

SOME HAWAIIAN
ORIBATOIDEA (ACARINA)

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CONTENTS

	PAGE
Introduction	3
Acknowledgments	3
Specific characters and terminology.....	3
Material studied	5
Family Epilohmanniidae	5
Genus Epilohmannia	6
Oribatidae-Carabodinae	9
Tribe Carabodini	10
Genus Udetaliodes	10
Tribe Cepheini	11
Genus Odontocephus	11
Oribatidae-Oribatinae	15
Tribe Oribatini	15
Genus Dameosoma	19
Genus Oppia	25
Tribe Eremaeini	28
Genus Calvoppia	28
Genus Imparatoppia	30
Genus Phauloppia	34
Oribatidae-Ceratozetinae	36
Tribe Oribatulini	37
Genus Cardioribates	37
Tribe Ceratozetini	39
Genus Protoschelobates	40
Genus Scheloribates	51
Genus Styloribates	61
Genus Xyloribates	64
Genus Humerobates	66
Oribatidae-Galumminae	68
Genus Zetes	70
Genus Galumna	75
Phthiracaridae-Phthiracarinae	81
Genus Oribotritia	81
Genus Indotritia	82
Faunal relations	84
Distributional agents	85
Wind	85
Birds	88
Ocean currents and driftwood.....	90
Man	91
Rate of change	92
Economic importance	93
Ecological niches	93
Literature cited	95
Plate legends	97
Plates 1-16.	



Some Hawaiian Oribatoidea (Acarina)

By

ARTHUR PAUL JACOT

INTRODUCTION

ACKNOWLEDGMENTS

The present report had its inception in 1923 when, because of doubt concerning the identity of *Oribata alata* (45),* a request for the original material deposited at Bernice P. Bishop Museum was kindly met by Mr. Otto H. Swezey, who sent not only *O. alata* but *O. globula* and some of the Tanager Expedition material. In 1926, while at the invitation of Alexander Hume Ford, Mrs. Jacot and I spent a week at the Pan-Pacific Research Institution in Honolulu, six lots of oribatids were collected near the head of Manoa Valley. I was further encouraged when Mr. E. H. Bryan, Jr., entrusted me with more material from Bernice P. Bishop Museum collections and Dr. Frederick Muir of the Experiment Station of the Hawaiian Sugar Planters' Association turned over for study an interesting collection made by Cyril E. Pemberton, and when Mr. R. H. Van Zwaluwenburg of the same institution contributed material from soil samples. Again in 1928 Mr. Van Zwaluwenburg mailed me material "from soil samples in cane fields, island of Oahu." We are indebted to these gentlemen for information here included.

Although the species of the genus *Udetaliodes* have already been reported (29), they are included in the general discussions of this paper.

SPECIFIC CHARACTERS AND TERMINOLOGY

One of the characteristics of the Oribatoidea which appealed to me 17 years ago was the methodical spacing of the bristles in the smooth chitinous expanse. Here seemed a definite, compact, and untouched field for the study of evolution as expressed in structure. During these years I have enjoyed the study of these minute yet complex and highly developed organisms, and though a little has been learned, much still remains to be done.

In the course of these studies it has been found essential to name each bristle or pair. Fortunately, the number and disposition of bristles is not nearly as complicated as in the Diptera or other groups of arthropods, so

* Numbers in parentheses refer to Literature Cited, pages 95-96.

that there is no excuse except inadequacy of material for neglecting to record the location of each pair of bristles in future specific descriptions.

As heretofore, bristles in series or rows are numbered from the anterior backward, or from the proximal (on appendages) distad, using arabic numerals. Similarly, the rows themselves are enumerated from the mesal outward (laterad), using roman numerals. This system accounts for the bristles of the notogaster. The same system is usable for genital and anal cover bristles which are in more than one longitudinal row.

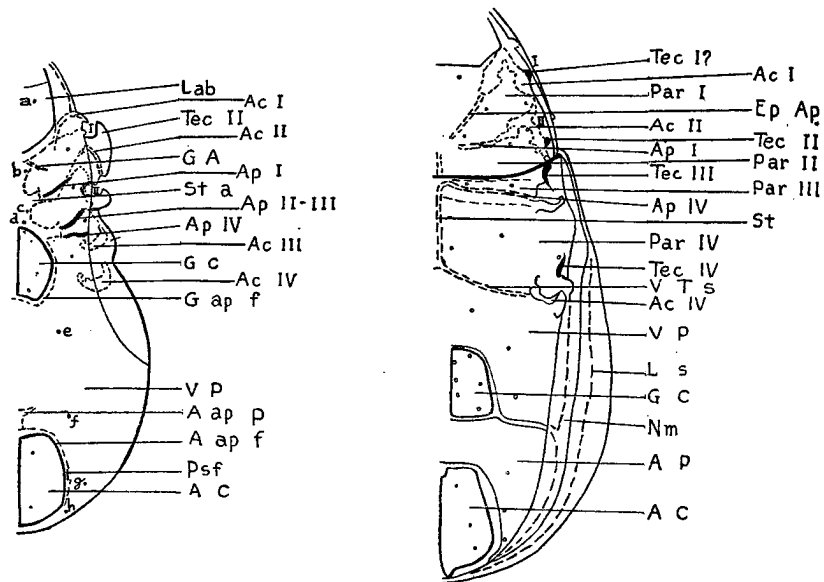


FIGURE 1. Specific characters and terminology of Oribatoidea. *a*, labium bristle; *b*, gular or first sternal; *c*, middle sternal; *d*, posterior sternal; *e*, paramesal; *f*, preanal; *g*, lateral postanal; *h*, mesal postanal. *A ap f*, anal aperture frame; *A ap p*, anal aperture process; *Ac*, acetabulum; *Ac*, anal cover; *Ap*, apodemata; *AP*, anal plate; *Ep Ap*, episternal apodemata; *G A*, gular apodemata; *G ap f*, genital aperture frame; *G C*, genital cover; *Lab*, labium; *L s*, lateral suture; *N m*, notogastral membrane; *Par*, parasterna; *P s f*, pseudofissura; *St*, sternum; *St a*, sternal arm; *Tec*, tectopodia; *V P*, ventral plate; *V T s*, ventro-thoracic suture.

For some unaccountable reason systematists have, in the past, neglected to study the ventral aspect of their species. Yet there are more characters and modifications of greater phylogenetic significance here than elsewhere. The names of the bristles of this area are depicted in figure 1.

It should be borne in mind that some of these bristles hold radically different positions in different subfamilies. For instance, the preanal bristles of the Ceratozetini are considered to be the paranal bristles of the Galumninae. In some groups this pair of bristles is more or less intermediate in position

or entirely absent. There is likewise considerable change in the position of the three pairs of sternal bristles. These shifts are of phylogenic significance and may be indicative of mechanical rearrangements rather than "blind groping." The point of origin or insertion of a bristle is called its "insertion" or "puncture." The terms "remote" and "approximate" always refer to the relative distance of two members of the one pair. The word "lateral" is used instead of "outer" (not ectal) and "mesal" instead of "inner" (not ental).

Color is of only slight importance, as it varies either individually or with degree of chitinization. A pale specimen is usually one which has just transformed and therefore has not yet deposited its normal thickness of chitin. Such specimens show bristle insertions very clearly but areae porosae very poorly. The opposite is true of heavily chitinized individuals. Color records are as seen in balsam mounts by indirect illumination with a blue ground-glass disk if artificial light is used. Presence or absence of redness is of far more importance than degree of yellowness or intensity of the one color. Pale spots may be due to translucency of the whole body at a certain point, for example, lack of opaque organs as in *Humerobates humeralis*, or to lack of pigment in the chitin as in *Parakalumma robustum* (same area).

Dimensions are not actual but projected, as measured in entire mounts, placed as nearly horizontally and as little obliquely as possible, by micrometer eyepiece. Thus length of anal aperture is far from actual when it is set obliquely (diagonally) into ventral plate. Length of ventral plate behind anal aperture is still more illusory and may vary with degree of retraction of notogaster. It is, however, worth noting.

MATERIAL STUDIED

Family EPILOHMANNIIDAE (42, p. 79)

Shape elongate; cephaloprothorax freely articulated to notogaster by a thin membrane; three ventral plates, the posterior two deeply excavate for accommodation of genital and anal apertures; all apodemata entirely anterior to genital aperture; genital aperture considerably separated from anal.

The only species carefully described (40, pp. 78-84) was recorded as having four ventral plates, the second being called the metapodosomal and described (40, p. 81) as "sharply delimited (defined) from the genital and not fused to it," also as "closely fitting to it, yet not linked with it." Yet the figures (40, figs. 128-129) show no separation, whereas the separation of the genital and anal plates is shown by a double line—as though a space even existed between these plates. This latter is in concord with my examination. On the other hand there is no separation whatever in the genital plate and no amount of manipulation will cause a separation to show

itself. Furthermore, a break across this area is clean and transverse. Thus I must consider the genital plate as extending forward to form the anterior edge of the abdomen. That is, there are but three free ventral plates, the anal, the ventral, and the cephaloprothoracic.

The most astounding phenomenon in this group is the segmentation across the ventral part of the abdomen with none across the dorsal (notogaster). It is, in all other groups, the notogaster which retains segmentation after the ventral plate has lost it. Here the reverse is true. My studies of various groups of organisms have lead me to regard this as an independent development from more primitive stock. Furthermore, I know of nothing comparable among the Oribatoidea, and consider it an independent development. I rank it, then, as a family as distinct as the Phthiracaridae and as constituting therefore the most primitive of the three families of the Oribatoidea.

As *Lesseria* 1917 (40) is preoccupied by *Epilohmannia* 1916 (8, p. 176), the family name becomes *Epilohmanniidae* (42).

Genus EPILOHMANNIA (8)

Cephaloprothorax somewhat retractile within abdomen; lamellae absent; two rows of bristles on genital covers; coxae III and IV the only leg segments with flange-like plates; notogaster showing no evidence of segmentation.

Type: *Lohmannia cylindrica* (5, p. 23).

Epilohmannia verrucosa, new species (pl. 1, figs. 1-6).

Diagnosis

Surface roughened by fine pockmarks and minute stippling; pseudostigmatic organs with six cilia along sides at most; lateral bristles of third transverse row of notogaster, as seen from above, almost in line with the two mesal of transverse row 2; a distinct pore anterior to and slightly laterad of mesal bristle of fifth transverse row (bristle 1:5); notogastral bristles longer, smoother, more curved than in *E. szanisloi*; ventral bristles three times length of those of *E. szanisloi*; three pairs on parasterna I, one pair on parasterna II; the lateral pair of parasterna III more distant from mesal pair (than in *E. szanisloi*), those of parasterna IV likewise; bristles of genital covers arranged so that lateral of posteriormost pair (11:3) are far nearer posterior edge of cover than are the mesal ones, the two thus being far from the same transverse plane; anal plate with two bristles on its apertural edge; bristles of legs also different.

Description

Cephaloprothorax (pl. 1, figs. 1, 3) retractile within abdomen so that its exposed length will vary with degree of retraction. Owing to heaviness of chitinization and defraction of light through the chitin the posterior border is often difficult to make out accurately, so that the distance from the transverse plane at the posterior edge of the pseudostigmata to the transverse plane at the tip of the rostrum is a far more practical measurement in this family. Rostrum protrudes well beyond anterior edge of cephaloprothorax. Pseudostigmata small and barely protruding beyond surface of cephaloprothorax. In the three specimens studied, the bristles on the dorsal face are indistinct and their insertions indistinguishable from surface accumulations except for the vertex

(interlamellar) pair which are as in *E. szanisloi* but inserted more posteriorly than in *E. cylindrica* (5, pl. 2, fig. 40). A lateral aspect (pl. 1, fig. 3) shows a short, fine exopseudostigmatal bristle and the interlamellar bristles as short, curved, and quite ciliate. Ventral face of cephaloprothorax long, broad, well developed (pl. 1, fig. 1), divided by apodemata into five areas, a mesal (the episternum) and parasterna I and II. These are completely ankylosed but demarked from each other, except near the center (though they seem joined in specimen of slide 28iv), by the apodemata and/or their extensions. Tectopodia I represented by a slight ridge running up the side of the cephaloprothorax for a short distance (darkened in pl. 1, figs. 1, 3) nearly to what may be a still slighter ridge which runs along side of cephaloprothorax from ventrad of pseudostigmata forward and downward parallel to dorsal outline (pl. 1, fig. 3). Apodemata I articulated (not fused) to acetabula. A bristle posterior to each end of apodemata I, another at posterior bend of acetabula I. Parasterna II, apodemata II, acetabula II and tectopodia II similar to those of I, but tectopedial ridge II not as long as I (pl. 1, fig. 3), and with but one bristle. For pockmarked areas see plate 1, figure 3.

Abdomen (pl. 1, fig. 1) elongated, as seen from above: broadest behind middle, broadly rounded at posterior end, with two depressions anterior to middle, i.e., anterior half of notogaster transversely corrugated by very low, broad "swells"; these depressions are related to the bristles so that at least the lateral bristles are in the depressions; bristles very slightly barbed or roughened; arranged as in *E. szanisloi* (40, fig. 127) except for lateral bristles of third transverse row (bristles II:3) which are so far anterior to figured position as to be nearly in line with the mesal two of second row. Furthermore, the two longitudinal mesal rows are so widely spaced that their distance from each other is equal to distance between first and second transverse rows (these four insertions thus form the corners of a square). Finally the lateral bristles of first transverse row (bristles II:1) are further forward (similar to *E. cylindrica*) and the lateral of second transverse row (bristles II:2) are correspondingly further forward (even more than *E. cylindrica*) so that the end of II:1 overlaps the base of II:2. A distinct, round pseudoforamen anterior to and slightly laterad of bristles I:5 (figured in *E. cylindrica* as bristle-bearing—undoubtedly erroneously). Ventral edge of notogaster recurved so as to clip over rim of ventral plate; this ventral rim seems to be formed of a thin membrane extending beyond the chitinized area (indicated in plate 1, figure 1, by a thin line mesad of outline of anal and ventral plates); entire surface finely pockmarked and "stippled" except ventral rim (this smooth area is indicated in plate 1, figure 1, by a broken line); smooth area includes two pseudoforamina, the posterior ones opposite posterior edge of ventral plate.

Ventral and anal plates similarly sculptured. Parasterna III narrow, widest at lateral end, longitudinally concave, so that anterior rim of abdomen flares open, each plate bearing a pair of bristles as in plate 1, figure 1; tectopodia III projecting as crescentic ridges, with a fairly long bristle on their crest. Parasterna IV almost as long as broad! This unusual size of the posteriormost parasterna, along with the subequal length of the post-thoracic area, combine to make the ovipositor retrograde, a very unusual condition in this superfamily. Bristles of parasterna IV as in figure 1 except that the mesal pair are usually opposite each other. This unusual asymmetry has been figured to emphasize the fact that variations are usually asymmetrical. Were they symmetrical one would suspect a heritable mutation. Density of pockmarking is indicated between the two mesalmost bristles. Posterior to insertion of legs III and IV is a raised lip which seems to be the projecting edge of the acetabula, especially as it occurs at the distal end of the apodemata. Anterior to insertion of legs IV is a concave depression similar to that in parasterna III, only deeper for accommodation of the longer horn or flange of the coxae. Tectopodia IV very poorly developed, the bristle mesad of their anterior end. Circumgenital plate with three pairs of bristles (pl. 1, fig. 1). Genital covers narrowest anteriorly, with three pairs of bristle insertions, normally arranged as figured below the cover, the arrangement on the cover figured being that found on the specimen with

asymmetrical parasterna iv bristles. Anal plate broadly separating genital and anal apertures. This again is an unusual condition in primitive oribatids (as the *Hypochthoniini*),—it testifies to the independent origin of this group. The three pairs of bristles in this plate serve to emphasize the fact that all the paired sclerites have three pairs of bristles (three bristles a plate) except parasterna ii, in which the bristles may have been lost because of the telescoping of the abdomen over this area. These three pairs of bristles of the anal plate may well be the preanal and two postanal bristles of the higher genera. Anal covers with three pairs (three each) as in plate 1, figure 1. Postero-mesal rim descending as a protruding crest or flange. Anal plate (like ventral) not continuous behind aperture.

Legs smooth. Ungues with a single, strong hook. Legs i (pl. 1, fig. 4) longer than legs ii (pl. 1, fig. 5). Coxae small, upper half semiglobular; articulation with femur on ventral face; bristleless. Femora i elongate, cylindrical, distal end turned up at right angles to articulate with coxa by a broad circular joint, dorso-distal half transversely (?) wrinkled; armed with three bristles: a short, fine one on ventral face proximad of center, a longer, heavier one on ventral face near distal end, a much longer one on dorsal face near distal end. Femora ii shorter, their three bristles strikingly different: the posterior one much longer, rendered distally pectinate by about five long, well-spaced cilia, ventro-distal bristle well back from distal end, dorso-distal bristle quite short. Genuals i the largest of all the segments and as long as their femora, gourd-shaped; with two bristles on ventral face, the distal two to three times length of the short, fine posterior one; a very long, smooth one on dorsal face near distal end; one on each side of distal end, less than half length of the dorsal one. Genuals ii slightly shorter; armature similar but the longer bristles less developed, so that the two on ventral face are subequal, ventro-distal barbed. Tibiae i also gourd-like (foreshortened in pl. 1, fig. 4); with five medium long bristles about its larger part besides the usual long, stout, smooth major bristle. Tibiae ii similar but shorter, with only four slightly shorter bristles, two of them barbed, and a shorter major bristle. Tarsi i and ii quite similar, conical but obliquely truncate at distal end; bristles somewhat as in plate 1, figures 4 and 5, their appearance varying much with angle of vision, but tarsi i with a long major bristle on dorsal face near distal end, and a slender, prostrate bristle on dorsal face near proximal end reaching to hook of unguis, while tarsi ii have more and subequal bristles on dorsal face; on the other hand, tarsi i seem to have more bristles on ventral face, and the distal end has several short, basally stout, more or less sigmoid bristles, chiefly not reaching beyond hook; ventro-proximal bristles barbed.

Legs iii and iv quite long, especially iv owing in large part to length of coxae which have a proximally developed heel (pl. 1, fig. 6), a spur passing under femur, and a wing extending above it, this being the only segment in which superficial processes are developed; with two short, subequal, fine bristles on ventral face, spaced their own length from each other; in coxae iii these are much longer and closer together (actually); coxal articulation with neck which is as long as greatest width of coxae. Femora iv cylindrical, undulating, as long as their coxae; with two short, subequal, fine bristles on ventral face, more widely spaced than their length; another short, stout bristle on dorsal face near distal end, equal in length to those of ventral face; femora iii very similar. Genuals iv short, stout, broadest in middle; with two bristles on ventral face, both near middle, the proximal subequal to those of preceding articles, the distal shorter; one on each side; a long bristle on dorsal face inserted at distal end, reaching well beyond middle of their tibiae; genuals iii very similar, as long as their femora. Tibiae iv nearly as long as their femora, somewhat pedicelate, slightly longer than their genuals; with two bristles on ventral face: a long one at proximal end of head, the other halfway to distal end, and half as long; another inserted more distally on side; the usual major bristle as long as tarsus; tibiae iii very similar but ventro-distal bristles more distad and longer. Tarsi iv the longest of all the leg segments, slender, cylindrical, bluntly pointed; with a medium long bristle on ventral face proximad of center; a short, stout, knife-like

bristle-spine near distal end (one on each side); a slender, medium long bristle on dorsal face inserted distad of center; about four short bristles about distal end, not surpassing the hook. Tarsi III similar but pedicelate, with both ventral bristles alike and with two on dorsal face inserted near each other, the proximal one at center. All bristles very slightly barbed except where otherwise stated. None of the special bristles described in *E. szanisloi* have been noticed in this species.

As already described (40) the distal segment of the palp is very short and slender (pl. 1, fig. 2), the next one unusually long and pedicelate but set into what looks to me like a stout basal (third) segment.

The dimensions of three specimens as measured in microns are:

Length of notogaster.....	373-400
Length of ventral plates.....	344-361
Breadth of notogaster.....	106
Breadth of ventral plates (at leg III).....	102
Length of cephaloprothorax (total).....	105
Rostrum to posterior edge of pseudostigmata.....	97-100
Breadth of cephaloprothorax (including pseudostigmata).....	97
Length of genital aperture.....	65-70
Breadth of genital aperture.....	43-47
Length of anal aperture (projected).....	92-93
Breadth of anal aperture.....	91
Anterior edge of ventral plate to anterior edge of genital aperture.....	97

Color, chestnut brown.

Cotypes: Oahu, two oviferous females, from soil, experimental plot, Experiment Station, Hawaiian Sugar Planters' Association, slide no. 2618n1, Van Zwaluwenburg; Oahu, oviferous female, from soil sample from cane fields, no. 281vn, Van Zwaluwenburg.

The genotype (5) is pointed behind. In 1916 under *E. amygdaliformis* (5, p. 177) it was described as "puncture sculptured." By inference *E. ovalis* and *E. puella* should also be so sculptured, but this is not certain. Thus *E. szanisloi* seems to be the only smooth species thus far described. The species *E. amygdaliformis* has areolate-roughened legs, and *E. ovalis* of South America has long bristles and strongly undulate sides.

ORIBATIDAE-CARABODINAE

Wingless, though notogaster may be produced forward at outer anterior angles as short usually rounded bosses; chitin heavily sculptured; cephaloprothorax distinct from abdomen though anchylosed to it; legs highly developed, ambulatory, the tibiae much longer than the genuals; mandibles chelate.

The several genera which fall under this definition have recently (52) been placed in several families, a practice at variance with practical usage and biological phenomena. For instance, the "family" Neoliodiidae is characterized as having the notogaster so over-developed as to broadly overlap the ventral plate, as seen from below. This excludes the many tropical and subtropical species of *Udetaliodes* in which the notogaster, as seen from below, only narrowly overlaps the ventral plate equally all around. And yet

Udetaliodes is very closely related to the so-called *Neoliodes theleproctus* and *Platyliodes*, even in the diagonally divided genital covers.

In the same synopsis (52) the term Tegeocranidae is used, and the genus *Carabodes* placed under it. Yet the term Carabodides was used as a family designation in 1842 (34), and Carabodidae in 1859 (16). Furthermore, the term Tegeocranidae is used (52) though the type of *Tegeocranus* is placed under *Carabodes*. How can one sink the generic term *Tegeocranus* without equally submerging its derivatives?

Tribe CARABODINI, new tribe

Carabodinae with lamellae entirely absent or represented by broad thickening of the surface, not as slender, raised ridges or plates; genital and anal apertures often approximate.

Type, *Carabodes* (34, p. 107).

Genus UDETALIODES (29)

Carabodine mites bearing nymphal notogasters but having genital and anal apertures approximate; genital covers diagonally divided; a convex, mammelonate notogaster not broadly encroaching on venter; ventral plate complete behind anal aperture; nymphal girdles transversely corrugated by sharp ridges at least along their sides and posteriorly; short conical tarsi.

Type, *Liodes concentricus* (2, p. 15).

The three species thus far found in the Hawaiian islands, *Udetaliodes swezeyi* (Kaumuohona, Oahu), *U. hawaiiensis* (Oahu; Molokai; Maui; Lanai), and *U. hawaiiensis wakensis* (Wake Island), have already been sufficiently dealt with (29).

Eight specimens from the original material on which *Oribata lamellata* (47, p. 109) was based were kindly forwarded to me for study by Mr. W. T. Wells of the Australian Museum. These appear to be *U. hawaiiensis wakensis* but are so mounted as to present aspects of parts not presented in my earlier description (29). A description of these characters is therefore added to complete the record. As the pseudostigmatic organs (pl. 16, fig. 159) seem longer and more protuberant than in my earlier figure and the interpseudostigmatic style (interlamellar bristles) seems to differ, this Funafuti material may represent another subspecies. On the other hand, these differences may be due to the different angle at which these organs are viewed.

***Udetaliodes hawaiiensis wakensis* (pl. 16, figs. 159-165).**

Tarsi I (pl. 16, fig. 160) with distinct crest along dorsal face, the pair of proximal bristles remote from proximal edge of segment, with a much longer bristle inserted shortly distad; bristles of ventral face (foreshortened in plate 16, figure 160) well spaced out; distal bristles numerous. Tibiae I (pl. 16, fig. 160) with proximal end not attenu-

ated, a distinct flange along most of its length (or is this apparent flange formed by the walls of the areolations as it is in species with strongly areolated legs?); pair of major bristles, with distal one much the longer, extending far beyond apex of unguis, no fine bristle immediately proximad of this pair; a stout bristle-spine inserted at distal third, as long as diameter of segment; three other stout, possibly shorter bristles inserted each side of crest; ventral face with distal pair somewhat longer, a fine bristle shortly proximad of this pair; proximal edge with short flange; a short stout bristle inserted on a prominent nubbin on proximal edge. Tarsi IV (pl. 16, fig. 161) with proximal bristle inserted more proximad than in *U. hawaiiensis*, a very short bristle inserted closely distad of it; two fine, medium long, apically hooked bristles inserted near each other on distal third of dorsal face; ventral face with fine bristles inserted progressively (from distal to proximal edge of segment) more remotely from each other, proximal the longest, third next longest, fourth conspicuously shorter, second slightly shorter; ventro-distal area with apically hooked bristles. Tibiae IV (pl. 16, fig. 161) with dorsal and ventral edges more parallel; dorsal flange lower, not reaching proximal end of segment; ventral flange barely developed at distal end; but one bristle visible on dorsal face, inserted at distal third; ventral face with distal pair of bristles more slender; two short, somewhat stout bristles inserted one at proximal edge of body of segment, one distinctly proximad of center of body of segment. Genuals IV (pl. 16, fig. 161) with sickle-like bristle on dorsal face; a short bristle on proximal end of ventral flange. Femora IV (pl. 16, fig. 161) without flange distad of dorso-distal spine; ventral face with flange reduced to a triangular crest. Coxae and femora have their contiguous edges produced cup-like, the rim of the femora fitting over the rim of the coxae (pl. 16, figs. 162-165). Within these cups the articulation heads project. One of these very much recalls the articulation of the distal end of the tibia of the horse (pl. 16, fig. 163). Proximal end of coxae I similarly developed. Coxae III with a short, lancet-like bristle (pl. 16, figs. 164-165). The clavate bristle of femora III (pl. 16, fig. 164) inserted at center of body of segment (not counting the cup-like projection), clavate bristle of femora II inserted near distal end (pl. 16, fig. 162).

