

PRIMITIVE CRYPTOSTIGMATID MITES FROM THE CHIHUAHUAN DESERT OF NEW MEXICO

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TAXONOMY	SUMMARY : Thirteen species of <i>Oribatei Inferiores</i> , two of which are considered to be new, are described from arid soils in the Chihuahuan Desert of New Mexico.
TAXONOMIE	RÉSUMÉ : Treize espèces appartenant aux <i>Oribatei Inferiores</i> sont considérées. Ils habitent les sols xériques dans le désert de Chihuahua de l'Amérique du Nord. Deux espèces nouvelles, <i>Cosmochthonius juvenalis</i> et <i>Brachyochthonius americanus</i> sont décrites.

INTRODUCTION

This report forms part of a series on the soil and litter-dwelling Acari collected by WALLWORK in 1979 and three years later by KAMILL, in the northern part of the Chihuahuan Desert of New Mexico (see WALLWORK & WEEMS, 1984 ; WALLWORK *et al.*, 1984 ; KAMILL *et al.*, (1985). In spite of the evergrowing interest into the biology of desert microarthropods and their responses to extremes of temperature and moisture, very little attention has been paid to their taxonomy. In so far as the Acari are concerned, WALLWORK (1972) has recorded seven species of Cryptostigmata, five of which were considered to be new, from the Joshua Tree National Monument in California : *Aphelacarus acarinus* (Berlese), *Haplochthonius variabilis* Wallwork, *Oppia clavipectinata* (Michael), *Joshuella striata* Wallwork, *Eremaeus magniporus* Wallwork, *Passalozetes californicus* Wallwork and *Zygoribatula heteroporosa* Wallwork.

The present paper is concerned with the taxonomy of the *Oribatei Inferiores* from a number of localities on the New Mexico State University Experimental Range, 40 km north-north east of Las Cruces, Dona Ana County, New Mexico. Details of the localities examined are given in KAMILL *et al.* (1985) but for the purposes of the present paper it is sufficient to note that soil and litter from the following localities was studied : a large area of creosotebush (*Larrea tridentata*) on the lower slopes of the bajada (valley) ; thickets of hackberry (*Celtis reticulata*), desert willow (*Chilopsis linearis*), Apache plume (*Fallugia paradoxa*) and mesquite (*Prosopis glandulosa*) on the margins of an arroyo (outwash channel) ; scattered areas of juniper (*Juniperus monosperma*), desert oak (*Quercus grisea*), and black grama grass (*Bouteloua eriopoda*) on the higher slopes of the bajada. In addition, litter samples were taken beneath an area of saltbush (*Atriplex*) in White Sands National Monument, approximately

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150 km to the east of the Experimental Range. The "higher" Cryptostigmata from all these localities will be dealt with in later papers.

The present account is being written with the non-specialist as well as the specialist in mind. Therefore, a short, somewhat general introductory account of the basic external morphology of the Cryptostigmata has been included before the detailed taxonomic descriptions. The setal nomenclature used in the later works of GRANDJEAN has been followed throughout the descriptions.

EXTERNAL MORPHOLOGY

The majority of adult Cryptostigmata have a well-defined sejugal furrow dividing the body (*idiosoma*) into two major regions, the *proterosoma* bearing the first two pairs of legs and covered by a dorsal shield, the *aspis* or prodorsum (*Pr*), and the posterior *hysterosoma* bearing the hind two pairs of legs and covered by the *notogaster* (*Ng*) (Fig. 4). The venter of the idiosoma can be divided into two regions, an anterior *podosoma* (*Pd*) or leg-bearing region, and a posterior *opisthosoma* (*Opis*) in which the anal and genital apertures are located (Fig. 18). The region of the podosoma between the legs is occupied by a number of sclerotized plates, the *epimera* or *coxisterna* (Fig. 18), regarded as having been formed by the fusion of coxal and sternal elements. The genital and anal apertures, protected by paired valves, the *genital* and *anal shields*, may either be long and contiguous and flanked by two more pairs of shields, the *aggenitals* and *adanals* which may be fused into aggenito-adanal shields or shorten and well separated in a large *ventral shield*.

Within the Cryptostigmata, a group of "higher" families can be distinguished characterized by a circular ecdysial split, fused protero- and hysterosoma (at least ventrally) and long slender legs with short genua. The trochanters generally arise from the bases of cup-like depressions in the epimera (*acetabula*) and are further protected by sclerotized flanges such as *pteromorphae*, *lamellae*, *tutoria* and *pedotecta*. By contrast, the "lower" families (*Inferiores*) exhibit the follow-

ing characters : a longitudinal ecdysial split, a protero-hysterosomal articulation (with the exception of the Nothroidea) and leg genua and tibiae which are more or less equal in length. The legs are generally robust and in some families they can be tucked in close against the notogaster which provides a protective shield. In those "lower" groups with a protero-hysterosomal articulation, a continuous band of soft cuticle (sejugal membrane) extends from the *dorso-sejugal* region (*DSj*) separating the prodorsum and notogaster (Fig. 4) to the *ventro-sejugal* region (*VSj*) between the second and third pairs of epimera (Fig. 18).

DESCRIPTION OF SPECIES

The following thirteen species of "lower" Cryptostigmata were recorded in the desert samples. Two of these, namely *Cosmochthonius juvenalis* and *Brachychochthonius americanus* are considered to be new.

Gilarovella demetrii Lange
Aphelacarus acarinus (Berlese)
Hoplophorella cf. *cucullata floridae* Jacot
Rhysotritia ardua (C. L. Koch)
Sphaerochthonius splendidus (Berlese)
Haplochthonius variabilis Wallwork
Cosmochthonius plumatus Berlese
Cosmochthonius juvenalis sp. nov.
Cosmochthonius emmae Berlese
Liochthonius cf. *lapponicus* (Trägårdh)
Brachychochthonius americanus sp. nov.
Camisia cf. *horrida* Hermann
Trhypochthonius tectorum (Berlese)

Family CTENACARIDAE Grandjean, 1954

Gilarovella demetrii Lange

Gilarovella demetrii LANGE, 1974 : 18-20 ; BALOGH and MANHUNKA, 1983 : 44-45.

This species is only known from its type locality Badhüz, Turkmenia, Soviet Union. Four specimens were found in creosotebush litter (*Larrea tri-*

dentata) collected from the Jornada Experimental Range. As BALOGH and MAHUNKA (1983) pointed out this species is similar to *Neoctenacarus hastilis* Moritz and both genera are monotypic. *G. demetrii* differs by having : five pairs of anal setae, nine pairs of genital setae, two bifurcate eupathidia on the palpal tarsus, a large extent of striated cuticle between the prodorsum and notogaster, and a naso on which the rostral setae are inserted. New Mexican specimens measured 260-280 μm in overall length and agree well with LANGE's (1974) figures.

Family APHELACARIDAE Grandjean, 1954

Aphelacarus acarinus (Berlese)

Parhypochthonius acarinus BERLESE, 1910 : 219. Palermo, Sicily (ISZA, Florence [type series]).
Aphelacarus acarinus : GRANDJEAN, 1932a : 412 ; 1954 : 229.

The type locality is Palermo, Sicily. GRANDJEAN (1954) collected most of his material at Mongaillard, France and considered the species to be a " domestic " one since many specimens were found inside buildings, rather like the astigmatid mite, *Glycyphagus*. On the Jornada, large numbers of *A. acarinus*, agreeing well with GRANDJEAN's redescription, were recorded in creosote-bush litter.

EUPTYCTIMA Grandjean, 1967

In this group of mites the sejugal membrane is relatively wide, the individual epimera are separate and moveable, and the legs can be retracted into a space beneath the notogaster which is completely covered, " or closed ", by the aspis.

The Euptyctima were very poorly represented in the desert samples. In all only three specimens were collected representing two species, one of which (*Hoplophorella* cf. *cucullata floridae*) is a member of the Phthiracaroida and the other

(*Rhysotritia ardua*) a member of the Euphthiracaroida. Members of the two superfamilies can be easily distinguished by differences in the shape of the ano-genital region and in the arrangement of the covering shields. In the Euphthiracaroida the idiosoma is compressed laterally and the ano-genital region is narrow and covered by a series of contiguous elongated shields. By contrast, the idiosoma of the Phthiracaroida is not compressed laterally while the ano-genital region is broad and covered by four shields.

Family EUPHTHIRACARIDAE Jacot, 1930

Rhysotritia ardua (Koch)

Hoplophora ardua KOCH, 1841 : Fasc. 32, t. 15. Regensburg [type series lost].
Pseudotritia loricata FEIDER & SUCIU, 1957 : 40.
Rhysotritia ardua : MÄRKEL & MEYER, 1959 : 341.

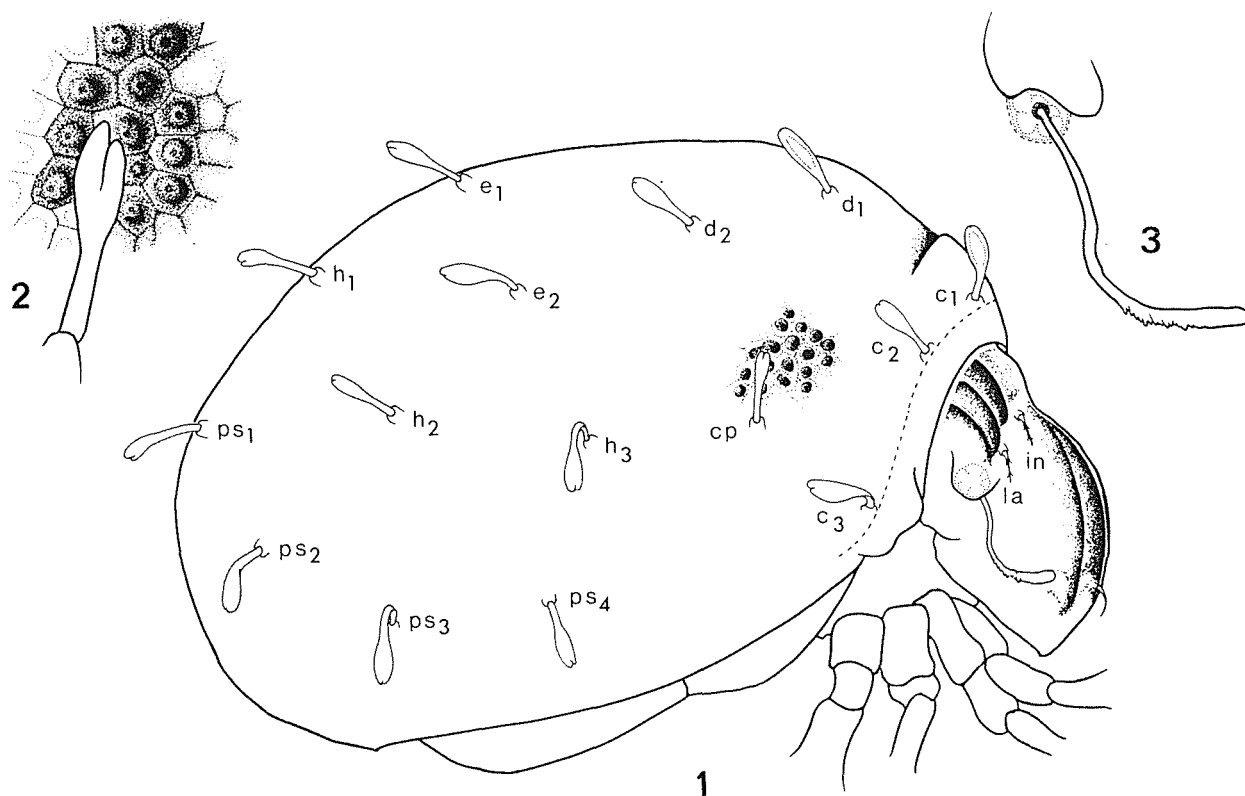
In comparison with topotypic material from VANDER HAMMEN's Regensburg collection (BMNH), the New Mexican specimen is smaller and less heavily sclerotized. Thus the aspal length in the specimen from New Mexico was 175 μm while in the topotypes examined the length of the aspis ranged from 215 to 250 μm . No other morphological differences could be detected. A single specimen was recorded in creosotebush litter.

