



## Article

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### **A new species of *Atopophlebia* Flowers (Ephemeroptera: Leptophlebiidae) from western Ecuador with ecological and biogeographic notes on the genus**

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#### **Abstract**

*Atopophlebia pitculya* is described from adults and nymphs from western Ecuador. Nymphs were found in leaf packs in small streams that can be intermittent in the dry season. This species along with *Atopophlebia fortunensis* are found associated with the accreted terranes of Central America, the Western Andes of Colombia, and the coastal mountains in north-western Ecuador.

**Key words:** *Atopophlebia*, Ephemeroptera, Leptophlebiidae, Ecuador, Romeral Fault

#### **Resumen**

Se describe *Atopophlebia pitculya* de adultos y ninfas del oeste de Ecuador. Se encontraron las ninfas en paquetes de hojas en quebradas pequeñas que pueden ser intermitente durante el verano (temporada seca). Esta especie y *Atopophlebia fortunensis* están asociadas con los terranes acrecentados de América Central, los Andes occidentales de Colombia, y las montañas costeras del noroeste de Ecuador.

#### **Introduction**

Although the Ephemeroptera (Insecta) of South America have become much better known in recent years, some areas of the continent are still poorly explored and are ripe for discovery of new species. The Pacific lowlands of Ecuador (Litoral) between the western range of the Andes and the ocean is one such area. A new *Thraulodes* Ulmer from this region was found in an urban setting along a highly impacted river (Flowers 2009). During an on-going survey of the *aquatic insects* of the Litoral, a striking new species of *Atopophlebia* Flowers was collected at several localities. In one locality subimagos were collected at blacklight and several were reared to the imago.

*Atopophlebia* to date has been found along the Andes from Costa Rica to northern Argentina. Flowers (1980) described the genus and species *A. fortunensis* from Panamá on the basis of the male imago. Later Flowers (1987) described the female and nymph of *A. fortunensis*, and the species *A. obrienorum* and *A. yarinacocha* from Amazonian Ecuador and Peru, respectively; and Dominguez and Molineri (1996) described *A. flowersi* from the Andes of Bolivia and northwestern Argentina. Of the five known species, three are now known from the nymphal stage.

#### **Materials and methods**

Nymphs were collected with a D-frame net from riffles and from leaf packs by washing and sieving. Subimagos were collected at blacklight and kept in large plastic bottles through the following day when most emerged to imago. Specimens are deposited in the following institutions: FAMU, Florida A&M University, Tallahassee, Florida, USA; IFML, Instituto Fundación Miguel Lillo, Tucumán, Argentina; PUCE, Museo de Invertebrados, Pontificia Universidad Católica de Ecuador, Quito, Ecuador.

