. attala</i>		<i>E. collocata</i>		<i>E. haematogastera</i>		<i>E. mithroides</i>		<i>E. peruviana</i>		<i>E. plebeja</i>		<i>E. simplicicollis</i>		<i>E. vesiculosa</i>	
	M*	F*	M	F	M	F	M	F	M	F	M	F	M	F	M	F
7 <sup>1</sup>	2,5,8,3 1	8	17,32- 34	17	8,35,36	17,33,34 ,38	17,33,34 ,38	3,8,13,3 6	8,35,36	3,7,8	3,5,7,8,31, 37	17,33,34,3 8	17,31,39	8,17,26,31,39, 40	1	
10 <sup>1</sup>	3,5	5	34,42	46	5,8,41	13,34	13,34	5,8,20,2 2	5,8,41	5,8,13	3,5	13,34	12,13,20	6,12,13,20	4	
11 <sup>1</sup>	1,2,3	1	1	1	1,2,3,5	1,5	1,5	1,3,7	1,2,3,5	1,5,6,8	2,5	1,5	1	1,6	1	
12 <sup>1</sup>	2,5,9	1	5,43	47	2,5,8,11	1,5,15,1 7	1,5,15,1 7	1,5,12,1 4	2,5,8,11	1,5,8,12,1 4	2,5	1,5,15,17	1,12	1,1,2,16	8	
16 <sup>1</sup>	56-58,	-	55-57	-	53-56,60	54,56	54,56	-	53-56	-	56-58	54,56	-	56-59	-	
19 <sup>1</sup>	49-51	49	49-51	49	49-51	49,50	49,50	49,50	49-51	49-51	49-51	49,50	49-51	49-52	5	
24a <sup>1</sup>	2,3,5	2,	13,44	20,4	2,3,5,23	5,24,25	5,24,25	2,3,5	2,3,5,23	2,3,5	2,3,5	5,24,25	3,22,23, 26	3,22,23,26	2	
24b <sup>1</sup>	2,3,5	2,	5	2,5	2,3,5	2,5	2,5	2,3,5	2,3,5	2,3,5	2,3,5	2,5	2	2,5	5	
26 <sup>2</sup>	56	-	53	-	53-57	53,54	53,54	-	53-57	-	54-56	53,54	-	56,57	-	
32 <sup>2</sup>	53	-	54-56	-	52,53	52,55,57	52,55,57	-	52,53	-	52-55	52,55,57	-	46,54,56	-	
33 <sup>2</sup>	52	-	54-56	-	52,53	53,54	53,54	-	52,53	-	52-56	53,54	-	-	-	
34 <sup>2</sup>	48-52	-	48,50,5	-	48-53	48-51	48-51	-	48-51	-	48-51	48,50	-	48-52	-	
60 <sup>2</sup>	2,9	5	45	17	2,7, 9,12,18	1,5,20	1,5,20	5,7,18,1 9	2,7, 9,12,18	2,3,5,8,18, 20	2,5	1,5,20	1,12,13	1,7,12,13	3	
81 <sup>2</sup>	5,29	5	12,27,2 8	28	5,10	13	13	5,10	5,10	5,29,30	5,10,29	13	5,8,21,2 8	10,32	3	

<sup>1</sup> = character number refers to Table 1, <sup>2</sup> = character number refers to Table 2. \* = M, \*\* = F. Numbers listed in each species correspond to the following character states: all yellow (1); all black (2); black and brown (3); black with yellow spots (4); all brown (5); orange (6); yellow, black, and brown (7); yellow and brown (8); black with purple overtones (9); all red (10); red, orange, and black (11); all green (12); green and yellow (13); yellow and brown with purple overtones (14); green with red overtones (15); yellow and orange (16); green with brown or black stripes (17); yellow and green with black anterior edge (18); yellow and green with brown anterior edge (19); green and brown (20); reddish (21); brown, green and yellow (22); black, green and yellow (23); green on anterior region and yellow-brown on posterior region (24); green on anterior region and yellow-red on posterior region (25); yellow, green, brown and black (26); green dorsal region and black ventral region (27); green dorsal region and brown ventral region (28); yellow with brown apex (29); brown with the black posterior region (30); yellow and black (31); green with yellow and red spots (32); green with brown spots (33); with pruinescence (34); purple and red (35); brown and red (36); black with pruinescence (37); green with yellow and red spots (38); green and black (39); green, brown, and black (40); all purple (41); green with yellow spots (42); green with a yellow stripe and green and brown spots on anterior region (43); brown internal surface and yellow (44); brown on anterior surface and posterior surface green with a brown stripe (45); green with yellow and brown spots (46); green with brown posterior edge (47); three (48); four (49); five (50); six (51); seven (52); eight (53); nine (54); ten (55); eleven (56); twelve (57); thirteen (58); fourteen (59); fifteen (60).

**Table 4.** The following characters aid to separate *Erythemis* M only (characters 1-25), F only (26-28) or M and F (29-42).

	<i>E. attala</i>	<i>E. carmelita</i>	<i>E. collocata</i>	<i>E. credula</i>	<i>E. haematogastra</i>	<i>E. mithroides</i>	<i>E. peruviana</i>	<i>E. plebeja</i>	<i>E. simplicicollis</i>	<i>E. esiculosa</i>
1.							X			
2.	X				X		X			
3.			X						X	
4.			X	X				X	X	
5.	X	X			X	X				
6.			X					X		X
7.				X	X					
8.										X
9.	X	X	X			X	X	X	X	
10.				X						
11.	X	X	X		X	X	X	X	X	X
12.							X			X
13.	X	X	X	X	X	X		X	X	
14.										X
15.	X				X	X	X	X		
16.	X			X	X	X	X	X		
17.							X			
18.										X
19.			X	X					X	X
20.	X	X			X	X	X	X		
21.	X		X	X					X	
22.		X								X
23.					X	X	X	X		
24.			X						X	X
25.	X	X		X	X	X	X	X		
26.				X			X	X		
27.	X	X	X		X	X			X	X
28.				X			X			
29.			X						X	
30.	X	X		X	X	X	X	X		X
31.	X	X		X	X	X		X		
32.							X			X
33.	X	X								
34.				X	X		X			X
35.		X			X			X		
36.							X			X
37.	X	X								
38.			X	X	X	X	X	X	X	X
39.					X					X
40.							X			
41.	X									
42.		X		X						

1. Yellow spots on labrum, 2. Purple overtones on frons, 3. Pruinescence on thorax, 4. Pruinescence on abdomen, 5. Posterior extension of ventral teeth of male cercus about the same length as the apex of epiproct or less, 6. Posterior extension of ventral teeth of male cercus beyond level of apex of epiproct, 7. Location of arculus may be proximal and anterior to second antenodal vein or proximal and posterior to second antenodal vein, 8. Location of arculus near the first or second antenodal vein, 9. Location of arculus near the second antenodal, 10. Vesica spermalis with hook not bilobed, 11. Vesica spermalis with hook bilobed, 12. Lateral lobe of vesica spermalis shorter than medial lobe, 13. Lateral lobe of vesica spermalis longer than medial lobe, 14. Posterior edge in vesica spermalis hook truncated, 15. Posterior edge in vesica spermalis hook acute, 16. Vesica spermalis with triangular hook, 17. Vesica spermalis with finger shaped hook, 18. Vesica spermalis with trapezoidal hook, 19. Vesica spermalis has exposed cornua, 20. Vesica spermalis has cornua covered by lateral lobes, 21. Cornua parallel to transversal axis of vesica spermalis, 22. Cornua perpendicular to transversal axis, 23. Cornua diagonal to transversal axis of vesica spermalis, 24. Cornual lobes are fused to the apex, 25. Cornual lobes separated, 26. Pale mid-dorsal thoracic stripe is bordered by dark antehumeral stripes, 27. Dorsal thoracic without stripes, 28. Yellow spots on labrum, 29. Basal area on HW hyaline, 30. Basal area on HW dark, 31. Dark basal area on HW reaching the media posterior vein (MP) or beyond, 32. Dark basal area on HW not reaching the media posterior vein (MP), 33. Dark basal area on HW reaching the first antenodal vein (fav, Fig. 26), 34. Dark basal area on HW not reaching the first antenodal vein, 35. Dark basal area on HW reaching the AA, 36. Dark basal area on HW not reaching the AA, 37. Dark basal area on HW reaching most of the base of the triangle, 38. Dark basal area on HW not reaching the base of the triangle, 39. Dark basal area on HW not reach the last rows of cells to anal angle, 40. Dark basal area on HW only extends to the penultimate row of cells (pra, Fig. 26), 41. Dark basal area on HW covering a small basal region or the row of marginal cells (MRA, Fig. 26), 42. Dark basal area on HW covering the penultimate or the row of marginal cells.

**Table 5.** Variation explained by the first six functions of the discriminant and canonical correlation analyses of the morphometric characters of M and F of *Erythemis*.

