



## ANIMAL SCIENCE

# Association between *Ichthyocladius* (Diptera: Chironomidae) and armored catfishes in the Guareí River basin, São Paulo State, Brazil

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**Abstract:** *Ichthyocladius* is a genus of chironomid (Diptera, Insecta) whose immature forms live attached to the bodies of some species of freshwater fishes. Here we investigate the association between *Ichthyocladius* spp. and armored catfish in streams of the Guareí River basin, Paraná River system, Brazil. We provide the first record of *I. lilianae* associated with fish in the São Paulo State and the Paraná River basin. In addition, this is the first report of *Ichthyocladius* associated with the armored catfishes *Hypostomus iheringii* and *H. tietensis*. Lastly, we record two undescribed species of Chironomidae (i.e., *Ichthyocladius* sp. 1 and *Ichthyocladius* sp. 2) associated with fishes.

**Key words:** fish fins, insects, larvae, Loricariidae, pupae, Upper Paraná River basin.

## INTRODUCTION

Different organisms can associate with fishes, either as parasites, commensals or mutualists. Freshwater fishes are hosts to many forms of life, including protozoa (e.g., Eiras et al. 2012, Martins et al. 2012), immature insects (e.g., Roque et al. 2004, Sydow et al. 2008), annelids (e.g., Ranzani-Paiva & Silva-Souza 2004), crustaceans (e.g., Neves & Tavares-Dias 2019) and other fishes (e.g., Zuanon & Sazima 2004, 2005). Among the insects, immature stages (i.e., larvae and pupae) of some Chironomidae (Diptera) may live attached to the bodies of aquatic animals (Tokeshi 1993, Roque et al. 2004, Sydow et al. 2008, Henriques-Oliveira & Nessimian 2009). Larva and pupae of the genus *Ichthyocladius* Fittkau, 1974, in particular, have been reported to live attached to fishes (e.g., Mendes et al. 2004, Roque et al. 2004).

Currently, *Ichthyocladius* is represented by three species, *Ichthyocladius neotropicus* Fittkau, 1974, the type species of the genus, *I. kronichticola*

Mendes, Andersen & Sæther, 2004, and *I. lilianae* Mendes, Andersen & Sæther, 2004 (Mendes et al. 2004), as well as several additional species awaiting formal description. Individuals of *I. kronichticola* and *I. lilianae* have been reported to live in association with armored catfish (Mendes et al. 2004, Roque et al. 2004). *Ichthyocladius lilianae* has been recorded in waterbodies of three Brazilian States: Rio Grande do Sul (Sydow et al. 2008, Dala-Corte & Melo 2018), Minas Gerais (Mendes et al. 2004), and Rio de Janeiro (Henriques-Oliveira & Nessimian 2009).

In a recent study, Azevedo-Santos et al. (2020) investigated the fish fauna of the Guareí River basin (Upper Paraná River basin), São Paulo, Brazil. When examining the material collected, we noted the presence of species of *Ichthyocladius* living on armored catfishes. In this short paper, we investigate the association between these insects with fishes. In particular, we report for the first time the association of *I. lilianae* and two other undescribed species of Chironomidae with

armored catfish (Loricariidae) in the Parana River basin, So Paulo State, Brazil.

