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A new species of *Anacroneuria* Klapálek 1909 (Plecoptera: Perlidae) and notes on the altitudinal distribution of the genus in Costa Rica

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Abstract

Anacroneuria is the most widespread genus of Perlidae throughout the Neotropical region and 30 species have been reported from Costa Rica. In this paper, we describe and illustrate a new species from a high elevation cloud forest, *A. quetzali* sp.n., increasing to 31 the number of described species for Costa Rica. In addition, we examine the altitudinal distribution of *Anacroneuria* in Costa Rica to determine possible patterns, using the data available on its altitudinal range (10–2700 masl). We divided the elevational range in seven categories, using 500 m intervals. We found that most species (90.3%) are distributed in elevations that range from 500 to 1500 masl, followed by low-elevations (35.5%). Interestingly, despite the fact that Plecoptera are known to inhabit clean, fast flowing water at high elevations, only 16.1% of the species have been found at high elevations in Costa Rica (above 2000 masl). Thus, it seems that most *Anacroneuria* species are distributed in middle elevations, which are the areas that have a high diversity of freshwater habitats.

Key words: altitudinal distribution, Central America, Mesoamerica, stoneflies, taxonomy

Resumen

Anacroneuria es el género más ampliamente distribuido de la familia Perlidae en la región Neotropical y 30 especies han sido reportadas para Costa Rica. En este trabajo, se describe e ilustra una nueva especie del bosque nuboso de altura, *A. quetzali* sp.n., aumentando a 31 el número de especies descritas para Costa Rica. Además, se examinó la distribución altitudinal de las especies de *Anacroneuria* en Costa Rica para determinar si existen posibles patrones, utilizando los datos disponibles sobre su distribución altitudinal (10–2700 msnm). Los rangos de elevación se dividieron en siete categorías, incrementando cada 500m. Se encontró que la mayoría de especies (90.3%) están distribuidas de los 500 a 1500 msnm, seguido por elevaciones bajas (35.5%). Interesantemente, a pesar de que se conoce que Plecoptera habita ríos de agua limpia y flujo rápido en zonas altas, únicamente el 16.1% de las especies han sido encontradas en elevaciones altas (2000 msnm o más). Por lo tanto, parece que la mayoría de especies de *Anacroneuria* se distribuyen en elevaciones medias, lo cual es consistente con áreas que tienen una alta diversidad de ambientes acuáticos.

Palabras claves: Centroamérica, distribución altitudinal, Mesoamérica, plecópteros, taxonomía

Introduction

The stonefly fauna of Central America is represented by *Anacroneuria* Klapálek 1909, the most widespread and species-rich plecopteran genus in the Neotropical region (Froehlich 2010), and *Perlestes* Banks 1906, which was reported for the first time from Costa Rica based on nymphal collections (Gutiérrez-Fonseca & Springer 2011). The first comprehensive study on Costa Rican stoneflies was published by Stark (1998), who reported 25 species, including 16 new species. An additional four species for Costa Rica were later described and reported by Stark (2014). One more species was recently added to the country (Gutiérrez-Fonseca *et al.* 2015), which was originally

described from Panama by Gutiérrez-Fonseca (2015). With the new species described herein, the species richness of *Anacroneuria* in Costa Rica now reaches 31 species.

The altitudinal distribution of *Anacroneuria* has been mainly examined in South America (e.g., Cressa *et al.* 2008, Tomanova & Tedesco 2007), and general patterns have shown a decrease in species numbers and an increase in body size with an increase in elevation. In Costa Rica, *Anacroneuria* species have been reported along a wide range of habitats and elevations (e.g., Gutiérrez & Springer 2011), but species richness patterns have not yet been determined. In this study, we describe a new species of *Anacroneuria* for Costa Rica based on specimens collected in Quetzales National Park and we discuss the altitudinal distribution of this genus for the country.

Material and methods

Study site. The specimens were collected at Paraíso de los Quetzales, located in Los Quetzales National Park in the Talamanca mountain range of southern Costa Rica (Fig. 1). Los Quetzales National Park has an area of 117.09 ha that extends across an elevation range of 1240 to 3190 masl.

The material was collected on May 2nd 2015, at the Parrita stream ($9^{\circ} 38' 53.25''$ N; $83^{\circ} 51' 17.96''$ W), which is a small, first order stream bordered by mature cloud forest. Dominant substrata are sand, rocks, boulders, and abundant wood and leaf litter. The Parrita stream is a tributary of the Pirrís River and is located in the Pirrís-Parrita watershed which drains to the Pacific coast of Costa Rica.

