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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

SPECIES OF MONOGENOIDEA FROM CICHLIDS WITH COMMERCIAL IMPORTANCE IN THE PERUVIAN AMAZON

ESPECIES DE MONOGENOIDEA DE CÍCLIDOS CON IMPORTANCIA COMERCIAL EN LA AMAZONIA PERUANA

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ABSTRACT

In the Peruvian Amazon, species of the Cichlidae constitute a valuable resource for fisheries and aquaculture activities. Due to the importance of cichlids in this region and the constant interest in conducting studies focused on the biodiversity of monogenoids, the present study aimed to present a checklist of monogenoids from the gills of cichlids with importance in aquaculture in the Peruvian Amazon. Thirteen species of cichlids were analyzed from November 2020 to May 2023 from different water bodies in the Peruvian Amazon. There were identified five species of *Gussevia* Kohn & Paperna, 1964*;* eight morphospecies of *Gussevia* (*Gussevia* sp. 1 to sp. 8); four species of *Sciadicleithrum* Kritsky, Thatcher & Boeger, 1989; eight morphospecies of *Sciadicleithrum*; one species of *Biotodomella* Morey, Arimuya & Boeger, 2019 and one species of *Trinidactylus* Hanek, Molnár & Fernando, 1974. Taxonomic studies should continue to describe the 16 morpho species recorded in this investigation, contributing to the knowledge of the biodiversity of monogenoids in the Peruvian Amazon.

Keywords: Cichlidae – ectoparasites – gills – monogenoids – pisciculture

RESUMEN

En la Amazonía peruana, las especies de Cichlidae constituyen un valioso recurso para las actividades pesqueras y acuícolas. Debido a la importancia de los cíclidos en esta región y al constante interés en realizar estudios enfocados en la biodiversidad de monogénoideos, el presente estudio tuvo como objetivo presentar una lista de verificación de monogénoideos de las branquias de cíclidos con importancia en la acuicultura de la Amazonía peruana. Se analizaron 13 especies de cíclidos desde noviembre del 2020 hasta mayo del 2023 de diferentes cuerpos de agua de la Amazonía peruana. Se identificaron cinco especies de *Gussevia* Kohn & Paperna, 1964; ocho morfoespecies de *Gussevia* (*Gussevia* sp. 1 a sp. 8); cuatro especies de *Sciadicleithrum* Kritsky, Thatcher & Boeger, 1989; ocho morfoespecies de *Sciadicleithrum*; una especie de *Biotodomella* Morey, Arimuya & Boeger, 2019 y una especie de *Trinidactylus* Hanek, Molnár & Fernando, 1974. Los estudios taxonómicos deben continuar para describir las 16 morfoespecies registradas en esta investigación, contribuyendo al conocimiento de la biodiversidad de monogénidos en la Amazonía peruana.

Palabras claves: branquias – Cichlidae – ectoparásitos –monogenoideos –piscicultura

INTRODUCTION

In the last five years in the Peruvian Amazon, various studies have been carried out in order to identify monogenoids from fish gills; thus; fish species have been captured from natural environments such as rivers, lakes, streams, ponds, as well as samples of fish from pisciculture and city markets (Acosta *et al.*, 2019; Mendoza-Palmero *et al.,* 2019; Morey *et al.*, 2019a; Morey *et al.*, 2019b; Morey *et al.*, 2020a; Morey *et al.*, 2020b; Mendoza-Palmero *et al.*, 2020; Morey, 2021; Morey *et al.*, 2021a; Morey *et al.,* 2021b; Quispe *et al.*, 2021; Feronato *et al.*, 2022; Chota *et al.,* 2022; Morey *et al.*, 2023; Olortegui-Zegarra *et al.,* 2023).

Fish are an important resource for Amazonian inhabitants. These are used as a source of animal protein and also as resources to generate economic income through their sale, both in the fish market for human consumption and in the ornamental market (Garcia *et al.,* 2021). The latter generates millions of dollars annually in fish export activities from the Peruvian Amazon to different countries in North America, Europe and Asia (Garcia *et al.,* 2021).

According to Garcia *et al.* (2018), 78 species of fish are sold in city markets as meat for human consumption. Of the total number of registered species, eight correspond to cichlids. In addition to fish farming for the production of animal protein, Garcia *et al.* (2021) mention the ornamental activity, with 212 fish species reported; among which, 54 correspond to ornamental cichlids (Garcia *et al.,* 2021).

Cichlids are fish of colorful colors, different sizes and shapes, being highly appreciated by aquarists and hobbyists throughout the world. The capture, breeding, management and commercialization of these fish generates an interesting flow in the Peruvian Amazon that links the fisherman with the collectors, exporters and importers (Garcia *et al*., 2021). This flow constitutes for many Amazon families, a form of economic income for their livelihood, so it is important to know the parasites present in these fish, creating information baselines that allow not only to know the existing biodiversity, to identify and describe new species of parasites, but also, allow further studies of ecology, control and prevention of parasitic diseases, among others (Garcia *et al*., 2021)..

Among the main risks identified in the aquaculture activity in the Peruvian Amazon, health problems caused by infestations of monogenoids (Monogenoidea) stand out (Morey, 2019). This group of parasites can cause various damage to the gills, leading the fish to die from suffocation. Thus, due to the importance of cichlids in the Peruvian Amazon and the constant interest in conduct studies focused on the biodiversity of monogenoids, the present study aimed to present a checklist of monogenoids from the gills of cichlids with importance in aquaculture in Loreto, Peru.

MATERIAL AND METHODS

Fish host species were obtained from November 2020 to May 2023 from different water bodies in the Peruvian Amazon. Excursions were made as part of researches focused on the registration and identification of monogenoids from the gills of cichlids with commercial importance in the Peruvian Amazonia. Some of the collected species are used in aquaculture for human consumption and others are important as ornamental fish, being exported from Iquitos-Peru to different countries around the world.

Thirteen species were collected: the bigeye cichlid *Acaronia nassa* (Heckel, 1840), the saddle cichlid *Aequidens tetramerus* (Heckel 1840), the greenstreaked eartheater *Biotodoma cupido* (Heckel 1840), the bujurquina *Bujurquina peregrinabunda* Kullander 1986, the peacock bass *Cichla monoculus* Spix & Agassiz 1831, the amazon cichlid *Cichlasoma amazonarum* Kullander 1983, the red-finned Pike *Crenicichla johanna* Heckel 1840, the severum *Heros efasciatus* Heckel 1840, the emerald cichlid *Hypselecara temporalis* (Günther 1862), the flag cichlid *Mesonauta mirificus* Kullander & Silfvergrip 1991, the angel fish *Pterophyllum scalare* (Schultze 1823), the demon eartheater *Satanoperca jurupari* (Heckel 1840) and the discus *Symphysodon tarzoo* Lyons 1959. Morphological characters were used for the taxonomical identification of fish-hosts, according to Garcia *et al.* (2018; 2021).

Fish were kept alive until their parasitological examination. In the laboratory, gill archers were removed and placed in vials containing hot water (65 °C). Each vial was shaken vigorously and 96% ethanol was added. The content of each vial was examined using a dissecting microscope and helminths were removed from the gills or sediment using dissection needles. Some specimens were mounted on slides using Hoyer's medium to determine the haptoral structures (bars, anchors and hooks) and male copulatory organ (MCO) and the accessory piece. Others specimens were stained with Gomori's trichrome (Humason, 1979; Boeger & Vianna, 2006) and mounted in Canada balsam to determine internal organs. Some specimens were preserved in ethanol 96%for future DNA analyses. All procedures were conducted in the "Laboratorio de Parasitología y Sanidad Acuícola" of the "Instituto de Investigaciones de la Amazonía Peruana" (IIAP) in Iquitos, Peru. Pictures of the parasites were taken by using a digital camera LEICA ICC50 W attached to a microscope LEICA DM750. Data were processed by using a LEICA Application Suite (LAS) EZ.

Vouchers of parasites were deposited in the collection of parasites belonging to "Laboratorio de Parasitología y Sanidad Acuícola" from "Instituto de Investigaciones de la Amazonía Peruana (IIAP), Iquitos, Loreto-Peru.

Ethic aspects: Statement on ethical approval from an ethics committee and license for working with fish species were followed according to the following resolutions: Resolution No132-2014-GRL-DIREPRO; Resolution Nº21-2016 GRL-DIREPRO; and PTH-068-16-PECSANIPES.

RESULTS

List of Monogenoidea by host belonging to CICHLIIFORMES: CICHLIDAE

Host: ***Acaronia nassa*** (Heckel, 1840)

Gussevia sp. 1 (Fig. 1)

Gussevia sp. 2 (Fig. 2)

Gussevia sp. 3 (Fig. 3)

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

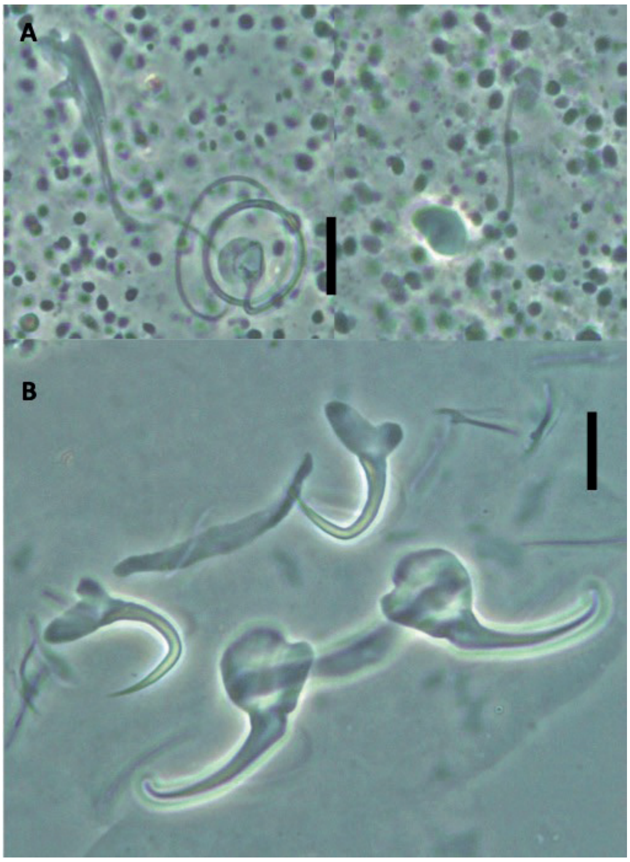

Figure 1. *Gussevia* sp. 1 collected from *Acaronia nassa.* Copulatory complex (A), structures of haptor (B). Scale bar: 40 µm.

Figure 2. *Gussevia* sp. 2 collected from *Acaronia nassa.* Ventral view whole body (A), Copulatory complex (B), Vagina (C), Egg (D), Structures of haptor (E). Scale bar: A = 100 µm. B-E = 40 µm.

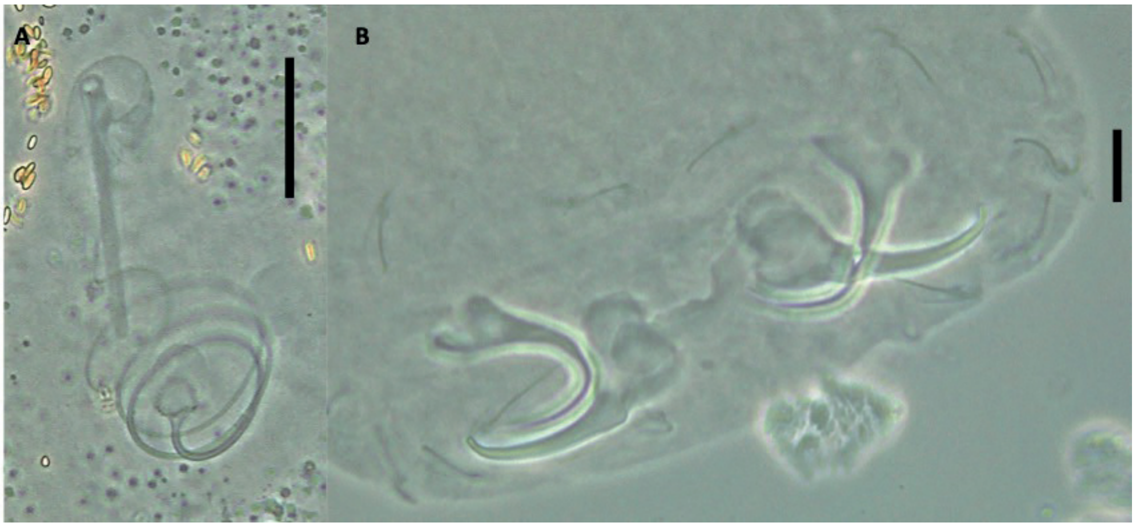

Figure 3. *Gussevia* sp. 3 collected from *Acaronia nassa.* Copulatory complex (A), Structures of haptor (B). Scale bar: A = 20 µm, B = 10 µm.