Family PHTHIRACARIDAE Perty, 1841

Hoplophorella cf. *cucullata floridae* Jacot
(Figs 1-3)

Hoplophorella cucullata floridae JACOT, 1933 : 250.
Gainesville, Florida [" cotypes " presumed lost].

ADULT (Fig. 1) : The aspis bears three pairs of short, rather stout and procumbent setae dorsally. There is a prominent median keel in front of the *in-la* setae and posteriorly the prodorsal integu-



FIGS. 1-3 : *Hoplophorella* cf. *cucullata floridae* : (1) adult, lateral ; (2) detail of notogastral integument and seta ; (3) sensillus.

ment is raised into a number of weakly developed longitudinal ridges. The sensilli, 75 μ m in length, are slightly membranous and serrated distally, while the basal portion is smooth, slender and distinctly elbowed (Fig. 3). The prodorsal integument is coarsely punctate. The notogaster is approximately 500 μ m in length along a line through c_1 - ps_1 . All 15 pairs of setae are short (less than the distance c_1 - d_1), spatulate and smooth (Fig. 2). Anteriorly there is a weakly developed hood bearing setae c_{1-3} . The fissures *ip* and *ips* are apparently absent while vestigial f_{1-2} could not be discerned in either of the two specimens available. The notogastral integument is coarsely punctate. The ano-genital region comprises a pair of ano-adanal plates and a pair of genito-aggenital plates. There are three pairs of marginal anal setae and two pairs of adanals located submarginally. The anal setae are all moderately stout, smooth and more or less equal in length. The anterior pair of adanal setae are

short and fine while the posterior pair, approximately 50 μ m in length, are rather stout, taper to a point, and are weakly serrated. In lateral aspect the paraxial margins of the anal plates are strongly convex and prominent. There are nine pairs of genital setae located marginally and a single pair of aggenitals located antiaxially. All the genital setae are short. The integument of the ano-genital region is coarsely punctate. The leg chaetotaxy closely resembles that found in other species of the genus and in the rest of the Phthiracaroida (see PARRY, 1979).

OTHER STAGES : Unknown.

MATERIAL : Two specimens only were collected, both under *Quercus*.

REMARKS : Species currently classified in *Hoplophorella* (type *Phthiracarus* (*Hoploph.*) *cucullatus* (Ewing)) are distinguished from those of *Stegana-*

carus and *Tropacarus* by the chaetotactic pattern of the anal setae (three subequally placed setae on median edge). However, while SHEALS' (1969) numerical analysis of the Phthiracaroidae suggests that *Hoplophorella* is neither a very "natural" nor a distinctive genus, BALOGH and MAHUNKA (1983) fail to recognize the genus, placing *cucullata* in *Steganacarus*.

It would appear that the specimens from New Mexico bear a form of notogastral seta (smooth and spatulate) and integumental ornamentation (coarsely punctate) which is common to *cucullata* and its three subspecies, *cucullata obsoletior* (Berlese), *cucullata cuculoides* Jacot and *cucullata floridae* Jacot. However, while a prominent hood is present in the nominate form and in *cuculoides*, a hood is absent entirely in *obsoletior* and only weakly developed in *floridae*.

Although JACOT's (1933) original figure of *cucullata floridae* from specimens collected in leaf litter, Gainesville, Florida, is extremely superficial, his description refers to the characteristic features of the species: smooth, spatulate notogastral setae; notogaster "stipple punctate"; weakly developed anterolateral hood on notogaster. While the New Mexican material agrees reasonably well with JACOT's description of *cucullata floridae*, in comparison with JACOT's specimens (notogastral length 336-426 μm) the material from New Mexico is somewhat larger (notogastral length 500 μm).

ENARTHRONOTA Grandjean, 1946

The Enarthronota are well represented in the desert where members of the Sphaerochthoniidae, Brachychthoniidae, Cosmochthoniidae and Haplochthoniidae were recorded.

In this group of "lower" Cryptostigmata the notogastral shield is subdivided both longitudinally and transversely. A pair of longitudinal bands of soft cuticle divide the notogaster into a dorsal notaspis which is flanked on either side by a lateral pleuraspis (Fig. 5). The notaspis is itself subdivided into two (Sphaerochthoniidae), three Brachychthoniidae, or four shields (Cosmochthoniidae and Haplochthoniidae) by one or three

bands of soft cuticle, and the pleuraspis may also be subdivided. All the members of the Enarthronota are small (less than 500 μm in length) and weakly sclerotized.

Family SPHAEROTHONIIDAE Grandjean, 1947

Sphaerochthonius splendidus (Berlese)

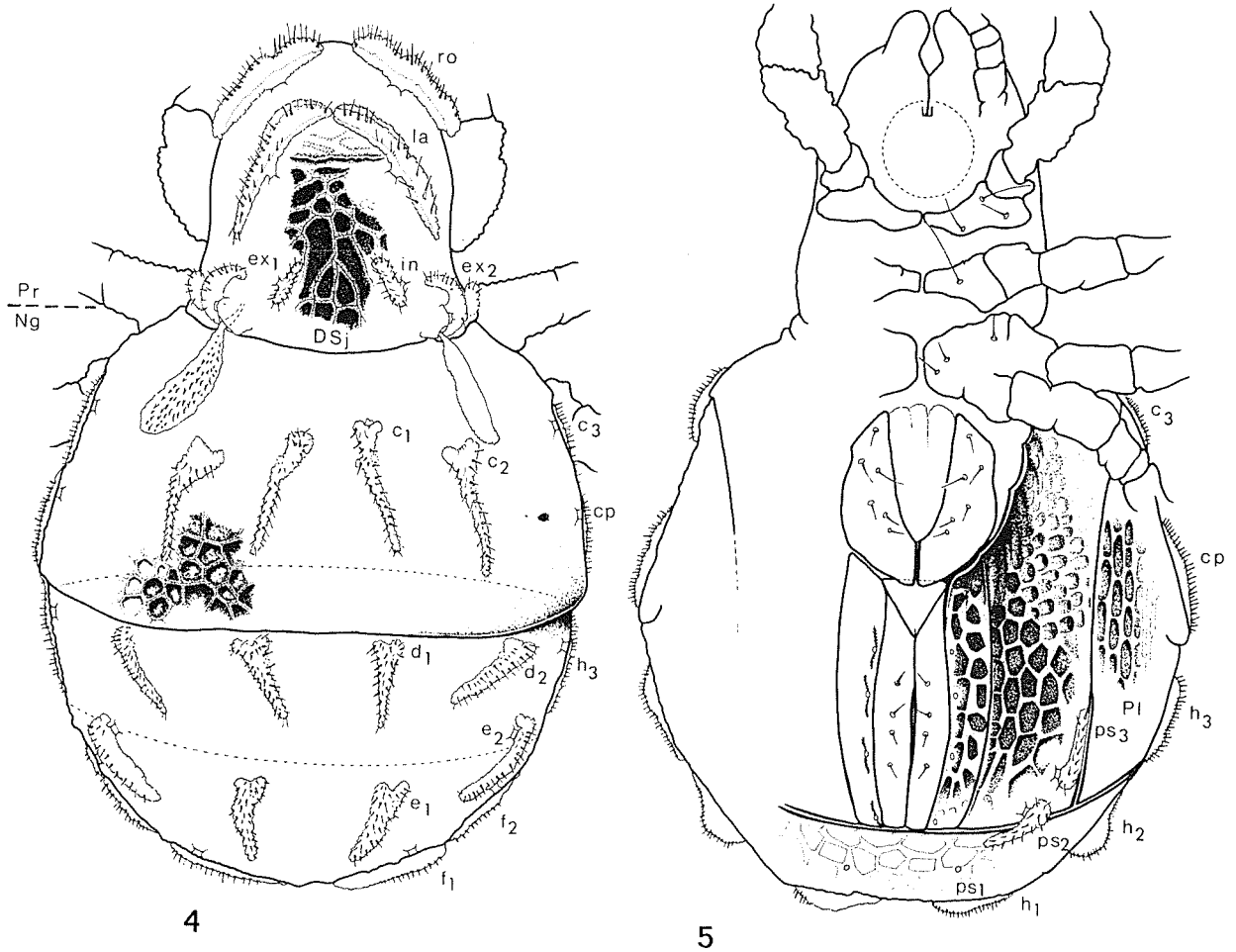
(Figs. 4-8 ; 29-30 ; 33)

Hypochthonius splendidus BERLESE, 1904 : 26. Boboli Gardens, Florence (SEA, Florence, [type series] 58/6-7).

Sphaerochthonius splendidus, BERLESE, 1910 : 223 ; GRANDJEAN, 1932b : 30 ; VAN DER HAMMEN, 1959 : 25.

The true identity of BERLESE's *splendidus* now appears to be certain (VAN DER HAMMEN, 1959). The convex notogaster bears a single suture while tarsi I-IV are tridactylous with a strong median claw flanked by two fine lateral claws. As VAN DER HAMMEN (1959) has pointed out, BERLESE was in error when he described the tarsi as being monodactylous. The species can be easily recognized by the "T-shaped" notogastral setae and also by the delicate "lace-like" appearance of the integument which is sculptured with a polygonal network. The redescription of *S. splendidus* given below is based on material collected in *Fallugia* litter.

ADULT (Figs. 4-5 ; 29-30 ; 33) : Rather small, weakly sclerotized and strongly convex. The species ranges in length from 255-325 μm . The prodorsum bears six pairs of setae and, with the exception of the sensilli, all are voluminous, procumbent and "T-shaped" (see VAN DER HAMMEN, 1959). Each of the two setal arms is more or less equal in length, covered with whorls of spicules and borne on a short, thick stem. Setae (*in*) are located just anterior to the bothridium and are less than half as long as setae (*la*). The sensillus, 30 to 40 μm , is broadly clavate and densely serrated distally with a smooth, slender basal



FIGS. 4-5 : *Sphaerochthonius splendidus* : (4) adult, dorsal ; (5) adult, ventral.