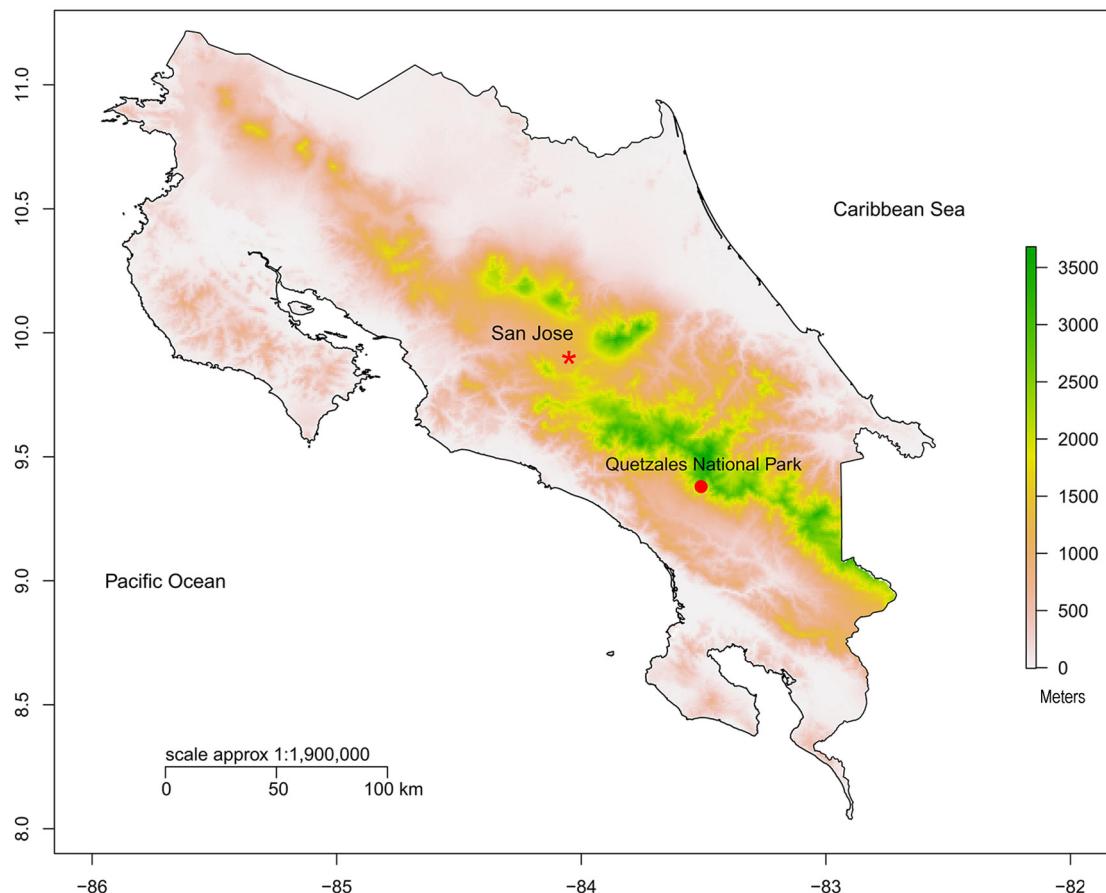


FIGURE 1. Site collection (red circle) at Los Quetzales National Park, Costa Rica.

Specimen collection and preparation. Stonefly adults were collected with light traps from 16:00 to 21:00h. The specimens were preserved in 80% EtOH. The apex of the abdomen was cut and placed in 10% KOH, allowed to remain in this solution for 24 hours, and then the aedeagus was removed from the genital capsule for subsequent study and drawing. The ventral, dorsal, and lateral views were drawn, as well as the 9th abdominal sternum of the male. The specimens are deposited in the following collections:

MZUCR	Zoological Museum at the University of Costa Rica, San Jose, Costa Rica
PEGFC	Pablo E. Gutiérrez-Fonseca Collection, University of Puerto Rico, San Juan, Puerto Rico
USNM	United States National Museum of Natural History, Washington, D.C., U.S.A.

