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New taxonomic knowledge of soil-inhabiting predatory mites (Acarina, Gamasina: Rhodacaroidea, Dermanyssoidea, Ascoidea)

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Abstract

Predatory Gamasina mites of the Rhodacaroidea, Dermanyssoidea and Ascoidea have been recorded world wide. New species from Venezuela, Ecuador and the Antarctic are described and documented. Keys are provided for all of the treated species complexes.

Rhodacaroidea: The *Protogamasellus*-complex Evans & Purvis, 1987 of the Rhodacaridae Oudemans, 1902 is revised, which includes the genera *Protogamasellus* Karg, 1962, *Protogamasellopsis* Evans & Purvis, 1987, *Protogamasellodes* Evans & Purvis, 1987 and *Protofurcatus* n. gen. The taxonomic characteristics are revaluated by comparing the *Protogamasellus*-complex with an economically relevant group of Acarina whose ecology had been investigated very intensively. Micro-differences are more strictly evaluated. One species from Venezuela is new. A second new species from Ecuador belongs to the Gamasiphidae Lee, 1970, genus *Gamasiphis* Berlese, 1904.

Dermanyssoidea: A new species of the genus *Pseudoparasitus* Oudemans, 1902, belonging to the Hypoaspididae Vitzthum, 1941 is described from Ecuador.

Ascoidea: Two new species of the Ascidae Voigts & Oudemans, 1905 are described from Ecuador, belonging to the genera *Cheiroseius* Berlese, 1916 and *Leioseius* Berlese, 1916. A new species of the Halolaelapidae Karg, 1965, genus *Halolaelaps* Berlese & Trouessart, 1883 originates from the Antarctic. The systematics of the related species, the *Halolaelaps celticus* species group, is analysed.

The origin and the development of soil-inhabiting Gamasina groups in the course of geological periods are discussed. Using historical zoogeography, it becomes obvious that ancient forms of this group have existed since the Permian and Triassic formation. Specialised forms, however, developed at the end of the Jurassic.

Keywords: taxonomy, systematics, soil-inhabiting mites

Zusammenfassung

Neue taxonomische Erkenntnisse über bodenbewohnende Raubmilben (Acarina, Gamasina: Rhodacaroidea, Dermanyssoidea, Ascoidea) – Gamasina-Raubmilben der Rhodacaroidea, Dermanyssoidea und Ascoidea wurden weltweit ermittelt. Neue Arten werden aus Venezuela, Ecuador und der Antarktis beschrieben und dokumentiert. Bestimmungsschlüssel für die behandelten Gruppierungen werden aufgestellt.

Rhodacaroidea: Der *Protogamasellus*-Komplex Evans & Purvis, 1987 der Rhodacaroidea wird revidiert. Zu dem Komplex gehören die Gattungen *Protogamasellus* Karg, 1962, *Protogamasellopsis* Evans & Purvis, 1987, *Protogamasellodes* Evans & Purvis, 1987 und *Protofurcatus* n. gen. Die taxonomischen Merkmale werden durch Vergleiche des *Protogamasellus*-Komplexes mit einer ökonomisch relevanten Gruppe der Acarina bewertet, deren Ökologie sehr eingehend untersucht wurde: Mikrounterschiede werden strenger bewertet. Eine Art aus Venezuela ist neu. Eine zweite neue Art aus Ecuador gehört zu den Gamasiphidae Lee, 1970, Gattung *Gamasiphis* Berlese, 1904.

Dermanyssoidea: Aus Ecuador wird eine neue Art der Gattung *Pseudoparasitus* Oudemans, 1902 ermittelt, die zu den Hypoaspididae Vitzthum, 1941 gehört.

Ascoidea: Es werden zwei neue Arten der Ascidae Voigts & Oudemans, 1905 aus Ecuador ermittelt: Gattung *Cheiroseius* Berlese, 1916 und Gattung *Leioseius* Berlese, 1916.

Eine neue Art der Halolaelapidae Karg, 1965, Gattung *Halolaelaps* Berlese & Trouessart, 1883 stammt aus der Antarktis. Die Systematik der verwandten Arten der *Halolaelaps-celticus*-Artengruppe wird analysiert.

Ursprung und Entwicklung von bodenbewohnenden Gamasina-Gruppen während des Verlaufs geologischer Perioden werden diskutiert. Durch die Anwendung der historischen Zoogeographie wird deutlich, dass ursprüngliche Formen der Gruppe seit dem Perm und der Trias existierten. Spezialisierte Formen dagegen entwickelten sich zum Ende des Jura.

1. Introduction

Step by step the extraordinary diversity of microscopic species living in the soil becomes obvious. In the limelight of investigations are predatory mites of the Gamasina Leach, which are acting at the end of food chains in the micro field (Walter & Proctor 1999). This group can therefore serve as an indicator for the diversity of microorganisms on the entirety of a certain biotope. They act as regulators in natural ecosystems (Karg & Freier 1995).

A revision of the Gamasina of Central Europe by Karg (1993a) accounted for 1000 species. According to worldwide revisions of single genera we can estimate that 8 times this number of species is known. This was shown by the example of the genus *Lasioseius* Berlese, 1916 (Christian & Karg 2006). Investigations of soil samples, however, yielded again and again new unknown species, especially in tropical rain forests (Karg 1996, 1998a, b, 2000a, b, 2006). Regularly recorded are species of the groups Rhodacaroidea, Dermanyssoidea and Ascoidea – very small forms inhabiting pores and capillaries of soil strata. In the present paper, new species from Ecuador are described and classified.

Taxonomic difficulties are caused by poor morphological differences between species which likely developed due to narrow microhabitats. It is sometimes not easy to evaluate morphological differences. For example, it can be uncertain if we have to classify a form as species or subspecies (Genis, Loots & Ryke 1967, Evans 1982). To solve this problem, we have to compare morphological differences in groups very precisely investigated both taxonomically and ecologically, these being mostly also of economic importance. This is demonstrated in the present paper.

Despite taxonomic difficulties, zoogeographic investigations of soil-inhabiting mites show remarkable results concerning the origin of special groups (Karg 1991, 1996, 2000a, b, 2003b). This is verified with regard to the presented groups.

2. Materials and methods

Predatory mites collected in South and Central America as well as in the Antarctic were sent to the author for classification. Before being studied, the mites were treated with a mixture of hot glycerine and acetic acid, then mounted in glycerine, studied and drawn. For preservation, the holotypes and in each case one or some paratypes were mounted in polyvinyl-lactophenol, remaining specimens were preserved in 70 % alcohol.

3. Deposition of types

Holotypes and paratypes are deposited in the scientific collections of the Staatliches Museum für Naturkunde Görlitz, 02806 Görlitz, Germany

4. Results and discussions

4.1. Rhodacaroidea Oudemans, 1903

4.1.1. Rhodacaridae Oudemans, 1903

Members of the Rhodacaridae belong to the most important soil-inhabiting Acarina. The highest diversity of species has been found in tropical regions (LEE 1970, KARG 1977b, 1979b, 1993b, 2000a). As habitats, they prefer soil strata of fields, meadows and forests. However, they have also been found in sand at the seaside, in garden mould and in rodent nests.

The *Protogamasellus*-group of the Rhodacaridae Oudemans, 1903 – The present investigations of mites yielded a new species from samples collected in rain forests of Venezuela,which inspired revision of the *Protogamasellus*-group.

EVANS (1982) and EVANS & PURVIS (1987) treated and established a group of species related to *Protogamasellus primitivus* Karg, 1962 and named it the *Protogamasellus*-group. EVANS & PURVIS (1987) included the group in the family of Ascidae sensu LINDQUIST & EVANS (1965). However, this family concept is a collective group of genera belonging to different systematic units. The group was established by plesiomorphic features.

»The Ascidae sensu Lindquist & Evans is not monophyletic« (WALTER 1998).

Based on a systematic-phylogenetic study on the Gamasina Leach (KARG 1965) the genus *Protogamasellus* Karg, 1962 was integrated into the family of Rhodacaridae Oudemans, 1903. Synapomorphic characteristics of the genera *Rhodacarus* Oudemans and *Protogamasellus* Karg, 1962 established this. A survey of the diagnostic characteristics occurring only in the Rhodacaridae was given by KARG (2000b).

Common characteristics of *Protogamasellus* Karg, 1962 and *Rhodacarus* Oudemans, 1903 –

1. Transverse lines on the podonotum at level of setae z5 and on the notogaster at level of setae I1 (Fig. 1).
2. Spermatodactyl of ♂ inserted inside of the digitus mobilis in form of a bulbodactylus – after KARG (2003a).
3. Chaetotaxy at tibia IV = 10-type: $2\frac{1}{1}, \frac{3}{1}2(1)$ – after EVANS (1963).
4. On the middle of podonotum repeatedly 3 to 4 scleronoduli (Scn, Fig. 1c) – after KARG (1965).
5. Anterior part of podonotum with transverse line (Fig. 1c).
6. Peritreme shortened (Fig. 2c).

