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A COMPARATIVE STUDY OF THE LIFE STAGES OF THE MITE, *STEREOTYDEUS MOLLIS* W. & S. (ACARINA)[1]

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Abstract: The life cycle of *Stereotydeus mollis* consists of 5 active stages: larva, protonymph, deutonymph, tritonymph, and adult. Characters that remain unchanged throughout the life cycle include the dorsal chaetotaxy of the idiosoma, 3 pairs of anal setae, and the apical setation of the femora, genua, tibiae, and tarsi of legs I, II, and III. All stages subsequent to the larva possess a ventral genital pore covered by two longitudinal flaps. The number of setae on each of these flaps provides the simplest method of separating each nymphal stage; nymph I has 1 seta on each flap; nymph II, 2, and nymph III, 3. The total complement of 2 prs. of genital suckers and 4 prs. of paragenital setae is attained at the molts to deutonymph and tritonymph respectively. On the basis of leg chaetotaxy, each stage can be recognized by a combination of the following features: (1) ventral setation patterns at tarsi I through IV; (2) coxal and trochanter setal formulas, *i.e.*, protonymph: coxa 3-1-3-0, trochanter 0-0-1-0; deutonymph: coxa 3-1-4-2, trochanter 1-1-1-0; tritonymph: coxa 3-1-4-3, trochanter 1-1-1-1; (3) number of rhagidiform organs at tarsi I and II; and (4) solenidia at genua I through III and tibiae I through IV. At the molts to tritonymph and adult, there are a variable number of setation changes at femora I, II, and III.

Of the terrestrial arthropods inhabiting Antarctica, free-living mites constitute the most abundant and widespread group. Since 1959, extensive collections have been made on all sides of the continent, but particularly along the coast of Victoria Land (Gressitt 1967). In northern and southern Victoria Land 5 species belonging to the genus *Stereotydeus*, family Penthalodidae, have been reported from 71° to 85° S. lat. (Tyndale-Biscoe 1960; Strandtmann 1967). One of these, *Stereotydeus mollis* Womersley & Strandtmann (1963), is widely distributed in southern Victoria Land from about 74° to 79° S. lat.

S. mollis is a soft-bodied, fast moving mite with slender, red legs and a rather plump, black body. Flat, rocky areas that are adequately supplied with moisture from melting snow or ice constitute the preferred habitats. The mites are assumed to feed on various species of algae and lichens that have been observed in most of the inhabited areas.

Relatively complete descriptive work has been accomplished with the genus *Stereotydeus* (Womersley & Strandtmann 1963; Strandtmann 1967); however, investigations on life cycles, variation, and ecology have not been extensively pursued. These deficiencies are not confined to mite populations in Antarctica but are characteristic of entomological research in general. Hubbell (1954) suggests that studies dealing with the biology and variation of arthropod populations are by necessity secondary to the description of an estimated one to several million species still undescribed.

Antarctic arthropods, by virtue of their unusual habitat and environmental preference, will no doubt be the subject of numerous physiological, behavioral, and ecological studies. Many of these studies demand recognition and separation of adult and immature stages of a particular species.

Certainly the first step in a study of immatures is to find a means of identifying each stage.

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Detailed comparisons of the external morphology of the life stages have been used extensively as a method of separation. Mitchell (1963) differentiated the larva, protonymph, and deutonymph stages of the nasal mite, *Rhinonyssus rhinolethrum*, by comparing idiosomal sclerotization, chelicerae, and idiosomal and leg chaetotaxy. Sengbusch (1954), Brickhill (1958), and others have combined external morphological studies with observations on the development of live specimens. Investigation utilizing both of these techniques are undoubtedly more desirable; however, when cultures of a particular species are difficult or impossible to maintain, one must rely entirely on external morphology.

The present study attempts to determine the idiosomal and leg chaetotaxy of the larva, nymphs, and adult and evaluate the effectiveness of various aspects of the chaetotaxy in separating immatures.

RESULTS

The life cycle of *S. mollis* consists of 5 active stages: larva (Fig. 3), protonymph (Fig. 4), deutonymph (Fig. 5), tritonymph (Fig. 6), and adult (Fig. 1 and 2). The larva is easily recognized because it is a hexapod. The mature ♂ and ♀ are distinguished from each of the 3 nymphal stages by the presence of 7 pairs of plumose setae situated underneath the genital flaps. In ♂♂ these setae are small and occupy an area less than 1/2 the length of the genital flaps while in ♀♀ these same setae are longer and occupy an area greater than 1/2 of the genital flap length (Strandtmann 1967). Males may also be recognized by the presence of an internal sperm sac just anterior to the genital pore.

Differences among the 3 nymphal stages were originally thought to be subtle, thus a large number of morphological features were analyzed and compared. Of these, the idiosomal length and chaetotaxy as well as certain aspects of the leg chaetotaxy vary markedly among stages but no detectable differences exist in the chaetotaxy and structure of the chelicerae and pedipalps. Therefore, the discussion of comparative morphology is limited to the characteristics of the idiosoma and legs. The number of specimens observed in each stage is given in Table 1.

Idiosomal Characteristics: In the larva, there are 12 pairs of setae located dorsally, 4 pairs on the propodosoma and 8 pairs on the hysterosoma (Fig. 3). No changes occur in the number and position of the dorsal setae through all stages.

With the exception of 3 pairs of anal setae bracketing the excretory pore, the venter of the larval idiosoma is nude (Fig. 3). The number and position of the anal setae remain constant throughout the life cycle. All stages subsequent to the larva have a ventrally located genital pore that is covered by 2 longitudinal flaps, the average lengths of which are given in Table 1. Considering all stages, the greatest increase in genital flap length occurs between the tritonymph and adult with the increase in the ♀ proportionately greater than the ♂. Although not as marked, this same relationship applies to the length of the idiosoma. Similar size differences have been combined with chaetotactic dif-

Table 1.

