

***Caleupodes*, a new genus of eupodoid mite (Acari: Acariformes) showing primary opisthosomal segmentation**

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Introduction

While sorting a large collection of eupodoid mites, several specimens were found which, although could be assigned to the family Eupodidae, could not be accommodated in any of the existing genera. These specimens are, therefore, considered to represent a new genus and the new taxon *Caleupodes reticulatus* will be described below.

Hitherto, it has been difficult to determine the association between opisthosomal segments, setae and lyrifissures in the Eupodoidea. *C. reticulatus*, however, is unique amongst the known taxa in possessing a clearly segmented opisthosoma. In this study, the segmental boundaries are used to resolve both the number of opisthosomal segments and the relationships between the segments and their structures (setae and lyrifissures).

Although Strandtmann developed a system of setal nomenclature for the Eupodoidea (see Strandtmann, 1967), the standardized notations devised by Grandjean (1947) are here applied to the opisthosomal structures of *C. reticulatus* and other members of the superfamily. This follows the example of other authors who have successfully applied Grandjean's system to a variety of acariform taxa (Knülle, 1959; van der Hammen, 1969; Lindquist, 1977; Quiros-Gonzalez & Baker, 1984) and, as a consequence, simplified the comparison of homologous opisthosomal segments.

Terminology

In the description of *C. reticulatus*, the notations for opisthosomal segments, their setae and lyrifissures are those of Grandjean (1947). Setae of the genital area are named in accordance with their homologues in other taxa and are based on Grandjean (1949). Terms used in this paper are compared with those proposed by Strandtmann (1967) in Table 1. Notations for other setae will be discussed in a subsequent paper on the Eupodoidea relating nomenclature to ontogeny (Baker, in prep.). In the interim, the system of Strandtmann (1967) is used.

Superfamily EUPODOIDEA

A general account of the external morphology of eupodoid mites is given by Strandtmann (1971), while the systematics are outlined in Kethley (1982).

Family EUPODIDAE

Genus *Caleupodes* gen. n.

DEFINITION. Small (300–330 µm long), soft-bodied mites, clearly divided into propodosoma and opisthosoma; blunt epivertex, not delimited dorsally, obvious as overhanging lobe in lateral view; opisthosoma divided into segments dorsally by transverse furrows of differentiated integument; dorsum of body with 12 pairs setae, three pairs lyrifissures; trichobothria filiform; palp tibiotarsus long, slender, tapering; genital setae in single file; anus ventro-terminal; two pairs pseudanal setae; one pair ventral lyrifissures; all legs shorter than body, slender, with no enlarged segments; rhagidial organs recumbent in pits, not T-shaped.

MALES AND IMMATURES. Unknown.

Table 1. Comparison of terms used for opisthosomal setae and lyrifissures of eupodid mites

	Strandtmann (1967)	This paper (see Figs 1–3)
Opisthodorsum—setae:	ih	c ₁ *
	eh	c ₂
	d ₁	d ₂
	d ₂	e ₁
	il	f ₁
	el	f ₂
	is	h ₁
	es	h ₂
—lyrifissures:	—	ia
	—	im
	—	ip
Anal region—setae:	a ₃	ps ₁
	a ₁	ps ₃
—lyrifissures:	—	ih
Genital area—setae:	igs	eu ⁺
	egs	g
	pgs	ag

— no name given

* terms below symbol based on Grandjean (1947)

+ terms below symbol based on Grandjean (1949)

TYPE SPECIES. *Caleupodes reticulatus* sp. n.

DIAGNOSIS. *Caleupodes*, known only from the type species, can be distinguished from other eupodid genera by the presence of external signs of opisthosomal segmentation.

ETYMOLOGY. The name is derived from the Greek 'calos' meaning beauty.

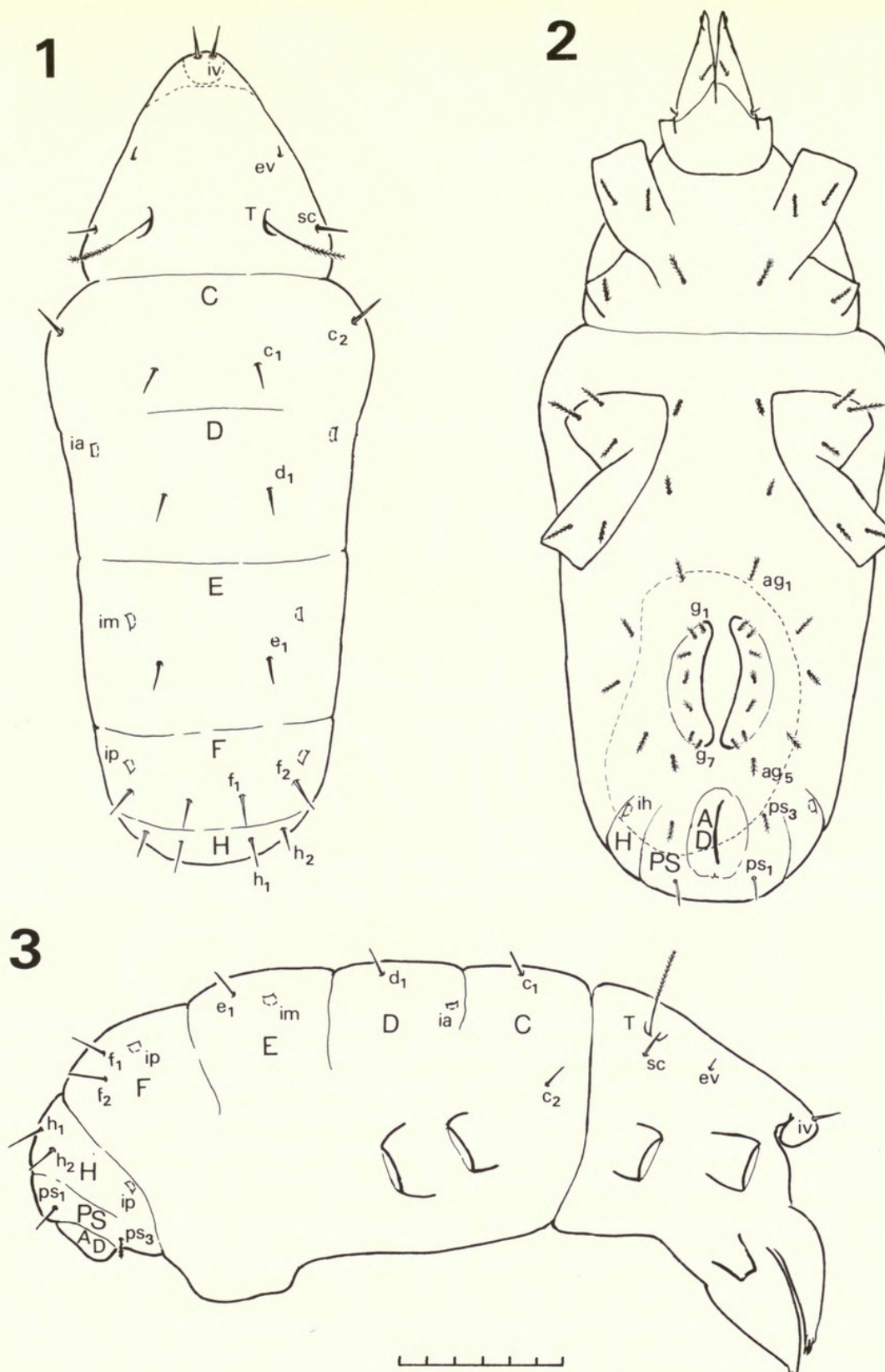
REMARKS. *Caleupodes* is classified in the superfamily Eupodoidea due to the presence of the anterior epivertex and recumbent leg solenidia (rhagidial organs). It is typical of the family Eupodidae in possessing an epivertex without an associated epirostrum, minute apical adoral setae, weakly chelate chelicerae, a tapering palp tibiotarsus, 12 pairs of dorsal setae and lacking adanal setae.

