

Volume 12 (2) 2009
ISSN 1388-7890

IJO International Journal of Odonatology
Official Organ of the Worldwide Dragonfly Association

Philip S. Corbet memorial issue

Editors:
Reinhard Jödicke
Natalia von Ellenrieder
Frank Suhling



IJO

Five new species of *Orthemis* from South America (Odonata: Libellulidae)

Natalia von Ellenrieder

Instituto de Bio y Geo Ciencias (IBiGeo), Museo de Ciencias Naturales,
Universidad Nacional de Salta, Mendoza 2, 4400 Salta, Argentina.
<natalia.ellenrieder@gmail.com>

Key words: Odonata, dragonfly, Libellulidae, *Orthemis*, new species, Ecuador, Peru, Paraguay, Argentina.

ABSTRACT

Five new species of the *levis*-group of *Orthemis*, *O. cinnamomea* (holotype ♂ in USNM: Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, 12°50'S, 69°17'W, 300 m, 23 vii 2002, leg. D. Paulson & N. Smith), *O. coracina* (holotype ♂ in USNM: Ecuador, Sucumbíos Province, Limoncocha, 00°24'S, 76°36'W, 300 m, 23 vii 1977, leg. D. Paulson), *O. harpago* (holotype ♂ in USNM: Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, 12°30'S, 69°12'W, 300 m, 17 vi 1977, leg. D. Paulson), *O. philipi* (holotype ♂ in MLP: Argentina, Salta Province, pond at route 15 between route 5 and Las Varas, 23°21'S, 64°08'W, 392 m, 23 v 2008, leg. N. von Ellenrieder), and *O. tambopatae* (holotype ♂ in USNM: Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, 12°30'S, 69°12'W, 300 m, 16 vi 1977, leg. D. Paulson), are described, illustrated, and diagnosed. A key for all species of the *levis*-group of *Orthemis* is provided.

RESUMEN

Cinco nuevas especies del grupo-*levis* de *Orthemis*, *O. cinnamomea* (holotipo ♂ en USNM: Perú, Departamento Madre de Dios, Explorer's Inn en Río Tambopata, 12°50'S, 69°17'O, 300 m, 23 vii 2002, leg. D. Paulson & N. Smith), *O. coracina* (holotipo ♂ en USNM: Ecuador, Provincia de Sucumbíos, Limoncocha, 00°24'S, 76°36'W, 300 m, 23 vii 1977, leg. DRP), *O. harpago* (holotipo ♂ en USNM: Perú, Departamento Madre de Dios, Explorer's Inn en Río Tambopata, 12°30'S, 69°12'O, 300 m, 17 vi 1977, leg. D. Paulson), *O. philipi* (holotipo ♂ en MLP: Argentina, Provincia de Salta, charco junto a ruta 15 entre ruta 5 y Las Varas, 23°21'S, 64°08'O, 392 m, 23 v 2008, leg. N. von Ellenrieder) y *O. tambopatae* (holotipo ♂ en USNM: Perú, Departamento Madre de Dios, Explorer's Inn en Río Tambopata, 12°30'S, 69°12'O, 300 m, 16 vi 1977, leg. D. Paulson), son descritas, ilustradas y diagnosticadas. Se provee una clave para todas las especies del grupo-*levis* de *Orthemis*.

INTRODUCTION

Orthemis Hagen, 1861, comprises 18 species primarily neotropical in distribution. Ris (1910) provided the first and only revision of *Orthemis* including 13 species. Five species were subsequently described (Ris 1919; Buchholz 1950; De Marmels 1989), one was synonymized (Garrison & von Ellenrieder 2004) and another originally described as subspecies was elevated to species status (Meurgey & Daigle 2007). Garrison et al. (2006) diagnosed the genus documenting its distribution from southern USA to central Argentina. Heckman (2006) keyed the South American species based almost exclusively on color characters taken from original descriptions which vary intraspecifically rendering his key unreliable.

Following Calvert (1906), Buchholz (1950) divided *Orthemis* into two groups; the *ferruginea*-group, including the type species *O. ferruginea* (Fabricius, 1775), and the *levis*-group. He characterized the first by a wide and depressed abdomen and smaller male hamule, and the second by a distally narrow abdomen and larger male hamule. Names assigned to specimens of the *ferruginea*-group have been particularly difficult to associate with species, and number of species included within this complex is not resolved (De Marmels 1988; Donnelly 1995; Paulson 1998, 2001; Meurgey & Daigle 2007).

On a recent trip to the arid Chaco forest of Salta province, Argentina, I collected specimens of an *Orthemis* species fitting within the *levis*-group, characterized by a peculiar marbled thoracic pattern and entirely orange-red abdominal dorsum, which keyed with *O. cultriformis* Calvert, 1899 in Ris' (1910) key but represented a new species. Another four new species from Ecuador and Peru were found among specimens kindly lent to me by Dennis R. Paulson. By the combination of Fw sectors of arculus stalked, Fw last Ax complete, Fw discoidal field approximately parallel sided, long Pt, posterior lobe of prothorax widest at base and bent caudally, and posterior hamule bifid these species fit well within the generic definition of *Orthemis* (Garrison et al. 2006); here I describe them and provide a key to all species of the *levis*-group.

MATERIAL AND METHODS

Nomenclature for wing venation follows Riek & Kukalová-Peck (1984) and for thorax Westfall & May (2006). Measurements are given in millimeters; Pt length was measured along costal side, S4 length at level of latero-ventral carina, S4 width at level of transverse carina (Fig. 6b), and female cercus and epiproct length along main longitudinal axis (Fig. 19). Drawings were made with the aid of a camera lucida coupled to a Wild M8 stereomicroscope and are not to scale unless indicated. Wings were scanned from specimens. Maps represent distribution records from collections and reliable literature records, and were created electronically from the Digital Chart of the World (1:1,000,000) using ArcView 9.1; longitude/latitude coordinates were culled from the Global Gazetteer website <<http://www.fallingrain.com/world/>>. Diagnoses for new species are in reference to other species of the *levis*-group.

Acronyms for collectors and collections are as follows:

- ANSP – Academy of Natural Sciences, Philadelphia, USA
 CMNH – Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA
 DRP – Dennis R. Paulson collection, Seattle, Washington, USA
 MLP – Departamento Científico Entomología, Museo de La Plata, Argentina
 NE – Natalia von Ellenrieder collection, Salta, Argentina
 RWG – Rosser W. Garrison collection, Sacramento, California, USA
 USNM – National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA

Specimens examined

Identification based on Ris (1910, 1919), Buchholz (1955), and De Marmels (1988, 1989). — *Orthemis aequilibris* Calvert, 1909: Brazil, Amazonas State: 1 ♂ (red form), Manaus, 20 vii 1922, leg. J.H. Williamson & J.W. Strohm (RWG); Venezuela, Barinas State: 1 ♀ (red form), swamp ca 25 km S of Barinas, 31 viii 1978, leg. DRP (RWG). — *O. ambinigra* Calvert, 1909: Argentina, Buenos Aires Province: 2 ♂, Punta Lara, selva, 23 i 1997, leg. NE (NE); 1 ♀, San Fernando, Otamendi, camping Cielo, 08 i 1999, leg. NE & J. Muzón (NE); Salta Province: 1 ♂, unnamed stream 20 km SE of Isla de Cañas, 22 v 2008, leg. NE (NE). — *O. ambirufa* Calvert, 1909: French Guiana: 1 ♂, small canal 17 km S of Tonate, 18 ii 1998, leg. RWG (RWG). — *O. anthracina* De Marmels, 1989: Panama, Panama Province: 1 ♂, trail at milepost 12, by Gaillard highway, 7.4 km SE of Gamboa, 08 iii 1979, leg. J.A. Garrison & RWG (RWG). — *O. attenuata* (Erichson, 1848): Colombia, Magdalena Department: 1 ♀, Fundación, 13 i 1917, leg. J.H. & E.B. Williamson (RWG); Brazil, Rondônia State: 1 ♂, stream 7 km SE of Caucalandia, ca 70 km SW of Ariquemes; Pará State: 1 ♂, Rio Iri Camp, ca 100 km S of Altamira, 17 x 1986, leg. P. Spangler & O.S. Flint Jr. (RWG); Peru: Loreto Department: 1 ♂, Quebrada Sucusari at Explor-Napo Camp, Río Sucusari, NE of Iquitos, 09 iii 1992, leg. P. Donahue (DRP); 1 ♀, Yarinacocha, forest trail, 14 viii 1972, leg. D.L. Pearson (DRP). — *O. biolleyi* Calvert, 1906: Brazil, Rondônia State: 1 ♂, Fazenda Rancho Grande, 62 km SW of Ariquemes, 02/11 xi 1989, leg. RWG (NE). — *O. cinnamomea* sp. nov.: see under description. — *O. concolor* Ris, 1919: French Guiana, de la Guyane Department: 1 ♂, Cacao, 31 viii 2001, leg. P. Johnson (RWG); Trinidad, St. Andrew County: 1 ♂, Aripo Savanna, 04 v 1988, leg. S.W. Dunkle (RWG). — *O. coracina* sp. nov.: see under description. — *O. cultriformis* Calvert, 1899: Trinidad, St. Andrew County: 1 ♂, 1 ♀, Aripo Savanna, 04 v 1988, leg. S.W. Dunkle (RWG); St. George County: 1 ♂, forest and small stream along Indian Walk Ride trail off main road, 3 km N of Cumuto, 07 iv 1980, leg. J.A. Garrison & RWG (RWG); Peru, Madre de Dios Department: 1 ♂, Manu, Pakitza, trail 1, 09 ix 1988, leg. O.S. Flint Jr. (NE); Loreto Department: 1 ♂, Explorama Inn, on Amazon River 40 km E of Iquitos, 09 viii 1992, leg. S.W. Dunkle (NE); Brazil, Rio de Janeiro: 1 ♂, Cachoeira de Macacú, Santana de Japuíba, Rio São João, 12 xi 2000, leg. RWG (RWG). — *O. discolor* (Burmeister, 1839): Brazil, Rondônia State: 2 ♂, 1 ♀, Fazenda Rancho Grande, 62 km SW of Ariquemes, 02/11 xi 1989, leg. RWG (NE); Argentina, Salta Province: 1 ♂, unnamed stream 20 km SE of Isla de Cañas, 26 viii 2008, leg. NE & RWG (NE); 1 ♂, same but 22 v 2008, leg. NE (NE); 1 ♂, Río Anta Muerta, 22 v 2008, leg. NE (NE); 1 ♂,

pond 1 km E of Embarcación, on road to Misión Chaqueña, 23 v 2008, leg. NE (NE); 2 ♂, 2 ♀, Chicoana, Quebrada de Tilián, pond, 06 xii 2006, leg. NE & F. Lozano (NE); Jujuy Province: 1 ♂, Arroyo Yuto, 20 iii 2006, leg. NE & RWG (NE). — *O. ferruginea* (Fabricius, 1775): USA, Arizona State: 1 ♂, Salt River at 51st. Avenue, Phoenix, 12 viii 1968, leg. RWG (NE); 1 ♂, Gila River at highway 95, NW of Yuma, 25 viii 2002, leg. NE (NE); Texas State: 2 ♂, Nueces river, 14 vii 2001, leg. NE (NE); 1 ♀, Guadalupe River, 6.5 km S of Gonzales, 30 vi 1975, leg. J.E. Hafernik Jr. (NE). — *O. flavopicta* Kirby, 1889: Panama, Panama province: 1 ♂, 7 km NW of Gamboa, Pipeline rd., trail nr. palm forest, 30 vii 1979, leg. J.A. Garrison & RWG (RWG); 1 ♂, 6 km E of Pacora, Hacienda San José, 29 viii 1972, leg. M. Perrone (DRP). — *O. harpago* sp. nov.: see under description. — *O. levis* Calvert, 1906: Costa Rica, Guanacaste Province: 1 ♂, Hacienda Taboga, 06 vii 1966, leg. DRP (RWG); Venezuela, Carabobo State: 1 ♀, San Esteban, leg. J.H., E.B. Williamson & W.H. Ditzler (RWG). — *O. philipi* sp. nov.: see under description. — *O. plaumanni* Buchholz, 1950: Peru, Madre de Dios Department: 1 ♂, 1 ♀, Tambopata Nature Reserve, 30 km SW of Puerto Maldonado, 20/22 xii 1986, leg. P.K. Donahue (DRP). — *O. nodiplaga* Karsch, 1891: Argentina, Buenos Aires Province: 1 ♂, Punta Lara, selva, 23 i 1997, leg. NE (NE); Corrientes Province: 1 ♂, 1 ♀, Pariopá stream and swamps, on road 94, ca 12 km N of Santo Tomé (NE); Salta Province: 1 ♂, pond 1 km E of Embarcación, on road to Misión Chaqueña, 25 viii 2008, leg. RWG & NE (NE); 1 ♂, 1 ♀, in copula, slough by provincial road 5, 01 xii 2007, leg. NE (NE); 1 ♀, Chicoana, Quebrada de Tilián, pond, 06 xii 2006, leg. NE & F. Lozano (NE); San Carlos, irrigation pond, 04 i 1999, leg. NE (NE). — *O. schmidti*: Ecuador, Napo Province: 1 ♂, 3.2 km E Tena rd. on Jatun Sacha Biological rd., sloughs along Napo River, 23 vii 1996, leg. S.W. Dunkle (NE). — *O. tambopatae* sp. nov.: see under description.

RESULTS

The groups of *Orthemis*

Ris (1910) attributed great importance to the presence of a second bridge crossvein and a second crossvein in Hw CuA space in *O. regalis* Ris, 1910 and even considered the possibility of creating a separate genus for it because of that. Buchholz (1950) reported the presence of a second crossvein in CuA space in one Hw of his type of *O. schmidti*, and of a second bridge crossvein in his type series of *O. plaumanni*. Both venational character states appear in at least some wings of the type series of *O. philipi*, and a second bridge crossvein in one wing of a paratype of *O. tambopatae*, both of which do not differ otherwise from a typical *Orthemis*. Therefore I do not consider these venational characters as informative regarding relationships within the genus. Buchholz (1950) stated that the hamule was smaller in species of the *ferruginea*-group versus larger in species of the *levis*-group, but I observed no consistent differences in hamule size between these two groups. Based on additional material studied here, I propose to redefine Calvert's (1906) two groups as follows:

Ferruginea-group: Abdomen robust and depressed with S4 shorter than $\frac{2}{3}$ of its width (S4 as long as 0.69-1.15 of its width measured at level of transverse carina, Figs 6a, b) and female cerci shorter than two times epiproct length (Fig. 19a); includes *O. aequilibris*, *O. biolleyi*, *O. discolor*, *O. ferruginea*, *O. macrostigma* (Rambur, 1842), *O. nodiplaga*, *O. schmidtii*, and *O. sulphurata* Hagen, 1868. For species diagnoses see De Marmels 1988 and Meurgey & Daigle 2007.

Levis-group: Abdomen slender with S4 longer than $\frac{2}{3}$ of its width (S4 as long as 0.19-0.62 of its width measured at level of transverse carina, Figs 6c-f); female cerci longer than two times epiproct length (Figs 19b, c); includes *O. ambinigra*, *O. ambirufa*, *O. anthracina*, *O. attenuata*, *O. cinnamomea*, *O. concolor*, *O. coracina*, *O. cultriformis*, *O. flavopicta*, *O. harpago*, *O. levis*, *O. philipi*, *O. plaumanni*, *O. regalis*, and *O. tambopatae*.

