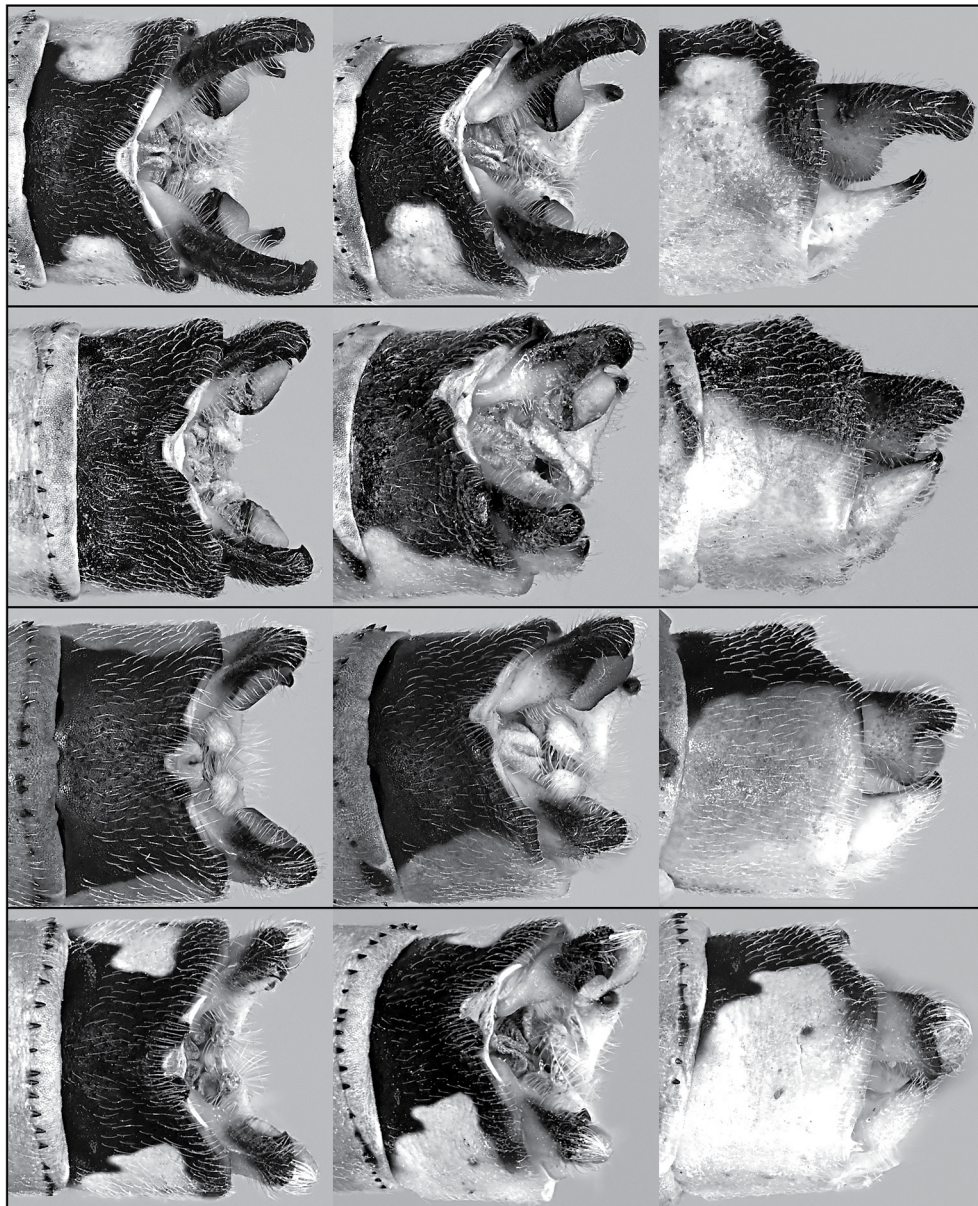


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An Updated List of the Odonata of Coahuila, Mexico, Including Forty-one New State Records and the First Mexican Occurrence of *Libellula composita* (Hagen)

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Key words: Odonata, Mexico, Coahuila, new records, dragonflies, damselflies

Abstract

Records are presented for Odonata located at various sites in the state of Coahuila, Mexico during May 2006 and June 2007. Based upon collected specimens, photos and sightings, 41 species (17 Zygoptera and 24 Anisoptera) are reported as new for the state. Also included is the first Mexican record of *Libellula composita* (Hagen, 1873).

Resumen

Se presentan los resultados de recolectas llevadas a cabo en diferentes sitios del estado de Coahuila, México durante Mayo 2006 y Junio 2007. Basados en el material recolectado, en fotos y observaciones, se incluyen registros de 41 especies de Odonata (17 Zygoptera y 24 Anisoptera) no reportados previamente por el estado. Se incluye el primero registro de *Libellula composita* (Hagen, 1873) para México.

Introduction

The northernmost states of mainland Mexico are (east to west): Tamaulipas, Nuevo León, Coahuila, Chihuahua, and Sonora. Parts of Nuevo León have been investigated by odonatologists making collections at popular sites such as the falls at Cola de Caballo outside Monterrey (D. Paulson pers. comm.). Tamaulipas has received some scrutiny, mainly from collectors taking the coastal route to tropical Mexico and, more recently, during natural history tourism. Recent studies in Sonora (Upson et al. 2007), Tamaulipas (Behrstock 2005, 2006; Behrstock et al. 2007), and Chihuahua (Behrstock et al. 2007) have added numerous species to each state's fauna, presenting a clearer picture of the Odonate fauna near the U.S. border.

In terms of the distribution and diversity of Odonata, Coahuila has remained the most poorly known border state. Most of Coahuila is part of the Chihuahuan Biotic Province with limestone-based desert habitats similar to the Trans-Pecos region of West Texas. Where it has not been cleared for agriculture, the eastern part of the state is predominantly Tamaulipan Scrub; its botanical affinities lie with southeast Texas and northeast Mexico. To the north, Coahuila shares 512 km of the Río Grande (Río Bravo del Norte) with the state of Texas. It also borders the Mexican states of Nuevo León to the east; San Luis Potosí and Zacatecas to the south; and Durango and Chihuahua to the west. With an area of

151,571 km² (58,067 mi²), Coahuila is Mexico's third largest state (Answer.com 2006).

Despite its abundance of deserts, or former deserts converted to crops such as corn and cotton, Coahuila has much to offer for the student of Odonata. Highlands composed of both sedimentary and igneous rocks, including the massive Serranías Del Burro that dominates the northern part of the state, may be well watered and host a diversity of stream species. Between Laredo, Texas and Coahuila's border with Nuevo León, five large rivers (Arroyo las Vacas, Río San Diego, Río San Rodrigo, Río Escondido, and Río Salado) provide habitat for odonates before entering the Río Grande. Several other rivers, including the Río San Juan, join together to form the 161 km long Río Sabinas, that flows off the northeast slopes of the Sierra del Carmen, eventually reaching the state of Nuevo León (Sauls 2002). Of particular interest is the Cuatrociénegas (AKA Cuatro Ciénegas) basin, a 40 km wide depression in the center of the state. Located about 75 km west of Monclova, the area covers over 2,176 km² (840 mi²) and contains nearly 200 ponds fed by springs emanating from the nearby Sierra San Marcos. Much of the basin is protected by the Comisión Nacional de Áreas Naturales Protegidas as the Área de Protección de Flora y Fauna Cuatrociénegas.

Only 24 species of Odonata were recognized from Coahuila—the seventh lowest total among Mexico's 32 states, sug-

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gesting the potential for new distributional records (Paulson & González-Soriano 2007). Additional species of Odonata have been recorded during aquatic invertebrate surveys at Cuatrociénegas (Dinger 2001; Dinger et al. 2005); however, these lists, based entirely on nymphs, are difficult to evaluate, as they contain various taxonomic errors, as well as species unlikely to be found at lower elevations in Chihuahuan Desert habitats, or in Mexico. Therefore, while some species they list may occur at Cuatrociénegas, the lists should be considered tentative. Plans are being made for these nymphs to be reexamined (Dinger and Abbott pers. comm.).

From 22–27 May 2006, Ro Wauer (RW) of Victoria, Texas was among a party of lepidopterists inventorying butterflies in Coahuila. Upon returning, he sent the author a series of photos taken during the trip. About 14 species—nearly all the Odonata he encountered—were new records for Coahuila. These included species photographed in the Maderas del Carmen, an isolated volcanic “Sky Island” mountain range in northern Coahuila that is surrounded by Chihuahuan Desert. Its habitats—desert shrub, chaparral, yucca grasslands, oak-pine forest, and fir forest—are similar to those of Big Bend National Park, barely 60 km to the northwest. However, the Carmens protect a much larger area of high elevation forest than do Big Bend’s Chisos Mountains, and possess more extensive lotic habitat. Few biologists have had the opportunity to visit this area and record its fauna.

From 17–23 June 2007, I accompanied Wauer and other lepidopterists to Coahuila. Concentrating on the northern half of the state, we visited several locations, including: sites in the Maderas del Carmen; the Río San Juan, a tributary of the Río Sabinas just north of the town of Múzquiz; the Cuatrociénegas region; and several other sites that were productive for Odonata. GPS readings and elevations were taken with a Garmin eTrex unit (no endorsement implied) and were especially variable in the canyons of the Maderas del Carmen.

Sites visited during May 2006 and June 2007

22–26 May 2006 (represented by Wauer photos) and 18 June 2007. Campo Uno guest house vicinity, Maderas del Carmen; 28° 59′ 29″ N, 102° 32′ 52″ W; elev. c. 1,825 m. Reservoir and sunny, rocky stream with vegetated side pools below dam spillway.

27 May 2006 (low water with riverside trails available; Wauer photos) and 20 June 2007 (high water with trails and adjacent understory flooded; RAB et al.). Río San Juan, a tributary of the Río Sabinas, c. 10 km N of the town of Múzquiz; 27° 58′ 14″ N, 101° 34′ 53″ W; elev. c. 455 m. Habitats included: cypress-lined river banks, edges of flooded cane beds, tall shrubbery with a flooded understory, dense riparian thickets, and weedy and grassy growth near the river.

17 and 20 June 2007. Pílares airstrip and office building; 28° 51′ 04″ N, 102° 39′ 02″ W; elev. c. 1,220 m. SW side of Maderas del Carmen, buildings and parking areas surrounded by desert scrub.

18–19 June 2007. Campo Dos guest cabin vicinity, Maderas del Carmen; 28° 59′ 24″ N, 102° 36′ 43″ W; elev. c. 2,316 m. Shallow, shaded stream in Western White Pine and fir forest.

18–19 June 2007. Stream crossings between Campo Dos and Campo Uno; elev. c. 2,286–1,830 m.

21 June 2007, Balneario Río Mezquites, c. 8 km SW of Cuatrociénegas de Carranza; 26° 55′ 38″ N, 102° 04′ 46″ W; elev. c. 720 m. Wetlands in Chihuahuan Desert. Large, deep, spring-fed pools connected by chutes and isolated shallow pools surrounded by salt grasses, reeds, sedges and mineralized gypsum soils.

22 June 2007. Centro de Informacion Para Visitantes “Poza Azul” c. 8 km S of Cuatrociénegas de Carranza, 26° 55′ 53″ N, 102° 07′ 28″ W; elev. c. 720 m. Spring-fed pools with vegetation similar to above and narrow streams surrounded by *Phragmites*.

22 June 2007. Roadside ditch approx. 4 km N of town of the town of Cuatrociénegas; 27° 00′ 56″ N, 102° 05′ 07″ W; elev. c. 736 m. Steep sided drainage ditch with shallow water and sparse aquatic vegetation.

23 June 2007. SW side of town of Sabinas; 27° 52′ 07″ N, 101° 08′ 08″ W; elev. c. 345 m. Large, shallow lake with weedy or muddy margins.

23 June 2007. Puente San Rodrigo II stream crossing, c. 64 km S of Ciudad Acuña; 28° 44′ 01″ N, 100° 54′ 46″ W; elev. c. 320 m. Shallow stream and nearby ponds on limestone substrate.

Odonata of Coahuila

First records for Coahuila are preceded by a plus sign (+), and are represented by specimens (21), photos (15), or sight records (5). New records, additional species encountered by our party, and literature records from Paulson and González-Soriano (2007) are combined to form an updated list of the Odonata of Coahuila. All specimens are deposited with the Colección Nacional de Insectos (CNIN), UNAM, Mexico. Photos and sightings are the author’s unless noted otherwise.

Hetaerina americana (Fabricius, 1798)—American Rubyspot: 20 June 2007, common along the Río San Juan on cane and branches over water; 21–22 June 2007, com-

mon along pond edges near moving water and along vegetation-lined streams at Cuatrociénegas.

+*H. vulnerata* Hagen in Selys, 1853—Canyon Rubyspot: 18 June 2007, one male collected from a boulder in the stream below the spillway at Campo Uno.

+*Archilestes grandis* (Rambur, 1842)—Great Spreadwing: May 2006, a newly emerged teneral was photographed in the vicinity of Campo Uno (RW); 18 June 2007, small numbers observed and one male collected at slower, weedy stream edges from Campo Dos down to near Campo Uno.

Lestes alacer Hagen, 1861—Plateau Spreadwing: 18 June 2007, very common in grassy vegetation at reservoir edge at Campo Uno including copulating pairs; three males collected.

+*Acanthagrion quadratum* Selys, 1876—Mexican Wedge-tail: 20 June 2007, one of two males seen was collected from the flooded edge of a stand of introduced giant cane (*Arundo donax* L.) near the banks of the Río San Juan.

+*Argia fumipennis* (Burmeister, 1839)—Variable Dancer: 27 May 2006, an adult was photographed along the Río San Juan (RW); 18 June 2007, a copulating pair was collected from lakeside grasses at the reservoir at Campo Uno; 20 June 2007, common in weedy growth near the Río San Juan, two males collected.