EVANS & PURVIS (1987) included the following taxa in the *Protogamasellus*-group: *Protogamasellus* Karg, *Protogamasellopsis* Evans & Purvis and *Protogamasellodes* Evans & Purvis. In the meantime, new species from different parts of the world have been discovered. After receiving a worldwide survey of a greater number of species, one was enabled to evaluate relevant taxonomic characteristics. From this resulted that diagnostic features are surprisingly constant. For example, I investigated the setation of the dorsum of *Protogamasellus primitivus* Karg, 1962 from Europe and from Iran. The length of the setae proved to be constant. I could not confirm a considerable variability of dorsal setae as remarked by EVANS (1982). Drawings by EVANS (1982) of specimens from Ireland are applicable to specimens from Germany and from Iran. This is especially relevant for species diagnosis. Therefore, *Protogamasellus primitivus* Karg, 1962 is not a synonym of *Protogamasellus mica* Athias-Henriot, 1961. The subspecies -*similis* and -*machadoi* (GENIS, LOOTS & RYKE 1967) and -*singularis* (EVANS 1982) must be classified as separate species. The differential features of the species are combined in the following keys of the genera. One new genus is established: *Protofurcatus* n. gen.

Such a process of revaluation have occurred repeatedly in acarology. Especially species groups which were well investigated concerning biography, ecology and food preference proved to be informative. An example is the *Bryobia* species group. The species of this group damage different trees, grasses and herbs. Minimal morphologic deviations correlate with decisive ecological differences and host preferences. The species of *Bryobia* Koch, 1836 are distinguished especially by the number of rows on the dorsal setae consisting of tiny denticles, 1.2 to 2.3 μm long (Fig. 3). Forms first regarded as subspecies or host-specific variants had to be classified as separate species (EYNDHOVEN 1955, 1956, MATHYS 1957, KARG 1985).

Key to the genera of the *Protogamasellus*-group

1(2) Bases of metasternal setae situated on postlateral corners of female sternal shield (Fig. 2b): *Protogamasellopsis* Evans & Purvis, 1987.

2(1) Bases of metasternal setae situated behind female sternal shield free on the interscutal membrane or on small platelets (Fig. 2a, c, d).

3(4) On the vertex dorsal setae i1 remarkably longer than z1, on the notogaster transverse line at level of I1 continuous between I1 – I1 (Fig. 1a), anus normal in size, adanal setae in line with or anterior to anterior margin of anus (Fig. 2a):

Protogamasellodes Evans & Purvis, 1987.

4(3) On the vertex dorsal setae i1 subequal to or shorter than z1, on the notogaster transverse line between I1 – I1 interrupted (Fig. 1c, d), anus remarkably large, adanal setae situated behind the anterior margin of the anus (Fig. 2c, d).

5(6) Podonotum with a transverse line posterior to setae i3 (Fig. 1c), corniculi horn-like (Fig. 4a):

Protogamasellus Karg, 1962.

6(5) Podonotum without a transverse line posterior to setae i3, corniculi slender, with bifurcate tips (Figs 1c, 4c, d):

***Protofurcatus* n. gen.**

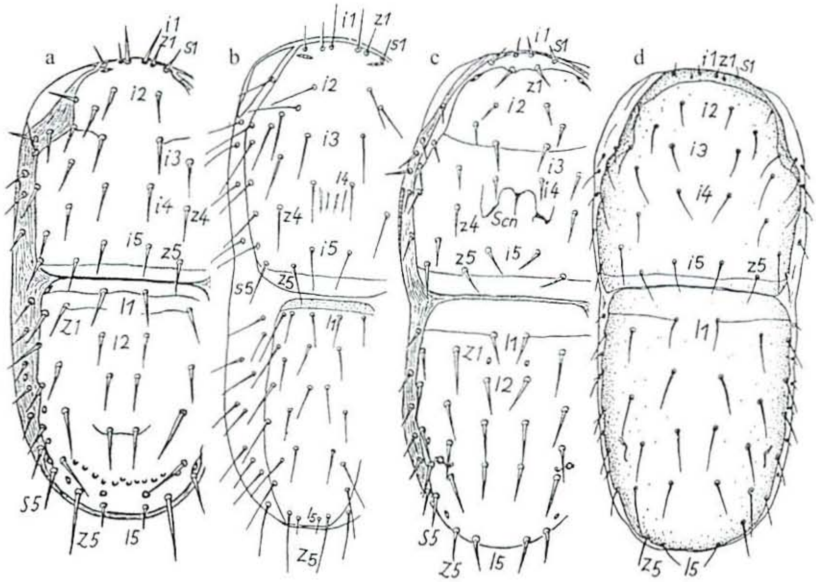

Fig. 1 Dorsum of species of the *Protogamasellus*-group: a) *Protogamasellodes singularis*, b) *Protogamasellopsis transversus*, c) *Protogamasellus primitivus*, d) *Protofurcatus bifurcalis*; chaetotaxy according to CHRISTIAN & KARG (2007)

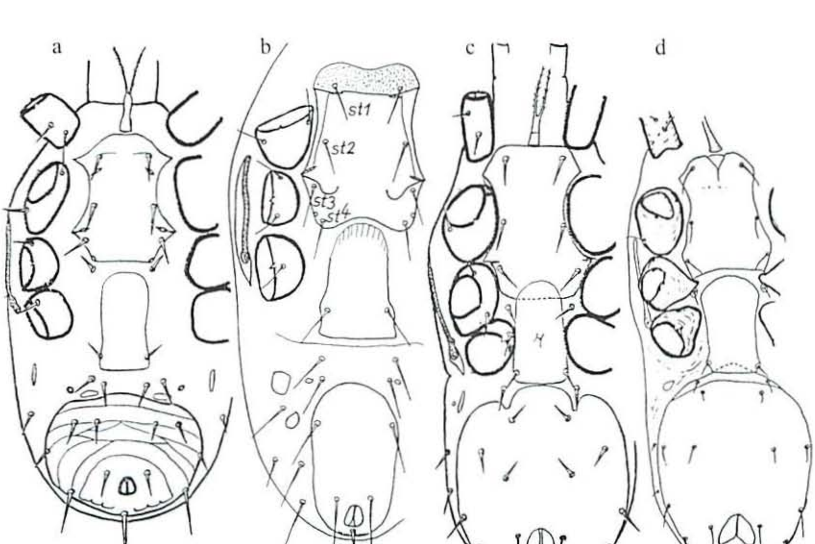

Fig. 2 Venter of species of the *Protogamasellus*-group: a) *Protogamasellodes singularis*, b) *Protogamasellopsis transversus*, c) *Protogamasellus primitivus*, d) *Protofurcatus bifurcalis*

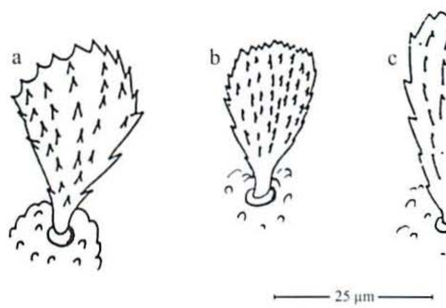

Fig. 3 Minimal morphologic deviations of mite species correlate with decisive biological differences – example: Diagnostic relevant dorsal setae in the genus *Bryobia*, a) *Bryobia calida* on greenhouse cucumber, b) *Bryobia rubrioculus* on fruit trees, c) *Bryobia graminum* in grass, d) *Bryobia kissophila* in ivy

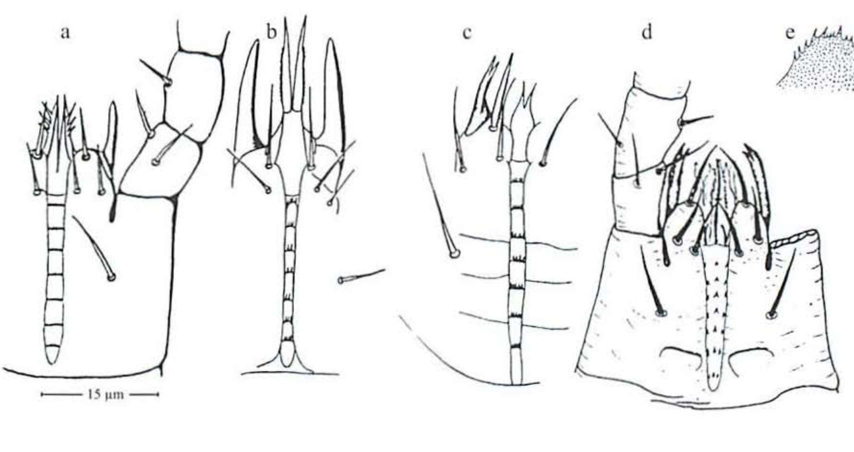

Fig. 4 a – d) Hypostom and corniculi of species of the *Protogamasellus*-group, a) *Protogamasellus primitivus*, b) *Protogamasellopsis transversus*, c) *Protofurcatus bicerratus*, d) *Protofurcatus bifurcalis*, e) tectum of *Protofurcatus bifurcalis*

Figs 1 – 4 based on partial figures published by KARG (1985, 1993a, 2000a, b), EYNDHOVEN (1955, 1956), GENIS, LOOTS & RYKE (1967); new combined

***Protofurcatus* n. gen.**

Diagnosis: Dorsal shield divided into podonotum and notogaster, setation similar to the genus *Protogamasellus*, however podonotum without a suture behind setae i3 and without scleronoduli between setae i4 and i5 (Fig. 1d), tectum multidentate (Fig. 4e), hypostom with 8 transverse strips, 7 strips in each case with 3 to 5 distinct teeth, corniculi distal furcate (Fig. 4c, d).

