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Review of *Scolia* (Hymenoptera: Scoliidae) from Central America, including seasonal flight activity in *Scolia guttata*

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ARTÍCULO DE INVESTIGACIÓN / RESEARCH ARTICLE

**REVIEW OF *Scolia* (Hymenoptera: Scoliidae) FROM CENTRAL AMERICA, INCLUDING
SEASONAL FLIGHT ACTIVITY IN *Scolia guttata***

**Revisión de *Scolia* (Hymenoptera: Scoliidae) para América Central, incluyendo actividad de vuelo
estacional en *Scolia guttata***

Running title: *Scolia* from Central America

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QUINTERO¹

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ABSTRACT

A taxonomic revision of the genus *Scolia* Fabricius, 1775 (Hymenoptera: Scoliidae) from Central America is presented. Two species of *Scolia* are present in Central America: *S. (Discolia) guttata* Burmeister, 1853 and *S. (Hesperoscolia) rufiventris* Fabricius, 1804, the latter representing the first record for Costa Rica, Panama and Colombia. The male of *S. rufiventris* is described and illustrated for the first time. Seasonal flight activity for *S. guttata* from two years of continuous Malaise trapping in Barro Colorado Island, Panama, is described.

Keywords: Scoliinae, seasonal flight activity, taxonomy, wasp.

RESUMEN

Se presenta una revisión taxonómica del género *Scolia* Fabricius, 1775 (Hymenoptera: Scoliidae) de América Central. Dos especies de *Scolia* están presentes en América Central: *S. (Discolia) guttata* Burmeister, 1853 y *S. (Hesperoscolia) rufiventris* Fabricius, 1804, esta última representa el primer registro para Costa Rica, Panamá y Colombia. El macho de *S. rufiventris* se describe e ilustra por primera vez. Se describe la actividad estacional de vuelo para *S. guttata* a partir de dos años de captura continua con trampas Malaise en la isla de Barro Colorado, Panamá.

Palabras clave: Avispa, nuevo registro de distribución, Scoliinae, taxonomía.

INTRODUCTION

Scolia Fabricius, 1775 is a cosmopolitan genus of fossorial solitary wasps in the subfamily Scoliinae presently containing 20 described species for America (Hanson, 2006). *Scolia guttata* Burmeister, 1853 was the only described species recorded for Central America (Cameron, 1893).

Scoliid larvae are ectophagous idiobiont parasitoids of large Coleoptera larvae, including Sacarabaeidae, Passalidae, Lucanidae, and Curculionidae (Fernández, 2006; Kumar, 2009), for which they have been used as biological control agents (Clausen, 1978).

In this paper, we review the genus *Scolia* from Central America. Also, we present seasonal flight records for *Scolia guttata* on Barro Colorado Island, Panama.

MATERIALS AND METHODS

Flight seasonality data come from the field station of the Smithsonian Tropical Research Institute (STRI) on Barro Colorado Island (BCI), located in Gatun Lake of the Panama Canal, 9° 09'17" N; 79° 50' 53" W. The seasonal flight activity of *Scolia guttata* was studied by sampling specimens from ten Malaise traps (Townes modified) installed at ground level in the old forest by the Smithsonian Environmental Studies Program (see Richards and Windsor, 2007). The samples were collected weekly, from January 2005 to December 2006. For other information of the study area, see Windsor, (1990) and Cambra *et al.*, (2018).

The following acronyms are used for the collections where type specimens and other materials are deposited:

BMNH The Natural History Museum, London, United Kingdom.

INBio Instituto Nacional de Biodiversidad (currently Museo Nacional de Costa Rica).

MIUP Museo de Invertebrados G.B. Fairchild, Universidad de Panamá.

MLUH Zoological Institute of the University of Halle, Germany.

ZMUC Natural History Museum of Denmark, University of Copenhagen.

RESULTS AND DISCUSSION

Scolia (Discolia) guttata Burmeister, 1853

(Fig. 1a-1c, Fig. 2a-2c)

Scolia guttata Burmeister, 1853: 36, lectotype female (Designation by Bradley and Brethem, 1966),

MLUH.

Discolia hecate Kirby, 1889: Bradley and Brethem, (1966).