Host: ***Aequidens tetramerus*** (Heckel, 1840)

Gussevia cichlassomatis (Molnár, Hanek & Fernando, 1974) (Fig. 4)

Gussevia sp. 4 (Fig. 5)

Gussevia sp. 5 (Fig. 6)

Sciadicleithrum sp. 1 (Fig. 7)

Locality: Lindero stream, Nanay River (3°55'16.31"S, 73°22'14.16"W)

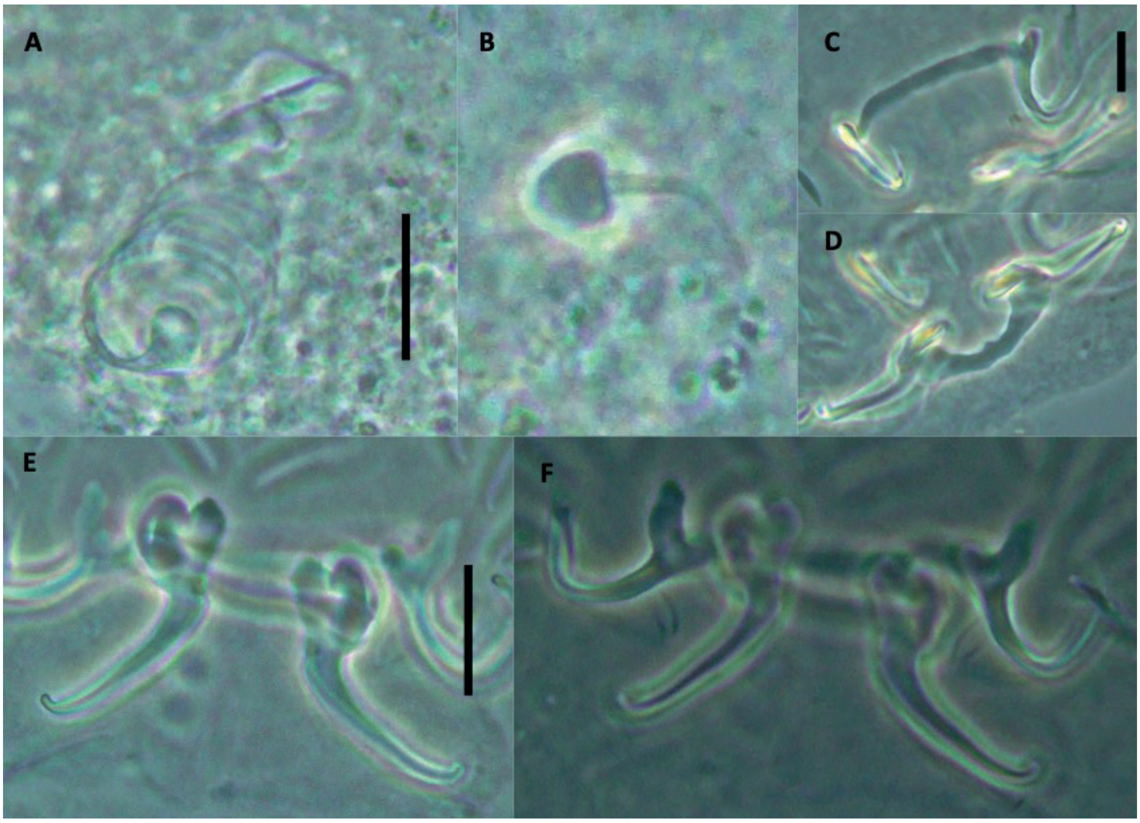

Figure 4. *Gussevia cichlassomatis* collected from *Aequidens tetramerus.* Copulatory complex (A), Vagina (B), Ventral bar and ventral anchors (C), Dorsal bar (D), Dorsal anchors (E), Haptor (F). Scale bar: A,B = 20 µm, C = 10 µm, E, F = 20 µm.

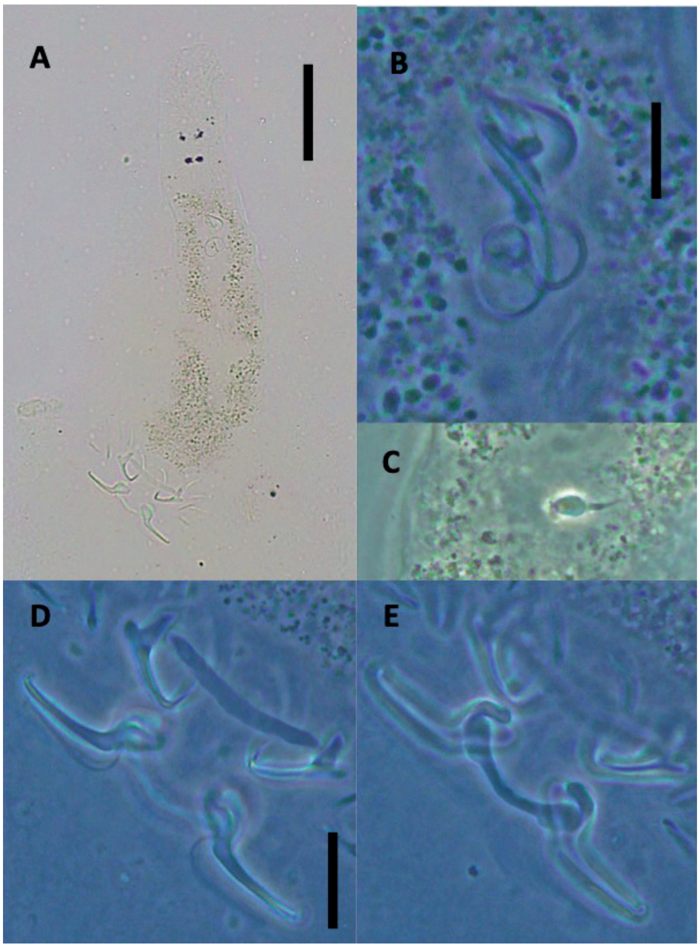

Figure 5. *Gussevia* sp. 4 collected from *Aequidens tetramerus.* Ventral view of whole body (A), Copulatory complex (B), Vagina (C), Haptor ventral view (D), Haptor dorsal view (E). Scale bar: A= 50 µm, B, C = 20 µm, D, E = 20 µm.

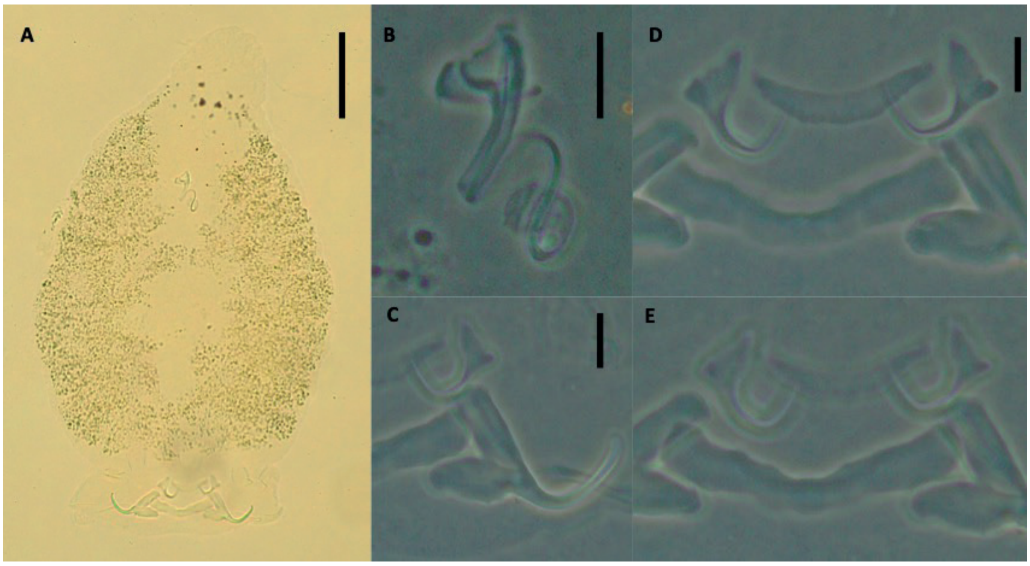

Figure 6. *Gussevia* sp. 5 collected from *Aequidens tetramerus.* Ventral view of whole body (A), Copulatory complex (B), Ventral and dorsal anchors (C), Ventral bar and ventral anchors (D), Dorsal bar and dorsal anchors (E). Scale bar: A= 50 µm, B = 20 µm, C = 20 µm, D, E = 10 µm.

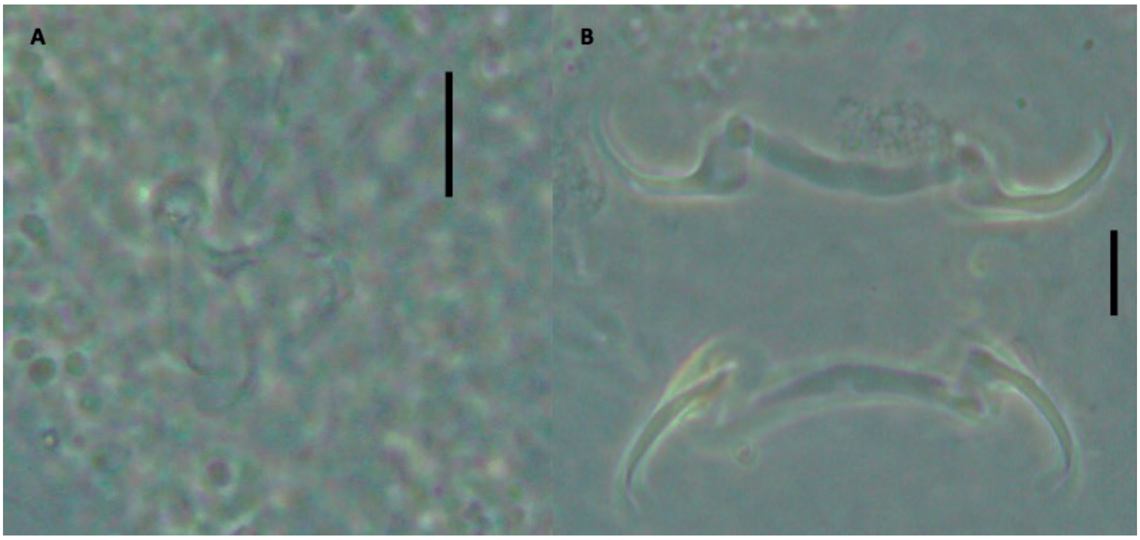

Figure 7. *Sciadicleithrum* sp. 1. Copulatory complex (A),

Host: ***Biotodoma cupido*** (Heckel, 1840)

Biotodomella mirospinata Morey, Arimuya & Boeger, 2019 (Fig. 8)

Sciadicleithrum sp. 2 (Fig. 9)

Locality: Shiruycaño pond, Nanay River (3°45'2.10"S, 73°17'16.28"W)

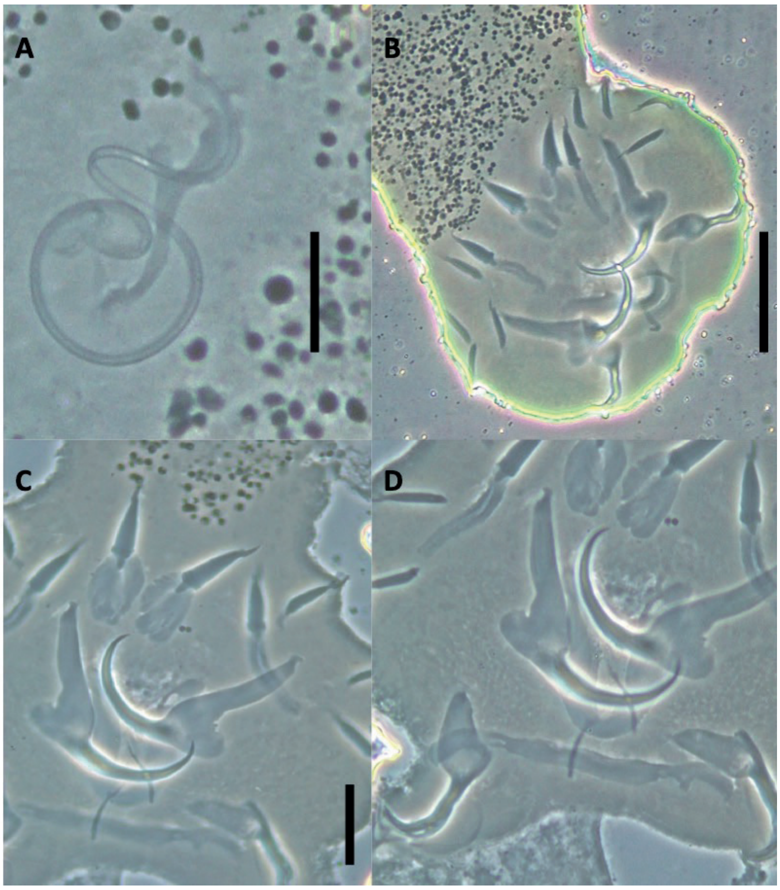

Figure 8. *Biotodomella mirospinata* collected from *Biotodoma cupido.* Copulatory complex (A), Haptor (B), Ventral anchors and ventral hooks (C), Ventral anchors, dorsal bar and dorsal anchors (D). Scale bar: A = 30 µm, B = 40 µm, C, D = 20 µm.

