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## NEW DISTRIBUTIONAL RECORDS OF MECOPTERA (INSECTA) FROM COLOMBIA

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### ABSTRACT

*We present new distributional records for two Colombian species of Bittacidae. Pazius convolutus García-García & Cadena-Castañeda, 2015 and Bittacus panamensis Byers, 1958 previously known from Cundinamarca department are herein newly recorded from Santander and Magdalena, respectively. In addition, we recorded Bittacus pignatelli Navás, 1932 in Colombia for the first time, increasing the number of species of Mecoptera in the country. Comments about mating behavior of P. convolutus, as well as a distribution map and a check-list of Colombian species of Mecoptera are included.*

KEY-WORDS: Hangingflies; New records; Neotropics; Mecoptera; Colombia.

### INTRODUCTION

Mecoptera is a relictual order of ancient holometabolous insects that includes nine families, 34 genera and an estimate of 600 species. This order has a widespread distribution and it occurs in all continents (Byers & Thornhill, 1983). It is a well-represented taxon in the fossil record and appears to have been much more diverse in past geological eras (Byers & Thornhill, 1983; Byers, 2002; Grimaldi & Engel,

2005; Somma & Dunford, 2009). In the Neotropical region the Mecoptera is composed of 106 species in 12 genera and five families, being Bittacidae the most species rich family (Machado *et al.*, 2009; Machado *et al.*, 2013; Contreras-Ramos *et al.*, 2014). Nevertheless, specimens are rarely collected, and therefore it is considered an elusive group of animals (Collucci & Machado, 2012). Moreover, a great extent of the Neotropical region lacks adequate sampling, the museum specimens are scarce, collecting methods are not stan-

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TABLE 1: Check-list of Colombian species of Mecoptera.

GENUS/SPECIES	LOCALITY RECORDS IN COLOMBIA	REFERENCES
<b><i>Bittacus</i> Latreille, 1805</b>		
<i>B. panamensis</i> Byers, 1958	Cundinamarca, Magdalena	Byers, 1958; Machado <i>et al.</i> , 2009; Rodríguez <i>et al.</i> , 2009; this work
<i>B. pignatelli</i> Navás, 1932	Antioquia	Byers, 1996; this work
<b><i>Issikiella</i> Byers, 1972</b>		
<i>I. amazonica</i> Byers & Flórez, 1995	Amazonas	Byers & Flórez, 1995; Flórez, 1996; Machado <i>et al.</i> , 2009
<b><i>Nannobittacus</i> Esben-Petersen, 1927</b>		
<i>N. pollex</i> Byers & Roggero, 1992	Valle del Cauca	Byers & Roggero, 1992; Flórez, 1996; Machado <i>et al.</i> , 2009
<i>N. tjederi</i> Byers, 1965	Antioquia	Byers, 1965; Flórez, 1996; Machado <i>et al.</i> , 2009
<b><i>Pazius</i> Navás, 1908</b>		
<i>P. cinctipes</i> Byers & Flórez, 1995	Amazonas	Byers & Flórez, 1995; Flórez, 1996; Machado <i>et al.</i> , 2009
<i>P. convolutus</i> García-García & Cadena-Castañeda, 2015	Cundinamarca, Santander	García-García & Cadena-Castañeda, 2015; this work
<i>P. gorgonensis</i> Ascuntar-Osnas, Torres-Domínguez & Chacón, 2016	Cauca (Gorgona Island)	Ascuntar-Osnas <i>et al.</i> , 2016

andardized, and the knowledge of their natural history is incipient (Collucci & Machado, 2012). Mecopterans are commonly known as hanging flies (Bittacidae) or as scorpion flies (Panorpididae, Panorpidae) owing to the distinctive morphology of the most known and common groups (Byers, 2002; Palmer, 2010). The most common families (Panorpididae, Bittacidae, and Apteropanorpididae) are easily recognized by feeding mainly on animal matter with their elongate rostrum (composed by labrum and clypeus) (Palmer, 2010). However, some genera of snow scorpion flies (Boreidae) which have an elongate rostrum present a phytophagous diet. The remaining groups (Panorpididae, Nannochoristidae, Choristidae, Eomeropidae, Meropidae and Caurininae) which have a short rostrum are phytophagous or saprophagous (Palmer, 2010). Moreover, this group is also distinguished by having anterior and posterior wings similar in size and shape with a relatively complete and intricate venation, although certain groups are known to be brachypterous or wingless (Penny, 1975; Grimaldi & Engel, 2005).

