Revista Mexicana de Biodiversidad 81: 177- 181, 2010

Track analysis of the species of *Agrodes* and *Plochionocerus* (Coleoptera: Staphylinidae)

Análisis de trazos de las especies de *Agrodes* y *Plochionocerus* (Coleoptera: Staphylinidae)

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Abstract. The geographical distributions of 2 species of *Agrodes* and 13 species of *Plochionocerus* were analyzed using a panbiogeographic approach to identify their biogeographic patterns. Nine species have been recorded as being exclusively from South America, 2 exclusively from Central America, and 4 are shared between both areas. Two species of *Agrodes* and 3 of *Plochionocerus* are widely distributed in 2 or more subregions of the Neotropical region, and 6 species of *Plochionocerus* have more restricted distributions, basically ranging in a single subregion, and 4 species are restricted to a small number of localities. Three generalized tracks were identified in the Mesoamerican dominion of the Caribbean subregion, in the northwestern South American dominion of the Caribbean subregion, and in the Amazonian subregion. Species of other staphylinid genera provide additional support to these tracks.

Key words: Xantholinini, panbiogeography, generalized tracks, Neotropical region.

Resumen. Se analizó la distribución geográfica de 2 especies de *Agrodes* y 13 especies de *Plochionocerus* utilizando un enfoque panbiogeográfico, con la finalidad de identificar sus patrones biogeográficos. De las especies analizadas, 9 han sido registradas exclusivamente para América del Sur, 2 exclusivamente para América Central y 4 son compartidas entre ambas áreas. Dos especies de *Agrodes* y 3 de *Plochionocerus* están distribuidas en 2 o más subregiones de la región Neotropical, 6 especies de *Plochionocerus* poseen distribuciones más restringidas, distribuyéndose básicamente en una sola subregión, y 4 especies se restringen a unas pocas localidades. Se identificaron 3 trazos generalizados en el dominio Mesoamericano de la subregion Caribeña, en el dominio Sudamericano Noroccidental de la subregión Caribeña y en la subregión Amazónica. Algunas especies de otros géneros de estafilínidos brindan soporte adicional a estos trazos.

Palabras clave: Xantholinini, panbiogeografía, trazos generalizados, región Neotropical.

Introduction

Agrodes Nordmann, 1837 and *Plochionocerus* Dejean, 1833 have been subjected to recent taxonomic revision (Asiain et al., 2007). Species assigned to these genera have metallic blue, purplish, green, and golden coloration, and a relatively elongate body. As a result of their systematic revision, several synonyms were detected, mainly for species of *Plochionocerus*, which currently comprises 18 species. Additionally, *Agrodes,* a former synonym of *Plochionocerus,* was resurrected and now includes 2 species. Recent phylogenetic analysis showed that both genera are monophyletic and sister taxa, and together constitute the sister group of *Renda* Blackwelder, 1952. Phylogenetic relationships among their species, however, are still poorly resolved (Asiain et al., 2007). Species of *Agrodes* and *Plochionocerus,* which are predators and apparently good flyers, mostly inhabit cloud and tropical forests, from 100 to 2 800 m. These species are distributed in the Neotropical region, from Mexico to Argentina.

We apply herein a panbiogeographic analysis to contribute to the knowledge of their distributional patterns and to compare them with the patterns of other Neotropical staphylinids.

Recibido: 24 enero 2009; aceptado: 09 julio 2009

Material and methods

We analyzed distributional data of 2 species of *Agrodes* and 13 out of the 18 species of *Plochionocerus*

from Asiain et al. (2007), excluding 5 species with only 1 locality record (*P. gracilis*, *P. hermani*, *P. modestus*, *P. reticularis* and *P. transversalis*). We added the first record for Honduras of *P. discedens* (HONDURAS: Cortés: Cofradía, 25 km N P.N. Cusuco, 1 550 m, 26.viii.15-ix.1994, cloud forest/ FMND 94-41, flight intercept trap 1, S. and J. Peck 94-59 FIELD MUS. NAT. HIST/ NB: Probably more specimens in alcohol at FMNH/ *Renda* det. Newton 1995/ *Plochionocerus discedens* Asiain and Márquez 2008 det.).