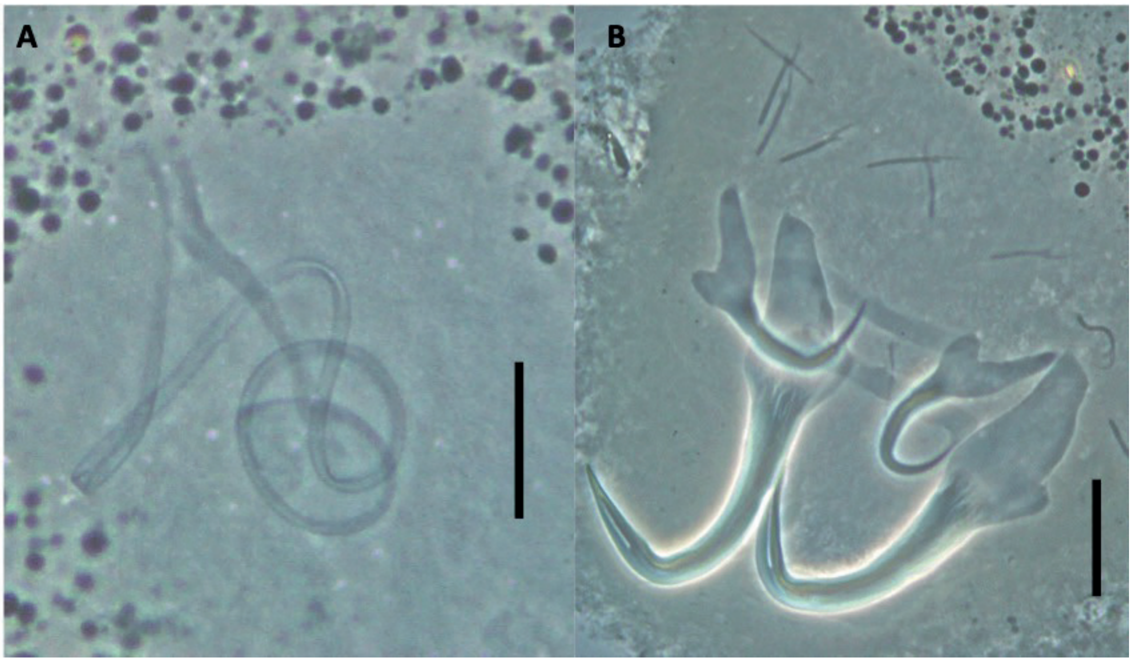

Figure 9. *Sciadicleithrum* sp. 2 collected from *Biotodoma cupido.* Copulatory complex (A), Haptor (B). Scale bar: A = 20 µm, B = 20 µm.

Host: ***Bujurquina peregrinabunda*** Kullander, 1896

Sciadicleithrum sp. 3 (Fig. 10)

Sciadicleithrum sp. 4 (Fig. 11)

Locality: Tanshi Stream (3°54'33.85"S, 73°24'37.65"W).

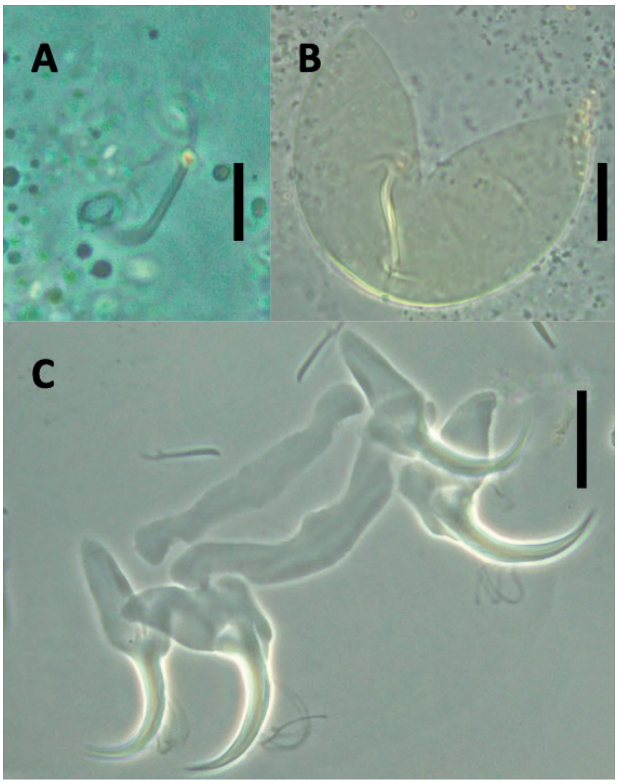

Figure 10. *Sciadicleithrum* sp. 3 collected from *Bujurquina peregrinabunda.* Copulatory complex (A), Egg (B), Haptor (C). Scale bar: A = 20 µm, B = 40 µm, C = 40 µm.

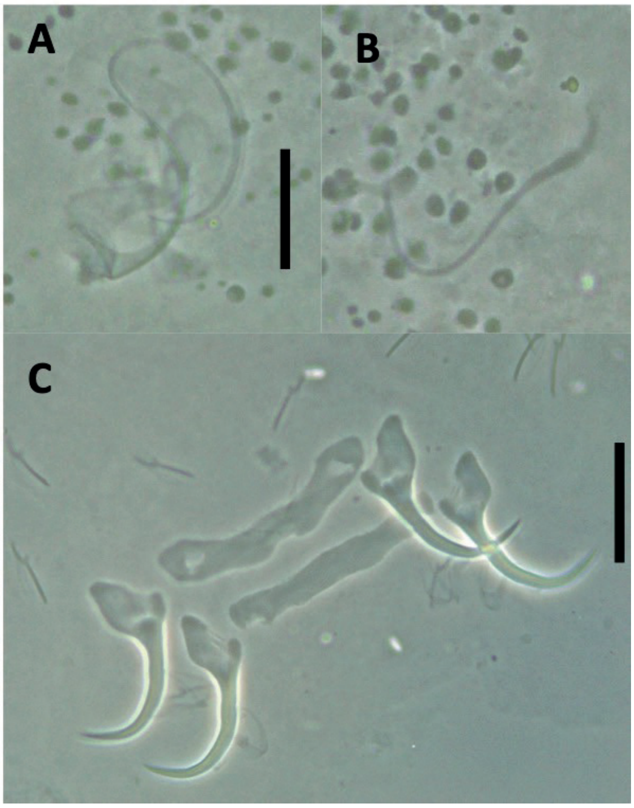

Figure 11. *Sciadicleithrum* sp. 4 collected from *Bujurquina peregrinabunda.* Copulatory complex (A), Vagina (B), Haptor (C). Scale bar: A, B = 30 µm, C = 40 µm.

Host: *Cichla monoculus* Spix & Agassiz, 1831

Sciadicleithrum umbilicum Kritsky, Thatcher & Boeger, 1989 (Fig. 12)

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W).

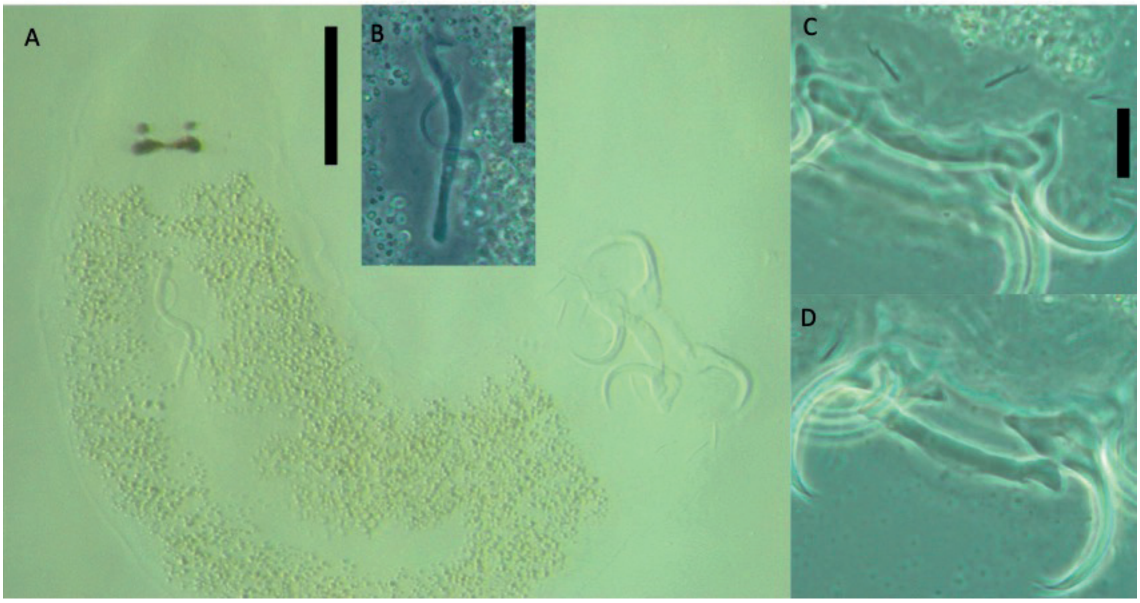

Figure 12. *Sciadicleithrum umbilicum* from *Cichla monoculus.* Ventral view of whole body (A), Copulatory complex (B), Ventral bar and anchors (C), Dorsal bar and anchors (D). Scale bar: A = 50 µm, B = 50 µm, C, D = 20 µm.

Host: *Cichlassoma amazonarum* Kullander, 1983

Gussevia cichlassomatis (Molnár, Hanek & Fernando, 1974) (Fig. 13)

Gussevia alii (Fig. 14)

Gussevia sp. 6 (Fig. 15)

Gussevia sp. 7 (Fig. 16)

Sciadicleithrum variabilum (Mizelle & Kritsky, 1969) (Fig. 17)

Trinidactylus cichlasomatis Hanek, Molnár & Fernando, 1974 (Fig. 18)

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

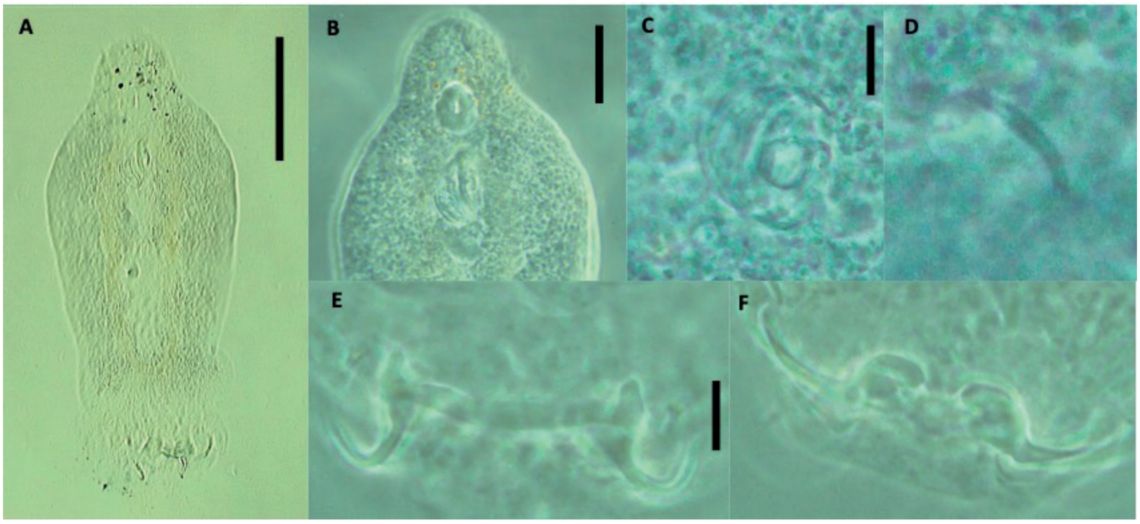

Figure 13. *Gussevia cichlassomatis* from *Cichlasoma amazonarum.* Ventral view of whole body (A), Anterior part of body showing the pharynx and copulatory complex (B), Copulatory complex (C), Vagina (D), Ventral bar and anchors (E), Dorsal bar and anchors (F). Scale bar: A = 100 µm, B = 40 µm, C, D = 10 µm, E, F= 20 µm.

