

PARASITES OF WESTERN AUSTRALIA  
VII  
OBSERVATIONS ON QUILL WALL MITES  
(ACARINA: ASTIGMATA)

F.S. Lukoschus\*  
and  
H.A.P.M. Lombert†

[Received 1 February 1978. Accepted 23 February 1978. Published 5 June 1979.]

ABSTRACT

Four species of astigmatic mites have been found in an hitherto unobserved biotope, the wall of the feather quills.

A new subfamily FAINOCOPTINAE within the family LAMINOSIOPTIDAE, Vitzthum, 1931 is erected. The species *Fainocoptes nixonii* gen.nov., sp.nov. from *Geopelia humeralis*, *Calamicoptes meliphagae* gen.nov., spec.nov. from *Philemon citreogularis*, *C. conopophilae* sp.nov. from *Conopophila rufogularis*, and *Streetacarus australis* gen.nov., spec.nov. from *Calyptorhynchus magnificus* are figured and described.

INTRODUCTION

During the Western Australian Field Programme 1976-1977 of the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth, the first author found four species of astigmatic mites in the quill walls of Australian birds; observations were made on the biology of these mites. They share many characteristics with *Laminosioptes hymenopterus* Jones & Gaud, 1962 which were obtained by washing specimens of the eastern American crow (*Corvus b. brachyrhynchus*), a technique which precludes gathering biological information.

There are some morphological similarities between *L. hymenopterus* and the subcutaneous parasites of galliform birds, *L. cysticola* (Viziola, 1870).

The shape of epimera I and II, the form of chelicerae, the shortened forelegs with partial fusion of femur and genu, short setae in dorsal file and long lateral setae, the presence of sejugal sclerites and in being viviparous indicates the morphological similarity. However, the strongly reduced propodosomal shield with characteristic

\*Department of Zoology, Catholic University of Nijmegen, The Netherlands.

†Department of Zoology, Catholic University of Nijmegen, The Netherlands.

borders, the feeble sclerotization of other dorsal parts, the weak coxal regions, the chaetotaxy of legs and lack of a sclerotized ring around the anus, the morphology of developmental stages and their biology indicate that the two species are not congeners.

European, African and American birds have yielded several species, which will be described soon. They form a group of morphologically and biologically related species and they will be separated at the subfamilial level.

Here we will define a new subfamily and describe the Australian genera and species assigned to this new taxon. All measurements are given in microns. In order to condense the descriptions and to give collecting dates for species to be described, many measurements are given in a tabulated form and are not repeated in the formal descriptions.

#### Family LAMINOSIOPTIDAE Vitzthum, 1931

Diagnosis: Small to medium sized astigmatic mites of elongated, dorsoventrally-flattened shape. Vertical setae absent, lateral setae of body remarkably long, dorsal setae very short. Cuticle of the sclerites is smooth, conjunctiva striated. Gnathosoma with short, broad palps and the chelicerae with reduced fixed digits.

Legs I and II short and broad with partial dorsal fusion of femur and genu. All tarsi with dorsal hooks and long stalked disc-like ambulacra. Epimera I Y-shaped with bifid termination, epimera II free with terminations essentially parallel, III and IV free. Sejugal sclerites often present. Female genital region with two valves in inverted V-shape between legs III or IV, and a third transverse valve, small epigynum without connection to epimera, small genital apodemes and no genital discs. Genital region in the males located behind coxal region IV. Adanal or tarsal discs in males absent. Without pronounced sexual dimorphism. Males with shorter opisthosoma, solenidia of the legs may be longer and stronger. Developmental stages with reduced setation. Species of the family are viviparous parasites of the internal feather walls of subcutaneous tissues of birds.

#### Subfamily LAMINOSIOPTINAE Vitzthum, 1931

Small mites (200-260 $\mu$ ) with characteristics of family as mentioned above. Large propodosomal, metapodosomal and opisthosomal shields separated by small regions of striated cuticle. Scapular setae on a propodosomal shield which has no strongly marked borders. The short triangular gnathosoma is broadly fused to the idiosoma, not extending legs I. The legs are inserted ventrally. All setae of legs are short and spinelike, the ambulacra of tarsi elongated, each with four small lobes. All coxal fields distinctly sclerotized. The female genital opening between legs III. Genital setae near the genital valves are lacking. A distinct ventral anal shield with strongly sclerotized ring around the anal split. Males with a short opisthosoma, the

genital region touching coxal fields IV. The solenidia of legs I and II are longer and stronger than in the female. The developmental stages have well formed legs III and IV and strongly sclerotized epimera.

Parasites of the subcutaneous tissues of birds.

Type genus: *Laminosioptes* Mégnin, 1880.

#### Subfamily FAINOCOPTINAE, new subfamily

We dedicate the typical genus to our colleague A. Fain, Antwerp. (koptein = to burrow, as to biology of these mites)

Medium sized mites with the characteristics of the family. The small prodorsal shield covers only the median part between the scapular setae, with characteristic *Knemidokoptes*-like sclerotized borders. Parts of the metapodosoma and opisthosoma may have feeble incrustated smooth regions without distinct borders to broad striated regions of body. The gnathosoma is broadest apically, the connection to the idiosoma appears neck-like. Gnathosomal wings may or may not be present, but the structure that may form these wings is always present. The segments of legs I and II of equal length; legs III and IV with femora and genua about half the lengths of the remaining segment. The ambulacra appear as rounded empodial discs, in which a triangular central plate may be present. The coxal fields lack sclerotization. The female genital opening lies between epimera IV with 1-2 genital setae near valvae. The anal opening is terminal, lacking anal shield and sclerotized ring. Males with the genital region separated from coxal fields IV on the opisthosoma; the opisthosoma shorter than in females. The solenidia of hind legs are longer than in females. Developmental stages with poorly formed hind legs and without visible epimerae.

Parasites of developing feathers.

Type genus: *Fainocoptes* gen.nov.

#### *Fainocoptes* gen.nov.

Legs III and IV long and slender. All setae of the idiosoma and legs are seti- to filiform. Lateral winglike protrusions are present behind legs II. Lateral flaps on gnathosoma are absent. Lateral sclerites (sejugal sclerites) between laterals 1 and the humerals are absent or only poorly sclerotized.

Chaetotaxy of idiosoma: present are *sc i*, *sc e*, dorsals 1-5, laterals 1-5, 1-2 pairs of genitals, *h*, *sh*, *cx I*, *cx III*, *cx IV* and one pair of anals.

Chaetotaxy of legs: tarsi 6-7-4-5, tibiae 1-1-1-1, genua 2-2-0-0, femora 1-1-0-0, trochanters 1-1-1-1.

Solenidiotaxy: tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-1-0.

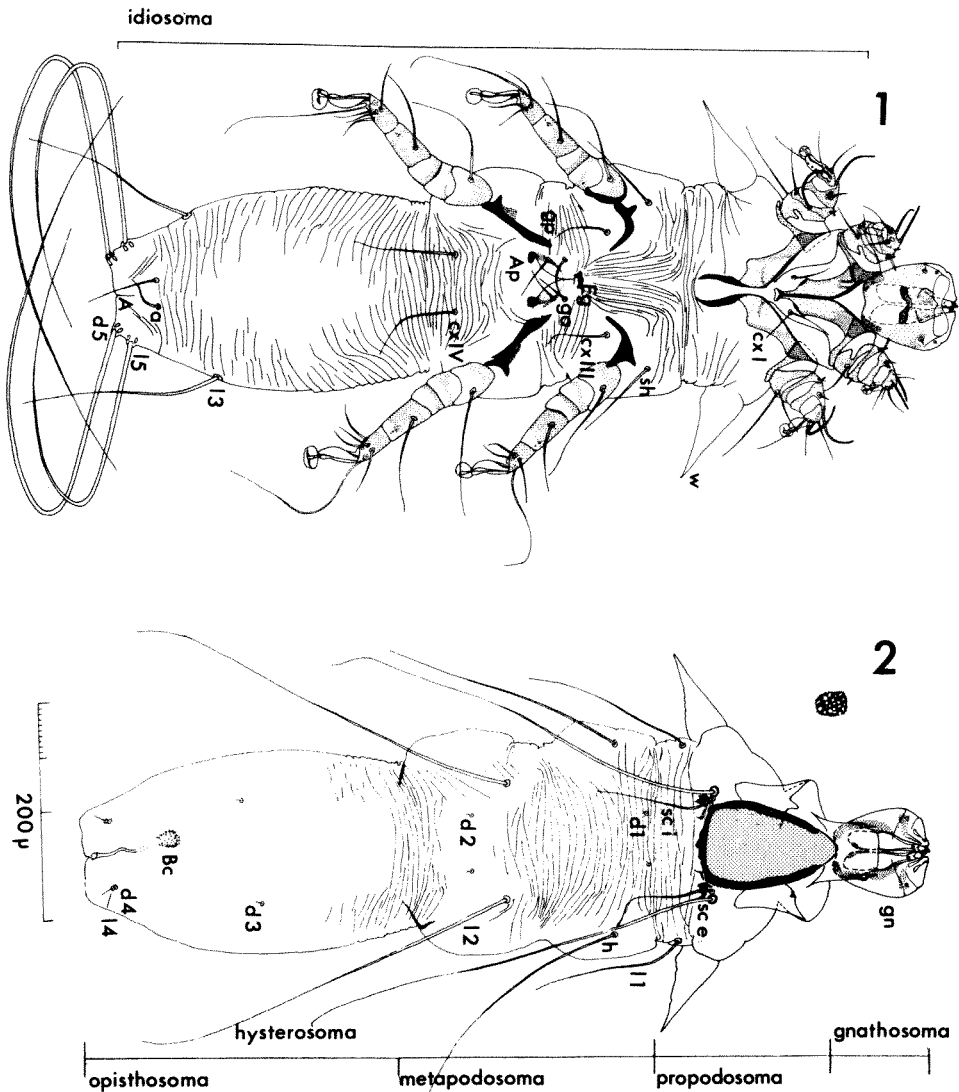
Type species: *Fainocoptes nixonii* spec.nov.