Of special note in plate 16, figure 159, is the spiral combing on the interlamellar bristle, its height relative to the pseudostigmatic organ, its raised insertion area; the fine ribs on sides of the cup of the pseudostigma; the chitin fold posterior to the pseudostigma; and the boldly rising notogaster.

Tribe CEPHEINI, new tribe

Carabodinae with lamellae represented by slender ridges or plates; genital and anal apertures often remote.

Type, *Cepheus* (34, p. 104).

Genus ODONTOCEPHEUS

Body elongate (abdomen much longer than broad); lamellae well developed; tectopodia I and II well developed; notogaster with antero-lateral bosses and at least one pair of bosses projecting from its anterior margin over cephaloprothorax, with long, stout bristles; interlamellar bristles on lamellae.

Type, *Tegeocranus elongatus* (36, p. 250, pl. 10).

This genus is very closely related to *Cepheus*, its bristles recalling those of *Oribatodes mirabilis* (2; 28).

Odontocephus immarginatus, new species (pl. 1, figs. 7-10; pl. 2, figs. 11-15).

Diagnosis

Abdomen with peripheral flange lacking except for a very short piece running back from anterior corners; pseudostigmatic organ head not with three longitudinal ribs, but much narrower than broad and with but one rib; sculpture of abdomen with hexagonal depressions; all bristles along ventral edge of femora IV short, clavate.

Description

Cephaloprothorax massive, broad, bluntly conical; rostrum broad and blunt; rostral bristles springing from prominent tubercles, strongly recurved over rostrum; lamellae very broad, considerably depressed so that even when animal is viewed partly from side one may look down on upper surface (pl. 1, fig. 7), extending laterad of pseudostigmata, and distad from base of lamellar bristles, tapering to a point which reaches to laterad of rostral bristle tubercles, faintly longitudinally corrugated (pl. 1, fig. 7); lamellar bristles inserted near outer edge of lamellae, arched mesad to reach toward center of cephaloprothorax; mesal edge of lamellae with prominent channel or thickening which springs from base of pseudostigmata and bifurcates at its distal end, one branch running onto cephaloprothorax, the other extending down side of cephaloprothorax to tectopodia I; center of cephaloprothorax slightly roughened by low ridges; three longitudinal at its base, a transverse near center, and a slender transverse depression between lamellar bristles; interlamellar bristles inserted on base of lamellae about halfway to lateral edge, reaching distad to beyond insertion of lamellar bristles; tectopodia I developed as broad flanges, paralleling lamellae, but shorter, their edges fringed by six to seven straight to curved, short, stout bristles! bolstered by two vertical stays which run down sides of cephaloprothorax toward tectopodia II (shaded in plate 1, figure 7); tectopodia II large, outer edge curved upward, forming (with thickened rim of side of cephaloprothorax) a somewhat oblong pocket, slightly broader at posterior end (between femora I and II, plate 1, figure 7); sides of cephaloprothorax somewhat pockmarked; pseudostigmata large, protruding cups, broader than deep, finely cyclically corrugated; pseudostigmatic organs (pl. 1, fig. 8) fairly long with pyriform head, lobed near apex, with thickened outer rim near base and a subsidiary ridge extending towards lobe.

Abdomen elongate-ovate, anterior corners built out by a short, slender flange (cross-hatched in plate 1, figure 9), strongly sculptured by irregular pits whose shape and size vary considerably but are usually much larger than intervening ridges (pl. 1, fig. 7), their sequence interrupted near outer border but more coarsely resumed around edge which, except for area near anterior corners, is broadly rounded; anterior edge, besides the two prominent anteriorly directed nubbins, broken by projecting end of a low longitudinal ridge (shaded on left side in pl. 1, fig. 7, ridge of right side on horizon); surface further enlivened by sixteen long, slightly curved bristles on dorsal face and twelve strongly curved along rim, the disc bristles arranged in four longitudinal lines of four each, so placed as to form transverse rows bowed forward, first transverse row almost straight, anterior six bristles directed forward. The original figures of *O. elongatus* (36) do not have the first transverse row, but have eight marginal bristles on left side and nine on the right. The Italian species (4, fasc. 50:1) is very peculiar in its setal armature, the peripheral bristles are figured as only slightly curved. The figure from north Germany (52, fig. 60) is very similar in most respects to the present one but has a continuous peripheral keel. The bristles are crescentic in cross-section but with a mesal ridge running lengthwise in the hollow of the crescent, making them three-ribbed on the dorsal face (see posterior bristles of plate 1, figure 7).

Venter similarly sculptured along sides posterior to legs; postanal bristles similar to peripheral of notogaster (see posterior edge of plate 1, figure 7, where two are visible), mesal pair centered behind each cover, lateral pair well beyond sides of aperture and laterad of its posterior end; preanal pair also beyond sides and equally anterior of

anterior edge of aperture; covers somewhat pockmarked, inner edge (pl. 2, fig. 15) with two well-developed, slender, cuneiform, interlocking ridges at anterior end (shaded in plate 2, figure 15), followed by a similar much broader ridge posterior to them, the two bristles near mesal edge, the anterior slightly anterior of middle, the posterior at three-fourths length of cover from anterior edge; paramesial bristles remote from genital aperture, on same longitudinal plane as its lateralmost edge (pl. 1, fig. 9); genital aperture broadest at anterior end which slopes very gradually to sides; covers thickened along mesal edge, bristles close to mesal edge, anterior pair quite close to anterior edge of cover, posteriormost remote from posterior border (pl. 1, figs. 9, 10); parasterna IV with two long, fine bristles, the anterior inserted slightly mesad of lateral edge of genital aperture, the posterior equally laterad of same; parasterna III at least with anterior bristles, the posterior pair represented by a small puncture (pl. 1, fig. 10), their approximation the reverse of those of parasterna IV; acetabulae IV (pl. 1, fig. 9) short, remote from genital aperture, the anterior edge of which is strengthened by a thickened band (pl. 1, fig. 10) set obliquely and in line with acetabulae IV, this thickened band of the genital aperture frame and the fragment of a similar thickened band recall a similar but continuous chitinous band in *Dameosoma* and related genera; apodemata IV well developed but somewhat short; apodemata II-III very similar to IV; sternum well developed, with long branches extending to apodemata III and IV (pl. 1, fig. 10); anterior crest of acetabula III (tectopedia III) bearing a short, rough, clavate bristle (pl. 1, fig. 9); a thin chitin shelf (tectopedia III and IV) extends below insertion of legs III (cross-hatched in plate 1, figure 10) and somewhat below legs IV; a short, rough, clavate bristle (tectopedia IV) springs from between legs III and IV (pl. 1, fig. 10); juncture between cephaloprothorax and abdomen not strongly ankylosed so that slight pressure causes the two to separate fairly regularly; parasterna II seem to be without bristles but with two small punctures; parasterna I with a bristle at anterior edge of acetabula II, with a small puncture near center; apodemata I developed like apodemata II-III; episternal apodemata projecting well beyond posterior edge of camerostome; a few pockmarks between acetabula I and camerostome.

Camerostome large and broad, not gradually tapering anteriorly (pl. 1, fig. 9). Labium with the usual bristles. Mandibles unusually high, their lateral profile incised by a constriction dorsad of base of cutting edge.

Legs smooth (or very slightly roughened); most bristles short and smooth; all armed with one strong, deeply curved hook; highly developed tibiae and femora and reduced tarsi; only legs I with major bristle. Legs I (pl. 2, fig. 11) slightly longer than legs II; tarsi short, distal two-thirds conical, dorsal face bearing three bristles on proximal third, of which the middle one is short and fine, the distal one quite stout, and three on distal two-thirds; ventral face with usual three bristles, the proximal most distant from middle one; distal bristles few. Tibiae one and one-half times length of tarsi, with long pedicel, dorsal edge with two bristles besides the extremely long major bristle, both near distal end, the distal one somewhat long, turned somewhat sideways; a fine bristle on lateral face, inserted proximad of dorso-proximal bristle, but one bristle on ventral edge, inserted on same transverse plane as the dorso-proximal. Genuals nearly as long as tarsus! with a long, stout, laterally curved bristle on dorsal face, near distal end; a fairly long bristle on ventral face at distal end. Femora very long, as long as tarsi and tibiae, distal half broad and deep (foreshortened in figure), proximal half (pedicel) slender and tubular, the two portions sharply differentiated; a long, depressed bristle inserted on dorsal face at juncture of pedicel and body of segment; two rather short bristles inserted near distal end, one on each side and one slightly behind the other; other bristles not definitely located but quite certainly with one at ventro-proximal angle of head. Coxae larger than pedicel of femur, with two medium long, curved bristles.

Legs II (pl. 2, fig. 12) similar but shorter. Tarsi with bristles crowded onto distal half. Tibiae with but one bristle on dorsal edge near distal end; a lateral bristle more proximally inserted. Genuals with a stout knife-like bristle on dorsal edge, near distal

end; a fine one inserted on side, near distal end; a fairly long, slightly barbed bristle on ventral face inserted on distal edge. Femora with body longer than in leg I; dorso-distal bristle inserted distad of middle of body of segment, heavy, barbed; dorso-proximal bristle similar to that of femora I; another on other side inserted slightly proximad of it; ventral edge with a short, stout, barbed, spike-like bristle inserted at center of segment head. Coxae minute.

Legs IV (pl. 2, fig. 13) longer than legs III. Tarsi with longer bristles than other legs, fewer than on tarsi III; proximal the longest, inserted just proximad of center. Tibiae clavate, long, nearly two times length of tarsi; but one slight bristle on dorsal face inserted less than diameter of segment from distal end; two ventral bristles: one inserted slightly more proximad than the dorsal, one near distal end. Genuals half length of tarsi; with a short bristle inserted near center of dorsal face. Femora conical, with a broad flange along ventral edge; a stout, curved, barbed bristle inserted near center of dorsal edge; a short, spatulate bristle inserted distad of center of ventral edge, extending just beyond flange. Coxae semiglobular with a semicircular flange on ventral face, extending upward behind articulation neck almost to dorsal edge!; dorsal edge roughened by two or three slight wrinklins; a curved, spatulate bristle inserted distad of center of ventral edge, projects beyond edge of flange.

Legs III (pl. 2, fig. 14) similar but tarsi with more bristles, the longest about distal end. Tibiae similar to tibiae IV but shorter, bristles stouter. Genuals with the addition of a dorso-distal bristle. Femora with two dorsal bristles: the proximal one long, stout, strongly deflected, inserted at proximal angle; the distal one as femora IV but inserted anterior to center; also two bristles on ventral edge, proximal one rather long and fine, inserted near proximal corner, distal one much as in femora IV. Coxae "longer" than coxae IV, their spatulate bristle straight.

Dimensions in microns: length of abdomen, 369; length of cephaloprothorax, 213; total length, 582; greatest breadth, 272; length of genital aperture, 66; genital aperture to anal aperture, 160; length of anal aperture, 90.

Holotype: from epigeal moss lying beneath a stratum of the fern *Sphenomeris chinensis* (Linnaeus) Maxon, on west shoulder of hill at head of Manoa Valley, Honolulu, July 29, 1926, no. 2624n, Jacot.

This species differs from all others thus far described in the lack of a circumabdominal parapet. It also differs from *Odontocephheus elongatus* in the following respects. In the genotype the base of the cephaloprothorax has longitudinal, more or less anastomosing, rough-edged corrugations, lacking in this species; the central part of the cephaloprothorax is smooth; bristles of notogaster in the genotype: I:1, closer together; III:1(2), more anteriorly inserted than II:2; I:3, more remote than I:2; I:4, slightly more approximate than I:1; II:1, on depressed edge of notogaster rim; III:1(2) and III:2(3), on the rim; III:3(4) and III:4(5), inserted below bulge of rim. The sculpture is more accentuated, the areolae are finer in the center of the notogaster, the ribs of the sculpturing are continuous onto the rim, down over the rim, and down to edge of notogaster; the ventral plate is strongly sculptured (weakly so in the island species); there is fine granulation on the area posterior to and laterad of leg IV (not present in the immarginate species); anal covers strongly sculptured with eleven to twelve pockmarks along its length, with punctures more anteriorly situated, more nearly with one at each third (the

posterior puncture—bristle insertion—is much posteriad of second third in the new species); fissurae as close to aperture as is postanal puncture, diverging backward from it (far from it, shorter, converging toward it and opposite center in the island species); preanal bristles inserted diameter of a cover from aperture; genital covers with a few pockmarks, anterior bristles nearer anterior edge, middle bristle at center, posterior bristle on posterior rim (thus much more widely spaced than in the immarginate species); chitin band running from anterior edge of genital aperture toward legs iv and strongly developed, lateral puncture of parasterna iv close “against” it; puncture of parasterna more widely spaced—that is, the mesal ones more mesad.

ORIBATIDAE-ORIBATINAE

Wingless, though tectopedial process and other chitinous extensions may resemble wings; chitin usually smooth especially notogaster and ventral plate; cephaloprothorax usually distinct from abdomen though anchylosed to it; legs nonsaltatorial, slender, often very long, usually without ridges or flanges, tibiae much longer than genuals, like femora pedicellate.

Type, *Oribata* (35, p. 65).

Tribe ORIBATINI, new tribe

Coxae iv gourd-shaped to clavate (straight to slightly curved), proximal end more slender than more swollen distal end; without longitudinal flange.

Type, *Oribata* (35).

The complex of genera which are included by the above definitions has been variously arranged under two or three families. I am not at present prepared to accept such grouping. A careful perusal of the genera here concerned leads to the following conclusions.

Genus *Belba* Heyden 1826 (p. 611)*

Type, *Notaspis corynopus* Hermann (19, p. 89, pl. 4, fig. 2).

In Moss, Strasbourg.

The most outstanding generic characteristics of *Notaspis corynopus* Hermann are its rather long legs, allying it to the *Damaeus* group, and the peculiar development of the tarsus which is figured only by Berlese in his *Belba sufflexa* (4, fasc. 74: 4). Usually when a major bristle is developed on the anterior legs, it is developed at the distal end of the tibiae. In *Belba*, however, it is developed near the middle of the tarsus. A careful comparison of the figures of Hermann and Berlese will show other corresponding

* Literature not given in the bibliography, pages 95-96, is listed fully in Jacot, A. P., Annotated bibliography of the moss mites (Oribatoidea, Acarina), 70 pp., 1927.

resemblances. For instance, the cephaloprothorax has no carina, ridges, or ears; the pseudostigmata are inserted on dorso-lateral rim (not on dorsal face); and the abdomen is oval, not round. Thus these two species are congeneric. *D. sufflexus* Michael 1887 is similar, but the figure does not show the tarsal spine. On page 416 he writes: "Each tarsus bears a large chitinous spike on its upper mesal line near proximal end." Thus this species also, though with rounded abdomen (the Italian is oval), is a member of this group. The characters of the cephaloprothorax are similar to those of Berlese's species. Berlese, by tilting his specimen, shows an ear below the pseudostigma and on sides of abdomen, which may not be visible when seen from mesal plane. Both Michael and Berlese describe their species as having notogaster strongly produced over venter, thus limiting the extent of the ventral plate. Michael's figure, like Hermann's, has a slender, almost pointed rostrum. There can be no doubt that these three species are congeneric and as they differ markedly from other Damean species they may well be segregated in Heyden's genus. *Belba corynopus* is still to be rediscovered, redescrined, and refigured. *Belba sufflexa* (Berlese), being preoccupied by *Belba sufflexa* (Michael), may be known as *Belba vallombrosae*, new name. *Belba* is evidently a misprint (like other genera of Heyden) for *Bella* (pretty). As there is no reason for changing it at this time, I consider it a first declension feminine noun in its original spelling.

Genus *Oppia* Koch 1842 (p. 104)

Type, *O. nitens* Koch (33, fasc. 3:10).

Among bushes in garden, near Regensburg.

The type is characterized by long, slender legs (proximal end of tibiae iv does not surpass the abdomen because of length of latter); lack of ridges, ears, or spines on cephaloprothorax and abdomen; pseudostigmata distant from notogaster; and the remote genital and anal apertures. *Damaeus nitens* Michael (38, p. 405) closely resembles it but has a more pointed abdomen and a notched plate at insertion of legs i.

Genus *Damaeus* Koch 1842 (p. 106)

Type, *D. auritus* Koch (33, fasc. 2:11).

Under stones or in epigeous moss, in woods near Regensburg.

The type species seems closely congeneric with the type of *Oribata*.

Genus *Amerus* Berlese 1896 (fasc. 79:7)

Monotype, *Belba troisiü* Berlese (4, fasc. 3:5, where its use was suggested by Berlese in 1883).

In moss, Frosinone, Italy.

This type is a rather short-legged "*Damaeus*" (base of tibia IV does not surpass abdomen); oval body; no abdomino-cephaloprothoracic suture; no ridges on cephaloprothorax; anal and genital apertures remote; pseudostigmata dorsal.

Genus *Dameosoma* Berlese 1896 (fasc. 79:9)

Type, *Dameosoma concolor*. This does not mean *Damaeus concolor* Koch. First used in 1887 (4, fasc. 43:1) as subgenus.

From moss throughout Italy.

The type species has as outstanding generic characters: pseudostigmata on dorsal face of cephaloprothorax; proximal end of tibiae IV opposite body; cephaloprothorax without ridges, with a slender rostrum and well-developed though nonprotruding ears, i.e., distal (anterior) end of tectopodia II re-entrant; genital and anal apertures remote. It should be noted that legs I, II, and IV each have a supernumerary segment between tarsi and tibiae. As this phenomenon recurs in legs III and IV of *Damaeus dugesii* Berlese, one is led to wonder if this curiosity is not due rather to exuberant imagination than to inconsistency of somatoplasm. Still more bewildering, one finds that figures 1 and 3 do not correspond as to relative length of bristles, as to inclusion of exopseudostigmal bristles in chitin plate, or as to degree of taper of rostrum.

Berlese has twice figured the ventral aspect of this species, figure 9 of the plate illustrating the generic characters of *Belba* (fasc. 63:3) and figure 6 of plate 9 of the general volume on the group. A collateral comparison of these two figures shows that they differ radically in degree of development of sternum, shape of proximal end of femora I, shape of tectopodia II, shape of ventral plate spine and postero-lateral corner, and shape of genital aperture. A comparison of these figures with that of the specific plate (4, fasc. 43:1) shows that the abdomen is of the ovate type (smaller at posterior end), and the snout is much more robust, but that the size of the femora and shape of the ventral plate tooth are exactly the same. Thus the figure 9 does not belong to the same species while figure 6 probably does.

On comparing these figures with those of Paoli (44, pl. 3, fig. 1)—a work of far greater accuracy—one finds a quite different figure. There are no exopseudostigmal bristles, there is a broader rostrum, a posteriorly pointed, denticulate abdomen with shorter bristles behind, and different arrangement, also shorter pseudostigmatic organs, serrate coxae III, and a forewaist bristle at sides. Yet we are to believe that this artist had the earlier original specimens before him. The appearance of the shape of the posterior end of the abdomen varies (1) possibly with angle of vision so that if viewed consider-

ably from in front and above the posterior end of the abdomen appears more rounded while if seen considerably from behind and above the same part appears tapering; (2) of the four specimens of a *Dameosoma* described below, not broken up, the only female (pl. 2, fig. 21) has a broad and posteriorly rounded notogaster, whereas the three males have this portion tapering to a blunt, rounded point (pl. 2, fig. 22) as figured by Paoli. Thus this one discrepancy may be accounted for on the basis of sexual dimorphism, whereas the others may be due to Berlese's having more than one species before him.

In the original description of *D. denticulata* Canestrini 1882 (p. 914) one finds a crude figure (40) without interlamellar bristles, while the description calls for long bristles on abdomen and a nearly spherical second segment to legs III. As this species came from Messina on the island of Sicily one might suspect a different species. If it is a different species, *Dameosoma concolor* Berlese will have to be renamed. Two years later in a redescription from many more specimens the pseudostigmatic organs are recorded as filiform!

Comparing these three Italian descriptions and figures with the type of *Oppia*, one finds the latter to be more elongate (abdomen oval), devoid of lateral tooth (tectopedia IV), tectopedia II not developed as ears, and pseudostigmatic organs remote from notogaster. After a careful review of various species of *Oppia* and *Dameosoma*, I find that the tooth of tectopedia IV (a protuberance of the ventral plate) is not correlated with other characters of phylogenetic significance; it is developed independently by various species without reference to other characters. Thus it cannot be used as a generic character. I find, however, that a character pointed out in 1908 (44), namely, distance of pseudostigmata from notogaster—which is an expression of amount of constriction of forewaist (mid-thoracic constriction), is of considerable significance. As the type of *Dameosoma* represents the group with slight constriction (and posterior pseudostigmata) and the type of *Oppia* the group of considerable constriction (and anterior pseudostigmata), no new names are needed to denominate these two groups.

Genus *Gymnodamaeus* Kulczynski 1902 (p. 93)

No type assigned; appointed as substitute for *Damaeus* Berlese. Berlese appointed no type to his *Damaeus*, which was a restricted use of Koch's. In 1928 Sellnick appointed *Damaeus bicostatus* Koch as type of *Gymnodamaeus*. For figures see Kulczynski, pl. 4, figs. 28, 30, 32, 34; pl. 5, fig. 70.

Near Regensburg.

Genus *Amolops* Hull 1916-a (p. 385)

Type, *Damaeosoma clavipectinata* (Michael) 1885, p. 392 (see 38, p. 387, pl. 32, figs. 7-11).

Considerable numbers, old thatched roof; Warwickshire, England.

A species with long oval body; no ears, ridges, or spines visible from above; tectopodia II very poorly developed; legs IV appearing short because of length of body; but coxae IV typical for the group. Thus quite similar to *Oppia nitens* but legs much shorter, rostrum broader, and cephaloprothorax very narrow.

Genus *Dissorhina* Hull 1916-b (p. 401)

Type, *Oppia splendens* Koch (33, fasc. 32:6).

Rather common; under moss or stones, in all woods; Regensburg.

The type is placed by Koch in the generic section without lamellae, which places it near *O. nitens* in this respect. It is without notogastral bristles in both figure and description. No mention is made of the striking rostral nipple. Thus a type has been assigned to a description or concept to which it bears no relation. The large femora and small coxae form an outstanding characteristic, as do the well-developed major bristles. Koch has also added a segment between tarsus and tibia! This generic name therefore does not belong to the species so well figured by Paoli (44, pl. 4, figs. 16-18).

Genus DAMEOSOMA

Oribatinae with anal and genital covers remote; proximal end of tibiae IV not surpassing posterior end of abdomen; cephaloprothoracic ornamentation consisting at most of flattened, appressed bands (slightly increased chitinization of the surface in definite tracts), though pockmarking may be present on sides; notogaster usually oval; cephaloprothorax and abdomen separated by a very slight constriction if any, this forewaist appearing as a dark narrow band about the body, and thus placing pseudostigmata, which are usually small, close to edge of notogaster.

Type, *Dameosoma concolor* (4, fasc. 43:1).

Dameosoma ultraciliata, new species (pl. 2, figs. 16-22).

Diagnosis

Chitin band at base of cephaloprothorax of same diameter throughout; interlamellar bristles inserted just anterior of this band which passes about base of pseudostigmata to merge with thickened sides of cephaloprothorax which appear from above as a scalloped band; exopseudostigmatal bristles fairly long and well developed, rather remote from pseudostigmata; pseudostigmatic organs without head, tapering from near base very gradually to a point, bordered on anterior (outer) side by cilia-like hairs (whence the specific name); notogaster bristles also ciliate on lateral (outer) edge; surface smooth except for sides of cephaloprothorax and abdomen, including tectopodia II, which are finely pockmarked.

Description

Cephaloprothorax, as seen from above (pl. 2, fig. 20), pyriform, broad, sides tapering but gradually to the blunt, conical rostrum which is tipped by a prominent nipple;

tectopedia I invisible from above; acetabula I represented by a slight flare opposite apex of tectopedia II, this flare is capped by a slight pimple-like protuberance; tectopedia II long but repressed, apex turning inward, surface roughened by fine pockmarking; surface otherwise quite smooth except for the possible very slight projection of the chitinous bands (described under diagnosis), and the stippled sides below lamellar band; rostral bristles medium long, diameter of pseudostigmata from mesal plane; lamellar bristles much longer, inserted slightly more laterad than rostral bristles, and considerably distad of center of cephaloprothorax; interlamellar bristles nearly as long, and about as remote from mesal plane as lamellar; pseudostigmata low, barely projecting, at angle of dorsal face and sides of cephaloprothorax, close to notogaster, opening laterally.

Abdomen depressed, as seen from above: circular in the single female (pl. 2, fig. 21) to ovate (narrowing posteriorly) in the males (pl. 2, fig. 22); notogaster encroaching slightly on venter at sides (see right side of plate 2, figure 21) and not covering antero-lateral angles of abdomen (which are also roughened by fine pockmarking) so that the undulate sides and tooth of ventral plate are visible from above; surface with a few minute dimples on anterior half; bristles rather long, fine, at least the posterior ones weakly ciliate especially towards distal end, arranged in two rows 4:5/5:4 as in plate 2, figures 21 and 22. The posteriormost bristles are on posterior edge of notogaster and ventrad of its outermost rim, thus best seen from ventral aspect, their depressed insertion causing a scalloping of edge of notogaster if animal is held so as to place these insertions on rim, bristles II:4 not visible from above, quite short; pseudofissurae laterad of bristles I:2 and midway between it and edge of notogaster, as seen from above.