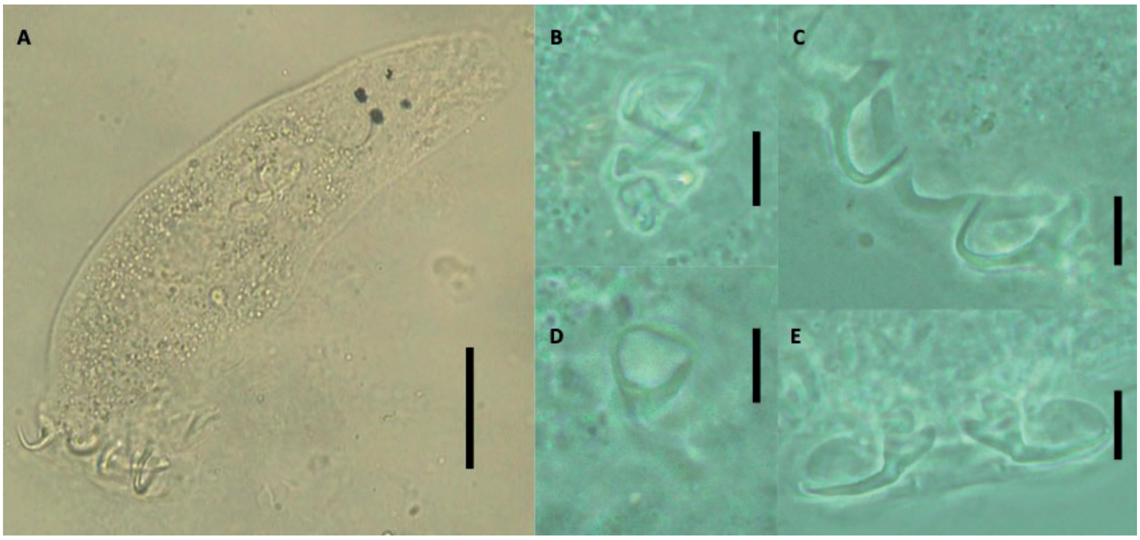

Figure 14. *Gussevia alii* from *Cichlasoma amazonarum.* Ventral view of whole body (A), Copulatory complex (B), Ventral bar and anchors (C), Vagina (D), Dorsal bar and anchors (E). Scale bar: A = 100 µm, B = 20 µm, C-E = 20 µm.

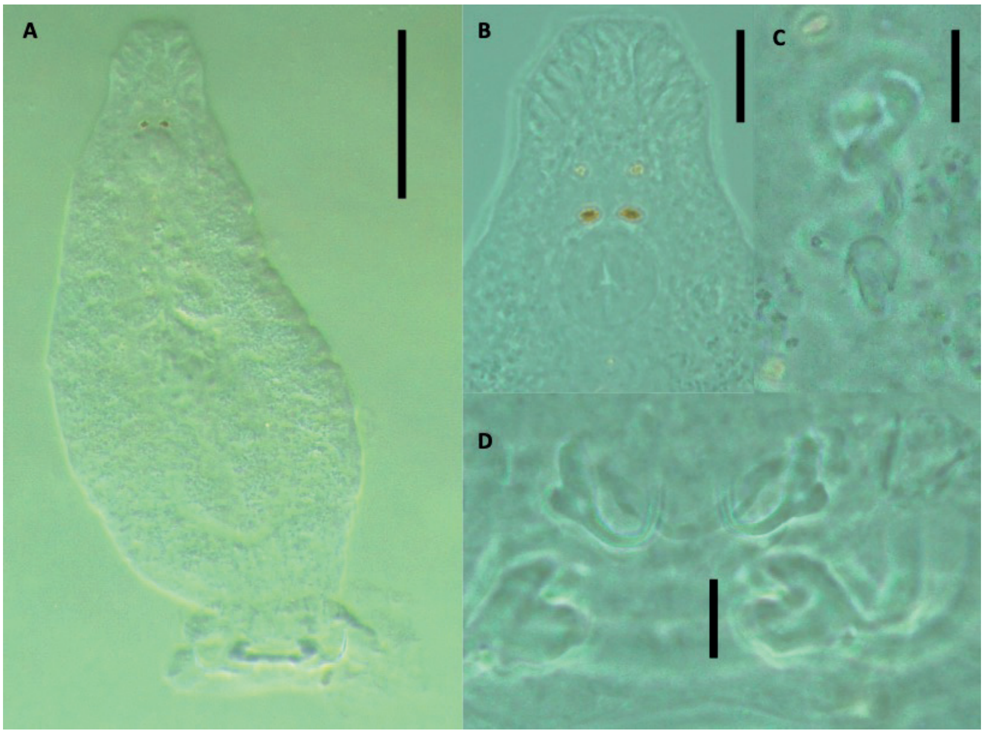

Figure 15. *Gussevia* sp. 6 from *Cichlasoma amazonarum.* Ventral view of whole body (A), Anterior part of body showing the eyes and pharynx (B), Copulatory complex (C), Haptor (D). Scale bar: A = 200 µm, B-D = 20 µm.

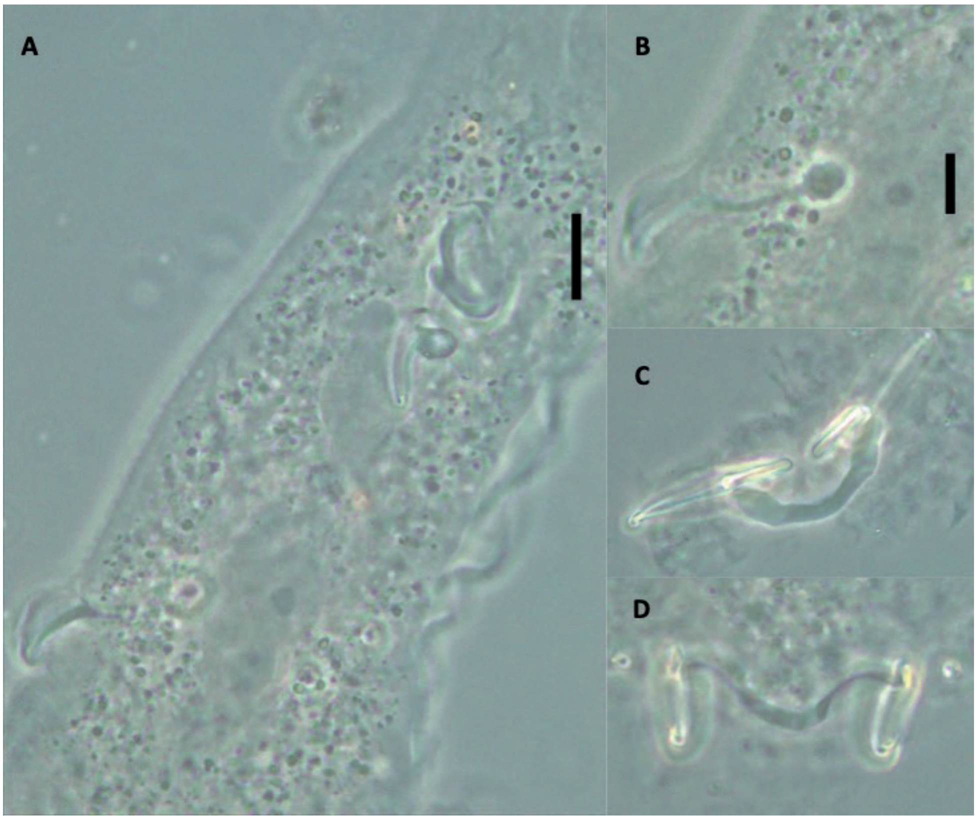

Figure 16. *Gussevia* sp. 7 from *Cichlasoma amazonarum.* Anterior part of body showing the copulatory complex and vagina (A), Vagina (B), Dorsal bar and anchors (C), Ventral bar and anchors (D). Scale bar: A = 20 µm, B-D = 15 µm.

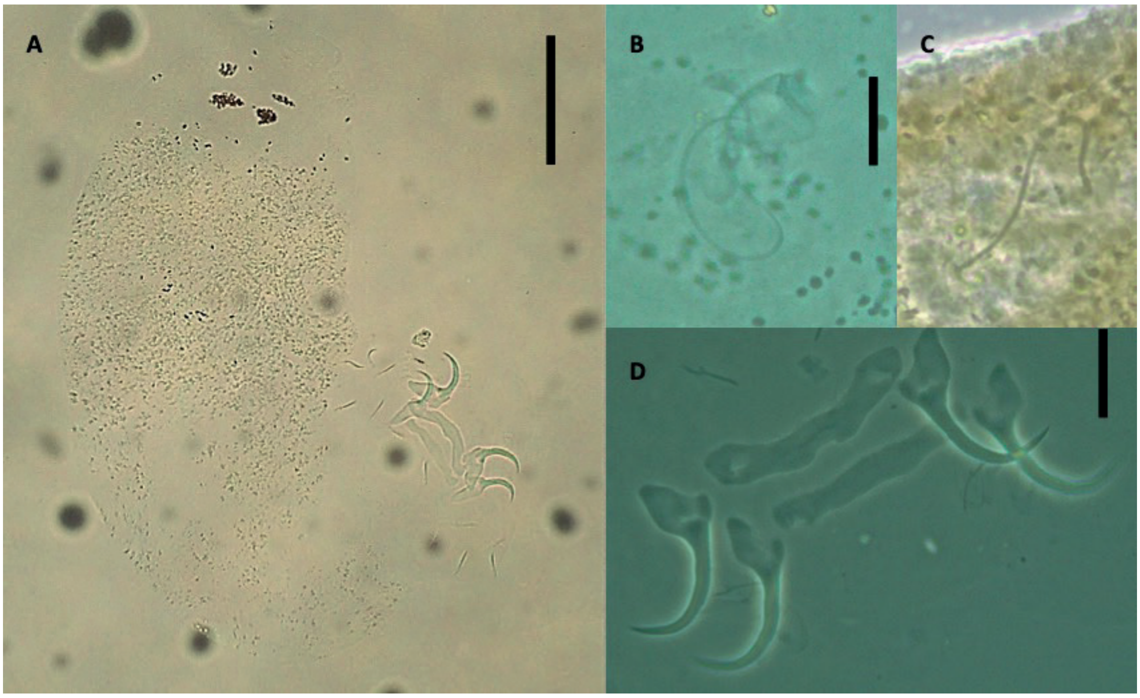

Figure 17. *Sciadicleithrum variabilum* from *Cichlasoma amazonarum.* Ventral view of whole body (A), Copulatory complex (B), Vagina (C), Haptor (D). Scale bar: A = 100 µm, B, C = 30 µm, D = 20 µm.

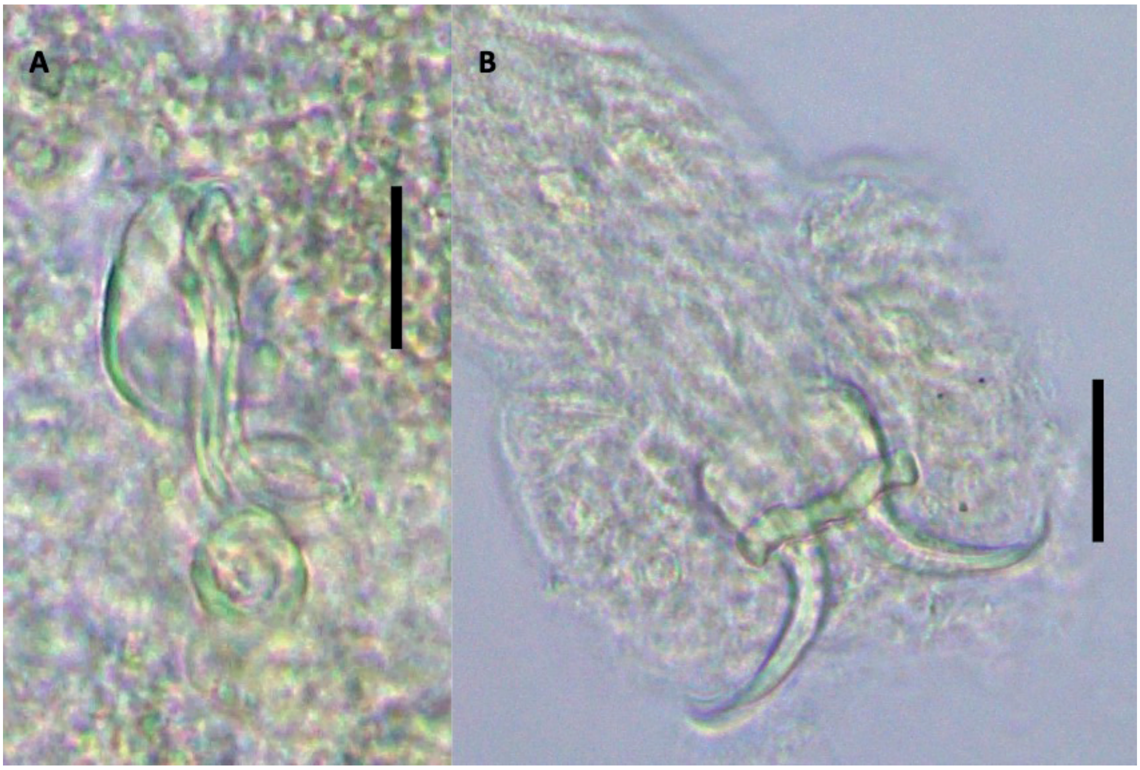

Figure 18. *Trinidactylus cichlassomatis* from *Cichlasoma amazonarum.* Copulatory complex (A), Haptor. Scale bar: A = 30 µm, B = 20 µm.

