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A new species of *Sycorax* Curtis (Diptera, Psychodidae, Sycoracinae) collected on harlequin frogs (Anura: Bufonidae, *Atelopus*) in the Ecuadorian Andes

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Abstract

Sycorax wampukrum **sp. nov.** is described from the Amazonian slopes of the Cordillera Oriental of southern Ecuadorian Andes. This new species constitutes the first record of the genus from Ecuador. Males and females of this new species were found in contact with the dorsal surfaces of head, body and extremities of male individuals of harlequin frogs, thus establishing the second record of species of the genus *Sycorax* feeding on frog blood.

Key words: Diptera, Psychodidae, Sycoracinae, *Sycorax*, new species, Harlequin frogs, *Atelopus*, Neotropical Region, Andes, Ecuador

Resumen

Sycorax wampukrum **sp. nov.** es descrita de la vertiente amazónica de la Cordillera Oriental en el sur de los Andes ecuatorianos. Este es el primer registro de una especie de este género en Ecuador. Los machos y hembras de la nueva especie fueron encontrados sobre la superficie dorsal de la cabeza, el cuerpo y las extremidades de ejemplares macho de ranas arlequín, lo que constituye el segundo registro de una especie de *Sycorax* alimentándose de sangre de anuros.

Palabras clave: Diptera, Psychodidae, Sycoracinae, *Sycorax*, especie nueva, ranas arlequín, *Atelopus*, Región Neotropical, Andes, Ecuador

Introduction

Sycorax Curtis is a small genus of psychodid flies with 33 described species (excluding fossil species) (Ježek 1999, Bravo 2003, 2007; Bejarano *et al.* 2008). At the moment, ten species have been described from the Neotropical region (Barretto 1956, Duckhouse 1972, Young 1979, Bravo 2003, 2007, Bejarano *et al.* 2008), with four of them being from the Andean region (all from Colombia): *S. andicola* Young, *S. colombiensis* Young, *S. fairchildi* Young and *S. trispinosa* Young (Young 1979). The female mouthparts of *Sycorax* include fully-developed toothed mandibles (Duckhouse 1972, Young 1979) that are presumed to help them to obtain blood from vertebrates. However, the feeding habits of the adults of most species of *Sycorax* are still unknown, with exception of *S. silacea* Curtis, specimens of which were collected feeding on frog blood and concomitantly transmitting a filarial worm (Desportes 1942). We describe here a new species of *Sycorax* collected on harlequin frogs (genus *Atelopus*) from the southeastern Ecuadorian Andes. This description constitutes the second documentation of hematophagy by *Sycorax* on anurans, and the first record of this genus for the Ecuadorian entomofauna.

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Materials and methods

Initial observations and collections of *Sycorax* flies were made during a demographic study of an undescribed species of *Atelopus* from 2004 to 2005 (Salazar-Valenzuela 2007). Additional collections were made in December 2007 and during 2008 and the captured specimens were preserved in 75% ethanol. On two occasions, frogs with flies on them were captured with plastic bags without any flies escaping. These flies were counted and sexed, and all type specimens were treated with 10% KOH and mounted in Canada balsam. Terminology for the morphological descriptions of the species of *Sycorax* follows McAlpine (1981) for the Diptera. The term "genital filament" as proposed by Young (1979) was accepted in this paper to describe a filamentous structure at the base of the aedeagus in the Andean species of *Sycorax*. The specimens were deposited in the Invertebrate Section of the *Museo de Zoología de la Pontificia Universidad Católica del Ecuador* (QCAZI), in Quito, Ecuador and the *Coleção Entomológica Prof. Johann Becker do Museu de Zoologia da Universidade Estadual de Feira de Santana*, in Feira de Santana, Bahia State, Brazil (MZUEFS).

Taxonomy

Sycorax wampukrum Bravo & Salazar-Valenzuela sp. nov.

(Fig. 1–13)

Type material. ECUADOR, Morona Santiago, Río Napinaza (2,92665° S, 78,40701° W, 1010 m.a.s.l.), holotype male, 28.IV.2005, Salazar-Valenzuela, D. (TiposQCAZI 2022); 1 paratype female, same locality, date and collector as holotype (TiposQCAZI 2023); 25 paratype males, same locality, date and collector as holotype (TiposQCAZI 2024–2037, MZUEFS #43842-43851).

Additional studied specimens. 58 males and 11 females preserved in 75% ethanol from the same locality as the holotype, all collected by David Salazar-Valenzuela (QCAZI 15289 and 15290): 10 males and 4 females, 9.XII.2007; 48 males and 7 females, 1.IV.2008.

