A revised setal nomenclature based on ontogenetic and phylogenetic characters and universally applicable to the idiosoma of Gamasina (Acari, Parasitiformes)

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Abstract

The configuration of body setation in a given species is essentially constant and therefore important for diagnosis and determination keys. Previous concepts of setal nomenclature are critically analysed. The majority of these efforts were mostly restricted to a limited taxonomic group and therefore limited in use, although most concepts aimed towards general application. For the revised setal nomenclature, embryonic development was analysed. A decisive process is the formation of the gnathosoma with a separation from the subsequent idiosoma segments. In the anterior part of the idiosoma, the segments of legs I, II, III and IV develop, furthermore those of the genital segment consisting of the fused segments 7 and 8. The posterior part of the idiosoma comprises the segments 9, 10, 11, 12 and 13. The parts of the dorsal shield should be named prodorsum and postdorsum, the parts of the ventral idiosoma sternum and venter. Transverse rows of setae and gland pores allow residues of the ancestral body segmentation to be recognised. On the dorsum of basal derivative Gamasina groups, 10 transverse rows of setae are clearly differentiated. On the dorsum we refer to four pairs of longitudinal rows with a tranverse division in five rows on the prodorsum and five rows on the postdorsum. We define a corresponding setal nomenclature separately for the prodorsum: i1 to i5, z1 to z5, s1 to s5, r1 to r5 and for the postdorsum: I1 to I5, Z1 to Z5, S1 to S5, R1 to R5. This pattern is generally maintained in all superfamilies of Gamasina. However, in single groups certain setae are suppressed or additional setae developed. Also, sometimes setae have changed their positions. The superfamilies of the Gamasina show specialisations concerning habitats and nutrition. According to their evolution, each superfamily has also developed characteristic trends in dorsal setation. This facilitates categorising unknown species. The findings are explained by 27 figures of species grouped into 6 superfamilies.

Zusammenfassung

Die Konfiguration der Körperhaare einer Art ist im Wesentlichen konstant und somit wichtig für die Diagnose und die Bestimmungsschlüssel. Frühere Konzepte zur Nomenklatur der Haare werden kritisch analysiert. Die Mehrzahl dieser Konzepte wurde auf bestimmte taxonomische Gruppen ausgerichtet und sie sind daher in der Nutzung eingeschränkt, obwohl die meisten Konzepte auf eine allgemeine Anwendung zielten. Für die überarbeitete Nomenklatur zur Chaetotaxie wurde die embryonale Entwicklung analysiert. Ein entscheidender Prozess ist die Herausbildung des Gnathosomas mit einer Trennung von den nachfolgenden Segmenten des Idiosomas. Im vorderen Teil des Idiosomas entwickeln sich die Segmente der Beine I, II, III, IV und weiterhin das Genitalsegment, bestehend aus den

verschmolzenen Segmenten 7 und 8. Der hintere Teil des Idiosomas besteht aus den Segmenten 9, 10, 11, 12 und 13. Die Teile des Dorsalschildes sollten Prodorsum und Postdorsum, die Teile der Ventralseite des Idiosomas Sternum und Venter genannt werden. Die Querreihen von Haaren und Drüsen-Poren lassen Rückschlüsse auf die ürsprüngliche Körpersegmentierung zu. Auf dem Dorsum basaler Gamasina-Gruppen sind 10 Haar-Querreihen klar differenziert. Weiterhin lassen sich auf dem Dorsum vier Haar-Längsreihen mit einer Aufteilung in fünf Querreihen auf dem Prodorsum und fünf Querreihen auf dem Postdorsum zuordnen. Wir definieren die entsprechende Haar-Nomenklatur getrennt für das Prodorsum: i1 bis i5, z1 bis z5, s1 bis s5, r1 bis r5 und für das Postdorsum: I1 bis I5, Z1 bis Z5, S1 bis S5, R1 bis R5. Dieses Muster ist in der Regel in allen Überfamilien der Gamasina ausgebildet. Allerdings werden in einzelnen Gruppen bestimmte Haare unterdrückt oder zusätzliche Haare entwickelt. Manchmal haben die Haare auch ihre Position geändert. Die Überfamilien der Gamasina zeigen Spezialisierungen bezüglich ihrer Lebensräume und ihrer Ernährung. Entsprechend dieser Entwicklungen hat die jeweilige Überfamilie auch charakteristische Tendenzen in der dorsalen Behaarung herausgebildet. Dies erleichtert die Einordnung unbekannter Arten. Die Ergebnisse werden in 27 Abbildungen von Arten aus 6 Überfamilien dargestellt.

1. Introduction

The body setation of Acari, especially of Gamasina, is very important for identification and taxonomy. However, up to now, many different systems of setal nomenclature are used in acarology. The setal nomenclature of these systems applies only to the body setation of several related groups. Therefore, the nomenclature systems are very limited in use and not compatible. Nevertheless, most of the systems aim towards a general application. Although the configuration of the body setation of higher systematic groups is fixed genetically, many efforts lack the inclusion of phylogenetic and ontogenetic interpretation. Therefore, the various efforts are confusing and difficult to compare. Halliday (1986) demonstrated solely for the Macrochelidae 11 different systems. In the following revision of gamasine setal nomenclature, embryonic-phylogenetic processes are considered and a nomenclature system for all groups of gamasine mites is presented.

2. Segmentation and soma arrangement of Gamasina mites

The basic arachnid body plan can be separated into two tagmata, a prosoma with the acron and the anterior six segments (chelicerae, pedipalps, 4 pairs of walking legs) and a posterior opisthosoma including the genital opening and without extremities (Kaestner 1956, Evans 1992, Moritz 1993). In Acari, the prosoma is fused with the opisthosoma over the entire width and a border is not visible. Furthermore, the coxae of the pedipalps are also fused and form together with the chelicerae and the cephalic lobe (acron) a part separated from the remaining body, the gnathosoma. The other segments of the prosoma (4 pairs of legs = podosoma) together with the opisthosoma form the idiosoma. Thus, the basic body plan of the Acari is in contrast to other Arachnids, with two basic tagmata: the gnathosoma and the idiosoma (Krantz 1978). In some groups of mites, the body additionally has a sejugal furrow ventrally and dorsally between the second and third pair of legs and is divided into the anterior proterosoma and the posterior hysterosoma (Hammen 1989, Weigmann 2006).

The two tagmata, the gnathosoma and the idiosoma, originate early during embryonic development. In *Hypoaspis* and *Trichouropoda*, the cephalic lobe (acron) and the anal lobe (telson) appear first. Ambilateral of the germ band then develop protuberances for the pedipalps and legs I, II, III followed by the cheliceral buds and those of leg IV (Ignatowicz 1974, Huțu 1991). In *Pergamasus, Hypoaspis* and *Trichouropoda*, the germ band was observed to shorten with a gradual migration of the cephalic lobe, which seems to be characteristic for all mites (Zukowski 1964, Ignatowicz 1974, Huțu 1991). In the first stage of shortening, the cephalic lobe reaches the level of the chelicerae. During the progressive contraction process, the embryo undergoes a rotary movement and concomitant with this process the gnathosoma forms with a separation from the following segment 3 (leg I) and the rest of the yolk disappears between the pedipalps (Zukowski 1964, Huțu 1991) (Fig. 1). This means that the gnathosoma develops embryonically and comprises an unsegmented lobe of the acron, segment 1 the chelicera and segment 2 the pedipalp. It seems that the gnathosoma and idiosoma separate completely at the segment border between segment 2 (pedipalp) and segment 3 (leg I).
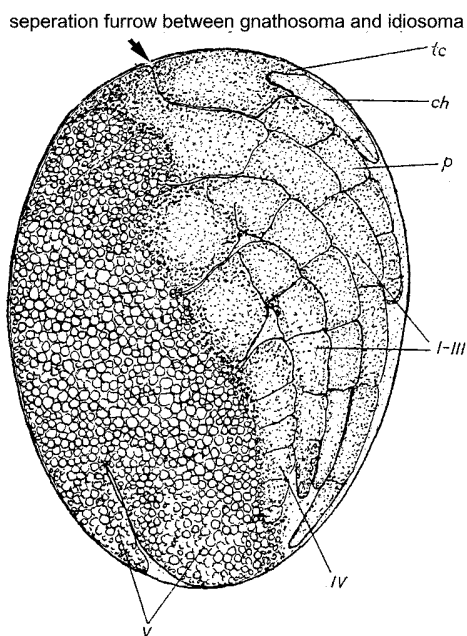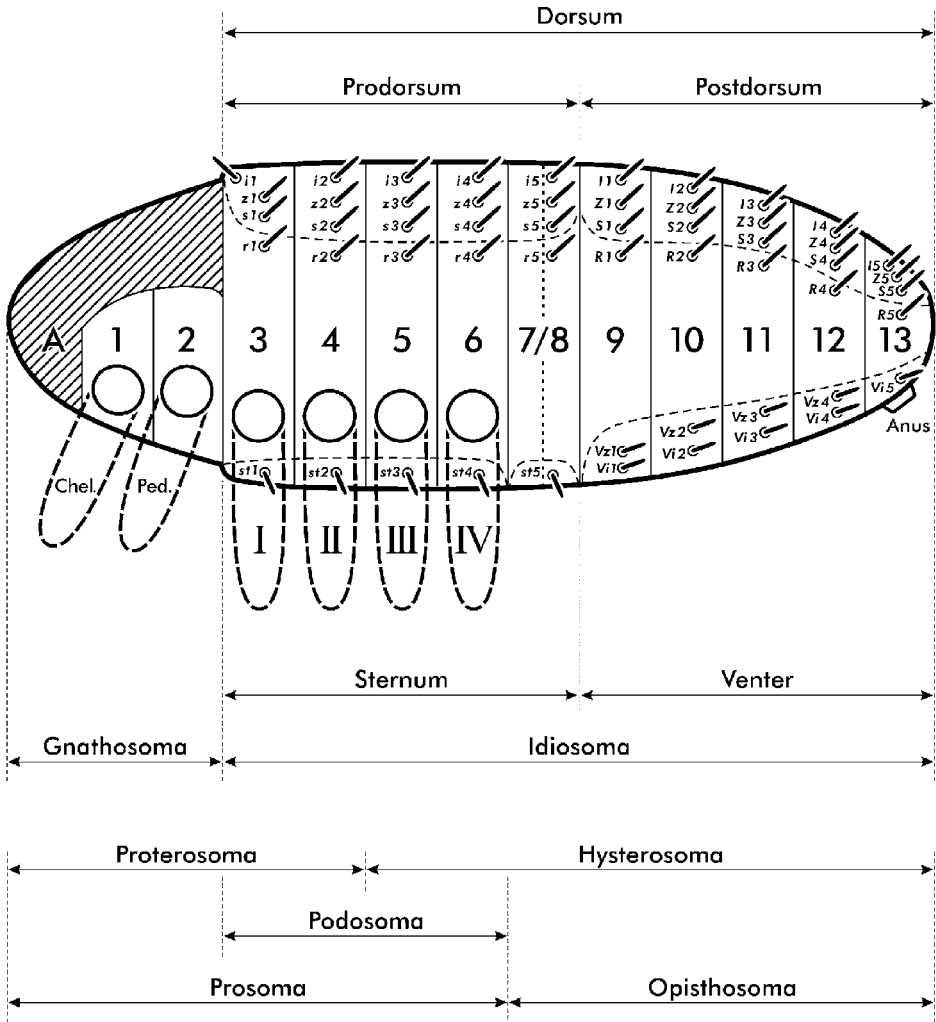

Fig. 1　The embryo after regressive rotations (ultimate position) (after Zukowski, 1964)
Designations: tc – tectum, ch – chelicera, p – pedipalpus, I-IV walking limbs, v – vitellus (yolk).
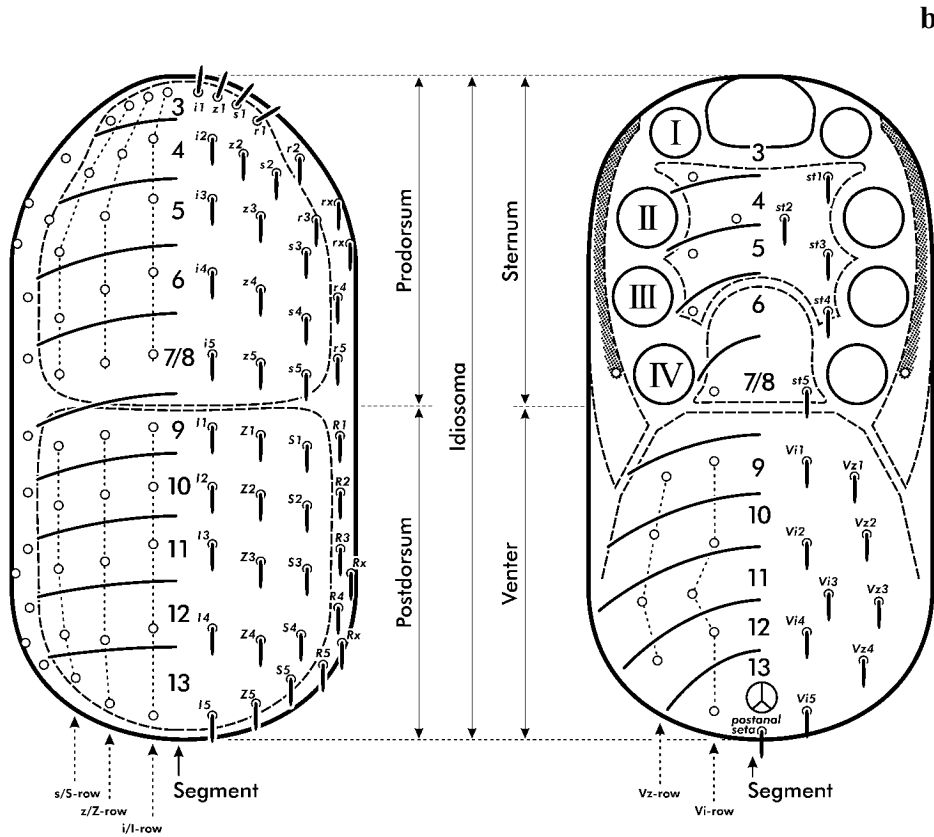
a

b

Fig. 2 Metamerism and ancestral body segmentation of Gamasina, modified on the basis of Coineau (1974): a lateral view, b dorsal view, c ventral view.