The panbiogeographic method (Croizat, 1958, 1964) consists of plotting distributions of species on maps, and connecting their localities together via minimum distance lines to obtain individual tracks. The overlap of the individual tracks of several species allows the identification of generalized tracks, which indicate the pre-existence of ancestral biotic components that have been fragmented by tectonic or climatic changes (Croizat, 1958, 1964; Craw et al., 1999; Morrone, 2004, 2009). Some country records without precise locality data were indicated with a question mark. The generalized tracks were obtained based on the congruent overlap of the individual tracks.

Results

The geographical distribution and individual tracks of the species of *Agrodes* and *Plochionocerus* are shown in figures 1-10. Nine species have been recorded exclusively from South America, 2 exclusively from Central America and 4 are shared between both areas. *Agrodes conicicollis* is recorded from Ecuador, Peru and Brazil, whereas *A. elegans* is recorded from Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia, and Brazil. Considering all species of *Plochionocerus* (18), Peru and Venezuela are the countries with the highest number of species, with 6 species each. They are followed by Costa Rica, Panama, Colombia, and Ecuador (5 species); Brazil (4 species); Bolivia and French Guyana (3 species); Mexico, Guatemala, El Salvador, Honduras, and Nicaragua (2 species); and Guyana, Surinam, Trinidad and Tobago, and Argentina (1 species). Two species of *Agrodes* and 3 of *Plochionocerus* are widely distributed in 2 or more subregions of the Neotropical region. Six species of *Plochionocerus* have more restricted distributions, basically being found in a single subregion. Four species of *Plochionocerus* are restricted to a few localities (Table 1, Figs. 1-10). The distribution of the species according to the regionalization of Latin America (*sensu* Morrone, 2006) is summarized in Table 1.

Based on the 15 individual tracks (Figs. 1-10), 3 generalized tracks were identified (Fig. 11). Two are in the Caribbean subregion (1 in the Mesoamerican domain and other in the Northwestern South American domain) and a third in the Amazonian subregion (Morrone, 2006).

Mesoamerican track. This track is based on individual tracks of *Plochionocerus discendens* (Fig. 5), *P. puncticeps* (Fig. 6), and partially supported by *Agrodes elegans* (Fig. 1), *P. humeralis* (Fig. 9), *P. marquezi* (Fig. 2), and *P. simplicicollis* (Fig. 7).

Northwestern South American track. This track fell within the northwestern South American dominion of the Caribbean subregion. It is based on the individual tracks of *Agrodes conicicollis* (Fig. 2), *Plochionocerus ashei* (Fig. 1), *P. impresipennis* (Fig. 10), *P. pronotalis* (Fig. 3), and partially supported by *A. elegans* (Fig. 1), *P. fulgens* (Fig. 8), *P. humeralis* (Fig. 9), *P. marquezi* (Fig. 2), and *P. simplicicollis* (Fig. 7).

Amazonian track. This track falls within the Amazonian subregion, and is based on the individual tracks of *Plochionocerus igneus* (Fig. 3) and *P. splendens*, and partially supported by *Agrodes conicicollis*, *A. elegans* and *P. fulgens* (Fig. 8).

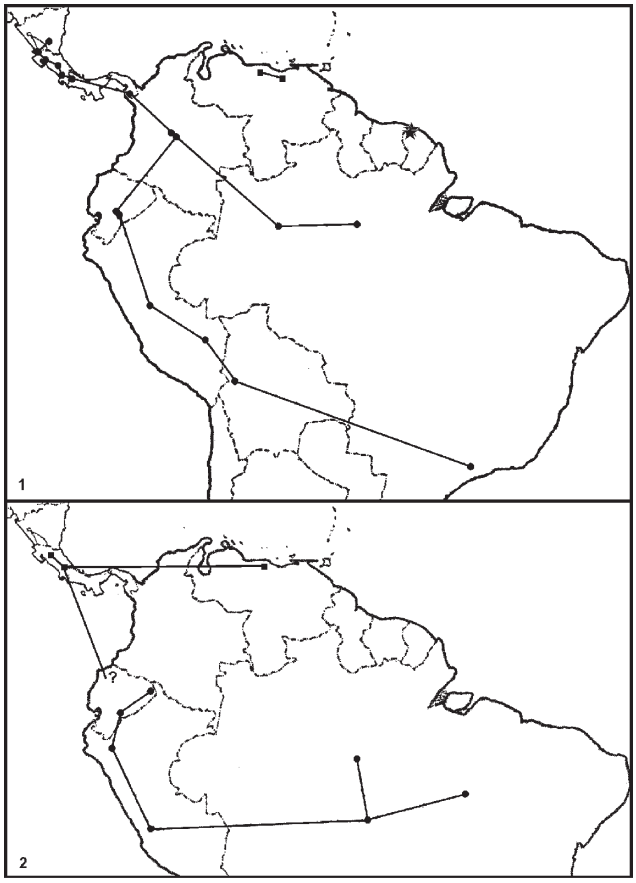
The geographical distribution of *Plochionocerus newtonorum* (Fig. 1) and *P. janthinus* (Fig. 4) does not coincide with any of the generalized tracks obtained. No nodes (areas of mixed biotic affinities) were found.

