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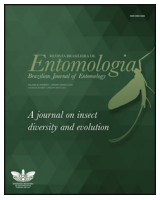

Prey of the Patagonian species *Hilarempis sigillata* Collin (Diptera, Empididae, Empidinae, Hilarini), and the first record of nocturnal activity in the tribe

José Albertino Rafael[1]*, Vera Cristina Silva[2], Galileu Petronilo da Silva Dantas[1], Dalton de Souza Amorim[3]

[1] *Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, AM, Brasil.*
[2] *Pesquisadora autônoma, Ribeirão Preto, SP. Brasil.*
[3] *Universidade de São Paulo (USP), Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), Departamento de Biologia, Ribeirão Preto, SP, Brasil.*

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ABSTRACT

The Empididae fauna of Chile is basically known from a taxonomic perspective. Herein, we have added biological data based on a species of Hilarini, improving our knowledge regarding the southern temperate fauna of the family. We report for the first time the prey and nocturnal activities of the Patagonian empidid species *Hilarempis sigillata* Collin, 1933. Specimens were collected until two hours after sunset on a white light sheet at a river margin in the Chilean region of Los Lagos, close to the Puyehue National Park. Adults were found on the sheet with prey of the Chironomidae genera *Cricotopus*, *Xestochironomus*, *Microtendipes*, *Podochlus*, *Heptagyia* and *Reissmesa* (Diptera), as well as a species of the Coniopterygidae genus *Semidalis* (Neuroptera) and a species of the Limoniidae genus *Erioptera* (Diptera). The empidids held the prey close to their body using the mid tarsi, in most cases with the ventral side of the prey turned up or laterally.

Introduction

The Empididae are a diverse group of flies, with over 3,425 described species found worldwide (Evenhuis and Pape, 2023). The biological information on this family is mainly on feeding and mating behavior, especially for Palearctic and Nearctic species (Forrest, 1985; Chvála, 2005; Cumming and Sinclair, 2009). Adults of the family have been reported to prey on a diversity of arthropods, including Acari, Collembola, Ephemeroptera, Plecoptera, Hemiptera, Thysanoptera, Lepidoptera, Trichoptera, Hymenoptera, Neuroptera, Coleoptera, and Diptera (Smith 1969; Cumming and Cooper, 1993; Cumming and Sinclair, 2009). Adult Empidinae primarily prey on other insects, often with only males capturing prey, which are presented to females during male swarming (Sinclair and Daugeron, 2017).

Nearly nothing is known on the biology of the Neotropical species of the family except for the habitats in which the adults were collected. This also applies to the Chilean fauna of empidids, which knowledge is practically restricted to the taxonomy. The only record on the behavior of Chilean species is for *Empis liberalis* Collin and *E. macrorrhyncha* Philippi (Daugeron et al., 2009).

Herein, we report details on the nocturnal flight and predation activity of the Hilarini species *Hilarempis sigillata* Collin for the first time.

Material and methods

Nocturnal sampling was carried out on November 26th, 2022, from 9:30 to 11:00 pm, starting 40 minutes after sunset (sunset: 8:50 pm), using a 250 W mercury vapor lamp set close to a white sheet at the margin of the Río Chanleufu (40°41'08"S 72°20'04"W, 196 m). Specimens that landed with prey on the sheet (Figs 1A–C) were collected with 50 ml falcon tubes filled with 94% alcohol. The flies captured with prey were separated from the remaining captured specimens. The Empididae were identified using the key in Collin (1933), and Chironomidae were identified using the keys in Brundin (1966) and Cranston et al. (1989). We strictly followed the Chilean legislation (CONAF rule II.A.8: "8), returning identified material to the Museo Nacional de Historia Natural

*Corresponding author.
E-mail: jarafael@inpa.gov.br (J.A. Rafael)

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(CONAF, 2013). Voucher specimens of the Empididae, Chironomidae, Coniopterygidae, and Limoniidae will be housed at the Museo Nacional de Historia Natural (MNHN), Santiago, Chile; Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil; Museu de Zoologia da Universidade de São Paulo (MZSP), São Paulo, Brazil; and the Museu Nacional do Rio de Janeiro (MNRJ), Rio de Janeiro, Brazil.