Ventral plate projecting as a shelf beyond sides of abdomen ventrad of legs II and IV, this shelf with fairly well developed, pointed tooth laterad of insertion of legs IV (as if tectopedia IV), posterior edge of tooth concave, with a fairly long, double-ciliate bristle (pl. 2, fig. 20, where the triangular point appears as seen somewhat from the side), shelf with two weak undulations laterad of and posterior to insertion of legs III (as if tectopedia III) thence extending to tectopedia II; there seems to be no bristle here; forewaist bristles long, curving ventrad. Anal aperture close to posterior edge of ventral plate, sides tapering conspicuously, anterior edge angularly joined to sides, emargination of covers slight; postanal bristles well developed, fine, mesal pair inserted more mesad than center of cover, on same longitudinal plane as notogastral bristles I:5, lateral pair remote from aperture, and anterior of widest part of aperture, on transverse plane of posterior bristles of covers; preanal bristles far to one side, near lateral border of ventral plate, posterior of anterior border of aperture; anal cover bristles nearer lateral edge of covers than to mesal edge, the anterior close to antero-lateral angle, the posterior in line with lateral pair of postanal bristles; paramesial bristles slightly nearer anal than genital aperture, and more remote than width of anal aperture; all these bristles fairly long, fine, short ciliate or barbed. Genital aperture its own length from forewaist chitin band, quite small, outer edges nearly parallel, cover bristles indistinct, the two posterior pairs close to outer edge, anterior two pairs on middle line of covers, pairs two and three twice as distant from each other as they are from pairs one and four; genito-thoracic suture directed postero-mesad of insertion of legs IV, thence slightly diagonally across to transverse plane of posterior edge of genital aperture, where it is sharply bent to extend quite close to the anterior corner of the aperture, then anterior to meet anterior rim of aperture at an acute angle, thus closely simulating *D. denticulata* (4, pl. 5, fig. 41), two or three swollen points as in plate 2, fig. 21; space thus enclosed (parasterna III-IV) occupied by three smooth, fine bristles inserted as in plate 2, figure 21, besides the longer, barbed bristle of tectopedia IV; the punctures over the sternum are without bristles and often but faintly discernible; these parasternal pieces do not seem to meet on the mesal plane but their edges seem firmly ankylosed to the sternum beneath; sternum very slender, with more thinly chitinized, broader edges, and a transverse stub or arm between parasterna II and III, and between parasterna III

and iv; apodemata II-III (forewaist band) stout, their distal ends broadly joined to the thickened band of the sides, enclosing rectangular parasterna II without bristles, and quadrilateral parasterna I each with a ciliate bristle inserted laterad of center; gular bristles above mesal end of episternal apodemata which are broadly joined to anterior end of longitudinal, lateral band and to sternum; a short, curved spur projecting into camerostome from side. Camerostome large, elongate oval; labium long, its bristles inserted near the lateral margin and anterior to the marginal spurs.

Legs terminated by a single weak, angular, poorly curved hook; armed except where specified, by rather long bristles, ciliate on lateral (outer) edge only (as signified by the specific name) though there may be two rows of such cilia on some bristles so that viewed at a certain angle a row is seen on each side of bristle shaft (see bristle of coxae I). Legs IV the longest, legs I the shortest; tarsi IV the longest, tarsi I the shortest; coxae IV the longest, coxae II the smallest.

Legs I (plate 2, fig. 16) longer than legs II. Tarsi angular, fairly broad near proximal end, dorsal face with eight bristles: proximal inserted at broadest part of segment, bristle 2 inserted close to proximal, bristle 3 short, like a knife blade, inserted very near second, bristle 4 quite long, inserted some distance from third, bristle 5 similar, inserted as far from 4 as 4 is from 3, bristle 6 shorter, inserted close to 5, bristle 7 short, inserted as far from 6 as 4 is from 5, bristle 8 similar, inserted close to 7; thus 5 and 6, and 7 and 8, form pairs; ventral face with seven bristles, all ciliate: 1 to 3 inserted opposite 1, 2, and 4 of dorsal face, the spinescent bristle not being represented on ventral face, bristles 4 to 7 inserted slightly more distad than the corresponding ones of dorsal face, bristles 1 and 2, 4 and 5, 6 and 7, approximated in pairs, almost half as far from each other as the adjacent interspaces; a lateral bristle inserted near dorsal face on transverse plane of dorsal bristle 4; another midway between bristles 2; another inserted just dorsad of ventral bristle 3; a mesal bristle between proximal bristles, possibly one slightly mesad of ventral bristle 4; minute bristle on apex of segment. Tibiae much shorter, with slender head and curved pedicel; dorsal edge with two bristles, the major bristle smooth, no longer than others, inserted near distal end of segment, and a ciliate bristle inserted equally distant from major as major is from distal end of segment (its insertion eclipsed in figure because of its procumbent position); a bristle on each side inserted nearer distal end of segment than major bristle; ventral edge with two bristles: the distal inserted on transverse plane of major bristle, the proximal inserted more than diameter of segment from distal end. Genuals quite short, curved; armed with a medium long, smooth bristle on dorsal face, and a long, ciliate bristle on each side, all three inserted on transverse center of segment. Femora with spindle-shaped body and well-developed shaft; a dorsal bristle inserted at broadest part of segment; a ventral bristle with but two coarse "cilia," inserted more proximally than dorsal bristle; a lateral bristle inserted on transverse plane passing between dorsal and ventral bristles; another lateral bristle inserted on shaft near its juncture with head of segment; clear areas are indicated on the figures, though it is not certain whether they are due to thinner chitinization or to internal phenomena. Coxae small, cup-shaped, with distally directed cusps; a long bristle, ciliate on two sides, inserted at distal end.

Legs II (pl. 2, fig. 17) similar to legs I but each segment proportionally shorter. Tarsi with bristles similar but longer and an additional one on each face. Tibiae with upper lateral bristle short and smooth; dorsal ciliate bristle longer; an additional bristle on ventral edge. Genuals with an additional bristle on dorsal edge at distal end, and a similar one on ventral edge. Femora with dorsal bristle more distally inserted; with three bristles projecting beyond ventral edge, apparently subequally spaced, the distal one inserted on transverse plane of dorsal, the middle on side of segment, the posterior on juncture of body and shaft of segment, mid-ventral bristle with three pectinations. Another rather short lateral bristle is inserted near dorsal edge proximad of dorsal bristle, a clear spot at anterior end of shaft. Coxae minute, without bristles.

Legs IV (pl. 2, fig. 18) the slenderest. Tarsi the longest segment of the eight legs,

very slender; ventral face with a pair of bristles inserted two-thirds distance from distal end, one of the pair being inserted somewhat on lateral face of segment; another pair more distally inserted; a single one near distal end; dorsal face with quite a long bristle inserted opposite the ventro-proximal pair; a pair inserted distad of ventral pair, one slightly in advance of the other; a lateral bristle inserted near proximal end. Tibiae much shorter, curved, cuneiform; a smooth bristle on dorsal edge, inserted near distal end; a ciliate bristle inserted on lateral face closely proximad of dorsal; one on ventral edge inserted more proximad than dorsal; a lateral bristle inserted slightly distad of center of segment (foreshortened in plate 2, figure 18). Genuals fairly long, tubular, curved; a smooth bristle on dorsal edge inserted just distad of center; another on lateral face inserted on transverse plane of dorsal. Femora of usual Indian club shape; a dorsal bristle inserted nearly diameter of segment from distal end; a lateral bristle with but one stout "cilium" inserted on transverse plane of dorsal bristle. Coxae (see also plate 2, figure 20) elongate, broadest distad of center; with a stout, pauciciliate bristle near distal end.

Legs III (pl. 2, fig. 19) shorter. Tarsi shorter and more robust than tarsi IV, one leg has a transverse partition at its center when held a certain way, but when rolled over the partition disappears in large part. This may be due to a partial partition extending along one face of the segment. Bristles of dorsal face more symmetrically spaced than in tarsi IV, all ciliate; bristles of ventral face not in pairs. Tibiae more robust than tibiae IV; dorsal bristle shorter, ventral and lateral bristles inserted close together. Genuals much shorter than genuals IV; dorsal bristle also much shorter; a long, slender, lateral bristle inserted on transverse plane of dorsal bristle. Femora similar to femora IV; bristles similar but lateral bristle with three pectinations. Coxae stout, capitate, with a crest at its proximal end on dorsal side, the articular neck quite short; a bristle inserted at juncture of dorsal and distal face; another on ventral face close to femoral articulation, with two rows of cilia. Mouth parts not unusual.

Color, reddish tan.

Dimensions: four specimens measured, including one female which was of average size but had a more rounded (not posteriorly pointed) notogastron, and which is delineated in plate 2, figure 21. Dimensions in microns are as follows:

	Dameosoma ultraciliata			Oppia cronus	
Total length of body.....	565	585	605	490	515
Length of notogastral plate.....	360	377	395	295	330
Breadth of notogastral plate.....	315	327	335	265	.....
Interlamellar bristle span.....	.....	115	.....	105	.....
Camerostome to genital aperture.....	145	150	150	144	.....
Length of genital aperture.....	50	54	58	45	.....
Breadth of genital aperture.....	45	47	50	50	.....
Genital aperture to anal aperture.....	125	130	130	80	85
Length of anal aperture.....	100	104	105	85	90
Breadth of anal aperture.....	100	106	110	85	.....

Cotypes: Oahu, five specimens from decaying cane stool, Experiment Station, Hawaiian Sugar Planters' Association, November 3, 1923, slides no. CGES10Pa-b, C. E. Pemberton. The one female has four eggs within the abdomen and one or two in the extruded, short-fingered, much-dilated ovipositor.

This species is thus very close to *Dameosoma denticulata* (4) but differs from all related species in its tapering pseudostigmatic organs.

I regard the dark band, so prominent in many of the Oribatinae, which extends from the region posterior to insertion of legs IV to anterior rim of genital aperture, as demarking the juncture of the genital plate and parasterna IV as found in plate 1, figure 1. Thus the ventral plate in the higher groups comprises, amongst other plates, the anal, the genital, the eight parasternal, and the mesal episternal plates. These are all evident in plate 1, figure 1. In the Oribatinae the anal plate has developed at the expense of the genital, shoving the genital aperture farther and farther forward.

Dameosoma alces, new species (pl. 16, figs. 154-158).

Diagnosis

All body bristles short and fine; no distinct chitinized bands about cephaloprothorax or forewaist, practically no difference between abdomen and cephaloprothorax; pseudostigmatic organs (pl. 16, fig. 154) long, with short, slenderly clavate head, four rather short cilia on posterior side of distal half of pedicel, one on posterior side of head, and three on the somewhat truncate apex; ventral plate with small (exaggerated in figures, due to angle of vision) tectopedial points; tectopodia II barely visible from above, when eye is above mesal plane.

Description

Cephaloprothorax broad and plain, unrelieved by ridges, furrows or chitinized bands, lateral edge barely undulate, quite straight; rostral bristles stout, fairly short, inserted diameter of pseudostigmata from mesal plane; lamellar and interlamellar bristles likewise, possibly finer; pseudostigmata on juncture of cephaloprothorax and abdomen, slightly oval, obliquely set; tectopodia I entirely lacking in dorso-ventral view; tectopodia II very poorly developed (exaggerated in plate 16, figures 154 and 155, by tilting of specimen), very short, the distal end depressed.

Abdomen ovate; notogaster bearing eighteen bristles arranged somewhat as in the one specimen in which the notogaster was transversely fractured at two or three places and much flattened out by pressure of cover-glass (pl. 16, fig. 154); evidently decurved over ventral plate so as to form a slender channel between the posterior edges as seen in ventral view, and projecting well beyond the broadly rounded ventral plate (pl. 16, fig. 155); lateral edge of ventral plate undulate posterior to insertion of legs IV, with a triangular tooth (tectopodia IV) between legs III and IV, bearing a short bristle at its posterior base; tectopodia III barely extant (just anterior to insertion of legs III, plate 16, figure 155), with a bristle at its base; a short, stout bristle at juncture of cephaloprothorax and abdomen (forewaist bristle); anal aperture with well-developed angles, sides only slightly tapering; mesal pair of postanal bristles at center of cover, lateral pair on transverse plane passing through center of aperture but close to edge of plate, pseudofissurae close to aperture and parallel with sides; anterior pair of cover bristles closer to lateral edge of cover than to anterior edge, posterior pair closer to mesal than to posterior edge and twice as remote from these as are the anterior pair from lateral edge of covers; preanal bristles close to lateral edge of ventral plate, anterior to transverse plane tangent to anterior edge of anal aperture; paramesial bristles about halfway between the two apertures but more remote than diameter of anal aperture. Genital aperture with well-rounded angles, especially the anterior; anterior two bristles inserted near mesal edge of covers, third and fourth nearly on longitudinal center; genitothoracic suture with lateral end remote from insertion of legs IV, nearly transverse, prominently angled at sides of aperture; parasterna III-IV with the anterior two pairs of bristles (parasterna III) quite remote, the lateral quite near leg insertion, the posterior two (of parasterna IV) also quite remote, the lateral one posterior to leg inser-

tion and on or even across the suture; parasterna II with one bristle at mesal third, without median spur or arm from sternum; parasterna I with lateral band (suture) poorly developed; sternum only weakly developed between parasterna I; camerostome broad, ovate; labial bristles near transverse center.

Legs not unusually slender, I and II rather stout for the genus, bristles mostly smooth, mostly rather short; unguis with the single hook quite slender, angular, not deeply curved. Legs I (pl. 16, figs. 154, 156) with distal end of genu exceeding tip of rostrum. Tarsi stout cuneiform; ventro-proximal bristle few-barbed, inserted close to proximal end, not reaching second; ventro-secondary with three short pectinations; other ventral face bristles smooth, fine; dorso-proximal bristle fine, medium long, inserted close to proximal edge of segment; dorso-secondary stout, curved, inserted quite near dorso-proximal; dorso-tertiary twice as far from second as second is from proximal, fine, curved laterally; dorso-quarternary stouter, medium long; a lateral bristle inserted close to ventral face, distad of proximal, another inserted close to dorsal face, proximad of dorso-tertiary. Tibiae with broad (deep) head and rather short, slender, clearly demarcated pedicel; major bristle inserted close to distal edge, slender, not extending beyond distal end of hook if laid flat, preceded (?) by a medium-long, fine bristle; probably two bristles on ventral face; a short mesal bristle inserted not far from distal end (pl. 16, fig. 154). Genuals short; a long, fairly fine bristle on dorsal face, close to distal edge; a barbed bristle inserted at center, near ventral face (pl. 16, fig. 154). Femora clavate; a medium long bristle on dorsal face (pl. 16, fig. 154), inserted near mesal edge; two shorter lateral bristles inserted more proximad, one barbed.

Legs II (pl. 16, figs. 154, 158) smaller. Tarsi with four barbed, subequally spaced, ventral face bristles; a lateral bristle inserted proximad of ventro-proximal; dorsal face with three bristles on proximal third: proximal fine, fairly long, the others much shorter, stouter, and stiff. Tibiae with pedicel more confluent than in tibiae I; major bristle stouter and shorter than in legs I; ventral bristles smooth, fairly long, the proximal inserted less than diameter of segment from distal end, reaching well beyond distal end of segment; a mesal and a lateral bristle inserted nearly on same transverse plane (pl. 16, figs. 154, 158), medium long, smooth. Genuals longer than genuals I; dorsal bristle shorter, though still quite long, inserted more proximally; a mesal bristle inserted close to distal end, smooth, fine (pl. 16, fig. 154). Femora with more confluent pedicel than in femora I; two smooth, medium-long dorsal bristles inserted one on each side of center of body of segment.

Legs IV (pl. 16, figs. 154, 157) long, slender, yet extending only a little beyond end of abdomen. Tarsi slender, more lanceolate than cuneiform; ventral face with two pauciciliate, short bristles inserted at each third of the segment; dorsal face with a rather long bristle inserted distad of ventro-proximal; a similar lateral inserted on same transverse plane; a barbed apical bristle. Tibiae slender clavate; major bristle well developed but fine; a lateral bristle inserted slightly proximad of transverse plane of major; ventral face with at least one short bristle inserted on transverse plane of lateral bristle. Genuals quite short, flaring distally (dorsal bristle lost), a short, fine, lateral bristle. Femora stout, clavate, pedicel barely differentiated, clear area present; at least a lateral bristle, inserted diameter of segment from distal end (pl. 16, fig. 154). Coxae curved, clavate, evidently bristleless.

Legs III similar but less drawn out. Femora less slender than femora IV, a dorsal bristle inserted diameter of segment from distal end of segment, a mesal bristle inserted near distal end; a lateral bristle inserted at proximal angle of head of segment, longest of the three. Coxae globular with a spine or thorn-like process on anterior face; a fairly long, short-ciliate bristle inserted at center of lateral face.

Dimensions, from the one shattered specimen: total length, 310; breadth, 180; camerostome to genital aperture, 82; length of genital aperture, 35; breadth, 40; genital aperture to anal aperture, 63; length of anal aperture, 53; breadth of anal aperture, 63.

Holotype, Honokaa, Hawaii, from within minute hole in cane root, July 10, 1922, slide no. CGES17P, C. E. Pemberton.

Although this species has a relatively simple body, it is specialized as to pseudostigmatic organs and leg armature.

Genus OPPIA

Oribatinae with anal and genital covers remote, proximal end of tibiae IV not surpassing posterior end of abdomen; cephaloprothoracic ornamentation consisting of flattened, appressed bands at most (i.e., slightly increased chitinization of the surface in definite tracts) though pockmarking may be present on sides; notogaster usually oval; cephaloprothorax and abdomen separated by a broad constriction (at least above and at sides) which, by transmitted light, appears dark, as though heavily chitinized and thus placing pseudostigmata a considerable distance from anterior edge of notogaster; tectopodia II not extending laterad of coxae I.

Type, *Oppia nitens* (33, fasc. 3:10).

Oppia cronus, new species (pl. 2, fig. 23; pl. 3, figs. 24-27.)

Diagnosis

Bristles fine, smooth, interlamellar the longest; pseudostigmatic organs with three or more bristles emerging from the pyriform head; genital plate punctures in diagonal row from antero-mesal corners.

Description

Cephaloprothorax, as seen from above (pl. 3, fig. 25) pyriform, slender, tapering gradually to the rather pointed rostrum which has a short nipple; sides flat, their continuity slightly indented by band of tectopodia I which arches up onto sides of cephaloprothorax (pl. 3, fig. 24) much as in the Galumninae, and distal end of acetabula I and II; tectopodia II barely discernible from above as special structures, conformable to bulge of cephaloprothorax, but slightly protruding behind insertion of legs I and tapering down so that point lies ventrad of the insertion; surface above tectopodia II and about base of pseudostigmata roughened by fine pockmarking (pl. 3, fig. 24); highest part of cephaloprothorax transversely wrinkled (pl. 3, fig. 24); posterior edge darker, more heavily chitinized (?) as an encircling band (the forewaist band) interrupted at sides (pl. 3, fig. 24), extending on dorsal face anteriorly as a mesal angle and about base of pseudostigmata (not shaded in plate 3, figure 25), similarly expanded on sides and on ventral face; no trace of lamellae; rostral bristles dorsally inserted, fine, medium-long, smooth; lamellar bristles inserted between dorsal end of tectopodia I, fairly short, fine, smooth; interlamellar bristles inserted between pseudostigmata, near forewaist band and in center of its arches (as seen from above), long, fine, smooth; all these bristles subequally distant from mesal plane; pseudostigmata fairly well developed, remote from notogaster, at angle of dorsal face and sides of cephaloprothorax, opening laterally; pseudostigmatic organs (pl. 3, figs. 24, 26) long, with a small curved head with three bristles, the anterior one short (as long as organ head) and usually bifurcate, the middle one about twice as long, and slightly curved, the posterior one at least twice length of middle one and curved in a graceful sickle-like arch (the entire organ calling to mind the iron sickle with which Cronus the Titan slew his father Uranus).

Abdomen, when not contracted, nearly as high as broad (pl. 3, fig. 24), as seen

from above, longer than broad, somewhat oblong, broadest behind middle, with well-developed "shoulders"; notogaster smoothly and regularly arched, anterior margin rounded-truncate, meeting sides at an obtuse angle, not entirely covering anterior edge of abdomen, posterior margin (as seen from above) with three well-defined pairs of depressions crenulating the outline; surface smooth; bristles rather long, fine, smooth: one (humeral) inserted on each antero-lateral angle in addition to the 4:5/5:4 (pl. 3, fig. 25); posterior to humeral bristle, low down on sides, an area porosa; anterior to bristles 11:2 a transverse fissura, laterad of fissura a large area porosa; mesad of 1:3 a large puncture; on posterior area the muscle insertions of anal area are plainly discernible.

Ventral plate well developed, not encroached on by notogaster, produced postero-mesally as a small tubercle, at sides of which are inserted the mesal postanal bristles (pl. 3, figs. 24, 25); also projecting as a narrow shelf along lateral margin of abdomen anterior to insertion of legs IV, and extending as a slender flange onto sides of cephaloprothorax, no vestige of triangular tooth characteristic of some species; anal aperture fairly close to posterior margin, sides tapering conspicuously, broadly rounded behind, anterior edge also broadly rounded; a slight pseudofissura at sides near center; covers convex (pl. 3, fig. 24), bristles remote from mesal edge, the anterior near antero-lateral corner, the posterior midway between lateral and mesal margins and equally distant from posterior margin; lateral pair of post-anal bristles inserted anterior to transverse plane of posterior cover bristles and near lateral edge of ventral plate; mesal pair slightly mesad of center of covers, close to edge of plate; preanal bristle anterior to transverse plane tangent to anterior edge of aperture, near lateral edge of plate; paramesial puncture small, on longitudinal plane tangent to lateralmost edge of anal aperture, but much nearer genital than anal aperture. Genital aperture very small, sides almost parallel, bristles in line from antero-mesal corner to postero-lateral angle, the third and fourth most widely spaced; genito-thoracic suture extends from insertion of legs IV almost directly to anterior edge of genital aperture, in side view it appears to be grooved, enclosing, with forewaist band, parasterna III and IV, produced dorsad nearly to rim of ventral plate, then curving forward it runs parallel to rim until it meets and joins forewaist-band (pl. 3, fig. 24); parasterna III-IV each bear three punctures arranged nearly in a straight, diagonal line extending from antero-mesal angle nearly to insertion of legs IV; a slender tectopedial ridge (tectopedia IV) runs between insertions of legs III and IV, with a bristle (tectopedial bristle) springing from its swollen posterior end (pl. 3, fig. 24); forewaist bristles rather long, fine, straight (pl. 3, fig. 25); sternum slender posterior to center of parasterna I, much broader anterior to it, truncately terminated between centers of parasterna II; with a weak spur under parasterna I and II, the latter with a slender bristle inserted near this spur (pl. 3, fig. 24); lateral edge of parasterna limited by longitudinal band from near whose center springs a fine bristle (pl. 3, fig. 24), tectopedia II extending far laterad of this band (pl. 3, fig. 25, which also shows how acetabula II pushes out sides of cephaloprothorax); apodemata slender, weakly abutting longitudinal band; parasterna I seeming longer than broad when seen from below, with a bristle beyond anterior end of sternum; episternal apodemata not developed; longitudinal band limiting tectopedia II ventrally, extending well up side of camerostome as a point and sending a point beneath labium (pl. 3, fig. 24). Camerostome elongate, its rim undulate (as seen from side), labium covering posterior half only, the bristles near center of each half.

Legs terminated by a single well-developed and well-rounded hook, and armed, except where specified, by rather long, smooth bristles which are sometimes smeared with granular foreign matter, giving them a heavily club-shaped appearance. Legs I the stoutest, legs IV the slenderest; tarsi usually the longest segment; all femora with a clear spot near juncture of pedicel and head, often just distad of insertion of a bristle (pl. 3, fig. 23, 27). Legs I (pl. 3, fig. 27) longer than legs II. Tarsi cuneiform, with short proximal neck and many bristles, dorsal face with eight bristles, of which the proximal curves distad, the next is similarly curved, shorter and quite stout, the third is

very long (subequal to major bristle of tibiae 1), the fourth short, very fine, these four subequally spaced, and fairly close together about widest portion of segment; the fifth more remote and quite as long as major bristle of tibiae 1, the sixth less long, the distal two, which are quite close together, of normal length for this group; a mesal bristle inserted at widest part; another shorter, finer bristle on lateral side, similarly inserted, so that with the ventro-proximal bristle there are four on the same transverse plane!; at least six recurved bristles on ventral face, of which the second from proximal end is longest. Tibiae nearly half as broad as long; major bristle barely length of segment; a short, curved bristle inserted slightly distad of it; two rather short bristles on ventral edge inserted on broadest part of the segment so that proximal is less than diameter of segment from distal edge of segment; a lateral bristle inserted near ventral edge slightly proximad of ventro-proximal; mesal bristle inserted near dorsal edge. Genuals quite short; with three bristles inserted near transverse center: a long dorsal, a much shorter on each side. Femora subequal to their tarsi, shaped like an Indian club, but unsymmetrical; a dorsal, depressed bristle inserted at widest part; a similar one on each side inserted more distally; a ventral bristle inserted slightly more proximally than dorsal. Coxae small with usual long distal bristle.

Legs II with each segment relatively shorter. Tarsi similar to I but with fewer bristles. Tibiae with but one bristle on dorsal edge, more proximally inserted; one on lateral edge; two on ventral edge inserted more distally than the dorsal. Genuals with a fairly long bristle on lateral side, inserted at distal end; a very fine, closely appressed one on mesal side also distally inserted. Femora with two outwardly curved bristles on dorsal edge, the anterior inserted just proximad of widest part of segment, the posterior at juncture of pedicel and head of segment; a bristle on mesal side more distally inserted than antero-dorsal; a ventro-lateral inserted on same transverse plane as dorso-posterior. Coxae very small, possibly with a bristle similar to that of coxae I.

Legs IV (pl. 2, fig. 23) with distal end of tibiae not surpassing abdomen. Tarsi slenderly fusiform; dorsal face with a fairly long bristle inserted at center of segment; another inserted near distal fourth of segment on a prominent tubercle; ventral face with four prominent, subequally spaced bristles: the proximal inserted proximad of dorsal; in addition, a fine, probably mesal one inserted proximad of dorso-proximal. Tibiae (as seen from side) shaped like femora I, with pedicel equaling length of head; major bristle equaling length of segment; a fairly long lateral bristle inserted near distal end of segment, two ventral bristles, the proximal short, inserted proximad of dorsal, the distal one quite long, inserted on distal end of segment. Genuals small, curved; with a short bristle on dorsal edge, inserted at center of segment; a finer lateral one, inserted near distal end. Femora broadly fusiform, with rather short pedicel; a dorsal bristle inserted at anterior third on broadest part of segment; a ventro-lateral bristle inserted slightly proximad of dorsal. Coxae gourd-shaped, slightly shorter and more slender than femora; with a bristle inserted near distal end on ventral edge.

