NORTH AMERICAN SYNICHOTRITIIDAE (ACARI: ORIBATIDA)

2. *SYNICHOTRITIA SPINULOSA* AND *S. CAROLI*

BY Jean-Claude LIONS* and Roy A. NORTON**

ABSTRACT: Two species of the oribatid mite genus *Synichotritia* (Euphthiracaroidea: Synichotritiidae), *S. spinulosa* and *S. caroli* (the type species), are redescribed, based on adult specimens from California (including paratypes). Despite differences in the setation of notogaster, ventral shield, ovipositor and legs, and different palp segmentation, we continue to consider these species congeneric. The three other described species of *Synichotritia* from China are transferred to *Sabahtritia*, requiring slight adjustment to the diagnosis of this closely related genus.

RÉSUMÉ: Deux espèces d'Oribates du genre *Synichotritia* (Euphtriracaroidea: Synichotritiidae), *S. spinulosa* et *S. caroli* (l'espèce type), sont redécrites à partir de spécimens adultes de Californie (comprenant les paratypes). Malgré des différences dans la chaetotaxie du notogaster, de la plaque ventrale, de l'ovipositeur, des pattes, et une segmentation différente du palpe, nous continuons de penser que ces espèces appartiennent au même genre. Les trois autres espèces de *Synichotritia* décrites de Chine, sont transférées au genre *Sabahtritia* au prix d'une légère modification de la diagnose de ce genre.

In the first paper of this series we proposed *Apotritia* (type-species, *A. walkeri*) as a new genus of euphthiracaroid oribatid mite and developed hypotheses about its relationships with the other genera of Synichotritiidae, *Synichotritia, Sabahtritia,* and *Temburongia* (NORTON & LIONS, 1992). Incomplete knowledge of some potentially important characters for the latter three genera precluded a detailed analysis, and the present paper attempts to partially fill this gap for the two named North American species of *Synichotritia.*

Synichotritia originally comprised of two Californian species, but three Oriental species have been named; these are discussed below and transferred to *Sabahtritia.* In addition, there are several undescribed species of *Synichotritia* from the eastern USA,

known to us from Florida, North Carolina and Mississippi[1]. The Californian species, *Synichotritia caroli* (the type species) and *S. spinulosa*, were described in relative completeness by WALKER (1965). However, some important features were not discussed or were misinterpreted; among others, these include structures of the genital region and gnathosoma, and homologies of setae on appendages. More recently, MAHUNKA (1990) offered a partial redescription of *S. caroli*, with additional comments on *spinulosa*, in the context of a review of genus- and family-group taxa of Euphthiracaroidea. Below we redescribe in detail the adult of *S. spinulosa*, a relatively large number of specimens of which was available for dissection and other rather destructive studies. *Synichotritia caroli* is then discussed in comparison.

To be consistent with part I of this series, certain terminology developed by F. GRANDJEAN, and normally used by the senior author, is altered. Herein the terms *subcapitulum, chelicera, coxisternum, abaxial* and *adaxial* are used in place of *infracapitulum, mandible, epimere, antiaxial* and *paraxial,* respectively. Voucher specimens will be deposited in the Field Museum (Division of Insects; Chicago, IL) with others retained by the authors.

SYNICHOTRITIA SPINULOSA WALKER, 1965

Material examined. The illustrations and most aspects of the redescription of this species were based on a collection of 14 specimens with the following data: USA, Oregon, Lincoln Co., Cascade Head Experiment Forest, L. J. METZ col., 1969 (no specific date available), from decomposing leaf litter in a red alder forest (*Alnus rubra* Bong.). Our specimens are from a slightly more northern latitude than those of WALKER (1964, p. 95), but they have been compared with paratype Californian specimens donated to R.A.N. by Dr. WALKER. Dr. J. Stary (Institute of Soil Biology, České Budějovice, Czech Republic) kindly allowed us to study a specimen of *Synichotritia spinulosa* with the following collection data: Canada, British Columbia, Vancouver Island, Long Beach; extracted from sphagnum moss under *Pinus contorta* in a peat bog, 12-X-1974, by J. RUSEK; this is a new distributional record.

Size, color, general form, sex. Detailed measurements of five females are presented in Table 1. All data are from specimens temporarily mounted in cavity slides in a medium of cold, diluted lactic acid (2/3 lactic acid, 1/3 water).

These mites have the habitus of normal euphthiracaroid Ptyctima, and at low magnification resemble the common genus *Rhysotritia.* The form of the ventral region is characteristic; uncleared alcoholic specimens have the cross-sectional shape of a somewhat flattened "W" (at the level of notogastral seta p_4) (Fig. 3F). Distension of specimens, i.e. during clearing in lactic acid, causes the "W" shape to become gradually eliminated. When studied by reflected light on a porous carbon block (GRANDJEAN, 1949) the notogastral setae, especially those of the four anterior rows (*c, d, e, h*), are erect. In such observations, the

	Females (n=5)	Males (n=4)
Notogastral length	461 ± 80	408 ± 15
Notogastral width	329 ± 48	285 ± 9
Notogastral height [a]	313 ± 47	288 ± 18
Prodorsal length	248 ± 44	240 ± 15
Prodorsal width	201 ± 27	183 ± 5
Prodorsal height	103 ± 21	91 ± 19
Length of sensillus	108 ± 14	105 ± 18

[a] This figure includes the total height of the opisthosoma in lateral view, including any small projecting part of the anogenital plates.

TABLE 1: Measurements of *Synichotritia spinulosa* Walker (in μm; mean and confidence limits (p = 0.05).

color is orangish yellow, lighter or darker according to the age of the specimen.

The known populations are clearly bisexual; WALKER's paratypes included 31 females and 67 males (1964, p. 91), while our sexed material includes 5 and 4, respectively. Five examined females contained 0, 2, 3, 5 and 7 eggs.

Cuticle (including cerotegument). Observations were made both with reflected light, on a porous carbon block, and with transmitted light. The cerotegument includes a mucilaginous layer, abundant over the whole body (notogaster, ventral parts, prodorsum). Often, organic debris from the environment is found adhering to it. In addition, the cerotegument exhibits the spinules for which the species was named (WALKER, 1965: 95). These spinules, in the form of small cones or columns, with rounded tips, are very abundant on the prodorsum and on the posterior third of the notogaster, less so in the lateral region. Spicules are absent at the level of the tectonotal notch (SANDERS, 1982, p. 31), where the bothridial scale behind the sensillus articulates. The largest spinules are 2.6 μm long, but most are about 1 μm. When heated in lactic acid, the mucilaginous material may disappear quickly, but the spinules remain in place. After a long period in lactic acid, or after strong heating, they may dissolve almost totally; they are accordingly attributed to the cerotegument. Whether numerous or few, the spinules shine brilliantly in polarized light. This is consistent with the observation by NORTON and BEHAN-PELLETIER (1991, p. 1505) that the cerotegument of various *Rhysotritia* species is birefringent. Anterior to setae *ro* of the prodorsum, the spinules take the form of rounded granules.
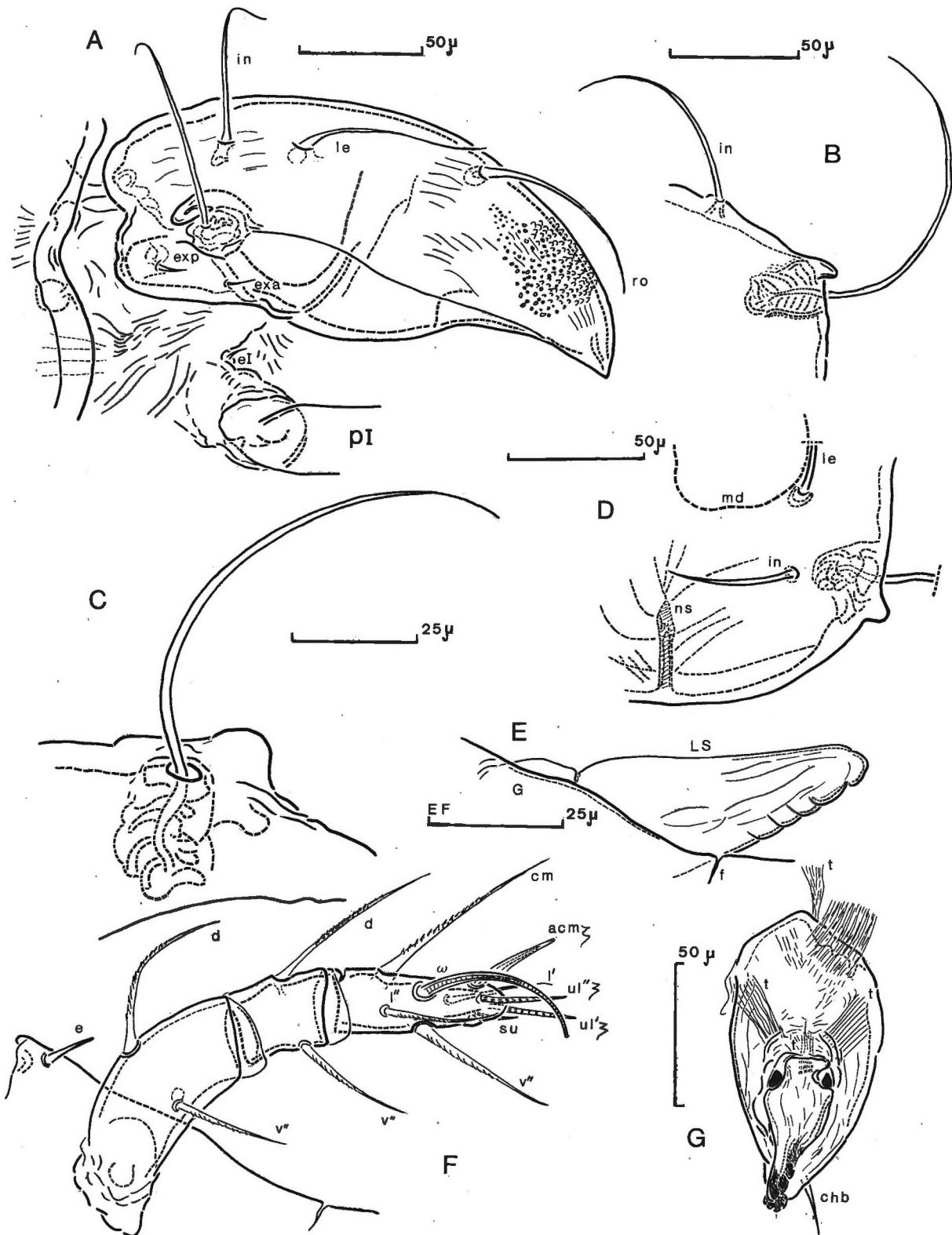
FIG. 1: *Synichotritia spinulosa* Walker

A. — Prodorsum (right lateral aspect). B. — Left sensillus and vicinity (frontal aspect). C. — Sensillus and vicinity (latero-ventral aspect). D. — Aspis, posterior right quarter, showing bothridial scale (dorsal aspect). E. — Labrum (lateral aspect). F. — Right palp and part of subcapitulum (abaxial aspect). G. — Right chelicera (antero-ventral aspect, posterior at top).