Discussion

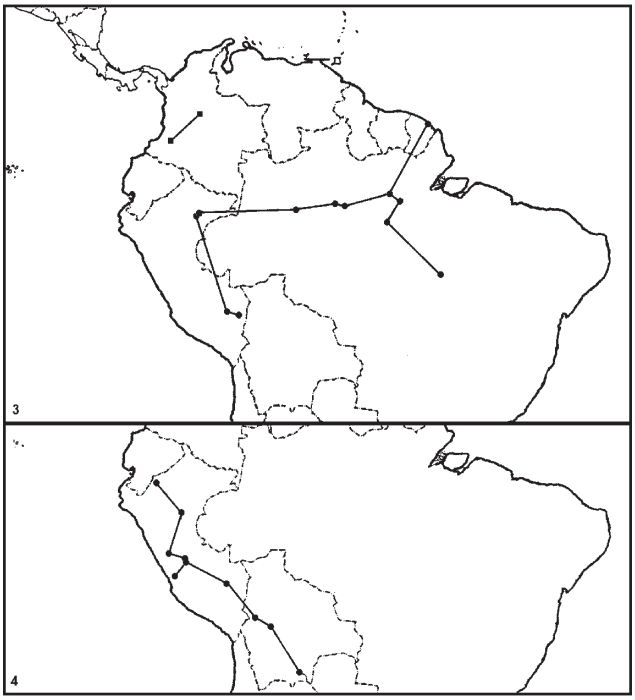
Other staphylinid taxa that support the Mesoamerican track are 22 species of *Homalolinus*, 1 species of *Heterolinus* Sharp, 1885 and 7 species of *Misantlius* Sharp, 1885 (Asiain and Márquez, 2003; Márquez and Morrone, 2003). Márquez and Morrone (2003) distinguished a northern and a southern generalized track within the Mesoamerican dominion, based on an analysis of species of *Homalolinus* and *Heterolinus,* with the Nicaraguan lowlands representing the boundary between them. Species of *Plochionocerus*, *Agrodes* and *Misantlius* seem to support this hypothesis. The northern Mesoamerican track is supported by 9 species of *Homalolinus* (*H. affinis*, *H. atronitens*, *H. confusus*, *H. mexicanus*, *H. minensis*, *H. obsoletus*, *H. rufopygus*, *H. sanguineus,* and *H. scutellaris*) and 6 species of *Misantlius* (*M. aequalis*, *M. carinulatus*, *M. hondurensis*, *M. optatus*, *M. rufipennis,* and *M. torquatus*). The southern Mesoamerican track is supported by 3 species of *Plochionocerus* (*P. humeralis*, *P. marquezi*, and *P. puncticeps*), 12 species of *Homalolinus* (*H. apiciventris*, *H. brevipennis*, *H. canaliculatus*, *H. dificilis*, *H. gracilis*, *H. mordax*, *H. planus*, *H. punctipennis*, *H. ruficollis*, *H. setosus*, *H. sharpi*, and *H. tripunctatus*), *Agrodes elegans*, *Misantlius gebieni*, and *Heterolinus basiniger* (Asiain and

Table 1. Distribution of the species of *Agrodes* and *Plochionocerus* for regions, subregions, dominions and provinces (*sensu* Morrone, 2006; Márquez and Morrone, 2003)