Bittacidae is a group of gondwanic origin that can be found in all biogeographic regions, though it is primarily distributed in the southern hemisphere in tropical rainy forests (Byers & Thornhill, 1983). Bittacids can be active at the day, twilight or night, and they mostly show predatory habits. They are usually found hanging from the forelegs on shrubby vegetation. Bittacids have a unique set of adaptations. For example, a characteristic found in this family is that all their legs are prehensile (Byers, 2002; Tan & Hua, 2009a). The femora and tibiae are long and robust

with thickened tarsi, and the fifth tarsomere folds strongly up to the fourth. A tarsal hook-shaped claw and thorn-like setae are also present (Byers, 2002; Tan & Hua, 2009a). The cruciform larva has a sclerotized cephalic capsule, compound eyes with seven ommatidia and a ocellus at the top of the frons; legs have simple claws; lateral and dorsal rows of three-forked scoli on meso- and metanotum as well as abdominal segments 1-9 are present, although some species lack of such scoli, and instead clavate vesicles are present (Setty, 1940; Penny & Arias, 1981; Byers & Thornhill, 1983; Byers & Roggero, 1992; Byers, 2002). The immature stages for most species are still unknown, especially at the Neotropical region, but the larvae of some species are known to be saprophagous and living in organic matter rich soils close to water bodies.

For Colombia, we have limited knowledge of the order, until now only seven Bittacidae species within four genera were known (Table 1) (Byers & Flórez, 1995; Flórez, 1996; Rodríguez *et al.*, 2009; Machado *et al.*, 2009; Ascuntar-Osnas *et al.*, 2016). A review of the Colombian Mecoptera has been made by Flórez (1996). The first species described from Colombia was *Nannobittacus tjederi* from Antioquia department (Byers, 1965). An account by Byers & Roggero (1992) described *Nannobittacus pollex* from Panama and a single record in the Colombian department of Valle del Cauca. Then, Byers & Flórez (1995) described the species *Issikiella amazonica* and *Pazius cinctipes*, found in the Amazonas department. A further account was made by Rodríguez *et al.* (2009), who reported *Bittacus panamen-*

sis Byers, 1958 for Cundinamarca department. Recently García-García & Cadena Castañeda (2015) described *Pazius convolutus*, a new species found in Nimaima municipality (Cundinamarca department). Thereafter, Ascuntar-Osnas *et al.* (2016), described *Pazius gorgonensis* from the Gorgona Island in the Cauca department, and provide an updated key to the species of the genus. The aim of this work is to present two new locality records for *P. convolutus* and *B. panamensis* for the departments of Santander and Magdalena, respectively. In addition, we reported *Bittacus pignatelli* Navás, 1932 from Colombia for the first time.

## MATERIALS AND METHODS

On May of 2008, during a field trip to Tobia, municipality of Nimaima, Cundinamarca (04°59'57,65"N; 74°28'14,15"W), a place located in the western slope of the Colombian oriental cordillera (842 m.a.s.l.), the third author (CJA) noted several hangingflies of the genus *Pazius*. The place of sighting was a relict of primary forest in the Negro river vicinity. The author observed three specimens, a couple pair and a single male hanging on thorny shrubs in a shady area near to the soil. The specimens were photographed using a Canon Eos Rebel Xti digital camera, and two of these hangingflies were captured using an entomological net. Such specimens were preserved in alcohol and stored in the Entomological Museum of the Universidad Distrital de Bogotá, Colombia (CAUD). Several years later, on the beginning of June 2013, after the first rainy season, and during fieldwork that took place in the Serranía de las Quinchas, at "El paujil" natural reserve, located in the municipalities of Puerto Boyacá, Bolívar and Cimitarra (06°02'46"N; 74°15'52"W, 150-1,200 m.a.s.l.), a third specimen of *Pazius* was obtained. It was captured using an entomological net, was preserved at 96% Ethanol and deposited in the entomological collection of Scholl of Agronomy of Universidad Nacional de Colombia (UNAB) (Bogotá, Colombia). Recently, during the revision of the Taxonomic National Collection of Insects "Luis María Murillo" (CTNI), Corporación Colombiana de Investigación Agropecuaria (Corpoica), Mosquera, Cundinamarca, some specimens of the genus *Bittacus* were identified. The external morphology was studied using a Zeiss stemi 2000 stereomicroscope, high resolution images were taken with the same equipment, adapted with an AxioCam ERc 5s digital camera. Identification of the species was made following the works of Byers (1958), Byers (1996),

Machado *et al.* (2009) and García-García & Cadena-Castañeda (2015). Finally, the distribution map was produced through SimpleMappr, available in the web page [www.simplemappr.net](http://www.simplemappr.net).