The cuticle is smooth and at certain places has a pale, shagreened structure, hardly discernable. As discussed by Norton & Behan-Pelletier (1991: 1506), such structure is often associated with cuticular mineralization, which they noted in this species, as demonstrated by general birefringence in polarized light. A weakly defined porosity is present on parts of the notogaster and the posterior region of the prodorsum.

Prodorsum (Figs. 1A-D). There are two pairs of exobothridial setae. Setae *ro, le* and *in* are smooth, and gradually thinner in respective order. The sensillus is rather fine, erect, and strongly recurved distally (Fig. 1B, C). The sagittal apodeme ("nervure") (Fig. 1D, ns) is well developed; it serves as the origin of muscles that are directed anteriorly and toward the subcapitulum (probably cheliceral retractor muscles). A lateral carina extends anteriorly from the bothridium to the margin of the prodorsum. The bothridial scale is situated behind the bothridium, and permits the precise folding of the aspis by coapting to the tectonotal notch on the anterior border of the notogaster, as described by Walker (1965; see also Sanders, 1982). The bothridium is composed of a simple exterior chamber, and a more internal group of finger-like chambers (a structure similar to that of the well-known *Rhysotritia ardua*). There are neither tracheoles nor brachytracheae extending internally from the bothridium. We have not discovered two structures known in *Rhysotritia ardua* (Grandjean, 1939: 110): the glands that open externally on the prodorsum (*dg.s, dg.v*), and the medioventral organ (*o.mv*). When folded during enptychosis, the anterior part of the prodorsum comes to lie against the carinae of the genital-aggenital valves (Figs. 3G, 4A, 5D).

Notogaster (Figs. 3A-F, 4A). The notogastral setae are strong, smooth, and attenuate (Fig. 3A, D). There are 15 pairs: $c_1, c_2, c_3, cp, d_1, d_2, e_1, e_2, h_1, h_2, h_3, p_1, p_2, p_3$ and p_4. Their lengths range from 62 μm (c_2) to 38 μm (c_3). There is no vestige of setae f_1 or f_2. The opisthosomal gland is also absent. A small cuticular impression (μ) marks the origin of a rather long tendon that is directed anteriorly and towards the ovipositor, as in *Oribotritia* (Grandjean, 1967: 263). Only three lyrifissures were located: *im, ip, ips*. In each case, they are clearly marked, with a small internal canal visible. Anteriorly, the tectonotal notch is well

formed, and below it is a curious formation in the thickened notogastral border (Fig. 3B, C). This is a small groove in the cuticle with a kind of circular impression, for which we cannot yet give a morphological or functional interpretation. The secondary chamber into which the legs are withdrawn ("la cage des pattes" of Grandjean, 1967: 267) is normal for the Eupyctima. Due to dissection, the podosomal region is not represented in Fig. 3A. In its natural state it is marked by retractor muscles that originate on the notogaster, run obliquely anteroventrally, and then insert on the coxisterna of the legs. Grandjean (1967: 267 and his Fig. 2) and Sanders (1982) have well described the function of this region in *Oribotritia* and *Euphthiracarus,* respectively, and the present species is probably similar. Eggs observed within female specimens have no chorion; the simple covering is rather thick (a little over 2 μm). Prelarvae have never been observed within a female.

Ventral region (Figs. 3A, G-I, 4A-E, 5A-H, 8A). The coxisternal region is typical of Euphthiracaroidea (Fig. 4D). The setal formula (I to IV) is 3-1-3-3. The shortest seta is *1a* (8 μm), the longest is *1b* (82 μm), and the others are between 10-21 μm. In contrast, the ventral region of the opisthosoma is quite different from that of most Euphthiracaroidea, and is the most striking characteristic of *S. spinulosa*. The ventral shield comprizes a single pair of large valves. In ventral aspect there is neither a transverse line (or vestige) of demarcation between the genital and anal regions, nor a longitudinal line (or vestige) between genital-aggenital or anal-adanal regions. The ventral shield is bordered laterally by the well sclerotized plicature band, or plate (Fig. 4A, BVP). Sagittally, there is an apparent normal median separation between halves of the ventral shield, but in fact only the anal opening exists. The part anterior to point α (Fig. 4A, 4B), that region corresponding to the ancestral genital valves, does not open; the medial line separating them represents a narrow band of unsclerotized cuticle that attaches the two valves from point α anteriad to the posterior of the two transverse carinae. The genital organs extrude anteriorly, between the ventral shield and the coxisternal zone (Fig. 5D). There is no cuticle attaching the valves in the region of the carinae, but this part of the ventral shield remains well closed, due to the attaching cuti-
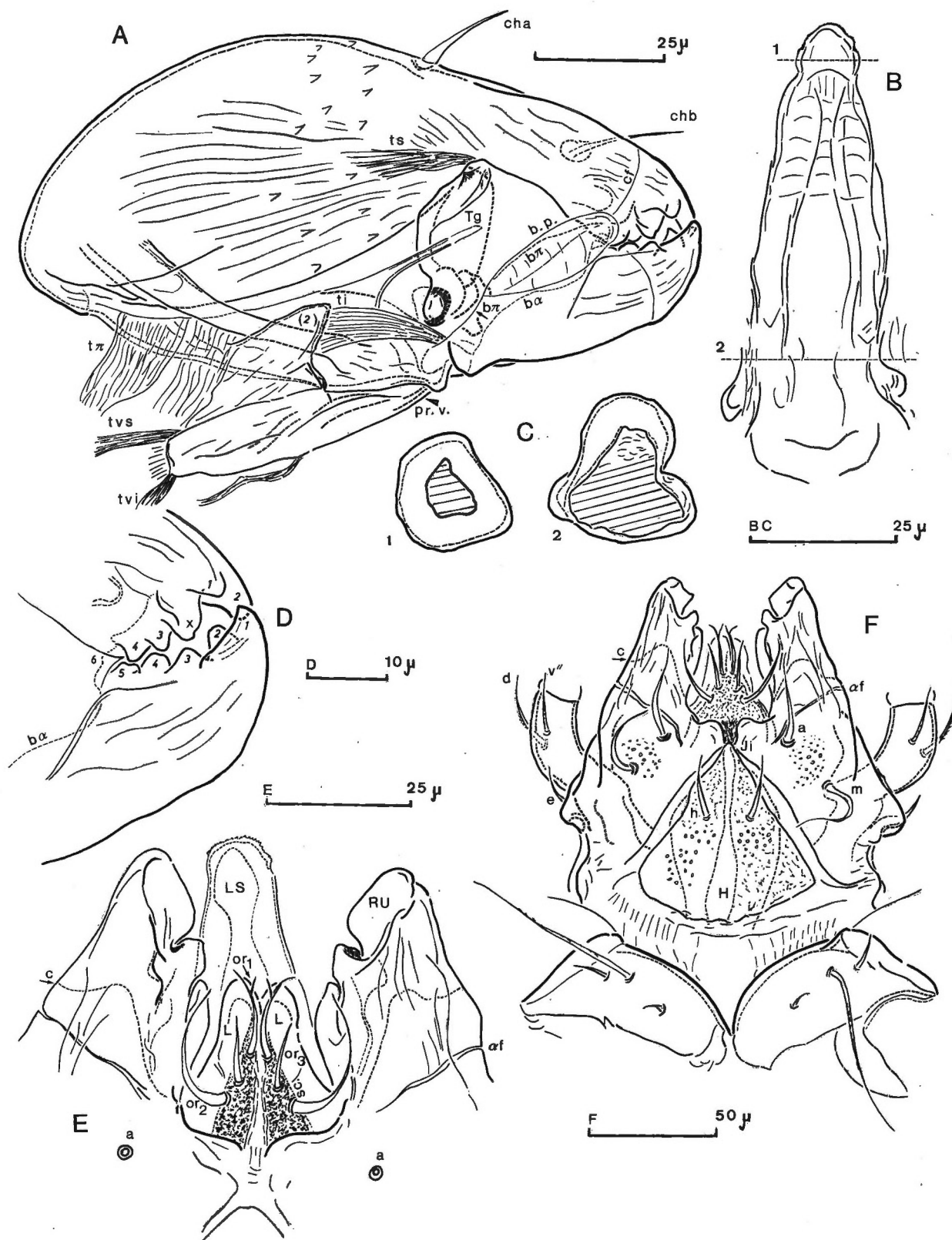
Fig. 2: *Synichotritia spinulosa* Walker

