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First record of the scarab beetle, *Phyllophaga lissopyge* from South America, with descriptions of adult seasonal activity and male response to sex attractants

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Abstract

Phyllophaga lissopyge (Bates) (Coleoptera: Scarabaeidae: Melolonthinae) is reported for the first time from South America. Male sex pheromone response is described for *P. lissopyge* and two other co-occurring *Phyllophaga* species. Adults of *P. lissopyge* and *P. menetriesi* (Blanchard) flew to traps baited with methyl 2-(methylthio) benzoate whereas adults of *P. obsoleta* (Blanchard) flew irregularly to four different pheromone compounds. Adult seasonal activity is described from males captures in Rionegro, Antioquia, Colombia.

Resumen

Se reporta por primera vez *Phyllophaga lissopyge* (Bates) (Coleoptera: Scarabaeidae: Melolonthinae) en Sur América. Se describe la respuesta de los machos de *P. lissopyge* y de otras dos species de *Phyllophaga* recolectados en trampas cebadas con feromona sexual. Los adultos de *P. lissopyge* y *P. menetriesi* (Blanchard) volaron a las trampas cebadas con metil-2 - (metiltio) benzoate mientras los adultos de *P. obsoleta* (Blanchard) volaron irregularmente a cuatro diferentes compuestos de la feromona. Se describe la actividad estacional de los adultos basada en los machos capturados en trampas en Rionegro, Antioquia, Colombia.

Keywords: Antioquia, methyl 2-(methylthio) benzoate, Coleoptera, Colombia, L-isoleucine, L-leucine, L-valine, Melolonthinae, methyl 2-(methylthio), pheromone, Scarabaeidae
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Introduction

The New World genus *Phyllophaga* (*s. lato*) (Coleoptera: Scarabaeidae: Melolonthinae) encompasses 865 extant species, including 442 from Central America, 217 from Canada and the United States, 186 from the Caribbean Islands, and 109 from South America (Evans and Smith 2009). Some overlap of species distribution occurs between these regions. Both larvae and adults of various *Phyllophaga* species are economically important pests of a variety of agricultural crops such as bean, cassava, coffee, corn, ornamentals, pasture grasses, peanut, pepper, potato, and sugarcane (King 1984, 1996a, 1996b; Morón 1986, 2006; Londoño 1993; Salvadori and Oliveira 2001; Salvadori and Silva 2004; Espinosa-Islas et al. 2005; Pardo-Locarno et al. 2005; Ortega-Ojeda et al. 2007).

Evans and Smith (2009) reported 28 species of *Phyllophaga* in Colombia (Table 1). Restrepo-Giraldo et al. (2003), however, reported 29 species in Colombia including *P. sericata* Blanchard, a species not reported by Evans and Smith (2009). Serna-Patiño (2004) added *P. gigantea* based on light-trap captures in Pereira, Risaralda. We report here the first capture of *Phyllophaga lissopyge* (Bates) (Coleoptera: Scarabidae) in South America, bringing the total number of species listed from Colombia to 31.

In Colombia, *Phyllophaga* flight activity generally occurs during the two rainy seasons, either March to May or September to November (Vallejo et al. 1998; Pardo-Locarno et al. 2002; Serna-Patiño 2004; Villegas et al. 2006, 2008). After emerging from the soil, females release sex pheromones by opening the pygidium and extruding a gland from which the pheromone volatilizes (for photos, see Leal et al. 1993; Nojima et al. 2003; Zarbin et al. 2007). Sex pheromones identified from the *Phyllophaga* include methyl 2-(methylthio) benzoate from *P. crinita* (Robbins et al. 2003); methyl esters of three amino acids, including L-valine, from *P. anxia* and *P.* (*Phytalus*) *georgiana* (Zhang et al. 1997; Robbins et al. 2009); L-isoleucine from *P. anxia* and *P. elenans* (Zhang et al. 1997; Leal et al. 2003); L-leucine from *P. lanceolata*, (Nojima et al. 2003); and phenol and *p*-cresol from *P. cuyabana* (Zarbin et al. 2007). Furthermore, an extensive trapping study by Robbins et al. (2006) demonstrated the widespread use of the methyl esters of L-valine and L-isoleucine methyl ester in the mate-finding systems of >50 species of *Phyllophaga* in the United States and Canada. This manuscript is the first part of a study of trapping *Phyllophaga* spp. with sex attractants in various regions of Colombia.