A. hinei Kennedy, 1918—Lavender Dancer: 18–19 June 2007, a few to very common along higher streams in the Sierra del Carmen down to the spillway stream below the reservoir at Campo Uno.

+*A. immunda* (Hagen, 1861)—Kiowa Dancer: 20 June 2007, fairly common in weedy growth near the Río San Juan, one male collected.

+*A. lugens* (Hagen, 1861)—Sooty Dancer: May 2006, both immature and adult males were photographed at the stream below the spillway at Campo Uno (RW); 18 June 2007 same location, at least 15 seen including females and immature males. One adult male was collected.

+*A. moesta* (Hagen, 1861)—Powdered Dancer: 21–22 June 2007, fairly common at pool edges, stream margins, bare ground, and nearby weedy growth at Cuatrociénegas. A pruinose male was photographed (RAB), males and females photographed (RW), perhaps 20, including both blue and brown morph females, were observed.

+*A. munda* Calvert, 1902—Apache Dancer: May 2006, one male photographed near Campo Uno (RW); 18 June 2007,

two males collected and several more seen at both roadside and streamside. Elevation ranged from c. 1,900–2,320 m. In all cases, this species was greatly outnumbered by *A. plana*.

+*A. nahuana* Calvert, 1902—Aztec Dancer: 21 June 2007, perhaps eight seen in salt grass near pond edges at Balneario Río Mesquites, male and female photographed. Many male *A. nahuana* exhibit a black or nearly all black abdominal segment 7. However, on these individuals the black was reduced to a small lateral streak near the front of the segment, and a reduced posterior ring that was not much more than opposing dorso-lateral dots separated by extensive blue on the dorsum. As is occasionally noted with *A. nahuana*, the humeral stripe was unforked.

+*A. plana* Calvert, 1902—Springwater Dancer: May 2006, one male photographed at the stream below the lake at Campo Uno (RW); 18–19 June 2007, common at rocky and vegetated stream edges where photographed (and two males collected) from the vicinity of Campo Dos down to Campo Uno, a range of c. 1,355 m. Like other *A. plana* in the eastern U.S. and northeast Mexico, this population exhibited a bright blue ground color. Calvert (1902) described *A. plana* as a variety of the similar but more westerly occurring *A. vivida* Hagen in Selys, 1865, and he included records of *A. vivida* from Monclova and two sites near Saltillo, Coahuila, as well as from the eastern states of Nuevo León and Veracruz. Gloyd (1958) raised *A. plana* to specific status. Based upon current understanding of its distribution, *A. vivida* is known from neither Sonora (Upson et al. 2008) nor Chihuahua (Behrstock et al. 2008). It is not known from mainland Mexico nor from the area between the Mississippi River and the Rocky Mountains (Garrison 1994). Thus, all records of *A. vivida* from Coahuila likely represent *A. plana*, or perhaps an undescribed member of the *A. vivida* group (Garrison pers. comm.).

+*A. rhoadsi* Calvert, 1902—Golden-winged Dancer: 27 May 2006. An adult male was photographed at the Río San Juan (RW); 20 June 2007, two males collected from the flooded edge of a giant cane bed near the banks of the Río San Juan.

A. sedula (Hagen, 1861)—Blue-ringed Dancer: 20 June 2007, common at the river edge and bare ground near the river at the Río San Juan; 21–22 June 2007, fairly common at pool edges, stream margins, and adjacent bare ground at Cuatrociénegas.

+*A. translata* Hagen in Selys, 1865—Dusky Dancer: 20 June 2007, one of two males seen was collected from low, emergent vegetation along the Río San Juan; 23 June 2007, at least 10 males and females noted along the stream at Puente San Rodrigo II.

Enallagma basidens Calvert, 1902—Double-striped Bluet: 20 June 2007, common in grassy and shrubby growth near the Río San Juan; 21–22 June 2007, common along pond edges and in nearby salt grasses or low shrubs at Cuatrociénegas, male photographed.

E. civile (Hagen, 1861)—Familiar Bluet: 18 June 2007, males were common and a few females were present in grassy and shrubby vegetation along the reservoir at Campo Uno; 19 June 2007, a male and female were in grassy vegetation along the stream just below Campo Dos.

+*E. novaehispaniae* Calvert, 1907—Neotropical Bluet: 20 June 2007, three males were observed and two collected from river edge emergent vegetation at the Río San Juan.

E. praevarum (Hagen, 1861)—Arroyo Bluet: 18 June 2007, many individuals were in lakeside grassy vegetation and emergent grasses at the reservoir at Campo Uno.

E. semicirculare Selys, 1876—Claw-tipped Bluet: Paulson and González-Soriano (2007).

+*Hesperagrion heterodoxum* (Selys, 1868)—Painted Damselfly: May 2006, adults and immatures were photographed in the vicinity of Campo Uno, where common (RW and Jim Brock); 18 June 2007, one male was collected and several more including adult females and teneral were seen in streamside vegetation between Campo Dos and Campo Uno. Several more were seen in grassy lakeside vegetation at Campo Uno.

Ischnura demorsa (Hagen, 1861)—Mexican Forktail: Paulson and González-Soriano (2007).

+*I. hastata* (Say, 1839)—Citrine Forktail: 20 June 2007, one male was collected in grasses surrounding a parking area perhaps 10 m from the Río San Juan; 23 June 2007, one male was collected and two females observed in weedy growth at pond edges near the Puente San Rodrigo II stream crossing.

+*I. ramburii* (Selys, 1850)—Rambur's Forktail: 21 June 2007, one male photographed at the edge of a shallow, mineralized pool at Balneario Río Mesquites. This individual was examined in hand to distinguish it with certainty from the similar Desert Forktail (*I. barberi*). Additionally, one orange female photographed at pond edge (RW); 23 June 2007, one male and two or three females seen at ponds near Puente San Rodrigo II.

+*Telebasis salva* (Hagen, 1861)—Desert Firetail: 20 June 2007, at the Río San Juan, one male was collected from weedy growth near river edge. During the entire trip, only one individual was encountered of this usually common and widespread species.

Anax junius (Drury, 1773)—Common Green Darner: 18 June 2007, one or two males patrolling the reservoir edge at Campo Uno; 23 June 2007, two or three were flying over the lake edge in Sabinas.

+*A. walsinghami* McLachlan, 1883—Giant Darner: 18 June 2007, one male was noted on several occasions as it flew long beats over the stream below the spillway at Campo Uno.

+*Oplonaeschna armata* (Hagen, 1861)—Riffle Darner: 18–19 June 2007, one or two individuals were noted at several stream crossings at higher altitudes between Campo Dos and Campo Uno. All appeared to be males, of which two were collected. One drove off a male *Cordulegaster diadema* that was patrolling the same stretch of water.

+*Rhionaeschna dugesi* (Calvert, 1905)—Arroyo Darner: 18 June 2007, one male was collected from the lake edge at Campo Uno where many were flying.

Aphylla protracta (Hagen in Selys, 1859)—Narrow-striped Forceptail: Paulson and González-Soriano (2007).

Erpetogomphus designatus Hagen in Selys, 1858—Eastern Ringtail: 18 June 2007, one male at the spillway stream below the lake at Campo Uno (examined in hand).

Phyllocycla breviphylla Belle, 1975—Ringed Forceptail: Paulson and González-Soriano (2007).

+*Phyllogomphoides stigmatus* (Say, 1839)—Four-striped Leaf-tail: 21 June 2007, at Balneario Río Mezquites, several were perched on shrubbery or very low growth near water, including one copulating pair (photos RAB and RW); 22 June 2007, at the Poza Azul visitor's center, several were noted on shrubbery near pond edges (photos RAB and RW).

+*Cordulegaster diadema* Selys, 1868—Apache Spiketail: 19 June 2007, two widely separated males were photographed while perched (RAB and RW). These were present at stream crossings in pine–fir forest below Campo Dos at an elevation of c. 2,300 m.

+*Brachymesia furcata* (Hagen, 1861)—Red-tailed Pennant: 23 June 2007, at least four males were perched on branch tips of a tall mesquite near the lake shore at Sabinas. One specimen was taken.

+*Cannaphila insularis* Kirby, 1889—Gray-waisted Skimmer: 20 June 2007, one male of this distinctive species was perched c. 1.5 m high on a tall shrub over a shallowly flooded weedy area c. 5 m from the banks of the Río San Juan.

+*Celithemis eponina* (Drury, 1773)—Halloween Pennant: 21 June 2007, at Balneario Río Mezquites, *C. eponina* was fairly common, perhaps six to eight—mostly females or immatures—were seen perched on the tips of tall salt grasses near ponds. At least two individuals were photographed (RAB and RW). This species has been recorded in Nuevo León (Paulson & González-Soriano 2007) and Tamaulipas (Harp 2008); Cuatrociénegas may represent the third locale for Mexico.

+*Dythemis nigrescens* Calvert, 1899—Black Setwing: 27 May 2006, Río Sabinas, c. 16 km N of Musquiz (RW photos); 21–22 June 2007, several at pool edges and nearby weedy growth at Cuatrociénegas; 22 June 2007, one male photographed in roadside ditch approx. 4 km N of town of Cuatrociénegas.

+*D. velox* Hagen, 1861—Swift Setwing: 22 June 2007, two mature males were seen and one photographed (RAB and RW) in shrubs and cane at the large pond closest to the Poza Azul visitor's center. This is another species recorded infrequently in Mexico, as it appears to be restricted to several northern states.

Erythemis collocata (Hagen, 1861)—Western Pondhawk: Paulson and González-Soriano (2007).

+*E. simplicicollis* (Say, 1839)—Eastern Pondhawk: May 2006, vicinity of Campo Uno where photographed (RW); 20 June 2007, one male was perched near the river edge at the Río San Juan; 22 June 2007, one male was perched in a roadside ditch approx. 4 km N of town of Cuatrociénegas; 23 June 2007, two females were collected from bare ground or low, open growth near the Puente San Rodrigo II and adjacent pools.

+*Erythrodiplax basifusca* (Calvert, 1895)—Plateau Dragonlet: 18 June 2007, one male was collected along an open, rocky section of the stream below the spillway at Campo Uno.

E. funerea (Hagen, 1861)—Black-winged Dragonlet: Paulson and González-Soriano (2007).

+*E. umbrata* (Linnaeus, 1758)—Band-winged Dragonlet: 23 June 2007, in Sabinas, at least three males were seen on low, emergent vegetation at lake edge. One was photographed by RAB and one female was photographed in shrubby growth away from the lake edge by RW; 23 June 2007, common in shrubby growth and tall grasses at shallow ponds near the Puente San Rodrigo II where at least eight were seen. All were yellow but not teneral females or young males. One immature male was taken.

+*Idiataphe cubensis* (Scudder, 1866)—Metallic Pennant: 21 and 22 June 2007, fairly common—perhaps ten seen of which two were photographed—perched on pond edge vegetation at Balneario Río Mesquites and the pools at the Poza Azul visitor's center. Of the four species in the genus *Idiataphe*, only one, *I. cubensis* is known to occur in Mexico. It has been recorded on the Gulf Coast from Tamaulipas through Campeche, the Yucatan and Quintana Roo. The nymphs of *I. cubensis* are known to occur in brackish water (Needham et al. 2000) and many of the pools at Cuatrociénegas have a substantial concentration of gypsum salts, as evidenced by the crystallized mineral crust that covers much of the ground. Examination of the photos and comparison with images from Florida confirm the Coahuila individuals as *I. cubensis* (D. Paulson pers comm.).

+*Libellula comanche* Calvert, 1907—Comanche Skimmer: 20 June 2007, a mature male was observed as it perched c. 1 m above the water in a shallowly flooded weedy area a short distance from the edge of the Río San Juan. The large size, pale blue coloration, rather long wings, white face and mostly white pterostigmas were noted. This is another species that barely penetrates northern Mexico.

+*L. composita* (Hagen, 1873)—Bleached Skimmer: 22 June 2007, a single pruinose male was encountered and photographed (RAB and RW) as it perched on low vegetation near mineralized ponds at the Poza Azul visitor's center. Flying often, it returned repeatedly to the same spot, appearing territorial. The brown areas at the wings bases were very pale on this individual. The nodal spots were pale on the forewings and virtually nonexistent on the hindwings. A characteristic species at mineralized streams and lakes in the Great Basin, south to southern California, Arizona, New Mexico, and the Big Bend region of Texas, *L. composita* was not unexpected in Coahuila. This is the first record for Mexico.

+*L. needhami* Westfall, 1943—Needham's Skimmer: 21 and 22 June 2007, perhaps six males and one female were seen (both sexes photographed by RW and RAB) at pond edges at Río Mesquites and the pools at the Poza Azul visitor's center. Needham's Skimmer is a characteristic and often abundant species in wetlands along the Atlantic seaboard and Gulf of Mexico south to Quintana Roo, where it inhabits both fresh and brackish habitats. Its occurrence this far inland is noteworthy. Published records of *L. auripennis* (Golden-winged Skimmer) at Cuatrociénegas (Dinger 2001; Dinger et al. 2005), a species not known from south of the Texas Coastal Bend, likely refer to *L. needhami*.

Libellula saturata Uhler, 1857—Flame Skimmer: 20 June 2007, several males perched in shrubbery near office buildings at Pilaes; 18 June 2007, numerous on the stream below the spillway at and a few at reservoir edge Campo Uno; 22

June 2007, four or five in territorial dispute over the roadside ditch N of Cuatrociénegas.

+*Macrothemis imitans* Karsch, 1890—Ivory-striped Sylph: 27 May 2006, one male photographed at the Río San Juan (RW).

+*M. inequiunguis* Calvert, 1895—Jade-striped Sylph: 20 June 2007, one female netted from the air by Brock and collected as it flew over a muddy road c. 30 m from a cypress-lined stretch of the Río San Juan.

Orthemis ferruginea (Fabricius, 1775)—Roseate Skimmer: 20 June 2007, one or two males in shrubbery alongside the Pilares airstrip and office complex; 20 June 2007, several males over river edge at the Río San Juan; 22 June 2007, three males in pursuit over the roadside ditch N of Cuatrociénegas.