Type species: *Protogamasellus bifurcalis* Genis, Loots & Ryke, 1967

Key to the known species (♀)

1(2) Dorsal setae of the notogaster relatively long, setae I1 to I3 nearly as long as the distances between their bases in series, I4 = $^3/_4$ – $^4/_5$ distance I4 – I5 long, setae z1 on the podonotum $^1/_3$ the length of i4, idiosoma 258 µm long:

P. ascleronodulus (Shcherbak & Petrova, 1987)

– Asia, Turkmenia, termite hills.

2(1) Dorsal setae shorter, setae of the I series shorter than their distances (Fig. 1d).

3(4) The caudal setae Z5 extremely long (= 275 µm long), ventral an anal shield developed only with the paranal setae, idiosoma = 600 – 630 long:

P. bicirratus (Karg, 1977)

– South America, Chile, in moss and litter of forests.

4(3) Caudal setae Z5 not longer than other setae, ventral a ventrianal shield with 7 pairs of setae, setae z1 on the podonotum tiny: = $^1/_8$ the length of i4, idiosoma 264 µm long:

P. bifurcalis (Genis, Loots & Ryke, 1967)

– South Africa, Natal, Athlone Peak, upper soil strata.

***Protogamasellus* Karg, 1962**

Key to the known species and the new species of *Protogamasellus* Karg (♀)

1(4) Dorsal setae as on the podonotum as on the notogaster remarkably long, i2 reaching i3 (Fig. 5a).

2(3) Maximal length of the marginal setae on the interscutal membrane of the opisthosoma: = $^1/_4$ to $^1/_3$ length of other setae, digitus mobilis of chelicera with two big teeth, tectum with 3 groups of points, idiosoma 247 – 259 µm long:

P. machadoi Genis, Loots & Ryke, 1967

new status for *P. primitivus machadoi* Genis, Loots & Ryke, 1967

– Western Africa, Angola, near the Kamuavi River, in soil.

3(2) Marginal setae not so remarkably short, about $^1/_2$ length of other setae, dorsal setae Z1 and S1 clearly longer than the distances to Z2 respectively to S2, ventrianal shield with 6 pairs of setae, ventrianal shield nearly as long as wide, length : width of sternal shield = 6 : 4 (Fig. 5a, b, c), idiosoma 250 – 270 µm long:

***P. americanus* n. sp.**

– South America, Venezuela, litter and soil.

4(1) Dorsal setae shorter, setae of the podonotum constantly short, i2 never reaching i3, only some posterior setae of the notogaster can be longer (Fig. 1c).

5(10) On the notogaster setae I1 very short: = $^1/_3$ to $^1/_2$ distance I1 – I2.

6(7) All dorsal setae very short, however I4 and Z4 remarkably long, I4 and Z4 twice the length of I3, Z1 = I1, I4 = about $^1/_2$ distance I4 – I5, ventral setae Vz4 = longer than the paranal setae, idiosoma 280 – 285 µm long:

P. elongatus Shcherbak & Petrova, 1987
– Asia, Turkmenia, termite hills.

7(6) On the notogaster only Z4 longer than other setae, Z4 = twice the length of I3.

8(9) Ventrianal shield nearly triangular and with 5 pairs of setae, ids = 220 – 290 µm long:

P. brevisaetosus Shcherbak, 1976
– Eastern Europe, Kiev, upper soil strata.

9(8) Ventrianal shield oval and with 6 pairs of setae, idiosoma 232 – 251 µm long:

P. dispar Genis, Loots & Ryke, 1967
– South Africa, upper soil strata.

10(5) Dorsal setae middle long, I1 = distance I1 – I2 or $^3/_4$ I1 – I2 (Fig. 1c).

11(12) Setae I3 and Z3 shorter than the distances to the next setae in series, the caudal setae Z5 equal in length as I5 or shorter, ventrianal shield with 5 pairs of setae, middle point of tectum lateral and distal serrate, sternal shield length : width = 5 : 2, idiosoma 277 – 283 µm long:

P. biscleronodulus Shcherbak & Petrova, 1987
– Asia, Turkmenia, termite hills.

12(11) Setae I3 and Z3 longer than the distances to the next setae in series or equal to the distances.

13(14) Digitus mobilis of the chelicera with 3 big teeth, posterior setae on the podonotum about as long as setae on the notogaster, s4 longer as distance s4 – z5, ventrianal shield with 6 pairs of medium-long setae, tectum one big dented protuberance, idiosoma 235 – 277 µm long:

P. mica Athias-Henriot, 1961
– North Africa, near Alger, in upper soil stratum.

14(13) Digitus mobilis with 2 big teeth, ventrianal shield with 6 pairs of short setae, Vi3 distinctly shorter than distance Vi3 to Vi4, tectum with three pronged middle point and broad dented lateral branches (Fig. 2c).

15(16) Genital shield tongue-shaped, length : width = 2 : 1, caudal broadened, caudal dorsal setae Z5 about as long as I5, idiosoma 230 – 240 µm long:

P. primitivus Karg, 1962
syn. *P. mica* sensu KARG (1993a)
– Europe, Asia, Iran, soil strata.

16(15) Genital shield length : width = 3 : 1, caudal conspicuous narrowed, dorsal setae Z5 distinctly longer than I5, idiosoma 235 – 248 µm long:

P. similis Genis, Loots & Ryke, 1967
new status for *P. primitivus similes* Genis, Loots & Ryke, 1967
– South Africa, upper soil strata.

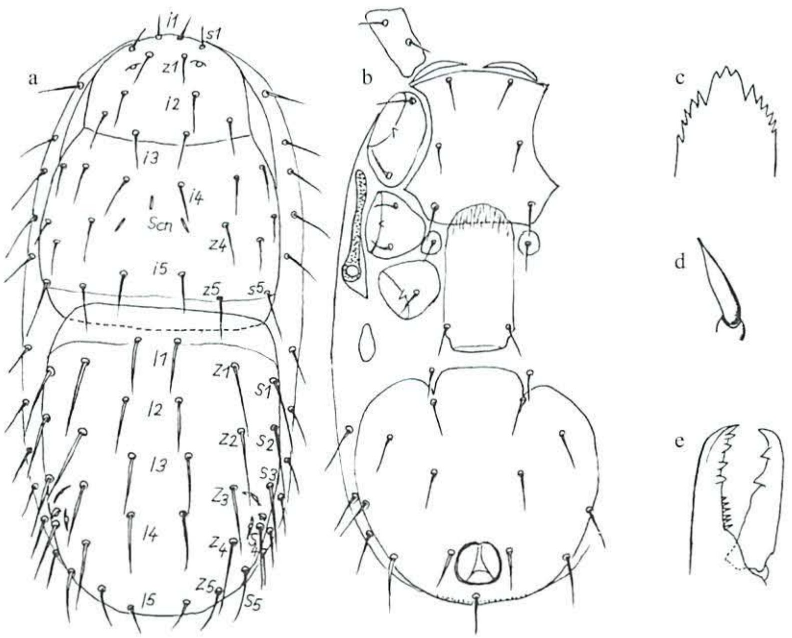

Fig. 5 *Protogamasellus americanus* ♀, a) dorsum, b) venter, c) tectum, d) corniculus, e) chelicera

***Protogamasellus americanus* n. sp.**

Fig. 5a – e

(*americanus*, referring to the locality in South America)

Holotypus ♀ Venezuela, 25 August 1973, at the road from Caracas to La Guaira, litter and soil.

Characterised by relative long setae of the notogaster.

Ids ♀ 250 – 270 x 100 – 115 µm, dorsal shields smooth, between i4 and i5 3 stroke-like scleronoduli (Scn in Fig. 5a), setae relatively long, on the notogaster longer than on the podonotum, most of notogaster setae reaching next setae in series, Z-setae and S-setae longer than their distances to the next setae in series, i1 = 11, z1 = 15, i2 = i3 = I4 = 20, s1 = 8, s5 = 20, I1 = 27, I2 = 26, I3 = I4 = 25, I5 = 15, Z1 = Z2 = 30, Z3 = 25, Z4 = 24, Z5 = 17 µm long, setae on the venter = 15 to 20 µm long, sternal shield 44 µm broad and 66 µm long, ventrianal shield 97 µm broad and 100 µm long bearing 6 pairs of setae, anus 24 µm broad and 15 µm long, digitus fixus of the chelicerae at the distal half with 4 greater teeth, proximal a row of fine teeth, digitus mobilis with 2 big teeth, tectum with a broad middle protuberance and small lateral teeth, corniculi distal pointed, legs: I = 230, II = 140, III = 120, IV = 220 µm long.

