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The Plecoptera of Panama. I. The stonefly fauna of Mount Totumas
Cloud Forest and Biological Reserve, including a new country record

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Abstract. The Republic of Panama currently has 21 recorded species of stoneflies, all in the genus *Anacroneuria* (Plecoptera: Perlidae). Herein, we record five species of this genus from the Mount Totumas Cloud Forest and Biological Reserve, in the upper reaches of the Río Chiriquí Viejo watershed. One of these species, *A. plutonis* (Banks), represents a new country record for Panama. These results are part of an ongoing effort to characterize the aquatic insect fauna of Panama, and to evaluate that country's major watersheds.

Key Words. Perlidae, *Anacroneuria*, new country record.

Introduction

Currently, *Anacroneuria* (Plecoptera: Perlidae) is the only stonefly genus known from Panama. A total of 21 species have been recorded (Cornejo and Gutiérrez-Fonseca 2015; Gutiérrez-Fonseca 2015), accounting for 42% of the 50 species known from Central America. Stoneflies were first reported from Panama in the 1920s (Klapálek 1922,1923; Needham and Broughton 1927), followed three decades later by Jewett (1958) in his work on Mexican and Central American stoneflies. Harper (1992) summarized and restated information on nine species, and included information about a number of undescribed species. Stark (1998) described or redescribed, 14 species which are currently known from Panama. Stark (2014) added a new species, two new country records, and confirmed the presence of *A. lineata* in Panama. Additional records (Stark and Kondratieff 2004, Gutiérrez-Fonseca et al. 2015) and the description of three new species from Darién Province (Gutiérrez-Fonseca 2015) has resulted in a total of 21 species currently known from Panama (Table 1). A recent summary of information on stoneflies in Panama (Cornejo and Gutiérrez-Fonseca 2015) provides additional information about distribution of species within Panama, and in other Central American countries.

Mount Totumas Cloud Forest and Biological Reserve (MTCF) is a private landholding in Chiriquí Province, adjacent to La Amistad International Park (PILA) and encompassing 160 ha. It is named for the nearby Cerro Totumas mountain (2,630 masl, maximum elevation). Whereas, the majority of Cerro Totumas is within the PILA boundaries, the western, lower slopes fall within the biological reserve. MTCF occupies the upper portion of the Río Colorado subwatershed (Fig. 1), immediately adjacent to and west of the headwaters of the Río Chiriquí Viejo watershed. The majority of the land is forested, with some pasture areas and livestock, but little or no crop-based agriculture.

The purpose of this paper is to record the MTCF stonefly fauna and to publish a new country record for Panama, *A. plutonis* (Banks).

Materials and Methods

Three streams were sampled during 2015. The upper extent of the Río Colorado is the principal stream on the MTCF property. It is approximately 5-9 m wide, contains a variety of substrates ranging from large boulders to coarse sand, and serves as a tributary of the Río Chiriquí Viejo. Quebrada Norte is a second order tributary of the Río Colorado, is approximately 1-2 m wide, joins the Río Colorado near the entrance to MTCF, and contains a variety of substrates from small boulders to fine sand. An unnamed, first order tributary arises in the western portion of MTCF and flows southeastward to join the Río Colorado. It is, in general, less than 1 m wide and contains a variety of substrate types including small boulders, gravel, fine sand, and organic detrital deposits. All three streams have a wooded riparian corridor.

Single-night collections were made during 2015, in general, using UV light and alcohol traps (Calor and Mariano 2012). Multiple-night collections were made with this same method or employing Malaise traps, as indicated below. The sample locations were located at 1,692 masl (Río Colorado and Quebrada Norte; both upstream of the confluence) and 1,922 masl (afluente de Río Colorado; approximately midway between the source and the confluence with the Río Colorado). The abdomen of adult stoneflies was removed, placed in 4% KOH, and processed as indicated in Stark (1998). Specimens listed in this publication will be deposited in the Museo de Invertebrados Fairchild de la University of Panamá (MIUP), the Colección Zoológica Dr. Eustorgio Méndez (CoZEM), or the authors' reference collections.

Results

Five species of stoneflies in the genus *Anacroneuria* were recorded from MTCF (Tables 1 and 2). Both UV light traps and Malaise traps were effective in capturing specimens for this study. One of these species, *A. plutonis*, is herein presented as a new record for Panama. Previously it was known only from Costa Rica. Collection and distribution information for each species follows and in Table 2.