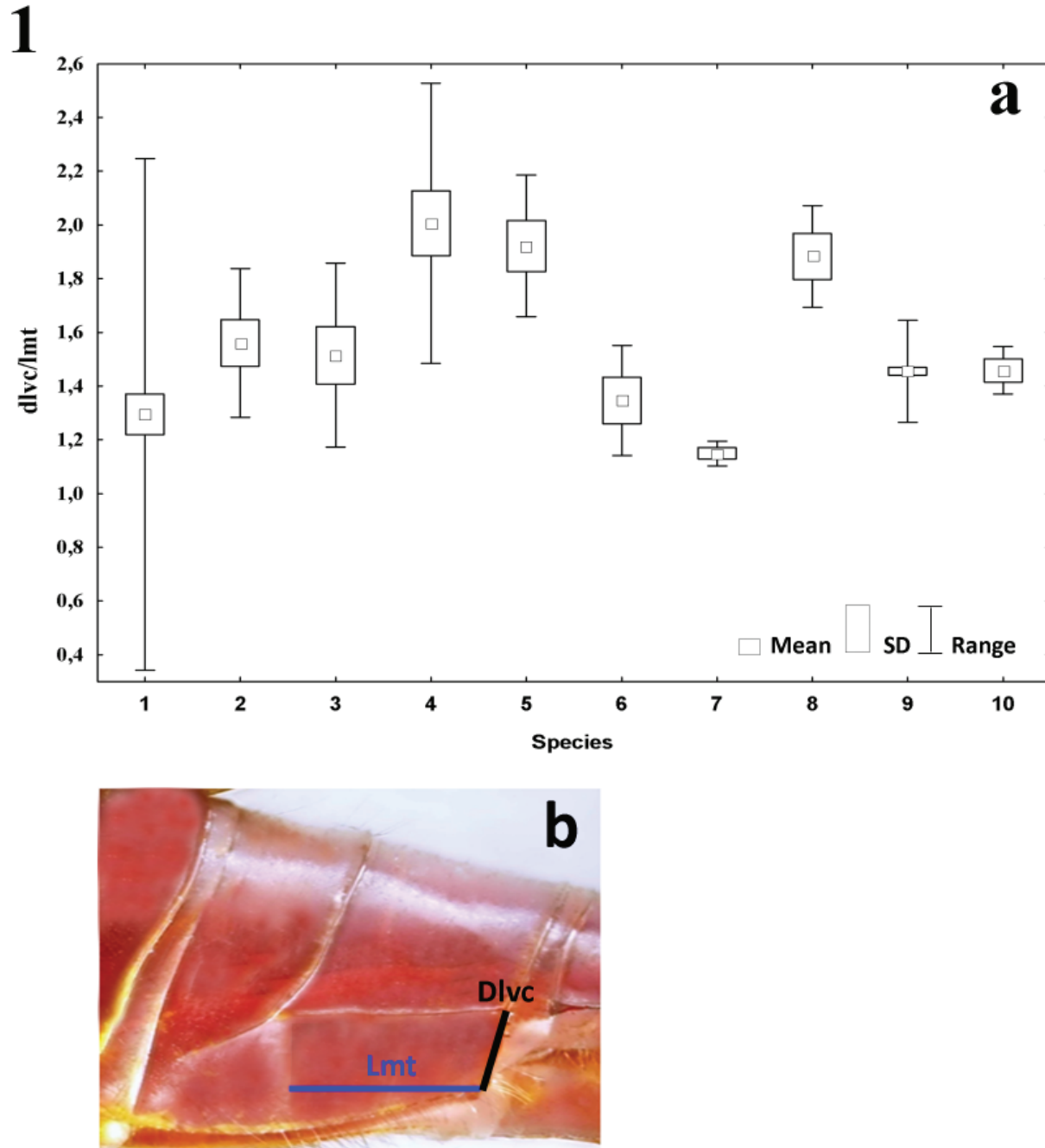
Discriminant Function	M			F			Canonical correlation
	Explained variation (%)	Cumulative Explained variation (%)	Canonical correlation	Explained variation (%)	Cumulative Explained variation (%)	Canonical correlation	
1	53.60	53.60	0.984	55.70	55.70		0.99
2	18.90	72.50	0.956	27.90	83.60		0.99
3	10.70	83.20	0.926	9.30	92.90		0.97
4	4.90	88.10	0.857	4.50	97.40		0.94
5	4.10	92.30	0.836	1.50	98.90		0.86
6	3.10	95.40	0.798	1.10	100.00		0.82

**Table 6.** Discriminant power of each morphometric character of M and F specimens of *Erythemis*. W: Wilks' Lambda, F: Distribution of the probability, P: Probability. See abbreviations above.

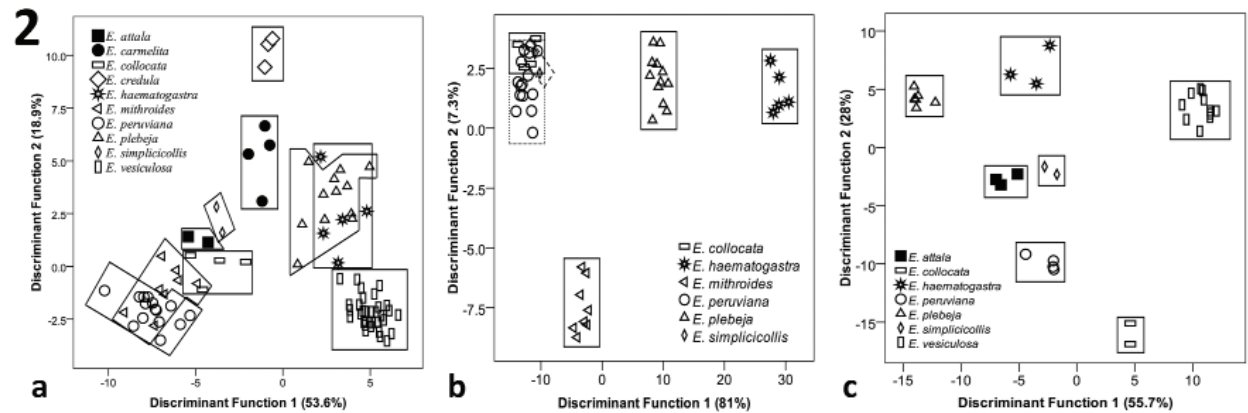
Variable	M			F		
	W	F	P	W	F	P
LHW/Lab	0.18	33402	<<0.01	-	-	-
Lab/Lecv-clS3	0.27	10.83	<<0.01	0.14	44.52	<<0.01
LclS3/LcaS3	-	-	-	0.20	30.15	<<0.01
Lab/Las	-	-	-	0.28	10.01	<<0.01
LHW/Acd	-	-	-	0.29	18.04	<<0.01
Lab/LcaS3	0.36	6.94	<<0.01	0.19	31.74	<<0.01
LFW/Lnpt	0.37	6.74	<<0.01	0.51	7.22	<<0.01
Lecv-clS3/LcaS3	0.40	11.22	<<0.01	0.40	11.22	<<0.01
Las/Anas	0.41	5.75	<<0.01	-	-	-
Lab/LclS3	0.42	5.32	<<0.01	0.25	22.28	<<0.01
Antr/Lar	0.45	4.83	<<0.01	0.51	7.39	<<0.01
Acd/Lban	0.46	4.54	<<0.01	0.46	4.54	<<0.01
AnptFW/LoptFW	0.47	4.51	<<0.01	0.53	3.53	0.012
Lar/Lba	0.47	8.39	<<0.01	0.47	8.39	<<0.01
Lnpt/Anb	0.48	4.19	<<0.01	0.54	6.53	<<0.01
LHW/Acd	0.50	3.98	<<0.01	-	-	-
Lban/Lasa-ca	0.57	5.70	<<0.01	-	-	-
LHW/LFW	0.64	4.32	<<0.01	-	-	-
AnptHW/LoptHW	0.65	3.97	<<0.01	-	-	-
Lban/Anb	0.68	3.54	0.01	0.40	5.87	0.01
Lba/Lban	0.71	3.04	<<0.01	-	-	-
Las/Ddas	0.77	2.26	0.02	-	-	-