Differential diagnosis: The new species is similar to *Protogamasellus machadoi* Genis, Loots & Ryke, 1967 because of the long setae of the podonotum and the notogaster. In this species however the marginal setae are tiny and the setae of the Z- and S- series are not as long as in *P. americanus*, the middle prong of the tectum is pointed.

***Protogamasellodes* Evans & Purvis, 1987**

Key to the known species (♀)

1(6) Notogaster considerably narrower than the width of the podonotum and at least 2 x as long as wide.

2(3) Ventrianal shield about as long as wide, in front of it a pair of nearly circular platelates, dorsal setae mostly short, only Z5 = about 3 x length of I5, idiosoma 310 µm long:

P. angustiventris (Athias-Henriot, 1961)
– Algeria, near Qued Bouzareah, litter and soil.

3(2) Ventrianal shield oval, longer than wide.

4(5) Dorsal setae I1 and I4 remarkably long: = 2 x the length of I3, digitus mobilis of chelicera with 4 teeth, without platelets in front of the ventrianal shield, idiosoma 317 – 365 µm long:

P. scuticalis (Genis, Loots & Ryke, 1967)
– South Africa, Potchefstroom, soil.

5(4) Dorsal setae I1 and I4 about equal as long as I3, digitus mobilis of chelicera with 2 teeth, in front of the ventrianal shield a pair of small platelets, idiosoma 260 µm long:

P. evansi Karg, 2000
– Cuba, Sierra Esperón, soil.

6(1) Notogaster about as wide as the posterior margin of the podonotum (Fig. 1a).

7(8) Form of the ventrianal shield like a pear and with 3 pairs of setae, dorsal setae I4 = $^1/_2$ distance I4 – I5, idiosoma 340 µm long:

P. cognatus (Athias-Henriot, 1961)
– North Africa, Algeria, Maison-Carée, compost.

8(7) Ventrianal shield nearly circular or broad-oval and with 4 to 5 pairs of setae.

9(12) Ventrianal shield about as long as wide.

10(11) Ventrianal shield with 4 pairs of setae, tectum like a roof and fine denticulate, I4 longer than distance I4 – I5, idiosoma 288 µm long:

P. massula (Athias-Henriot, 1961)
– North Africa, Algeria, near Menerville, litter.

11(10) Ventrianal shield with 5 pairs of setae, tectum with 3 prongs, I4 = about $^1/_2$ distance I4 – I5, idiosoma 250 – 259 µm long:

P. minor (Athias-Henriot, 1961)
– North Africa, Algeria, near Qued Bouzareah, litter and soil.

12(9) Ventrianal shield broad-oval, wider than long (Fig. 2a).

13(14) Dorsal setae remarkably long, I1 to I4 reaching the next setae in series, tectum with denticulate margin, idiosoma 260 µm long:

P. longipellis Karg, 2000
– Cuba, Sierra Maestra, soil.

14(13) Dorsal setae short, I1 to I4 shorter than their distances.

15(16) Dorsal setae Z4 short: = 1/2 distance Z4 – Z5, in front of the ventrianal shield no platelates, ventrianal shield with 4 pairs of setae, tectum with denticulate margin, idiosoma 217 – 232 µm long:

P. brevicornis (Genis, Loots & Ryke, 1967)
– South Africa, Potchefstroom, soil.

16(15) Dorsal setae Z4 reaching Z5, in front of the ventrianal shield a pair of platelets (Figs 1a, 2a).

17(18) Dorsal setae Z3 reaching Z4, I4 = 1/2 distance I4 – I5, on the ventrianal shield near the posterior margin a garland-like structure, tectum with 3 prongs, idiosoma 250 – 260 µm long:

P. singularis (Karg, 1962)
– Europe, soil.

18(17) Dorsal setae Z3 not reaching Z4, I4 = 1/3 distance I4 – I5, posterior of the anus an area of fine pores, tectum with denticulate margin, idiosoma 253 – 260 µm long:

P. hibernicus (Evans, 1982)
– Europe, Ireland near Cansore Point, soil of a sand dune.

Protogamasellopsis Evans & Purvis, 1987

Key to the known species (♀)

1(2) Setae of dorsal shields long, each seta reaching next seta in series (Fig. 1b), sternal shield with remarkable arched lines anteriorly of sternal setae st3 (Fig. 2b), idiosoma 420 – 460 µm long:

P. transversus Karg, 2000
– Ecuador, province Cotopaxi, near Paramo, soil.

2(1) Setae shorter, no seta reaching next seta in series.

3(8) Anteriorly of the sternal shield 3 to 7 pairs of small pre-endopodal shields.

4(5) Anteriorly of the sternal shield 7 pairs of pre-endopodal shields, postanal seta = 3 x the length of dorsal seta i4, Z5 = 2.25 x i4, idiosoma 485 – 545 µm long:

P. posnaniensis Wiśniewski & Hirschmann, 1991
– Europe, soil.

5(4) Anteriorly of the sternal shield 3 to 4 pairs of pre-endopodal shields.

6(7) Anteriorly of the sternal shield 4 pairs of pre-endopodal shields, marginal between sternal setae st2 and st3 on each side a semicircle configuration, postanal seta = 2 x the length of i4, Z5 = 1.7 x i4, i4 = 30 µm long, idiosoma (♂) 400 µm long:

P. praeendopodalis, Karg, 1994
– Galapagos, Fernandina, sea shore, litter and soil.

7(6) Anteriorly of the sternal shield 3 pairs of pre-endopodal shields, genital- and ventrianal shield very slender and close together, length : width of ventrianal shield = 3 : 1, leg I (= 430 µm) nearly as long as the idiosoma (= 440 µm), leg IV remarkably shorter (= 380 µm):

P. leptosomae Karg, 1994
– Galapagos, Sta. Cruz, Puntudo, litter.

8(3) Anteriorly of the sternal shield no pre-endopodal shields, only a granulated area with the sternal setae st1.

9(12) Middle point of the tectum about as long as the basis of the tectum broad, peritrema conspicuously short, only as long as the notogaster wide.

10(11) Notogaster = 75 µm wide, on the sternal shield anteriorly of setae st2 – st2 an area of fine pores, dorsal setae i4 (= 22 µm) = $^1/_2$ distance i4 to i5, idiosoma 420 µm long: *P. granulosus* Karg, 1994

– Galapagos, Sta. Cruz, Cueva Bella Vista, manure.

11(10) Notogaster = 105 – 115 µm wide, on the sternal shield between setae st2 and st3 two oval areas of especially deep and dense punctation, length of dorsal setae i4 = $^1/_3$ the distance i4 – i5, idiosoma 430 – 450 µm long: *P. corticalis* Evans & Purvis, 1987

– St Helena, under dead bark of a citrus tree imported from South Africa.

12(9) Length of the middle point of the tectum = $^1/_2$ the width of the basis, peritrema relatively long: = $1^1/_2$ the width of the notogaster, idiosoma 400 µm long: *P. dioscorus* (Manson, 1972)

– Polynesia, Tonga, from a yam.

4.1.2. Gamasiphidae Lee, 1970

To this family belong genera with abundant numbers of species such as the genus *Gamasiphis* Berlese, 1904. The group colonises particularly the Southern Hemisphere (Karg 1990). One new species was detected.

Gamasiphis silvestris n. sp.

Fig. 6a – c

(*silvestris* = living in a forest, referring to the habitat of the species)

Holotypus ♀ Ecuador 1990, between Calderon and Quevedo, litter in a rain forest, paratypes 5♀.

Characterised by a pair of long caudal macrochaetae, in front of this on the dorsum 8 pairs of further macrochaetae on the dorsum, middle point of tectum lanceolate.

Idiosoma ♀ 370 – 400 x 270 – 280 µm, brown, dorsum smooth and with 9 pairs of long setae terminal spatulate (35 – 55 µm long) and 8 pairs of short acicular setae (5 – 25 µm long), i1 = 15, i2 = 23, i3 = 45, i4 = 40, i5 = 35, z3 = 35, z4 = 42, z5 = 35, s3 = 39, I3 = 10, I4 = 5, Z2 = 50, Z5 = 60, S2 = 5 µm long, ventral shields reticulate, most of ventral setae 30 – 35 µm long, only sternal setae st3 short and thorn-like, besides a lateral pair of setae on the ventrianal shield and the paranal setae short, however thin, the caudal lateral setae 40 µm, the postanal seta 45 µm long, width : length of metapodal shields = 4 : 9, pars exterior : pars interior = 1 : 3, lateral points of the tectum = 5 µm, middle point = 27 µm long, ventrianal shield with lateral incisions, legs: I = 320, II = 270, III = 240, IV = 330 µm long.