## RESULTS

### *Bittacus* Latreille, 1805

The genus *Bittacus* is the most diverse and widely distributed group of the family Bittacidae in the world, with species in all tropical and temperate regions (Penny, 1975; Byers & Roggero, 1992; Machado *et al.*, 2009). For the Neotropics, *Bittacus* is composed of 34 species ranging from Mexico to Chile and Argentina, thus becoming in the most diverse mecopteran genus of this biogeographical region (Machado *et al.*, 2009). This genus is distinguished by having dichoptic eyes in the adult, 1A vein long extending beyond of the Rs origin in both wings; in the forewing, this vein is distinct from the Cu<sub>2</sub>, while they are basally fused in the hindwing (Byers & Roggero, 1992).

### *Bittacus panamensis* Byers, 1958 (Figs. 1, 6)

The species was originally described from Panama, but accounts with records from Colombia, Costa Rica and Venezuela (Machado *et al.*, 2009; Rodríguez *et al.*, 2009). In the present work, we extend the known distribution range of this species in Colombia, to the Magdalena department in the Caribbean coast of the country. This species is distinguished by its body color pattern, uniformly brown; wing membrane is light amber colored except for pterostigma, which is slightly darker; the distal part of forewing has extra series of crossveins between Rs<sub>1</sub> and M<sub>2</sub> veins (Byers, 1958). The male genitalia have epiandrial lobes rectangular in lateral view, and are equipped with short and black setae along the dorsal and caudal margins on the inner surface; a few longer setae in the posterodorsal angle are also present. Inner margins of both lobes are parallel in dorsal view, with anterior angles subquadrate. The aedeagus is basally thickened, abruptly narrowed at midlength and thin at the apex (Byers, 1958).

**Specimen examined.** Magdalena, Zona Bananera, Caribia (Corpoica), 10°43'38,24"N; 74°13'29,48"W, 12 m, 25.VIII.1986, F. Posada, light trap (1♂-CTNI)

***Bittacus pignatelli* Navás, 1932**  
(Figs. 2, 6)

This species was previously recorded from Costa Rica and Panama (Byers & Roggero, 1992; Machado *et al.*, 2009). In the present work, we reported this species in Colombia for the first time, with a single record from Antioquia department. This bittacid species is distinguished by its wing coloration pattern, consisting in the presence of numerous dark amber spots on the membrane inside cells and bordering crossveins (Byers, 1996). Additionally, its head, thorax and abdomen are mainly reddish brown, and femora and tibiae yellow except by their dark reddish brown apices (Byers, 1996).

**Specimen examined.** Antioquia, Chigorodó, 07°39'47,7"N; 76°40'20,77"W, 36 m, 25.IV.1974, A. López, in flight (1♀-CTNI)

***Pazius* Navás, 1908**

The genus *Pazius* Navás is endemic to the Neotropical region, and is often found in the northwestern part of South America but extending up to Central America (from Brazil to Costa Rica). This group was reviewed by Byers (1957, 1977), and currently consist of eleven species grouped into three species groups (Machado *et al.*, 2009; Ascuntar-Osnas *et al.*, 2016; Lima & Dias, 2016). The genus is easily distinguished from other members of Bittacidae by its narrow wings with short anal veins (Fig. 3a) (Byers, 1957; 1977), compound eyes are holoptic, and are connected below the antennae insertion. Furthermore, the abdomen is elongated and narrow, extending beyond the wing tips (Byers, 1957; 1977; Machado *et al.*, 2009; Tan & Hua, 2009b). Lima & Dias (2016) provided a complete identification key for all species of *Pazius*.

***Pazius convolutus* García-García & Cadena-Castañeda, 2015**  
(Figs. 3-6)

*Pazius convolutus* belongs to the *furcatus* group because of the presence of a bifurcated projection ventrally located near to aedeagus base (Byers, 1977; García-García & Cadena-Castañeda, 2015). This species is morphologically similar to *P. furcatus*, but it is distinguished by having a black dotted, light brown pteropleura; trochanter in all legs has a black dot ventrally on inner surface (Fig. 3b); epiandrial lobe has

subtle posterodorsal projection equipped with apical spiniform setae (Fig. 3c); a subconical ventral projection with two apical spines on the posterior half of the epiandrial lobe is present (Fig. 3d). The slightly divergent and medially curved projections of aedeagus and a strongly coiled aedeagus with an approximated of four convolutions are also diagnostic traits (García-García & Cadena-Castañeda, 2015).

**Specimen examined.** Santander, Reserva Natural el paujil, near to Ermitaño river, 06°02'46"N; 74°15'52"W, 06.VI.2013, J. Vargas-Fique, entomological net (1♂-UNAB).