Analysis of altitudinal distribution. To determine the altitudinal distribution patterns of *Anacroneuria* species reported from Costa Rica, we examined elevational ranges available in the literature using Stark (1998, 2014), Gutiérrez-Fonseca & Springer (2011) and Gutiérrez-Fonseca *et al.* (2015). We divided the elevational range (i.e., 10–2700 masl) in seven categories, using 500 m intervals. Species of a specified range were counted if they were found in the range of a distribution of ±250 masl of each category.

Results

Anacroneuria quetzali, sp.n.

(Figs. 2–6)

Material examined. Holotype ♂ (USNM), Costa Rica: San José, Los Quetzales National Park, Paraíso de los Quetzales, Parrita stream, 9° 38' 53.25"N; 83° 51' 17.96"W, 2600 masl, 2 May 2015, M. Springer, P.E. Gutiérrez Fonseca, light trap. Paratypes: Same location, 1♂ (PEGFC). Same location, 1♂ (MZUCR).

Adult habitus. General color brown. Head with dark pigment over occiput and ocelli, extending laterally to eyes and forward to M-line; antennae brown. Pronotum mostly dark brown, but with scattered pale areas, narrow mesal stripe pale. Femora mostly brown, but hind femora banded in two sections, basal section yellowish and apical section brown. Tibiae brown with a yellow band in the middle. Wing membrane brownish, veins brown. Cerci yellow (Fig. 2).

Male. Forewing length 26–26.5mm. Hammer absent (Fig. 3). Aedeagal apex simple, truncate and slightly emarginated, with base wide and low rounded shoulders (Fig. 4). Lateral aspect of aedeagus spoon-shaped (Fig. 5). Ventral membranous lobes small, ventrolateral margin sclerotized (Fig. 6). Dorsal keel absent, aedeagal hooks slender.

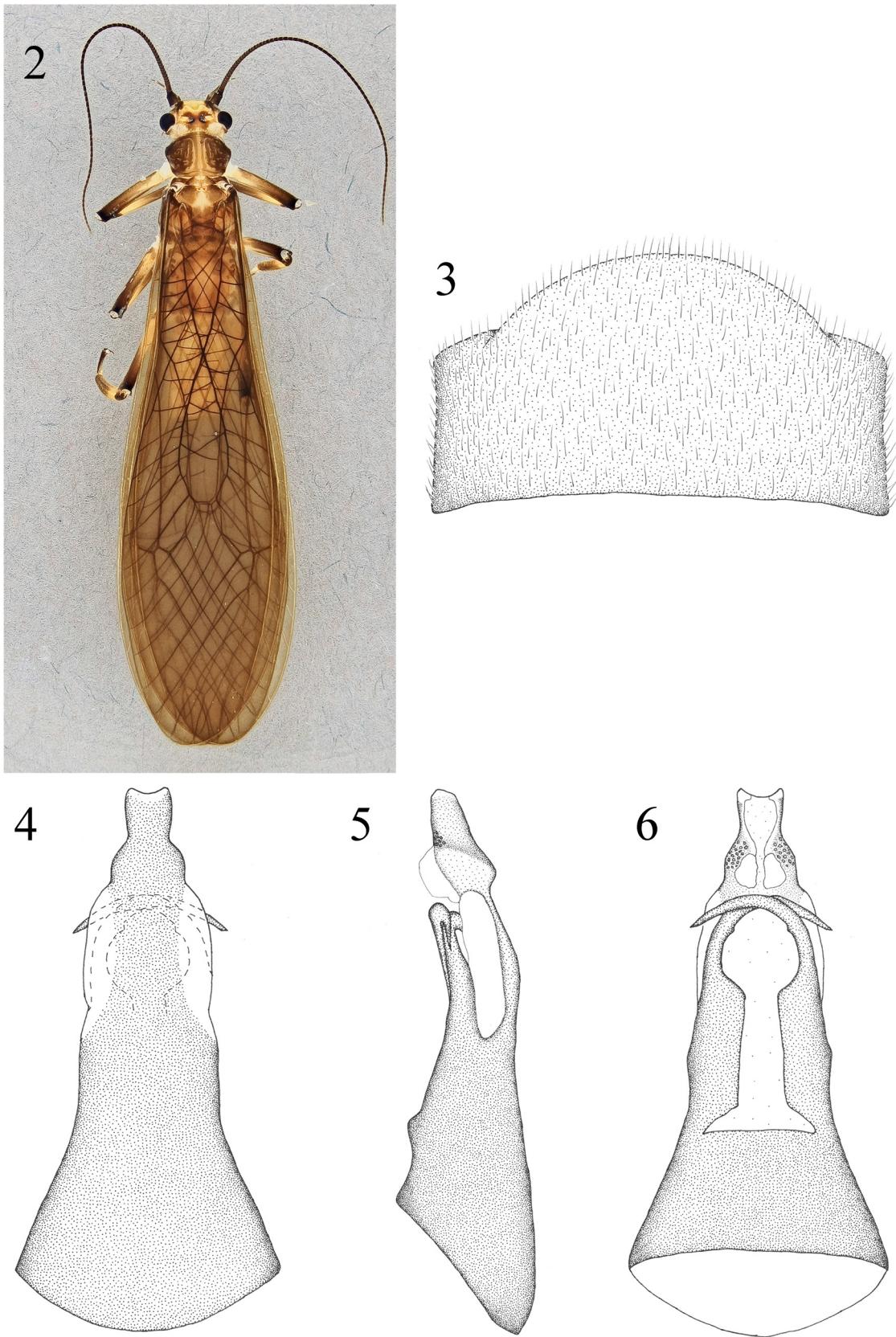
Female. Unknown.