Stage	Idiosomal length		Genital flap length		Specimens observed
	Mean	Range			
Larva	175.34	(165–188)	—		17
Protonymph	220.29	(210–237)	22	(17–30)	20
Deutonymph	250.60	(237–260)	34	(24–39)	20
Tritonymph	335.45	(330–345)	47	(40–58)	20
Adult ♂	431.07	(380–480)	63	(58–70)	150
♀	440.50	(390–490)	84	(76–92)	150

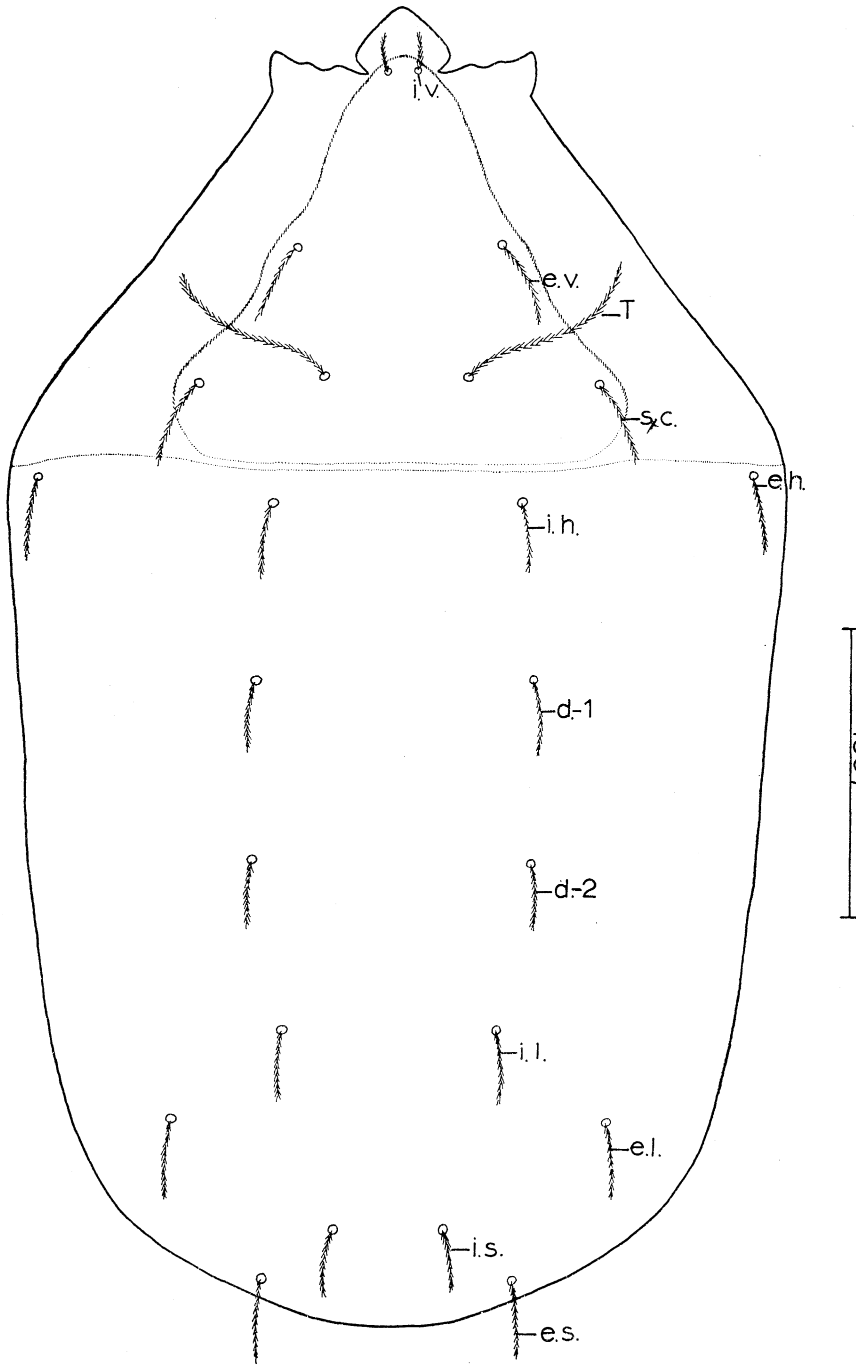

Fig. 1. Dorsal view of ♂. Names of setae: i.v., internal vertical; e.v., external vertical; T, trichobothrium; sc., scapular; e.h., external humeral; i.h., internal humeral; d1 and d2, 1st and 2nd dorsals; i.l., internal lumbar; e.l., external lumbar; i.s., internal sacral; e.s., external sacral.