Legs III with tarsus stouter; three bristles on dorsal face and five on ventral of which the proximal is rather short; the second is fairly long; the third seems shorter and pectinate. Tibiae stouter than tibiae IV, the armature similar. Genuals stouter; with a spinelike bristle on lateral side inserted near middle; a long one on dorsal edge inserted near distal end. Femora as long as and similar to femora IV, but mesal face quite flat; with four fairly long bristles: one on ventral edge inserted at middle; two dorsal: the proximal inserted considerably proximad of ventral, the other at widest part of segment (distad of ventral); a ventro-lateral inserted on transverse plane between dorso-distal and ventral. Coxae mushroom-shaped with a prominent transverse, horn-like spur on proximal face, appearing as a slight tooth when seen from above (pl. 3, fig. 25); two fairly long bristles: one inserted near center of dorsal face, the other near distal end.

Dimensions, entered in table under *Dameosoma ultraciliata*, page 22. The most complete measurements are from a male (pl. 3, fig. 25). The others are of females.

Again the females seem somewhat larger though none is so mounted as to disclose sexual dimensuration.

Color, reddish tan, though paler than *D. ultraciliata*.

Cotypes, Oahu, five specimens, soil samples, cane fields, no. 281vn, R. H. Van Zwaluwenburg.

This earth dweller may be distinguished from all other species by its conspicuous sickle-like pseudostigmatic organs.

Tribe EREMAEINI, new tribe

Oribatinae with coxae IV plate-like or buckler-like, the articulating arm or pedicel more or less at right angles to body of segment; contrasting with the simpler condition in the Oribatini in that this segment has mushroomed, flattened out, while the shaft has rotated 90 degrees, thus being similar to coxae III; abdomen elongate so that legs IV do not usually extend beyond end of abdomen; anal and genital apertures remote.

Type, *Eremaeus* (34, p. 102).

Genus CALVOPPIA, new genus

Similar to *Phauloppia* but cephaloprothorax without lamellae or trace thereof; anterior border of notogaster even more developed; sternum and apodemata well developed; notogaster without or with extremely fine bristles; tarsi I and II short, stout; tibiae I and II stout, much longer than their tarsi.

Type, *Calvoppia perkinsi*, new species.

Calvoppia perkinsi, new species (pls. 4-5, figs. 38-41).

Diagnosis

Cephaloprothoracic bristles long, fairly smooth; pseudostigmatic organs almost entirely covered by notogaster, obovate, short-stalked; dorso-posterior face of cephaloprothorax faintly, transversely corrugated or roughened; second pair of bristles of genital covers more mesal than first pair, third and fourth pair mesad of center; major bristle of genitals I nearly as long as tibiae I.

Description

Cephaloprothorax (pl. 4, fig. 38) broad, sides (as seen from above) flat-sided, tapering to bluntly pointed rostrum, the sides barely interrupted by insertion of rostral bristles, and transverse grooves, sloping broadly down onto tectopodia II; dorsal surface near notogaster, roughened by transverse wrinklins, no trace of lamellae; tectopodia II broad, with broad and shallow notch for reception of legs I, a short curved bristle inserted at center; rostral bristles very fine but long, incurved at tip; lamellar bristles extending beyond rostral, robust and very minutely roughened in longitudinal rows, inserted rather low on cephaloprothorax; interlamellar bristles also very long, robust, roughened like lamellar, inserted close to notogaster and well down on sides; pseudostigmatic organs (pl. 5, fig. 40) as above described; an exopseudostigmatic (?) bristle below pseudostigmata inserted close to forewaist band (pl. 5, fig. 40).

Abdomen broad, oval, somewhat truncate behind, regularly and smoothly arched so that height is 245 microns, or considerably less than half length, lateral outline being

semilenticular (more tapering behind than in plate 4, figure 33, and more arched in center); notogaster smooth, anterior edge very much produced over cephaloprothorax (or sides of body very much constricted beneath it) so that pseudostigmata are far within its rim (pl. 4, fig. 38); anterior edge flattened or impressed at sides so as to make a distinct angle with sides and front margin; bristles extremely fine, short and caducous, so as to be very difficult to find in specimens at hand (which had been mounted on paper points for some time), their insertions very minute (pl. 4, fig. 38), a pair of areae porosae at sides far behind pseudostigmata; posterior margin sometimes slightly indented by sunken insertions of two posteriormost bristles.

Ventral plate much narrower anteriorly than notogaster, thus causing overhang of notogaster and setting leg insertions far under abdomen; anal aperture close to posterior border, truncate behind, sides flat, almost parallel, anterior margin only slightly oblique, anterior corners broad, posterior corners small; cover bristles remote, anterior pair laterad of center of their cover and nearly as close to anterior border as to sides, posterior pair mesad of center, as near mesal edge as posterior margin (seen from below); postanal bristles with mesal pair close to posterior corners of aperture, but laterad of sides and distad of posterior edge, with lateral pair anterior to transverse center of aperture and nearer sides of ventral plate than to aperture; preanal bristles just posterior to anterior edge of aperture, but well beyond sides of aperture; paramesial bristles (?); other very fine punctures exist, but are without bristles. Genital aperture (pl. 4, fig. 39) elongate, sides converging but not strongly, corners broadly rounded, anterior and posterior ends thickened, bristle insertions mesad of center, second and third remote, fourth very close to posterior edge, second and fourth closest to mesal plane; sternum broad, broadly expanded into broad genital aperture frame; apodemata well developed, slender, extending from sternum to acetabula; bristles and insertions as in plate 4, figure 39; a long bristle inserted at base of tectopodia III. Camerostome oval, sides tapering conspicuously.

Legs (not readily comparable) terminating with three strong, subequal, well-curved hooks, and armed with relatively long, smooth bristles. Legs I (pl. 5, fig. 41) with segments stout, strong, with irregular outline. Tarsi much shorter than their tibiae, short conic, with undulate dorsal face, all bristles smooth; lateral face with a fairly long bristle inserted near proximal end; dorsal face with at least seven bristles, of which the longest (considerably longer than the segment) is inserted on transverse center, a short, stiff one inserted nearly midway between this long one and proximal end, the others (three are fairly long and gracefully curved) inserted more or less in pairs distad of the long one; ventral face with at least three bristles, of which two rather short ones are inserted close together on transverse plane passing shortly proximad of long-dorsal bristle, the other fairly long, inserted halfway between the ventral pair and distal end. Tibiae as long as femur, broad-cuneiform, with well-developed antero-distal knob; major bristle extremely long (longer than the segment); with a stiff bristle distad; a bristle on each side of segment inserted more proximally than major bristle; one on ventral edge, inserted still more proximad. Genuals conical, stout, nearly straight; a short bristle on each side, inserted near distal end, the lateral one much the shorter; a long one (longer than dorsal of tarsus) on dorsal edge, inserted near distal end. Femora broadly fusiform with irregular outline (pl. 5, fig. 41), each bearing five bristles: a dorsal inserted at center, a dorso-lateral inserted a little more proximad, a ventral inserted on a tubercle near coxa, a ventro-mesal inserted on transverse plane passing slightly distad of dorsal, and a ventro-lateral inserted at distal fourth of segment.

Legs II very similar to I but relatively shorter. Femora with dorsal bristles heavily ciliate, and ventro-proximal bristles more distally inserted and not on a tubercle. Genuals with only a dorsal and a mesal bristle.

Legs IV with tarsi lacking in the present material. Tibiae long, clavate, slender; a fine dorsal bristle inserted at distal end; two stout ventral bristles: the distal inserted

at distal end, the proximal less than length of genuals from it; a fine bristle on side inserted more proximally than dorsal bristle. Genuals with two rather short bristles inserted distad of center. Femora broad; with at least two dorsal bristles inserted somewhat proximad of center; one ventral. Coxae with one dorsal bristle inserted near center of segment.

Legs III very similar but shorter. Tarsi with a dorsal bristle inserted one-third length of segment from proximal end; a dorsal pair inserted at distal third; a shorter dorsal bristle inserted halfway between the pair and distal end of segment; a lateral bristle inserted more proximad than dorso-proximal; two ventral bristles each inserted more proximad than the corresponding two dorso-proximal. Tibiae similar to IV but major bristle longer (as long as tarsus), inserted more distant from distal end; at least one ventral bristle, inserted on transverse plane of dorsal bristle. Genuals, femora, and coxae similar to those of legs IV.

Dimensions, entered in table under the next species.

Color, reddish tan.

Cotypes, two specimens, no. BBM691P (figured); one specimen, no. BBM199P; two fragments of one specimen, no. BBM532P; one fragmented specimen, no. BBM656P; R. C. L. Perkins.

See remarks under the next species.

Genus IMPARATOPPIA, new genus

Similar to *Phauloppia* but no trace of lamellae; abdomino-cephaloprothoracic suture evanescent to very faint in the middle; sternum not developed; apodemata very poorly developed, apodemata IV almost lacking; tarsi I and II short, stout; tibiae I and II stout, much longer than their tarsi.

Type, *Imparatoppia imparata*, new species.

Differs from *Calvoppia* in the great reduction of chitinization on cephaloprothorax (abdomino-cephaloprothoracic suture, and corrugations), and between camerostome and genital aperture.

Imparatoppia imparata, new species (pl. 4, figs. 31-37).

Diagnosis

Rostrum blunt, broad; rostral, lamellar, interlamellar bristles stout, long; pseudo-stigmatic organs short, clavate-pedicellate; notogaster truncate behind with flaring rim, its bristles well developed, 2:5:6/6:5:2 plus humeral, II:3 and II:5 close to II:4; post-anal bristles, laterad of sides of aperture; genital aperture bristles grouped in two widely separated pairs.

Description

Cephaloprothorax broad, with broad rostrum which is slightly transversely lined or grooved, otherwise perfectly smooth, no trace of lamellae, or of lateral ridges (whence the specific name, meaning "unfurnished") as in *Calvoppia perkinsi*, but rostral bristles inserted on a tubercle which breaks outline of cephaloprothorax as seen from above (pl. 4, fig. 34); tectopedia I entirely absent, but one must not regard evagination of lateral edge of acetabula I as forming tectopedia. For instance, in plate 5, figure 40, the distalmost, dark, curved band is cast by the anterior edge of acetabulum I (an internal structure), while the undulating line within this dark band is the rim of the notch housing leg I (an external structure). In plate 4, figure 34, acetabulum I is represented as a broken line originating at anterior end of the notch and thence curving

across to camerostome. This detail was masked in plate 4, figure 33, by the legs. Thus any leg may cause an evagination of the animal's body due to the presence of the acetabulum, and an outfolding (not to be confounded with evagination) of the chitin to form a tectopedium. Tectopedia II broad, extending well beyond cephaloprothorax, short; bristle on ventral face. Plate 4, figure 31, is an antero-dorsal view (so that many of the bristles are foreshortened, and tectopedia II forelengthened—between coxae I and II). This plate 4, figure 31, is the same specimen as plate 4, figure 34, before being flattened down for the dorso-ventral aspect. In tectopedia II one has a combination of evagination of acetabula II in the posterior half, while the antero-lateral corner is a tectopedial outfolding about insertion of legs I. Rostral bristles stout, fairly long, curved downward more than curved mesad; lamellar bristles long, inserted somewhat more remotely than rostral (the broken line passing about base of lamellar bristle in plate 4, figure 35, is an expression of the thickness of the chitin wall of cephaloprothorax and has nothing to do with a lamella); interlamellar bristles very long, inserted well down on sides, nearly under rim of notogaster (compare plate 4, figures 34 and 35; only the base shown in figure 33 just behind head of pseudostigmatic organ); notopseudostigmatic bristles long and fine (pl. 4, fig. 35); pseudostigmata under rim of notogaster, the organs elongate oval, pedicelate (pl. 4, fig. 35, upper), somewhat truncate, often seeming rounded by foreshortening (pl. 4, figs. 35, lower organ, 31).

Abdomen oval, somewhat truncate behind; notogaster encroaching on cephaloprothorax and overhanging abdomen anteriorly so that legs are inserted under sides of abdomen. Plate 4, figure 31, is presented to show the degree of this overhang, somewhat masked by inclusion of coxae IV. Degree of flare of posterior rim is shown in plate 4, figure 33; the dorsal outline, however, may be too depressed as figured, as the specimen was not whole and probably distorted. Plate 4, figure 35, shows notogaster depressed at insertions of bristles both at sides and on posterior rim (eclipsed by the flaring rim when seen from above), and protrusion of "alar" angle—posterior to upper (right) pseudostigmatic organ; sides as also antero-lateral and postero-lateral area flattened so as to form an ill-defined octagon (as seen from above). A striking character of this species is not only the disposal but also the number of notogastral bristles, for there seem to be six longitudinal rows of which the mesal pair bear six bristles each, the last two appearing crowded on posterior slope, while bristles I:1 are far more remotely spaced than the others; the next row (each side) has 5 bristles (6 if the humeral are included), and the last 3 appear closely spaced on posterior slope; finally the lateralmost (third) row comprises but two bristles inserted on posterior half and far down on sides (pl. 4, figs. 33, 35). There are two pairs of areae porosae: the anterior one posterior to humeral angle, the posterior one between bristles II:3 and III:1; the pseudofissurae are very slightly transverse, mesad of longitudinal plane of areae porosae and somewhat nearer the posterior one; finally there is a pseudoforamen or bristle insertion posterior to bristle II:2 and nearer posterior areae porosae than the bristle. If this proves to be a bristle insertion, this species would then have six bristles in the second row.

Ventral plate truncate behind, leaving a fairly broad space between it and posterior rim of notogaster, but with a secondary flare more dorsad (broken line, plate 4, figure 33) which causes this upper, more internal rim to quite meet the notogaster, at least when detracted. In plate 4, figure 34, the lower rim is shown by a broken line, the upper by a solid line. In plate 4, figure 32, the three solid lines represent (from inner outward) lower rim of ventral plate, upper rim of same, lower rim of notogaster (heavy), dorsal curve of notogaster. Ventral plate narrow antero-laterally so as to be considerably overhung by notogaster (pl. 4, fig. 34); anal aperture remote from posterior edge of plate, sides nearly parallel, posterior edge quite oblique, anterior edge also, making sides short, with well-rounded corners; cover bristles mesad of center, anterior pair nearer anterior edge than mesal edge, posterior pair nearer mesal than posterior edge, postanal bristles long, the mesal pair inserted at sides of aperture, pos-

terior to transverse plane of posterior cover bristles, remote from aperture; lateral pair inserted posterior to transverse plane of anterior edge of aperture and more remote from aperture than mesal pair; pseudofissurae short, near center of anterior margin; preanal bristles not discernible; paramesial bristles nearly on transverse plane of posterior edge of genital aperture but nearly its diameter from it. Genital aperture with strongly converging sides and very sloping anterior edge, corners well rounded, much closer to camerostome than in *Calvoppia perkinsi*; cover bristles mesad of center, 1 and 4 very close to rim, near mesal edge, 2 and 3 far from each other; sternum entirely lacking leaving a clear, oval area between genital aperture and camerostome!; of the three pairs of sternal bristles the anterior pair are jugular in position (in *Calvoppia perkinsi* they are at center of parasterna I), middle pair posterior to ends of apodemata I, posterior pair anterior to the narrowly thickened rim of genital aperture; bristles of parasterna I rather long; episternal apodemata short; apodemata I medium long; apodemata II-III reaching genital aperture, mesal end widening about rim of genital aperture, lateral end separate, straddling the slender bristle-tipped tectopedia III; apodemata IV very short; tectopedia IV well developed, bilobed!; parasterna III-IV with three bristles: an unusually long one inserted near distal end of apodemata II-III, the other two as in plate 4, figure 34. According to plate 4, figure 35, tectopedia IV have each a bristle. Camerostome broad, sides nearly parallel; labial bristles inserted near anterior (distal) edge.

Legs terminated by three subequal, stout hooks (pl. 4, fig. 37) and armed with rather long, smooth bristles (relatively shorter than in *Calvoppia perkinsi*). As far as discernible with present scant material: legs I (pl. 4, fig. 36) with segments stout, strong. Tarsi shorter than their tibiae, short conic with produced distal end; dorsal face with 7 bristles; 2 long ones inserted on transverse center, another fairly long one shortly proximad, the remainder shorter, inserted distad of long pair; outer face with 3 or 4 bristles; the proximal inserted near proximal end, the next on transverse plane just proximad of dorsal pair; ventral face with 3 rather long, ciliate bristles; the proximal the longest. Tibiae with well-developed antero-distal knob; major bristle extremely long (nearly as long as its tarsus and tibia); a stiff bristle distad; a bristle on each side of segment inserted much more proximally than major bristle; the mesal much the longer; ventral edge with two ciliate bristles inserted distad of transverse plane of lateral bristle and subequally spaced with distal end of segment. Genuals curved, stout; with an extremely long, fine, dorsal bristle (as long as major bristle of tibiae!); a bristle on each side, inserted near middle of segment. Femora broad, not thick, both dorsal and ventral edges serrate at proximal end; with a fairly long, stout, barbed bristle inserted at widest part (center) of segment; a dorso-mesal bristle, inserted shortly distad of dorsal bristle; a lateral bristle inserted more distad than dorso-mesal; two shorter, curved bristles mesad of ventral edge, the distal one inserted on transverse plane of outer lateral, the proximal one inserted on proximal third of segment. Coxae very small with a fairly long, fine bristle (not figured).

Legs II very similar but tibiae with only the proximal bristle on ventral edge. Genuals with dorsal bristle shorter but still very long. Femora with dorsal and ventral bristles inserted more proximad, so that ventro-proximal bristle springs from base of pedicel; ventro-distal bristle more proximad than the dorsal, one of the lateral bristles inserted distad of distal fourth of segment.

Legs IV much more slender than legs I and II. Tarsi cuneiform, with usual bristles present; ventral ones with a few stout cilia; the dorso-proximal inserted at center of segment; the dorso-distal slightly distad of distal fourth of segment. Tibiae slender, clavate; major bristle very long and fine, nearly equal to the tarsus and tibia, inserted quite near distal end of segment; ventral edge with two pauciciliate bristles, the distal one inserted on transverse plane of major bristle, the proximal one an equally short distance proximad of distal bristle; a rather short bristle on lateral side inserted on transverse plane between the two ventral bristles. Genuals slightly curved; an equally

long bristle on dorsal edge inserted near distal end; a shorter bristle on each side inserted at center of segment. Femora oblong-oval; with a heavy, rough bristle inserted at center of dorsal edge; a much shorter, fine one at center of ventral edge. Coxae mushroomed; no bristle visible in present material.

Legs III very similar but with bristles usually inserted more proximally than in legs IV. Tarsi shorter than those of legs IV; with shorter bristles, those of ventral face conspicuously ciliate; one on lateral side, inserted on transverse plane midway between the two proximal bristles of ventral face; bristles of dorsal face each inserted more distally than the corresponding one of ventral face. Tibiae very similar to those of legs IV, but major bristle correspondingly shorter (nearly equal to length of tarsus and tibia), inserted more proximad; the two ventral edge bristles inserted correspondingly more proximad, strongly pauciciliate. Genuals more curved; the dorsal bristle more proximally inserted; the side bristles inserted at center of segment. Femora similar to those of legs IV but dorsal bristle more proximally inserted and correspondingly longer; the ventral bristle more lateral and inserted on transverse plane distad of the dorsal. Coxae with a bristle on lateral face, inserted near distal end; a dorsal one inserted near center.

Color, slightly more yellowish than *Calvoppia perkinsi*.

Dimensions in the following table are: in the first column, of the one measurable specimen (male, figure 38) of *Calvoppia perkinsi* (by contrast, another individual, sex not determinable—probably female, has a total length of 630 μ and notogastral length of 395 μ); in the second column, of the one measurable specimen (male, figure 34) of *Imparatoppia imparata* (by contrast, another individual, figure 33, sex female, fractured and probably somewhat lengthened by pressure of cover glass, has a total length of 565 μ); in the third column, of the average of three males of *Phauloppia bryani* (by contrast, another individual, sex not determinable but probably a female, has a total length of 550 μ , and distance from genital to anal apertures 140 μ).

	Calvoppia perkinsi	Imparatoppia imparata	Phauloppia bryani
Total length of body.....	590	465	500
Length, notogastral plate.....	465	.....	360
Breadth, notogastral plate.....	370	285	290
Interlamellar bristle span.....	.....	102	57
Length, ventral plate (mesal).....	445	350	410
Camerostome to genital aperture.....	135	90	105
Length, genital aperture.....	78	60	60
Breadth, genital aperture.....	75	60	57
Genital aperture to anal aperture.....	105	100	125
Length, anal aperture.....	120	80	100
Breadth, anal aperture.....	125	80	90

Each of these three species is strikingly different as to size. The males show a small amount of differentiation; one female of *P. bryani* is a little larger than the largest male. Thus there is evidence, with that from other genera, of sexual dimensurism. The most striking dimensional difference between these three species is that in *I. imparata*: the size is so much less that the largest is smaller than the smallest *C. perkinsi*; the genital aperture is much more anteriorly located; the anal aperture is much smaller and is much farther from the posterior edge of the ventral plate, and its distance from the genital aperture is subequal to that of *C. perkinsi*.

Cotypes: one male, no. BBM540P (pl. 4, fig. 34); one fragmented female, no. BBM56P; one female, no. BBM532P (pl. 4, fig. 35); R. C. L. Perkins.

In 1910 *C. perkinsi* and *I. imparata* were recorded as *Notaspis lucorum* Koch (45). The above described material is based on only 7 of the original 18 specimens.

Although it was at first thought that the two species were congeneric, on consideration of the reduction of chitinization in *I. imparata* at abdomino-cephaloprothoracic suture and sternal area, both differences in skeletal development, the difference was deemed fundamental enough to warrant generic segregation. The differences in the relative sizes and positions of the apertures of the ventral plate tend to corroborate this position.

Phauloppia nemoralis (9, p. 325), from moss in open woodland, Cosentia, Italy, is related by its very insignificant lamellae. The English *Notaspis lucorum* (38, p. 371, pl. 30, figs. 1-5) is a composite species. The description calls for lamellae; the figure shows none and the lamellar and interlamellar bristles are very approximate.

Genus PHAULOPPIA (6, p. 8)

Lamellae low, slender; antero-lateral edges of notogaster somewhat overhanging sides of abdomen; tectopedia I not developed; tectopedia III well developed, visible from above, extending beyond tectopedia II.

Type, *Oppia conformis* (4, fasc. 77:7). Not rare, in moss; Padua, Italy.

Phauloppia bryani, new species (pl. 5, figs. 42-45).

Diagnosis

Bristles well developed; pseudostigmatic organs clavate with three to five very short points at apex; posterior edge of tectopedia II denticulate; posterior edge of tectopedia III with broad flange or plate; all tectopedia with a bristle; anal cover bristles not remote; genital cover bristles laterad of central line of cover except possibly the posteriormost; apodemata I short, apodemata II-III well developed, mesal ends united a short distance anterior to genital aperture, apodemata IV and sternum lacking.

Description

Body, as seen from side, fairly well arched, outline not perfectly regular and with projecting "shoulders" of notogaster; as seen from above, very irregularly elongate oval with deep notches anterior to tectopedium II and behind tectopedium III; rostrum drawn out (mammelonate); cephaloprothorax slender, much longer than broad, sides smooth and uninterrupted; lamellae on dorsal face, slightly projecting (pl. 5, fig. 43; basal "channel" shown as a black band), curving conspicuously towards mesal plane then converging much more gradually, much less than half length of cephaloprothorax, not extending to transverse plane of anterior end of tectopedia II; rostral bristles well developed, slightly rough, inserted on dorsal face of rostrum; lamellar bristles as approximate as rostral and interlamellar and about as long as interlamellar, inserted closer to interlamellar than to rostral, both slightly barbed; pseudostigmata small, well up on dorsal face of cephaloprothorax, slightly protruding (pl. 5, fig. 43), well formed, with unnotched rim; pseudostigmatic organs as above described (pl. 5, fig. 44; foreshortened, pl. 5, fig. 42), granulations of head large, few; tectopedia II extending far beyond cephaloprothorax, long, with shallow notch for legs I, the bristle short, inserted on ventral face; bulge of acetabula I considerable, extending conspicuously beyond sides of cephaloprothorax; a somewhat short bristle inserted above base of tectopedia II may be

the exopseudostigmal bristle (pl. 5, figs. 42, 43, 45); small areae porosae below base of lamellae; posterior edge or face of tectopodia II transversely wrinkled or beaded (pl. 5, fig. 42).

Abdomen short-ovate, broadly joined to cephaloprothorax; notogaster highly developed, extending well beyond ventral plate antero-laterally and broadly clipping over ventral plate behind and at sides, anterior edge with two lobes each side of central lobe, the mesal one bearing a fairly long humeral bristle inserted very close to edge, the lateral lobe more conspicuous from above but without bristle; extent of overhang indicated by broken lines in plate 5, figures 42 and 43, posterior edge on mesal plane produced as a slight lappet (pl. 5, fig. 42, right half laterad of broken line); bristles medium long, fine, gradually tapering, arranged in three longitudinal rows, 2:5:6/6:5:2 plus the pair of humeral bristles. Since this humeral bristle is straight, stout, barbed, whereas the others are curved, fine, and smooth, it is regarded as an unrelated structure. A pair of long areae porosae between humeral bristles and 1:1; smaller areae porosae between bristles: (1) II:2 and II:3 (but more ventral and its own length from II:3), (2) II:4 and II:5 (intermediate), (3) II:5 and I:5 (intermediate); bristles 1:1 and 1:2, II:3 and II:4, I:5 and II:5 spaced fairly close together in pairs; bristles of row III best seen from ventral view; bristles II:6 about on transverse plane of posterior bristles of anal aperture; 1:1 quite widely spaced (as in *Imparatoppia imparata*).