portion (Fig. 30). The exobothridial setae are short and their bases difficult to discern owing to the convexity of the prodorsum — it would appear that the anterior pair (ex_1) are “T-shaped” while the posterior pair (ex_2) are uniramous. The voluminous appearance of all the setae is due to their dense secretion of tubercles. Scanning electron micrographs show that the outer surfaces of the tubercles are deeply sculptured (Fig. 33). The prodorsal integument is ornamented with an irregular reticulate pattern and is also invested with a sparse covering of tubercles. The latter are most numerous around the raised margins of the depressions. At the level of the lamellars the cuticle is thickened to form a distinct carina. The notaspis, almost spherical in dorsal aspect, is

divided by a single suture into two separate plates, the pronotaspis and the pygidium. The latter bears two faint carinas (see GRANDJEAN, 1932b), one at the level of the d setae and another at the level of the e setae. The anterior carina is often difficult to discern since it is partially covered by the posterior border of the pronotaspis. Ventrolaterally, the pleuraspis (Pl) is divided into four plates, two laterals and two inguino-scapular plates. Of the 16 pairs of setae, c_{1-3} and cp are located on the pronotaspis and d_{1-2} , e_{1-2} , f_{1-2} , h_{1-3} and ps_1 on the pygidium. The remaining notogastral setae (ps_{2-3}) are borne on the inguino-scapular plate. Difficulty was experienced in discerning setae h_{1-2} and it is possible that GRANDJEAN (1932b) experienced similar difficulty since he

described a *Sphaerochthonius* species with 14 pairs of setae. He later, however (GRANDJEAN, 1949), described the adult as being holotrichous. All 16 pairs of setae are of a similar length and all are aligned antero-posteriorly, those in the *c* series being the most prominent. Unlike the prodorsal setae, the notogastrals are rather fine and composed of two equal arms, a short anterior arm and a longer one directed posteriorly. A dense covering of tubercles partially obliterates the whorls of the spicules and gives each seta an extremely "bulky" appearance in surface view. The six notogastral plates differ somewhat in their integumental sculpturing — the two dorsal plates bear a reticulate pattern (the raised margins of the depressions forming a regular polygonal network), the laterals have a longitudinal-reticulate appearance, while the ornamentation of the inguino-scapulars is rather striking and may be described as reticulate-coriaceous. The notogastral integument is invested with a covering of tubercles similar to that of the prodorsum. The ano-genital region is shown in Fig. 5. The anal and adanal plates are distinct while the genital and aggenital plates are fused. The preanal plate is triangular in ventral aspect. On each anal plate there are four, short, simple setae located submarginally. The four pairs of marginal adanal setae are biramous and covered with whorls of spicules — both arms are short and more or less equal in length. On each genito-aggenital plate there are six short, simple genital setae. There are no aggenital setae. The ornamentation of the anogenital region is reticulate and the integument is invested with a sparse covering of tubercles. There are three pairs of genital papillae, the posterior pair being rather small.

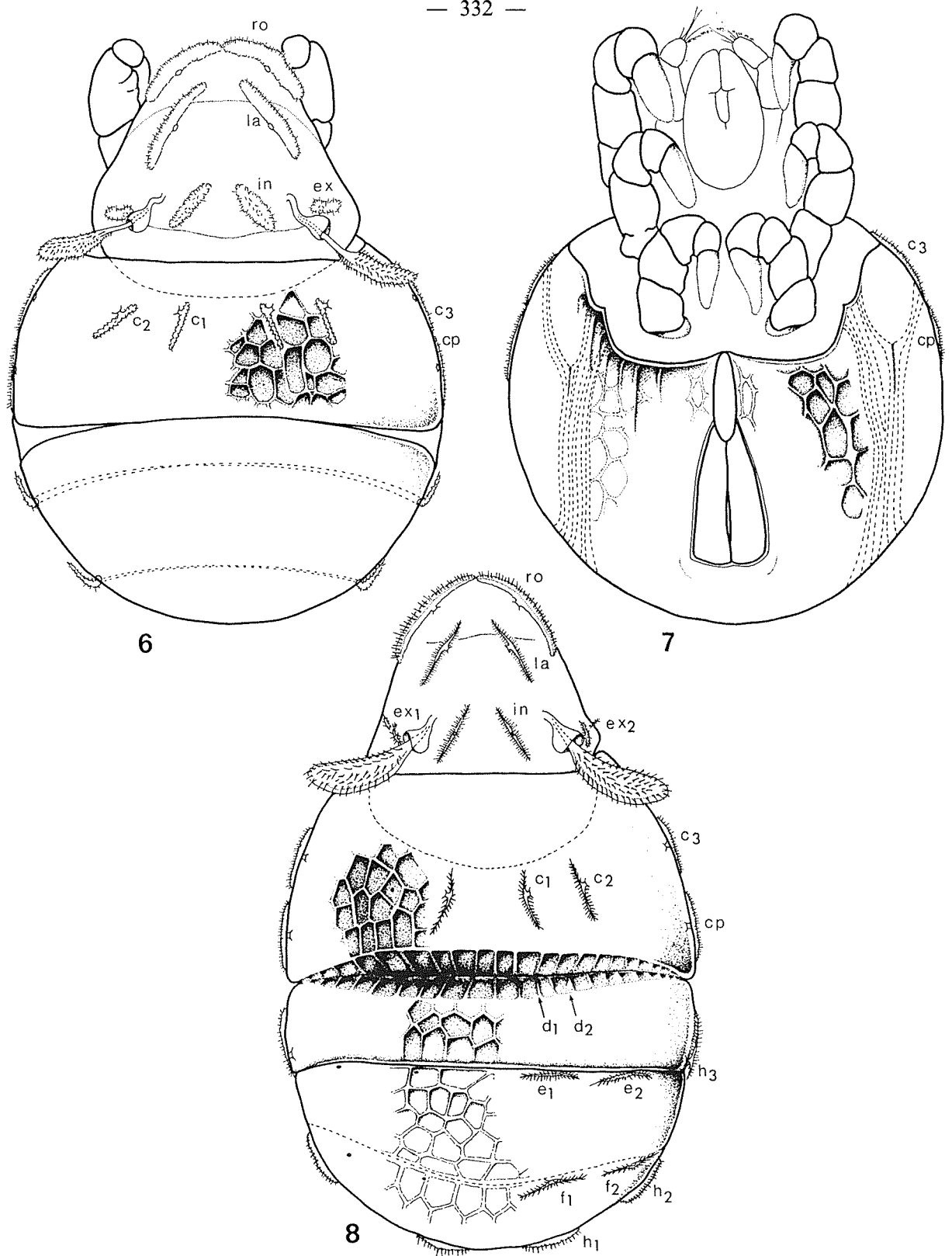
DEUTONYMPH (Figs. 6-7) : Approximately 160 μm in length. The form and arrangement of setae on the prodorsum is essentially the same as in the adult — the exobothridial setae are, however, extremely difficult to discern, especially the posterior pair. At the level of the lamellars and at the level of the bothridia, a thickened carina is visible. The integument of both the prodorsum and the notogaster is reticulate and tuberculate although

the tubercles are less numerous than in the adult (Fig. 6). In the specimen figured only six pairs of notogastral setae appeared to be present although GRANDJEAN (1949) described both nymphs, and the adult, as being holotrichous. The eight setae in the *c* series resemble those in the adult, both from the point of view of shape and alignment while the two other pairs of setae are uniramous. All the setae bear whorls of spicules and a covering of tubercles. A single suture separates the pronotaspis from the pygidium. The pygidium bears two faint carinas, the anterior of which is more clearly visible than in the adult as, at this stage, the pronotaspis has not as yet grown down to cover it completely. Ventrally, there are apparently no setae, either on the pleuraspis or, in the anal or adanal series (Fig. 7). A longitudinal band of soft cuticle separates the lateral from the inguino-scapular plate. All the tarsi are monodactylous.

TRITONYMPH (Fig. 8) : 250 to 275 μm in length. With the exception of setae d_{1-2} which are minute and barely visible, and setae e_{1-2} and f_{1-2} which are orientated transversely, the disposition as well as the number of dorsal setae, are similar to those of the adult. The suture on which the *d* setae are located is deeply indented and there is also a second suture at the level of the *e* setae. In comparison to the adult, setae f_{1-2} and h_{1-2} are more easily discernible since f_{1-2} are located dorsally and h_{1-2} posteriorly. Ventrally, the ano-genital region is similar to that of the adult although at this stage there are apparently only two pairs of genital setae present. The integument of the prodorsum, notogaster and ano-genital region is reticulate and tuberculate. The tarsi are monodactylous.

OTHER STAGES : Unknown.

MATERIAL : *S. splendidus* was uncommon in the desert samples and was found in only two species of litter, namely, *Fallugia* and *Atriplex*. In all about 20 specimens were collected of which one was a deutonymph, two were tritonymphs and the remainder were adults.



FIGS. 6-8 : *Sphaerochthonius splendidus* : (6) deutonymph, dorsal ; (7) deutonymph, ventral ; (8) tritonymph, dorsal.

Family HAPLOCHTHONIIDAE van der Hammen

Haplochthonius variabilis Wallwork

Haplochthonius variabilis WALLWORK, 1972 : 94. Joshua Tree National Monument, Riverside County, California (USNM, Washington). [Examined].

One adult (275 μm in length) agreeing well with WALLWORK's description was collected under juniper. In comparison with the Californian material however, the New Mexican specimen has rather stouter and more lanceolate notogastral setae.

Family COSMOCHTHONIIDAE Grandjean, 1947

Cosmochthonius plumatus Berlese

(Figs. 9-10 ; 32)

Cosmochthonius plumatus BERLESE, 1910 : 221. Holotype, Monte Giovi, Italy (ISZA, Florence, no. 80/7) ; GRANDJEAN, 1950 : 78.

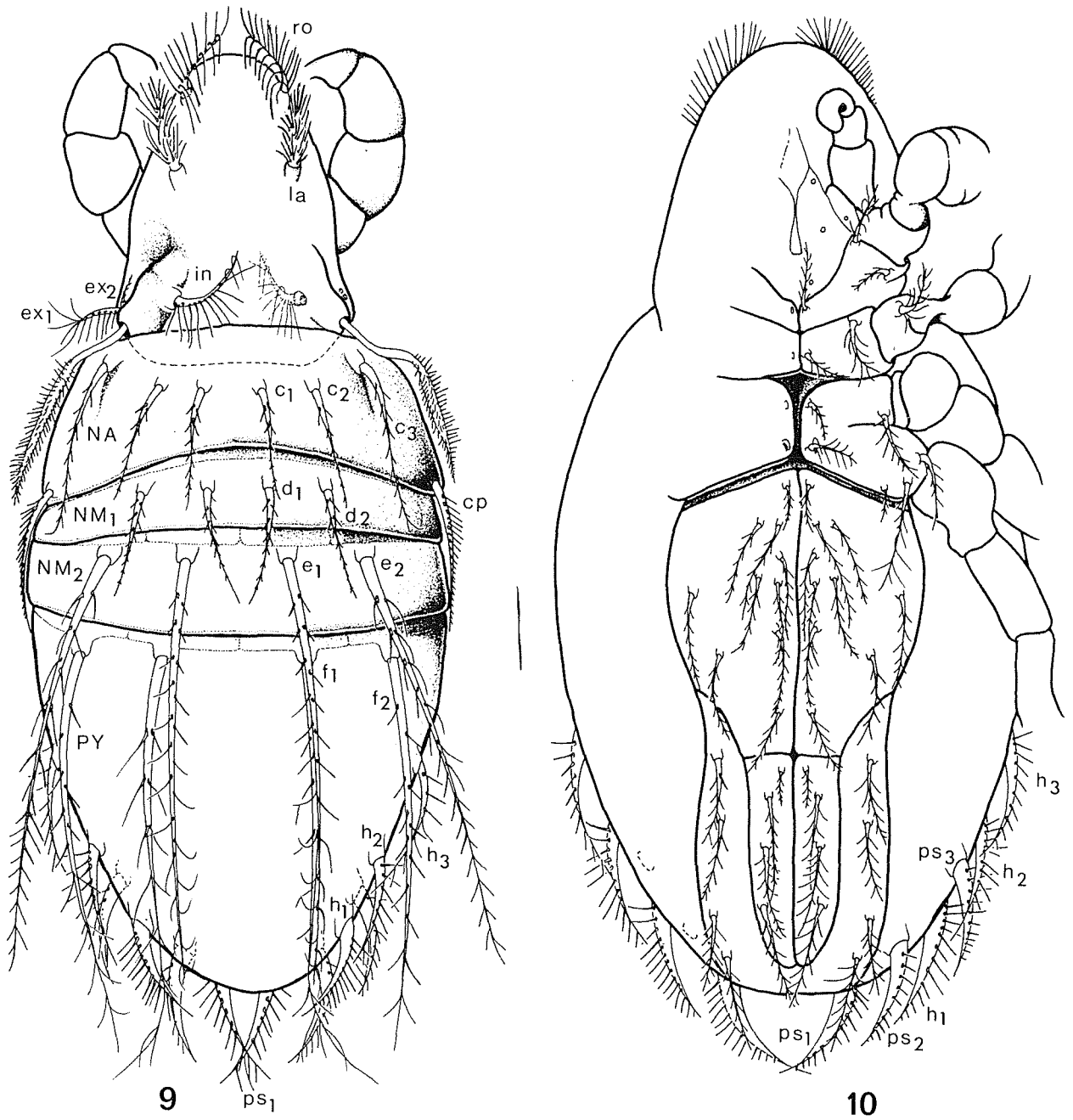
The New Mexican material compares reasonably well with BERLESE's figure of the species. Tarsi I are bidactylous while tarsi II to IV are tridactylous, the lateral claws being very slender. The notogastral setae, (e_{1-2}) and (f_{1-2}) are long, slender and barbed. The redescription given below is based on specimens collected under *Atriplex*.