Host: ***Crenicichla johanna*** Heckel, 1840
Sciadicleithrum sp. 5 (Fig. 19)
Sciadicleithrum sp. 6 (Fig. 20)

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

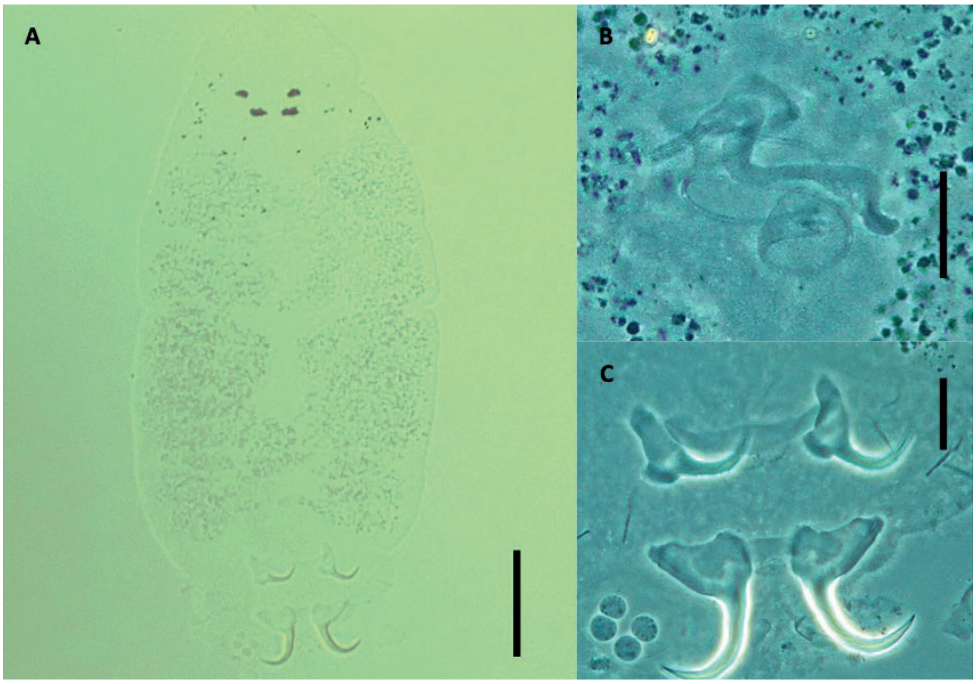

Figure 19. *Sciadicleithrum* sp. 5 from *Crenicichla johanna.* Ventral view of whole body (A), Copulatory complex (B), Haptor (C). Scale bar: A = 100 µm, B = 40 µm, C = 20 µm.

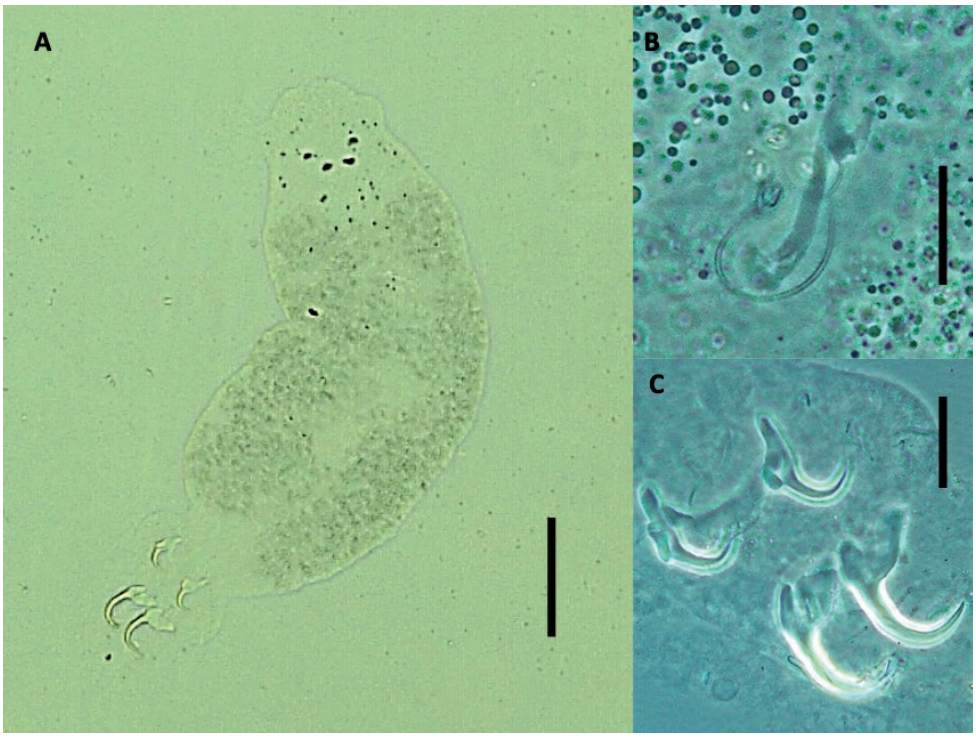

Figure 20. *Sciadicleithrum* sp. 6 from *Crenicichla johanna.* Ventral view of whole body (A), Copulatory complex (B), Haptor (C). Scale bar: A = 100 µm, B = 40 µm, C = 30 µm.

Host: *Heros efasciatus* Heckel, 1840

Gussevia dispar Kritsky, Thatcher & Boeger, 1986 (Fig. 21)

Gussevia disparoides Kritsky, Thatcher & Boeger, 1986 (Fig. 22)

Gussevia sp. 8 (Fig. 23)

Sciadicleithrum variabilum (Mizelle & Kritsky, 1969) (Fig. 24)

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

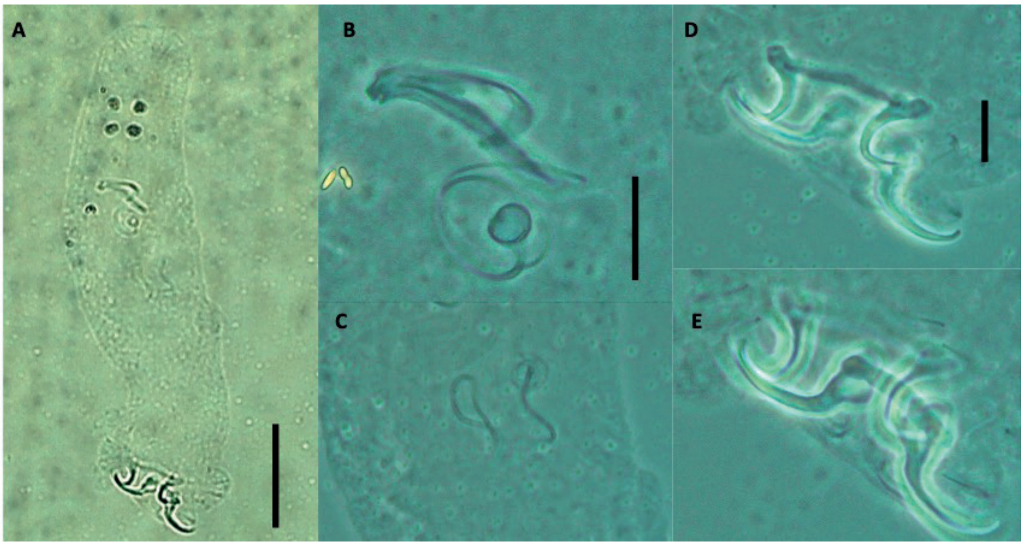

Figure 21. *Gussevia dispar* from *Heros efasciatus.* Ventral view of whole body (A), Copulatory complex (B), Vagina (C), Ventral bar and anchors (D), Dorsal bar and anchors (E). Scale bar: A = 100 µm, B, C = 20 µm, D, E = 40 µm.

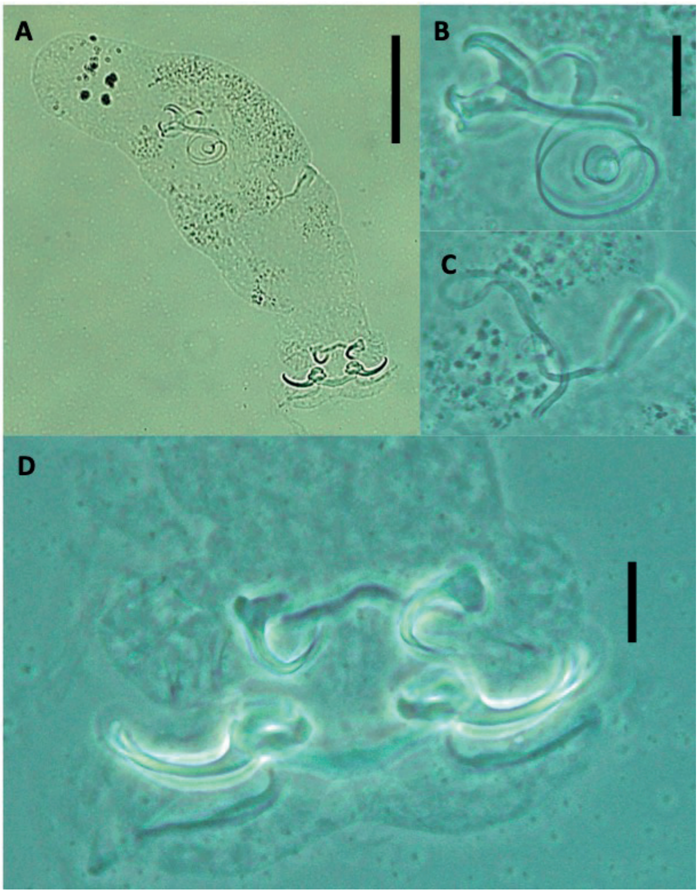

Figure 22. *Gussevia disparoides* from *Heros efasciatus.* Ventral view of whole body (A), Copulatory complex (B), Vagina (C), Haptor (D). Scale bar: A = 200 µm, B, C = 30 µm, D = 20 µm.

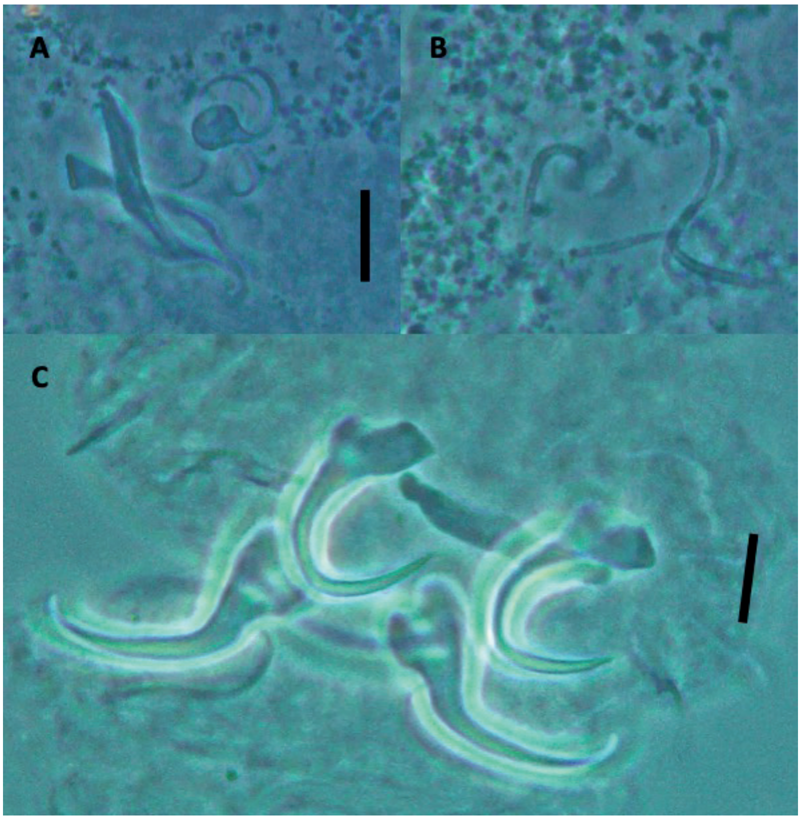

Figure 23. *Gussevia* sp. 8 from *Heros efasciatus.* Copulatory complex (A), Vagina (B), Haptor (C). Scale bar: A, B = 40 µm, C = 20 µm.

