Phyllomedusa 18(2):277–281, 2019

ISSN 1519-1397 (print) / ISSN 2316-9079 (online)
doi: http://dx.doi.org/10.11606/issn.2316-9079.v18i2p277-281

Short Communication

Flesh-fly myiasis (Diptera: Sarcophagidae) in *Dendropsophus schubarti* (Anura: Hylidae) from Peru

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Keywords: amphibians, Cocha Cashu, Madre de Dios, Manu National Park, parasitoidism.

Palavras-chave: anfíbios, Cocha Cashu, Madre de Dios, Manu National Park, parasitoidismo.

Sarcophagidae is a fly family that feeds on decomposed organic material, and some species occasionally parasitize invertebrates and vertebrates (Guimarães and Papavero 1999) by depositing larvae on the host. The larvae then feed on the host's tissues, which include either fresh or dead tissues, corporal fluids, or ingested food (Zumpt 1965). Two types of myiasis are recognized. In primary myiasis, the larvae penetrate through intact skin or natural holes, whereas in secondary or tertiary myiasis, they use trauma or wounds to infiltrate the tissue (Soler-Cruz 2000, Francesconi and Lupi 2012).

Myiasis is well documented in humans, domestic animals, mammals, and wild birds (Acha and Zsyfres 2003). However, there are also dipterans that infest ectothermic vertebrates such as *Anolisimyia blakeae* Dodge, 1955 (Sarcophagidae) in reptiles (Dodge 1955). In amphibians from Europe and North America, the most common myiasis agents are species of Calliphoridae, whereas in Central and South America, Sarcophagidae is predominant, and Chloropidae is found in Australia and New Zealand (Kraus 2007).

In the Neotropics, reports include sarcophagid larvae parasiting several anuran families, as follow: Centrolenidae: *Hyalinobatrachium fleischmanni* (Boettger, 1893) (Medina *et al.* 2009); Hylidae: *Boana* (= *Hypsiboas*) *atlantica* (Camaraschi and Velosa, 1996) (Oliveira *et al.* 2012), *Scinax fuscovarius* (Lutz, 1925) and *S.* gr. *ruber* (Laurenti, 1768) (Souza-Pinto *et al.* 2015), and *Dryaderces inframaculata* (Boulenger, 1882) (Pinto *et al.* 2017); Strabomantidae: *Pristimantis thectopternus* (Lynch, 1975) (Gómez-Hoyos *et al.* 2012); Bufonidae: *Rhinella diptycha* (Cope, 1862) (treated as *Rhinella schneideri*); Leptodactylidae: *Leptodactylus latrans* (Steffen, 1815) (Müller *et al.* 2015). In some reports, it is possible to identify the dipteran species involved. For example, *Lepidodexia bufonivora* (Lopes and Vogelsang, 1953) seems to be the most common cause of myiasis in the Neotropics (Travers and Townsend

Received 11 March 2019
Accepted 03 October 2019
Distributed December 2019

2010); it parasitizes the following anurans: Bufonidae: *Atelopus varius* (Lichtenstein and Martens, 1856) in Costa Rica (Crump and Pounds 1985); Hylidae: *Aplastodiscus arildae* (Cruz and Peixoto, 1987) in Brazil (Eizemberg *et al.* 2008) and *Rheohyla miotympanum* (Cope, 1863) in Mexico; Ranidae: *Lithobates berlandieri* (Baird, 1859) in Mexico; Craugastoridae: *Craugastor rhodopis* (Cope, 1867) in Mexico (Vázquez-Corzas *et al.* 2018). A second species that have been identified as a myiatic agent in the Neotropics is *Lepidodexia centenaria* (Mello-Patiu, 2010), which parasitizes the hylid, *Hypsiboas beckeri* (Camaraschi and Cruz, 2004), in Brazil (Mello-Patiu and Luna-Dias 2010).

In Peru, there are reports of myiasis from the departments of Loreto and San Martín in the dendrobatids *Ameerega bassleri* (Melin, 1941), *A. cainarachi* (Schulte, 1989), and *A. trivittata* (Spix, 1824) in 1982, 1989, 1998, and 2004. The species of flesh fly was identified as *Peckia* (= *Sarcodexia) lambens* (Wiedemann, 1830) in *A. cainarachi* and *A. trivitatta* collected in San Martín region (Hagman *et al.* 2005). An additional three reports include myiasis by an unidentified fly in the dendrobatid, *Ranitomeya uakarii* (Brown, Schulte, and Summers, 2006), in Loreto region and in two hylids, *Osteocephalus leprieuri* (Duméril and Bibron, 1841) and *Dendropsophus leali* (Bokermann, 1964), in 2012, 2016 and 2017, respectively (von May *et al.* 2019). Herein, we report the occurrence of a sarcophagid larval myiasis in the hylid, *Dendropsophus schubarti* (Bokermann, 1963).

