

## New species of the genus *Cheiroseius* (Acarina, Parasitiformes, Gamasina, Ascidae) from tropical rain forests of Ecuador, South America

Wolfgang Karg<sup>†</sup> and Anita Schorlemmer<sup>1,\*</sup>

<sup>†</sup> Department of Cell Biology, John A. Burns School of Medicine, University of Hawaii, 651 Ilalo Street, Honolulu HI 96813, USA

\* Corresponding author, e-mail: schorlem@hawaii.edu

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### Abstract

The present studies continue our acarological investigations of soil inhabiting Parasitiformes from South and Central America. We discovered very remarkable species of the genus *Cheiroseius* Berlese, 1916 (Gamasina, Ascidae) from Ecuador. We explain the function of special organs of *Cheiroseius* and outline the significance of Parasitiformes in soil biology. Two new species of the subgenus *Cheiroseius* Berlese, 1916 s. str. and three new species of the subgenus *Episeius* Hull, 1918 are described and illustrated. Diagnoses of the genus *Cheiroseius* and the subgenera are given. We further generate keys for known and new species of the *Cheiroseius tennesseensis*-complex and the *Cheiroseius necorniger*-complex.

**Keywords** Acari | Ascidae | new species | taxonomy | keys for determination | functional relations | bio-indicator

### 1. Introduction

**Fundamentals.** Over the last decades, our soil-zoological studies focused on the analysis of soil samples from South and Central America (Karg 1994, 1997, 2003, 2006, 2007, Karg & Schorlemmer 2009, 2011). The late A. Zicsi, formerly University of Budapest, sent us samples from Acarina, cohorts Gamasina. As an essential basis for these studies served the internationally compiled annual series *Bibliographia Acarologica*, published by Axel Christian from the Senckenberg Museum für Naturkunde Görlitz. These studies also show that systematics by Kranz & Walter are not always based on phylogenetic findings but convergent similarities (Note by Christian & Karg 2006: The predatory mite genus *Lasioseius*, p. 102).

**Genus *Cheiroseius*.** Species of *Cheiroseius* prefer moist habitats located near brooks or pools in moss or litter (Karg 1981, 1982, 1998). Adult females of *Cheiroseius* are phoretic on flies colonizing these

habitats (Krantz & Walter 2009). They orient themselves by moving leg I up and down. Leg I is equipped with apical thin tactile setae and tubular setae which allow for the receiving of chemical and olfactory stimuli (Fig. 1A). Simultaneously, special ambulacra with lobate pulvilli of leg II to IV enable the mites to move over the moist substrata (Fig. 1B). The chelicerae are formed like tweezers (Fig. 2). With these mouth parts, the animals are able to pull out Nematodes from moist substrates. Species of *Cheiroseius* are specialized in this type of prey (Karg 1962, 1968, 1973). Further, the prominently developed peritremes of *Cheiroseius* are remarkable (Figs 5, 6, 7). They allow respiration under very wet conditions of the soil strata.

The genus was revised by Evans & Hyatt (1960), Karg (1981, 1998), chaetotaxy after Evans (1963). Karg (1981) divided the genus into two subgenera: subgenus *Cheiroseius* Berlese, 1916 s. str. and subgenus *Episeius* Hull, 1918 (Syn.: *Posttrematus* Karg, 1981). Dividing

the genus taxonomically activated an old synonym of *Cheiroseius*: *Episeius* Hull, 1918. This old name has priority and is used for the new subgenus.

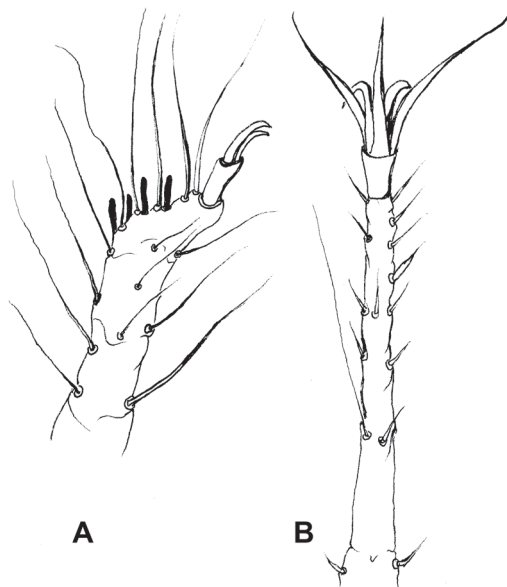
According to soil biology, the presence of this genus represents a suitable bio-indicator for decaying processes under wet and damp conditions (Karg 1982). We have found species of the genus in high numbers in soils of tropical rain forests, both, high in numbers of individuals as well as species, compared to European habitats (Karg 1998).

In samples from Ecuador, the genus *Cheiroseius* proved especially species-rich (Karg 1998). The number of individuals was relatively low. Nine sample sites contained 17 species, of which 16 were novel species. In the present analysis, the last three samples of this series were assessed. Five new species were described.

## 2. Material and methods

Prior to studying, the mites are treated with a mixture of hot glycerine and acetic acid. Subsequently, they are mounted in glycerine, studied and drawn. For preservation, the Holotypes and paratypes are mounted in polyvinyl-lactophenol. The chaetotaxy of dorsum and venter follows Christian & Karg (2008).

**Deposition of types:** Holotypes and paratypes are deposited in the Acarological Collection of the Senckenberg Museum für Naturkunde Görlitz.



**Figure 1.** Ambulacra of tarsi, (A) at tarsus I with thin tactile setae – 43 to 68  $\mu\text{m}$  long; (B) at tarsi II, III, IV with slender and markedly acute pulvilli – 37 to 47 long; (A) female of *Cheiroseius christiani* n. sp. (B) female of *Cheiroseius macrotarsus* n. sp.