## MATERIALS AND METHODS

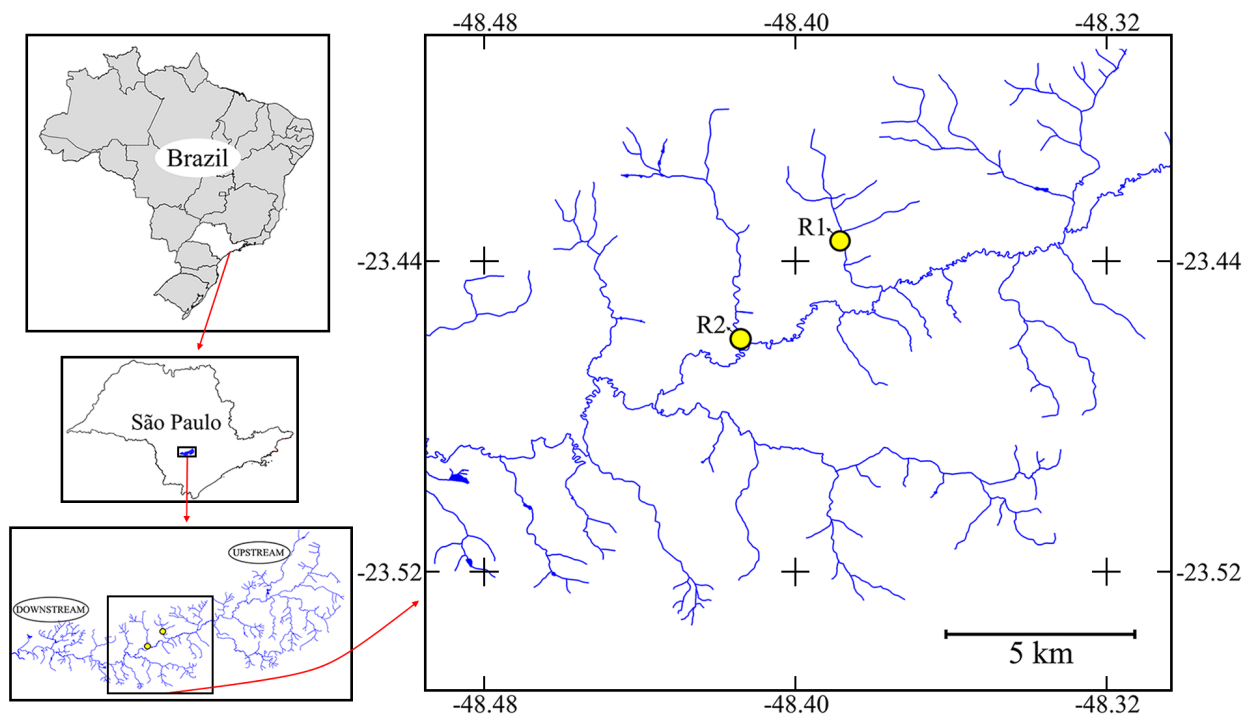
Fish specimens were collected in the Guareı River basin, located in the upper reaches of the Paranapanema River (Parana River system), So Paulo, Brazil. Armored catfishes were sampled in two tributaries of the right bank of the Guareı River during June and August 2017. Fish sampling is described in Azevedo-Santos et al. (2020). Sampling sites were designated as R1 (-23.434932S -48.388695W) and R2 (-23.460077S -48.414122W) (Figure 1).

We searched for chironomids on the exterior surfaces of captured loricariids. All larvae and prepupae were removed and mounted on slides with Euparal. Chironomidae species were identified according to Fittkau (1974) and

Mendes et al. (2004) and by comparison with type specimens deposited at the Museu de Zoologia da Universidade de So Paulo (hereafter MZ), So Paulo, Brazil. Immature individuals (at least one for each species of *Ichthyocladius*) were deposited as vouchers at the MZ. Standard Length (SL) of all hosts was measured with a digital caliper (in millimeters - mm). Classification of the catfishes (see Table S1) followed Fricke et al. (2019a, b).

## RESULTS

We examined nine armored catfishes, of which six served as hosts for *Ichthyocladius*. We recorded 13 larvae and one prepupa of the genus *Ichthyocladius*, including *I. lilianae* and two taxa identified at the morphospecies level (*Ichthyocladius* sp.1 and *Ichthyocladius* sp.2). This is the first record of *I. lilianae* for the Parana River basin and for the State of So Paulo. The catfish