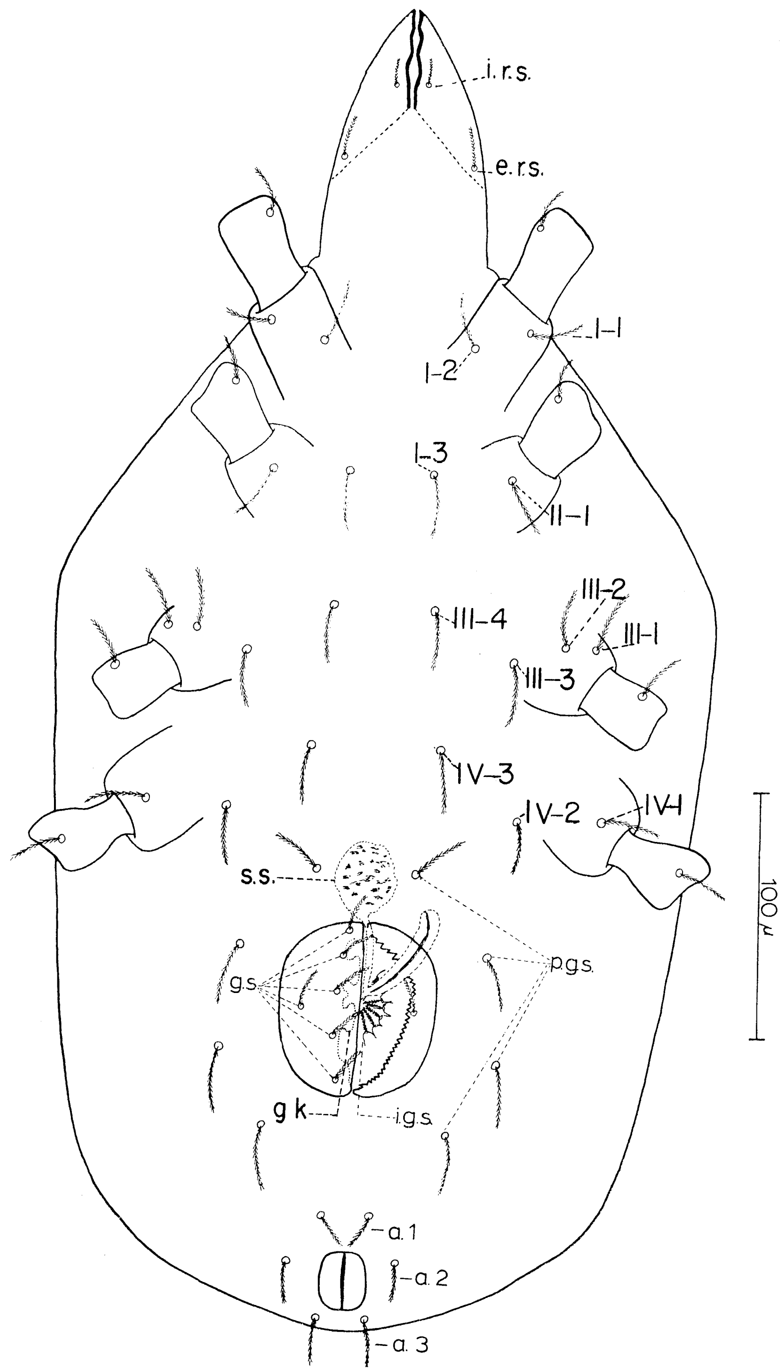

Fig. 2. Ventral view of ♂ showing coxae and trochanters. The left flap of the genitalia is shown partially removed. Names of setae: p.g.s., paragenital setae; g.s., genital setae; i.g.s., internal genital setae; a 1–a 3, anal setae. s.s., sperm sac; g.k., genital knobs I–1, I–2—IV–2, IV–3 = coxal setae. i.n.s, e.r.s—internal and external rostral setae respectively.

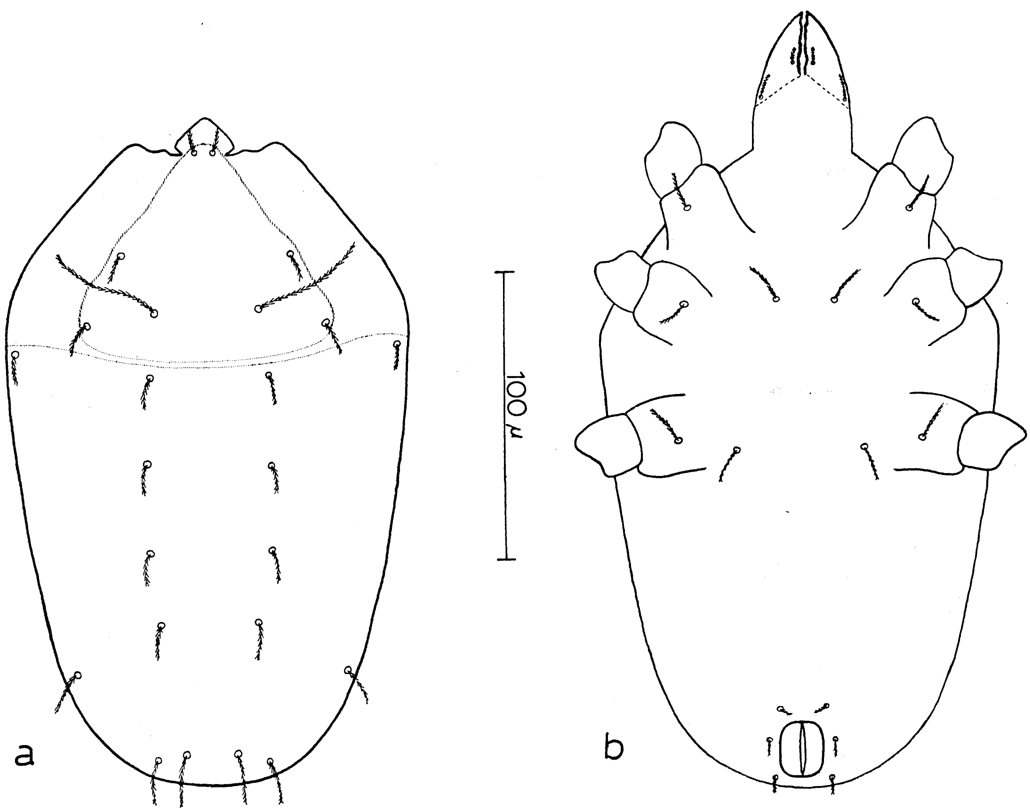

Fig. 3. Larval idiosoma; a, dorsum; b, venter.

ferences to demonstrate sexual dimorphism in the nymphs of *Rhinonyssus rhinolethrum* and *Dyscinetonyssus hystricosus* (Mitchell 1963; Moss & Funk 1965 respectively). However, genital flap measurements for specimens in each nymphal stage of *S. mollis* fell within a narrow range that approached a normal curve. Such results indicate a homogeneity in flap length since consistent differences between ♂ and ♀ nymphs would be expressed in the form of a bimodal curve with a relatively wide range. It is possible that the hormonal mechanisms that induce genitalia and other secondary sex differences are secreted or functional only in the final molt. On the other hand, flap length may be a sexually dimorphic character in nymphs but to a lesser degree than in adults. If this is the case, the sample size used in this study could have been too small to detect such a slight difference, or the sampling procedure might have been biased.

The increase in genital flap length at each molt is accompanied by an increase in the number of setae situated on the flaps (external genital setae). One pair of genital setae is present in the protonymph. At each of the molts to deutonymph and tritonymph, an additional pair is added (Fig. 4, 5, 6). In passing from tritonymph to mature ♂ and ♀, 3 pairs of external genital and 7 pairs of internal genital setae are added for the total complement of 6 external and 7 internal pairs (Fig. 2). The number of external genital setae provides the simplest method of separating the nymphal stages.

The protonymph possesses 1 pair of genital suckers situated below the genital flaps (Fig. 4).