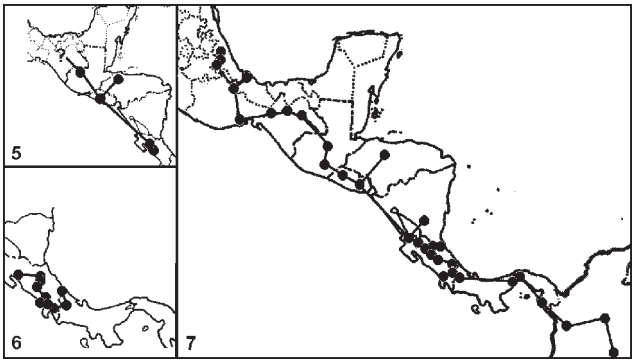
Region	*Subregions*	*Dominions*	*Provinces*	*Species*
Neotropical	Caribbean	Northern Mesoamerican	Mexican Pacific Coast	*P. discedens*, *P. simplicicollis*
			Mexican Gulf	*P. discedens*, *P. simplicicollis*
			Chiapas	*P. discedens*?, *P. simplicicollis*
		Southern Mesoamerican	Eastern Central America	*A. elegans*, *P. discedens*, *P. humeralis*, *P. marquezi*, *P. puncticeps*, *P. simplicicollis*
			Western Panamanian Isthmus	*A. elegans*, *P. humeralis*, *P. puncticeps*, *P. simplicicollis*
		Northwestern South American	Choco	*A. elegans*, *P. simplicicollis*
			Maracaibo	*P. humeralis*,
			Venezuelan Coast	*P. ashei*, *P. fulgens*, *P. humeralis*, *P. marquezi*
			Trinidad and Tobago	*P. humeralis*
			Magdalena	*A. elegans*, *P. pronotalis*, *P. simplicicollis*
			Venezuela Llanos	*P. humeralis*
			Cauca	*P. fulgens*, *P. humeralis*, *P. impressipennis*, *P. pronotalis*, *P. simplicicollis*
			Western Ecuador	*P. fulgens*, *P. humeralis*, *P. impressipennis*
			Arid Ecuador	*P. humeralis*, *P. impressipennis*
			Tumbes-Piura	*P. humeralis*
	Amazonian		Napo	*A. elegans*, *A. conicicollis*, *P. fulgens*, *P. humeralis*, *P. igneus*, *P. impressipennis*, *P. janthinus*, *P. simplicicollis*
			Imeri	*P. fulgens*
			Humid Guyana	*P. fulgens*, *P. igneus*, *P. newtonorum*
			Roraima	*P. fulgens*
			Varzea	*P. fulgens*, *P.humeralis*, *P. igneus*, *P. splendens*
			Ucayali	*A. elegans*, *P. fulgens*, *P. humeralis*, *P. janthinus*
			Madeira	*A. elegans*, *A. conicicollis*, *P. fulgens*, *P. humeralis*, *P. igneus*, *P. splendens*
			Tapajos-Xingu	*P. fulgens*, *P. igneus*
			Para	*P. fulgens*
			Pantanal	*A. conicicollis*, *P. fulgens*, *P. splendens*
			Yungas	*A. elegans*, *P. igneus*, *P. humeralis*, *P. impressipennis*, *P. janthinus*, *P. splendens*
	Chacoan		Cerrado	*A. conicicollis*, *P. igneus*, *P. splendens*
			Chaco	*P. fulgens*
	Parana		Brazilian Atlantic Forest	*P. fulgens*
			Parana Forest	*A. elegans*, *P. fulgens*, *P. humeralis*, *P. splendens*
			Araucaria angustifolia Forest	*P. fulgens*
South American transition zone			North Andean Paramo	*A. elegans*, *A. conicicollis*, *P. fulgens*, *P. humeralis*, *P. impressipennis,*
			Coastal Peruvian Desert	*P. janthinus*
			Puna	*A. elegans*, *A. conicicollis*, *P. janthinus*



Figures 1-2. Individual tracks. 1, *Agrodes elegans* (black circles); *Plochionocerus ashei* (black squares); *P. newtonorum* (black stars); 2, *A. conicicollis* (black circles); *P. marquezi* (black squares).



Figures 3-4. Individual tracks. 3, *Plochionocerus igneus* (black circles); *P. pronotalis* (black squares); 4, *P. janthinus*.