A. — Left chelicera (adaxial aspect). B. — Labrum (dorsal aspect). C. — Cross-sections of labrum at position "1" (left) and position "2" (right) indicated in Fig. 2B. D. — Left chelicera, distal half of digits (adaxial aspect). E. — Anterior region of subcapitulum, showing rutella, labrum and lateral lips (ventral aspect, slightly inclined posteriorly). F. — Subcapitulum and anterior region of coxisterna (ventral aspect).
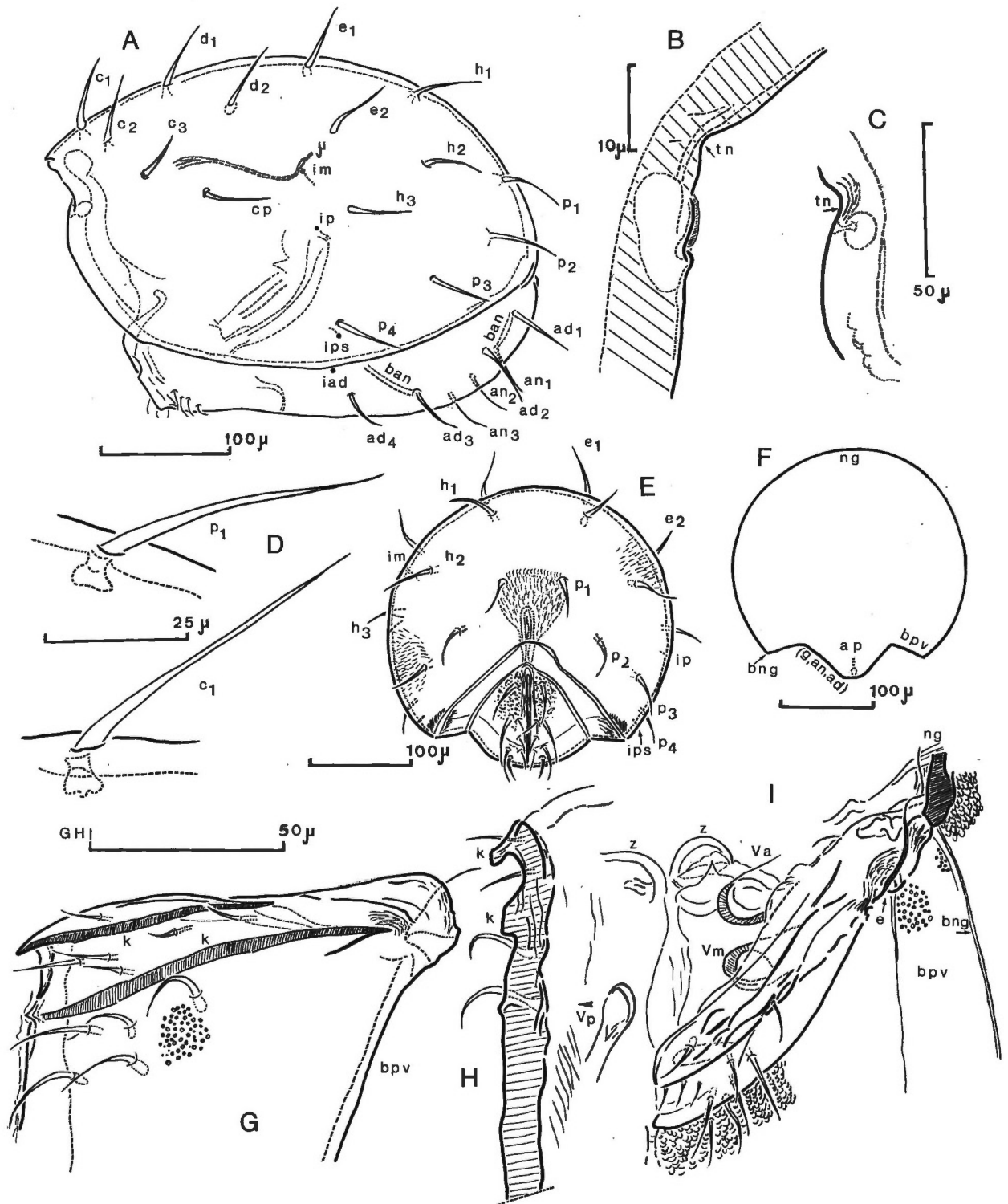
FIG. 3: *Synichotritia spinulosa* Walker.

A. — Opisthosoma (left lateral aspect). B. —Anterior border of notogaster, right side (slightly inclined toward the observer); *tn* = tectonotal notch. C. — Same, left side (fully lateral aspect). D. — Notogastral setae p_1 (top) and c_1 (bottom) of left side. E. — Opisthosoma (posterior aspect). F. — Schematic cross-section of opisthosoma at level of notogastral seta p_4. G. — Anterior part of left ventral plate (ventral aspect). H. — Anterior part of right ventral plate, in optical section. I. — Anterior part of left ventral plate and genital vestibule (frontal and slightly ventral aspect; prodorsum and legs removed).

cle situated immediately posteriad. A pair of transparent, semicircular structures appear in front of the anterior carinae, overhanging the coxisternal region (z in Figs. 3I, 4A, 5D); these seem to protect the progenital cavity and the base of the extruded ovipositor. The 11 pairs of genito-aggenital setae (the two groups are not distinguishable) are easily seen when the shield is dissected. The two rather strong transverse carinae (Figs. 3G, I) delimit three zones of paired setae; one seta is anterior to the carinae, five are between the carinae and five are posterior to them. The venter possesses flexibility at point e of Fig. 3I. There is a definite point of articulation between the each half of the ventral shield and the repsective plicature plate (bpv) at this point; a condyle is produced from the shield, with an articulating surface (cotyloid cavity), developed on the plicature plate[2]. In some cases the plicature plates are partially drawn down over the halves of the ventral shield (compare GRANDJEAN, 1933: 310). At contact bng, between the notogaster and the plicature plate, the flexibility is reduced to the suppleness of the articulating cuticle (Fig. 3I). Lyrifissure (pore) iad is present approximately at the level of, and lateral to, seta ad_4.

From point α to the level of setae ad_4, or even beyond, according to the state of inflation of the individual) the two halves are close together. The three pairs of anal setae (an_1, an_2, an_3) insert near the medial edge of the valves, on a narrow band of smooth cuticle. In contrast, the four pairs of adanal setae insert slightly more mediad, on granular cuticle. The smooth and granular regions may respectively represent ancestral anal and adanal plates, but they are fully fused, without trace of articulation. The anal setae are spaced equidistantly, and both these and the adanal setae are smooth.

One female specimen, with seven eggs and greatly inflated by strong heating in lactic acid, became torn in the anterior region of the anogenital plate, allowing a detailed view of the underlying structures (Fig. 4B). Figure 4C shows this region from an internal aspect of a dissected male, such that the anal aperture is opposite the observer, and Fig. 4E shows it in lateral aspect, by transparency. These figures show a well sclerotized, elongated, double-walled, lamellate apodeme (ap) in the midsagittal plane. Anterior to point α a pair of large muscles originate at the anterior extent of the apodeme, and run forward toward the genital vestibule; they may serve for the retraction of its walls during enptychosis. The apodeme itself, called a *preanal apodeme* by SANDERS (1982)[3], was briefly described in our previous paper (NORTON & LIONS, 1992). It has different cross sections along its length (Fig. 8A); more posteriorly, where it forms an upside-down "V", each wall is clearly porose and attaches to the medial margin of the respective half of the ventral shield. The porosity may be responsible for the aeration of another set of muscles: the paired anogenital compressor muscles that originate broadly on this apodeme and insert laterally on the ano-adanal plate, near its junction with the plicature plate (SANDERS, 1982). SANDERS (1982) considered this apodeme the "kingpost" ("poinçon") of the anogenital compressor muscle system. Posteriorly, it attaches to the digestive tract (rectum); it is at this point that it appears thicker in dorsal aspect and develops the inverted "V" shape, as the ventral part of the apodeme merges with the sclerotized walls of the anal vestibule (ban). The apodeme therefore extends from point α to a level between setae ad_4 and ad_3. The anal vestibule is visible posterior to seta ad_4 (Figs. 3A, 4B, 4C); its walls are sclerotized (ban). The aperture itself opens at the level of ad_2.

The genital organs and genital papillae are shown in Fig. 5. The ovipositor is extruded anteriorly, emerging between the anterior margin of the ventral shield and the voluminous integument of the leg chamber, behind the coxisternal region (Fig. 5D). At the time of extrusion the semicircular protective structures in the anterior part of the progenital cavity can be seen (z in Figs. 4A, 5D). The ovipositor (Fig.

2. This flexibility must be limited. Since each half of the shield is a single sclerite, flexibility in the terminal region of the plates is only that allowed by the sclerotized cuticle itself.