Anacroneuria acutipennis Klapálek, 1923

Material examined— **Chiriquí Province: Cuenca 102**, Quebrada Norte, Mount Totumas Cloud Forest and Biological Reserve, 8.87361°N and 82.69051°W, 14.iv.2015, B. and T. Armitage, 1 female; *ibid.*, afluyente Río Colorado, 8.884713°N and 82.68408°W, 14.iv.2015, B. and T. Armitage, 1 male.

Distribution: Costa Rica, Guatemala, Panama (Chiriquí).

Anacroneuria annulipalpis Klapálek, 1922

Material examined— **Chiriquí Province: Cuenca 102**, Río Colorado, Mount Totumas Cloud Forest and Biological Reserve, 8.87356°N and 82.68999°W, 21.v.2015, B. and T. Armitage, 1 female; *ibid.*, afluyente Río Colorado, 8.884713°N and 82.68408°W, 21.v.2015, B. and T. Armitage, 1 male; *ibid.*, 14.iv.2015, B. and T. Armitage, 1 male; *ibid.*, 7-13.vii.2015 (Malaise trap), J. Dietrich, 2 males and 7 females; *ibid.*, Quebrada Norte, 8.87361°N and 82.69051°W, 30-31.viii.2015 (Malaise trap), B. and T. Armitage, 1 female.

Distribution: Costa Rica, Panama (Chiriquí).

Anacroneuria marca Stark, 1998

Material examined— **Chiriquí Province: Cuenca 102**, Quebrada Norte, Mount Totumas Cloud Forest and Biological Reserve, 8.87361°N and 82.69051°W, 14.iv.2015, B. and T. Armitage, 1 male;