*Fainocoptes nixonii* spec.nov.

We dedicate the species to Mr John Nixon, Beverley Springs Station, who with his family, has given much help and facilities to the base camp.

Elongate species of pale yellow colour with brown legs and a prodorsal shield.

**Female (holotype) (Figs 1-6):** Length including gnathosoma 770, average of 10 paratypes 782 (756-799), width 195, in paratypes 216 (189-237).

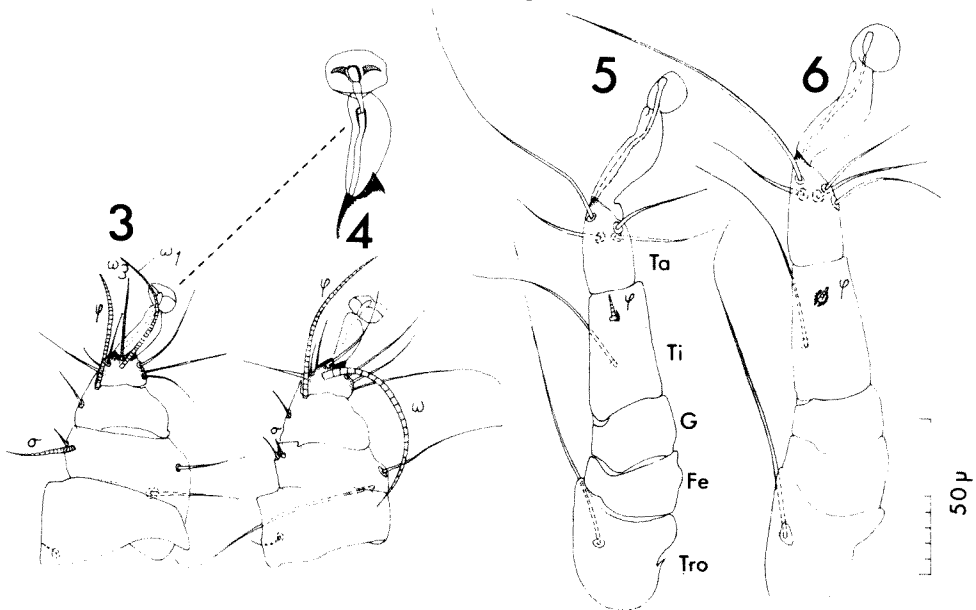


Figs 1,2: *Fainocoptes nixonii* spec.nov. Holotype female. 1 - ventral view, 2 - dorsal view.

**Venter (Fig. 1):** Idiosoma with characteristic striation, as figured. Insertion of legs in two widely separated groups. All legs inserted laterally. Genital region lies between epimera IV. Genital opening in the form of an inverted V with three valves. Small epigynum (Eg) in front of the genital valves; genital apodemes (Ap) are present. No connections of genital sclerites to epimera III or IV. Two pairs of genital setae (*g a* and *g p*) present near valves. Anus (A) terminal, without sclerotized ring. One pair of anal setae (*a*) present on venter. Further idiosomal setae: coxal setae in fields I, III and IV (*cx I*, *cx III* and *cx IV*) and subhumeral setae (*sh*). Lateral setae 3 + 5 and dorsals 5 shifted to lateral sides of venter, not inserted on protruding tubercles.

**Dorsum (Fig. 2):** Propodosomal shield with strongly sclerotized borders and U-shaped. Scapular setae on edges of the shield. Cuticle in the region of dorsals 2 and on the middle of opisthosoma without striation and slightly incrustated. There are definite changes of striated to somewhat incrustated regions of cuticle without distinct borders. Bursa copulatrix (Bc) ending dorsoternally. Dorsal setae 4 and laterals 4 are very close.

**Legs (Figs 3-6):** with five free segments and long stalked pretarsus, with the exception of segments femur and genu of legs I and II, which are partially fused dorsally. Legs I and II notably shorter and broader than the hind legs. Tarsi of the forelegs with two, hind legs with one, strongly sclerotized hook. Pretarsi in the form of long empodial discs with condylophore and without empodial claw. Pretarsi on forelegs are smaller and shorter than on the hind legs.



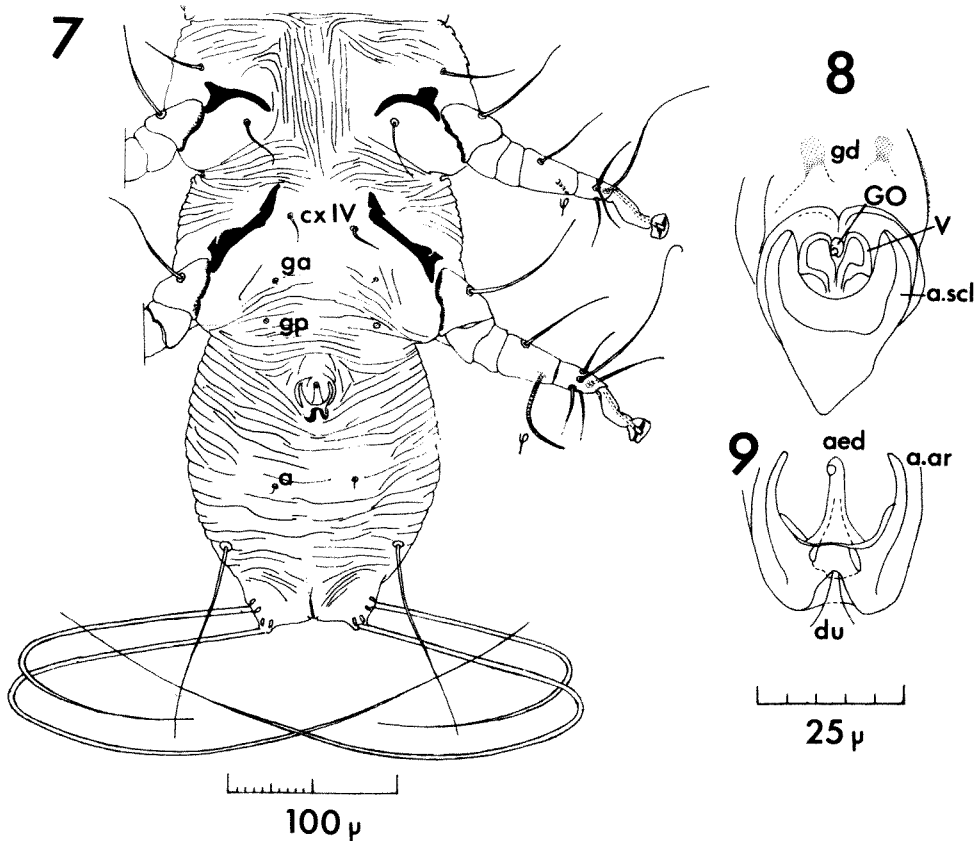
**Figs 3-6:** *Fainocoptes nixonii* spec.nov. Holotype female, legs in dorsal view. 3 - leg I, 4 - leg II, 5 - leg III, 6 - leg IV.