Pachydiplax longipennis (Burmeister, 1839)—Blue Dasher: 18 June 2007, one male noted on shrubs in a narrow channel near the lake shore at Campo Uno; 23 June 2007, common in shrubby growth around the ponds at Puente San Rodrigo II.

Paltothermis lineatipes Karsch, 1890—Red Rock Skimmer: 18 June 2007, several males and one ovipositing female in the stream below the dam at Campo Uno; 18–19 June 2007, small numbers of males were seen at most stream crossings while descending from Campo Dos to Campo Uno.

Pantala flavescens (Fabricius, 1798)—Wandering Glider: 23 June 2007, one observed flying low over the lake edge at Sabinas.

P. hymenaea (Say, 1839)—Spot-winged Glider: Paulson and González-Soriano (2007).

Perithemis intensa Kirby, 1889—Mexican Amberwing: Paulson and González-Soriano (2007).

P. tenera (Say, 1839)—Eastern Amberwing: Paulson and González-Soriano (2007).

+*Plathemis lydia* (Drury, 1773)—Common Whitetail: May 2006, vicinity of Campo Uno where photographed (RW); 17 June 2007, a female photographed in Chihuahuan Desert scrub along the Pilares office building; 18 June 2007, several in lakeside vegetation and open ground near the reservoir at Campo Uno and others along the stream below the spillway; 20 June 2007, one pruinescent male perched on a dirt trail near the river edge at the Río San Juan.

+*Pseudoleon superbus* (Hagen, 1861)—Filigree Skimmer: May 2006, several individuals photographed in the vicinity of Campo Uno, and Río San Juan (RW); 18 June 2007, one at a wooded stream crossing with much exposed substrate

c. 100 m higher in elevation than Campo Uno; 22 June 2007, one photographed at roadside c. 4 km N of town of Cuatrociénegas.

Sympetrum corruptum (Hagen, 1861)—Variegated Meadowhawk: 21–22 June 2007, several immatures and/or females seen at pond edges and on bare ground at Cuatrociénegas.

+*S. illotum* (Hagen, 1861)—Cardinal Meadowhawk: May 2006. Several individuals were photographed in the vicinity of Campo Uno (RW); 18 June 2007. Several teneral flushed from lakeside shrubbery at the edge of the lake at Campo Uno, and many including ovipositing pairs along the quieter, weedy pools or backwaters of the stream below the reservoir's spillway.

+*Tramea lacerata* Hagen, 1861—Black Saddlebags: 18 June 2007, one perched on tall shrubs at the lake edge at Campo Uno; 22 June 2007, one male at pond edge at Poza Azul; 23 June 2007, several over the lake edge at Sabinas.

+*T. onusta* Hagen, 1861—Red Saddlebags: 18 June 2007, one patrolling the lake edge at Campo Uno; 20 June 2007, two at the Pilares office building flying for five min in the lee of a large mesquite at the edge of a parking area, occasionally dipping toward the ground; 23 June 2007, six or more including ovipositing pairs at the lake edge in Sabinas; 23 June 2007, at least five including ovipositing pairs were observed flying over ponds at Puente San Rodrigo II. Wing pattern, lack of thoracic stripes, and, on some individuals, the pale sides of the last several abdominal segments eliminated similar species.

Discussion

The number of Odonata known from Coahuila is increased from 24 to 65 species. Verification of previously collected specimens (Dinger 2001; Dinger et al. 2005) could increase the total to approximately 70 species. Several days of focused field work should easily bring the state total to 80 species, the same number now recognized from neighboring Chihuahua which shares many similar habitats (Behrstock et al. 2007).

New records for Coahuila include representatives of a number of geographic regions. These consist of species widespread in the U.S. (*Argia fumipennis*, *Ischnura ramburii*, *Erythemis simplicicollis*, *Plathemis lydia*); the southern or southeastern U.S. (*Celithemis eponina*, *Dythemis velox*); the southwest U.S. (*Cordulegaster diadema*), eastern Mexico (*Argia rhoadsi*), western Mexico (*Argia munda*, *Rhionaeschna dugesi*) and tropical America (*Acanthagrion quadratum*, *Brachymesia furcata*, *Macrothemis imitans*).

As anticipated, the Cuatrociénegas area produced some of the most interesting records. Its mineralized waters were home to *Libellula composita*, a species characteristic of the Great Basin, *L. needhami*, a representative of the Gulf Coast fauna, and *Idiataphe cubensis*, a species with a limited inland presence. Several pigmentation characteristics of Odonata at Cuatrociénegas were noted: the barely visible nodal spots of *L. composita* and the reduced abdominal pigmentation of *A. nahuana* may be adaptive over the white, mineralized crust that covers the soil near the ponds.

Acknowledgements

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Presumed *Enallagma anna* Williamson × *carunculatum* Morse Hybrids from Oregon and California

Jim Johnson¹

Key words: Odonata, *Enallagma*, hybrid, damselflies

Abstract

Two presumed male *Enallagma anna* Williamson × *carunculatum* Morse hybrids, one from Crook County, Oregon, the other from Inyo County, California, are described and their abdominal terminalia are figured. Figures of *E. anna* and *carunculatum* are provided for comparison.

Although the frequency of hybridization in Odonata is indeterminable, detected incidents are undoubtedly much less frequent than actual incidents—especially in the case of hybridization between parent species which are similar except upon close examination.

There are few published reports of hybrids among *Enallagma* in North America: *Enallagma optimolocus* Miller & Ivie (1996) from Montana is believed by some odonatologists to be a hybrid between *E. anna* Williamson and *E. carunculatum* Morse, or possibly *E. anna* and *E. civile* (Hagen) (Westfall & May 2006; Garrison 2007); Garrison (2007) mentions a specimen from Oregon, collected by Ken Tennessen, with appendage morphology intermediate between *E. anna* and *E. carunculatum*; Donnelly (2000) reported apparent hybrids of *E. anna* and *E. civile* from Iowa and Ontario; Catling (2001) described an apparent hybrid of *E. ebrium* (Hagen) and *hageni* (Walsh) in Ontario; Williamson (1906) reported apparent hybrids of *E. carunculatum* and *civile* in Indiana, as did Donnelly (2008) from Michigan and New York.

In this paper, I report two presumed male *Enallagma anna* × *carunculatum* hybrids collected by me—one from California and the other from Oregon, USA (Fig. 1). The California specimen was collected 23 June 2003 on Red Pine Canal at the intersection of Hwy 395 and Fish Springs Road, Inyo County (37.1045° N, 118.2534° W, 1185 m elev.). *Enallagma anna* and *E. carunculatum* were both numerous at the time of the collection. The Oregon specimen was collected 25 August 2007 on Crooked River along Hwy 380 about 14 mi. SE Prineville, Crook County (44.1790° N, 120.6243° W, 990 m elev.), in the company of *E. anna*, *E. annexum* (Hagen) (previously known as *cyathigerum* Auct.; see Stoks et al. 2005), and *E. carunculatum*. Both specimens reside in my personal collection at this time.

Although I believe both individuals are *Enallagma anna* × *carunculatum* hybrids, there are noticeable differences in

cerci morphology (Figs. 3, 4). In lateral view, the Crook County, Oregon specimen exhibits a smaller angle (about 90°) between the posterior and ventral arms of the cerci and more of the pale tubercle is visible, extending nearly to the posterior tip of the cerci. This is very similar to the profile illustration of *E. optimolocus* abdominal terminalia presented by Miller and Ivie (1996). The Inyo County, California specimen exhibits a greater angle (more than 90°) between the posterior and ventral arms of the cerci and much less of the tubercle is visible in lateral view. Dorsally, the tubercle is more elongated and thinner on the Oregon specimen, while it is more bulbous on the California specimen.

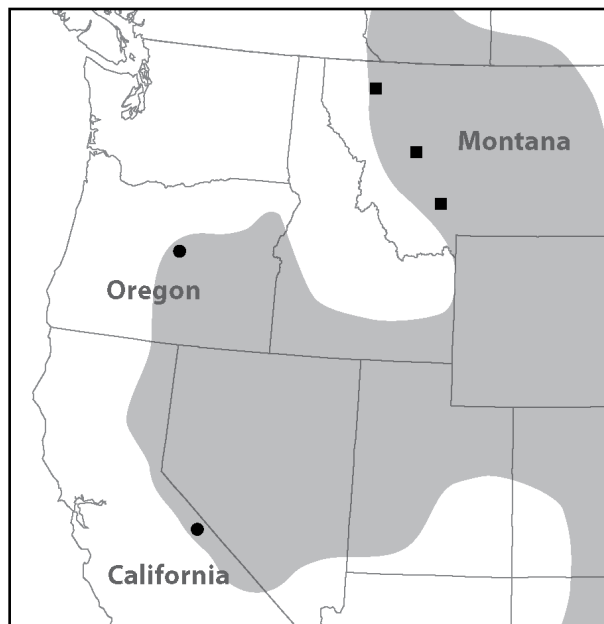
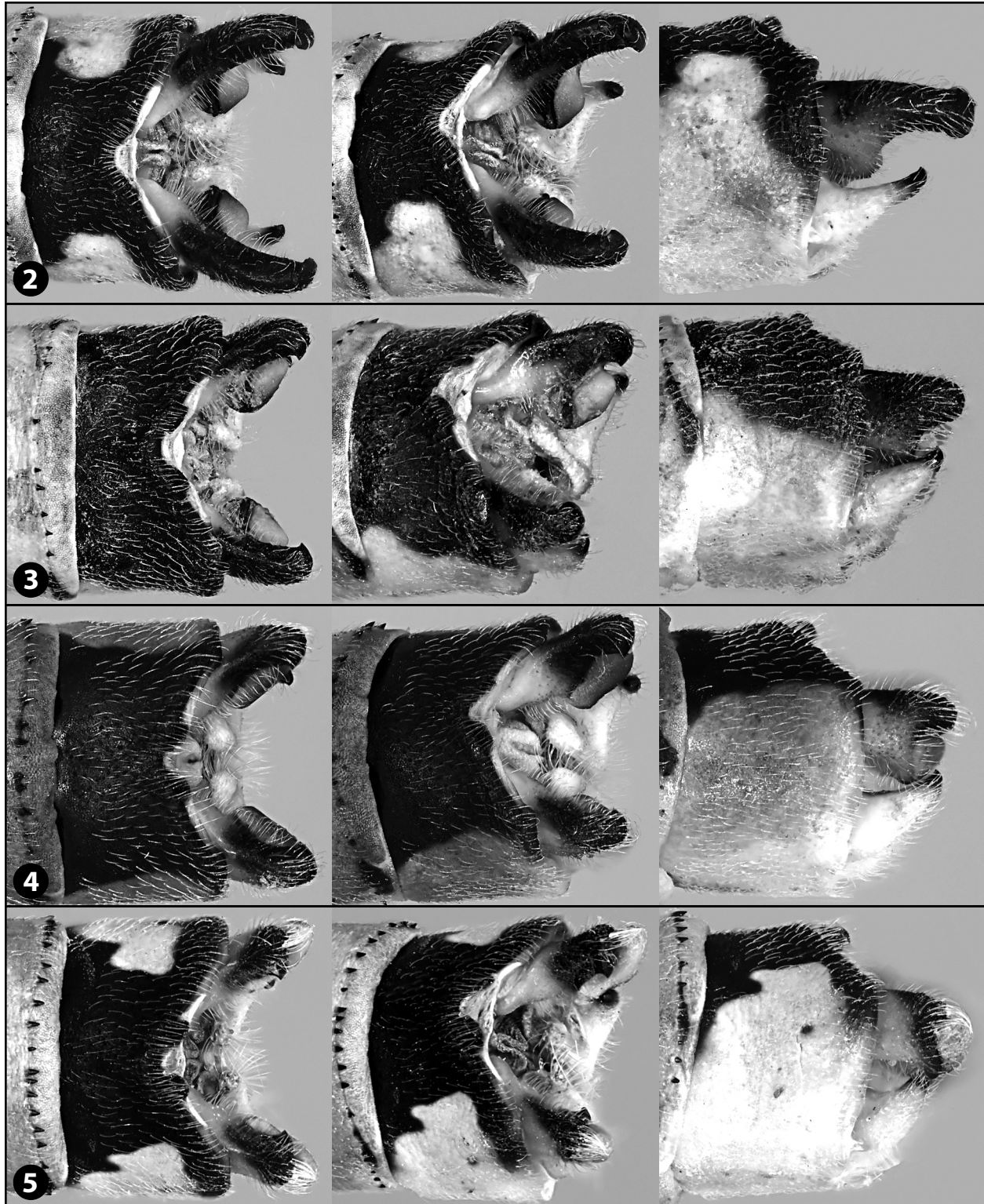


Figure 1. Northwestern contiguous United States. Shaded area is approximate range of *Enallagma anna* within the region based on Abbott (2008); circles indicate the locations of presumed *Enallagma anna* × *carunculatum* hybrids described in this paper; squares indicate the approximate locations of *E. optimolocus* (Miller & Ivie 1996). *Enallagma carunculatum* occurs throughout this region.

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Figures 2–5. Abdominal terminalia of four *Enallagma* specimens; left column, dorsal, middle column, oblique, right column, lateral. Figure 2. *Enallagma anna*, collected 14 September 2002, Twin Springs, Harney Co., Oregon. Figure 3. presumed *Enallagma anna* × *carunculatum* hybrid collected in Inyo County, California, 23 June 2003. Figure 4. presumed *Enallagma anna* × *carunculatum* hybrid collected in Crook County, Oregon, 25 August 2007. Figure 5. *Enallagma carunculatum*, collected 2 May 2004 at Twin Springs, Harney co., Oregon. Photomicrographs courtesy of Steve Valley/Oregon Department of Agriculture.

