GENERIC CONCEPTS IN THE DAMAEIDAE (ACARI : ORIBATEI) I. THREE NEW TAXA BASED ON SPECIES OF NATHAN BANKS

BY

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ABSTRACT

Species described by Nathan Banks in the oribatid mite genera *Belba* and *Oribata* are discussed. *Belba australis, B. floridana, B. minuta, Oribata consimilis, O. neosota* and *O. perolata* are not members of the Damaeidae. *Oribata carolinensis* is designated type-species of *Dyobelba* n. gen. ; *O. diversipes* is a synonym. *Protobelba* n. subg. is proposed as a subgenus of *Belba*, with *O. californicus* as type. *Akrodamaeus* n. subg. is proposed as a subgenus of *Epidamaeus*, with *O. longiseta* as type. *Belba inaequipes* is recombined to *Epidamaeus* (*Akrodamaeus*) *inaequipes*. *Oribata canadensis* is recombined to *Epidamaeus* (*E.*) *canadensis*.

RÉSUMÉ

On discute les espèces décrites par Nathan Banks chez les genres *Belba* et *Oribata*. *Belba australis, B. floridanus, B. minuta, Oribata consimilis, O. neosota* and *O. perolata* ne sont pas des Damaeidae. On désigne *Oribata carolinensis* espèce-type de *Dyobelba* n. gen. ; *O. diversipes* est un synonyme. On propose *Protobelba* n. subg. comme un sous-genre de *Belba*, avec *O. californicus* comme espèce-type. On propose *Akrodamaeus* comme un sous-genre d'*Epidamaeus*, avec *O. longiseta* comme espèce-type. *Belba inaequipes* devient *Epidamaeus* (*Akrodamaeus*) *inaequipes* et *Oribata canadensis, Epidamaeus* (*E.*) *canadensis*.

Although known from every continent except Australia and Antarctica, the vast majority of the approximately 150 described species of the oribatid mite family Damaeidae are restricted to the Northern Hemisphere (BULANOVA-ZACHVATKINA, 1973). Over 80 % of these are known from Europe and western Asia, but the poorly-studied nearctic region has a fauna which is potentially equally as rich. Because of the efforts of numerous investigators of the Eurasian fauna and the apparent relative paucity of species in the Southern Hemisphere, detailed studies of North American taxa will probably make this the best-known major oribatid family.

Even a cursory examination of North American Damaeidae would show that the generic concepts of BULANOVA-ZACHVATKINA (1967) do not accommodate many of our species. In certain instances it is sufficient to broaden her concepts somewhat ; in other cases the proposal of new genus-group taxa seems warranted. The first several papers of this series will be devoted to the latter effort, with new taxa being mostly from North America. The final contribution will revaluate previous classifications of the Damaeidae both at the genus-and family-group levels. It should be mentioned at the outset that throughout this series I use the broad concept of the family Damaeidae expressed by BALOGH (1965), with the exception that *Veloppia* Hammer is excluded (NORTON, 1978a). The final paper will demonstrate why, on the basis of the nearctic fauna, I feel the division of the Damaeidae into three families (BULANOVA-ZACHVATKINA, 1967) is unjustified.

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The terminology used in the following descriptions is based on the many studies of F. GRANDJEAN (see TRAVÉ and VACHON, 1975 for references). Conventions of leg setal nomenclature are summarized by NORTON (1978b). Modifications in the nomenclature of idiosomal tubercles is explained by NORTON (1978a). The " ventral body length " is measured from the rostral tip to the posterior edge of the ventral plate ; it avoids discrepancies caused by different degrees of notogastral distension. Lengths of leg segments include the portion inserted in the next most proximal segment.

BANKS' SPECIES OF DAMAEIDAE

This first contribution proposes three new taxa based on species described by the American arthropodologist Nathan Banks. During his work on North American Oribatei, which spanned three decades between 1890 and 1920 (plus a single paper in 1947), Banks proposed approximately two-dozen species in the genera *Belba* Heyden and *Oribata* Latreille. By modern standards his descriptions were very incomplete and sometimes inaccurate, so that reference to his original specimens is necessary. Fortunately, almost all are well maintained in the Museum of Comparative Zoology, Cambridge, Massachusetts (MCZ). Of the species cited below, only the original specimens of *Belba australis* and *Oribata puritanica* could not be located.

BANKS' generic concepts were not constant. In his pre-1900 works, he followed the lead of A. D. MICHAEL (1888) in grouping the genus *Oppia* C. L. Koch and its relatives with species now placed in the Damaeidae. Unlike MICHAEL, however, BANKS utilized the name *Belba* instead of *Damaeus* for this heterogeneous group [1]. None of the three species of *Belba* (*B. australis*, *B. floridana*, *B. minuta*) proposed during this period (BANKS, 1895a, 1896) can be included in modern concepts of the Damaeidae ; all are apparently members of the Oppiidae. At this time Banks also followed MICHAEL'S use of the genus *Oribata* ; he included all of what we now call poronotic Branchypylina. The nine *Oribata* species proposed during this period (BANKS 1895a, 1895b) are not related to the Damaeidae.

After about 1900, BANKS, concept of *Oribata* apparently became similar to that of KULCZYNSKI (1902), that is, equivalent to the present families Damaeidae, Gymnodamaeidae and Ameridae, but included still other diverse pycnonotic groups. Banks proposed ten *Oribata* species in this later period, seven of which belong in the Damaeidae [2]. As noted by NORTON (1977) *O. angustipes* Banks, 1906 was correctly transferred to *Damaeus* by EWING (1909) ; the remaining six species of *Oribata* have never been recombined using modern classifications.

Oribata californica Banks, 1904, *O. longiseta* Banks, 1906 and *O. carolinensis* Banks, 1947 are here proposed as type-species of three new genus-group taxa. As noted later, careful study of Banks' original damaged specimen of *O. diversipes* Banks, 1947 has shown it to be conspecific with *O. carolinensis*. *Oribata canadensis* Banks, 1909, a species common in decaying wood in eastern North America, is here recombined to *Epidamaeus canadensis* (Banks) (*new combination*).

The vial in the MCZ which supposedly housed the single alcoholic specimen of *O. puritanica* Banks, 1906 was found to be empty. Although re-collecting at the type-locality in Massachusetts is needed, the original description corresponds fairly well with a widespread species of *Epi-*

1. *Belba* Heyden, 1826 and *Damaeus* C. L. Koch, 1836 were usually considered synonyms at this time ; *Belba* had priority.

2. The three to be removed are : *Oribata neosota* Banks, 1909 which is a species of *Eremobelba* ; *O. perolata* Banks, 1909 which can be placed in a broad concept of *Oppia* ; and *O. consimilis* Banks, 1910 which is also an *Oppia*.

damaeus. This is very similar to, and possibly conspecific with, *E. grandjeani* Bulanova-Zachvatkina, described from eastern Asia.

Banks' concept of the genus *Belba* after 1900 is not clear. He proposed only one *Belba* species during this period : *B. inaequipes* Banks, 1947. As noted later, I consider this species congeneric with *Oribata longiseta*.

Epidamaeus : subgenus **Akrodamaeus** n. subg.

TYPE SPECIES : *Oribata longiseta* Banks ; Banks, 1906, p. 498.

ETYMOLOGY

The prefix *akro* is from the Greek word meaning " extremity ". It refers ot the abundance of regressive character-states.

DESCRIPTION

Adult. Medium sized species, ventral body length about 400 to 650 μm ; medium brown to black. Cerotegument cylindrical to filamentous, not thickly developed. Prodorsal surface usually smooth. Apophysis P usually absent, sometimes weakly developed. Tubercle Da usually well developed, Ba rarely present ; Dp and Bp always absent. Sensillus finely attenuate to flagellate. Notogaster usually hemispherical, evenly rounded, sometimes elliptical viewed perpendicular to circumgastric suture. Spinae adnatae absent. Notogastral setae of diverse size and form. Neither immature gastronomic exuviae nor organic debris carried by adult. Tubercles Sa, Sp variously developed ; Va usually present, Vp present or absent, E2a, E2p usually absent. Discidium present, variously developed. Epimeral setation 3-1-3-4. Legs clavate to moniliform but usually moderately long ; leg IV distinctly longer than total body length. Trochanteral setation 1-1-2-1. Femoral setation 7-6-4-4. Genual setation 4-4-3-3 ; seta *d* present on each genu. Tibial setation 4-4-3-3 ; seta *d* absent on all tibiae. Tarsal setation (famulus included) 20-17-17-14 (*v″* present on all tarsi). Setae *p′*, *p″* and *s* eupathic on tarsus I.

Ontogeny. Cornicle *k* present on all nymphs, straight, narrow, elongate ; exuviae highly stacked. No organic debris carried. Famulus regressive, sunken in sclerotized cup in immatures. Seta *v′* tritonymphal on trochanter IV and deutonymphal on genu III.

DIAGNOSIS

This subgenus is readily distinguishable from the nominate subgenus by the absence of spinae adnatae.

REMARKS

1. A second species belonging to this subgenus has been described from the eastern U.S., *Epidamaeus* (*Akrodamaeus*) *inaequipes* (Banks) (*new combination*). About a dozen North American species are undescribed and another species has been collected from South America.

2. Using the somewhat artificial classification of BULANOVA-ZACHNATKINA (1967), this subgenus not only would have to be established as a separate genus, but on the basis of absence of spinae adnatae would be placed in a family (Belbidae) separate from *Epidamaeus* (Damaeidae). In the last paper of this series I will investigate generic groupings from a phylogenetic viewpoint and demonstrate the close relationship of these two taxa. The importance associated with presence or absence of spinae adnatae in earlier classifications greatly obscures such relationships in a number of groups within the Damaeidae.

Epidamaeus (Akrodamaeus) longiseta (Banks)

ADULT

Dimensions. Mean ventral body length of 10 specimens 574 μm (range 531-611 μm) ; mean maximum notogastral width 382 μm (range 346-422 μm).

Cerotegument. Mostly filamentous, but filaments appear covered with fine powder. Filaments longest on notogaster, terminating in spherical clump of granules ; reduced on distal portion of legs. Setae of notogaster and legs usually covered with granules or short, closely appressed loops.