ADULT (Figs. 9-10 ; 32) : Small and weakly sclerotized. The species ranges in length from 240 to 290 μm . Of the six pairs of setae on the prodorsum (*in*), (*la*), (*ro*) and (*ex*₁) are large and prominent. Each seta is strongly curved and carries numerous long, slender spines. Setae (*ex*₂) are tiny and bear whorls of spicules. The sensillus, 50 to 60 μm , is distinctly elbowed ; the basal portion is smooth and slender while towards the elbow the sensillus thickens and carries many whorls of long, delicate spicules. Scanning elec-

tron micrographs show that the prodorsal integument is finely striated. The notaspis is somewhat elongate in dorsal aspect and is subdivided into four separate plates by three transverse bands of soft cuticle (Fig. 32). The most anterior plate in the dorsal series is the pronotaspis (*NA*) and the most posterior, the pygidium (*PY*). Two other plates, the first and second median notaspals (*NM*₁ and *NM*₂), are interposed between the pronotaspis and the pygidium (Fig. 9). Longitudinal intercalary sclerites arranged between *NM*₁ and *NM*₂, and between *NM*₂ and *PY*, protect the transverse bands of soft cuticle. There is a broad, apparently unprotected band of soft cuticle between *NA* and *NM*₁ which allows for some flexibility between the two most anterior plates. Sixteen pairs of setae are present in the notogastral series. The setae in the *c* series arise from the pronotaspis and those in the *d* series from the furrow between *NA* and *NM*₁. Setae *c*₁₋₃ and *cp*, and *d*₁₋₂ are relatively short and barbed, setae *c*₃ being particularly prominent. The very long setae (*e*₁₋₂) and (*f*₁₋₂), are about equal in length (25-30 μm), each seta arising from a longitudinal sclerite (see GRANDJEAN, 1962). All the *e* and *f* setae bear two rows of very long barbs. Setae *h*₁₋₃ and *ps*₁₋₃ are short, somewhat broad and densely barbed. Setae *h*₁₋₃ are located dorsally while setae *ps*₁₋₃ are inserted ventro-laterally on the pleuraspis. The notogastral integument is weakly striated (cf. BALOGH and MAHUNKA, 1983). The ano-genital region is shown in Fig. 10. The genital and aggenital plates are fused while the anal and adanal plates are distinct. On each anal plate there are four barbed setae, the anterior pair being rather short. The four pairs of adanal setae are more or less equal in length and located submarginally. On each genito-aggenital plate there are ten pairs of setae. There are no aggenital setae. The integument is densely punctate.

OTHER STAGES : Unknown.

MATERIAL : This species, the type material of which was collected from moss and humus is Central Italy (BERLESE, 1910), appears to be rather rare (VAN DER HAMMEN, 1959). It occurred in



FIGS. 9-10 : *Cosmochthonius plumatus* : (9) adult, dorsal ; (10) adult, ventral.

very small numbers in the Chihuahuan Desert, five specimens only were recorded under *Atriplex* and three under juniper.

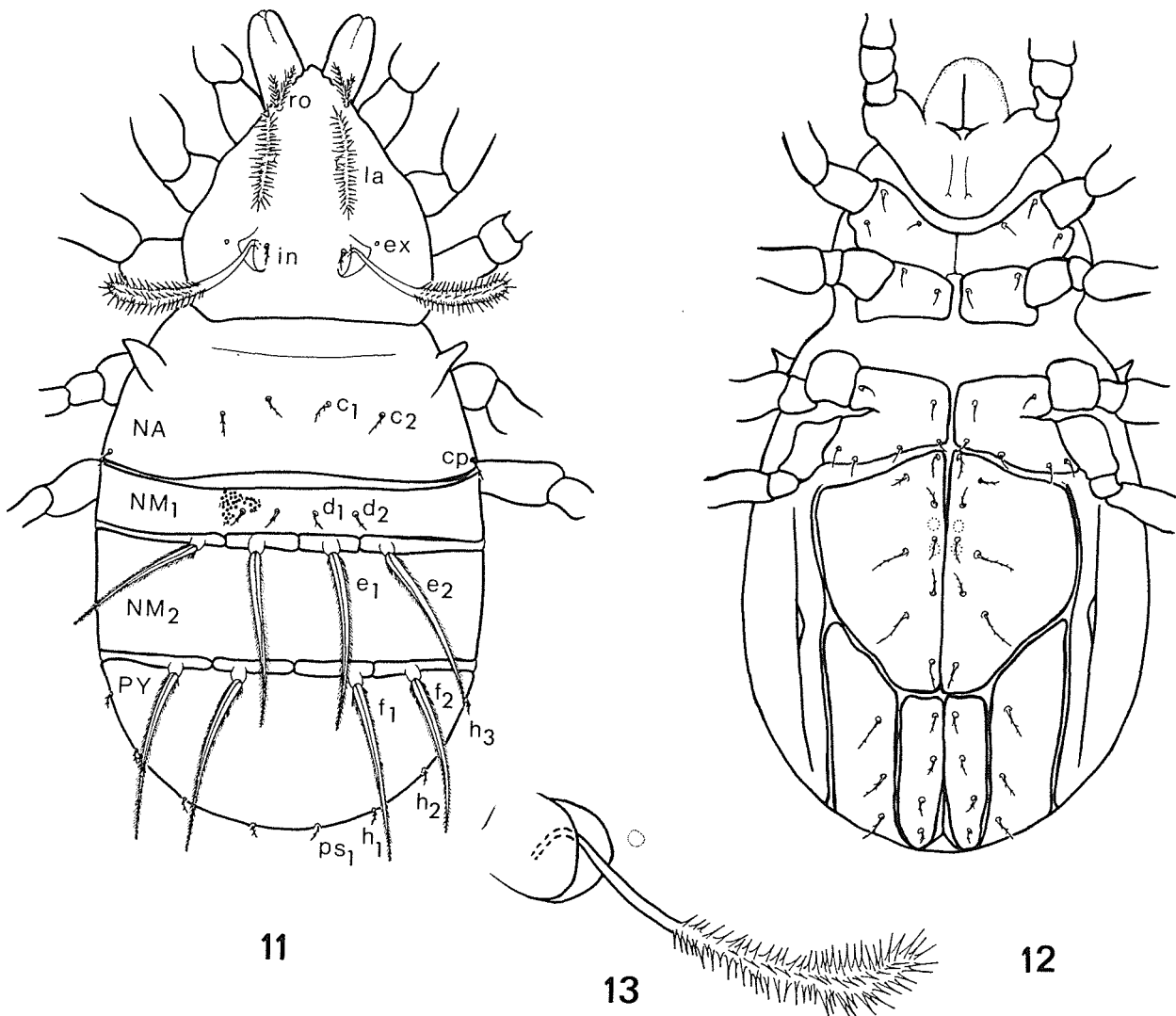
REMARKS : VAN DER HAMMEN (1959) suggests that MARIE HAMMER's subspecies, *suramericanus*, described from the Argentine (HAMMER, 1958), is perhaps a nymph of *plumatus*. In comparison with the species (240-290 μm in length), the subspecies is somewhat smaller (220 μm in length). HAMMER noted that the *d* setae on *NM*₁ were further apart than in *plumatus*, while the *e* and *f*

setae were somewhat thinner. Unfortunately, HAMMER did not figure or describe the tarsi.

***Cosmochthonius juvenalis* sp. nov.**

(Figs. 11-13)

The smallest of the 17 described species of *Cosmochthonius*, *C. juvenalis* (overall length 160 μm) is somewhat unusual in relation to the form of the setae on *NM*₂ and on the pygidium. Each seta is rather short and lanceolate with a central



FIGS. 11-13 : *Cosmochthonius juvenalis* : (11) adult, dorsal ; (12) adult, ventral ; (13) sensillum.

midrib and a highly ciliated margin. Although a central midrib extends the length of each seta in *C. emmae* and in other closely related species, these *e* and *f* setae are very long, broad and leaf-like. The tarsal claw formula in *C. juvenalis* resembles the condition found in *C. plumatus*, namely, 2-3-3-3. The holotype is deposited in the collections of the Acarology Laboratory of the Ohio State University.

ADULT (Figs. 11-13) : Very small, weakly sclerotised and almost transparent. The species is 160-165 μm in length. The prodorsal setae (*la*) and (*ro*) are biramous, each of the two setal arms being more or less equal in length and covered with whorls of spicules. Setae (*in*) and (*ex*₁) are minute and carry very few spines — setae (*ex*₂) could not be discerned in the two available specimens. The sensillus, approximately 35 μm , is densely serrated in the distal two-thirds with a smooth, slender basal portion (Fig. 13). The prodorsal integument is apparently smooth. The notaspis is ovoid in dorsal aspect and divided by three sutures into four separate plates, three of which (*NA*, *NM*₂ and *PY*) are more or less equal in depth while *NM*₁ is considerably more shallow (Fig. 11). A pair of lateral apophyses are located on the pronotaspis. Setae *c*₁₋₃ and *cp* are located on *NA* while setae *d*₁₋₂ are on *NM*₁. The *c* and *d* series setae are very short and carry few spines while the longer setae, (*e*₁₋₂) and (*f*₁₋₂), are more or less equal in length (35 μm), each seta arising from a longitudinal sclerite. All the *e* and *f* setae are slender and lanceolate with a central midrib and a densely ciliated margin. Setae *h*₁₋₃ and *ps*₁₋₃ are short and barbed. The notaspal integument is distinctly granular. The ano-genital region is shown in Fig. 12. The anal and adanal plates are distinct while the genital and aggenital plates are fused. On each anal plate there are four short, barbed setae and on each adanal plate a further three barbed setae. On each genito-aggenital plate there are eight barbed setae, five of which are located marginally and three submarginally. There are apparently only two pairs of genital papillae.

OTHER STAGES : Unknown.

TYPES : Holotype, and one paratype, reg. no. AL-2917, from creosotebush litter (*Larrea tridentata*), Jornada Experimental Range, New Mexico. The material was collected by D. C. WEEMS, July, 1983.

REMARKS : In relation to the general depths of the notaspal shields and the lengths of the gastro-notal setae, *C. juvenalis* is atypical of the genus. Moreover, while the number of tarsal claws resembles the condition found in *C. plumatus*, the form of the *e* and *f* setae is reminiscent of *C. emmae*.