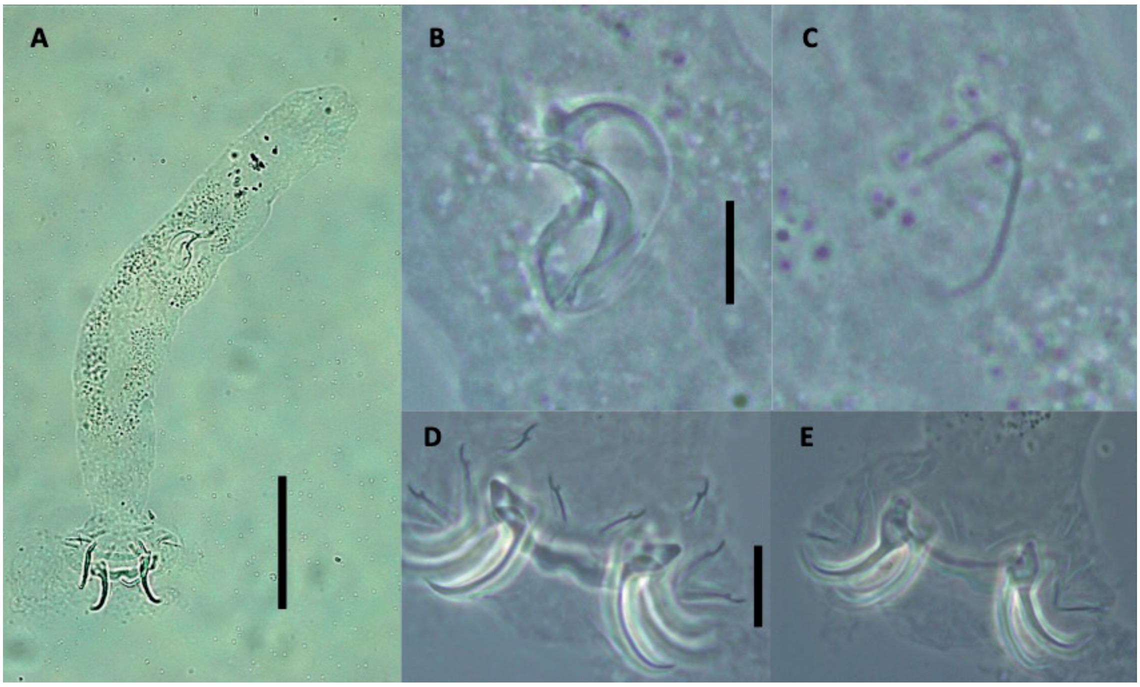

Figure 24. *Sciadicleithrum variabilum* from *Heros efasciatus.* Ventral view of whole body (A), Copulatory complex (B), Vagina (C), Ventral bar and anchors (D), Dorsal bar and anchors (E). Scale bar: A = 200 µm, B, C = 30 µm, D, E = 20 µm.

Host: *Hypselecara temporalis* (Günther, 1862)

Sciadicleithrum sp. 7 (Fig. 25)

Locality: Lindero stream, Nanay River (3°55'16.31"S, 73°22'14.16"W)

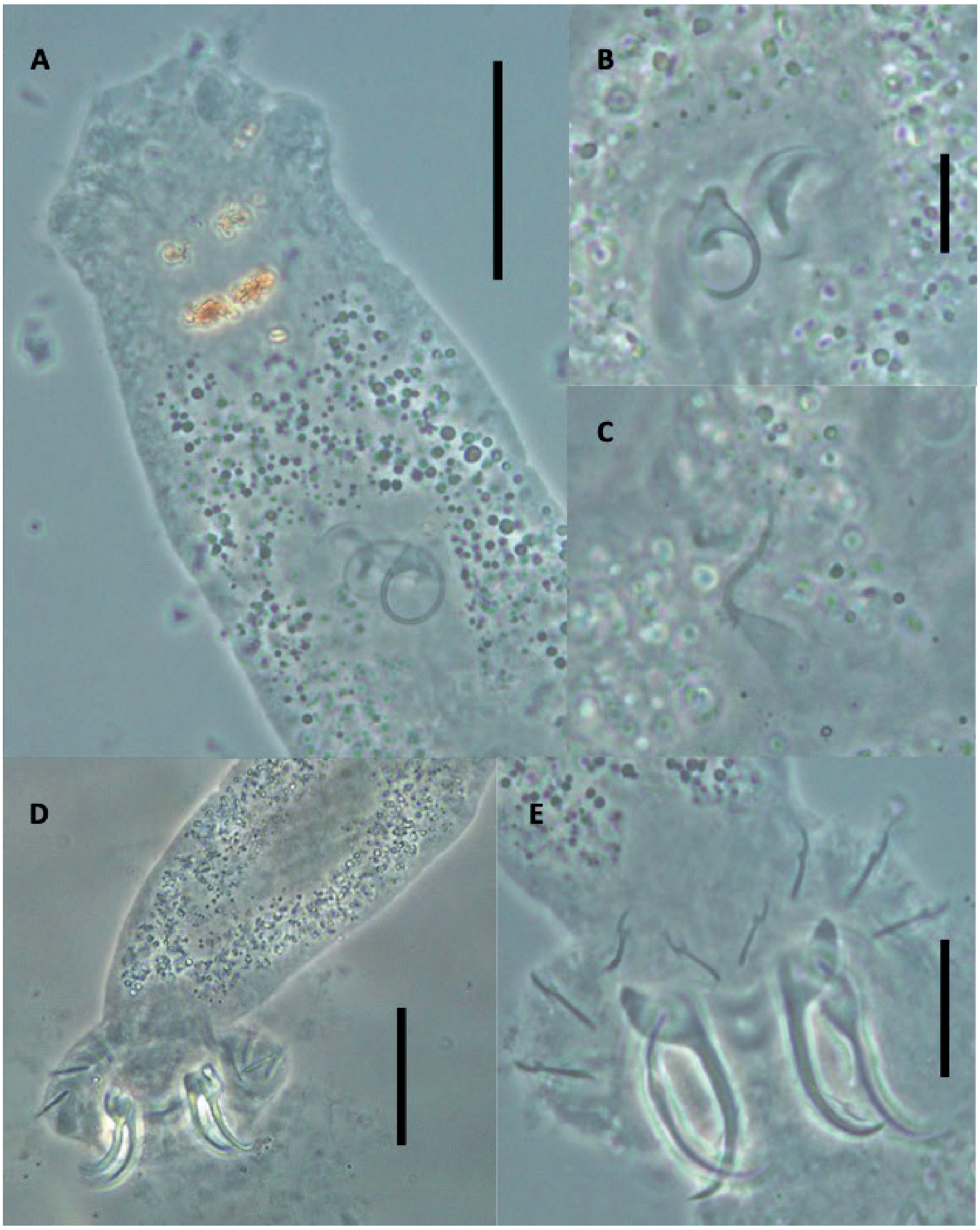

Figure 25. *Sciadicleithrum* sp. 7 from *Hypselecara temporalis.* Anterior part of body (A), Copulatory complex (B), Vagina (C), Haptor (D), Ventral anchors and hooks (E). Scale bar: A = 40 µm, B, C= 20 µm, D = 40 µm, E = 20 µm.

Host: ***Mesonauta mirificus*** Kullander & Silfvergrip, 1991

Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

Sciadicleithrum sp. 8 (Fig. 26)

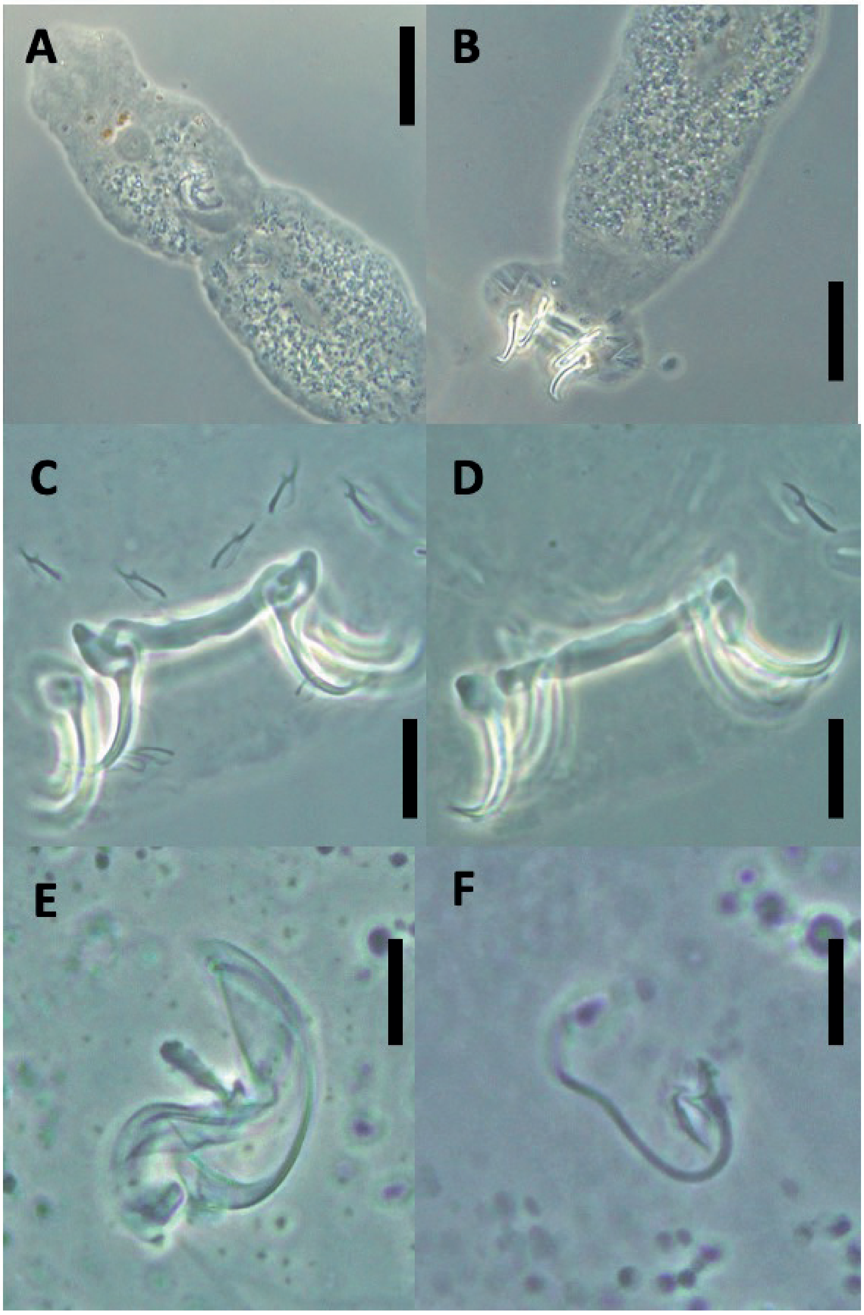

Figure 26. *Sciadicleithrum* sp. 8 from *Mesonauta mirificus*. Anterior part of body (A), Posterior part of body showing the haptor (B), Ventral bar, anchors and hooks (C), Dorsal bar and anchors (D), Copulatory complex (E), Vagina (F). Scale bar: A = 40 µm, B = 40 µm, C, D = 20 µm, E, F = 20 µm.