Prodorsum (Fig. 1A). Tubercles Ba, Bp absent. Tubercles Da widely spaced, tips usually rounded but sometimes acute ; Dp absent, but integument slightly thickened in its place.

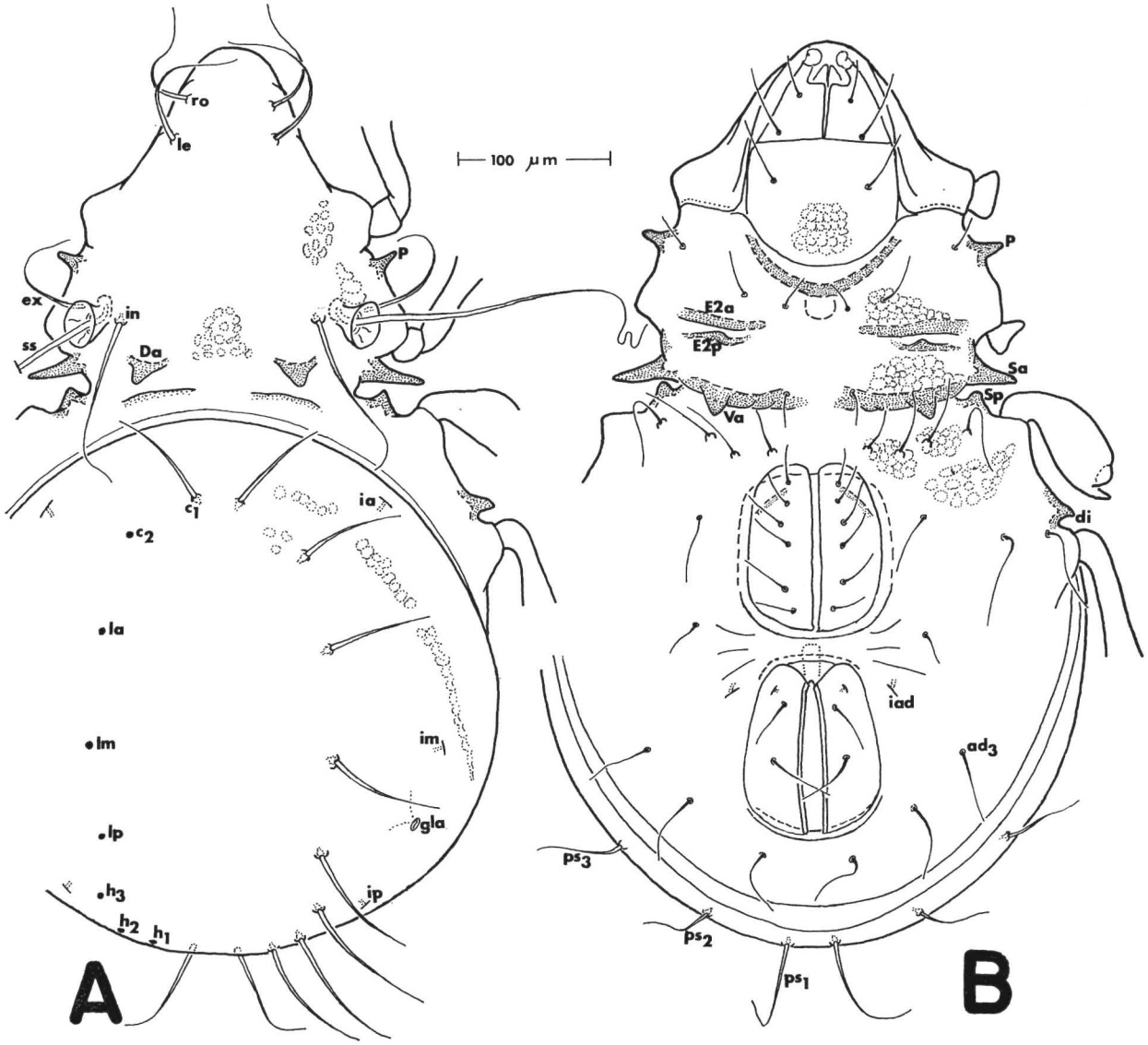

FIG. 1. — *Epidamaeus (Akrodamaeus) longiseta* (Banks), adult :
A) dorsal aspect ; B) ventral aspect.

A small, narrow apophysis P present, directed antero-laterally. Setae *ro*, *le* and *ex* similar, relatively thin, smooth, finely attenuate, medially curved ; *in* smooth, longer, sub-flagellate. Sensillus (*ss*) longer than prodorsum ; smooth, flagellate, with terminal undulations.

Notogaster. Very slightly elliptical viewed perpendicular to circumgastric suture ; 1.1 times longer than wide, with series of irregular, low, somewhat longitudinally arranged ridge-like undulations (best seen in reflected light). Dorsal notogastral setae of moderate length, thin, smooth, acuminate, erect, radially directed ; *h* series often slightly longer than anterior setae. Setae ps_1 ps_2, ps_3 finely attenuate, with laterally curving tips (Fig. 1B). Gastronotic scalps of immatures not carried by adults [1].

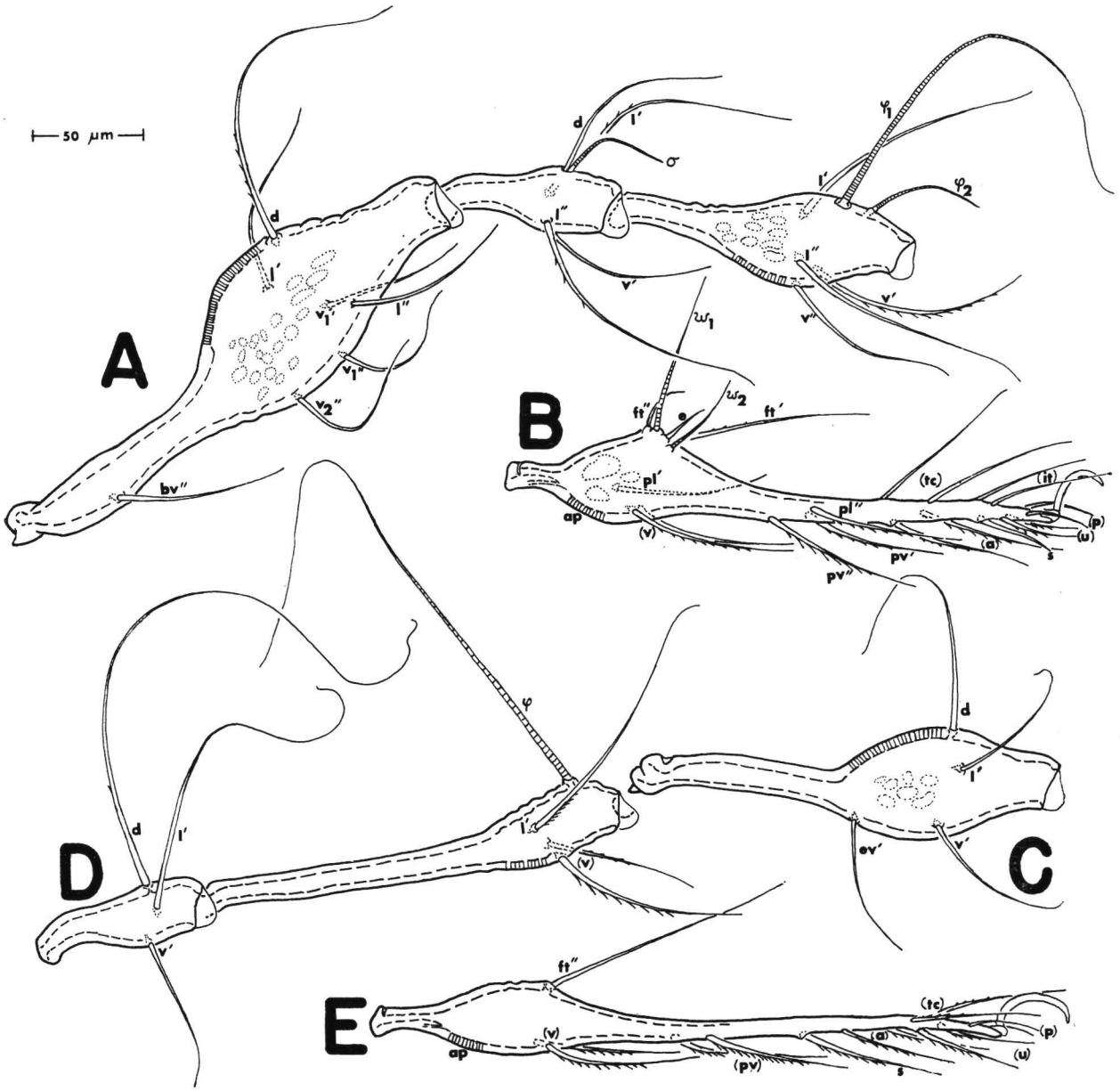

FIG. 2. — *Epidamaeus* (*Akrodamaeus*) *longiseta* (Banks), adult :
A) femur, genu and tibia I ; B) tarsus I ; C) femur IV ; D)genu and tibia IV ; E) tarsus IV (all antiaxial aspect).

1. In laboratory cultures adults occasionally carry these exuvial scalps for a short time after molting ; they have never been seen on specimens collected from the field.

Ventral region (Fig. 1B). Tubercles E2a, E2p not well developed, represented only by a thickened ridge on each side of deep second epimeral groove. Tubercle Va large, sub-triangular, usually rounded at tip ; Vp absent. Tubercle Sa elongate, usually acute terminally ; Sp much shorter, rounded. Discidium (*di*) conical, acute, usually slightly posteriorly curved. Epimeral setation 3-1-3-4 ; setae smooth, inserted on individual small tubercles. Setae *3c*, *4c*, *4d* longer than others, flagellate. A series of indistinct surface undulations radiate on each side from area between anal and genital apertures. Seta ad_3 laterally displaced.

Gnathosoma. Generally typical of family. Mentum of infracapitulum quadrate, with distinct, dark, circular to rod-shaped microtubercles in lateral region.