Lectotype designation for *O. cultriformis*

The most common and widespread species of the *levis*-group is probably *O. cultriformis* (Fig. 21) examples of which can be found in almost any collection of neotropical dragonflies. Because it can vary in size and coloration, and because of its similarity with some species documented here, I deemed it necessary to associate and confirm examined material with type material representing this name. The original description of *O. cultriformis* was based on one male deposited at ANSP, one male deposited at MCZ, and one male and one female of unknown depository (Calvert 1899). In order to distinguish the new species from *O. cultriformis*, descriptions were compared to the syntype male of *O. cultriformis* at ANSP lent to RWG, and RWG kindly illustrated its diagnostic structures. Hereby I designate the male specimen at ANSP depicted by Calvert (1899: 32, fig. 4) and here in Figs 2e, 8i, 9h, 14h, 15h as lectotype of *O. cultriformis*. Type labels accompanying lectotype are as follows (handwriting in italics): [*S. Pedro, Paraguay.*] [*Orthemis TYPE/ cultriformis Calv./ orig. of fig. 4, p. 31/ An. Mus. Nac. Buen. Aires VII 1899*] [*Orthemis/ cultriformis type/ (fig. made/ from this)/ 2 abd. segs lost*] [*Type 9265/ Orthemis/ cultriformis/ Calvert*].

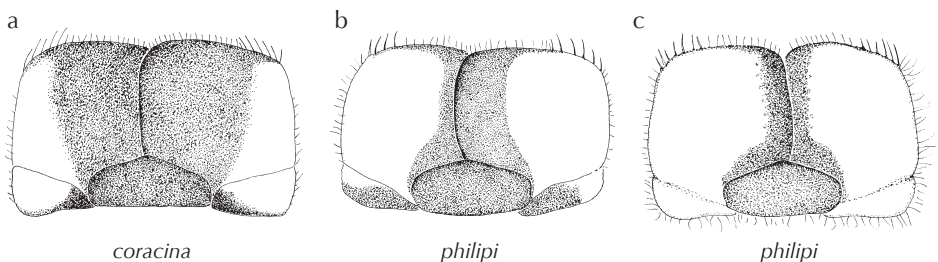


Figure 1: Labium, ventral view — (a) *Orthemis coracina*, holotype; (b) *O. philipi*, holotype; (c) *O. philipi*, paratype.

Orthemis cinnamomea sp. nov.

Figs 2b, c, 4a, 8e, 9e, 11b, 12a, 13a, 14e, 15e, 16, 17e, 18c, 19b, 22, Pl. VIII

Orthemis concolor Ris, 1919 — Paulson (1985: 13, record from Tambopata, Peru).

Etymology

From Latin *cinnamomeus* (of cinnamon), referring to the predominant reddish brown color of frons and thorax.

Type specimens

Total 3 ♂, 4 ♀. — Holotype ♂: Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, 39 km SW Puerto Maldonado, main trail (12°50'18"S, 69°17'59"W, 300 m), 23 vii 2002, leg. DRP & N. Smith (USNM); paratypes: 1 ♀, same data as holotype but muddy stream, 26 vii 2002 (DRP); 1 ♀, same but 20 viii 1978, leg. P.K. Donahue (RWG); 1 ♀, Peru, Loreto Department, Yarinacocha, forest trail (8°17'S, 74°37'W, 145 m), 11 viii 1972, leg. D.L. Pearson (DRP); 1 ♂, 1 ♀, Ecuador, Sucumbíos Province, Limoncocha, lake edge (0°24'S, 76°36'W, 300 m), 13-16 i 1972, leg. D.L. Pearson (DRP); 1 ♂, same but 20 ii 1972 (RWG).

Male holotype

Head: Labium black, with palps pale yellow with a medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black; labrum reddish brown with free margin narrowly margined with black; base of mandibles yellow; lateral portion of clypeus along eyes pale yellow, remainder of clypeus pale reddish brown; basal portion of antefrons pale reddish brown, dorsal portion of antefrons, postfrons, occipital triangle, and rear of head reddish brown lacking metallic reflections; vertex dark reddish brown. Postfrons with wide-shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax: Prothorax reddish brown except pale yellow medial portion of anterior lobe. Pterothorax reddish brown with pale yellow stripes as follows: an ill-defined diffuse narrow stripe lateral to medio-dorsal carina, a wider ill-defined diffuse stripe at mid-width, and a narrow and short ill-defined diffuse stripe along mesepisternal-mesepimeral suture; mesepimeron with a well defined wide stripe along posterior half narrowing dorsally; metepisternum with a narrow stripe along ventral margin and another sinuous one ventrally to metastigma; metepimeron with antero-ventral corner yellow, a stripe along posterior half, and a triangular spot on antero-dorsal corner; venter of pterothorax pale yellow with an elongate reddish brown spot on each side (Fig. 2b, Pl. VIIIb). — Legs black with coxa and trochanter and basal 0.50 of extensor surface of pro- and mesofemur reddish brown; metafemur armed with 19 (right) to 21 (left) short spurs followed distally by one longer spur. — Wings hyaline with small amber spots at base not surpassing level of first row of anal cells. Hw extending to mid-length of S4; one cubito-anal crossvein in Fw and Hw; arculus opposite to Ax2 in Fw, distal to Ax2 in Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 4 cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 7 (right) or 5 (left)

rows at hind margin, Hw with 3 at base, then 2, then increasing to 14 (right) or 15 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 26 (right) to 29 (left) cells. Pt dark reddish brown, 4.75 long in Fw and 4.5 in Hw, overlying 5-6 cells in Fw and Hw. Ax: 18 (right) and 17 (left) in Fw; 14 (right) and 13 (left) in Hw; Px: 12 (right) and 14 (left) in Fw; 15 in Hw.

Abdomen: Parallel-sided in ventral view, S4 almost three times as long as wide (ratio width/ length = 0.3). Dark reddish brown except latero-ventral margins of S1-3 pale greenish yellow, narrow longitudinal orange stripes medio-dorsally on S1-7 and both dorsally and ventrally to latero-ventral carinae on S3-7 (Fig. 4a, Pl. VIIIb). Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Fig. 9e);

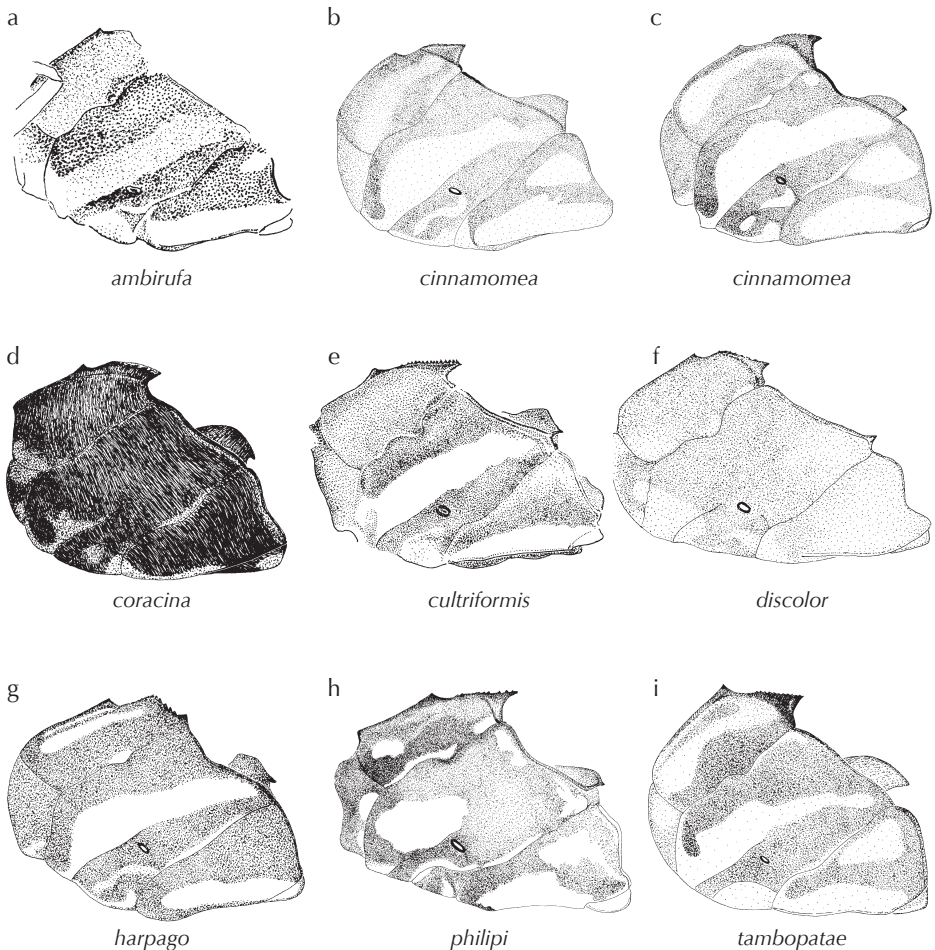


Figure 2: Pterothorax, lateral view — (a) *Orthemis ambirufa*, holotype; (b) *O. cinnamomea*, holotype; (c) *O. cinnamomea*, female paratype; (d) *O. coracina*, holotype; (e) *O. cultriformis*, lectotype; (f) *O. discolor*, male, Argentina, SE of Isla de Cañas; (g) *O. harpago*, holotype; (h) *O. philipi*, paratype; (i) *O. tambopatae*, holotype. Figures 2a, e by Rosser Garrison.

hamule bifid with small inner branch forming a short pointed spine, and larger outer branch bent ventrally over inner branch with blunt tip; outer corner of outer branch smoothly rounded (rc, Fig. 8e). Distal segment of vesica spermalis with basal portion trapezoidal in ventral view (as in Fig. 12a), with distal lobes represented on each side by a medio-ventral semicircular membranous lobe with a sclerotized lateral projection margined with denticles, and an elongate dorso-distal lobe approximately rectangular in lateral view, about as long as basal portion, with a flagellum on dorsal surface (as in Figs 11b, 12a). Cercus markedly curved ventrally in lateral view, with tip upturned, with a row of 8-6 low rounded tubercles at base and a row of 6-4 larger ones at distal 0.50 (Fig. 14e); in dorsal view converging along basal 0.70 with opposite cercus to then run approximately parallel to it along distal 0.30 (Fig. 13a). Epiproct extending to 0.83 of cerci length, with apex entire and about as wide as 0.50 of basal width (Fig. 15e).

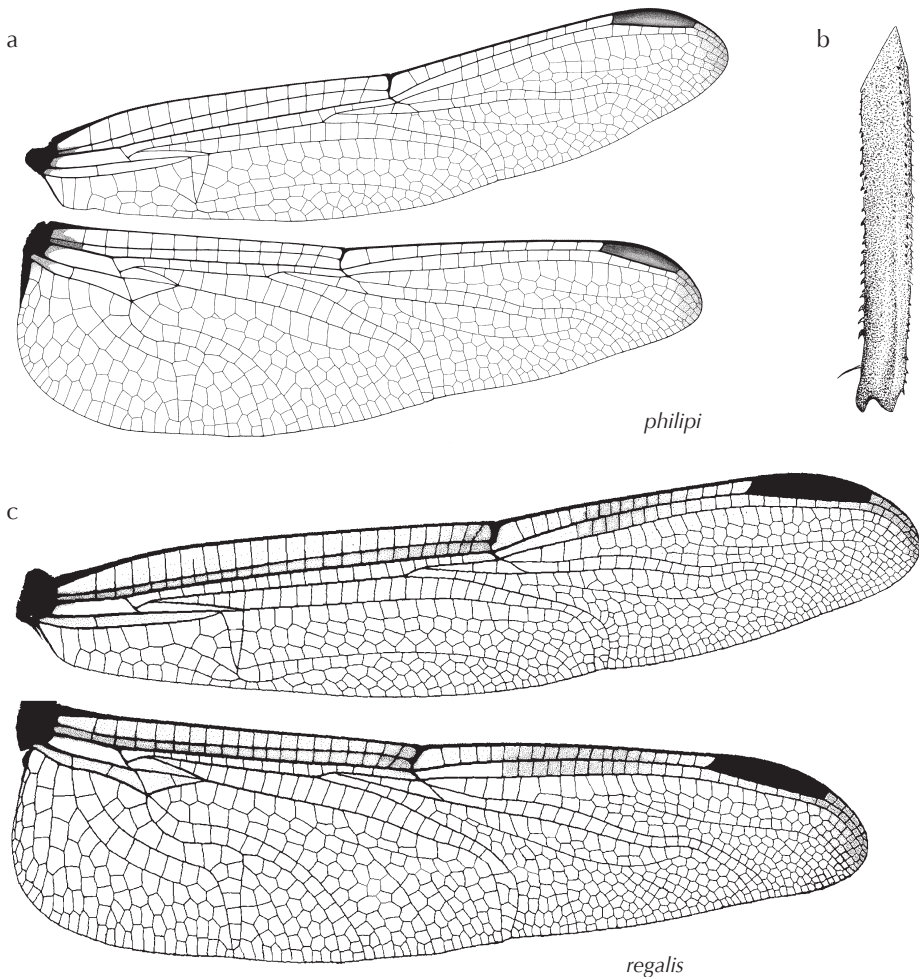


Figure 3: Pterothorax, lateral view — (a) *Orthemis philipi*, left pair of wings, paratype; (b) *O. philipi*, left hind femur, holotype; (c) *O. regalis*, left pair of wings, male, Surinam, Granholosoela.

Dimensions: Total length 49.7; abdomen length 30; Fw length 38; Hw length 38; Hw maximum width 11.

Variation in male paratypes

Head: As for holotype.

Thorax: As for holotype but 18-22 metafemoral spurs; small amber spots at base of wings extending from level of first row of anal cells to second row; arculus in Fw distal to Ax2; Fw discoidal field with 4-7 rows of cells at hind margin, Hw with 14-16 at hind margin; anal loop enclosing 22-28 cells. Pt 4.2 in Fw, 3.9 in Hw; Ax 18-20 in Fw; Px 13-15 in Fw, 14-15 in Hw. In one paratype from Ecuador all pale yellow stripes of pterothorax diffuse and ill defined.

Abdomen: As for holotype but ratio S4 width/length 0.28-0.29; tubercles of cercus 8-10 at base, 5-6 at distal 0.50.

Dimensions: ($n = 2$): male total length 44.7-47.7; abdomen length 29; Fw length 35-36; Hw length 34-34.5; maximum Hw width 10.3-10.5.

Variation in female paratypes

Head: As for holotype.

Thorax: As for holotype but 17-20 metafemoral spurs; arculus in Fw distal to Ax 2; Fw discoidal field with 3 to 7 rows of cells at hind margin, Hw with 13 to 14 at hind margin; anal loop enclosing 25-28 cells. Pt 4.2-4.9 in Fw, 3.95-4.6 in Hw; Ax 17-20 in Fw, 13-15 in Hw; Px 13-17 in Fw, 15-16 in Hw.

Abdomen: As for holotype but ratio S4 width/length 0.32-0.34. Ventro-lateral flap on S8 ivory, relatively wide, as about three times its height (Figs 16, 17e); vulvar lamina narrow, as wide as 0.33 or less of S8 width, lacking a medial cleft (Fig. 18c); cerci cylindrical ending on acute tip, as long as 2.5-2.7 of epiproct length (Fig. 19b).

Dimensions: ($n = 4$; mean in parenthesis): total length 44.3-46.3 (45.3); abdomen length 29-30 (29.75); Fw length 35.5-36 (35.75); Hw length 33.5-35 (34.38); maximum Hw width 9.5-10.2 (9.95).

