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ORIGINAL ARTICLE

Ergasilus turkayi n. sp. (Copepoda, Cyclopoida, Ergasilidae): a gill parasite of *Serrasalmus hollandi* Jégu, 2003 (Characiformes, Serrasalmidae) from the Paragua River, Bolivia

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ABSTRACT

A new parasitic copepod species, *Ergasilus turkayi* n. sp., found on the gills of the Holland's piranha, *Serrasalmus hollandi* Jégu, 2003, in the Paragua River, Bolivia, is described based on 10 adult females. The new species presents a triangular-shaped cephalothorax, spinules on interpodal plates and aesthetascs on antennule - two aesthetascs on the sixth, and one aesthetasc plus two setae on the fifth segment. Additionally, the second abdominal somite of *E. turkayi* n. sp. bears an anal pseudoperculum, a dorsal and elongate projection which is usually absent or vestigial in poecilostome families within the Cyclopoida but that was never reported in species of Ergasilidae.

KEY WORDS

Copepod, *Ergasilus*, parasite, Actinopterygii, Neotropics.

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Introduction

Ergasilidae von Nordmann, 1832 is one of the major families of Poecilostomatoida (Cyclopoida) and comprehends 27 genera of parasitic copepods found in marine, brackish, and freshwater environments worldwide. The majority of the ergasilids parasitizes the gill filaments, gill rackers, nasal cavities and body surface of fish species (Boxshall and Defaye, 2007). Species of Ergasilidae share a unique life cycle: only fertilized females are parasitic, being the phase most widely used for the description and determination of most species (Boxshall and Defaye, 2007). Species of Ergasilidae feed on host tissue and are considered a pest in aquaculture (Kabata, 1970).

Presently, 69 species of Ergasilidae are known from Brazilian fishes (see Marques, 2017). In South America, only five species have been reported outside Brazil: *Ergasilus argulus* Cressey and Collette, 1970; *Ergasilus pitalicus* Thatcher, 1984 and *Ergasilus curticrus* Muriel-Hoyos *et al.*, 2015, all from Colombian fish hosts, plus *Ergasilus parabahiensis* El-Rashidy and Boxshall, 1999, from Guyana, and *Ergasilus ecuadorensis* El-Rashidy and Boxshall, 2002, from Ecuador. The species proposed herein, *Ergasilus turkayi* n. sp., is the first described from Bolivia. The specimens used for the description were collected from the gills of the Red-Hook Piranha, *Serrasalmus hollandi* Jégu, 2003, a characiform distributed along the Madeira River subbasin (Amazon River basin) in Bolivia.

Material and Methods

Fish hosts, *S. hollandi*, were collected in September 2005 from the Paragua River (13°32'24.8"S 61°49'27.4"W), near confluence with the Iténez River (Amazon basin), Province Beni, Bolivia. Gills were removed and fixed in 5% formalin; copepod parasites were removed, fixed and stored in 95% ethanol.

Copepods were cleared in lactic acid and mounted in Hoyer's mounting medium (prepared according to Humason, 1979). Whenever necessary, specimens were dissected with the help of acupuncture needles. Illustrations were made with the aid of an Olympus BX51 microscope with DIC illumination and camera lucida. All measurements are in micrometres; measurements are presented by the range followed by the mean and the number of measurements in parentheses). Type specimens are deposited in the Helminthological Collection of the Instituto Oswaldo Cruz, Brazil.

Six specimens used for scanning electron microscopy were dehydrated in an increasing ethanol series. The specimens were critical-point dried with CO_2 and sputter-coated with gold. The images were made with a TESCAN VEGA3 LMU scanning electron microscope at an accelerating voltage of 15.0 kV. All procedures were performed at the "Centro de Microscopia Eletrônica, Universidade Federal do Paraná (CME-UFPR)."

Systematics

Order Cyclopoida Burmeister, 1834

Ergasilidae Burmeister, 1835

***Ergasilus* von Nordmann, 1832**

***Ergasilus turkayi* n. sp.**
(Figs. 1, 2)

Type host. Serrasalmus hollandi Jégu, 2003.