Etymology. The name *wampukrum* is a word in the Shuar language that means "extremely poisonous colorful frog" (Arbeláez Ortiz 2005). This is the name given by the Shuar people (an ethnic group that inhabits the southeastern region of Ecuador and northeastern Peru) to the *Atelopus* species inhabiting the area where the specimens of the new species of *Sycorax* were found. The Shuar word is actually spelled *wampukrum* (Ernesto Arbeláez Ortiz, pers. comm.), and not *wampucrum* as used by Arbeláez Ortiz (2005).

Type locality. The specimens of the new species of *Sycorax* were collected on the margin of Napinaza River on the Amazonian slopes of the Cordillera Oriental in the southern Ecuadorian Andes. The collection locality is situated 6.6 Km north of the central park of General Plaza (also known as Limón) on the main highway to Macas. The vegetation in this region belongs to Foothill Evergreen Forest (Bosque Siempreverde Piemontano, *sensu* Palacios *et al*. 1999), although it has largely been cleared for cattle ranching and agriculture, with an annual rainfall of 1500–2000 mm, and annual temperature of 18–22°C (Cañadas-Cruz 1983).

Diagnosis. First flagellomere 2.1X length of second flagellomere; male genitalia not inverted; gonostylus with a long subterminal hair and three long, thick spines, one of them apical, one preapical and one at middle; aedeagus with one aperture; genital filaments of male terminalia parallel in ventral and dorsal views and U-shaped in lateral view; sternite 8 of female fused to tergite 8; lobes of sternite 8 of female wider dorsally than ventrally

Description. Male. Eyes separated, without eye bridge; clypeus rectangular; labrum triangular, 1.8X length of clypeus (Fig. 1); antenna with 13 flagellomeres; scape smaller than pedicel (Fig. 2); basal flagellomeres cylindrical (Fig. 2); 1st flagellomere 2.1X length of 2nd flagellomere (Fig. 2); ascoids lost in all specimens studied; fovea of ascoids observed in all flagellomeres, except the last; flagellomeres 3 to 13 shorter than the first and second (Fig. 3); last flagellomere (13th) with small conical apiculus (Fig. 3); palpus

formula = 1.0:0.8:0.7:0.9 (Fig. 4). Wing (Fig. 5) with Sc reaching the C vein; CuA_2 short, not reaching the wing margin. Male genitalia not inverted. Epandrium pilose (Figs. 6, 10), with the posterior margin V-shaped in dorsal view (Fig. 10); cerci long (Fig. 10), 0.35X length of gonocoxite, with micropilosity and few bristles at the apex (Figs. 6, 10). Gonocoxite pilose, 2.0X length of gonostylus (Figs. 6, 8); gonocoxites separated on dorsal surface (Fig. 8); gonocoxal apodeme triangular not fused medially (Fig. 9); gonocoxites with long posterior bristle (Figs. 6, 7, 8). Hypandrium lost. Gonostylus pilose with a long subterminal hair and three long, thick bristles (= spine), one of them apical, one preapical and one at middle (Figs. 6, 7, 8). Sternite 10 long, triangular in dorso-ventral view, with apical micropilosity (Fig. 10). Parameres pilose, complex, as drawn (Figs. 8, 11); parameres linked by a subrectangular sclerotized sclerite (Fig. 8). Aedeagus with one aperture (Figs. 8, 11); genital filaments parallel in ventral and dorsal views (Figs. 8, 9) and U-shaped in lateral view (Fig. 11). Aedeagal apodeme 0.8X length of gonocoxite, narrow in dorsal view (Figs. 8, 9), wide in lateral view (Figs. 6, 11).