Chaetotaxy and solenidiotaxy as in the definition of genus.

Measurements in **Tables I and II.**

Gnathosoma head-like, articulated with smaller 'neck' to idiosoma, with short two-segmented palps and scraping chelicerae without fixed digit. Gnathosoma distinctly surpassing tarsi I in length. Four pairs of setae are present on the gnathosoma: two on palp tibia, the dorsal one closer to the idiosoma than the ventral one, and two setae and one solenidion on the palp tarsus, the setae more or less inserted laterally near the base of the tarsus. Two additional pairs of setae may be present on the tarsus between the two anterior sclerotized edges behind the solenidion.

**Male (allotype) (Figs 7-9):** Length 596, width 194; 5 male paratypes with average length of 585 (564-602), average width 200 (185-213).



**Figs 7-9:** *Fainocoptes nixonii* spec.nov. Allotype male. 7 - venter of hind region, 8 - surface view of genital region, 9 - internal view of genital region.

Like females with only differences in measurements, which are given in **Tables I and II**. Genital region distinctly behind legs IV (**Fig. 7**). Long setae near epimera IV are coxal setae IV. The genital region is shifted backwards to the opisthosoma, while genital setae remain constant in positions. Solenidia *phi* on tibiae IV are much longer than in the female. Surface of genital region is shown in **Fig. 8**. Small genital opening (GO) surrounded by genital valves (V) and aedeagal sclerites (a scl). Genital discs, adanal discs and modifications of legs are absent. In front of the copulatory apparatus are two chitinized gland ducts (gd) which open into genital chamber. **Fig. 9** shows a more internal view with an aedeagal duct (du), a short curved aedeagus (aed) with aedeagal articulations (a ar) connected with aedeagal sclerites of the surface.

**Tritonymph (Figs 10-16):** elongated, dorsoventrally flattened, with soft cuticle and with transverse striae on part of dorsum. Legs inserted laterally. Legs I and II with epimera as figured, III and IV without visible epimera. Large winglike projections on dorsolateral surface, contrary to adults, where they are lateral. Opisthosoma tapering to a bilobed end (**Fig. 11**), with anus between the lobes. Propodosomal shield without strong lateral borders but with lateral encavements (**Fig. 12**).

Idiosomal setae *sc i*, *sc e*, *l 1-3*, *l 5*, *h*, *sh*, *d 2*, *d 3* and *d 5* present, speculiform or represented by vestigial setal rings. Functional parts of the gnathosoma as in adults. Legs I and II (**Figs 13 + 14**) of similar shape, though smaller than in adults; III and IV (**Figs 15 + 16**) strongly reduced, probably with unimportant locomotary function.

All tarsi with short pretarsi (Pta), having two hooks each and a small ambulacrum. Setae of the legs short, thin, speculiform or so indistinct that signatures can not be assigned with certainty. Unusual are two solenidia on tarsus II in all observed tritonymphs (also observed in related species, with one exception).

**Protonymph:** like tritonymph with shorter winglike projections, similarly shaped dorsal shield and more reduced setation. Idiosomal setae have not been observed. Tarsi of legs I and II with only one solenidion each.

**Larva:** with three pairs of legs, a short rounded caudal end, with only short winglike projections and somewhat smaller dorsal shield. Solenidia present on tarsi and tibiae I and II. Measurements shown in **Tables I and II**.

**Viviparity:** In females, well chitinized larvae are found in the metapodosoma and opisthosoma always with gnathosomata directed caudally. No eggshells or remnants have been observed. There seems to be almost simultaneous reproduction at a low rate. In a total of 18 females we found:

- 4 ♀ ♀ enclosed or near tritonymphal skin
- 5 ♀ ♀ without enclosed larvae
- 2 ♀ ♀ with 1 enclosed larvae

- 1 ♀ with 2 enclosed larvae
- 1 ♀ with 4 enclosed larvae
- 5 ♀ ♀ with 5 enclosed larvae.

**Biology:** Mites burrow in the outer layer of the quill wall during development. They cause furrows in the surface of the quills, mostly in the part beneath the vane, feeding during development of the feathers in the region of the unkeratinized portion above the feather germ. Mites burrow mostly in the direction of the germ either in a straight line or spiral-like and most of them with the speed of the growing feather. They remain in the region where the cells of the outer layer show first signs of keratinization. Mites with deficiencies in movement, i.e. during moulting shift away from the growing feather to regions of keratinization, which they can not pass. They become situated in hard cornified layers, and are captured between the quill and the feather sheath. Mites found in fully developed feathers are always enclosed between quill and feather sheath, while many feathers are found with only the mite-caused furrows up to base on the outside of the quill without pathological attachment of the sheath to the quill. Living mites have been found in very young feathers at the base of the blue germ. Intervals between the moults of the host are survived in a somewhat inactive stage in the skin near the papilla. Histological observations on the biology of a species assigned to another genus will be published elsewhere.

#### **Host and locality**

*Geopelia humeralis*, Columbidae, Columbiformes. Beagle Bay, 25-VIII-1976, Lukoschus leg. Mites were found on quills of the primaries.

**Deposition of types:** Holotype and allotype in Western Australian Museum, Perth. Paratypes in Field Museum of Natural History, Chicago; U.S. National Museum of Natural History, Washington; the Acarology Laboratory, Columbus, Ohio; Queensland Institute of Medical Research, Herston, Brisbane; Institute of Parasitology, Prague; Institute of Tropical Medicine, Antwerp; Department of Zoology, Catholic University, Nijmegen.

#### *Calamicoptes* gen.nov.

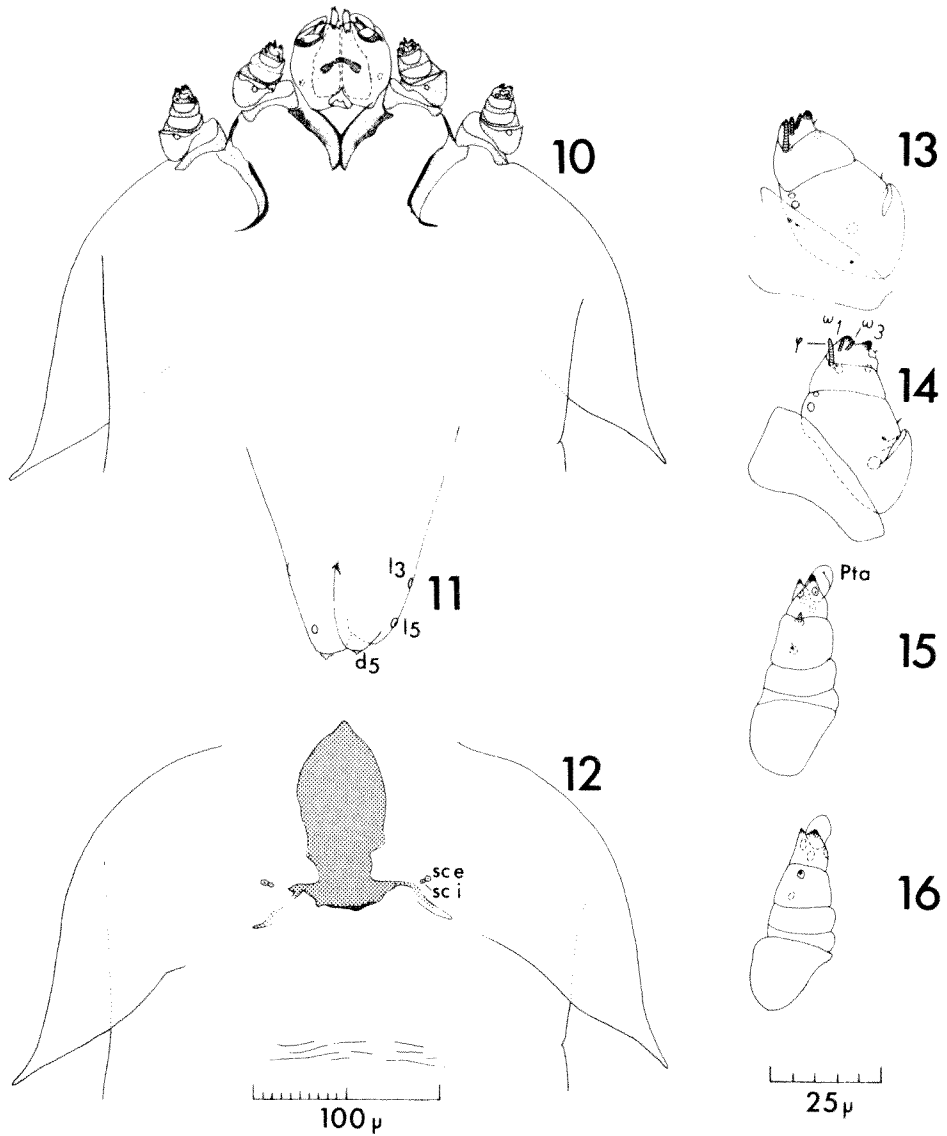
(Calamus = part of feather, situated within the skin.) Legs III and IV slender. All setae of idiosoma and legs seti- to filiform. Winglike projections present on gnathosoma and propodosoma. Sejugal sclerites present between laterals 1 and humerals. Often pores are present behind humerals. Chaetotaxy of legs as in *Fainocoptes*.