Differential diagnosis: The new species belongs to a group of species having a remarkable single pair of dorsal macrochaetae at the caudal margin as in *Gamasiphis lanceolatus* Karg, 1987. A key is given to the species complex:

Key to the known species of the *Gamasiphis-lanceolatus*-species complex (♀)

1(6) Only the caudal dorsal hair pair (Z5) developed as macrochaetae.

2(5) Peritremes shortened, anteriorly reaching only coxae II.

3(4) Middle point of the tectum like a flower, dorsal setae of the posterior part of the dorsum relatively long, I3 arrives nearly I4, idiosoma 340 – 380 µm long:

G. furcatus Karg, 1990

– Central America, St Lucia, soil, sample no. 27 of collector Sandor Mahunka, Budapest.

4(3) Middle point of the tectum like an ear, dorsal setae shorter, I3 = $^1/_2$ distance I3 – I4, idiosoma (♂) 350 µm long:

G. trituberosus Karg, 1990

– Central America, St Lucia, soil, sample no. 33, 91 of collector Sandor Mahunka, Budapest.

5(2) Peritremes anteriorly reaching coxae I, middle point of the tectum lanceolately, idiosoma 330 – 380 µm long:

G. adanalis Karg, 1990

– Central America, St Lucia, soil, sample no. 3, 11, 55-2, 91 of collector Sandor Mahunka, Budapest.

6(1) Additional dorsal setae developed as macrochaetae.

7(8) In addition to the single pair of caudal dorsal setae the shoulder hair pair developed as macrochaetae, idiosoma 500 µm long:

G. hamifer Trägardh, 1952

– S. E. Polynesia, Mangareva, litter.

8(7) More than one additional pair of macrochaetae.

9(24) On the posterior half of the dorsum no additional macrochaeta, only on the anterior part additional macrochaetae.

10(15) Anterior part of the dorsum with 5 to 8 pairs of macrochaetae.

11(12) Anterior part of the dorsum with 5 pairs of macrochaetae, idiosoma 550 µm long:

G. elegantellus Berlese, 1910

– Asia, Java, soil.

12(11) Anterior part of the dorsum with 8 pairs of macrochaetae, tectum with a conspicuously long middle point.

13(14) Dorsal setae i4, i5 and z5 short, idiosoma (♂) 700 µm long:

G. superardor Karg, 1993

– Australian Region, New Caledonia, near Koumac, litter in a cave.

14(13) Dorsal setae i4, i5 and z5 as macrochaetae, idiosoma 639 – 666 µm long:

G. indicus Bhattacharyya, 1978

– India, West Bengal, soil.

15(10) Anterior part of the dorsum with 10 to 11 pairs of macrochaetae.

16(17) Idiosoma nearly circularly, anterior part of the dorsum with 10 macrochaetae, idiosoma 470 – 510 µm long:

G. pinguis Karg, 1990

– Central America, St Lucia, soil, sample no. 27, 44, 68, 88, 91-2 and at the Vigie Point near Castries, collector Sandor Mahunka, Budapest.

17(16) Idiosoma oval.

18(23) Lateral fissures on the ventrianal shield long: reaching ventral setae Vi4 or Vi3, dorsum anteriorly with 10 to 11 pairs of macrochaetae.

19(22) Lateral fissures on the ventrianal shield reaching Vi4 in the middle of the shield.

20(21) Anteriorly with 10 macrochaetae, dorsal setae z1 at the vertex very short, idiosoma 366 – 395 μm long:

G. krieli Driel, Loots & Marais, 1977

– South Africa and St Helena, High Peak, soil.

21(20) Anteriorly with 11 macrochaetae, dorsal setae z1 as macrochaetae, idiosoma 400 μm long:

G. decoris Karg, 1990

– Central America, St Lucia, Mangareva, soil.

22(19) Lateral fissures on the ventrianal shield reaching Vi3, macrochaetae lanceolate, idiosoma 420 – 440 μm long:

G. lanceolatus Karg, 1987

– Central Europe, under glass.

23(18) Lateral fissures on the ventrianal shield shorter: reaching only hair pair Vz3, anteriorly of the dorsum 11 pairs of macrochaetae, idiosoma 380 – 420 μm long:

G. hemicapillus Karg, 1990

– Central America, St Lucia, litter and soil, sample no. 11-3, 27, 33, 44, 91 and at the Vigie Point near Castries, collector Sandor Mahunka, Budapest.

24(9) On the posterior part of the dorsum 1 – 2 pairs of additional macrochaetae (Fig. 6a).

25(28) On the posterior part of the dorsum one pair of additional macrochaetae: Z2 (Fig. 6a).

26(27) Furthermore in the middle of the dorsum setae i5 and z5 as macrochaetae (Fig. 3), idiosoma 370 – 400 μm long:

***G. silvestris* n. sp.**

– South America, Ecuador, between Calderon and Quevedo; litter.

27(26) In the middle of the dorsum no macrochaetae, idiosoma (♂) 720 μm long:

G. macrorbis Karg, 1993

– Australian Region, New Caledonia, near Koumac, litter in a cave.

28(25) On the posterior part of the dorsum two pairs of additional macrochaetae: I2 and Z2, furthermore in the middle of the dorsum 4 pairs of macrochaetae, idiosoma 499 μm long:

G. sextus Vitzthum, 1921

– Central Europe, under glass, soil.

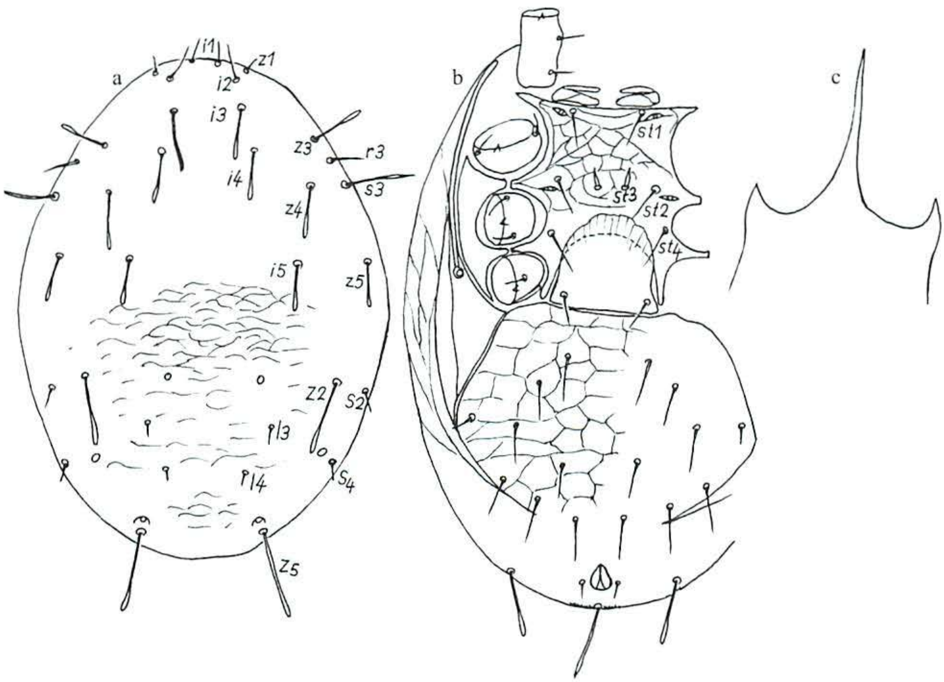

Fig. 6 *Gamasiphis silvestris* ♀, a) dorsum, b) venter, c) tectum

4.2. Dermanyssoidea Kolenati, 1859

4.2.1. Hypoaspididae v. Vitzthum, 1941

Species of the Hypoaspididae are distributed world wide (Evans & Till 1966, Karg 1978, 1993a, c, 2000a, 2006). A new species is recorded of *Pseudoparasitus* Oudemans, a specialised group with a strong sclerotisation of the body integument.

Pseudoparasitus Oudemans, 1903

Pseudoparasitus rencornis n. sp.

Fig. 7a – c

(*ren* = kidney, *cornis* = horn, referring to the peculiarly shaped metapodal shields)

Holotypus♀ Ecuador, 1990, near Flavio Alfaro, cacao plantation, litter, paratypes: 2♀; from cacao plantation near Napo: 3♀.

Characterised by a large genital shield with 4 pairs of setae, by well-developed metapodal shields consisting of two parts: a lateral kidney-shaped part and an interior horn-shaped part.

Idiosoma ♀ 580 – 600 x 300 – 320 µm, brown, posterior part of dorsum reticulated with short setae: i1 = 13, i4 = 25, r3 = 25, I4 = 33, I5 = 38, Z5 = 38, S5 = 35 µm long, ventral shields also reticulated, a pair of oval presternal shields, sternal setae = 40, genital setae = 38, ventral setae Vi1 = 50, Vi2 = 43, Vi4 = 45 µm long, genital shield 190 – 200 µm wide and 273 µm long, anal shield 140 µm wide and 90 µm long, inguinal shields like small rods beside the genital shield, peritremata long reaching the vertex dorsal, metapodal shields consisting of two parts: a lateral kidney-shaped part and an interior horn-shaped part, tectum semicircle-shaped with a few single, little teeth, legs: I = 480, II = 400, III = 320, IV = 550 µm long.