3. GRANDJEAN had some knowledge of the preanal apodeme, as indicated in the text and drawing of an unpublished dossier on *Oribotritia berlesei*. In a figure of an internal projection of the anal valves, he noted a brown-colored "carina" formed by the base of the rectum, on which tendons were inserted. There is no reason to suggest any type of homology between this apodeme in euphthiracaroid mites and the *preanal organ* of higher oribatid mites (GRANDJEAN, 1957a), which has a somewhat analogous position. Both may be involved in the operation of the anogenital region, but their evolutionary origins are clearly independent.
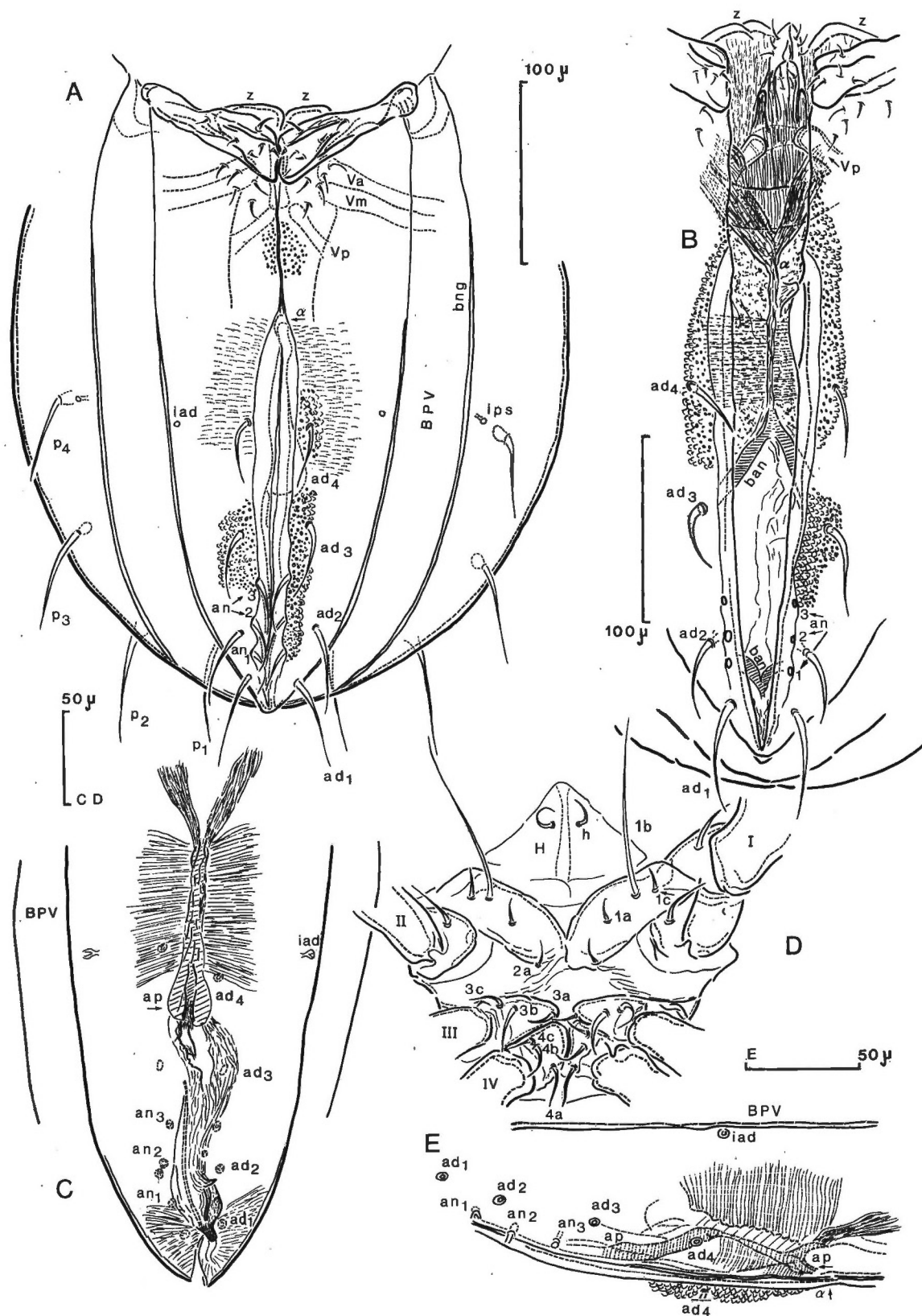
FIG. 4: *Synichotritia spinulosa* Walker.

A. — Opisthosoma, female (ventral aspect, anterior to top). B. —Medio-ventral region of opisthosoma, after artificial splitting of anogenital plate into halves by inflating in lactic acid. C. — Internal view of anal region of male, after dissection of notogaster. D. — Coxisternal region (ventral aspect, same specimen as A). E. — Preanal apodeme (*ap*) and surrounding structures of male, after dissection (lateral aspect).
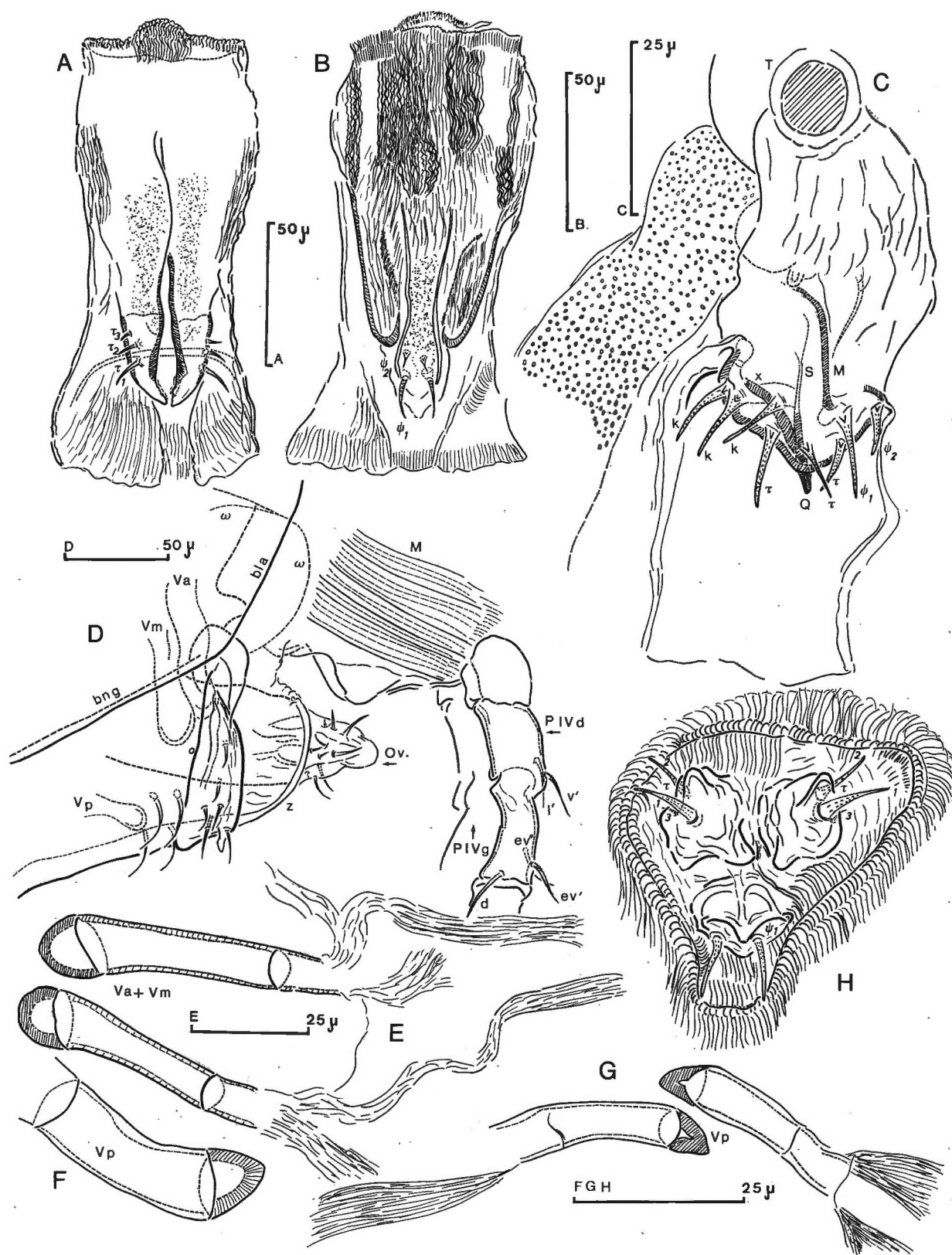
FIG. 5: *Synichotritia spinulosa* Walker.

A. — Retracted ovipositor, showing paired dorsal lobes (anterior aspect, dorsal to top, seen as if part of the external wall were removed). B. — Same, showing unpaired ventral lobe (posterior aspect). C. — Genital organ of male (left lateral aspect). D. — Female genital region, with slightly protruding ovipositor (right lateral aspect). E. — Genital papillae *Va* and *Vm*. F. — Genital papilla *Vp*. G. — Genital papilla *Vp*, two variations. H. — Ovipositor, retracted (viewed along its axis from distal end).

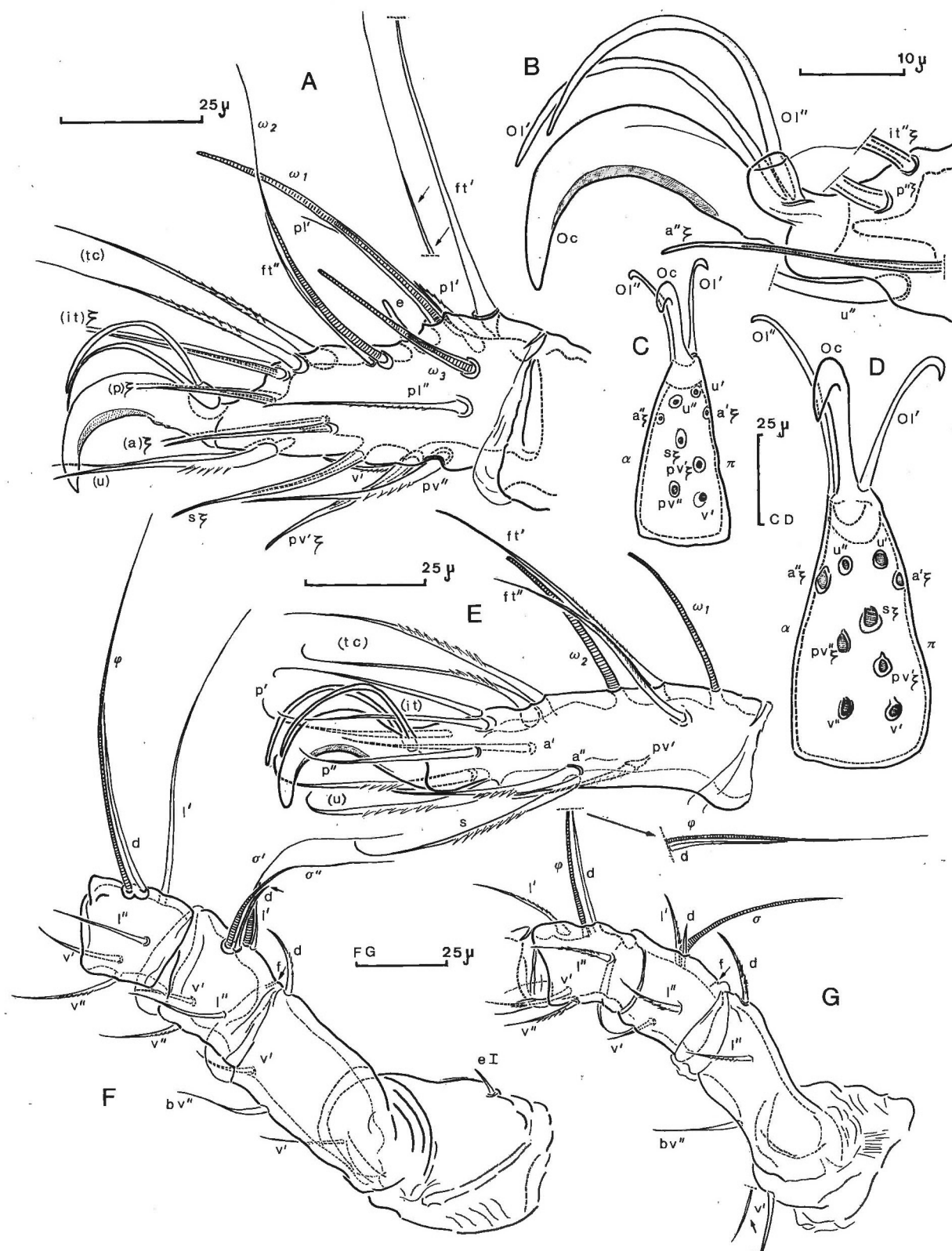FIG. 6: *Synichotritia spinulosa* Walker (A-C, E-G) and *S. caroli* Walker (D).