Site on host. Gill filaments.

Type locality. River Paragua, near confluence with Iténez River (Amazon basin), 13°32'24.8"S 61°49'27.4"W, Province Beni, Bolivia.

Type specimens. Holotype: adult female (CHIOC 38685a). Paratype specimens: 9 female specimens (CHIOC 38685b-q).

Etymology. The specific name is in honor of the late Dr. Michael Türkay (Research Institute and Natural History Museum Senckenberg (Frankfurt am Main, Germany) for his extensive contributions to the study of Crustacea.

Description. Adult female (Fig. 1A–I) [based on 10 specimens]. Body length from anterior margin of prosome to posterior of caudal rami 522–689 μm (603; n = 10). Body comprising prosome and urosome, bearing multiple small sensilla along entire body (Fig. 2C); prosome consisting of non-inflated, triangular cephalosome and 4 pedigerous somites. Rostrum

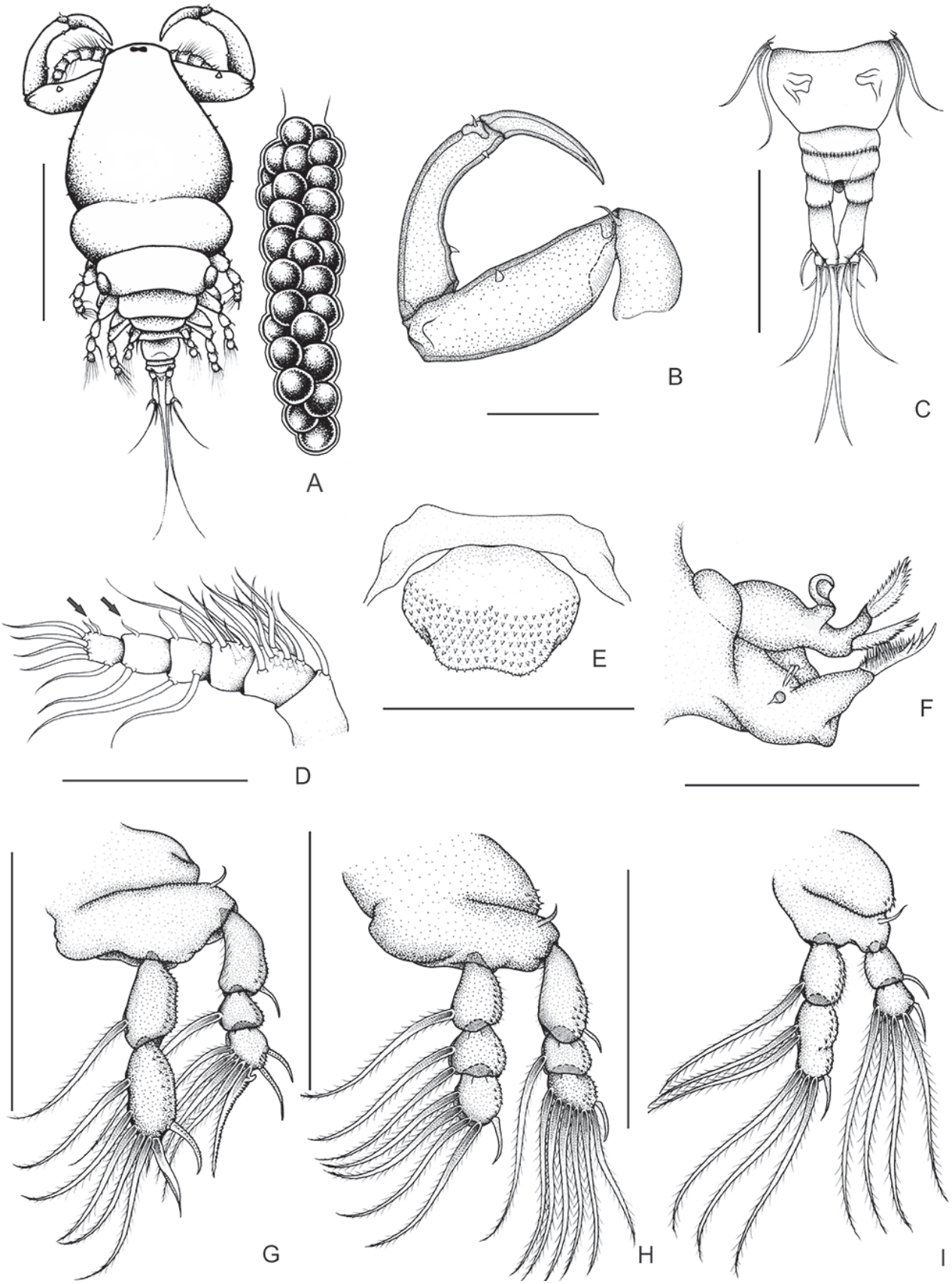

Figure 1. *Ergasilus turkayi* n. sp., adult female, egg sac. A, Dorsal view; B, antenna; C, abdomen and caudal rami; D, antennule, setae pointing to aesthetascs; E, interpodal plates; F, mouthparts; G, leg 1; H, leg 2; I, leg 4. Scale bars: A, 150 µm; B, C, F–I, 50 µm; D, E, 25 µm.