It is interesting that two "species groups" can be recognized within the genus *Cosmochthonius*, based on the tarsal claw formula and on the form of the "long" setae. The tarsal claws may number 2-3-3-3 as in *plumatus* or, 2-2-2-3 as in *emmae*, while setae (*e*) and (*f*) may be slender and barbed (*plumatus*) or foliate with a central rib and marginal serrations (*emmae*). *C. juvenalis* shows affinities with both of these groupings.

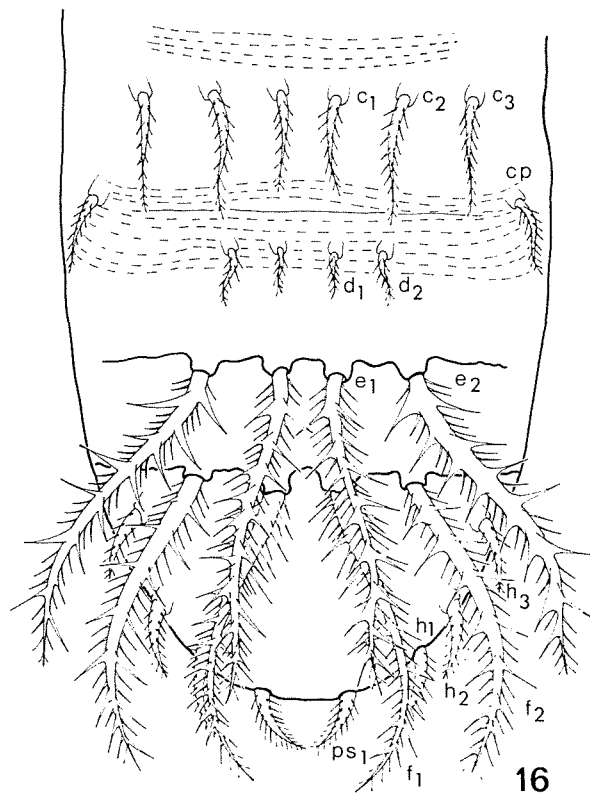
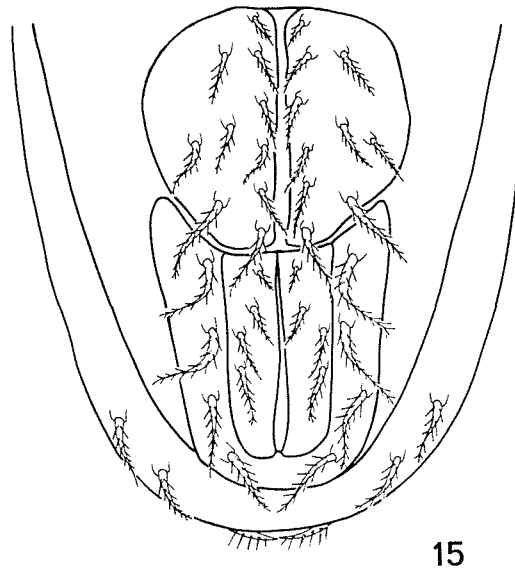
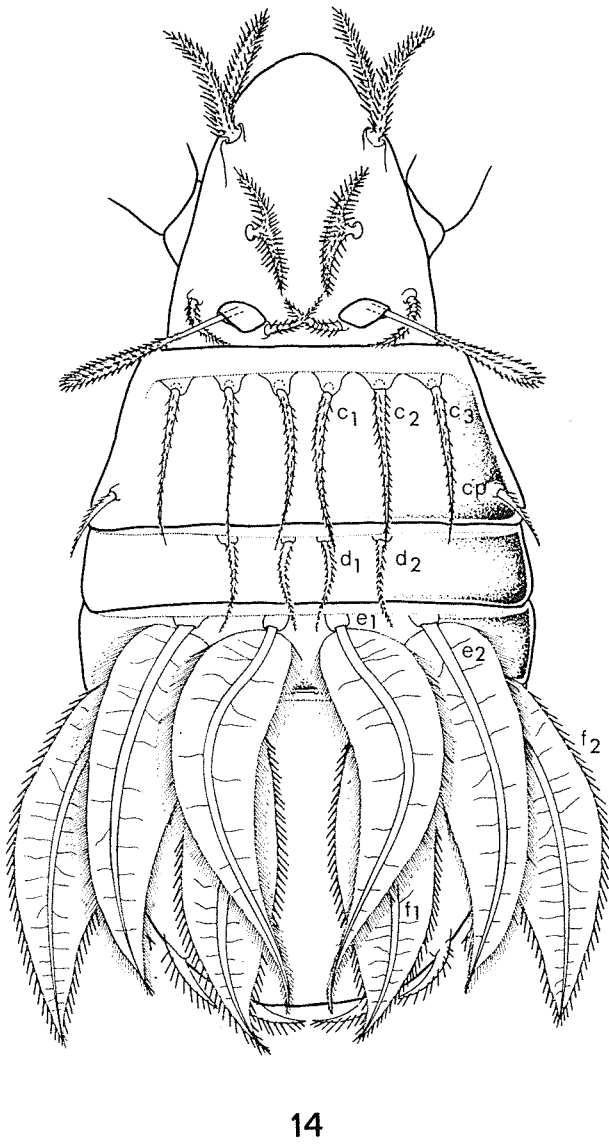
Cosmochthonius emmae Berlese

(Figs. 14-16)

Cosmochthonius emmae BERLESE, 1910 : 222. Holotype, S. Vincenzo, Pisa, Italy (ISZA, Florence, no. 69/19); GRANDJEAN, 1950 : 80; MAHUNKA, 1977 : 254.

Phylozetes emmae : GORDEEVA, 1978 : 1099.

ADULT : The only European species of the genus *Cosmochthonius* with the tarsal claw formula 2-2-2-3 (see GORDEEVA, 1978 ; 1980). *C. emmae* can be identified from the figure and description given by BERLESE (1910) and can be easily recognized by the remarkable development of foliate setae in the *e* and *f* series (Fig. 14) on the second median notaspis and on the pygidium respectively. Both *e* and *f* setae bear a thick, central rib and easily discernible transverse venation. Through the courtesy of Dr. F. PEGAZZANO (ISZA), the material from New Mexico has



FIGS. 14-16 : *Cosmochthonius emmae* : (14) adult, dorsal ; (15) adult, ano-genital region ; (16) tritonymph, notogaster, dorsal.

been compared with BERLESE's type specimen (slide no. 69/19) in Florence. The form of the notaspal setae in the New Mexican material agrees well with the holotype, although there are minor differences. For example, in the Italian specimen the margins of the foliate setae bear similar spine-like serrations, while in the American material setae e_{1-2} bear numerous delicate marginal hairs and setae f_{1-2} bear fewer, more spine-like serrations. Although BERLESE (1910) described the margins of both the e and f setae as being barbed, he was in error when he figured these setae with smooth margins. MAHUNKA (1977), in his redescription of *emmae* based on specimens collected in Indonesia, distinguished two forms of setal margin in the e and f series (ciliated and serrated) but failed to indicate which form of margin was characteristic of the e , and which of the f series. GORDEEVA (1980), working with material from the Soviet Union, figured a specimen of *emmae* in which both the e and f setae carried similar marginal serrations.

Other characteristic features of the species are the biramous rostral and lamellar setae, and the simple barbed setae (c_{1-3} , cp , d_{1-2}) on the two anterior notaspal shields. The general arrangement of the plates on the venter is characteristic of the genus (Fig. 15). Each genito-aggenital plate bears 10 setae, while both the anal and the adanal plates bear four setae. All the setae in the ano-genital region are strongly barbed.

TRITONYMPH : A single, somewhat damaged specimens was recorded. The number and disposition of the dorsal setae are essentially similar to those of the adult, except setae (e_{1-2}) and (f_{1-2}) which, unlike the foliate expansions seen in the adult, are long, thickened and bear whorls of strong spines (Fig. 16).

OTHER STAGES : Unknown.

MATERIAL : The type locality is Pisa. *C. emmae* appears to be rather rare in Europe (VAN DER HAMMEN, 1959) although MAHUNKA (1977) recorded this species from a number of habitats in Indonesia. In New Mexico only two specimens were recorded in creosotebush litter.

REMARKS : Based on a study of 11 species, GORDEEVA (1978) separated those species with "four dorsal sutures", foliate e and f setae, and with 2-2-2-3 tarsal claws, from *Cosmochthonius* (three dorsal sutures, slender e and f setae, tarsal claws 2-3-3-3) and placed them in the genus *Phylozetes* Gordeeva, 1978 (type, *C. emmae*). In the original figure of the species (BERLESE, 1910), the notaspis is shown to be divided by three sutures into four separate plates — the apparent division of the pronotaspis shown in the figure is almost certainly due to the exposure of the soft cuticular band between NA and NM_1 (see Fig. 32, *C. plumatus*). Although it has not been possible to study any of the specimens determined by GORDEEVA as *emmae*, Dr. PEGAZZANO has confirmed that the type specimen bears only three dorsal sutures. Moreover, Dr. PEGAZZANO has compared the New Mexican material with BERLESE's specimens and was unable to determine any morphological differences.

The evidence suggests, therefore, that while morphological differences, particularly in the form of the e and f setae, could provide a useful basis for dividing this genus into two species groupings, the number of dorsal sutures is not a feature which could be used. Moreover, as noted earlier, *C. juvenalis* shows affinities with both of these groupings. Another species (*Cosmochthonius bengalensis* Chakrabarti *et al.*, 1972), described from West Bengal, India, falls into neither grouping since all four tarsi are bidactylous.