Typical individual variation may account for these differences. However, the possibility that one or both are backcrosses (i.e. the product of one hybrid parent and one non-hybrid parent) cannot be ruled out either. There is no reason to presume that *Enallagma* hybrids are infertile or otherwise incapable of reproduction.

The amount of black on the middle abdominal segments of each specimen is also different. The Oregon individual exhibits more black: On the third abdominal segment the black area just reaches the midpoint on the dorsal surface; on the fourth segment the black area reaches slightly past the midpoint. This is similar to typical *E. carunculatum*. The abdominal black areas are more reduced on the California individual, extending about two-fifths the length of the third segment on the dorsal surface and just reaching the midpoint on the fourth segment. The anterior ends of these black areas are also more acutely pointed on the California specimen. In these respects this individual is more reminiscent of *E. anna*.

In profile, the cerci of the Oregon specimen, in particular, are reminiscent of those of *Enallagma civile*, however there are no medial teeth basal to the tubercles. Additionally, the amount of black on the middle abdominal segments is greater than is typically seen on *E. civile*, but this feature is presumably more prone to variation.

The possibility that these individuals are *Enallagma anna* × *civile* hybrids must be considered. A sketch of the abdominal appendages of an apparent *E. anna* × *civile* hybrid from Ontario (Donnelly 2000) indicates that a more elongated cercus with a less prominent ventral arm is to be expected. Also, while *E. civile* is certainly in the area where the California hybrid was found (Manolis 2003; Abbott 2008), it is not known to occur in the region where the Oregon hybrid was found (Johnson & Valley 2005; Abbott 2008). Therefore, while the presence of *E. civile* in the lineage of the California hybrid cannot be ruled out, it is unlikely in the case of the Oregon hybrid.

The apparent hybrid *Enallagma* which Ken Tennessen collected in Oregon (Garrison 2007) was also in Crook County in the Crooked River drainage, about 50 km east of the location where my specimen was collected: "OREGON, Crook County; South Fork Crooked River, nr. confluence w/ North Fork; 10 August 1994". Its cerci morphology appears identical to that of the specimen which I collected in Crook County, but it exhibits more black on the middle abdominal segments—about three-fifths of the dorsal surface of the third segment. I believe this is another example of an *E. anna* × *carunculatum* hybrid.

Of note is the fact that the presumed instances of *Enallagma anna/carunculatum* hybridization reported here, plus the

known locations of *E. optimolocus* (regarded as equivalent hybridization), are all on the western fringes of the known range of *E. anna* (Fig. 1).

I am grateful to Steve Valley of the Oregon Department of Agriculture for providing photomicrographs of the abdominal terminalia which appear in this paper. I also thank Dennis Paulson for reviewing those images and offering his opinion regarding the parentage of the specimens. I thank Ken Tennessen for comments on an early draft of this paper and for kindly making his apparent hybrid specimen available for examination. Thanks also to Rosser Garrison and Nick Donnelly for providing valuable comments.

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On a Small Collection of Dragonflies from Barcarena Municipality, Pará State, Brazil, with the Rediscovery of *Acanthallagma luteum* Williamson & Williamson

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Key words: Odonata, *Acanthallagma*, Brazilian Amazon, geographic distribution, Neotropical region, taxonomy, Zygoptera

Abstract

A small series of 42 specimens of Odonata from the Barcarena municipality, northern Brazil, is brought on record. Eighteen species belonging to the families Calopterygidae, Coenagrionidae, and Libellulidae were identified. The rare species *Acanthallagma luteum* Williamson & Williamson is reported for the first time after its description and represents the first record of the genus from Pará state. In addition we provide taxonomic remarks on the Libellulidae *Erythrodiplax fusca* (Rambur), *Gynothemis pumila* (Karsch), *Orthemis ferruginea* (Fabricius) and *Zenithoptera lanei* Santos.

Resumo

Uma pequena série de 42 espécimes de Odonata do município de Barcarena, norte do Brasil, é registrada. Foram identificadas 18 espécies pertencentes às famílias Calopterygidae, Coenagrionidae e Libellulidae. A ocorrência da rara espécie *Acanthallagma luteum* Williamson & Williamson é registrada pela primeira vez após a sua descrição e corresponde ao primeiro registro do gênero para o estado do Pará. Além disso, algumas notas taxonômicas são fornecidas sobre os Libellulidae *Erythrodiplax fusca* (Rambur), *Gynothemis pumila* (Karsch), *Orthemis ferruginea* (Fabricius) e *Zenithoptera lanei* Santos.

Introduction

The dragonfly fauna of the Neotropical region is one of the richest in the world, with more than 1600 species recorded. This number should be much higher considering that the biodiversity is the least known of all biogeographic regions (Garrison et al. 2006; Kalkman et al. 2008).

Among the countries in the Neotropics, Brazil undoubtedly has the highest Odonata diversity with 667 species; at least 220 species are endemic (Paulson 2004). The current estimates could be considered conservative and the total number of the species probably exceeds 730 (cf. Anjos-Santos & Costa 2006). Brazil is the largest South American country and although there are consolidated groups studying dragonflies, its biodiversity is probably underestimated in comparison with other countries of the region with active specialists, i.e. Argentina and Venezuela (von Ellenrieder & Muzón 2008; De Marmels 1990; respectively). Regional faunistic lists are available only for southeastern Brazilian states (e.g. Machado 1998; Carvalho & Nessimian 1998; Carvalho 1999; Costa et al. 2000; Costa & Oldrini 2005; Anjos-Santos & Costa 2006). In comparison, the northern and north-

eastern states, including the entire area of “Amazônia Legal”, despite high richness, are less surveyed.

The aim of this paper is to register a small collection of dragonfly specimens from Barcarena municipality, near the capital Belém, Pará state, northern Brazil. The series includes a rare species of the Coenagrionidae genus *Acanthallagma* Williamson & Williamson, 1924, reported for the first time in this state. In addition, taxonomic remarks on some species of Libellulidae are provided.

Area Description

The Barcarena municipality (about 01° 30' S, 048° 39' W) was visited during an environmental impact assessment for the implementation of an electricity distribution utility, between August and September 2006. Five collecting points were sampled: Loc. 050 (north portion of Igarapé Dendê, 01° 33' 58" S, 048° 44' 48" W); Loc. 060 (south portion of Igarapé Dendê, 01° 34' 27" S, 048° 45' 49" W); Loc. 070 (Igarapé Acuí, 01° 35' 49" S, 048° 45' 11" W); Loc. 110 (Igarapé Pramajó, 01° 34' 34" S, 048° 43' 14" W); and Loc. 120 (Igarapé Japinzinho, 01° 34' 44" S, 048° 41' 37"

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W). This area undergoes intense anthropogenic activities, as it is surrounded by roads and agricultural habitations. Although this area formally is classified as Amazonian rainforest, it is poor in natural dense vegetation.

Results and Discussion

We collected 42 adults of 18 species representing the families Calopterygidae, Coenagrionidae, and Libellulidae (Table 1). All specimens were deposited in the collection of the Departamento de Zoologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro (DZRJ). The majority of the dragonflies registered breed in typical lentic environments, with the dominant family being Libellulidae [e.g. *Erythrodiplax* spp., *Diastatops obscura* (Fabricius, 1775), *Orthemis* spp.].

Some exceptions are the probable stream dwellers *Gynothemis pumila* (Karsch, 1890), *Mnesarete williamsoni* Garrison, 2006, and *Acanthallagma luteum* Williamson & Williamson.

The genus *Acanthallagma*

The enigmatic genus *Acanthallagma* contains three species, i.e. *Acanthallagma caeruleum* Williamson & Williamson, 1924, *Acanthallagma luteum* Williamson & Williamson, 1924, and *Acanthallagma strohmi* Williamson & Williamson, 1924, all described in the same paper. They are small river dwellers with short and wide wings, characterized by a large dark spot on the basal half of both pairs (Williamson & Williamson 1924). Some aspects of their morphology are very peculiar, making them difficult to classify under traditional taxonomic ranks (cf. Davies & Tobin 1984). For example, their wings are very wide and less petioled in comparison with all other Coenagrionidae genera (Williamson & Williamson 1924). These features resemble those found in Calopterygidae, a lineage probably very distant phylogenetically from *Acanthallagma* (cf. Rehn 2003). It has been suggested that *Acanthallagma* is closely related to some Platycnemididae genera, such as the African *Metacnemis* Selys, 1863 (Williamson & Williamson 1924) and the monotypic New Guinean *Thaumatagrion* Lieftinck, 1932 (R. Garrison pers. comm.), the last genus doubtfully included in that family (Gassman 2005). Despite wing venation characters, all other features are very similar to species of *Acanthagrion*

Table 1. List of Odonata species from Barcarena municipality, Pará state, Brazil, with collecting points (described in "Area Description") and respective number of specimens. * = species with taxonomic remarks in text; m = male, f = female.

Family/Species	Collecting Point (Loc.)	Number of Specimens
CALOPTERYGIDAE		
<i>Mnesarete williamsoni</i> Garrison, 2006	120	1 m
COENAGRIONIDAE		
<i>Acanthallagma luteum</i> Williamson & Williamson, 1924*	110, 120	2 m
LIBELLULIDAE		
<i>Brachymesia herbida</i> (Gundlach, 1889)	060	2 m
<i>Diastatops obscura</i> (Fabricius, 1775)	050, 120	6 m
<i>Erythrodiplax basalis</i> (Kirby, 1897)	120	1 m
<i>E. castanea</i> (Burmeister, 1839)	050, 110	3 m, 1 f
<i>E. fusca</i> (Rambur, 1842)*	050, 070, 110	4 m
<i>E. melanica</i> Borror, 1942	120	1 m
<i>E. umbrata</i> (Linnaeus, 1758)	060	1 f
<i>Gynothemis pumila</i> (Karsch, 1890)*	050, 110	3 f
<i>Idiataphe batesi</i> (Ris, 1913)	110	1 m
<i>Micrathyria artemis</i> Ris, 1911	110	1 m
<i>Oligoclada crocogaster</i> Borror, 1931	050	1 m
<i>Orthemis aequilibris</i> Calvert, 1909	060	1 m
<i>O. biolleyi</i> Calvert, 1906	120	1 m
<i>O. ferruginea</i> (Fabricius, 1775)*	060	4 m
<i>Perithemis lais</i> (Perty, 1834)	050	2 m, 1 f
<i>Zenithoptera lanei</i> Santos, 1941*	120	4 m, 1 f

Selys, 1876 (Coenagrionidae), particularly the posterior anal appendages and accessory genitalia of males (Williamson & Williamson 1924).

The geographic distribution of *Acanthallagma* is essentially Amazonian (Fig. 1), with topotypes recorded from the following localities in Brazil: Abunã, Porto Velho municipality (*A. caeruleum*) and Vila Murtinho, Nova Mamoré municipality (*A. luteum*), both from Rondônia state; Nova Olinda, Tapauá municipality (*A. strohmi*) from Amazonas state (Williamson & Williamson 1924). The only published additional information on the genus after the original descriptions is a brief report on the occurrence of *A. caeruleum* from Shushufindi city, Sucumbíos province, Ecuador (Tennesen 1996). On the other hand, there is at least one record of this species from Napo province, also in Ecuador, waiting to be published (D. Paulson pers. comm.). Excluding these records, there is no other information on these species, indicating their rarity.

The two males of *A. luteum* from Barcarena agree almost perfectly with the features reported in the original description, with some variation on the color pattern of the head. One male (Loc. 110) exhibits the tripartite black spot expansion not connected with the triangular area that encloses the median ocellus and there are two small pale spots on each side of the postclypeus (Fig. 2), while the other male (Loc. 120) presents a postocular pale spot only on one side of the head (Fig. 3). Williamson & Williamson (1924) observed