A. — Tarsus I, left (abaxial aspect). B. — Ambulacrum and distal part of left tarsus I (abaxial aspect). C. — Tarsus I, right, setae indicated only by insertions (ventral aspect). D. — Same, *S. caroli*. E. — Tarsus II, left (abaxial aspect). F. — Proximal segments of left leg I, *sans* tarsus (abaxial aspect). G. — Same, leg II.

5A, B, D, H) exhibits the typical three distal lobes, each having a small, hardly discernable sclerite on its external wall. On the unpaired lobe and the anterior faces of the paired lobes, these sclerites do not extend to the ends of the lobes. The usual 5 pairs of setae are present on the lobes. Of the two setae on the unpaired lobe, ψ_1 (12 μm) is eupathidial, but this could not be determined with confidence for ψ_2 (2 μm). Setae τ_1 (12 μm) and τ_2 (8 μm) of the paired lobes are eupathidial, but τ_3 (4 μm) is too small to determine this. The coronal setae (k) are absent. Two large retractor muscle masses insert on the distal part of the ovipositor.

The male genital organ (Fig. 5C) bears eight pairs of eupathidial setae (7-10 μm) having distinct canals: ψ_1, ψ_2 τ_1, τ_2, τ_3, τ_4, τ_5 and τ_6. WALKER (1964: 94) did not enumerate these setae, but did provide a figure for the male organ of *Oribotritia megale* (p. 114), which also appears to have eight pairs. In its constitution and the general distribution of setae, the distal part of the male organ is homologous to the three lobes of the ovipositor. The tendons of two retractor muscles insert on the smooth, sclerotized exterior wall of the organ. Three poorly defined internal processes can be seen, labeled x, s, and m in Fig. 5C. It is difficult to relate these processes to the internal extensions observed in the higher oribatid mites (GRANDJEAN, 1956: 210). Nevertheless, structures x and s seem to delimit the eugenital canal, and they terminate in a carina (Q). The carina, with a central opening, represents a eugenital slit. This organ is very difficult to study, and the exact opening through which the spermatophore is extruded is poorly documented in the oribatid mites (GRANDJEAN, 1969: 340).

The genital papillae are heterogeneous. Two pairs (*Va, Vm*) are in a dorsal position in relation to the third (*Vp*), which is ventral and lies just above the anogenital plate (Fig. 5D). The dorsal papillae are large, with rounded, sclerotized tips (Fig. 5E); their retractor muscles are large, conspicuous, and originate in their normal position well dorsad on the notogaster. These papillae can be fully extruded, as seen in many specimens. In contrast, the ventral pair are small, with a conical tip that sometimes has very thick walls (Figs. 5F, G). Though we have no histolo-

gical evidence, the muscles of *Vp* are short, and have a posterolateral direction totally different from those of the anterior pair. In fact, the muscles appear to originate laterally on the ventral shield itself, very close to the border with the plicature plate, at about the one-third point of the shield's length. We have not seen *Vp* extruded from the genital vestibule, even when the ovipositor is fully extended.

Gnathosoma (subcapitulum, chelicera, palp). As the illustrations of these structures are relatively numerous and explicit (Figs. 1, 2), we limit comments to the more salient traits. The subcapitulum is stenarthric. The capitular apodeme is somewhat pointed posteriorly, as described for other Ptyctima by GRANDJEAN (1957a: 92). There is no trace of a subcapitular gland, nor indication of a duct (GRANDJEAN, 1957: 88). The labrum (*LS*, Figs. 1E, 2B, C, E) is very slightly dentate in its distal extremity, which is delimited by two small lateral notches (Fig. 2B). The adoral setae insert on the sclerites of the lateral lips (Fig. 2E); seta *or₁* is bifurcated distally. On the rutellum the limits of collar *c* (indicating the presence of actinopilin) are visible even in normal light[4]. There is no rutellar brush.

The chelicera is typical for euphthiracaroid mites (Figs. 1G, 2A, D). The limits of the abaxial (*bα*) and adaxial (*bπ*) faces are distinguishable on the fixed digit. About ten spinules are present on each side of the cheliceral body. Most teeth of the two digits are comprised of the peculiar cuticular substance called "dental chitin" by GRANDJEAN (1947, p. 319), but the point on the movable digit labeled "6" in Fig. 2D is an ordinary cuticular formation — it is not birefringent. An adaxial swelling ("bouffisure paraxial") is clearly present.

Perhaps the most interesting feature of the chelicera, having general significance in studies of oribatid mite relationships, is the presence of a structure that by its form and position resembles a Trägårdh's organ (Fig. 2A, *Tg*). GRANDJEAN (1959, p. 359) noted that this organ is well defined only in the "nothroids" (Desmonomata, except absent in Malaconothridae), and the higher oribatid mites (Brachypylina, or Circumdehiscentiae), but it is also rather large in Collohmanniidae (R.A.N., unpublished observations). On

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4. All the designations on the figures are the standard ones employed by GRANDJEAN (1957c: 236).

	trochanter	femur	genu	tibia	tarsus
Leg I	v'	d, bv'', v'	(dσ''), (1'σ'), 1'', (v)	(dφ), (l), (v)	(ft), (pl), (tc), (it), (p), (u), s, (a) (pv), v', e, ω₁, ω₂, ω₃
Leg II	v'	d, bv'', 1''	(dσ), (l), v'	(dφ), (l), (v)	(ft), (tc), (it), (p), (u), s, (a) pv' ω₁, ω₂
Leg III	1', v'	d, ev'	(dσ), 1', v'	(dφ), 1', (v)	(ft), (tc), (it), (p), (u), s, (pv)
Leg IV	1', v'	d, ev'	d, v'	(dφ), (v)	(ft), (tc), (p), (u), s, (pv)

TABLE 2: Leg setation of *Synichotritia spinulosa* Walker (parentheses around setae denote a pair; parentheses around seta and solenidion denote coupling).

the adaxial face of the chelicera of *S. spinulosa* a kind of small tongue-like structure is present; it has the most adaxial position possible, i.e. it passes above the condyle of the movable digit articulation. When cleared in lactic acid, the proximal part remains visible no matter how long clearing is extended, but the distal part seems to dissolve, even when not heated. Nevertheless, annular formations (partitions?) can be distinguished proximally, showing that the organ is hollow and not a simple cuticular band. We have briefly examined the chelicera of *Steganacarus magnus*, directly from alcohol without treatment with dilute lactic acid, and the same structure exists. GRANDJEAN (in unpublished dossiers) had observed the same structure in *Phthiracarus, S. magnus*, and *Rhysotritia ardua*, and it has been illustrated for *Oribotritia* by YASTREBTSOV (1991). The consistency of these observations suggests that this structure is a true Trägårdh's organ, homologous to that of the nothroids and higher oribatid mites. Whether the small size of this organ in Ptyctima represents a reduced (vestigial) or ancestrally minute state, is uncertain, especially since it is large in Collohmanniidae, a group that may be closely related to Euphthiracaroidea (GRANDJEAN, 1966).

At the base of Trägårdh's organ, and a little below it, is consistently found a conical, tongue-like structure (Fig. 2A, *2*) that is part of the trochanter. It is appressed to the side of the chelicera and has borders that are irregular, but not denticulate. We have observed a similar structure in an undescribed species of *Phthiracarus* and GRANDJEAN (in unpublished dossiers) noted it in *Steganacarus magnus* and *Rhysotritia ardua*.

The palp has four free segments (Fig. 1F); femur and genu seem to be fused, but with no suture or

other trace to mark their limits. The setal formula (proximal to distal) is: 0-2-2-8, plus solenidion ω on the tarsus. Three tarsal setae are eupathidial: pair (*ul*) and seta *acm*. Seta *su* is a non-eupathidial spine, close to *ul'*, but independent from it.

Legs (Figs. 6, 7). Setal formulas for the legs (I to IV) are as follows (famulus included on tarsus I): trochanters (1-1-2-2); femora (3-3-2-2); genua (5-4-3-2), tibiae (5-5-4-3); tarsi (19-14-13-11). Setal homologies are given in Table 2. Supracoxal seta *eI* is present (Figs. 1A, 6F), but may be confused with a trochanteral seta. The famulus of leg I is simple, without striations (Fig. 7D); occasionally there are indistinct crenulations. Solenidial formulae are as follows: genu (2-1-1-0); tibiae (1-1-1-1); tarsi (3-2-0-0). All pretarsi are heterotridactylous, with a strong central claw and a pair of fine lateral claws. There are no circumscribed porose areas on the legs, but the cuticle exhibits a general fine porosity. The figures represent the various setae as they are after preservation in alcohol, i.e., before treatment with lactic acid. Though we have not made an exhaustive study, certain setae seem to be susceptible to damage in dilute lactic acid (2/3 acid, 1/3 water). Setae (*u*) and *tc''* of leg I are especially fragile. On the whole, all setae show an instability in this medium, which is unusual for oribatid mites.