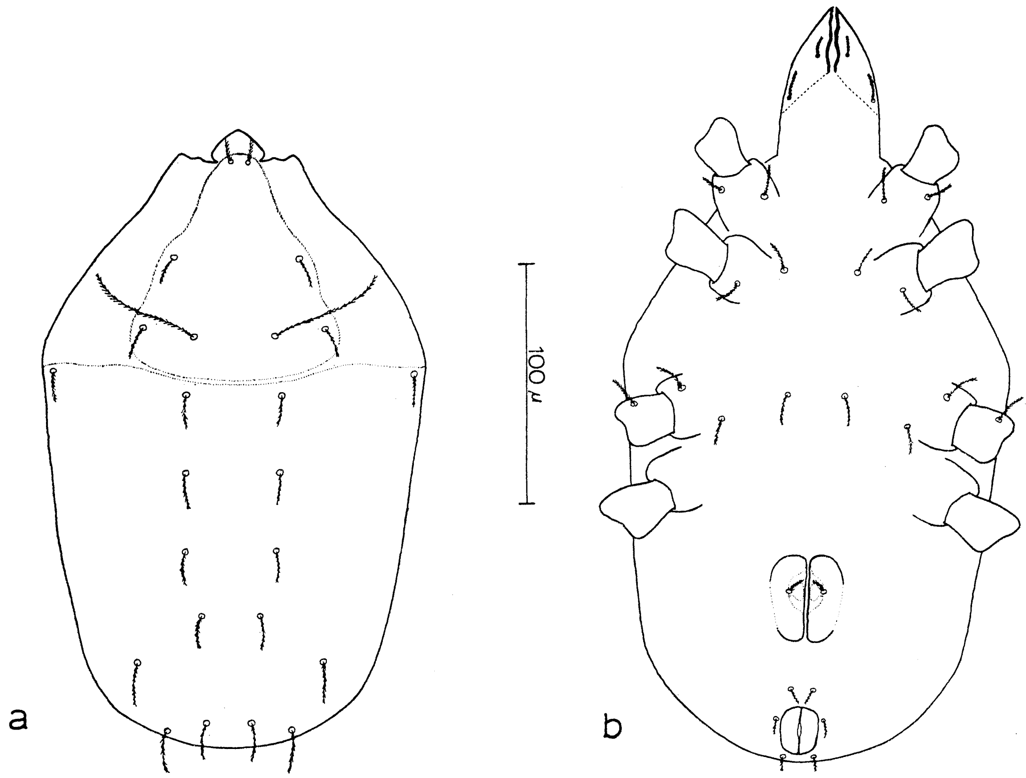

Fig. 4. Protonymphal idiosoma; a, dorsum; b, venter.

This number is increased to 2 pairs in the deutonymph and remains constant at 2 pairs through the remaining stages (Fig. 2, 5, 6).

Finally, paragenital setae bracket the genital pore in all stages except the protonymph. There are 2 pairs in the deutonymph and 4 pairs in the tritonymph and mature ♂ and ♀. (Fig. 2, 5, 6). Since the total complement of paragenital setae and genital suckers is attained early in the life cycle, neither, by itself, is effective in distinguishing the various stages.

Leg Chaetotaxy: Table 2 gives the number of setae located on the dorsal and ventral surfaces of the leg segments in each stage (rhagidiform organs and solenidia excepted). The setation patterns are illustrated in Fig. 7–11. To avoid confusion in interpreting these patterns, ventral setae have not been drawn; their positions are represented by black circles.

On legs I, II, and III the number and pattern of setae situated at the apical end of each segment remains unchanged from larva to adult. On these same legs the genua, tibiae, and tarsi have practically the full complement of dorsal setae in the larval stage (compare Fig. 7–11). Therefore, most additions occur at the mid- and posteroventral positions of each segment, particularly at the last 2 molts. Preliminary work by Strandtmann indicates that the apical setation patterns on each leg segment of *S. mollis* are identical to other species within the genus (pers. comm.). Additional investigations may confirm that these patterns are indeed constant throughout the genus.

Excluding the addition of legs IV at the molt to protonymph, setation changes occur at 5

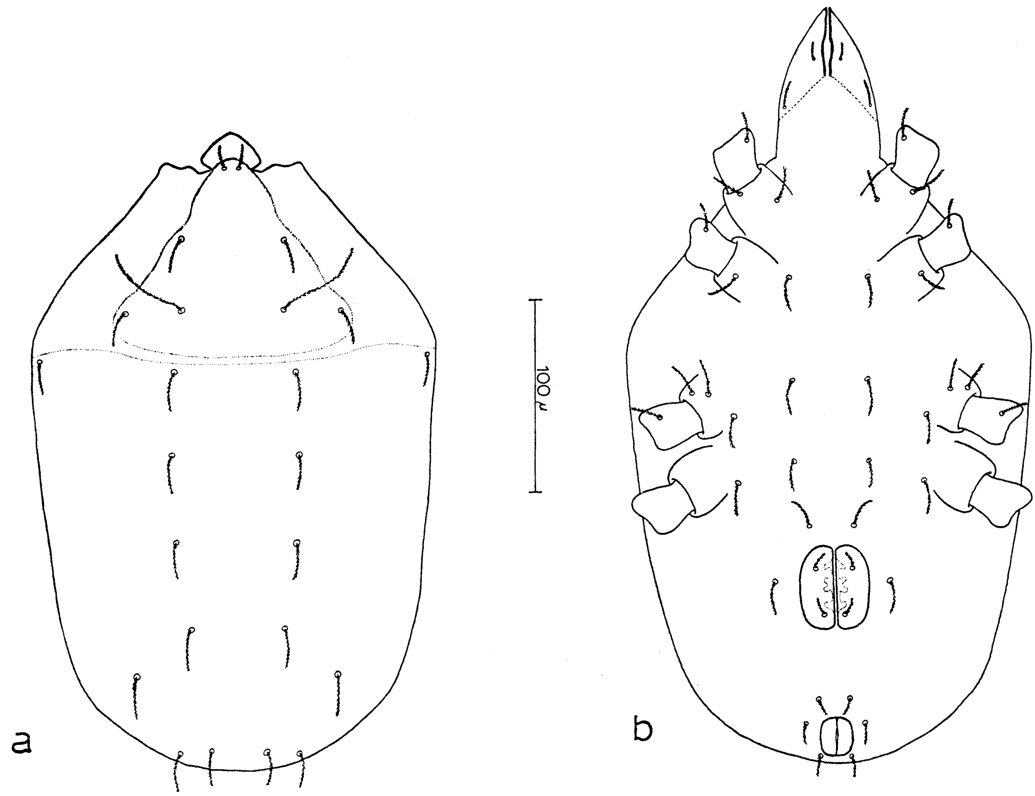

Fig. 5. Deutonymphal idiosoma; a, dorsum. b, venter.