The idiosoma thus comprises the ancestral segments 3 (leg I), 4 (leg II), 5 (leg III), 6 (leg IV) and all opisthosomal segments. Raw (1957) interpreted the number of ornaments along the posterior margin of the body in some Ixodida to indicate the presence of six opisthosomal segments, but this criterion is not reliable. Embryological evidence of only five segments (plus telson) in the opisthosoma of the Ixodida have been found (Evans 1992). In the opisthosoma of actinotrichid mites (Acariformes) the first 7 (rarely only 5) metameras develop embryonically (Moritz 1993, Weigmann 2001). The Opilioacarida (= Notostigmata) show some external evidence of body segmentation, but the number of opisthosomatic segments (11 or 13) is unclear (Sitnikova 1978, Hammen 1979). Additionally, the tendency of segments 7 and 8 to fuse related with an anterior displacment of the genital opening is well-known from several groups of Arachnida. Also, it can be recognised in Hammens's (1966) drawing of *Opilioacarus* that the segments 7 and 8 are fused on the dorsal side of this primitive species (laterally still visibly separated) and that the genital opening is displaced between the coxae of leg IV.

In the absence of metamerism in the embryo or of definite external evidence of segmentation in the larva and succeeding instars, opisthosomatic segmentation in the Gamasida is speculative, but some attempts have been made to determine the number of body segments on the basis of setal patterns (Evans 1992). In many species, especially in Gamasina, the ancestral body segments are suggested in all stages by transverse rows of setae (Moritz 1993). The maximum number of dorsal idiosomatic gland pores is nine pairs, of which five pairs are located in the prosomatic region and four pairs in the postsomatic region (Athias-Henriot 1975a, b). This indicates that the idiosoma of gamasina mites should have dorsally and ventrally one transverse row of setae and one pair of gland pores on segment 3 (= leg I), segment 4 (= leg II), segment 5 (= leg III), segment 6 (= leg IV), segment 7/8 (= fused pregenital and genital segment) and the other opisthosomal segments 9, 10, 11, 12 and 13 (Fig. 2). On the dorsum of ancestral gamasine groups such as *Protogamasellus*, *Dendrolaelaps*, 10 rows of setae are clearly differentiated (Fig. 3). The division of the dorsal shield after the fifth row of setae is secondary and does not mark the border between the prosoma and opisthosoma. Therefore, the parts of the dorsal shield should be named prodorsum and postdorsum. On the basis of these 10 rows of setae and their allocation to 10 transverse segments (inclusive the suppressed segment 7), a new setal nomenclature is presented.

3. Chaetotaxy of the dorsal and ventral sides

Prerequisite for using setation in descriptions, diagnoses and determination keys is a terminological and nomeclatural system for the setae. A number of previous attempts were mostly restricted to a limited systematic group. For example, for the genera of Phytoseiidae the setae of four paired longitudinal rows were named and numbered from anterior to posterior: D-, M-, L- rows (Garman, 1948); D-, AM-, PM-, Al-, PL-, S- rows (Wainstein 1962); or V-, D-, M-, L- rows (Muma & Denmark 1970). In the genera of this family, reduction of the setation has developed in a very diverse manner (Chant 1993). Therefore, these nomenclatura systems are very limited in use and not compatible. Unfortunately, some authors apply these hypotrichous systems to holotrichous systematic groups: F-, D-, S-, M-, Pl- rows (Bregetova & Koroleva 1960, Ghilarov & Bregetova 1977, Shcherbak 1978, Ma 1997). Other authors apply the hypotrichous systems of the Phytoseiidae to other hypotrichous groups, for example the Eviphidoidea including the Macrochelidae (Evans & Browning 1956, Bregetova & Koroleva 1960). These groups, however, show another scheme of reduction. The setal systems are again incompatible. Note, however, 'the setation is not a static record of the past: rather, it remains dynamic to-day' (Takahashi 1990: In Chant 1993).

In another attempt, Hirschmann (1957) advanced the system of Sellnick (1944) with separate paired rows of longitudinal setae on the prodorsum and the postdorsum. The symbols for the setal rows are mainly based on Sellnick (1944) and comprise a dorsocentral row (**i-I** = '**I**nnenreihe'), a mediolateral row (**z-Z** = '**Z**wischenreihe'), a lateral row (**s-S** = '**S**eitenreihe') and a marginal row (**r-R** = '**R**andreihe'). The setae on the prodorsum are written in lower case letters and the setae on the postdorsum in capital letters. Each subseries are numbered consecutively from anterior to posterior. The Sellnick symbols have also been used by Lindquist & Evans (1965), Costa (1966), McGraw & Farrier (1969), Krauß (1970), Karg (1971, 1993), Van Driel et al. (1977), Tenorio & Marshall (1977), Krantz (1981), Halliday (1986), Evans (1992) and Christian & Karg (2006). The Hirschmann concept was further
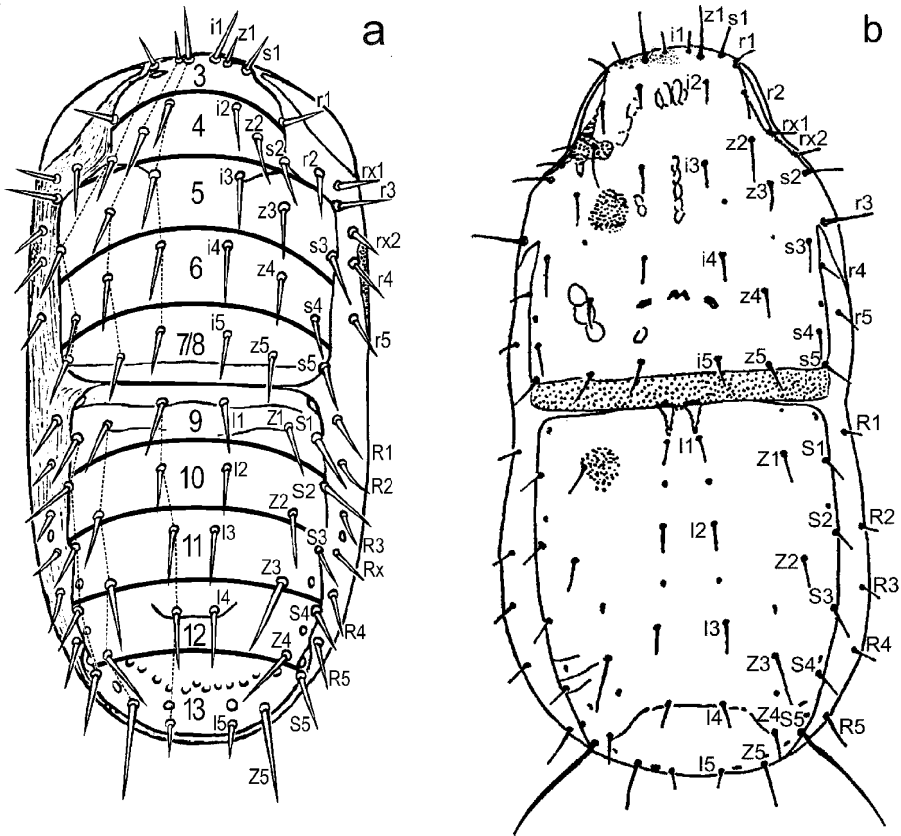
Fig. 3   Dorsal chaetotaxy: a *Protogamasellodes singularis* (Karg, 1962), b *Dendrolaelaps cornutus* (Kramer, 1886).

developed and some illogical designations of mediolateral setae corrected by Lindquist & Evans (1965). The concept of these authors, however, is based on the family Ascidae. In this group, setae of the vertex have changed their position (Christian & Karg 2006) and it seems that there are six transvers rows of setae on the prodorsum. For this reason, their concept leads to a questionable interpretation. Nonetheless, while including a fundamental correction, this concept is the basis for our revision.

Due to the embryonic separation of the gnathosoma from the idiosoma, the segments 1 (chelicera) and 2 (pedipalp) do not take part in formation of the dorsal side of the idiosoma and they are therefore also not recognisable in transverse rows of setae on the prodorsum. The first transverse row of dorsal setae belongs to segment 3 (leg I), followed by three transverse rows of setae belonging to segments 4, 5 and 6 (leg II, III and IV). The fifth and last row of setae on the prodorsum belongs to the fused segments 7 and 8 (the genital segment), which grow together along the entire width with the prosoma. These five segments (3, 4, 5, 6, 7/8) are marked by 5 transverse rows of setae on the dorsal and ventral side, visible as i1-z1-s1-r1, i2-z2-s2-r2, i3-z3-s3-r3, i4-z4-s4-r4, i5-z5-s5-r5 and st1, st2, st3, st4, st5 (Figs. 2, 3, 4) and also by 5 pairs of dorsal idiosomatic gland pores on the prodorsum. Due to this arrangement, we refer in the comparative morphology to 5 series of setae on the prodorsum (i1-i5, z1-z5, s1-s5, r1-r5) and to five pairs of setae on the anterior ventral side (st1, st2, st3, st4, st5). On the ventral side, besides the genital shield, platelets or pores and one to three small setae are visible behind coxae IV, especially in Veigaiaidae and Parasitidae. This may be an indication of a setal remnant of segment 7 (Figs. 4b, 18c: setae Vx1, Vx2).
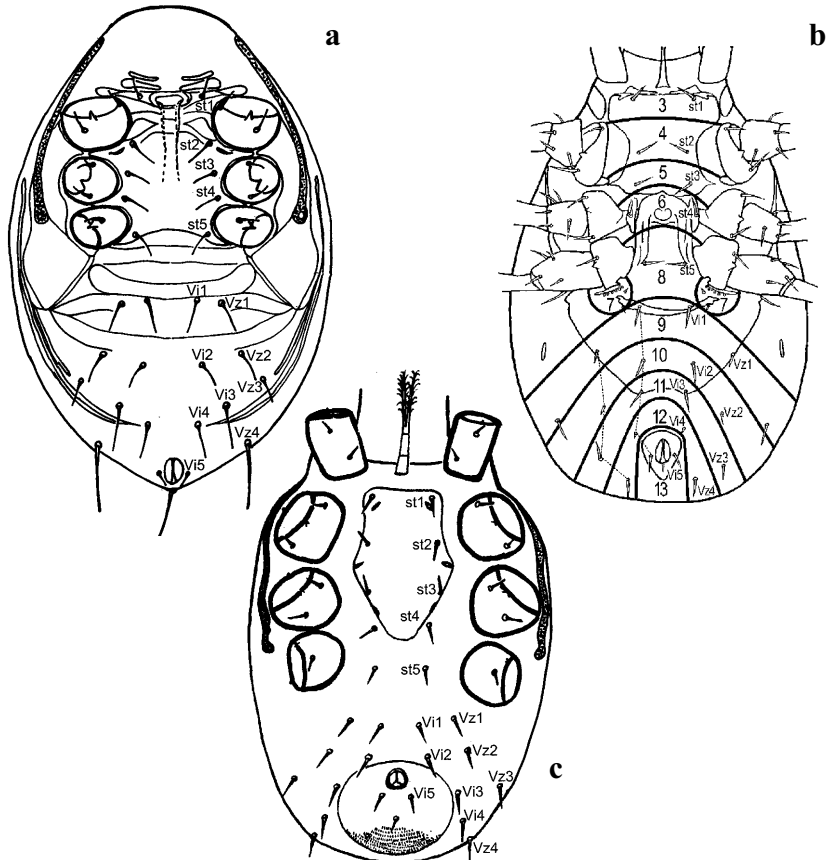

Fig. 4   Ventral chaetotaxy: a *Gamasiphis lanceolatus* Karg, 1987, male; b *Veigaia cerva* (Kramer, 1876), female; c *Cheiroseius borealis* (Berlese, 1904), deutonymph.