Materials and Methods

The study site was located at the "La Selva" research station of the Corporación Colombiana de Investigación Agropecuaria in Rionegro, Antioquia, Colombia (latitude 6° 9' 17.1792", longitude -75° 22' 52.845", and 2150 m elevation). This site was chosen because of its history of abundant *Phyllophaga* populations. According to the Instituto de Hidrología, Meteorología y Estudios Ambientales station in Rionegro, Antioquia, the average temperature at the location is 17º C (8.0-25.0º C) and precipitation is 1800-2500 mm per year, largely falling in a bimodal pattern from April-May and September-October.

The methodology used in the present study was similar to prior studies (Zhang et al. 1997; Leal et al. 2003; Nojima et al. 2003; Robbins

Table 1. Checklist of the *Phyllophaga* from Colombia.

	Species	Subgenus	Authority	Source*
1	*aguadita*	Phyllophaga	Saylor, 1942	1
2	*apolinari*	Phyllophaga	Saylor, 1940	1
3	*apolinaria*	Phyllophaga	Saylor, 1942	1
4	*brevisetosa*	Phyllophaga	Moser, 1918	1
5	*caviceps*	Phyllophaga	Moser, 1918	1
6	*chiriquina*	Phyllophaga	Bates, 1888	1
7	*columbiana*	Phyllophaga	Blanchard, 1850	1
8	*densepunctata*	Phyllophaga	Moser, 1918	1
9	*fragilipennis*	Phyllophaga	Blanchard, 1850	1
10	*gigantea*	Phyllophaga	Bates, 1888	3
11	*impressipyga*	Phyllophaga	Frey, 1975	1
12	*lebasii*	Phyllophaga	Blanchard, 1850	1
13	*lissopyge*	Phyllophaga	Bates, 1888	4
14	*longicornis*	Phyllophaga	Blanchard, 1851	1
15	*luridipennis*	Phytalus	Moser, 1918	1
16	*martinezi*	Phyllophaga	Frey, 1975	1
17	*menetriesi*	Phyllophaga	Blanchard, 1851	1
18	*obsoleta obsoleta*	Phytalus	Blanchard, 1851	1
19	*pachypyga*	Phyllophaga	Burmeister, 1855	1
20	*pruinipennis*	Phyllophaga	Moser, 1918	1
21	*punctulata*	Phyllophaga	Blanchard, 1851	1
22	*rorulenta rorulenta*	Phyllophaga	Burmeister, 1855	1
23	*roscida*	Phyllophaga	Burmeister,1855	1
24	*ruficollis*	Phyllophaga	Moser, 1918	1
25	*rugipennis*	Phyllophaga	Shaufuss, 1858	1
26	*schneblei*	Phyllophaga	Frey, 1975	1
27	*sericata*	Phyllophaga	Blanchard, 1850	2
28	*setifera*	Phyllophaga	Burmeister, 1855	1
29	*thoracica*	Phyllophaga	Burmeister, 1855	1
30	*transversicollis*	Phyllophaga	Moser, 1918	1
31	*yucana*	Phyllophaga	Saylor, 1937	1

* 1 Evans and Smith 2009. 2 Restrepo-Giraldo et al. 2003, Cat. Coll. Ins. Col. 2:136. 3 Serna-Patiño 2004. 4 Morales et al. (current manuscript). Species reported first time in Colombia in this paper.

