

Systematics, Morphology and Biogeography

A new species of *Drepanocnemis* (Diptera, Muscidae) from Andes in Peru, with an updated phylogenetic analysis of species



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ABSTRACT

Drepanocnemis Stein (Diptera, Muscidae) is a small genus of flies that occur in high altitudes in the Colombian Andes, Ecuador, Peru and Bolivia. Herein we describe *Drepanocnemis aurifrons* **sp. nov.** from Cuzco, Peru, which is found from high (2904 m) to lower altitudes (707 m). An updated phylogeny, key to species and map of species' distributions are provided, together with images and illustrations of the male and the female terminalia.

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Introduction

Drepanocnemis Stein, 1911 is a small genus of South American Muscidae with three species: *D. dorae* Stein, 1911 (type-species), *D. hirticeps* Stein, 1911 and *D. griseovirens* Malloch, 1928 (de Carvalho et al., 2005). These species of the genus are found from high altitudes in the Andes (about 2000–5000 m) in Colombia, Ecuador, Peru and Bolivia (Löwenberg-Neto and de Carvalho, 2013). Nothing is known about their biology or immature stages (Couri and de Carvalho, 2008).

The recent taxonomic history of the genus is brief. Pont (2001) studied the holotype of the male of *D. dorae*. Couri and de Carvalho (2008) revised *Drepanocnemis*. Their revision included phylogenetic and a biogeographic analyses of the genus, as well as diagnosis and redescriptions of *D. griseovirens* and *D. hirticeps*, including images of the male and female terminalia.

The monophyly of *Drepanocnemis* is supported by modifications in the fore tibia of the male (Couri and de Carvalho, 2002). In the cladistic analysis of the world Coenosiini (Coenosiinae), *Drepanocnemis* was transferred from Coenosiini to Limnophorini, another tribe of the subfamily (Couri and Pont, 2000), since *Drepanocnemis* species do not share with Coenosiini the lower proepimeral seta directed downwards (Malloch, 1928; Couri and Pont, 2000).

Here, we describe a new species of *Drepanocnemis* found from high (2904 m) to lower altitudes (707 m) in Peru and provide a new phylogenetic analysis for this small genus.

Material and methods

This study was mostly based on 217 specimens of *Drepanocnemis* collected by Malaise trap between December 2010 and January 2013, and which are deposited in the National Museum of Natural History [formerly United States National Museum] (USNM). Additionally, the lectotype male of *Drepanocnemis hirticeps* Stein, 1911 was borrowed from the Staatliches Museum für Tierkunde, Dresden (SMT). The type specimens of the new species were deposited in the USNM, Padre Jesus Santiago Moure Entomological Collection, Universidade Federal do Paraná (DZUP) and Museu Nacional, Rio de Janeiro (MNRJ).

For examination of the male and female terminalia, the abdomen was removed from a dry specimen and was placed in cold potassium hydroxide (KOH) 10% for 24 h to soften and lighten the parts. The abdomen was transferred to acetic acid, and then to glycerine. The postabdominal structures were separated from the rest of the abdomen. Examination and illustration of the structures were done using a microscope and a stereomicroscope with a camera lucida attached to it. Dissected terminalia were placed in glycerine, inside microvials pinned beneath the respective specimens. The terminology in the descriptions follows Cumming and Wood (2009). The following abbreviations are used

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in the description: M = medial vein; R₄₊₅ = branch 4 and 5 of radius. Images were stacked using an auto-montage setup acquired by the Taxonline project (UFPR – <http://www.taxonline.ufpr.br/>). The distribution map was produced using the software QuantumGIS (available in: <http://www.qgis.org/en/site/>). The biogeographical regions follow Morrone (2014) and the shapefile used was available by Löwenberg-Neto (2015).