*Solenidiotaxy:* tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-0-0.

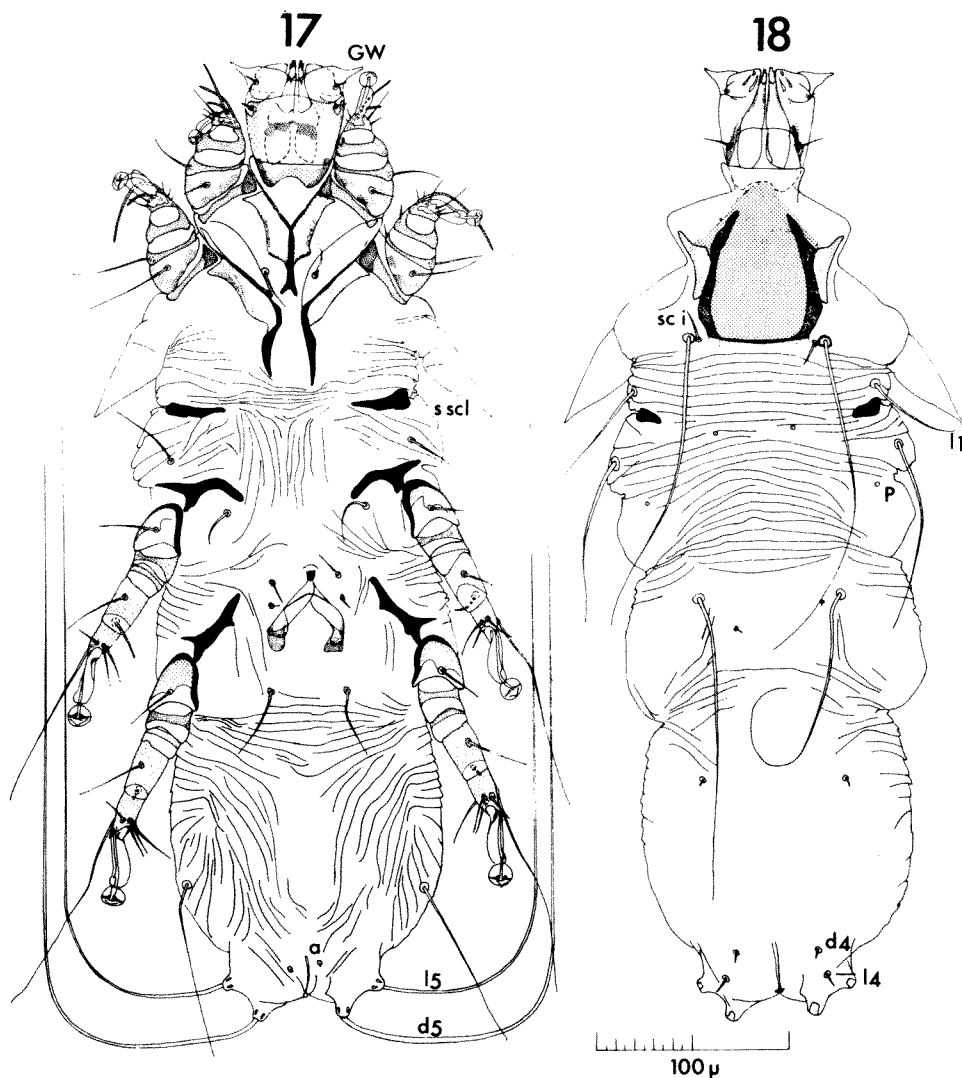
*Chaetotaxy of idiosoma as in Fainocoptes.*

Type species: *Calamicoptes meliphagae* spec. nov.





**Figs 10-16:** *Fainocoptes nixonii* spec.nov. Tritonymph. **10** - ventral view of anterior part, **11** - caudal end in ventral view, **12** - propodosoma in dorsal view, **13** - leg I, **14** - leg II, **15** - leg III, **16** - leg IV.



Figs 17,18: *Calamicoptes meliphagae* spec.nov. Holotype female. 17 - ventral view, 18 - dorsal view.

*Calamicoptes meliphagae* spec.nov.

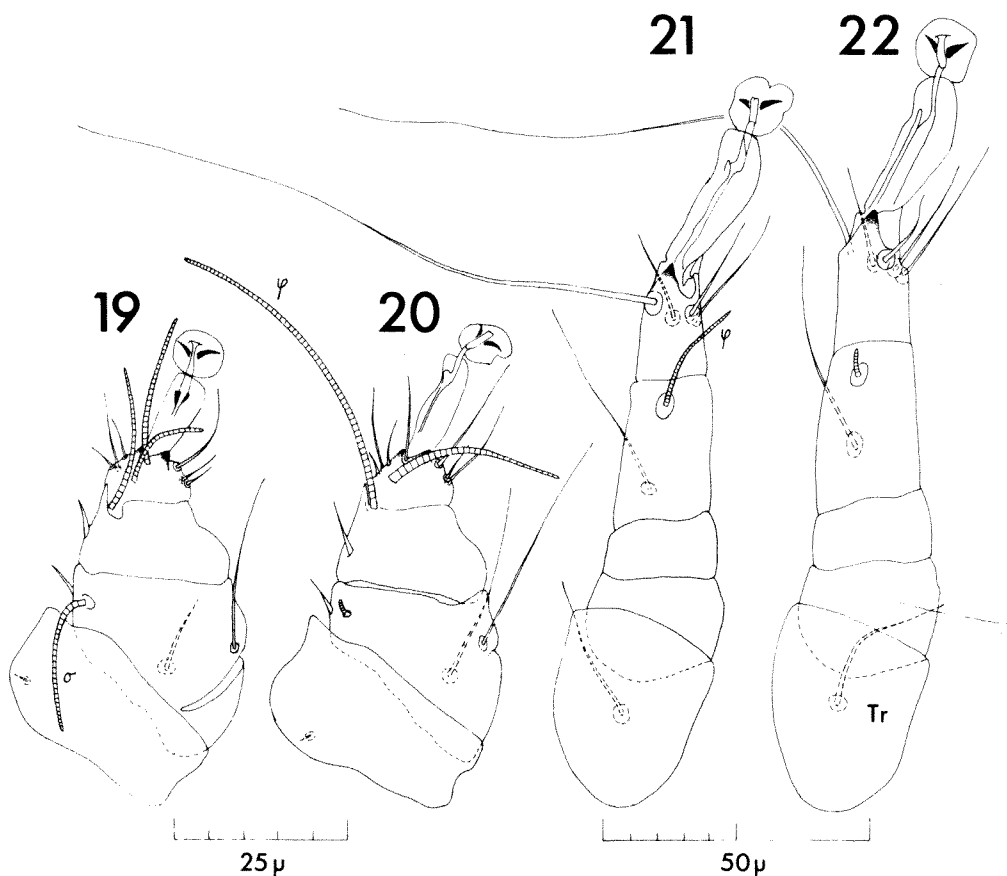
**Female:** (holotype) (Figs 17-22): Length 495, 6 paratypes averaged 513 (485-532), width 164, in paratypes 171 (162-176).