**Remarks.** The specimen was found in the afternoon eating a small insect at the margin of a small road and hanging on shrubby vegetation in the Ermitaño river vicinity.

**Comments on the Biology of *Pazius convolutus***

Bittacidae adults can prey a wide variety of arthropods, and likewise as in Panorpidae feeding and mating behaviors are closely related (Tornhill, 1978). In many Bittacidae members, nuptial gift has been reported as a part of sexual selection (Byers, 2002). This mechanism has evolved probably due to the lack of prey disponibility, or because searching for food can exposes females to predation (Byers & Tornhill, 1983). Mating behavior varies between species; some hanging flies can mate during the day, at night or even at dawn. Generally copulatory behavior begins when a male catches a prey. The male eats a small portion of the prey and then he can either discard the prey or go in search for a bigger and/or more palatable one, or carry out short flights on vegetation while it holds the prey. Many Bittacidae species have pheromone glands located dorsally between the abdominal segments 6-7 and 7-8, although some African species lack these glands (Byers & Tornhill, 1983; Byers, 2002). During courtship, the female evaluates the prey offered by the male, she then discriminates between small or unpalatable preys. If this is the case, she flies away or responds to another male's pheromones. Females can also copulate for a short period of time before the male achieves the transference of sperm. Moreover, males can use a large prey in consecutive matings with different females. There are species, in which male mimics the female behavior, in order to steal a prey (Byers & Tornhill, 1983). The stealing behavior of preys from other males is an important component in sexual selection in this group of insects (Torn-



hill, 1978). In the Japanese species *Bittacus maestrillii* Navás, three different types of mating behavior have been observed. The first type involves chemical cues expelled by the abdominal glands of the male, he then offers a prey to the female, she responds and finally the mating pair couples their genitals (Iwasaki, 1996). Another type of copulatory behavior of this species

begins when a female has previously captured a prey, subsequently the male arrives and tangles its mid legs with those of the female and proceeds to mate with her while feeding on the prey captured. On the other hand, mating can also occur without nuptial gift, and instead the male secretes saliva which the female eats while mating occurs. In all cases the male tangles the