Diagnosis. Integument mostly black (Fig. 1a-1c), terga two-three with lateral yellow spots (Fig. 1a); female with the anterior margin of clypeus convex (Fig. 1c); paramere apex angulate (Fig. 2a-2b); penis valve with small spines on dorsal margin (Fig. 2c).

Material examined. GUATEMALA (no other data), one male (MIUP). COSTA RICA (98 males, 56 females, INBio, see table 1): Alajuela: Est. San Ramón, 3–19.iv.1994, F. Quesada, one female; same data except: 13–30.viii.1996, D. Briceño, one male; P.N. Arenal, San Carlos, R.F. Arenal, Sen. Mena, 600 m, 16.vii.2001, G. Cabarillo, one female; same data except: Send. Pilon, 650 m, 23.vii.2001, two females; 14–25.viii.2001, one male, two females. Cartago: Grano de Oro, 1120 m, 8–30.viii.1992, P. Campos, two females; same data except: Monumento Nacional Guayabo, 1100 m, vii.1994, G. Fonseca, one female. Guanacaste: P.N. Guanacaste, Est. Biol. Cacao, 1000–1400 m, SW side Vol. Cacao, ix.1989, R. Banco and C. Chaves, one male; same data except: 1100 m, xii.1993–ix.1994, G. Chavarría, one male; 1200 m, vi.1997, R. Moraga, four females; Est. Los Almendros, 13 Oct–3.xi.1993, K.

Martínez, nine males; Est. Maritza, 600 m, viii.1990, four males, eight females; same data except: 27.ii–10.iii.1994, F. A. Quesada, one female; Est. Murciélago, 100 m, 3–12.xii.1993, F. A. Quesada, one male; Est. Pitilla, 700 m, nine km S Sta. Cecilia, ix.1988, two males; same data except: x.1988, 16 males, one female; xi.1988, 23 males, 11 females; i.1989, four females; 21.iii–21.iv.1989, one male; x.1989, C. Moraga and P. Ríos, three males; i.1991, one female; 2–19.iii.1992, P. Ríos, one male; 18 iv–9.v.1993, C. Moraga, one male; iii.1994, C. Moraga, one male; Est. Sta. Rosa, 300 m, vii.1992, R. Moraga, two females; same data except: 1.v.1995, F. A. Quesada, one male; Fca. Jenny, 30 km N Liberia, ix.1988, one male, one female; same data except: x.1988, two males, three females; 5–20.ix.1993, E. Araya, one male; 6–15.xi.1993, one male; ix.1998, three males; Fca. Loaiciga, 500 m, 6–28.i.1992, C. Moraga, one female; La Cruz, Cerro El Hacha, 26–30.vii.1986, I. Chacón, two males; P.N. Rincón de la Vieja, Est. Las Pailas, 800 m, 15.vii–14.ix.1992, J. Sihezar, one female; same data except: 27.vii–15.viii.1992, C. Cano, eight males, five females; 24.viii–14.ix.1992, one male, one female; 5–24.viii.1994, D. García, one male. Limón: R.N.F.S. Barra Del Colorado, 50 m, vi.1994, F. Araya, one female. Puntarenas: P.N. Corcovado, Est. Agujas, Send. Zamia, 300 m, 10.ii.1998, A. Azofeifa, one male; same data except: La Bonanza, 495 m, 4–22.v.1999, J. Azofeifa, one female; Est. Sirena, 100 m, ii.1990, G. Fonseca, one male, one female; Rancho Quemado, Península de Osa, 200 m, viii.1991, F. Quesada, one male; same data except: 7–27.i.1992, A. Gutiérrez, one male; ii.1992, F. Quesada, three males; 1–20.xii.1993, A. Marin, one male. San José: Reserva Privada, Universidad para La Paz, Fila Diamante, 1021 m, 8.vii.2001, M. Solís, one male. **PANAMA**: Panamá Province: Barro Colorado Island, ten Malaise traps, 2005–2006, col. D. Windsor, 137 males, one females (MIUP); Parque Nacional Soberanía, camino Plantación, 3.viii.2001, D. Quintero, R. Cambra, one female (MIUP).

Distribution: U.S.A. (Arizona, Texas) to Venezuela (Cameron, 1893; MacKay, 1987; Maes, 1989) (Fig. 3).

