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Revalidation of *Handschinia* Stach, 1949 (Collembola, Neanuridae) with description of a new species from Brazil

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Abstract

The analysis of species of *Arlesia* Handschin, 1942 with 7+7 eyes revealed new characteristics, such as position and shape of guard S-chaetae of Ant III organ, mandible teeth number, number of chaetae on thorax I and mucro: dens ratio, which supported the revalidation of *Handschinia* Stach, 1949. *Arlesia fluminensis* (Arlé, 1939) and *Arlesia proxima* (Arlé, 1939) are formally transfered to *Handschinia*, *H. fluminensis* (Arlé, 1939) comb. nov. and *H. proxima* (Arlé, 1939) comb. nov., and a new species, *Handschinia rauli* sp. nov. is described and illustrated. Remarks on the genus *Arlesia* and *Handschinia* are made. The diagnosis of *Handschinia* is expanded.

Keywords Pseudachorutinae | taxonomy | chaetotaxy | diversity | Neotropics

1. Introduction

The subfamily Pseudachorutinae is, up to date, the most diverse within Neanuridae in South America. In Brazil, this tendency is also true, where about 80 % of the species of Neanuridae belong to this subfamily (Abrantes et al. 2012). There are, nowadays, 58 described species, allocated in 14 genera of Pseudachorutinae in Brazil. Among these, there are five species, out of seven, of the Neotropical genus *Arlesia* Handschin, 1942.

The genus *Arlesia* was erected by Handschin (1942) in order to include the Pseudachorutinae species with 5+5 eyes, without PAO and well developed furca, although two Brazilian species with 7+7 eyes were also included in this genus, *Pseudachorutes fluminensis* Arlé, 1939 and *Pseudachorutes proximus* Arlé, 1939. Latter, Stach (1949) erected the genus *Handschinia* and transferred to it these two species with 7+7 eyes described from southeast Brazil, *Handschinia fluminensis* (Arlé, 1939) and *Handschinia proxima* (Arlé, 1939). The genus *Handschinia* Stach, 1949 was mainly characterized by 7+7 eyes, mandible with 25–30 apical and two basal teeth, dens shorter than mucro, well-developed paratergites and blue color with large orange areas on some body segments.

Afterwards, Massoud (1967) claimed that the number of eyes should not be considered as a generic characteristic for the austral species of Pseudachorutinae with well-developed furca and paratergites and, therefore, synonymized the genus *Handschinia* with *Arlesia*. Nevertheless, Massoud (1967) did not take into consideration the other diagnostic characteristics proposed by Stach (1949) for *Handschinia*, such as mandible teeth and ratio mucro: dens, for example.

Recent samplings of the Collembolan fauna from a mountainous range of Southeastern Brazil, the 'Serra do Caparaó', revealed many interesting Pseudachorutinae new to science. Among these, there is one species similar to *Arlesia fluminensis* and *A. proxima*.

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After the analysis of this new material and specimens of *Arlesia fluminensis* and *A. proxima*, other characteristics were observed and provided new insights relative to generic diagnosis and the status of these *Arlesia* species. Consequently, due to a unique combination of characteristics, the revalidation of the genus *Handschinia* Stach, 1949 is established together with the recombination of two species, *Arlesia fluminensis* (Arlé, 1939) as *Handschinia fluminensis* (Arlé, 1939) comb. nov. and *Arlesia proxima* (Arlé, 1939) as *Handschinia proxima* (Arlé, 1939) comb. nov., and the description of a new species *Handschinia rauli* sp. nov.

Abbreviations used in text: Ant – antennal segment, **Abd** – abdominal segment, **a.s.l.** – above sea level, **ICMBio** – Instituto Chico Mendes da Biodiversidade, **MNRJ** – Museu Nacional do Rio de Janeiro, Brasil, **PAO** – Post-antennal organ, **Scx 1** – Subcoxae 1, **Sgd** – dorsal guard S-chaetae, **Sgv** – ventral guard S-chaetae, **Th** – thoracic segment, **Tita** – Tibiotarsi.