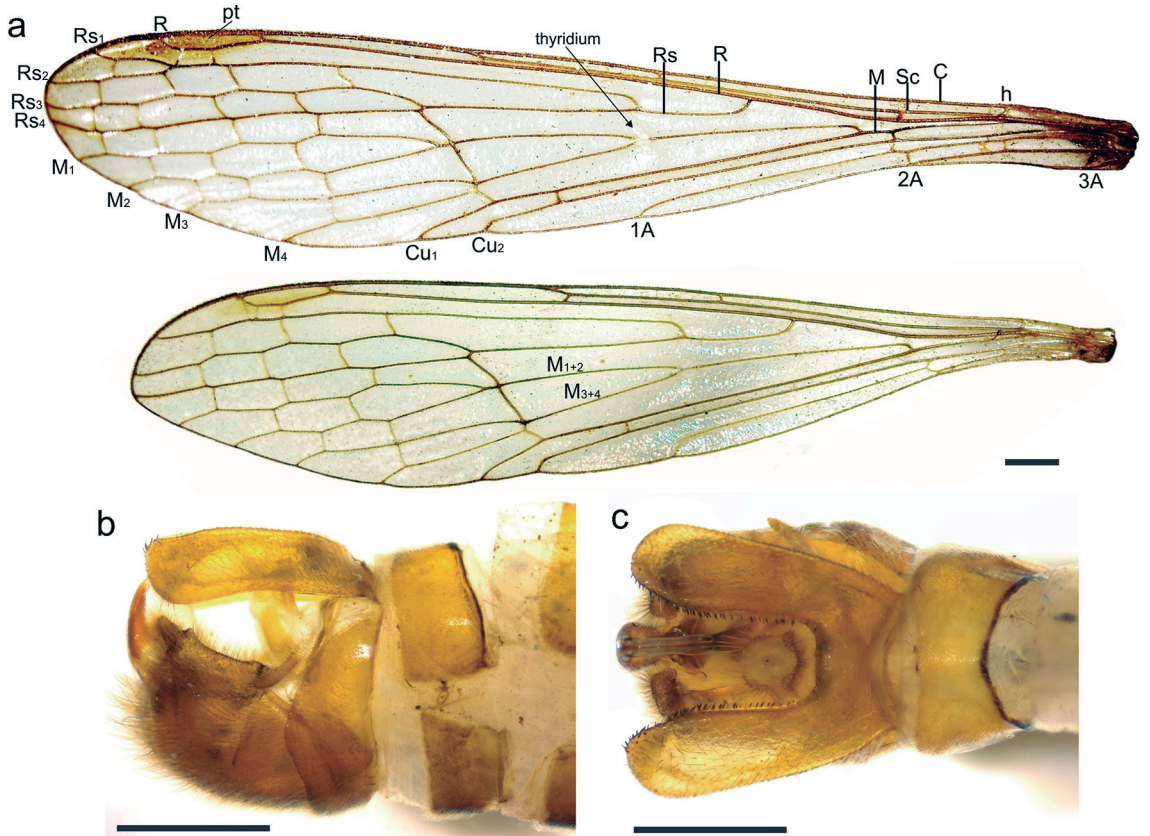
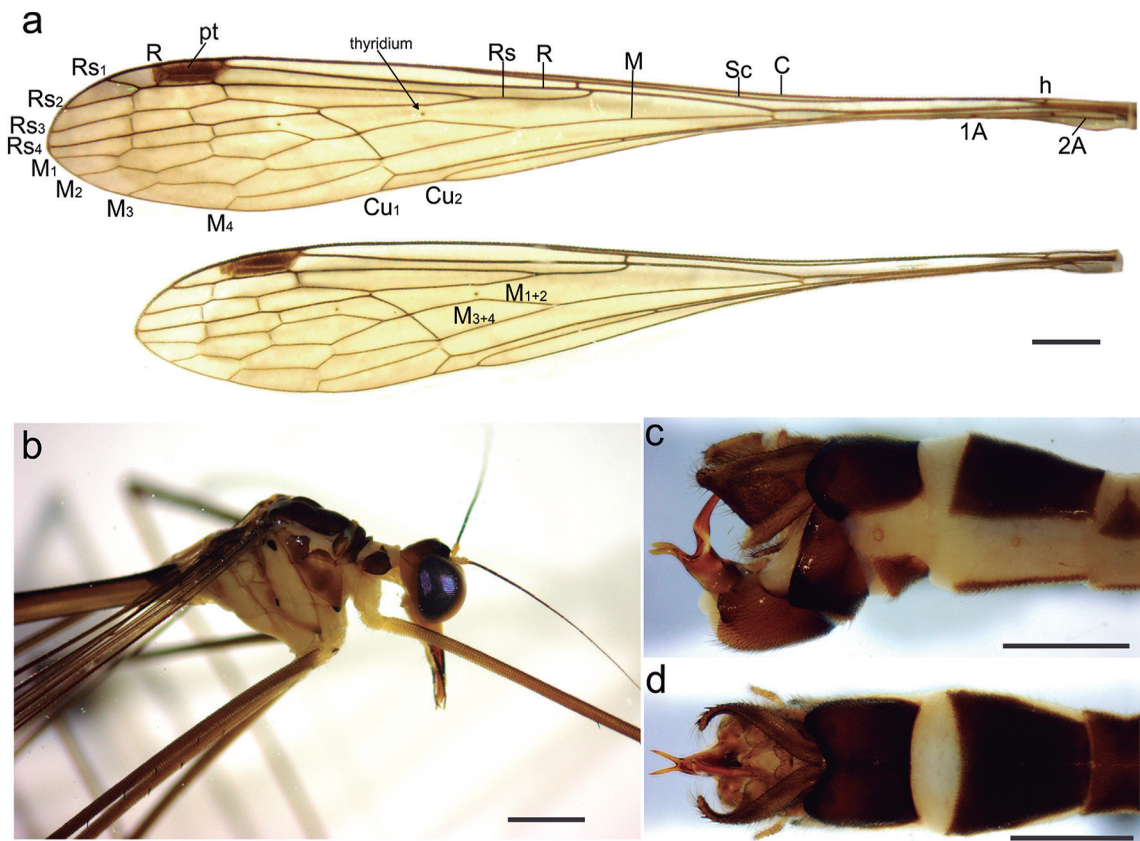


FIGURE 1: *Bittacus panamensis*: (A) wing venation; (B) male terminalia, lateral; (C) same, dorsal. Scale bars: 1 mm.



FIGURE 2: *Bittacus pignatelli*: fore- and hindwing. Scale bar = 1 mm.



**FIGURE 3:** *Pazius convolutus*: (A) wing venation; (B) head and thorax, lateral; (C) male terminalia, lateral; (D) male terminalia, dorsal. Scale bars = 1 mm.

legs of the female and in the final stages of mating he holds both the prey and the female. In some cases, the male can hang only using one of its forelegs (Iwasaki, 1996).