## 3. Results

### Genus *Cheiroseius* Berlese, 1916

**Typus species:** *Sejus viduus* C. L. Koch, 1839

**Diagnosis:** Ambulacra of Legs II-IV well developed, each leg consists of a pair of claws and three slender pulvilli markedly pointed, an adaptation for movement over a moist substratum, relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1, chelicerae formed like tweezers. Particularly characteristic are the serrated cross-ledges of the hypostom without lateral borders (Karg 1993, p. 269, Fig. 202 d), valid for all embryonal states. Note: While characteristic for the genus, the hypostom is not relevant for the distinction of species.

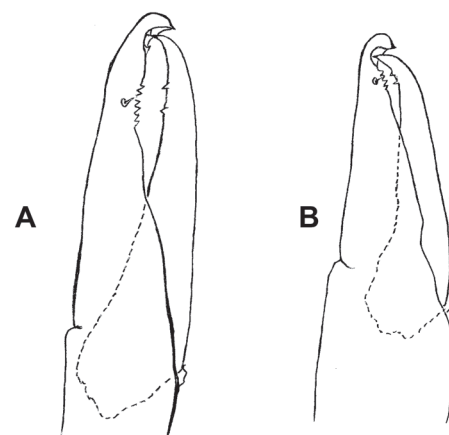
**1. Subgenus *Cheiroseius* Berlese, 1916 s. str.**

**Diagnosis:** Stigma situated between coxae III and IV, peritreme without posterior prolongation or with a short respectively slender posterior prolongation at most extending to about the middle of coxa IV.

**2. Subgenus *Episeius* Hull, 1918 (Syn.: *Posttrematus* Karg, 1981)**

**Diagnosis:** Stigma situated between coxae III and IV, peritreme with distinct posterior prolongation reaching beyond the posterior margin of coxa IV.

We detected two new species that belong to the Subgenus *Cheiroseius* Berlese, 1916 s. str. and three new species that belong to the Subgenus *Episeius* Hull, 1918.



**Figure 2.** Chelicerae of females: (A) *Cheiroseius macrotarsus* n. sp.; (B) *Cheiroseius christiani* n. sp. (see text for measuring values).

### 3.1. Subgenus *Cheiroseius* Berlese, 1916 s. str.

#### *Cheiroseius stigmaticus* n. sp.

**Material examined:** Holotypus ♀. Ecuador, 1987, Province Napo, Pusono, on the left banks of Rio Pusono, 300 m a.s.l., moss from tree stems, in the rainforest.

**Etymology:** As to the extremely large stigma.

**Diagnosis:** Leg I shorter than the length of idiosoma, tarsus I longer than tibia I, ventrianal shield bearing 5 pairs of setae, middle prolongation of the tectum nearly three times the length of the lateral prolongations, stigma extremely large, ventrianal shield some wider as long.

**Description:** Idiosoma ♀ 310 × 218 µm, oval, color brown.

**Dorsum:** Surface of the pro-dorsum reticulated, setae at the vertex 7–9 µm long, at the middle of the shield 20–30 µm long, most of dorsal setae 30–35 µm long and arise from small protuberances (Fig. 3A).

**Venter:** Ventrianal shield pentagonal, 129 µm wide, 95 µm long, bearing 5 pairs of setae, 15–17 µm long, postanal seta only 10 µm long, genital shield nearly as long as wide, genital setae 15 µm long, setae of the sternal shield 22 µm long, peritremes slender with a small, very short prolongation, however the stigma extremely large, in diameter as the anus, broad (Fig. 3B).

**Gnathosoma:** Tectum with three prongs which are forked apically, middle prong = 16 µm, lateral prongs = 6 µm long (Fig. 3C). Digitus mobilis of the chelicerae with two teeth, digitus fixus with three teeth.

Legs: I = 270, II = 209, III = 174, IV = 296 µm long corresponding to an idiosoma of 310 µm length, all of the tarsi with paired claws, at leg I shorter, tarsus I = 87 µm, tibia I = 44 µm long, setae mostly very short, apical touch-setae at tarsus I longer: 25–26 µm long. relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1 (Fig. 3D).

#### *Cheiroseius zicsii* n. sp.

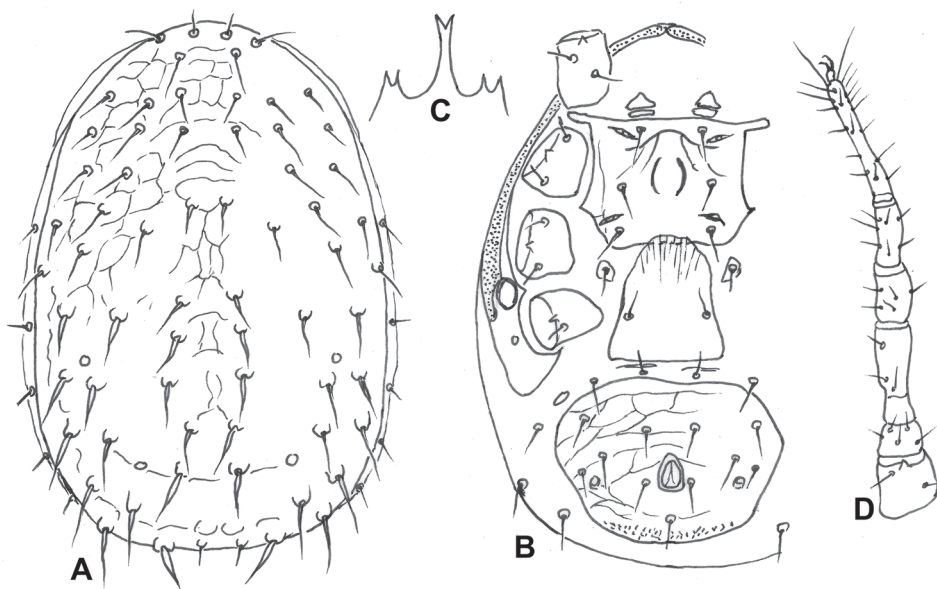
**Material examined:** Holotypus ♀. Ecuador, 1987, Province Napo, Pusono, on the left banks of Rio Pusono, 300 m a.s.l., moss from tree stems, in the rainforest.