**Venter (Fig. 17):** Many characteristics as in previous species with somewhat different measurements, shown in Tables I and II. Strongly sclerotized band surrounding lateral sides on a line between pro- and metapodosoma. Laterals I belonging mor-

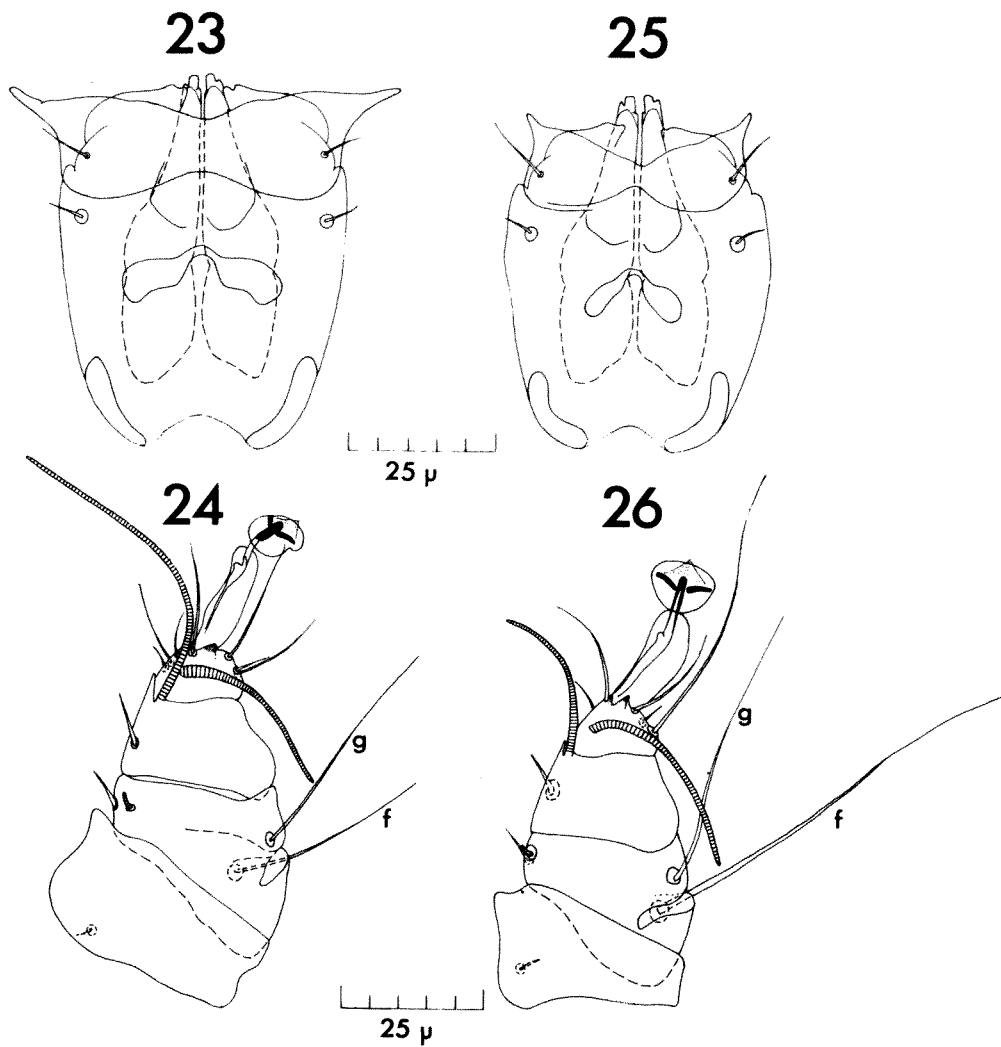
phologically to metapodosoma however are positioned anterior to these sclerites; freshly mounted specimens show them to be placed for attachment of muscle fibres; sclerotizations on this place have not been recorded from astigmatic mites; the term sejugal sclerites (s scl) is proposed. Behind the humerals are small ringlike pores (P). Gnathosoma with winglike projections (gnathosomal wings GW) and longer setae; anterior margins of gnathosomal alae in slight median curve. Caudal end of the opisthosoma slightly bilobed with *d* 5 and *l* 5 on short tubercles. Anal setae very short.

**Dorsum (Fig. 18):** Remarkably different from previous species are the short length of *sc* *i*, *l* 1, *l* 2; the distance between dorsals 4 and laterals 4, and the shape of the opisthosoma. Measurements shown in **Tables I and II**.

Male: and developmental stages have not been collected.



**Figs 19-22:** *Calamicoptes meliphagae* spec.nov. Legs in dorsal view. 19 - leg I, 20 - leg II, 21 - leg III, 22 - leg IV.



**Figs 23-26:** Comparison of *Calamicoptes* species. **23** - *C. meliphagae*, gnathosoma in ventral view. **24** - *C. meliphagae*, leg II in dorsal view. **25** - *C. conophilae* spec.nov. gnathosoma in ventral view. **26** - *C. conophile* spec.nov. leg II in dorsal view.

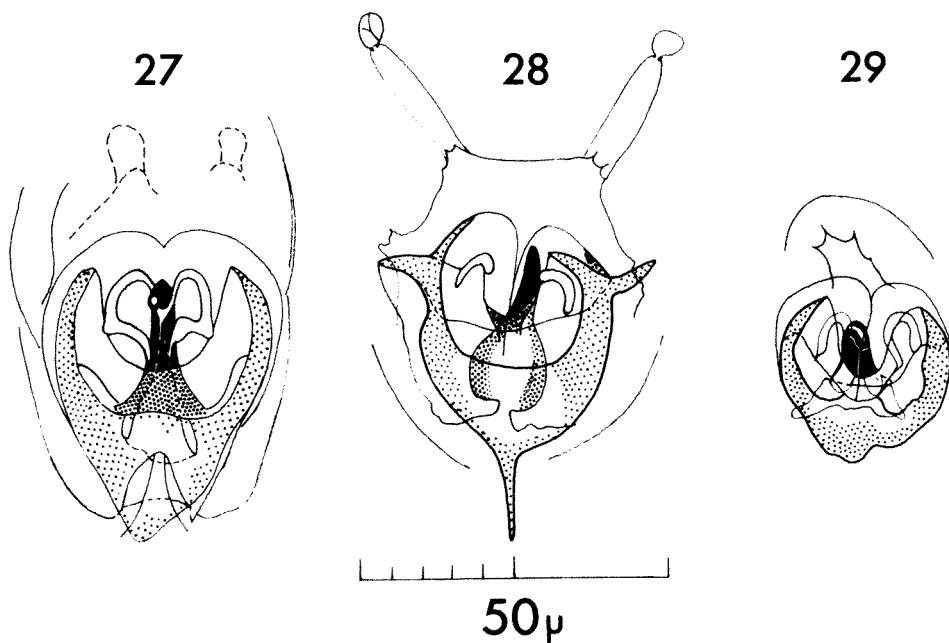
**Host and locality:** *Philemon citreogularis*, Meliphagidae, Passeriformes, 26-VIII-1976, Beagle Bay, Lukoschus leg.

**Deposition of types:** Holotype in Western Australian Museum, Perth. Paratypes (6) in Chicago, Washington, Antwerp and Nijmegen.

*Calamicoptes conopophilae* spec.nov.

Closely related to *C. meliphagae*. The species parasitizes related hosts of the family Meliphagidae.

**Female** (holotype): Length 442, width 147. Main characteristics: presence of sejugal sclerites, pores behind humerals, winglike lateral projections on propodosoma and gnathosoma; anterior margins of the lobes on the gnathosoma form strong curve. Distance between *d* 4 and *l* 4 similar to previous species. Differences surpassing the range of variability are the length of solenidia and setae of legs, of the genital and anal setae, the length and width of gnathosoma and the lateral projections on propodosoma and gnathosoma. In Figs 23-26 gnathosoma and legs II of both species are compared.



Figs 27-29: Male genital regions of 27 - *Fainocoptes nixon*, 28 - *Streetacarus australis* and 29 - *Calamicoptes conopophilae*.

**Male** (allotype): Length 245, width 139. Main characteristics are sejugal sclerites, lateral winglike projections on the gnathosoma and propodosoma, pores behind humerals as in female. Distinctly different are the measurements of the opisthosoma, genital setae and *phi IV*. Male genital region located on posterior half of opisthosoma. Details of genital apparatus (**Fig. 29**) similar to *F. nixoni*.

**Tritonymphs**: without lateral wings, but with rounded caudal end and with longer solenidia on legs I and II. Other characteristics as in *F. nixoni*.