Legs (Fig. 2). Leg segments often with slightly wrinkled integument on bulbs. Femora and tibiae with circular to rod-shaped microtubercles. Internal muscle scars very prominent on cleared specimens. In addition to normal porose areas on all femora and trochanters III and IV, all tibiae and tarsi have porose areas on proximoventral region of bulb (Fig. 2B, E ; *ap*). All femora with bulb constricted distally. Leg IV 1.4 to 1.5 times ventral body length. Femur IV 1.2 to 1.3 times length of trochanter IV ; femur III 1.5 to 1.6 times length of trochanter III. Ventro-distal tectum well developed on trochanters III and IV. In addition to setal differences noted below, leg II differs from leg I in being slightly shorter ; leg III also shorter than IV, basal stalk of tibia III approximately equal to length of bulb. Setal formulae (famulus included, solenidia in parentheses) : leg I, 1-7-4(1)- 4(2)-20(2) ; leg II, 1-6-4(1)-4(1)-17(2) ; leg III, 2-4-3(1)-3(1)-17 ; leg IV, 1-4-3-3(1)-14. No variations were observed. Setae *p'*, *p"* and *s* eupathic on tarsus I. Seta *d* of genu IV, and tibia IV solenidion ø flagellate, each exceeding tibia IV in length.

ONTOGENY

Dimensions. Mean total length of four larvae 266 μm (range 241-281 μm) ; two protonymphs 306 μm (289, 322 μm) ; three deutonymphs 405 μm (range 362-450 μm) ; three tritonymphs 568 μm (range 522-603 μm).

Cerotegument. Granular in all immatures ; no filaments present.

Prodorsum. All prodorsal setae in larva similar to those of adult, except *ro* and *le* may have one or two small barbs and *ro* strongly displaced medially. Seta *in* short in nymphs, with blunt, slightly swollen tip and minute terminal points ; other setae similar to adult.

Gastronotic region. Larva more or less truncate posteriorly (Fig. 3A) ; nymphs rounded or slightly tapered (Fig. 3B). Cornicle *k* narrow, elongate, straight or with only slight curvature. Larval setae c_1, c_2, *da*, *dm*, *dp* long, flagellate, strongly barbed ; *lp* similar, but even longer, approximately equal to length of body ; c_3, *la*, *lm* much thinner, shorter, but also flagellate, with at most one or two small barbs. Nymphs lack setae *da*, *dm*, *dp* ; remaining setae essentially smooth, flagellate, generally decreasing in length posteriorly, except for h_1, which is as long as body. Pair h_1 inserted on same sclerite ; all others on individual sclerities.

Ventral region. Epimeral setation as follows : larva 2-1-2 ; protonymph 3-1-2-1 ; deutonymph 3-1-2-2 ; tritonymph 3-1-3-3. In one tritonymph seta *4d* appeared prematurely on one side. Ontogeny of anal and genital regions typical of family [1]. One tritonymph had two setae ad_3 inserted in same alveolus.

Legs. Solenidial ontogeny typical of family. Solenidion $ø_1$ of tibia I large, tactile in all stases ; coupled seta *d* very small. Seta *d* always longer than ø on tibiae of legs II and III in immatures ; *d* slightly shorter than ø on leg IV. Seta *d* on genu I to III minute in larva, very

1. This ontogeny is described for the genus *Damaeus* by NORTON (1977).

difficult to see ; solenidion σ appressed to posterolateral surface of genu. Famulus minute, sunken in sclerotized cup in all immatures.

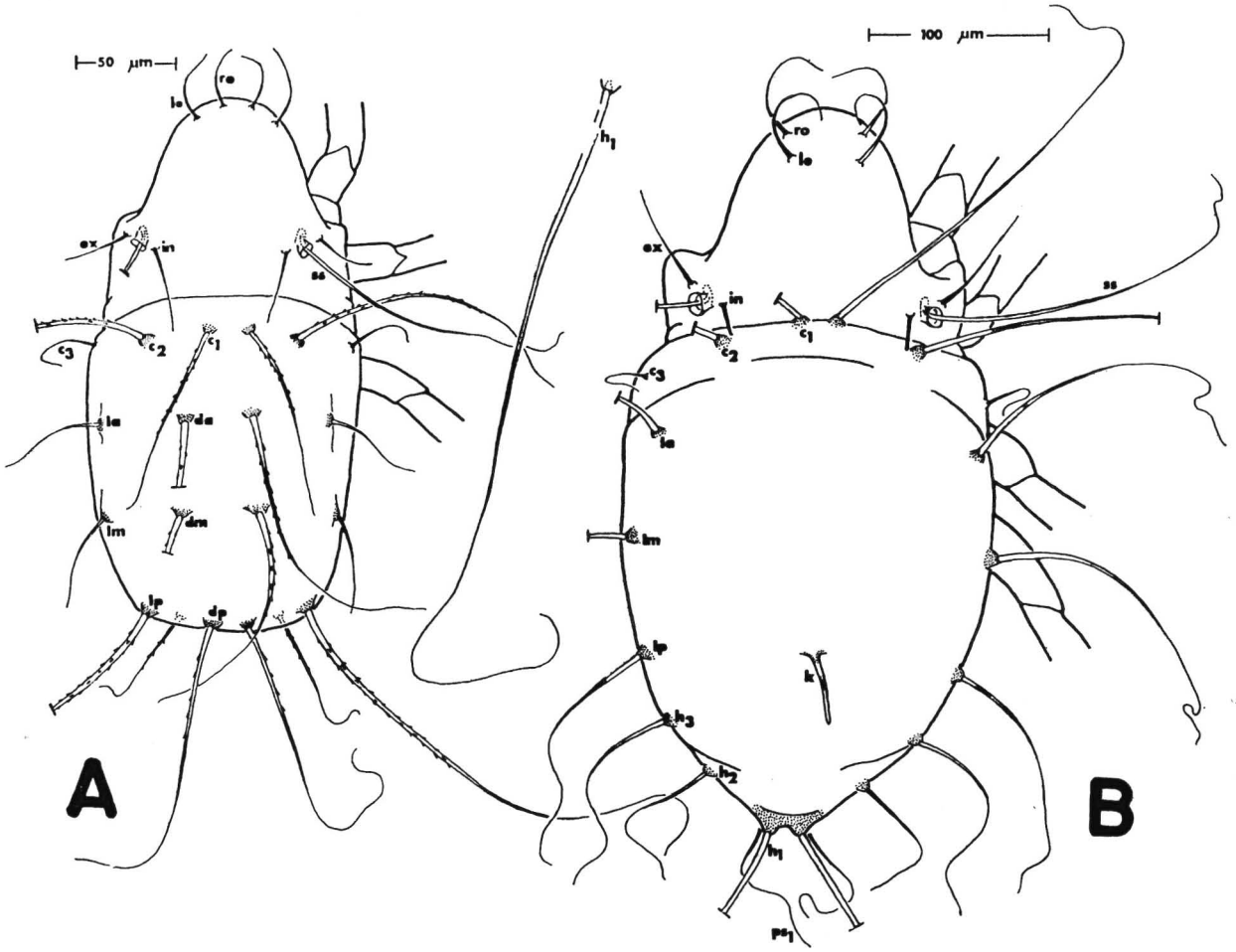

FIG. 3. — *Epidamaeus* (*Akrodamaeus*) *longiseta* (Banks) :
A) larva, dorsal aspect ; B) dorsal aspect of deutonymph (with separated seta y_1).

Setal ontogeny for leg I as follows [1]. Trochanter : *v'* (n_2). Femur : *d*, *bv"*, *l'* (n_2), *l"* (n_2), v_1" (n_3), v_1' (Ad), v_2" (Ad). Genu : *d*, *l'*, *l"*, *v'* (n_2). Tibia : *d*, *l'*, *l"*, *v'*, *v"* (n_2). Tarsus : *ft'*, *ft"*, *pl'*, *pl"*, *pv'*, *pv"*, *s*, *a'*, *a"*, *tc'*, *tc"*, *u'*, *u"*, *p'*, *p"*, *e*, *it'* (n_3), *it"* (n_3), *v'* (Ad), *v"* (Ad).

Leg II. Trochanter : *v'* (n_2). Femur : *d*, *bv"*, *l'* (n_2), *l"* (n_2), *v'* (Ad), *v''* (Ad). Genu : *d*, *l'*, *l"*, *v'* (n_2). Tibia : *d*, *l'*, *v'*, *l"* (n_2), *v"* (n_3), *d* lost in adult. Tarsus : *ft'*, *ft"*, *pv'*, *pv"*, *s*, *a'*, *a"*, *tc'*, *tc"*, *u'*, *u"*, *p'*, *p"*, *it'* (n_3), *it"* (n_3), *v'* (Ad), *v"* (Ad).

Leg III. Trochanter : *v'* (n_1), *l'* (n_2). Femur : *d*, *ev'*, *l'* (n_2), *v'* (Ad). Genu *d*, *l'*, *v'* (n_2). Tibia : *d*, *l'*, *v'*, *v"* (n_2), *d* lost in adult. Tarsus : *ft'*, *ft"*, *pv'*, *pv"*, *s*, *a'*, *a"*, *tc'*, *tc"*, *u'*, *u"*, *p'*, *p"*, *it'* (n_3), *it"* (n_3), *v'* (Ad), *v"* (Ad).

Leg IV. Trochanter *v'* (n_3). Femur : *d* (n_2), *ev'* (n_2), *l'* (n_3), *v'* (Ad.) Genu : *d* (n_2), *l'* (n_2). *v'* (n_2). Tibia : *d* (n_2), *l'* (n_2), *v'* (n_2), *v"* (n_3), *d* lost in adult. Tarsus : *ft"* (n_1), *pv'* (n_1), *pv"* (n_1), *u'* (n_1), *u"* (n_1), *p'* (n_1), *p"* (n_1), *s* (n_2), *a'* (n_2), *a"* (n_2), *tc'* (n_2), *tc"* (n_2), *v'* (Ad), *v"* (Ad).

1. Instar of setal formation is indicated by n_1 (protonymph), n_2 (deutonymph), n_3 (tritonymph) or Ad (adult). Setae without parenthetic labels are formed in the larval instar.