**Etymology:** We name the species in honor of the late A. Zicsi from the research team of the University of Budapest who has sent us mites from South and Central America for our investigations of Parasitiformes.

**Diagnosis:** Leg I shorter than the length of idiosoma, tarsus I longer than tibia I, stigma extremely large, sternal shield with a reticulated area medially, ventrianal shield distinctly wider than long, width : length = 5 : 3 and bearing 5 pairs of setae, middle prolongation of the tectum remarkably longer than the lateral prolongations.

**Description:** Idiosoma ♀ 336 × 210 µm, oval, color brown.

**Dorsum:** Surface of the pro-dorsum reticulated, setae at the vertex 8 µm long, at the middle of the shield 30 µm long, most of dorsal setae 31–35 µm long and arise from small protuberances (Fig. 4A).



**Figure 3.** *Cheiroseius stigmaticus* n. sp. female, (A) dorsum; (B) venter; (C) tectum; (D) leg I (see text for measuring values).

Venter: Sternal shield with a reticulated area medially, sternal setae 18–22  $\mu\text{m}$  long, ventrianal shield pentagonal 145  $\mu\text{m}$  wide, 85  $\mu\text{m}$  long bearing 5 pairs of setae, 15–17  $\mu\text{m}$  long, postanal seta only 9  $\mu\text{m}$  long, genital shield wider than long, genital setae 15  $\mu\text{m}$  long, peritremes slender with a small, very short prolongation, however the stigma extremely large, in diameter as the half width of coxa IV (Fig. 4B).

Gnathosoma: Tectum with three prongs which are forked apical, middle prong = 12  $\mu\text{m}$ , lateral prongs = 9  $\mu\text{m}$  long (Fig. 4C). Digitus mobilis of the chelicerae with two teeth, digitus fixus with five teeth. Hypostome: Fig. 8A.

Legs: I = 280, II = 245, III = 231, IV = 205  $\mu\text{m}$  long appropriate an idiosoma of 336  $\mu\text{m}$  length, all of the

tarsi with paired claws, at leg I shorter than at tarsi II to IV, tarsus I = 91  $\mu\text{m}$ , tibia I = 39  $\mu\text{m}$  long, setae mostly very short: 7–12  $\mu\text{m}$  long, apical touch-setae at tarsus I longer: 26–28  $\mu\text{m}$  long, at tarsi of legs II to IV two thin macro setae: 26 and 34  $\mu\text{m}$  long respectively; relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1 (Fig. 4D).

The two new species, *Cheiroseius stigmaticus* n. sp. and *Cheiroseius zicsii* n. sp., belong to the ***Cheiroseius tennesseensis*-complex s. Karg (1998)**:

**Diagnosis:** Leg I shorter than the length of idiosoma, peritreme with a slender posterior prolongation, shorter than the diameter of coxa IV, tarsus I longer than tibia I, ventrianal shield bearing 4–5 pairs of setae (para-anal setae included).

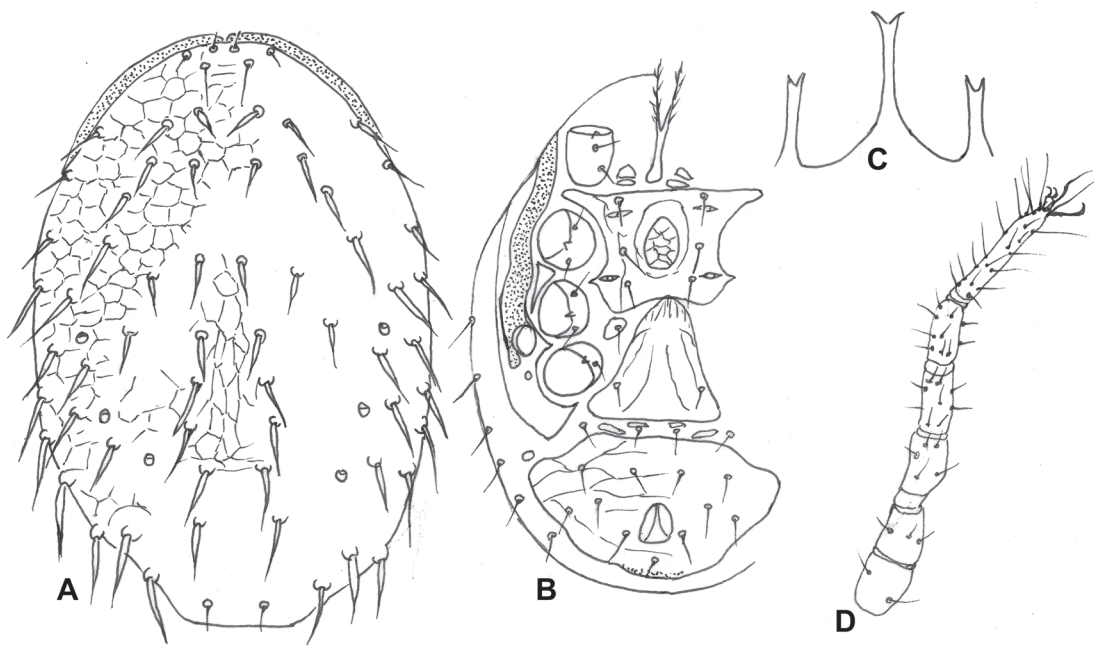


Figure 4. *Cheiroseius zicsii* n. sp. female, (A) dorsum; (B) venter; (C) tectum; (D) leg I (see text for measuring values).