The biology of the genus *Pazius* is poorly documented, in this group nuptial gift is a mechanism of sexual selection, although, it is completely unknown whether in this genus there are different mating tactics performed by the male as in other species of Bittacidae. During the rainy season on early May 2008, the third author (CJA) carried out field observations of *P. convolutus* in its type locality (Nimaima, Cundinamarca), he also collected some specimens that were then described by García-García & Cadena-Castañeda (2015). Unfortunately, only two male specimens were captured in that time. *Pazius convolutus* activity has been observed during the day on shrubby vegetation in shady areas of primary forest. In this species, the male tangles its mid legs with those of the females, while both individuals hold the prey using their hind legs. The male was observed completely suspended, while the female was holding both, prey and male, using their forelegs (Figs. 4, 5). In this case, only the female was observed feeding on prey. It is possible that

this behavior resembles the second type of copulatory behavior of *Bittacus maestrillii* in which the female firstly catches a prey and the male is who arrives in order to mate and feed (Iwasaki 1996). Alternatively, this behavior could correspond to the attraction of the female by the chemical cues and nuptial gift offered by the male. The male holotype of *P. gorgonensis* was carrying a small moth when it was captured, which may supports the second hypothesis, however, as mentioned by the authors, it is not possible to confirm if the prey was associated with mating behavior (Ascuntar-Osnas *et al.*, 2016). Nevertheless, it should be noted that during observations of mating behavior as well as in the observed specimens in laboratory, no glandular structures between abdominal terga were found, being these apparently absent. Moreover, García-García & Cadena-Castañeda (2015), in their description of the species indicated that there are openings in the three pairs of legs at the level of the trochanter, and raised the question about the possible glandular nature of these structures. Unfortunately, at moment only male specimens are known and described, and it is unknown if such openings are present in females also, producing only hypothetical





**FIGURE 4:** *Pazius convolutus*. Mating pair observed on May of 2008 in primary forest of Tobia, in vicinity of Río Negro, Nimaima, Cundinamarca.

statements about the relationship of these structures with sex pheromones. It is important to conduct field observations and studies in the laboratory on mating behavior of *P. convolutus* to enrich the knowledge of the biology of Bittacidae, as well as to give light on phylogenetic relationships of this group of hanging-flies.

## DISCUSSION

Most of the Colombian territory comprises plains below of 500 m.a.s.l, and it can be divided into two major regions. The trans-inter-Andean region, which includes three cordilleras with their respective valleys, as well as littoral regions of the Caribbean Sea and Pacific Ocean; on the other hand, the cis-Andean region, comprises the Orinoco and Amazon basins (Hernández-Camacho, 1992). There are very few records of Mecoptera from Colombia, and conclusions about their distribution are still premature (Fig. 6). It is important to note that because the biogeographical characteristics of the country, Colombia could have an important diversity of this group. Bittacids are in-



**FIGURE 5:** *Pazius convolutus*. Mating pair observed on May of 2008 in primary forest of Tobia, in vicinity of Río Negro, Nimaima, Cundinamarca.

sects with a poor dispersion capacity, and the Neotropical species are apparently associated with moist lowland forests (Flórez, 1996). As expected, Colombian mountain ranges constitutes a relevant factor in the diversification of Mecoptera, as in the vast majority of the Neotropical biota elements. This spectacular barrier between the Amazon basin and Central America delimit and isolate most of the biodiversity of these regions (Hernández-Camacho *et al.*, 1992). Colombian mountain ranges are important centers of endemism with suitable conditions for genetic isolation, as an example, the recently described *P. convolutus*, the possible sister taxon of *P. furcatus* Byers, 1957 from the Venezuelan Andes. Despite of the scarcity of records, Colombian fauna of Bittacidae is composed of Central American elements such as *B. pignatelli* and *N. pollex* distributed in the Darien and Cauca regions, respectively. Another example is *B. panamensis*, which extends its distribution from Costa Rica and Panama through Colombian Caribbean plains towards mountain ranges in the central Magdalena basin, particularly in the western slope of the oriental cordillera. Moreover, *N. tjeideri* distributed in the eastern foothills of the central Colombian cordillera, has some