We added the new species of *Drepanocnemis* and one character (character 19) to the matrix of Couri and de Carvalho (2008), which originally contained 25 morphological characters. We also added a new character state to character 5 of that matrix. As in Couri and de Carvalho (2008), five species were used as outgroups, one Anthomyiidae (*Pegomya notate* Albuquerque, 1957 – Neotropical), and four Muscidae: *Spilogona golbachii* Snyder, 1957 (Limnophorini, Neotropical), *Pygophora nigribasis* (Stein, 1915) (Coenosiini, *Lispocephala*-group, Oriental), *Anaphalanthus longicornis* (Macquart, 1843) and *Neodexiopsis neoaustalis* Snyder, 1957 (Coenosiini, *Coenosia* – group, respectively Afrotropical and Neotropical).

The characters were coded as either binary or multistate and were treated as unordered (Table 1). Information that was not available was coded as a question mark (?). A cladistics analysis using parsimony was performed with TNT (Tree analysis using New Technology), version 1.5 (Goloboff and Catalano, 2016). Cladograms were produced using heuristic search with the command Implicit enumeration to search for the most parsimonious cladogram. The parameters used were on default mode. Fast character optimization and tree edition were performed using WinClada version 1.00.08 (Nixon, 2002) (Table 2).

Results and discussion

Taxonomy

Drepanocnemis Stein, 1911

Type-species, *dorae* Stein (Malloch, 1928).

Diagnosis: Dichoptic. Distance between eyes widening to vertex. Eye large, gena is narrower than flagellum. Upper frontal pair of setae directed out and backwards. Antenna inserted at level of middle of eyes. Arista long, very finely pubescent. Labella

reduced, prestomal teeth developed. Lower proepimeral seta directed upwards. Dorsocentrals 1 + 3; intralars 2; prealar absent; katepisternum with many ground setae; 0 + 1 in males and 1 + 1 + 1 in females. Prosternum, propleuron, anepimeron and meron bare. Lower calypter about twice as large as upper one. Fore tibia with a long anterodorsal seta close to base. Male fore tibia very broad with long submedian seta on anterodorsal surface and long sub-basal seta on posterodorsal surface. Mid tibia with one median posterior seta. Wing veins bare. Veins R₄₊₅ and M parallel at apex. Anal vein short. Sternite 1 bare. Male with hypandrium tubular, and female with long ovipositor covered with microtrichia; tergites and sternites slender.

Distribution: Bolivia (Sorata, Mapiri), Colombia (Pasto), Ecuador (Pichincha Province) and Peru (Chanchamayo, Cusco, Huariaca, Madre de Dios, Tarma).

Key to the males of *Drepanocnemis* Stein species (modified from Couri and de Carvalho, 2008)

1. Eyes densely covered by short cilia; fore tibia with long median anterodorsal seta 2
- Eyes bare; fore tibia with long sub-basal anterodorsal seta 3
2. Frons brown; calypter yellowish-white; wing not infuscated; anepisternum covered by long and numerous cilia [Peru, Bolivia] *D. hirticeps* Stein
- Frons with golden copper pollinosity; calypter dark brown; wing infuscated; anepisternum covered by short and not numerous cilia [Peru] *D. aurifrons* sp. nov.
3. Frons brown; two dorsal abdominal spots [Peru] *D. dorae* Stein
- Frons densely grey-green dusted; one dorsal abdominal spot [Peru, Ecuador] *D. griseovirens* Malloch

Drepanocnemis aurifrons sp. nov.

(Figs. 1–13)

Diagnosis: Eyes densely covered by short cilia. Frons and fronto-orbital plate with golden copper metallic reflex. Fore femur on anteroventral, ventral and posteroventral surfaces with a row of fine and long setae. Fore tibia with a long median anterodorsal seta; posterodorsal surface with a long median seta; dorsal surface with a row of short setae; posterior surface with a long and fine preapical seta, posteroventral surface with three median to submedian setae. Ventral to anteroventral surface of hind femur with a supra-median differentiated area, with a group of pale short setae.

Table 1

Characters and character states used in the cladistics analysis of *Drepanocnemis* species (modified from Couri and de Carvalho, 2008).