1.1. Remarks on *Arlesia* Handschin, 1942 and *Handschinia* Stach, 1949

One of the new differential characteristics for these genera is the position and size of Sgd of Ant III organ. Except for *Arlesia cochabambensis* Cassagnau & Rapoport, 1962, for which there is no drawing or mention of this S-chaetae, all other species, *Arlesia albipes* (Folsom, 1927), *A. arleana* Mendonça & Fernandes, 1999, *A. intermedia* Fernandes & Mendonça, 2004 and *A. variabilis* Thibaud & Massoud, 1983, have a Sgd of Ant III organ that is shorter than Ant IV S-chaetae (about half the length), slightly stouter, and displaced upwards, more or less in line with S2 and S3 of Ant IV (Fig. 1). On the other hand, for *Handschinia* the Sgd of Ant III organ is subequal, or slightly smaller, and slightly stouter than S-chaetae of Ant IV and is below S2–S3 and more or less in line with S1 of Ant IV (Fig. 2).

The number of eyes in *Handschinia* is 7+7 (the missing eye is probably H) while in *Arlesia* it is 5+5 (the missing eyes are probably D, G and H).

The mandible of *Arlesia* is small and the number of teeth varies from 4 to 8, while in *Handschinia* the mandible is longer, shaped like a saw, and the teeth number varies from 16–25 small teeth (sometimes interspersed with tiny teeth) plus two basal stronger teeth, the total number of teeth varying from 18 to 40.

The mucro: dens ratio of *Arlesia* species is 1:2 or higher, i.e. dens is always longer than mucro. For *Handschinia* species this ratio is at most 1:1.5, i.e. dens is almost subequal, and for *A. fluminensis* is even smaller, than mucro.

Although there is no illustration or description of dorsal chaetotaxy available for *Arlesia cochabambensis* Cassagnau & Rapoport, 1962 and *Arlesia variabilis* Massoud & Thibaud, 1983, all other species with the above mentioned characteristics for *Arlesia*, have only 2+2 chaetae on thorax I. Some descriptions mention 3+3 chaetae, but they actually take into account the Scx 1 chaeta of leg I. In fact, there is one axial/internal chaeta and one external chaeta, while for *Handschinia* species there are always 3+3 chaetae on thorax I, with 2 chaetae located more axially and one more external chaeta. The main differences between *Arlesia* and *Handschinia* are summarized in Table 1.

Its noteworthy that the dorsal chaetotaxy from Th II–Abd VI of both *Arlesia* and *Handschinia* species, although overall reduced, is fairly stable – at least for those species with available illustrations, such as *Arlesia albipes* in Massoud 1963; *Arlesia arleana* and *Handschinia proxima* in Mendonça & Fernandes, 1999; *Arlesia intermedia* Fernandes & Mendonça, 2004. Therefore, such difference in thorax I number of chaetae can be considered as an important differential characteristic.

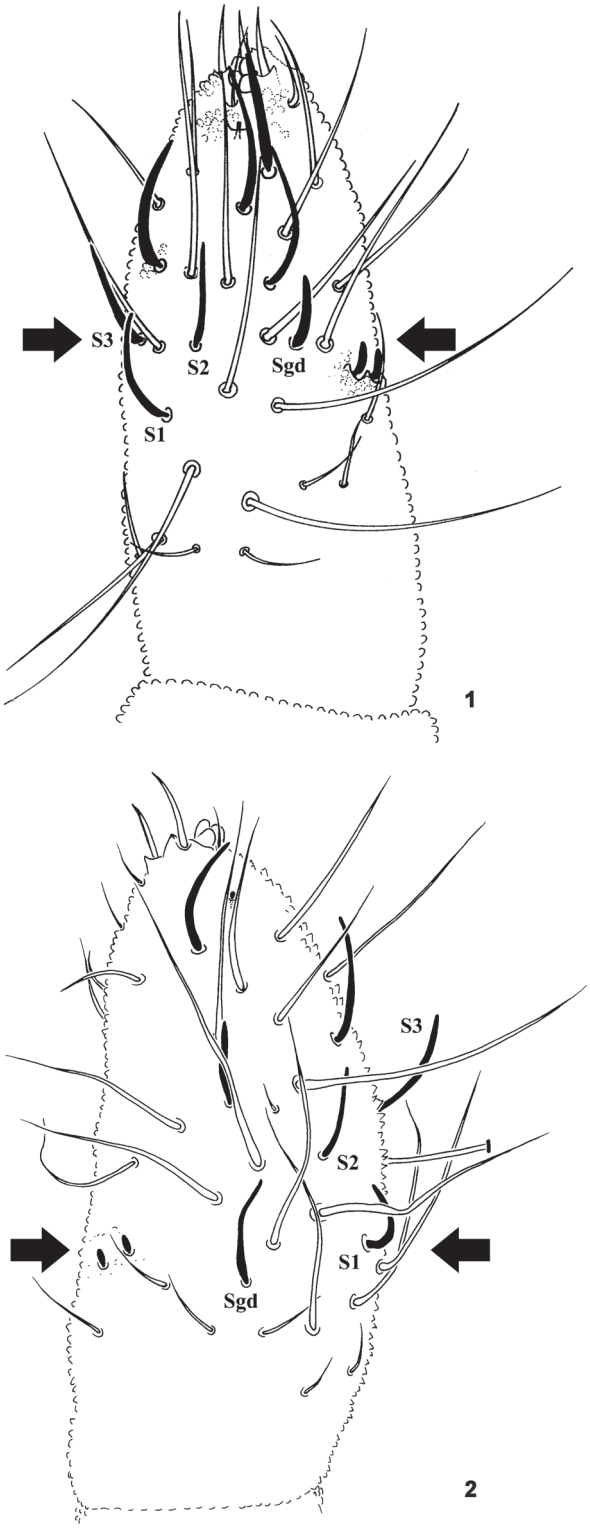
1.2. Remarks on *Handschinia fluminensis* (Arlé, 1939)