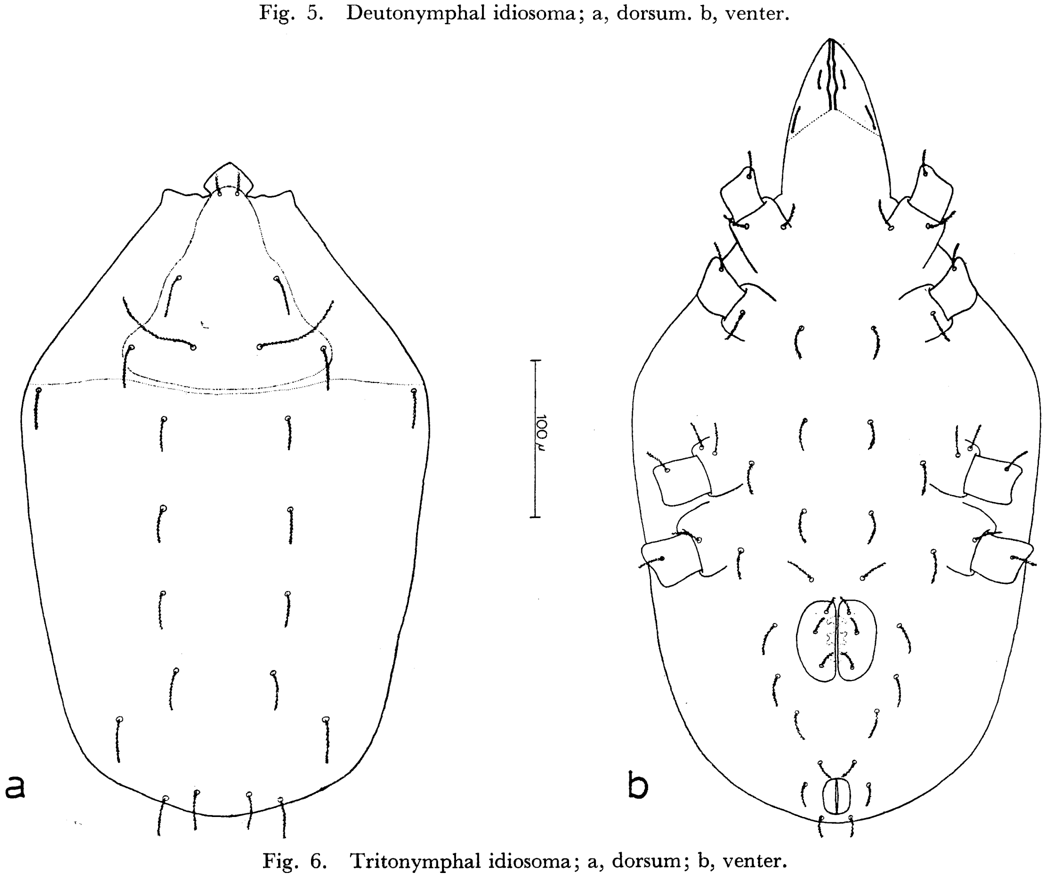

Fig. 6. Tritonymphal idiosoma; a, dorsum; b, venter.

Table 2. Chaetotaxy of legs. Dorsal and ventral refer to surfaces of the leg segments. Leg segments indicated by C, T, F, G, T, T are coxa, trochanter, femur, genu, tibia, and tarsus, in that order.

Leg	Larva	Protonymph	Deutonymph	Tritonymph	Adult
Dorsal	C T F G T T	C T F G T T	C T F G T T	C T F G T T	C T F G T T
I	0 0 3 2 3 8	0 0 3 2 3 8	0 0 5 2 3 8	0 0 6 3 3 8	0 0 9 5 3 8
II	0 0 3 2 3 3	0 0 3 2 3 5	0 0 3 2 3 5	0 0 6 3 3 5	0 0 6 3 3 5
III	0 0 3 2 3 2	0 0 3 2 3 2	0 0 4 2 3 4	0 0 5 2 3 4	0 0 6 2 3 4
IV	– – – – – –	0 0 0 0 0 3	0 0 2 3 3 5	0 0 3 3 3 5	0 0 4 3 3 5
Ventral					
I	2 0 3 2 2 4	3 0 3 2 2 6	3 1 3 2 2 8	3 1 5 3 2 10	3 1 6 3 3 12
II	1 0 4 2 2 6	1 0 4 2 2 6	1 1 4 2 2 6	1 1 4 2 2 8	1 1 6 3 2 9
III	2 0 2 2 1 6	3 1 2 2 1 6	4 1 2 2 1 6	4 1 3 2 2 8	4 1 3 3 3 9
IV	– – – – – –	0 0 0 0 0 4	2 0 2 1 2 6	3 1 3 1 2 8	3 1 4 2 3 8

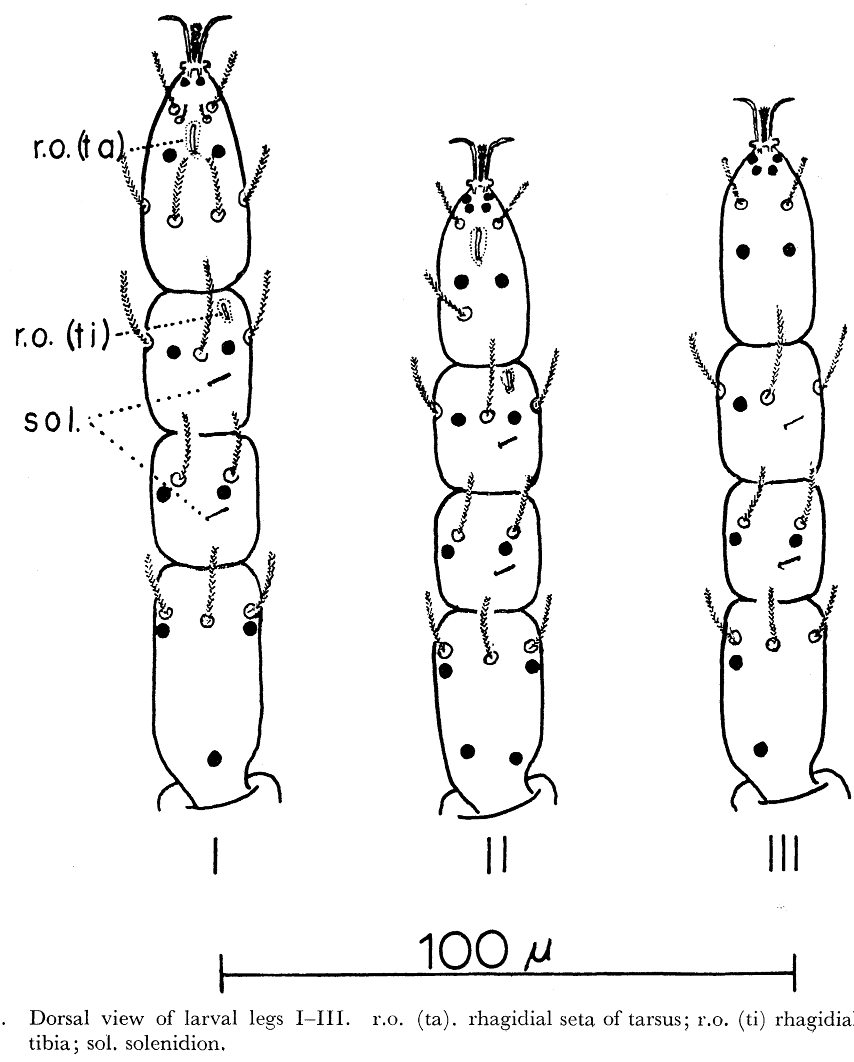

Fig. 7. Dorsal view of larval legs I–III. r.o. (ta). rhagidial seta of tarsus; r.o. (ti) rhagidial seta of tibia; sol. solenidion.