Number	Character	States
1	Male frons	(0) Holoptic; (1) dichoptic
2	Cilia on eye	(0) Absent; (1) present
3	Cilia on arista	(0) Present along its whole length; (1) present only in basal half
4	Ors proclinate in female	(0) Present; (1) absent
5	Colour of pollinosity on frons	(0) Brown; (1) grey-green; (2) golden
6	Labella	(0) Developed; (1) reduced
7	Development of prestomal teeth	(0) Weakly developed; (1) greatly developed
8	Lower proepimeral seta	(0) Upcurved; (1) downcurved
9	Prealar seta	(0) Present; (1) absent
10	Pre-sutural dorsocentral setae	(0) 2; (1) 1
11	Post-sutural intralar setae	(0) Long; (1) reduced
12	Disposition of katepisternal setae in male	(0) 1 + 2; (1) 1 + 1 + 1; (2) 0 + 1
13	Disposition of katepisternal setae in female	(0) 1 + 2; (1) 1 + 1 + 1
14	Cilia on inferior portion of scutellum	(0) Present; (1) absent
15	Length of anal vein	(0) Long, reaching wing margin; (1) short
16	Fore tibia of male	(0) Not modified; (1) modified, very broad
17	Anterodorsal long seta on male fore tibia	(0) Absent; (1) present
18	Position of long anterodorsal setae on fore tibia	(0) Sub-basal; (1) almost median
19	Calypter colouration	(0) Yellowish white; (1) dark brown
20	Number of preapical setae on dorsal surface of hind femur	(0) 2; (1) 3
21	Spots in abdominal tergites	(0) Paired, not fused; (1) fused
22	Shape of hypandrium	(0) Plate-like, not tubular; (1) tubular
23	Length of female ovipositor	(0) Moderately long; (1) short; (2) long
24	Shape of female cerci	(0) Short and round; (1) medium to long and slender
25	Hypoproct	(0) Reduced; (1) developed
26	Shape of female tergites 6 and 7	(0) One broad plate; (1) two broad plates; (2) intermediate to slender plates

Table 2Data matrix of 26 characters used in the cladistics analysis of *Drepanocnemis* species.

	1													2												
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
<i>Pegomya notate</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spilogona golbachii</i>	0	0	0	1	0	1	1	0	0	1	1	0	0	?	0	0	0	1	0	0	0	1	0	0	0	0
<i>Pygophora nigribasis</i>	1	0	1	0	0	1	1	1	1	1	1	1	0	0	?	?	0	0	0	1	1	0	1	0	1	0
<i>Anaphalanthus longicornis</i>	1	0	0	1	0	1	1	1	1	1	1	1	0	0	?	?	0	0	1	2	1	1	2	1	1	2
<i>Neodexiopsis neoaustralis</i>	1	0	0	1	0	1	1	1	0	1	1	1	1	0	0	?	0	1	0	1	2	1	1	2	1	2
<i>Drepanocnemis doriae</i>	1	0	0	1	0	1	0	0	2	?	?	1	1	1	0	?	1	0	?	?	?	?	?	?	?	?
<i>Drepanocnemis hirticeps</i>	1	1	0	1	0	0	1	0	0	2	1	1	1	1	0	1	1	?	2	1	1	2	1	1	2	1
<i>Drepanocnemis griseovirens</i>	1	0	0	1	0	1	0	0	2	1	1	1	1	0	0	1	1	1	2	1	1	2	1	1	2	1
<i>Drepanocnemis aurifrons</i> sp. nov.	1	1	0	1	2	0	1	0	1	0	0	2	1	1	1	1	0	1	1	1	2	1	1	2	1	2

Note: 0, 1 and 2, character states; ?, missing data. The character states follow [Couri and de Carvalho \(2008\)](#).