MATERIAL EXAMINED

Two specimens are in the MCZ collections ; neither is intact. One (labeled " type ") is mounted in balsam. The label appears to be in the handwriting of A. P. Jacot and carries a note : " only 2 specimens found in vial — 1 remains ". The second specimen is in alcohol and is undoubtedly the specimen referred to by Jacot when he mounted the " type ". In addition to these specimens, approximately 50 others have been observed from the localities cited below.

DISTRIBUTION

Epidamaeus (*A.*) *longiseta* has been collected from the following states and counties : Arkansas (Van Buren Co.) ; Delaware (Sussex Co) ; Maine (Knox, Hancock Co.) ; Missouri (Boone, Calloway Co.) ; New Hampshire (Carroll, Merrimack, Sullivan Co.) ; New York (Onondaga, Suffolk Co.) ; Pennsylvania (Centre Co.) ; Texas (Grayson Co.) ; Virginia (Fairfax, Mecklenburg Co.) ; and Washington (Chelan, Okanogan Co.). It is also known from Ontario, Canada (Oliphont and Chafey's Locks). These records, mostly from east of the Rocky Mountains, are from the litter of a wide variety of forest types, including various species of spruce, pine, oak, maple and others.

A very similar undescribed " species " is common throughout most of the western U.S. and appears to be sympatric with *E. longiseta* in Washington. Further collection and study will be necessary to understand the relationship between the two groups.

REMARKS

Banks' original description of the adult was misleading on several points. Most of the setae he mentioned as being " plumose " or " barbate " are actually perfectly smooth ; he probably was confusing the cerotegument covering with the setae themselves. He estimated the number of notogastral (abdominal) setae to be " about 25 " ; there are 22, as in all Damaeidae. He also gave the length as .75 mm (750 μm) ; the one type-specimen measured by me was 603 μm, total length.

Belba : subgenus **Protobelba** n. subg.

TYPES-SPECIES : *Oribata california* Banks ; Banks, 1904, p. 367.

ETYMOLOGY

The prefix *proto* is from the Greek word meaning " before ". It refers to the ancestral condition of having spinae adnatae.

DESCRIPTION

Adult. Medium to large species, about 600-900 μm ventral body length ; Cerotegument reticulate, usually with small cylindrical tubercles. Rostrum relatively small, triangular, compared to broad, quadrate remainder of prodorsum. Tubercle Da present ; Dp, Ba, Bp absent. Sensillus attenuate ; bothridium with very large, expanded rim. Notogaster oval, slightly laterally compressed, evenly rounded in lateral aspect. Spinae adnatae present, of moderate size. Notogastral setae mostly short, distally curved or hook-like Large compact mass of organic debris carried on notogaster ; gastronotic exuviae compressed beneath it. Tubercles Sa, Sp well developed ; Va, Vp, E2a, E2p absent. Discidium absent. Epimeral setation 3-3-3-4.

Leg segments mostly clavate ; leg IV slightly longer body. Trochanteral setation 1-1-2-2. Femoral setation 7-7-4-4. Genual setation 4-4-3-3 ; seta *d* present on all legs. Tibial setation 4-5-4-4 ; seta *d* absent on leg I, present on II, III, IV. Tarsal setation (famulus included) 20-17-17-14 (*v″* present on all legs). Setae *p′*, *p″* and *s* eupathic on tarsus I.

Ontogeny. Cornicle *k* present in nymphs, digit-like, slightly curved ; exuviae appressed to gastronotic region under organic debris. Larval seta *dp* inserted on extremely long, narrow apophysis. Famulus normal, emergent in all stases. Seta *v′* and *l′* deutonymphal on trochanter IV ; *v′* also deutonymphal on genu III and IV. Well developed tracheal vestibules present in nymphs.

Diagnosis

This subgenus is distinguishable from the nominate subgenus by the presence of spinae adnatae on adults and long apophyses carrying seta *dp* in the larva.

Remarks

Only two species have been collected, both of these from the Pacific Coast. The smaller, undescribed species is from Central America and Mexico.

Belba (*Protobelba*) *californica* (Banks)

Oribata californica Banks ; Banks, 1904, p. 367.
Damaeus californicus (Banks) ; Ewing, 1909, p. 386.

Adult

Dimensions. Mean ventral length of 15 specimens 787 μm (range 724-884 μm) ; mean maximum notogastral width 492 μm (range 450-579 μm).

Cerotegument. Basically irregularly reticulate. Tubercles form at intersections ; small or absent in ventral region, rodlike and closely packed in most other areas, often with globose tips. Cerotegument appears very thick and matted, especially on legs ; usually with many adherent fungal spores, hyphal fragments and other foreign objects. Cerotegument mostly absent from setae.

Prodorsum. Integument relatively smooth, not distinctly microtuberculate except posterolaterally. Apophysis P absent. Tubercle Da present, broadly rounded (Fig. 4A) ; Dp absent. Rostrum relatively narrow, elongate, triangular ; remainder of prodorsum relatively broad, almost quadrate in general form. Setae *ro* and *le* thick, attenuate, *in* anterodorsally directed, pointed but not attenuate ; *ex* relatively large, thick, terminally rounded. Seta *in* with small barbs ; remainder of prodorsal setae (including sensillus) without barbs but indistinctly rugose. Bothridial rim very large, bowl-shaped, with supportive radiating bands of slightly thicker chitin ; an antiaxial split always present. Sensillus (ss) tapering but not flagellate ; with slight bend in proximal half, almost straight distally.

Notogaster. Ovate viewed perpendicular to circumgastric suture, about 1.3 times longer than broad ; almost evenly rounded in lateral view (Fig. 5A). Setae c_1 and c_2 inserted on low ridge (Fig 4A) ; one or two somewhat parallel ridges often present postero-mediad of the first. Spinae adnatae (*sa*) of moderate size, usually sharply pointed, directed toward dorsosejugal groove. All notogastral setae with minute barbs ; c_1 and c_2 anteriorly or antero-laterally directed ;

l and *h* series shorter, hook-shaped, in general postero-lateral direction. Pseudanal (*ps*) setae ventro-laterally curved (Fig. 4B), not as attenuate as dorsal setae. Adults carry large load of compact organic debris, with some pollen, spores and small mineral particles ; immature exuviae present under debris, but inconspicuous.

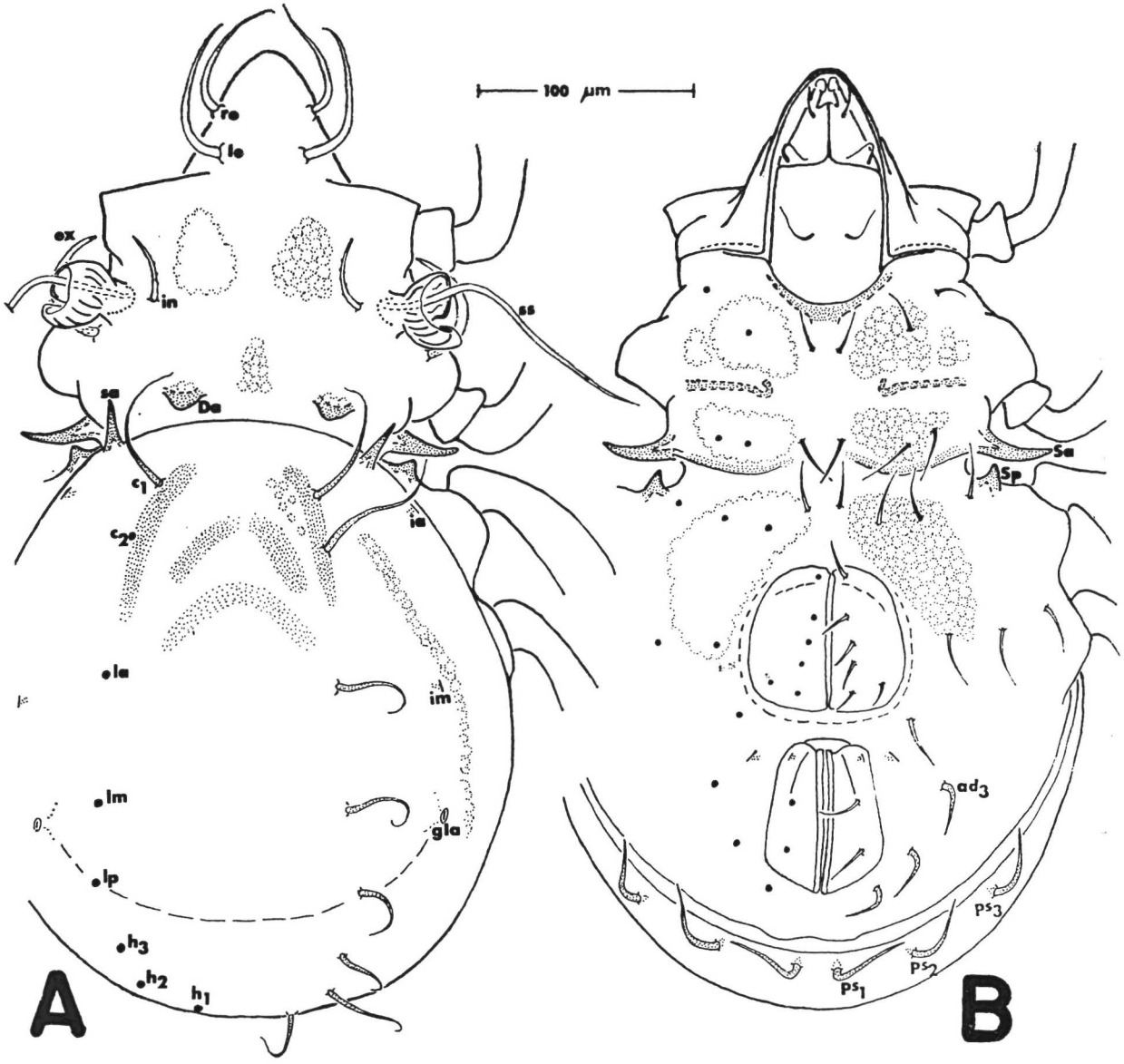

FIG. 4. — *Belba* (*Protobelba*) *californica* (Banks), adult :
A) dorsal aspect ; B) ventral aspect.