### Key to the females of the *Cheiroseius tennesseensis*-complex – new and known species

- 1 (6) Ventrianal shield bearing 5 pairs of setae para-anal setae included .....
- 2 (5) Stigma at the peritreme exceptionally large, stigma diameter is  $\frac{1}{3}$  to  $\frac{1}{2}$  of the diameter of coxa IV .....
- 3 (4) Middle prolongation of the tectum nearly three times the length of the lateral prolongations, ventrianal shield somewhat wider as long: ..... *Cheiroseius stigmaticus* n. sp.
- 4 (3) Middle prolongation of the tectum at best twice the length of the lateral prolongations, stigma extremely large, in diameter =  $\frac{1}{2}$  the diameter of coxa IV, ventrianal shield distinctly wider than long, width : length = 5 : 3: ..... *Cheiroseius zicsii* n. sp.
- 5 (2) Stigma at the peritreme not enlarged, in diameter about  $\frac{1}{10}$  of the diameter of coxa IV: .....  
..... *Cheiroseius levicuspipidis* Karg, 1998
- 6 (1) Ventrianal shield bearing 4 pairs of setae para-anal setae included .....
- 7 (8) Middle prolongation of the tectum = three times the length of the lateral prolongations: .....  
..... *Cheiroseius brevivermis* Karg, 1998

- 8 (7) Middle prolongation of the tectum = at most twice the length of the lateral prolongations .....
- 9 (14) Middle prolongation of the tectum = 1½ to twice the length of the lateral prolongations .....
- 10 (13) Length of leg I = 300 to 370 µm .....
- 11 (12) Leg I with claws, dorsal setae simple, I4 relatively short, shorter than ½ distance I4 to I5: .....  
*Cheiroseius tennesseensis* (De Leon, 1964)
- 12 (11) Leg I without claws, dorsal setae lanceolate, I4 remarkably long reaching setae I5: .....  
*Cheiroseius browningi* (Evans et Hyatt, 1960)
- 13 (10) Length of leg I = 260 µm ..... *Cheiroseius siphonophorus* Karg, 1998
- 14 (9) Middle prolongation of the tectum only something longer than the length of lateral prolongations .....
- 15 (16) Dorsal shield covered by a reticulated pattern, leg I = 410 µm, tarsus I = 120 µm long: .....  
*Cheiroseius dungeri* Karg, 1971
- 16(15) Dorsal shield without a reticulated pattern, leg I = 440–470 µm, tarsus I = 104 µm long: .....  
*Cheiroseius bryophilus* (Karg, 1969)

**3.2. Subgenus *Episeius* Hull, 1918**

We detected three new species of the *Cheiroseius necorniger*-complex, see Karg (1998) and Faraji, Arjmandi-Nezhad & Karg (2008).

***Cheiroseius macrotarsus* n.sp.**

Material examined: *Holotypus* ♀. Ecuador, 1987, Province Napo, Pusono, on the left banks of Rio Pusono, 300 m a.s.l., moss from tree stems, in the rainforest.

Etymology: As to the remarkably long tarsus of the first legs, macros = long.

**Diagnosis:** Leg I distinctly longer than the length of idiosoma, tarsus I longer than tibia I, tarsus I = 210 µm, tibia I = 133 µm long, dorsal setae medium long, nearly as long as distance I1-I2 or longer, setae I4: 60 µm long, lateral setae on shield and on lateral skin especially long: = 60–70 µm and arise from small protuberances, peritremes remarkably broad, ventrianal shield 200 µm long and 255 µm wide.

**Description:** Idiosoma ♀ 713 × 417 µm, oval, color brown. Dorsum: Surface reticulated, within the areas of the network fine stroke-structures, setae at the vertex 26–27 µm, at the middle of the shield 45–47 µm, i2 and I4: 51–60 µm long, at the margin remarkably longer: 60–70 µm, posterior setae I5 = 22 µm long (Fig. 5A).

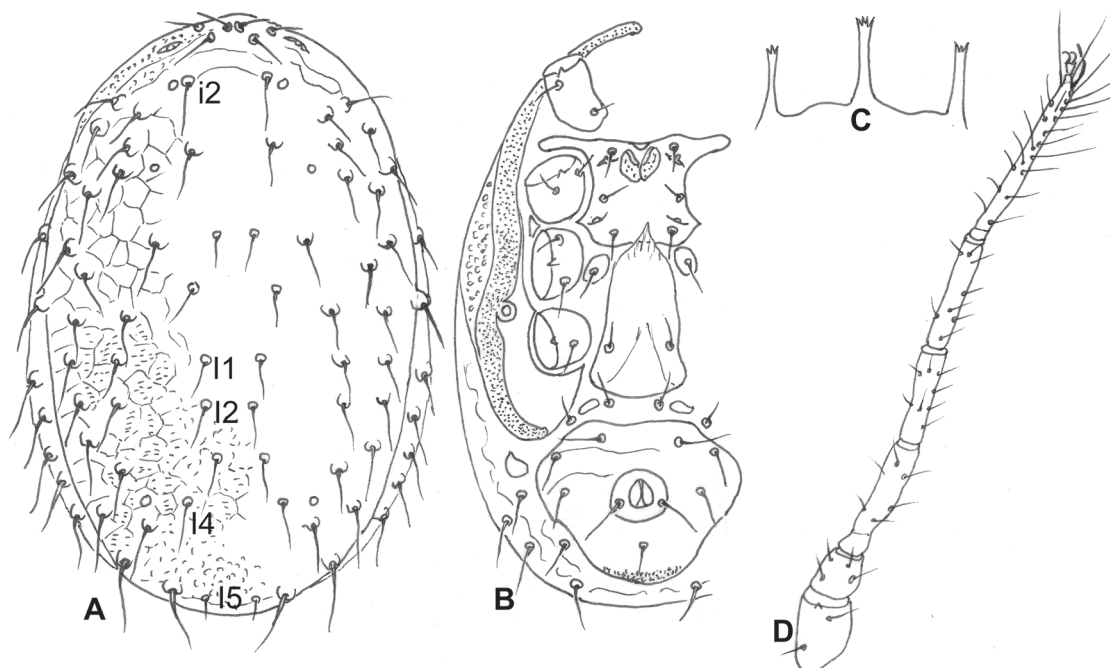


Figure 5. *Cheiroseius macrotarsus* n. sp. female, (A) dorsum; (B) venter; (C) tectum; (D) leg I (see text for measuring values).