Description. Male (holotype): length: body: 3.5 mm; wing: 3.6 mm. Male morphological variations: Body length: 3.0–3.5 mm; wing length: 3.3–3.6 mm. Head with 6–7 frontal setae; row of 6–7 setae on anepisternum; acrostichals setae ranging from $\frac{1}{4}$ to half of the length of dorsocentral setae. General colouration: dark brown with grey pollinosity, frons and fronto-orbital plate with golden copper metallic reflex. Face dark brown with a lightly grey reflex. Antenna dark brown, pedicel with grey pollinosity. Palpus and legs brown, with grey and golden pollinosity. Thorax dark brown with

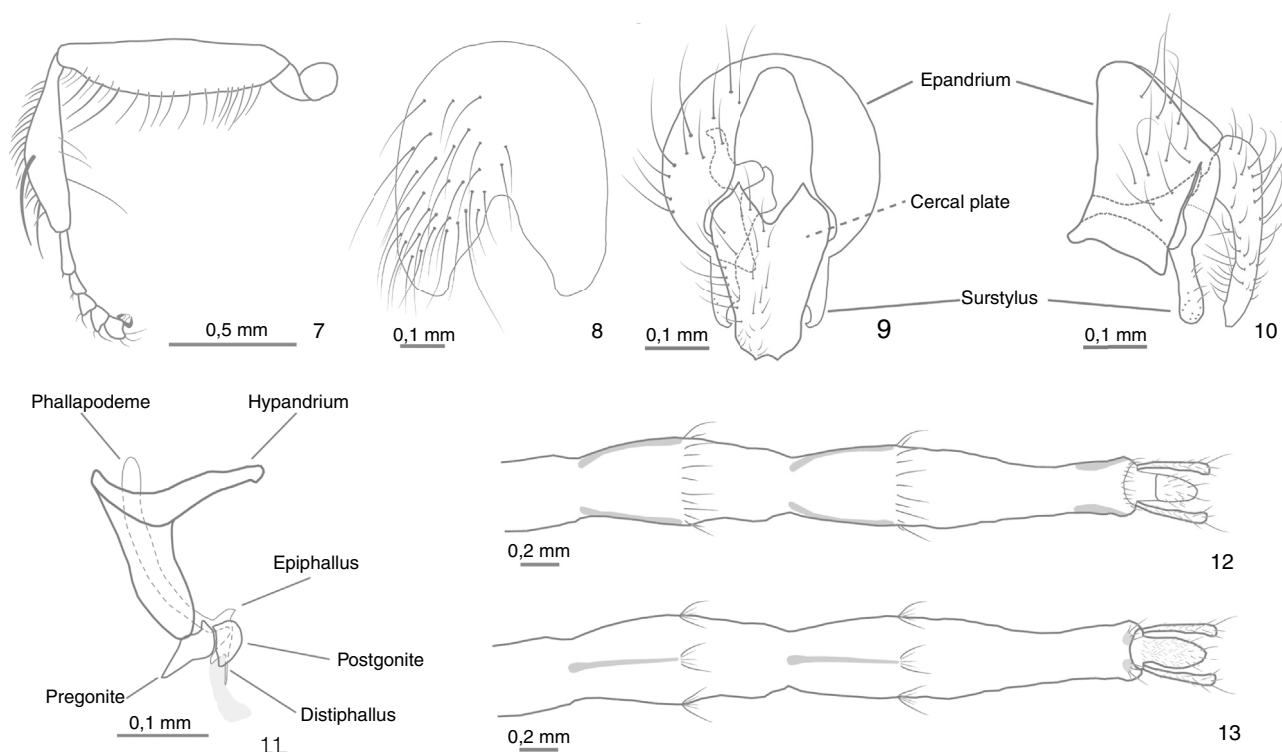
grey reflex under certain lights. Calypter dark brown; halter yellow. Wings smoky, mainly on costal region. Abdomen uniformly dark brown.

Head: Dichoptic, eyes densely covered by short cilia, separated by a space measuring about one third of head width at vertex. Frontal setae with about six pairs of setae, the two upper ones longer, with about twice the length of the others. Ocular setae long and fine. Outer vertical seta strong. Antenna long not reaching epistome; flagellum measuring about twice the length of the pedicel. Arista finely pubescent only on the base. Palpus a little enlarged to the tip. Gena almost linear. Vibrissa long and strong, with many sub-vibrissal strong setae, with half the length of the vibrissa ([Figs. 1 and 2](#)).