Diagnosis

Extremely slender abdomen with S4 not wider than 0.34 of its length and approximately parallel-sided is shared with *O. attenuata*, *O. concolor*, *O. levis*, and *O. harpago* (Table 1), and among them, a reddish brown frons lacking metallic reflections is shared only by *O. concolor*. It differs from *O. attenuata*, *O. concolor*, and *O. levis* by outer branch of hamule bent ventrally over inner branch and with outer corner smoothly convex (Fig. 8e), ventro-distal lobe of vesica spermalis rectangular and about as long as basal portion of distal segment (Fig. 11b), male cercus markedly curved ventrally (Fig. 14e) and converging with opposite cercus along basal 0.70 in dorsal view (Fig. 13a), and apex of male epiproct as wide as about 0.50 of its basal width (Fig. 15e). In the first three species outer branch of hamule ends on same plane as inner branch and its outer corner is angled (Figs 8d, g, l), dorso-distal lobe of vesica spermalis is triangular and shorter than basal portion of distal segment (Fig. 11c), male cercus is slightly curved ventrally (Figs 14d, f) and converges with opposite cercus along basal 0.50 in dorsal view (Fig. 13b), and apex of male epiproct is as wide as about 0.33 of its basal width (Figs 15d, f, k). Hamule with inner branch shorter than outer branch (Figs 8e, 9e) and ventral margin of male cercus smoothly concave

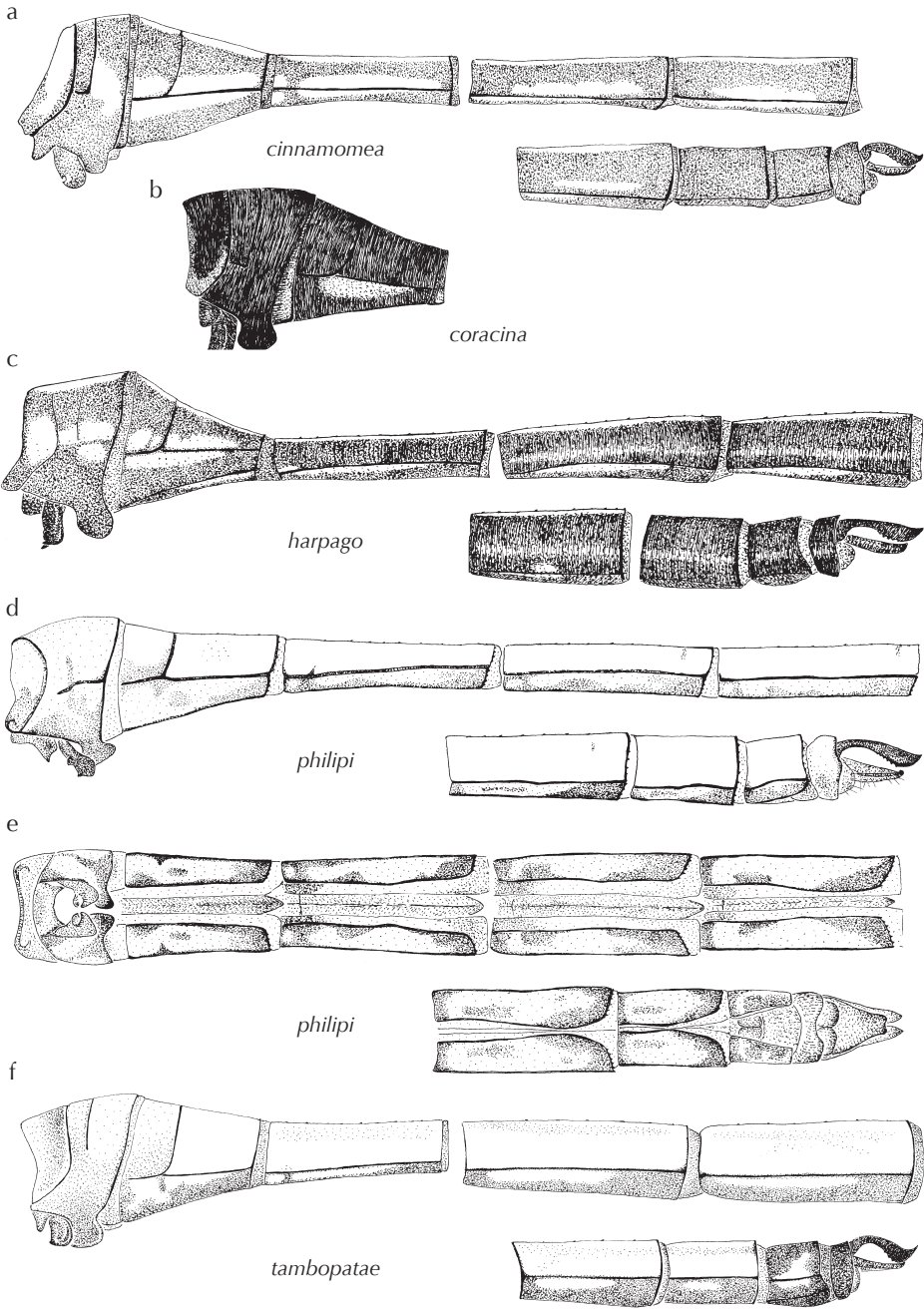


Figure 4: Male abdomen of holotypes — (a) *Orthemis cinnamomea*, sp. nov.; (b) *O. coracina*, sp. nov.; (c) *O. harpago*, sp. nov.; (d, e) *O. philipi*, sp. nov.; (f) *O. tambopatae*, sp. nov. — (a-d, f) lateral view; (e) ventral view.

at base (Fig. 14e) separate it from *O. harpago*, with inner branch of hamule longer than outer branch (Figs 8k, 9j) and ventral margin of male cercus with a marked concavity at base (Fig. 14j).

Female differs from those of *O. attenuata* and *O. levis* by its wider ventro-lateral flap on S8 as wide as three times its length (Fig. 17e) and narrow vulvar lamina as wide as 0.33 or less of S8 width, lacking a medial cleft (Fig. 18c); in *O. attenuata* and *O. levis* latero-ventral flap on S8 is narrower, as wide as four times or more its length (Figs 17c, d, g), and vulvar lamina is as wide as S8 and has a deep medial U-shaped cleft (Figs 18b, e). Female differs from all other known females of the *levis*-group (Figs 18a, b, d-f) by its narrow vulvar lamina as wide as 0.33 of S8 or less (Fig. 18c), approaching the condition of the vulvar lamina of *O. cultriformis*, which is however as wide as 0.50 of S8 (Fig. 18d).

Distribution and biology

Found within the lowland Amazon forest of Ecuador and Peru (Fig. 22) along margins of streams and lakes, and flying at forest edge and along forest trails.

Orthemis coracina sp. nov.

Figs 1a, 2d, 4b, 7h, 8g, 10d, 11b, 13g, 14g, 20

Etymology

From the Greek adjective *korákinos* (raven-black), latinized to *coracinus*, in reference to its predominantly black body.

Type specimens

Total 1 ♂. — Holotype ♂: Ecuador, Sucumbíos Province, Limoncocha, forest edge (00°24'S, 76°36'W, 300 m), 23 vii 1977, leg. DRP (USNM).

Male holotype

Head: Labium black, with palps pale yellow with a medial black stripe as wide as 0.70 of palp width and anterior margin narrowly black (Fig. 1a); labrum black; base of mandibles yellow; clypeus and basal portion of antefrons dark reddish brown with lateral portion yellow; dorsal portion of antefrons, postfrons, and vertex bright metallic blue with turquoise reflections; occipital triangle black; rear of head dark reddish brown with some pale yellow spots. Postfrons with wide-shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobed.

Thorax: Prothorax black. Pterothorax black with greenish-blue metallic reflections, with some restricted brown areas at ventral portion of sclerites as shown in Figure 2d; venter of pterothorax black with central area brown. — Legs black with lateral and extensor surfaces of procoxa and protrochanter pale brown; metafemur armed with 16 (right) to 17 (left) short spurs followed distally by one longer spur. — Wings hyaline with small amber spots at base not surpassing level of second row of anal cells, and at apex distally to Pt. Hw extending to apex of S3; one cubito-anal cross-vein in Fw and Hw; arculus distal to Ax2 in Fw and Hw; sectors of arculus stalked;

Fw triangles crossed, Hw triangles free; Fw subtriangle with 4 cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 6 rows at hind margin, Hw with 3 at base, then 2, then increasing to 15 (right) or 14 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 24 cells. Pt dark reddish brown, 4.1 long in Fw and 4.0 in Hw, overlying 5 to 6 cells in Fw and 4 to 5 in Hw. Ax: 17 (right) and 18 (left) in Fw; 13 in Hw; Px: 13 in Fw; 16 (right) and 14 (left) in Hw.

Abdomen: Gradually narrowing distally in ventral view, abruptly along S3 in lateral view; S4 slightly longer than twice its width in ventral view (ratio width/ length = 0.42). Black except for pale brown areas along antero-ventral margin of S1, on intersegmental membranes posterior to S2 and S3, pale yellow medio-dorsal carinae on S1-4, and longitudinal stripe along medio-ventral margin of latero-ventral carina on S3 (Fig. 4b). Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Fig. 9g); hamule bifid with small inner branch forming a short pointed spine, and larger outer branch bent ventrally over inner branch with blunt square tip; outer corner of outer branch angled (Fig. 8h). Distal segment of vesica spermalis with basal portion trapezoidal in ventral view (Fig. 12b), with distal lobes represented on each side by a medio-ventral semicircular membranous lobe with a sclerotized lateral projection margined with denticles, and an elongate dorso-distal lobe approximately rectangular in lateral view, longer than basal portion, with a flagellum on dorsal surface (Figs 11d, 12b). Cercus markedly curved ventrally in lateral view, with tip slightly upturned, with a row of 9-10 low rounded tubercles at base and a row of 5 larger ones at distal 0.50 (Fig. 14e); in dorsal view converging along basal 0.70 with opposite cercus to then run approximately parallel to it along distal 0.30. Epiproct extending to 0.82 of cerci length, its apex bifid and as wide as about 0.50 of basal width (Fig. 15g).

Dimensions: Total length 42.8; abdomen length 26.6; Fw length 35; Hw length 34; Hw maximum width 10.4.

Diagnosis

O. coracina shares with *O. ambinigra*, *O. ambirufa*, *O. anthracina*, *O. cultriformis*, *O. flavopicta*, *O. plaumanni*, and *O. tambopatae* a less slender abdomen at base which gradually narrows distally (Table 1). Among these it shares hamule with outer branch bent ventrally over inner branch (Fig. 8h) only with *O. anthracina*, *O. cultriformis*, *O. philipi*, and *O. tambopatae* (Figs 8c, i, m, o), but differs by outer corner of outer branch angled (Fig. 8h), versus outer corner smoothly rounded (Figs 8c, i, m, o). Distance separating inner and outer branches of hamule shorter than length of inner branch (Fig. 8h) will further separate it from *O. anthracina* and *O. cultriformis* in which distance separating both branches is about twice the length of inner branch (Figs 8c, i). Epiproct as wide at apex as 0.50 of its basal width (Fig. 15g) and dorsum of S1-8 mostly black (Fig. 4b) will further separate it from *O. philipi* and *O. tambopatae*, which have epiproct as wide at apex as 0.30 of its basal width (Figs 15l, n) and dorsum of S1-8 red (Figs 4d, e).

Distribution and biology

Found within the lowland Amazon forest of Ecuador (Fig. 21) flying along forest edge.

Orthemis harpago sp. nov.

Figs 2g, 4c, 7h, 8j, 9a, 10f, 11d, 13j, 14j, 21

Orthemis sp. A — Paulson (1985: 13, record from Tambopata, Peru).

Etymology

From Latin *harpago* (a masculine noun meaning harpoon), in reference to its unique hamule shape reminiscent of a grappling hook in ventral view.

Type specimens

Total 2 ♂. — Holotype ♂: Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, 30 km SW Puerto Maldonado, muddy forest stream (12°30'S, 69°12'W, 300 m), 17 vi 1977, leg. DRP (USNM); 1 ♂ paratype, same data as holotype (DRP).

Male holotype

Head: Labium black, with palps pale yellow with a medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black; labrum black with a pair of medio-lateral small yellow spots at clypeo-labral suture; base of mandibles yellow; clypeus pale yellow with a black stripe along ventral margin of postclypeus; basal portion of antefrons pale yellow, dorsal portion of antefrons, postfrons, and vertex bright metallic blue with turquoise reflections; occipital triangle black; rear of head reddish brown with some pale yellow spots. Postfrons with wide-shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobed.

Thorax: Prothorax dark reddish brown. Pterothorax dark reddish brown with well-defined pale yellow stripes (Fig. 2g) as follows: narrow stripe lateral to medio-dorsal carina, a wider stripe at mid-width, and a oval spot at mid-length of mesepisternal-mesepimeral suture; mesepimeron with a well defined wide stripe along posterior half narrowing dorsally; metepisternum with a narrow stripe along ventral margin, another sinuous one ventrally to metastigma, and a narrow stripe along metepisternal-metepimeral suture; metepimeron with a stripe along posterior half; venter of pterothorax dark reddish brown, with a yellow spot posterior to hind legs.

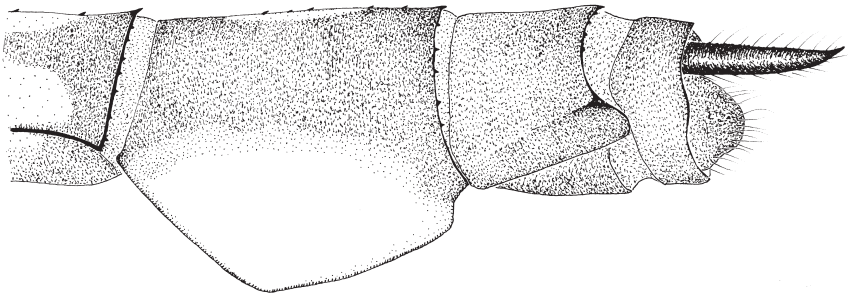


Figure 5: *Orthemis cinnamomea*, female paratype, S8-10, lateral view.

— Legs black with lateral and extensor surfaces of coxa and trochanter pale brown; metafemur armed with 17 (right) to 15 (left) short spurs followed distally by one longer spur. — Wings hyaline with small amber spots at base not surpassing level of second row of anal cells. Hw extending to base of S4; one cubito-anal crossvein in Fw and Hw; arculus opposite to Ax2 in Fw, distal to Ax2 in Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangle with 3 (right) or 4 (left) cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 6 rows at hind margin, Hw with 3 at base, then 2, then increasing to 10 at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 18 cells. Pt dark reddish brown, 3.9 long in Fw and 3.7 in Hw, overlying 5 cells in Fw and Hw. Ax: 14 (right) and 15 (left) in Fw; 12 in Hw; Px: 13 (right) and 12 (left) in Fw; 12 (right) and 13 (left) in Hw.