Although we do not know the ontogenetic development of *spinulosa*, tarsus I of the adult (Fig. 6A, C) has what we tentatively consider accessory seta *v'* (see Remark 1, below, for explanation). Eupathidial setae include *s, pv'* (but not *pv''*), and pairs (*it*), (*p*), and (*a*). The two lateral claws have an insertion protected by a tubular "cuff" of cuticle, and the same transparent cuticle is prolonged proximally to near the bases of setal pairs (*p*) and (*it*) (Fig. 6B). Genu I
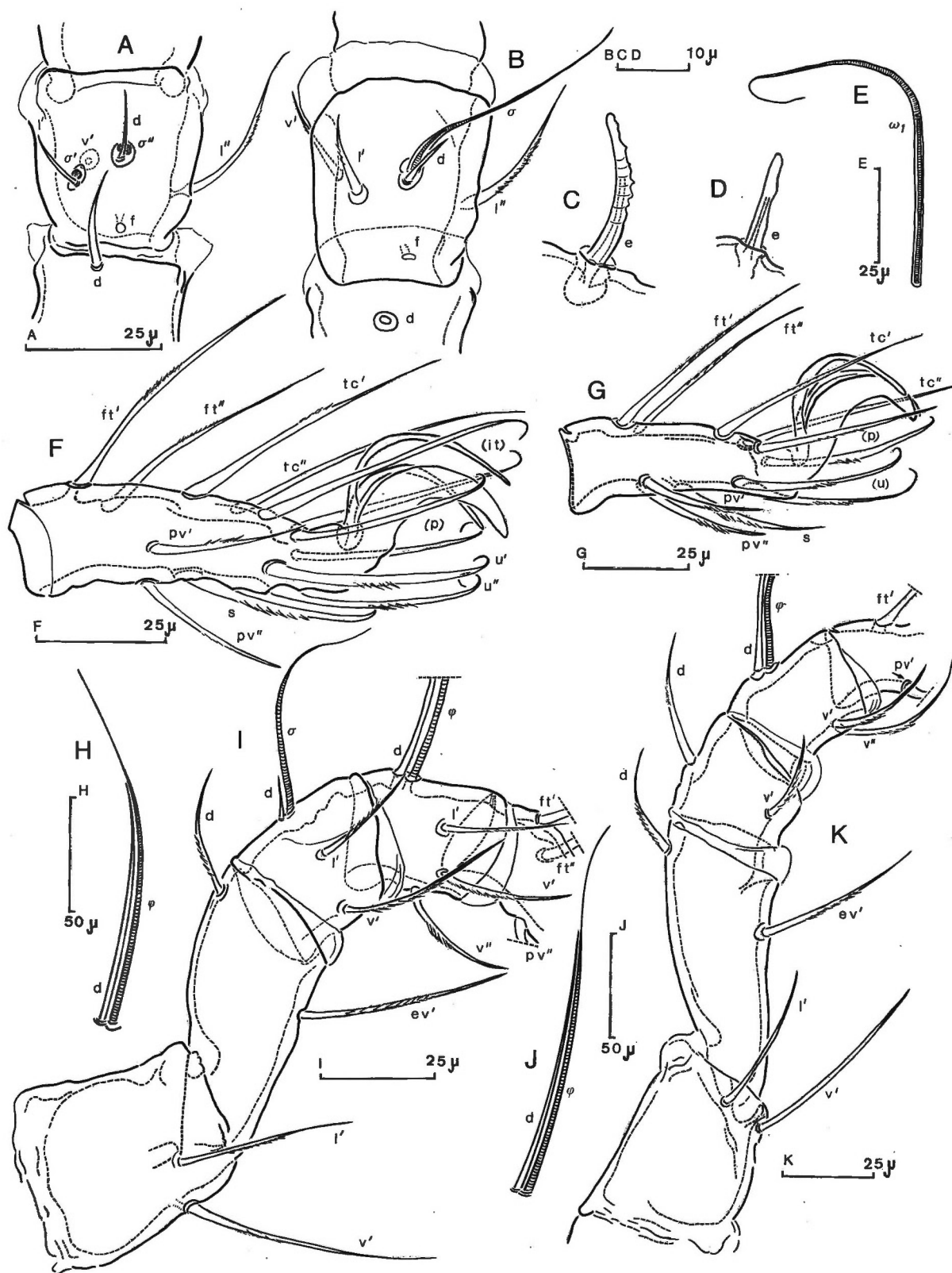
FIG. 7: *Synichotritia spinulosa* Walker (A, B, D, F-K) and *S. caroli* Walker (C, E).

A. — Genu and adjacent segments of right leg I, (dorsal aspect, distal to top). Notes: f = genual pore; the two solenidia are represented only by their alveoli; seta v'' absent, an anomaly. B. — Genu II; same, but solenidion drawn. C. — *S. caroli*, famulus of left tarsus I (adaxial aspect). D. — *S. spinulosa*, famulus of right tarsus I (abaxial aspect). E. — *S. caroli*, solenidion $_1$ of left tarsus I. F. — Left tarsus III (abaxial aspect). G. — Left tarsus IV (abaxial aspect). H. — Solenidion and seta d of left tibia III. I. — Left leg III (abaxial aspect, *sans* part of tarsus). J. — Solenidion and seta d of left tibia IV. K. — Left leg IV (abaxial aspect, *sans* part of tarsus).
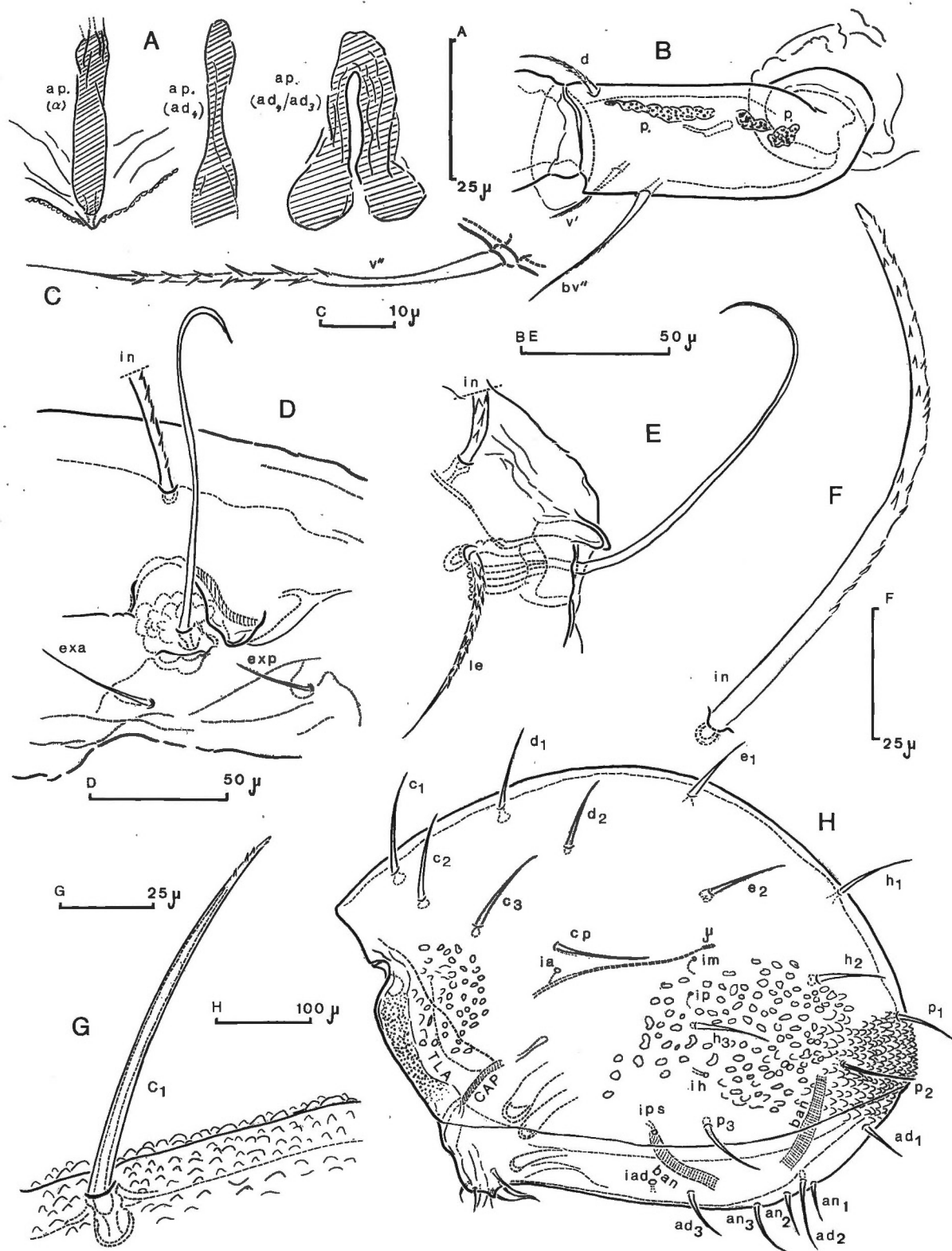
FIG. 8: *Synichotritia spinulosa* Walker (A) and *S. caroli* Walker (B-H).

A. — Preanal apodeme of female in cross section; seen (left to right) at levels of α, ad_4 and between ad_4 and ad_3 (see Fig. 4A). B. — Left femur I (abaxial). C. — Seta v'' of left tibia I. D. — Posterior corner of prodosum in region of sensillus (left lateral aspect). E. — Left sensillus and nearby region (frontal aspect). F. — Left seta *in*. G. — Left notogastral seta c_1. H. — Opisthosoma (lateral aspect of male).

exhibits a pore in the dorsal region (Fig. 6F, 7A, f; see GRANDJEAN, 1940: 64), as in *Apotritia walkeri* (NORTON & LIONS, 1992) and *Rhysotritia ardua* (GRANDJEAN, 1942: 41).