Comments: From Costa Rica (years 1986 to 2001) we examined 154 specimens (98 males and 56 females) of *S. guttata*; the specimens were collected mostly with hand nets during November (33 males /11 females), August (19 / 17) and October (18 / 4), the three months with greatest numbers of specimens captured (102 specimens = 66.2 %). These data suggest that adults of *S. guttata* are present in all months of the year. However, this information gives an inadequate indication of flight seasonality because the data were not collected with equal effort across the year.

Scolia (Hesperoscolia) rufiventris Fabricius, 1804

(Fig. 1d-1f, Fig. 2d-2f)

Scolia rufiventris Fabricius, 1804. Lectotype female (designated by J. C. Bradley, 1929), Essequibo [Guyana]. Catalogue number 00241358 ZMUC.

Scolia (Lacosi) anceps Saussure, 1858, type female, Mexico: Osten (2005).

Scolia (Lacosi) drewseni Saussure, 1858, type female, Brazil, Minas Gerais: Osten (2005).

Ycasbraia Argaman, 1996. Type species: *Scolia rufiventris* Fabricius, 1804. =*Hesperoscolia* Bradley, 1974: objective synonym (Kimsey and Brothers, 2016).

Diagnosis. Head and mesosoma black, metasoma and legs mostly orange-red (Fig. 1d-1e); female with the anterior margin of clypeus with a triangular projection medially (Fig. 1f); paramere apex rounded (Fig. 2d-2e); penis valve with large and small projections on dorsal margin (Fig. 2f).

Description. MALE. Body length 17.5 mm, forewing 14 mm. Color: integument of head, mesosoma and antenna black except eye inner emargination with small yellow spot; basal half of mandible black, apex mostly orange; metasoma, legs and tibial spurs orange-red except coxa black; wings infuscate, with feeble violaceous reflection; vertex and gena with sparse, semi-erect, black setae; frons, clypeus and scape with fulvous setae; pronotum, mesoscutum and scutellum mostly with black setae, propodeum,

meso and metapleuron mostly with short white pubescence and few semierect black setae; legs and metasoma with semi-erect fulvous setae. **Head:** mostly with dense, medium-sized, close punctures except gena with small sparse punctures and discal area of clypeus impunctate; head in dorsal view, including eyes, $0.69 \times$ maximum wide of mesosoma; ocelli small, distance between eye margin and lateral ocellus $0.59 \times$ as long as maximum diameter of ocellus; clypeus convex mesally, its anterior margin straight; scape not carinate, $1.66 \times$ as long as wide; first flagellomere $1.10 \times$ as long as second. **Mesosoma:** with dense, medium-sized, close punctures; antero-dorsal area of propodeum extends backward $1.0 \times$ length of scutellum then sharply bends downward forming nearly right angle; posterior area of propodeum strongly concave; meso and metatibiae with a row of spines in dorsal area, their apices with four spines, not including tibial spurs. **Metasoma:** First metasomal segment, in dorsal view, $0.67 \times$ as long as the second; paramere and penis valve as fig. 2d-2f.

Material examined. COSTA RICA (28 males, 22 females, INBio): Guanacaste: P. N. Guanacaste, Est. Agua Buena, 220 m, 8.ii–1.iii.1993, E. López, one female; Est. Cacao, 1000–1400 m, Lado SO Vol. Cacao, iii.1991, C. Chaves, one female; same data except: Sector Cacao, 1200 m, vi.1997, R. Moraga, one male, one female; Est. Los Almendros, 0 m, E. López, 15–27.viii.1994, one female; same data except: 300 m, 3–23.xii.1994, E. López, one female; Est. Pitilla, 700 m, nine km S Sta. Cecilia, 18.iv–9.v.1993, C. Moraga, two males; same data except: iv.1994, P. Ríos, one female; Fca. Jenny, 30 km N Liberia, 1.x.1988, two males; same data except: x.1988, two males, nine females; vii.1991, R. Espinoza, one female; P.N. Rincón de la Vieja, Est. Las Pailas, 800 m, 9–27.ii.1993, K. Taylor, one male; same data except: 16–24.viii.1993, D. García, one male. Limón: P. N. Tortuguero, Cerro Tortuguero, 100 m, iv.1989, R. Aguilar and J. Solano, two females; same data except: iii.1993, R. Delgado, one male; R.B. Hitoy Cerere, 100 m, vii.1992, G. Carballo, one male; same data except:

Talamanca, Cerro Bitarkara, 1025 m, 15–17 x.2004, Y. Cárdenas, one female; Veraguas Rainforest, Restaurant, 400–440 m, ix.2008, R. Villalobos, one male. Puntarenas: Buenos Aires, P. Int. La Amistad, 1766 m, 5–9.iii.1996, R. Villalobos, one male; same data except: Sendero a Casa Coca, 1700 m, 7–25.xi.2002, D. Rubi, two males, one female; Est. Agujas, Sendero Zamia, 300 m, 1–7.xii.1997, A. Azofeifa, two males; Est. Biol. Las Alturas, 1500 m, x.1991, M. Zumbado, one male, one female; same data except: Sendero Cerro Echandi, Coto Brus, xii.1997, B. Gamboa, one male; Sendero R. Bella Vista, 1400 m, 3–5.iii.1992, M. Zumbado, one male; Est. Cerro de Oro, Sendero Guapinol, 345 m, 10.i.1996, L. Angulo, two males; Est. Pittier, 1670 m, 5–18.i.1995, L. Angulo, one male; Est. Sirena, one–100 m, i.1995, G. Fonseca, one female; Cerro Biolley, Sector Altamira, La Amistad, 1800 m, 4.iii.1995, M. Segura, one male; Pta. Llorona, Sendero a San Pedrillo, 100 m, 2–3.iii.1997, J. Silva and E. Fletes, one male; Rancho Quemado, 200 m, Península de Osa, ix.1991, F. Quesada, two males. San José: Est. Santa Elena, Sendero La Bota, 1690 m, 25.iv.1996, E. Alfaro, one male. **PANAMA**: Panamá Province: Cerro Azul, Bosque en Residencial Las Nubes, 15.iii.1999, one male (MIUP); ciudad de Panamá, El Cangrejo, 6.x.2015, G. De La Guardia, one female (MIUP).

Distribution: Mexico (without other data) (Saussure, 1858), Costa Rica, Panama, Colombia (First records), Guyana, Peru, Brazil (Mato Grosso and Minas Gerais) (Fabricius, 1804; Saussure, 1858; Fox, 1896; Dos Santos *et al.*, 2015) (Fig. 3).

Comments: The two species of *Scolia* present in Central America, *S. guttata* and *S. rufiventris*, are differentiated by the diagnostic morphological characters presented above. Fernández and Cubillos, (1999) examined specimens of *Scolia* sp. 1 from Costa Rica (INBio) and Colombia (Antioquia, Cali, Valle, Dagua) and gave a brief description of *Scolia* sp. 1 that agrees with the description of *Scolia rufiventris*. Considerable effort was made to locate specimens collected from Colombia without positive

results. Existing evidence (morphology and distribution) indicates that the specimens mentioned by Fernández and Cubillos (1999) are *S. rufiventris*.

Seasonal flight activity for *Scolia guttata* from Barro Colorado Island, Panama

During the two continuous sampling years (2005–2006) in BCI, 144 specimens of *Scolia guttata* (137 males and seven females) were collected, 106 individuals during 2005, 38 individuals in 2006. Collections peaked during June with 127 specimens (88.2 %), the remainder captured during May, July, and December (Fig. 4). All seven females from BCI were captured in June. No *S. rufiventris* were recovered from the same BCI trap samples. The much smaller catch of *S. guttata* females relative to that of males in BCI could be the result of sampling methodology. Female Scoliidae typically spends a long time in the ground digging for larval hosts. For this reason, they are seldom collected with Malaise traps. However, males spend more time flying, mainly in search of females, thereby increasing chances of capture by Malaise traps. The under-representation of females in Malaise traps is not seen in the hand net collections from Costa Rica (INBio) where we had 56 females and 98 males of *S. guttata*.