Abdomen: Parallel-sided in ventral view, abruptly narrowed along S3 in lateral view (Fig. 4c); S4 about four times as long as wide in ventral view (ratio width/length = 0.23). Dark reddish brown except latero-ventral margins of S1-3 pale yellow, a medio-dorsal yellow stripe on S1-3, medio-dorsal carina of S4-8 narrowly yellow, a latero-ventral longitudinal yellow stripe on S3-8 ventrally to latero-ventral carinae and also dorsally to latero-ventral carinae on S6-8. Anterior lamina in lateral view shorter than hamule and as high as genital lobe (Fig. 9j); hamule bifid with outer branch pointed at antero-ventral corner (Fig. 10a), inner branch longer than outer branch with tip directed anteriorly (Figs 8k, 9j, 10a). Distal segment of vesica spermalis with basal portion trapezoidal in ventral view (Fig. 12d), with distal lobes represented on each side by a medio-ventral semicircular membranous lobe with a sclerotized lateral projection margined with denticles, and an elongate dorso-distal lobe approximately rectangular in lateral view, about as long as basal portion, with

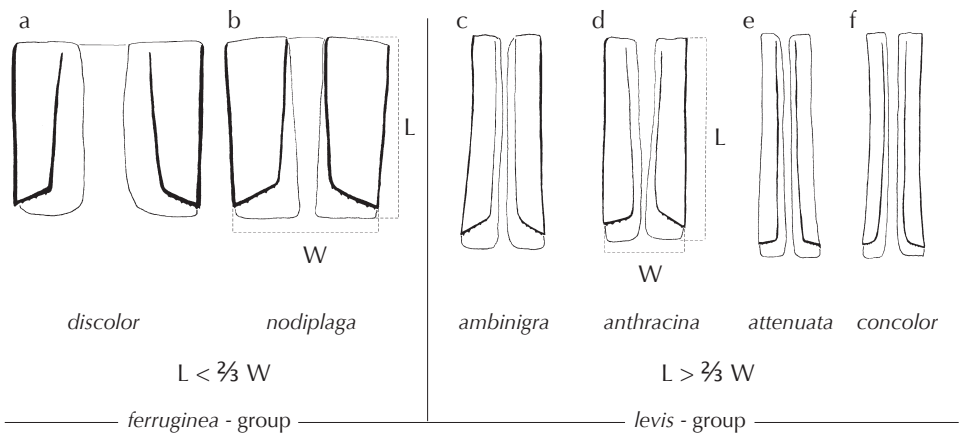


Figure 6: Male S4, ventral view (to scale) — (a) *Orthemis discolor*, Argentina, SE of Isla de Cañas; (b) *O. nodiplaga*, Argentina, Salta, road 5; (c) *O. ambinigra*, Argentina, SE Isla de Cañas; (d) *O. anthracina*, Panama, SE of Gamboa; (e) *O. attenuata*, Peru, Susucari; (f) *O. concolor*, Trinidad, Aripo. L: length; W: width.

a flagellum on dorsal surface (Figs 11f, 12b). Cercus markedly curved ventrally in lateral view, with a marked concavity at base and tip upturned, with a row of 8-9 low rounded tubercles at base and a row of 5 larger ones at distal 0.50 (Fig. 14j); in dorsal view converging along basal 0.70 with opposite cercus to then run approximately parallel to it along distal 0.30. Epiproct extending to 0.80 of cerci length, with apex entire and about as wide as 0.50 of basal width (Fig. 15j).

Dimensions: Total length 40.1; abdomen length 26; Fw length 31; Hw length 30; Hw maximum width 9.

Variation in male paratype

Head: As for holotype.

Thorax: As for holotype but 14-16 Ax in FW, 12 in Hw; 12 Px in Fw and Hw.

Abdomen: As for holotype but ratio S4 width/length 0.19.

Dimensions: ($n = 1$): total length 38.6; abdomen length 24.5; Fw length 29; Hw length 27.5; maximum Hw width 8.

Diagnosis

This species shares the extremely slender and parallel-sided abdomen with *O. attenuata*, *O. concolor*, *O. levis*, and *O. cinnamomea* (Table 1), and ventral margin of male cercus with a marked concavity at base (Fig. 14j) only with *O. anthracina* (Fig. 14c). It is unique by its hamule, in which outer branch is projected into a point at antero-ventral corner (Fig. 10a), tip of inner branch is directed anteriorly and inner branch is longer than outer branch (Figs 8k, 9j), rather than outer branch not projected into a point at antero-ventral corner (Fig. 10b), tip of inner branch directed posteriorly and inner branch shorter than outer branch (Figs 7, 8a-j, l-o, 9a-I k-o).

Distribution and biology

Found within lowland Amazon forest of SE Peru (Fig. 22) flying along margins of a muddy stream.

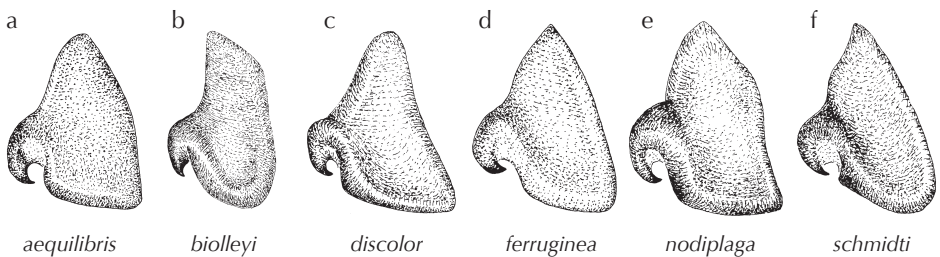


Figure 7: Male posterior hamule of the *Orthemis ferruginea*-group, frontal view — (a) *O. aequilibris*, Brazil, Manaus; (b) *O. biolleyi*, Brazil, Fazenda Rancho Grande; (c) *O. discolor*, Argentina, Chicoana; (d) *O. ferruginea*, USA, Gila River; (e) *O. nodiplaga*, Argentina, Salta, road 5; (f) *O. schmidti*, Ecuador, Napo River.

Orthemis philipi sp. nov.

Figs 1b, c, 2h, 3, 4d, e, 7m, 8l, 9b, 10g, 11e, 12c, 13k, 14l, 19; Plate VIIe, f

Etymology

This species is named *philipi* (noun in the genitive case) after the late Philip S. Corbet, in recognition of his invaluable contributions to the knowledge of odonate biology.

Type specimens

Total 4 ♂. — Holotype ♂: Argentina, Salta Province, pond at route 15 between route 5 and Las Varas (23°21'19"S, 64°08'37"W, 392 m), 23 v 2008, leg. NE (MLP); paratypes: 2 ♂, same data as holotype but (NE, RWG); 1 ♂, Paraguay, San Pedro Department, Antequera, in town (24°08'00"S, 57°05'00"W, 64 m), 12 xii 1979, leg. L. Strickman (DRP).

Male holotype

Head: Labium black, with palps pale yellow with a medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black (Fig. 1b); labrum black with a pair of medio-lateral small orange spots at clypeo-labral suture; base of mandibles orange and yellow; lateral portion of clypeus along eyes pale yellow, remainder of clypeus pale brown with a dark brown stripe along suture between ante- and post-clypeus; basal portion of antefrons pale brown, dorsal portion of antefrons, postfrons, and anterior 0.50 of vertex dark metallic blue with purple reflections; posterior 0.50 of vertex and occipital triangle black (Pl. VIIe), the latter with posterior margin pale yellow; rear of head with alternating transverse pale yellow and brown stripes along compound eyes. Postfrons with wide-shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle approximately linear with only a minute medial notch.

Thorax: Prothorax black with a dorso-lateral rounded pale yellow spot on each side. Pterothorax covered with long hairs, reddish brown with marbled pattern of pale yellow spots and stripes and dark reddish brown and black irregular areas (as in Fig. 2h, Pl. VIIe) as follows: mesepisternum dark reddish brown except distal 0.20 reddish brown, with a rounded small pale yellow spot at basal 0.20, postero-dorsal corner pale yellow, and a narrow sinuous pale yellow stripe along humeral suture; metepimeron with an oval pale yellow spot on postero-ventral 0.50, bordered ventrally and anteriorly by a diffuse black stripe which continues dorsally along humeral suture; metepisternum dark at antero-ventral 0.50, with a narrow wavy pale yellow stripe extending to mid-length of metapleural suture, and postero-dorsal corner pale yellow; metepimeron with a large pale yellow oval spot along ventral margin bordered ventrally and anteriorly by a black diffuse stripe and dorsally by a dark reddish brown area, remainder of metepimeron pale yellowish brown; venter of pterothorax pale brown, with an orange spot posterior to hind legs and outer margins along metepimeral suture black. — Legs black with lateral and extensor surfaces of trochanter and basal 0.50 of femur reddish brown; metafemur armed with 23 (right) or 24 (left) short spurs followed distally by one longer spur (Fig. 3b). — Wings hyaline with small amber spots at base not surpassing level of Ax1, and at apex distally

to Pt (Fig. 3a). Hw extending to base of S4; one cubito-anal crossvein in Fw, two in Hw; arculus opposite to Ax2 in Fw, distal to Ax2 in Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 3 cells; one bridge crossvein in Fw, one (right) or two (left) in Hw; Fw discoidal field with 3 rows of cells at base to 6 rows at hind margin, Hw with 3 at base, then 2, then increasing to 14 (right) or 15 (left) at margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 24 (right) or 25 (left) cells. Pt pale orange brown, 4.5 long in Fw and Hw, overlying 4 cells in right Fw, 5 in left Fw, 4 in Hw. Ax: 14 (left) and 15 (right) in Fw; 13 (left) and 12 (right) in Hw; Px: 10 in Fw; 10 (left) and 12 (right) in Hw.

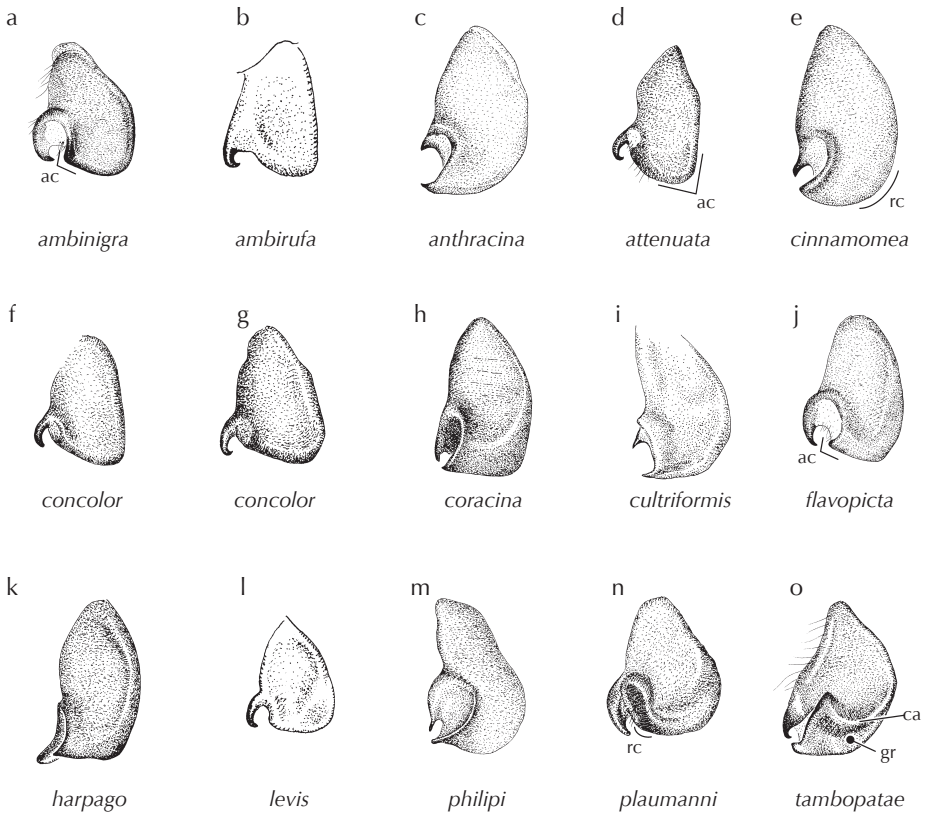


Figure 8: Male posterior hamule of the *Orthemis levis*-group, frontal view — (a) *O. ambinigra*, Argentina, SE Isla de Cañas; (b) *O. ambirufa*, holotype; (c) *O. anthracina*, Panama, SE of Gamboa; (d) *O. attenuata*, Brazil, Cauca landia; (e) *O. cinnamomea*, holotype; (f) *O. concolor*, Trinidad, Aripo; (g) *O. concolor*, French Guiana, Cacao; (h) *O. coracina*, holotype; (i) *O. cultriformis*, lectotype; (j) *O. flavopicta*, Panama, NW of Gamboa; (k) *O. harpago*, holotype; (l) *O. levis*, Costa Rica, Hacienda Taboga; (m) *O. philipi*, paratype; (n) *O. plaumanni*, Peru, Tambopata; (o) *O. tambopatae*, paratype. ac: angled corner; ca: carina; gr: groove; rc: rounded corner, Figures 8b, i, l by Rosser Garrison.

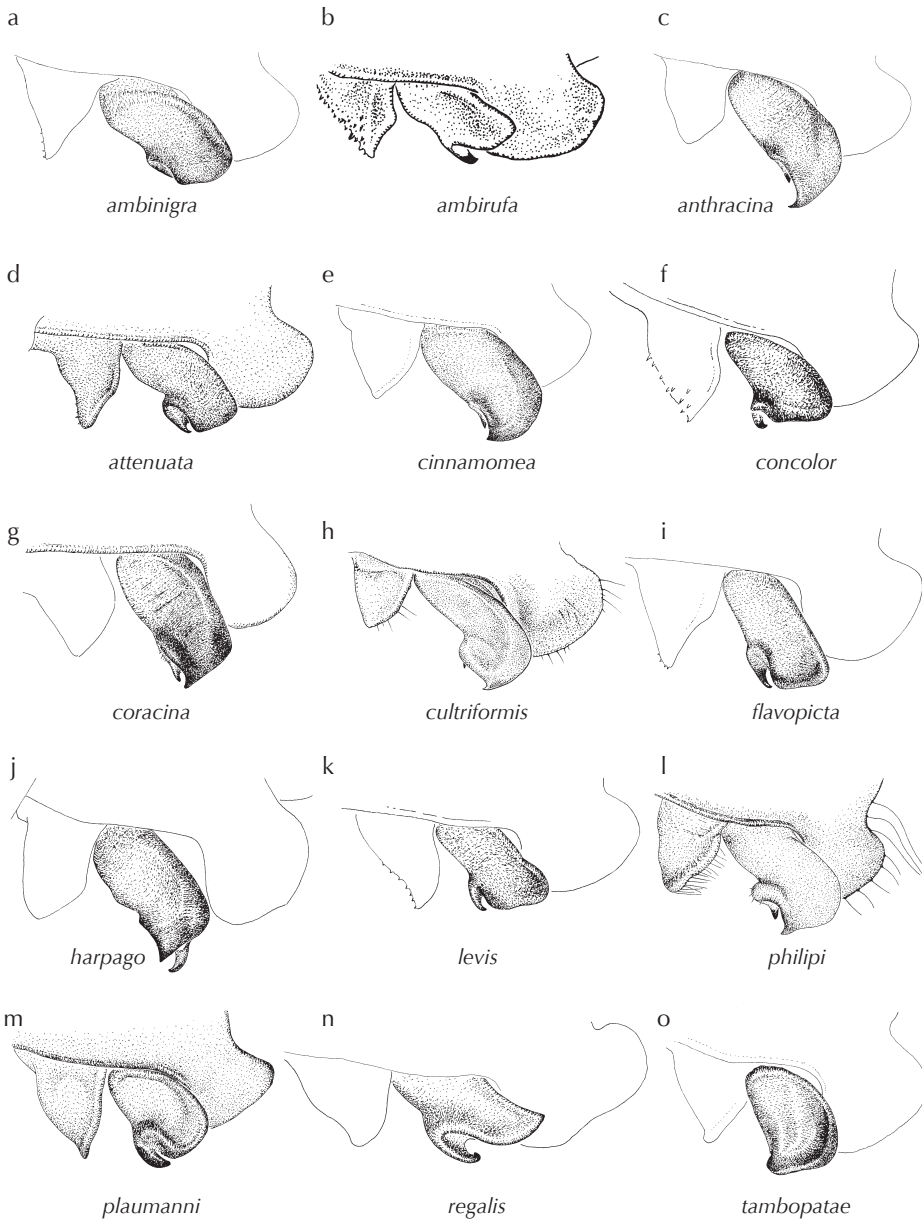


Figure 9: Male posterior hamule of the *Orthemis levis*-group, lateral view — (a) *O. ambinigra*, Argentina, SE Isla de Cañas; (b) *O. ambirufa*, holotype; (c) *O. anthracina*, Panama, SE of Gamboa; (d) *O. attenuata*, Brazil, Caucaalandia; (e) *O. cinnamomea*, holotype; (f) *O. concolor*, French Guiana, Cacao; (g) *O. coracina*, holotype; (h) *O. cultriformis*, lectotype; (i) *O. flavopicta*, Panama, NW of Gamboa; (j) *O. harpago*, holotype; (k) *O. levis*, Costa Rica, Hacienda Taboga; (l) *O. philipi*, paratype; (m) *O. plaumanni*, Peru, Tambopata; (n) *Orthemis regalis*, holotype; (o) *O. tambopatae*, paratype. Figs 9b, h, k by Rosser Garrison, 9n redrawn from Ris (1910).

