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First record of predation by the Andean white-eared opossum *Didelphis pernigra* on the red swamp crayfish *Procambarus clarkii* in Colombia

Primer registro de depredación de la zarigüeya *Didelphis pernigra* sobre el cangrejo rojo de río *Procambarus clarkii* en Colombia

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The Virginia opossum (*Didelphis virginiana*) has been identified as a predator of the red swamp crayfish (*Procambarus clarkii*) in North America. In the regions where this crayfish has been introduced, other mammals have been identified that include it in their diet. The present paper is the first record of predation by *D. pernigra*, a species that is endemic to the Andean Mountain range, on the invasive exotic crayfish *P. clarkii* in Colombia. We carried out 100 m transects in a riverside forest in the middle basin of the Chicamocha River, Colombia. We collected feces and recorded tracks, and afterwards, obtained photographic records of individual opossums in the area. We weighed the feces, then dissolved them and separated them in Petri dishes. The tracks and the individuals photographed were identified using a specialized bibliography. We found structures in the feces that allowed the identification of 5 individuals of the species *P. clarkii*, an odonate, as well as Poaceae seeds. The tracks and the specimens photographed belong to the species *D. pernigra*, a species previously recorded in the region. The colonization and reproduction of *P. clarkii* in the area represents a new resource that the species *D. pernigra* has integrated into its diet. *D. pernigra's* predation on *P. clarkii* may be related to the nocturnal behaviour of both species, which increases the probability of predation. It is likely that this South American species of the genus *Didelphis* may modify their diet if the invasion area of *P. clarkii* increases.

Key words: Decapods; diet; feces; invasive species.

La zarigüeya de Virginia (*Didelphis virginiana*) ha sido identificada como depredador del cangrejo rojo de río (*Procambarus clarkii*) en Norteamérica. En las regiones en donde ha sido introducido este cangrejo se han identificado otras especies de mamíferos que lo integran en su dieta. El presente trabajo es el primer registro de depredación de *D. pernigra,* especie endémica de la cordillera de los Andes, sobre el cangrejo exótico invasor *P. clarkii* en Colombia. Se realizaron transectos de 100 m en bosque ribereño de la cuenca media del río Chicamocha, Colombia, en donde se recolectaron las heces y se registraron huellas, posteriormente se obtuvieron registros fotográficos de individuos de zarigüeya en la zona. Las heces se pesaron, disolvieron y separaron en cajas de Petri. Las huellas e individuos fotografiados se identificaron empleando bibliografía especializada. En las heces se encontraron estructuras que permitieron identificar 5 individuos de la especie *P. clarkii*, un odonato y semillas de Poaceae. Las huellas y ejemplares fotografiados corresponden a la especie *D. pernigra,* una especie registrada previamente en la región. La colonización y reproducción de *P. clarkii* representa una nueva oferta de recursos que la especie *D. pernigra* ha integrado a su dieta. La depredación de *P. clarkii* por parte de *D. pernigra* puede estar relacionado con el comportamiento nocturno de las 2 especies, que aumenta la posibilidad de depredación. Probablemente las especies del género *Didelphis,* en Sudamérica, puedan modificar su dieta, si aumenta el área de invasión de *P. clarkii*.

Palabras clave: Decápodos; dieta; especie invasora; heces.

The marsupial genus *Didelphis* contains 6 species distributed throughout the American continent (Lemos and Cerqueira 2002; Cerqueira and Tribe 2007). In Colombia, *D. marsupialis* is distributed mostly between 0 and 2,000 m, and *D. pernigra,* between 2,000 and 3,900 m (Alberico *et al.* 2000; Dias-Rocha *et al.* 2021), although Medina *et al.* (2021) note a record of *D. marsupialis* cohabiting with *D. pernigra* in the higher altitude range. The latter is the species of the genus *Didelphis* that predominates in the middle basin of the Chicamocha River in Colombia (GBIF 2021). Species belonging to the *Didelphis* genus are an omnivorous and opportunistic group that include plants, rodents, birds, reptiles, and insects in their diet, and although in North America *D. virginiana* is a natural predator of river crayfish, it is not common for *Didelphis* species in South America to consume crustaceans (Knudsen and Hale 1970; Hobbs 1993; Leite *et al.* 1996; Cáceres 2002; Durant 2002).