Thorax: postpronotum hairy. Acrostichals 2+3 series, with misaligned pairs; postpronotal lobe covered with setulae; lower proepimeral seta directed upwards; dorsocentrals 1+3; two intralars postsutural; one supralar postsutural; prealar absent. Notopleuron with two setae of almost the same length. Scutellum with one long basal and one long apical pair of setae of similar length. Anepisternum covered by cilia, with a series of about six setae. Katepisternum setae 0+1 and covered by setae. Lower calypter about twice the length of the superior ([Figs. 3 and 4](#)). Wing veins bare; R_{4+5} and M parallel at apex. Fore femur bare on dorsal and anterodorsal surfaces; a row of fine and long setae on anteroventral, ventral and posteroventral surfaces. Fore tibia with



Figs. 1–6. *Drepanocnemis aurifrons* sp. nov., male holotype: (1) head, anterior view; (2) head, lateral view; (3) lateral view, male paratype; (4) dorsal view, female paratype; (5) head anterior view; (6) lateral view. Scale: 0.5 mm.



Figs. 7–13. *Drepanocnemis aurifrons* sp. nov., male: (7) fore leg, posterior view; (8) sternite 5, dorsal view; (9) epandrium, cercal plate and surstyli, dorsal view; (10) epandrium, cercal plate and surstyli, lateral view; (11) hypandrium and associated structures, lateral view; female: (12) ovipositor, dorsal view; (13) ovipositor, ventral view.

numerous short setae on anterior surface; anteroventral surface bare; series of short and strong setae on dorsal surface; a long median seta on posterodorsal surface; a long and fine preapical seta on posterior surface; three fine median setae on ventral surface. Fore tarsomeres laterally flattened with a strong and short apical seta and a lateral pair weaker on each tarsomere, the three more apical are more flattened. Claws and pulvilli short (Fig. 7). Mid femur with a series of long setae on basal half on anteroventral, ventral and posteroventral surface; two preapical setae on posterior surface. Mid tibia with a long posterior median seta. Hind femur on apical half with five long anteroventral to ventral setae; short close cilia on posteroventral and anteroventral surfaces; two strong basal setae on posteroventral surface; a median differentiated area with a group of short setae on ventral surface. Hind tibia with one median anterodorsal and one preapical dorsal setae.

Abdomen: covered by short cilia. Tergite 5 with two pairs of long setae. Sternite 5 with long setae on disc, except at middle and base (Fig. 8). Terminalia: cercal plate longer than wide, about the same length of surstylus; presence of setae on inner and external surface of cercal plate; surstylus a little enlarged at apex with presence of few setae; (Figs. 9 and 10). Phallic complex with long hypandrium (Fig. 11).

Female: length. Body: 3.2–3.6 mm; wing: 3.4–3.6 mm. Similar to male, differing as follows: frons brown (sometimes lighter); wing not smoked on costal region; lower calypter light brown; katepisternal setae 1:1:1 disposed as an equilateral triangle; postpronotal lobe with two setae, the lower about twice the length of the upper one. Legs not modified, fore tibia and tarsomeres not broad, submedian posterodorsal seta shorter, about half length of male, submedian row of posteroventral setae absent, dorsal row of short and strong setae absent, tarsomeres without short and strong dorsal setae on apex; mid tibia with a long submedian anterodorsal seta, hind femur with two long anteroventral to ventral setae on

apical half, posteroventral surface without strong basal setae and mid femur with a long median ventral seta (Figs. 5 and 6). Ovipositor long with many dorsal and ventral microtrichia on both sides; tergites and sternites thin (Figs. 12 and 13). Three round spermathecae.