et al. 2003, 2006, 2008, 2009; Alm et al. 2004) that captured *Phyllophaga* adults using sex attractants. Cross-vane traps (see Robbins et al. 2006) were hung on a series of metal stakes such that the trap bottom was 1 m above the ground. A line of 12 traps, each separated by 20 m, were situated along the edge of a corn and cabbage field. Traps were maintained in the field from August 2003 to September 2004. Traps were emptied and re-randomized weekly. Pheromone lures were replaced every 4 weeks. Each trap was baited with an individual lure from the following: eight blends of the methyl esters of L-valine and L-isoleucine (100:0, 90:10, 80:20, 60:40, 40:60, 20:80, 10:90 and 0:100) (4 mg each rubber septa), L-leucine methyl ester (4 mg each rubber septa), methyl 2-amino benzoate (1 mg each rubber septa), methyl 2-(methylthio) benzoate (1 mg each rubber septa), and a control trap containing a blank septa. All lures were supplied by ChemTica Internacional, (www.chemtica.com). After collection, insects were frozen until identification. All specimens were identified to species using characteristics of the male genitalia (Morón 2001, 2003). The identification of *P. lissopyge* was confirmed by Dr. María Milagro Coca-Abia (Centro de Investigaciones y Tecnologías Agroalimentarias, Zaragoza, Spain) by comparison with museum specimens. Local

rainfall data were obtained directly from the Instituto de Hidrología, Meteorología y Estudios Ambientales station in Rionegro, Antioquia.

A male capture response curve was constructed for each *Phyllophaga* species to illustrate the proportional capture of males collected over the entire study with respect to pheromone treatment. The seasonal incidence of each species was also examined by plotting the number of captures versus weekly precipitation to reveal any correspondence between rainfall and adult activity.

Results

Material examined

A total of 156 males and no females were captured, representing three species of *Phyllophaga*. These included 135 *P.* (*Phyllophaga*) *lissopyge*, 20 *P.* (*Phytalus*) *obsoleta*, and 1 *P.* (*Phyllophaga*) *menetriesi*, representing 86.5, 12.8, and 0.7% of total captures, respectively. This is the first record of *P. lissopyge* from Colombia and South America.

Male pheromone response

For *P. lissopyge*, male captures were greatest in those traps baited with methyl 2-(methylthio) benzoate (97.8%, n = 132); the remaining males (2.2%, n = 3) all flew to L-leucine methyl ester (Figure 2). In contrast, *P. obsoleta* showed no clear preference for any pheromone treatment; males were recovered from 100% L-valine methyl ester (15.0%, n = 3), 10:90 L-valine methyl ester: L-isoleucine methyl ester (20.0%, n = 4), L-leucine methyl ester (25.0%, n = 5), methyl 2-(methylthio) benzoate (10.0%, n = 2), and untreated check trap (30.0%, n = 6). The single male *P. menetriesi* was captured in a trap baited with methyl 2-(methylthio) benzoate.

Seasonal incidence

Figure 1. Geographic distribution of *Phyllophaga lissopyge.* High quality figures are available online.