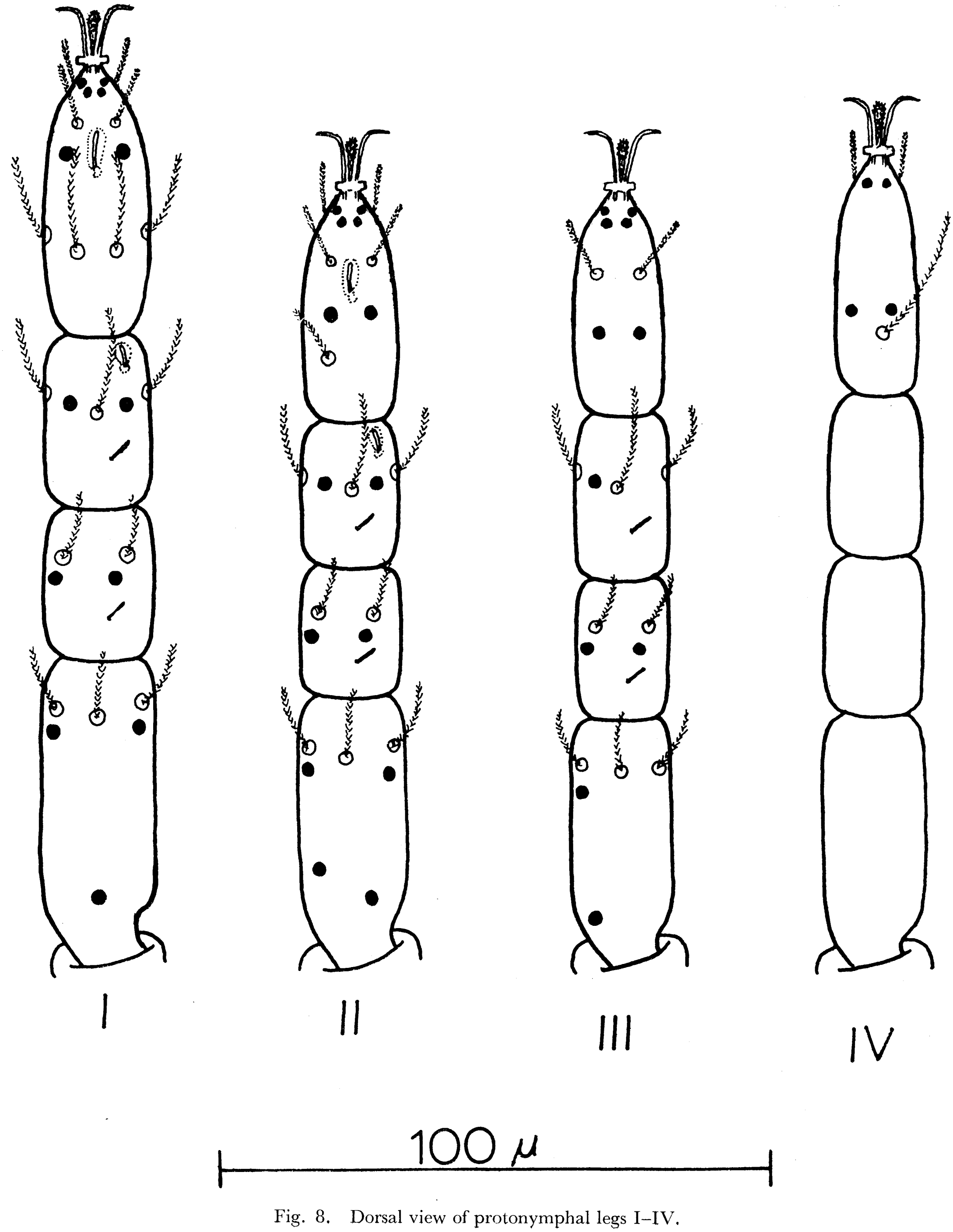

Fig. 8. Dorsal view of protonymphal legs I–IV.