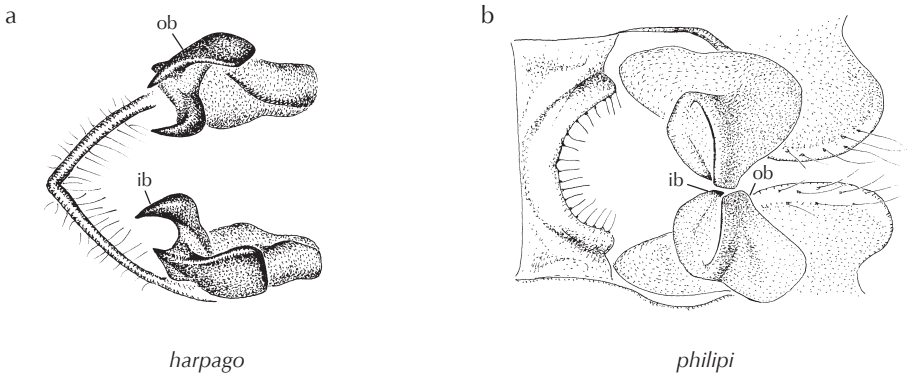


Figure 10: Male posterior hamule, ventral view — (a) *Orthemis harpago*, holotype; (b) *O. philipi*, paratype. ib: inner branch; ob: outer branch.

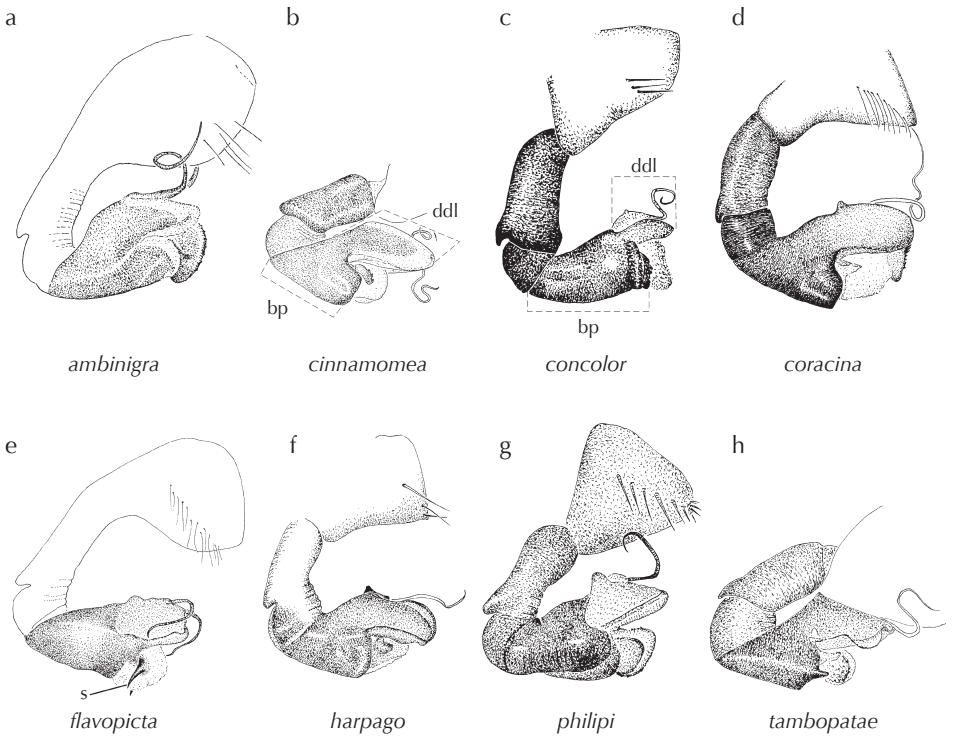


Figure 11: Male vesica spermalis, lateral view — (a) *Orthemis ambinigra*, Argentina, SE Isla de Cañas; (b) *O. cinnamomea*, paratype; (c) *O. concolor*, French Guiana, Cacao; (d) *O. coracina*, holotype; (e) *O. flavipicta*, Panama, NW of Gamboa; (f) *O. harpago*, holotype; (g) *O. philipi*, holotype; (h) *O. tambopatae*, paratype. bp: basal portion of distal segment; ddl: dorso-distal lobe; s: spine.

Abdomen: Narrowing gradually from base to tip in ventral view (Fig. 4e); S4 almost twice as long as wide in ventral view (ratio width/length = 0.49). Dorsal terga red except latero-ventral margins of S1-2 pale greenish yellow, antero-ventral corner of S3 dark brown, S10 dark reddish brown, transverse and lateral carinae narrowly black (Fig. 4d, Pl. VIIe); ventral terga pale yellow with brown spots as in Figure 4. Anterior lamina with posterior margin smoothly concave in ventral view, in lateral view shorter than hamule and genital lobe (Fig. 9l); hamule bifid with small inner branch forming a short pointed spine, and large outer branch bent ventrally over inner branch and almost touching it at medial line, forming a flat square-tipped spine (Figs 8m, 9l, 10b). Distal segment of vesica spermalis with basal portion parallel sided in ventral view (Fig. 12e), with distal lobes represented by two medio-ventral semicircular membranous lobes bordered by denticles and a dorso-distal transverse lobe semicircular with apex cleft in ventral view and triangular in lateral view, with a pair of flagella on dorsal surface (Figs 11g, 12e). Cercus slightly curved ventrally in lateral view, with tip upturned, with 5 low rounded tubercles in a row at base and 6 larger ones at distal 0.50 (Fig. 14k); in dorsal view converging along basal 0.70 with opposite cercus to then run approximately parallel to it along distal 0.30 (Fig. 13c). Epiproct extending to 0.80 of cerci length, its apex entire and about as wide as 0.33 of basal width (Fig. 15l).

Dimensions: Total length 46; abdomen length 30.6; Fw length 35; Hw length 34; Hw maximum width 13.

Variation in paratypes

Head: As for holotype but labium medial black area as wide as 0.20 (Fig. 1c) to 0.25 of palp width. Labrum yellow with free margin and a medial spot black; basal portion of antefrons pale brown; postfrons black with blue metallic reflections (Pl. VIII f) or mostly metallic purple; posterior 0.50 of vertex and occipital triangle orange brown.

Thorax: As for holotype but 18-20 metafemoral spurs; one cubito-anal crossvein in Fw and Hw; arculus distal to Ax2 in Fw and Hw; Fw triangles crossed, Hw triangles free except right Hw in one male; one bridge crossvein except 2 in right Fw in one male, and 2 in left Hw of another male; Fw discoidal field with 3 rows of cells at base to 5 or 8 at hind margin, Hw with 3 at base, then 2, then increasing to 11, 12, or 13 at margin; anal loop enclosing 19-23 cells. Pt 4.3 in Fw, 4.2-4.3 in Hw; Ax 14-15 in Fw, 11-12 in Hw; Px 9-11 in Fw, 9-13 in Hw. In one male pterothorax as in Fig. 1c, in another male dark reddish brown area of mesepisternum reduced to outermost lateral 0.60 along sinuous humeral stripe.

Abdomen: As for holotype but in two paratypes, probably younger males, dorsum orange instead of red; ratio S4 width/length 0.47-0.49; tubercles of cercus 8-12 at base, 5-6 at distal 0.50.

Dimensions: ($n = 3$; mean in parenthesis): total length 44.85-45.25 (45.05); abdomen length 29.6-30.3 (30); Fw length 33-35 (33.8); Hw length 32.5-34.5 (33.3); maximum Hw width 9.7-10.3 (10).

Diagnosis

Marbled pterothorax (Fig. 2h, Pl. VIIe, f) is unique; other species either have pale pterothoracic stripes (Figs 2a-e, g, i, Pl. VIIa-d, g, h) which in mature males can become entirely obscured by pruinescence, or have an approximately monochromatic thorax with ill-defined paler areas (i.e. pink with orange spots in *O. discolor*, Fig. 2f).

Shape of male hamule with a small inner branch forming a short spine and a larger outer branch bent ventrally over inner branch converging medially towards it (Figs 8m, 9l, 10b) resembles that of *O. anthracina*, *O. cinnamomea*, *O. coracina*, *O. cultriformis*, and *O. tambopatae* (Figs 8c, e, h, i, o, 9c, e, g, h, o); in all other described species both branches end at about the same ventral level (Figs 7, 8a, b, d, f, g, j, l, n) or inner branch is longer (only in *O. harpago*, Figs 8k, 9j). *O. philipi* differs from *O. anthracina* and *O. cultriformis* by tips of hamule's inner and outer branches almost touching, separated by a distance shorter than length of inner branch (Fig. 8m), and by basal portion of distal segment of vesica spermalis approximately quadrangular in ventral view, with sides parallel before converging at tip (Fig. 12e); in *O. anthracina* and *O. cultriformis* distance separating tips of hamule's inner and outer branches is about as long as twice the length of inner branch (Figs 8c, i), and basal portion of distal segment of vesica spermalis is trapezoidal in ventral view, with sides diverging before converging at tip (Fig. 12c). *O. philipi* differs from *O. cinnamomea* by its wider abdomen gradually narrowing distally and metallic purple blue frons, which in *O. cinnamomea* are narrower and parallel-sided, and dull reddish brown respectively (Table 1, Pl. VIIb, e, f). Color pattern of head and abdomen of *O. philipi* is the same as for *O. tambopatae* (Table 1, Pl. VIIe, f, h), but differs by the less marked ventral curvature of cercus (Fig. 14k) and outer branch of hamule with smooth ventral surface (Fig. 8m); in *O. tambopatae* ventral curvature of cercus is marked (Fig. 14m) and ventral surface of outer branch of hamule is grooved (Fig. 8o).

Female of *O. philipi* is unknown, but if as it is the case in other species of the genus it shares venation and basic head and pterothoracic color with male, it would be recognizable from all other known females by a marbled pterothorax.

Distribution and biology

This species was found within the Arid Chaco biome in Argentina and Paraguay (Fig. 20), a plain with slow slopes, vegetation characterized by thorny bushes (i.e. *Prosopis* sp.), shrubs, and cacti (i.e. *Opuntia* sp.), with scattered trees up to 13 m

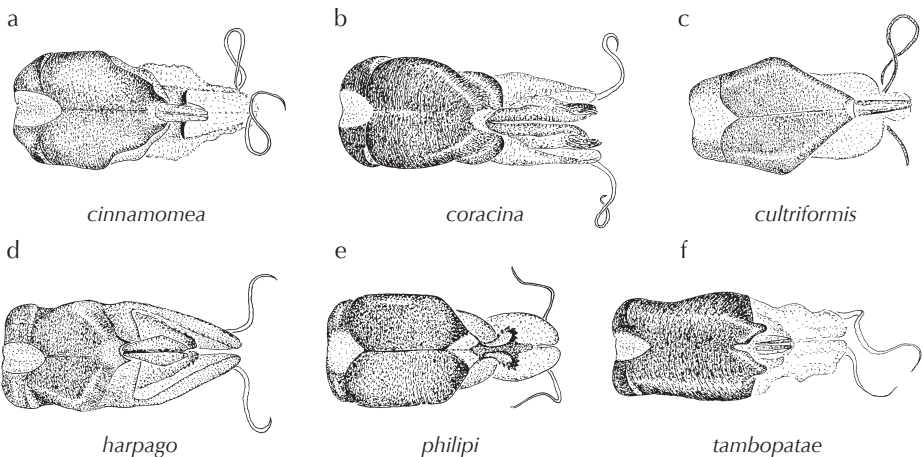


Figure 12: Male vesica spermalis, ventral view — (a) *Orthemis cinnamomea*, paratype; (b) *O. coracina*, holotype; (c) *O. cultriformis*, Peru, Pakitza; (d) *O. harpago*, holotype; (e) *O. philipi*, holotype; (f) *O. tambopatae*, paratype. bp: basal portion of distal segment; ddl: dorso-distal lobe.

high (i.e. *Aspidosperma quebracho-blanco*, *Bulnesia sarmientoi*, and *Schinopsis* sp.) and some isolated tracts of thick primary thorn forest. The three males of *O. philipi* collected in Argentina were found at a shallow pool surrounded by grass next to a dirt road bordered by thorn forest. They were perching on tips of dry twigs exposed to the sun at ca 1-2 m above ground.

Orthemis tambopatae sp. nov.

Figs 2i, 4e, 8o, 9o, 11h, 12f, 14m, 15n, 21; Plate VIIIh

Orthemis sp. B — Paulson (1985: 13, record from Tambopata, Peru).

Orthemis sp (nearest *ambinigra*) — Butt (1995: 96, record from Tambopata, Peru).

Etymology

This species is named *tambopatae* (genitive of Latinized Tambopata, meaning ‘of’ or ‘from Tambopata’), referring to its type locality, which supports the highest biodiversity of Odonata known from anywhere in the world (Paulson 1985).

Type specimens

Total 5 ♂. — Holotype ♂: Peru, Madre de Dios Department, Explorer’s Inn on Río Tambopata, 30 km SW Puerto Maldonado, small oxbow lake (12°30’S, 69°12’W, 300 m), 16 vi 1977, leg. DRP (USNM); 1 ♂ paratype, same data as holotype (DRP); 1 ♂ paratype, Tambopata Research Center, forest pond, 20 vii 2002, leg. DRP & N. Smith (DRP); 2 ♂ paratypes, Tambopata-Cándamo Reserved Zone, Camp 3, the Collpa, Río Tambopata west bank, marsh (13°08’31’’S, 69°36’4’’W), 01 ix 1992, leg. M. Butt (RWG).

Male holotype

Head: Labium black, with palps pale yellow with a medial black stripe as wide as 0.33 of palp width and anterior margin narrowly black; labrum dark reddish brown with orange spots; base of mandibles yellow; clypeus brown with narrow pale yellow line between ante- and postclypeus; basal portion of antefrons brown, dorsal portion of antefrons and postfrons bright metallic blue; vertex black; occipital triangle dark brown; rear of head reddish brown with some yellow spots. Postfrons with wide-shallow medial furrow; vertex with a pair of low tubercles; posterior margin of occipital triangle slightly bilobate.