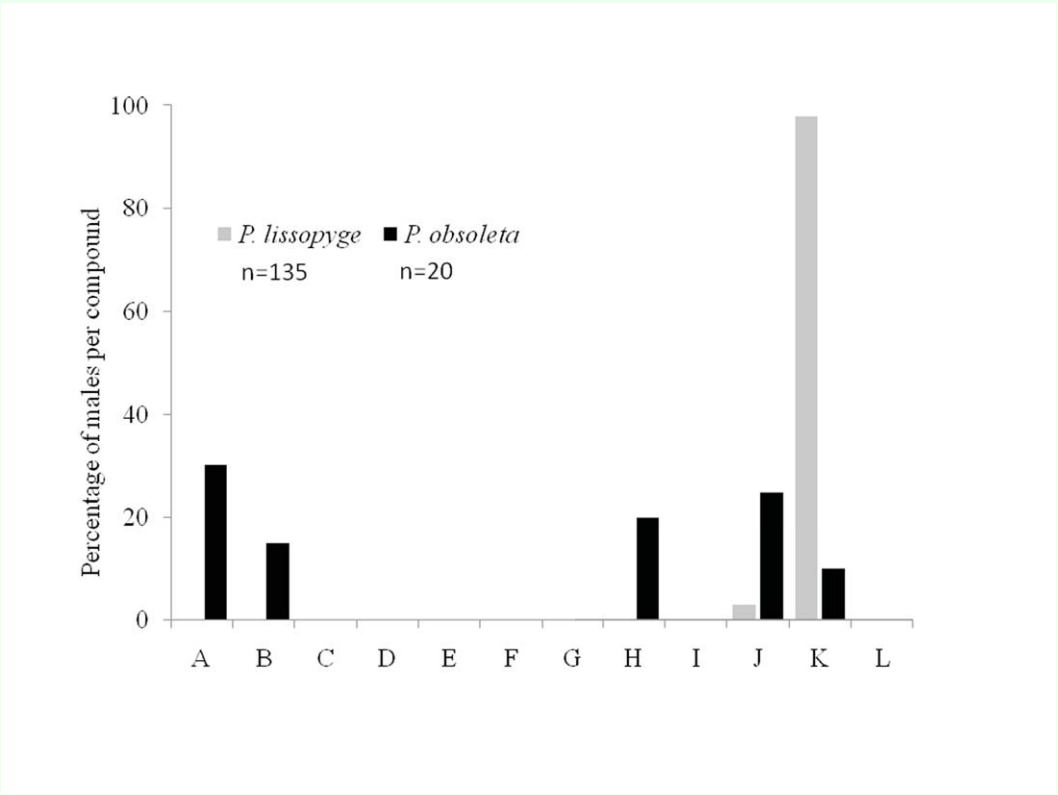

Figure 2. Proportional catch, by species, of adult *Phyllophaga lissopyge* and *P. obsoleta* in traps with 12 different blends of pheromones in Rionegro, Antioquia, Colombia. (A) untreated check, (B) 100:0, (C) 90:10, (D) 80:20, (E) 60:40, (F) 40:60, (G) 20:80, (H) 10:90, and (I) 0:100 of L-valine methyl ester: L-isoleucine methyl ester; (J) L-leucine methyl ester, (K) methyl 2-(methylthio) benzoate, (L) methyl 2-amino benzoate. High quality figures are available online.

Adults of white grub species are commonly called "marceños" (March beetles) because many species fly in March. *Phyllophaga lissopyge*, however, was captured during every month of the year with the exception of August in both 2003 and 2004 (Figure 3). Almost half of all captures (48.1%) occurred during the four months of highest precipitation, March to June 2004 (Figure 3). *Phyllophaga lissopyge* adults were captured primarily after or during a period of high precipitation (Pearson's r = 0.64364; n = 14) with the exception of January 2004 (usually the driest month in the area), when 8 males were captured after the field was heavily irrigated.

Phyllophaga obsoleta males were captured mainly during August and September of both years (9 adults in 2003 and 8 in 2004). Three *P. obsoleta* males were captured in December, January, and February (one each month) (Figure 3). The single male *P. menetriesi* was captured the second week of May.

Discussion

Three species of *Phyllophaga* were captured during the study: *P. lissopyge, P. menetriesi*, and *P. obsoleta*. This information expands the geographical distribution of *P. lissopyge* to the country of Colombia and continent of South America. Bates (1888) described this species from two specimens collected at Volcán Chiriqui, Panama and Chontales, Nicaragua. Morón (2001) reported the occurrence of this species from between southern Costa Rica to western Panama. In 2003, Morón (2003) expanded the range of *P. lissopyge* from central Nicaragua to central Panama (Figure 1). *Phyllophaga lissopyge* is usually found on mountain slopes (620 to 2136 m elevation)