The dimensions, the short setae, the slender femora IV and the genital setae arranged in single file, as seen in *Caleupodes*, agree most closely with the characters of the now invalid genus *Prottereunetes* Berlese, whose members are at present included in *Eupodes* C. L. Koch (Fain, 1964; Strandtmann, 1970). *Caleupodes*, however, differs by lacking a distinct epivertex and by possessing two and not three pairs of pseudanal setae.

The species of *Cocceupodes* Thor possess two pairs of pseudanal setae and an epivertex that is not clearly differentiated dorsally. *Caleupodes*, by contrast, lacks the swollen femora IV and the T-shaped rhagidial organs found in *Cocceupodes*, while the internal vertical setae are located on the epivertex and not posterior to it.

Caleupodes reticulatus sp. n.
(Figs 1–14; 19–27; 29–36)

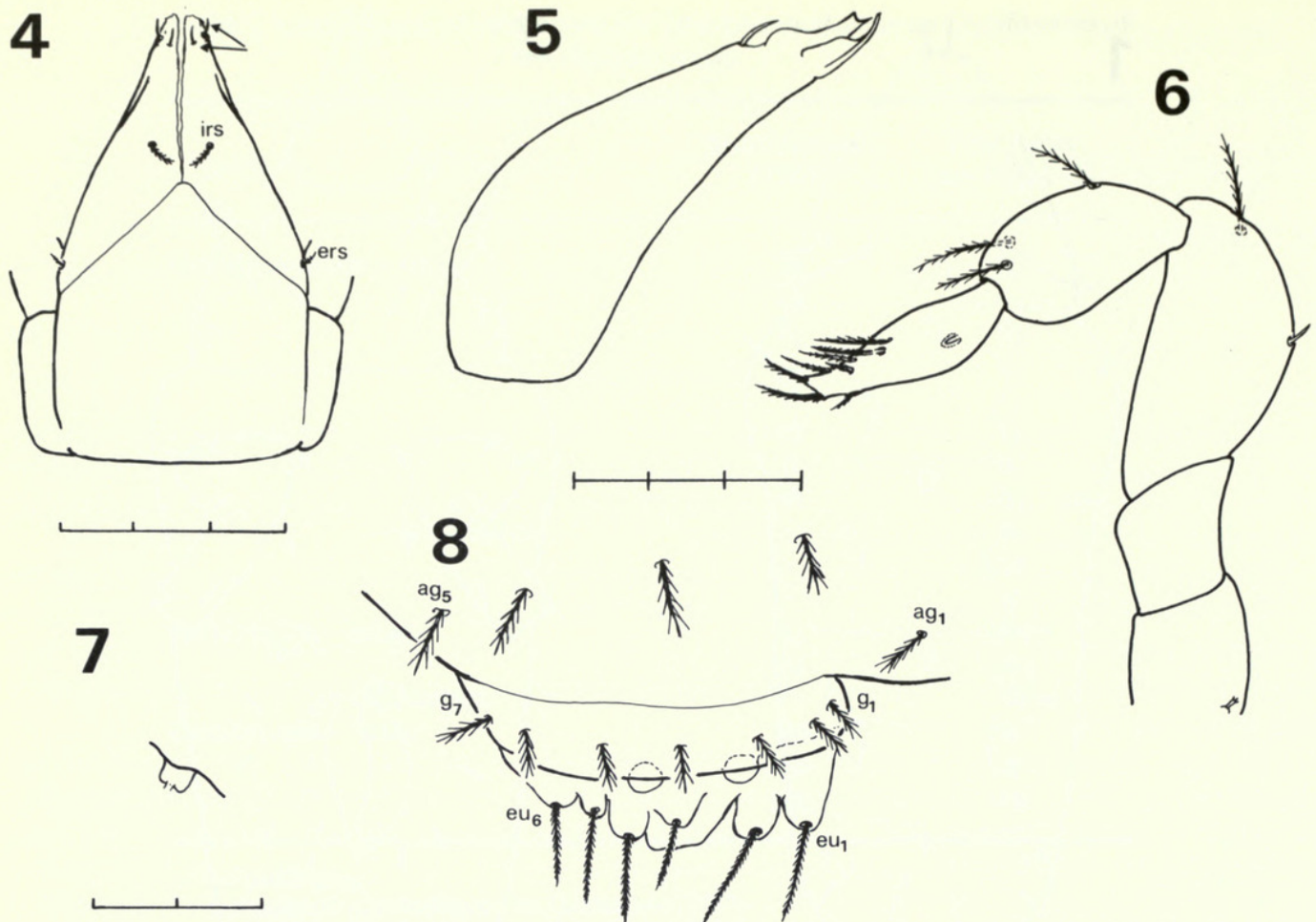
ADULT ♀ (7 specimens examined). With the characters of the genus. Body length 313 µm (300–330), width 152 µm (141–163); distinct sejugal furrow; propodosoma roughly triangular; shoulders of opisthosoma prominent, tapering slightly posteriorly (Figs 1 & 19). *Integument*: conspicuously ornamented, predominantly with reticulations of papillae or spicules linked by fine striae (Figs 20,



Figs 1–3 *Caleupodes reticulatus*: (1) idiosoma, dorsal view; (2) idiosoma and hypostome, ventral view; (3) idiosoma, lateral view. Scale intervals 10 μ m.

25–27, 29–31); dorsally, apart from over sejugal furrow and segmental boundaries, some papillae enlarged forming second network (Fig. 20); hypostome, chelicerae, palp tibiotarsus and ventrally surrounding anal and genital shields striate-spiculate.