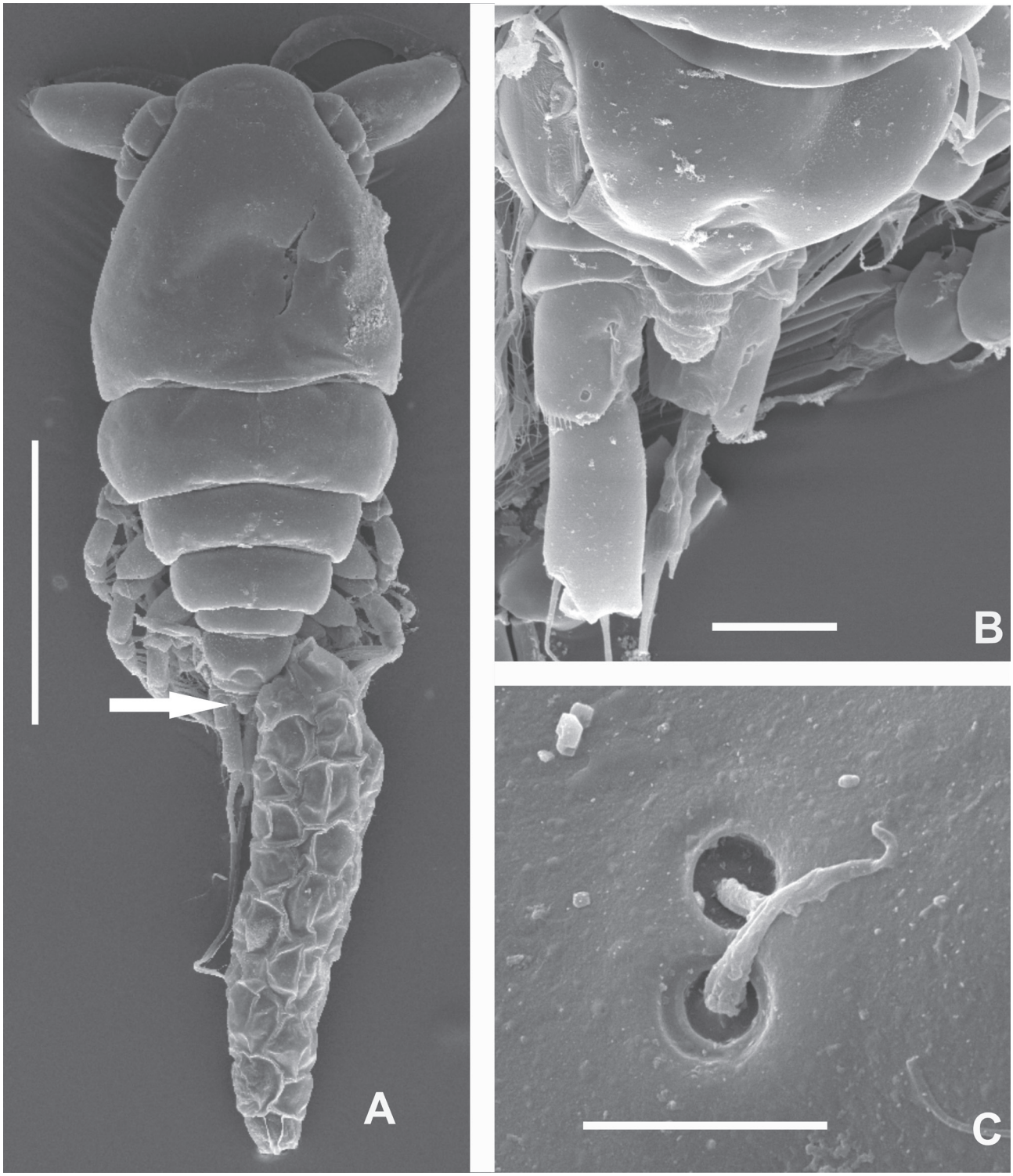

Figure 2. Scanning electron microscopy of *Ergasilus turkayi* n. sp., adult female. A, Dorsal view, arrow pointing the U-shaped dorsal pseudoperculum in the anal somite; B, closer dorsal view of the pseudoperculum; C, multiple small sensilla distributed along the entire body. Scale bars: A, 200 µm; B, 20 µm; C, 5 µm.

presenting a row of frontal sensilla. Cephalosome and first pedigerous not fused. Cephalosome less than twice width, comprising more than 50% of body length. Urosome (Fig. 1C) consisting of 5 pedigerous somite, double genital somite, 3 free abdominal somites. Double-genital somite barrel-shaped, narrowing posteriorly, ventral surface lacking spinules. Abdominal somites with row of spinules on postero-ventral

margins. Second abdominal somite presenting a blunt pseudoperculum (Fig. 2A, B). Caudal ramus longer than wide, armed with one long, one median, and two smaller lateral setae; spinules absent. Two long egg sacs with 2–3 rows of eggs.

Antennule (Fig. 1F) with 6 segments, tapering distally, aesthetascs present on fifth and sixth segments. Setal formula: 1:9:5:4:1+1 ae: 5+2 ae.

Antenna (Fig. 1B) comprising coxobasis, three-segmented endopod, and terminal claw. Coxobasis short, presenting tiny distal seta at inner distal corner; membrane between coxa and first segment of endopod not inflated. First endopodal segment with length/width ratio approximately 3; sensillum near mid length. Second segment curved, as long as first segment, presenting proximal sensillum and small distal sensillum. Third endopodal segment with single seta. Claw evenly curved, with small pit (fossa) distally on concave margin.

Mouthparts (Fig. 1D) comprising mandible, maxilla and maxillule; maxilliped absent. Mandible with median and posterior blades; anterior blade absent; median blade completely toothed. Basis of maxilla partially toothed, with a sensillum on proximal region, spinulated setae on maxilla absent. Two setal elements on maxillule present.

Interpodal plates (Fig. 1E) of all legs ornamented with spinules ventrally, variable in number and distribution among plates. Swimming legs 1–4 biramous and with separate coxa and basis. Armature of legs (setae, Arabic numerals; spines, Roman numerals) as in Tab. 1.

Leg 1 (Fig. 1G). Coxa with smooth margins, lacking spinules; basis with smooth margins, lacking spinules, with proximal outer seta. Exopod with 3 segments; first segment pilose on inner margin, with spinules distally on outer margin, lacking inner seta, distal spine on outer margin present; second segment with spinules on entire outer margin, with one seta, distal spine absent; third segment with spinules distally on outer margin, with one pectinate seta and four pilose setae, two distal spines spinulated. Endopod with 2 segments; first segment not pilose, with spinules on entire outer margin, with one seta; second segment with spinules on entire outer margin, with five setae and two straight spines, only outer spine spinulated.