Differential diagnosis: Diagnostic features arranged as:

Key to the known species and the new species of *Pseudoparasitus*

1(6) Genital shield broad, about as long as wide, anal shield twice as wide as long.

2(5) Genital shield with 5 pairs of hairs.

3(4) Ventrianal shield 330 µm long, 300 µm wide, hair-pair Vi1 standing in a distance to the margin, metapodal shields drop-shaped, idiosoma 700 µm long:
P. guttulae Karg, 1997
– South America, Ecuador, province Imbabura, in moss hanging from trees.

4(3) Ventrianal shield as long as wide, hair-pair Vi1 standing on the margin of the shield, metapodal shields with a broad-oval figure, idiosoma 500 – 600 µm long:
P. centralis Berlese, 1920
– Europe, litter of deciduous forest.

5(2) Genital shield with 4 pairs of setae, metapodal shields inwards with widened margins touching the genital shield, idiosoma 480 – 550 µm long:
P. quadrisetatus Karg, 1981
– Central America, Cuba, Sierra Esperón, upper soil strata.

6(1) Genital shield obviously longer than wide, mostly with 4 pairs of setae (Fig. 7b).

7(8) Metapodal shields very slender, awl-shaped, idiosoma 500 – 550 µm long:
P. exilis Karg, 1981
– South America, Brazil, Faz. Itaquere, upper soil strata.

8(7) Metapodal shields well developed, triangular or oval shields (Fig. 7b).

9(10) Edging of the metapodal shields eye-shaped, idiosoma 550 µm long:
P. ocularis Karg, 1981
– South America, Venezuela, upper soil strata.

10(9) Metapodal shields triangular, without an edging.

11(22) Genital shield hexagonal, as broadened as the distance of coxae IV, inguinal shields like small rods beside the genital shield (Fig. 7b).

12(13) Digitus fixus of chelicerae with 6 – 7 teeth, idiosoma 600 – 700 µm long:
P. meridionalis (G. & R. Canestrini, 1882)
– South Europe, litter.

13(12) Digitus fixus of chelicerae with 3 – 4 teeth, ids = 450 – 680 µm long.

14(17) Distance of dorsal setae I2 – I2 about = distance I1 – I1, dorsal setae 30 – 40 µm long.

15(16) Metapodal shields shaped like a kidney, inguinal shields shorter than the ventral setae, dorsal setae Z5 = 40 µm, idiosoma 550 – 610 µm long:

P. schatzi Karg, 1993

– Galapagos, Sta. Cruz, litter.

16(15) Metapodal shields triangular and covered with little pores, inguinal shields longer than the ventral setae, dorsal setae Z5 remarkably short (= 18 µm), idiosoma 520 – 550 µm long:

P. germanicus Karg, 1965

– Europe, upper soil strata.

17(14) Distance of dorsal setae I2 – I2 = 2 x distance I1 – I1 (Fig. 7a).

18(19) Genital shield with 5 pairs of setae, metapodal shields triangular, dorsal setae relatively long, i3 reaching i4, Z5 = twice the length of I5, idiosoma 586 – 643 µm long:

P. jilinensis Ma, 2004

– China, Jilin Provence, Changchun City, from forest soil.

19(18) Genital shield with 4 pairs of setae, metapodal shields consisting of two parts (Fig. 7b), dorsal setae short, i3 not reaching i4, Z5 as long as I5 or something longer.

20(21) Genital shield remarkably wide (190 – 200 µm), length : width = 3 : 2, lateral part of metapodal shields kidney-shaped, interior part horn-shaped, caudal setae = 35 – 38 µm long, idiosoma 80 – 600 µm long (Fig. 7):

***P. rencornis* n. sp.**

– Ecuador, near Flavio Alfaro and Napo, cacao plantations, litter.

21(20) Genital shield not remarkably wide (155 µm), length : width = 3.4 : 2, lateral part of metapodal shields like a little triangle, interior part nose-shaped, caudal setae = 50 – 55 µm long, idiosoma 480 – 490 µm long:

P. nasipodaliae Karg, 1993

– Galapagos, Sta. Cruz, litter.

22(11) Genital shield drop-shaped, inguinal shields like short rods.

23(24) On the genital shield setae Vi1 localised near the lateral margin, setae Vi4 on the back margin of the shield, dorsal setae 42 – 45 µm long, idiosoma 730 – 760 µm long:

P. marginatus Karg, 1997

– South America, Ecuador, province Pichinca, litter.

24(23) On the genital shield setae Vi1 and Vi4 localised at a distance from the margins, dorsal setae 30 – 38 µm long.

25(26) Metapodal shields interior with a conspicuous margin, genital shield broad, length : width = 1 : 0.7, idiosoma 520 µm long:

P. porulatus Karg, 1989

– Central America, St Lucia near Castries, upper soil strata.

26(25) Metapodal shields without interior margin, genital shield length : width = 1 : 0.4, idiosoma 564 – 678 µm long:

P. dentatus (Halbert, 1920)

– Europe, in moss, in sand and tidal debris at the shore.

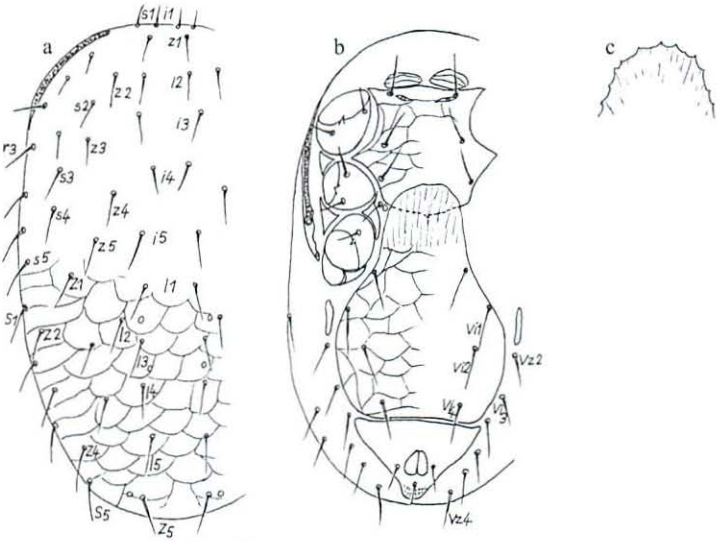

Fig. 7 *Pseudoparasitus rencornis* ♀, a) dorsum, b) venter, c) tectum

4.3. Ascoide Karg, 1965

4.3.1. Ascidae Voigts & Oudemans, 1905

Previous investigations of the Ascidae from rain forests yielded the greatest number of new species in the genus *Cheiroseius* Berlese, 1916 (Evans & Hyatt 1960, Karg 1998a). These species prefer moss vegetations, a substrate absorbing great amounts of water in the rain forests. In the present research a new species was detected.

Another new species of the family belongs to the genus *Leioseius* Berlese, 1916, which indicates decaying organic materials at moderate humidity. The genus is only represented in the rain forests by a few species (Karg 1998a).

Leioseius Berlese, 1916

(syn. *Gamasellodes* Athias-Henriot, 1961; *Arctoseiodes* Willmann, 1949)

Note: Some authors (Halliday, Walter & Lindquist 1998) separate *Leioseius* species with a divided dorsal shield as genus *Gamasellodes* and species with a holodorsal shield as genus *Leioseius*. However, in *Leioseius* we know all transitive stages with divided dorsum to a holodorsal shield. *Leioseius plaire* (Halliday, Walter & Lindquist, 1998), for example, shows lateral incisions and a median dividing line, however no complete separation. Such a phylogenetic process has developed convergently in several genera, for example in *Veigaia* Oudemans, *Gamasodes* Oudemans, *Arctoseius* Sig Thor and *Parasitus* Latreille (♀-♂). Therefore it is not justified to erect genera characterised by a dorsal shield being divided or not.

In the genus *Leioseius* Berlese we know a species complex closely related to *Leioseius bicolor* (Berlese, 1918), a world wide distributed species. From Central America a new species of the species complex was discovered.

Leioseius-bicolor-species complex

Diagnosis: Dorsal shield divided, ventrianal shield (♀) with 5 pairs of setae, some caudal setae lengthened, on the posterior part of the notogaster garland-like structures (Fig. 8).

Key to the known species and the new species of the *Leioseius-bicolor*-species complex

1(2) The caudal setae I4, Z4, Z5 and S5 remarkably longer than other dorsal setae: about 3 x so long, one garland-like structure in front of Z5 and I5, posterior part of the genital shield broadened like a stamp (Fig. 8), idiosoma 322 – 333 µm long:

L. *eusetosus* n. sp.

– Central America, Lesser Antilles, St Lucia, Mangareva, soil, sample no. 19, collector Sandor Mahunka, Budapest.

2(1) Some caudal setae lengthened, however setae I4 constantly short.