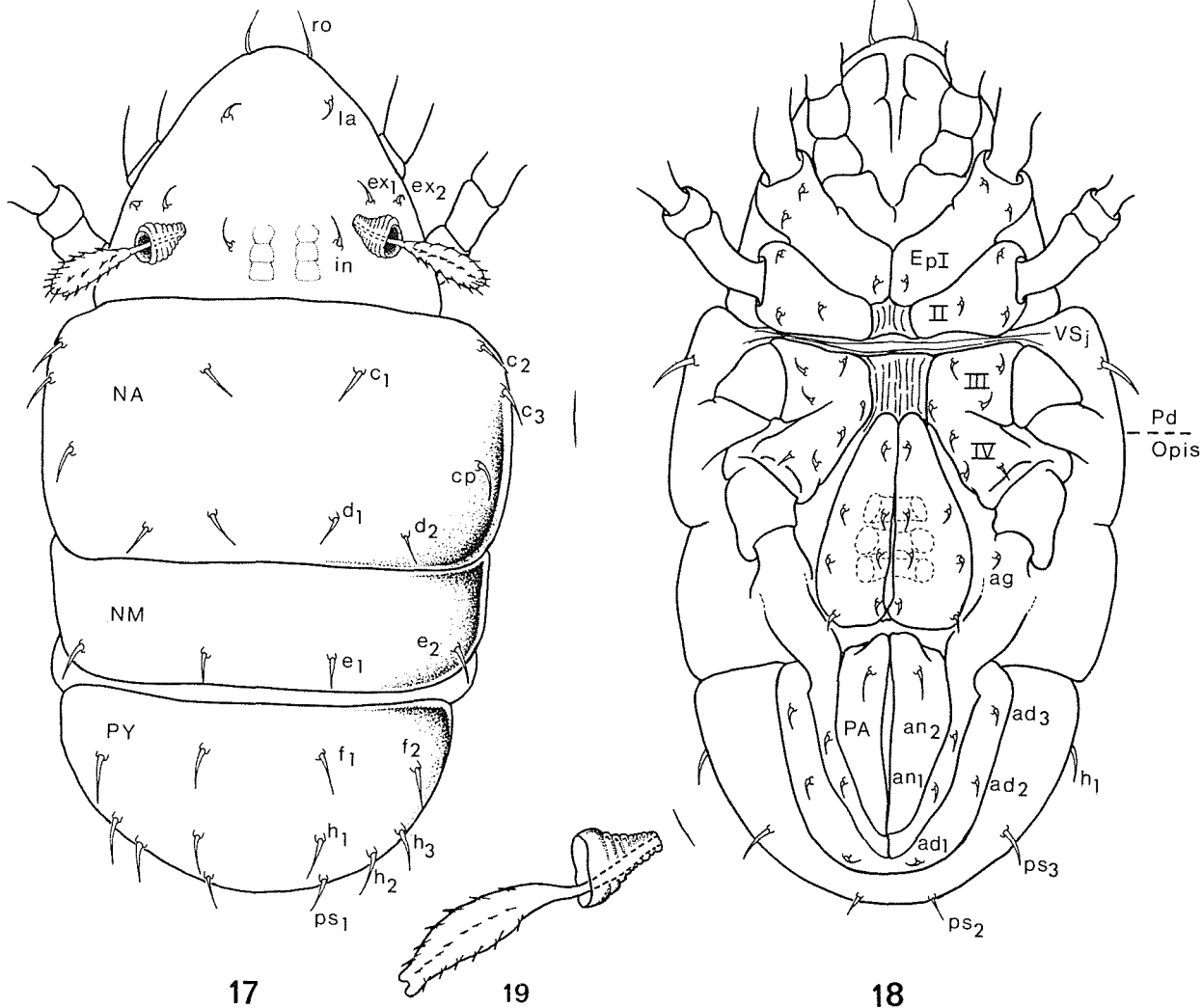
Family BRACHYCHTHONIIDAE Thor

Liochthonius cf. *lapponicus* (Trägårdh)

(Figs. 17-19)

Hypochthonius brevis Mich. var. *lapponica* TRAGÄRDH, 1910 : 549. Sarekgebirge, Lappland, holotype (Nr. 42), Naturhistoriska Riksmuseet, Stockholm.

Liochthonius lapponicus : FORSSLUND, 1964 : 237 ; GHILAROV & KRIVOLUTSKY, 1975 : 64 ; MORITZ, 1975 : 69.



FIGS. 17-19 : *Liochthonius* cf. *lapponicus* : (17) adult, dorsal ; (18) adult, ventral ; (19) sensillus.

Although rather larger (220 μ m compared to 180 μ m) the New Mexican specimens agree reasonable well with TRÄGÄRDH's description. However, in his revision of the Brachychthoniidae based on topotypic specimens collected by TRÄGÄRDH, MORITZ (1976) recorded an overall body length of 200 μ m. Moreover, MORITZ has shown that in addition to the pattern of roundish areas (three pairs) between the bothridia, the Lappland material bears additional weakly patterned areas on the pro- and median notaspis and on the pygidium. The notogastral integument of the North American material was apparently unpatterned.

L. cf. lapponicus resembles *Liochthonius breviseta* described by HAMMER (1958) from moist

Umbelliferae growing along the Arroyo El Obscuro in the Argentine. However, an examination of the type of *breviseta* (UZM, no. 241) revealed that the notogastral setae are very much more spine-like than those of *L. lapponicus* while the sensillus is lanceolate (see Fig. 19). Another difference can be seen in the form of certain of the setae on the pygidium. In *breviseta*, setae (f_1) = (c_1) and (h_1) = (c_2) each arises from a tuberculate-like swelling of the integument (= "low hill"), while in *lapponicus* these setae emerge directly from the pygidial integument.

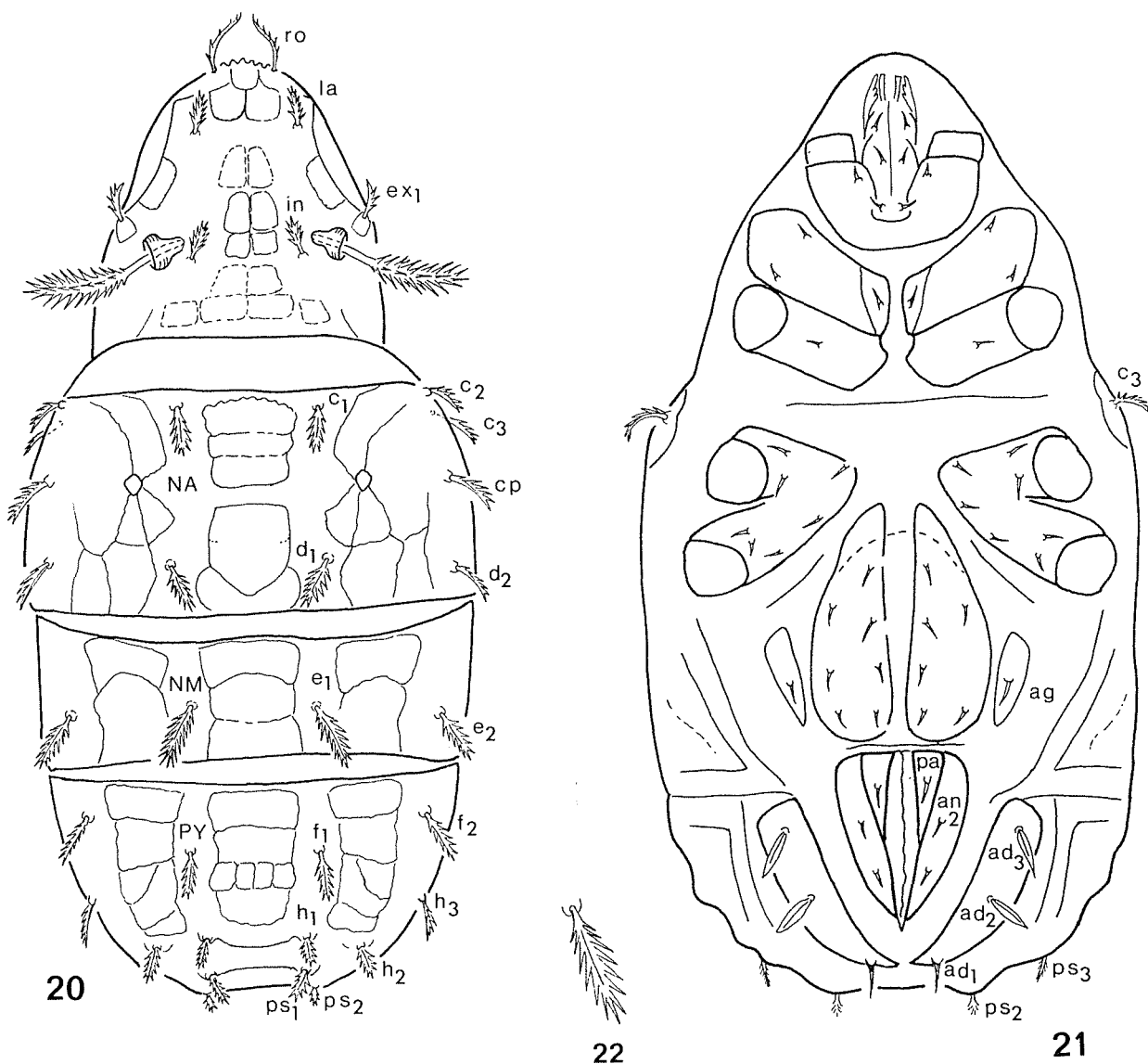
MATERIAL : Twenty adults of *L. cf. lapponicus* were collected, all under juniper.

***Brachyochthonius americanus* sp. nov.**

(Figs. 20-23)

ADULT (Figs. 20-23) : Overall length 174-190 μm . Sculpturing on the prodorsum is not strongly defined but 16 plates are normally discernable (Fig. 20). Rostral setae inserted just above the scalloped anterior edge of the prodorsum and are the longest of the prodorsal setae. Lamellar seta

inserted on a transverse ridge and are strongly serrated. The interlamellar setae are similar to the lamellar setae both in size and shape. Anterior exobothridial setae (ex_1) inserted on small lateral tubercles ; only alveoli of posterior exobothridial setae (ex_2) present (Fig. 23). Distal part of sensillus fusiform, bearing sharply pointed spines. Pronotaspis (NA) has two ring spots which are partly surrounded by plates, those lateral to the spots undivided. Anterior plate has weak transverse divisions. Lateral plates on pygidium (PY)



FIGS. 20-22 : *Brachyochthonius americanus* : (20) adult, dorsal ; (21) adult, ventral ; (22) seta.

are well defined but vary slightly in shape. Notogastral setae are deeply serrate, e_1 appears to be the longest in the dorsal series (Fig. 22). In lateral view (Fig. 23), the suprapleural plates C , E and F can be seen as can the lyrifissures ia , im , ip , ih and ips . The medial seta on coxa I is situated on a separate plate (Fig. 21). There are seven pairs of genital setae. Adanal setae ad_2 and ad_3 are clearly blade-like.

Characters of the gnathosoma including those of the palp and chelicerae are similar to those described for *B. lydiae* by REEVES and MARSHALL (1971). Leg chaetotaxy is also similar to that of *B. lydiae* except that tarsus II appears to have 13 setae and one solenidion compared with 14 setae and one solenidion. The posterior ilteral setae appears to be missing.

TRITONYMPH : Overall body length 154-166 μm . Dorsum has weak sculpturing but shape of dorsal setae similar to the adult. Only six pairs of genital setae present.

DEUTONYMPH : Overall body length 154 μm . Similar to tritonymph except that there are only

three pairs of genital setae and the coxisternal setal formula is 3-1-3-3.

OTHER STAGES : Unknown.

TYPES : Holotype and paratypes (8 adults, 4 tritonymphs, 1 deutonymph), reg. no. AL-3040. From creosotebush litter (*Larrea tridentata*), Jornada Experimental Range, New Mexico. Collected in most monthly samples throughout 1983 and 1984. Deposited in the collections of the Acarology laboratory of Ohio State University.

REMARKS : There are few *Brachychochthonius* species with serrated notogastral setae. *B. americanus* differs from all of these species in the pattern of the sculpturing on the notogaster, the shape of the notogastral setae and sensillus. *B. hauserorum* Mahunka is the most similar species but can be distinguished by radiating lines lateral to the ring spots on *NA*, indistinct lateral plates on *PY*, more slender and less deeply serrated setae on the dorsum and by many small serrations on the sensillus.