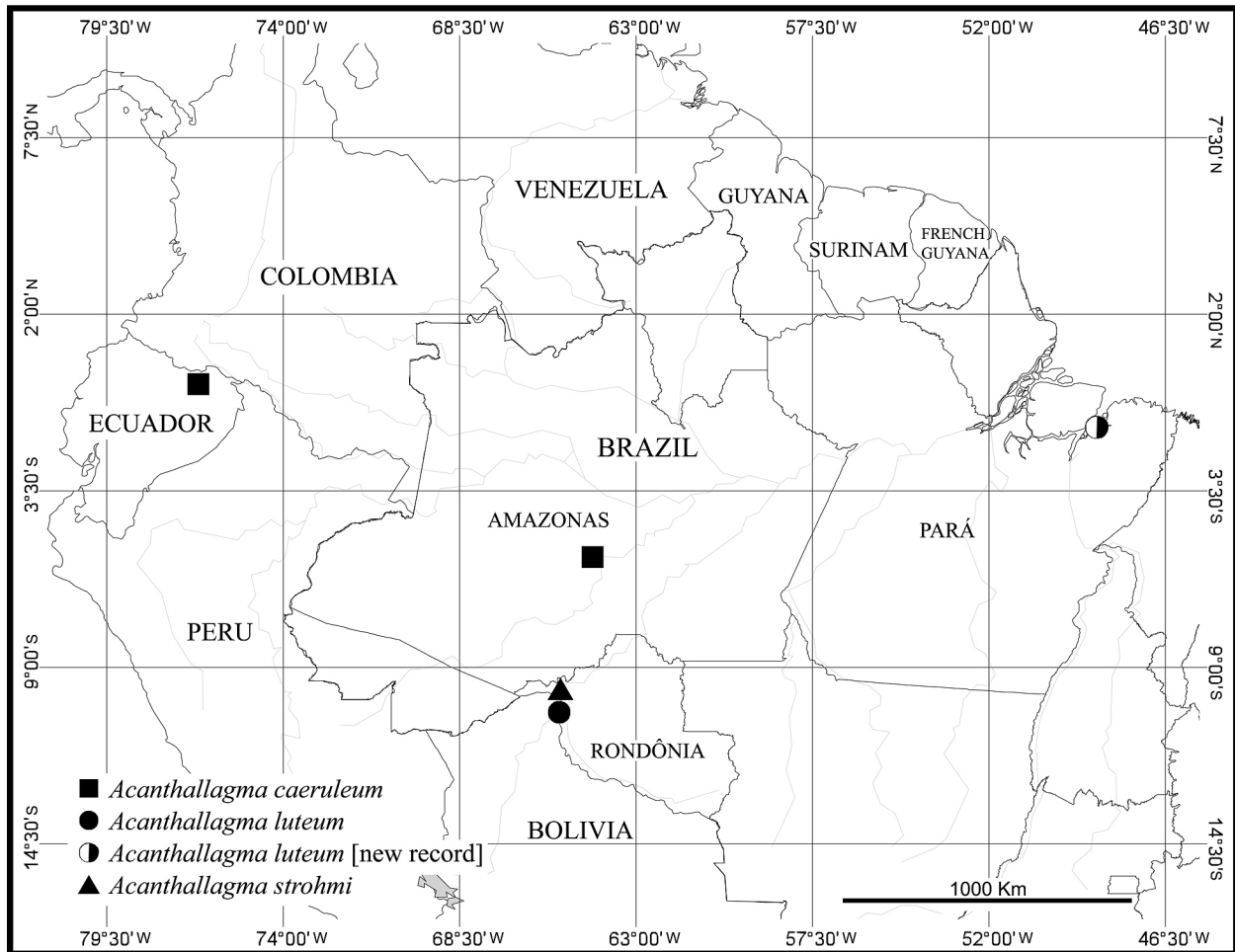
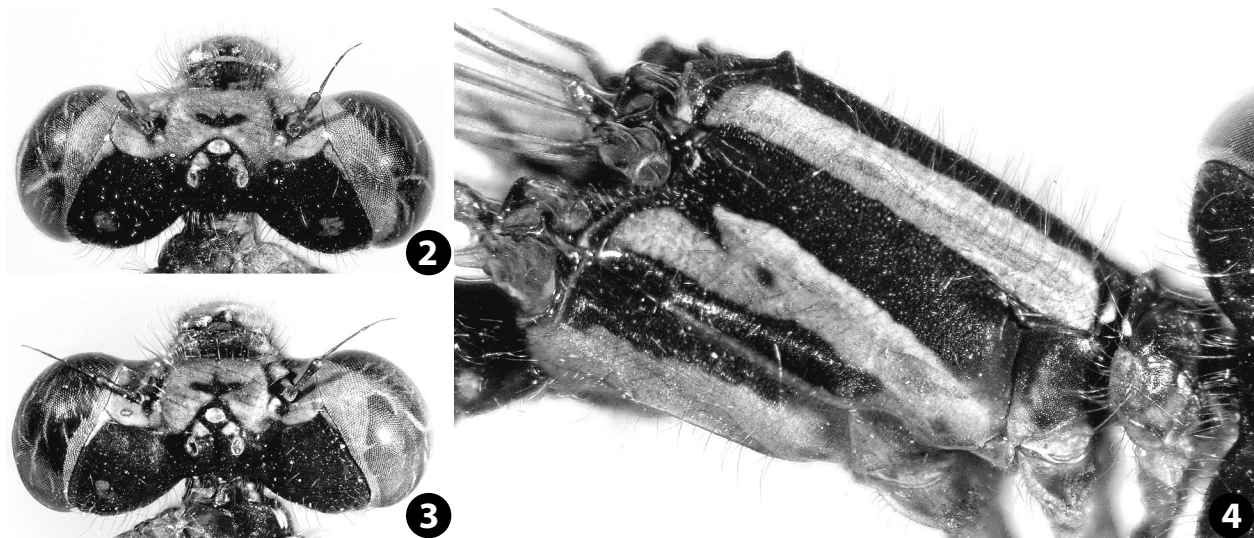


Figure 1. Map of northwestern South America showing published distribution records of *Acanthallagma* species.



Figures 2–4. *Acanthallagma luteum*, adult males. 2. head in dorsal view, specimen from Loc. 110. 3. same of specimen from Loc. 120. 4. thorax in lateral view, specimen from Loc. 120. Pale areas on compound eyes in 2 and 3 correspond to irregular detachment of internal structures from the cuticular lens.

variation in the color of the head in the type specimens and related it to adult maturation. The small rounded dark spot on the yellow stripe between mesepimeron and metepisternum is located on the level of the first lateral suture (intersegmental suture), not on the second lateral suture (metapleural suture) as stated by Williamson & Williamson (1924: 18). Besides the excellent description, they did not draw the head and the thorax. Therefore, to complement the original description, we offer photographs of these parts (Figs. 2–4).

Acanthallagma luteum is reported for the first time after its description; this is the first occurrence of the genus in Pará state. This record is more than 2000 km from the topotype locality, which underscores the very poor knowledge about the distributions of the Amazonian dragonflies. The fact that *A. luteum* was found in an open area occupied by agricultural pastures agrees with the earlier field observations of Williamson & Williamson (1924), and probably this species is not a forest dependent. Collecting expeditions must be made a priority to allow for advances in taxonomy, ecology and conservation of the northern Brazilian Odonata.

Additional taxonomic notes

Erythrodiplax fusca (Rambur, 1842) (Red-faced Dragonlet). This widespread tropical species belongs to the confusing *connata* group of *Erythrodiplax* Brauer, 1868. Paulson (2003) revised this group solving most of the persistent taxonomic questions. This species is commonly confused with the very similar *Erythrodiplax melanorubra* Borror, 1942 based on the red color of the frons, and can be distinguished only by the smaller length of the distal segment of the vesica spermalis (≤ 1.3 mm) and by the larger rounded basal spot on the hind wing (Borror 1942; Paulson 2003). Four males specimens were studied, two with pruinosity on the abdomen (blue form) and two others without evident pruinosity (red form). Concerning the blue specimens (blue-abdomened sensu Paulson 2003), one of them corresponds perfectly to the Paulson's diagnosis, with pruinosity between the transverse carina of segment 3 (S3) tergite and the posterior portion of S7 tergite. The other blue specimen is unusual, with distinctive pruinosity only on S3–S4; this variation has not been previously reported. The red-abdomened males (sensu Paulson 2003) seemingly possess a very thin layer of wax on S3–S7 similar to that found on S5–S7 of the second blue specimen mentioned. All the specimens do not have a true red abdomen, being rather dark brown to black in color. This fact could be explained in part by postmortem color changes. Paulson (2003) suggests that the two forms do not occur in the same area and that those with a red abdomen are represented by two geographically isolated populations, one occurring from southern Pacific coast of Costa Rica to western Ecuador and the other in southern Brazil. Com-

parisons with red-abdomen specimens from Rio de Janeiro state deposited in DZRJ did not show significant differences with the Barcarena specimens. Furthermore, we examined characteristic specimens of the two morphs taken simultaneously in several municipalities in that state (e.g. Angra dos Reis, Magé, Maricá and Rio de Janeiro). Thus, allopatric distribution of the two morphs suggested by Paulson (2003) is not confirmed.

Gynothemis pumila (Karsch, 1890). The genus *Gynothemis* Calvert in Ris, 1909 was recently redefined by Garrison and von Ellenrieder (2006); it is comprised of four species. In that new diagnosis the authors emphasized the difficulty in separating female specimens from those of *Macrothemis* Hagen, 1868 which can be placed in the proper genus only after specific identification. The three females we studied are small; hind wing length less than 21 mm (19.5–20.5 mm) with a large yellow basal spot in both wings; thorax with well-defined yellow stripes; pretarsus with claws subequal in size; abdomen length less than 17 mm (15.0–16.5 mm) and with yellow longitudinal stripes. Although there are some *Macrothemis* species with similar small size (e.g. *M. bellata* Belle, 1987), the combined features convinced us these specimens belong to *Gynothemis*. Garrison and von Ellenrieder (2006: 273) cited *Gynothemis venipunctata* Calvert in Ris, 1909 as the only species with a basal wing spot. Despite the presence of this feature in our specimens, the subequal tarsal claws, well-defined yellow stripes on thorax, and comparison with females from other localities taken with males indicate they are *G. pumila*. The two other possible species, *G. uniseta* Geijskes, 1972 and *G. venipunctata*, have the inferior tarsal claw smaller than the superior, and the thorax is uniformly colored in the latter species, without pale stripes. The subgenital plate is very similar to the figure of *G. venipunctata* furnished by Garrison and von Ellenrieder (2006: 283).

Orthemis ferruginea (Fabricius, 1775) (Roseate Skimmer). This specific name has been applied indiscriminately to five sibling species of the genus for a long time. The status of *Orthemis discolor* (Burmeister, 1839), mainly in relation to *O. ferruginea*, is uncertain. A solution to differentiate these two “species” was proposed primarily by De Marmels (1988) considering the coloration of thorax and abdomen. The northern populations are assumed to constitute mainly *O. ferruginea*, while the southern (including north portion of South America) *O. discolor*, with a large sympatric distribution in Central America and southern Mexico (cf. De Marmels 1988; Donnelly 1995; Paulson 1998a,b). However, the populations in South America are very heterogeneous and probably the two “species” are in sympatry in a large area of this region. *Orthemis ferruginea* has been recorded in the southeastern and southern states of Brazil (Santos 2004; Costa & Oldrini 2005). Based especially on the characteristic dark marks on the thorax, we identified our specimens as

O. ferruginea. Therefore, this assertion concurs with Santos (2004) on the occurrence of *O. ferruginea* in Brazil, at least in the northern states. On the other hand, it is possible that our specimens are representatives of an eastern morph of *O. sulphurata* Hagen, 1868, (J.J. Daigle pers. comm.). This species was described based only on the female holotype which appears to be lost (Santos 2004). The controversy thus far remains unresolved; indeed, this group requires revision (Garrison et al. 2006).

Zenithoptera lanei Santos, 1941. The wing color variation in *Zenithoptera* Bates in Selys, 1869 was extensively studied and ten morphological patterns were proposed based on the disposition of the pale spots (Pujol-Luz 1991; Pujol-Luz & Fonseca 1997). Nevertheless, four of our five specimens of *Z. lanei* do not agree exactly with any of the described patterns. All the specimens have the general wing coloration similar to pattern six. One male differs from this pattern by the reduced subapical spot (SS) on distal portion of the hind wing and by a vestigial costal spot on both wings. Another male and one female present just a weak trace of SS in one or both hind wings. Finally, the two other males do not present SS spot on the hind wing, composing a pattern of coloration very distinct from those proposed by Pujol-Luz (1991).

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New Records of *Acanthagrion* (Odonata: Coenagrionidae) from Colombia

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Key words: Odonata, Colombia, *Acanthagrion*, distribution, Neotropics, damselflies

Abstract

Seven species of *Acanthagrion*, *A. abunae*, *A. adustum*, *A. inexpectum*, *A. minutum*, *A. vidua*, *A. peruvianum*, and *A. viridescens*, are newly reported from Colombia and characters that differ from the original descriptions are mentioned, thus expanding their known variability.

Resumen

Se registran siete especies de *Acanthagrion* para Colombia por primera vez: *Acanthagrion abunae*, *A. adustum*, *A. inexpectum*, *A. minutum*, *A. vidua*, *A. peruvianum* y *A. viridescens*. Se mencionan caracteres que difieren con respecto a las descripciones originales, ampliándose la variabilidad conocida de los mismos.

Introduction

The order Odonata has approximately 5,500 species worldwide and reaches its greatest diversity in tropical zones (Esquivel 2006; Wolf 2006). There are approximately 1,270 species recorded for the Neotropics and a review of the literature indicates that there are 244 species reported for Colombia (Ris 1918; Schorr et al. 2008; von Ellenrieder 2008; von Ellenrieder & Garrison 2008a, 2008b); this low number, compared with the records from Brazil (660 species), Venezuela (487 species), and Peru (368 species), highlights the lack of studies of the order in the country (Schorr et al. 2008). Only a few local surveys have been conducted such as these of Pérez (2003) and Martínez (2006) who added the species *Miathyria simplex* Rambur, 1854 and *Telebasis corallina* (Selys, 1876) respectively to the national records. This note reports seven new records for the genus *Acanthagrion* Selys, 1876 from Colombia.

Materials and Methods

We examined the collections of Entomology of the Instituto de Ciencias Naturales (ICN-MHN-OD), Universidad Nacional de Colombia and the Natural History Museum (ANDES-E), at the Universidad de los Andes. These collections are the most representative of the country with approximately 2,800 specimens each, some of which were collected since 1940. To identify specimens we followed standard procedures for Odonata taxonomy looking at diagnostic characters on male anal appendages and genital ligula, and using the keys of Förster (1999) and Leonard (1977).

Abbreviations: Px = postnodal crossveins, Fw = fore wing, Hw = hind wing.

Results

Each record provides collection data and comments on differences between descriptions and specimens studied.

Acanthagrion abunae Leonard, 1977

Specimens examined: 1 male. Colombia, Meta, Villavicencio, CORPOICA Estación “La Libertad” (04° 03' 43" N, 073° 28' 09" W) 445 m. [ANDES-E 10241]. It was previously known from Guyana, Brazil, and Paraguay (Leonard 1977; Schorr et al. 2008).

Acanthagrion adustum Williamson, 1916

Specimens examined: 1 male. Colombia, Meta, Villavicencio, CORPOICA Estación “La Libertad” (04° 04' 47" N, 073° 27' 40" W). 385 m. [ANDES-E 2666]. Its known distribution included Venezuela, Guyana, Surinam, and Brazil (Leonard 1977; Schorr et al. 2008).

Comments: In lateral view, the middle part of distal portion of genital ligula is narrower than in the illustration provided by Leonard (1977).

Acanthagrion inexpectum Leonard, 1977

Specimens examined: 2 males. Colombia, Cundinamarca,

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rca, La Mesa, Vda. Lagunas (04° 35' 42" N, 074° 27' 49" W). 950 m., 19 Feb 2007. [ICN-MHN-OD 1864–1865]. The species was known from Mexico, Honduras, Costa Rica, Panamá, Belize, and Venezuela (Leonard 1977; Schorr et al. 2008).