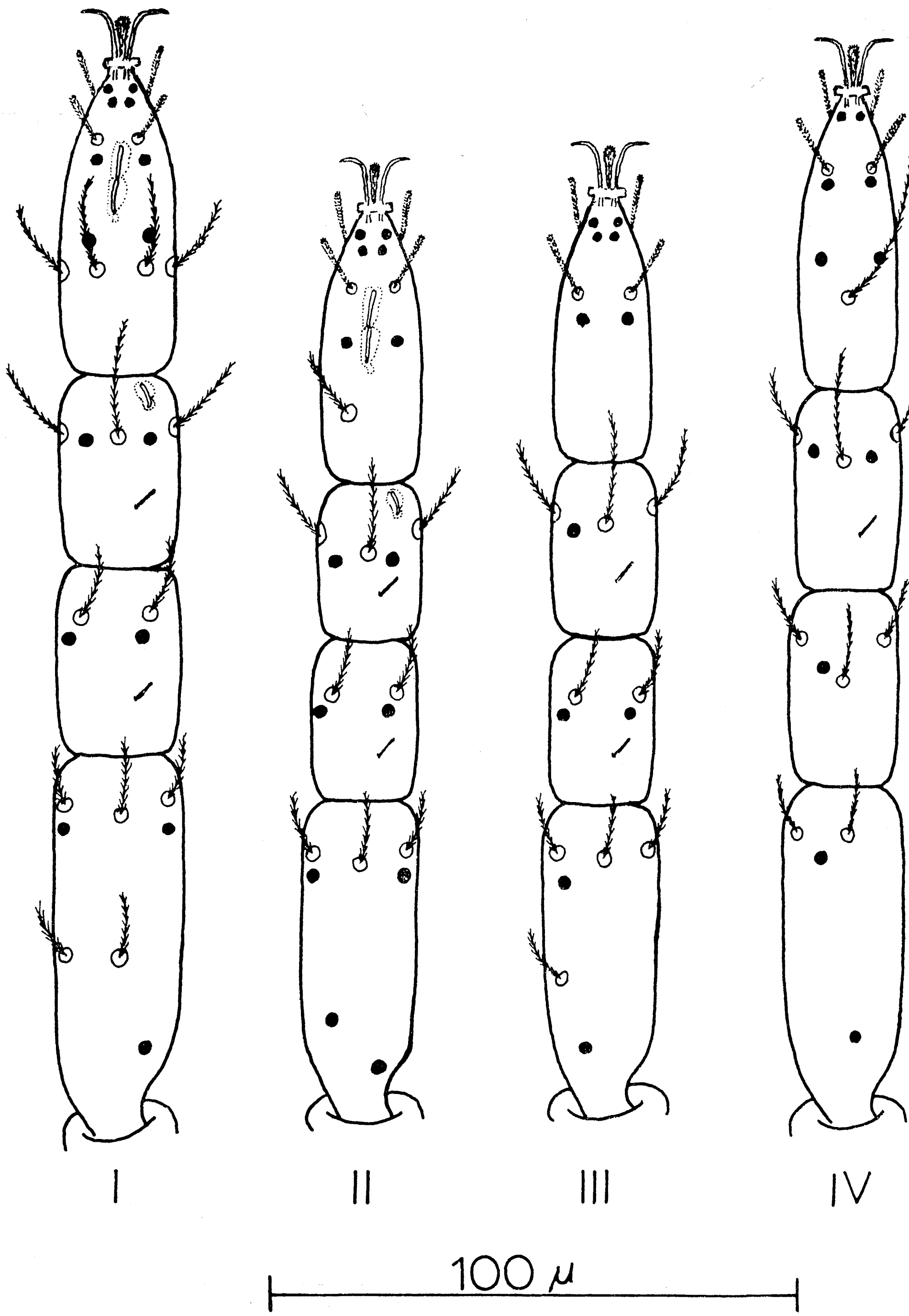

Fig. 9. Dorsal view of deutonymphal legs I–IV.

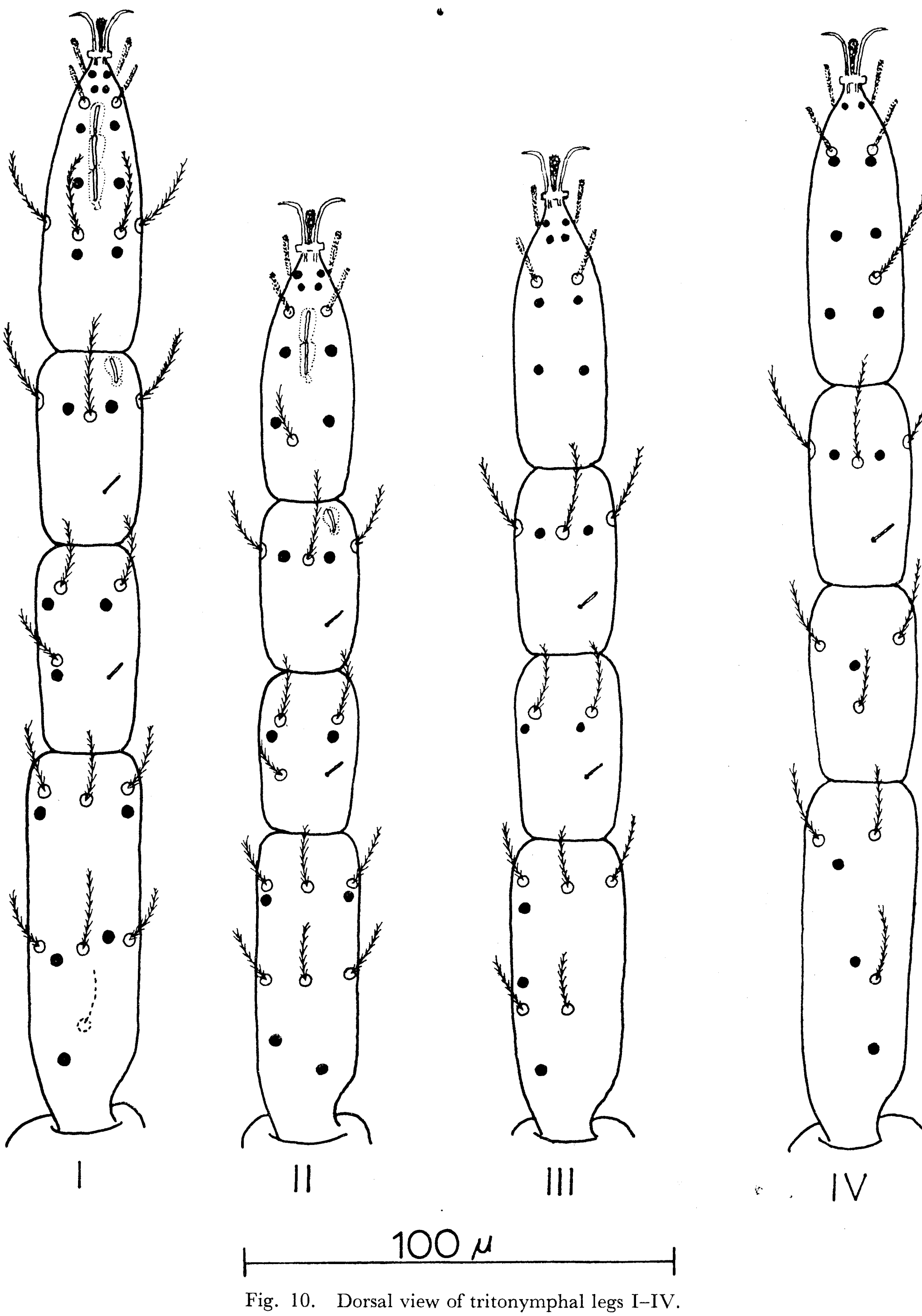

Fig. 10. Dorsal view of tritonymphal legs I–IV.