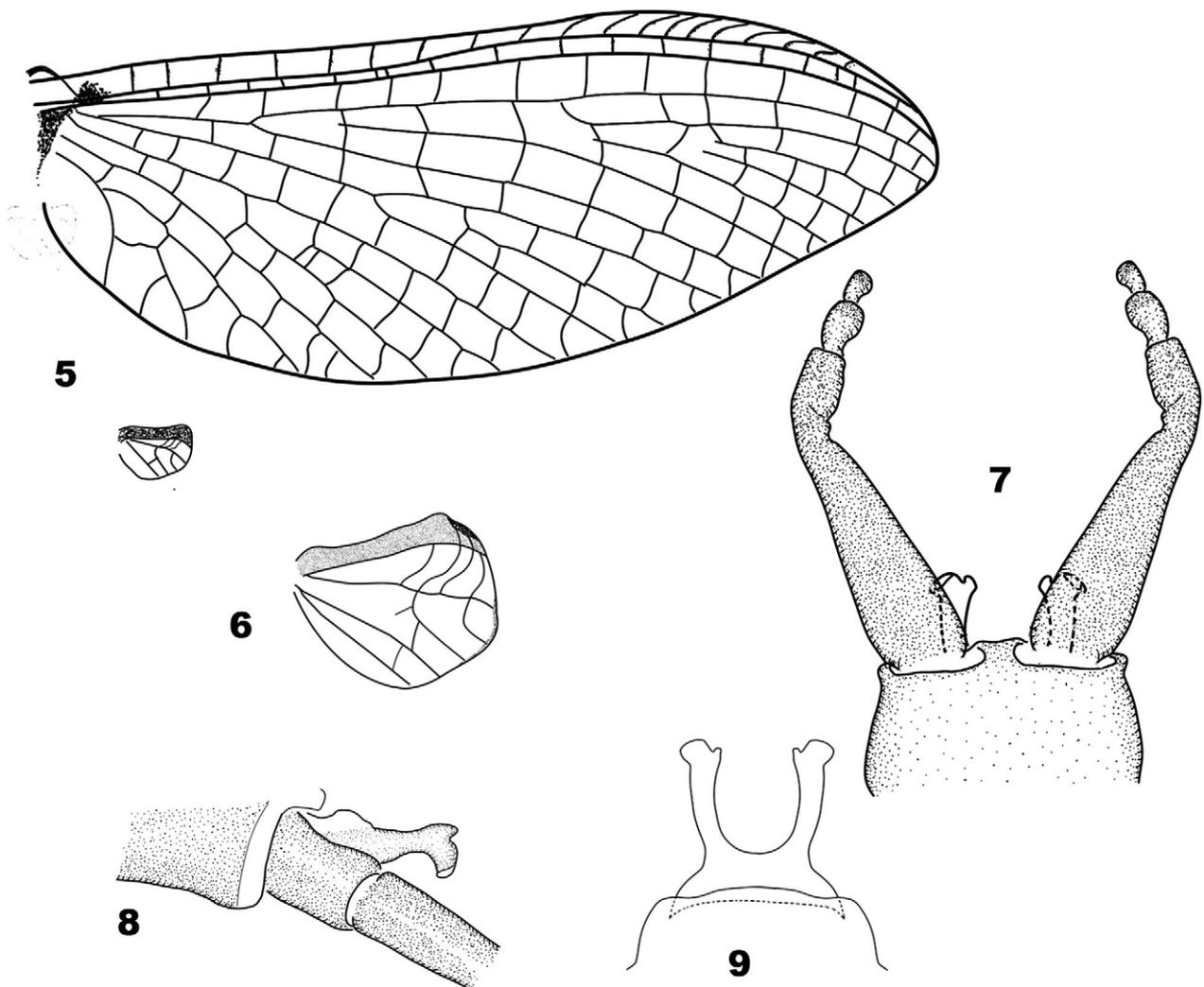


**FIGURES 1–4.** *Atopophlebia pitculya*. 1, male imago, lateral view; Figs. 2–3, mature nymph: 2, dorsal view; 3, ventral view. 4, habitat of nymph, Estero Jurón, Bosque Protector Cantagallo, Manabí, Ecuador.