DORSUM. *Lyrifissures*: *ia*, *im*, *ip* located on segments D, E, F respectively (Figs 1 & 3); roughly circular in surface view, laterally appear cup-shaped with pore perforating base (Fig. 7); in SEMs seen as depressed area of smooth cuticle with minute papillae (Fig. 21).



Figs 4–8 *Caleupodes reticulatus*: (4) hypostome, ventral view; (5) chelicera, antiaxial view; (6) palp, antiaxial view; (7) dorsal lyrifissure *im*, lateral view; (8) genital region, lateral view. Scale intervals 10 μ m.

Dorsal setae: arranged as in Fig. 1; trichobothria (*T*) 33 μ m (31–35), spinose, markedly so in distal half, inserted in enlarged pit (Fig. 22); other setae fine, taper to point, appear smooth or sometimes weakly serrate under optical microscope, SEMs though show external verticals (*ev*) to be ridged (Fig. 23), the remainder serrate, increasing in degree from internal verticals (*iv*) to *h* setae (Fig. 24); *iv* ca. 14 μ m long, scapulars (*sc*) 16 μ m, *ev* distinctly shorter than others at ca. 8 μ m, opisthosomal setae increase gradually in length from *c* row, ca. 15 μ m, to *h* row, ca. 18 μ m.

VENTER. *Coxae:* faintly defined; setae 3–1–4–3, arranged as in Fig. 2, plumose (Fig. 25), proximal seta of coxae I, III and IV located outside coxal limits, setae increase in length distally on I, III and IV from ca. 10 to 15 μ m, seta of II ca. 13 μ m.

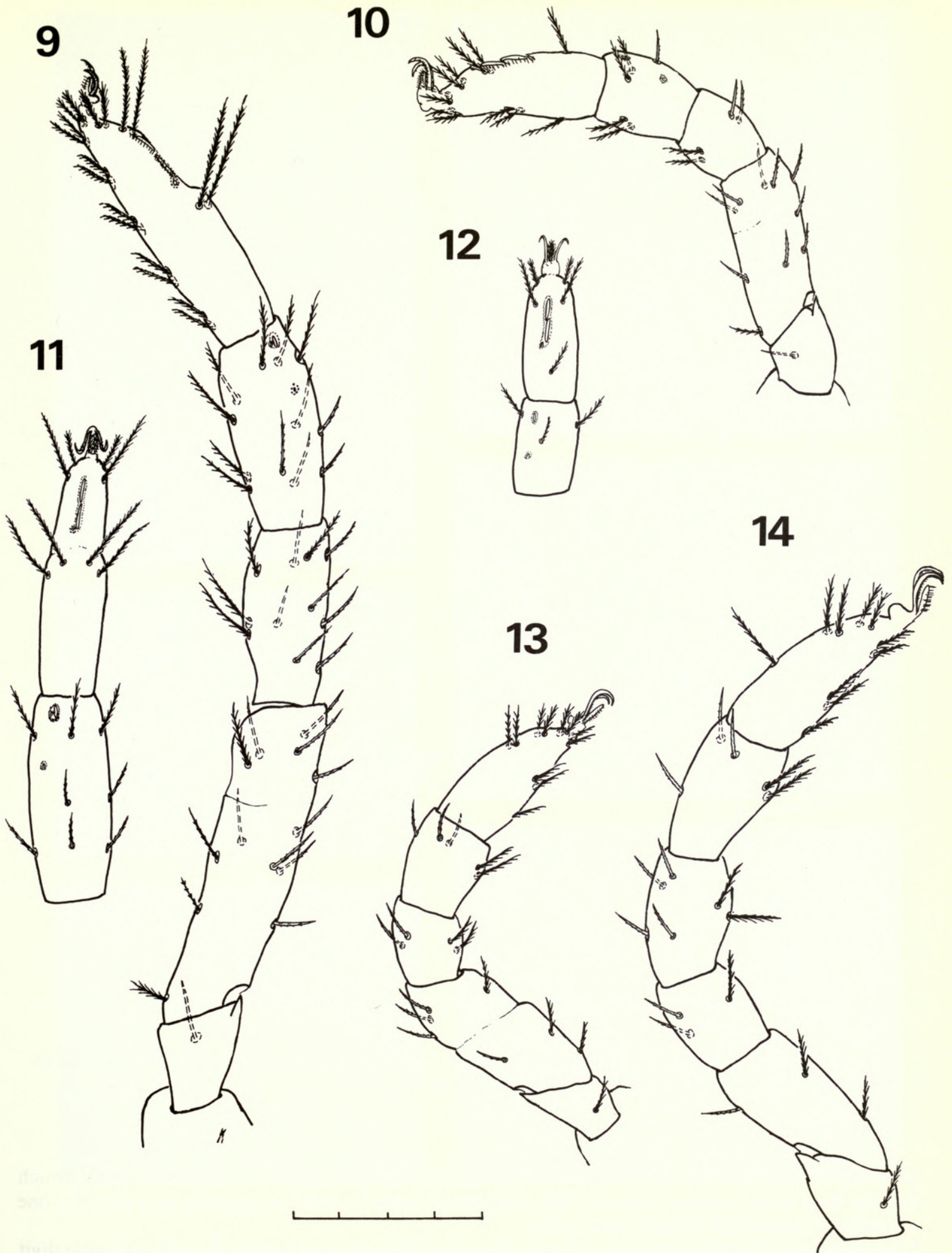
Genital area (Figs 2, 8 & 26): six pairs fine, tapering, pilose eugenital setae (*eu*_{1–6}), located on short protuberances, *eu*₃ slightly external to others, ca. 10 μ m long, remainder subequal, 13–15 μ m; seven pairs subequal, 6–8 μ m, plumose genital setae (*g*_{1–7}); five subequal, 9–11 μ m, plumose aggenital setae (*ag*_{1–5}); four gravid females, three with a single egg (Fig. 2), one with two, all eggs reniform, ca. 120 μ m long.

Anal region (Figs 2, 3 & 27): anus opens onto adanal segment; two pairs pseudanal setae, *ps*₁ dorsal to anus, ca. 13 μ m long, serrate, *ps*₃, ca. 10 μ m, plumose.