We collected a specimen of *Dendropsophus schubarti* on 09 November 2014 at 22:10 h in the Amazon rainy season, while conducting a survey at Cocha Cashu Biological Station situated in the core area of Manu National Park in the Peruvian Amazon at 340 m a.s.l. (11°53'41.45" S, 71°25'0.01" W). Our field studies were conducted in an intact mature floodplain forest that surrounds the Lago Cocha Cashu. The specimen was preserved and deposited in the Natural History Museum of San Marcos National University in Lima (MUSM 34636).

The anuran, which was relatively immobile, had a small larva below the dermis. We collected the frog and kept it in captivity for further observations. On the following day, we observed that the larva had grown and moved from the back to the dorsal part of the head. There, we could observe a small hole in which the larval spiracles were visible (Figure 1).

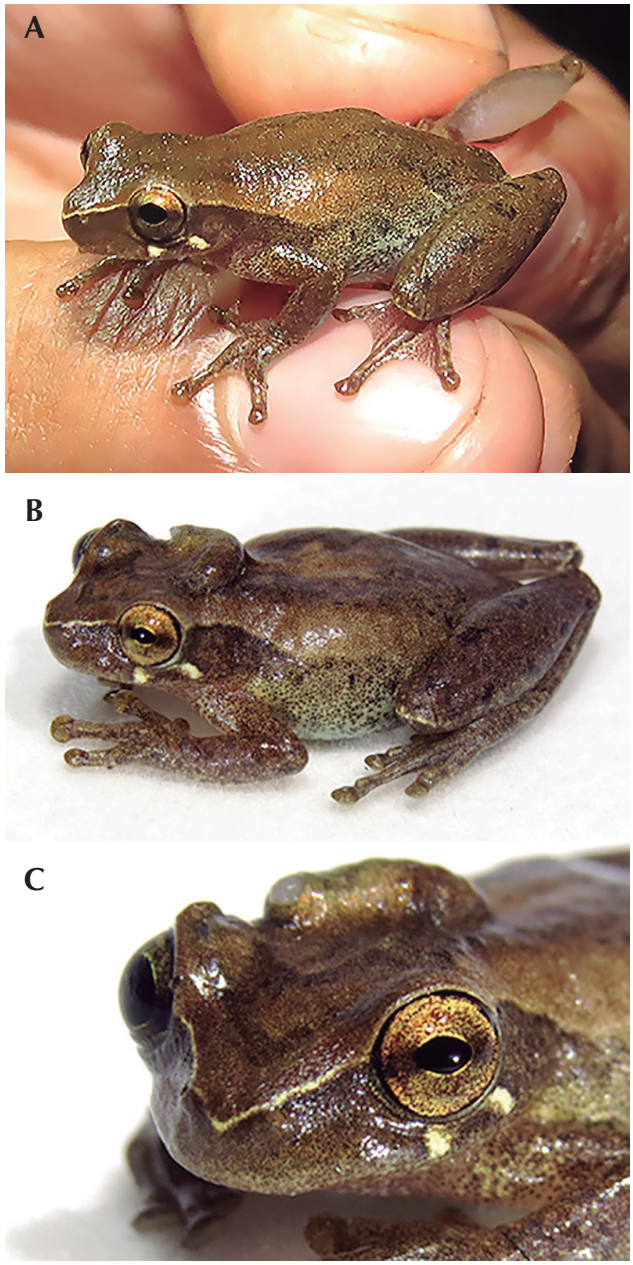

Figure 1. *Dendropsophus schubarti* infested by sarcophagid larva. (**A**) Day of capture, (**B**) second day of capture, (**C**) detail of spiracle hole.