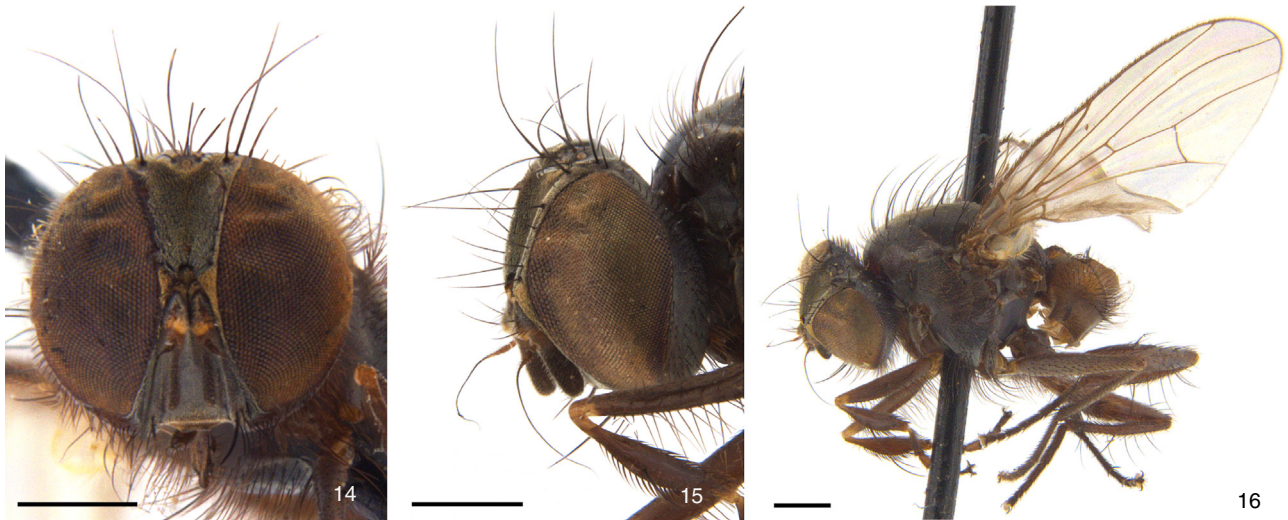
Type material. Holotype. Male (USNM), “PERU: Cuzco, Est. Biol.\Wayqecha, jct.Trochas\Schefflera & Picaflor,\Malaise trap, WP 583,\13.17385 S 71.58808\W, 2905 m. 1–12 Jun\2012, A. L. Norrbom, B.\D. Sutton, B. Luz Puma\& C. Quispe.”

Paratypes. 47 males and 130 females (USNM, DZUP, MNRJ). “PERU: Cuzco, Est. Biol.\Wayqecha, jct.Trochas\Schefflera & Picaflor,\Malaise trap, WP 583,\13.17385 S 71.58808\W, 2905 m. 1–12 Jun\2012, A. L. Norrbom, B.\D. Sutton, B. Luz Puma\& C. Quispe”; 9 males and 15 females (USNM, DZUP, MNRJ), “PERU: Cuzco, Est. Biol.\Wayqecha, cabins área\Malaise trap, WP 511,\13.17456 S\71.58707\W, 2924 m. 1–12 Jun 2012, A. L.\Norrbom, B. D. Sutton,\B. Luz Puma\& C. Quispe”; 2 males and 8 female (USNM, DZUP), “PERU: Cuzco, Est. Biol.\Wayqecha, Trochas Oso\Near 2nd landslide,\Malaise trap 6, WP 532,\13.1845 S 71.58459\W\2806 m. 8–11 Dec 2011\Norrbom, Steck, Sutton\& Nolasco”; 1 male and 4 females (USNM, DZUP), “PERU: Cuzco: Estacion\Biologica Villa Carmen,\Trail 8 mark 8–1654,\-12.5409 S -7.2431 W\[-70.2431, error]\707 m trap VC-ML-14,\27 Nov 2012–20 Jan\2013, A. L. Norrbom, E.\Rodriguez, G. J. Steck,\B. D. Sutton”.

Distribution: Peru, Cuzco.

Etymology: The species epithet, *aurifrons*, refers to the golden colouration of the frons (from the latin *auri* = golden; *frons* = face). It an adjective and agrees in gender with the feminine *Drepanocnemis*.

Remarks: *Drepanocnemis aurifrons* sp. nov. is similar to *D. hirticeps* (Figs. 14–16) and can be separated from it by the golden copper pollinosity of the male frons, calypter dark brown; wing dark brown infuscated; postpronotum without long differentiated seta; notopleuron with two setae of almost the same length; anepisternum covered by shorter and less numerous cilia.