**Host and locality**: *Conopophila rufogularis*, Meliphagidae, Passeriformes, Brook-  
ing Springs, 1-X-1976, Lukoschus leg. Mites have been found in quills of the  
primaries.

**Deposition of types**: Holotype in Perth, paratypes in Chicago and Nijmegen.

*Streetacarus* gen.nov.

Legs III and IV slender. All setae of idiosoma and legs are seti- to filiform. Without winglike lateral projections on gnathosoma and propodosoma. Sejugal sclerites present. Chaetotaxy of idiosoma and legs and solenidiotaxy as in *Fainocoptes*.

Type species: *Streetacarus australis* spec.nov.

We dedicate the genus to the sponsor of the expedition, Mr William S. Street.

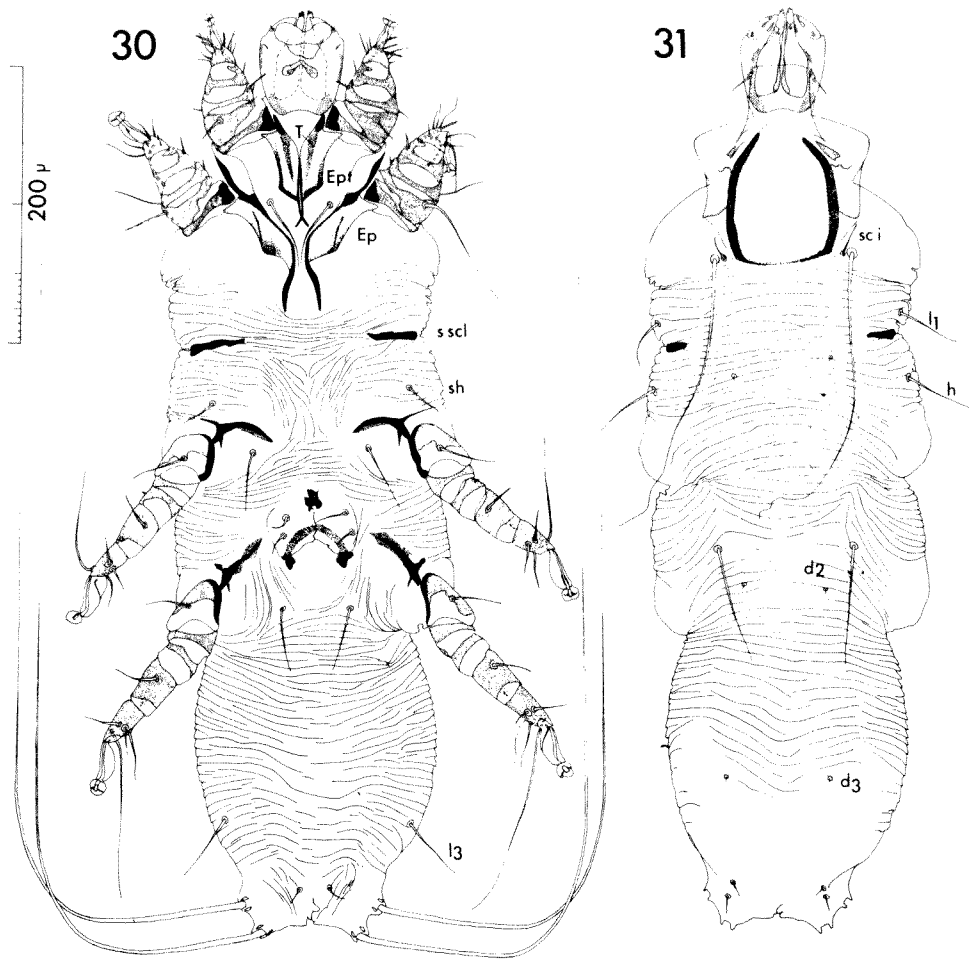
*Streetacarus australis* spec.nov.

Medium sized mites of pale yellow colour and brown legs.

**Female** (holotype) (**Figs 30-35**): Length 655, 10 paratypes measured 698 (661-722), width 221, in paratypes 217 (205-228).

**Venter** (**Fig. 30**): Striation of idiosoma is as figured. Legs inserted laterally, the coxal fields without sclerotization. In coxal fields I epimerites (Ept) are present, running to epimera II (Ep). Sejugal sclerites are lacing lateral sides of body between laterals 1 and humerals. Setae *sh* and *l 3* are relatively short. Genital region located between epimera IV, with broad valves, epigynum and genital apodemes. Setae *g a* and *g p* on valves, *cx IV* far behind *g p*. Gnathosoma without winglike projections, 'headlike', articulated to the idiosoma. Distinct tendons (T) on dorsal and ventral sides act for movement.

**Dorsum** (**Fig. 31**): Transverse striations on most parts, a smooth, poorly sclerotized cuticle restricted to the region between dorsals 3 and 4. Setae *sc i*, *l 1* and *l 2*, *h* relatively short. Bursa copulatrix dorsoterminal on short tubercle. Legs (**Figs 32-35**) in shape and setation as in *Fainocoptes*. (Presence of solenidion on genu III indicates a more primitive condition.)



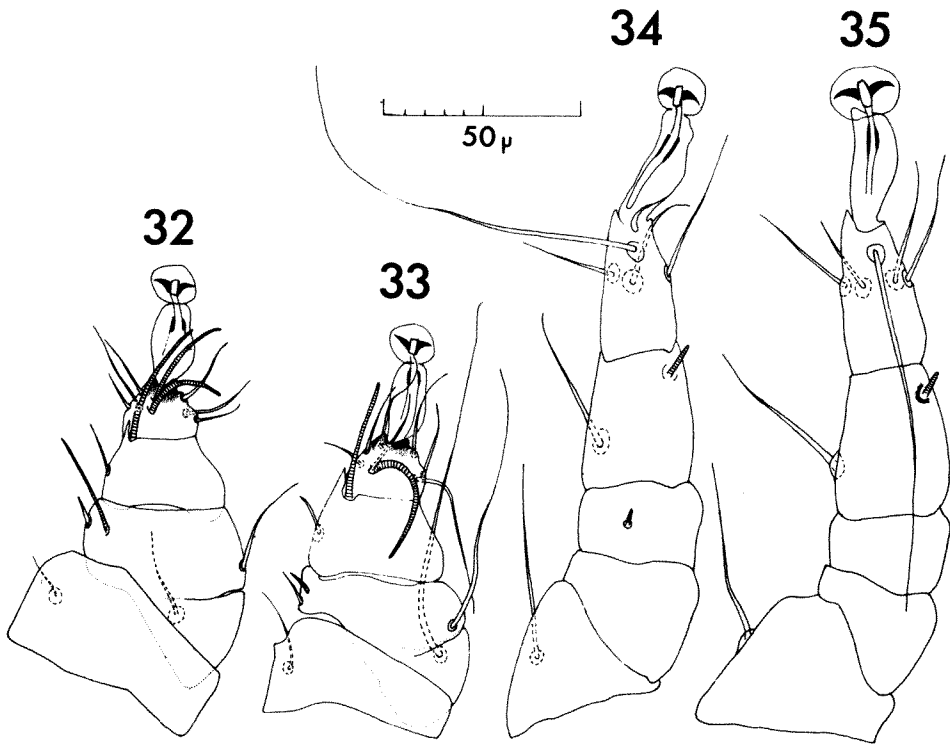
30,31: *Streetacarus australis* spec.nov. Holotype female. 30 - in ventral view, 31 - in dorsal view.

**Male** (allotype): Length 638, 3 paratypes average 600 (597-606); width 237, paratypes average 223 (218-228). Without remarkable sexual dimorphism. Striation ventrally as in female; dorsally the smooth cuticle extends also to the front of dorsals 3. In legs IV the apical setae thin and short (9 contrasted to 130 in female) and solenidion *phi* of leg IV is  $20\mu$  (in female 6). Genital region located in the middle of the opisthosoma. Genital apparatus (**Fig. 28**) with distinct genital atrium and long chitinized parts of accessory gland ducts.