Venter: Ventrianal shield nearly pentagonal, with 4 pairs of setae, 43–49  $\mu\text{m}$  long, postanal seta only 17  $\mu\text{m}$  long, genital shield nearly twice as long as wide, genital setae 30  $\mu\text{m}$  long, the pair of setae behind the shield 42  $\mu\text{m}$  long, setae of the sternal shield: 32–37  $\mu\text{m}$  long, semicircular depressions near its anterior margin connected with two oval figurations, peritremes broad, at the middle region distinctly broader than the anus, further lateral of the middle region a field of minute tubercles (Fig. 5B).

Gnathosoma: Tectum with three prongs which are apically finely dented, middle prong = 20  $\mu\text{m}$ , lateral prongs = 18  $\mu\text{m}$  long Fig. (5C), digitus mobilis of chelicerae = 98  $\mu\text{m}$  long, with two teeth; digitus fixus apical with a row of 5 small teeth and terminal one further tooth (Fig. 2A).

Legs: I = 757, II = 610, III = 592, IV = 827  $\mu\text{m}$  long as appropriate to an idiosoma of 713  $\mu\text{m}$  length, all of the tarsi with paired claws, tarsus at leg I shorter than at legs II to IV, tarsus I = 210  $\mu\text{m}$ , tibia I = 133  $\mu\text{m}$  long, setae mostly short: 14–18  $\mu\text{m}$  long, apical touch-setae at tarsus I longer: 73–77  $\mu\text{m}$  long. at tarsi II to IV most of setae short: 20–25  $\mu\text{m}$  long, at tarsi II and III one thin macro seta: 63  $\mu\text{m}$  long at tarsus IV two macro setae: 53 and 123  $\mu\text{m}$  long respectively, relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1 (Fig. 1B, 5D).

### *Cheiroseius christiani* n. sp.

**Material examined:** Holotypus ♀, 1 Paratypes ♀ Ecuador 1986, Province Cotopaxi, on the way to San Francisco de las Pampas, 2200 m a.s.l., moss from rock moistened continuously by a small spring.

**Etymology:** We name the species in honor of Axel Christian for the extraordinary facilitation of international collaboration and information in the field of Acarology.

**Diagnosis:** Leg I shorter than the length of idiosoma, tarsus I longer than tibia I, tarsus I = 144  $\mu\text{m}$ , tibia I = 77  $\mu\text{m}$  long, dorsal setae medium long nearly as long as distance II-12, peritremes slender, nearly half as broad as the anus width, ventrianal shield remarkably broad, 115  $\mu\text{m}$  long, 210  $\mu\text{m}$  broad.

**Description:** Idiosoma ♀ 531 × 374  $\mu\text{m}$ , oval, color brown.

Dorsum: Surface reticulated, setae at the vertex 10–30  $\mu\text{m}$ , at the middle of the shield 30–40  $\mu\text{m}$  long, most of dorsal setae 45–47  $\mu\text{m}$  long, posterior setae 15 = 46  $\mu\text{m}$  long. all setae arise from small protuberances (Fig. 6A).

Venter: Ventrianal shield pentagonal, with 4 pairs of setae, 43–49  $\mu\text{m}$  long, postanal seta only 17  $\mu\text{m}$  long, genital shield nearly twice as long as wide, genital setae 20  $\mu\text{m}$  long, the pair of setae behind the shield 25  $\mu\text{m}$  long, setae of the sternal shield 22–24  $\mu\text{m}$  long, semicircular depressions near its anterior margin connected with a relatively long middle line, peritremes slender, not as broad as the anus (Fig. 6B).

Gnathosoma: Tectum with three prongs which are forked apically, middle prong = 22  $\mu\text{m}$ , lateral prongs = 16  $\mu\text{m}$  long

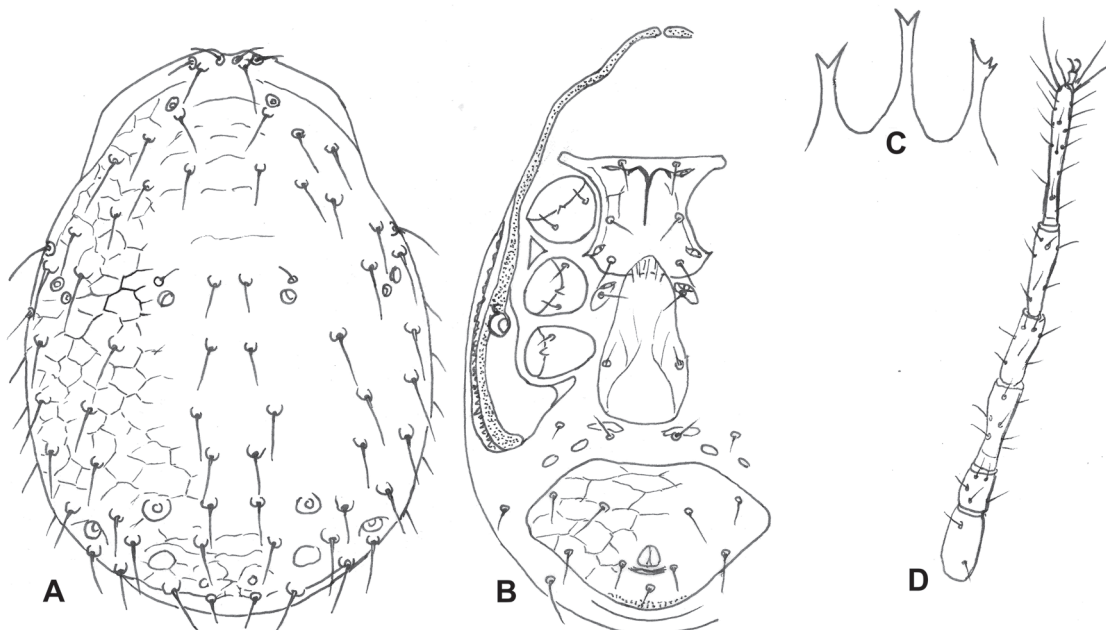


Figure 6. *Cheiroseius christiani* n. sp. female, (A) dorsum; (B) venter; (C) tectum; (D) leg I (see text for measuring values)