**Table 7.** Variation in ratio characters for the species of *Erythemis*. See abbreviations above.

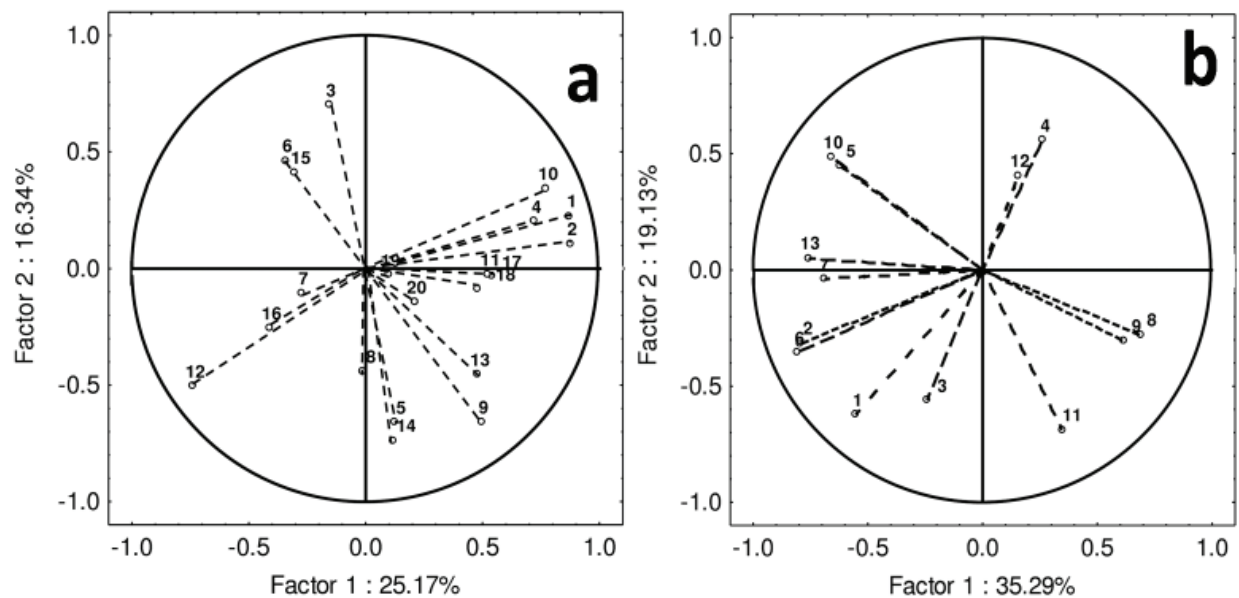
Ratio	<i>E. attala</i>	<i>E. carmelita</i>	<i>E. collocata</i>	<i>E. credula</i>	<i>E. haematogastera</i>	<i>E. mithroides</i>	<i>E. peruviana</i>	<i>E. plebeja</i>	<i>E. simplicicollis</i>	<i>E. vesiculosa</i>
No. M/F	19/7	10/0	5/3	6/0	5/11	20/2	53/29	22/20	4/3	94/36
<i>Lab/Lecu-clS3</i>	1.82-1.90	1.83-2.23	1.36-1.80	1.88-1.99	1.86-2.60	1.54-2.02	1.39-1.79	1.94-2.43	1.75-1.82	2.20-3.40
	1.68-2.03	-	1.66-1.90	-	2.03-2.57	-	1.61-2.13	2.04-2.79	2.01-2.13	2.00-2.89
<i>Lab/LcaS3</i>	2.32-2.49	2.86-3.90	2.40-2.51	3.58-4.19	4.01-5.00	1.84-2.51	1.65-2.10	3.12-5.95	2.52-2.68	1.78-4.98
	1.95-2.23	-	2.07-2.67	-	4.11-4.82	-	1.81-2.26	2.60-2.79	2.60-2.88	2.21-4.79
<i>LFW/Lnpt</i>	2.64-2.83	2.89-3.07	2.89-3.04	3.11-3.11	2.78-3.05	2.59-3.01	2.86-3.22	2.78-3.25	3.02-3.07	2.61-3.11
	2.70-2.80	-	2.92-3.00	-	2.76-2.84	-	2.96-3.11	2.82-3.09	2.81-2.86	2.87-3.10
<i>Lab/LclS3</i>	1.31-1.35	1.19-1.34	1.20-1.83	1.28-1.49	1.45-1.86	1.28-1.83	1.33-1.69	1.33-1.79	1.30-1.30	1.62-2.15
	1.11-1.19	-	1.18-1.27	-	1.23-1.43	-	1.25-1.41	1.17-2.09	1.08-1.09	1.45-1.72
<i>Antr/Lar</i>	9.50-13.37	5.00-6.00	2.37-6.01	6.50-27.2	7.41-19.5	3.67-18.2	4.0-10.36	3.10-6.0	2.42-6.21	3.89-12.2
	2.60-3.00	-	1.18-5.01	-	3.87-8.00	-	4.0-10.36	1.83-3.51	1.37-1.44	1.50-4.28
<i>Lar/Lba</i>	0.11-0.14	0.21-0.29	0.22-0.44	0.05-0.20	0.11-0.19	0.04-0.31	0.13-0.32	0.18-0.39	0.21-0.46	0.10-0.29
	0.09-0.11	-	0.06-0.23	-	0.04-0.08	-	0.10-0.19	0.07-0.14	0.17-0.18	0.07-0.15
<i>Acad/Lban</i>	3.81-3.93	3.24-3.83	3.65-4.49	4.18-4.51	3.52-4.15	3.76-4.18	3.48-4.50	3.29-4.29	3.82-3.87	3.42-4.28
	4.42-4.84	-	4.63-4.86	-	3.89-4.55	-	4.45-5.04	4.31-5.03	4.58-4.69	4.32-4.83
<i>AnptFW/LoptFW</i>	0.25-0.28	0.22-0.26	0.18-0.24	0.18-0.20	0.19-0.21	0.15-0.26	0.17-0.22	0.19-0.23	0.16-0.22	0.00-0.24
	0.20-0.24	-	0.20-0.23	-	0.19-0.23	-	0.17-0.22	0.17-0.22	0.20-0.22	0.17-0.22
<i>AnptHW/LoptHW</i>	0.20-0.24	0.22-0.26	0.20-0.22	0.17-0.17	0.17-0.23	0.14-0.24	0.17-0.22	0.18-0.23	0.16-0.21	0.15-0.24
	0.23-0.27	-	0.17-0.25	-	0.20-0.24	-	0.19-0.21	0.17-0.23	0.19-0.19	0.19-0.22
<i>Lnpt/Anb</i>	1.69-1.84	1.55-1.67	1.38-1.46	1.51-1.57	1.47-1.75	1.51-1.85	1.22-1.80	1.31-1.68	1.35-1.37	1.46-1.84
	1.22-1.40	-	1.09-1.13	-	1.37-1.50	-	1.08-1.34	1.10-1.34	1.22-1.30	1.24-1.39
<i>LHW/Acd</i>	3.37-3.39	3.27-3.42	3.15-3.45	3.66-3.72	3.65-3.72	3.17-3.51	3.35-3.58	3.39-3.86	3.42-3.48	3.45-4.22
	0.51-0.53	-	0.47-0.50	-	0.54-0.60	-	0.47-0.55	0.48-0.53	0.52-0.53	0.49-0.55
<i>Lban/Lasa-ca</i>	4.38-4.90	2.35-4.26	1.36-1.79	1.62-2.02	2.11-3.08	2.34-3.55	1.23-2.79	2.04-3.96	2.00-2.60	2.54-9.14
	1.80-6.85	-	0.89-1.25	-	1.99-2.36	-	1.17-1.83	1.82-3.21	1.08-1.54	2.27-4.56
<i>LHW/Lab</i>	1.21-1.46	1.20-1.26	1.14-1.20	1.12-1.16	0.91-1.12	1.19-1.29	1.05-1.27	0.92-1.22	1.08-1.10	0.91-1.11
	1.26-1.42	-	1.12-1.19	-	1.03-1.11	-	1.12-1.25	1.03-1.18	1.07-1.18	0.93-1.02
<i>Lban/Anb</i>	2.02-2.11	2.03-2.08	1.73-1.82	1.95-2.14	1.80-2.06	1.83-2.05	1.56-2.36	1.78-2.16	1.66-1.76	1.79-2.24
	1.32-1.50	-	1.26-1.39	-	1.62-1.66	-	1.32-1.65	1.32-1.65	1.40-1.44	1.49-1.67
<i>LHW/LFW</i>	0.99-1.02	0.99-1.02	0.95-0.97	0.98-1.01	0.98-1.01	0.98-1.02	0.95-0.98	0.90-1.01	0.95-0.97	0.96-1.04
	0.96-0.99	-	0.93-0.96	-	0.97-1.01	-	0.94-0.98	0.96-1.00	0.95-0.98	0.93-0.99
<i>Las/Ddas</i>	3.62-3.62	3.29-5.81	3.22-6.25	4.17-5.50	3.39-4.72	3.12-4.83	2.36-7.53	3.60-6.21	5.41-5.81	2.44-6.67
	-	-	-	-	-	-	-	-	-	-
<i>Lba/Lban</i>	1.70-1.90	1.82-1.88	1.92-2.09	2.14-2.18	1.79-2.01	1.64-2.08	1.77-2.03	1.69-1.98	2.04-2.21	0.00-2.21
	2.01-2.19	-	2.23-2.51	-	1.97-2.09	-	2.13-2.39	1.91-2.33	2.09-2.40	1.90-2.22
<i>LclS3/LcaS3</i>	1.78-1.84	2.27-3.00	1.35-2.00	2.6-2.89	2.69-3.0	1.10-2.00	1.09-1.47	2.06-3.08	1.94-2.06	1.67-2.62
	1.63-2.00	-	1.65-2.27	-	3.23-337	-	1.39-1.59	1.32-1.48	2.41-2.65	1.29-2.93
<i>Lecu-clS3/LcaS3</i>	1.22-1.37	1.34-1.75	1.33-1.82	1.62-2.16	1.6-2.1	1.10-1.92	1.0-1.33	1.31-2.45	1.44-1.47	0.66-2.07
	1.10-1.16	-	1.25-1.40	-	1.69-2.27	-	1.05-1.29	1.00-2.45	1.29-1.35	1.11-2.07
<i>Las/Anas</i>	3.06-7.25	2.55-4.83	2.64-5.81	2.78-2.94	4.58-8.50	2.50-5.81	3.12-5.08	1.50-7.12	3.00-3.22	2.83-5.86
	2.60-3.75	-	2.00-3.00	-	2.72-6.35	-	2.67-3.65	2.00-3.61	2.43-3.00	3.10-6.21



**Figure 1. a)** Plot showing continuous variation for the character distance between lateral and ventral carinae ( $dlvc$ ), opposite to meeting point of lateral and medial transverse carinae on S3 ( $lmt$ ). Numbers represent the following species: 1) *E. attala*, 2) *E. carmelita*, 3) *E. collocata*, 4) *E. credula*, 5) *E. haematogastra*, 6) *E. mithroides*, 7) *E. peruviana*, 8) *E. plebeja*, 9) *E. simplicicollis*, 10) *E. vesiculosa*. **b)** S1-3 *E. carmelita* males showing the measures from Williamson (1923): distance between lateral and ventral carinae ( $dlvc$ ), divided by the measure of distance between meeting point of lateral and medial transverse carinae and ventral carinae ( $lmt$ ).

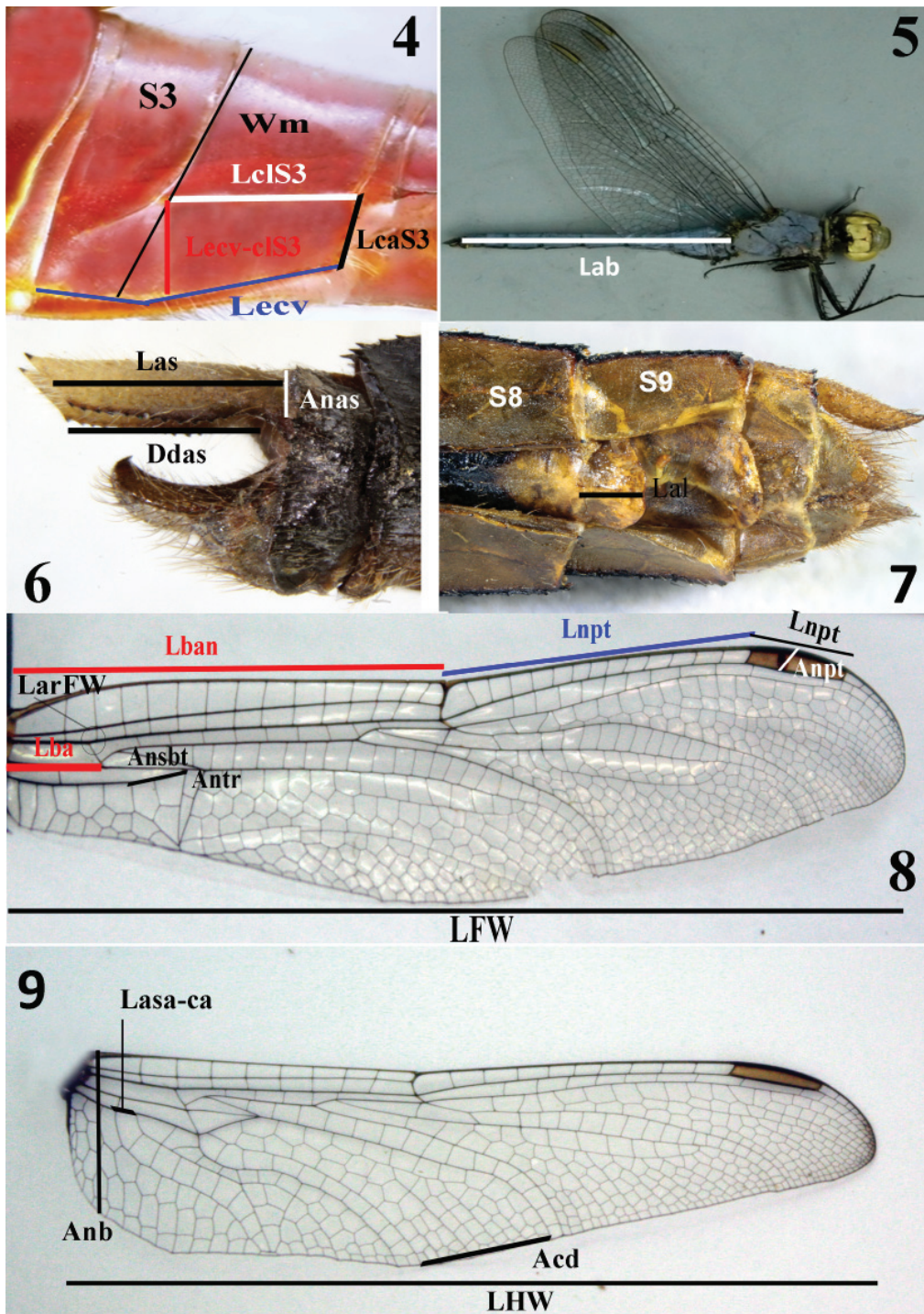


**Figure 2.** Plots of the first two discriminant functions of the discriminant analysis. **a)** The first two discriminant functions explain 72.5% in males, the cases in where species are overlapped were analyzed by separated in **b).** The first two discriminant functions explain 88.3% in males, and **c)** The first two discriminant functions explain 83.7% in F. Polygons define the limits of proposed groups.