A species introduced into a new habitat may become a food source for species already established there. For example, in the Iberian Peninsula, mammals such as the red fox (*Vulpes vulpes*), the common genet (*Genetta genetta*), the Egyptian mongoose (*Herpestes ichneumon*), and the otter (*Lutra lutra*) quickly included the red swamp crayfish into their diet, which is one of the most widely introduced species in the world (Correia 2001; Ruiz-Olmo and Clavero 2008; Oficialdegui *et al.* 2020). The first records of *P. clarkii* in high Andean ecosystems were in 2004 (Campos 2005). As from 2016, their presence was identified in the middle basin of the Chicamocha river in the towns of Sotaquirá and Paipa (Colombia). Notwithstanding, before now, the predation upon this introduced species by South American native mammals had not been documented.

The objective of the study was to record the incorporation into the diet of the Andean white-eared possum (*D. pernigra*) of the introduced species, the red crayfish (*P. clarkii*) in Colombia.

We conducted the study in the rural area of El Salitre, in the town of Paipa (Colombia), at an altitude of 2,500 m, at the coordinates 5° 45' 29.60" N, 73° 9' 33.27" W. We searched for feces, foraging areas and tracks of opossums in 10 100 m transects, parallel to the edges of a riverside forest on the Chicamocha river. We obtained photographs of opossums *in situ* during a mammal monitoring carried out in 2022 in the same study zone.

During the sampling, we found a foraging area with feces and tracks in the sediment on the edge of a stream. We collected the feces in resealable plastic bags and photographed the tracks after placing a measuring tape as a reference. In the laboratory, we dissolved the feces in Petri dishes using 70 % alcohol and separated and identified the items found using a ZEISS stemi 305 stereo microscope, with the support of researchers from the biology department of the Universidad Pedagógica y Tecnológica de Colombia. Tracks of *D. pernigra* were identified according to Navarro and Muños (2000). The identification of the species was confirmed through photographic records (Lemos and Cerqueira 2002).

On average, the feces were 4.5 cm long and had a dry mass of 5.0 g. We identified the remains of red crayfish, a pair of wings of an odonate and Poaceae seeds. We found 4 pairs of claws, an exoskeleton with claws attached and 3 rostrum structures with antennae corresponding to at least 5 individuals of *P. clarkii* (Figure 1).

The tracks, of both front and rear paws, had 5 digits with sole and palm pads. The front tracks were 3.9 ± 0.05 cm long and 4.4 ± 0.65 cm wide. The rear tracks were 7.3 ± 0.4 cm long and 4.6 ± 0.3 cm wide, and the rear limbs' first digits, or hallux, were opposable and did not have claws. The tracks and photographed specimens match the description of the species *D. pernigra* (Figure 2), which is the only species of *Didelphis* previously recorded in the zone and therefore the most likely source of the feces found during the study.