On the postdorsum of many gamasine groups, especially in ancestral genera such as *Protogamasellus* or *Dendrolaelaps*, five rows of setae are clearly differentiated (Fig. 3). These 5 transverse rows of setae (I1-Z1-S1-R1, I2-Z2-S2-R2, I3-Z3-S3-R3, I4-Z4-S4-R4, I5-Z5-S5-R5) mark the ancestral body segments 9, 10, 11, 12 and 13 (Figs. 2, 3). On the venter of gamasine mites, an anterioral shift of the anal shield from the end of the idiosoma toward the coxae and between the ventral transverse rows of setae can be observed. Five transverse rows of ventral setae are differentiated (Vi1-Vz1, Vi2-Vz2, Vi3-Vz3, Vi4-Vz4, Vi5) and mark the ancestral body segments 9, 10, 11, 12 and 13 on the venter (Figs. 2, 4). Segment 13 is represented on the ventral side by the anus with Vi5 (the paranal setae) and the postanal seta. This could be also the Telson, because only 4 pairs of dorsal idiosomatic gland pores on the postdorsum are known (Athias-Henriot 1975 a, b). Due to this arrangement, we refer in the comparative morphology also to 5 series of setae on the postdorsum (I1-I5, Z1-Z5, S1-S5, R1-R5) and to five series of setae on the venter (Vi1-Vi5, Vz1-Vz4).

4. The system of dorsal setation in the superfamilies of Gamasina

The superfamilies of Gamasina show specialisations concerning habitats and nutrition (Karg 1993). According to these evolutionary trajectories, each superfamily has developed characteristic trends in altered dorsal setation. Within these developments, certain setae are suppressed or have changed their position stepwise (Karg 1998, Christian & Karg 2006).

The soil strata are considered to be the ancestral habitats of gamasine mites. Based on this, an original setation is to be assumed in groups living there. This applies especially to the group of Rhodacaroidea. Here, a complete ensemble of dorsal setae is present (Fig. 3): four pairs of longitudinal rows with a transverse division in five rows on the anterior part of the dorsum (prodorsum) and five rows on the posterior part of the dorsum (postdorsum). This pattern is generally maintained in all superfamilies of Gamasina. However, in individual groups certain setae are suppressed or additional setae have developed, for example in the marginal r- and R-rows. Sometimes setae have changed their position. A special importance is seen in seta-pair r3, the so called shoulder setae. These projecting setae function in touch and are mostly longer than other setae. We consider these setae to be homologous in most groups.

In the following, the setation of the superfamilies is characterised based on the systematics according to Krantz & Ainscough (1990) as well as Karg (1993, 2006). The presented studies are restricted to free-living mites. The post-embryonic development stages of Gamasina will be explained in the larval sections and nymphal stages (protonymph and deuteronymph) and in the adult sections.

4.1. Larva and nymphal stages in the superfamilies

The dorsal setation of larva and nymphal stages are investigated again based on Karg (1962). One example was analysed for each superfamily: *Dendrolaelaps rectus* Karg, 1962 from the Rhodacaroidea (Fig. 5), *Lysigamasus misellus* (Berlese, 1904) from the Parasitoidea (Fig. 6), *Alliphis siculus* (Oudemans, 1905) from the Eviphidoidea (Fig. 7), *Hypoaspis aculeifer* (Canestrini, 1883) from the Dermanyssoidea (Fig. 8), *Amblyseius obtusus* (C.L. Koch, 1839) from the Phytoseioidea (Fig. 9) and *Cheiroseius borealis* (Berlese, 1904) from the Ascoidea (Fig. 10). Comparing the setation of the prodorsum, it is clearly visible that larva