The hosts of *S. guttata* and other *Scolia* species in the Neotropical region remain unknown. However, the hosts of some Nearctic *Scolia* species have been reported. Rau and Rau, (1918) recorded *Cotinis nitida?* (L., 1758) (Scarabaeidae: Cetoninae) as a host of *S. dubia dubia* Say, 1837, and Ryckman, (1956) reported a larva of Scarabaeidae as the host of *S. nobilitata otomita* Saussure, 1858. The greater abundance of *S. guttata* in BCI during June may be related to a greater abundance of scarabaeid larvae present in the soil and available to be parasitized during the early wet season. Ratcliffe, (2003) notes the abundance of some Dynastinae scarab beetles on BCI is greater in May, June and July (E.g. *Cyclocephala* species). Further biological and abiotic information is necessary to better correlate flight seasonality and annual abundance of *S. guttata* in BCI.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Table 1. Total of *Scolia guttata* specimens collected by month in 16 years (1986–2001) in Costa Rica

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986							2m					
1987												
1988									3m/1f	18m/4f	23m/11f	
1989	4f			1m				3m	1m			
1990		1m/1f						4m/8f				
1991	1f							1m				
1992	1m/1f	3m	1m				2f	8m/7f	1m/2f			
1993					1m				1m		10m	2m
1994			1m/1f	1f		1f	1f	1m	1m			
1995					1m							
1996								1m				
1997	4f											
1998		1m							5m			
1999					1f							
2000												
2001							1m/3f	1m/2f				
TOTAL	1m/10f	5m/1f	2m/1f	1m/1f	2m/1f	1f	3m/6f	19m/17f	12m/3f	18m/4f	33m/11f	2m