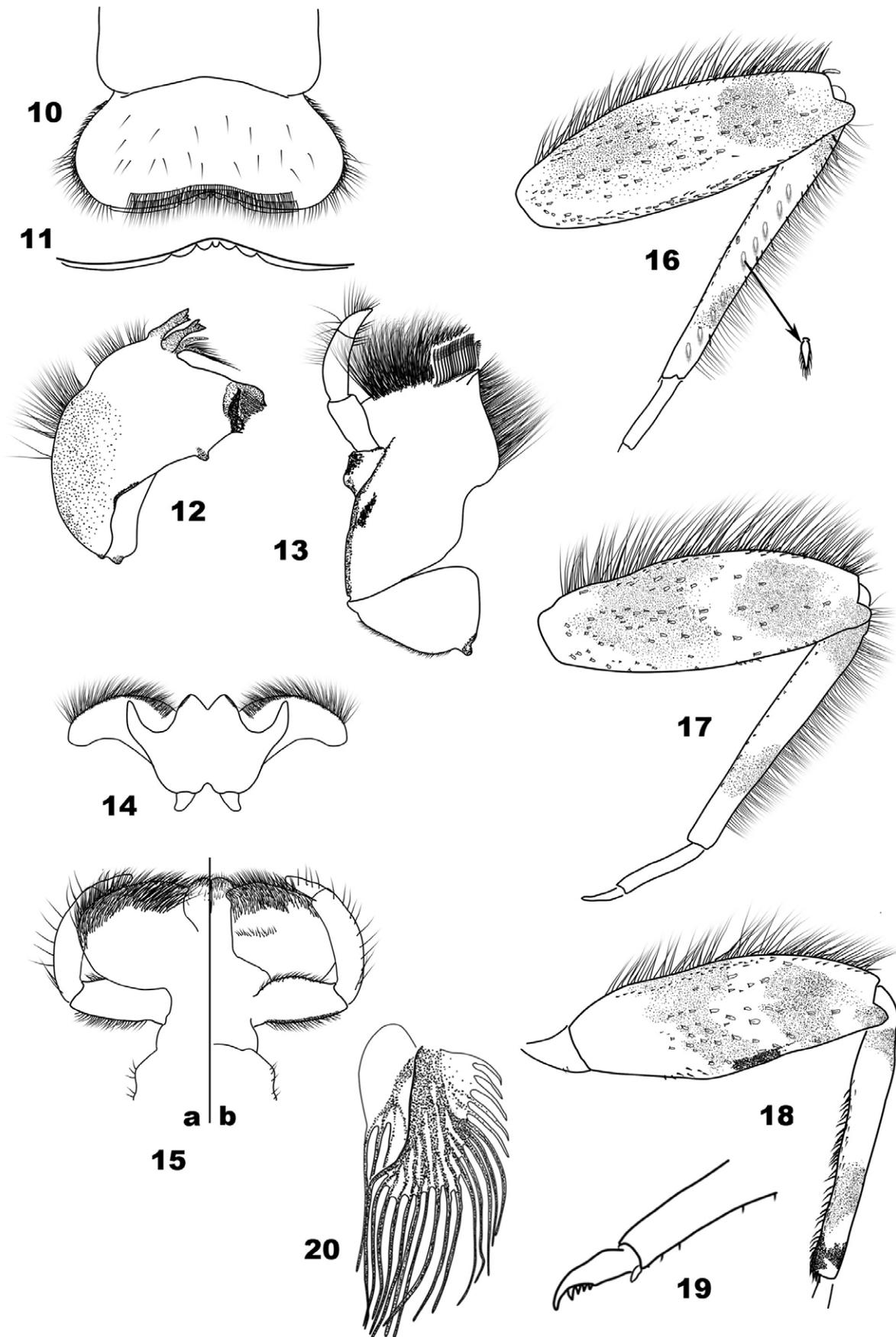
***Atopophlebia pitculya* Flowers, new species**

(Figs. 1–3, 5–20)

Description. Male Imago (Fig. 1). Holotype. Length: body 5.8mm, Forewing 5.7mm. Head: Eyes separated on meson of head by one-half the maximum width of an ocellus. Maximum width of forewings 0.54 times maximum length. Head orange-tan with black markings above clypeus and around antennal socket. Upper portion of turbinate eyes yellowish tan, lower portion dark grey. Thorax: General color tan (bright orange in life) with a pair of black spots on posterior scutal protuberances; pleural sclerites washed with black. Wings: Forewings (Figs. 1, 5) with membrane hyaline, veins amber, crossveins purplish black, a purplish black spot just anterior to basal arc. Vein MP2 attached at base to MP1 and CuA with cross vein. IMP attached at base to veins MP1 and MP2. Hind wing (Fig. 6) one-tenth length of forewing, entire costal and subcostal membranes dark purplish brown. Costal projection subapical, well developed, apex of wing obtuse, rounded; cross veins few and clustered in apical 1/2 of wing. Ratios of segments of male foreleg, 0.74: 1.00 (3.4mm): 0.04: 0.32: 0.24: 0.14: 0.06. Forefemur pale orange–yellow with a black ventral subapical dash; foretibia orange–yellow, apex yellowish white with a subapical black band. Middle and hind legs yellowish–white. Abdomen: orange-yellow with posterior margins of tergites black; black margins wider on tergites 5–8. Tergites 1 and 2 with black postero-lateral spots; tergites 7–9 with large anterolateral spots (Fig. 1). Abdominal sterna 2–9 with pairs of black antero-lateral dashes. Apex of subgenital plate and forceps smoky brown (Fig. 7). Penes (Figs. 8, 9) characteristic of the genus; fused in basal third with lobes narrow and separated in apical 2/3; each lobe with a stout apical projection directed ventro-laterally. Cerci and terminal filaments whitish tan.



**FIGURES 5–9.** *Atopophlebia pitculya*, imago. Figs. 5–6, wings: 5, fore and hind wing; 6, hind wing enlarged. Figs. 7–9, male genitalia: 7, subgenital plate and penes, ventral view; 8 penes and base of forceps, lateral view; 9, penes, dorsal view.