and protonymphs of gamasine groups show a uniform development of the prodorsum. The shield of the larva consistently bear the setae-pairs i1 to i5, z2, z3, z4 and s3, giving a total of 9 pairs of setae. In the protonymph the setae-pairs z1 and z5 appear additionally on the shield, so that 11 pairs of setae exist, with one exception: In *Amblyseius obtusus*, a representative of the Phytoseiidae, the development comes to a halt from the larval stage onwards. Concerning the presented study, it is important that there are only five pairs of setae on the middle line, i1 to i5, a reference to five segments.
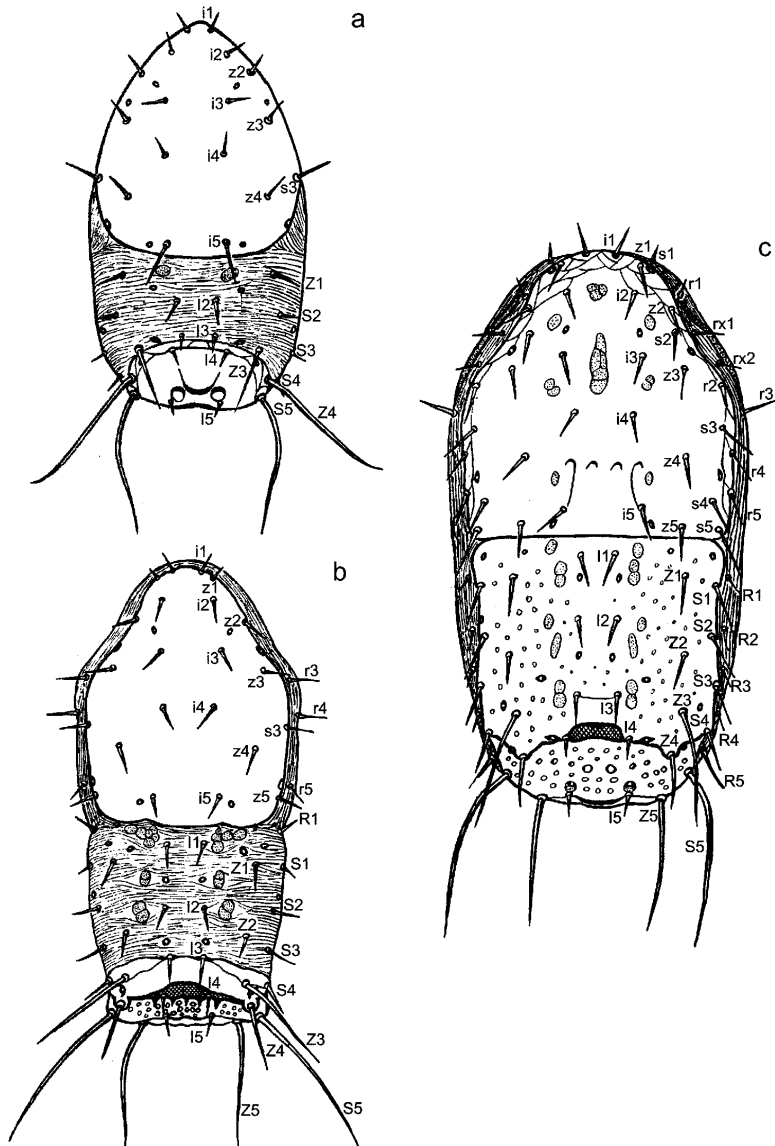
Fig. 5   Dorsum of *Dendrolaelaps rectus* Karg, 1962 (Rhodacaroidea): a larva; b protonymph; c deutonymph.
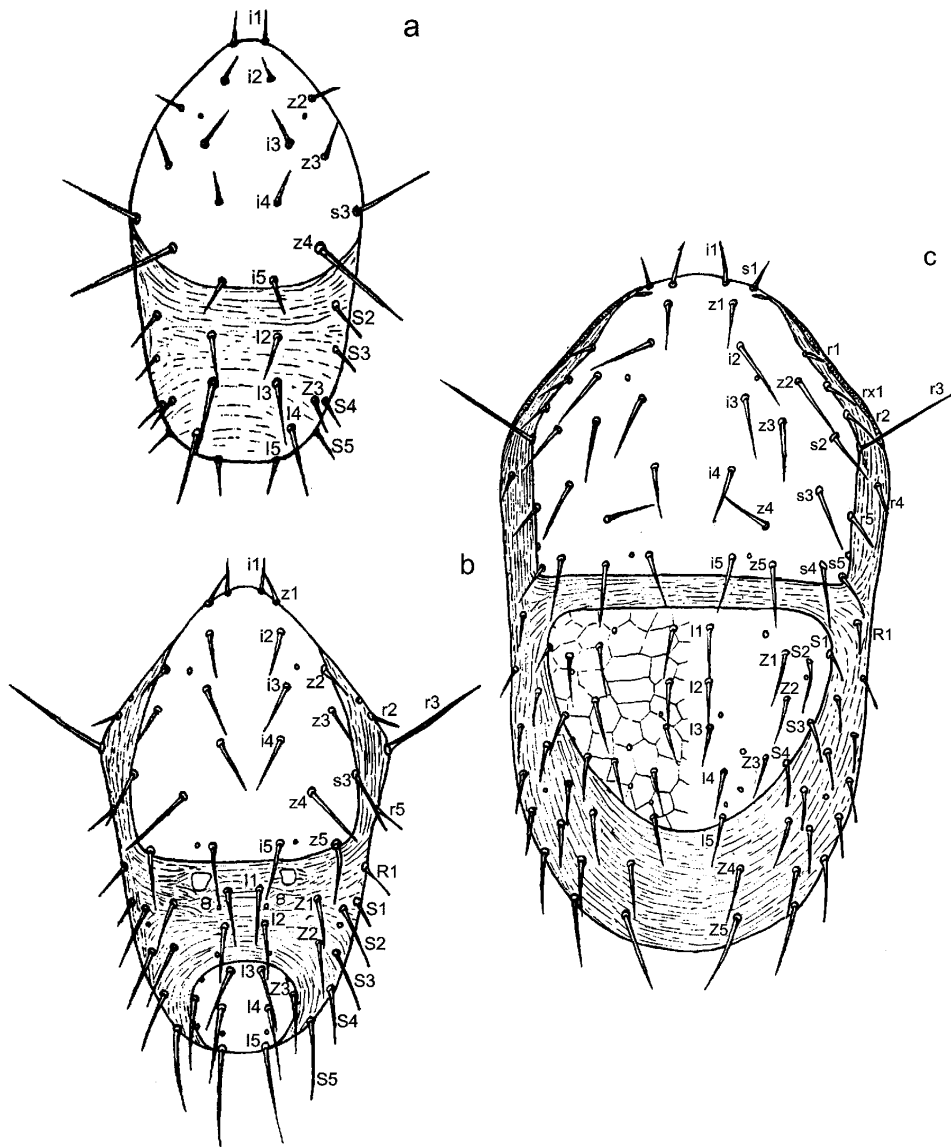
Fig. 6   Dorsum of *Lysigamasus misellus* (Berlese, 1904) (Parasitoidea): a larva; b protonymph; c deutonymph.
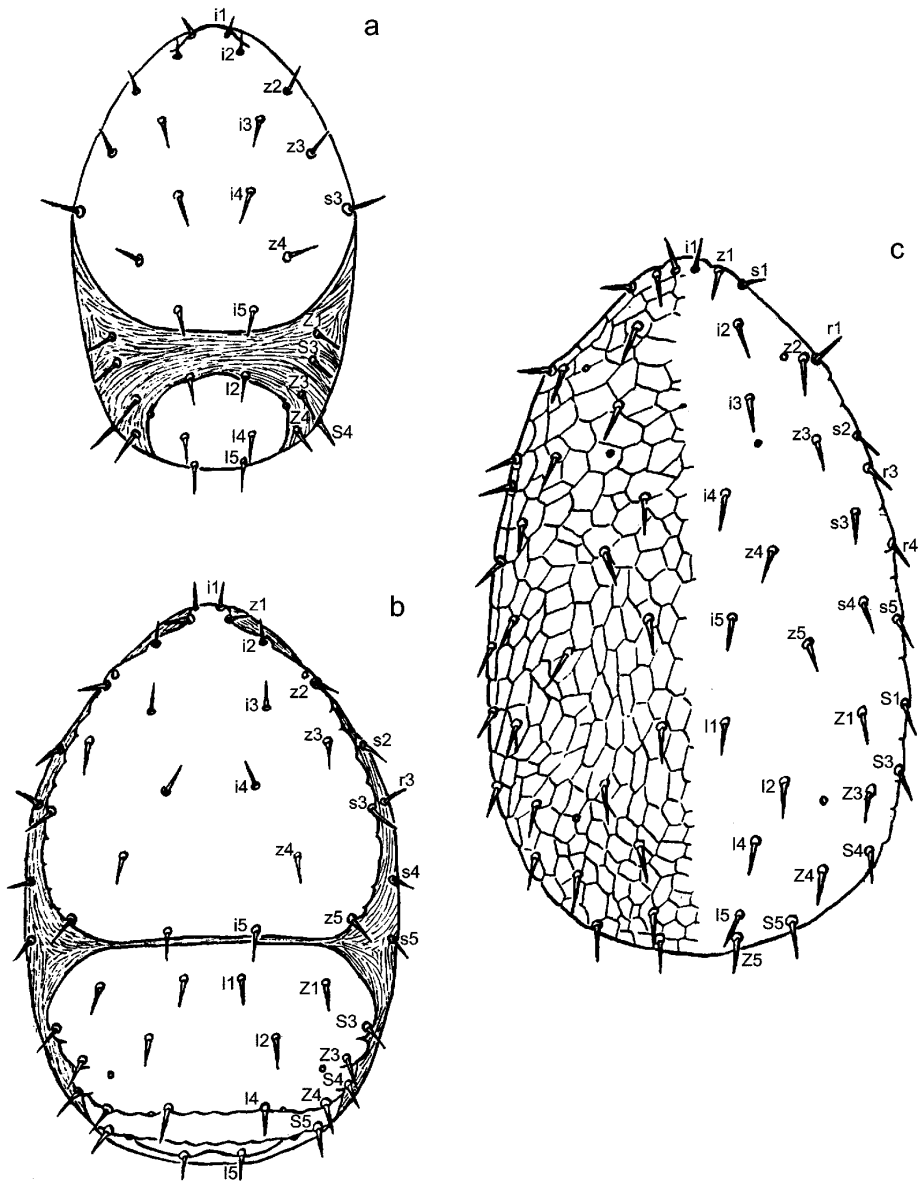
Fig. 7   Dorsum of *Alliphis siculus* (Oudemans, 1905) (Eviphidoidea): a larva; b protonymph; c deutonymph.
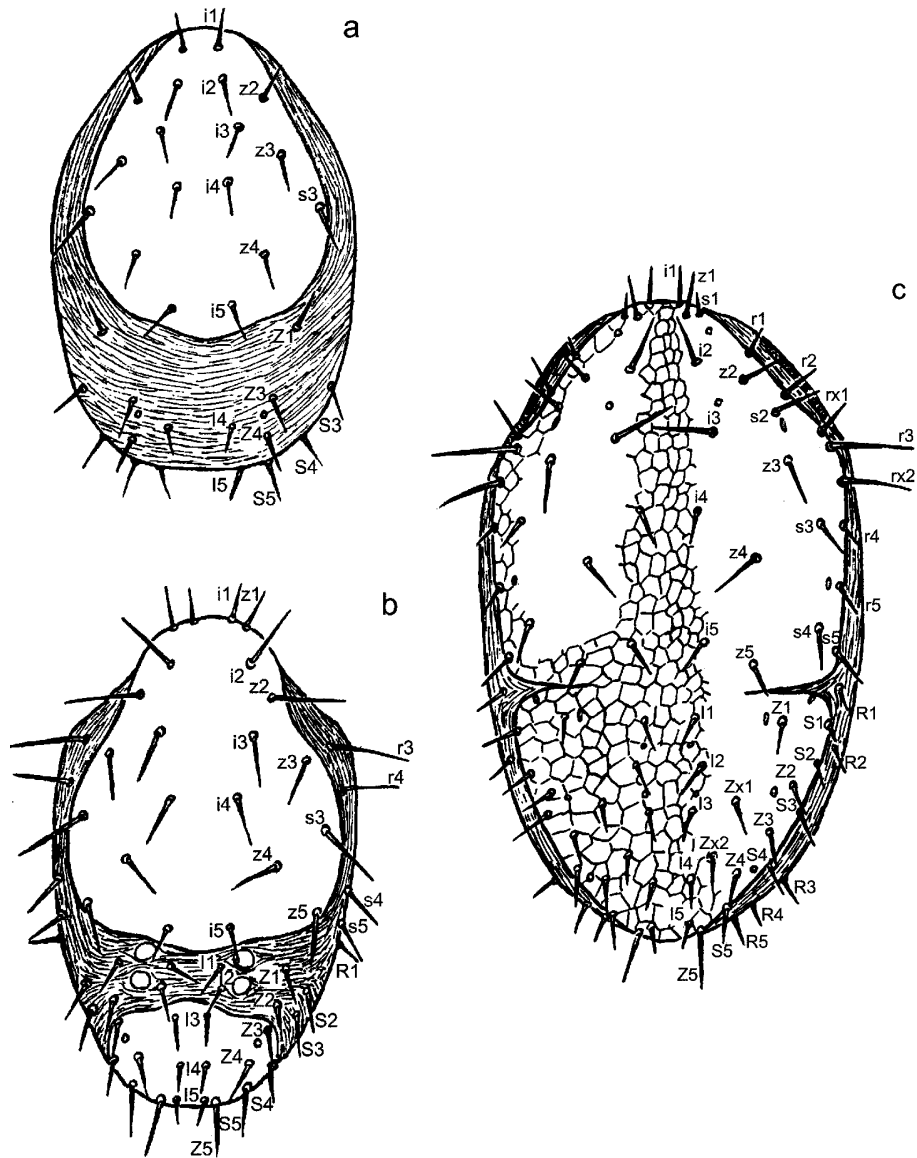
Fig. 8   Dorsum of *Hypoaspis aculeifer* (Canestrini, 1883) (Dermanyssoidea): a larva; b protonymph; c deutonymph.
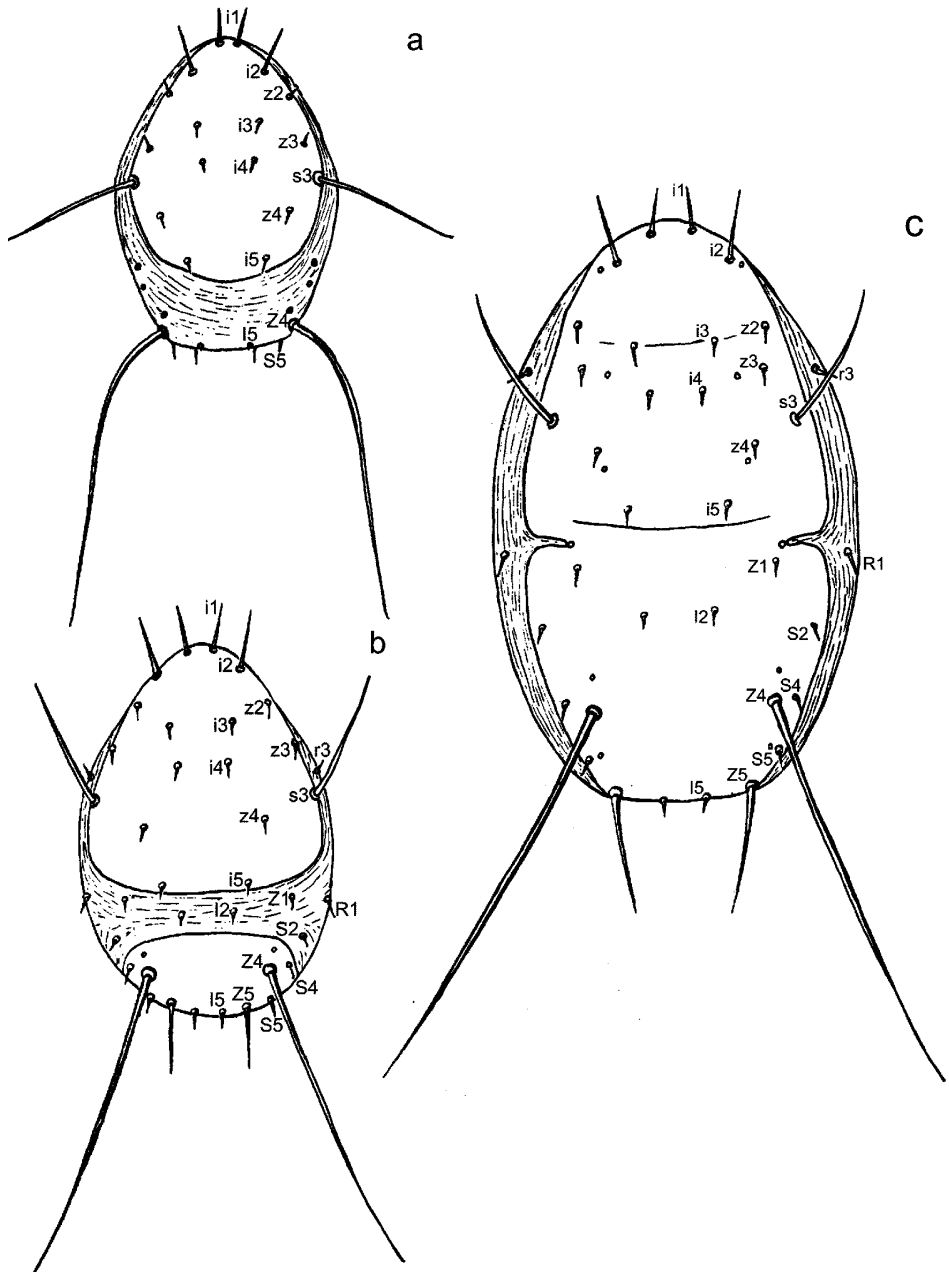
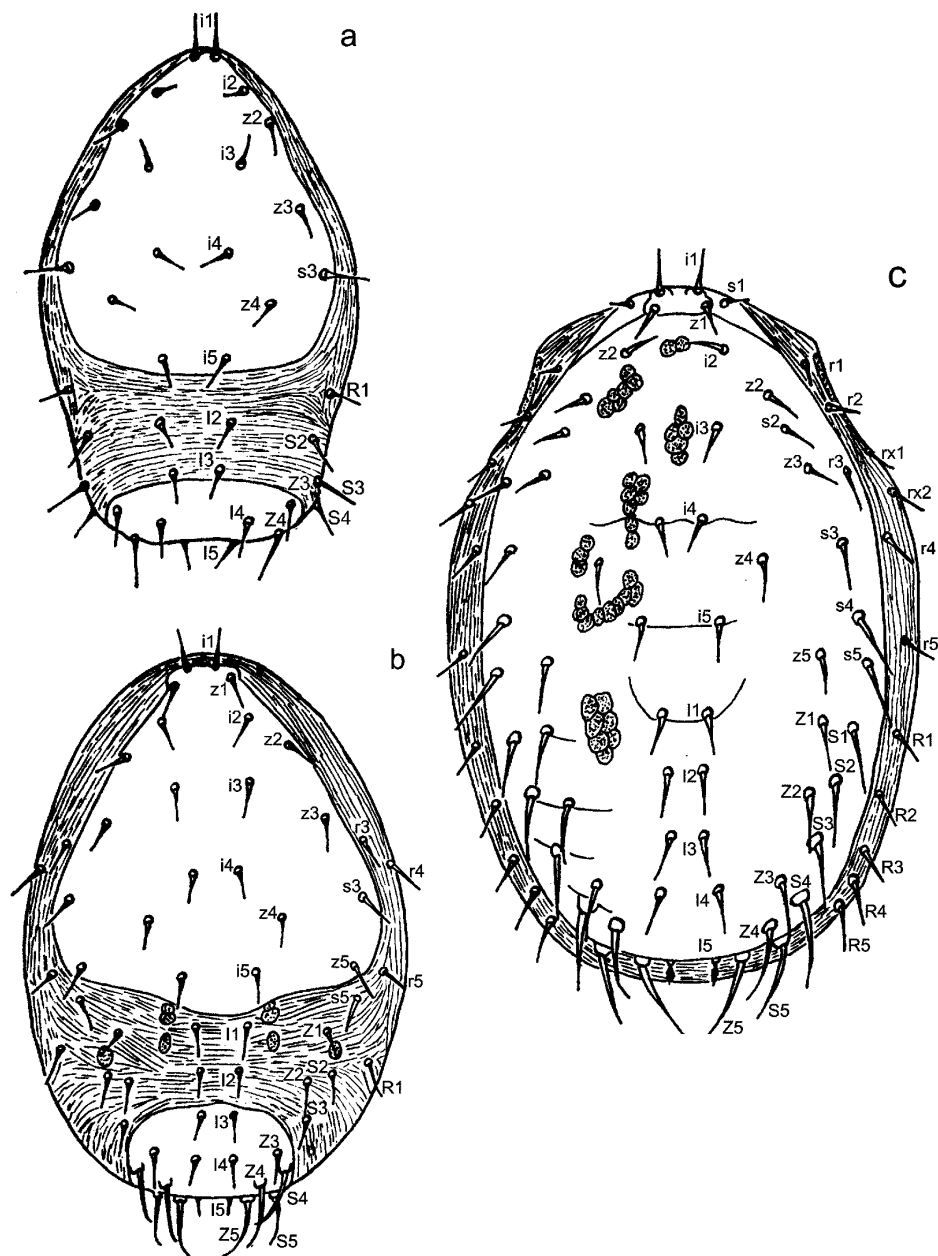Fig. 9   Dorsum of *Amblyseius obtusus* (C. L. Koch, 1839) (Phytoseioidea): a larva; b protonymph; c deutonymph.

Fig. 10   Dorsum of *Cheiroseius borealis* (Berlese, 1904) (Ascoidea): a larva; b protonymph; c deutonymph.

A differentiated development of the prodorsum in gamasine groups begins with the deutonymphal stages. On the prodorsum, a different number of additional s- and r-setae appear. The number and pattern of setae in deutonyphal stages mostly correspond with the adult mite. Additionally, there is a trend towards a fusion of the prodorsum and postdorsum. In spite of the described general setation of Gamasina groups, in each of these groups a few specific deviations have developed in each species.