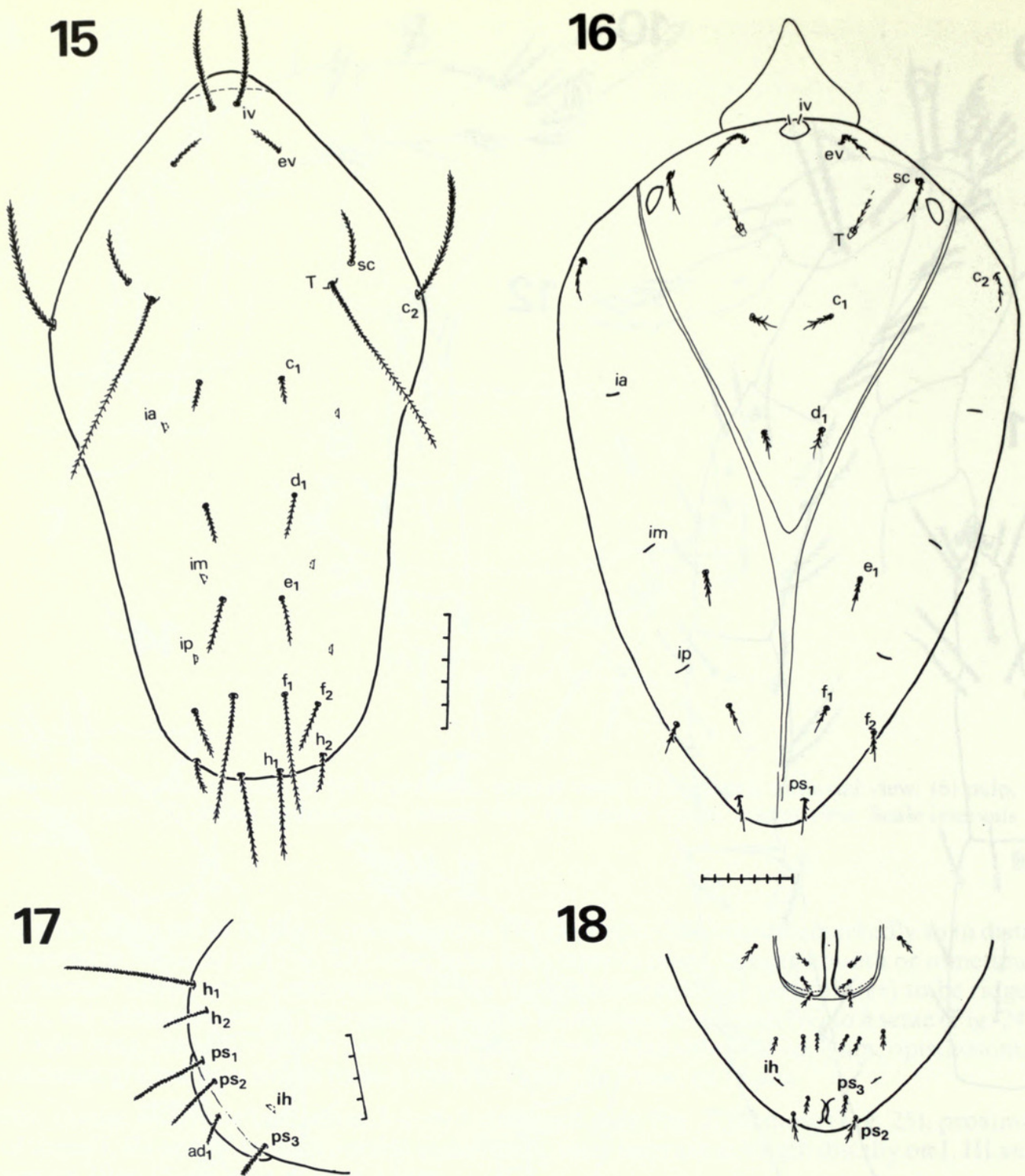
Lyrifissures: one pair, *ih*, ventrally on segment H, just inside anterior limit of segment, lateral to *ps*₃ (Fig. 2); similar form to dorsal lyrifissures (Fig. 29).

GNATHOSOMA. **Hypostome** (Figs 4 & 5): two pairs smooth, apical adoral setae (arrow, Fig. 30) difficult to discern under optical microscope; one pair plumose internal rostral setae (*irs*), ca. 8 μ m long; one pair sparsely spined external rostral setae (*ers*), ca. 4.5 μ m long.

Palps (Fig. 6): total length 103 μ m (100–108); setae 1–0–2–3–8, supracoxal seta minute, terminates



Figs 9–14 *Caleupodes reticulatus*: (9) leg I, posterolateral view; (10) leg II, posterolateral view; (11) tarsus and tibia I, dorsal view; (12) tarsus and tibia II, dorsal view; (13) leg III, anterolateral view; (14) leg IV, anterolateral view. Scale intervals 10 μ m.