Ventral plate quite continuous and uniform; anal aperture fairly remote from posterior edge, sides subparallel, posterior margin only slightly curved, anterior margin very oblique; cover bristles near mesal edge, inserted as close to each other as anterior one is from anterior edge; postanal bristles close to aperture, mesal pair inserted behind center of each cover, lateral pair inserted close to postero-lateral corner of aperture; preanal bristles as distant from aperture as anterior cover bristles are from anterior margin, as remote as are lateral postanal bristles; paramesial bristles more remote than preanal, more distant from genital aperture than preanal are from anal aperture. Genital aperture nearly semicircular but well indented on posterior margin, bristles 1, 2 and 3, 4, subequally spaced, 2 and 3 remote, 1, 2, 4 close to edge of cover; of the three pairs of sternal bristles, the posterior pair is closely anterior to apodemata II-III and to mesal plane, the middle pair about halfway between posterior pair and end of apodemata I, the anterior pair as remote as middle pair but near mesal end of apodemata I (jugular); bristles of parasterna I a little further from jugular bristle than the latter is from mesal plane; tectopodia III projecting well beyond tectopodia II, with a tubercle-tipped plate extending out from posterior edge, the tubercle bearing a bristle (pl. 5, fig. 43); tectopodia IV very small, a mere tubercle with a bristle on apex (pl. 5, fig. 43). There seem to be but two pairs of bristles on parasterna III-IV.

Camerostome broad at base; labial bristles near anterior edge and mesal plane.

Legs rather slender; unguis triheterohamate, the hooks rather elongate, poorly curved; bristles mostly smooth, fine, in general, not particularly lengthened. Legs I (pl. 5, fig. 45) with tarsi about as long as tibiae or femora, cuneate, conspicuously notched; dorsal face with at least six bristles of which the proximal is quite short, the second the longest, the third quite curved, inserted at about the middle of the segment and quite close to the fourth, a lateral bristle inserted more proximad than dorso-proximal; ventral face with a pair of barbed bristles inserted slightly distad of transverse plane of dorso-proximal, two other barbed bristles inserted distad of this pair more remote from each other than the middle one is from the pair. Tibiae thick, clavate, curved, with distinct dorso-distal protuberance; major bristle longer than tarsus and unguis; with a short bristle distad; another bristle (probably dorso-mesal) inserted at distal third of segment; a fairly long bristle on lateral face, inserted at distal third of segment; a fairly long bristle on lateral face, inserted at distal third of segment; two bristles on ventral edge, the distal one inserted a short distance from distal edge; the longer, stouter, proximal one inserted at distal third of segment, thus forming a whorl

of three at this point. Genuals quite curved, not much broadened at distal end; dorsal edge with a long bristle (reaching to distal third of the tibia), inserted at distal third of segment; a rather long, barbed bristle inserted at center of mesal side; a much shorter, stiff, barbed bristle inserted at center of lateral side. Femora broadest far proximad of middle of head; dorsal edge with weakly barbed bristle, inserted at broadest point and extending to beyond distal end of segment; a lateral and a mesal bristle inserted far distad of dorsal bristle and near middle of head; a fine bristle inserted at juncture of head and pedicel of segment on mesal side. Coxae not discernible.

Legs II very similar but shorter. Tarsi with six subequal bristles on dorsal face; a long bristle on lateral face, inserted on transverse plane of dorso-proximal. Tibiae with major bristle more remote from distal end; ventro-distal more proximad than major bristle, quite long and barbed; lateral bristle inserted just distad of ventro-proximal; mesal bristle inserted on same transverse plane as ventro-proximal. Genuals with bristles a little shorter than those of genuals I. Femora with two barbed, dorsal bristles more distally inserted (one of these being the mesal of femora I); the lateral more proximally inserted.

Legs IV the longest. Tarsi the longest segment of all the legs, very slender; dorsal bristle inserted considerably distad of center; a short distal bristle; ventral face with usual three barbed bristles, the distal one inserted slightly distad of proximo-dorsal; terminal bristle fine. Tibiae clavate, bent at juncture of pedicel; the major bristle shorter than its segment; of the two ventral bristles the distal is much the longer and barbed, inserted on transverse plane of major; the ventro-proximal inserted more proximad than diameter of segment; lateral bristle inserted diameter of segment from distal end of segment. Genuals strongly curved; a short, fine bristle inserted at distal fourth of segment; a similar lateral inserted on the same plane. Femora quite oblong, transversely wrinkled on ventral face near coxa; dorsal bristle inserted at distal third of segment; the shorter ventral bristle inserted still more distad. Coxae with a single bristle inserted at distal edge of ventral face.

Legs III quite similar but tarsi with two well-developed dorsal bristles, the proximal inserted on transverse plane midway between second and third ventral bristles. Tibiae with ventro-proximal bristle inserted more proximad; lateral (and major) bristles more proximally inserted, major shorter than that of tibiae IV. Genuals with mesal bristle lacking, the lateral inserted at center. Femora with the two dorsal and ventral bristles inserted just distad of center; a dorso-lateral bristle inserted just proximad of center. Coxae with two bristles: one near distal end, one on dorsal face.

Dimensions: six specimens measured in part or in whole; see table under *Imparatoppia imparata*. The variation in total length among the three males varies from 490-510 microns; the smallest female is 520 microns long, the largest 550 microns long. Breadth of smallest measurable female is 300 microns.

Color, amber yellow, slightly reddish.

Cotypes: French Frigates Shoal, 10 specimens, June 22, 1923, no. BBMO5T, E. H. Bryan, Jr., Tanager Expedition.

ORIBATIDAE-CERATOSZETINAE (26, p. 278)

Oribatidae with small pteromorphae which certainly do not extend anteriorly beyond anterior edge of abdomen; lamellae slender, strap-like, more or less attached to cephaloprothorax by their ventro-mesal edges only, to lacking.

Type: *Ceratoszetes* (6, p. 4).

Tribe ORIBATULINI (30, p. 429)

Pteromorphae lying in but one plane, not curving downward (ventrad) to protect legs, the anterior edge as seen from above, usually curving posteriad.

Type, *Oribatula* (4, fasc. 79:12).

Genus **CARDIORIBATES**, new genus

Abdomen ovate, posterior end bluntly pointed; abdomino-cephaloprothoracic suture distinct; cephaloprothorax small, rostrum bluntly rounded; lamellae slender; translamella developed; pteromorphae triangular, continuous with lateral outline of abdomen, anteriorly truncate and continuing anterior outline of abdomen, not or barely curving ventrad and thus not covering legs; sternum absent; apodemata poorly developed; tectopodia II poorly developed.

Type, *Oribata oriformis* (45, p. 703).

In the key to the pterogasterine Oribatidae (30, p. 428) this genus runs to *Schelorbates*, which actually belongs under tribe Ceratozetini as the pteromorphae curve ventrad nearly to insertion of legs.

Cardioribates oriformis (45, p. 703) (pl. 3, figs. 28-30).

Diagnosis

Rostral, lamellar, and interlamellar bristles very well developed; pseudostigmatic organs very small, short-stalked, with obovate head; notogaster with a pair of very small bristles close to anterior edge and mesal plane; the four genital cover bristles near lateral edge of cover, nearly subequally spaced.

Description

Rostrum very broad, broadly rounded, with very slight mesal swelling; cephaloprothorax broader than long, sides smooth except for a slight ridge running back from base of rostral bristles along ventral side, parallel to rim of camerostome; lamellae, as seen from above, broadest at rounded apex, broader than breadth of pseudostigmatic organ head, bristles springing from apex; translamella very slender; interlamellar bristles long, incurved, smooth; pseudostigmata directed forward, inserted in anterior face of abdomen rather than sides of cephaloprothorax, slightly projecting beyond edge of notogaster; pseudostigmatic organ with pedicel as long as the obovate head which is about as long as diameter of pseudostigmata at rim; acetabulae broadly projecting and visible from above.

Notogaster ovate; almost without bristles, only those of anterior margin discernible in the sole specimen at hand; a puncture at anterior margin of wing, laterad of longitudinal plane of legs I; a pair of long, curved areae porosae laterad and posteriad of anterior bristles and very near them, extending to base of pseudostigmata.

Ventral plate much narrower than dorsal (notogaster); broadly overlapped by notogaster along posterior half of sides; strongly converging to a blunt point behind, narrowing posterior to insertion of legs IV; legs thus inserted far mesad of sides of notogaster; anal aperture remote from posterior edge of ventral plate, its sides parallel, posterior margin strongly oblique forming a very open curve with sides, anterior margin only slightly oblique forming a fairly sharp curve with sides; covers serrate along postero-mesal edges (pl. 3, fig. 30), with thickened rims, bristles well developed, fine, fairly close to mesal edge, distant from each other but closer to mesal than to anterior

and posterior margins; postanal bristles remote from aperture, both pairs posterior to aperture, lateral pair as far from mesal pair as mesal pair are from aperture; preanal bristles at sides of aperture, posterior to transverse plane of anterior cover bristles; paramesial bristles on transverse plane passing near genital aperture, but greatest diameter of a genital cover from genital aperture. Genital aperture broadly oval, no distinct angles, only slightly emarginate behind; cover bristles four, first and second most closely spaced (fused to one, on left side of this one specimen), a smaller bristleless puncture on posterior rim; of the three pairs of sternal bristles the middle and posterior pair are very close to each other, closer than posterior pair are to genital aperture, anterior pair midway between middle pair and camerostome; episternal apodemata absent; apodemata I represented by a short transverse bar, II-III short, not reaching genital aperture, apodemata IV still shorter; acetabula I broadly projecting and with prominent, diagonally truncate outer corner; tectopodia II represented by a very thin, small plate extending not far distad of acetabula II, the bristle well developed; tectopodia III well developed and with posterior extension so that leg insertions are not very close, bristle on the extension, very small (or absent); tectopodia IV developed as a broad, angular projection between insertion of legs III and IV; parasternal bristles as in plate 3, figure 29.

Camerostome long, sides subparallel; labial bristles close to anterior edge and to mesal plane.

Legs well developed, smooth, terminated by triheterohamate, often swollen shafted unguis (pl. 3, figs. 28-III, 29-IV), and armed with slightly roughened, medium-long bristles; unguis (pl. 3, fig. 28) with a pair of curved, pectinate bristles inserted about their center; only the ventro-proximal bristles of tibiae ciliate, claws split near apex (pl. 3, fig. 28-III). Legs I (pl. 3, fig. 29) with tarsi heavily armed. Tibiae pedicelate, equaling their tarsi in length; antero-dorsal edge produced as a bifurcated process bearing two major bristles of which the lateral is much the longer, exceeding the tarsus and unguis; a fairly long ventral bristle inserted width of tibia from its ventro-distal edge; a shorter, lateral bristle inserted more distad than ventral; a still shorter, mesal bristle inserted more proximad than ventral. Genuals (pl. 3, fig. 29, foreshortened) with a long bristle extending nearly to end of tibia, inserted on dorso-mesal edge at center of segment; another shorter bristle inserted on dorso-lateral edge near distal end of segment; a medium-long bristle inserted at ventro-lateral edge at center of segment; a similar one inserted at ventro-mesal edge near distal end of segment. Femora with a slender flange along ventral edge; bearing four bristles: a dorsal inserted at distal third, a ventral inserted slightly more proximad, a mesal and a lateral each inserted still more proximally (near center of segment). Coxae not discernible.

Legs II similar but longer. Tarsi with usual bristles on ventral face; dorsal face with a short fine bristle inserted on transverse plane just distad of ventro-proximal; a pair of fairly long ones inserted a distance distad of the short bristle equivalent to diameter of segment at this point; two equally long bristles distad of this pair subequally spaced with the pair. Tibiae pedicelate, distal end not produced; with a single major bristle not as long as that of legs I; a whorl of four bristles about widest portion of segment inserted a distance equal to diameter of segment at that point from distal end. Genuals similar to genuals I but bristles shorter. Femora also similar but the five bristles more scattered along length of segment: the ventral near distal end, another ventral bristle near proximal end, a dorsal inserted each side of middle of segment.

Legs IV more slender. Tarsi quite slender with elongate unguis; dorsal face with but two bristles, the proximal the longer and inserted at distal third of segment; ventral face with usual three bristles, the first and second quite remote, a lateral bristle inserted on transverse plane between them but nearer second. Tibiae slender, clavate, with stout pedicel; major bristle not as long as tarsus; two ventral bristles, the distal inserted on transverse plane of major, the proximal a distance greater than diameter of segment

proximad of ventro-distal; a lateral bristle inserted between major and ventro-distal. Genuals with but two bristles, a dorsal and a lateral inserted near distal end of article. Femora with keel along ventral face; a dorsal and a ventral bristle inserted on about the same plane at distal third of segment. Coxae with a proximally lobed flange along ventral edge; a single bristle inserted at ventro-distal end.

Legs III similar but tarsi with the three ventral bristles more subequally spaced; dorsal face with three bristles; sides with two bristles placed so near dorsal face that they may appear to be on dorsal face when tarsus is slightly turned, the proximo-lateral inserted proximad of all other bristles, disto-lateral inserted rather close to middle-dorsal so that they may appear as a pair. Tibiae differing by their more proximally inserted bristles, except for the ventro-proximal which is thus brought nearer the others. Genuals with the two bristles more centrally inserted. Femora with a lateral bristle inserted on plane of dorsal, the ventral more distally inserted. Coxae with a distal and a lateral bristle inserted slightly distad of center of segment.

Dimensions in microns: total length, 935; total breadth, 750; lamellar bristle span, 127; length of genital aperture, 100; breadth of genital aperture, 97; genital aperture to camerostome, 135; length and breadth of anal aperture, 170.

Color, reddish amber-yellow.

Delineotype: one male, now no. BBM656P (old no. 656), R. C. L. Perkins, without data but sent under the designation *Notaspis lucorum* Koch.

The original description, based on a single specimen 1.1 mm. long (female?), characterizes the texture as finely punctate, and the cephaloprothorax as long! Thus there is a possibility that the above described specimen represents another species. This, however, is unlikely.

The double end and two major bristles of tibia I, the lack of ciliate bristles on ventral face of tarsi, but ciliate ventro-proximal bristles on all tibiae are interesting departures which may be of generic rank.

Tribe CERATOZETINI (30, p. 429)

Ceratozetinae with pteromorphae produced ventrad over the sides of abdomen to partially cover and protect legs, the anterior edge, as seen from above, recurved so as to be in line with anterior edge of abdomen.

Type, *Ceratozetes* (6, p. 4).

A study of the eight species of "*Schelorbates*" secured from the Hawaiian islands and comparison with several holarctic species, reveals two contrasting groups of species, possibly connected by intermediate forms. One, typified by *S. latus* (Koch), has apodemata IV so lengthened as to abut on the side of the genital aperture close to the mesal end of apodemata II-III. In the other group the mesal end of these apodemata is remote from the side of the genital aperture. Thus in true *Schelorbates* apodemata IV are strongly braced (not floating). Accompanying this greater development of the apodemata is the greater chitinization of the sternal area in general, so that usually the sternum extends as a distinct, thickened band to the posterior edge of the camerostome. In the third place, this greater strengthening and chitinization of the ventral area is usually accompanied by a still more in-

interesting phenomenon, namely, the connection of the distal end of the lamellae with the camerostome by a prominent ridge, the lamello-rostral ridge, as though the lamellae were weakly produced to the rim of the camerostome. Since the majority of the species fall definitely in one of the two groups and intermediate species are so few as to be considered exceptional, two genera should be recognized. The more primitive being unnamed, I propose the term *Protoschelobates*.

Genus **PROTOSCHELOBATES**, new genus

Ceratozetini without translamella; pteromorphae confluent with body outline behind; tectopodia I undeveloped; lamellae well developed; anterior edge of notogaster distinct; distal end of lamellae without lamello-rostral ridge extending to rim of camerostome; femora I without broad flange along ventral edge; mesal end of apodemata IV remote from rim of genital aperture; sternal region usually unthickened and not specially differentiated (posteriormost punctures of notogaster not more remote than greatest width of an anal cover).

Type, *Murcia insularis* (40, p. 67).

Species in which the lamello-rostral ridges are lacking but the apodemata are fully developed belong under *Schelorbates*, as I consider the full development of the apodemata as of greater phyletic and structural significance than the lamello-rostral ridges. Species in which the union of apodemata IV with genital aperture frame is not quite complete, irrespective of other considerations, belong in *Protoschelobates* on the basis that *Schelorbates* has not been attained.

Protoschelobates insularis (40, p. 67, figs. 120-124), new combination.

Diagnosis

Cephaloprothoracic bristles well developed; pseudostigmatic organs when elbowed not extending beyond pteromorphae, head oval; pteromorphae with two vertical undulations; acetabulae I not visible from above; ends of apodemata I joined with each other and with genital aperture by a slender Y-shaped sternum (furculum); area anterior to and at sides of genital aperture is areolated by very shallow, irregular depressions or thinning of the chitin; anterior edge of genital aperture bent at a wide angle, nearly rectilinear; punctures mesad of center of covers.

Although this species has been carefully described and figured, it becomes necessary to make certain modifications to the original description after a comparative study of the types, kindly sent me by their original describer, with material from the Hawaiian islands. There are two pairs of post-anal bristles as in most species; there is no real translamella; the translamellar line is single (not double as in 40, fig. 120), and often much more deeply emarginate at center than figured. This line is due to a superficial depression or an internal structure and abuts the lamellae well back from the point. A second

such transverse line or depression passes around the cephaloprothorax between the ends of the lamellae and the rostral bristles. This dark line seems to be caused by the bend in the chitin where the slope of the cephaloprothorax changes to form the protruding rostrum. It is characteristic of species which have no lamello-rostral ridges (typical *Protoschelobates*). Pseudostigmatic organs are normally elbowed slightly distad of the organ head, the distal end of head rounded, appearing pointed when seen obliquely.

Protoschelobates insularis sandvicensis, new subspecies (pl. 6, figs. 46-50).

Diagnosis

Pteromorphae not extending anteriorly to be nearly in line with anterior edge of notogaster (compare 40, figure 120, with my plate 6, figure 46) so that there is no marked invagination of notogastral outline above pseudostigmata; cephaloprothorax broader than long (i.e., short); apodemata I heavier than in *P. insularis*, their mesal end not like a bent L, on its back (pl. 6, fig. 50, left of numeral), but produced as a blunt point, the posteriorly directed point more or less confluent and directed laterally (pl. 6, fig. 50), the whole end piece (head) much more sagittate; furculum (rudimentary sternum) much more slender, even slightly longer; gular apophyses less divergent, their ends closer to rim of camerostome (in *P. insularis* as represented by the single broken line on the upper half of plate 6, figure 50); areolation of pregenital area never so coarse and therefore never breaking up mesal arm of furculum (in the species it is broken up to become double or treble, as well as setting punctures off asymmetrically); sternal punctures usually quite symmetrical; preanal bristles much within line of sides of aperture produced; sides of anal aperture more rounded, more bowed.

Description

Cephaloprothorax broad, broader than either minor or major length, that is, distance from pseudostigmata to pseudostigmata (outer rims) is greater than distance from apex of rostrum to notogaster along mesal line (minor length) or even than distance from apex of rostrum to a line joining posterior edge of pseudostigmata (major length); descending rapidly at ends of lamellae (pl. 6, fig. 47) giving the appearance, when seen from above, of being circumscribed by a transverse line (pl. 6, fig. 46) which looks like a translamella (external fold or ridge of chitin joining the lamellae); rostrum drawn out as a distinct nubbin (pl. 6, figs. 46, 47); lamellae (pl. 6, figs. 46-48) well developed ridges set onto a fairly broad blade so that, seen from above, one looks diagonally down upon the inner face of the ridge and its juncture with the "bed plate," and as the bed plate follows the contour of the cephaloprothorax, the ridge seems to have a spiral twist. Plate 6, figure 48, represents the ridge as seen when looking more directly down upon it. As seen from above (pl. 6, fig. 46) the distal end tapers quite markedly, thus diverging from sides of cephaloprothorax; rostral, lamellar, and interlamellar bristles quite long, undulate, and smooth, rostral inserted on a prominent nubbin (pl. 6, fig. 47) so as to form a break in the cephaloprothoracic outline as seen from above (pl. 6, fig. 46); interlamellar bristles inserted some distance from lamellae and notogastral rim; pseudostigmata barely projecting beyond lamellae; pseudostigmatic organ with slender, elbowed pedicel (longer than in *P. insularis*) and oval head (pl. 6, figs. 47, 49) which appears pointed if seen somewhat obliquely (pl. 6, fig. 46); tectopodia I absent; tectopodia II prominently developed, quite evident from above. I see no bristle in the four specimens before me, possibly because of interposition of legs, although I see what may be a puncture near the distal edge. They are well developed in the species.

Notogaster (pl. 6, fig. 46) quite broad. In *P. insularis* the ratio between breadth of notogaster and length to anterior edge of pteromorphae of three females averages 84

(ranges from 82-88), of four males averages 90 (ranges 83-96) while in *P. insularis sandwicensis* it averages in four females 94 (ranges 90-96). (My measurements of the types differ in being constantly 5 microns longer in 200 than the measurements given in the original description.) The amount of variation in breadth is in part due to the amount of closure of the flexible pteromorphae (this should not amount to very much because they do not flex very much at their posterior end, the widest part of the notogaster), and partly to the tilting of the body and consequent foreshortening; anterior edge broadly bowed out; pteromorphae extending well out beyond tectopedia II and edge of base of lamellae (compare figures 46 and 55, plate 6), but not extending much anterior to base of tectopedia II; double invagination of sides of pteromorphae more conspicuous in some specimens than in others, always most evident when viewed in ventral aspect; posterior edge broadly rounded. Only a few of the punctures and areae porosae visible in material at hand; the areae porosae adalares are elongate in the species, roundish in the variety. In *P. insularis* I also discern two posterior pairs not distinctly indicated by Oudemans (40, fig. 120) which I omit for lack of definiteness in the four specimens; posterior rim with four very short bristles (pl. 6, fig. 46). These also exist in *P. insularis* as well as another pair further forward. A generic character is that the middle pair are about as close together as the diameter of an anal cover.

Ventral plate well developed along posterior border, more restricted along sides; anal aperture near posterior edge of plate, sides subparallel but conspicuously bowed while those of *P. insularis* are more flat-sided, anterior and posterior edges also subparallel, joining sides at distinct but well-rounded angle; cover bristles nearer middle of cover than mesal edge, the anterior pair as far from anterior edge as from sides, posterior pair slightly further from anterior pair than anterior pair are from anterior edge of cover; postanal bristles distant from mesal plane, mesal pair just mesad of line of sides (produced), outer pair on transverse plane with posterior pair of cover bristles; preanal bristles well within line of sides (farther out in the species); paramesial bristles about as remote as diameter of genital aperture and length of side of genital aperture distant from its posterior edge, sometimes indistinct or divided (in one specimen there are two on one side). Is this a transitory step towards loss or doubling? Genital aperture (pl. 6, fig. 50) with anterior edge bent so as to form a very wide angle, posterior edge subparallel to anterior, sides barely curved; cover bristles mesad of center, the anterior pair on very rim of covers, second pair very near the anterior (usually more distant in *P. insularis*), posterior pair very near posterior margin, third pair fairly close to posterior pair, nearly on longitudinal center of covers; edge of aperture broadly thickened at sides but band anterior to aperture is narrow and almost transverse, and bears on or just off its rim the pair of posterior sternal bristles which are very close together, in *P. insularis* due to the still further reduction or almost entire absence of the mesal branch of the furculum, these bristles are often touching or thrown one anterior to the other or otherwise altered. This seems to be a last step before their amalgamation to form one. Sternal area as above described, mesal ends of apodemata I drawn out into blunt points running out onto ends of furculum, more remote than anterior and middle pairs of sternal bristles, middle pair of sternal bristles slightly more remote than anterior pair; tectopedia III well developed, convex at distal end with a minute projecting angle on postero-distal corner.

Legs fairly stout, unguis triheterohamate, the middle hook stout, well curved, the outer quite slender, their apex not as curved as the middle hook; bristles mostly smooth, rather long. Legs I closely resemble those of plate 6, figure 54, but tarsi about as long as tibia, stout-cuneate, conspicuously notched for insertion of bristles; dorsal face with six fairly stout bristles (see pl. 6, fig. 55 for similar arrangement), the proximal fairly long, quite depressed, distally curved so as to cross the second which is slightly longer, but recurved, inserted close to proximal, third bristle more distantly inserted, similar to proximal, fourth bristle close to third (thus making, like proximal with the second, a pair with the third), fifth bristle separated from other dorsal bristles by widest

gap, quite long, curved, somewhat depressed; the three ventral bristles with three to four strong cilia; apex with two or three short, stout bristles, that of ventral face almost spinous; a fairly long lateral bristle inserted on transverse plane of second dorsal bristle; a mesal bristle similarly inserted but more dorsal. Tibiae broad, beaker-like but compressed, with well developed, stout pedicel; major bristle surpassing tarsal hooks, preceded by a fine bristle, a bristle on each side, inserted on transverse plane passing twice the distance from distal edge of segment as is major bristle, subequal, fine, rather long; ventral edge with two short bristles, the proximal inserted on transverse plane slightly proximad of that of lateral bristle and somewhat on side, the distal one with at least six cilia, inserted slightly proximad of the other. Genuals stout, curved, with a long bristle almost reaching major bristle, inserted close to distal end on dorsal face; a fairly long, fine bristle inserted on lateral face near distal end; a shorter bristle similarly inserted near middle of ventral face, a fairly long, fine, curved bristle inserted on ventro-distal rim. Femora broad, compressed, irregularly oblong, with well-developed articulating head at proximal end; dorsal edge with two bristles, the proximal one two-fifths length of segment, barbed, inserted at center of segment, the distal one very slightly longer, finely barbed, inserted nearly midway between distal end and dorso-proximal bristle; ventral edge also with two bristles, the proximal inserted near proximal end on posterior angle, the distal one short, fine, inserted on transverse plane of dorso-proximal.