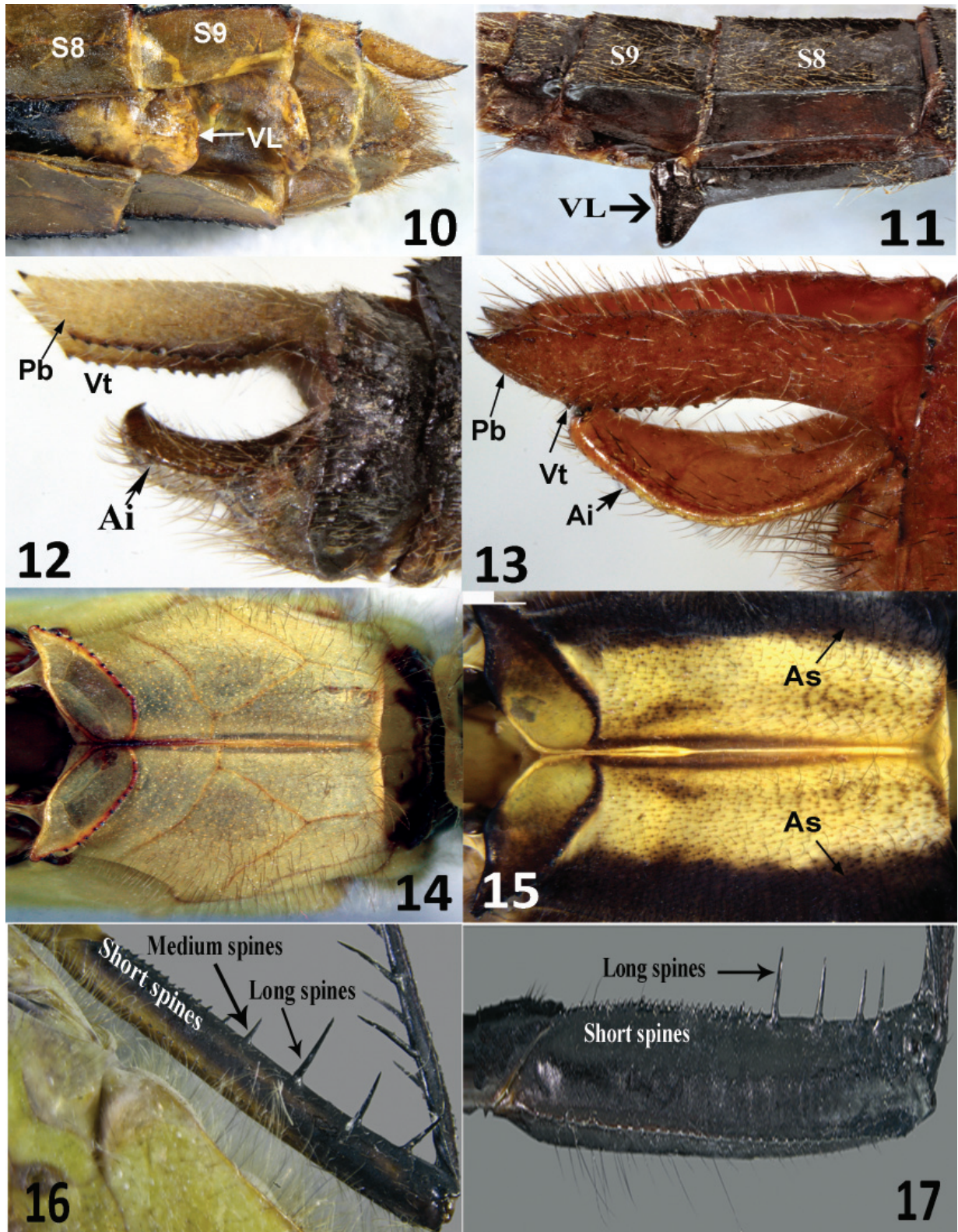


**Figure 3.** PCA diagrams for the first two factors using continuous characters as defined in the present study. **a)** Biplot shows distribution of morphological characters in M of *Erythemis*. Numbers represent the following ratio characters: 1) Lab/Lecv-clS3, 2) Lab/LcaS3, 3) LFW/Lnpt, 4) Lab/LclS3, 5) Antr/Lar, 6) Lar/Lba, 7) Acd/lban, 8) AnptHW/LoptHW, 9) Lnpt/Anb, 10) LHW/ Acd, 11) Lban/ Lasa-ca, 12) LHW/Lab, 13) Lban/Anb, 14) LHW/LFW, 15) Las/Ddas, 16) Lba/Lban, 17) LclS3/ LcaS3, 18) Lecv-clS3/LcaS3, 19) Las/Anas, 20) Lab/Las. **b)** Biplot shows distribution of morphological characters in F of *Erythemis*. Numbers represent the following ratio characters: 1) Lab/Lecv-clS3, 2) Lab/LcaS3, 3) Lab/LclS3, 4) Lab/Las, 5) LHW/Acd, 6) Lban/Anb, 7) Lecv-clS3/LcaS3, 8) Acd/lban, 9) Lar/Lba, 10) Antr/Lar, 11) LFW/Lnpt, 12) AnptHW/LoptHW, 13) LHW/Lab. See above for abbreviations.