Nymph. Unknown.

Etymology. The species name refers to the collection site which is dedicated to the Resplendent Quetzal, considered one of the most beautiful birds in the region. It is used as a noun in apposition.

Comments. *Anacroneuria quetzali* is similar to *A. socapa* Stark & Zúñiga 1999 in Stark *et al.* (1999) from Colombia. However, the head of *A. socapa* is mostly yellow, except for a pair of dark spots in front of the ocelli. The middle stripe of the pronotum is wider in *A. socapa* than in *A. quetzali*. The two species differ in the extent of shoulders of the aedeagus and *A. socapa* lacks membranous lobes. The aedeagus of *A. quetzali* is similar to that of *A. magnirufa* Stark 1998, but differs in several structures, such as the dorsal keel, which is present only in *A. magnirufa*. Finally, males of *A. quetzali* are notably larger than males of any other known *Anacroneuria* species from Costa Rica and exceed *A. socapa* in body length by 4mm.

Altitudinal distribution of *Anacroneuria* species in Costa Rica. Costa Rican *Anacroneuria* species are distributed within a wide range of elevations from near sea level (10 masl) to páramo areas (~2700 masl). The altitudinal distribution of individual species is shown in Figure 7, which shows that only 3 species (16.1%) are found at elevations above 2000 masl. The 1500 masl elevation band has 15 species (48.4%), decreasing to 12 species (38.7%) at the 1000 masl elevation band. Species richness increases to 20 (64.5%) in the 500 masl elevation band. Finally, only 11 species (35.5%) are recorded at the 0 masl elevation band.



FIGURES 2–6. *Anacroneuria quetzali* sp.n. male 2, habitus. 3, ninth sternum. 4, dorsal aedeagus. 5, lateral aedeagus. 6, ventral aedeagus.