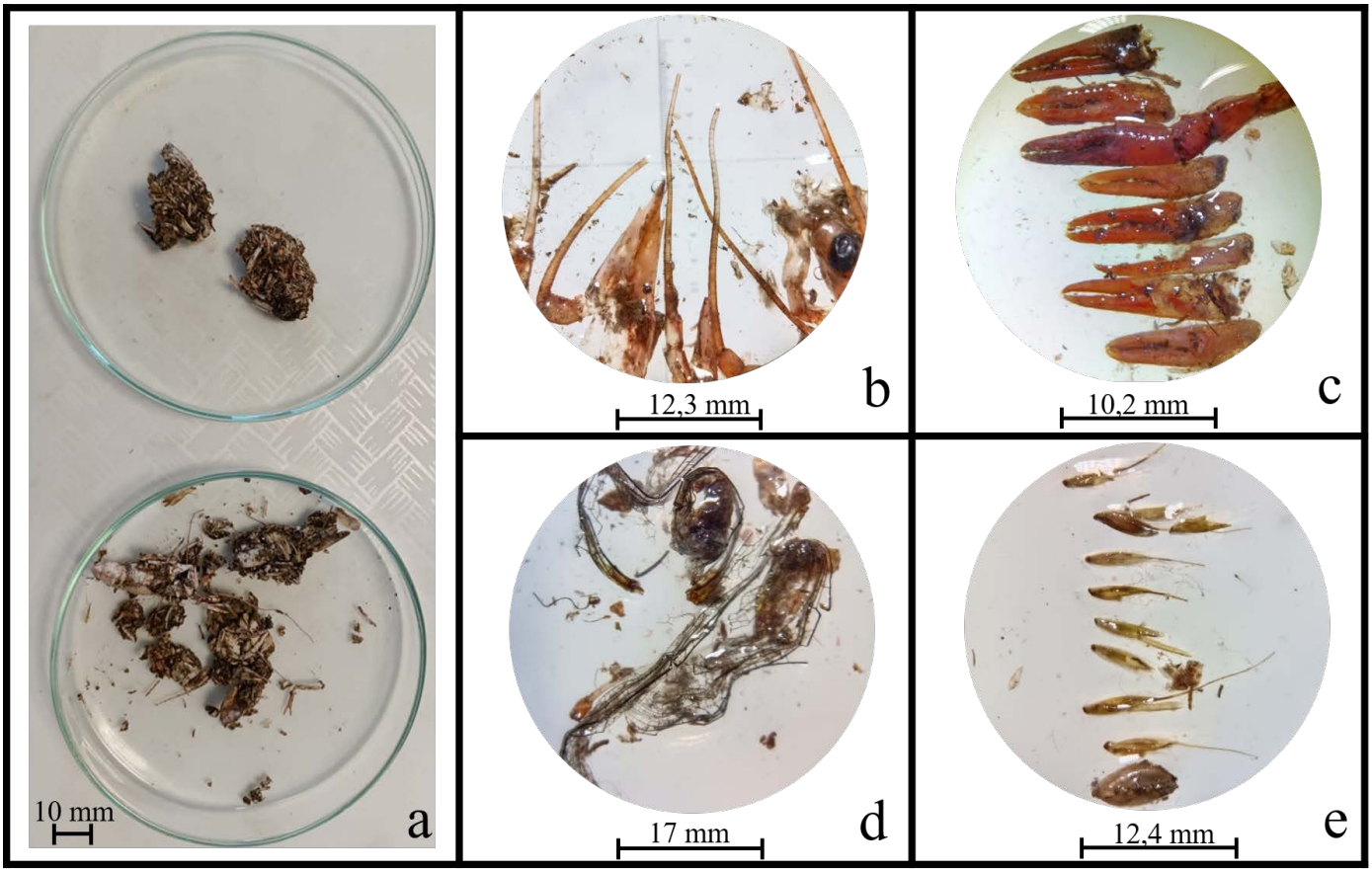

Figure 1. Identification of the remains found in feces of *Didelphis pernigra* in the Chicamocha River, Colombia: a) feces, b) rostrum remains, c) cheliform appendages, d) odonate wings, e) gramineae seeds (Poaceae).