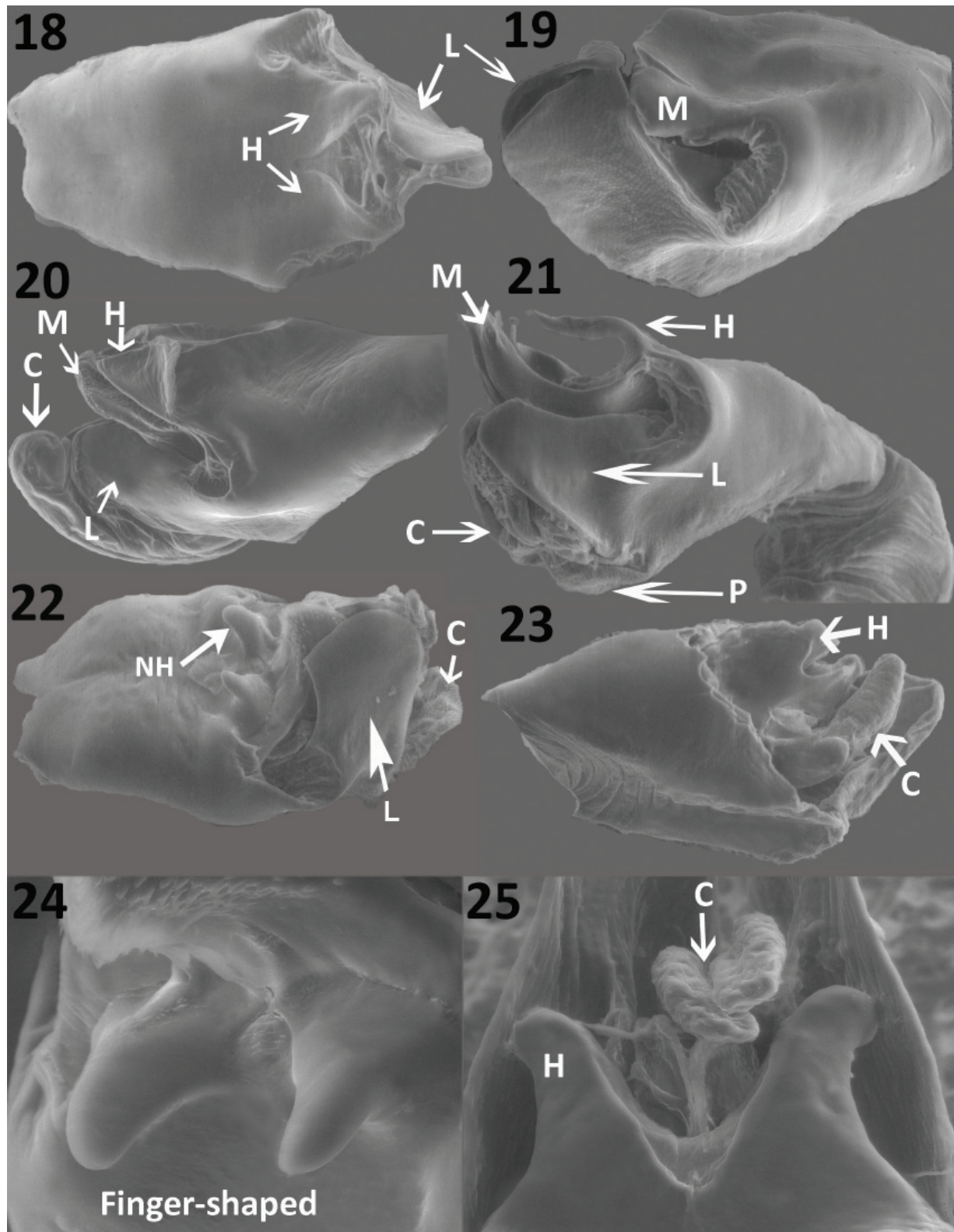




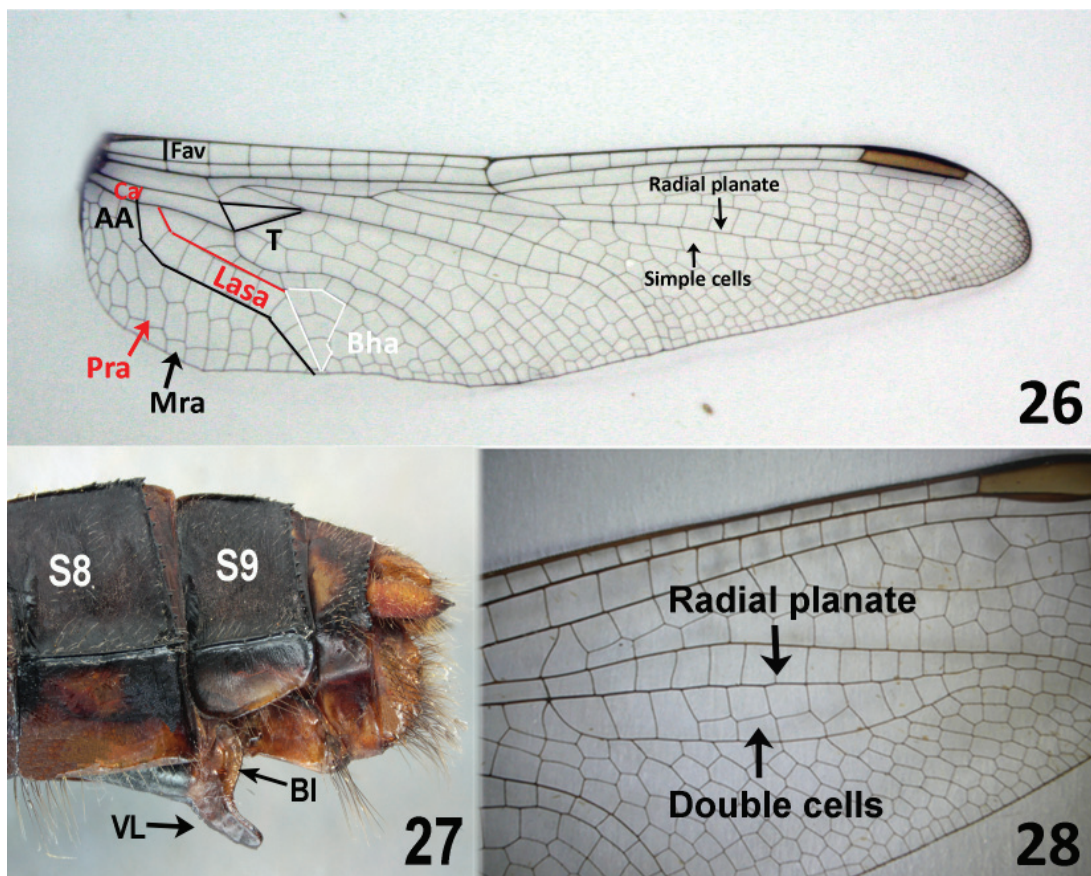
**Figures 4–9.** Morphometric characters. 4) S1-3 of *E. carmelita* male, 5-6) *E. simplicicollis* male; 7) *E. peruviana* female; 8) FW of *E. vesiculosa* male; 9) *E. simplicicollis* male. Abbreviations indicate the following characters, LFW, LHW: FW or HW length; Lnpt: Nodus-pterostigma length; Antr: Triangle width; Lar: Arculus-second antennodal length; Lba: wing base-arculus length; Lban: Wing base-nodus length; Anpt: Pterostigma width; Lopt: Pterostigma length; Ansb: Subtriangle width; Acd: HW discoidal field posterior border width; Anb: HW base width; Lasa-ca: Supplementary anal vein-Cu-A crossvein, Lab: Abdomen length; Las: Cercus length; Ddas: reach of teeth on ventral region of cercus; Anas: Anterolateral width of cercus; S<sub>3</sub>: Abdominal segment 3; LclS3: Lateral carina length; LcaS3: Apical carina length; Lecv: Ventral carina length; Lecv-clS3: Basal area between ventral-lateral carinae on S3; Wm: Width medial region of the abdominal segment; S<sub>8</sub>: Abdominal segment 8; S<sub>9</sub>: Abdominal segment 9; Lal: Female lamina length from base of basal lobe to apex.



**Figures 10–17.** Discrete characters of vulvar lamina, abdominal appendages, thorax, and femur. Numbers represent the following species: **10)** *E. peruviana* female; **11)** *E. plebeja* female; **12)** *E. simplicicollis* male; **13)** *E. mithroides* male; **14)** *E. vesiculosa* male; **15)** *E. peruviana* female; **16)** *E. vesiculosa* female, **17)** *E. attala* male. Abbreviations indicate the following characters, S<sub>8</sub>-S<sub>9</sub>: Abdominal segments 8-9; LV: Vulvar lamina; Pb: Posterior border; Vt: Teeth ventral; Ai: Inferior appendage; As: Antehumeral stripe.



**Figures 18–25.** Discrete characters of vesica spermalis. Numbers represent the following species: **18)** *E. mithroides*, dorsal view; **19)** *E. carmelita*, left side view; **20)** *E. vesiculosa*, left side view; **21)** *E. peruviana*, left side view; **22)** *E. credula*, dorsal view; **23)** *E. haematogastra*, right side view; **24)** *E. credula*, finger-shaped structures, dorsal view; **25)** *E. plebeja*, dorsal view. Abbreviations indicate the following characters, C: Cornua; L: Lateral lobe; H: Hook; P: Posterior border; M: Medial lobe; P: Posterior lobe; NH: Hook not bilobed.



**Figures 26-28.** Discrete characters of HW and vulvar lamina in **26)** *E. simplicicollis* male; **27)** *E. mithroides* female; **28)** *E. vesiculosa* male. Abbreviations indicate the following characters, AA: Anal Anterior vein; T: triangulus; Lasa: Anal supplementary; Bha: Anal bifurcation keel; Mra: Marginal row in anal field; Pra: Penultimate row in anal field; Ca: MP crossvein; Fav: First antenodal vein; S<sub>8</sub>-S<sub>9</sub>: Abdominal segments 8-9; VL: vulvar lamina; Bl: Basal lobe.

29

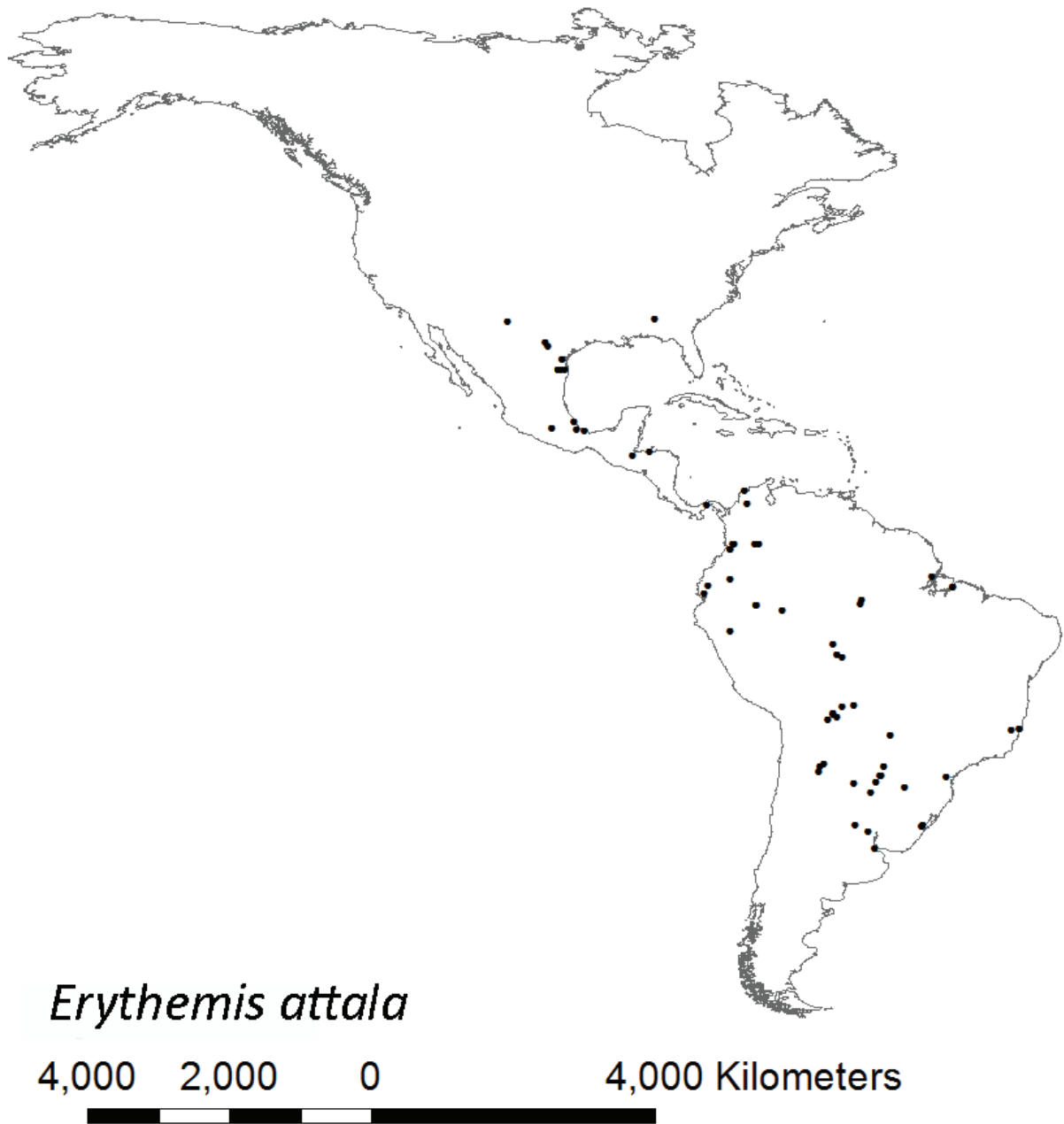


Figure 29. *Erythemis attala* distribution map.

**30**

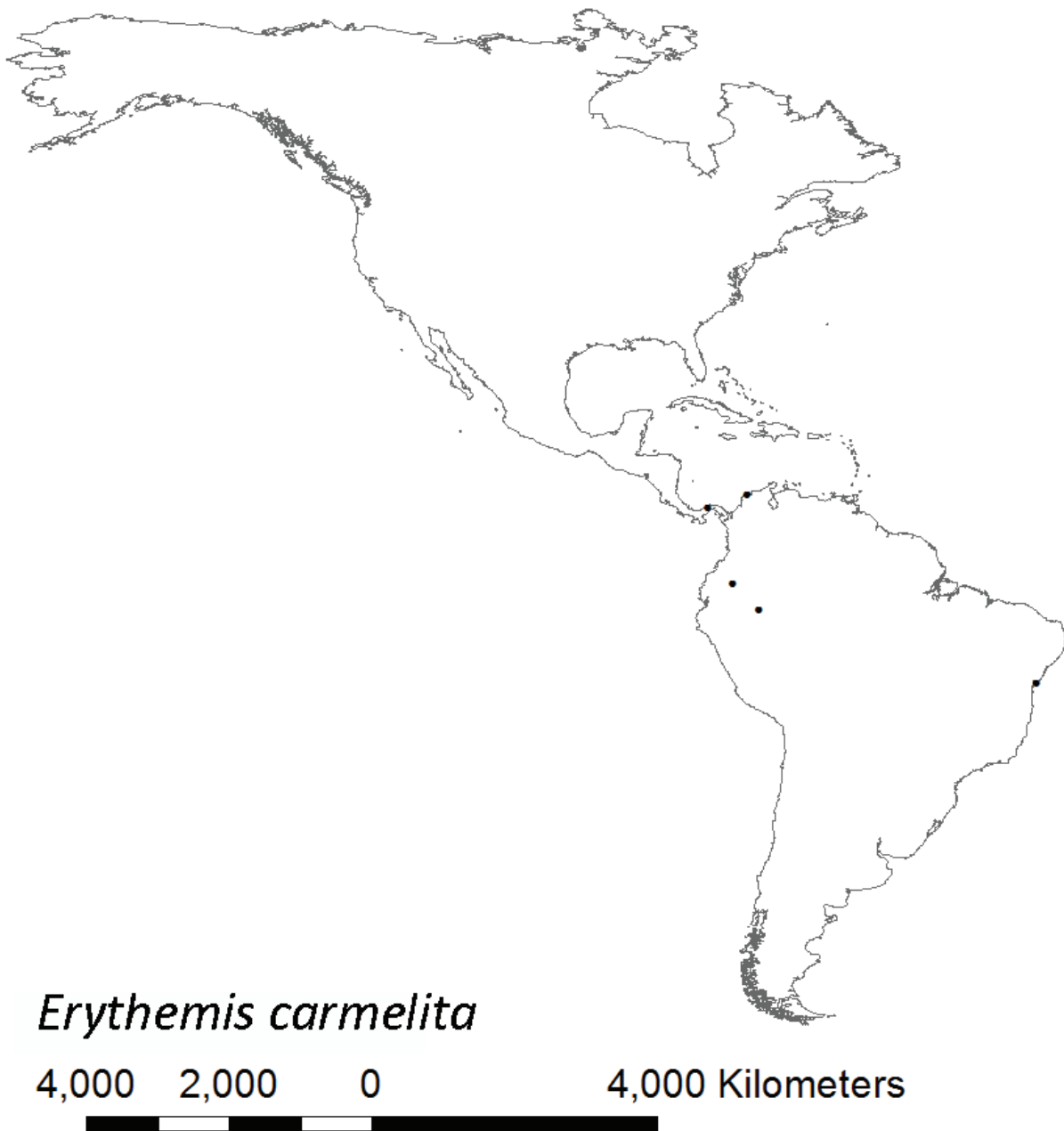


Figure 30. *Erythemis carmelita* distribution map.