Legs II shorter, more slender, similar to legs I but tarsi with bristles of distal half more crowded. Tibiae almost oblong, the pedicel very short, forming a sharp, oblique, rimmed angle with body of segment on ventral edge (pl. 6, fig. 55); dorso-distal bristle smaller, ventro-lateral long. Genuals with all bristles shorter, lateral bristle inserted proximad of middle. Femora more regular in outline, produced ventrally to form a sharp ventro-distal angle around which the flange forms a conspicuous crest, flange quite as broad as distal end of genual; an additional barbed bristle between the two dorsal, but nearer the proximal; both dorsal bristles ciliate; both ventral bristles longer, the distal one inserted at center of flange at point of curvature.

Legs IV (compare plate 6, figure 57) long and slender; tarsi quite slender; dorsal face with three bristles, proximal inserted slightly distad of center of segment, second one inserted, the diameter of the segment at that point distad of proximal bristle; ventral face with four three- to four-ciliate bristles, the distal inserted on transverse plane of second dorsal, the third inserted on transverse plane which passes slightly proximad of dorso-proximal bristle, the second inserted somewhat laterad and halfway between proximal and third. Tibiae slender, cuneate; dorsal bristle as long as segment, inserted less than diameter of base of tarsus from distal end of segment; ventral bristle inserted twice as far from distal end as is dorsal bristle, pauciciliate, surpassing end of segment. Genuals slender, slightly curved; with a ventral bristle inserted on distal rim; a dorsal bristle inserted near distal end; a lateral bristle surpassing segment inserted at center of segment. Femora short oblong, with well-developed pedicel and slender flange; dorsal bristle curved, surpassing segment, inserted two-fifths length of segment from proximal end of segment; ventral bristle much shorter, inserted at base of flange at point of curvature. Coxae as high as long, including the well-developed ventral flange which extends distad beyond body of segment; a short, fine bristle inserted near distal end of flange, close to its base.

Legs III (compare plate 6, figure 56) with each segment shorter and stouter. Tarsi with the three dorsal bristles each more proximally inserted. Femora with dorsal bristle surpassing insertion of dorso-proximal bristle of tarsi, inserted the diameter of pedicel from distal end; ventral bristle ciliate, inserted on transverse plane of dorsal bristle. Genuals with a fine, rather short dorsal bristle; dorsal and lateral bristles longer; lateral bristle inserted proximad of center. Femora tapering towards distal end, flange not extending onto distal edge; dorsal bristle surpassing end of segment though inserted far proximad of center; with a similar but finer and shorter bristle inserted a short distance proximad and slightly below dorsal rim,

usually curving down over side of segment; ventro-lateral bristle barbed, rather long, insertion remote from distal end of segment. Coxae higher than long; no bristles discernible.

Color, reddish amber.

Dimensions. Minimum, average, and maximum sizes of *P. insularis* males, females, and *P. insularis sandvicensis* females, respectively and in the order just given, are as follows:

Total length of body.....	310	346	375	375	406	465	405	420	425
Length, notogastral plate.....	240	265	285	285	320	370	325	328	340
Breadth, notogastral plate.....	205	224	245	235	256	285	275	287	300
Length, pteromorphae	225	259	270	275	302	345	295	302	310
Interlamellar bristle span.....	40	44	50	50	50	55	50	58	60
Length, ventral plate (mesal).....	235	262	280	285	316	360	300	308	320
Camerostome to genital aperture.....	65	77	80	80	90	100	74	74	75
Length, genital aperture.....	35	37	40	45	49	55	50	50	55
Breadth, genital aperture.....	35	39	40	45	48	55	50	52	55
Genital aperture to anal aperture.....	70	82	85	85	95	105	95	99	105
Length, anal aperture.....	55	63	65	70	75	90	75	75	80
Breadth, anal aperture.....	60	70	80	80	85	100	85	86	90

Length of pteromorphae in this group is measured from anterior edge of pteromorphae to posterior edge of abdomen on mesal line.

Although the number of specimens measured is small, it is sufficient to give an indication of trends of differences. As usual the males are conspicuously smaller than the females. The variety averages larger than its species, but has relatively shorter pteromorphae and ventral plate. A study of the ventral plate areas shows this difference in length to come between the camerostome and the genital aperture. Interspecific comparisons are given under the next two species.

Cotypes: Hawaii, Honokaa, two females (1 egg), hole 1 mm. in diameter in sugar cane stool, underground, July 5, 1922, no. CGES06P; Oahu, Experiment Station, Hawaiian Sugar Planters' Association, one female (8 eggs), in decaying cane stool, November 3, 1923, no. CGES13P; Oahu, upper Manoa Valley, one female (3 eggs), beneath moss, November 4, 1923, no. CGES09P; C. E. Pemberton.

Protoschelobates vanzwaluwenburgi, new species (pl. 6, figs. 51-57).

Diagnosis

General body shape of *P. insularis sandvicensis* but pteromorphae extending anteriorly nearly as far as anterior border of notogaster, leaving a well-defined invagination in anterior outline at juncture of pteromorphae and notogaster (i.e., above pseudostigmata); cephaloprothorax more slender so that tectopodia II are far more evident (in dorsal view); lamellae very similar; pteromorphae, seen from above, concave posterior to anterior end so as to form a gently undulating outline; rostral bristle quite barbate, lamellar and interlamellar less so; pseudostigmatic organ clavate, thorny (pl. 6, fig. 51); genital aperture with rounded anterior edge; anterior part of frame broad; third pair of punctures mesad of longitudinal center of cover (pl. 6, fig. 52); mesal end of apodemata I ending in a simple rounded nubbin; furculum indistinct; anal aperture parallel-sided; preanal punctures mesad of sides, remote from aperture.

Description

Cephaloprothorax broader than long, sides overhung by lamellae, rostrum barely differentiated from cephaloprothorax, confluent with it (pl. 6, fig. 53); lamellae broad at base, tapering gradually to distal end, barely twisted, with a transverse ridge reaching outer edge slightly distad of center, basal channel flaring at apex to form broad base of bristle and projecting corner of lamellae (pl. 6, fig. 53); translamellar line nearly complete; rostral bristles strongly ciliate; lamellar bristles weakly ciliate, interlamellar bristles barbed; rostral bristles inserted on slight swelling; lamellar bristles inserted near apex of lamellae (pl. 6, fig. 53); interlamellar bristles appear to be inserted nearer lamellae than notogaster when seen from above; areae porosae small, oval, less than their diameter from lamellae; acetabula I deflecting walls of cephaloprothorax at a sharp angle (pl. 6, fig. 52), the end slightly swollen; tectopodia II slender but long, projecting well beyond anterior end of pteromorphae, outer edge crescentic.

Notogaster broadest at posterior angle of pteromorphae, bluntly rounded behind, making posterior edge almost flattened (as seen from above or side), highest behind middle; pteromorphae invaginate posterior to anterior end, this evagination in the form of a vertical sulcus or very shallow depression, anterior edge invaginate postero-laterad of pseudostigmata so that outer anterior edge projects nearly as far forward as anterior edge of notogaster; rim of pseudostigmata projecting in this invagination as a narrow rim terminated by a short, pointed cusp; areae porosae adalares small, oval, an adalar pseudoforamen remote from pteromorphae; posterior areae porosae small, oval from above, actually nearly circular, with a central, vermiform thickening; a pseudoforamen less than diameter of areae porosae postero-mesad; a very short diagonal pseudofissura some distance laterad; other pseudofissurae (?) about posterior edge.

Ventral plate similar to *P. insularis sandvicensis* but anal aperture close to posterior edge, sides parallel, slightly bowed, angles well rounded, posterior edge rather flattish, posterior pair of cover bristles nearly as remote (seen from above) from posterior edge as from lateral, the two pairs subequally spaced from mesal edge; lateral pair of postanal bristles well up on sides of aperture, in line with the posterior anal cover bristles, distant from aperture; mesal pair of postanals laterad of center of cover; preanal bristles more approximate than sides of aperture, more anterior than anterior edge of aperture; paramesial bristles distant from genital aperture a little less than its length, as remote as greatest breadth of genital aperture. Genital aperture (pl. 6, fig. 52) rather large, sides almost parallel, anterior edge broadly rounded; cover bristles mesad of center of covers, anterior pair on rim, second pair as far from mesal edge as from anterior, third pair as far from side as from posterior bristles; furculum indistinct, deeply bifurcate, leaving a short, stout, midpiece (pl. 6, fig. 52); tectopodia III slightly emarginate, the anterior lobe much the larger, rounded (pl. 6, fig. 52).

Legs, in general, similar to preceding but varying specifically as follows: Legs I (pl. 6, fig. 54) with tarsi slightly longer than their tibiae, broad cuneate; dorsal face with about seven bristles, of which the proximal is medium long, fine, bent distally, the second quite long, erect, third stout, shorter, more depressed, bent forward so as to cross the fourth, fourth nearly as long as second, erect, slightly bent back, these four inserted quite near to each other, thus forming a group, fifth paired, quite long, curved, reaching well over hooks of unguis, inserted subequally between fourth and sixth, sixth bristle as usual; ventral face with three fairly long, pauciciliate bristles, the proximal inserted quite near proximal end of segment, the others progressively more distant distad, cilia six or more per bristle; a medium-long lateral bristle inserted on transverse plane of second dorsal; a mesal quite depressed, springing from near insertion of proximal. Tibiae goblet-shaped with a stout shaft, shorter than bowl, the proximal end narrowed by a transverse flange on ventral face; major bristle quite long, exceeding unguis if laid along tarsus, inserted very near edge of segment; a fine medium-long dorsal bristle inserted on very edge of segment; ventral face also with two bristles: the distal one ciliate, shorter than dorso-distal, the proximal inserted near base

of bowl; a lateral bristle inserted on transverse plane passing slightly proximad of major; a dorso-mesal bristle inserted on transverse plane passing about half way between lateral and ventro-proximal. Genuals quite curved; with a long bristle reaching nearly to major of tibiae, inserted close to dorso-distal edge; a lateral bristle as long as mesal of tibiae, inserted close to distal edge; a shorter ventral bristle inserted more proximad than the other two. Femora irregularly oblong, very angular; dorsal edge with two marked angles, one at center from which there springs a stout, barbed bristle, the other halfway to distal edge, giving rise to a slightly longer, curved, barbed bristle which reaches beyond end of segment, ventral edge broken by an angular hump near distal end; proximal corner furnished with a fairly long, fine, curved bristle; a shorter bristle inserted at center of edge, articulating head well formed.

Legs II (pl. 6, fig. 55) similar but tarsi with proximal bristle of dorsal face rather short, appressed, crossing the second which is nearly twice as long, with a similar one a short distance to one side, third dorsal bristle shorter, its end curved back, these four forming a distinct though crude brush, other bristles shorter than in legs I; ciliate bristles of ventral face with but four or five cilia; lateral bristle not evident. Tibiae oblong, pedicel swollen out to become part of head, oblique flange less oblique, forming posterior end of oblong; all the bristles much shorter, no ciliate bristle at ventro-distal edge, no mesal bristle. Genuals stouter; the bristles quite short, no ventral bristles visible; a rather long lateral, inserted at center. Femora shorter but broader, dorsal outline flatter, ventro-distal angle drawn out far below genual insertion; all bristles shorter; dorsal edge with proximal bristle in center of oblique proximal slope, distal bristle midway to intermediate bristle, also barbed; ventro-distal bristle on ventral corner.

Legs IV (pl. 6, fig. 57) with tarsi very slender, concave on ventral face; dorsal face with two bristles besides the usual subdistal, proximal inserted at center of segment, the other halfway between the proximal and distal end; ventral face with usual three barbed bristles, the proximal inserted greatest diameter of segment from proximal end. Tibiae slender, clavate; major bristle as long as tarsi; ventral face with two bristles, proximal surpassing distal end of segment, inserted on transverse plane passing just proximad of major bristle, distal one shorter, inserted close to distal end; a ventro-lateral bristle nearly as long as ventro-proximal, inserted on transverse plane passing halfway between the two ventral bristles. Genuals stout, rather straight; with a fine bristle about as long as genual, inserted close to dorso-distal edge; another shorter bristle inserted at center of ventral face. Femora roughly oblong, with a slender flange along ventral edge; a rather short bristle inserted on ventro-distal angle; a long, curved bristle reaching center of genuals, inserted at center of dorsal edge. Coxae longer than high, upper edge curved, lower edge drawn out into a slender, anteriorly pointed flange; no bristles observed.

Legs III (pl. 6, fig. 56) similar but stouter; tarsi with dorsal bristle inserted more proximally; ventral bristle inserted more distally. Tibiae with major bristle much shorter, inserted more distally; one bristle on ventral edge, inserted slightly more distad than major. Genuals more slender, more curved; an additional bristle at side. Femora with dorsal bristle inserted at proximal third of segment; ventro-distal bristle longer, more distally inserted. Coxae similar but lower edge with corners less pointed.

Dimensions. Only two females and one male measurable. The average for the three, especially as the measurements for the male are included by the smallest female, are presented, with the largest and smallest, in the table with one of the following species. One specimen was found to be 170 microns high. The male has a decidedly smaller genital aperture. Compared to *P. insularis sandvicensis* it is as long, but has a longer and narrower notogastral plate, longer pteromorphae, longer interspace between camerostome and genital aperture and between genital and anal apertures and a narrower anal aperture.

Color, reddish amber.

Cotypes: Oahu, 10 specimens, soil samples from cane fields, no. 281v02, R. H. Van Zwaluwenburg. Evidently quite terricolous. A maximum of two eggs was found.

Although very closely related to the preceding, it is readily distinguished by its almost flat pteromorphae, bristles on pseudostigmatic organs, and weaker furcula area, thus being the more primitive.

Protoschelobates pambertoni, new species (pl. 7, figs. 58-60).

Diagnosis

Pteromorphae not extending anteriorly to be nearly in line with anterior edge of notogaster, so that there is no marked invagination of notogasteral outline above pseudostigmata; cephaloprothorax only slightly broader than long, slender; abdomen slender; pteromorphae not invaginate at sides; lamellae not twisted; pseudostigmatic organs ciliate along anterior, distal edge, extending well beyond pteromorphae; ends of acetabulae I projecting beyond sides of cephaloprothorax towards tectopodia II whose anterior ends are incised; mesal ends of apodemata I simple; furculum with stout transverse head; genital aperture with anterior edge very sloping to form on acute mesal angle; anterior side of genital frame broad, broadly enclosing posterior pair of sternal punctures; genital cover punctures laterad of center of covers.

Description

Cephaloprothorax (pl. 7, fig. 58) slender, barely broader than long, if length is taken from line joining posterior edge of pseudostigmata; anterior end steep, so as to form a prelamellar transverse "shadow" line (postrostral sulcus); rostrum drawn out as a distinct nubbin; lamellae well-developed ridges, not twisted (as in *P. insularis sandvicensis*), equally broad throughout their length, barely tapering at distal end, thus being parallel to sides of cephaloprothorax; rostral, lamellar and interlamellar bristles quite long, fine, undulate, smooth; rostral bristles inserted at base of rostral bulge, on very faint nubbins; lamellar bristles inserted at base of lamellae; interlamellar bristles inserted much nearer lamellae than to rim of notogaster; pseudostigmata projecting beyond rim of pteromorphae as a rounded rim; pseudostigmatic organs with rather stout pedicel, and clearly demarked head (pl. 7, fig. 59) which tapers abruptly into pedicel though pedicel is swollen to meet it; sides of cephaloprothorax nearly flat, barely convex; acetabulae I project prominently, forming a conspicuous rim about base of cephaloprothorax, beveled backward; tectopodia I absent; tectopodia II standing out as prominent wings anterior to pteromorphae, incised at anterior end, where they join the cephaloprothorax, the notch being partly occupied by the acetabular ridge, bristle insertion close behind articulation of legs I.

Notogaster (pl. 7, fig. 58) slender. The ratio between breadth of notogaster and length to anterior edge of pteromorphae of four females averages 85 (range, 83-90), of five males averages 86 (range, 83-89), thus being quite similar to *P. insularis sandvicensis* and contrasting with *P. insularis*. Notogaster broadest at posterior end of pteromorphae; anterior edge flatly curved, flowing into anterior edge of pteromorphae, posterior edge flattened; pteromorphae with a vertical invagination posterior to anterior end, projecting but slightly laterad of tectopodia II, invaginate postero-laterad of pseudostigmata, but not conspicuously so, to not at all; pseudostigmata barely projecting as a low, rounded rim; a curved pseudofissura on anterior half of pteromorphae near the attachment to notogaster, curving parallel to curve of abdomen; posterior half with a pseudoforamen or puncture separated from abdomen by a depressed segment of a circle, forming a slight, curved, black line; areae porosae small (pl. 7, fig. 58): adalar small, oval; a pseudoforamen slightly less than diameter of these areae porosae postero-mesad of them; posterior areae porosae short-vermiform; a pseudoforamen on

mesal plane well behind transverse plane of posterior areae porosae; a pseudofissura antero-laterad of posterior areae porosae; posterior bristles fine, very short.

Ventral plate well developed along posterior border, more restricted along sides; anal aperture very close to posterior edge of plate, sides subparallel, angles broadly rounded, forming a squarish aperture, slightly broader than long; cover bristles fairly close to mesal edge, as far from each other as from lateral edge; postanal bristles inserted close to aperture, mesal pair opposite center of cover, lateral pair beyond sides of aperture, and posterior to transverse plane of posterior cover bristles; preanal bristles mesad of sides of aperture on outer edge of aperture frame; paramesial bristles a little nearer genital than anal aperture, as remote as outer edges of genital aperture. Genital aperture (pl. 7, fig. 60) with anterior and posterior sides bent so as to form a sharp angle, as if narrowing of abdomen had crushed them backward; sides strongly converging, thus forming the most oblique covers I have so far studied; anterior pair of cover bristle punctures on very rim of covers, often seeming on aperture rim (pl. 7, fig. 58), posterior pair remote from edge, half way between sides, third pair as near lateral edges as posterior pair are from posterior edge; frame of aperture very broad anterior to aperture, including posterior pair of sternal bristles; furculum as above described; mesal ends of apodemata I nearly or quite as approximate as are anterior sternal bristles; apodemata slender; tectopedia III well developed, rather broad at base, distal end with rounded anterior angle and produced, bill-like, posterior corner (pl. 7, fig. 58).

The present material is such as to make a dissection for leg study inadvisable.

Dimensions include minimum, average, and maximum of five males and the same for four females:

	Minimum	Average	Maximum	Minimum	Average	Maximum
Total length of body.....	335	364	385	395	417	450
Length, notogastral plate.....	260	284	305	310	333	370
Breadth, notogastral plate.....	215	227	246	255	260	280
Length, pteromorphae	240	264	285	290	305	340
Interlamellar bristle span.....	45	48	50	45	50	55
Length, ventral plate (mesal).....	245	271	305	305	318	345
Camerostome to genital aperture.....	75	83	90	85	88	100
Length, genital aperture.....	35	36	37	45	49	55
Breadth, genital aperture	38	40	40	45	49	55
Genital aperture to anal aperture.....	80	86	90	90	98	105
Length, anal aperture.....	55	63	70	75	78	85
Breadth, anal aperture.....	61	67	75	80	85	95

It is evident that the males are constantly smaller than the females, there being no overlapping in our nine specimens from the same locality. The length of the genital and anal apertures is slightly longer (proportionally) in the female, making the interspace relatively shorter. Compared to both *P. insularis sandvicensis* and *P. vanzwaluwenburgi* the breadth of notogaster and interlamellar bristle span is noticeably less while the length of ventral plate and distance from camerostome to genital aperture is greater.

Color, slightly darker than *P. insularis sandvicensis*.

Cotypes: Hawaii, Honokaa, 1 male, 3 females with 2 to 4 eggs, on cane roots, July 14, 1922, no. CGES07P; 4 males, 2 females, from hole 1 mm. in diameter in cane stool underground, July 5, 1922, no. CGES06P (were *P. insularis sandvicensis* and this species found in the same hole?); 1 female with 1 egg, on cane stool underground, July 7, 1922, no. CGES14P, C. E. Pemberton. Oahu, 1 female with 3 eggs, soil samples from cane fields, no. 28rvo2, R. H. Van Zwaluwenburg.

It is owing to the painstaking investigations of Pemberton that these two additions to the terricolous fauna have been made. It is therefore just that one of the species should bear his name. *Protoschelobates indica* was found in the leaf cups of *Nepenthes destillatoria*; it is thus negatively terricolous, though it may be found among fallen leaves, especially during daylight.

The above three species form a closely related group. They can be discriminated by the diagnostic characters. That three such closely related species, especially as *P. insularis sandvicensis* and *P. vanzwaluwenburgi*, should be found together, may well be due to the recent introduction of *P. vanzwaluwenburgi*, as *P. insularis sandvicensis* appears to be a natural development from the East Indian *P. insularis*. By its slenderness, absolutely flat-sided pteromorphae, very sloping genital aperture with cover bristles inserted laterad of middle, and bristled pseudostigmatic organ head, *P. pembertoni* is at once distinguished.

Variety? Two specimens under no. CG506P, though closely resembling *P. insularis sandvicensis* in most respects, have the slender form of *P. pembertoni* (elongate oval, though larger; pseudostigmatic organ with head conspicuously thorny though symmetrically oval; pteromorphae not undulate but flat; genital covers in one specimen, with bristles along longitudinal center). Thus, although superficially resembling *P. pembertoni* in dorso-ventral outline, its other characters are normal for the genus. If, then, these are the result of interbreeding, the effect has been to draw *P. insularis sandvicensis* nearer a normal type. The effect, to date, has not been great. It has not affected the ventral area between camerostome and genital aperture.

***Protoschelobates castlei*, new species (pl. 7, figs. 61-66).**

Diagnosis

Unusually small, barely visible to unaided eye, 0.3 mm. long; pale honey yellow; quite translucent; pseudostigmatic organ spoon-shaped with very slender pedicel, smooth head with conspicuous "oil-globules"; pteromorphae sloping back from pseudostigmata; genital aperture relatively large; only one pair of posterior genital cover bristles; sternal area well developed, arms broad, with central portion extending to camerostome; mesal ends of parasterna slender.

Description

Cephaloprothorax, as seen from above (pl. 7, fig. 61), fairly slender, about as broad as long, sides gently convex, bulging slightly beyond edges of lamellae; seen from the side (pl. 7, fig. 62) gently convex; rostrum separated from cephaloprothorax only by a gentle impression of the outline; insertion of rostral bristles protuberant; lamellae slender though heavily chitinized, strongly twisted (pl. 7, fig. 61), tapering strongly towards distal end; channel strongly marked, its distal end turned up and swollen to form base of bristle insertion, seen from side (pl. 7, figs. 62, 64) they seem to overhang or roof over the rather large areae porosae which seem to be sunk under edge of lamellae, decurrent at distal end for some distance down side of cephaloprothorax; translamellar line entirely lacking; postrostral sulcus well developed, near ends of lamellae; rostral and lamellar bristles smooth; interlamellar bristles barbed (pl. 7, fig. 62), from above seen to be inserted much closer to lamellae than to notogaster; pseudo-

stigmata not to barely projecting beyond edge of pteromorphae and lamellae (pl. 7, fig. 65), ventrally limited by a short, thick, cuneate plate (stippled in plate 7, figure 64); pseudostigmatic organs as above described, compressed (pl. 7, fig. 63).

Notogaster, seen from above (pl. 7, fig. 61), oval, broader posteriorly, posterior end quite rounded, anterior edge distinct, remote from edge of pteromorphae (heavy line in plate 7, figure 65); pteromorphae rather small, anteriorly contracted, anterior edge, as seen from above, extending obliquely backward and downward (pl. 7, fig. 61), extending ventrad not to leg insertions (pl. 7, fig. 62), dorsal portion with two pseudofoforamina (pl. 7, figs. 61, 62); attachment area of mandibular retractor (behind anterior edge of notogaster) rather short; punctures quite easily distinguished (pl. 7, fig. 61); areae porosae indistinct, adalar rounded, remote from pteromorphae.

Ventral plate (pl. 7, fig. 61) broadly overhung by notogaster along sides; anal aperture close to posterior edge, so that postanal bristle insertions are crowded well to one side, the mesal pair on line of sides, the lateral pair well up on sides of aperture but remote from it; preanal insertions also remote from aperture, inconstant in exact position, the pair often asymmetrically disposed, minute (as though their stability were upset by incursion of postanal); anal aperture parallel-sided, posterior margin very convex, anterior margin also very convex, concave at center; cover bristles unusually remote from each other, subequally spaced from anterior and posterior margin, posterior pair twice as far from posterior margin as from mesal; paramesial bristles inconstant and often asymmetrical in position, usually nearer genital aperture. Genital aperture fairly large, with angles broadly rounded, so as to make it more rounded than usual, cover bristles mesad of longitudinal center of covers, anterior pair on rim close to mesal edge, second pair as far from anterior edge as from mesal, posterior pair invisible, third pair as far from posterior edge as from mesal edge, thus more posteriorly situated than in the preceding species; anterior edge of aperture frame broad, with a broad tongue reaching out to apodemata II-III; sternum complete, extending as a broadening tongue to camerostome, sending out broadening tongues to apodemata I; sternal bristles inserted on sternum; camerostome long; tectopedia II with tapering ends, extending well in advance of pteromorphae and far out beyond sides of cephaloprothorax, bristleless, or with very faint puncture in middle of tectopedia; tectopedia III stout, not bicephalic, anteriorly recurved, no bristle observable; apodemata I slender, ental branch extending posteriad of posterior branch, then returning to join it.