3(4) Peritreme shortened, beginning at the shoulders, on the posterior part of the notogaster 3 garland-like structures, in front of these a net-like pattern out of small pores, idiosoma 280 – 290 µm long:

L. insignis (Hirschmann, 1963)

– Central Europe, in humus soil and in moss.

4(3) Peritreme beginning at the vertex, between Z4 – Z4 a garland-like structure.

5(10) Dorsal setae Z4 relatively long, reaching the basis of Z5.

6(7) Ventrianal shield bell-shaped, posterior margin smooth, also the posterior margin of notogaster smooth, idiosoma 365 – 385 µm long:

L. major (Athias-Henriot, 1961)

– Western Europe, Pontevedra, Sierra de Estrella (Portugal), litter and moss.

7(6) Ventrianal shield broad oval, posterior margin wavy, also the posterior margin of the notogaster wavy.

8(9) Ventrianal shield with a straight anterior margin, posterior part of the notogaster with 3 garland-like structures between Z4 – Z4 and Z5 – Z5, in front of these a reticulate pattern, idiosoma 330 – 342 µm long:

L. plaire (Halliday, Walter & Lindquist, 1998)

– Australia, Canberra, on daffodil bulb.

9(8) Anterior margin of the ventrianal shield rounded, 2 garland-like structures on the posterior part of the notogaster between Z4 – Z4 and I5 – Z5, however no reticulate pattern, posterior margin of the notogaster and the ventrianal shield distinctly wavy (Fig. 5d, e), idiosoma 310 – 400 µm long:

L. bicolor (Berlese, 1918)

– Europe, South America, humus soil, litter, manure and mould.

10(5) Dorsal setae Z4 not reaching Z5, front part of ventrianal shield remarkably broad, length : width = 5 : 7, one garland-like structure between Z4 – Z4, idiosoma 302 – 330 µm long:

L. rectiventris (Lindquist, 1971)

– North America, Florida, Lousiana, leaf litter, under bark of *Pinus*.

***Leioseius eusetosus* n. sp.**

Fig. 8a – c

(*eu* = proper, *setosus* = setation, referring to the remarkable long setation on the posterior part of the notogaster)

Holotype ♀ Central America: Lesser Antilles, St Lucia, Mangareva, 1980; soil sample no. 19, collector Sandor Mahunka, Budapest; paratype 1♀, similar data as holotype.

The new species is characterised by a divided dorsum, by long setae on the posterior part of the notogaster, especially dorsal seta I4 = three times as long as i4 and by a genital shield posteriorly formed like a stamp.

Idiosoma ♀ 322 – 333 x 193 – 196 µm, brown, dorsum divided, shields nearly smooth, only 2 pairs of pores on the podonotum and 5 pairs of pores on the notogaster, in front of dorsal setae Z5 and I5 a garland-like structure, in the middle of the notogaster net lines outlined, dorsal setae on the podonotum and on the front part of the notogaster relatively short: i1 = 8, z1 = 12, i2 = 13, i3 = 12, i4 = 10, i5 = 13, I1 = 13, I2 = 13 µm long, deviating the posterior setae: I3 = 22, I4 = 35, I5 = 15, Z4 = 35, Z5 = 43, S3 = 20, S4 = 33, S5 = 37 µm long, peritremes beginning at the vertex behind setae s1.

Ventral shields reticulate, sternal shield 62 µm broad (level of st2) and 90 µm long, sternal setae 17 µm long, genital shield caudal broadened, 58 µm broad, genital setae 21 µm long, ventrianal shield 166 µm broad and 116 µm long, with 5 pairs of setae, posterior margin wavy, behind the anus an area of fine pores, between genital- and ventrianal shield two pairs of setae, 17 µm long, most setae of the ventrianal shield 21 to 22 µm long except the caudal setae: postanal seta = 30 µm, Vz4 = 43 µm long; 1 pair of oval little inguinal shields present; gnathosoma: transverse lines Q2 to Q8 at the hypostom with 4 to 5 little teeth, coxal setae of pedipalps acicular, C1 = 15, C2 = 15, C3 = 17, C4 = 20 µm long, corniculi wedge-shaped, tectum with three roof-like prongs about as long as their distances, digitus fixus of the chelicerae with 5 teeth, digitus mobilis with 2 teeth, legs: I = 287, II = 221, III = 196, IV = 231 µm long.

***Cheiroseius* Berlese, 1916**

***Cheiroseius pustulus* n. sp.**

Fig. 9a – d

(*pustulus* = blister, referring to the little blister at the tarsus of the first leg)

Holotypus ♀ Ecuador 1990, near Loreto, coffee plantation, litter, paratypes 2♀.

Characterised by short first legs shorter than the idiosoma, tarsus I without claws, however with a little blister, by a large ventrianal shield with 4 pairs of setae, tectum with a large middle prong, a caudal process of the peritreme weakly developed.

Idiosoma ♀ 400 – 450 x 260 – 280, brown, dorsum reticulate, dorsal setae long, I2, I3, I4 longer than the distances to the next setae in series, however the vertical setae very short: i1 = s1 = 15, z1 = 25 µm long, i2 = 34, i3 = i4 = 40, I4 = 70, I5 = 14, Z5 = S1 = S2 = 60 µm long, setae of the venter 20 – 25 µm long, ventrianal shield 130 µm long, 180 µm wide and reticulate, sternal shield smooth, peritrematal shield with broad prolongation behind the stigma, however the peritreme with a barely visible caudal process, tectum with a large middle prong and little lateral points, legs: I = 330, tarsus I = 80, tibia I = 40 µm long, at the top of tarsus I long setae and a little blister, no claws, leg II = 290, III = 300, IV = 400 µm long, pulvilli of the tarsi II – IV consisting of tree slender lobs, 17 µm long, claws 8 µm long.

Differential diagnosis: Dorsal and ventral shields and their setation are similar to those in *Cheiroseius trilobus* Karg, 1981 from Ecuador. In this species, however, setae s1 and z1 are longer (= 2 – 3 x length of i1), leg I of this species has claws, the middle prong of the tectum is shaped ear-like, the lateral points are long and serrate, the pulvilli of leg II, III and IV are short trilobate.

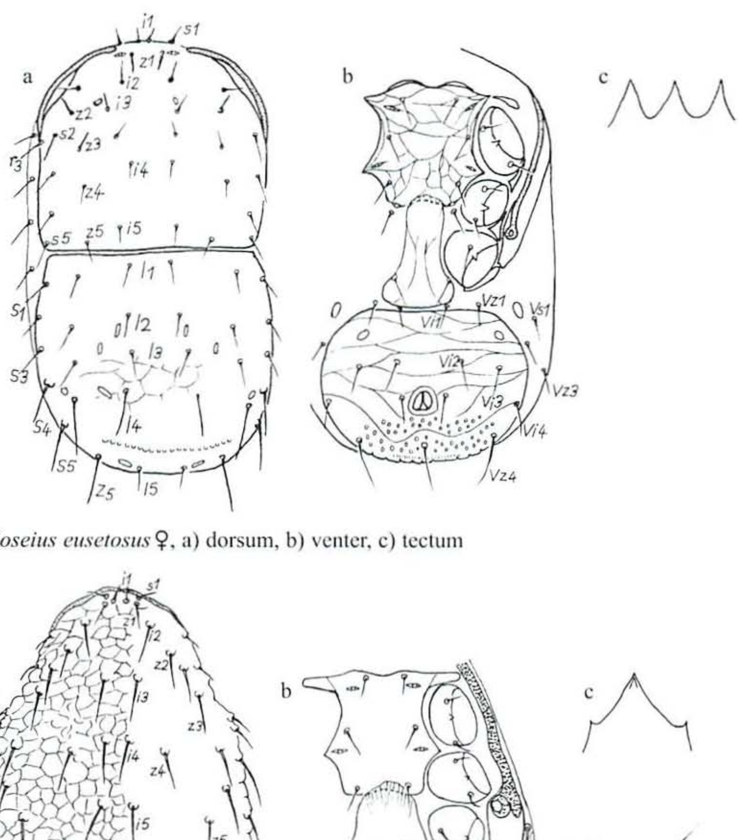

Fig. 8 *Leioseius eusetosus* ♀, a) dorsum, b) venter, c) tectum

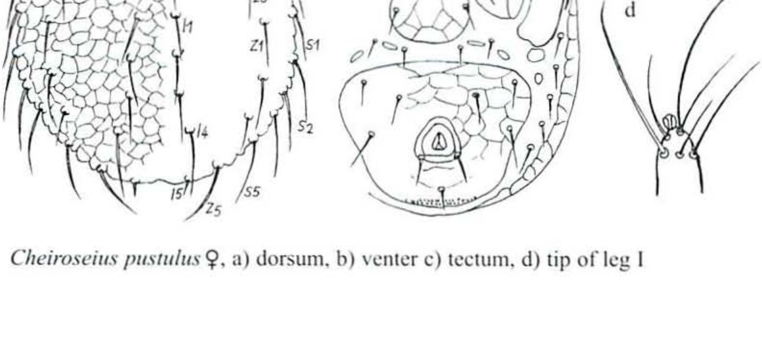

Fig. 9 *Cheiroseius pustulus* ♀, a) dorsum, b) venter c) tectum, d) tip of leg I

4.3.2. Halolaelapidae Karg, 1965

Species of the Halolaelapidae prefer decaying plant residues. This refers especially to the genus *Halolaelaps* Berlese & Trouessart, 1889. About one-half of the species was found in decaying litter and in compost heaps, the other at the seaside in decaying organic materials (HIRSCHMANN 1968, KARG 1979a, 1993a). The present investigations showed that the species are distributed worldwide, as a new species was discovered from the Antarctic.