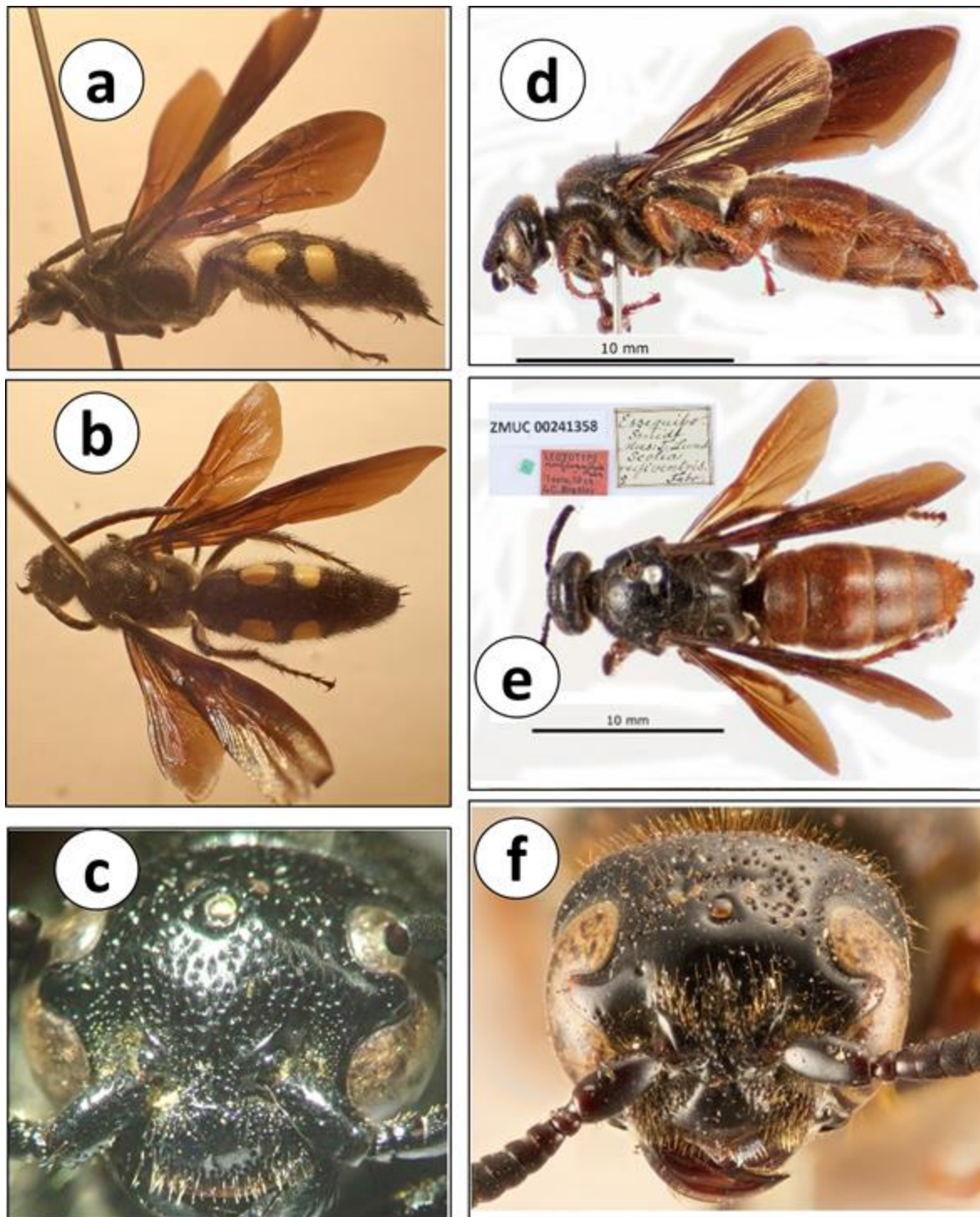


Figure 1. a-c. *Scolia guttata*. a,b. Habitus, male a. lateral view, b. Habitus, Dorsal view, c. Head, frontal view, female. d-f. *Scolia rufiventris*, female. d. Habitus, lateral view, e. Habitus, dorsal view and lectotype labels, f. Head, frontal view.