Legs typical; bristles if anything longer than usual, barbed and ciliate bristles of legs I and II weakly barbed; outer unguis very slender. Legs I (pl. 7, fig. 66) somewhat stout. Tarsi short for the genus (compare with plate 7, figure 69); dorsal face with six bristles: proximal the shortest, distally bent, inserted at broadest part of segment, second bristle the longest, erect, nearly straight, inserted near proximal, third bristle medium long, bent sharply distad so as to cross the fourth, inserted at foot of second, fourth bristle medium long, slightly curved, somewhat distally directed, inserted as far from third as second is from proximal, fifth bristle nearly as long as second, directed distad, inserted nearly twice as far from fourth as fourth is from third; ventral face with four nearly smooth bristles, subequally long, subequally distant, an additional stout distal bristle; a lateral bristle inserted near ventro-proximal. Tibiae broad cuneate, stout, dorso-distal area produced as a stout, unusually long nubbin, bearing, at its end, the major bristle (compare with plate 7, figure 69) which is very long, far exceeding tarsus and unguis; a rather short, fine bristle inserted on rim of nubbin; a longer bristle inserted near base of nubbin on mesal side; ventral face with a fine, medium long bristle, inserted at two-thirds distance from proximal end; a similar bristle inserted on lateral side near distal margin. Genuals at least half as long as the tibia (without nubbin), slightly curved; dorsal face with a long, fine bristle extending nearly to base of major bristle, inserted near distal edge; two shorter bristles inserted on ventral face at distal edge. Femora curved, irregular, compressed; dorsal face with two medium long bristles, the proximal inserted slightly proximad of center, the distal inserted mid-

way between proximal and distal margin, extending nearly to center of genual; ventral face with a similar bristle inserted a third of the distance from proximal end of body of segment.

Legs II similar to those of *P. vanzwaluwenburgi* (pl. 6, fig. 55) but major bristle longer, ciliate bristles only weakly ciliate, other characters not distinguishable in present material.

Legs IV similar to those of *P. vanzwaluwenburgi* (pl. 6, fig. 57) but ventro-proximal bristle of tarsi more proximally inserted; major bristle still longer; genuals more slender; femoral flange narrower at distal end, not projecting beyond segment; dorsal bristle of femora more proximally inserted; coxae with dorso-distal angle higher and more produced.

Legs III similar to those of *P. vanzwaluwenburgi* (pl. 6, fig. 56) but coxae tapering at distal end, with a slender keel at center, from which springs the ventral bristle; coxae with a ventral bristle near proximal end.

Dimensions. In the following table are given in order, minimum, average, and maximum of seven females; average of two subequal males; minimum, average, and maximum of *P. vanzwaluwenburgi* of two females and a male:

Total length of body.....	310	330	345	300	400	415	425
Length, notogastral plate.....	230	255	275	234	330	335	345
Breadth, notogastral plate.....	185	192	195	168	270	280	290
Length, pteromorphae	215	231	240	213	300	315	325
Interlamellar bristle span.....	40	45	48	43	57	57	57
Length, ventral plate (mesal).....	240	260	270	232	300	310	330
Camerostome to genital aperture....	60	63	68	60	80	85	90
Length, genital aperture.....	37	45	50	35	50	43 ♂	50
Breadth, genital aperture.....	43	45	45	35	50	45 ♂	50
Genital aperture to anal aperture....	80	88	90	80	100	103	105
Length, anal aperture.....	60	62	65	50	70	74	80
Breadth, anal aperture.....	60	62	65	53	75	80	85

Color, paler than *P. pembertoni* and more thinly chitinized.

Cotypes: Oahu, Manoa Valley, wooded slope behind Castle home, 23 specimens, handpicked from under face of chips of wood, July 28, 1926, no. 262001, Jacot.

Because of the large size of the eggs (17.8 microns long) there are but two eggs per individual, each egg occupying the greater part of each half of the abdomen.

Thus this species has developed a distinct step towards *Schelorbates* in that the furculum is well developed. The rather elongated tip of the lamellae also indicates this tendency. This species is by far the smallest of the genus known to me, and strikingly unlike the preceding in the pseudostigmatic organs, arrangement of pseudoforamina, extremely posteriorly situated anal aperture with the consequent changes in bristle location, very weakly ciliate tarsal bristles of legs I and II, and other diagnostic characters.

Genus SCHELORIBATES (6, p. 2)

Ceratozetini without translamellae; pteromorphae confluent with body outline behind; tectopodia I not developed; lamellae well developed; anterior edge

of notogaster distinct; distal end of lamellae with lamello-rostral ridge extending to rim of camerostome; mesal end of apodemata iv fused to frame of genital aperture; sternum well developed to camerostome; femora I without broad flange along ventral edge (posterior-most punctures of notogaster much more remote than diameter of an anal cover).

Type, *Oribates latipes* (34, fasc. 38:14).

In the key to the pterogasterine Oribatoidea (30, p. 430) this genus is placed in the tribe Oribatulini, evidently by oversight. As the pteromorphae distinctly curve ventrad so as to cover a part of the side of the abdomen and partially cover the legs when they are folded upward from their point of insertion, the genus belongs in the tribe Ceratozetini. In the key, the species work down to *Melanozetes* provided they are always considered as having elongate abdomen and cephaloprothorax (thus the couplet 9 is, in some, weak and deceptive). This genus differs from *Melanozetes* as indicated in the following addenda to the key:

- | | |
|--|-------------------------|
| 12a. Femora I with broad flange along ventral edge..... | Melanozetes |
| 12a. Femora I without broad flange along ventral edge..... | 12b |
| 12b. Apodemata IV not extending to genital aperture; edge of camerostome not joined to lamellae by a raised ridge..... | Protoschelobates |
| 12b. Apodemata IV abutting on genital aperture; rostro-lamellar ridge well developed | Scheloribates |

Because of its close connection with Hawaiian species, I include a re-characterization and figure of *Scheloribates indica*, based on the types.

Scheloribates indica (40, p. 64) (pl. 7, figs. 67, 68).

Diagnosis

Abdomen rather broad; cephaloprothorax quite short and broad; lamello-rostral ridge making a quite conspicuous break in outline of rostrum as seen from above; lamellae quite broad for the genus, with a slight transverse depression posteriorly of apex; cephaloprothoracic bristles well developed, smooth, the lamellar quite stout; pseudostigmatic organs (pl. 7, fig. 68) small, not reaching much beyond tectopodia II as seen from above (pl. 7, fig. 67), head oval (appearing obovate, pointed at apex when obliquely turned), smooth or with extremely short and fine points; areae porosae quite small; fissurae longitudinal; mesal pair of postanal bristles behind center of cover; lateral pair on transverse plane passing anteriorly of posterior bristles of anal covers; preanal bristles on produced line of sides of anal aperture; paramesial bristles near genital aperture; third pair of genital cover bristles near outer edge of covers; acetabulae I projecting as a point beyond their conspicuous bulge; tectopodia II with well-developed bristles inserted at their center; apodemata well developed, posterior process of I not visible, mesal end of IV curving up about end of apodemata II-III; tectopodia III long, distinctly emarginate, with a bristle near its base; tectopodia IV semiovate, with a bristle near its posterior end; sternal processes well developed; that housing apodemata I quite broad and flaring at ends.

Dimensions are listed under the next species.

Two specimens which I can differentiate from this species only by their relatively larger pseudostigmatic organs were sunned from epigeous moss

forming a mat under a growth of the fern *Sphenomeris chinensis* on the west slope of the hill at the head of Manoa Valley, Oahu, July 29, 1926 (Jacot, no. 262402).

Schelorbitates muiri, new species (pl. 8, figs. 69-79).

Diagnosis

Abdomen round-oval, similar to *S. indica*; rostral and lamellar bristles with a few weak cilia; pseudostigmatic organs larger, head more slender, edge distinctly to conspicuously barbed; areae porosae and pseudofissurae differently situated; pteromorphae with radial combing or fine corrugations on shoulders; genital aperture with anterior edge forming an acute angle, cover punctures near longitudinal center of covers; sides of tectopodia II strongly converging toward rostrum; tectopodia III strongly notched and with anterior corner much produced; all bristles longer than in *S. indica*.

Description

Cephaloprothorax, as seen from above (pl. 8, fig. 73), about as broad as long (using center of pseudostigmata as terminals of base line and not including tectopodia II), outline broken by lamello-rostral ridge; seen from side (pl. 8, figs. 72, 77), conic, flat below, convex above, outline of rostrum barely differentiated; lamellae, seen from above, slender, undulate on outside, distal end tapering, sides of cephaloprothorax always visible beyond them; translamellar line short; lamello-rostral ridge well developed, embracing base of rostral bristle (pl. 8, fig. 72); acropleural areae porosae distant from lamellae, small, oval; bristles long, fine, rostral and lamellar finely barbed, interlamellar inserted nearer edge of notogaster than to lamellae when viewed from above, base of lamellae merging into pteromorphae (pl. 8, fig. 78); pseudostigmata (pl. 8, fig. 78) with rim surpassing edge of pteromorphae (pl. 8, fig. 73), organs with head at least as long as the stout pedicel, "oil globules" conspicuous but fine and regular, not extending to proximal end of head, barbs almost spinescent, invisible when seen from side, the compressed edge thus appearing quite different; acetabulae I projecting beyond cephaloprothorax as a slender ridge (pl. 8, figs. 75, 77).

Abdomen rounded-oval, anterior edge of notogaster strongly bowed, its sides merging into pteromorphae, anterior half more flattened than posterior half (pl. 8, fig. 72), pteromorphae anteriorly restricted, concave, not extending far down on sides, with a bristle on antero-dorsal area, inserted near a slight but deep-cut groove (pl. 8, figs. 73, 74), incurved postero-laterad of pseudostigmata; areae porosae small, oval; pseudofissurae fine, fairly long; anal cover retractors (dotted in plate 8, figure 72) forming at least four distinct attachment areas on posterior edge (pl. 8, fig. 73); marginal bristles quite distinct, at least the mesal pair curved downward (pl. 8, fig. 72), not as remote as mesal pair of postanal bristles.

Ventral plate (pl. 8, fig. 75) with anterior half strongly contracted, well rounded behind; anal aperture broader than long, sides parallel, ends strongly curved, angles well rounded; cover bristles equally distant from mesal edge, subequally spaced from anterior and posterior edges respectively; postanal bristles short, lateral pair inserted laterad of sides of aperture, exact distance varying with the individual, more posterior than transverse plane of posterior cover bristles, mesal pair laterad to opposite center of covers; preanal bristle punctures as distant from aperture edge as are cover bristles, slightly more remote than greatest width of aperture; paramesial bristle punctures less than length of genital covers from genital aperture, slightly more remote than greatest width of aperture. Genital cover bristles mesad of longitudinal center of covers, anterior and posterior pairs not on rim as usual in *Protoschelobates*, third pair varying as indicated in plate 8, figure 75; posterior edge of aperture deeply emarginate, sides very short, shorter than anterior slope, aperture frame fairly broad; sternum somewhat slender; posterior sternal bristles on frame, others just off edge of sternum (pl. 8, figs. 75, 76);

apodemata I with ental branch distinct; parasternal bristles well developed; camerostome slender; tectopedia II short, sides oblique; tectopedia III rather broad, distal end with conspicuous notch and well drawn out anterior corner.

One specimen under no. 261801 has postero-mesal area of ventral plate pinched together into a blunt point; another has three bristles on one anal cover.

Legs strongly bristled, rather more specialized than in *Protoschelobates*; terminated by triheterohamate unguis, the hooks slender but well curved, with rather long shaft. Legs I (pl. 8, fig. 69) with tarsi conical, fairly stout, flattened on ventral face which bears four fairly long, multi-ciliate bristles, the proximal inserted less than greatest diameter of segment from its proximal end, the distal two inserted distad of center; dorsal face with five bristles on proximal half, of which the proximal is shortest, the second twice as long, straight, the third still longer, recurved to cross second, the fourth short, fine, nearly prone, the fifth nearly as long as second, directed obliquely forward; distal half of dorsal face with two bristles, the proximal fine, fairly long, crossing unguis, the distal one ciliate-barbate, as long as the ciliate bristle of opposite side; a long, fine lateral bristle inserted on transverse plane of ventro-proximal, reaching to middle of unguis; distal bristles stout, extending nearly to end of unguis. Tibiae broad, somewhat rectangular, broadest at distal end, with dorso-distal corner drawn out into a very prominent nubbin; ventro-proximal area drawn out into rimmed corner; major bristle considerably surpassing its tarsus, preceded by a fairly long bristle; ventral face with a fairly long ciliate bristle, inserted slightly distad of center; a medium long bristle on each side, inserted slightly distad of transverse plane of ventral bristle, one of them barbed. Genuals half length of their tibiae, hardly curved, distal end twice diameter of proximal; a rather long bristle on dorsal face, inserted near distal end; a medium long, barbed ventral bristle, inserted near distal end; a slightly longer, fine bristle on each side inserted slightly distad of center of segment. Femora broad, oval, flattened on ventral side, which has a slight flange; dorsal edge with two barbed bristles as long as genual, proximal one inserted its length from proximal end, the distal inserted its length from proximal bristle; a shorter, fine bristle on ventral face, inserted two-fifths distance from proximal end.

Legs II (pl. 8, fig. 70) similar, less specialized, but tarsi shorter, more slender; with but three ciliate bristles on ventral face; dorsal face with proximal bristle fairly long, second bristle directed laterally, recurved at tip, third bristle with distal end strongly recurved; lateral bristle more dorso-distally inserted. Tibiae more oblong, more uniform in width throughout, no dorso-distal nubbin, ventro-proximal corner produced proximad under genual; major bristle shorter, no bristle before it!; ventral bristles ciliate; the distal inserted nearer center, the proximal inserted one third length of segment from proximal end; a fine dorsal bristle inserted opposite ventro-distal; a long, fine mesal bristle inserted on transverse plane proximad of major bristle. Genuals stouter, also oblong; dorsal bristle barbed, nearly as long as segment, inserted proximad of center; ventral bristle fine, rather short, inserted near distal edge. Femora broad, oval, with well-developed flange or keel, emarginate ventro-distally, distal edge angled; dorsal face with three bristles, proximal and middle ones fine, distal one barbate-ciliate; ventral face with two fairly long, fine bristles, proximal one inserted near proximal end of segment, distal one inserted at flange notch.

Legs IV (pl. 8, fig. 71) much more slender, more specialized. Tarsi slender, cuneiform; with usual two dorsal bristles, the proximal inserted somewhat proximad of center, and usual three barbed bristles on ventral face. Tibiae similarly slender but cuneate in reversed direction, proximal end obliquely truncate; usual erect dorsal bristle, nearly as long as tibia; of the two ventral bristles the distal is nearly as long as dorsal, inserted close to distal edge, proximal short, barbed; a lateral inserted near ventral edge. Genuals quite long, nearly as long as their femora, nearly straight; with a short bristle on dorsal face, inserted near distal edge. Femora short, broad, compressed, dorsal edge arched, with a long, fine bristle inserted at center, surpassing center of

genual; ventral edge with slender flange produced distally as a prow; a fine bristle inserted greatest breadth of flange from distal edge. Coxae without bristles, pentagonal, distal edge flattened, angular, fitting to femora.

Legs III similar, less specialized. Tarsi with three barbate-ciliate bristles on ventral face, the proximal quite long, inserted less than diameter of segment from proximal end; three barbate, rather long, dorsal bristles, the second the longest, the proximal inserted one-third length of segment from proximal end; a lateral bristle inserted on transverse plane distad of ventro-proximal bristle. Tibiae roughly oblong, wider at distal end, with oblique flange at ventro-proximal angle; ventral edge with a long, ciliate bristle, inserted proximad of transverse plane of major bristle, a similar bristle inserted on transverse plane distad of major bristle; a shorter, ciliate bristle inserted at center of segment; major bristle as long as tarsus, inserted close to distal end of segment. Genuals stouter and shorter than genuals IV; a short, dorsal bristle inserted less than diameter of segment from distal edge; two barbed ventral bristles inserted at center of segment. Femora elongate oval, dorsal face fairly straight; with barbed bristle inserted two-thirds length of segment from proximal end; ventral face with distal end tapering, with a slight median flange, a fairly long, barbed bristle inserted at center. Coxae higher than coxae IV.

Dimensions: 12 specimens measured; those definitely identified as males are larger than smallest female. The measurements for the two sexes were therefore lumped. Minimum, average of 12, and maximum for this species, with minimum, average of 4 (chiefly males), and maximum of *S. indica* are as follows:

	<i>Scheloribates muiri</i>			<i>Scheloribates indica</i>		
Total length of body.....	490	533	595	550	570	590
Length, notogastral plate.....	395	410	460	435	450	455
Breadth, notogastral plate.....	330	351	375	375	393	410
Length, pteromorphae.....	380	398	450	420	435	450
Interlamellar bristle span.....	61	66	71	75	80	80
Length, ventral plate (mesal).....	375	406	450	425	444	455
Camerostome to genital aperture.....	95	103	115	115	125	125
Length, genital aperture.....	60	64	75	65	67	70
Breadth, genital aperture.....	55	61	67	65	66	70
Genital aperture to anal aperture.....	120	126	135	130	138	145
Length, anal aperture.....	98	100	100	105	111	120
Breadth, anal aperture.....	98	100	105	115	123	130

As but four specimens of *S. indica* were available for study, comparative ratios are inadvisable. The largest *S. muiri* is separated from the next largest by a difference of 50 microns. It is probably safe to say, however, that *S. muiri* is somewhat smaller, and that the anal aperture is as wide as long.

Color, reddish amber, rustaceous.

Cotypes: Oahu, 24 specimens, soil samples, cane fields, no. 281v01; 1 specimen, no. 281v02; 31 specimens, no. 281v04; R. H. Van Zwaluwenburg. Honolulu, experimental plot, Sugar Planters' Association, 5 specimens, from soil, no. 261801; 6 specimens, no. 261802; R. H. Van Zwaluwenburg. Experiment Station, Hawaiian Sugar Planters' Association, 2 specimens, under dry cane leaf sheath, June 26, 1922, no. CGES08P; 3 specimens, from soil near surface, November 26, 1923, no CGES11P; C. E. Pemberton. Manoa Valley, on hillside behind Castle home, 2 specimens, under surface of stones, July 27, 1926, no. 2619h; west slope of hill at head of Manoa Valley, 4

specimens, from dead twigs lying beneath grass, July 27, 1926, no. 262202; Jacot.

This typically terricolous species, which may well have been imported on introduced plants (potted geraniums, taro roots, potato earth, nursery stock, and a host of others) before the days of fumigation, is readily distinguished from *S. insularis* by its much larger pseudostigmatic organs with long bristled head, centralized genital cover bristles, and combed pteromorphae.

Schelorbates manoai, new species (pl. 9, figs. 83, 84).

Diagnosis

Quite small, 3.6 mm. long; abdomen broadly rounded, very high at posterior end, so that notogastral and ventral plates appear flattened when seen from side, and anal plate appears very close to posterior rim when seen from below; cephaloprothorax broad, so as to leave tectopodia II exposed as much as width of lamellae at proximal third; lamellae with sides curving mesad at apex, so that sides of cephaloprothorax are visible laterad of their distal ends when viewed from above, seen from side, distal end is very slender, proximal end unusually broad; acroleural areae porosae very small, nearly circular, touching rim of lamellae; rim of pseudostigmata projecting beyond edge of pteromorphae as a blunt ridge, scale elongate triangular, lying along posterior edge, with a lacuna below it; cephaloprothoracic bristles strongly ciliate; interlamellar bristles, seen from above, inserted closer to edge of notogaster than to lamellae; pseudostigmatic organs asymmetrical, edge spiny (pl. 9, fig. 84).

Sides of pteromorphae narrow, undulate, the anterior undulation remote from anterior rim, the posterior close to posterior edge; postanal bristles with mesal pair near lateral edge of covers, lateral pair anterior to transverse plane of posterior cover bristles, closer to aperture than to rim of ventral plate when seen from below; preanal bristles most remote from aperture, opposite middle of covers; paramesial bristles as close to genital aperture as greatest width of a cover, as remote as greatest width of aperture; genital area as in plate 9, figure 83; tectopodia II rather slender, anterior half incurved, pointed, with conspicuous bristle inserted close behind leg insertion.

Legs with triheterohamate unguis, the outer hooks slender; tarsi I with dorsal brush of four bristles subequally spaced, proximal medium long, curved distad to touch the unusually long second, third intermediate in length between first and second, curved back to nearly touch second, fourth barely as long as proximal, curved distad; other bristles not unusual, ventral strongly pauciciliate; femora III with a slender crest on ventral edge, a bristle springing from center of its base.

It does not seem advisable to draw up a more detailed description based on one specimen.

Dimensions in microns of single specimen, female bearing two eggs: total length, 355; length of notogaster, 285; breadth of notogaster, 230; length of pteromorphae, 255; interlamellar bristle span, 53; length of ventral plate (mesal), 280; camerostome to genital aperture, 67; length of genital aperture, 50, breadth, 45; genital aperture to anal aperture, 92; length of anal aperture, 90; breadth, 83.

Color, reddish amber to rustaceous.

Holotype: Oahu, hill at head of Manoa Valley, 1 specimen from leaf base of stump of tree fern (*Sadleria cyatheoides*), July 29, 1926, no. 2623, Jacot.

Recognizable by its small size; high, blunt posterior end; asymmetrical, spiny-edged pseudostigmatic organ head; anterior position of postanal bristle; and great breadth of sternum, so broad, in fact, as to house sternal bristles.

Scheloribates oahuensis, new species (pl. 9, figs. 80-82).

Diagnosis

Shape, seen from above, oval, bluntly pointed at both ends; lamellae broad, overhanging sides of cephaloprothorax; bristles of cephaloprothorax smooth; pseudostigmatic organs with short, cuneate head drawn out into apicule; tectopodia II not prominent; pteromorphae anteriorly narrowed (as seen from above); notogaster long, anterior edge strongly bowed, cephaloprothorax correspondingly short; mesal pair of postanal bristles laterad of center of covers, lateral pair just beyond line of sides, posteriad of sides (in the strict sense); genital cover with anterior pair of bristles mesad of center of covers, posterior pair on longitudinal center; apodemata I very short.

Description

Cephaloprothorax (pl. 9, fig. 80) short by encroachment of notogaster, dorso-ventral outline broken by prominent projection of lamello-rostral ridges; rostral bristles rather short, fine; lamellar bristles long, fine; lamellae broad at base, extending across to pteromorphae with which they are confluent, overhanging sides of cephaloprothorax, tapering at apex but not exposing sides of cephaloprothorax! appearing very slender from side; areae porosae short oval, close up against lamellae; pseudostigmata projecting very slightly as a pointed cusp beyond pteromorphae, scale short triangular, on ventral edge; pseudostigmatic organs with stout pedicel, recurved near apex, head rather long (see Diagnosis).

Abdomen (pl. 9, fig. 80) oval, broadest at posterior end of pteromorphae, posterior half of sides flattened, quite transverse, posterior end angular, narrow; pteromorphae flat, not extending far laterad of lamellae, only slightly invaginate postero-laterad of pseudostigmata, with a puncture at anterior and one at posterior end; areae porosae small, adalar oval, with a pseudoforamen the length of areae porosae mesad of it; posterior areae porosae circular; marginal bristles quite distinct.

Ventral plate with anterior end quite broad and well developed; anal aperture fairly close to posterior edge, sides parallel, flat, anterior edge quite broadly rounded, posterior pair of anal cover bristles closer to mesal edge than are anterior pair, the two pairs as far from each other as posterior pair are from sides; for postanal bristles see Diagnosis; preanal bristles close to aperture, as far from mesal plane as are mesal post-anals; paramesial bristles near genital aperture, the anterior edge of which is strongly bowed, merging gradually into sides; frame of aperture broad; mesal ends of apodemata II-III, and IV distant from each other; apodemata I short, mesal end recurved, hook-like, lateral end dividing to form two branches; sternum broad with broad tongues; bristles all on sternum; tectopodia II transverse, sides gently convex, with bristle; tectopodia III slender, with anterior angle much produced (pl. 9, fig. 80).

Legs fairly stout; unguis triheterohamate, outer hooks quite slender, distal end short, shaft flattened. Legs I (pl. 9, fig. 81) with tarsi bluntly conical; ventral face with three fairly long, ciliate bristles, a barbate one near distal end, distal bristles stout; dorsal face with four proximal bristles fairly closely inserted, second twice length of proximal and third, which are but slightly bent, fourth bristle quite long, reaching over hooks of unguis; bristles of distal half fairly long, depressed. Tibiae elongate triangular, the sides quite straight and uninterrupted; major bristle very long, a fairly long, fine, dorsal bristle inserted at distal edge; ventral face with a medium long, barbed bristle inserted at distal third of segment; an equally long lateral bristle inserted on transverse plane passing slightly distad of ventral bristle, but well up on side; a shorter mesal bristle inserted still more distad and low down on side. Genuals slightly curved; with a dorsal bristle inserted near distal end, reaching to insertion of lateral bristle of tibiae; two rather short ventral bristles, inserted one at center of segment, one near distal end. Femora with well-developed, pediceled knob at proximal end; dorsal face with two medium long bristles, the distal one inserted at center of dorsal edge, the proximal barbed, inserted near center of dorsal edge; ventral face with a short bristle

on a triangular point at proximal end; a short lateral bristle, inserted at center but close to ridge base.

Tibiae II with ventro-proximal flange well developed. Genuals quite short (pl. 9, fig. 82). Femora with well-developed keel on ventral edge, shallowly notched near distal end, and at insertion of distal bristle; ventro-proximal bristle close to proximal edge; dorsal edge with three bristles, distal one pauciciliate, short, inserted slightly less than length of genuals from distal edge, middle one longer, inserted closer to distal than distal is to distal edge, proximal one nearly as long as middle one, slightly ciliate, inserted rather close to proximal edge.

Legs III similar to those of *S. muiri* but bristles shorter. Genuals without bristles visible on ventral face, shorter than genuals II. Femora with two dorsal bristles inserted close to each other, a barbed one reaching to center of genual, the other fine and curved; ventral face with a wider flange, rounded at distal end, proximal half sloping gradually to body of segment. Coxae with a fairly long bristle inserted proximad of center.

Legs IV not notably differing from those of *S. muiri* but coxae with dorso-distal angle strongly rounded; ventral edge without slightest keel.

Dimensions: holotype broken beyond measurement, smaller than *S. muiri*.

Color, pale amber.

In length of body, pseudostigmatic organ head, and leg bristles, this species is more drawn out, more of a linear than the terricolous *S. muiri*.

Holotype: Oahu, west slope of hill at head of Manoa Valley, 1 specimen, from dead twig lying beneath grass, July 29, 1926, no. 262203, Jacot.

Scheloribates fimbriatus calcaratus, new subspecies (pl. 9, figs. 85-94).