Comments: Our material differs from the description and illustrations of Leonard (1977) as follows (alternative states for Leonard in parentheses): nine Px in Fw and eight Px in Hw (10 and 12 Px in Fw and nine to 10 Px in Hw); a group of setae between first and second segment of male genital ligula (absent); row of setae along the first segment of genital ligula absent (present). We emphasize that Leonard did not mention in his descriptions the different location of the hooks on distal segment of genital ligula although his illustrations show them at the base of lateral lobes in *A. inexpectum* instead of at apex of these lobes in *A. abunae*. This is a helpful character to separate these species.

Acanthagrion minutum Leonard, 1977

Specimens examined: 1 male. Colombia, Meta, Villavicencio, CORPOICA Estación “La Libertad” (04° 03' 43" N, 073° 28' 09" W), 445 m. [ANDES-E 3605]. Given the species known distribution from Peru, Bolivia, Argentina, Venezuela, and Brazil (Leonard 1977; Schorr et al. 2008), its presence in Colombia was expected.

Acanthagrion peruvianum Leonard, 1977

Specimens examined: 5 males. Colombia, Meta, Restrepo, Vda. El Palmar, Caño Caribe, 25 Oct 1994; Meta, Villavicencio, Vda. Cocuy, Río Negro, 28 Oct 1994; Meta, Villavicencio, Vda. Buena Vista, Fca. Juanambú, 700 m.; Meta, Acacias, Vda. San José, Colegio Departamental Agropecuario, 660 m., 2 Dec 1985; Meta, San Juan de Arama, Finca, Caño Limón, 400 m., 23 Sep 2005 [ICN-MHN-OD 1125, 1150, 1198 and 1819, ANDES-E 2351]. This species was reported from Peru, Ecuador, and Argentina (Leonard 1977; von Ellenrieder & Muzón 2008).

Comments: Our material differs from the original description (Leonard 1977) as follows (states for Leonard in parentheses): 1. Nine to 11 Px in Fw and eight to 10 Px in Hw (11 to 13 and nine to 11, respectively), 2. Nine and ten Px in Fw (11 and 13 Px), 3. Origin point of R₃ falls within the 5–10% least common variation range described by Leonard; this is just proximal to fifth Px in Fw and fourth Px in Hw for the Colombian specimens. In addition, the last two characters exhibit interesting differences in symmetry. 4. Series of ventrally oriented small setae in first segment of genital ligula (dorsally ori-

ented). 5. Spines only at the top of the dorsal margin of cerci (evenly distributed along). 6. Apex of paraprocts is more curved.

Acanthagrion viridescens Leonard, 1977

Specimens examined: 3 males. COLOMBIA, Meta, Villavicencio, Vda. Buena Vista, Fca. Juanambú, 700 m.; Meta, Villavicencio, Estación La Terraza [ICN-MHN-OD 2225, ANDES-E 2349 and 9051]. This species was known from Ecuador, Bolivia, and Brazil (Leonard 1977; Schorr et al. 2008).

Comments: Abdominal segment 10 is narrower in the specimens studied than that illustrated by Leonard (1977). Width of this structure is measured in comparison to segment 9.

Acanthagrion vidua Selys, 1876

Specimens examined: 5 males. COLOMBIA, Meta, Restrepo, Vda. Caney alto, alrededor de Río Caney, 22 Oct 1994; Meta, Villavicencio, Vda. La Argentina, 04° 13' 22" N, 073° 38' 18" W, 544 m.; Meta, Villavicencio, Balneario Pozo Azul 04° 10' 40" N, 073° 37' 35" W, 593 m.; Cundinamarca, Medina, Vda. Esmeralda, 340 m., 28 Aug 1986. [ICN-MHN-OD 0263, 1166 and 0281; ANDES-E 2684 and 10240]. This species was previously known from Bolivia, Trinidad and Tobago, and Venezuela (Leonard 1977; Schorr et al. 2008). Colombian records are all from the eastern slope of the eastern cordillera.

Comments: We observed small spines located dorsally on male cerci that were not illustrated by Leonard (1977).

Discussion

Of the 40 species described for the genus *Acanthagrion* (von Ellenrieder & Lozano 2008), 13 are now known from Colombia. The geographic distribution of these species is increased along the eastern foothills of the Andes. As mentioned above, the knowledge of Colombian Odonata richness is quite low compared to that of other South American countries and more intensive sampling efforts are needed. With this publication the recorded number of Odonata for Colombia is increased to 251 species.

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Distribution, Status and Ecology of *Cordulegaster sayi* Selys in Georgia, USA (Odonata: Cordulegastridae)

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Key words: Odonata, *Cordulegaster sayi*, distribution, ecology, nymph, conservation status

Abstract

Cordulegaster sayi is one of the most poorly known dragonfly species of the southeastern United States. Over a 13-year period (1996–2008), we documented *C. sayi* from 17 sites in 11 counties in southern Georgia, including nymph collections. At 11 (65%) sites, nymph habitat consisted of mucky seepages at the base of the slopes of xeric sandhills; at the remaining six sites, the habitat consisted of seepages on the slopes of steep hardwood bluffs above major streams (or within ravines associated with these bluffs). Salamanders of the genus *Pseudotriton* (*P. ruber* and *P. montanus*) are characteristic associates of *C. sayi* nymph habitats. Because nymph habitats are perennial seepages located downslope of Longleaf Pine (*Pinus palustris*)–Turkey Oak (*Quercus laevis*) sandhills, and because adults typically forage in these habitats, we consider *C. sayi* a Longleaf Pine ecosystem endemic.

Introduction

Five of the nine species of cordulegastrid dragonflies native to North America are known from Georgia: *Cordulegaster bilineata* (Carle, 1983) (Brown Spiketail), *C. erronea* Hagen in Selys, 1878 (Tiger Spiketail), *C. maculata* Selys, 1854 (Twin-spotted Spiketail), *C. obliqua* (Say, 1840) (Arrowhead Spiketail), and *C. sayi* (Selys, 1854) (Say's Spiketail) (Beaton 2007). Although recent studies have increased our understanding of the distribution and biology of *Cordulegaster* species in Georgia (Mauffray & Beaton 2005; Beaton 2007), the distribution and ecology of the Coastal Plain endemic *C. sayi* remains poorly known. Specific details pertaining to the habitat requirements and nymph ecology of *C. sayi* in Georgia have not been published. This may be attributed to its early and brief flight season, specialized habitat requirements, the difficulty in finding *C. sayi* nymphs in the field, and the species' rarity (Dunkle 1989, 1994; Mauffray 1995; M.J. Westfall, Jr. pers. comm. 1997). Currently, *C. sayi* is listed as "Threatened" by the state of Georgia and is classified as "Vulnerable" on the IUCN Red List of Threatened Species; it has no listing status in the state of Florida.

Herein, we summarize our knowledge of *C. sayi* in Georgia based on collections and field observations made over a 13-year period. We describe in detail the nymph and adult habitat and present new information germane to the ecology of nymphs and adults—including the co-occurrence of *C. sayi* nymphs with salamander larvae. We also discuss the species relationship with the Longleaf Pine (*Pinus palustris*) ecosystem, and map the distribution of the species in Georgia and range-wide.

Methods

We surveyed for *C. sayi* from 1996–2008, with the majority of our surveys conducted from 1996–1997 (Stevenson 1997) and from 2007–2008 (Beaton 2008). To locate *C. sayi* habitat (i.e., mucky seepage habitats associated with sandhills or mesic hardwood forests), we consulted aerial photos, U.S. Geological Survey topographic maps, and U.S. Department of Agriculture county-level soil survey maps. Because Coastal Plain seepages are novel, locally-distributed, and typically picturesque habitats, they leave an impression on those who visit them; thus, we also corresponded with private landowners and biologists in an effort to locate sites. We identified *Cordulegaster* nymphs using diagnostic characters given in Needham et al. (2000) and Carle (1983). *Cordulegaster sayi* nymphs can be distinguished from other *Cordulegaster* species native to the southeastern United States by the following combination of characters: median tuft of setae on frontal shelf sparse; 5 palpal setae; and 5–6 large and 3–4 small premental setae (Minter J. Westfall, Jr. pers. comm. 1997; Needham et al. 2000). Following Ferreras-Romero and Corbet (1999), we measured head width (maximum distance between the lateral margins of the compound eyes) and total body length (maximum distance between the mouthparts and the end of the cerci measured along the dorsal surface) soon after killing nymphs in isopropyl alcohol or hot water. At each site where we documented *C. sayi*, we listed representative canopy, sub-canopy, shrub, and herb layer plant species; we subsequently identified the natural community types present at each site in accordance with a comprehensive ecosystem classification (NatureServe 2008). Based on

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these vegetation associations, we classified *C. sayi* nymph habitat at each site as either a “sandhill–bay swamp seepage” or a “hardwood bluff–ravine seepage”. With respect to the upland habitats proximal to seeps, we defined “intact sandhills” as open-canopied or somewhat open-canopied xeric uplands on sandy soils dominated by Longleaf Pine (*Pinus palustris*), Turkey Oak (*Quercus laevis*), and Wiregrass (*Aristida stricta*) (Wharton 1978); such habitats often showed evidence of recent fire, and typically supported Gopher Tortoise (*Gopherus polyphemus*) populations. We defined “unintact sandhills” as disturbed, lightly developed, and/or fire-suppressed xeric uplands lacking these characteristic plant species. Salamander larvae were identified using Petrunka (1998). We submitted precise locality data for our *C. sayi* observations to the Georgia Natural Heritage Program. Voucher specimens were deposited in the International Odonata Research Institute Collection at the Florida State Collection of Arthropods, Gainesville, Florida, USA.

Results and Discussion

We found *C. sayi* at 17 sites in 11 Georgia counties (Figure 1). These totals include two new county records (Camden and Irwin) and two sites—one each in Evans and Tattnall counties—where *C. sayi* was found in the mid-1990s prior to our surveys (Mauffray 1995). At three of the sites, both adult and nymph *C. sayi* were found; at 11 sites we found only nymphs and at three sites we found only adults (Table 1). We classified 11 (64.7%) of our *C. sayi* localities as sandhill–bay swamp seepages and six (35.3%) as hardwood bluff–ravine seepages (Table 1). Intact sandhill habitat was present at ten (58.8%) of the sites (Table 1). Salamanders of the genus *Pseudotriton* including *P. montanus* (Mud Salamander) and/or *P. ruber* (Red Salamander) were found at 12 of the 15 sites (80.0%) where we located suitable or occupied *C. sayi* nymph habitat.

Nymph Morphology and Ecology

The *C. sayi* nymphs that we collected conformed closely to descriptions in Needham et al. (2000). However, of a large series ($n = 85$) collected 7 July 1997 in Liberty Co., Georgia, some specimens possessed atypical setae counts: 4+5 palpal setae ($n = 1$); 5+6 palpal setae ($n = 6$); 5+5 prementals ($n = 1$); 5+6 prementals ($n = 3$); 6+7 prementals ($n = 1$). The remainder had typical counts of 5+5 palpal setae and 6+6 premental setae.

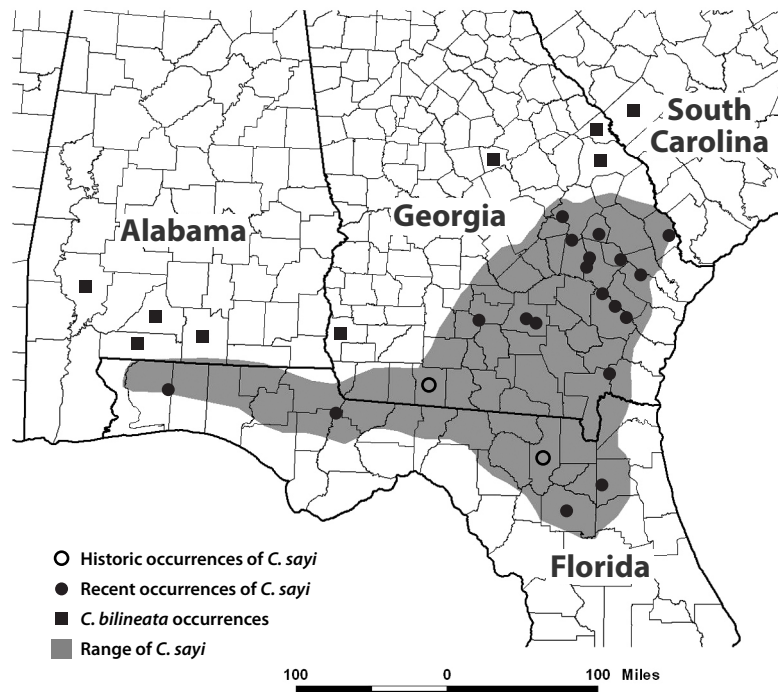


Figure 1: Range-wide distribution (shaded) of *Cordulegaster sayi*. Solid circles represent recent (1995–present) records; open circles represent historic records (Georgia as summarized in this article; Florida from Mauffray and Westfall, 1994; some circles represent more than one site). Solid squares are records of *Cordulegaster bilineata* sites close to range of *C. sayi*, as follows: Alabama from Tennesen et al. (1995) and Steve Krotzer (pers. comm., 2008); Georgia, Mauffray and Beaton (2005) and Giff Beaton (unpubl. data); South Carolina from Kondratieff and Pyott (1987).

Nymph collections made by Mauffray and Westfall (1994) and Stevenson (1997) indicate that *C. sayi*, like other cordulegastrids that have been studied, is semivoltine. In this study, we consistently collected a wide range of *C. sayi* size classes during each of our sampling events (irrespective of season), indicating that nymphs survive multiple years. By plotting the total lengths (TL) of 85 *C. sayi* nymphs collected at a single site on 7 July 1997, we attempted to discern the relationship between age and size cohorts (Figure 2). Although total length data is imprecise due to individual nymphs stretching or compressing their abdomens (Glotzbober 2006), we believe that this sample is large enough to provide meaningful information. These data suggest that nymphs in their first summer, presumably recently hatched, reach a TL of only ca. 5 mm. By their second summer, most nymphs are 14–22 mm TL (with corresponding head-widths [HW] of 3.0–4.2 mm); a lesser peak evident in Figure 2 (nymphs 26–28 mm TL; 4.4–4.6 mm HW) may represent nymphs in their 3rd summer. Final (F-0) instars nearing emergence are from 34–40 mm TL and 7.5–7.6 mm HW.