The analysis of specimens of *Handschinia fluminensis* from Serra dos Órgãos, Teresópolis municipality, Rio de Janeiro State (1 young female, 2310 CM/MNRJ slide B; 1 female 2312 CM/MNRJ slide C), agrees

Table 1. Main differences between the genera *Arlesia* Handschin, 1942 and *Handschinia* Stach, 1949.

	Arlesia Handschin, 1942	***Handschinia*** Stach, 1949
Ant III Sgd/Ant IV S-chaetae	shorter, stouter*	subequal, slightly stouter
Eyes	5+5	7+7
Mandible teeth	4–8	18–40
Thorax I chaetae	2+2**	3+3
Ratio mucro: dens	≥1:2	≤1:1.5

* no illustration or reference given in the description of *A. cochabambensis* Cassagnau & Rapoport, 1962.
**no dorsal chaetotaxy of *A. cochabambensis* Cassagnau & Rapoport, 1962 and *A. variabilis* Massoud & Thibaud, 1983 available.



Figures 1–2. (**1**) Dorsal view of Ant III–IV of *Arlesia arleana* Mendonça & Fernandes, 1999, arrows indicate the alignment of Sgd and S2–S3 (Modified from Mendonça & Fernandes, 1999); (**2**) Dorsolateral view of Ant III–IV of *Handschinia fluminensis* (Arlé, 1939), arrows indicate the alignment of Sgd and S1.

with Arlé's description and corroborates the mentioned characteristics of *Handschinia*: the 7+7 eyes in semi-circular disposition, mucro longer than dens, the Th I chaetae number of 3+3 and the Sgd of Ant III organ (see Fig. 2). The mandible teeth number of these specimens was about 27–29 and, although, the tiny teeth interspersed with the small teeth are sometimes difficult to see, their overall number could reach the 40 teeth mentioned in the original description. In addition to that, some other characteristics included are: body color as described, the number of S-chaetae of Ant IV is 6; number of chaetae on the ventral tube is 3+3; two teeth on each ramus of tenaculum; Abd II and III have 3+3 and 5+5 ventral chaetae, respectively; manubrium has 23 chaetae; upper anal valves have 15 chaetae and 2 hr chaetae each.

2. Taxonomy

Poduromorpha
Neanuridae
Pseudachorutinae

Handschinia Stach, 1949

Type species *Pseudachorutes fluminensis* Arlé, 1939 [= *Arlesia fluminensis* (Arlé, 1939)], by designation.