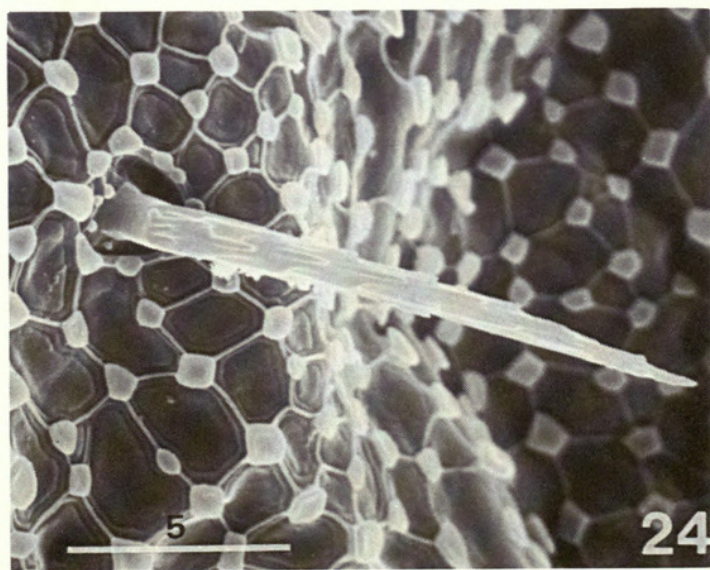
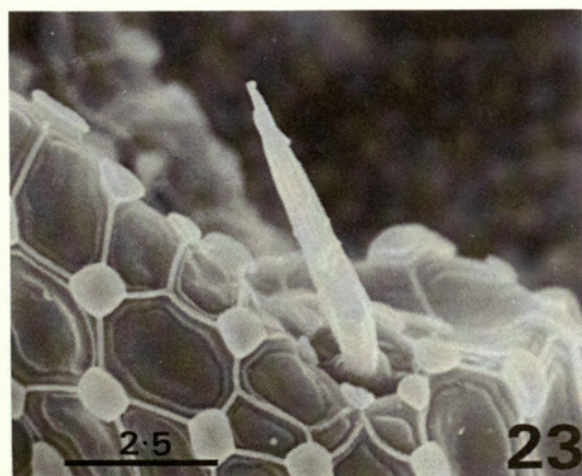
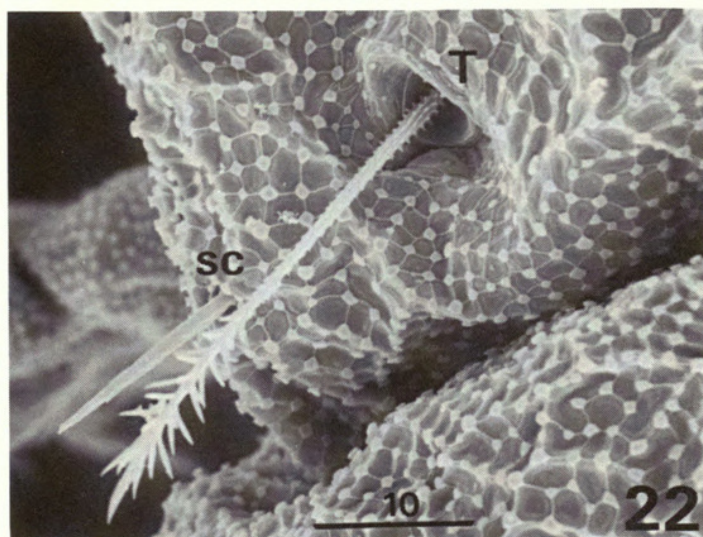
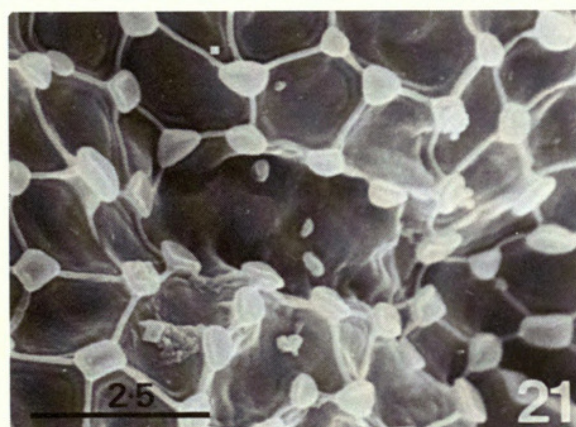
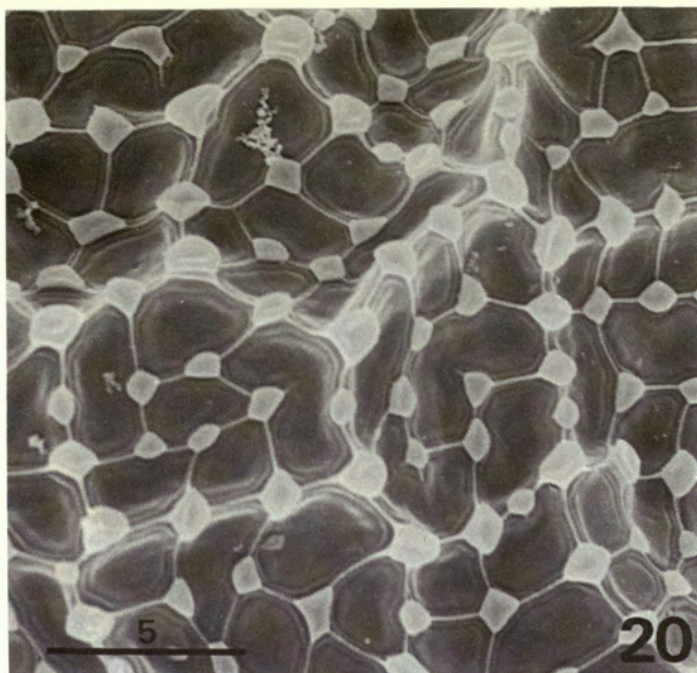
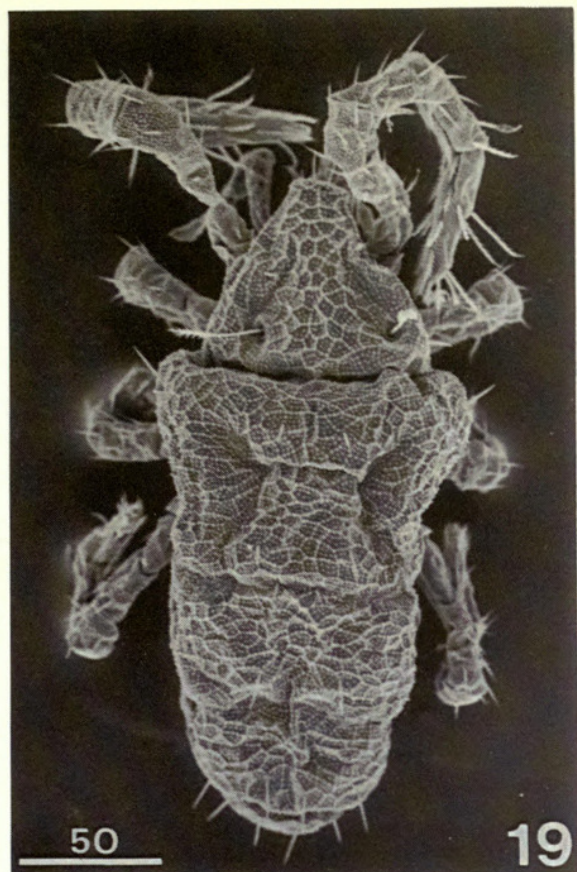


Figs 15 & 16 Idiosoma, dorsal view: (15) *Cocceupodes* sp.; (16) *Penthalodes* sp.