It is difficult to estimate ages of nymphs after their second summer, perhaps due to split cohort development or variation in growth rates (Ferreras-Romero & Corbet 1999; Glotzbober 2006; Marczak et al. 2006). Although more inten-

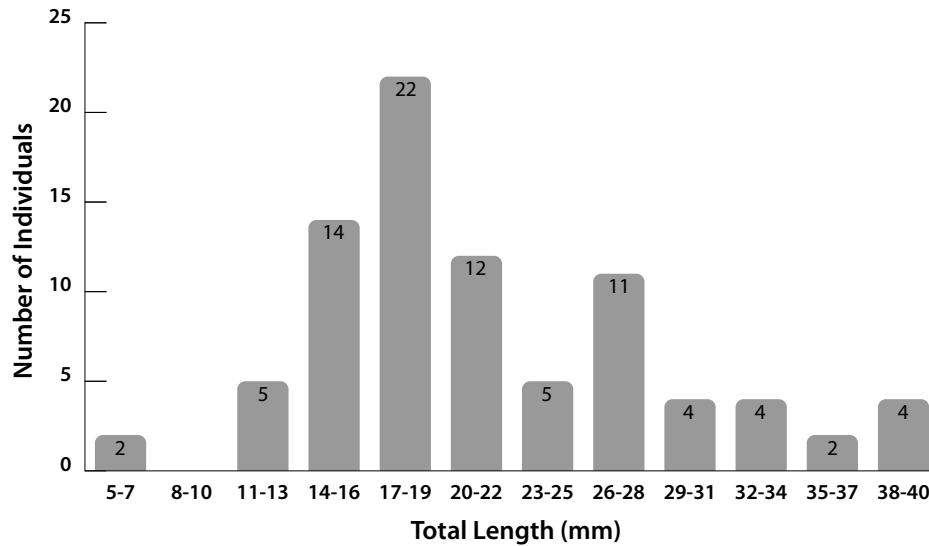


Figure 2: Size distribution (total length in mm) of *Cordulegaster sayi* nymphs (n = 85) collected 7 July 1997 in Liberty County, Georgia.

sive study is clearly needed, we suspect that nymphs emerge in the third or fourth year of life (see Glotzhober 2006 for a thorough discussion and literature review of cordulegastid nymph development).

We collected *C. sayi* nymphs, which rest buried shallowly in muck, by turning, swirling, and sorting by hand saturated (“pudding-like”) or soupy, “slurry-like” muck. The cryptic nymphs would invariably reveal their presence as they kicked and feebly moved about. A number of nymphs that we collected were in shallow muck interlaced with the convoluted roots of Sweet Bay (*Magnolia virginiana*) and Loblolly Bay (*Gordonia lasianthus*). We found that using dipnets or rakes to haul mucky deposits to land is also effective in collecting *C. sayi* nymphs, but this method is discouraged because it is destructive to these small and fragile seepage habitats. At known sites, we typically captured nymphs within a few minutes of searching. At a Liberty Co., Georgia, site where numerous mucky hillside seepages are present on a north-facing Canoochee River bluff, the senior author collected 85 *C. sayi* nymphs on 7 July 1997. Only ca. 10% of the habitat was sampled; when this site was revisited in 2007, *C. sayi* nymphs of various size classes were found with little effort, suggesting that the species is still flourishing at this site.

The mucky seepages inhabited by *C. sayi* nymphs abound with invertebrate life, especially amphipods, annelids, and occasionally isopods or crayfish. Fish were absent from these seepages, and other species of odonate nymphs were virtually never encountered. Glotzhober (2006) similarly reported no fish and a paucity of other odonates from *Cordulegaster erronea* habitats in Ohio. We collected nymphs of three other *Cordulegaster* species during our surveys: *Cordulegaster bilineata*, *C. maculata*, and *C. obliqua*; two of these (*C. maculata*, *C.*

obliqua) occurred sympatrically with *C. sayi*. In areas of sympatry, nymphs of *C. sayi* and other *Cordulegaster* species are typically found in different habitats (Carle 1983; Westfall pers. comm. 1997). However, we did find *C. sayi* and *C. obliqua* nymphs syntopically at one site. Unlike Dunkle (1981), we never found *Tachopteryx thoreyi* (Gray Petaltail) and *C. sayi* nymphs together. We only documented *T. thoreyi* at one *C. sayi* site; however, we did not target this species and suspect that it was present at other *C. sayi* localities.

Salamanders are typically abundant in and near *C. sayi* habitats. We captured Southern Two-lined Salamander (*Eurycea cirrigerra*) larvae in syntopy with *C. sayi* nymphs at many sites. We also captured larvae and adults of the Spotted Dusky Salamander (*Desmognathus fuscus conanti*) in syntopy with *C. sayi* nymphs where their ranges overlap in the Altamaha and Savannah River basins. Notably, at most (85.7%) sites where we collected *C. sayi* nymphs we found larvae and adults (usually larvae) of the Red Salamander (*Pseudotriton ruber*) and/or Mud Salamander (*P. montanus*). Both of these salamanders are confirmed seepage denizens, with aquatic larvae that frequent mucky seepages (Means 2000; Stevenson 2008). In the Coastal Plain, Red Salamanders have a larval period of 18–24 months (Semlitsch 1983), while Mud Salamanders have a larval period of 15–17 months (Bruce 1975; Stevenson 2008). We posit that *Pseudotriton* species and other salamander species with aquatic larvae that inhabit mucky seepages may be important predators, prey, and/or competitors with *C. sayi* nymphs. Red Salamander larvae typically co-occur with nymphal *C. erronea* (Tiger Spiketail) in spring-fed streams habitats in Ohio, and it has been suggested that both are dominant predators of these habitats (Glotzhober 2006).

Adult Ecology

We observed adult *C. sayi* from 8 March to 4 April. These observations are within the reported flight dates for the species (Needham et al. 2000). We observed adults feeding on nectaring hymenoptera in Turkey Oak sandhill habitats; adults in copulo in sandhill habitats on 4 April and on 6 April; and female *C. sayi* ovipositing in mucky seepages on 9 March and 2 April. At both sites where we

Table 1: Descriptive details for known *Cordulegaster sayi* sites in Georgia (see text). Legend: Y = yes; N = no; U = unknown due to lack of surveys; 1 = sandhill–bay swamp seepage; 2 = hardwood bluff–ravine seepage.

GA County	Site Name	Lat/Long*	Yr. Disc.	Adults	Nymphs	Nymph Habitat	<i>Pseudotriton montanus</i>	<i>Pseudotriton ruber</i>	Intact Sandhill
Camden	private tract	31.01° N, 81.90° W	2005	N	Y	2	Y	N	N
Candler	R.G. Daniels Prsrv. (TNC)	32.35° N, 82.03° W	1997	Y	N	1	U	U	Y
Coffee 1	private tract	31.53° N, 82.82° W	1996	N	Y	1	N	N	N
Coffee 2	private tract	31.49° N, 82.75° W	2000	Y	N	1	U	U	Y
Effingham	private tract	32.35° N, 81.25° W	1997	Y	Y	2	Y	N	N
Emanuel	Ohoopsee Dunes Prsrv (TNC)	32.52° N, 82.45° W	1996	N	Y	1	N	Y	Y
Emanuel	Covena Tract (GA DNR)	32.49° N, 82.41° W	2008	N	Y	1	Y	Y	Y
Evans	Fort Stewart	32.11° N, 81.78° W	1995	Y	Y	1	Y	Y	Y
Irwin	private tract	31.50° N, 83.38° W	2008	N	Y	1	N	N	Y
Liberty	Fort Stewart	31.96° N, 81.56° W	1996	N	Y	2	Y	N	N
Tattnall 1	Gordonia-Alata-maha St. Pk.	32.08° N, 82.14° W	1985	N	Y	1	N	Y	N
Tattnall 2	private tract	32.04° N, 82.16° W	2008	N	Y	1	Y	N	Y
Toombs	private tract	32.29° N, 82.35° W	1997	Y	N	1	N	Y	Y
Wayne 1	private tract	31.78° N, 81.99° W	1996	Y	Y	2	N	Y	N
Wayne 2	private tract	31.67° N, 81.85° W	2008	N	Y	2	N	Y	N
Wayne 3	Penholoway Swamp WMA	31.55° N, 81.75° W	2008	N	Y	2	N	N	Y
Wayne 4	Penholoway Swamp WMA	31.55° N, 81.72° W	2008	N	Y	1	Y	N	Y

* Precise coordinates not provided to protect habitat.

observed oviposition a nearly imperceptible flow of seepage water trickled over the muck where the female deposited her eggs. A female observed on 9 March oviposited in the manner described by Carle (1983), dipping her abdomen ca. 70 times at intervals of less than one second. At several sites we searched for, but were unable to find, exuviae of *C. sayi*.

Habitat Description

All *C. sayi* nymph collections were made from 1st–2nd order mucky, perennial seepages (i.e., ground water springs originating from small, nearby sand aquifers issue water continuously year-round) surrounded by forest. The *C. sayi* seepages that we visited during a protracted drought (1998–2001) were flowing. Muck is partially decomposed organic matter (i.e., not inorganic clay and silt) formed by slow but steady decomposition of hardwood litter (Means 2000). Muck and peat deposits require constant water in which to form, otherwise they will decompose quickly (Means 2000). The peaty muck that comprises *C. sayi* nymph habitat is usually reddish-brown or brown in color; often a slight, nearly imperceptible current of water flows over the muck. These seepages form narrow (1–2 m wide) and shallow rivulets that flow downslope where they ultimately join 3rd order sand-bottomed streams or hardwood swamps in stream floodplains.

In Georgia, bay swamp (i.e., baygall) vegetation typically occurs adjacent to the mucky seeps inhabited by *C. sayi* nymphs. Canopy species include Sweet Bay (*Magnolia virginiana*), Swamp Red Bay (*Persea palustris*), Loblolly Bay (*Gordonia lasianthus*), Swamp Black Gum (*Nyssa biflora*) Tulip Poplar (*Liriodendron tulipifera*), and Loblolly Pine (*Pinus taeda*); characteristic shrubs include Sweet Pepperbush (*Clethra alnifolia*), Fetterbush (*Lyonia lucida*), Dog Hobble (*Leucothoe axillaris*) and Large Gallberry (*Ilex coriacea*). Other than sparse ferns (*Woodwardia* spp., *Osmunda* spp.), or occasionally Bog-moss (*Mayaca fluviatilis*), living green vegetation in the actual seeps is scant; lush growth of *Sphagnum* moss often fringes the margins of the seeps. Convoluted surface roots of bays and other trees are a hallmark of seepage environments. NatureServe (2008) classifies these communities as “Sandhill Swamp Black Gum Hillside Seepage Forest” (CEGL004645) and “Loblolly Bay Forest” (CEGL007044).

Eleven (64.7%) of our *C. sayi* localities are best described as “sandhill–bay swamp” seepages located at the base of gently sloping xeric sandhills; eight of these seepages may be further described as located at the base of aeolian dune-type sandhills (Ivester & Leigh 2003). In the Atlantic Coastal Plain of southeastern Georgia, large (up to 8 km long) parabolic-shaped ridges of deep (10–30 feet), excessively

well-drained sands (soil type: Kershaw) of aeolian origin are present along the northeastern side of major blackwater streams and their major tributaries (Wharton 1978; Ivester & Leigh 2003). Seepages are often located downslope from the porous sands of these ridges (Wharton 1978; D. Stevenson unpubl. data).

We classified nymph seepages for the remaining six (37.5%) *C. sayi* sites as “hardwood bluff–ravine” seepages. These seepages were located directly on steep, mesic bluffs (usually north-facing)—or within ravines incised into these bluffs, above major streams or their floodplains. Mature mixed hardwood forest communities, the beech-magnolia slope forests of Wharton (1978), characterize these habitats. Canopy dominants include American Beech (*Fagus grandiflora*), Southern Magnolia (*Magnolia grandiflora*), White Oak (*Quercus alba*), and Spruce Pine (*Pinus glabra*); sub-canopy components include American Holly (*Ilex opaca*) and Wild Olive (*Osmanthus americanus*); common shrub and ground cover species are Horse-sugar (*Symplocos tinctoria*), Giant Cane (*Arundinaria gigantea*), and Partridge Berry (*Mitchella repens*). NatureServe (2008) classifies these communities as “Atlantic Coastal Plain Acidic Loam Beech-Magnolia Forest” (CEGL007459). These habitats are uncommon and locally distributed in southern Georgia (Wharton 1978). Longleaf Pine sandhills are located upslope (i.e., atop these mesic bluffs) under natural conditions (Wharton 1978). Mauffray (1995) also reported *C. sayi* from steep-sided hardwood habitats in northern Florida.

Distribution and Status

Prior to our surveys, *C. sayi* was reported from only three counties in Georgia, namely Thomas (Bick 1983), Evans, and Tattnall (Mauffray 1995). The original description of *C. sayi* by Selys (1854) was based on a specimen from Georgia without further data. Our surveys indicate that *C. sayi* is more widely distributed in southeastern Georgia than previously recognized, and document that the Vidalia Uplands physiographic province, a vast sandhill region where moderate relief produces numerous seepages (Wharton 1978), is an important area for this dragonfly. We documented *C. sayi* from the Alapaha, Altamaha, Ogeechee, Satilla, and Savannah River watersheds. Our Savannah River basin collection (seepage adjacent to Ebenezer Creek, Effingham County) is within 6.5 km of the South Carolina state line; however, suitable *C. sayi* mucky seepage habitats are not known from the adjacent lower Coastal Plain of South Carolina (D. Stevenson pers. obs.; Steve Bennett, South Carolina Department of Natural Resources, pers. comm. 2008).