Diagnosis. Habitus similar to *Brasilimeria* Stach, 1949. Body color blue to black, sometimes Ant III–IV and dorsal body with spots of white to yellow-orange. Body integument with well-developed secondary granules. Buccal cone moderately elongate. Antennae subequal or shorter than head diagonal. Apical bulb trilobed. Subapical organite rounded. Without dorsolateral S-microchaeta. Ant IV with 5 or 6 S-chaetae. Sgd of Ant III organ subequal to or slightly shorter than S-chaetae of Ant IV, positioned in line with S1 of Ant IV and below S2–S3 of Ant IV. Eyes 7+7. Without PAO; distinct area of primary granulation in the position of PAO. Mandible long, saw-like, with 16–25 small teeth interspersed with tiny teeth and two basal stronger teeth; maxillae styliform with hooked apex. Labium with chaetae A–G, F being longer. No plurichaetosis. Dorsal chaetotaxy reduced, consisting of small ordinary chaetae and long S-chaetae; ratio ordinary chaeta: S-chaetae ≥ 1:5. Thorax I with 3+3 chaetae. S-chaetae formula by half body= 22/11111. Tibiotarsi I–III with 19, 19, 18 chaetae, respectively. Tenent hair acuminate. Chaetae B4 and B5 longer than others. Unguis of legs I–III with basal inner tooth. Ventral tube with 3+3 chaetae. Tenaculum teeth 2–3 on each ramus. Manubrium with 20–23 chaetae. Furca shorter than manubrium; dens with 6+6 chaetae;

mucro stout, tapering; ratio mucro: dens ≤ 1:1.5. Abd VI partially visible dorsally; tendency to cryptopygy.

Handschinia rauli sp. nov.

Type Locality. Parque Nacional do Caparaó (ICMBio). Alto Caparaó municipality, Minas Gerais State, Brasil. Local coordinates: 20°26'26.77″S 41°48'1.00″W. About 2700 m a.s.l. Soil and leaf litter of 'campos de altitude'. **Type Material.** Holotype female 2157 CM/MNRJ. Paratypes on slides: 2221 CM/MNRJ 1 juvenile; 2230 CM/MNRJ 1 juvenile; 2237 CM/MNRJ 2 males (slides C, D), 1 female (slide E); 2238 CM/MNRJ 1 juvenile; 2345 CM/MNRJ 1 male; 2350 CM/MNRJ1 female; 2351 CM/MNRJ 1 young female; 2355 CM/MNRJ 1 male, 1 juvenile (slide A). Paratypes in ethanol: 2349 CM/MNRJ 1 specimen; 2354 CM/MNRJ 1 specimen; 2357 CM/MNRJ 2 specimens; 2361 CM/MNRJ 1 specimen.

Description. Body length of holotype: 2.13 mm. Body length range of paratypes: 0.95–2.43 mm (mean: 1.74 mm). Habitus similar to *Brasilimeria* Stach, 1949. Color light greyish blue to dark blue. Body integument with secondary granules well developed.

Ant IV with long ordinary chaetae and 6 slender curved S-chaetae (probable homology: S1–4, S8–9); chaeta i very small. Apical bulb trilobed. Subapical organite rounded and continued into the integument; without dorsolateral S-microchaeta (Fig. 3). Ventrally with about 6 chaetae with bent tips interspersed with ordinary chaetae. Ant III and IV fused dorsally. Ant III organ with Sgd and Sgv subequal or longer and stouter than Ant IV S-chaetae, two rod-shaped inner S-microchaetae, ventral S-microchaetae present. Ventral separation marked between Ant III and IV (Fig. 4). Ant I and II with 7 and 11 chaetae, respectively. Antennae shorter than head diagonal. Ratio antennae: head diagonal = 1:1.5.

Buccal cone moderately elongate; chaetae A–G present, F chaeta long (Fig. 5). Distal portion of labrum oval-shaped with thin apex (Fig. 6). Labral chaetotaxy 2/5?3?4?. Mandible with 18–20 teeth: two basal strong curved teeth followed by a row of 16–18 small and tiny teeth apically; maxillae styliform with hooked apex (Fig. 7).

Head and dorsal chaetotaxy of body as in figure 8. Chaetotaxy reduced, consisting of small chaetae and long S-chaetae. Ratio ordinary chaetae: S-chaetae = 1:5.5. No plurichaetosis. Dorsoexternally to S-chaetae of body there is an area of primary granulation, especially on abdomen. S-chaetotaxy formula by half body = 22/11111. Thorax I with 3+3 chaetae in one row, two of them closer to the axis and the third one situated more externally. Abd VI partially visible dorsally, with 6+6 chaetae plus one unpaired chaeta and 2 hr chaetae.

Eyes 7+7 (3 specimens with 6+7 eyes) in strongly pigmented eye patch; eyes A–D closer to each other, E–G further apart. Without PAO. Area of primary granulation next to eyes in the position of PAO (detail of Fig. 8). Head with one long ventrolateral chaeta on each side.