Ventral region. Integument indistinctly microtuberculate. Tubercles E2a, E2p, Va, Vp absent. Tubercle Sa long, gradually tapering ; Sp much shorter, usually acute, occasionally rounded terminally (Fig. 4B). Discidium absent. Epimeral setae minutely barbed, with basal tubercles indistinct or absent ; setation 3-3-3-4. Setation of genital and anal regions generally typical of family ; setae g_5 and ad_3 laterally displaced. Genital, aggenital and anal setae essentially smooth ; adanal setae thicker, darker, with small, coarse barbs.

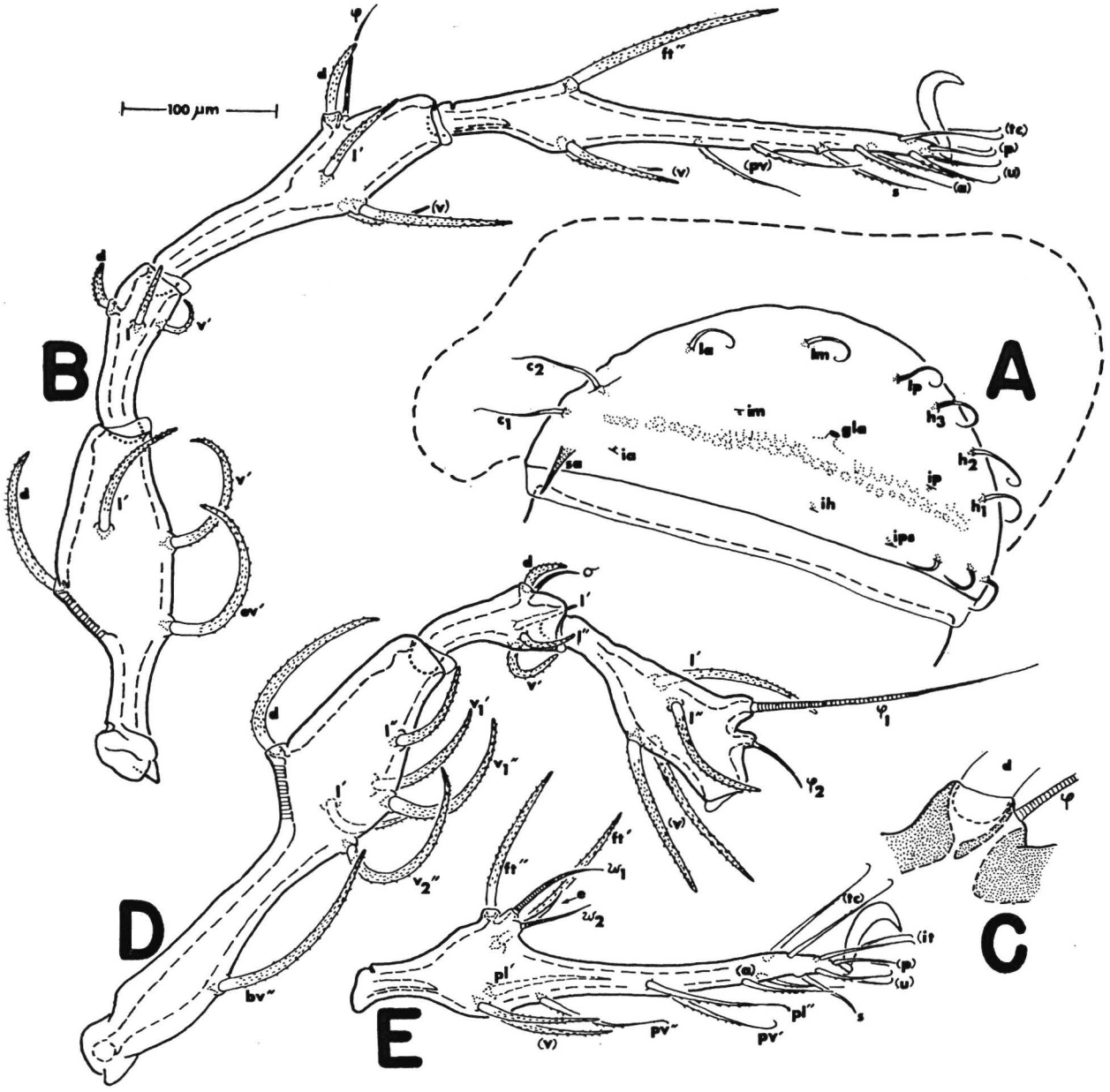

FIG. 5. — *Belba* (*Protobelba*) *californica* (Banks), ♂ dult :
A) notogaster, lateral aspect (dashed line indicates extent of organic debris) ; B) leg IV ; C) seta *d* and solenidion ø of tibia I ; D) femur, genu and tibia I ; E) tarsus I (legs all antiaxial aspect).

Gnathosoma. Infracapitular mentum microtuberculate, elongate (1.1 times longer than broad). Remainder of infracapitulum, palps and chelicerae typical of family.

Legs (Fig. 5B-E). Femora indistinctly microtuberculate. Trochanteral tectum strongly developed on legs III and IV. Leg II similar to I except slightly shorter (about 1 : 1.3) and with setal differences noted below. Leg III shorter than IV by same amount. Leg IV 1.3 to 1.4 times ventral body length. Femur III 1.0 to 1.1 times length of trochanter III ; femur IV 0.9 times length of trochanter IV. Most leg setae thick, relatively rounded terminally, with small coarse barbs or surface rugosity. Setal formulae (famulus included, solenidia in parentheses) : leg I,

1-7-4(1)-4(2)-20(2) ; leg II, 1-7-4(1)-5(1)-17(2) ; leg III, 2-4-3(1)-4(1)-17 ; leg IV, 2-4-3-4(1)-14. No variations observed. Setae p', p'' and s eupathic on tarsus I. Coupled setae $d\sigma$ on genu I and II and $d\varnothing$ on tibiae II-IV not truly in same alveolus ; a narrow strip of chitin separates their bases (Fig. 5C). Tibia I solenidion $\varnothing_1$ ceratiform, not tactile.

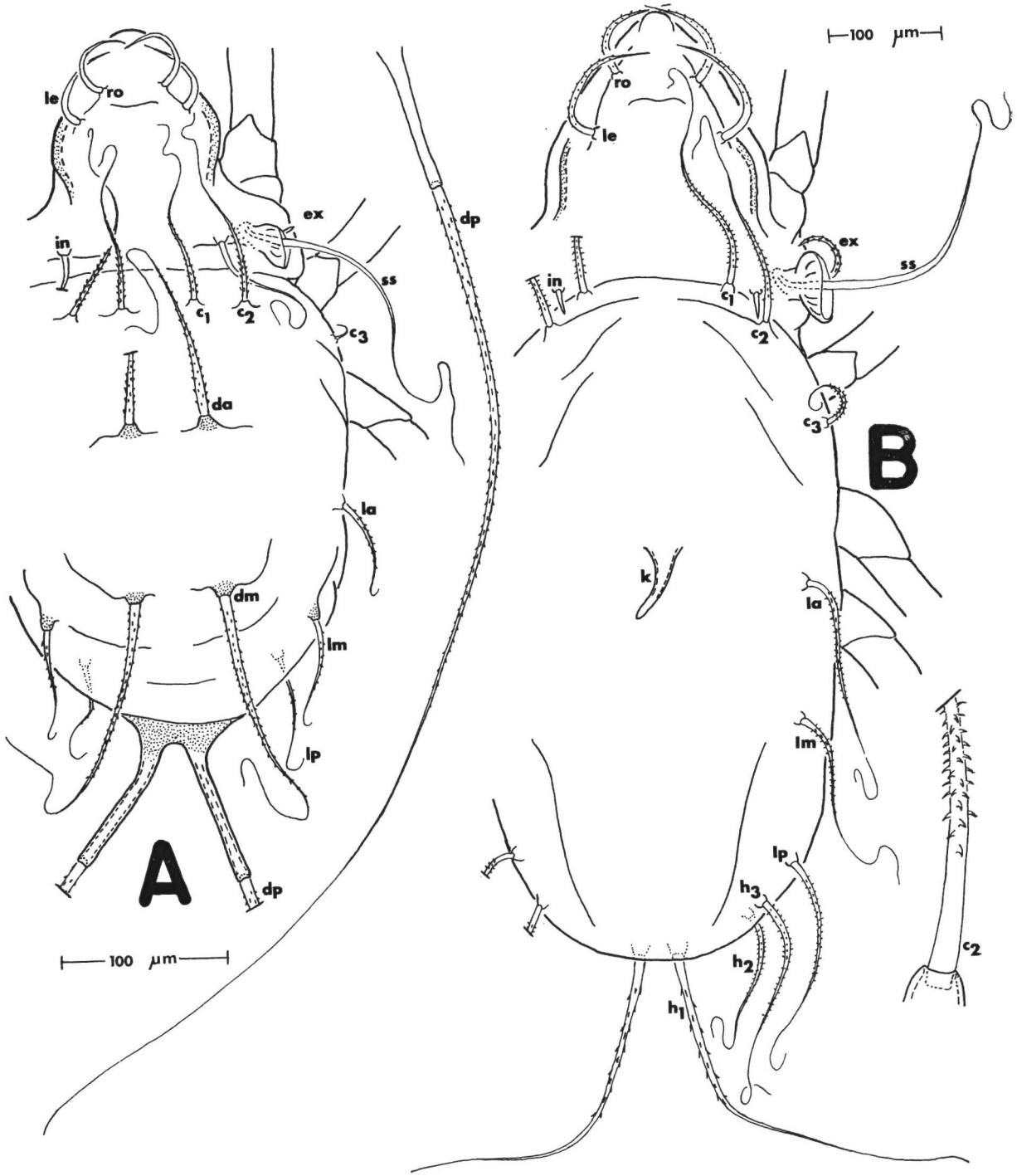

FIG. 6. — *Belba* (*Protobelba*) *californica* (Banks) :

A) larva, dorsal aspect (with separated apophysis and seta *dp*) ; B) tritonymph, dorsal aspect (with enlarged base of seta c_2).

ONTOGENY

Dimensions. Mean total length of : 10 larvae 417 μm (range 390-422 μm) ; 5 protonymphs 470 μm (range 450-490 μm) ; 8 deutonymphs 629 μm (range 595-683 μm) ; 10 tritonymphs 773 μm (range 656-844 μm).