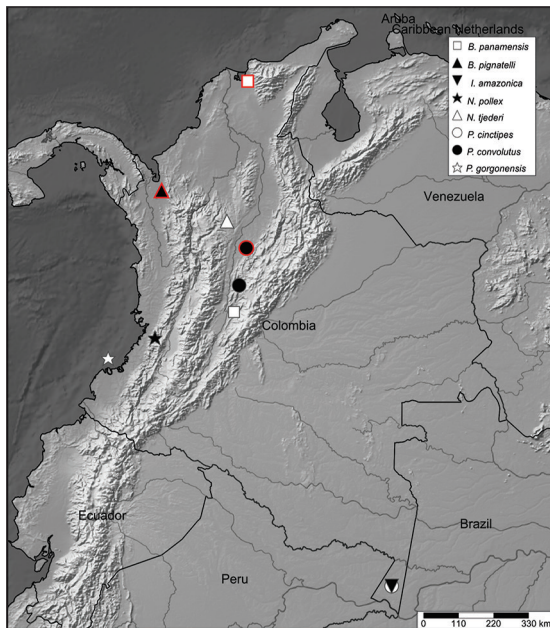


FIGURE 6: Collecting records of Colombian species of Mecoptera. The new records are bordered with red.

tentative records from Panama and Venezuela (Byers, 1965). There are autochthonous elements also, such as *P. convolutus* from central mountainous part of the oriental cordillera, and *P. gorgonensis*, an isolated species discovered from the Gorgona island located in the Colombian Pacific coast, closely related with Central American species of *Pazius* (the *obtusus* group) (Ascuntar-Osnas *et al.*, 2016). In the Amazonian basin of Colombia, there are two species with Amazonian affinity, *P. cinctipes* and *I. amazonica*, species closely related to Brazilian species of these genera (Byers & Flórez, 1995). There is a vast area in the country, including most of the Amazonian region and the Orinoco basin without records, factor that undoubtedly could mean in the discovery of new species and new records as fieldwork in these unexplored areas is carried out.

## RESUMEN

Nuevos registros distribucionales para dos especies de Bittacidae de Colombia son presentados. *Pazius convolutus* García-García & Cadena-Castañeda, 2015 y *Bittacus panamensis* Byers, 1958 previamente conocidos en el departamento de Cundinamarca se registran aquí en Santander y Magdalena, respectivamente. Además, *Bittacus pignatelli* Navás, 1932 se reporta para Colombia por primera vez, aumentando el número de especies de Mecoptera en el país. Se incluyen comentarios sobre el

comportamiento copulatorio de *P. convolutus*, así como también un mapa de distribución y un listado actualizado de Mecoptera de Colombia.

PALABRAS-CLAVE: Bittacidae; Nuevos registros; Neotrópico; Mecoptera; Colombia.

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## REFERENCES

- ASCUNTAR-OSNAS, O.; TORRES-DOMINGUEZ, D.; CHACÓN DE ULLOA, P. & MACHADO, R.J.P. 2016. First record of the order Mecoptera (Insecta) for the Gorgona Island (Colombia), with the descriptions of a new species. *Zootaxa*, 4097(2):271-279.
- BYERS, G.W. 1957. The Neotropical genus *Pazius* (Mecoptera: Bittacidae). *Occasional Papers of the Museum of Zoology, University of Michigan*, 582:1-11.
- BYERS, G.W. 1958. Description and distributional records of American Mecoptera. *Journal of the Kansas Entomological Society*, 31(3):213-222.
- BYERS, G.W. 1965. New and Uncommon Neotropical Mecoptera. *Journal of the Kansas Entomological Society*, 38(2):135-144.
- BYERS, G.W. 1977. Revision of the genus *Pazius* (Mecoptera: Bittacidae). *Revista de Biología Tropical*, 25(1):109-121.
- BYERS, G.W. 1996. Descriptions and Distributional Records of American Mecoptera. IV. *The University of Kansas Science Bulletin*, 55(14):519-547.
- BYERS, G.W. 2002. Scorpionflies, hangingflies, and other Mecoptera. *Kansas School Naturalist*, 48(1):1-15.
- BYERS, G.W. & FLÓREZ, E. 1995. Two new species of Bittacidae (Mecoptera) from the Amazon forest in Southern Colombia. *Tropical Zoology*, 8:153-158.
- BYERS, G.W. & ROGGERO, R.J. 1992. Hanging-flies of Panama (Mecoptera: Bittacidae). In: Quintero, D. & Aiello, A. (Eds.). *Insects of Panama and Mesoamerica: selected studies*. Oxford, Oxford University Press. p. 594-599.
- BYERS, G.W. & THORNHILL, R. 1983. Biology of the Mecoptera. *Annual Review of Entomology*, 28:203-228.
- COLLUCCI, E. & MACHADO R.J.P. 2012. Mecoptera. In: Rafael, J.A.; Melo, G.A.R.; de Carvalho, C.J.B.; Casari S.A. & Constantino R. (Eds.). *Insetos do Brasil, Diversidade e Taxonomia*. Ribeirão Preto, SP, Holos Editora. p. 684-688.
- CONTRERAS-RAMOS, A.; SARMIENTO-CORDERO, M.A. & PENNY, N.D. 2014. Biodiversidad de Mecoptera en México. *Revista Mexicana de Biodiversidad*, 85:339-344.