Host: ***Pterophyllum scalare*** (Schultze, 1823)
Gussevia spiralocirra Kohn & Paperna, 1964 (Fig. 27)
Sciadicleithrum iphthimum Kritsky, Thatcher & Boeger, 1989 (Fig. 28)
Locality: Huachana pond, Nanay River (3°43'43.50"S, 73°16'38.22"W)

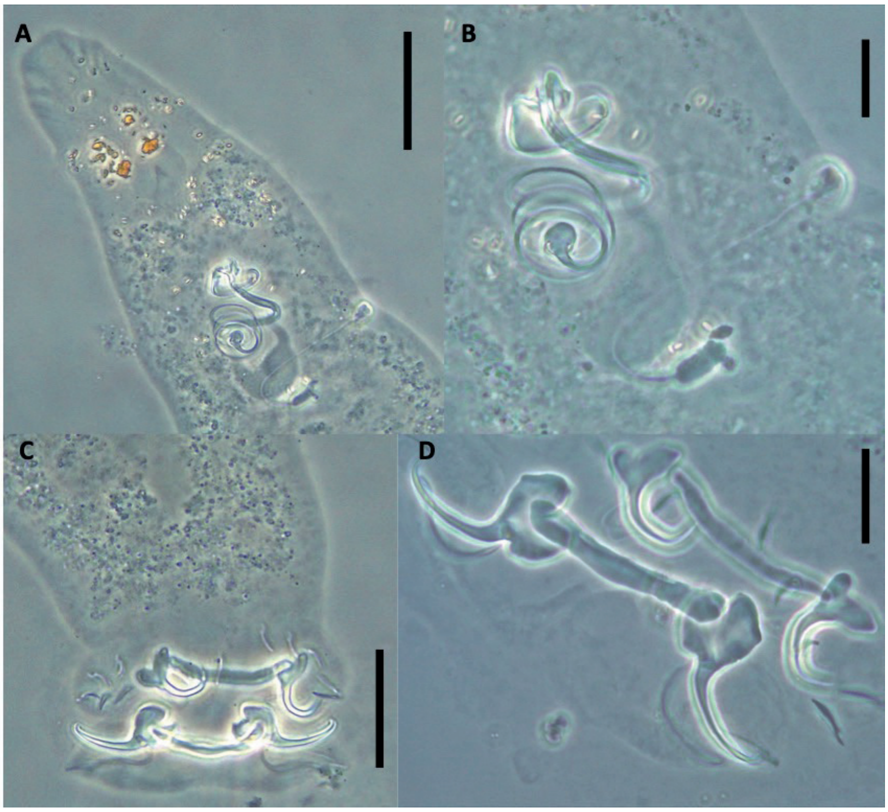

Figure 27. *Gussevia spiralocirra* from *Pterophyllum scalare*. Anterior part of body (A), Copulatory complex and vagina (B), Haptor (C), Structures of haptor: bars, anchors and hooks (D). Scale bar: A = 40 µm, B = 20 µm., C = 50 µm, D = 40 µm.

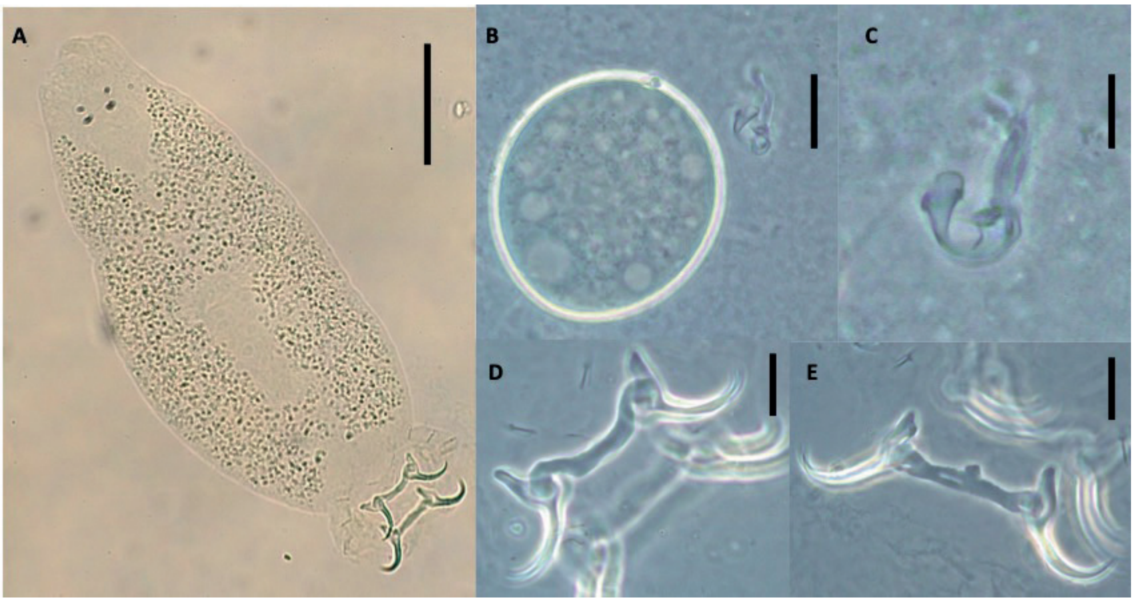

Figure 28. *Sciadicleithrum iphitium* from *Pterophyllum scalare*. Ventral view of whole body (A), Egg (B), Copulatory complex (C), Ventral bar and anchors (D), Dorsal bar and anchors (E). Scale bar: A = 200 µm, B = 40 µm,

Host: ***Satanoperca jurupari*** (Heckel, 1840)

Sciadicleithrum satanopercae Yamada, Takemoto, Bellay & Pavanelli, 2009 (Fig. 29)

Locality: Shiruycaño pond, Nanay River (3°45'2.10"S, 73°17'16.28"W)

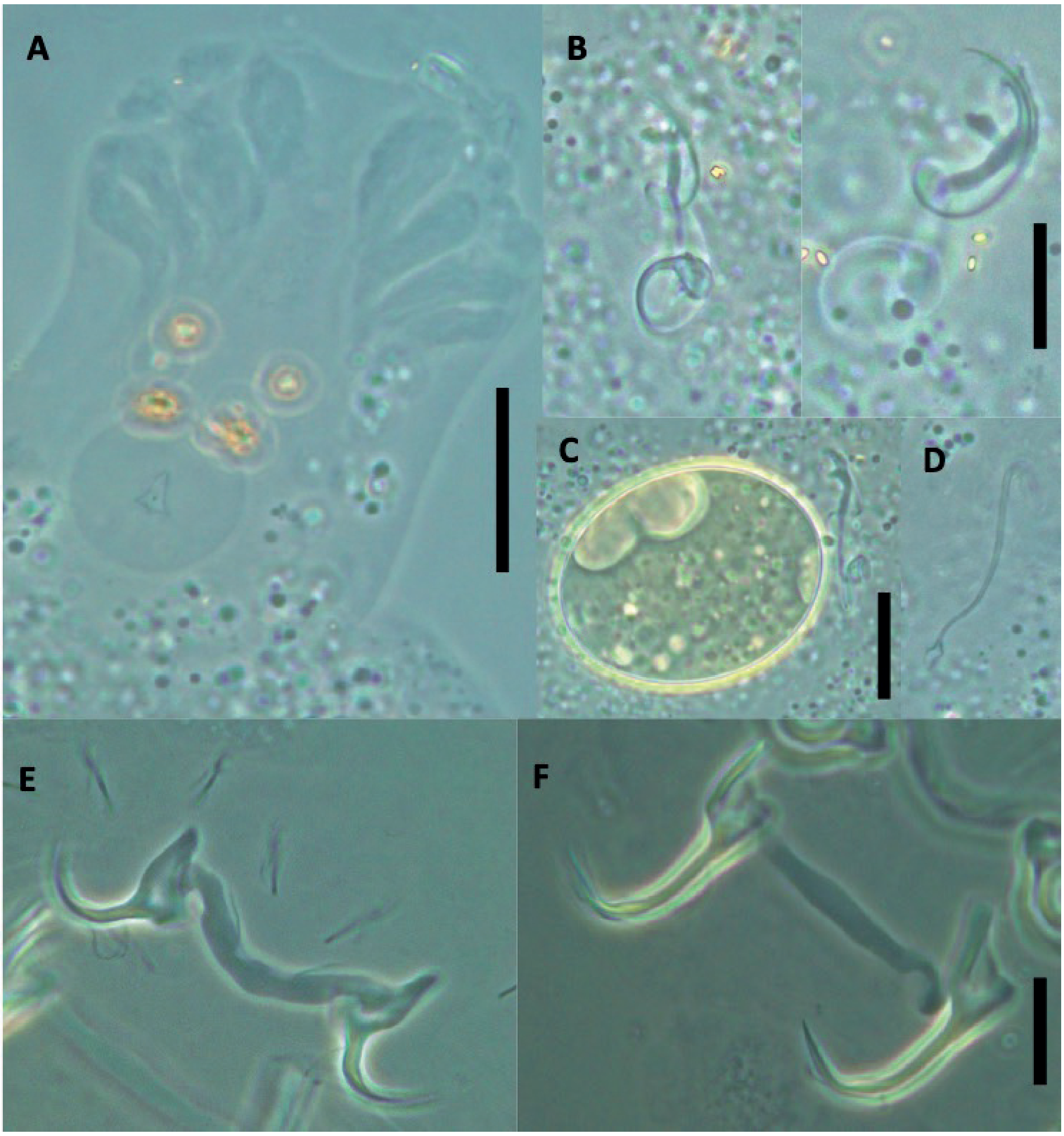

Figure 29. *Sciadicleithrum satanopercae* from *Satanoperca jurupari*. Anterior part of body (A), Copulatory complex (B), Egg (C), Vagina (D), Ventral bar, anchors and hooks (E), Dorsal bar and anchors (E). Scale bar: A, B = 20 µm, C = 10 µm, C-F = 30 µm.

Host: *Symphysodon tarzoo* Lyons, 1959

Sciadicleithrum variabilum (Mizelle & Kritsky, 1969) (Fig. 30)

Locality: Tipishca pond, Nanay River (3°47'16.01"S, 73°21'18.81"W).

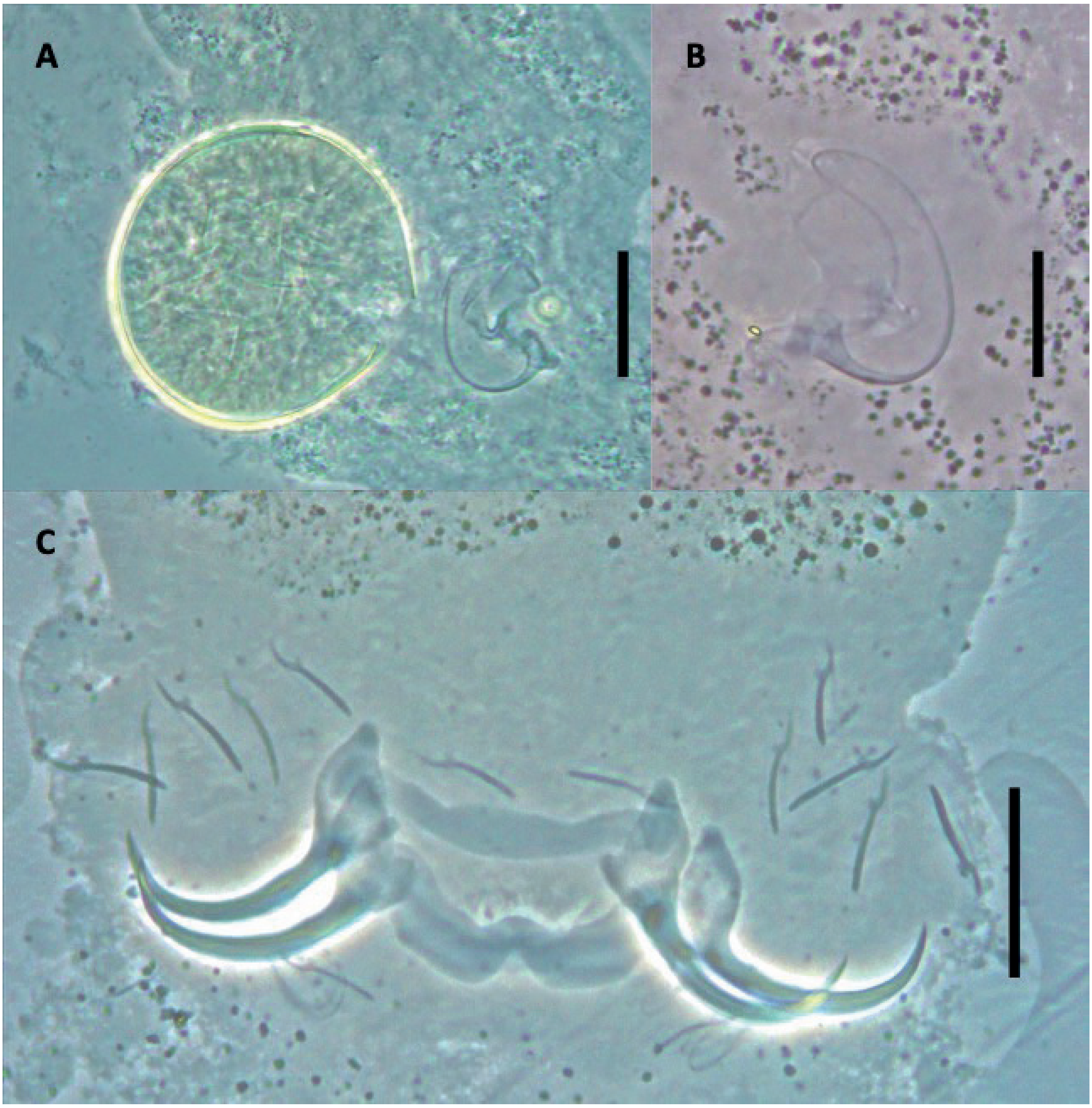

Figure 30. *Sciadicleithrum variabilum* from *Symphysodon tarzoo*. Egg and copulatory complex (A), Copulatory complex (B), Haptor (C). Scale bar: A = 40 µm, B = 30 µm, C = 40 µm.