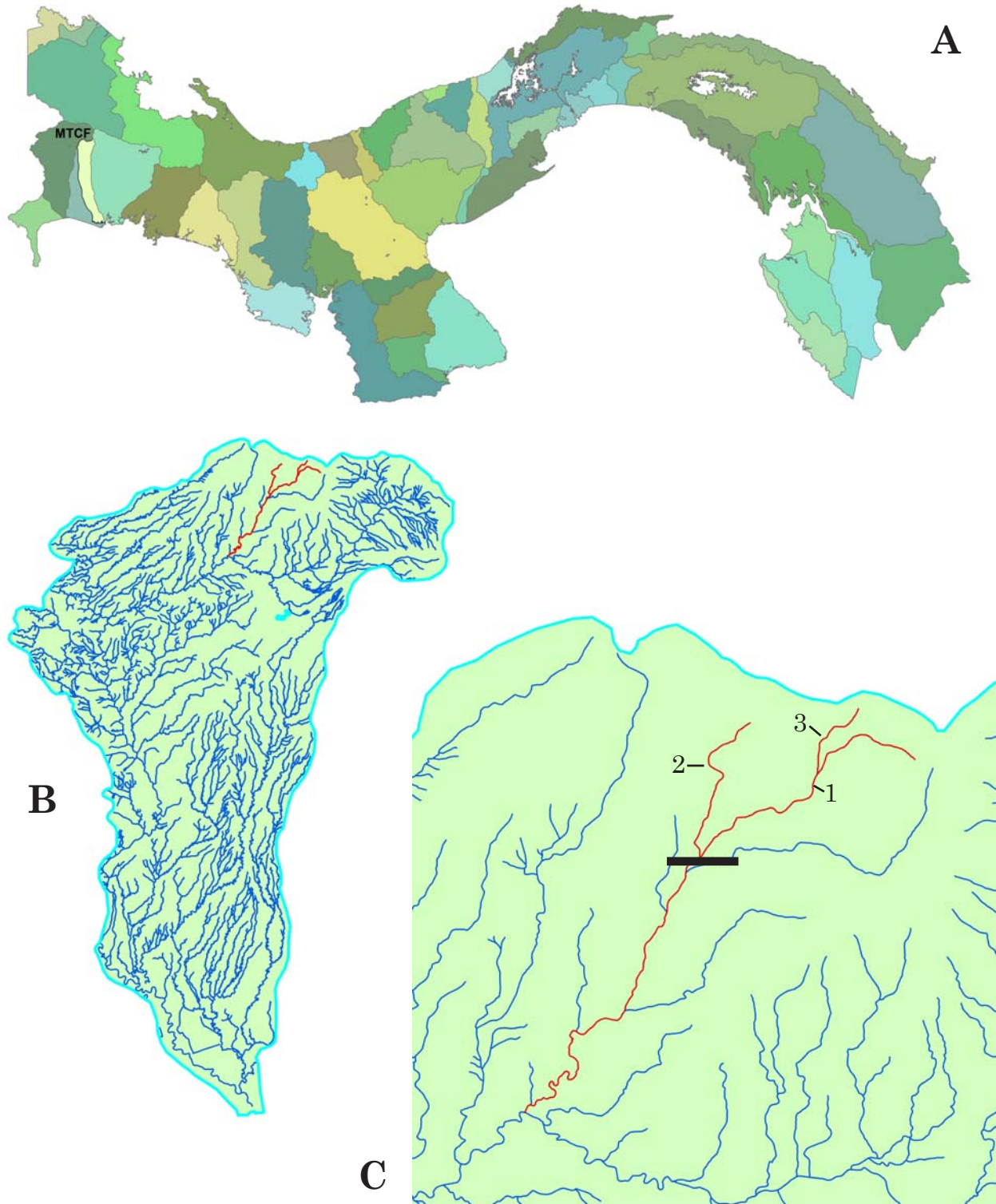


Figure 1. Maps of the study site. **A.** Major watersheds (cuencas) of Panama, with the Mount Totumas Cloud Forest and Biological Reserve (MTCF), Chiriqui Province, Panama location indicated on the far left in the Río Chiriquí Viejo watershed. **B.** Hydrography of the Río Chiriquí Viejo watershed with the study streams colored in red. **C.** Close-up of the study area (1-Río Colorado, 2-Quebrada Norte, 3-afuente de Río Colorado). The southern limit of MTCF is approximately where Quebrada Norte enters the Río Colorado (thick black line).

ibid., 26.iv-10.v.2015 (Malaise trap), J. Dietrich, 1 male; ibid., Río Colorado, 8.87356°N and 82.68999°W, 21.v.2015, B. and T. Armitage, 3 males and 1 female; ibid., 20.viii.2015, B. and T. Armitage, 4 males; ibid., 30.viii.2015, B. and T. Armitage, 4 males.

Distribution: Costa Rica, Panama (Chiriquí).

***Anacroneuria plutonis* (Banks, 1914)**

Chiriquí Province: Cuenca 102, Quebrada Norte, Mount Totumas Cloud Forest and Biological Reserve, 8.87361°N and 82.69051°W, 26.iv-10.v.2015 (Malaise trap), J. Dietrich, 5 males and 3 females; ibid., 18.v-23.v.2015 (Malaise trap), 2 males; ibid., 26.iv.-10.v.2016, B. and T. Armitage, 1 female; ibid., Río Colorado, 8.87356°N and 82.68999°W, 21.v.2015, B. and T. Armitage, 1 male; ibid., 7-13.vii.2015 (Malaise trap), J. Dietrich, 2 males and 2 females; ibid., Quebrada Norte, 8.87361°N and 82.69051°W, 30-31.viii.2015 (Malaise trap), B. and T. Armitage, 1 female.

Distribution: Costa Rica; Panama (Chiriquí).

***Anacroneuria totumas* Stark, 2014**

Material examined— Chiriquí Province: Cuenca 102, afluyente Río Colorado, Mount Totumas Cloud Forest and Biological Reserve, 8.884713°N and 82.68408°W, 14.iv.2015, B. and T. Armitage, 1 male; Quebrada Norte, Mount Totumas Cloud Forest and Biological Reserve, 8.87361°N and 82.69051°W, 26.iv-10.v.2015 (Malaise trap), J. Dietrich, 1 male; ibid., 7-13.vii.2015, B. and T. Armitage, 2 males.

Distribution: Costa Rica, Panama (Chiriquí).

Discussion

With the publication of this paper, there are now five species of *Anacroneuria* currently known from MTCF, compared to 10 species in its major watershed, the Río Chiriquí Viejo, and 11 species from its province, Chiriquí (Cornejo and Gutiérrez-Fonseca 2015). All five species were found in mid-sized, Quebrada Norte, with three species found in both the headwater stream and the Río Colorado (Table 2). It is remarkable to find five species of this genus in such a relatively small area, although a total of 15 species have been collected by light trap at a single location in Guanacaste Province, Costa Rica (Stark 2014). Given this latter report and MTCF's proximity to the Costa Rican border, where other, different species are found, it is within the realm of possibility that more *Anacroneuria* species will be recorded in the future from this landholding.