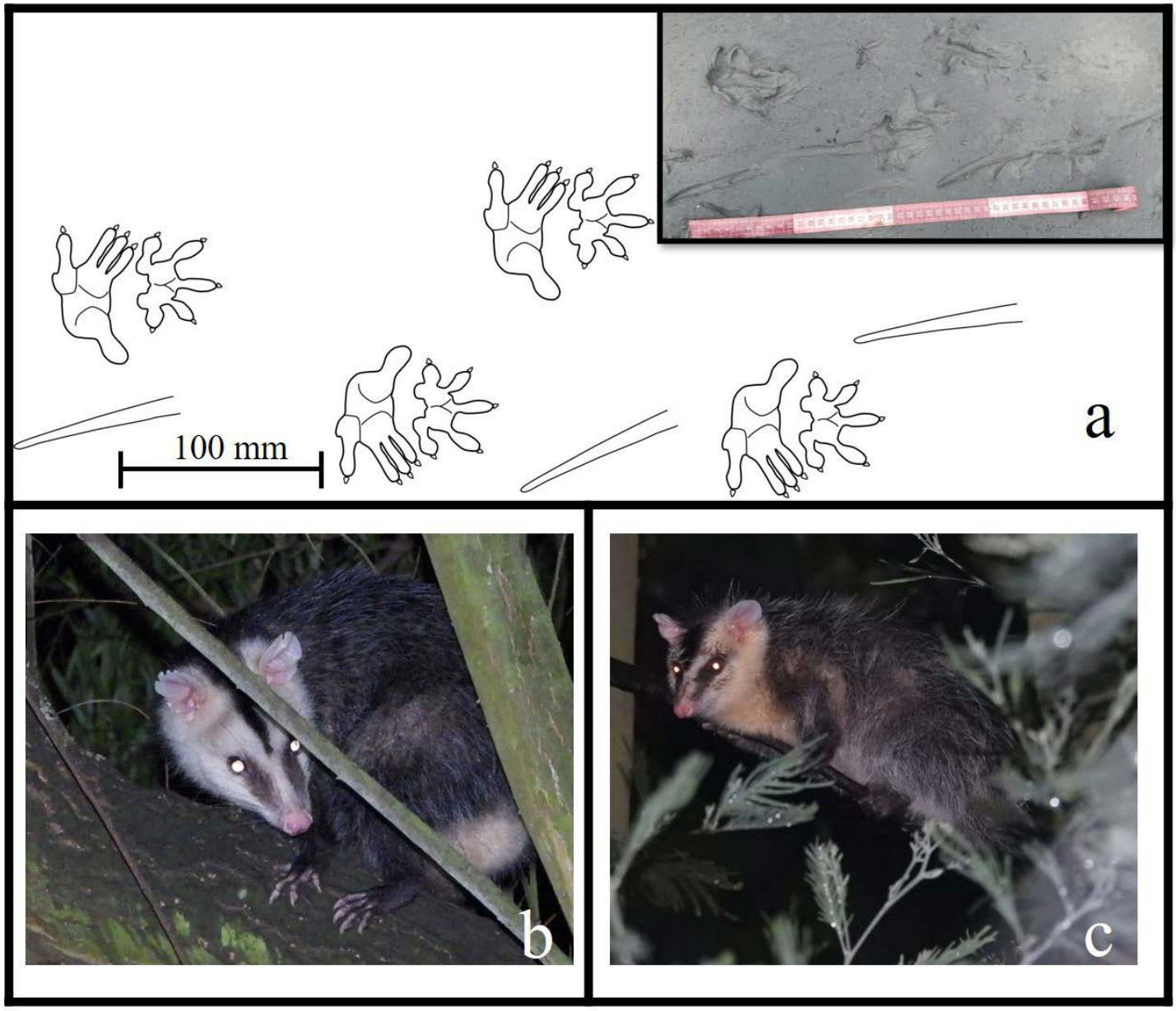

Figure 2. Records obtained: a) tracks, b) and c) individuals of the species *Didelphis pernigra* photographed in the Chicamocha River, Colombia. Photographs by L. Arias.

This is the first record of the red swamp crayfish in the diet of the Andean white-eared opossum in South America. The genus *Didelphis* is an omnivorous group that consumes resources according to their availability in the environment. However, it is uncommon for them to include native decapod crustaceans in their diet. Evidence of *D. albiventris* eating native decapods has only been reported in the south of Brazil (Cáceres 2002). However, in North America, *D. virginiana* includes crayfish in its diet (Knudsen and Hale 1970; Hobbs 1993).

The introduction of exotic species creates the opportunity of new food sources for omnivorous and opportunistic mammal species. This is the case of *P. clarkii* in South America, where it has apparently become a new permanent food supply for *D. pernigra*, which will cause modifications to their diet.

Encounters and predation by *D. pernigra* on *P. clarkii* most likely occur during the night, given that both species have nocturnal habits, and the red swamp crayfish has greater locomotive exploratory activity out of the water at night (Rodríguez-Sosa *et al.* 2017). Birds have also been observed in predating nocturnally on *P. clarkii* in the swamps of Portugal and the Guadalquivir Marshes in Spain (Correia 2001; Montesinos *et al.* 2008).

This paper leads us to suppose that this South American species of the *Didelphis* genus may rapidly adapt to changes in the food supply in its ecosystems, due to the introduction of exotic species such as *P. clarkii.* It appears that *P. clarkii* is advancing their distribution from the north to the south of South America (Palaoro *et al.* 2013; Camacho-Portocarrero *et al.* 2021) and possibly other species of the *Didelphis* genus might integrate it into their diet.

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