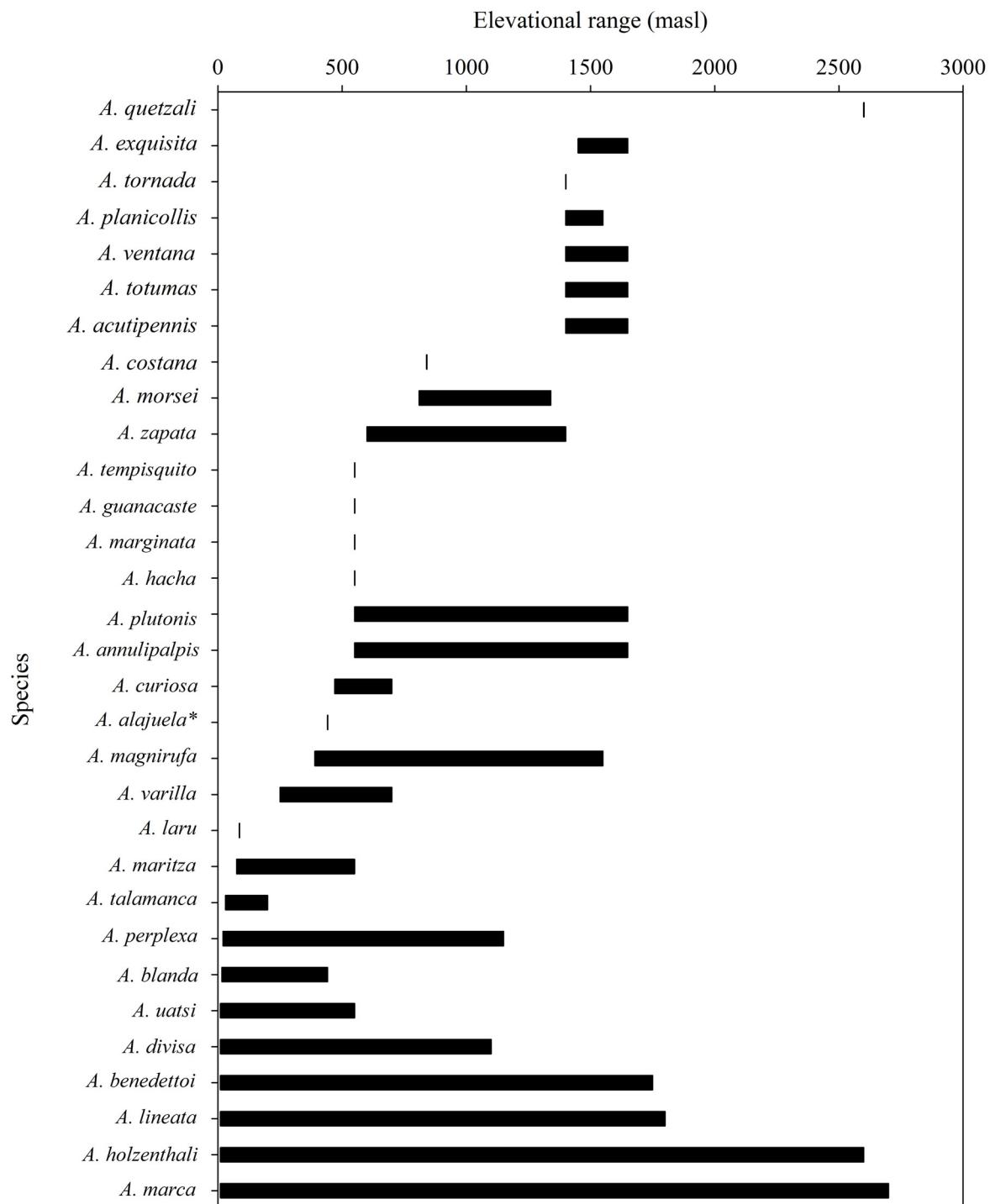


FIGURE 7. Altitudinal distribution range for Costa Rican *Anacroneuria* species, based on collection sites in published literature (Stark 1998, 2014, Gutiérrez-Fonseca & Springer 2011, Gutiérrez-Fonseca *et al.* 2015). *Species for which the altitude was estimated based on the collection site due to the lack of altitude data in the original descriptions.

Discussion

Stoneflies are among the least diverse aquatic insect orders in the Neotropical region but, even so, new species are frequently discovered (e.g., Stark 2014, Gutiérrez-Fonseca 2015). With this new description, the total number of *Anacroneuria* species known from Costa Rica now reaches 31, exceeding the number reported for larger countries such as Mexico (Stark & Kondratieff 2004), a country about 40 times the size of Costa Rica. Considering that the

total number of stoneflies reported from Central America is fewer than 50 species (Stark 2014, Gutiérrez-Fonseca 2015), many more species can be expected in this highly diverse region with an increase in collection efforts.

Anacroneuria species in Costa Rica are more species-rich at mid elevations (between 500 to 1500 masl), while richness decreases at low (~0 masl) and high elevations (>2000 masl). These distributional patterns are primarily the result of many species having 1500 as their upper limit of distribution, rather than high elevation species extending downward to mid elevations. This pattern is consistent with the observation that these areas (elevations) also contain a high diversity of freshwater habitats and ecoregions (de la Rosa 1995, Ortiz-Malavasi 2008). Our results are consistent with those from South America for other species in the genus (e.g., Cressa *et al.* 2008, Tomanova & Tedesco 2007).

Despite the increase in distributional data and taxonomy of Plecoptera in Costa Rica, we recognize that there is still a relative lack of detailed information. Numerous species are known only from a single location, several of these sites are relatively well sampled. For example, 15 species have been described from the Estación Biológica Maritza (Guanacaste, Costa Rica) from monthly collections with light traps over several years (Stark 2014). Thus, an increase in the study of this genus within the country will undoubtedly uncover wider distributions for many of the already described species as well as provide information about their biology and vulnerabilities in a changing world.

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