Figs. 14–16. *Drepanocnemis hirticeps* Stein, 1911, male lectotype: (1) head, anterior view; (2) head, lateral view; (3) lateral view. Scale: 0.5 mm.

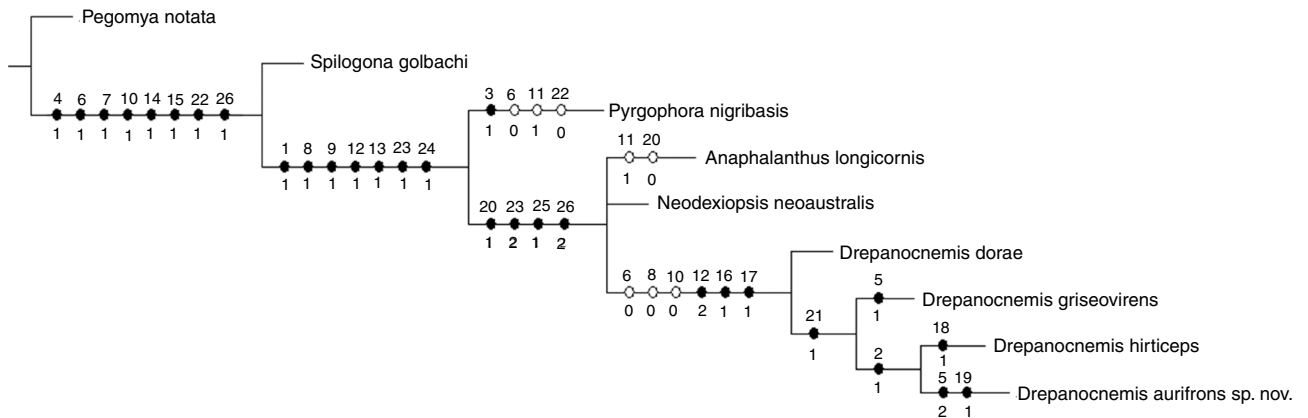


Fig. 17. Strict consensus tree of *Drepanocnemis* species with outgroups *Pegomya notata*, *Spilogona golbachii*, *Pyrgophora nigribasis*, *Anaphalanthus longicornis* and *Neodexiopsis neoaustralis*. Tree length = 37, consistency index = 0.81, retention index = 0.78. Black circles, synapomorphies; clear circles, homoplasies.