***Halolaelaps antarcticus* n. sp.**

(*antarcticus* = Antarctic, referring to the locality of the species)

Figs 10c, 11a – e

Holotypus ♀ Antarctic Region: South Georgia, 1990, seaside, in decaying plant residues, paratype 1 ♂; Coll. Philip J. A. Pugh, British Antarctic Survey.

Characterised by a very wide ventrianal shield nearly twice as wide as long, 3 pairs of remarkable long and strong setae on the podonotum and 3 adequate pairs of setae on the notogaster.

Idiosoma ♀ 720 x 520, brown, dorsum divided in a podonotum and a notogaster, posterior margin of podonotum convex, anterior margin of notogaster in the middle concave, shields finely pointed and with very different setae: on the podonotum 16 pairs of setae, 3 pairs of setae remarkably long and strong, 2 – 3 times as long as the remaining setae (z3, s5, i5), on the notogaster 9 pairs of setae, also 3 pairs of setae long and strong (Z3, Z4, Z5), setae s1 at the vertex little and club-like, the other short setae acicular, i1 = 5, z1 = 22, i2 = 12, i3 = 24, i4 = 24, i5 = 50, s1 = 10, z3 = 68, z4 = 20, r3 = 17, s5 = 60 µm long, setae I1 = 21, I2 = 39, I4 = 20, I5 = 20, Z1 = 30, Z3 = 56, Z4 = 60, Z5 = 54 µm long, the longest setae z3 terminal pectinate, the longer setae i5, s5, Z4 apical weakly furcate, the ventral sternal shield very slender, the genital shield tongue-like, the ventrianal shield 186 µm long and 366 µm wide, the cribrum-area extends to the dorsal side, peritrematic shields free, not fused with exopodal shields, sternal setae st2 stronger than most other ventral setae, only the postanal seta thickened, st1 = 20, st2 = 27, st3 = 29, genital setae = 27, Vi1 = 31, Vi2 = 30, Vi3 = 30, Vz4 = 44 µm long, the postanal seta = 40 µm long, tectum with a central spine and basal irregular points, digitus mobilis of the chelicerae with 3 teeth, digitus fixus with 3 teeth also, hypostom with 10 transverse lines carrying 8 to 15 little teeth, legs: I = 480, II = 465, III = 440, IV = 560 µm long, limbs of the legs with short acicular setae and stronger thorn-like setae, femur I dorsal with 3 thorns, ventral with 2 longer thorns and 1 short thorn, femur II with 2 dorsal and 2 ventral thorns, femur III with 1 ventral thorn, femur IV with 3 dorsal and 1 ventral thorns.

Idiosoma ♂ 672 x 320, more strongly sclerotised than the female, no marginal skin, the podonotum ventral fused with the peritrematic shields and the notogaster caudal with the ventrianal shield, the characteristic longer dorsal setae similar to those in the female, legs with acicular setae, leg I, II and III furthermore with strong thorns mostly localised on a rising base, femur II besides with a big club-like figuration.

Systematics: *Halolaelaps antarcticus* n. sp. belongs to the *Halolaelaps celticus* group characterised by an extremly wide ventrianal shield and 9 pairs of setae on the female notogaster. We now know 3 species: From northern Europe *H. celticus* Halbert, 1915, from southern Europe *H. schusteri* Hirschmann, 1966 and from the Antarctic *H. antarcticus* n. sp. All three species were detected at the seaside in plant residues. Comparing the 3 species we see an increasing differentiation of the setation on the dorsal shields beginning in the northern species to the highest stage of differentiation in the species of the Southern Hemisphere. In *H. celticus* from Ireland, the setae of the dorsal shields are – except the shorter setae of the vertex – similar in the length (Fig. 10a), in *H. schusteri* from Italy certain setae on the dorsum are thickened and barbed, however not very remarkably (Fig. 10b, setae z3, i5, s5, Z3, Z4). The same 5 setae in *H. antarcticus* have developed to remarkable lengthened macrochaetae (Fig. 10c).

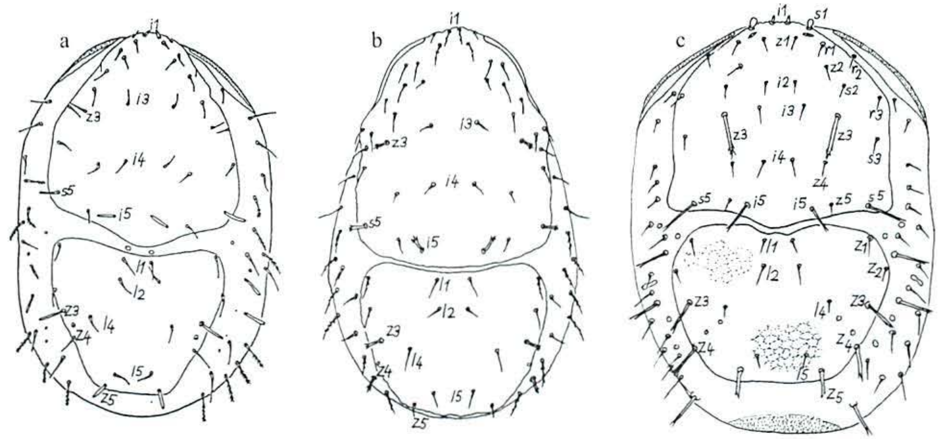

Fig. 10 Dorsum of species of the *Halolaelaps celticus* group showing an increasing differentiation of the setation: a) *Halolaelaps celticus* from northern Europe, b) *Halolaelaps schusteri* from southern Europe, c) *Halolaelaps antarcticus* from the Antarctic
Fig. 10a, b based on figures published by KARG (1993a) and HIRSCHMANN (1968)

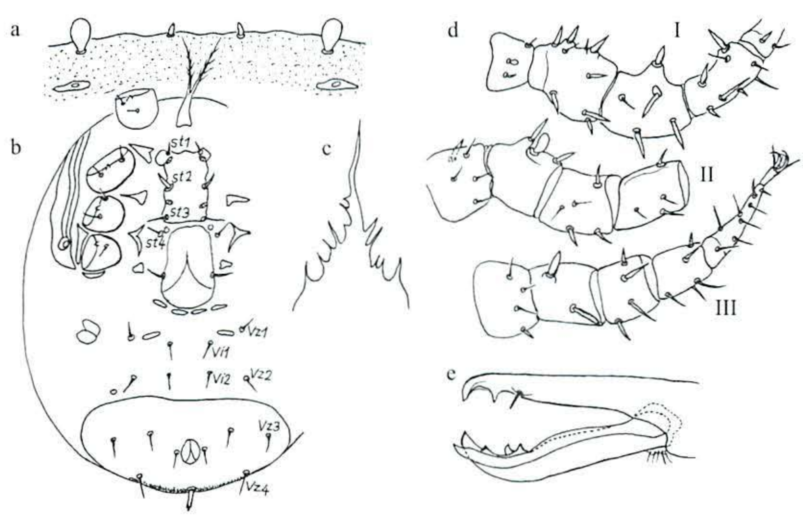

Fig. 11 *Halolaelaps antarcticus*, a – c ♀, a) vertex, stronger magnified, b) venter, c) tectum; d, e ♂, d) spur-like structures on podomeres of leg I, II, III, e) chelicera

5. Discussion concerning the evolution of the treated groups of Gamasina

We can hypothesise that *H. celticus* represents the ancestral form of the *Halolaelaps celticus* group. Descendants had spread from north to south, simultaneously developing a more and more diverse setation. Of course this colonisation only could have developed under the condition of universal connections of the continents. Such a super-continent existed in the Permian and Triassic, 290 to 210 million years ago – the so called Pangaea – in the history of our earth. However, at the end of the Jurassic, 160 to 140 million years ago, the super-continent began to split up. This induced the development of new taxa. Obviously, several groups of mites had developed at this time. Using historical zoogeography this had been already demonstrated for the Leptolaelapidae (Karg 1991, 1997a), the Rhombognathinae (Abé 1998) and for the Rhodacaridae (Karg 2003b). The distribution of primitive Rhodacaridae and Hypoaspididae however, indicates their ancient existence already in the Permian (Karg 1982, 2000a). Specialised genera must have developed later in the Jurassic (Karg 1989a). With high probability the more specialised taxa of the Halolaelapidae have developed also in this geological period.

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