Results

Eighty specimens of *Hilarempis sigillata* were collected until two hours after sunset on the white light sheet. Most adults were found carrying specimens of Chironomidae, a single specimen of Limoniidae, and a couple of specimens of Coniopterygidae (Neuroptera).

Figure 1 *Hilarempis sigillata* Collin, 1933 and prey. A, white light sheet used to capture insects with *H. sigillata* smaller than specimens of trichopterans; B, male with prey (black arrow) and female without prey (white arrow) standing on sheet; C, detail of male holding the prey on sheet. Figures D–G. Multilayered photo montage from alcohol preserved specimens. D, male specimens holding the prey by the mid tarsi; E, a chironomid specimen, specifically a prey specimen belonging to the genus *Cricotopus*, adult partially contained within the pupal exuviae; F, *Hilarempis sigillata*, male; G, *Hilarempis sigillata*, female.

***Hilarempis sigillata* Collin**

(Figs 1A–D, F–G)

Hilarempis sigillata Collin, 1933: 142, fig. 26f, g.

Material examined (Empididae). 78 males, 2 females, Chile, Region de los Lagos, Osorno, Rio Chanleufu, 40°41'08"S 72°20'04"W, 196 m, light trap, 26.xi.2022, J.A. Rafael, D.S. Amorim & V.C. Silva cols. (MNHN, INPA, MNRJ, MZSP). Chironomid specimens were collected as prey, and they received the same label data (MNHN, INPA, MNRJ, MZSP). Limoniid and coniopterygid specimens at MNHN.

Hilarempis sigillata. Male (Fig. 1F) mostly greyish, with eyes separated on the frons, antennae dark, styli somewhat elongate, thorax dark (brown in alcohol preserved specimens), dorsocentral setae uniserial, femora without stout setae or spines ventrally, and legs yellowish with mid and hind tarsomeres from apex of first tarsomeres dark brown to black; terminalia dark, dorsally directed. Female (Fig. 1G) as in male, except fore first tarsomere not swollen, hind tibiae with sub-basal black band and abdomen tapering towards apex.

Sampling began at 9:30 pm, 40 minutes after sunset. There was no sunlight on the horizon when the lamp was turned on and soon after hundreds of *H. sigillata* specimens began to show up on the white sheet, either with or without prey (Figs. 1A–C). We stayed at this Chanleufu collecting site for about one and a half hours, totaling two hours after sunset. *Hilarempis sigillata* specimens arrived continuously, even more densely in the second hour of collecting than in the first hour, with the number of arrivals only decreasing in the last 15 minutes.

Of the 80 adults collected with prey, 78 were males, and two were females. Both females with prey presumably already had them as a gift given by a male before they landed. From the prey in our sample, 77 were Chironomidae belonging to different subfamilies; two were Coniopterygidae (Neuroptera), and one was Limoniidae (Diptera) (Table 1).

According to Downes and Smith (1969), this feeding habit (males hunting, perhaps not feeding; females non-hunting, receiving prey by transfer at mating) is a specialized feature restricted to the *Empis-Hilara-Rhamphomyia* group (Empidinae), to which *Hilarempis* belongs.

Details of evening activities of Empidinae were poorly reported for Hilarini, as for *Hilara* species, and the known data point to their beginning a few minutes after sunset (Chvála, 2005) to a maximum of 20 minutes after sunset (Forrest, 1985), and also in the dusk and dawn (Murray et al., 2022). As we collected the *H. sigillata* specimens until two hours after sunset, we could consider this species as crepuscular, with specimens resting on the surrounding vegetation after grasping their prey, and later being attracted to the light sheet soon after the light was turned on. However, the number of *Hilarempis sigillata* specimens collected in the second hour after sunset and appearing with prey captured in the emerging process (many prey specimens with wings not fully extended) indicates nocturnal activity.