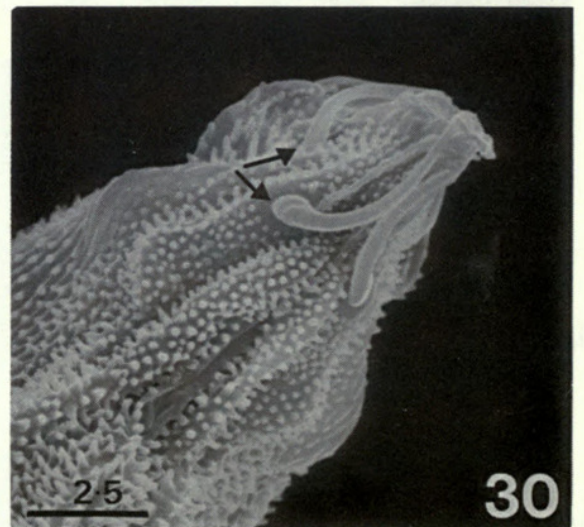
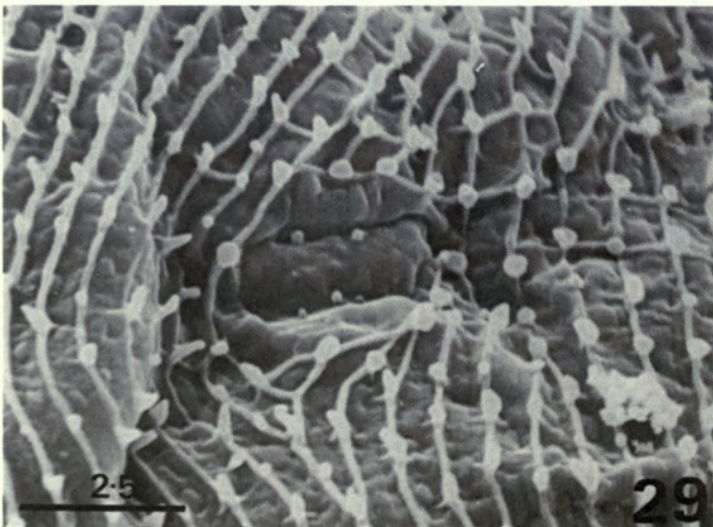
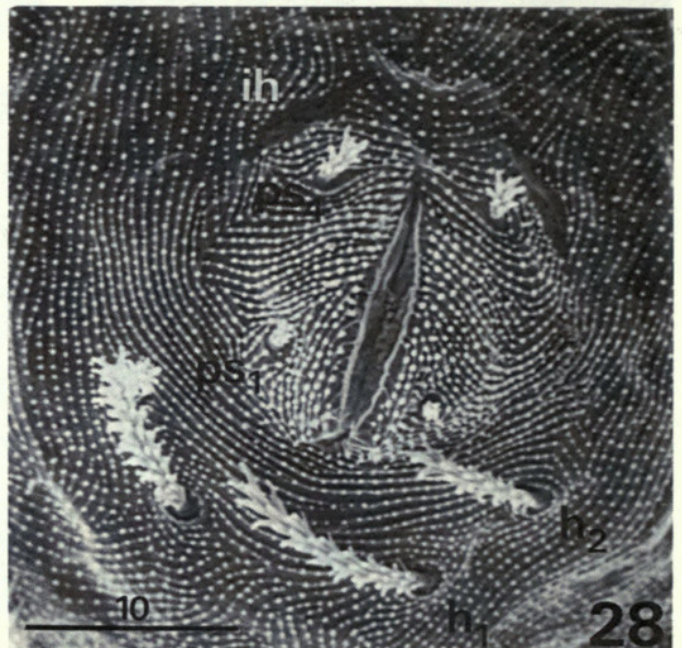
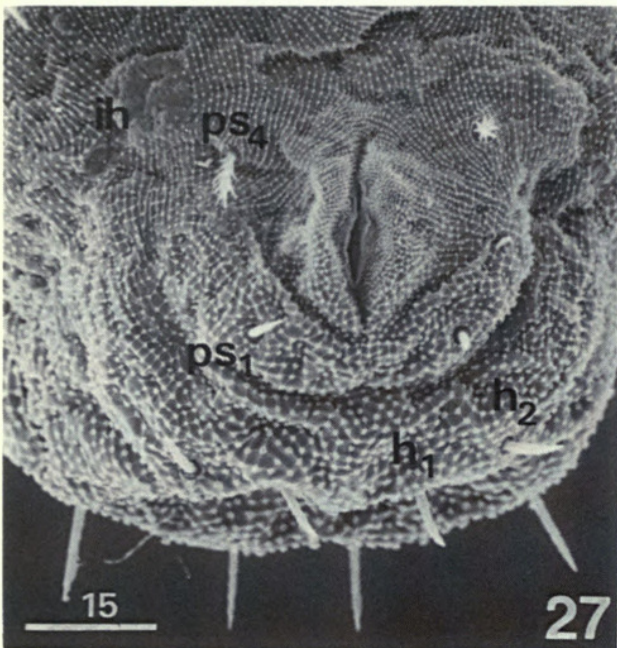
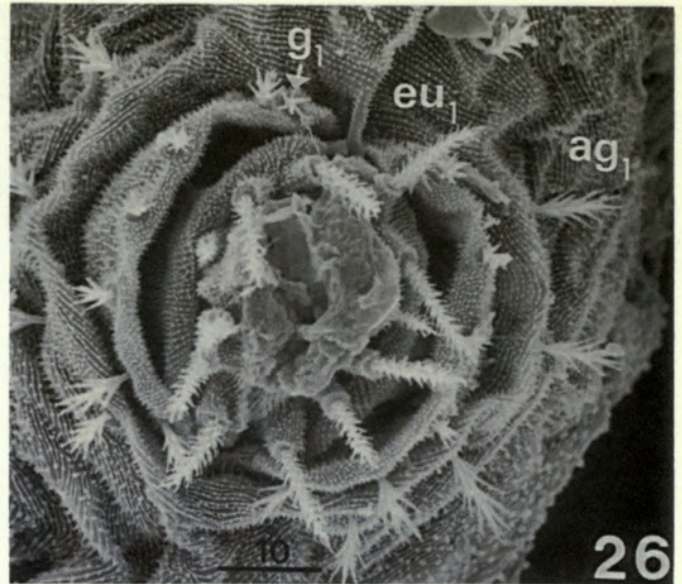
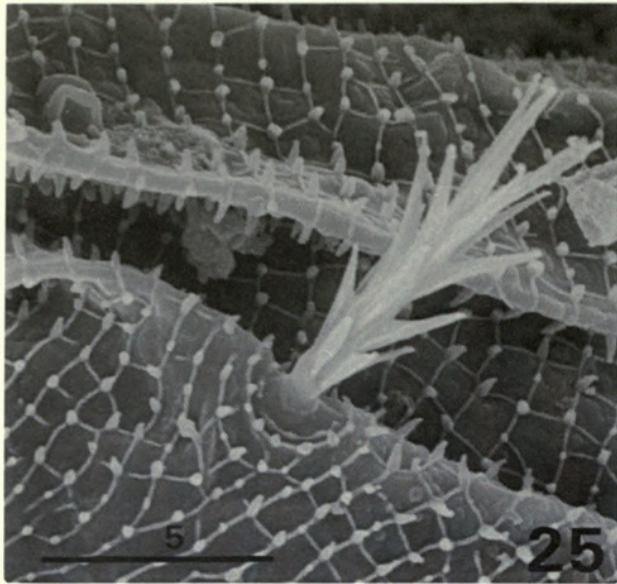
Figs 17 & 18 Anal region: (17) *Rhagidia* sp., lateral view; (18) *Penthalodes* sp., ventral view. Scale intervals 10 μ m.

in crown of blunt spicules as in supracoxal seta I (Fig. 32); proximal femoral seta smooth, much shorter than other, spinose femoral seta; tibiotarsal setae inserted marginally and distally, one rhagidiform solenidion located antiaxially.

Chelicerae (Fig. 5): total length ca. 70 μ m; distal end of fixed digit slightly forked; movable digit tapered from distal half; one short, smooth seta inserted on dorsal antiaxial surface just proximal to fixed digit.