- FLÓREZ, E. 1996. Los Mecópteros de Colombia. In: Andrade-C, M.G.; Amat, G. & Fernández, F. (Eds.). *Insectos de Colombia, estudios escogidos*. Santafé de Bogotá, Academia Colombiana de Ciencias Exactas, Físicas y Naturales. p. 65-73.
- GARCÍA-GARCÍA, A. & CADENA-CASTAÑEDA, O.J. 2015. Una nueva especie de *Pazius* Navás, 1908 (Mecoptera: Bittacidae) de Colombia. *Boletín de la Sociedad Entomológica Aragonesa*, 57:200-204.
- GRIMALDI, D. & ENGEL, M.S. 2005. *Evolution of the insects*. New York, Cambridge University Press., 755p.
- HERNÁNDEZ-CAMACHO, J. 1992. Caracterización geográfica de Colombia. *Acta Zoológica Mexicana*, (número especial): 45-54. (Halffter, G. (Compilador). La Diversidad Biológica de Iberoamérica)
- HERNÁNDEZ-CAMACHO, J.; ORTIZ-QUIJANO, R.; WALSCHBURGER, T. & HURTADO-GUERRA, A. 1992. Estado de la Biodiversidad en Colombia. *Acta Zoológica Mexicana*, (número especial): 55-104. (Halffter, G. (Compilador). La Diversidad Biológica de Iberoamérica).
- IWASAKI, Y. 1996. Hunting and Mating Behavior in the Japanese Hangingfly *Bittacus mastrillii* (Mecoptera: Bittacidae). *Annals of the Entomological Society of America*, 89(6):869-874.
- LIMA, A.R. & DIAS, P.G. 2016. The uncommon Neotropical genus *Pazius* Navás, 1913 (Mecoptera: Bittacidae): a comprehensive synthesis, with description of a new Brazilian species. *Zootaxa*, 4169(3):504-514.
- MACHADO, R.J.P.; GODOI, F.S.P. & RAFAEL, J.A. 2009. Neotropical Mecoptera (Insecta): new generic synonymies, new combinations, key to families and genera, and checklist of species. *Zootaxa*, 2148:27-38.
- MACHADO, R.J.P.; KAWADA, R. & RAFAEL, J.A. 2013. New continental record and new species of *Austromerope* (Mecoptera, Meropeidae) from Brazil. *Zookeys*, 269:51-65.
- PALMER, C.M. 2010. Diversity of feeding strategies in adult Mecoptera. *Terrestrial Arthropod Reviews*, 3:111-128.
- PENNY, N.D. 1975. Evolution of the Extant Mecoptera. *Journal of the Kansas Entomological Society*, 48(3):331-350.
- PENNY, N.D. & ARIAS, J.R. 1981. Observations on the Eggs and Larvae of *Nannobittacus elegans* Esben-Petersen, 1927 (Mecoptera: Bittacidae). *Journal of the Kansas Entomological Society*, 54(3):465-468
- RODRÍGUEZ, W.; FLÓREZ, E. & ALFONSO, O. 2009. Un nuevo e inusual registro de “moscas colgantes” para Colombia (Mecoptera, Bittacidae). *Revista Colombiana de Entomología*, 35(2):288-288.
- SETTY, L.R. 1940. Biology and Morphology of Some North American Bittacidae (Order Mecoptera). *The American Midland Naturalist*, 23(2):257-353.
- SOMMA, L.A. & DUNFORD, J.C. 2009. Records for *Bittacus* Hangingflies and *Panorpa* Scorpionflies (Mecoptera: Bittacidae and Panorpidae) in Florida. *Insecta Mundi*, 84:1-5.
- TAN, J.L. & HUA, B.Z. 2009a. *Terrobittacus*, a new genus of the Chinese Bittacidae (Mecoptera) with descriptions of two new species. *Journal of Natural History*, 43:47-48.
- TAN, J.L. & HUA, B.Z. 2009b. *Bicaubittacus*, a new genus of the Oriental Bittacidae (Mecoptera) with descriptions of two new species. *Zootaxa*, 2221:27-40.
- TORNHILL, R. 1978. Sexually Selected Predatory and Mating Behavior of the Hangingfly, *Bittacus stigmaterus* (Mecoptera: Bittacidae). *Annals of the Entomological Society of America*, 71(4):597-601.

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