**Tritonymph**: elongated, dorsoventrally flattened; dirty white in colour.

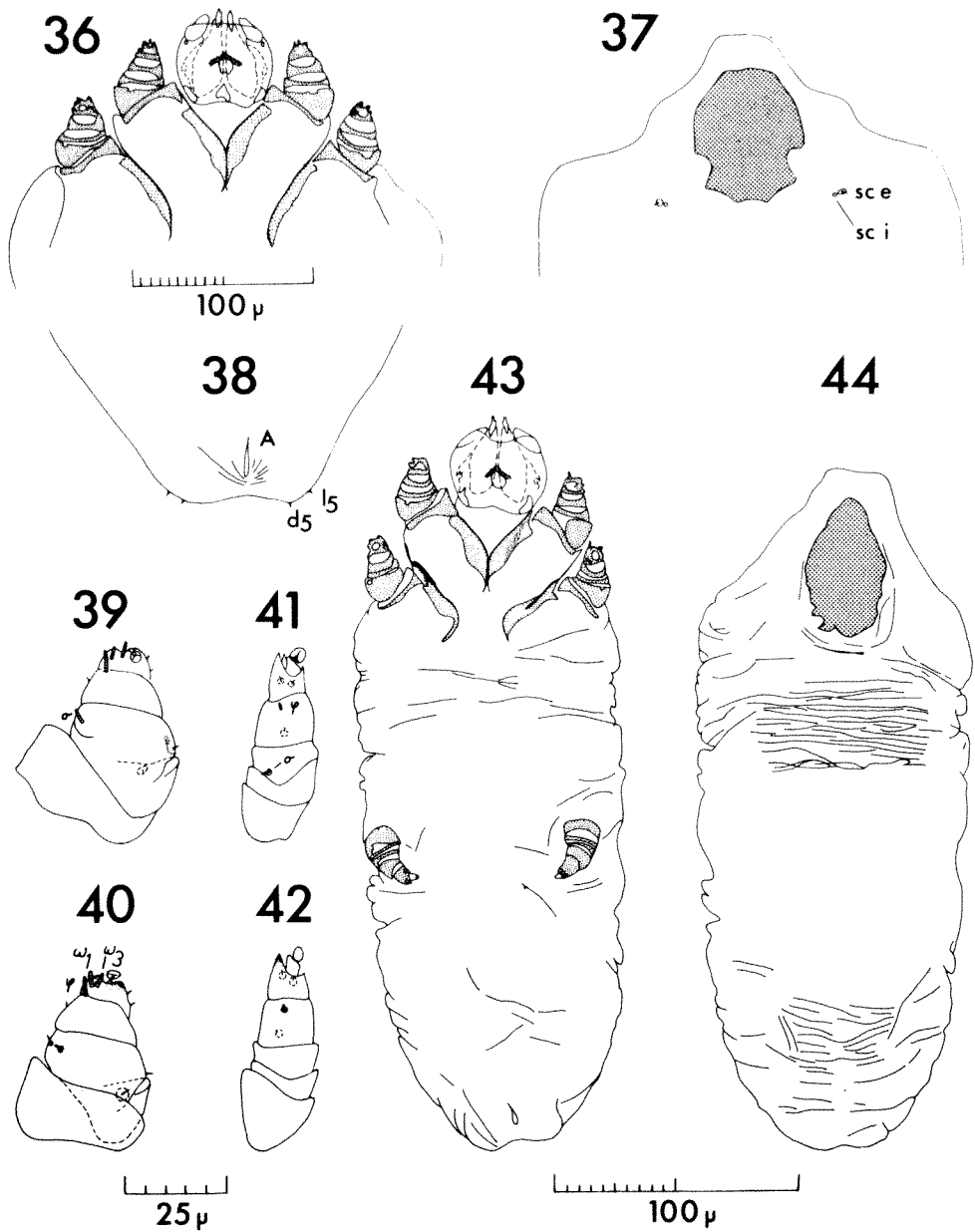
**Venter (Figs 36 + 38):** All legs inserted laterally, epimera I in short Y-shape almost similar to adults, II short without parallel terminations, III and IV absent. Gnathosoma shorter and rounder than in adults. Anal split (A) subterminal. Caudal end blunt.

**Dorsum (Fig. 37):** with weakly sclerotized propodosomal shield without pronounced borders running to scapular setae. Shield symmetrical with laterocaudal incisions. Cuticle very soft with transverse striations in median parts. Setation of idiosoma reduced. Observed have been only peglike *sc i*, *sc e*, and laterals 5 and dorsals 5. All legs (Figs 39-42) short with segments as in adults. Pretarsi with short stalked small, round ambulacral discs. Sclerotized hooks on tarsi less pronounced than in adults. Chaetotaxy: tarsi 4-7-2-2, tibiae 1-1-1-1, genua 1-2-0-0, femora 1-1-0-0, trochanters 0-0-0-0. Solenidiotaxy: tarsi 2-2-0-0, tibiae 1-1-1-1, genua 1-1-1-0.



32-35: *Streetacarus australis* spec.nov. Legs in dorsal view. 32 - leg I, 33 - leg II, 34 - leg III, 35 - leg IV.





**Figs 36-44:** *Streetacarus australis* spec.nov. 36 - Tritonymph anterior part in ventral view, 37 - in dorsal view, 38 - caudal part in ventral view, 39 - leg I, 40 - leg II, 41 - leg III, 42 - leg IV, 43 - larva in ventral view, 44 - larva in dorsal view.

**Larva:** similar to tritonymph in body shape and cuticular structure. Epimera I fused in V-shape; II shorter than in tritonymph. Propodosomal shield smaller, without lateral incisions. Caudal end rounded. Anal slit subterminal. No idiosomal setae observed. Three pairs of legs each with five free segments and smaller pretarsus than in tritonymph. Separation line of femur and genu in legs I and II on dorsal surface distinct. Sclerotized hooks on tarsi present. Solenidiotaxy: tarsi 1-1-0, tibia 1-1-1, genua 0-0-0. Setae very short or pointlike.

**Biology:** The species is viviparous, 8 of 38 females have been found with 1-2 well-developed larvae in the opisthosoma. Larval gnathosomata always directed toward caudal end.

**Host and locality:** *Calyptorhynchus magnificus*, Psittacidae, Psittaciformes, Mount Hart, 10-IX-1976, Lukoschus leg. Mites have been collected from quills of tails and upper tail coverts.

**Deposition of types:** Holotype and allotype in Perth. Paratypes in Chicago, Washington, Columbus, Brisbane, Prague, Antwerp, Nijmegen, Department of Entomology, Athens; Faculté de Médecine, Nice; Zoologisches Museum, Hamburg; British Museum (Natural History), London; Musée National d'Histoire Naturelle, Paris; Rijksmuseum van Natuurlijke Historie, Leiden.

## DISCUSSION

Species of Fainocoptinae are extraordinary in morphology and biology. They share a mixture of primitive characteristics and secondary adaptations to the biotope, as well as morphological deviant characteristics, not generally or quite unknown in astigmatic mites. Idiosomal and leg setae of unmodified seti- to filiform shape must be regarded as primitive, so to the long stalked empodial suckers. However the tarsal setation 6-7-4-5 is lower than in related families. The legs are only slightly modified for burrowing tissues; legs I and II are strong and shortened as in all burrowing animals (mites, insects, mammals). However, there is no fusion of tarsus and tibia as in *Knemidokoptes* or in subcutaneous hypopi like Echimyopinae and Muridectinae. There is only a partial dorsal fusion of segments femur and genu in the forelegs in the adult and nymphal stages. Absence of this fusion in the larvae and in larvae and adults of European species to be described later indicate the adaptative character of fusion. The stronger sclerotized feebly pronounced hooks of the tarsi are not modified for anchoring, although they maintain the mite in its feeding position. The winglike lateral appendages behind legs II also serve to anchor. The more dorsal position in developmental stages can be compared with those in *Saimirocoptes* Fain, 1968. Additionally ventrolateral appendages are present on the gnathosoma as in Gastronyssidae Fain, 1956. Absences of vertical setae indicates the higher degree of skin or internal parasitism like the Psoroptidae, Pyroglyphidae, Gastronyssidae,

Cytoditidae, Epidermoptidae, Knemidokoptidae and Lobalgidae. Absence of genital discs in both sexes and of anadal or tarsal suckers in the male points in the same direction. The propodosomal shield with the typical strong sclerotization of the lateral borders is not only present in the Knemidokoptidae, but also in genera with a lower degree of parasitic adaptation like *Dermoglyphus* Mégnin, 1877 and *Paralges* Trouessart, 1885. The genital region of the female, with three valves, is of primitive shape; the epigynum and genital apodemes are not connected to sclerites. Copulatory opening is lying on a small tubercle dorsotermally. As in the Sarcoptidae and Knemidokoptidae the bursa copulatrix opens into the receptaculum seminis without chitinous appendages. The male genital region is shifted far to the opisthosoma while the genital setae do follow this shifting, it is not to the same extent so they are positioned between coxals IV and the genital apparatus. Pores behind humerals, in both sexes of some species, are doubtful in function. Ducts to dorsal or salivary glands have not been observed so far. The distinct gnathosoma articulated to the idiosoma by a 'neck-like' base must be regarded as a secondary adaptation for feeding of the elongated mite within the hard-walled tunnel. Not known in any family of astigmatic mites is the presence of two solenidia on tarsus II of tritonymphs. We regard it as a secondary adaptation rather than primitive. Presence of trochanter setae IV in both sexes is only known from the most developed species of the genus *Myialges* (Epidermoptidae). Fain (1965) has regarded it as hypertrichy. These setae have also been found by Atyeo in a new genus of feather mites (personal communication).