**31**

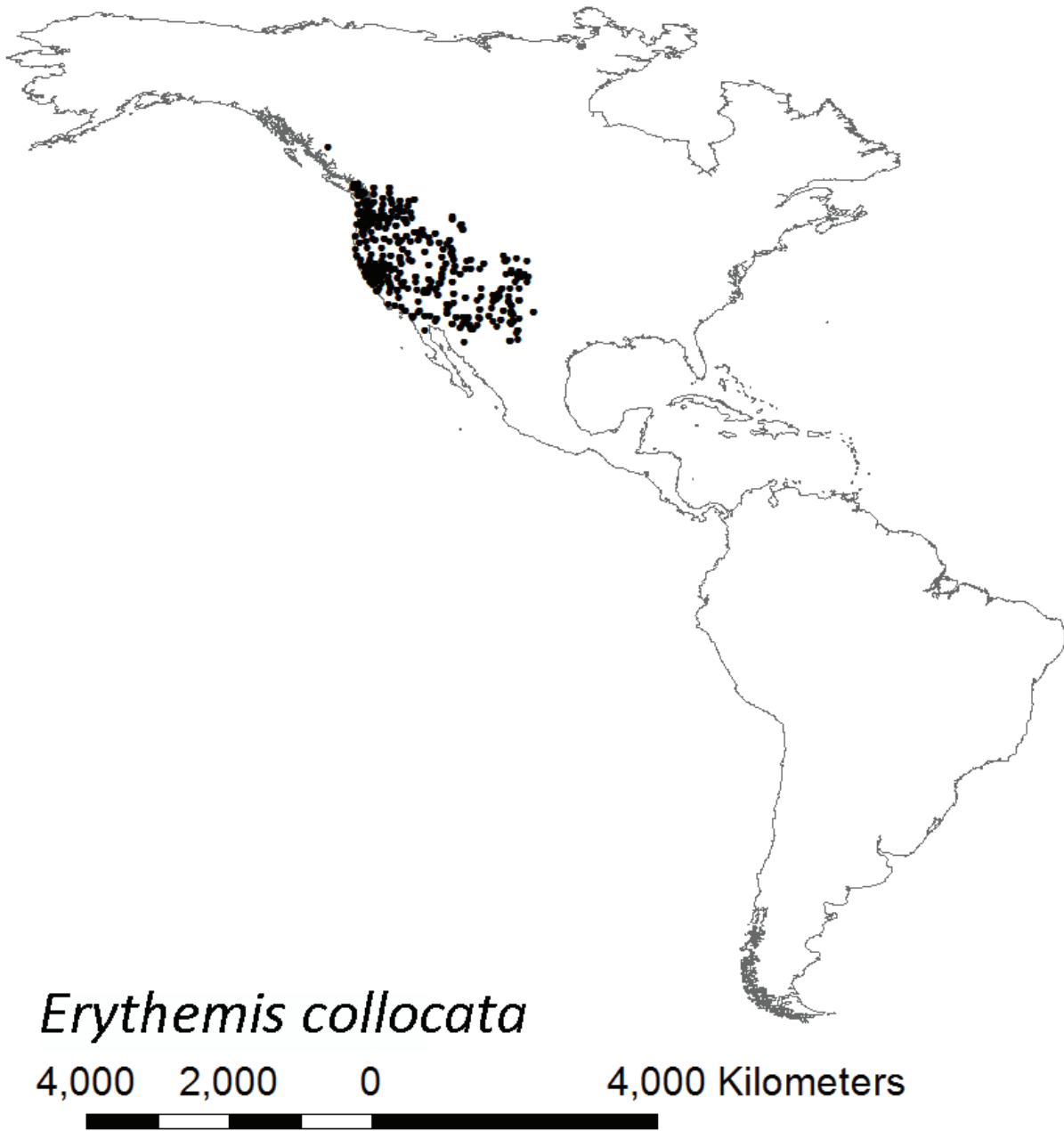


Figure 31. *Erythemis collocata* distribution map.

32

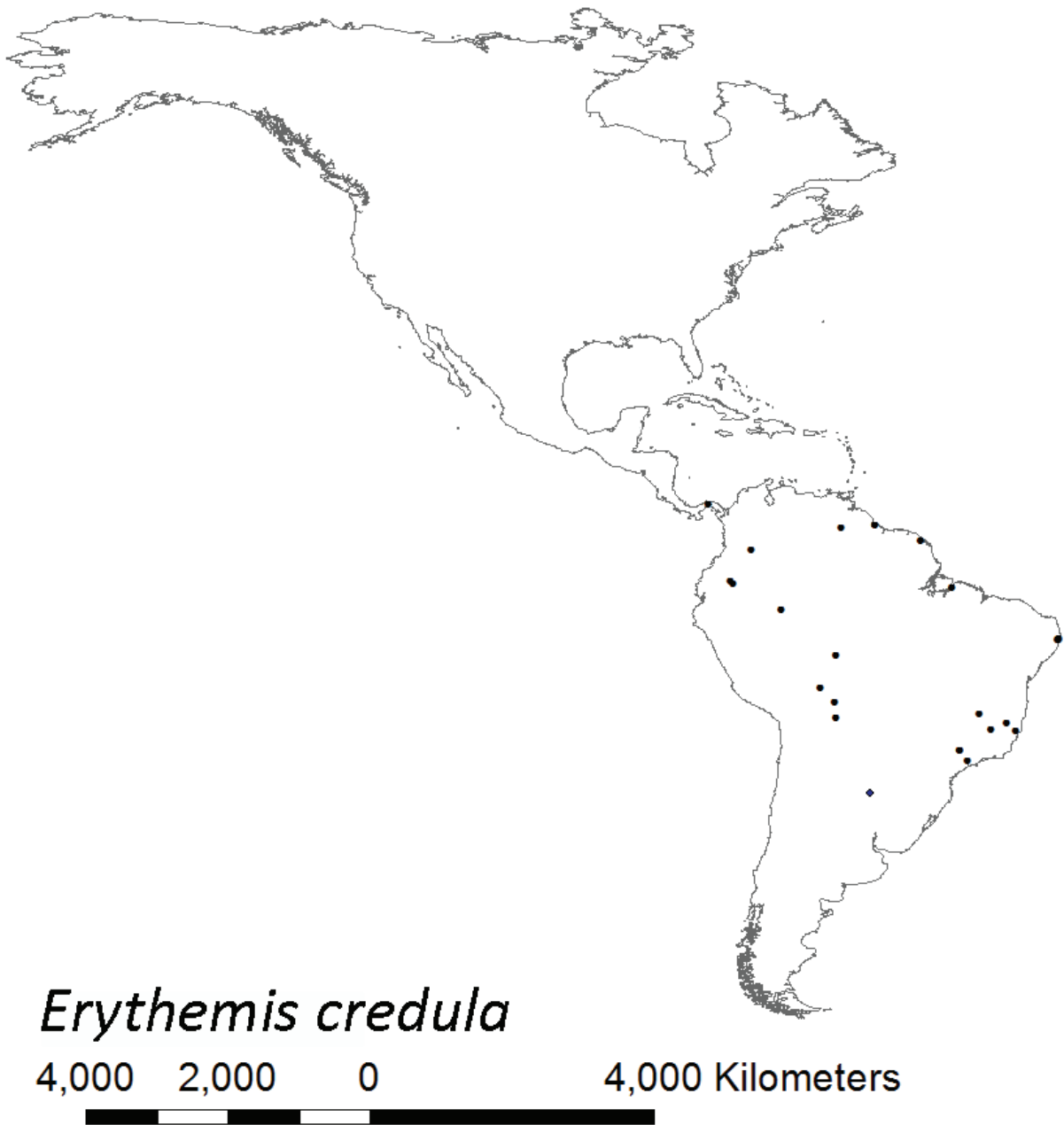


Figure 32. *Erythemis credula* distribution map.