Cerotegument. Relatively thick, often with adherent debris. Tubercles variable in size, but granular in all immatures. Most setae with thin cerotegument covering, at least basally.

Prodorsum. Lightly sclerotized in all immatures. Setae *ro* and *le* of larva smooth or with several small barbs, closely appressed to rostrum ; *ro* more medially inserted than *le* in all immatures (Fig. 6A, B). Seta *ex* small in larva, erect, essentially smooth ; *ex* relatively large in nymphs, anteriorly curved, with many barbs. Larval seta *in* smooth, flagellate, with colorless isotropic extremity ; *in* very short, acute in all nymphs. In all immatures sensillus smooth, flagellate, with large, expanded bothridial rim.

Gastronotic region. Body of all immatures rounded posteriorly ; nymphal integument very thin, soft dorsally. Cornicle *k* of nymphs tapering, slightly curved. All larval setae except c_3 densely barbed, with flagellate, isotropic tips ; c_3 short, attenuate, dorsally curved. Seta *dp* about 1.5 times body length, inserted on long, divergent, sclerotized projections which basally fuse to a single sclerite. Other larval setae on small, thin, separate sclerites. Larval setae in order of decreasing length : *dp* ; *da, dm* ; c_1, c_2 ; *la, lm, lp* ; c_3. Nymphal setae all inserted separately. Listed in order of decreasing length : h_1 ; c_1, c_2 ; *la, lm, lp*, h_3 ; h_2 ; c_3. Seta h_1, as in larval setae, with normal, distally directed barbs ; other nymphal setae with barbs directed perpendicular to major setal axis or slightly basally curved (Fig. 6B). All immatures carry load of debris similar to that of adult.

Ventral region. Setal formulae of epimeres as follows : larva 2-1-2 ; protonymph 3-1-2-1 ; deutonymph 3-2-3-2 ; tritonymph 3-3-3-3. Ontogeny of anal and genital regions typical of family.

Setal ontogeny for leg I as follows. Trochanter : *v'* (n_2). Femur *d, bv", l'* (n_2), *l"* (n_2), v_1" (n_3) v_1' (Ad), v_2" (Ad). Genu : *d, l', l", v'* (n_2). Tibia : *d, l', l", v', v"* (n_2), *d* lost in adult. Tarsus : *ft', ft", pl', pl", pv', pv", s, a', a", u', u", tc', tc", p', p", e, it'* (n_3), *it"* (n_3), *v'* (Ad), *v"* (Ad).

Leg II. Trochanter : *v'* (n_2). Femur : *d, bv", l'* (n_2), *l"* (n_2), v_1" (n_3), v_1' (Ad), v_2" (Ad.) Genu : *d, l', l", v'* (n_2). Tibia : *d, l', v', l"* (n_2), *v"* (n_3). Tarsus : *ft', ft", pv', pv", s, a', a", tc', tc", u' ,u", p', p", it'* (n_3), *it"* (n_3), *v'*, (Ad), *v"* (Ad.)

Leg III. Trochanter : *v'* (n_1), *l'* (n_2). Femur : *d, ev', l'* (n_2), *v'* (Ad). Genu : *d, l', v'* (n_2). Tibia : *d, l', v', v"* (n_2). Tarsus : *ft', ft", pv', pv", s, a', a", tc', tc", u, u", p', p", it'* (n_3), *it"* (n_3), *v'* (Ad), *v"* (Ad).

Leg IV. Trochanter : *v'* (n_2), *l'* (n_2, occasionally n_3). Femur : *d* (n_2), *ev'* (n_2), *l'* (n_3), *v'* (Ad). Genu : *d* (n_2), *l'* (n_2) *v'* (n_2). Tibia : *d* (n_2), *l'* (n_2), *v'* (n_2), *v"* (n_3). Tarsus : *ft"* (n_1), *pv'* (n_1), *pv"* (n_1), *u'* (n_1), *u"* (n_1), *p'* (n_1), *p"* (n_1), *s* (n_2)' *a'* (n_2), *a'* (n_2), *tc'* (n_2), *tc"* (n_2), *v'* (Ad), *v"* (Ad).

Seta *d* of tibia I relatively large in all immatures ; one-third the length of $ø_1$ in larva, almost one-half in nymphs. Seta *d* on larval genu I, II and III small, but distinct ; associated solenidion σ appressed to posterior side of genu. Famulus normal, emergent in all instars.

MATERIAL EXAMINED

The holotype, from Mt. Shasta, Sikiyou County, California, is in alcohol in the MCZ. About a hundred additional specimens have been examined from the localities listed below.

DISTRIBUTION

This species is known only from the Pacific coastal states. Specimens have been collected from the following states and counties : California (Del Norte and Siskiyou Co). ; Oregon (Lincoln and Tillamook Co.) ; and Washington (Jefferson Co.). The known habitats are all moist, cool forests dominated by red alder, or a variety of conifers, such as western hemlock, sitka spruce, western redcedar, Douglas-fir, or coast redwood.

Genus **Dyobelba** n. g.

TYPES-SPECIES : *Oribata carolinensis* Banks ; Banks, 1947, p. 119.

ETYMOLOGY

The prefix *dyo* is from the Greek word meaning " two ". It refers to the retention of setae *d* on two adult tibiae.

DESCRIPTION

Adult. Small to large species about 350 to 800 µm ventral body length, light brown to black. Cerotegument usually with granular to conical or cylindrical tubercles. Surface of prodorsum various ; smooth to highly pitted. Apophysis P present or absent. Tubercle Da usually present, Dp present or absent ; Ba, Bp usually absent. Sensillus of diverse form. Notogaster of various shapes ; circular, oval or elliptical viewed perpendicular to circumgastric suture. Spinae adnatae present or absent. Notogaster without gastronotic exuviae of immatures. Ventral tubercles Sa, Sp well developed ; E2a, E2p usually absent ; Va, Vp present or absent. Discidium usually present. Epimeral setation 3-1-3-4. Legs with clavate to sub-moniliform segments ; leg IV at least equal to total body length, usually distinctly longer. Trochanteral setation 1-1-2-1 (seta *l'* absent on IV) or 1-1-2-2 (*l'* present on IV). Femoral setation 7-6-5-4 or 7-6-4-4. Genual setation 4-4-3-3 ; seta *d* present on all legs. Tibial setation 4-5-4-3 or 4-4-4-3 ; seta *d* present only on II and III. Tarsal setation (famulus included) 20-17-17-14 (*v"* present on all tarsi). Setae *p'*, *p"* and *s* eupathic on tarsus I.

Ontogeny. Cornicle *k* present in nymphs, straight, narrow, usually elongate ; exuviae highly stacked. Famulus regressive, sunken in sclerotized cup. Seta *v'* tritonymphal on trochanter IV, deutonymphal on genu III.

DIAGNOSIS

Dyobelba is distinguishable from other genera of Damaeidae by the following combination of leg setal character-states : famulus regressive in immatures ; adult trochanteral setation 1-1-2-1 or 1-1-2-2 ; all femora with 7 setae or less ; seta *d* present on adult tibiae II and III.

REMARKS

About a dozen species from the continental United States remain to be described. Two more are known from South and Central America. *Dyobelba tectopediosa* (Jacot) (*new combination* from *Oribata*) is the only described member of a species complex apparently restricted to the southern Appalachian Mountains.

Dyobelba carolinensis (Banks)

Oribata carolinensis Banks ; Banks, 1947, p. 119.
Oribata diversipes Banks ; Banks, 1947, p. 120 (*new synonymy*).

ADULT

Dimensions. Mean ventral length of 20 specimens 417 μm (range 378-458 μm) ; mean maximum notogastral width 273 μm (range 233-297 μm).

Cerotegument. Body and legs mostly with granular cerotegument. Tubercles evenly spaced, slightly elongate in axis perpendicular to integument ; often conical in epimeral region. Setae of body and legs (except distally on tarsus) with similar cerotegument, but with smaller tubercles.

Prodorsum (Fig. 7A). Integument microtuberculate, especially in middle third of prodorsum.