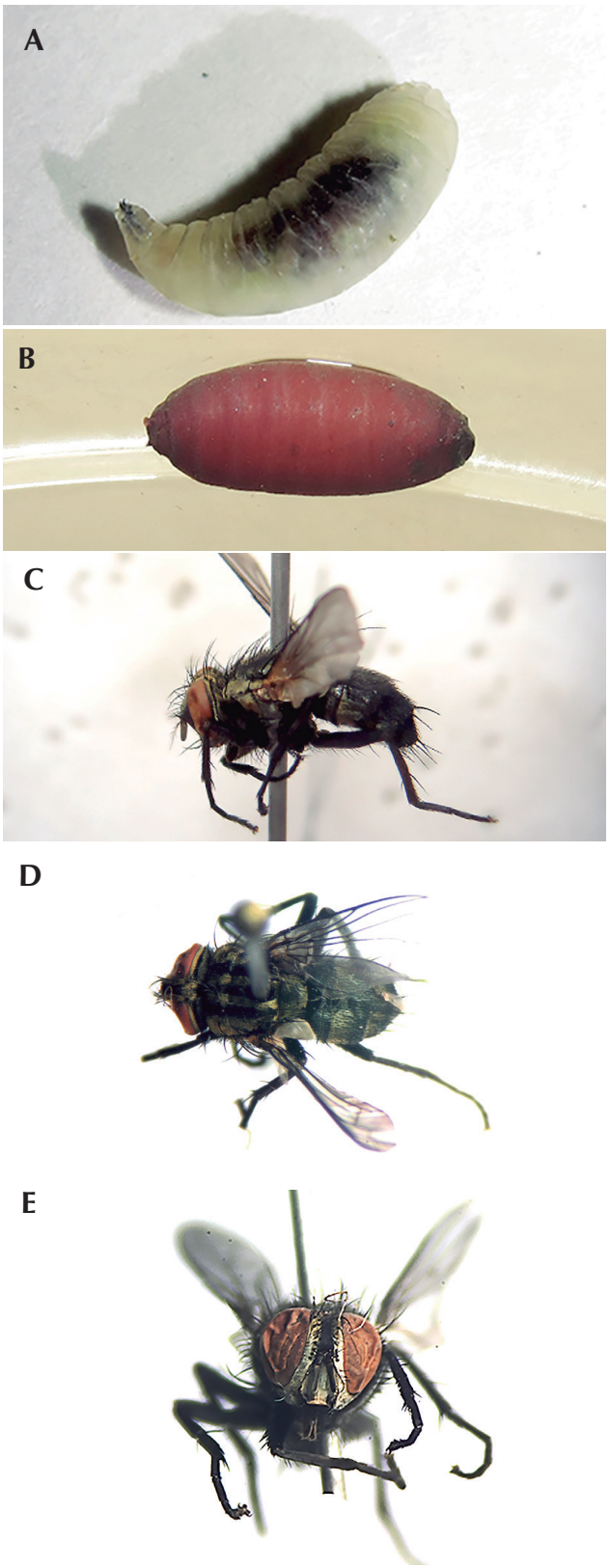

Figure 2. Sarcophagidae (**A**) larva (about 12 mm), (**B**) pupa (about 10 mm), and adult in (**C**) lateral (**D**) dorsal, and (**E**) frontal view.

Two days later, the larva exited the frog through the aforementioned hole near the right eye; the larva may have caused the frog's death. We kept the larva in a plastic box with leaf litter at room temperature. It pupated the next day (Figure 2A–B) and the adult fly emerged between 12 and 14 days later (Figure 2C–E). The fly was identified at the Entomology Laboratory of San Marcos National University as a sarcophagid, most likely *Lepidodexia* sp. following the identification key of Pape and Dalhen (2010).

Myiasis caused by Sarcophagidae usually is lethal to the host (Crump and Pounds 1985, Kraus 2007), even in larger species such as *Anaxyrus* (= *Bufo*) *americanus* (Holbrook, 1836) (Bolek and Coggins 2002). Similarly, in small amphibians such as the dendrobatid, *Ameerega* sp., larvae destroy muscle tissue producing immobility and finally death (Hagman *et al.* 2005).

Unlike myiasis in mammals and birds, parasitic larvae can penetrate the intact skin without wounds or lacerations in amphibians (Bolek and Coggins 2002, Medina *et al.* 2009). Since sarcophagid species usually are primary invaders, they penetrate the intact skin or natural cavities of the host (Soler-Cruz 2000, Francesconi and Lupi 2012). Thus, this case is a primary myiasis owing to the absence of wounds in the frog's skin when it was collected.

During our survey, we recorded 816 anurans of which 145 were hylids and 28 were members of the genus *Dendropsophus*. Myiasis was limited to one specimen and there were no larvae on any of the other anurans that we examined. However, we may have overlooked some infected frogs, because fly larvae can develop under intact skin without external evidence (von May *et al.* 2019).

Sarcophagid activity usually is diurnal, with low probabilities of larviposition at night (Greenberg 1990, Hagman *et al.* 2005, Medina *et al.* 2009); in contrast, *Dendropsophus schubarti* is primarily nocturnal, although the frog may be found early in the morning

(Duellman 2005). This suggests that larviposition may have occurred when the frog was inactive; this would be advantageous for the fly because it would be less subject to predation. Alternately, larviposition may have occurred in the early morning hours when both the frog and the fly would have been active.

There are no reports of timing and duration of larval development in myiasis-inducing Sarcophagidae in amphibians in natural conditions. Nevertheless, the observed larvae and pupa period of development corresponds with Kamal's (1958) report for four species of sarcophagid flies under laboratory conditions.

Despite the numerous reports of myiasis, little is known about the ecological aspects of this host-parasite interaction in anurans. It would be useful to know whether anurans are more susceptible to parasitic infection if mycotic or bacterial infection is present, and if the prevalence of myiasis is related to environmental factors in an anuran community.

Acknowledgments.—We thank the Organization for tropical Studies (OTS) for the financial support and Manu National Park for the research authorization. We are especially thankful with Cesar Flores, Veronica Chávez, and Roxana Arauco from Cocha Cashu Biological station, for the logistic facilities and their hospitality in field. Moreover, thanks to Dr. José Pérez Z. for the suggestions in this note.

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Editor: Jaime Bertoluci