4.2. Adult stages in the superfamilies

4.2.1. Rhodacaroidea

In this group the ancestral pattern of dorsal setae is generally developed. However, in several species, the Z-row approaches the S-row. Sometimes, the position of setae-pairs z1 or Z5 are altered backwards (Figs. 11, 12, 13). To this superfamily belong Rhodacaridae, Ologamasidae, Sessiluncidae and Gamasiphidae.
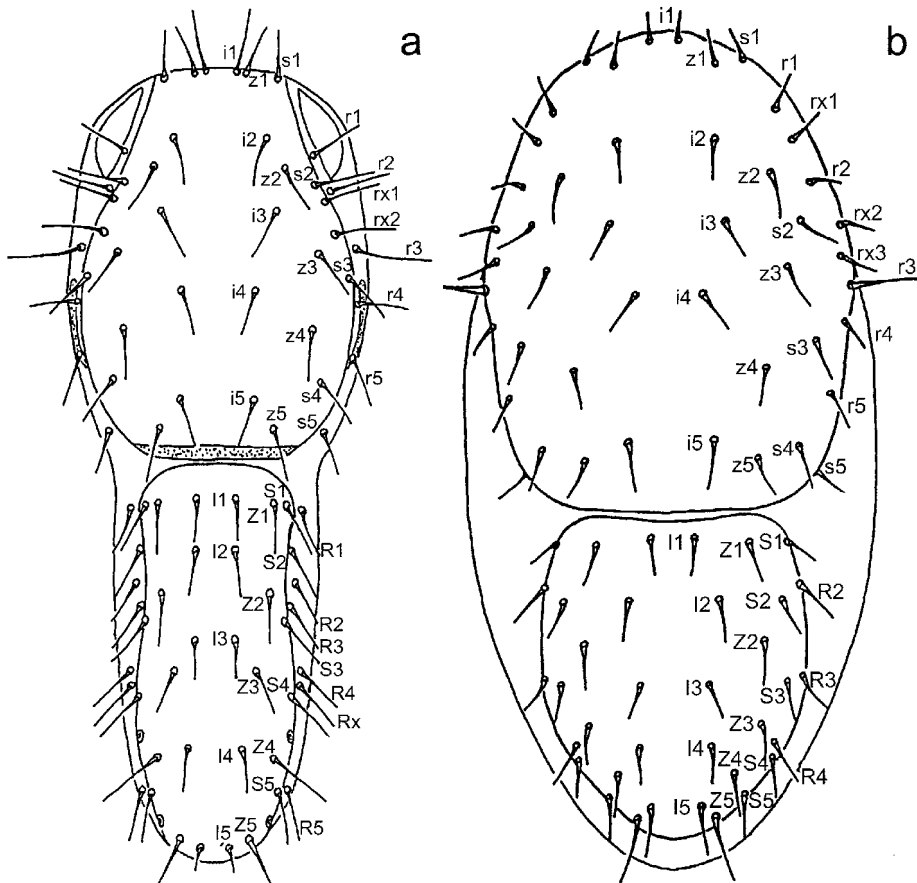

Fig. 11   Dorsum of species of Rhodacaroidea: a *Protogamasellopsis leptosomae* Karg, 1994; b
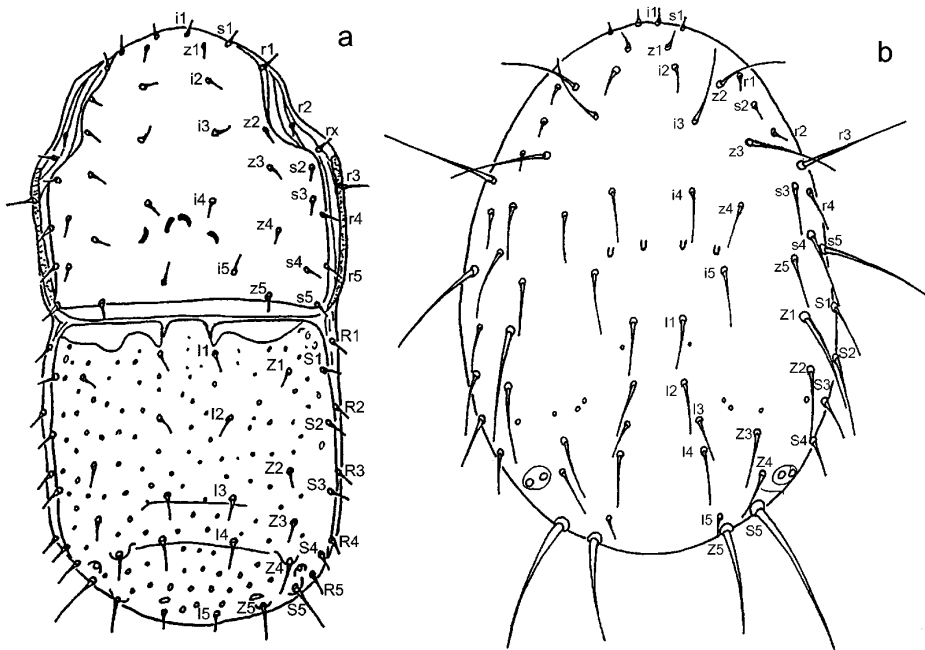   *Rhodacaroides calidus* Karg, 1977

Fig. 12   Dorsum of species of Rhodacaroidea: a *Dendrolaelaps arenarius* Karg, 1971; b *Panteniphis mirandus* Willmann, 1949.
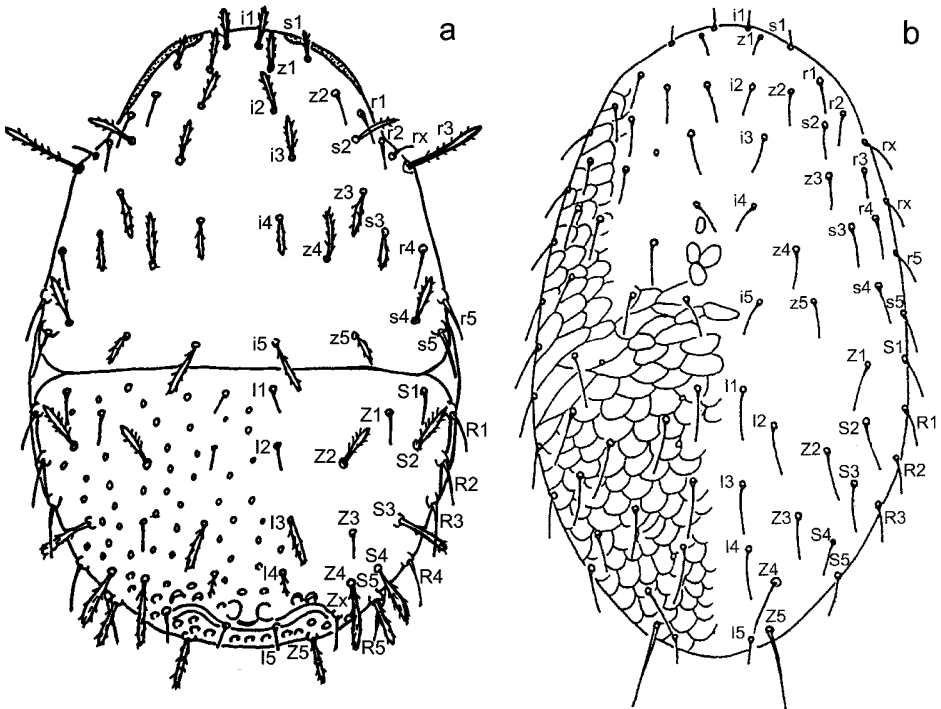
Fig. 13   Dorsum of species of Rhodacaroidea: a *Acuphis octornatus* Karg, 1998; b *Gamasiphis furcatus* Karg, 1990.

4.2.2. Parasitoidea

This superfamily is related to the Rhodacaroidea. The complete setation is preserved. However, in several genera such as *Pergamasus*, *Amblygamasus* and *Parasitellus*, a polytrichous postdorsum has developed. A first polytrichous case can already be seen in *Cyrtolaelaps mucronatus* (G. & R. Canestrini, 1881), which belongs to the superfamily Rhodacaroidea. Remarkably, in several species of Parasitoidea, single specially shaped setae exist, which are longer, thicker or brush-like, as in *Parasitus* (Fig. 14). To this superfamily belong the Parasitidae, Veigaiaidae and Arctacaridae.
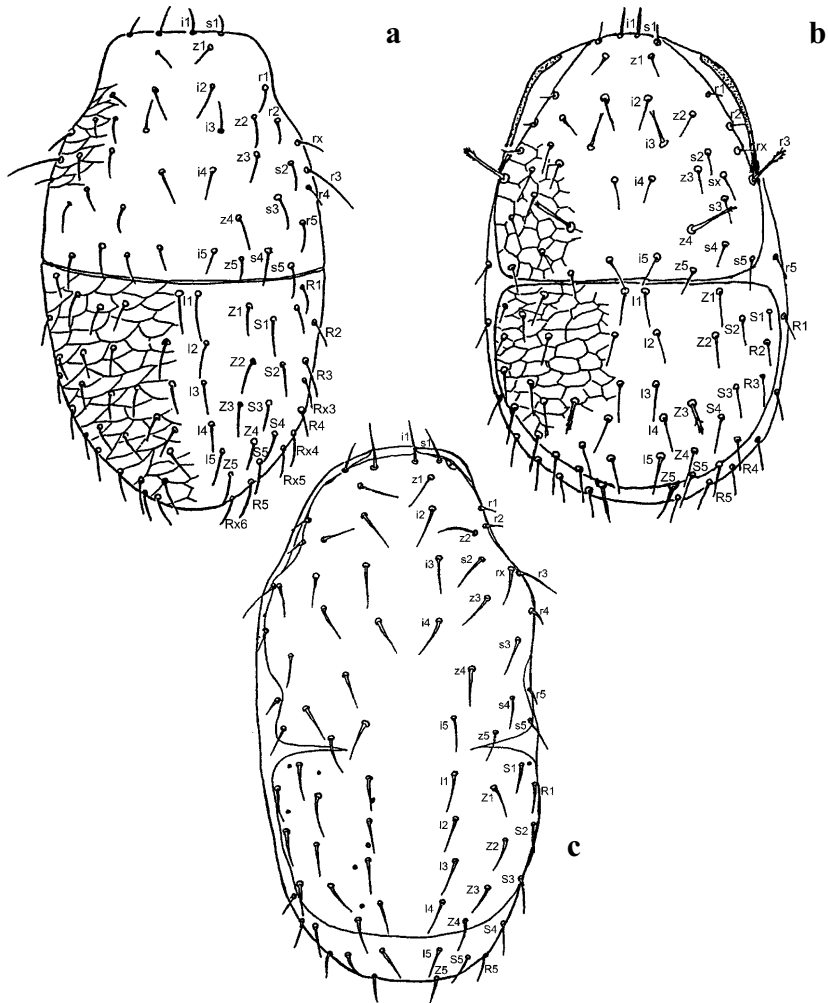

Fig. 14   Dorsum of species of Parasitoidea: a *Lysigamasus cuneatus* Karg, 1968; b *Parasitus pectospinosus* Karg, 1998; c *Veigaia exigua* (Berlese, 1917).

4.2.3. Eviphidoidea

This taxonomic group shows a very characteristic pattern of setae on the postdorsum. The setae-pairs I3 and mostly S2 and Z2 are suppressed. Setae I2 – I2 stand remarkably far apart (Figs. 15, 16, 17). In some species, further setae-pairs disappear beyond setae-pair I3: I2, I4, S3 or S4. However, in the Leptolaelapidae and Parholaspidae, some species also show the complete number of setae. To this group belong the Eviphididae, Macrochelidae, Parholaspidae, Bulbogamasidae, Leptolaelapidae, Pachylaelapidae and Pseudolaelapidae.
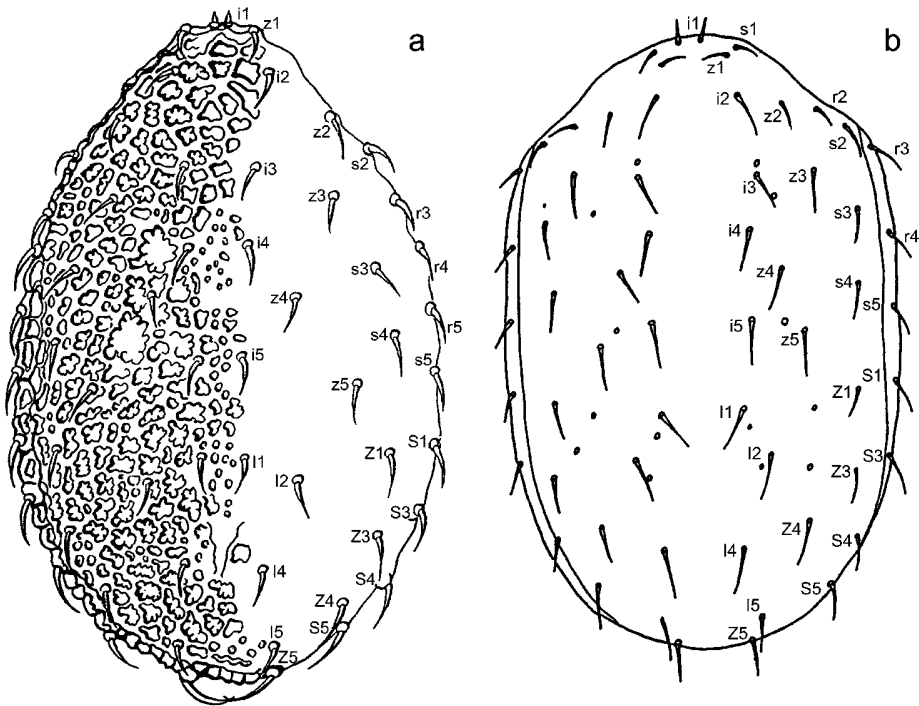