(Fig. 6C), digitus mobilis of chelicerae 51  $\mu\text{m}$  long with two teeth, digitus fixus with 4 teeth (Fig. 2B). Hypostome: Fig. 8B.

Legs: I = 496, II = 409, III = 348, IV = 470  $\mu\text{m}$  long appropriate an idiosoma of 531  $\mu\text{m}$  length, all of the tarsi with paired claws, at leg I shorter than at legs II to IV, tarsus I = 144  $\mu\text{m}$ , tibia I = 77  $\mu\text{m}$  long, setae mostly very short: 11–18  $\mu\text{m}$  long, apical touch-setae at tarsus I longer: 73–77  $\mu\text{m}$  long, most of setae at legs II to IV very short: 12 to 17  $\mu\text{m}$  long, at tarsi of legs II and III in each case three thin macro setae: 39, 32 and respectively 53  $\mu\text{m}$  long, at tarsi of leg IV macro setae longer: 35, 70 and respectively 115  $\mu\text{m}$  long, relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1 (Fig. 1A, 6D).

### *Cheiroseius macropos* n. sp.

**Material examined:** *Holotypus* ♀ Ecuador 1986, Province Pichinca, Pasochoa National Park 2800–2850 m a.s.l., wet moss cover of stones lying in the creek.

**Etymology:** As to the extremely long first leg, macros = long, podos = leg.

**Diagnosis:** Leg I extremely long, longer than the length of idiosoma, tarsus I shorter than tibia I, tarsus I = 260  $\mu\text{m}$ , tibia I = 305  $\mu\text{m}$  long, dorsal setae medium long, nearly as long as distance I2-I3, peritremes relatively broad, nearly as broad as the anus, ventrianal shield broad, 147  $\mu\text{m}$  long, 200  $\mu\text{m}$  broad.

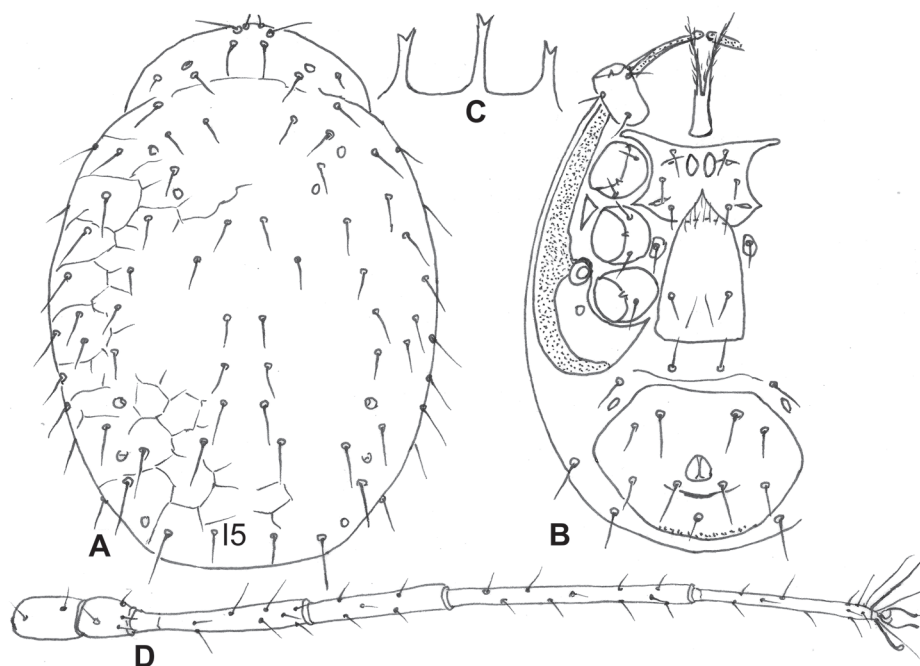
**Description:** Idiosoma ♀ 626  $\times$  444  $\mu\text{m}$ , oval, color brown.

**Dorsum:** Surface reticulated, setae at the vertex 7, 25, and 34  $\mu\text{m}$  long at the middle of the shield 24–35  $\mu\text{m}$  long, most of dorsal setae 43–45  $\mu\text{m}$  long, posterior setae I5 = 26  $\mu\text{m}$  long, all setae simple, needle like (Fig. 7A).