SYNICHOTRITIA CAROLI WALKER, 1965

As noted above, our discussion of this species is limited mostly to differences with *S. spinulosa*; other morphological characters are considered identical. Methods of study are the same as discussed above.

Material examined. Five specimens from the following location were studied: California (U.S.A.), Del Norte Co., Jedediah Smith Redwoods State Park, 8-VI-1973, R. A. NORTON, col. (RAN 73-160). Ex: litter and small twigs in *Sequoia sempervirens* forest. Two specimens (one male, one female) were dissected. Also studied was a series of 9 paratypes deposited in R.A.N.'s collection by N. A. WALKER: California, Humboldt Co., Humboldt Redwoods State Park, 4 km west of Miranda, 23-III-1956, N. A. WALKER, col.

Size, general form, color, sex. Various measurements of a male and female are given in Table 3. Observed on a porous carbon block, individuals are covered with debris, especially on the ventral surface; the notogaster has less debris. The notogaster is light yellow, whereas the prodorsum and anogenital plate are medium brown. In such observation the articulation of the bothridial scale with the tectonotal notch is easily discerned. The notogastral setae are erect, nearly perpendicular to the surface, and the long sensillus is recurved, like a shepherd's crook.

	Male	Female
Notogastral length	708	841
Notogastral width	383	475
Notogastral height	467	533
Prodorsal length	359	407
Prodorsal width	250	292
Prodorsal height	141	166
Sensillar length	152	171

TABLE 3: Measurements (in μm) of a male and female *Synichotritia caroli* Walker.

Cuticle (including cerotegument). The cerotegument forms corpuscles of various form and size; seen in profile they are conical. GRANDJEAN (in his unpublished dossiers and in correspondence with N. WALKER), noted that these granular projections disappear if one scrapes the notogastral surface, and observed that the projections are very birefringent; we have made the same observation. The cuticle itself is strongly birefringent, indicative of mineralization (NORTON & BEHAN-PELLETIER, 1991: 1506).

Prodorsum (Figs. 8D-F). The larger prodorsal setae are rugose (*ro, le*), or bear clear barbules (*in*). The exobothridial setae (*exa, exp*) are relatively long (40, 25 μm, respectively).

Notogaster (Figs. 8G, H, 9A). There are 14 pairs of strong, erect notogastral setae (Fig. 8G); unlike *S. spinulosa* pair p_4 is absent. Setae are hollow to various degrees: their whole length (c_1, c_2, *cp*, h_1, p_1); for the basal 3/4 of their length (c_3); for half their length (p_3); or for 1/4 their length (d_1, d_2, e_1, e_2, h_2, h_3, p_2). Most of these setae terminate in barbules or spines, but d_2, h_3 and p_1 are blunted. There are five pairs of lyrifissures: *ia, im, ip, ih* and *ips*. The curious structure seen below the tectonotal notch in *S. spinulosa* is also present in *caroli*, but only the circular impression in the thickened integument is noticeable. It is located slightly more dorsally, closer to the notch than in *spinulosa*, and there is no trace of the groove in the cuticle anterior to this impression. Again, we have no interpretation of its function.

Ventral region (Figs. 8H, 9A, B, D, E). The formula of coxisternal setae (I-IV) is 3-1-3-3. Their lengths range from 4 μm (*1a, 3a*) to 131 μm (*1b*), and some are clearly barbed (*3b, 3c*, respectively 62 and 92 μm) [5]. Two differences with *spinulosa* are immediately apparent: there are 10 pairs of genito-aggenital setae, and there are only three pairs of adanal setae. Other differences are less conspicuous. Anteromedially, in the genital region internal to the carinae, a pair of oblique internal carinae (*k*, Fig. 9A, D, E) form a "V". Posterior to this, the medial cuticle of each valve forms a shallow depression in the thickness of the plate (its margins are indicated by line *p*

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5. We did not observe numerical variation on coxisterna I, III and IV, in contrast to MAHUNKA (1990). Unlike his Fig. 41, seta 3a is very short, spiniform, in all our specimens, including paratypes.
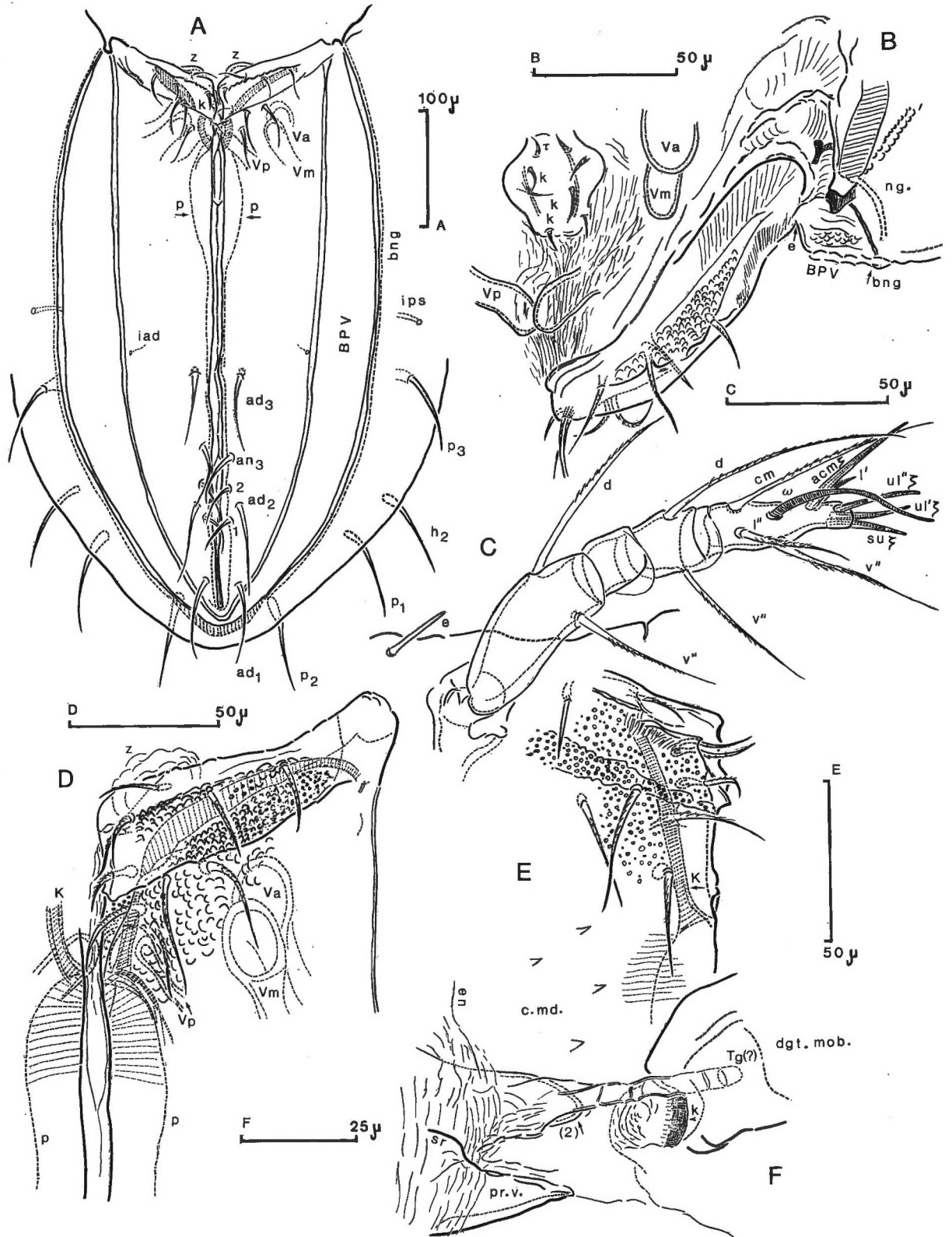
Fig. 9: *Synichotritia caroli* Walker.

A. — Opisthosoma (ventral aspect of male). B. — Left ventral plate and genital vestibule of same individual (frontal aspect, after removal of legs and prodorsum; not all setae of genital organ are illustrated). C. — Right palp, with independent eupathidia *ul'*, *su* and *ul''* (abaxial aspect). D. — Left ventral plate of male, anterior region (ventral aspect). E. — Right ventral plate of female, anterio-medial region, showing carina *k* (ventral aspect). F. — Detail of left chelicera, after dissection, showing the small Trägårdh's organ, partially dissolved during preparation (adaxial aspect).

in Fig. 9D)[6]. The general porosity of the ventral plates is more conspicuous than in *spinulosa,* and the anal setae insert at the edge of the more lateral granular zone, rather than within the smooth band. Anteriorly, the region of flexibility between the ventral shield and the plicature plate (Fig. 9B) is similar to that of *spinulosa.*

As in *spinulosa,* the medial attachment of the halves of the ventral shield is associated with the anterior extrusion of the genital organs, between the shield and the coxisternal region. The medial attachment was studied after strong heating in lactic acid. Under these conditions, in the anterior region (the area of the carinae) the closure is very tenacious; the plates and carinae are touching. Posteriorly, to a level just anterior to *iad,* the plates are joined by the attaching cuticle. Between this region and the level of setae ad_3, the valves separate, and internally one can see the sheets of muscle (identical to *spinulosa*). The anal aperture occupies the level from ad_3 to ad_1 and has the same sclerotized border (*ban*) as *spinulosa.* Posterior to ad_1 the valves are closed. As in *spinulosa* (Fig. 4C, E), there is a preanal apodeme in the middle third of the ventral region; but that of *caroli* is thinner and smaller.