Fig. 15   Dorsum of species of Eviphidoidea: a *Alliphis sculpturatus* Karg, 1998; b *Pachylaelaps jurassicus* Schweizer, 1961.
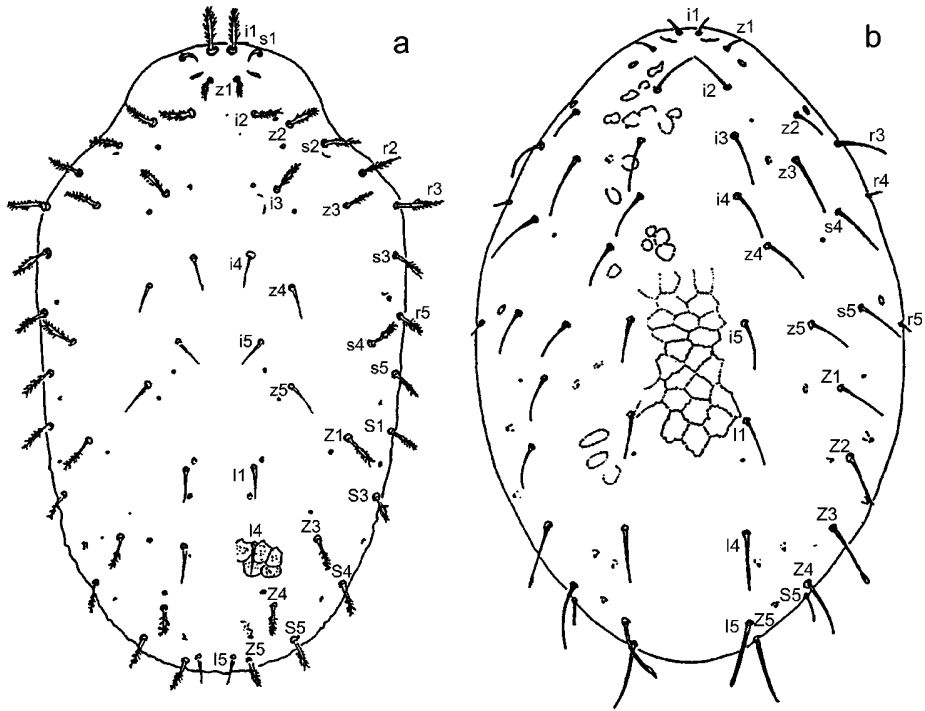
Fig. 16   Dorsum of species of Eviphidoidea: a *Macrocheles montanus* (Willmann, 1951); b *Pseudolaelaps doderoi* (Berlese, 1910).
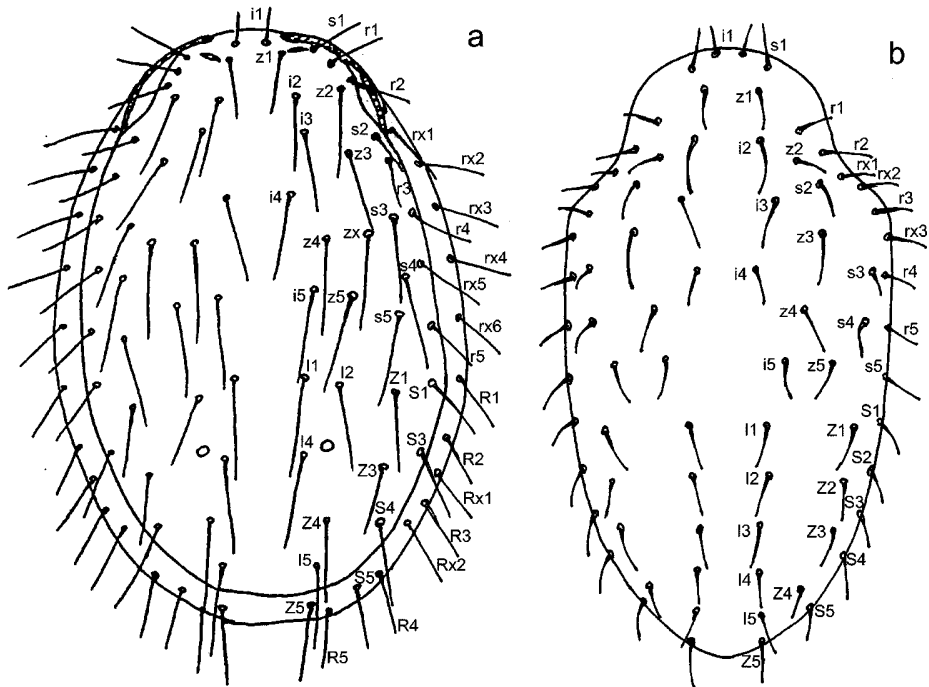
Fig. 17   Dorsum of species of Eviphidoidea: a *Gamasholaspis lingualis* Karg, 2006; b *Leptolaelaps capensis* Evans, 1957 (redrawn after Evans, 1957).

4.2.4. Dermanyssoidea

The dorsal setae pattern is characterised by additional Z-setae on the postdorsum, mostly two pairs (Zx1 and Zx2), and sometimes an additional unpaired I-setae. There is a visible trend towards multiplication of the marginal r- and R-setae (Figs 18, 19). To this group belong the free living Hypoaspididae, Laelapidae, Hämogamasidae and Macronyssidae.
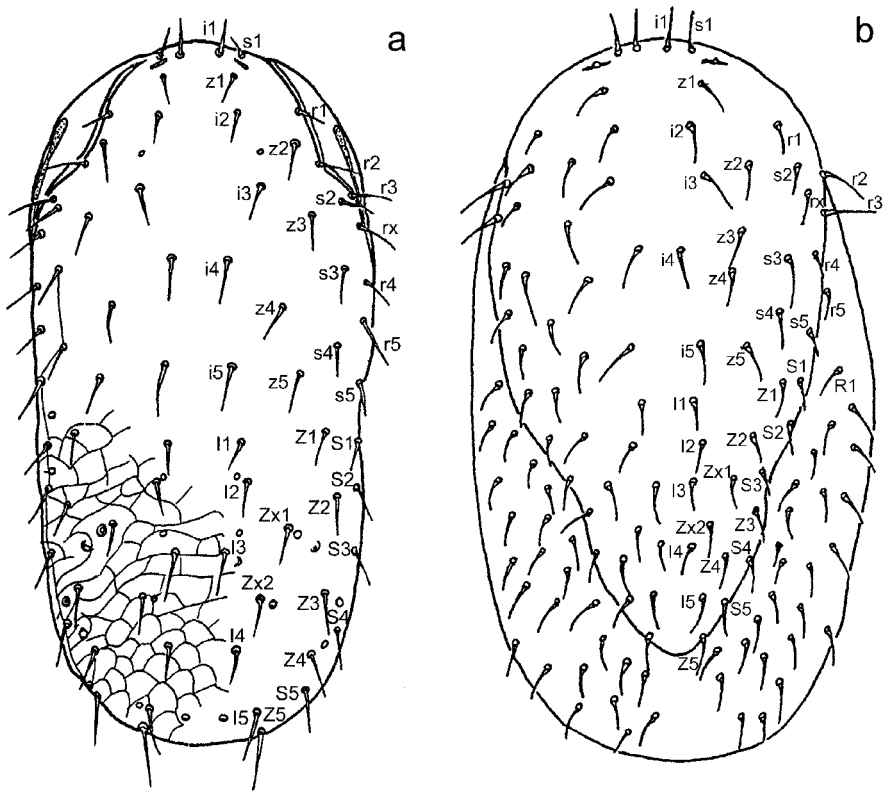
Fig. 18   Dorsum of species of Dermanyssoidea: a *Hypoaspis (Geolaelaps) praesternalis* Willmann, 1949; b *Hypoaspis (Geolaelaps) angustiscutata* Willmann, 1951.
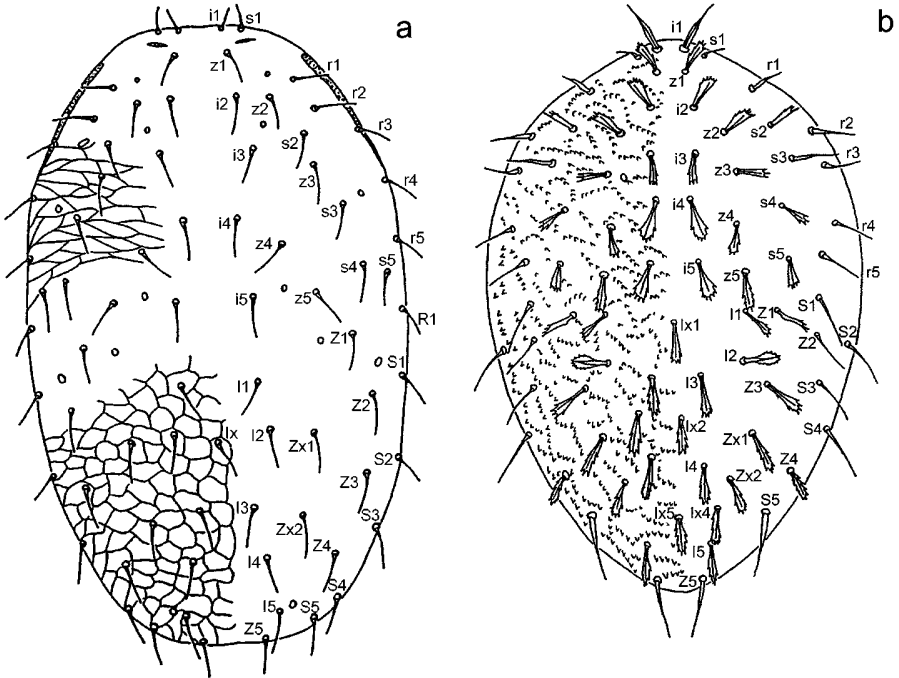
Fig. 19   Dorsum of species of Dermanyssoidea: a *Pseudoparasitus porulatus* Karg, 1989; b
           Hypoaspis (*Cosmolaelaps*) *aciphila* Karg, 1989.

4.2.5. Phytoseioidea

In this superfamily a remarkable trend towards reduction of the number of setae on the
dorsum can be observed. The degree of reduction differs from genus to genus. Furthermore,
the setae are frequently considerably different in length or certain setae are feathered,
trispinate or leaf like (Figs. 20, 21, 22). To this group belong the Phytoseiidae, Podocinidae,
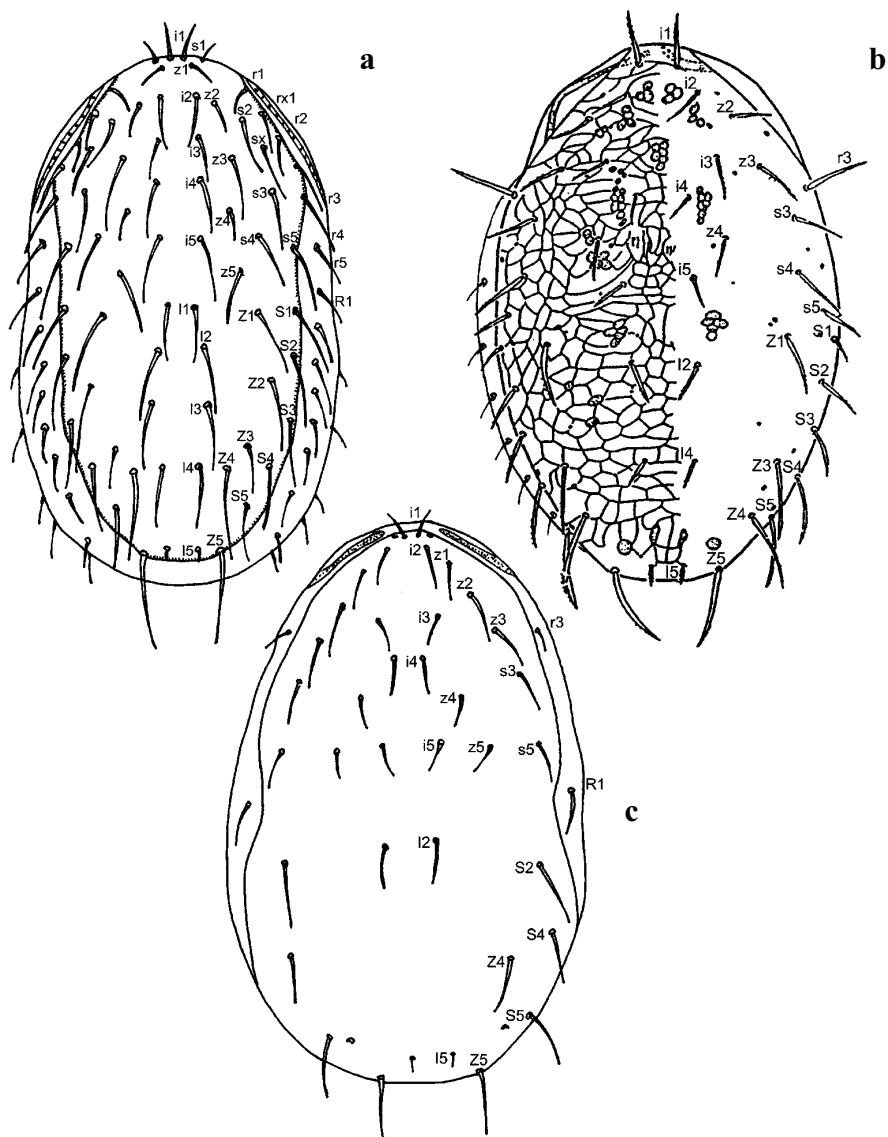Ameroseiidae and Epicriidae.