**FIGURES 10–20.** *Atopophlebia pitculya*. Figs. 10–15, mouthparts: 10, labrum; 11, labral denticles; 12, left mandible; 13, maxilla; 14, hypopharynx; 15, labium: a, dorsal view, b, ventral view. Figs. 16–19, legs of nymph: 16, hind leg; 17, middle leg; 18 foreleg, 19, tarsal claw. 20, fifth gill.

Female Imago. Allotype. Length: body 11.6mm, forewing 10.3mm. Head and body pale orange yellow. Head as in male but compound eyes widely separated, and a black mark on vertex behind each lateral ocellus. Thorax and abdomen with black markings as in male, abdominal tergites marked laterally with pale brown. Wing coloration and venation similar to male but base of ICu free. Subgenital plate orange–yellow, broadly rounded at apex. Caudal filaments pale grayish brown, segments at base with white rings. Variations. One of three females have ICu1 attached at base to MP2.

Mature Nymph. Male; length 10mm, cerci broken at about one half their lengths. Head pale yellowish brown, ocelli black, compound eyes with outer portion black, inner portion reddish brown. Antenna yellowish white. Clypeus with lateral margins subparallel. Mouthparts: Labrum and dorsal surface of mandibles yellowish white, a black streak on lateral margin of maxillary stipes. Labrum (Fig. 10) with lateral margins rounded, dorsum with a subapical line of strong setae, scattered setae basally. Apical denticles (Fig. 11) short and very broad. Mandibles strongly curved with a line of setae at mid-length and apically (Fig. 12). Maxilla (Fig. 13) broad, a row of 17 subapical pectinate setae present, cardo with short fine setae on outer margin. Maxillary palp with a row of long setae on apical half of outer margin of segment 2 and margin of segment 3, three strong setae at apex of inner margin of segment 2 and three setae at base of inner margin on segment 3. Hypopharynx (Fig. 14) with narrow curved lingulae, superlingulae with curved lateral arms. Labium (Fig. 15): Glossae with fine setae on apical half, paraglossae with long inwardly directed setae on apical fourth, a short row of setae on ventral surface. Palpal segments 2 and 3 with evenly spaced long setae on their outer margins. Thorax: Pronotum yellowish brown with black lateral band; pronotal margins expanded and translucent. Pterothorax yellowish brown dorsally, marked with black laterally. Wingpads yellowish brown with a black spot at basal costal margin (Fig. 2). Thoracic sterna yellowish white (Fig. 3). Legs (Figs. 16–19) yellowish white; each femur with two pale brown chevron shaped bands; apex of foretibia dark grey. Foreleg (Fig. 18) with dorsal margin of femur with long setae and short spatulate setae on anterior surface. Foretibia with a dense row of short setae on apical two-thirds of inner surface. Middle (Fig. 17) and hind leg (Fig. 16) with femur similar to foreleg, tibiae with a dense row of long fine setae on outer margin. In addition, the hind tibia has a row of large pectinate spatulate setae on its dorsal surface (Fig. 16). Tarsal claws (Fig. 19) with a row of four denticles, the apical denticle larger than the others. Abdomen yellowish brown with black markings as in male imago. Abdominal terga also with yellow lateral spots and yellow postero-median markings on terga 4, 5, 7–9 (Fig. 2). Abdominal sterna yellowish white with a pair of black lateral spots (Fig. 3). Postero-lateral spines present on segments 2–9, becoming larger apically. Gills (Fig. 20) grayish, tracheae black, a large basal lobe on inner lamella; seventh gill much reduced. Caudal filaments yellowish white, ringed with pale brown on articulations.

## Etymology

Pitculya: (Cayapas, one of the indigenous cultures of northwestern Ecuador); refers to a mythical being that lives in rivers and streams. It decorates its body with yellow dye (Encalada 2010).

## Distribution

Ecuador: Manabí and Esmeraldas provinces.

## Material Examined

Holotype: one male imago (reared from subimago)(PUCE): Ecuador, Manabí, Bosque Protector Cantagallo, Jurón S01.28401°; W80.70531°; 139m, Estero Jurón, 26-feb-2010, R.W.Flowers.

Allotype: one female imago (reared) (PUCE): same data as holotype.