**Figure 1.** Sampling reaches (R1 and R2) in the Guareı River system - map modified from Azevedo-Santos et al. (2020).

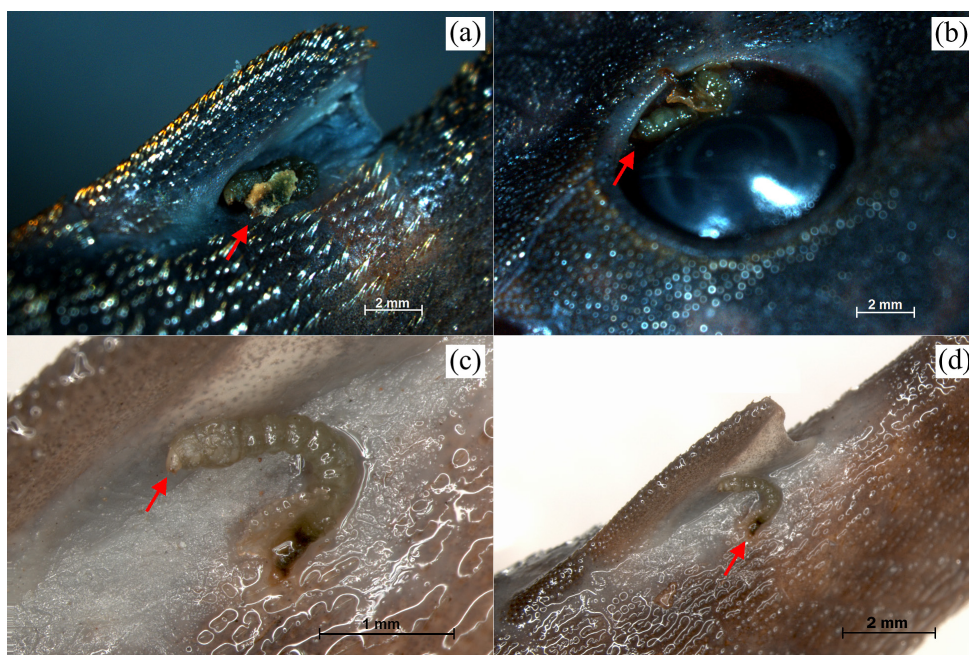
hosts were individuals of *Hypostomus iheringii* (Regan, 1908) and *H. tietensis* (Ihering, 1905) (28.6 - 95.2 mm of SL). We found larvae attached to different regions of the body – including the eyes and fins (Table I; and examples in Figure 2a-d). Virtually all fish with associated chironomids had *Ichthyocladius* in the adipose fin region.

## DISCUSSION

*Ichthyocladius liliana*e was described by Mendes et al. (2004) based on specimens collected in the São Francisco basin, Minas Gerais State. These authors reported its association with two loricariid fishes, *Harttia* sp. and *Hypostomus* cf.

**Table I. Chironomids associated with armored catfishes from the Guareí River basin, São Paulo, Brazil. Classifications and voucher numbers can be found in Table SI.**

Reach	Hosts	Associated species (local in the fish)
R1	One <i>Hypostomus iheringii</i> (Regan, 1908)	Three larvae of <i>Ichthyocladius liliana</i> e (right eye; left eye; lateral of the adipose fin)
R1	One <i>Hypostomus tietensis</i> (Ihering, 1905)	One larvae of <i>Ichthyocladius</i> sp.1 (right eye); and one larvae of <i>I. liliana</i> e (lateral of the adipose fin)
R2	One <i>Hypostomus iheringii</i> (Regan, 1908)	One larvae of <i>I. liliana</i> e (lateral of the adipose fin)
R2	One <i>Hypostomus iheringii</i> (Regan, 1908)	Two larvae of <i>I. liliana</i> e (pectoral fin; lateral of the adipose fin)
R2	One <i>Hypostomus iheringii</i> (Regan, 1908)	One larvae of <i>I. liliana</i> e (lateral of adipose fin)
R2	One <i>Hypostomus iheringi</i> (Regan, 1908)	Two larvae of <i>Ichthyocladius</i> sp. 2 (both on the lateral of the adipose fin); two larvae of <i>I. liliana</i> e (near to the adipose fin and other between the adipose fin and caudal fin); and one prepupa of <i>I. liliana</i> e (near to the adipose fin basin).



**Figure 2. The association between chironomids and armored catfishes: (a) red arrow indicates *Ichthyocladius liliana* in the adipose fin of *Hypostomus tietensis*; (b) red arrow indicates *Ichthyocladius* sp. 1 in the right eye of *H. tietensis*; (c) red arrow indicates the head of *I. liliana*; (d) red arrow indicates *I. liliana* on the adipose fin of *H. iheringii*.**

*garmani* (Regan, 1904). This species of chironomid has since been recorded in four Brazilian states and in different hydrographic basins, including São Francisco and Paraíba do Sul (Sydow et al. 2008, Mendes et al. 2004, Dala-Corte & Melo 2018, Henriques-Oliveira & Nessimian 2009; see details in Table II). Our work expanded its recorded range to include São Paulo State and the Paraná River basin.