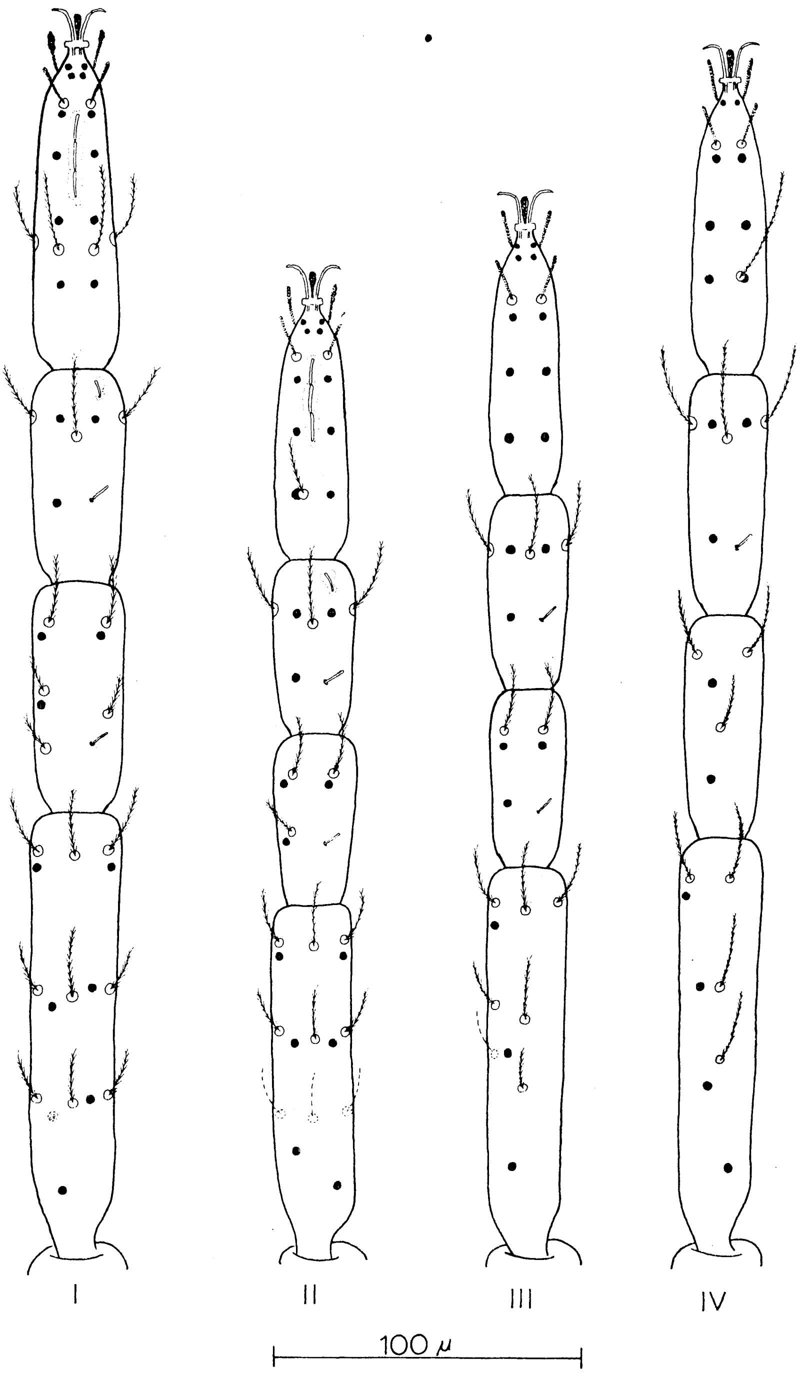

Fig. 11. Dorsal view of adult legs I–IV showing variable setation on femora I, II, and III (see text for explanation).

segments (considering only the legs on one side of the body) involving the addition of 7 setae. At the molt to deutonymph, 27 setae are added at 15 segments. The increase from zero to 13 setae on the femur, genu, and tibia of legs IV is an effective criterion for distinguishing between protonymph and deutonymph.

In passing from deutonymph to tritonymph, 23 to 24 setae are added at 13 segments; and from tritonymph to adult, 25 to 30 setae are added at all segments except tarsi IV. At the molts to tritonymph and to adult, two setae are added on the ventral surfaces of tarsi I, II, and III. This provides a reliable means of differentiating deutonymph, tritonymph, and adult. However, the coxal and trochanter setae formulas provide the simplest method of separating the 3 nymphal stages, on the basis of leg chaetotaxy alone. The coxal formulas are 3, 1, 3, 0 (protonymph); 3, 1, 4, 2 (deutonymph); and 3, 1, 4, 3 (tritonymph). Trochanter setation is 0, 0, 1, 0 in the protonymph and 1, 1, 1, 0 and 1, 1, 1, 1 in the deutonymph and tritonymph respectively.

In the molts to tritonymph and to adult there is a variable number of setation changes at femora I, II, and III. Those additions that occurred in at least 50% of the specimens observed are illustrated as closed stipled circles (ventral setae) and broken lines arising from open circles (dorsal setae). A variable number of setae have also been noted on the femora of *Stereotydeus belli* and *S. punctatus* (Strandtmann, pers. comm.).

In addition to setae, rhagidiform organs and solenidia occur on the genua, tibiae, and tarsi. In mature ♂♂ and ♀♀, 3 rhagidiform organs are situated longitudinally and in a confluent field on the dorsal surfaces of tarsi I and II. A small stellate seta subtends the rhagidiforms on tarsus I and a small nude seta occupies the same position on tarsus II. In the larva and protonymph, there is 1 rhagidiform on tarsi I and II each. At the molt to deutonymph, a rhagidiform is added at each of these tarsi. Passing from deutonymph to tritonymph, 1 rhagidiform is added at tarsus I for the total complement of 3 while tarsus II remains unchanged. The addition of the 3 rhagidiform to tarsus I may be used as a criterion for separating the deutonymph and tritonymph. Similarly, the addition of the 3rd rhagidiform on tarsus II at the final molt provides a method of differentiating the tritonymph and adult.

Tibiae I and II each have a rhagidiform organ situated dorso-apically; however, in contrast to the tarsal rhagidiforms, their position and number remains constant through all stages.

The solenidia constitute the smallest and most cryptic morphological feature of the legs. In the larva and protonymph, genua I, II, and III and tibiae I, II, and III each possess a mid dorsal solenidion situated on the basal 1/2. At the molt to deutonymph, a solenidion is added at tibia IV. No additions occur through the remainder of the life cycle. Since the full complement is attained at the molt to deutonymph, solenidia can only be used to differentiate between the protonymph and deutonymph.

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