Chaetotaxy of legs I–III as follows: Subcoxae 1– 1,2,2; Subcoxae 2– 0,2,2; Coxae– 3,6,7; Trochanter– 7,6–7,6–7; Femora– 13,12,10–11; Tibiotarsi– 19,19,18. Chaetae B4 and B5 of tibiotarsi well developed, chaeta M present, displaced basally. Unguis with basal inner tooth (Figs 9, 10).

Ventral tube with 3+3 chaetae. Abd II–III with 3+3 and 5+5 ventral chaetae, respectively. Tenaculum with 3 teeth on each ramus. Manubrium with 20–23 chaetae, including three basal central chaetae with great variation among specimens (Fig. 11). Furca fully developed, mucro shorter than manubrium; 6 chaetae on each dens. Mucro stout, with two small tapering lamellae, apex slightly curved (Fig. 12). Ratio mucro: dens = 1:1.5. Each upper anal-valve with 15 chaetae and 2 hr chaetae. Female and male genital plates as in Figures 13 and 14, respectively.

Derivatio nominis. A tribute to the popular Brazilian rock singer Raul Seixas, also known as 'Raulzito'.

3. Discussion

As discussed above, the number of eyes, mandible shape, Th I chaetae and furca are in accordance with the diagnosis of the genus *Handschinia*, therefore, the new species *H. rauli* sp. nov. is well characterized within it. The main differences separating it from the other two species, *H. fluminensis* (Arlé, 1939) (Figs 15–18) and *H. proxima* (Arlé, 1939) (Figs 19–22), are body color pattern, arrangement of eyes, mandible shape and number of teeth and also mucro: dens ratio.

While *H. rauli* sp. nov. presents only light to dark blue pigment all over body (Fig. 23), the other two species present an unique body color pattern: *H. fluminensis* is mostly black with white to yellow-orange pigment on Ant III–IV, patches covering almost entirely thorax II, lateral spots on Abd I and Abd V and VI completely covered (Fig. 15); *H. proxima* is mostly black with white to yellow-orange pigment on Ant III–IV, two dorsoexternal spots on thorax II and Abd V–VI completely covered (Fig. 19).

The eyes of *H. fluminensis* are arranged in a semi-circular way, while *H. proxima* and *H. rauli* sp. nov. have eyes A–D closer to each other and E–G further apart (Figs 16, 20, 24).