The species, *A. totumas*, was described by Stark (2014) from Panama in MTCF. It was also recorded at that time from Costa Rica. No female or nymph are known, and although four additional males were collected from MTCF, no female associations could be made and the female of this species remains unknown. It is the only MTCF species with an unassociated female. Currently, there are 7 of 22 species in Panama for which the female is unknown (Table 1). However, given that four of the five MTCF species have unknown immature stages, the focus of our future effort will be to associate the adults of these species with their nymphs, either through rearing or employing DNA-matching.

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We thank the Gorgas Institute and the Ministry of the Environment of Panama for making it possible for us to collect this material. We are grateful to Jeffrey Dietrich of Mount Totumas

Table 1. List of known *Anacroncuria* (Plecoptera: Perlidae) from Panama. Modified from Gutiérrez-Fonseca (2015) (*—Mount Totumas Cloud Forest and Biological Reserve, Chiriqui Province, Panama taxa; **—new Panama record).

| MTCF | Species | Male | Female | Nymph |
|------|---|---------------------------------------|--------------------------|-----------------------------------|
| * | <i>A. acutipennis</i> Klapálek, 1923 | Stark 1998 | Stark 1998 | Unknown |
| * | <i>A. annulipalpis</i> Klapálek, 1922 | Stark 1998 | Stark 1998 | Unknown |
| | <i>A. azul</i> Rojas & Baena, 1999 | Rojas & Baena in Stark et al. 1999 | Unknown | Unknown |
| | <i>A. benedettoi</i> Stark, 1998 | Stark 1998 | Stark 1998 | Gutiérrez-Fonseca & Springer 2011 |
| | <i>A. blanda</i> Needham & Broughton, 1927 | Stark 1998 | Stark 1998 | Unknown |
| | <i>A. choco</i> Stark & Bersosa in Zumiga et al. 2006 | Stark & Bersosa in Zumiga et al. 2006 | Unknown | Unknown |
| | <i>A. costana</i> (Navás, 1924) | Navás 1924 | Unknown | Unknown |
| | <i>A. curiosa</i> Stark, 1998 | Stark 1998 | Unknown | Unknown |
| | <i>A. darien</i> Gutiérrez-Fonseca, 2015 | Gutiérrez-Fonseca 2015 | Gutiérrez-Fonseca 2015 | Unknown |
| | <i>A. embera</i> Gutiérrez-Fonseca, 2015 | Gutiérrez-Fonseca 2015 | Unknown | Unknown |
| | <i>A. harperi</i> Stark, 1998 | Stark 1998 | Stark 1998 | Unknown |
| | <i>A. laru</i> Gutiérrez-Fonseca, 2015 | Gutiérrez-Fonseca 2015 | Gutiérrez-Fonseca 2015 | Unknown |
| | <i>A. lineata</i> (Navás, 1924) | Stark 1998 | Stark & Kondratieff 2004 | Gutiérrez-Fonseca & Springer 2011 |
| | <i>A. litura</i> (Pictet, 1841) | Stark & Kondratieff 2004 | Stark & Kondratieff 2004 | Unknown |
| | <i>A. magnirufa</i> Jewett, 1958 | Stark 1998 | Stark 1998 | Unknown |
| * | <i>A. marca</i> Stark, 1998 | Stark 1998 | Stark 1998 | Gutiérrez-Fonseca & Springer 2011 |
| | <i>A. planicollis</i> Klapálek, 1923 | Stark 1998 | Stark 1998 | Unknown |
| ** | <i>A. plutonis</i> (Banks, 1914) | Stark 1998 | Stark 1998 | Unknown |
| | <i>A. talamanca</i> Stark, 1998 | Stark 1998 | Stark 1998 | Fenoglio 2007 |
| * | <i>A. totumas</i> Stark, 2014 | Stark 2014 | Unknown | Unknown |
| | <i>A. varilla</i> Stark, 1998 | Stark 1998 | Stark 1998 | Gutiérrez-Fonseca & Springer 2011 |
| | <i>A. zarpa</i> Stark, 1998 | Stark 1998 | Unknown | Unknown |

Table 2. Distribution of *Anacroneuria* species among three Mount Totumas Cloud Forest and Biological Reserve (Chiriqui Province, Panama) stream sizes.