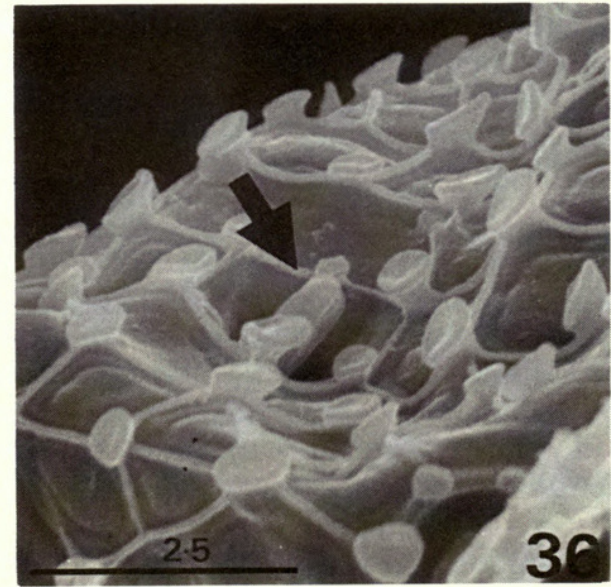
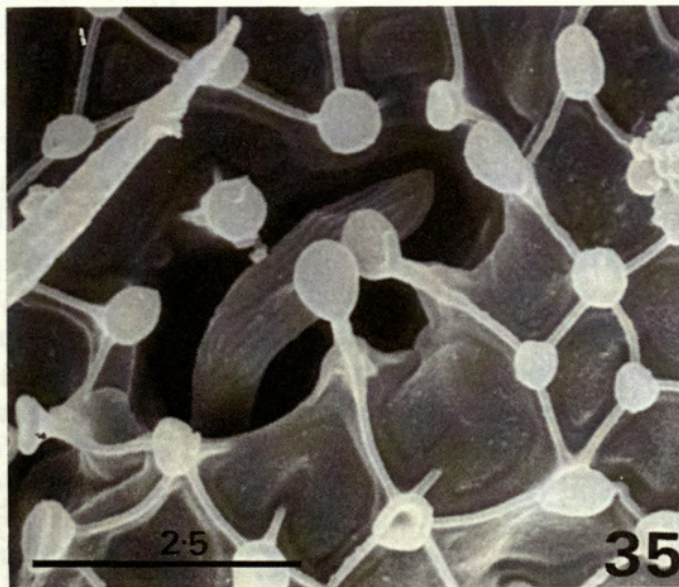
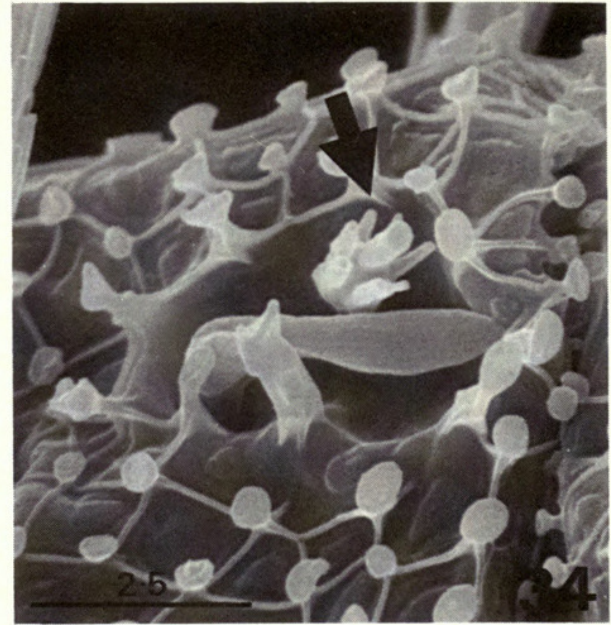
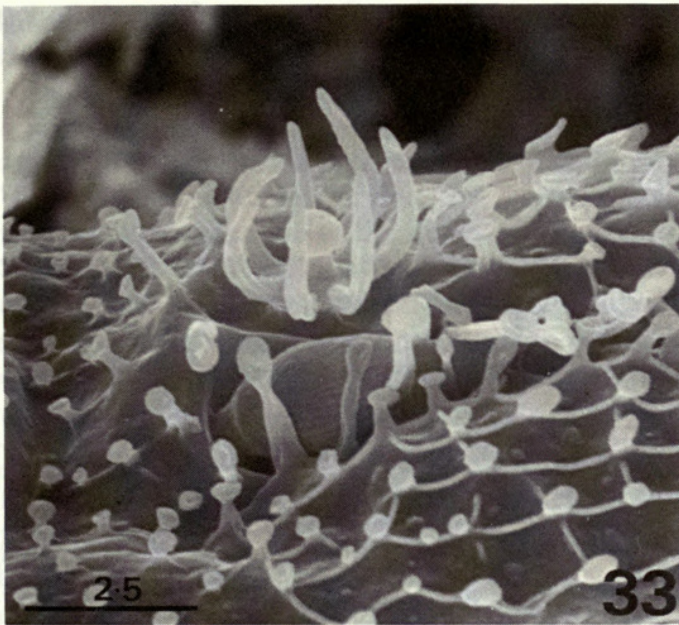
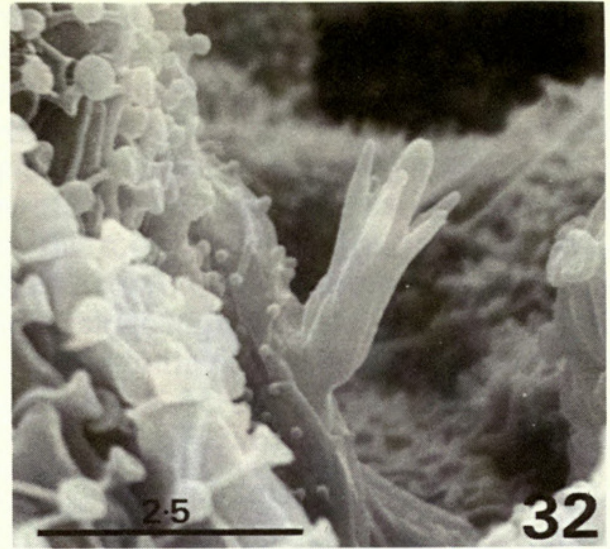
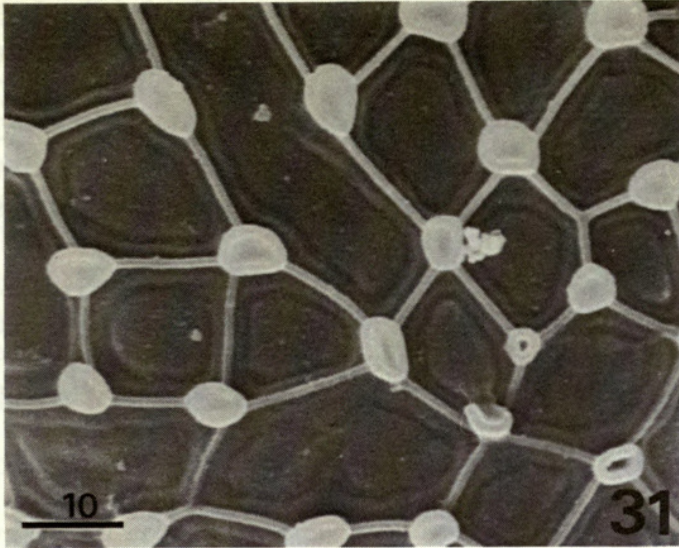
Figs 19–24 *Caleupodes reticulatus*: (19) idiosoma, dorsal view; (20) detail of notogastral integument; (21) dorsal lyrifissure *im*; (22) trichobothrium (T) and scapular seta (sc); (23) external vertical seta; (24) seta *h*₁. Measurements on scale bars in μm .