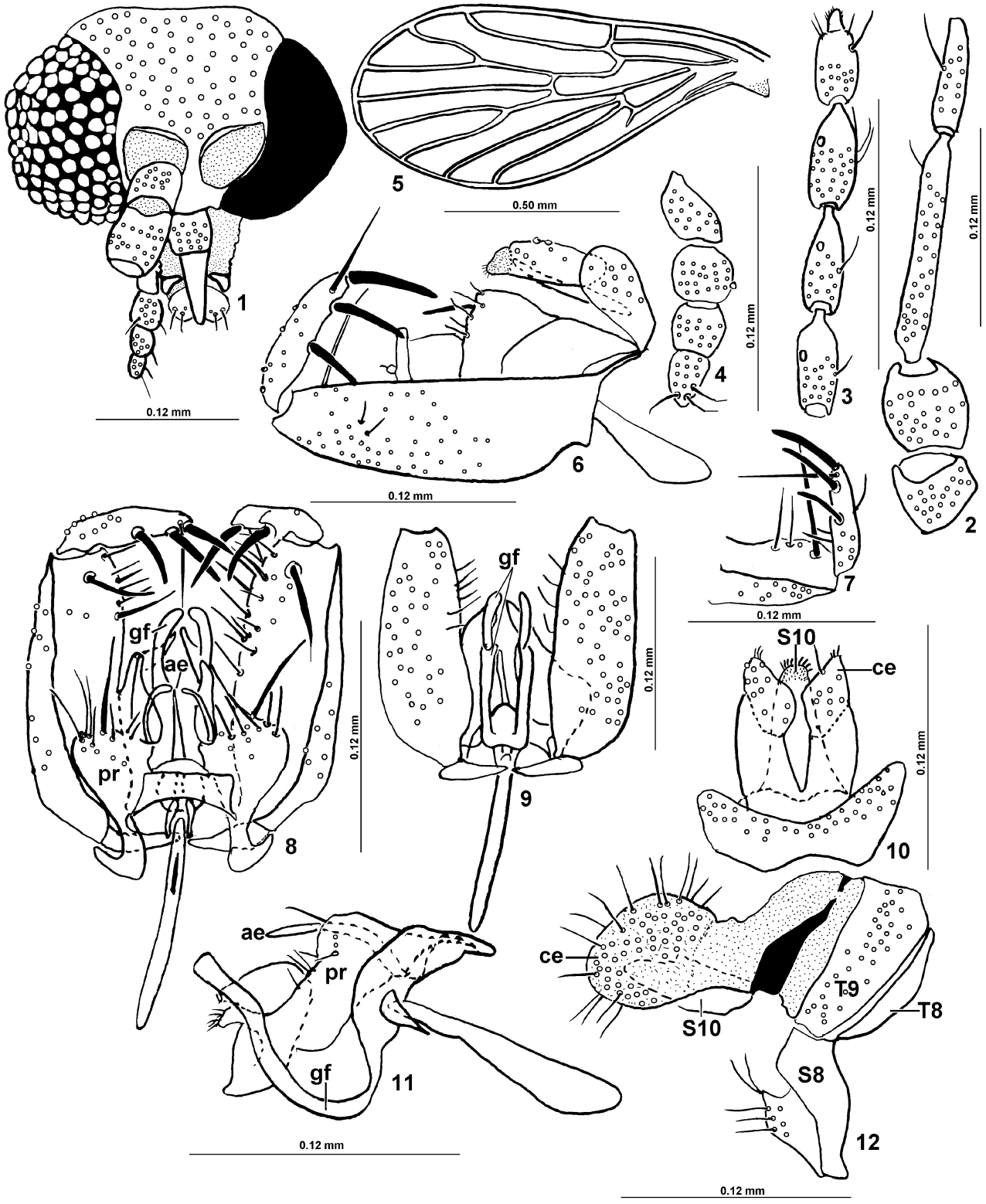
Female. Similar to males except as follows: sternite 8 fused to tergite 8 (= sintergosternite) (Fig. 12); lobes of sternite 8 wider dorsally than ventrally (Fig. 12). Tergite 9 wide (Fig. 12). Tergite 10, subtriangular in lateral view, sclerotized, articulated to sternite 10 (Fig. 12); sternite 10 between the cerci (Fig. 12); cerci hemispheric in lateral view (Fig. 12).

Taxonomic comments. The new species described here is morphologically similar to four other species from the Pacific slopes of the Colombian Andes that were described by Young (1979). These five species have three or more spines on the gonostylus as well as a characteristic genital filament not observed in other Neotropical species of *Sycorax*. Three species of Andean *Sycorax* have 3 spines in the gonostylus: *S. colombiensis* Young, 1979; *S. fairchildi* Young, 1979; and *S. trispinosa* Young, 1979. The other species, *S. andicola* Young, 1979, has 4 spines in the gonostylus. Only *S. colombiensis* and *S. fairchildi* have a gonostylus with a long subterminal bristle. The new species can be differentiated from the latter two species by the shape of the genital filaments as observed in lateral view: in *S. colombiensis* it is longer than the aedeagus and sinuous; in *S. fairchildi* it is the same length of the aedeagus and slightly curved; and in the new species it is longer than the aedeagus and U-shaped.