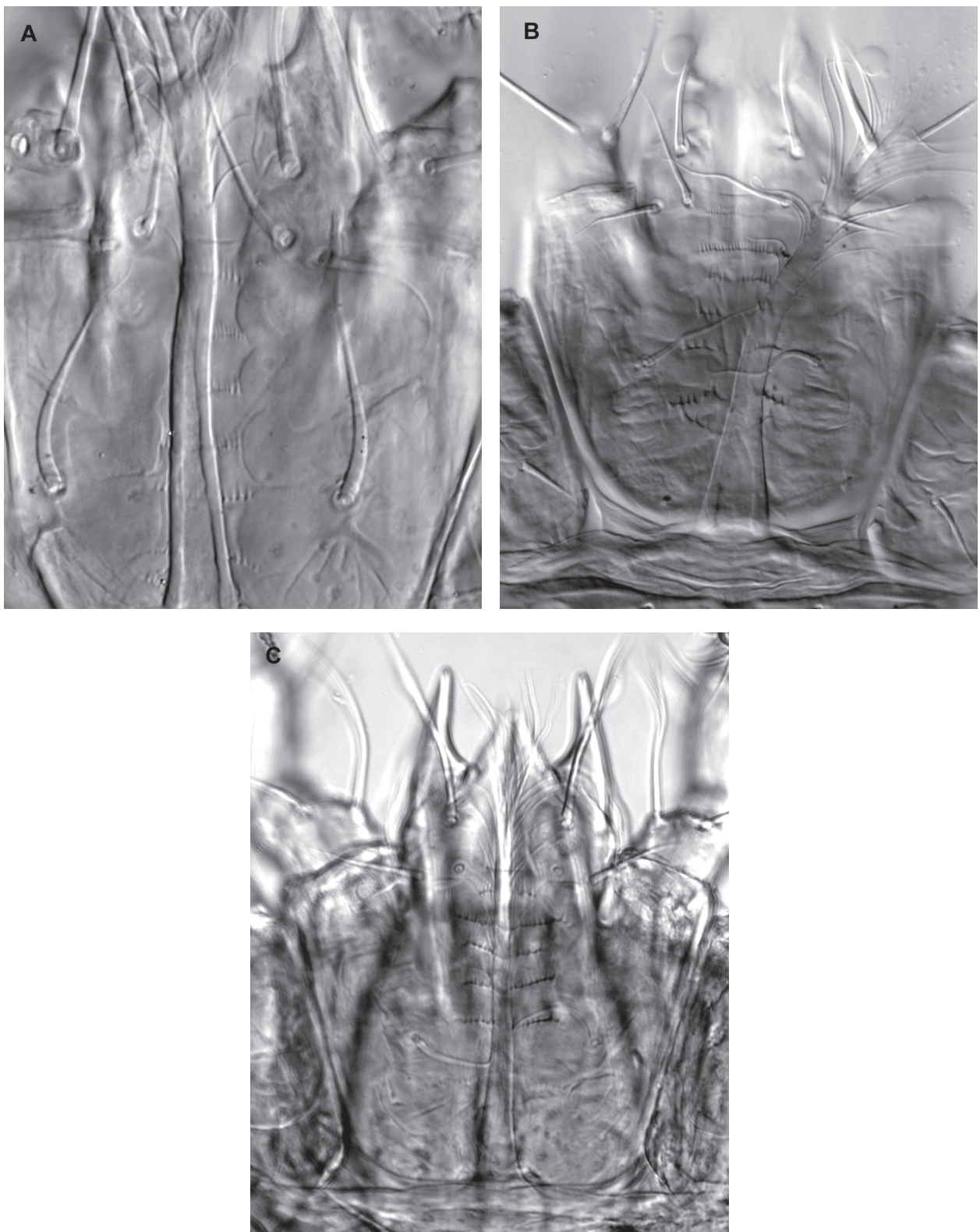
**Venter:** Ventrianal shield pentagonal, with 4 pairs of setae, 28–53  $\mu\text{m}$  long, postanal seta only 13  $\mu\text{m}$  long, genital shield nearly twice as long as wide, genital setae 14  $\mu\text{m}$  long, the pair of setae behind the shield 25  $\mu\text{m}$  long, setae of the sternal shield 18  $\mu\text{m}$  long, semicircular depressions near its anterior margin connected with two oval figurations, peritremes nearly as broad as the anus (Fig. 7B).

**Gnathosoma:** Tectum with three prongs which are forked apically, middle prong = 24  $\mu\text{m}$ , lateral prongs = 17  $\mu\text{m}$  long (Fig. 7C), digitus mobilis of chelicerae: 77  $\mu\text{m}$  long with two teeth, digitus fixus apically with a row of 6 small teeth and terminally one further tooth. Hypostome: Fig. 8C.

Legs: I = 1088, II = 550, III = 530, IV = 756  $\mu\text{m}$  long corresponding to an idiosoma of 626  $\mu\text{m}$  length, all of the tarsi with paired claws, at leg I shorter than at tarsi II to IV: 10  $\mu\text{m}$  long, tarsus I = 260  $\mu\text{m}$ , tibia I = 305  $\mu\text{m}$  long, setae mostly very short: 12–17  $\mu\text{m}$ , apical touch-setae at tarsus I longer: 50  $\mu\text{m}$  long, at tarsi II to III in each case two thin macro setae: 46 and respectively 53  $\mu\text{m}$  long, other setae short: 14 to 17  $\mu\text{m}$  long, relevant chaetotactic formulae of legs refer to tibia IV: X-type 2-1/1,3/1-2 and genu IV: IX-type 2-2/1,3/0-1 (Fig. 7D).



**Figure 7.** *Cheiroseius macropos* n. sp. female, (A) dorsum; (B) venter; (C) tectum; (D) leg I (see text for measuring values).



**Figure 8.** Hypostome: (A) *Cheiroseius zicsii* n. sp., (B) *Cheiroseius christiani* n. sp., (C) *Cheiroseius macropus* n. sp.; Photos: D. Goernert.