Figs 25–27 *Caleupodes reticulatus*: (25) coxa of leg III, seta and detail of integument; (26) genital region, ventral view; (27) anal region, ventral view.

Fig. 28 *Cocceupodes trisetatus*: anal region of larva, ventral view.

Figs 29 & 30 *Caleupodes reticulatus*: (29) ventral lyrifissure *ih* and detail of integument; (30) apex of hypostome, adoral setae arrowed. Measurements on scale bars in μm .



Figs 31–36 *Caleupodes reticulatus*: (31) femur of leg I, detail of integument; (32) supraxocal seta I; (33) tarsus I, stellate seta; (34) tibia I, distal rhagidial organ, spine with crown of papillae arrowed; (35) tibia II, distal rhagidial organ; (36) tibia I, proximal rhagidial organ, arrowed. Measurements on scale bars in μm .

LEGS (Figs 9–14): first pair approximately three-quarters body length, second and third just below half body length, fourth just above; all femora subdivided, I, II, III faintly; in lateral aspect, tarsus I with dorsal step about halfway along length.

Setae: formulae I 1–13(8+5)–11–12–18, II 1–10(5+5)–4–5–12, III 1–7(3+4)–4–5–11, IV 1–6(3+3)–6–5–10; all moderately short; tarsal setae spinose, on other segments ventral setae spinose, laterals spinose or weakly serrate, dorsals weakly serrate; supracoxal seta I minute, terminates in crown of blunt spicules (Fig. 32).

Rhagidial organs: located as shown in Figs 9–12; those of tarsus I with stellate seta (Fig. 33) adjacent to posterolateral margin of pit at base of proximal organ; those of II subtended by a short, slightly postero-lateral spine within pit; proximal rhagidial organs of tibiae minute (arrow, Fig. 36), distal ones longer (Figs 34 & 35), those of I with associated spine with crown of papillae posterolaterally in pit (arrow, Fig. 34).

MALES AND IMMATURES. Unknown.

DISTRIBUTION. England.

MATERIAL EXAMINED. Holotype ♀, ENGLAND, Suffolk, Hollesley Common, from rotten pine stump, 7.iii.1964 (P. N. & K. Lawrence) (BMNH, reg. no. 1985.7.2.1). Paratypes 6♀♀, same data as holotype (BMNH, reg. nos 1985.7.2.2–7).

Discussion

The furrows of differentiated opisthosomal integument of *C. reticulatus* are considered to indicate boundaries of primary segments. All segments have, at most, one transverse row of setae plus one pair of lyrifissures. These observations parallel those of authors studying other taxa of acariform mites (Grandjean, 1935; Knülle, 1959; Coineau, 1974; Lindquist, 1977). In *C. reticulatus*, seven opisthosomal segments are delimited. Applying Grandjean's (1947) notation system, they are from anterior to posterior, C, D, E, F, H, PS and AD (see Figs 1–3). The segmental boundaries show that lyrifissures *ia*, *im* and *ip* are located on segments D, E and F respectively, while *ih* is situated ventrally on segment H. D and E both possess a single pair of setae; C, F, H and PS all carry two pairs. The anus opens onto AD, the adanal segment, which is devoid of setae and lyrifissures. The most posterior setae are therefore the pseudanals. Within the Eupodoidea, the maximum number of three pairs of pseudanal setae occurs. The two pairs present in *C. reticulatus* appear to correspond to the most dorsal and ventral of these and so are respectively denoted *ps*₁ and *ps*₃. Setae *ps*₁ are of the same form as those which occur on the dorsum of the body, whereas *ps*₃ are like those found ventrally, illustrating the 'caudal bend' as discussed by Sitnikova (1978).

Larval acariform mites possess six opisthosomal segments (Grandjean, 1954), or five segments and a telson (Anderson, 1973; Aeschlimann & Hess, 1984), consequently the seven present in *C. reticulatus* indicate that one is added after the larval stage. Unfortunately, attempts to collect immature stages of *C. reticulatus* have been unsuccessful and so it has not been possible to study the ontogenetic development. Furthermore, the lack of postlarval addition of opisthosomal setae and lyrifissures in eupodid and penthalodid mites provides no evidence for anamorphosis (Pittard, 1971; Gless, 1972). Observations of larvae of other eupodid species, however, suggest that a segment is indeed added subsequently. The anal shields in the larva of *Cocceupodes trisetatus* Strandtmann & Prasse bear two pairs of setae while the ventral lyrifissures, *ih*, lie close to the junction of the shields and the surrounding integument (Fig. 28). In the adult *C. reticulatus*, by contrast, the anal shields are devoid of setae while *ih* are located some way from the anus (Fig. 27). More support was gained when, contrary to the situation described by other authors (Zacharda, 1980; Kethley, 1982), postlarval setal addition was observed in the Rhagidiidae. As in the other holotrichous eupodoid families, the pseudanal setae (three pairs) are located on the anal flaps of the larva. In the protonymph, however, the pseudanals have moved away from the anus, but the shields now bear a single pair of setae, which are here identified as adanals (*ad*₁) (Fig. 17).

Apart from the markedly hypertrichous genera of the families Penthalidae and Strandtmanniidae, the homologues of opisthosomal structures of *Caleupodes* can be identified in the other

eupodoid genera (Figs 15–18). Eight pairs of dorsal setae are normally present, the exception being in the genus *Penthalodes* Murray. Strandtmann (1971) suggests that members of this genus have only six pairs of dorsal setae, the missing ones being d_1 and f_2 , and three pairs of pseudanal setae. However, the interpretation of the relationships between opisthosomal segments, setae and lyrifissures, resulting from the discovery of *C. reticulatus*, indicates that it is h_1 and h_2 which are absent (Figs 16 & 18). Setae and lyrifissures are arranged more or less in the pattern seen in *C. reticulatus*. Differences occur in the number of pseudanal setae, there being three pairs in penthalodids, rhagidiids, *Benoinyssus* Fain, *Claveupodes* Strandtmann & Prasse, *Eupodes*, *Hawaiieupodes* Strandtmann & Goff and two pairs in *Caleupodes*, *Cocceupodes* and *Linopodes* Koch.

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