Thorax: Prothorax reddish brown except pale yellow medial portion of anterior lobe. Pterothorax reddish brown with pale yellow stripes (Fig. 2 i, as in Pl. VIIIh) as follows: an ill-defined diffuse narrow stripe lateral to medio-dorsal carina, a wider stripe at mid-width; mesepimeron with a wide stripe along posterior half narrowing dorsally; metepisternum with a narrow stripe along ventral margin; metepimeron with antero-ventral corner yellow, a stripe along posterior half, and a triangular spot on antero-dorsal corner; venter of pterothorax pale yellow with an elongate brown spot on each side. — Legs black with coxa and trochanter and basal 0.50 of extensor surface of pro- and mesofemur, and extensor surface of tibiae reddish brown; metafemur armed with 20 short spurs followed distally by one longer spur. — Wings hyaline with small amber spots at base not surpassing level of first row of anal cells,

and at apex distally to Pt. Hw extending to apex of S3; one cubito-anal crossvein in Fw and Hw; arculus distal to Ax2 in Fw and Hw; sectors of arculus stalked; Fw triangles crossed, Hw triangles free; Fw subtriangles with 3 (right) or 4 (left) cells; one bridge crossvein in Fw and Hw; Fw discoidal field with 3 rows of cells at base to 5 rows at hind margin, Hw with 3 at base, then 2, then increasing to 14 (right) or 15 (left) at hind margin; 3 rows of cells between wing margin and anal loop at level of anal angle of triangle; anal loop enclosing 19 (right) to 20 (left) cells. Pt dark reddish brown, 4.3 long in Fw and 4.2 in Hw, overlying 5-6 cells in Fw and 4-5 in Hw. Ax: 16 in Fw; 13 (right) and 12 (left) in Hw; Px: 10 (right) and 11 (left) in Fw; 11 in Hw. **Abdomen:** Gradually narrowing distally in ventral view, abruptly along S3 in lateral view; S4 slightly longer than twice its width in ventral view (ratio width/length = 0.4). Dorsum red except for pale brown areas on sides of S1-2, ventro-lateral carinae narrowly black, a diffuse black longitudinal stripe to each side of medio-longitudinal carina on S4-8, and most of S9-10 black (Fig. 4e, as in Pl. VIIIh); ventral terga dark reddish brown with orange stripes along basal 0.6 of S3-8 (Fig. 4e). Anterior lamina in lateral view shorter than hamule and about as high as genital lobe (as in Fig. 9o); hamule bifid with small inner branch forming a short pointed spine, and larger outer branch bent ventrally over inner branch with a blunt tip; outer corner of outer branch rounded in frontal view (as in Fig. 8o); medial corner of outer branch with a distinct carina, delimiting a medial groove on its ventral surface (as in Fig. 8o). Distal segment of vesica spermalis with basal portion approximately parallel-sided in ventral view (as in Fig. 12f), with distal lobes represented on each side by a medio-ventral semicircular membranous lobe with a sclerotized lateral projection margined with denticles, and an elongate dorso-distal lobe approximately triangular in lateral view, about as long as basal portion, with a flagellum on dorsal surface (as in Figs 11h, 12f). Cercus markedly curved ventrally in lateral view, with tip strongly up-turned, with a row of 10-11 low rounded tubercles at base and a row of 4 larger ones at distal 0.50 (as in Fig. 14m); in dorsal view converging along basal 0.70 with opposite cercus to then run approximately parallel to it along distal 0.30. Epiproct extending to 0.88 of cerci length, its apex entire and about as wide as 0.30 of basal width (Fig. 15n).

Dimensions: Total length 43.75; abdomen length 28; Fw length 34; Hw length 33; Hw maximum width 10.1.

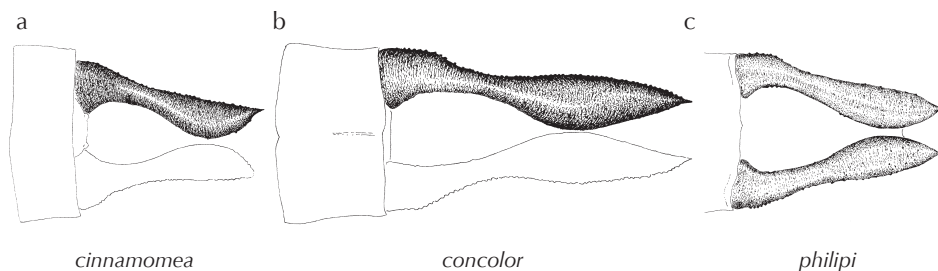


Figure 13: Male S10, dorsal view (to scale) — (a) *Orthemis cinnamomea*, holotype; (b) *O. concolor*, French Guiana, Cacao; (c) *O. philipi*, holotype.

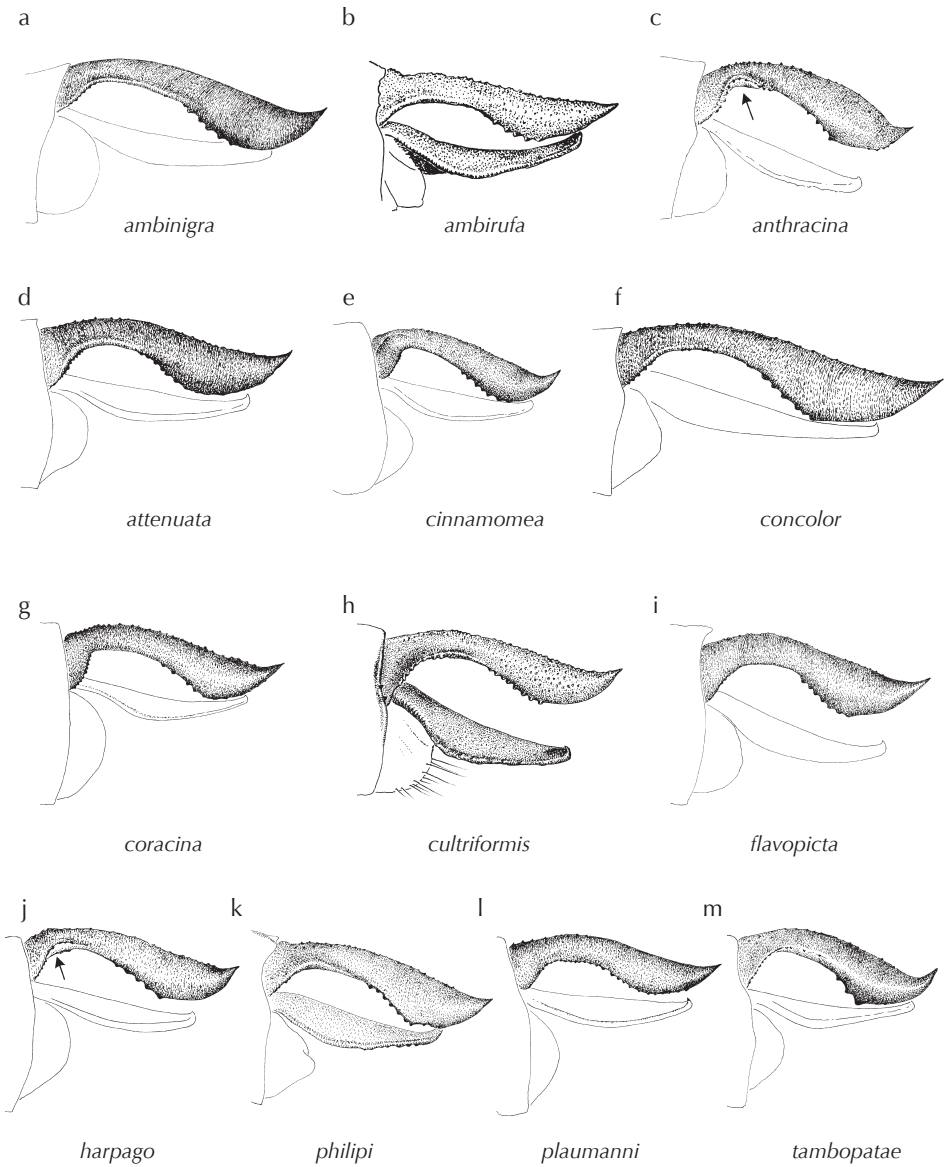


Figure 14: Male S10, lateral view — (a) *Orthemis ambinigra*, Argentina, Punta Lara; (b) *O. ambirufa*, holotype; (c) *O. anthracina*, Panama, SE of Gamboa; (d) *O. attenuata*, Peru, Sucusari; (e) *O. cinnamomea*, holotype; (f) *O. concolor*, Trinidad, Aripo; (g) *O. coracina*, holotype; (h) *O. cultriformis*, lectotype; (i) *O. flavopicta*, Panama, NW of Gamboa; (j) *O. harpago*, holotype; (k) *O. philipi*, holotype; (l) *O. plaumanni*, Peru, Tambopata; (m) *O. tambopatae*, paratype. Arrows point at marked concavity of ventral outer margin at base of cercus. Figures 14b, h by Rosser Garrison.

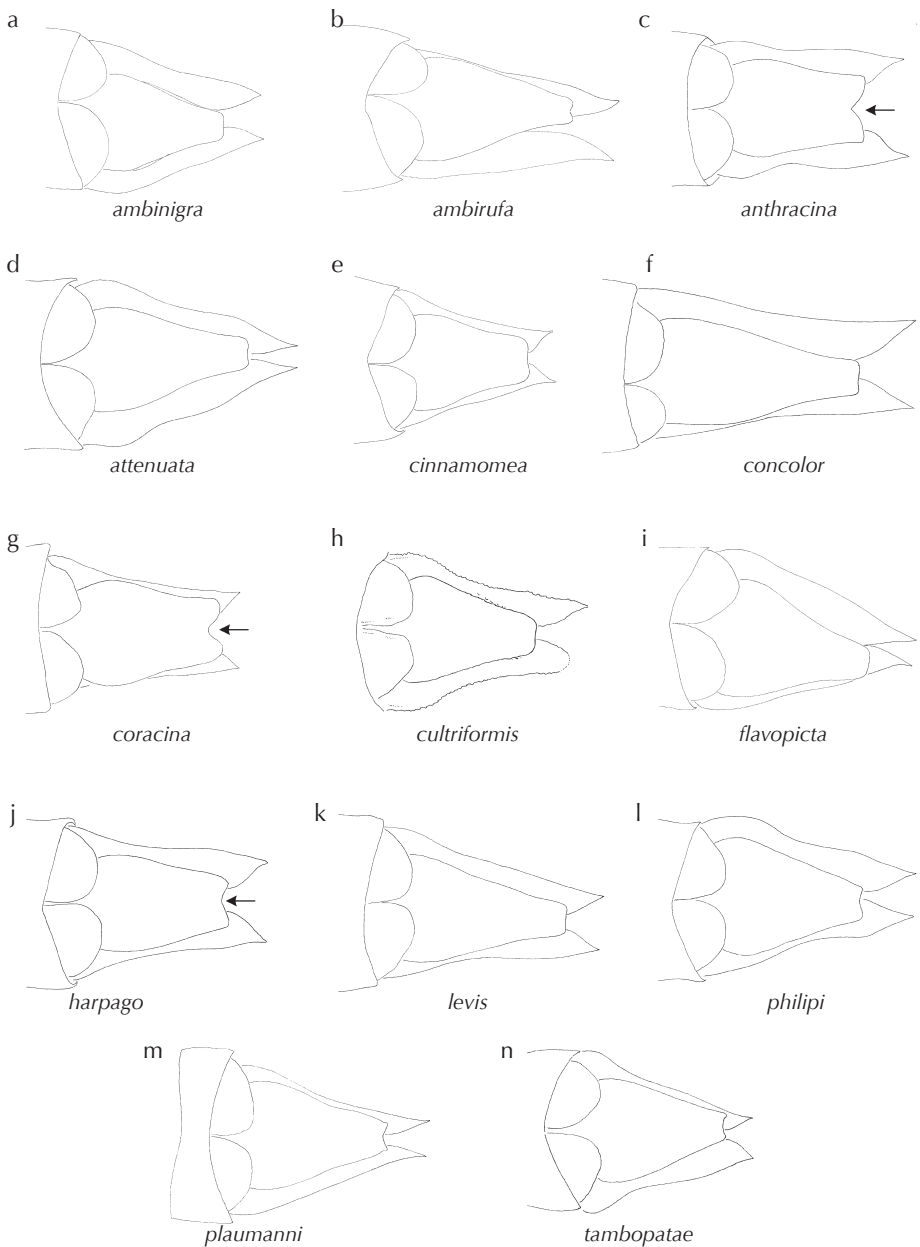


Figure 15: Male S10, ventral view — (a) *Orthemis ambinigra*, Argentina, Punta Lara; (b) *O. ambirufa*, holotype; (c) *O. anthracina*, Panama, SE of Gamboa; (d) *O. attenuata*, Peru, Sucusari; (e) *O. cinnamomea*, holotype; (f) *O. concolor*, Trinidad, Aripo; (g) *O. coracina*, holotype; (h) *O. cultriformis*, lectotype; (i) *O. flavopicta*, Panama, NW of Gamboa; (j) *O. harpago*, holotype; (k) *O. levis*, Costa Rica, Hacienda Taboga; (l) *O. philipi*, holotype; (m) *O. plaumanni*, Peru, Tambopata; (n) *O. tambopatae*, paratype. Arrows point at distinctly bifid apex of epiproct. Figure 15h by Rosser Garrison.

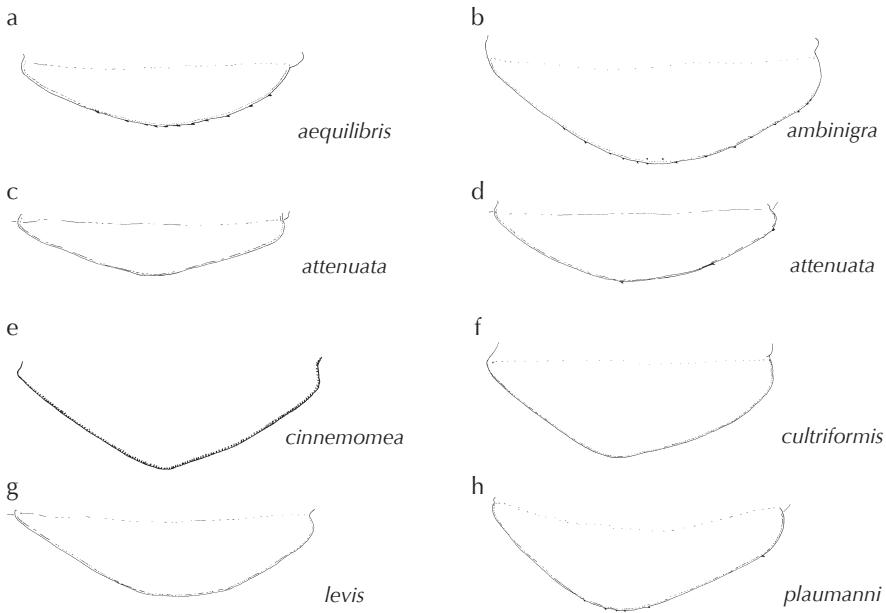


Figure 16: Lateral flap on female S8, lateral view (to scale) — (a) *Orthemis aequilibris*, Venezuela, Barinas; (b) *O. ambinigra*, Argentina, Punta Lara; (c) *O. attenuata*, Peru, Yarina-cocha; (d) *O. attenuata*, Colombia, Fundación; (e) *O. cinnamomea*, paratype; (f) *O. cultriformis*, Trinidad, Aripo; (g) *O. levis*, Venezuela, San Esteban; (h) *O. plaumanni*, Peru, Tambopata.

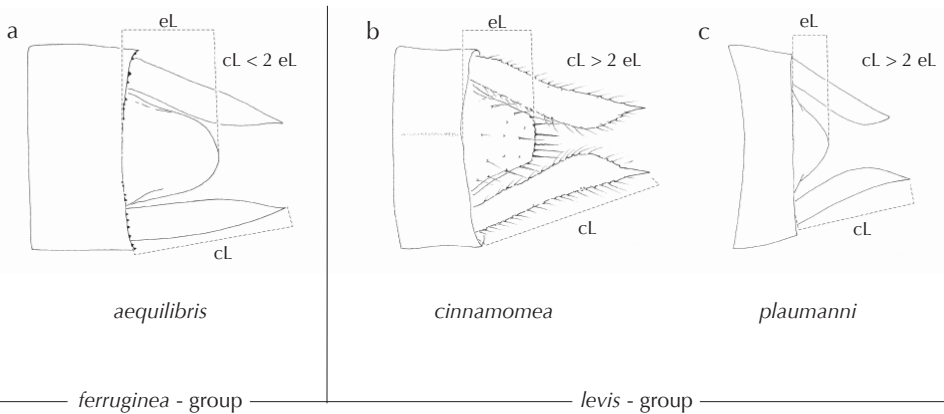


Figure 17: Female S10, dorsal view — (a) *Orthemis aequilibris*, Venezuela, Barinas; (b) *O. cinnamomea*, paratype; (c) *O. plaumanni*, Peru, Tambopata (left cercus atrophied). cl: cercus length; el: epiproct length.

Variation in paratypes

Head: As for holotype.