When we compared Malaise traps samples set for a long period (Nov. 2019–Jul. 2021 and Jun–Nov. 2022) in different sites in the Puyehue National Park, in addition to the January/February specimens captured in 2017 (Amorim et al., 2022), there were more *H. sigillata* specimens caught within one and a half hours of light trapping effort than in those Malaise traps set for month-long periods. One 6-meter-long Malaise trap working for ten days collected 14 males in Termas Águas Calientes along the margin of Río Chanleufu. Quite surprisingly, 187 males and 11 females were collected at a lake shore in Chiloé Island using a 6-meter-long Malaise trap set over three days. This result may have been influenced by a 250 W illuminated light sheet set around 20 meters away for one night or by a swarm near the trap. This is additionally indicative of nocturnal activity for *H. sigilatta*.

There is another detail of hunting behavior that is worth mentioning. It seems likely that this Hilarine species either captured the adult chironomids as they were emerging from the water surface (or in flight soon after emerging). The wings of some of the prey were not even fully extended. In one case, the chironomid specimen was partially within the pupal exuviae (Fig. 1E). This evidences that *H. sigillata* is indeed able to capture their prey from the water surface. We could not see any specimen catching prey on the light trap, and there is no evidence that *H. sigillata* captured any prey from the sheet.

Another interesting detail is that the empidids hold the chironomid by the mid tarsi (Figs 1B–D). The prey size varied from half to three fourths of the empidid body length. Chironomids were held close to the predator body, typically with the ventral side of the body turned up, or less frequently laterally (Figs 1C–D). The fact that there are two coniopterygids and one limoniid among the prey in our sampling shows that *H. sigillata* does not feed exclusively on chironomids.

Chironomid emergence pattern of adults is a complex phenomenon influenced by various parameters, such as latitude, season, local environmental conditions (such as temperature and light), lunar phases, and taxonomic groups (Armitage, 1995). Most studies on the emergence patterns of chironomids were conducted in the Northern Hemisphere and typically only focus on a few species. More research would be necessary on the emergence patterns of Neotropical species of Chironomidae, and therefore our understanding of this topic is limited by our limited knowledge of the diversity of the biology of the family along its geographic distribution in the neotropics. Nevertheless, there appears to be a general trend for Chironomidae to emerge at sunset and/or during the night (Vilchez-Quero and Lavandier, 1986; GPSD pers. obs.). This is in line with *Hilarempis sigillata* specimens collected until two hours after sunset on the light trap. In other words, if *H. sigillata* prey is largely composed of chironomids (some specimens captured in the emerging process with wings not fully extended), it reinforces the hypothesis that this species presents nocturnal activities.

After the information above, some additional taxonomic considerations can be made for *H. sigillata*. Collin (1933) originally placed this species in *Hilarempis* only because of the incomplete vein Sc, and considered *H. sigillata* in an isolated position within *Hilarempis*, out of both groups

Table 1
Hilarempis sigillata prey in the Río Chanleufu light trap sampling in southern Chile.

Family/Subfamily	Genera, Species/morphospecies
Chironomidae Orthocladiinae	*Cricotopus* spp., 4 morphotypes
Chironomidae Chironominae	*Xestochironomus* cf. *aisenensis* Andersen & Kristoffersen, 1999
	Microtendipes sp., 1 morphotype
	unidentified genera, females
Chironomidae Podonominae	*Podochlus* aff. *beschis* Brundin, 1966
Chironomidae Diamensinae	*Heptagyia annulipes* Philippi, 1866
	Reissmesa aff. *antiqua* (Brundin, 1966)
Limoniidae	*Erioptera* sp., one female
Neuroptera Coniopterygidae	*Semidalis* sp., 2 females

(first and second "sections") he had for the remaining Patagonian species. He also noted that *H. sigillata* had much in common with the species of *Hilara*. The taxonomic placement of this species apparently still deserves further investigation, especially considering the nocturnal activity recorded.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

JAR and DSA: conceptualization, collection, investigation, methodology. All authors: analysis, writing – review & editing.

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