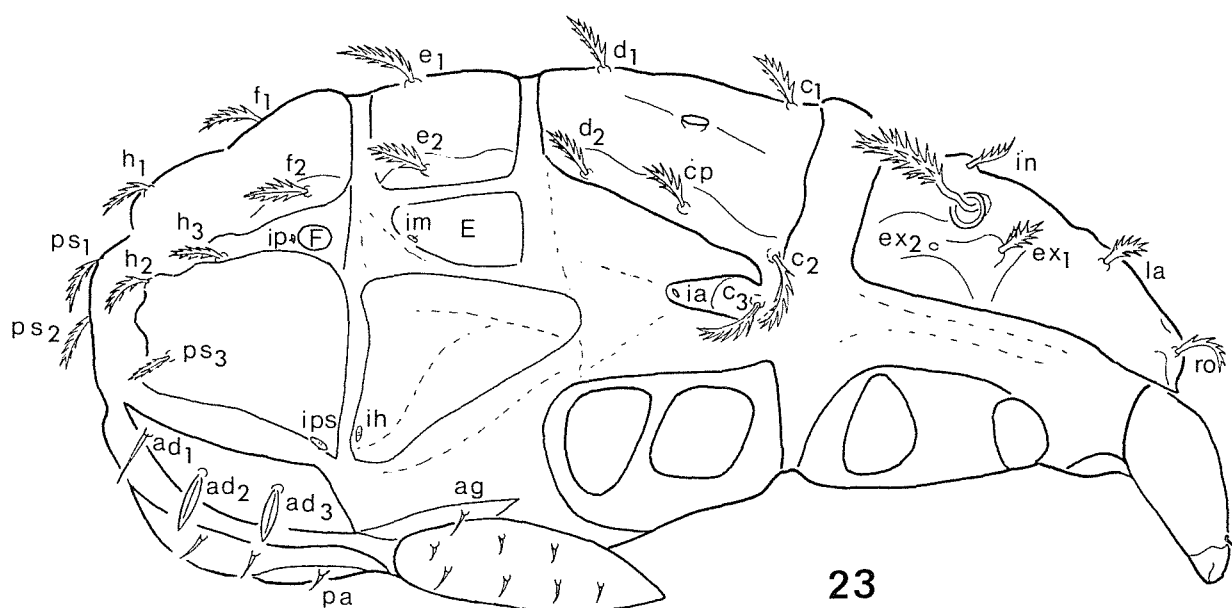


FIG. 23 : *Brachychochthonius americanus* : (23) adult, lateral.

Family CAMISIIDAE Oudemans, 1900

Camisia cf. *horrida* (Hermann)

- Notaspis horridus* HERMANN, 1804 : 90.
Nothrus horridus : BERLESE, 1885 : fasc. 17 (1).
Camisia horridus : GRANDJEAN, 1936 : 51.
Camisia horrida : SELNICK & FORSSLUND, 1955 : 486.

The description and figure of this species given by BERLESE (1885) are adequate for its identification.

MATERIAL : Two specimens (970 μm in length) which have been found to fall within the size range given by GRANDJEAN (1936) for *horrida* (850-1 030 μm) were recorded under juniper.

Family TRHYPOCHTHONIIDAE Willmann, 1931

Trhypochthonius tectorum (Berlese)
 (Figs. 24-25 ; 26-28 ; 31 ; 34)

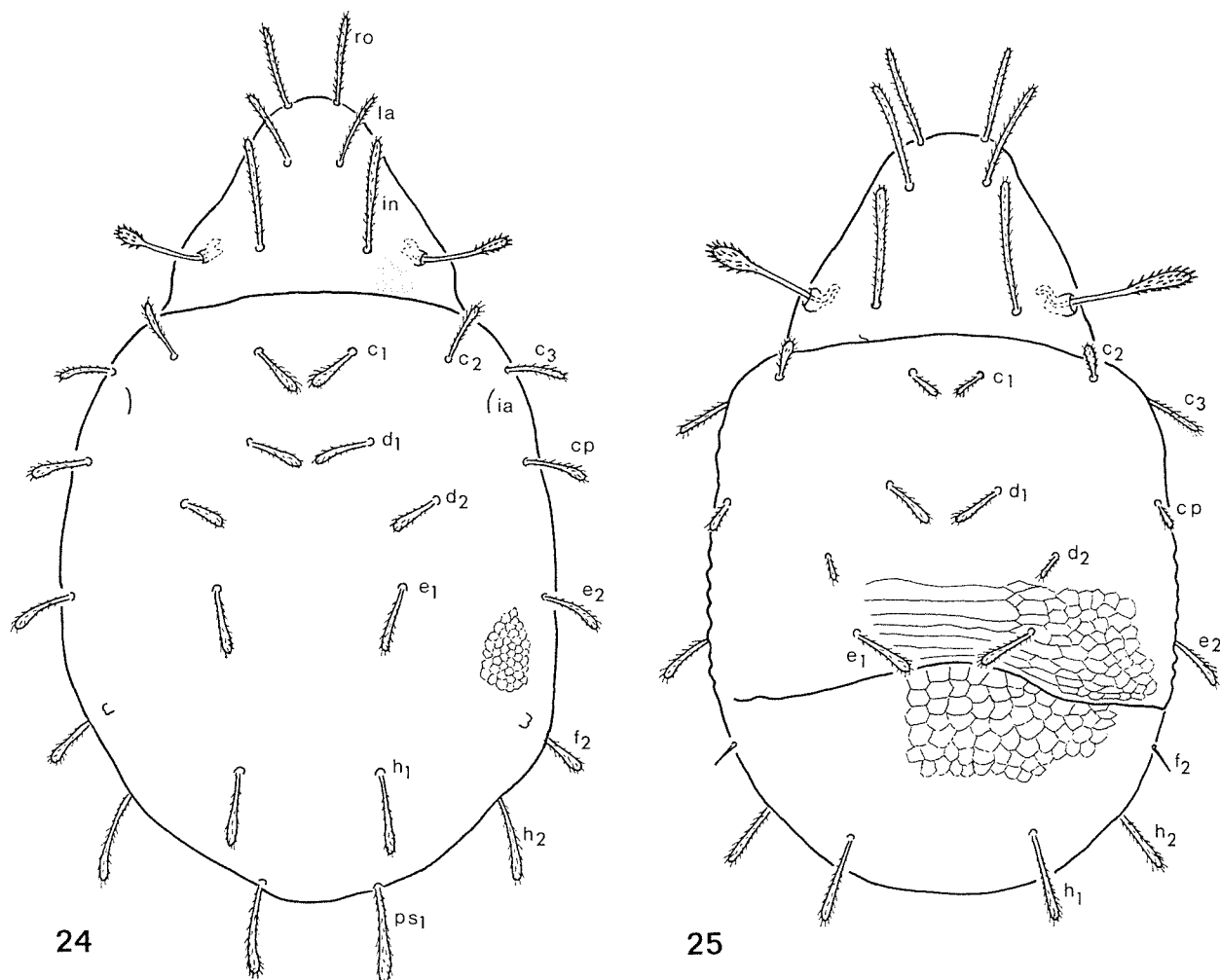
- Hypochthonius tectorum* BERLESE, 1896 : Fasc. 78 (8).
Trhypochthonius tectorum : WILLMANN, 1931 : 103 ;
 VAN DER HAMMEN, 1956 : 402.

BERLESE's (1896) description and figure of this species based on specimens collected from moss on roofs in Florence, are adequate for its identification. The characteristic features of *tectorum* are the deeply serrated, narrowly spatulate, notogastral setae and the reticulate ornamentation of the notogastral integument. The specimens from New Mexico, although rather smaller (545-605 μm in length) than the Italian material (750 μm in length), are probably referable to this species. WILLMANN (1931) records an overall body length of 660-690 μm , VAN DER HAMMEN (1956) 775 μm for *tectorum*. Specimens from Holstein in the STRENZKE Collection (BMNH 1953, 5. 16. 3) are 730-750 μm and two British specimens from Dungeness are 580-655 μm in length. BALOGH and

MAHUNKA (1983) state that the rostral setae are shorter than all of the other prodorsal setae and this is the case in the Holstein specimens. In the New Mexican material, the lamellar setae are the shortest (Fig. 24), while the British specimens are not consistent in this regard. Fig. 31 shows the structure of the sensillus and Fig. 34 that of the notogastral integument. There are fewer genital setae in the specimens from New Mexico, 6-7 pairs compared 9-11 pairs recorded for European specimens by GRANDJEAN (1949) and VAN DER HAMMEN (1956). We have examined specimens of *T. tectorum* from PEARCE's Sikkim-Himalaya collection (BMNH) (PEARCE, 1906), and found them to be somewhat larger (615-640 μm in length), more heavily sclerotized and having more pointed posterior notogastral margins than the New Mexican material.

T. tectorum bears some resemblance to a North American species, namely *T. americanus* (Ewing, 1908). However, the latter differs from *tectorum* in having a tuberculate-like swelling at the posterior tip of the notogaster, by having slender, barbed setae (cf. Fig. 24) and also in the overall body length (533 μm , see WOOLLEY, 1956). VAN DER HAMMEN (1956) has suggested that the posterior swelling in *T. americanus* could be attributable to coverslip pressure, but WOOLLEY (1956) has recorded a posterior swelling in seven specimens of *americanus* collected in Colorado.

We have also been able to examine material of *Trypochthonius tectorum longipes* (Warburton, 1912) recorded from the island of Mahé in the Seychelles. WARBURTON's collection was found to contain one slide (BMNH reg. no. 1984, 2. 23. 1) bearing two specimens mounted in BERLESE's fluid. Both of the specimens are in good condition and are conspecific. After comparison with the nominate form, we consider *longipes* to be very close to, but not identical to, the former (see VAN DER HAMMEN (1956)). In WARBURTON's subspecies, the legs are considerably thinner than in the typical *tectorum*, the sensillus is rather long, slender and serrated, and the notogastral integument is raised reticulate. GRANDJEAN (1940) described a subspecies *tectorum congregator* from France, based principally on the size and location of the



FIGS. 24-25 : *Trhypochthonius tectorum* : (24) adult, dorsal ; (25) protonymph, dorsal.

soledinions on tarsus I. In *congregator* solenidion ω_3 is elongated and inserted close to ω_2 . New Mexican material belongs to the typical form in having a short ω_3 which does not reach ω_2 . MARSHALL (1968) gives the distribution of *tectorum*, in addition to the areas mentioned above, as Iceland, Faroes, Peru, Alaska and Canada.

GRANDJEAN (1934, 1949) records the epimeral, genital and anal chaetotaxies for all stages of *tectorum*. There are several differences that we observed in the New Mexican material and these are described below. The tritonymph has been figured by TABERLY (1952), but the other juvenile stages have been treated only briefly by WILL-

MANN (1928) and VAN DER HAMMEN (1956). More detailed descriptions of the immature stages are given below based on material collected from juniper litter.