Fig. 20   Dorsum of species of Phytoseioidea: a *Paragarmania dentritica* (Berlese, 1918) (redrawn after Evans 1958); b *Lasioseius youcefi* Athias-Henriot, 1959 (redrawn after Westerboer 1963); c *Paraseiulus triporus* (Chant & Yoshida-Shaul, 1982) (redrawn after Chant & Yoshida-Shaul 1982).
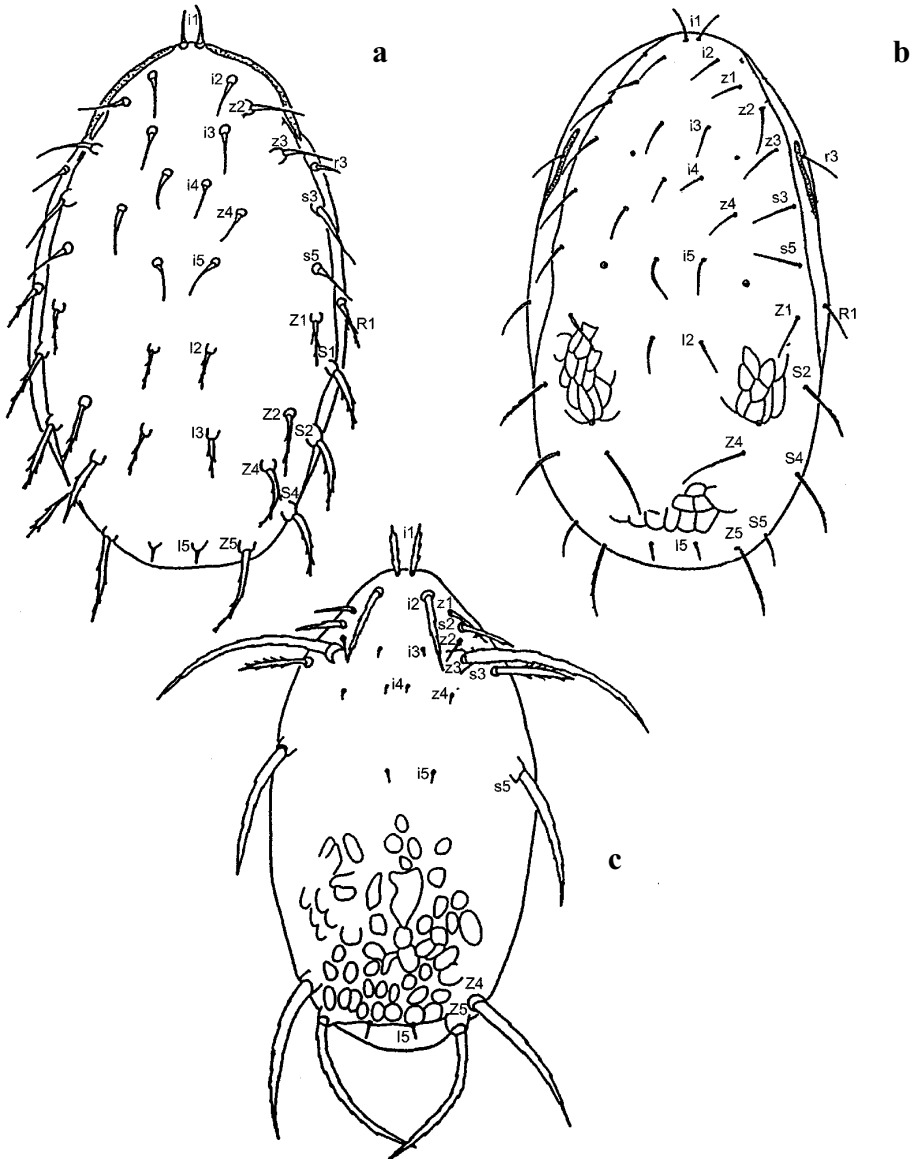
Fig. 21   Dorsum of species of Phytoseioidea: a *Chileseius campiosi* Gonzalez & Schuster, 1962, syn.
Avioseius pennatus Karg, 1976; b *Seiulus tiliarum* (Oudemans, 1930); c *Dubininellus*
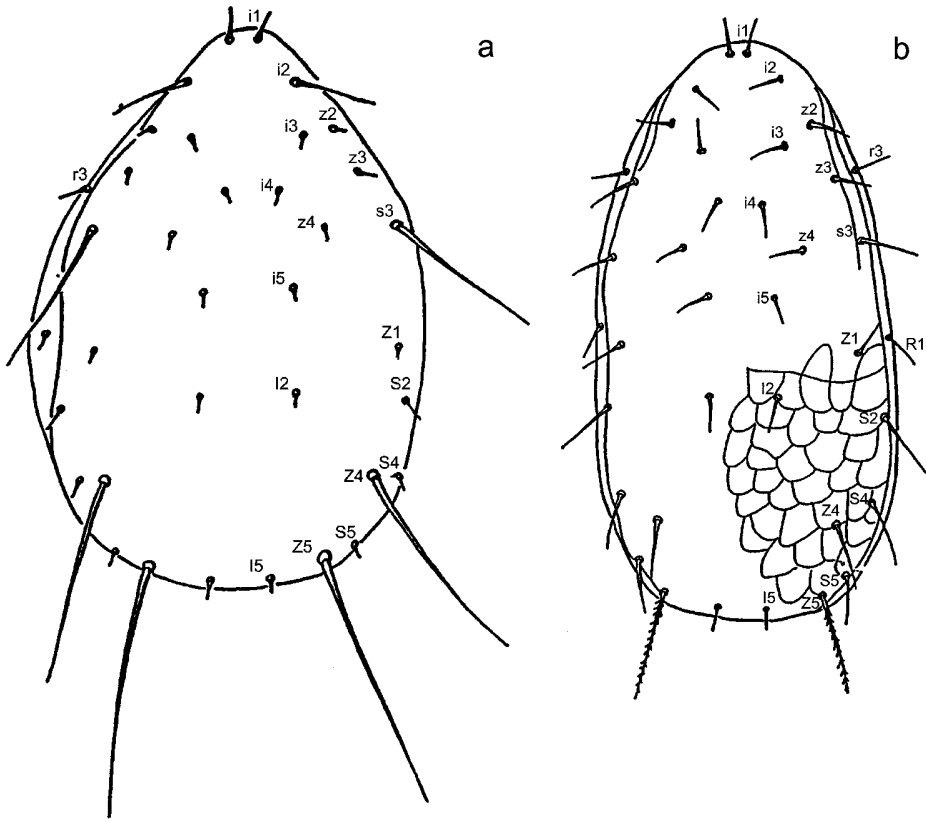*macropilis* (Banks, 1909).

Fig. 22   Dorsum of species of Phytoseioidea: a *Chelaseius freni* Karg, 1976; b *Amblyseius cucumeris* (Oudemans, 1930).

4.2.6. Ascoidea

In this group the ancestral number of setae is mostly preserved. However, the distances between them are changed. The Z-row is closer to the S-row and seta S1 is frequently suppressed. The distance between setae I4-I4 is wide, the position of seta-pair z1 is altered and localised behind i1 (Fig. 23). There are also particularities: In the Halolaelapidae seta-pair I3 is suppressed and in the Zerconidae an additional I-seta-pair can be observed (Fig. 23). The hypothesis of Lindquist & Moraza (1998) that in the Zerconidae setae Z3 or Z4 are displaced to the I-row is doubtful. It seems that these authors did not consider the decisive configuration of setae Z3, Z4 and pore Po3 in the gamasine groups. On the postdorsum of Zerconidae, this configuration is especially distinct. This is probably the cause of an additional pair of setae in the I-row. This development is based on a considerable large pygidial shield in the protonymph stage of the Zerconidae compared with other groups of Ascoidea (Fig. 10, 24). To this superfamily belong the Ascidae, Halolaelapidae and Zerconidae.
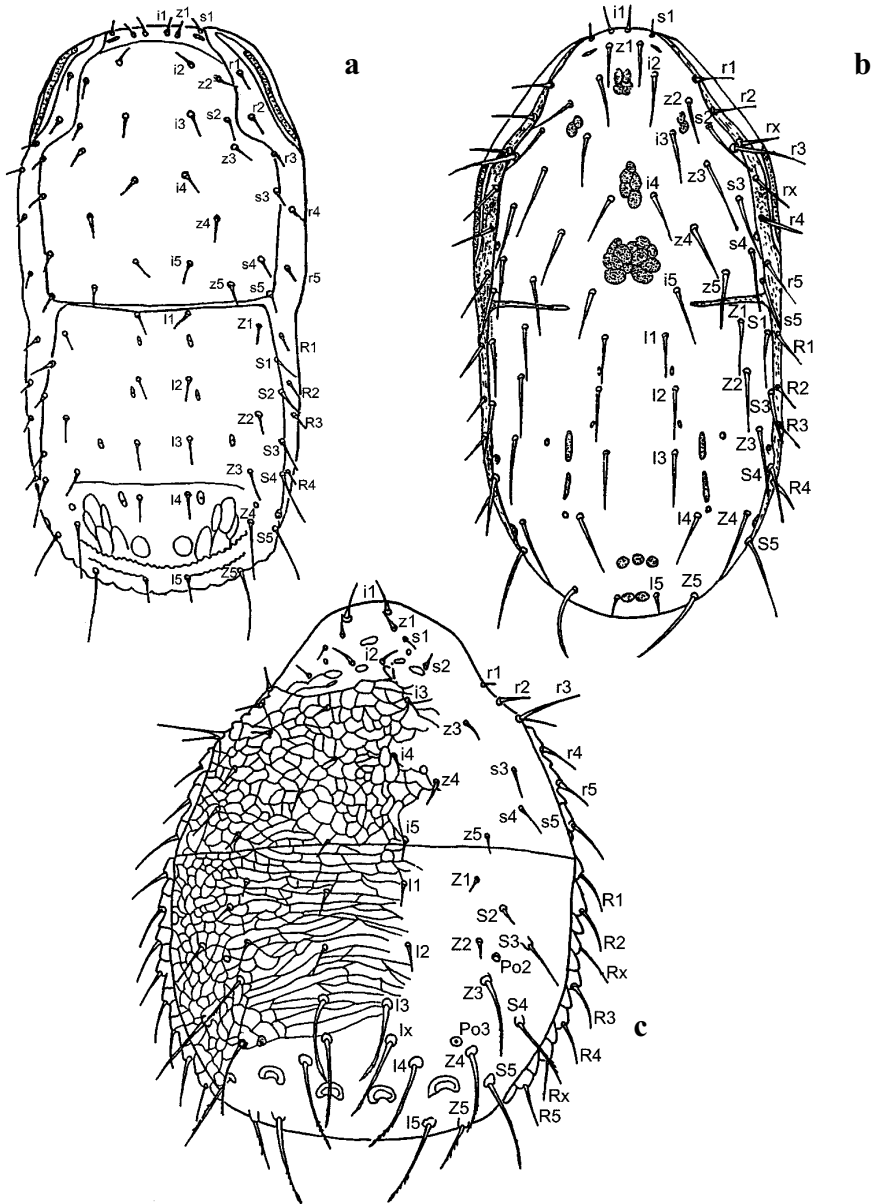
Fig. 23   Dorsum of species of Ascoidea: a *Leioseius bicolor* (Berlese, 1918); b *Arctoseius semiscissus* (Berlese, 1892); c *Zercon vagabundus* Karg, 1971.
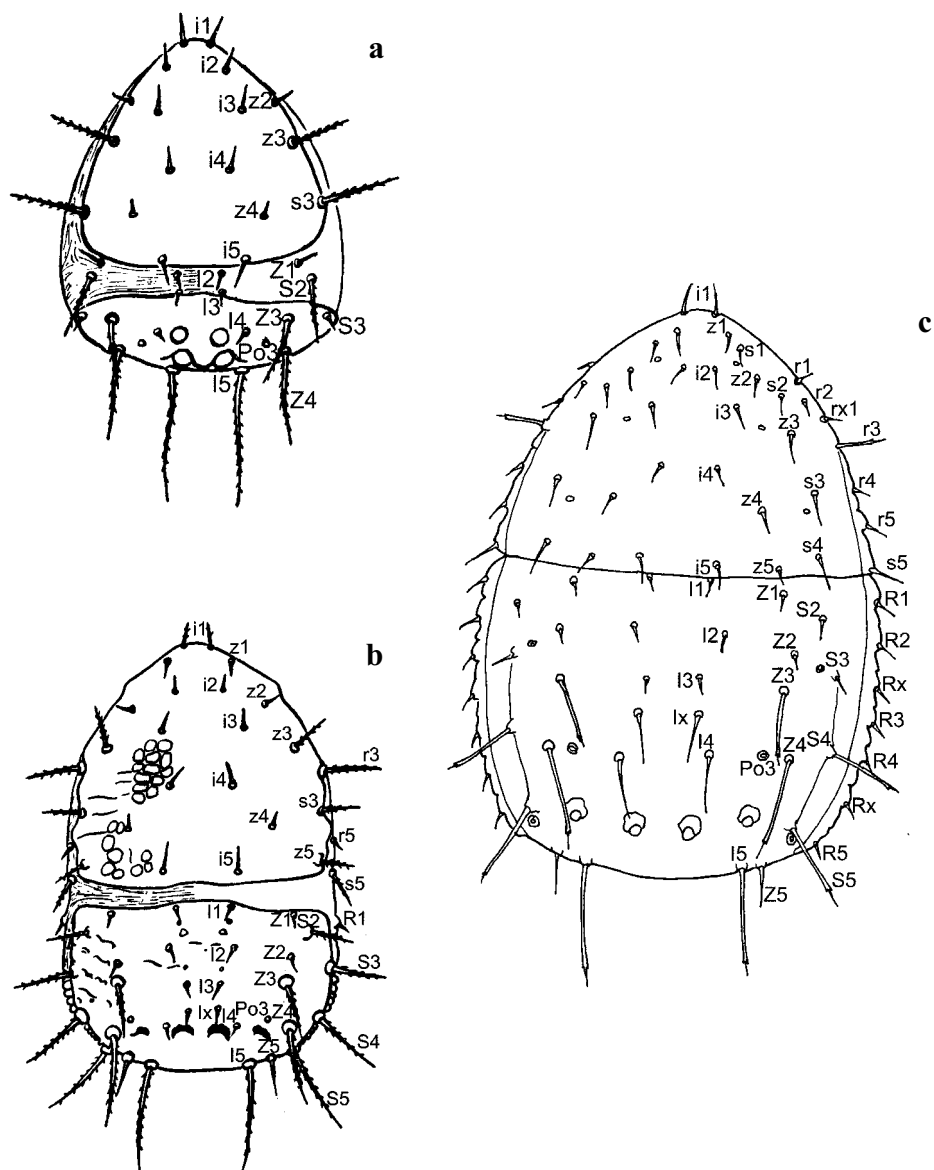
Fig. 24   Dorsum of *Zercon peltatus* C.L. Koch, 1836 (Ascoidea): a larva; b protonymph; c deutonymph.