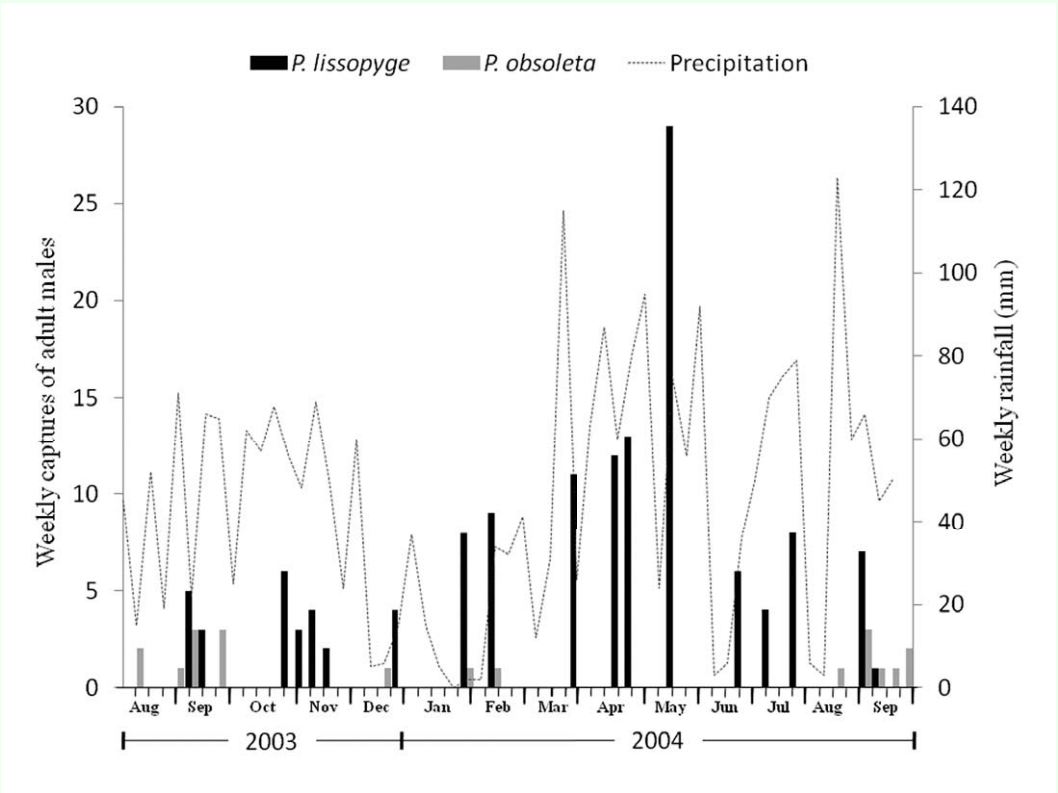

Figure 3. Numbers of adult *Phyllophaga lissopyge* and *P. obsoleta* collected weekly from pheromone traps with respect to weekly precipitation in Rionegro, Antioquia, Colombia. High quality figures are available online.

with cloud forests, tropical rain forest, and coffee plantations (Morón 2003). *Phyllophaga lissopyge* may have arrived in Colombia through natural or human-mediated dispersal. *Phyllophaga lissopyge* could have spread from Panama to the north of Chocó department through the Darien Gap, and then through the same mountain system to Antioquia. Human-mediated dispersal is also likely, the commercial interchange between Colombia and Panama in this area being very intense and unregulated. Peck et al. (2001) suggested the same route of invasion for *Prosapia simulans* (Walker) (Homoptera: Cercopidae) from Central America to Colombia.

Phyllophaga lissopyge is a member of the genus *Phyllophaga* (*sensu stricto*), and is one of 865 species of *Phyllophaga* (*s. lato*) recorded from the New World (Evans and Smith 2009). However, based on phylogenetic analysis of external morphological and genitalic characteristics, Coca-Abia (2002) proposed the re-establishment of the genus *Trichesthes* (Erichson 1847) and removed 38 species from the *Phyllophaga* and into *Trichesthes*, including *P. lissopyge* and *P. gigantea*.

The flight patterns of *P. lissopyge* in Central America (Morón 2001, 2003) mirror our observations in Colombia, in that adults fly from February to November, with the largest flights occurring during March, April, and May.

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