| | afluente de Río | | |
|------------------------|-----------------|----------------|----------|
| | Río Colorado | Quebrada Norte | Colorado |
| <i>A. acutipennis</i> | | x | x |
| <i>A. annulipalpis</i> | x | x | x |
| <i>A. marca</i> | x | x | |
| <i>A. plutonis</i> | x | x | |
| <i>A. totumas</i> | | x | x |

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Literature Cited

- Banks, N. 1914.** New neuropteroid insects, native and exotic. *Proceedings of the Academy of Natural Science of Philadelphia* 66: 608-632.
- Calor, A. R., and R. Mariano. 2012.** UV light pan traps for collecting aquatic insects. *EntomoBrasilis* 5: 164-166.
- Cornejo, A., and P. E. Gutiérrez-Fonseca. 2015.** Orden Plecoptera (Insecta) en Panamá: listado distribución de especies, comparación con la riqueza taxonómica regional. *Puente Biológico* 7: 109-129.
- Fenoglio, S. 2007.** Stoneflies (Plecoptera: Perlidae) of Nicaragua. *Caribbean Journal of Science* 43: 220-225.
- Gutiérrez-Fonseca, P. E. 2015.** Three new species of *Anacroneuria* Klapálek (Plecoptera: Perlidae) from Panama. *Zootaxa* 3957(3): 69-76.
- Gutiérrez-Fonseca, P. E., and M. Springer. 2011.** Description of the final instar nymphs of seven species from *Anacroneuria* Klapálek (Plecoptera: Perlidae) in Costa Rica, and first record for an additional genus in Central America. *Zootaxa* 2965: 16-38.
- Gutiérrez-Fonseca, P. E., A. M. Alonso-Rodríguez, A. Cornejo, A. C. Bailey, J. M. Maes, and A. Ramírez. 2015.** New records of *Anacroneuria* Klapálek, 1909 (Plecoptera: Perlidae) for Central America. *Zootaxa* 3994 (3): 445-448.
- Harper, P. P. 1992.** Stoneflies of Panama (Plecoptera). p. 113-121. *In*: D. Quintero and A. Aiello (eds.). *Insects of Panama and Mesoamerica: selected studies*. Oxford University Press, England. 692 p.
- Jewett, S. G. 1958.** Stoneflies of the genus *Anacroneuria* from Mexico and Central America (Plecoptera). *American Midland Naturalist* 60(1): 159-175.
- Klapálek, F. 1922.** Plécoptères nouveaux. Quatrième partie. *Annales de la Société Entomologique de Belgique* 62: 89-95.
- Klapálek, F. 1923.** Plécoptères nouveaux. Cinquième partie. *Annales de la Société Entomologique de Belgique* 63: 21-29.
- Navás, L. 1924.** Plecópteros. *Insectos de la América Central, Série Zoológica (Brotéria)* 21: 55-86.
- Needham, J. G., and E. Broughton. 1927.** Central American stoneflies, with descriptions of new species (Plecoptera). *Journal of the New York Entomological Society* 35(2): 109-121.
- Pictet, F. J. 1841.** Histoire naturelle générale et particulière des insectes Névroptères. Première monographie. amille des Perlides I partie. Langlois & Leclercq, Paris. 423 p.

- Stark, B. P. 1998.** The *Anacroneuria* of Costa Rica and Panama (Insecta: Plecoptera: Perlidae). *Proceedings of the Biological Society of Washington* 111(3): 551–603.
- Stark, B. P. 2014.** Records of Mesoamerican *Anacroneuria* (Plecoptera: Perlidae), with descriptions of four new species. *Illiesia* 10(2): 6–16.
- Stark, B. P., and B. C. Kondratieff. 2004.** *Anacroneuria* from México and upper Mesoamerica (Plecoptera: Perlidae). *Monographs of the Western North American Naturalist* 2(1): 1–64. <http://dx.doi.org/10.3398/1545-0228-2.1.1>
- Stark, B. P., M. C. Zúñiga, A. M. Rojas, and M. L. Baena. 1999.** Colombian *Anacroneuria*: descriptions of new and old species (Insecta, Plecoptera, Perlidae). *Spixiana* 22(1): 13–46.
- Zúñiga, M. del C., B. P. Stark, J. J. Vásquez, F. Bersosa, and L. D. Vimos. 2006.** Columbian and Ecuadorian *Anacroneuria* (Plecoptera: Perlidae): seven new species, records, and life stages. *Studies in Neotropical Fauna and Environment* 41: 45–57.

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