The male organ exhibits no clear differences with that of *spinulosa;* it has the same eight pairs of eupathidial setae. The ovipositors of the two species are similar, except that there is an additional pair of setae in *caroli* (τ_4, 3 μm), giving a total of six pairs; the eupathidial state of the additional seta is unknown due to its very small size. The sclerotization of the outer surfaces of the lobes is clearly more pronounced than in *spinulosa.* The anterior extrusion of this organ was clearly observed, with the ventral shield halves being firmly attached medially, regardless of the state of inflation of the opisthosoma. The genital papillae are similar to those of *spinulosa,* except the small ventral pair (*Vp*) is distally rounded, not conical.

Gnathosoma (subcapitulum, chelicera, palp). The sclerites of the lateral lips are well developed, and adoral seta or_1 is even more strongly forked than in *spinulosa.* Neither the subcapitular gland nor ducts were observed, and the capitular apodeme is like that of *spinulosa.*

The chelicera is very similar to that of *spinulosa,* but some differences were noted. Setae *cha* and *chb* are slightly rugose. Also, teeth 3 and 4 of the fixed digit, and 4 and 5 of the movable digit, appear eroded. A small Trägårdh's organ is present, but its distal region is difficult to distinguish after preparation in lactic acid (Fig. 9F). At certain places its cuticle shines when observed with polarized light. It is therefore not an ordinary section of synarthrodial cuticle (i.e. it is not part of the conical formation labeled *2*). The presence of this structure corroborates our observation of a small Trägårdh's organ in *spinulosa.*

The palp (Fig. 9C) has five segments; the genu is freely articulated with the femur, not fused as in *spinulosa.* The setal formula is: 0-2-0-2-8, plus solenidion ω. Four tarsal setae are eupathidial: *acm, su,* and pair (*ul*). Setae *ul'* and *su* are clearly separated, independent, and solenidion ω is distinctly curved.

Legs. The setation and solenidial complements are similar to those of *spinulosa,* with two exceptions[7]. First, tarsus I has two ventral setae that are assumed to be accessory (Fig. 6D); i.e. *v"* is present, in addition to *v'* (see Remark 1). Second, tibia III has only three setae (*v"* is absent). *Leg I.* In addition to the general porosity of the cuticle of femur I, there is a group of larger pores, seemingly plugged, on the abaxial and adaxial faces (Fig. 8B). Setae *v'* and *bv"* of femur I are barbed, especially the middle third of the latter seta. The genual pore is very distinct, and on the abaxial face of this segment there is a poorly defined porose area. On the tibia *v'* and *v"* (Fig. 8C) have large barbs. The setae of the tarsus, especially pairs (*u*) and *(tc),* are very fragile in preparations with lactic acid (diluted by 1/3 with water). Tarsal eupathidia include *s,* and pairs *(p), (a), (it),* and *(pv).* Solenidion ω_1 is longer than in *spinulosa,* and is distally flagellate (Fig. 7E). Unlike that of *spinulosa,* the famulus of *caroli* exhibits clear crenulations and weak transverse striae (Fig. 7C); a similar morphology was described for *Oribotritia berlesei* (GRANDJEAN, 1935: 12). *Other*

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6. This is a general thinning of the plate, and not a distinct pocket such as that present in *Sabahtritia* (MAHUNKA, 1987)

7. Our data on leg setation in this species are consistent with the formulae given by MAHUNKA (1990, p. 71), with one exception. He suggested that there are 15 setae on tarsus II, but we found 14 on all specimens, except one leg of a paratype that lacked both primiventral setae (i.e., 13).

Legs. On leg II the genual pore is slit-like, as in *spinulosa,* and seta *d* is coupled with solenidion σ on the genu; all tarsal setae are very fragile in lactic acid. On leg III, the only differences with *spinulosa* are the absence of tibial seta *v″,* noted above, and the presence on the femur (dorsally and abaxially) of regions of the cuticle with a form of porosity different from that of the general cuticle; tarsal setae are also very fragile. Leg IV is similar to that of *spinulosa* in all respects. In addition, there is a scissure of some kind on the femur, genu and tibia of legs III and IV, directed from the area of seta *d* vertically on the adaxial face; this scissure was not seen in *spinulosa.*

REMARKS

1. *The identity of proximal ventral setae on tarsus I of* S. spinulosa *and* S. caroli.

Both species of *Synichotritia* have more setae on the venter of tarsus I than does *Apotritia walkeri:* one more in *spinulosa,* two more in *caroli.* Since we lack specimens of immature instars and could not study setal ontogeny, the interpretation of their ventral setae is provisional. Our interpretation is based on the assumption that extra setae are *accessory —* added to the tarsus during ontogeny. If any prove to be *fundamental*—present when the leg first forms, i.e. the larva in this case—other interpretations will be necessary.

It seems likely that the extra seta of *S. spinulosa* is accessory ventral seta *v′* (Fig. 6C), first added during some late instar. This interpretation is consistent with two generalities: 1) accessory setae (other than iterals) are added proximally on the tarsus (see general discussion in GRANDJEAN, 1958); 2) if there is disjunction to the primiventral pair (*pv*), it is a *prime disjunction—pv′* is more distal (GRANDJEAN, 1962, pp. 416-417). We see only two other plausible arguments. First, more than one subunguinal seta might be present. Two eupathidial *s* setae are found, for example, in the early derivative oribatid mites *Palaeacarus hystricinus* (GRANDJEAN, 1954: 209), and *Stomacarus macfarlani* (GRANDJEAN, 1957b: 214), and the latter has a third subunguinal that has normal form. This explanation seems unlikely, since extra

subunguinals are associated with additional full verticils added to the proximal region of the tarsus in these primitive species, and there are no such verticils in *S. spinulosa.* Further, none of the setae proximal to *s* are aligned with it in the plane of pseudosymmetry. As a second explanation, one of the proximal setae may be the *monotrope* seta, *m″,* a fundamental seta inserted between *s* and *pv″* in various Enarthronota, Parhyposomata and Lohmanniidae (GRANDJEAN, 1941: 36; 1962: 415). However, this makes little sense for *S. caroli,* since there is only one seta on the abaxial side (Fig. 6C); i.e. the pattern is the mirror image of what it should be if *m″* were the extra seta. GRANDJEAN found its opposite member, *m′* (also called *n′* and *y*) to exist rarely in oribatid mites, and to be accessory and never added unless *m″* is already present[8].

Our interpretation is less certain for *S. caroli* (Fig. 6D). It assumes that the posterior two setae, *v′* and *v″,* are added during ontogeny. However, by default this requires that pair (*pv*) sometimes has a disjunction opposite to that of *spinulosa* and any other oribatid mite in which the two setae are not aligned transversely. In *caroli* there is either no disjunction or the seta labeled *pv″* in Fig. 6D is the more distal. It seems unlikely that all four setae lying proximal to *s* in Fig. 6D will prove to be fundamental. If only two are fundamental, then our interpretation is probably correct, with the unusual distal position of *pv″* perhaps being related to its eupathidial transformation. If three of them are fundamental, then one explanation seems most likely: tarsus I of *caroli* may be the same as that of *spinulosa,* but with the addition of *m″.* This could be envisioned using Fig. 6D by changing *pv″* to *m″,* and changing *v″* to *pv″.*

2. *Are* Synichotritia spinulosa *and* S. caroli *congeneric?*

There are several differences between *spinulosa* and *caroli* that might be considered significant enough to propose separate genera for the two species; i.e. similar differences are used to distinguish genera in various other groups of mites. These respective differences include: 1) the number of notogastral setae (30 vs 28); 2) the number of notogastral lyrifissures

8. TRAVÉ (1967: 99) considered a fundamental adaxial (′) seta to be *m′* on tarsus I of *Phyllochthonius.*

(3 vs 5); 3) the number of genito-aggenital setae (11 vs 10); 4) the number of adanal setae (4 vs 3); 5) the number of palpal segments (4 vs 5); 6) the number of setae on the paired lobes of the ovipositor (3 vs 4); 7) the number of setae on tibia III (4 vs 3). However the overall similarity of these species is great, and considering the strong modifications of other genera in this morphologically plastic family (NORTON & LIONS, 1992) we continue to regard them as congeneric.

3. *The combinations of other species.*

Three other species of *Synichotritia*—all from China—have been named, but we transfer each of them to the Oriental genus *Sabahtritia,* and slightly broaden its diagnosis (compare MAHUNKA, 1990: 66). NORTON & LIONS (1992) considered three traits of *Sabahtrita* to be apomorphies that distinguished it from *Synichotritia*: 1) a pair of poorly-characterized, deep hollows in the genital region; 2) monodactyly by loss of lateral claws; and 3) a regressed genito-aggenital setation of 7 pairs. Based on the two species described by MAHUNKA (1987, 1991), one could now add: 4) combined ventral plates broadest medially (broadest anteriorly in *Synichotritia*); 5) anterior band of genital region, defined by paired carinae, transverse and rectangular (band broadest medially and strongly angled in *Synichotritia*); 6) genito-aggenital setae strongly dimorphic (rather similar in size and shape in *Synichotritia*); 7) setae ad_3 removed from medial margin of plate a moderate to large distance (relatively close to margin in *Synichotritia*. The precise structure and significance of the internal structures (hollows, tubes) associated with the genital region of *Sabahtritia* remain to be determined, and in fact they seem quite different in the two described species.

The three Chinese species have most of the above traits. *Sabahtritia foveolata* (HU et al., 1991)—*new combination*—has all of them except that legs are tridactylous, and it has lost yet another genito-aggenital seta (6 pairs). *Sabahtritia tianmuensis* (HU et al., 1991)—*new combination*—has most listed traits, but it is also tridactylous and the genito-aggenital setation is not reduced (10 pairs). *Sabahtritia furcata* (HU & WANG *in* WANG et al., 1992)—*new combination*—has most of the listed traits, except that

there are 10 pairs of genito-aggenital setae and they are homogeneous. (The legs of *S. furcata* were not described; no internal hollow or tube associated with the genital region was illustrated for this species, but this should be re-investigated, since internal structures are often not figured.) All three of these species can be included in *Sabahtritia* if its generic diagnosis is modified to include tridactylous species and those with genito-aggenital setations from 6-10 pairs.

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