Thorax: As for holotype but 14-17 metafemoral spurs; 2 bridge crossveins in one Fw; Ax arculus opposite to Ax2 in Fw; anal loop enclosing 18-21 cells. Pt 4.6-4.9 in Fw, 4.5-4.7 in Hw; Ax 14-16 in Fw, 12-15 in Hw, Px 11-14 in Fw, 12-15 in Hw.

Abdomen: As for holotype but ratio S4 width/length 0.38-0.47 (mean 0.43); tubercles of cercus 9-12 at base, 3 at distal 0.50.

Dimensions: ($n = 4$; mean in parenthesis): total length 43.75-45.82 (44.27); abdomen length 27-29 (28); Fw length 34-36 (34.5); Hw length 33-35 (33.5); maximum Hw width 10-10.1 (10.05).

Diagnosis

The grooved outer branch of hamule (Fig. 8o) is unique within the genus and will separate this species from all other known *Orthemis* (Figs 7, 8a-n). Male shares with *O. ambinigra*, *O. ambirufa*, *O. anthracina*, *O. cultriformis*, *O. flavopicta*, *O. plaumanni*, *O. philipi*, and *O. coracina* a less slender abdomen at base gradually narrowing distally (Table 1), and hamule with outer branch bent ventrally over inner branch (Fig. 8o) only with *O. anthracina*, *O. coracina*, *O. cultriformis*, and *O. philipi* (Figs 8c, h, i, m). It differs from *O. anthracina* and *O. cultriformis* by distance separating both branches shorter than length of inner branch (Fig. 8o), versus distance separating inner and outer branches about twice the length of inner branch in these two species (Figs 8c, i). Outer corner of outer branch smoothly rounded in frontal view (Fig. 8o), epiproct as wide at apex as 0.30 of its basal width (Fig. 15n), and dorsum of S1-8 mostly red (Fig. 4e, Pl. VIIIh) will separate it from *O. coracina*, which has outer corner of outer branch angled (Fig. 8h), epiproct as wide at apex as 0.50 of its basal width (Fig. 15g), and dorsum of S1-8 mostly black (Fig. 4b).

Distribution and biology

Found within the lowland Amazon forest of SE Peru (Fig. 21) flying at a forest oxbow pond, a small lake, and a marsh on the bank of a river.

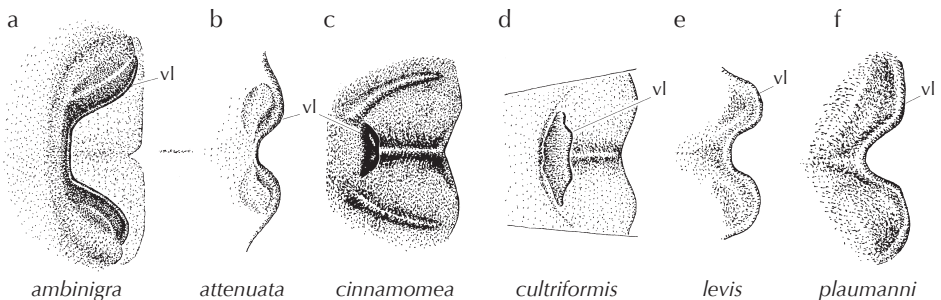


Figure 18: Vulvar lamina, ventral view (to scale) — (a) *Orthemis ambinigra*, Argentina, Punta Lara; (b) *O. attenuata*, Peru, Yarinacocha; (c) *O. cinnamomea*, paratype; (d) *O. cultriformis*, Trinidad, Aripo; (e) *O. levis*, Venezuela, San Esteban; (f) *O. plaumanni*, Peru, Tambopata. vl: vulvar lamina.

Table 1. Diagnostic characters for the species of the *Orthemis levis*-group.

	<i>ambinigra</i>	<i>ambirufa</i>	<i>anthracina</i>	<i>attenuata</i>	<i>cinnamomea</i>	<i>concolor</i>	<i>coracina</i>
Head							
Labial palp black at medial	≥ 0.66	≤ 0.33	≥ 0.50	≤ 0.33	0.20-0.25	0.33	≥ 0.50
Frons	Metallic purple-blue	Reddish brown	Metallic purple-blue	Metallic purple	Reddish brown	Reddish brown	Metallic turquoise-blue
Pterothorax							
Pale areas on sides*	Yellow stripes	Yellow stripes	Yellow stripes	Yellow stripes	Yellow stripes	Yellow stripes	Small brown spots
C-RA space of wings with brown markings	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Abdomen							
Dorsum of S4-6 mostly	Red	Red	Red or black	Black	Black	Black	Black
S4-10 ventrally	Narrowed distally	Narrowed distally	Narrowed distally	Parallel-sided	Parallel-sided	Parallel-sided	Narrowed distally
Ventral width/length S4	0.41-0.5	0.52	0.4	0.22-0.26	0.29-0.34	0.25-0.3	0.42
Posterior hamule							
Outer branch ending respect to inner branch	At same level	At same level	Ventrally	At same level	Ventrally	At same level	Ventrally
Inner branch compared to outer branch	Smaller	Smaller	Smaller	Smaller	Smaller	Smaller	Smaller
Inner branch directed	Posteriorly	Posteriorly	Posteriorly	Posteriorly	Posteriorly	Posteriorly	Posteriorly
Outer corner of outer branch in frontal view	Angled not projected	Angled not projected	Smoothly convex	Angled not projected	Smoothly convex	Angled not projected	Angled not projected
Outer branch ventral surface	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Vesica spermalis							
Paired ventro-lateral spines	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Male caudal appendages							
Cercus curvature in lateral view	Slight	Slight	Marked	Slight	Marked	Slight	Marked
Outer margin of cercus base ventrally	Smooth	Smooth	Markedly concave	Smooth	Smooth	Smooth	Smooth
Epiproct apex distinctly bifid	No	No	Yes	No	No	No	Yes
Width of epiproct apex	≤ 0.33	≤ 0.33	≥ 0.50	≤ 0.33	≥ 0.50	≤ 0.33	≥ 0.50
Female							
Height/width flap of S8	3.3	—	—	4.1-5.2	3	—	—
Vulvar lamina width/S8 width	Subequal	Subequal	—	Subequal	≤ 0.33	—	—

*In mature males pale areas can be obscured entirely (i.e. *concolor*, *levis*).

<i>cultriformis</i>	<i>flavopicta</i>	<i>harpago</i>	<i>levis</i>	<i>plaumanni</i>	<i>philipi</i>	<i>regalis</i>	<i>tambopatae</i>
0.40-0.50	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33
Metallic purple-blue	Metallic blue	Metallic turquoise-blue	Metallic purple	Metallic blue	Metallic purple-blue	Metallic blue	Metallic purple-blue
Yellow stripes	Yellow stripes	Yellow stripes	Yellow stripes	Yellow stripes	Large yellow spots	Yellow stripes	Yellow stripes
Absent	Absent	Absent	Absent	Absent	Absent	Present	Absent
Red or black	Black	Black	Red	Red	Red	Black	Red
Narrowed distally	Narrowed distally	Parallel-sided	Parallel-sided	Narrowed distally	Narrowed distally	Narrowed distally	Narrowed distally
0.35-0.5	0.44-0.56	0.23	0.26	0.62	0.47-0.49	0.48-0.53	0.38-0.45
Ventrally	At same level	Ventrally	At same level	At same level	Ventrally	At same level	Ventrally
Smaller	Smaller	Longer	Smaller	Smaller	Smaller	Smaller	Smaller
Posteriorly	Posteriorly	Anteriorly	Posteriorly	Posteriorly	Posteriorly	Posteriorly	Posteriorly
Smoothly convex	Angled not projected	Angled not projected	Angled not projected	Smoothly convex	Smoothly convex	Angled projected posteriorly	Smoothly convex
Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Grooved
Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent
Slight	Slight	Marked	Slight	Slight	Slight	Slight	Marked
Smooth	Smooth	Markedly concave	Smooth	Smooth	Smooth	Smooth	Smooth
No	No	No	No	No	No	No	No
≤ 0.33	≤ 0.33	≥ 0.50	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33	≤ 0.33
3.2	—	—	4	3.7	—	—	—
0.50	—	—	Subequal	Subequal	—	Subequal	—

KEY TO MALES OF THE *levis*-GROUP OF SPECIES

Positive identification relies primarily on hamular and cercal morphology. Hamules were illustrated both in frontal view (at an angle of view normal to the flat surface of hamule; Figs 8a-o) and in lateral view (coincident to lateral view of abdomen; Figs 9a-o). Since hamules can be variably rotated in life and may assume a variety of positions relative to abdomen after preservation, I advise rotating specimens in order to best compare hamules with illustrations. Following key uses some color pattern characters of head, thorax, and abdomen. However, thoracic color pattern may become obscured due to age and/or postmortem effects; i.e. in *O. concolor* and *O. levis* reddish brown thorax with yellow stripes may become entirely reddish

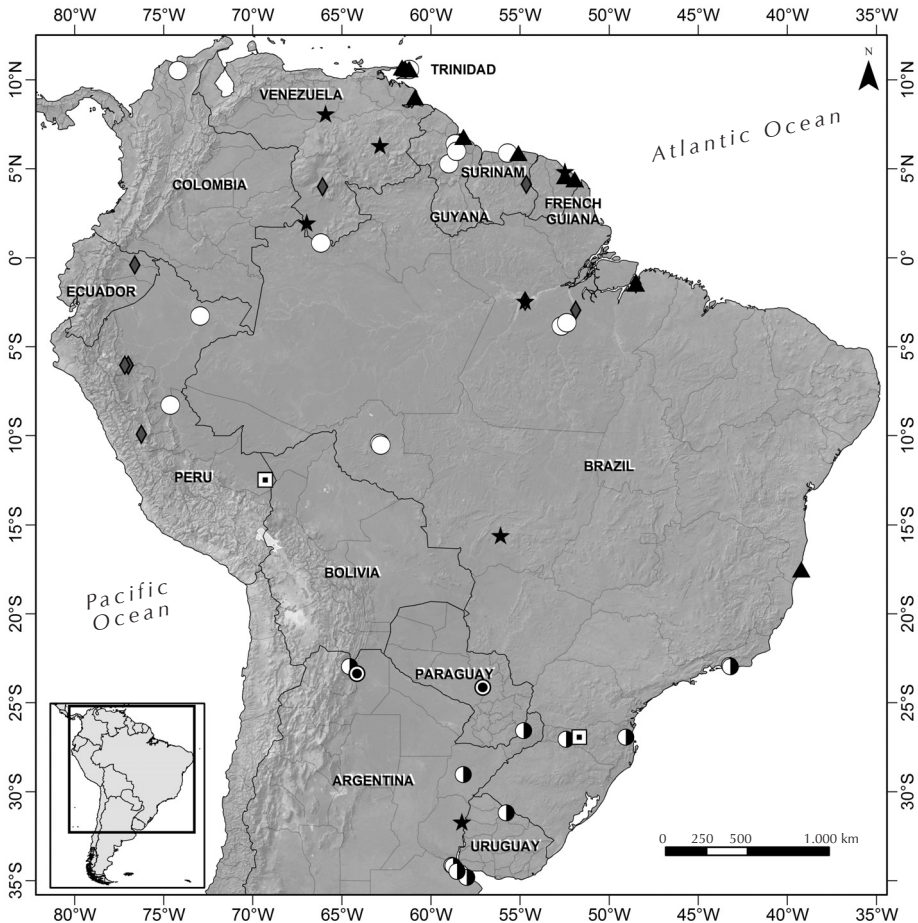


Figure 19: Distribution of species of the *Orthemis levis*-group in the Neotropical region — (●) *O. ambinigra*; (★) *O. ambirufa*; (○) *O. attenuata*; (▲) *O. concolor*; (◐) *O. philipi*; (◑) *O. plau-manni*; (◒) *O. regalis*.

brown in mature specimens. Additionally, abdominal color pattern can be extremely variable in some species; i.e. *O. anthracina* and *O. cultriformis* (Table 1). A wider range of color variability than the one accounted for here may be expected when more specimens become available.

Within the *levis*-group, females of *O. anthracina*, *O. coracina*, *O. harpago*, *O. philipi*, and *O. tambopatae* are unknown, those of *O. ambirufa* and *O. concolor* have been incompletely described, and identity of females described as *O. flavopicta* by Ris (1910) needs to be confirmed as this author misapplied the name (Garrison 1984; Garrison & von Ellenrieder 2004). For these reasons following key is designed primarily for males, although couplets 1-4 will also allow identification of females. Diagnostic characters listed in Table 1 under headings for head, thorax, and abdomen will most likely apply to both sexes, and can be therefore used to narrow identification of females to a smaller number of possible species. Comparison of unknown material to descriptions and figures is advised before considering identifications as final.

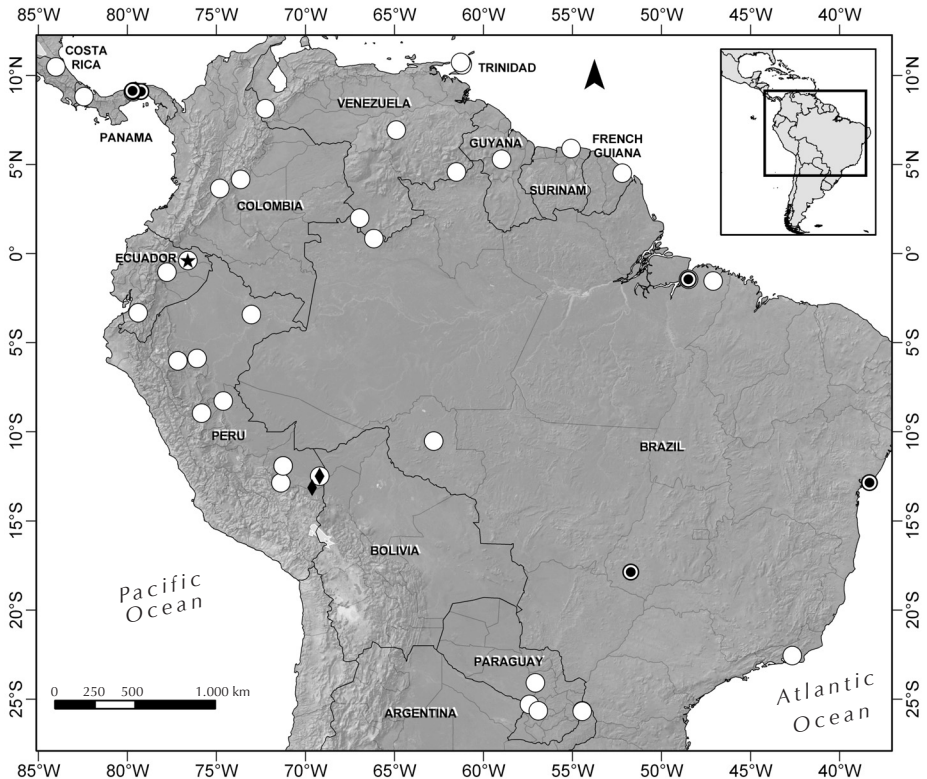


Figure 20: Distribution of species of the *Orthemis levis*-group in the Neotropical region — (★) *O. coracina*; (○) *O. cultriformis*; (⊙) *O. flavopicta*; (◆) *O. tambopatae*.