Pictures of fish-hosts are presented in Fig. 31.

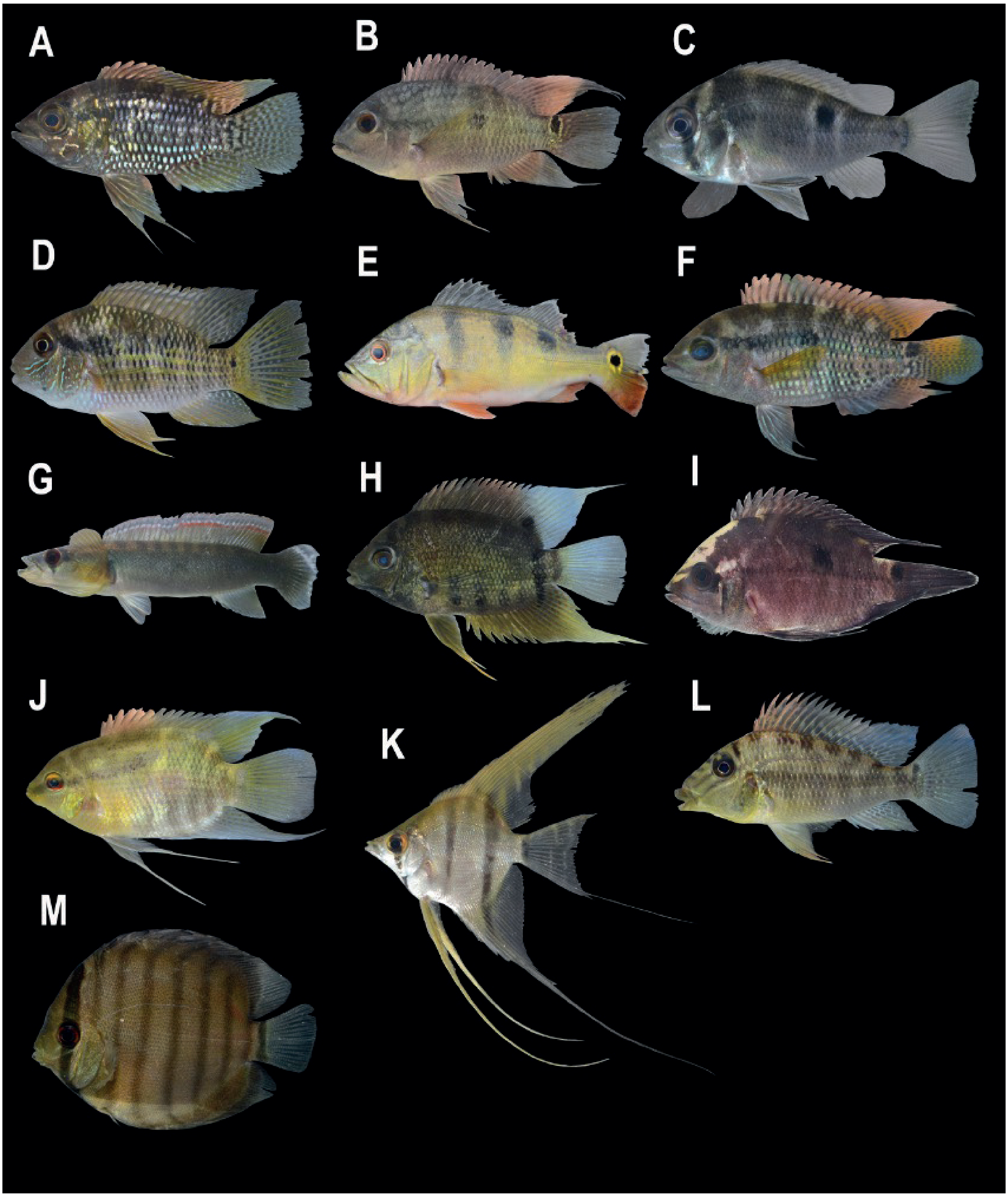

Figure 31. Cichlids hosts of species of Monogenoidea. *Acaronia nassa* (A), *Aequidens tetramerus* (B), *Biotodoma cupido* (C), *Bujurquina peregrinabunda* (D), *Cichla monoculus* (E), *Cichlasoma amazonarum* (F), *Crenicichla johanna* (G), *Heros efasciatus* (H), *Hypselecara temporalis* (I), *Mesonauta mirificus* (J), *Pterophyllum scalare* (K), *Satanoperca jurupari* (I), *Symphysodon tarzoo* (M).

DISCUSSION

An estimation of 800 freshwater fish species is recorded for the Peruvian Amazon (Ortega *et al.*, 2010), with 78 valid species reported as fish used for human consumption (Garcia *et al.,* 2018) and 212 used as ornamental fish (Garcia *et al.*, 2021). Despite the commercial importance that fish have for the Peruvian Amazon, to date, few studies have been carried out focused on cataloging the parasitic fauna of these fish. For the Peruvian Amazon, the study carried out by Morey *et al.* (2023) was the first reporting monogenoids parasitizing fish species used for aquaculture purposes. The present study constitutes the second check list of these group of parasites infesting fish host species, and the first, that shows a detailed list of parasitic monogenoids from the gills of cichlids with economic importance for this region of Peru.

With the studies conducted by Morey *et al.* (2023), the number of species of Monogenoidea was estimated in 114; in this study, we present 16 possible new species: named as *Gussevia* sp. 1 from *Gussevia* sp. 8 and *Sciadicleithrum* sp. 1 from *Sciadicleithrum* sp. 8. Morphologic characteristics observed in the sclerotized structures of the haptor and copulatory complex led us to assume that they are species not yet described for these two genera of monogenoids that parasitize the gills of cichlids.

For *A. nassa* it was reported only one species of Monogenoidea: *G. disparoides*, parasitizing the gills of specimens collected from the Igarapé Fortaleza basin, Amapá state, Brazil. (Tavares-Dias *et al.*, 2019). In the present study, we reported three morphospecies of *Gussevia* Kohn & Paperna, 1964, assuming that they are not yet described.

For *A. tetramerus, G. disparoides* and *G. alioides* were found parasitizing the gills of fish collected from the lower Jari River, State of Amapá, Brazil (Borges *et al.*, 2019). In the present study we identified *G. cichlassomatis* and four morphospecies, three belonging to *Gussevia* and one to *Sciadicleithrum* Kritsky, Thatcher & Boeger, 1989.

For *B. cupido* the only record of monogenoids parasitizing this fish species were cited by Morey *et al.* (2019) who discovered and described *B. mirospinata* from specimens collected in natural environment in Loreto, Peru. In the present study, we reported for the second time to *B. mirospinata* and additionally, a morphospecies of *Sciadicleithrum* from the gills of *B. cupido.*

For species belonging to *Bujurquina* Kullander, 1986, there are non-records about their parasitic fauna. *Bujurquina* spp. are predominantly found in rivers of the western Amazon, with high diversity in Ecuador and Peru (Koblmüller *et al.,* 2023). According to these authors, studies conducted provided evidence for multiple undescribed, locally endemic species. The results of the present study, with the evidence of two morphospecies of *Sciadicleithrum* contributes to the first monogenoids reported for a species of *Bujurquina*.

For *C. monoculus*, the following monogenoids have been cited in Peru: *G. arilla, G. longihaptor, G. undulata, G. tucunarense, S. ergensi, S. uncinatum, S. umbilicum* and *Tucunarella cichlae* (Mathews *et al.*, 2012; Seidlová, 2019; Ortiz *et al.*, 2020; Morey *et al.*, 2023). In the present study, working with specimens collected in the Nanay River, there were found only one species: *S. umbilicum*.

For *C. amazonarum* collected in Peru, Rozkošná (2008) found *G. cichlasomatis*, *G. disparoides, S. variabilum, T. cichlasomatis*; Rozkošná (2010) reported *G. disparoides, G. tucunarense* and *Sciadicleithrum* sp.; Mendoza-Franco *et al.* (2010) found *G. disparoides;* Lo *et al.* (2011) reported the presence of a species belonging to the Dactylogyridae. Seidlová (2019), recorded *G. disparoides, S. variabilum, T. cichlasomatis* and two morphospecies of *Gussevia* and one of *Sciadicleithrum.* In the present study, we found *G. cichlasomatis, S. variabilum* and *T. cichlasomatis*, as some of the aforementioned authors. In addition, we present *G. alli* as a new record on this fish host and two morphospecies belonging to *Gussevia*. Probably, the morpho species found by (Seidlová, 2019) are the same found in the present study.

For species of *Crenicichla* Heckel, 1840, some studies have been conducted in Brazil: for *C. niederleinii* (Holmberg, 1891) and *C. britskii* Kullander, 1982 from the Paraná River, the monogenoidean *S. joanae* has been recorded (Yamada *et al.*, 2009); the same species was found by Tavares-Dias *et al.* (2019) on *C. lugubris* Heckel, 1840 and *C. saxatilis* (Linnaeus, 1758). For Peru, the first records of monogenoids parasitizing a species from *Crenicichla* are presented in the present study, indicating two morphospecies of *Sciadicleithrum* from the gills of *C. johanna.*

For species of *Heros,* Cohen *et al.* (2013) cited three monogenoids from the gills of *H. severos* from Brazil: *G. alioides, G. dispar* and *G. disparoides.* Tavares-Dias *et al.* (2019) found *G. disparoides* on the gills of fish from the Igarapé Fortaleza basin, Amapá state, Brazil. In the present study, *G. dispar, G. disparoides* were also recorded. *Sciadicleithrum variabilum* is cited for the first time for this fish-host and a morphospecies of *Gussevia* was also found.

For *H. temporalis* there are no records concerning to monogenoids. The present study provides the first record of a monogenoid parasitizing this fish species. We recorded one morphospecies of *Sciadicleithrum* in the gills of this fish.

For species of *Mesonauta* Günther, 1862, there are few records about monogenoids parasitizing their gills. In Brazil, *S. joanae* was found in the gills of *M. acora* (Castelnau, 1855) collected from the Igarapé Fortaleza, Amapá, Brazil (Bittencourt *et al.,* 2014). In the present study, the morphospecies *Sciadicleithrum* sp. was recorded from the gills of *M. mirificus,* being the first record of a parasite for this fish species.

For *P. scalare* collected in Brazil, two species are cited: *G. spiralocirra* and *S. iphitium* (see Cohen *et al.,* 2013). In Peru, the only record of a monogenoid parasitizing the gills of *P. scalare* was the research conducted by Seidlová (2019). In the present study, we reported *G. spiralocirra* and *S. iphitium*, being the last parasite cited for the first time for a fish-host from the Peruvian Amazon.

For *S. jurupai* collected in Brazil, two species of *Sciadicleithrum* were found: *S. satanopercae* (Melo *et al.*, 2012, Cohen *et al.*, 2013, Bittencourt *et al.*, 2014) and *S. edgari* (Paschoal *et al.,* 2016). In the Peruvian Amazon, the researchers conducted by Rozkošná (2008, 2010) recorded the presence of *S. satanopercae* on the gills. In the present study, this parasite species was also found, being to date the only monogenoid parasitizing this host species from Peru.

For *Symphysodon* Heckel, 1840, Cohen *et al.* (2013) cited the presence of *S. variabilum* parasitizing the gills of *S. discus* from Brazil. For studies conducted in Peru, Aguinaga *et al.* (2015) reported the presence of one species of Monogenoidea from the gills of *S. aequifasciatus,* Rozkošná (2008, 2010), recorded *S. variabilum* from *S. discus*. In the present study, *S. variabilum* is recorded for the first time parasitizing the gills of a species of *Symphysodon* collected from Peru.

Taxonomic studies must continue in the Peruvian Amazon, since the number of new species that are being discovered and described is increasing as more research is carried out in this territory. This shows that the number of monogenoid species to be discovered is still quite large and deserves special attention. Additionally, it is important to study the fish parasites that have commercial importance in the Peruvian Amazon, since knowing the parasites present in the fish creates important baselines that will allow other types of studies to be carried out, such as ecological, sanitary, among others.

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