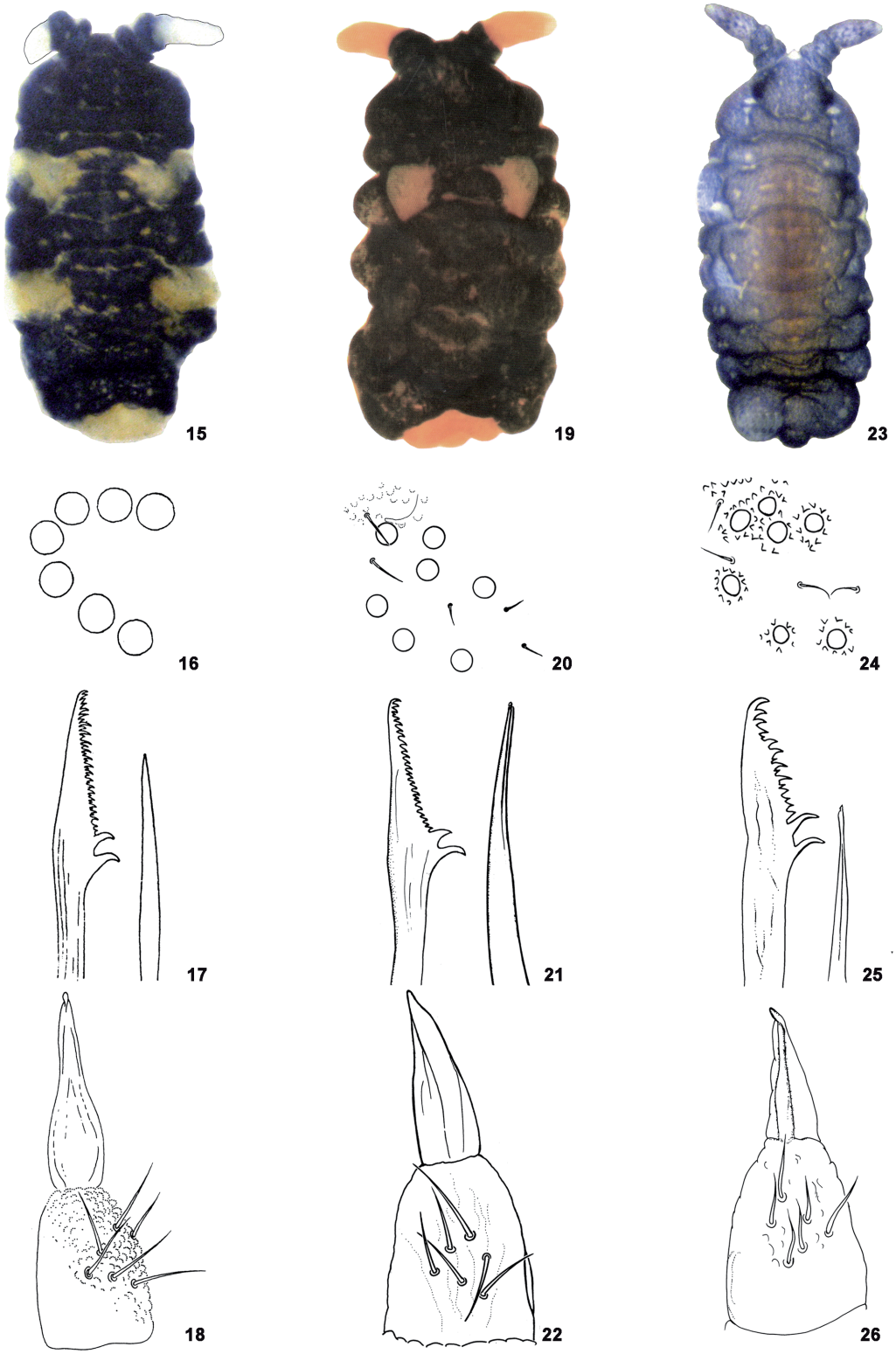
The mandible of the new species *H. rauli* sp. nov. has less teeth, only 18–20, and is slightly stouter than the mandibles of *H. fluminensis* and *H. proxima* which have up to 40 and 27 teeth, respectively, and are more slender apically (Figs 17, 21, 25).

Figures 3–8. *Handschinia rauli* sp. nov. (**3**) Dorsal view of Ant III–IV; (**4**) Ventral view of Ant III–IV; (**5**) Labium; (**6**) Distal portion of labrum; (**7**) Mandible and maxilla; (**8**) Dorsal head and body chaetotaxy with detail of primary granulation area near the eyes. Scale bars: 20 µm (Figs 1–7); 200 µm (Fig. 8).

There is a gradual increase of mucro: dens ratio from *H. fluminensis* (1:0.8) to *H. proxima* (1:1) and *H. rauli* sp. nov. (1:1.5). The mucro shape is more or less the same for all three species, stout with two small tapering lamellae and a curved apex. Apart from the size, the dens shape is also similar for all three species, with the same number (6+6) and disposition of chaetae (Figs 18, 22, 26).

In addition to that, *H. rauli* sp. nov. has a long ventrolateral chaeta on the head, while the other species have only small ordinary chaetae on head.

Figures 9–14. *Handschinia rauli* sp. nov. (**9**) Tibiotarsus I; (**10**) Tibiotarsus III; (**11**) Ventral chaetotaxy (x indicates missing chaetae; * indicates chaetae with great variability among specimens); (**12**) Furca; (**13**) Female genital plate; (**14**) Male genital plate. Scale bars: 20 μm (Figs 9–10, 12–14); 100 μm (Fig. 11).



Figures 15–18. *Handschinia fluminensis* (Arlé, 1939). (**15**) Photography of specimen in ethanol; (**16**) Eye arrangement (modified from Arlé, 1939); (**17**) Mandible and maxilla (modified from Arlé, 1939); (**18**) Furca (modified from Arlé, 1939).

Figures 19–22. *Handschinia proxima* (Arlé, 1939). (**19**) Photography of specimen in ethanol; (**20**) Eye arrangement (modified from Mendonça & Fernandes, 1999); (**21**) Mandible and maxilla (modified from Mendonça & Fernandes, 1999); (**22**) Furca (modified from Mendonça & Fernandes, 1999).

Figures 23–26. *Handschinia rauli* sp. nov. (**23**) Photography of specimen in ethanol; (**24**) Eye arrangement; (**25**) Mandible and maxilla; (**26**) Furca.

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