We recorded two undescribed Chironomidae species (e.g., *Ichthyocladius* sp. 1 and *Ichthyocladius* sp. 2) associated with catfishes in the Guareí River system. *Ichthyocladius* sp. 1 is the only one without anal seta among the known species. The procercus is also absent in this species. *Ichthyocladius* sp. 2 differs from other species of *Ichthyocladius* by presenting the mentum with more than 24 median teeth and the premandible with pale teeth. In addition to these two, three additional species of the genus await formal description, being one from Ecuador (Fittkau 1974), other from Marauíá River, and the last from Argentina (Mendes et al. 2004). Therefore,

the diversity of Chironomidae associated with catfishes is certainly underestimated.

Only two previous studies have reported an association between *Ichthyocladius* and *Hypostomus* Lacepède, 1803. Mendes et al. (2004) mentioned the presence of *Ichthyocladius* on *H. cf. garmani* while Roque et al. (2004) reported the interaction with *Hypostomus* species. Our work is the first to report *Ichthyocladius* on *H. iheringii* and *H. tietensis*. All hosts had at least one chironomid in the region close to the adipose fin. In the studied streams, the hosts were captured in rocky streambeds with moderate water flow, or with some turbulence. It is likely that the adipose fin, because of its particular position, is less disturbed by water turbulence, providing greater opportunities for adherence by *Ichthyocladius*. Individuals were also found in the eye, sometimes within the orbit (e.g., Figure 2b), possibly because it provides a more stable environment.

We finalize by emphasizing the need for more studies on the taxonomy, biogeography and ecology of *Ichthyocladius* – including field

**Table II. Fish species with records of *Ichthyocladius lilianae* on their body.**

Host (fish)	Hydrographic basins	Brazilian State	Reference
SILURIFORMES			
<b>Loricariidae</b>			
<i>Ancistrus cf. multispinis</i> (Regan, 1912)	Maquiné River	Rio Grande do Sul	Sydow et al. (2008)
<i>Harttia</i> sp.	São Francisco River	Minas Gerais	Mendes et al. (2004)
<i>Hypostomus cf. garmani</i> (Regan, 1904)	São Francisco River	Minas Gerais	Mendes et al. (2004)
<i>Hypostomus iheringii</i> (Regan, 1908)	Guareí River	São Paulo	This work
<i>Hypostomus tietensis</i> (Ihering, 1905)	Guareí River	São Paulo	This work
<i>Pareiorhaphis hypselurus</i> (Pereira & Reis, 2002)	Maquiné River	Rio Grande do Sul	Sydow et al. (2008), Dala-Corte & Melo (2018)
<i>Pareiorhaphis nudula</i> (Reis & Pereira, 1999)	Maquiné River	Rio Grande do Sul	Sydow et al. (2008)
<i>Pareiorhina rudolphi</i> (Miranda Ribeiro, 1911)	Preto River	Rio de Janeiro	Henriques-Oliveira & Nessimian (2009)
<b>Trichomycteridae</b>			
<i>Trichomycterus mirissumba</i> Costa, 1992	Preto River	Rio de Janeiro	Henriques-Oliveira & Nessimian (2009)



surveys and laboratory investigations. These organisms and their ecological interactions are poorly understood, and their possible effects on fish ecology and behavior remain largely unknown.