**33**

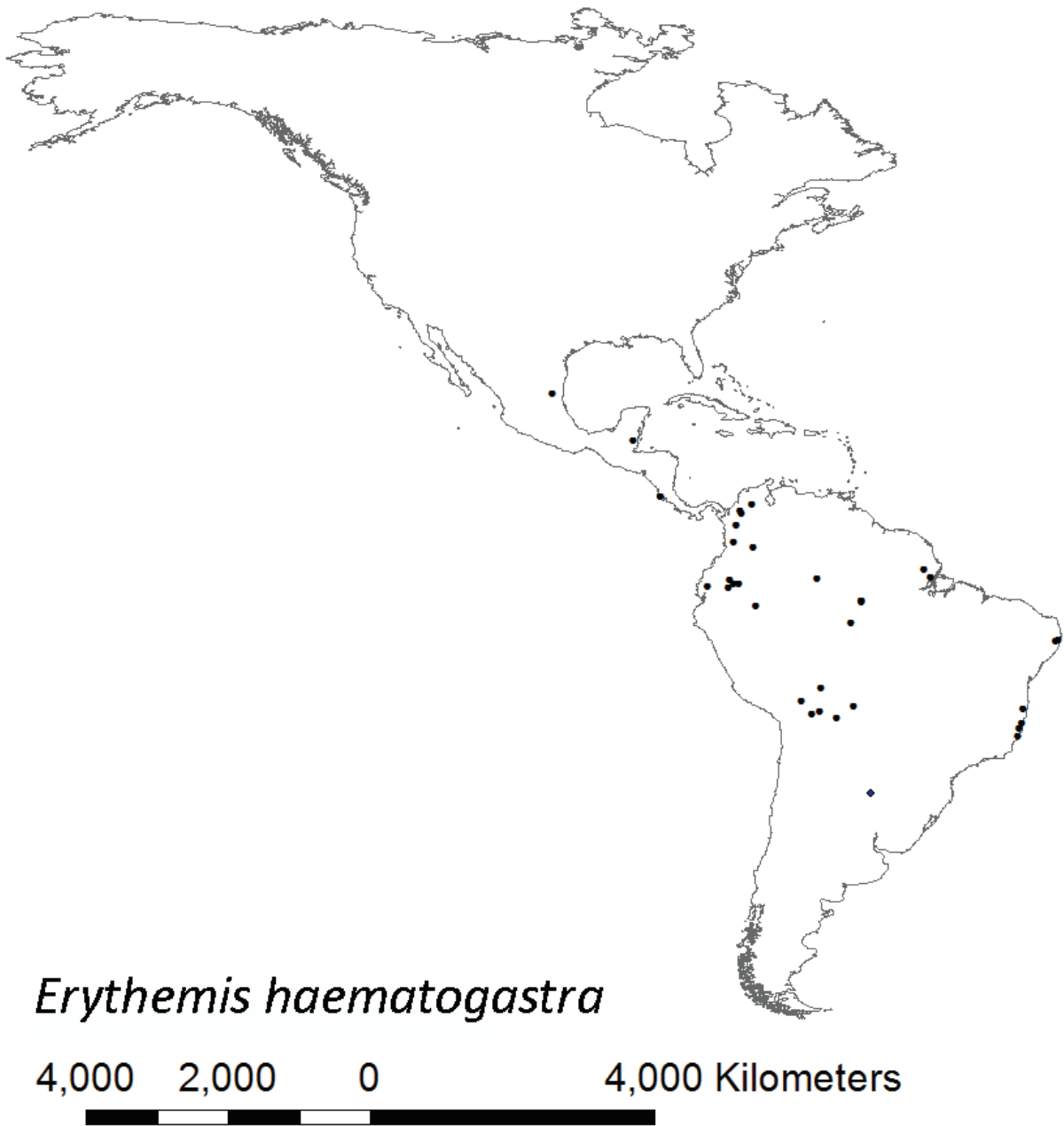


Figure 33. *Erythemis haematogastra* distribution map.

34

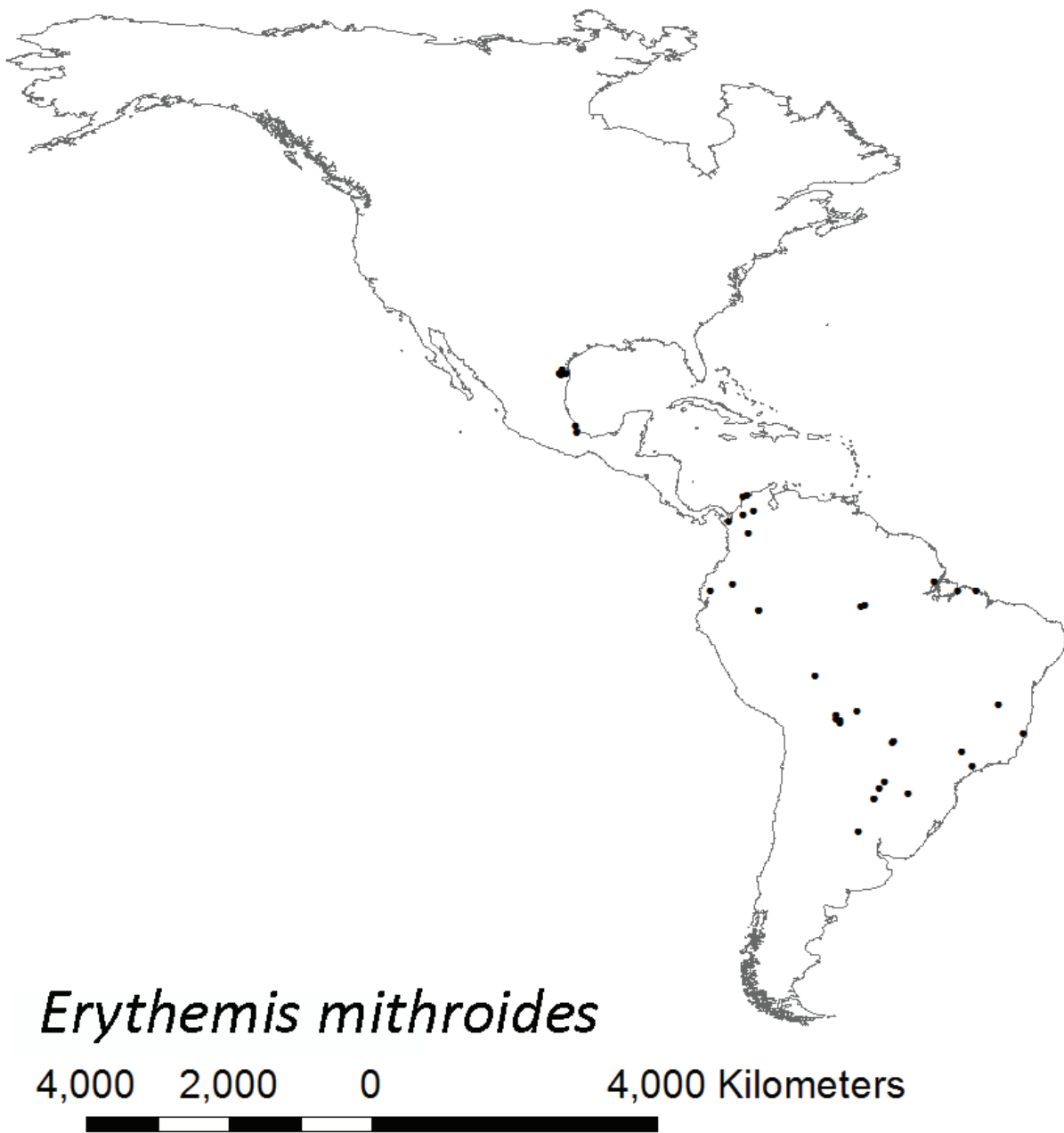


Figure 34. *Erythemis mithroides* distribution map.

35

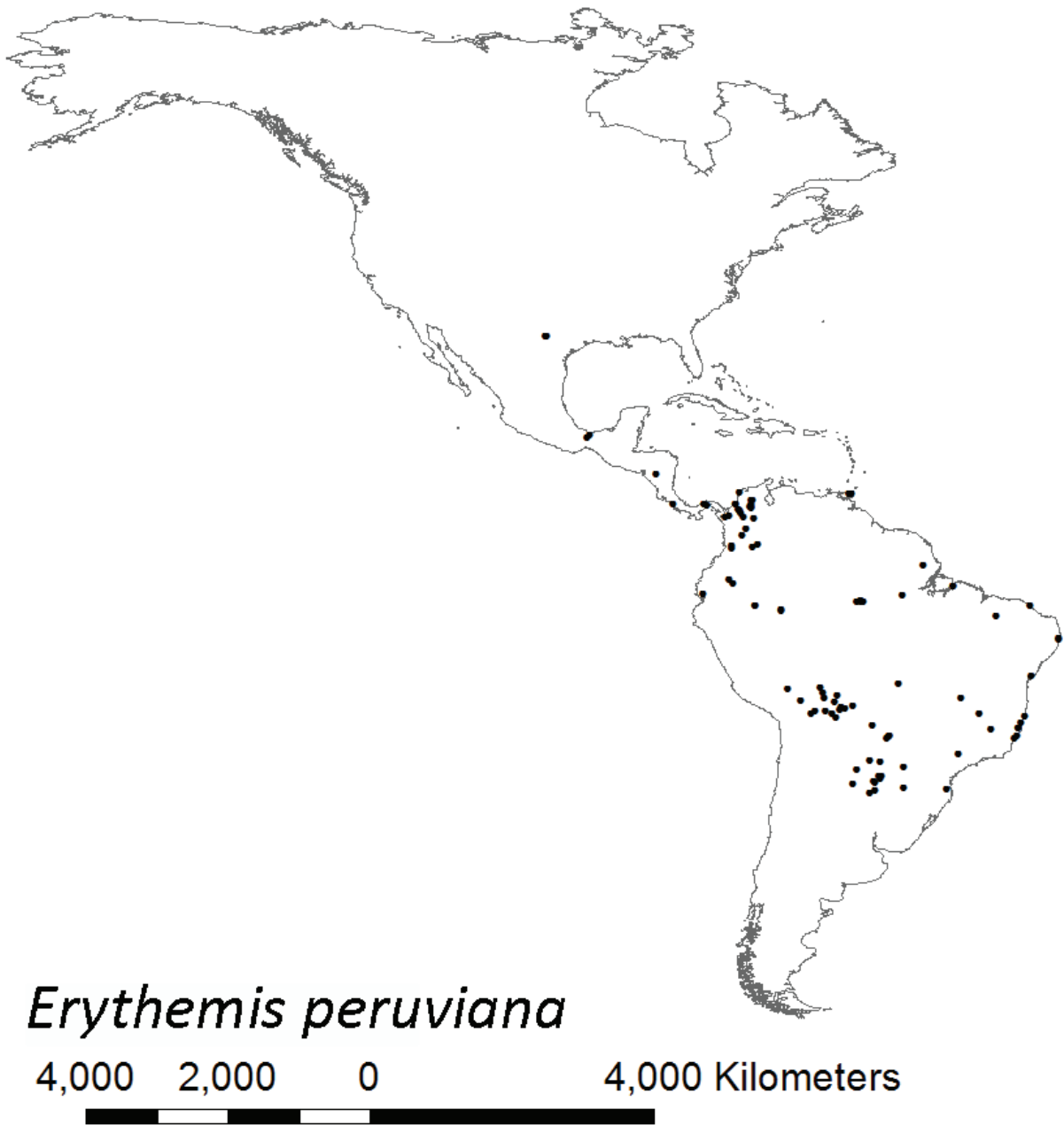
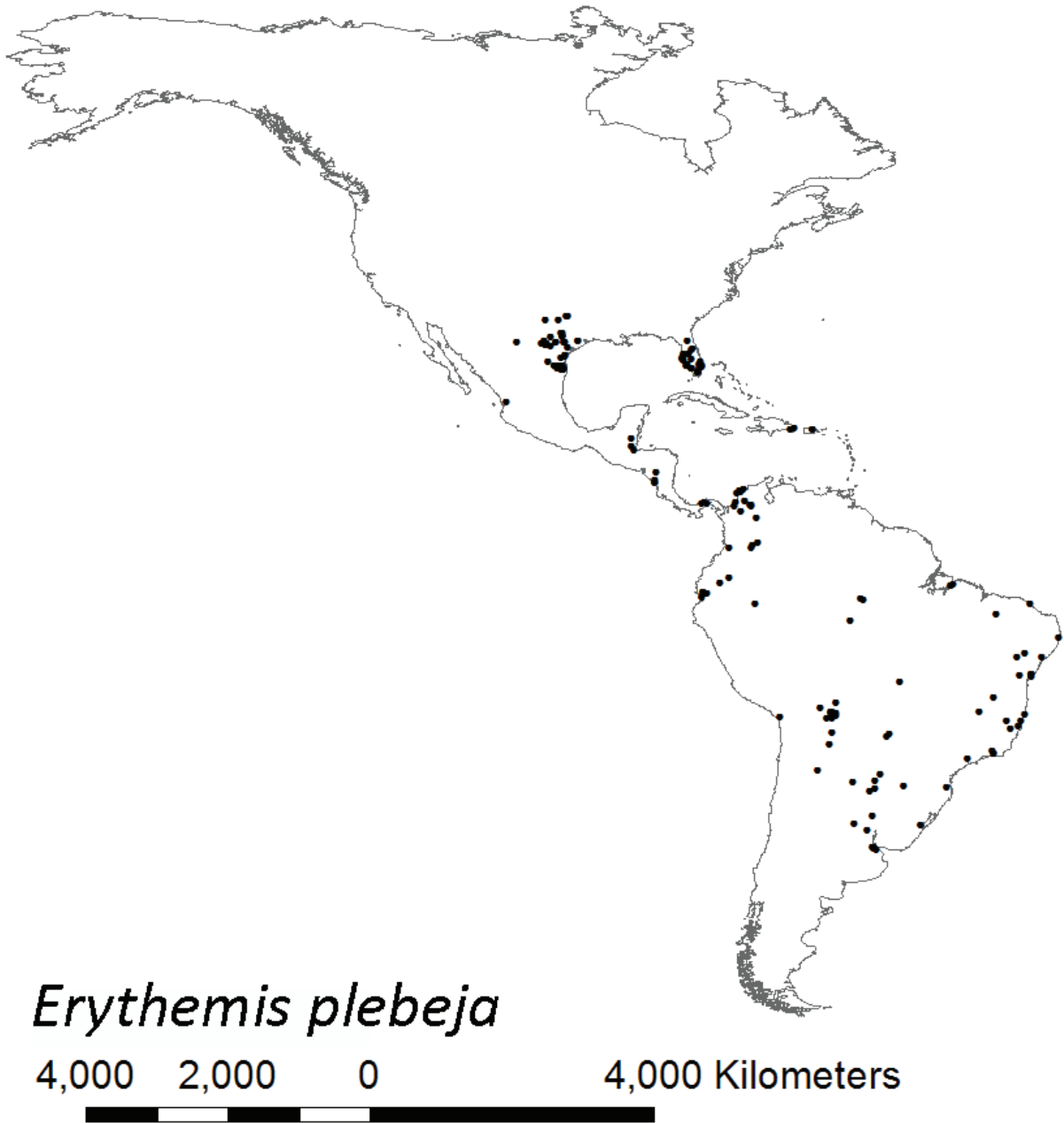