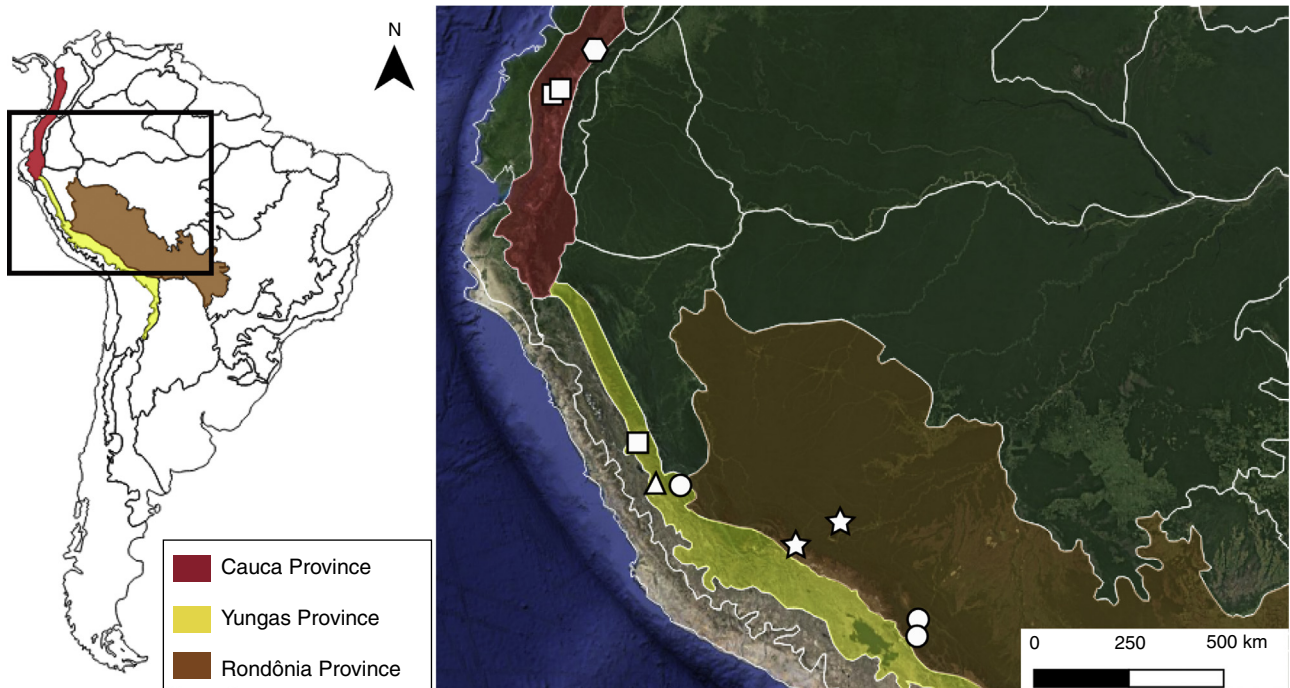


Fig. 18. Geographic distribution of *Drepanocnemis* species on Pacific dominion and South Brazilian dominion (Morrone, 2014). Symbols: triangle (*D. dora*); circle (*D. hirticeps*); square (*D. griseovirens*); star (*D. aurifrons* sp. nov.); hexagon (*Drepanocnemis* sp.).

Cladistic analysis

The analysis estimated two topologies with 36 steps, consistency index 0.83, retention index 0.81 (not shown). The consensus tree was generated with 37 steps, Ci 0.81, Ri 0.78 (Fig. 17). The results are entirely congruent with the relationships found by Couri and de Carvalho (2008). In the outgroup, the polytomy including *Anaphalanthus longicornis* and *Neodexiopsis neoaustralis* was maintained. *Drepanocnemis* is a monophyletic group, supported by three synapomorphic male characters: number and position of katepisternal seta (0 + 1), presence of one long anterodorsal setae on fore tibia, and fore tibia very broad. *Drepanocnemis dora*e is the sister group of the clade *D. griseovirens* + (*D. hirticeps* + *D. aurifrons* **sp. nov.**), supported by fused spots on the abdominal tergites. *Drepanocnemis griseovirens* is the sister group of the clade *D. hirticeps* + *D. aurifrons* **sp. nov.**, supported by the colour of the frontal pollinosity, greyish. The clade *D. hirticeps* and *D. aurifrons* **sp. nov.** is supported by the ciliated eyes. *Drepanocnemis aurifrons* **sp. nov.** can be separated from *D. hirticeps* by the golden pollinosity on frons, calypters dark brown and a submedian, long anterodorsal seta on fore tibia.

Drepanocnemis distribution

Some changes in the generic distribution presented by Löwenberg-Neto and de Carvalho (2013) have resulted from this work; a specimen identified as *D. dora*e from Pasto (Nariño, Colombia) has been re-identified as *Drepanocnemis* sp., since we cannot be sure of the identity of this poorly preserved female specimen. Additionally, the geographical coordinates of *D. griseovirens* from Huariaca (Pasco, Peru), which were incorrect, have been corrected to 10.2798S, 76.1911W. *Drepanocnemis* is found in two biogeographical regions: Pacific dominion (Cauca province) and South Brazilian dominion (Rondônia and Yungas province) (Fig. 18) (see Morrone, 2014). Before this contribution, species of the genus were only found in high altitudes, from 3000 m (*D. griseovirens*) to 5000 m (*D. hirticeps*) (Couri and de Carvalho, 2008). *Drepanocnemis aurifrons* **sp. nov.** is also found in high altitudes (2924 m), but can be found in altitudes as low as 707 m, the lowest recorded for a species of the genus.

Conflicts of interest

The authors declare no conflicts of interest.

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