The special biotope is the feather quill during development of the feather. Species feed on the outer layers of the nonkeratinized quill. All stages feed in the same biotope on the same substrate. Chelicerae are adapted to this food: reduction of the fixed digit and strong development of the three-toothed digitus mobilis as in the description of the chelicerae of *Laminosioptes cysticola* by Fain (1956). It is not surprising to find mouthparts with almost the same morphology and size in all stages. There is only a short period to obtain suitable food during the development of the feather and a long period between the moults of the host, when feeding is impossible. Only the germ of the feather quill is suitable for feeding, thus mites have to move with the growing feather, otherwise they are shifted to keratinized regions and thus eliminated by the host. Mites found in full grown feathers are mostly moulting stages. Tritonymphs within the protonymphal skin exclude the possible suggestion that a heteromorphic deutonymph may be present, adapted to survive the long periods between moults of the host. The short time of suitable food and the speedy keratinization of the biotope surely has necessitated viviparity. In spite of the fact that there is only a short time for development, all developmental stages of both sexes are present: larva-protonymph-tritonymph-adults. Periods between moults of the host are survived by the adult female near to the base of the full grown feather.

TABLE I

Measurements (in  $\mu$ ) of 4 Australian quill wall mites belonging to the genera *Fainocoptes*, *Calamicoptes* and *Streetaacus*; idiosomatal characters.

	<i>F. nixonii</i>					<i>C. meliphagae</i>							
						<i>C. conopophilae</i>				<i>S. australis</i>			
	♀	♂	TrN	PrN	L	♀	♀	♂	TrN	♀	♂	TrN	L
	total length	770	596	1029	658	224	495	442	245		655	638	710
width	195	194	268	221	73	164	147	139		211	237	217	111
length gnathosoma	70	72	47	39	29	59	54	52	38	68	68	44	34
width gnathosoma	81	74	53	47	33	52	50	47	40	64	64	51	40
length opisthosoma	252	179	489	301	90	155	153	87		213	163	276	125
length prod. shield	112	112	99	73	53	88	81	83	63	110	114	65	58
width prod. shield	76	74	48	29	24	64	63	65	55	89	88	56	32
dorsal 1	4	3				2	4	5		4	2		
dorsal 2	4	4				4	5	4		4	4		
dorsal 3	6	6				5	6	6		7	6		
dorsal 4	-	-				7	6	5		9	8		
dorsal 5	492	492				364	348	319		483	558		
lateral 1	134	106				62	43	37		98	38		
lateral 2	327	311				156	139	106		97	82		
lateral 3	160	130				95	96	76		52	45		
lateral 4	16	16				11	8	13		14	6		
lateral 5	288	300				282	273	208		345	267		
sc i	88	79				17	15	17		28	23		
sc e	330	332				172	171	106		229	225		
sh	76	68				40	34	27		24	29		
h	184	206				117	120	111		53	84		
g a	34	5				14	16	5		26	3		
g p	32	3				11	15	3		16	3		
a	67	3				3	14	2		15	2		
cx I	36	37				24	29	38		50	52		
cx III	50	45				35	36	31		53	47		
cx IV	79	22				40	43	39		49	21		
d 4 - 1 4	0	0				13	11	10		6	4		
length propod. alae	89	81	123	52	13	54	45	47		-	-	-	-
width propod. alae	38	27	91	39	9	23	19	16		-	-	-	-
d. palptarsal seta	5	4				3	3	3		3	4		
V. palptarsal seta	4	4				10	15	14		7	6		

TABLE II

Measurements (in  $\mu$ ) of 4 Australian quill wall mites belonging to the genera *Fainocoptes*, *Calamicoptes* and *Streetaacus*; characters of legs and solenidia and hairs of the legs.

	<i>F. nixonii</i>					<i>C. meliphagae</i>							
						<i>C. conopophilae</i>				<i>S. australis</i>			
						♀	♂	TrN	PrN	L	♀	♂	TrN
leg I	66	59	42	33	22	57	54	53	34	74	74	44	28
leg II	67	58	40	30	20	55	53	53	32	78	80	38	27
leg III	135	120	43	25	16	94	90	84	29	138	134	43	26
leg IV	146	127	40	25	-	101	93	89	29	143	135	40	-
pretarsus I	24	23				25	24	22		28	29		
pretarsus II	25	29				31	29	27		35	34		
pretarsus III	42	43	4			31	29	32	4	39	40	6	
pretarsus IV	45	45	5			38	31	30	4	39	41	6	
ambulacrum I	8	7				9	9	11		10	11		
ambulacrum II	9	9				9	10	12		13	15		
ambulacrum III	12	14	6			11	11	12		14	14		
ambulacrum IV	13	13	6			12	11	13		14	14		
omega 1	40	32	4	3	3	17	15	17	8	20	20	4	4
leg I													
omega 3	28	27	2	-	-	27	22	20	5	23	24	3	-
omega 1	50	55	3	2	3	31	36	43	5	42	33	4	3
leg II													
omega 3	-	-	3	-	-	-	-	-	7	-	-	5	-
phi I	32	35	5	3	3	32	27	26	11	31	24	5	3
phi II	43	43	5	4	2	60	32	27	9	30	27	5	4
phi III	7	6	2	2		20	7	6	2	9	7	2	2
phi IV	5	61	2			5	3	18	2	6	20	2	
sigma I	25	16				26	19	18	4	24	19	4	
sigma II	6	5				4	5	5		8	6	2	
sigma III	3	3	1			-	-	-	-	5	5	2	
genu I seta	18	18				30	35	24		19	15		
genu II seta	43	33				43	52	41		73	77		
femur I seta	30	15				11	19	22		20	17		
femur II seta	75	60				39	67	62		92	96		
tarsus													
III seta	124	77				92	92	87		107	101		
tarsus													
IV seta	153	107				110	97	76		130	9		
trochanter													
III seta	101	91				30	32	26		38	41		
trochanter													
IV seta	104	92				30	31	26		35	32		

## ACKNOWLEDGEMENTS

This paper results from the Western Australian Field Programme 1976-1977 sponsored by the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of Mr William S. and Mrs Janice Street Ono, Washington, and the aid of grant R87-111 by the Netherlands Organization for the Advancement of Pure Research (ZWO). We are grateful to Dr R.E. Crabill, Jr, curator of Myriapoda and Arachnida who loaned us the types of *Laminosioptes hymenopterus* Jones & Gaud, 1962. We thank very much Dr A. Fain, Antwerp and Dr W.T. Atyeo for their suggestions and corrections of the manuscript.

## REFERENCES

- FAIN, A. (1956)—Une nouvelle famille d'Acariens endoparasites des chauves-souris: Gastronomysidae fam.nov. *Ann. Soc. belg. Méd. Trop.*, **36**(1): 87-98.
- FAIN, A. (1965)—A review of the family Epidermoptidae Trouessart, parasitic on the skin of birds. (Acarina: Sarcoptiformes). *Konink. VI. Acad. Wetensch. Let. schone Kunst. Belgie*, **84**(I-II): 1-176: 1-144.
- FAIN, A. (1968)—Notes sur trois acariens remarquable (Sarcoptiformes). *Acarologia* **10**: 276-291.
- JONES, J. & GAUD, J. (1962)—The description of *Laminosioptes hymenopterus* n.sp. (Sarcoptiformes) from the American crow. *Acarologia* **4**: 391-395.
- KRANTZ, G.W. (1971)—*A manual of Acarology*. O.S.U. Book Stores, Inc. Corvallis, Oregon, 335 pp.