Paratypes: 2 ♂♂, 3 ♀♀ subimagos (1♂, 1♀ PUCE, 1 ♀ IMFL, remainder FAMU), 1 nymph (PUCE), same data as holotype; 15 nymphs (7 PUCE, 8 FAMU), Estero Jurón at 300m, 25-ene-2010, F. Garcia, P. Garcia, R.W. Flowers; 61 nymphs (10 IMFL, 20 PUCE, remainder FAMU), Manabí, Reserva Lalo Loor, Estero Limón, pools in

stream bed, S00.06972°; W80.14146°, 10-set-2008, M. Martínez, R.W. Flowers; 1 ♂ imago, at blacklight (FAMU), Esmeraldas, Reserva Biologica Bilsa, S00.359167°; W79.700556° ~300m, 6-mar-2010, R.W. Flowers; 13 nymphs (7 PUCE, 6 FAMU), same locality, Estero Duchá, 2-nov-2009, R.W. Flowers, S. Pérez.

Non paratype material: 1 nymph, Esmeraldas, Estero Suvere, N00.83756°; W79.69659, 25m. 16-abr-2007, J. Salazar, S. Benton, R. Troya, R.W. Flowers

## Discussion

The adult of *Atopophlebia pitculya* can be distinguished from all other known species in this genus by the hind wing which has a strongly shaded costal margin and the costal projection at the apex of the wing (Figs. 1, 6). Both sexes of the adults and the nymphs are also easily separable from other known *Atopophlebia* by the pairs of dark dots on the abdominal sterna (Fig. 3). The penes of *A. pitculya* follow the pattern of the other species: two narrow, slightly sinuate rods projecting from a broad base with the tips of the penes bent downward and outward. There are no spicules on the penes of *A. pitculya* such as those described for *A. flowersi* (Domínguez and Molineri 1996).

*A. pitculya* and *A. fortunensis* adults share a similar hind wing structure in which the costal projection is very close to the apex. All other species have the costal projection set back from the apex, and *A. flowersi* has the costal projection midway on the anterior margin of the forewing.

The principal morphological differences between the nymphs of *A. pitculya* and *A. fortunensis* are in the labrum and abdominal gills. In *A. pitculya* the sides of the labrum are rounded (Fig. 10) while in *A. fortunensis* the sides are slightly angulate (Fig. 9, Flowers 1987). The abdominal gills of *A. pitculya* have a large basal lobe on the inner lamella (Fig. 20); this lobe is lacking in *A. fortunensis*. Only the color pattern of the nymph of *A. flowersi* was described, with the comment that there were no significant morphological differences between it and *A. fortunensis* (Domínguez and Molineri 1996).

*Atopophlebia pitculya* nymphs were found in leaf packs in a variety of stream habitats. In Reserva Bilsa they were found in leaves at the bottom of a pool beneath a small waterfall; in B.P. Cantagallo they were in leaf packs formed along the sides of a shallow stream running through tagua palm forest (Fig. 4). In Lalo Loor they were found in small remnant pools in the bed of a temporary stream close to the Pacific coast. Mosquera et al. (2001) found *A. fortunensis* nymphs in leaf packs in a sandy bottomed aqueduct stream in the Cordillera Occidental of Colombia.

Diagnosis. Both adults and nymphs of *Atopophlebia* can be separated only by patterns of dark markings on the abdomen. These patterns appear when the nymphs are approximately half grown and carry through to the imago. As noted in the description, *Atopophlebia pitculya* is the only species currently known with dark markings on the venter of the abdomen.