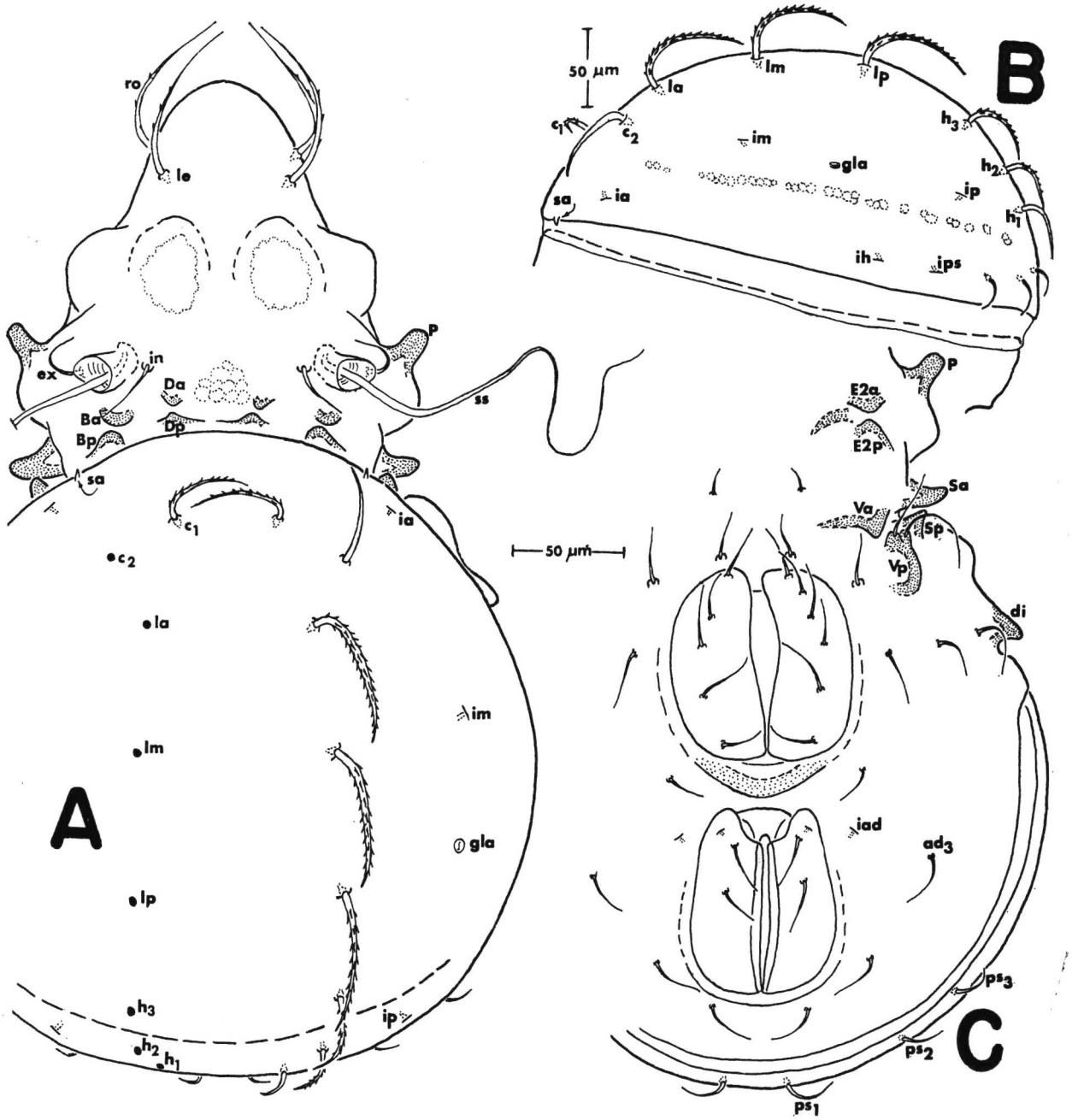

FIG. 7. — *Dyobelba carolinensis* (Banks), adult :
A) dorsal aspect ; B) lateral aspect of notogaster : C) ventral aspect (partial).

Apophysis P present ; usually parallel sided. Tubercles Ba and Bp of moderate size, Da and Dp smaller ; all typically rounded terminally but occasionally acute ; Bp produced postero-dorsally as a small ridge. A pair of large dome-like swellings present in center of prodorsum. Setae *ro*, *le* similar, evenly curving, with several distinct barbs ; *ex* and *in* much smaller, smooth or with several very inconspicuous barbs. Sensillus (*ss*) smooth, long, flagellate, with distinctive " bow-like " undulation in distal half.

Notogaster. Ovate when viewed perpendicular to circumgastric suture, widest in posterior half ; 1.1 times longer than broad. Spinae adnatae (*sa*) minute (Fig. 7A, B) (extremely difficult to see if cerotegument is not removed) ; directed toward dorsosejugal groove. Surface generally smooth and evenly rounded, but several slight undulations or very low ridges may be present near anterior margin. Setae c_1 acuminate, strongly barbed, curved, directed toward each other ; separated by distance about equal to their length. Setae c_2 sharply bent close to insertion, appressed to notogaster, anteriorly or antero-laterally directed ; usually smooth, at most with several small distal barbs. Setae *la*, *lm*, *lp* of moderate length, heavily barbed, evenly spaced, posteriorly directed. Setae h_1, h_2, h_3 much smaller, more closely spaced than *l* series ; h_3 barbed, h_2 barbed or smooth, h_1 usually smooth. Pseudanal setae (*ps*) short, smooth, ventro-laterally curved (Fig. 7C).

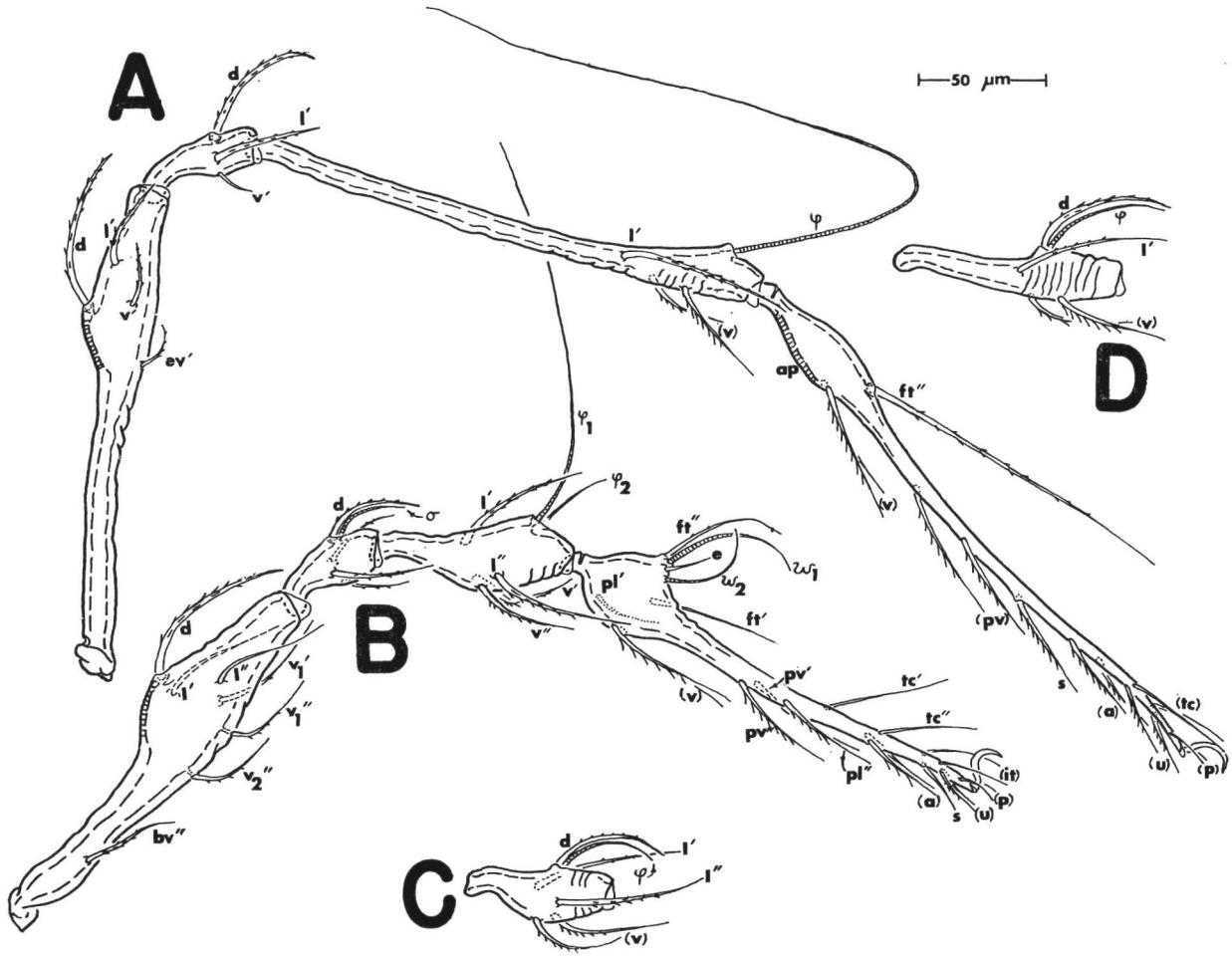

FIG. 8. — *Dyobelba carolinensis* (Banks), adult :
A) leg IV ; B) leg I ; C) tibia II ; D) tibia III (all antiaxial aspect).

Ventral region. Epimeres, anal and genital plates with distinct microtubercles. Tubercle E2a weakly developed, E2p indistinct or virtually absent ; Va large, triangular, Vp mound-like (Fig. 7C). Tubercle Sa thick, moderately long, rounded terminally ; Sp much shorter. Discidium (*di*) well developed, thick, rounded, postero-laterally directed. Epimeral setae inserted on small raised tubercles ; setation usually 3-1-3-4 ; seta *4d* occasionally unilaterally absent. Seta *3b* and *3c* inserted on tubercle Vp ; *3c* relatively long, with distinct barbs, remainder of ventral setae smooth or with sparse, inconspicuous barbs. Setation of anogenital region typical of family. Seta ad_3 displaced laterally.

Gnathosoma. Infracapitular mentum quadrate, very slightly wider than long ; integument with distinct, rod-shaped, transversely oriented microtubercles. Remainder of gnathosoma typical of family.

Legs (Fig. 8). Leg segments, especially femora and tibiae, usually with wrinkled integument. All femora distinctly microtuberculate. Typical porose areas present on all femora and trochanters III and IV. Tarsus IV with large, ventro-lateral porose area on bulb (Fig. 8A ; *ap*) ; none on other tarsi. Femoral bulbs strongly constricted distally. Ventro-distal tectum not strongly developed on trochanters III and IV. Leg II similar to leg I, but slightly shorter and with setal differences noted below ; leg III approximately equal in length of I ; leg IV very long, 1.8 to 1.9 times ventral length. Femur IV 2.1 to 2.2 times length of trochanter IV ; femur III 1.9 to 2.0 times trochanter III. Setal formulae (famulus included, solenidia in parentheses) as follows : leg I, 1-7-4(1)-4(2)-20(2) ; leg II, 1-6-4(1)-5(1)-17(2) ; leg III, 2-4-3(1)-4(1)-17 ; leg IV, 1-4-3-3(1)-14. No variations have been observed. Setae *p'*, *p"* and *s* eupathic on tarsus I. Tibial solenidion ϕ_1 on leg I and ϕ on leg IV very long tactile ; ϕ on legs II and III much shorter, ceratiform, approximately equal to coupled seta *d*.

ONTOGENY

Dimensions. Mean total length (10 individuals each)of : larva 206 μm (range 201-209 μm) ; protonymph 261 μm (range 249-281 μm) ; deutonymph 330 μm (306-362 μm) ; tritonymph 408 μm (range 374-450 μm).

Cerotegument. Granular in all immatures, covering body, legs and parts of most setae ; all tubercles circular in cross section.