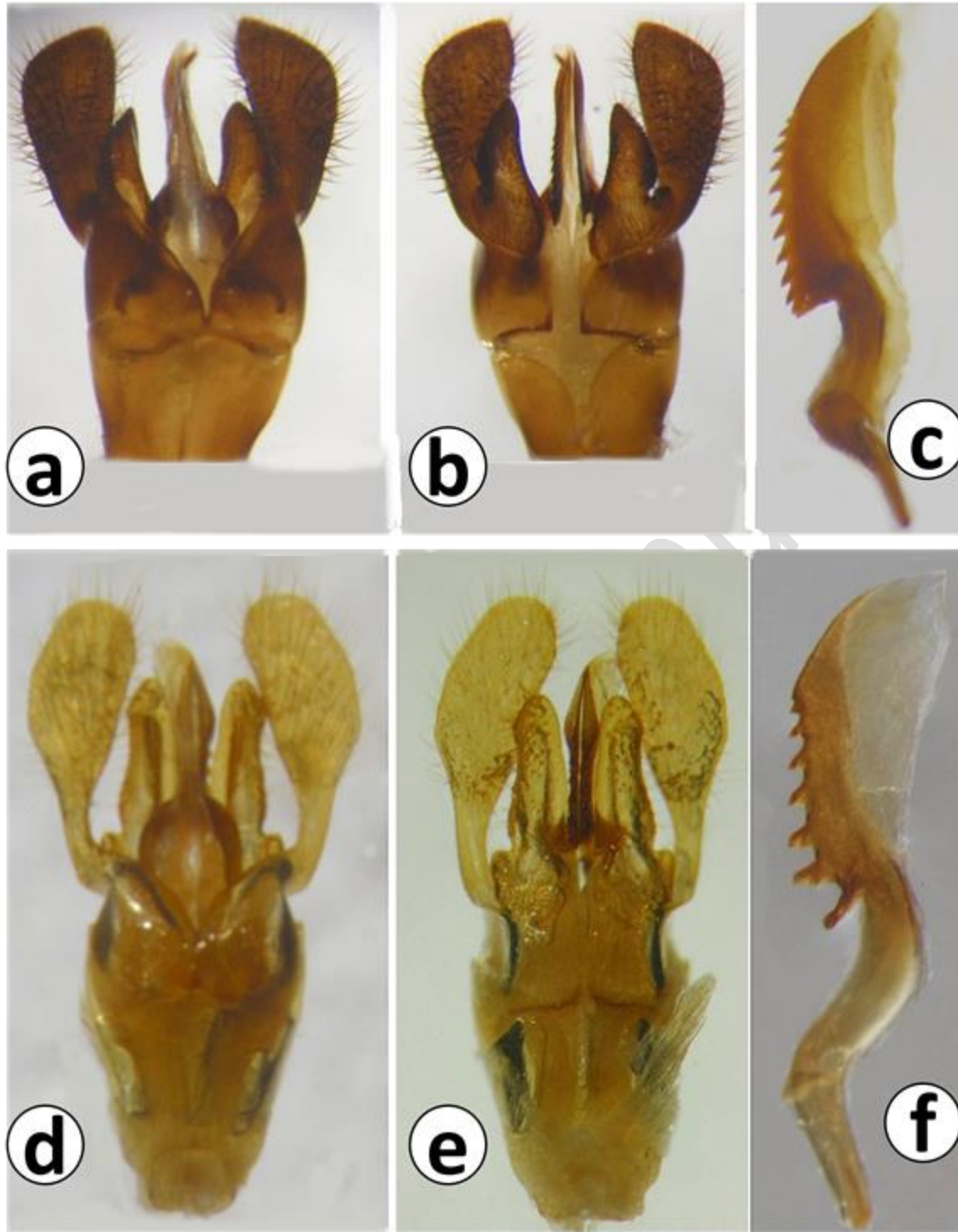


Figure 2. Genitalia, males. a-c. *Scolia guttata*, a. Dorsal view, b. Ventral view, c. Penis valve, lateral view. d-f. *Scolia rufiventris*, d. Dorsal view, e. Ventral view, f. Penis valve, lateral view.



Figure 3. Distribution of *Scolia guttata* and *Scolia rufiventris* in America.

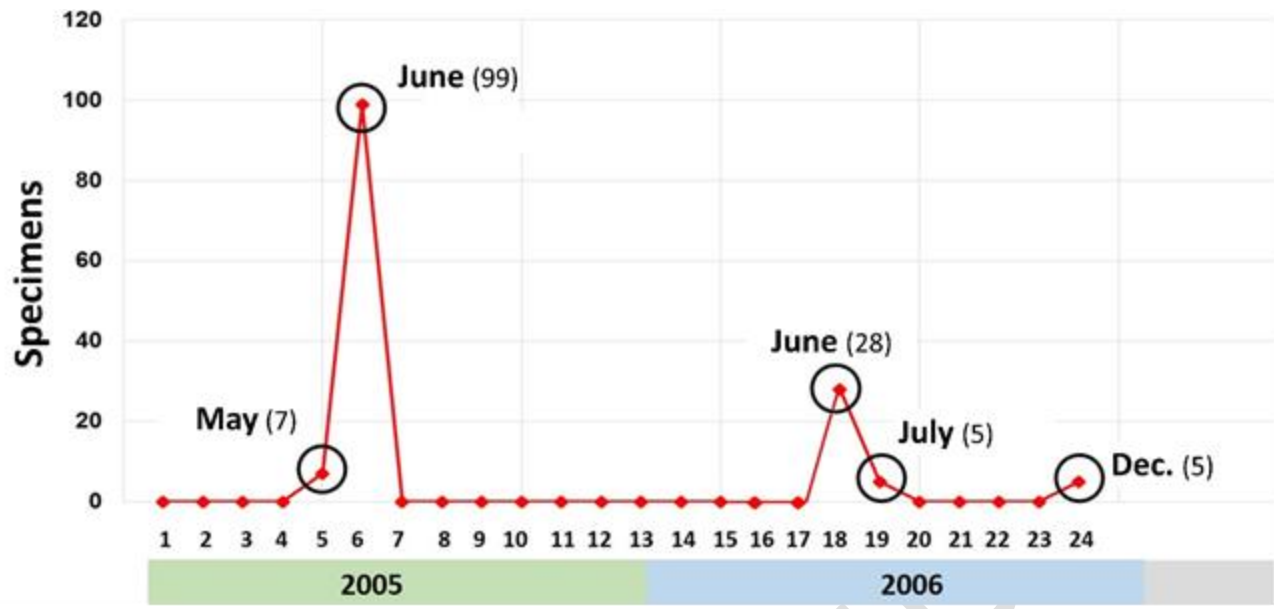


Figure 4. Total of *Scolia guttata* specimens captured by month in two years (2005-2006) with ten Malaise traps in BCI.