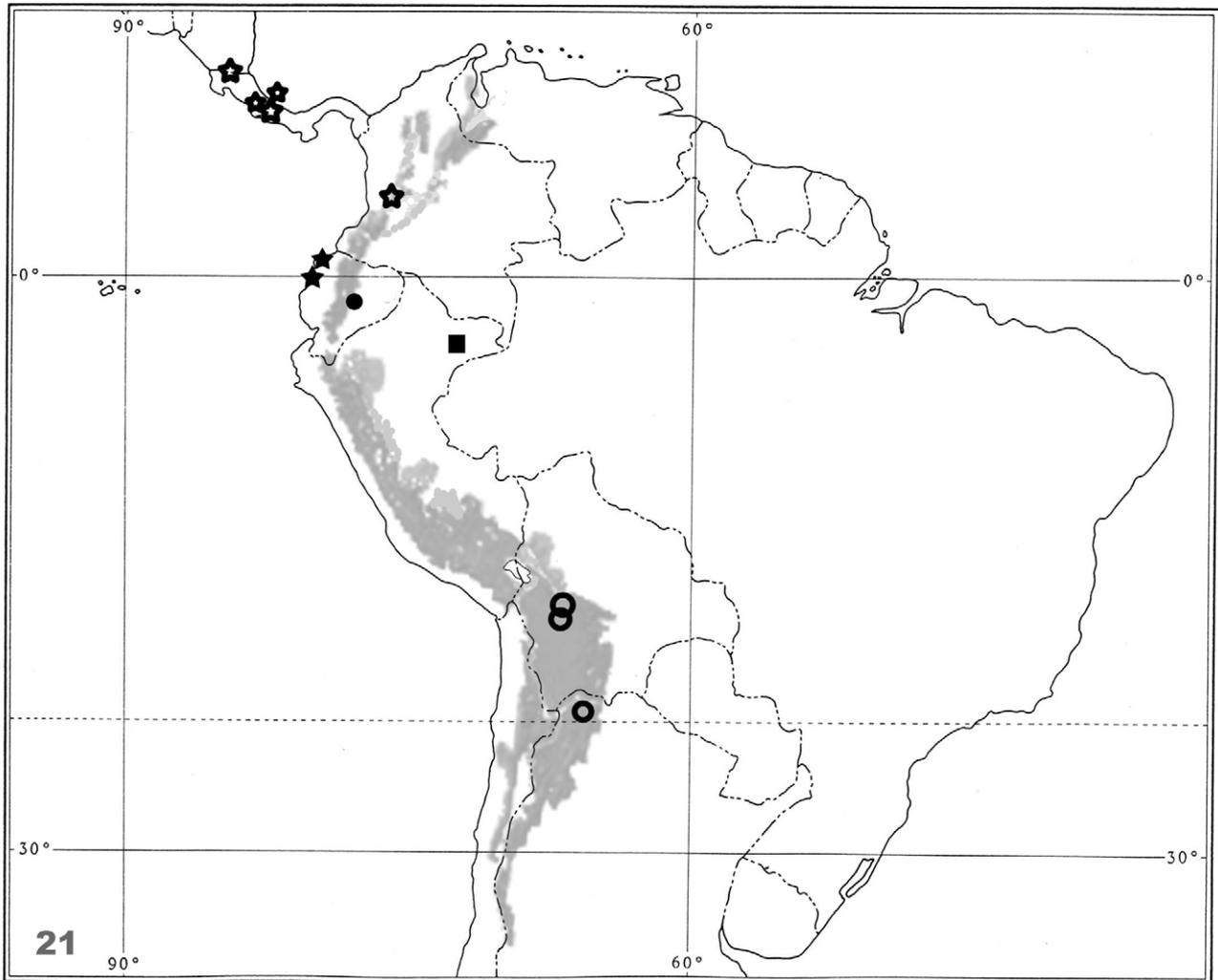
## Biogeography

*Atopophlebia* extends from Lower Central America along the northwestern Andean orogeny in South America to northern Argentina (Fig. 21). It shows a pattern common to many plants and animals that is best explained by an ancestral pre-Andean population being fragmented by the Andean uplift (Alzate et al. 2008, Croizat 1958, Croizat 1976, Heads 2012).

All species of *Atopophlebia* except *A. yarinacocha* are associated with low to mid-elevation mountain systems along the Andes range. *A. pitculya*, while not strictly Andean, has been found close to the Mache-Chindul mountains of western Ecuador. There has been no exploration of this mountain range for insects, let alone *aquatic insects*, but is reasonable to suppose that since *A. pitculya* occurs both to the northeast and southwest, it will eventually be found in between.

Heads (2012) notes that Central America, the western Andes, and the mountains of western Ecuador are accreted terranes, divided by the Romeral Fault Zone from the rest of the Andes. It is interesting that both *Atopophlebia* species in this region (*A. fortunensis* and *A. pitculya*) share a character not found in the other species (the hind wing shape), probably suggesting a common ancestry. This would coincide with the intra-generic vicariance also found across this zone within several genera of primates, notably howler monkeys (Heads 2012). It

would be of great biogeographic interest to compare in detail nymphs of the other species of *Atopophlebia* on the Amazonian side of the Romeral Fault with the nymphs of *A. fortunensis* and *A. pitculya* to see if they also show equivalent differences.



**FIGURE 21.** Ranges of species of *Atopophlebia*. Open stars, *A. fortunensis*; closed stars, *A. pitculya*; solid circle, *A. obrienorum*; square, *A. yarinacocha*; open circles, *A. flowersi*.

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