Prodorsum. Larval seta *ro* distinctly more medially inserted than *le* (Fig. 9A) ; *ro, le, in* and *ex* with small barbs ; *ex* less attenuate than others. Setae *ro, le* and *ex* in all nymphs similar to larva but with more barbs and *ro* positioned more laterad (Fig. 9B) ; *in* short, truncate in nymphs, smooth except for several minute terminal points. Sensillus long, flagellate, smooth in all immatures, distally curving but usually without characteristic " bow-like " undulation of adult.

Gastronotic region. Body elliptical to almost rectangular in larva (Fig. 9A), ovate in nymphs (Fig. 9B). Cornicle *k* narrow, straight or only slightly undulating. Larval setae all distinctly barbed, flagellate, listed in order of decreasing length as follows : *lp* (slightly longer than body) ; *dp* ; c_2, *da* ; c_1, *dm* ; *la* ; *lm*, c_3. Nymphal setae c_2 and h_1 very large (h_1 about 1.5 times body length) flagellate, partly with heavy barbs. Remaining nymphal setae much shorter, finely attenuate to flagellate ; of these, c_1 is longest. All setae inserted on thin sclerites ; setae h_1 share a sclerite in nymphs, all others on individual sclerites.

Ventral region. Setal formulae for epimeres as follows : larva 2-1-2 ; protonymph 3-1-2-1 ; deutonymph 3-1-2-2 ; tritonymph 3-1-3-3. Ontogeny of anal and genital regions typical of family.

Legs. Setal ontogeny similar to that of *Epidamaeus* (*A.*) *longiseta*, except genu IV seta *v'* is retarded until the tritonymph and seta *d* of tibiae II and III is not lost in the adult instar.

Tibia I solenidion ϕ_1 long, tactile in all instars ; coupled seta *d* smallest in larva, about 1/4 length of ϕ_1, relatively longer in each succeeding instar, until approximately 1/3 length of ϕ_1 in tritonymph. Larval genu seta *d* minute on all legs ; associated solenidion σ curves around posterior surface of segment ; nymphs with normal seta *d* and erect solenidion σ, subequal in length. Famulus sunken in sclerotized cup in all immatures, but minute, nonemergent only in larva ; nymphal famulus small, but slightly emergent.

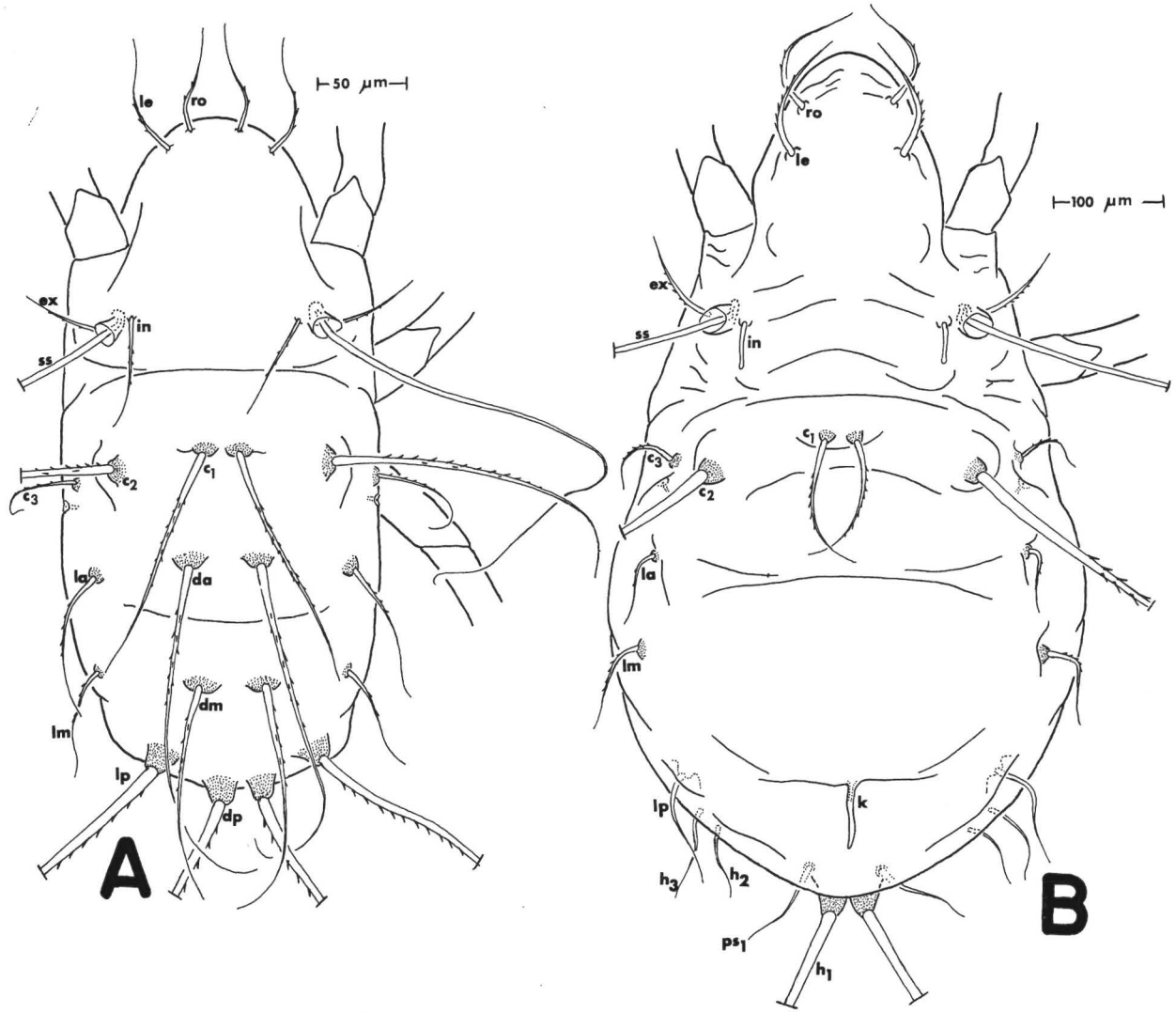

FIG. 9. — *Dyobelba carolinensis* (Banks) :
A) larva, dorsal aspect ; B) tritonymph, dorsal aspect.

MATERIAL EXAMINED

The holotype female from the Duke Forest, Durham Co., North Carolina, is slightly damaged and mounted in balsam (MCZ type no. 3010). A paratype, also in balsam, is mounted on the same slide as the holotype of *Belba inaequipes* Banks. Both are located in the MCZ. About 150 specimens have been examined from the localities cited below.

DISTRIBUTION

This species appears to be restricted to the middle and southern Appalachian region, piedmont, and coastal plain of the eastern U.S. It has been collected from the following states and

counties : Georgia (Clarke, Rabun, Thomas Co.) ; North Carolina (Avery, Buncombe, Durham, Haywood, Macon, Wake Co.) ; Tennessee (Sevier Co.) ; Virginia (Amherst, Grayson, Mecklenburg Co.) ; and West Virginia (Mercer Co.). In the vast majority of collections the habitat was mixed hardwood leaf litter, but the species has also been extracted from pine litter and epigeal bryophytes.

REMARKS

Immediately following the original description of *Oribata carolinensis*, Banks (1947) described as new *Oribata diversipes* from the same locality in North Carolina. It is represented by a single damaged specimen (labeled " type ") in the MCZ. Close examination and comparison of types revealed that the two species are identical. Because *O. carolinensis* is better represented by well-preserved specimens which are distributed between two institutions (also in the U.S. National Museum collections), I here consider *O. diversipes* to be a junior subjective synonym of *O. carolinensis*. It is curious that Banks considered *O. diversipes* to be most similar to *O. angustipes* Banks and *O. grossmani* Wilson, which are both members of the genus *Damaeus*, rather than to *O. carolinensis*, but the damaged, incomplete nature of the type of *O. diversipes* might account for this.

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LITERATURE CITED

BALOGH (J.), 1965. — A synopsis of the world oribatid (Acari) genera. — Acta Zool. Hung., **11** : 5-99.

BANKS (N.), 1895a. — On the Oribatoidea of the United States. — Trans. Amer. Entomol. Soc., **22** : 1-16.

—, 1895b. — Some acarians from a sphagnum swamp. — J. N. Y. Entomol. Soc., **3** : 128-130.

—, 1896. — New North American spiders and mites. — Trans. Amer. Entomol. Soc., **23** : 57-77.

—, 1904. — Some Arachnida from California. Proc. Calif. Acad. Sci., **3** : 331-374, pls. 38-41.

—, 1906. — New Oribatidae from the United States. Proc. Acad. Nat. Sci., Phil., **58** : 490-500, pl. 14-18.

—, 1947. — On some Acarina from North Carolina. — Psyche, **54** : 110-141.

BULANOVA-ZACHVATKINA (E. M.), 1967. — Armoured mites-oribatids. — Higher School. Moscow, 254 pp.

—, 1973. — The systematics and geographical distribution of mites of the superfamily Belboidea Dub., 1958 (Acariformes : Oribatei). — Pages 75-77 *in* Proc. 3rd Int. Congr. Acarology, Prague, 1971.

EWING (H. E.), 1909. — The Oribatoidea of Illinois. — Bull. Ill. St. Lab. Nat. Hist., **7** : 337-390.

KULCZYNSKI (V.), 1902. — Species Oribatinarum (Oudms.) (Damaeinarum Michael) in Galicia collectae. — Diss. Math. Phys. Aca. Litt. Cracovie (B), **42** : 10-56.

MICHAEL (A. D.), 1888. — British Oribatidae. Vol. II. — Ray Society, London, pp. 337-657, pls. 25-54.

NORTON (R. A.), 1977 (1978). — The genus *Damaeus* Koch (Acarina : Oribatei) in the eastern United States. — Acarologia, **19** (2) :

—, 1978a. — *Veloppia kananaskis* n. sp., with notes on the familial affinities of *Veloppia* Hammer (Acarina : Oribatei). — Int. J. Acarology, **4** (2). In press.

—, 1978b. — A review of F. Grandjean's system of leg chaetotaxy in the Oribatei (Acari) and its application to the family Damaeidae. — In : Biology of oribatid mites (D. L. Dindal, ed.). In press.

TRAVÉ (J.) and VACHON, 1975. — François Grandjean 1882-1975 (Notice biographique & bibliographique). — Acarologia, **17** (1) : 1-19.

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