Legs 2 and 3 similar (Fig. 1H). Coxa ornamented with spinules; basis lacking spinules, with proximal seta. Exopod presenting 3 segments; first segment twice as long than wide, pilose on inner and outer sides, with spinules on all outer margin with non-spinulated distal spine, lacking seta; second segment with spinules on entire outer margin, with one seta, distal spine absent; third segment with spinules on entire outer margin, with six setae and one non-spinulated spine. Endopod with 3 segments; first segment pilose on outer side, with spinules on entire outer margin, with one seta; second segment not pilose, with spinules on entire outer margin, with two setae, distal spine absent; third segment with spinules on entire outer margin, with four setae and one non-spinulated distal spine.

Leg 4 (Fig 1I). Coxa ornamented with spinules; basis presenting single small proximal seta. Exopod with 2 segments; first segment pilose on inner margin, lacking spinules, lacking seta, with one non-spinulated distal spine; second segment lacking spinules, with four setae and one non-spinulated distal spine. Endopod with 2 segments; first segment pilose on outer side, with spinules on entire outer margin and one seta; second segment with spinules on entire outer margin, with five setae and one non-spinulated distal spine.

Leg 5 (Fig. 1C). Reduced to 2 unequal setae.

Discussion

Some species from Brazil have the triangular-shaped cephalothorax not fused with the first pedigerous somite, such as *Ergasilus bryconis* Thatcher, 1981, *Ergasilus holobryconis* Malta and Varella, 1986, *Ergasilus*

Table 1. *Ergasilus turkayi* n. sp., armature of legs (setae, Arabic numerals; spines, Roman numerals).

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	0-1	I-0; 0-1; II*-4	0-1; II-5
Leg 2	0-0	0-1	I-0; 0-1; I-6	0-1; 0-2; I-4
Leg 3	0-0	0-1	I-0; 0-1; I-6	0-1; 0-2; I-4
Leg 4	0-0	0-1	I-0; I-4	0-1; I-5

*Pectinated seta

coatiarus Araujo and Varella, 1998, *Ergasilus jaraquensis* Thatcher and Robertson, 1982, *Ergasilus urupaensis* Malta, 1995, and the new species. Furthermore, *E. pitalicus*, *Ergasilus leporinidis* Thatcher, 1981, and *Ergasilus hypophthalmi* Boeger, Martins and Thatcher, 1993 presents the interpodal plates ornamented with spinules, similar to those observed in *E. turkayi* n. sp. The new species also possess a 2-segmented exopod on Leg 4, with a partly fused second and third exopodal segments, a feature also present in *Ergasilus salmini* Thatcher and Brasil-Sato, 2008, *Ergasilus chelangulatus* Thatcher and Brasil-Sato, 2008, and *E. jaraquensis*.

However, *E. turkayi* n. sp. can be differentiated from these by the number of setae and aesthetascs on the antennule - two aesthetascs on the sixth, and one aesthetasc plus two setae on the fifth segment. Additionally, the second abdominal somite of *E. turkayi* n. sp. bears an anal pseudoperculum, a dorsal and elongate projection which is a character previously known, although rare, in species of Harpacticoida and Calanoida (Lee and Yoo, 1998; Ohtsuka *et al.*, 2002; Karanovic *et al.*, 2015). In poecilostome families within the Cyclopoida it is usually absent or vestigial (Böttger-Schnack and Huys, 2001; Boxshall and O'Reilly, 2015; Moles *et al.*, 2015). Until now, this structure was not reported in any species of Ergasilidae.

Ergasilus turkayi n. sp. presents a pinnate (falciform) seta on the third exopodal segment of the first pair of legs accompanied by four pilose setae, which is a trait shared with other Neotropical species of *Ergasilus*.

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