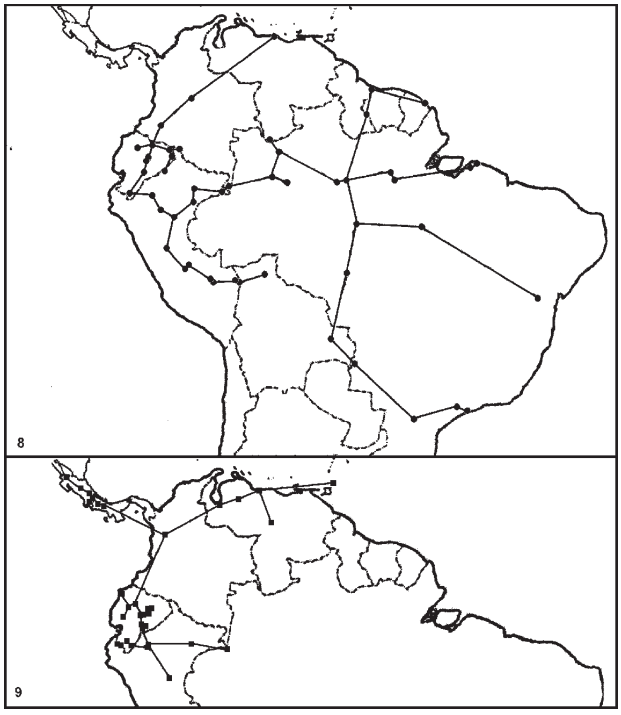


Figures 5-7. Individual tracks. 5, *Plochionocerus discendens*; 6, *P. puncticeps*; 7, *P. simplicicollis*.

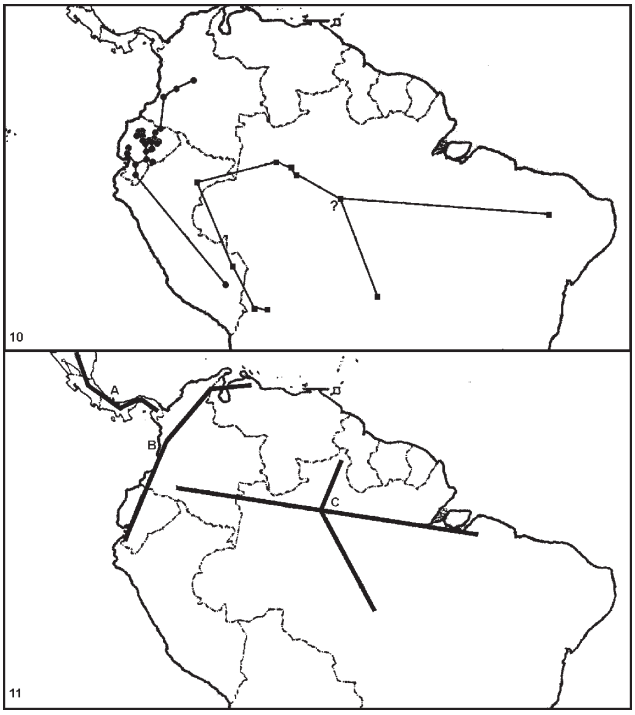
Márquez, 2003; Márquez and Morrone, 2003; Navarrete-Heredia, 2005; Asiain et al., 2007).

The lowlands of Nicaragua seem to represent a biogeographic barrier for montane insect fauna, as previously noted by Halffter (1987). The emergence of these lowlands can be also interpreted as a vicariant event fragmenting a previously continuous distribution of several taxa, as is the case for some of the staphylinid beetles herein analyzed. The highest number of species of *Plochionocerus* is found in South America and the highest number of species of *Homalolinus* in Central America. Both genera include species that probably did not speciate after the vicariant event or events that fragmented the Mesoamerican and South American generalized tracks, namely *Plochionocerus discedens*, *P. simplicicollis* and *Homalolinus divisus*. Species from other staphylinid taxa supporting the northwestern South American track are *Homalolinus aequatorialis*, *H. canaliculatus*, *Heterolinus basiniger, H. puncticeps and H. xanthogaster* (Márquez and Morrone, 2003). No species of *Misantlius*, *Homalolinus* and *Heterolinus* support the Amazonian track.

Our analysis provides further species supporting the primary biogeographic homology of the 3 detected generalized tracks, which correspond to 3 major biotic components. These results allow corroboration of previous biogeographic hypotheses, although the lack of congruence with other biological groups may indicate the lack of appropriate studies. The absence of nodes may indicate that there were no events of biogeographic convergence



Figures 8-9. Individual tracks. 8, *Plochionocerus fulgens*; 9, *P. humeralis*.



Figures10-11. 10, Individual tracks, *Plochionocerus impresipennis* (black circles); *P. splendens* (black squares); 11, schematic representation of the generalized tracks: A, Mesoamerican; B, Northwestern South American; C, Amazonian.

(Morrone, 2008) in the biotic components analyzed, which correspond all to the Neotropical region.

Acknowledgements

We thank Mark Olson and 2 anonymous reviewers for their important suggestions to this work.

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