Figure 35. *Erythemis peruviana* distribution map.

36



*Erythemis plebeja*

4,000 2,000 0 4,000 Kilometers

Figure 36. *Erythemis plebeja* distribution map.

**37**

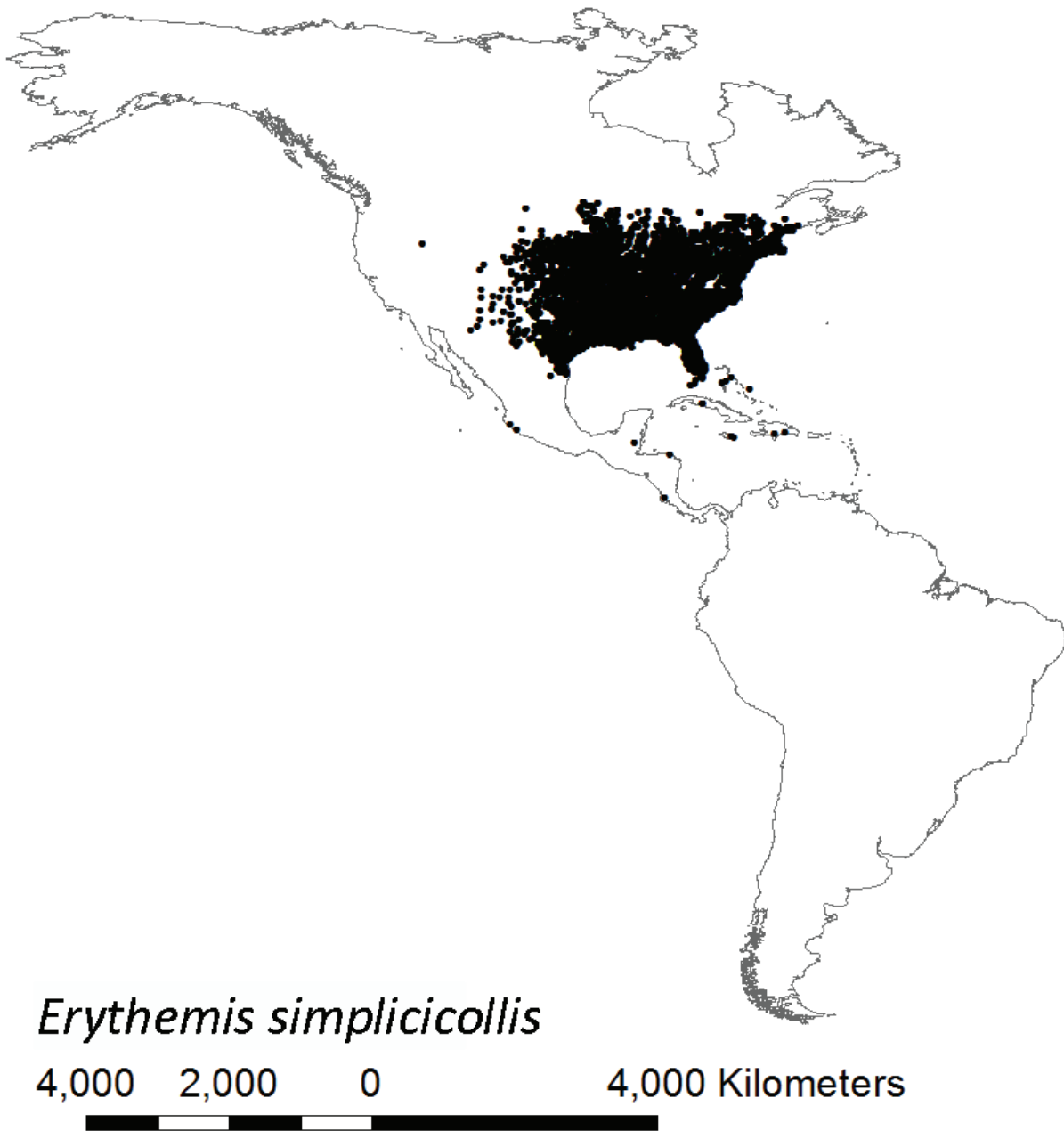
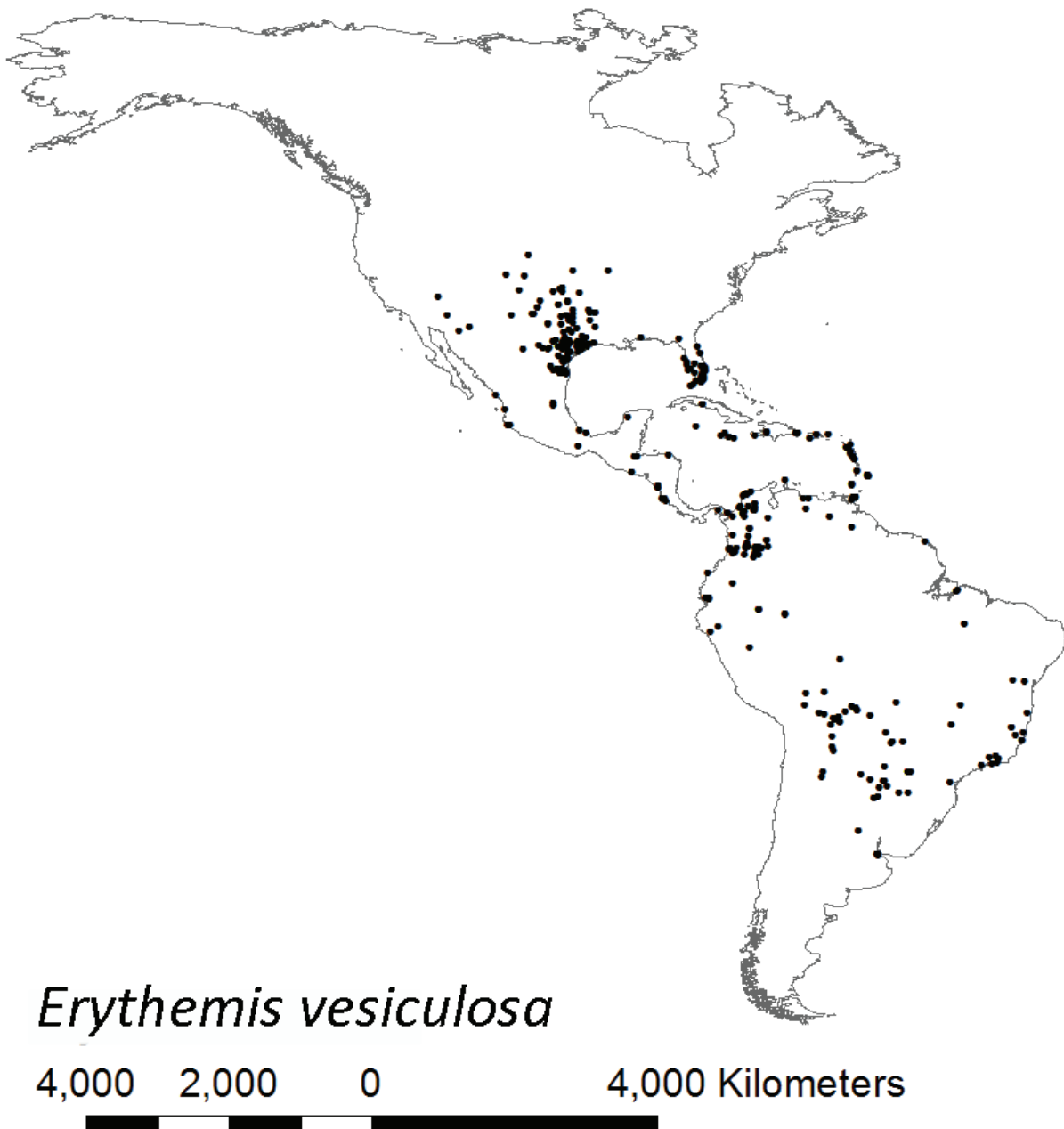


Figure 37. *Erythemis simplicicollis* distribution map.

38



*Erythemis vesiculosa*

4,000 2,000 0 4,000 Kilometers

Figure 38. *Erythemis vesiculosa* distribution map.