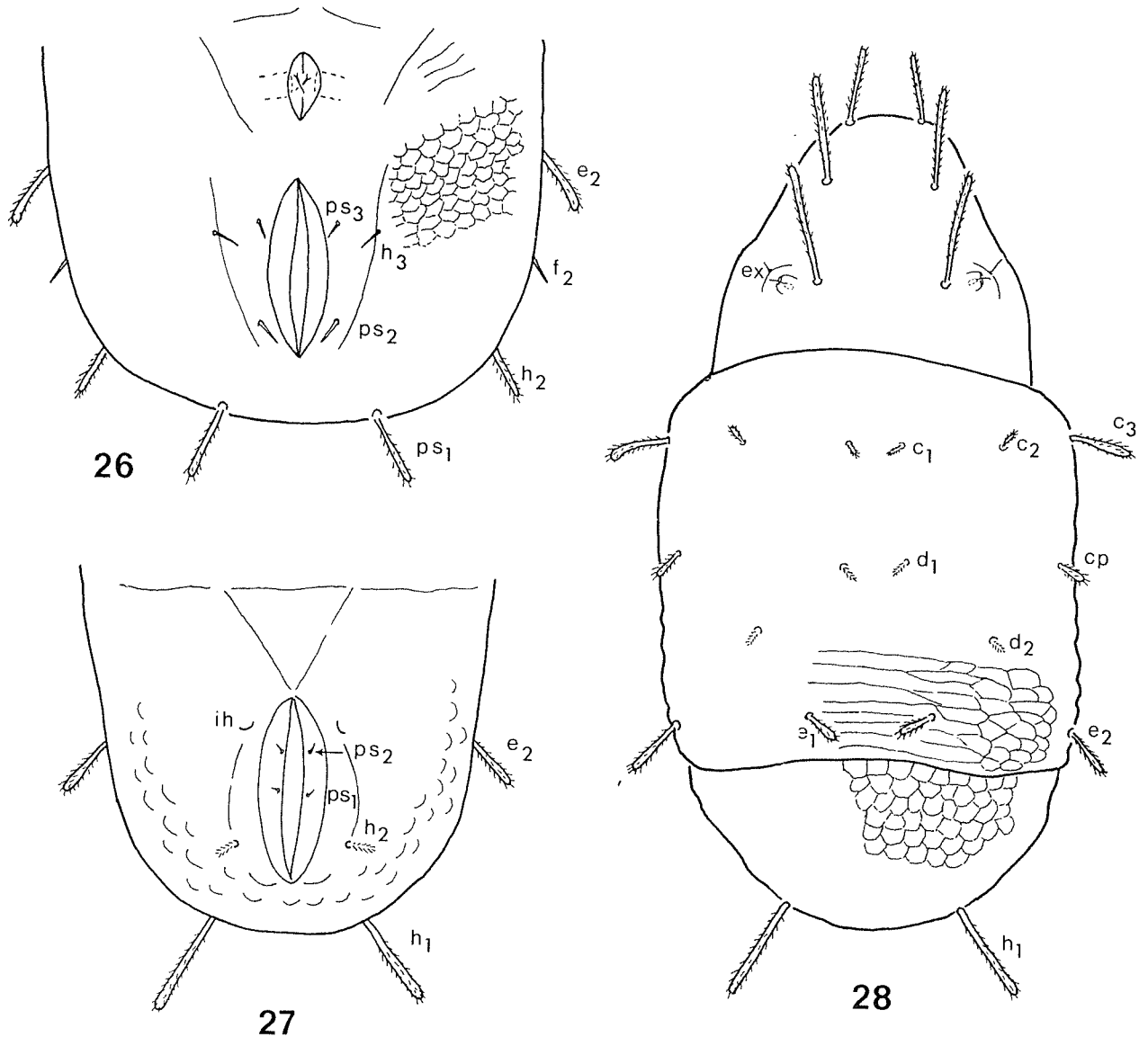
TRITONYMPH : Overall body length 400-490 μm , width 245-275 μm . European specimens 525 μm in length, 300 μm in width (WILLMANN, 1928), and British specimens 450-525 μm in length, 225-300 μm in width. The notogaster is divided into two parts by a line of dehiscence, the anterior part is roughly striated and the posterior part reticulate. The notogastral chaetotaxy is unideficent (15 pairs) and includes three pairs of pseudoanal setae. The form of the setae is similar to that of

the adult (Fig. 24). The epimeral setal formula is 3-1-3-3, identical to that recorded by GRANDJEAN (1934). New Mexican specimens have 5-6 pairs of genital setae, GRANDJEAN (1949) recorded 6-8 pairs. There are three pairs of adanal and one pair of anal setae. All legs are monodactylous.

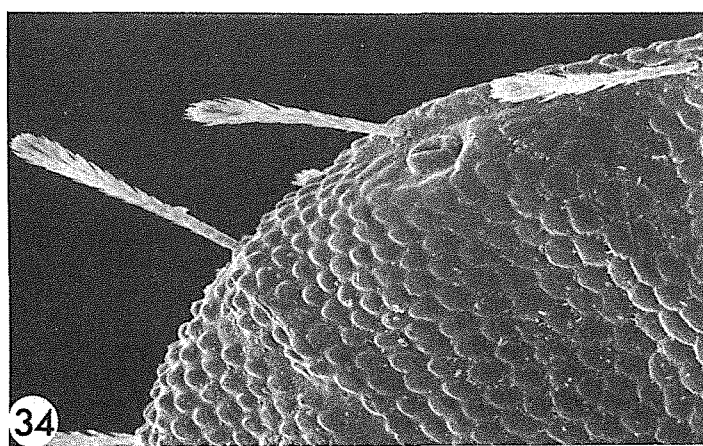
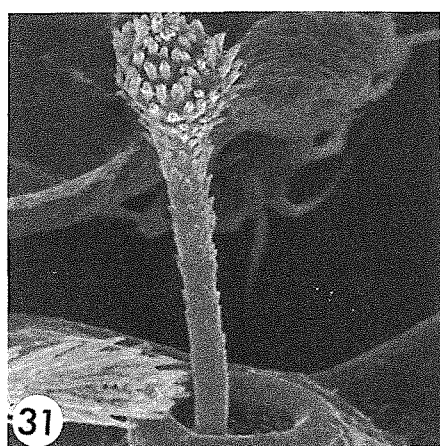
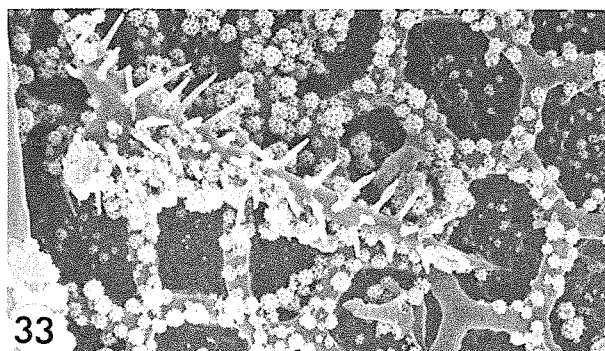
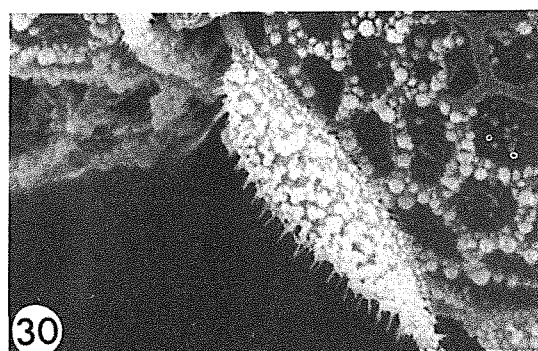
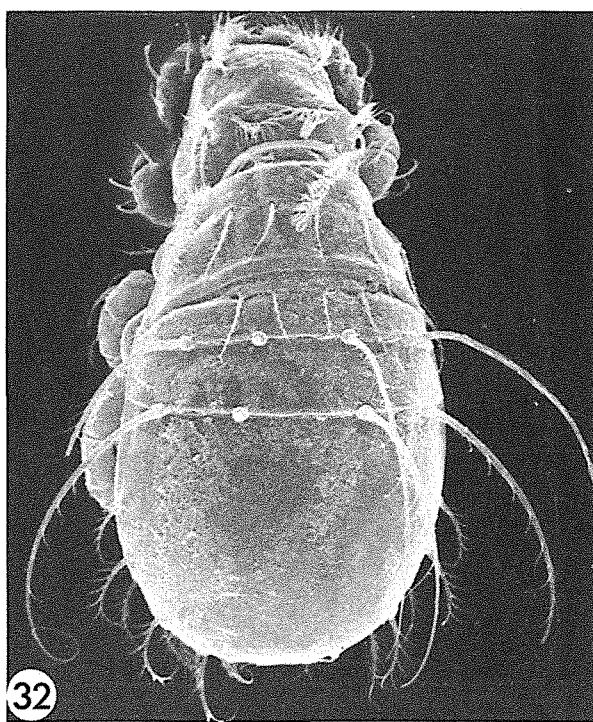
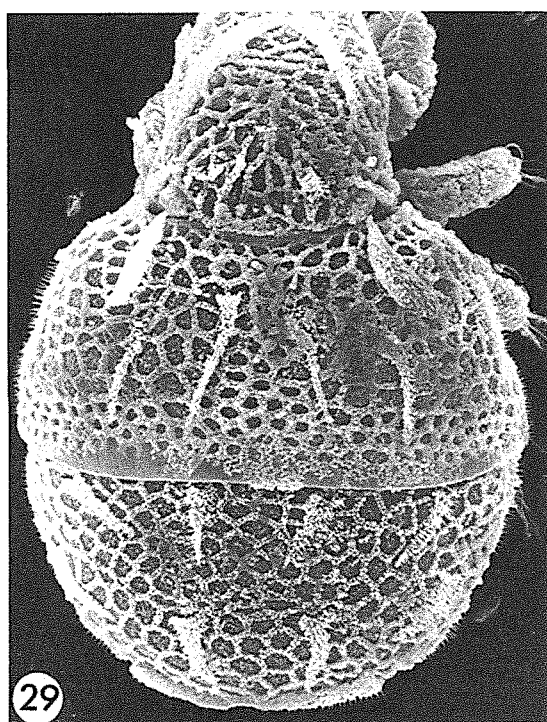
DEUTONYMPH : Overall body length 375-400 μm , width 180-225 μm . Similar to the tritonymph except for the following : epimeral chaetotaxy is

3-1-2-3 and identical to that given by GRANDJEAN (1934). These are 3-4 pairs of genital setae (GRANDJEAN 1949) recorded four pairs. The anal setae are absent.

PROTONYMPH (Figs. 25-26) : Overall body length 275 μm , width 170 μm . Similar to the deutonymph except : setae f_2 are small and setiform, epimeral chaetotaxy is not clear but GRANDJEAN (1934) gives 3-1-2-1, a single pair of genital setae.



FIGS. 26-28 : *Trhypochthonius tectorum* : (26) protonymph, ventral ; (27) larva, ventral ; (28) larva, dorsal.



FIGS. 29-34 : " Lower " Cryptostigmata. (29) *Sphaerochthonius splendidus*, dorsal aspect, $\times 440$; (30) sensillus of *S. splendidus*, $\times 2\,390$; (31) sensillus of *Trhypochthonius tectorum*, $\times 2\,640$; (32) *Cosmochthonius plumatus*, dorsal aspect, $\times 363$; (33) *S. splendidus*, detail of notogastral integument and setae d_1 , $\times 2\,260$; (34) *T. tectorum*, detail of notogastral integument, setae and pore-like opening of latero-abdominal gland, $\times 960$.

LARVA (Figs. 27-28) : Overall body length 200-245 μm , width 100-180 μm . The sensillus is reduced and a pair of exobothridial setae are present. The notogastral setae are deficient in respect of all the other stages, GRANDJEAN (1949) recorded 11 pairs (excluding the two pairs of pseudoanal setae). The f_2 setae are absent and in the New Mexican material only two pairs of h setae are visible (Fig. 27). The epimeral chaetotaxy is 2-1-2.

MATERIAL : *T. tectorum* was common under juniper but was not found under any of other plants sampled. In all about 200 adults were collected together with small number of larvae, proto-, deuto- and tritonymphs.

END NOTE

The description of *C. juvenalis* sp. nov. was prepared by B. S. K. and the correct designation is *Cosmochthonius juvenalis* Kamill. M. M. prepared the description of *B. americanus* sp. nov. and the correct designation is *Brachychochthonius americanus* MacQuitty.

ACKNOWLEDGEMENTS

This work forms part of a broad ecological study of litter decomposition in desert watersheds supported by a U. S. National Science Foundation Grant DEB 80-20083. Two of us (B. W. K. and M. M.) were able to participate in this work through the courtesy of a NERC post-doctoral assistantship.

Specimens from the BERLESE Collection were kindly examined by Dr. F. PEGAZZANO, Istituto Sperimentale per la Zoologia Agraria (ISZA), Florence, and Dr. H. ENGHOFF, University of Copenhagen Zoological Museum (UZM), allowed us to borrow the type material of MARIE HAMMER's species. We are grateful to the British Museum (Natural History) (BMNH) for the use of their acarological Collections, and also to Mr. D. MACFARLANE, Commonwealth Institute of Entomology for his invaluable taxonomic advice.

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Paru en Décembre 1986.