As currently known, the Georgia range of *C. sayi* barely extends into the Upper Coastal Plain and does not extend into the Fall Line Sandhills physiographic province. Nor has the species been collected in extreme southwestern Georgia

or southern Alabama (Tennessen et al. 1995; S. Krotzer pers. comm. 2008). It appears to be replaced by its close relative *C. bilineata*, whose nymphs also inhabit mucky seepages, in the above-mentioned regions (Carle 1983). These two species have not been found to occur sympatrically; however, two adults that appear to be intermediate between *C. sayi* and *C. bilineata* were collected in southern Alabama, Escambia County, in 1993 by Steve Krotzer (Tennessen 2004).

We propose classifying *C. sayi* as a Longleaf Pine ecosystem endemic. Based on our observations and those of Mauffray (1995), and a review of USDA soil maps, the open-canopied upland habitats (required by foraging adults) upslope and adjacent to all known *C. sayi* nymph sites in Georgia are—or were historically prior to anthropogenic disturbance—dominated by Longleaf Pine–Turkey Oak sandhill communities. To our knowledge, this is also true for all *C. sayi* sites in Florida (Dunkle 1994; Mauffray 1995). The fact that only nine of our 16 *C. sayi* sites are within intact sandhill landscapes indicates that *C. sayi* populations may persist at sites where native uplands have been degraded (due to forestry practices, fire suppression, light residential development, etc.). At sites lacking good-condition sandhills, adult *C. sayi* are exploiting primitive roads, cutover, weedy fields, and similar anthropogenic light gaps (this study; also Dunkle 1994; Mauffray 1995). Habitat management practices on public lands and preserves that foster open-canopied sandhills (e.g., prescribed fire, selective thinning, hardwood control) also benefit *C. sayi*.

Presently, *C. sayi* is known from approximately 25 sites range-wide (this study; Bill Mauffray pers. comm. 2008). Our field experience suggests that the species is uncommon and locally distributed, albeit widespread, in southeastern Georgia.

Of the 17 known Georgia sites, eight are located on publicly-owned lands (two on a Department of Defense military installation, two on preserves owned by The Nature Conservancy, and four on state lands managed by the Georgia Department of Natural Resources). We concur with Bick's (2003) designation of *C. sayi* as “Rare” (i.e., a species with a rare habitat type and/or a small geographic range) and recommend periodic monitoring of known sites and surveys for new sites.

Acknowledgements

We are indebted to the late M.J. Westfall, Jr. for graciously sharing his expertise. Our *Cordulegaster* nymph specimen identifications were confirmed by M.J. Westfall, Jr. and by S. Krotzer. The senior author tips his odonate hunting cap to S. Roble for his endless support and encouragement. S. Krotzer assisted with field and habitat surveys. B. Mauffray was helpful throughout this study. K. Tassin and B. Willis-Stevenson assisted with surveys and in locating habitat. B. Albanese

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Notes on the Odonata of Refugio de Fauna Monte Cabaniguán, Las Tunas, Cuba

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Key words: Odonata, Cuba, Cabaniguán, records, dragonflies, damselflies

Abstract

The Odonata fauna at Refugio de Fauna Monte Cabaniguán (Las Tunas Province) in eastern Cuba is brought on record. A total of 19 species in four families (Lestidae, Coenagrionidae, Aeshnidae, Libellulidae) were collected; 15 were libellulids.

Refugio de Fauna Monte Cabaniguán is the second largest wetland of Cuba, located south of Las Tunas (Fig. 1). This refuge covers 14,000 acres, of which 2,500 are covered by semideciduous mesophytic forest and the rest by swamps. About 50% of Cuban endemic bird species occur there, and it hosts the largest populations of aquatic birds in the Antilles, as well as populations of American crocodile, *Crocodylus acutus* (Cuvier), and Cuban iguana, *Cyclura nubila* (Gray).

The aim of this research was to determine the dragonfly fauna of this refuge; two surveys were conducted, 1–7 August 2005 and 26–30 June 2008. Four sites were visited: the surroundings of the Estación Biológica Don Miguel Álvarez del Toro (EB); La Salina (LS) by the East shore of the station; the savanna of *Copernicia* (SC) at the border between salt marsh and savanna; and Puentecito (P) to the north of the swamp (Fig. 1).

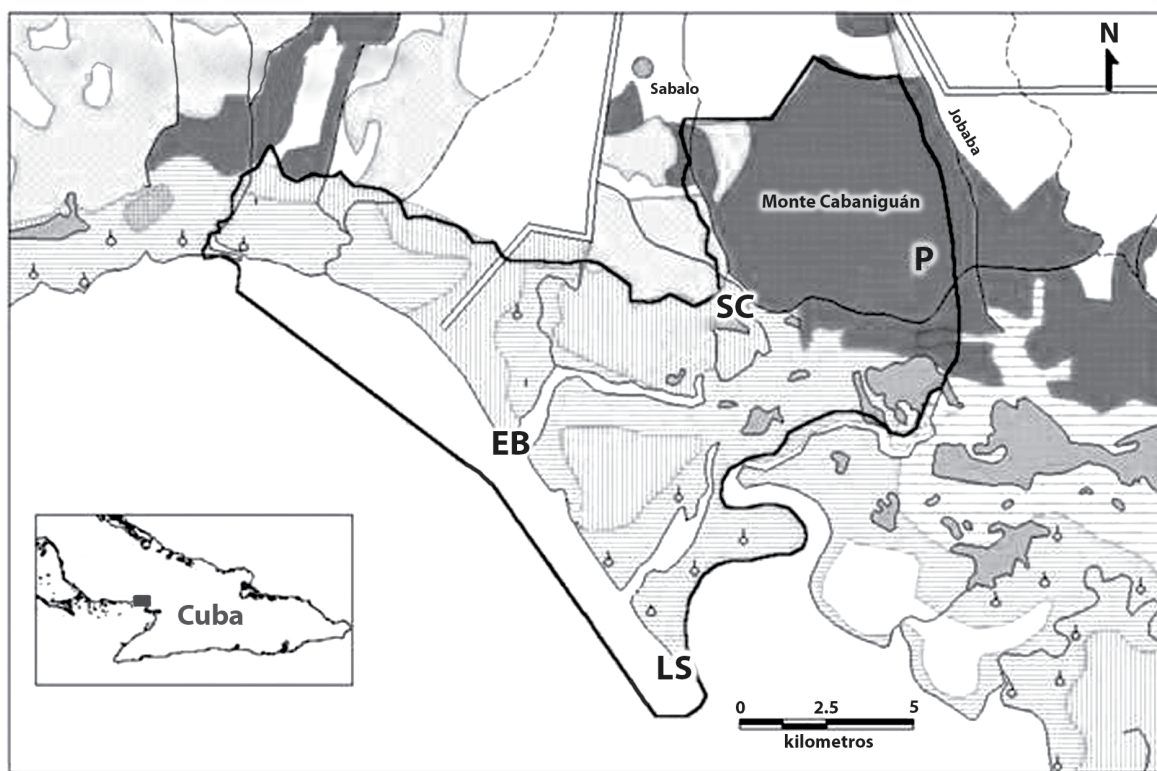


Figure 1. Geographic location of collection sites at the Refugio de Fauna Monte Cabaniguán. **EB**—Estación Biológica D. Miguel Álvarez del Toro; **LS**—La Salina; **SC**—Savanna of *Copernicia*; **P**—Puentequito. Inset identifies the location of the refuge on the southern coast of Cuba.

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Table 1. List of the Odonata species at Refugio de Fauna Monte Cabaniguán, Las Tunas, Cuba; EB = Biological Station, LS = La Salina, SC = Savanna of *Copernicia*, P = Puertecito.

Families	Species	Stations			
		EB	LS	SC	P
LESTIDAE	<i>Lestes forficula</i> Rambur				•
COENAGRIONIDAE	<i>Ischnura hastata</i> (Say)		•		
	<i>I. ramburii</i> (Selys)	•	•		
AESHNIDAE	<i>Coryphaeschna adnexa</i> (Hagen)			•	
LIBELLULIDAE	<i>Brachymesia herbida</i> (Gundlach)		•	•	
	<i>Crocothemis servilia</i> (Drury)	•	•	•	•
	<i>Erythemis vesiculosa</i> (Fabricius)	•	•		
	<i>Erythrodiplax berenice naeva</i> (Hagen)	•			•
	<i>E. fervida</i> (Erichson)	•			•
	<i>E. umbrata</i> (L.)	•	•	•	
	<i>Libellula needhami</i> Westfall				•
	<i>Macrodiplax balteata</i> (Hagen)	•	•	•	
	<i>Miathyria marcella</i> (Selys)			•	
	<i>M. simplex</i> (Rambur)		•	•	
	<i>Micrathyria aequalis</i> (Hagen)				•
	<i>Orthemis discolor</i> (Burmeister)			•	•
	<i>O. ferruginea</i> (Fabricius)	•	•	•	
	<i>Pantala flavescens</i> (Fabricius)	•	•	•	•
	<i>Tramea abdominalis</i> (Rambur)		•	•	

Orthemis ferruginea and *Erythrodiplax umbrata*, both widely distributed and abundant in Cuba (Alayo 1968; Trapero & Naranjo 2003), oviposit in still waters or temporary ponds and were recorded from three stations. *Macrodiplax balteata*, primarily an estuarine species, was observed in the savanna of *Copernicia*, although in low abundance. This species has also been observed along the coastal line of Santiago de Cuba.

Two sites yielded all Libellulidae, except for *Ischnura ramburii*, which is considered the most abundant damselfly in Cuba; it occurs at ponds and slow rivers less frequent on the coast, as was the case of Refugio de Fauna Monte Cabaniguán. The libellulids *Erythrodiplax berenice naeva* and *Tramea abdominalis* are common in coastal zones, whereas *Erythrodiplax fervida*, *Miathyria simplex*, and *Brachymesia herbida* were novelties for this kind of habitat since no previous records of their presence at these ecosystems had been recorded.

The Biological Station and La Salina are coastal zones with mangroves alternating with beaches and grasslands. The most abundant species are the mangroves *Rhizophora mangle* L. and *Avicennia germinans* L., and the succulent salt-tolerant herbaceous *Sesuvium portulacastrum* (L.). The savanna of *Copernicia* is diverse in species of the palm genus after which it is named, plus there is *Brya ebenus* (L.), commonly known as espinó, and other grasses and shrubs. Puertecito is located in the semideciduous mesophytic forest where the invasive tree *Dichrostachys cinerea* (L.) Wight & Arn., Marabú is dominant. Cacti and other tree species are also common, for example *Tabebuia angustata* Britton and *Bucida buceras* L. (W. Bonet, R. Verdecia and M. Alonso unpubl. data).

Dragonflies were collected using insect nets and sometimes identified by direct observation, always between 0800 and 1600 hrs. Unidentified specimens were kept in vials with 75% alcohol and determined at the Universidad de Oriente's Entomology Lab.

The odonate fauna at Refugio de Fauna Monte Cabaniguán is represented by 19 species from 14 genera and four families (Table 1), which account for 24% of the known Cuban dragonflies.

The most widely found species were *Crocothemis servilia*, of great dispersal capacity and widely distributed in Cuba, and *Pantala flavescens*, the only cosmopolitan odonate known from Cuba. The majority (68%) of the species were observed at two or more stations (Figure 2).

Six species were found in only one site: the damselflies *Lestes forficula* and *Ischnura hastata*, and four dragonflies typical of water bodies with abundant aquatic vegetation. *Libellula needhami* had been recorded so far only from Ciénaga de Zapata in western Cuba (Alayo 1968); our record from eastern Cuba is new.

The richest sites in species were La Salina and the savanna of *Copernicia* with 11 taxa each. Though coastal, La Salina is preceded by a large salt marsh with high vegetation which is conducive for odonate swarms to forage on other insects.

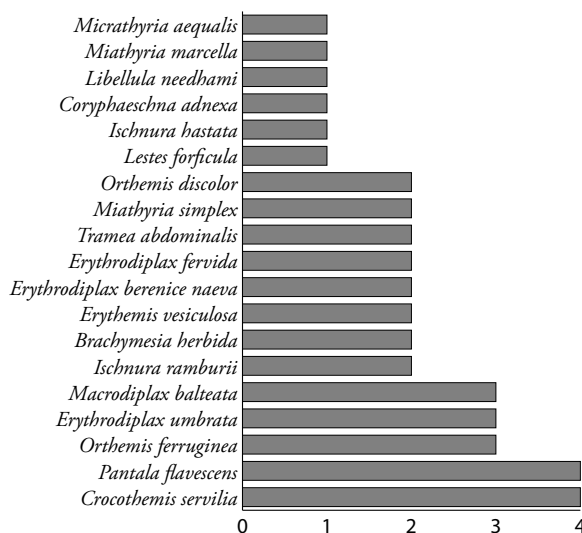


Figure 2. Dragonflies per site at Refugio de Fauna Monte Cabaniguán.

The savanna, characterized by palm trees, bushes, and herbaceous plants, also attracts countless numbers of insects which are preyed upon by dragonflies. Temporary ponds probably form in this area when it rains, providing suitable habitat for odonates. The Biological Station and Puertecito accounted for nine and eight species respectively.

Lestes forficula, *Libellula needhami*, and *Micrathyria aequalis*, all typical of more humid and less saline habitats, and *Coryphaeschna adnexa*, considered a disperser due to its great flight capacity, were found at only one site.

Several environmental and educational activities with schools and local communities directed towards sustainable development are routinely held at Monte Cabaniguán. As a result of the present research, a slide presentation on the dragonfly diversity of this protected area has been prepared in order to show its faunistic value.

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The Dragonfly Society Of The Americas

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