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## REFERENCES

- AZEVEDO-SANTOS VM, PELICICE FM & HENRY R. 2020. Knowing biodiversity: Fishes from the Guareí River basin, a tributary of the Jurumirim reservoir, Paranapanema River, Brazil. *Biota Neotrop* 20(3): e20201031. <https://doi.org/10.1590/1676-0611-bn-2020-1031>.
- DALA-CORTE RB & MELO AS. 2018. Living on a catfish: nested occupation of ectosymbiont chironomids on host body. *Can J Zool* 96(7): 692-699. <https://doi.org/10.1139/cjz-2017-0141>.
- EIRAS JC, TAKEMOTO RM, PAVANELLI GC & LUQUE JL. 2012. Checklist of Protozoan parasites of fishes from Brazil. *Zootaxa* 3221: 1-25. <http://dx.doi.org/10.11646/zootaxa.3221.1.1>.
- FITTKAU EJ. 1974. *Ichthyocladius* n. gen., eine neotropische Gattung der Orthoclaadiinae (Chironomidae, Diptera) deren Larven epizoisch auf Welsen (Astroblepidae und Loricariidae) leben. *Nordisk Hygienisk Tidskrift Supplementum* 95: 91-106.
- FRICKE R, ESCHMEYER WN & FONG JD 2019b. Species by Family/Subfamily. (<http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp>). Electronic version accessed 08/01/2019 [Recalculated with each new version; based on current literature, this provides all available species names, valid species, and species described in the last 10 years by family/subfamily.].
- FRICKE R, ESCHMEYER WN & VAN DER LAAN R. 2019a. Catalog of Fishes: Genera, Species, References. (<http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>). Electronic version accessed 08/01/2019.
- HENRIQUES-OLIVEIRA AL & NESSIMIAN JL. 2009. Phoresy and commensalism of Chironomidae larvae (Insecta: Diptera) in the state of Rio de Janeiro, Brazil. *Lundiana* 10(1): 11-18.
- MARTINS ML, MARCHIORI N, ROUMBEDAKIS K & LAMI F. 2012. *Trichodina nobilis* Chen, 1963 and *Trichodina reticulata* Hirschmann et Partsch, 1955 from ornamental freshwater fishes in Brazil. *Braz J Biol* 72: 281-286. <http://dx.doi.org/10.1590/S1519-69842012000200008>.
- MENDES HF, ANDERSEN T & SÆTHER OA. 2004. New species of *Ichthyocladius* Fittkau, a member of the *Corynoneura*-Group (Diptera: Chironomidae: Orthoclaadiinae), with a review of the genus. *Stud Neotrop Fauna E* 39: 15-35. <https://doi.org/10.1080/01650520412331270936>.
- NEVES LR & TAVARES-DIAS M. 2019. Low levels of crustacean parasite infestation in fish species from the Matapi River in the state of Amapá, Brazil. *Rev Bras Parasitol Vet* 28: 493-498.
- RANZANI-PAIVA MJT & SILVA-SOUZA AT. 2004. Co-infestation of gills by different parasite groups in the mullet, *Mugil platanus* Günther, 1880 (Osteichthyes, Mugilidae): effects on relative condition factor. *Braz J Biol* 64: 677-682. <http://dx.doi.org/10.1590/S1519-69842004000400016>.
- ROQUE FO, TRIVINHO-STRIXINO S, JANCOS M & FRAGOSO EN. 2004. Records of Chironomidae larvae living on other aquatic animals in Brazil. *Biota Neotrop* 2: 1-9. <http://dx.doi.org/10.1590/S1676-06032004000200018>.
- SYDOW VG, VILELLA FS, HARTZ SM & RODRIGUES GG. 2008. *Ichthyocladius* (Diptera, Chironomidae) on loricariid fishes in Atlantic Forest streams: influence of host size and corporal region on larval attachment. *Acta Limnol Bras* 20: 333-337.
- TOKESHI M. 1993. On the evolution of commensalism in the Chironomidae. *Freshw Biol* 29(3): 481-489.
- ZUANON J & SAZIMA I. 2004. Vampire catfishes seek the aorta not the jugular: candirus of the genus *Vandellia* (Trichomycteridae) feed on major gill arteries of host fishes. *Aqua* 8: 31-36.
- ZUANON J & SAZIMA I. 2005. Free meals on long-distance cruisers: the vampire fish rides giant catfishes in the Amazon. *Biota Neotrop* 5: 109-114.

## SUPPLEMENTARY MATERIAL

### Table S1. Classification of chironomids and armored catfishes (*sensu* Fricke et al. 2019a, b) from the Guareí River Basin, São Paulo, Brazil.

#### How to cite

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### Author contributions

VMAS collected and identified fish species, conceptualized the manuscript, wrote the first draft, and revised the new versions. EMS identified insect species and collaborated with ideas and writing. FMP collaborated with ideas and writing. RH collaborated with ideas and writing.