1. Wings with dark markings on C-RA space (Fig. 3c, Pl. VIIg); larger species (Hw > 50 mm); outer corner of outer branch of hamule triangular and projected ventro-posteriorly in lateral view (Fig. 9n); Venezuela, Surinam, French Guiana, N Brazil, Ecuador, and Peru (Fig. 20) *O. regalis*
- 1'. Wings lacking dark markings along C-RA space (Fig. 3a, Pl. VIIa, c-f); smaller species (Hw < 45 mm); outer corner of outer branch of hamule not triangular and projected ventro-posteriorly in lateral view (Figs 9a-m, o) 2
2. Abdomen extremely slender in ventral view, with ratio of S4 width/length of 0.20-0.34 (Figs 6e, f, Table 1) 3
- 2'. Abdomen less slender in ventral view, with ratio of S4 width/length of 0.35-0.62 (Figs 5, 6c, d, Table 1) 7
3. Dorsum of S1-3 orange or reddish brown, S4-10 mostly dark with narrow orange to yellow medio-longitudinal stripes and sometimes latero-ventral stripes (Figs 4a, c, Pl. VIIb) 4
- 3'. Dorsum of S1-7 orange to reddish brown, S8-10 mostly dark; Mexico to Venezuela (Fig. 22, Pl. VIII) *O. levis*
4. Frons bright metallic purple or blue; with well-defined yellow stripes on mesepisternum (Fig. 2g) 5
- 4'. Frons red to reddish brown with reduced metallic reflections; with ill-defined diffuse yellow stripes or areas on mesepisternum (Figs 2c, Pl. VIIb) 6
5. Frons metallic purple; hamule with outer branch broadly rounded and larger than inner branch and tip of inner branch directed posteriorly (Figs 8d, 9d); outer ventral margin of male cercus smoothly concave at base in lateral view (Fig. 14d); epiproct apex entire, about as wide as 0.33 of epiproct basal width (Fig. 15d); Trinidad, Guyanas, Colombia, NW Brazil, and Peru (Fig. 20) *O. attenuata*
- 5'. Frons metallic blue with turquoise reflections; hamule with outer branch pointed at antero-ventral corner and shorter than inner branch and tip of inner branch directed anteriorly (Figs 8k, 9j); outer ventral margin of male cercus with an abrupt concavity at base in lateral view (arrow in Fig. 14j); epiproct apex bifid, about as wide as 0.50 of epiproct basal width (Fig. 15j); SE Peru (Fig. 22) *O. harpago*
6. Medial 0.20-0.25 of labial palp black; outer branch of hamule pointed and bent ventrally over inner branch; male cercus markedly curved ventrally (Fig. 14e) and converging with opposite cercus along basal 0.70 in dorsal view (Fig. 13a); male epiproct as wide at apex as about 0.50 of its basal width (Fig. 15e); Ecuador and Peru (Fig. 22) *O. cinnamomea*
- 6'. Medial 0.33 of labial palp black; outer branch of hamule broadly rounded and ending on same plane as inner branch; male cercus slightly curved ventrally (Fig. 14f) and converging with opposite cercus along basal 0.50 in dorsal view (Fig. 13b); male epiproct as wide at apex as about 0.33 of its basal width (Fig. 15f); Guyanas, Trinidad, Venezuela, and E Brazil (Fig. 20) *O. concolor*
7. Outer branch of hamule bent ventrally over inner branch (Figs 8c, h, i, m, o) 8
- 7'. Outer branch of hamule ending at about same plane as inner branch (Figs 8a, b, j, n) 12

- 8. Labial palp with medial 0.40 or more black (Fig. 1a); pterothorax dark reddish brown to black with yellow stripes (Figs 2e, i, Pl. VIIa, c, h; in mature males thoracic markings might be obscured and pterothorax be entirely dark) or mostly dark with restricted ventral brown spots (Fig. 2d); Pt dark reddish brown to black 9
- 8'. Labial palp with medial 0.33 or less black (Figs 1b, c); pterothorax marbled (Fig. 2h, Pl. VIIe, f); Pt pale orange brown; Chaco forest in Argentina and Paraguay (Fig. 20) *O. philipi*
- 9. Epiproct as wide at apex as 0.50 of its basal width (Figs 15c, g) 10
- 9'. Epiproct as wide at apex as 0.30 of its basal width (Figs 15h, n) 11
- 10. Outer ventral margin of male cercus with abrupt concavity at base in lateral view (Fig. 14c); inner and outer branches of hamule separated by a distance as long as two times the length of inner branch, postero-ventral corner of outer branch rounded (Fig. 8c); Panama and Venezuela (Fig. 22) *O. anthracina*
- 10'. Outer ventral margin of male cercus smoothly concave at base in lateral view (Fig. 14g); inner and outer branches of hamule separated by a distance shorter than length of inner branch, postero-ventral corner of outer branch angled (Fig. 8h); Ecuador (Fig. 21) *O. coracina*

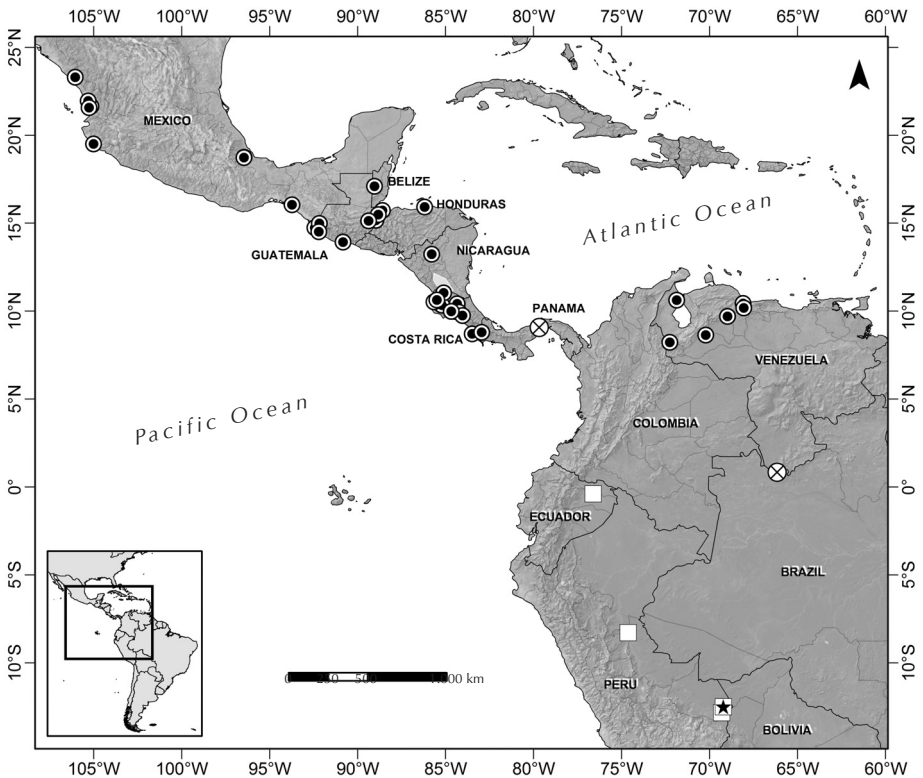


Figure 21: Distribution of species of the *Orthemis levis*-group in the Neotropical region — (⊗) *O. anthracina*; (□) *O. cinnamomea*; (★) *O. harpago*; (⊙) *O. levis*.

- 11. Dorsum of S1-8 red (Figs 4e, Pl. VIIh); inner and outer branches of hamule separated by a distance shorter than length of inner branch, ventral surface of outer branch grooved (gr, Fig. 8o); SE Peru (Fig. 21) *O. tambopatae*
- 11'. Dorsum of S1-7 black, black with red restricted to medio-longitudinal and latero-ventral stripes (Pl. VIIc), or entirely red on S4-7; inner and outer branches of hamule separated by a distance as long as two times the length of inner branch, ventral surface of outer branch smooth (Fig. 8i); widespread from Costa Rica south to NE Argentina (Fig. 21) *O. cultriformis*
- 12. Inner corner of hamule outer branch rounded (Figs 8b, n); cerci tips only slightly upturned (Figs 14b, l); dorsum of S8 lacking black; red extending over S2-8 to S2-10 13
- 12'. Inner corner of hamule outer branch angled (Figs 8a, j); cerci tips markedly upturned (Figs 14a, i); dorsum of S8 with black; red extending over of S2-7 to absent with S1-10 mostly black 14
- 13. Frons red to reddish brown lacking metallic reflections (Pl. VIIa); one crossvein in CuA space; outer corner of outer branch bluntly angled (Fig. 8b); male cercus only slightly curved ventrally (Fig. 14b); Venezuela, Surinam, French Guiana, Brazil, and NE Argentina (Fig. 20) *O. ambirufa*
- 13'. Frons bright metallic purple-blue; two crossveins in CuA space; outer corner of outer branch broadly rounded (Fig. 8n); male cercus markedly curved ventrally (Fig. 14l); SE Peru and SE Brazil (Fig. 20) *O. plaumanni*
- 14. Labium with medial 0.66 or more of palp black (as in Fig. 1a); abdomen mostly red, with black restricted to dorsum of S8-10; distal lobe of vesica spermalis apex lacking a central spine (Fig. 11a); S Brazil, Argentina, and Uruguay (Fig. 20) *O. ambinigra*
- 14'. Labium with medial 0.33 or less of palp black (as in Figs 1b, c); abdomen mostly black, with medio-dorsal yellow stripes on S1-7 and latero-ventral yellow stripes on S1-8; distal lobe of vesica spermalis with a strong central sclerotized spine (Fig. 11e); Panama and Brazil (Fig. 21) *O. flavopicta*

ACKNOWLEDGEMENTS

I thank Rosser Garrison, Dennis Paulson, Jürg De Marmels, Jerrell Daigle, and Thomas Donnelly for critically reviewing the manuscript and for their helpful suggestions; Dennis Paulson and Rosser Garrison for the loan of comparative specimens; Dennis Paulson for the privilege of describing the new species in his collection and for his help gathering color photos, taken both by him and by others; Jason Weintraub (ANSP) for the loan of the lectotype of *Orthemis cultriformis*; Rosser Garrison for his drawings included in this paper; Heinrich Fliedner for advice on spelling and etymology of the new names; and the Consejo Nacional de Investigaciones Científicas y Técnicas de Argentina (CONICET) and FONCyT (PICT 2006-1378) for financial support.

REFERENCES

- Buchholz, K.-F., 1950. Zwei neue *Orthemis*-Arten (Odonata, Libellulinae). Bonner Zoologische Beiträge 1: 79-82.
- Butt, M., 1995. Odonata collected from the Tambopata-Candamo reserved zone, southeastern Peru, August 1992 – January 1993. Notulae Odonatologicae 4: 93-97.
- Calvert, P.P., 1899. A contribution to knowledge of the Odonata of Paraguay. Anales del Museo Nacional de Buenos Aires 7: 25-35.
- Calvert, P.P., 1906. Odonata. In: Godman, F.D. & O. Salvin (eds) „Biologia Centrali Americana: Insecta Neuroptera“. R.H. Porter and Dulau & Co., London, pp. 213-308.
- Calvert, P.P., 1909. Contributions to a knowledge of the Odonata of the Neotropical region, exclusive of Mexico and Central America. Annals of the Carnegie Museum 6: 73-280.
- De Marmels, J., 1988. Odonata del Estado Tachira. Revista Científica Unet 2: 91-111.
- De Marmels, J., 1989. Odonata or dragonflies from Cerro de la Neblina. Academia de las Ciencias Físicas, Matemáticas y Naturales, Caracas, Venezuela 25: 1-78.
- Donnelly, T.W., 1995. *Orthemis ferruginea* – an adventure in Caribbean biogeography. Argia 7 (4): 9-12.
- Garrison, R.W., 1984. *Orthemis flavopicta* Kirby, new for Panama (Anisoptera: Libellulidae). Notulae odonatologicae 2: 48-49.
- Garrison, R.W. & N. von Ellenrieder, 2004. *Orthemis sibylla* a junior synonym of *O. ambirufa* (Odonata: Libellulidae). International Journal of Odonatology 7: 467-470.
- Garrison, R.W., N. von Ellenrieder & J.A. Louton, 2006. The dragonfly genera (Odonata: Anisoptera) of the New World. An illustrated and annotated key. The Johns Hopkins University Press, Baltimore.
- Heckman, C.W., 2006. Encyclopedia of South American aquatic insects: Odonata – Anisoptera. Illustrated keys to known families, genera, and species in South America. Springer, Dordrecht.
- Meurgey, F. & J.J. Daigle, 2007. New status for *Orthemis macrostigma* (Rambur, 1842) from the Lesser Antilles (Anisoptera: Libellulidae). Odonatologica 36: 71-78.
- Paulson, D.R., 1985. Odonata of the Tambopata Reserved Zone, Madre de Dios, Perú. Revista Peruana de Entomología 27: 9-14.
- Paulson, D.R. 1998. *Orthemis discolor* (Orange-bellied skimmer), a new species for the U.S. Argia 10 (1): 7.
- Paulson, D.R. 2001. *Orthemis schmidti* is a widespread species. Argia 13 (3): 24-25.
- Riek, E.J. & J. Kukulová-Peck, 1984. A new interpretation of dragonfly wing venation based upon Early Upper Carboniferous fossils from Argentina (Insecta: Odonatoidea) and basic character states in pterygote wings. Canadian Journal of Zoology 62: 1150-1166.
- Ris, F., 1910. Libellulinen monographisch bearbeitet, Vol. I. Libellulinen 3. Collections Zoologiques du Baron Edm. de Selys Longchamps. Catalogue Systématique et Descriptif 11: 245-384.
- Ris, F., 1919. Libellulinen monographisch bearbeitet, Vol. III. Libellulinen 9. Collections Zoologiques du Baron Edm. de Selys Longchamps. Catalogue Systématique et Descriptif 16 (Deuxième Partie): 1043-1278.
- Westfall Jr., M.J. & M.L. May, 2006. Damselflies of North America. Revised edition. Scientific Publishers, Inc., Gainesville.



Colour plate VII: Neotropical *Orthemis* species of the *levis*-group, males — (a) *O. ambirufa*, tentative identification based on picture as there is no voucher specimen available, Brazil, Mato Grosso State, Cristalino Jungle Lodge, 5 October 2007;— (b) *O. cinnamomea* sp. nov., holotype, Peru, Madre de Dios Department, Explorer's Inn on Río Tambopata, main trail, 23 July 2002; — (c) *O. cultriformis*, Peru, Madre de Dios Department, Cocococha swamp at Explorer's Inn, 29 July 2002; — (d) *O. levis*, Venezuela, Cojedes State, Hato Piñero, 31 December 2000; — (e) *O. philipi* sp. nov., holotype, Argentina, Salta Province, pond at route 15 between route 5 and Las Varas, 23 May 2008; — (f) *O. philipi* sp. nov., paratype, Argentina, Salta Province, pond at route 15 between route 5 and Las Varas, 23 May 2008; left pair of wings clipped; — (g) *O. regalis*, Brazil, Mato Grosso State, Cristalino Jungle Lodge, 25 October 2006; — (h) *O. tambopatae* sp. nov., paratype, Peru, Madre de Dios Department, Tambopata Research Center, forest pond, 20 July 2002. Photos by Johan van't Bosch (a); Dennis Paulson (b-d, h); NvE (e, f); Rich Hoyer (g).

International Journal of Odonatology

Official Organ of the Worldwide Dragonfly Association

Volume 12 (2) 2009



This issue has been prepared in memory of and as a tribute to **Philip Steven Corbet**. It includes invited and submitted papers in the areas of ecology and behaviour as well as taxonomic papers with new taxa names dedicated to Philip.

Philip Corbet died in Cornwall on 13 February 2008, but he lives on through his very exceptional contributions to Odonatology. He was



widely recognised and respected as the World's foremost odonatological authority, and the range and depth of his knowledge was astonishing, as is evident in his wonderful volume 'Dragonflies: behaviour and ecology of Odonata' and his other numerous publications. He was always happy to share his expert knowledge, treating young and older odonatologists as equals and friends, and his enthusiasm and encouragement inspired numerous entomologists of all ages and levels of expertise.

Here odonatologists of the world offer tribute to his memory with eighteen fascinating papers on reproductive behaviour, population ecology, biogeography, morphology, molecular biology, and taxonomy of both temperate and tropical odonates, including seven species named in his honour.

Publication date: 01 October 2009

ISSN 1388-7890