- 34(35)** Dorsal setae extremely short, no seta reaching the next seta in longitudinal rows, I3 = ½ distance I3-I4, ventrianal shield round, diameter less than twice the width of the genital shield: ..... *Cheiroseius sistaniensis* Faraji, Arjmandi-Nezhad et Karg, 2008
- 35(34)** Dorsal setae not extremely short, I3 = distance I3-I4, I1 not reaching I2, I2 not reaching I3, width of ventrianal shield = twice the width of the genital shield, digitus fixus of chelicerae in the distal half with a row of coarse teeth ..... *Cheiroseius serratus* (Halbert, 1915)
- 36(33)** Dorsal setae of middle length, I1 reaching I2, I2 reaching I3, I3 reaching I4, digitus fixus of chelicerae distal with a short row of fine teeth, width of ventrianal shield = 2 ½ the width of the genital shield: ..... *Cheiroseius mutilus* (Berlese, 1916)

#### 4. References

- Christian, A. & W. Karg (2006): The predatory mite genus *Lasioseius* Berlese, 1916 (Acari, Gamasina). – *Abhandlungen und Berichte des Naturkundemuseums Görlitz* **77** (2): 99–250.
- Christian, A. & W. Karg (2008): A revised setal nomenclature based on ontogenetic and phylogenetic characters and universally applicable to the idiosoma of Gamasina (Acari, Parasitiformes). – *Soil Organisms* **80** (1): 45–79.
- Evans, G. O. & K. H. Hyatt (1960): A revision of the *Platyseiinae* (Mesostigmata : *Aceosejidae*) based on material in the collection of the British Museum (Natural History). – *Bulletin of the British Museum (Natural History), Zoology*, London, **6** (2): 27–101.
- Evans, G. O. (1963): Observations on the Chaetotaxy of the legs in the free-living Gamasina (Acari: Mesostigmata). – *Bulletin of the British Museum (Natural History) Zoology*, London, **10** (5): 277–303.
- Faraji, F., A.-R. Arjmandi-Nezhad & W. Karg (2008): A new species of *Cheiroseius* Berlese (Acari, Gamasina, Ascidae) from Iran with a key to the species of *necorniger* species-complex. – *Zoosystematics and Evolution* **84** (2): 211–214.
- Karg, W. (1962): Zur Systematik und postembryonalen Entwicklung der Gamasiden (Acarina, Parasitiformes) landwirtschaftlich genutzter Böden. – *Mitteilungen aus dem Zoologischen Museum in Berlin* **38**: 25–119.
- Karg, W. (1968): Bodenbiologische Untersuchungen über die Eignung von Milben, insbesondere von parasitiformen Raubmilben als Indikatoren. – *Pedobiologia*: 30–49.
- Karg, W. (1971): Zur Kenntnis der Gattungen *Cheiroseius* Berlese und *Epicriopsis* Berlese (Acarina, Parasitiformes). – *Abhandlungen und Berichte des Naturkundemuseums Görlitz* **46** (6): 1–8.
- Karg, W. (1973): Zur Kenntnis der Ascidae Oudemans, 1905 (Acarina, Parasitiformes). – *Deutsche Entomologische Zeitschrift, Neue Folge* **20** (IV-V): 229–338.
- Karg, W. (1981): Die Raubmilbengattung *Cheiroseius* Berlese, 1916. – *Zoologische Jahrbücher, Systematik* **108**: 51–69.
- Karg, W. (1982): Untersuchungen über Habitatsprüche, geographischer Verbreitung und Entstehung von Raubmilbengattungen der Cohors Gamasina für ihre Nutzung als Bioindikatoren. – *Pedobiologia* **24**: 241–247.
- Karg, W. (1993): Acari (Acarina) Milben, Parasitiformes (Anactinochaeta) Cohors Gamasina Leach: Raubmilben. – *Tierwelt Deutschlands*, 59. Teil. Gustav Fischer Verlag, Jena, Stuttgart, New York, 523 pp.
- Karg, W. (1994): Raubmilben der Ascidae, Ameroseiidae Rhodacaridae und Macrochelidae auf dem Galapagos Archipel (Acarina, Parasitiformes). – *Mitteilungen aus dem Zoologischen Museum in Berlin* **70** (1): 113–131.
- Karg, W. (1996): Neue Arten aus Raubmilbengattungen der Gamasina Leach (Acarina, Parasitiformes) mit Indikationen zum Entwicklungsalter. – *Mitteilungen aus dem Zoologischen Museum in Berlin* **72** (1): 149–195.
- Karg, W. (1997): Zur Kenntnis der Raubmilbencohors Gamasina Leach (Acarina, Parasitiformes) tropischer und subtropischer Gebiete. – *Mitteilungen aus dem Zoologischen Museum in Berlin* **73** (1): 63–88.
- Karg, W. (1998): Neue Raubmilbenarten der Ascidae Oudemans, 1905 im tropischen Regenwald von Ecuador (Acarina, Parasitiformes). – *Mitteilungen aus dem Museum für Naturkunde in Berlin, Zoologische Reihe* **74** (1): 49–64.
- Karg, W. (2003): Neue Raubmilbenarten aus dem tropischen Regenwald von Ecuador mit einem kritischen Beitrag zur Merkmalsevolution bei Gamasina (Acarina, Parasitiformes). – *Mitteilungen aus dem Museum für Naturkunde in Berlin, Zoologische Reihe* **78**: 229–251.
- Karg, W. (2006): The systematics of Parasitiformes, especially of Gamasina Leach (Acarina), with new species from Ecuador. – *Mitteilungen aus dem Museum für Naturkunde in Berlin, Zoologische Reihe* **82** (1): 140–169.
- Karg, W. (2007): New taxonomic knowledge of soil-inhabiting predatory mites (Acarina, Gamasina: Rhodacaroidea, Dermanyssoidea, Ascoidea). – *Abhandlungen und Berichte des Naturkundemuseums Görlitz* **78** (2): 113–139.
- Karg, W. & Schorlemmer, A. (2009): New insights into predatory mites (Acarina, Gamasina) from tropical rain forests with special reference to distribution and taxonomy. – *Zoosystematics and Evolution* **85** (1): 57–91.
- Karg, W. & Schorlemmer, A. (2011): New insights into the systematics of Parasitiformes (Acarina) with new species from South America. – *Acarologia* **51** (1): 3–29.
- Krantz, G. W. & Walter, D. E. (eds.) (2009): *A manual of Acarology*, 3rd Edition. – Texas Tech University Press: 807 pp.