Among the Andean species of *Sycorax*, the Colombian species collected on the Pacific slopes and the new Ecuadorian species collected on the Amazonian slopes seem to belong to a unique evolutionary lineage, separated from the other species of Neotropical *Sycorax*. We prefer not propose a new supraspecific taxon at this time for these Andean species of *Sycorax* because this genus has not yet been well studied.

Biological remarks. All the specimens of the new species of *Sycorax* were found in contact with the dorsal surfaces of head, body and extremities of male individuals of *Atelopus* sp. (Fig. 13). The flies were found active at night when the frogs were resting on top of leaves from vegetation adjacent to the stream. Of 1306 captures of individuals of *Atelopus* sp., *Sycorax* flies were detected on nine occasions, in April, August, September, November and December. The number of flies counted on frogs varied from 5 to 55 (mean 19 ± 17, n = 9) (Salazar-Valenzuela 2007). One frog rubbished its back with its front and hind legs when dipterans were present, and another frog was found with its hands on top of its eyes when a high number of flies (7) were present on its head. On December 9th, 2007, 14 flies were found on a male *Atelopus* sp. Of these, ten were males and four were females (two with blood in their abdomen). On April 1st, 2007, 55 flies were found on another male *Atelopus* sp. Of these, 48 were males and seven were females (three with blood in their abdomen).

Desportes (1942) collected specimens of the European *Sycorax silacea* feeding on frogs' blood of the species *Rana esculenta* L. (= *Pelophylax lessonae* x *Pelophylax ridibundus*, Frost 2008); the female flies collected were infected with filarial worms of *Icosiella neglecta* (Diesing). It is known that only females of *Sycorax* bite, because only they possess mandibles. Our finding of blood on females of the new species of *Sycorax* suggests that they were feeding on harlequin frogs' blood. The high number of male flies collected on *Atelopus* sp. can be interpreted as an aggregation behavior of males to mate.



FIGURES 1–12. *Sycorax wampukrum* Bravo & Salazar-Valenzuela **sp. nov.**, male. 1. Head. 2. Antenna: scape, pedicel and basal flagellomeres. 3. Antenna: flagellomeres 10–13. 4. Palpus. 5. Wing. Male terminalia, Figures 6–11: 6. Lateral. 7. Gonostylus and gonocoxite 8 Dorsal. 9. Ventral. 10. Epandrium, Cerci and sternite 10. 11. Aedeagus, paramere and genital filament. Female terminalia, Figure 12: 12. Lateral. (ae = aedeagus; ce = cercus; gf = genital filament; pr = paramere; S8 = sternite 8; S10 = sternite 10; T8 = tergite 8; T9 = tergite 9).

FIGURE 13. Specimen of harlequin frog, *Atelopus* sp., from Río Napinaza, Ecuador, with specimens of *Sycorax wampukrum* Bravo & Salazar-Valenzuela **sp. nov.** on the dorsal surface of its body.

It is worth noting that the biological association between flies of the genus *Sycorax* and harlequin frogs presented in this paper differs from parasitic associations reported between other groups of flies [blow flies (Calliphoridae), flesh flies (Sarcophagidae), grass flies (Chloropidae) and muscid flies (Muscidae)] and several anuran families (see Hagman *et al*. 2005). In those cases, flies produce myasis –invasion of fly larvae in vertebrate tissues – which is lethal for frogs. The low frequency of encounters of *S. wampukrum* **sp. nov.** on *Atelopus* sp. (nine registers of over 1300 frog captures) is in agreement with the classification of Skevington (2002) of members of the family Psychodidae as transient blood-suckers, rather than true parasites. This last statement might change in the future if filarial worms are found infecting the frogs. At this time, we have not been able to examine blood contained on female flies or frogs' blood due to scarcity of encounters with flies and the endangered status of the population of harlequin frogs monitored.

Most flies of the subfamily Sycoracinae have been collected on vegetation close to running water (Bejarano *et al*. 2008), and as this is the same type of habitat associated with harlequin frogs, because they reproduce under lotic conditions (Lötters 1996), it is quite possible that these two taxa interact in other regions of the Neotropics. Given the critical challenge of conserving these frogs, more information will be needed about their basic biology (Lötters 2007). Ecological interactions between insects and harlequin frogs is an important area of research as previous studies have shown that these relationships can have significant consequences on individual frogs (such as lethal parasitism, Crump & Pounds 1985) or on their habitats (such as alterations in aquatic insect communities, Ranvestel *et al*. 2004).

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