5. The system of ventral setation in families of Gamasina

On the ventral side of the idiosoma we distinguish the sternal setae and the genital seta anteriorly (st1 to st5) and posteriorly two longitudinal rows, the ventrocentral row Vi1 to Vi5 and the mediolateral row Vz1 to Vz4 (Fig. 25). However, in many groups, some setae of the transverse rows have altered positions or are suppressed. For example, in *Gamasiphis* setae pair st3 is displaced forwards between st2 (Fig. 25 a). Also, the anus with the circumanal setae is often displaced forwards (Veigaiaidae, Fig. 4), in several groups simultaneously suppressing setae pair Vi4: Hypoaspididae (Fig. 26 a, b), Eviphididae (Fig. 26 c), Rhodacaridae (Fig. 26 d, 27 b), Phytoseiidae and Macrochelidae (Fig. 27 a, c). The longitudinal row Vz1 to Vz4 is repeatedly displaced backwards, for example in Veigaiaidae and the Hypoaspididae (Fig. 4, 26 a, b).

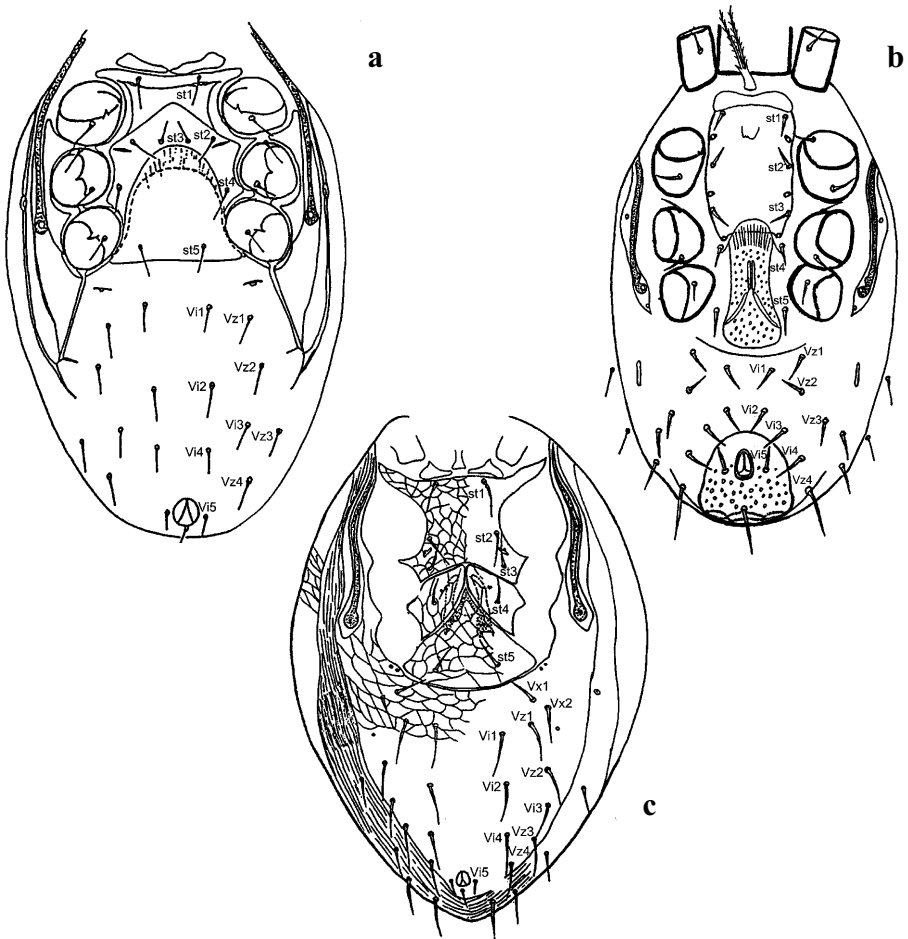Fig. 25   Venter of gamasine species: a Gamasiphidae: *Gamasiphis anguis* Karg, 1993; b Ascidae: *Arctoseius cetratus* (Sellnick, 1940); c Parasitidae: *Leptogamasus crassipilis* (Holzmann, 1969).
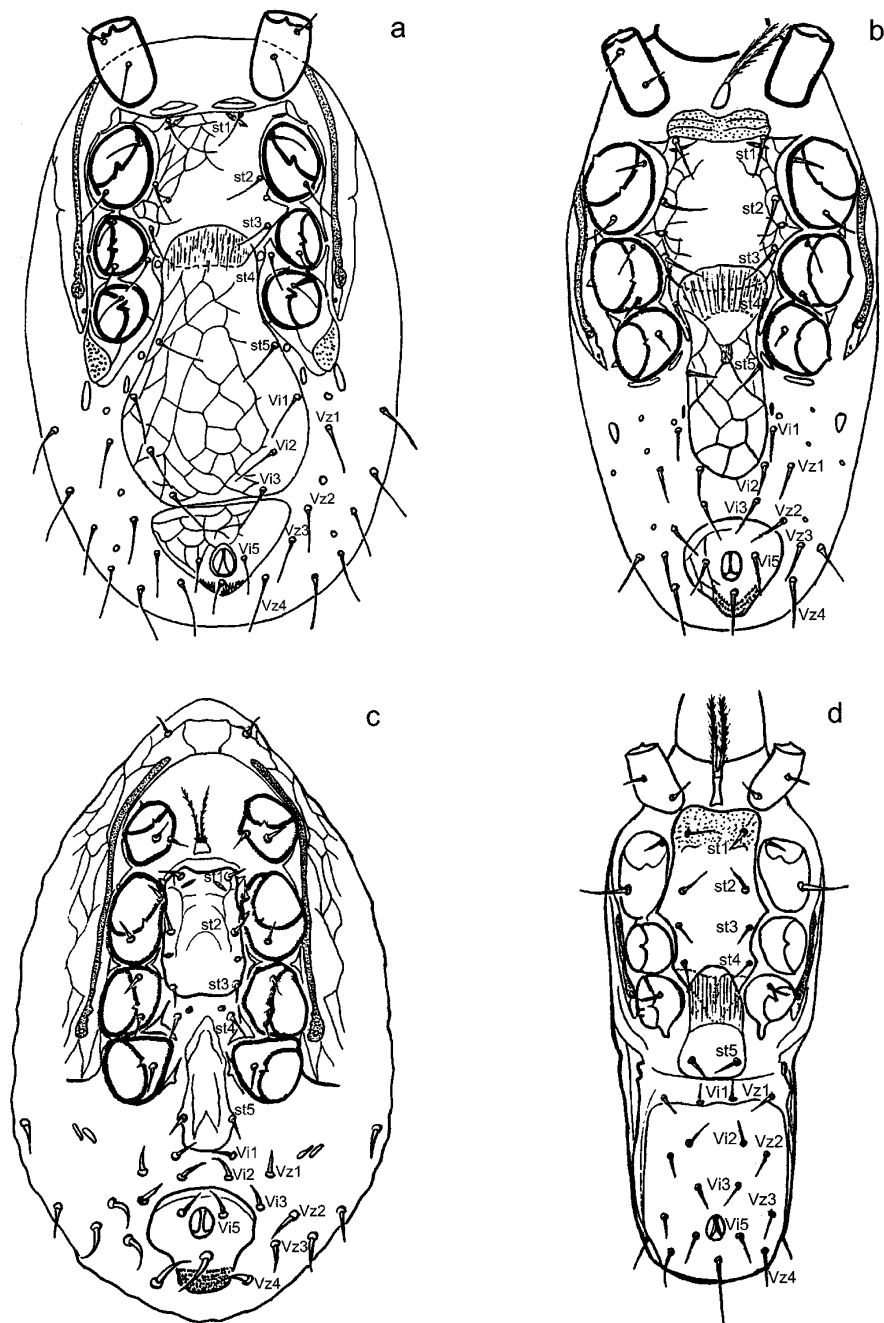
Fig. 26 Venter of gamasine species: Hypoaspididae: a *Pseudoparasitus porulatus* Karg, 1989; b *Hypoaspis nolli* Karg, 1962; c Eviphididae: *Alliphis sculpturatus* Karg, 1963; d Rhodacaridae*: Rhodacarellus apophyseus* Karg, 1971.
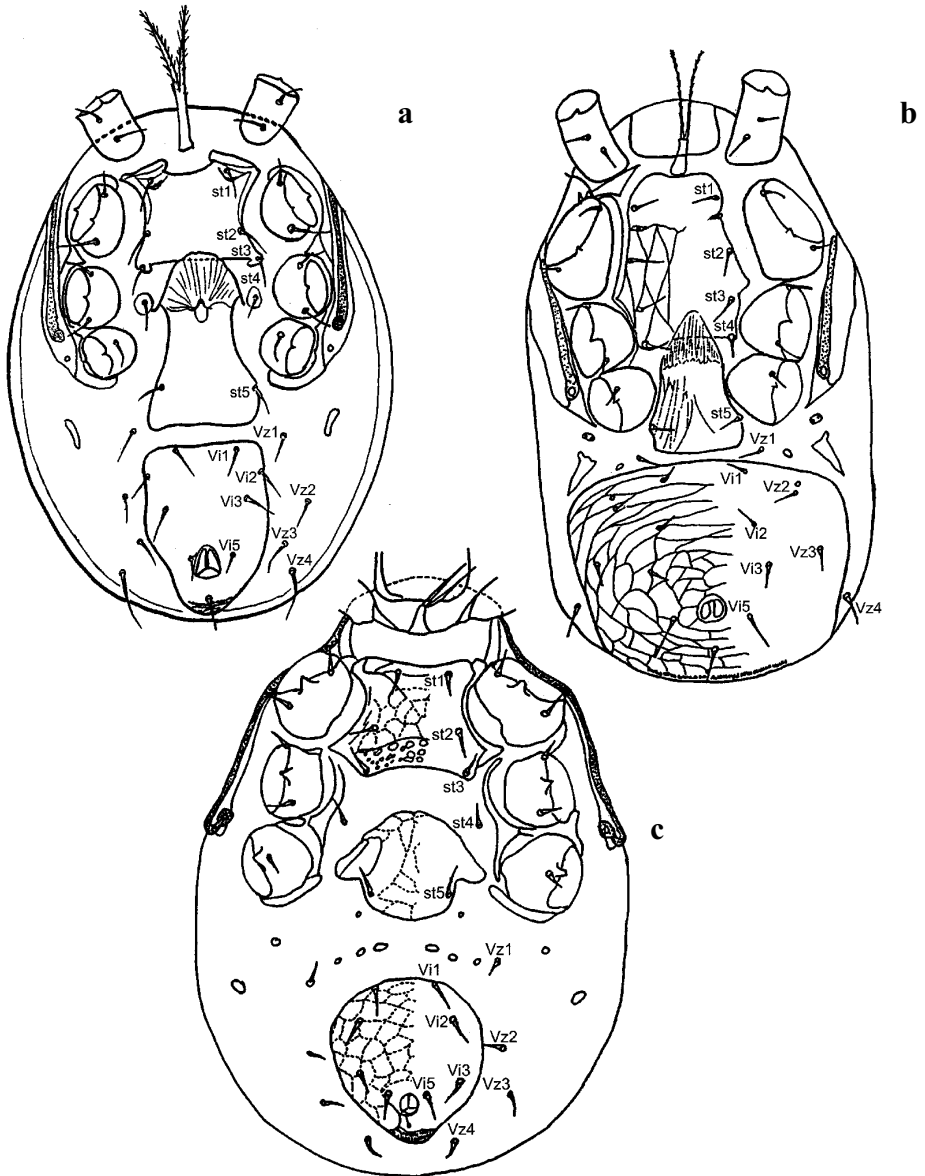
Fig. 27   Venter of gamasine species: a Phytoseiidae: *Paraseiulus talbii* (Athias- Henriot, 1960), b Rhodacaridae: *Dendroseius reticulatus* (Sheals, 1956), c Macrochelidae: *Macrocheles carinatus* (C. L. Koch, 1839).

6. Acknowledgements

7. References

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