Diagnosis

Body slender, sides nearly parallel; pteromorphae not invaginate postero-laterad of pseudostigmata; cephaloprothorax bristles ciliate; pseudostigmatic organs with long pedicel gracefully curved upward and backward, with several cilia or bristles on its antero-lateral edge near head, which is quite slender (pl. 9, figs. 87, 92-94), furnished with similar cilia or bristles and a much longer one at distal end, a few small "oil-globules" sometimes visible (pl. 9, fig. 93, foreshortened); sternum slender; bristles of genital covers close to lateral edge; parasternal punctures midway between apertures.

Description

Cephaloprothorax tapering regularly, sides, seen from above, barely interrupted by rim of lamello-rostral ridges, projecting well beyond lamellae; interlamellar area tapering regularly (translamellar line not developed); lamellae, seen from above, slender, slightly twisted, so as to present an undulate outline, tapering at distal end so that sides of cephaloprothorax are broadly visible laterad of them (only narrowly so otherwise), seen from side: broad at base, with slender distal end (pl. 9, fig. 87). Plate 9, figure 89, is as seen somewhat from side, looking down on the edge; lamello-rostral ridges, seen from side, incurved (pl. 9, figs. 87, 90); areae porosae nearly as large as aperture of pseudostigmata, oval-triangular, touching lamellae; tectopedia I (?) indicated by a slight, sigmoid, dark line (pl. 9, figs. 87, 90); tectopedia II quite distinct, undulate, with a conspicuous bristle dorsad of its proximal end (pl. 9, fig. 87); bristles and pseudostigmatic organs described under diagnosis; rim of pseudostigmata projecting beyond lamellae and pteromorphae for its entire length (pl. 9, fig. 88), lateral corner prominent, somewhat rounded.

Notogaster (pl. 9, figs. 85-88), seen from above, almost parallel-sided, anterior edge bowed considerably onto cephaloprothorax; rather blunt behind. Plate 9, figure 88 indicates by a broken line the appearance of the posterior end of a specimen more tilted than usual and therefore the necessity of studying, when possible, more than one specimen to determine length and shape. Seen from side, flattened on anterior two-thirds,

with angular hump at juncture of anterior and posterior slopes. Plate 9, figure 85 shows a specimen with notogaster fully elevated. The upper black line at posterior end forms lower rim of notogaster, the lower black line is the upper rim of ventral plate, these connected by a curtain of thin skin and overlap along middle of abdomen. In plate 9, figure 85 note also the anal cover retractor, indicated by broken lines. This muscle may serve to draw together the notogaster and ventral plate, as well as to close tight the covers. Plate 9, figure 86, shows the notogaster closely drawn down, widely overlapping the ventral plate and thus almost touching anal covers. Note that the lower edge of the notogaster (as in most of the pterogasterines) is band-like and the pteromorphae are attached to the upper edge of this band. In plate 9, figure 87, the notogaster is half drawn down. The postanal bristles are thus seen to be instrumental in registering detraction of the notogaster, and it is not unless they become unusually long that they become postero-tactile in function. Areae porosae adalares small, oval, as seen from above, with vermiform appendage, distant from edge of pteromorphae, a pair low down on sides, not distinguishable from side view; pseudoforamina as in plate 9, figures 85-88; pseudofissurae rather short, midway between adalar and lateral areae porosae; pseudoforamina (punctures) on pteromorphae as in plate 9, figure 88; pteromorphae small for the genus, not extending as far down on sides as usual (pl. 9, fig. 87), not extending forward at anterior edge (pl. 9, fig. 88), undulate behind anterior angle.

Ventral plate (pl. 9, figs. 87, 88) quite slender along anterior half; anal aperture fairly close to posterior end, sides parallel, slightly curved, anterior edge similarly curved, corners well rounded, cover bristles, as seen from above, equally spaced with anterior and posterior edges, equally spaced from mesal edge; mesal pair of postanal bristles close to aperture and close to sides; lateral pair on transverse plane passing posterior to posterior cover bristles; preanal bristles fairly close to aperture, opposite center of covers; paramesial bristles halfway between apertures, as remote as sides of genital aperture. Genital aperture with anterior edge sloping far back, longer than lateral edge, cover bristles close to lateral edge, fairly closely grouped in anterior and posterior pairs; aperture frame fairly wide; sternum slender, posterior sternal bristles on frame, others off, the anterior pair most remote; apodemata much more slender than furculum tongues; apodemata I with posteriorly directed process well developed (pl. 9, figs. 88, 91); tectopedia II undulate, contracted along anterior half, distal end slender, bristle inserted slightly distad of middle; tectopedia III with minute posterior point and very much developed anterior horn with its lateral edge convex; camerostome slender.

Legs not unusually specialized; unguis triheterohamate, middle hook neatly rounded, outer ones very slender. Legs I (pl. 9, fig. 90) similar to *S. muiri* but most bristles shorter. Tarsi with dorsal bristle three straight, stout, blunt. Tibiae with premajor bristle fairly long. Femora with a fine, ventro-proximal bristle inserted on proximal corner. Legs II with ventro-proximal angle of tibiae oblique. Femoral flange straight, not bowed, along distal edge; mid-dorsal bristle heavy, barbed. Legs III with flange of femora broader and more extensive than in femora IV. Legs IV with ventro-distal bristle of tibiae shorter; major bristle shorter. Dorsal bristle of femora inserted at center of segment or slightly distad of center.

Dimensions: minimum, average of five males and females, and maximum are given in table under the next species. A female is almost as small as the smallest male. A male is almost as large as the largest female secured. From the table of measurements it will be seen that this species is consistently smaller than *S. muiri*.

Color, reddish amber, sometimes pale honey yellow.

Cotypes: Oahu, 16 specimens, from soil samples, canefields, no. 281v02; Experiment Station, Hawaiian Sugar Planters' Association, specimen from soil taken July 26, 1926, no. 261801, Van Zwaluwenburg. Like *S. muiri*, a soil-dweller.

This terricolous, much smaller, slender species with very striking pseudostigmatic organs, was originally found with *Hydracarina* on the under face of a stone in a rapid flowing spring at the foot of the Mogul-tau Range (southwestern outpost of Talass-Alatau Mts.) about 100 kilometers south of Tashkent, Turkestan.

Since having received the holotype from its authority (53), I find that the Hawaiian species differs in enough characteristics as to warrant its recognition as a subspecies. Due to the holotype's having been mounted in "Berlese's Liqu. de Faure" the cilia of the cephaloprothoracic bristles and pseudostigmatic organs are barely visible. The latter seem identical. The adalar areae porosae of the species are very narrow, grub-like, parallel to longitudinal plane of body; the pseudofissurae are longer; the mesonotic areae porosae are slightly more approximate than the adalar and similar but shorter, the posterior mesonotic are similar to the mesonotic, and quite near posterior border of notogaster. The venter is identical as to anal area but resembles *Scheloribates oahuensis* as to sternal and genital area. *Scheloribates fimbriatus* differs from both in having the middle pair of sternal bristles on a triangular spur of the sternum, thus setting them out beyond the sternal bar. In *oahuensis* they are nearly as approximate as the posterior sternal pair. In *Scheloribates fimbriatus calcaratus* they are as remote but over no spur. The genital cover bristles are situated like those of *Sch. oahuensis* but the aperture has the shape of *Sch. fimbriatus calcaratus*. The apodemata are those of *Sch. oahuensis* but the posterior process on apodemata I is longer and more pointed in *Sch. fimbriatus*. Tectopodia III are almost truncate, only slightly oblique, with almost no prominence to posterior angles, certainly no point. Thus *Scheloribates fimbriatus calcaratus* seems to be intermediate between *Sch. fimbriatus* and *Sch. oahuensis*. In general shape and in greatest number of points, *Sch. fimbriatus* resembles the subspecies *calcaratus*, but it has striking resemblance to *Sch. oahuensis* in sternal and genital area. In general shape and in greatest number of points *Scheloribates fimbriatus calcaratus* resembles *Sch. fimbriatus* but differs in its unique sternal and genital area, the three striking differences being the marginal position of the genital cover bristles, the lack of triangular spurs under middle pair of sternal bristles, and the long process (or spur) running posteriad of mesal end of apodemata I, whence the subspecific name. The lamellae and areae porosae are also different, as already pointed out. From the table of measurements under the next species it will be seen that the species is slightly larger than the subspecies but is relatively more slender. Furthermore, the genital and anal apertures seem to be exactly as broad as long. In my opinion, neither is, taken as a whole, more primitive than the other, neither is derived from the other. Is the "parent" of both in the Indo-Malayan region?

The holotype which has very kindly been loaned to me by Dr. Sig Thor is a female bearing one huge egg which takes up all the space on one side ever occupied by eggs.

Scheloribates fimbriatus javensis (54a, p. 273) differs in having different pseudostigmatic organs, buttresses running mesad from anterior end of lamellae, and larger size (510-560 μ). No notogastral porose areas are figured or mentioned.

According to the law that subspecies become smaller in proportion to their distance from the parent form, or place of origin, *Scheloribates fimbriatus javensis* would be the parent form, *Sch. fimbriatus* having migrated northward and *Sch. fimbriatus calcaratus* eastward.

Genus STYLORIBATES, new genus

Similar to *Protoschelobates* but palps so lengthened as to reach anterior edge of camerostome, tipped by a translucent, hook-like style which projects beyond anterior rim of rostrum as two glass-like stylets; pteromorphae drawn out ventrally to a blunt point; furculum entirely lacking; rostrum broad, blunt; tectopodia I developed as slight ridges; apodemata IV anteriorly bent so as nearly to touch apodemata II-III; articulation head of femora II at right angles to body of segment (pl. 10, fig. 102).

Genotype, *Styloribates pectinatus*, new species.

***Styloribates pectinatus*, new species (pl. 10, figs. 95-102).**

Diagnosis

Cephaloprothorax, seen from above, broad, visible beyond lamellae, bristles sparsely barbed; pseudostigmatic organ (pl. 10, fig. 98) long, compressed, gracefully arched, sickle-like (without handle), outer edge incised-laciniate, distal end pointed (pl. 10, fig. 98); abdomen neatly rounded behind; mesal pair of postanal bristles long, projecting well beyond edge of notogaster, inserted just mesad of sides of aperture, outer pair minute, remote, anterior to transverse plane of posterior cover bristles; genital cover punctures on longitudinal middle of covers.

Description

Cephaloprothorax, seen from above (pl. 10, fig. 95), much broader than long (using center of pseudostigmata rim as base line), projecting well beyond edge of lamellae, slightly undulate at sides, rostrum broadly rounded; seen from side (pl. 10, fig. 97) high, convex, bowed well up above lamellae, the rostrum forming a distinct but slight inflation; lamellae, seen from above: fairly broad, slightly twisted near proximal end, equally broad throughout except extreme tip, seen from side (pl. 10, fig. 97): quite broad at base, distal half slender; areae porosae very small, circular, touching lamellae; no evidence of interlamellar depressions (translamellar line); lamello-rostral ridges not at all developed; cross-hatched area of rostrum in plate 10, figure 97, represents an internal, chitinized plate to the proximal end of which the mandible elevator is attached; tectopodia I developed as slender ridges parallel with lamellae!; rostral bristles almost as long as lamellar, the basis not at all swollen; interlamellar about equally spaced from lamellae and notogaster; a fairly long fine bristle inserted above insertion of legs II (pl. 10, fig. 97); apodemata I pushing out sides of cephaloprothorax so as to make a distinct

angle (compare both sides of plate 10, figure 95); pseudostigmata projecting slightly beyond rim of notogaster; pseudostigmatic organs long (see extent, plate 10, figure 95).

Notogaster, seen from above (pl. 10, fig. 95) regularly and broadly rounded behind, anterior edge rather flattened, seen from side (pl. 10, fig. 97) gently convex, with peak of curve just behind middle; pteromorphae as long as broad (pl. 10, fig. 97), ventral edge pointed (see also upper side, plate 10, figure 95), with a distinct emargination laterad of pseudostigmata, posterior edge suddenly contracted (pl. 10, fig. 97); adalar areae porosae oval; posterior small, round; pseudoforamina and fissurae as in plate 10, figures 95 and 97.

Ventral plate (pl. 10, fig. 95) nearly as broad as notogaster; anal aperture quite close to posterior edge of plate (see also plate 10, figure 97), sides of aperture parallel, anterior and posterior edges equally curved making a very symmetrical design, aperture unusually long; covers with posterior edge highly developed to extend well into rim of aperture (pl. 10, fig. 96, where the stippled area is the retractor muscle); anterior pair of cover bristles as far from anterior edge as from lateral edge; posterior pair much nearer mesal edge, as far from posterior edge as from lateral edge; lateral pair of postanal bristles anterior to transverse plane of posterior pair of cover bristles; preanal bristles fairly close to aperture, slightly more approximate than mesal pair of postanals; paramesial bristles halfway between apertures, slightly more remote than sides of genital aperture. Genital aperture with anterior edge broadly rounded, aperture frame slender, cover bristles almost subequally spaced; apodemata IV short, mesal end curving towards apodemata II-III to which they are joined by a slightly thickened plate which extends to aperture frame, thus making this area much more rigid; no furculum or sternum; apodemata I quite short, mesal ends remote, with postero-laterally projecting spur; sternal punctures indistinct; tectopodia II slender, slightly concave at center; tectopodia III blunt, not emarginate; camerostome oval, broadest at sides of apodemata I.

Legs similar to those of *Protoschelobates* but flanges even less developed; unguis triheterohamate, the outer hooks very slender, with weakly developed hook and flattened shaft; ventro-distal bristles of all tarsi well developed, thick in center, slightly curved. Legs I (pl. 10, fig. 99) most specialized. Tarsi with dorso-distal brush composed of four bristles of which the proximal is fine, distally curved so as to cross third, inserted as far from proximal end as greatest width of segment; second bristle shorter, straight, depressed, inserted at foot of proximal; third longer than proximal, quite erect; fourth much stouter, almost spine-like, still longer, distally curved, to cross the shorter fifth which is inserted twice as far from fourth as fourth is from third; sixth and seventh similar to those in *Schelorbates*; ventral face with three specialized bristles, proximal long, barbed, inserted just distad of transverse plane of dorso-proximal, second specialized bristle shorter, barbed, third one quite long, with five well-spaced cilia; proximal of these is a short, fairly stout bristle not found in related genera!; at least one other bristle distad of the specialized; all these ventral bristles are subequally spaced; three lateral bristles of which the proximal is inserted on transverse plane of ventro-proximal. Tibiae almost oblong, with well-developed ventro-proximal angle, and well-developed major bristle nubbin, dorsal edge unusually wrinkled; major bristle quite long, equaling length of its tarsus and unguis; a fine premajor bristle; ventral edge with a barbed bristle surpassing insertion of ventro-proximal bristle of tarsus, inserted distad of center of segment; a nearly equally long lateral bristle, inserted nearer distal end of segment. Genuals quite long, more than half length of their tibia, dorsal edge also very wrinkled, ventral edge with distinct distal emargination; a long dorsal bristle extending nearly to insertion of major, inserted near distal edge; a much shorter, ventral bristle inserted close to distal edge. Femora unsymmetrically oval, without ventral keel; dorsal edge with two bristles, the proximal inserted at center of segment, the distal midway between distal edge and proximal bristle, slightly longer than the proximal; there seems to be a bristle insertion at base of articulation head.

Legs II shorter. Tarsi with dorso-proximal bristle slightly barbed, longest of dorsal brush, second and third stout, spine-like, slightly curved, subequal, closely spaced, fourth reaching to center of hook; ventral face similar to tarsi I but without extra, short proximal. Tibiae more regular, as broad at proximal as at distal end; ventral bristle quite long, barbed; major bristle quite long; lateral bristle barbed, inserted midway between major and ventral; a similar mesal bristle. Genuals stout, rather short; a long dorsal bristle inserted slightly distad of center, a short lateral or mesal one, inserted near distal edge. Femora (pl. 10, fig. 102) broad-oblong, the position of the articulation head is very unusual for this leg; the three dorsal bristles barbed; ventral face with slight flange which is drawn out into a point at distal corner; two ventral bristles, proximal medium long, fine, inserted close to pedicel, distal long, barbed, inserted one-third length of flange from distal end.

Legs III (pl. 10, fig. 100) similar to *Protoschelobates*. Tarsi with two fairly long dorsal bristles of subequal length, inserted fairly close together, the proximal inserted less than diameter of segment from proximal end; another pair, slightly shorter, inserted a little distad of center of segment, also the usual apical bristles; ventral face with a fairly long, barbed bristle inserted proximad of transverse plane of dorso-proximal bristle, with two shorter, long ciliate bristles, and with an equally long barbed bristle, the ciliate bristles more approximate than their distance from the barbed bristles. Tibiae short, claviform; with the usual bristles. Genuals stout, a medium long bristle inserted at center of dorsal face; a fine one on ventro-distal edge. Femora of usual shape; the dorsal bristle barely barbed; flange rather narrow, broadening distally to form a rounded corner; but one ventral bristle discernible in present material. Coxae of usual form, dorso-proximal area quite flattened to slightly concave; ventral edge thickened and produced under entire length of articulation head, the tip of this spur bearing a long, barbed bristle; proximal face also produced distally to cover top of articulation head. As the proximal end of the femur is produced proximally to broadly overlap the coxa, this joint is extremely well protected from attack even when bent so as to separate the joint considerably. A fine lateral bristle inserted just proximad of proximal end of articulation head.

Legs IV (pl. 10, fig. 97) very slender. Tarsi as usual but more slender, ventral bristles two and three barbed. Tibiae much more slender than usual; bristles arranged as usual but major appearing more remote from distal end by reason of slenderness of segment, extending (if bent forward) to end of tarsal hooks; a clear spot as figured in *Oppia ultraciliata* and related species, slightly proximad of center. Genuals as usual; dorsal bristle slightly distad of center. Femora with slender flange; a short ventro-distal bristle. Coxae with broad flange extending well beyond proximal edge of segment and well under body of femora as a pointed prow, bearing an extremely fine bristle inserted close to dorsal edge of flange; no others discernible.

Palp with proximal segment long, second and third segments together half as long, distal segment (pl. 10, fig. 101) with distal end bifurcate, dorsal prong shortest, bearing a curved, thickened style, ventral prong bearing two bristles directed towards the curved style. It is this style which projects beyond rim of rostrum and gives the genus its name.

Dimensions: the following table includes measurements of *Schelorbitates fimbriatus calcaratus* in the first three columns, and of *Schelorbitates fimbriatus* in the fourth. Of the two specimens of the present species the smaller is a male, the larger a female bearing at least four eggs. The last two columns present the measurements of these two specimens.

Total length of body.....	410	434	465	490*	620	535
Length, notogastral plate.....	305	327	335	373	480	340
Breadth, notogastral plate.....	245	268	300	310*	375	330
Length of pteromorphae.....	275	298	310	335	435	370
Interlamellar bristle span.....	55	57	60	67	110	100
Length, ventral plate (mesal).....	315	331	355	370	475	415
Camerostome to genital aperture.....	75	82	90	97	100	100
Length, genital aperture.....	48	49	52	60	60	55
Breadth, genital aperture.....	45	47	50	60	60	50
Genital aperture to anal aperture.....	100	103	105	105	165	130
Length, anal aperture.....	90	92	100	97	145	130
Breadth, anal aperture.....	80	83	90	97	125	110

* My measurements are 10 microns greater than those made by Thor.

Thus the species is large, with small genital aperture and a long anal aperture which, in the male, is as long as the interspace of the apertures.

Color: male amber yellow to tan yellow; female has parts of abdomen suffused with red.

Cotypes: Oahu, 2 specimens, from soil samples, cane fields, no. 281v03 (a, b), Van Zwaluwenburg.

Genus *XYLORIBATES* (30, p. 429)

Ceratozetini without translamellae; with pteromorphae confluent with body outline behind; tectopodia I invisible from above; lamellae distinct only at tip, the mesal edge confluent with surface of cephaloprothorax; with distinct cephaloprothoracic suture; abdomen as seen from above, oval, smooth.

Type, *Oribates lophothrichus* (5, p. 27, pl. 2, fig. 48).

Xyloribates pembertoni, new species (pl. 10, figs. 103-110).

Diagnosis

In comparison with the genotype, the Hawaiian species has shorter rostral bristles, stouter legs, tarsi with normal dorsal bristles. From *P. capucinus* (6, p. 2) which is "similar to *P. lophothrichus*," it differs in its narrower rostrum and non-clavate pseudostigmatic organs. It sounds as though *P. capucinus* might be related to the preceding, but Berlese's species are mostly nomina nuda. From *P. quadripilis* (9, p. 316) it differs in its more elongate abdomen, less conspicuous lamellae and shorter posterior bristles. In fact this latter species may not be a *Xyloribates*.

Description

Cephaloprothorax, as seen from above (pl. 10, fig. 103): fairly broad, as seen from side (pl. 10, fig. 104): conical, broad, barely convex, slightly undulate, lower edge thickened; rostrum, seen from side, pointed; lamellae barely distinguishable from above, seen from side, a slender, slightly undulate ridge, with a lanceolate, projecting wing rising from below the pointed apex (what appears as the apex from above), seen more from above, that is, looking diagonally down on the lamellae (pl. 10, fig. 105), the lamellae are seen to be cuneate blades with the usual channel along mesal edge and a transverse fold near base; tectopodia I developed as a slender, distally descending ridge (pl. 10, fig. 104), foreshortened in plate 10, figure 105, which also shows acetabulae I; rostral bristles short, fine; lamellar bristles medium long, curved (foreshortened in plate 10, figure 105, omitted in figure 104); interlamellar bristles lost in holotype, inserted nearer

to lamellae than to notogaster; pseudostigmata horizontal, with slender lip or sill along lower margin; pseudostigmatic organs setiform, more or less ciliate, 145 microns long.

Notogaster, as seen from above, slender, acute oval behind; pteromorphae similar to preceding species; adalar areae porosae small, circular; posterior bristles as in genotype. Ventral plate badly fractured; anal covers rather short, rather square, with posterior bristles closer to mesal edge than are anterior bristles, closer to posterior margin than anterior bristles are to anterior margin, as close to anterior bristles as anterior bristles are to anterior margin; genital aperture with sides moderately converging, anterior edge flatly rounded, posterior margin not emarginate, more flattened than anterior; cover bristles on longitudinal center, second pair as close to anterior pair as third pair are to posterior (1:2 = 3:4); aperture frame slender around anterior edge, broad at sides and behind; no sternal thickening; apodemata IV as long as apodemata II-III, their mesal ends almost touching; apodemata I very short, bent in center; second pair of sternal bristles posteriad of this bend; tectopodia II short, rather slender, lateral edge barely undulate; camerostome very broad.

Legs very broad and compressed, stoutly articulated; bristles well developed, the solitary unguis stout, well curved. Legs I (pl. 10, fig. 107) well compacted. Tarsi high, blunt, oblong, with short, triangular apex; ventral face with what appears to be a slight flange at proximal end, the ventro-proximal bristle medium long, barbed, inserted near apex of flange, second bristle shorter, barbed, third bristle the longest with four well-developed cilia (compare with plate 10, figure 99) bristles four and five as long as second; sigmoid bristle short, bristles two and three most remote; dorsal face strongly notched, with a stout, almost spine-like bristle inserted width of segment from proximal end, extending to tip of unguis hook when it is bent down against tarsus; proximal bristle shorter, finer, inserted close behind this stout, second dorsal; a short, fine bristle inserted fairly close behind dorso-proximal but a short distance down on side of segment; third dorsal bristle long, fine, recurved, inserted some distance distad of second, just distad of center of segment; two other shorter bristles, projecting beyond apex of hook when it is bent back against segment. Tibiae S-curved, proximal end quite broad, articulation head very short, shoulder long but not prominently projecting, no flange; major bristle nubbins very long, applied close to tarsus; major bristle surpassing tarsus, with two fairly long bristles inserted at its base, one of them probably being the dorso-lateral often found near base of nubbins; a fine, medium long, ventro-lateral bristle; a ventral bristle inserted at apex of ventral angle. Genuals stout, nearly as broad (high) as long, strongly curved (on ventral edge); with a long, curved bristle inserted close to dorso-distal edge; a fairly long, slightly barbed bristle inserted on ventral edge, more proximad than dorsal, both of them bent towards tibia. Femora including flange, oblong with dorso-proximal corner broadly rounded off; flange quite large, more than half length of segment, half as wide as segment at its distal end, overlapping genual; a short fine bristle inserted on proximal end of flange; two dorsal bristles, distal one quite depressed, reaching well over genual, inserted diameter of distal end of segment from distal end, proximal bristle longer, barbed, not reaching insertion of distal bristle, inserted a little proximad of center of segment. Coxae flattened, biscuit-like, against base of cephaloprothorax.

Legs II similar to legs I but tarsi shorter, with more diminutive terminal cone; a heavy spine-like bristle inserted at center of segment, and now become third by reason of complete dorsal position of dorso-lateral of legs I; proximal bristle of legs I similarly become second, quite stout; third bristle of legs I become fourth, inserted on dorso-distal angle, curving gracefully over and surpassing tip of unguis hook; ventral face with second bristle finely ciliate, ventro-proximal coarsely barbed. Tibiae less broad (high), without major bristle nubbins, though bristle is quite long. Femora (pl. 10, fig. 109) long, twisted, with a deep invagination at dorso-proximal area, forming a sharp dorsal angle, ventral edge of pedicel strongly, transversely wrinkled; flange broad (deep), extending distad well over genual, seemingly twisted over on itself.

Legs III (pl. 10, fig. 110) short, stout, though not as highly differentiated as legs I and II. Tarsi conical; dorsal bristles subequal in length, stout, barely longer than diameter of segment, proximal inserted the diameter of segment from proximal end; ventral face with apparently three bristles; proximal a pair, as long as dorsal, short ciliate to barbed, inserted on transverse plane of first dorsal; second ventral shorter, coarsely few-barbed; third longer, dorsally curved. Tibiae gourd-like, with pedicel stout, as long as body, body nearly as broad as long, a slight flange filling angle between pedicel and body; dorsal bristle short, as long as dorsal of tarsus, inserted near center of body of segment; two bristle insertions on same transverse plane as dorsal bristle. Genuals short, stout, curved; a barbed, dorsal bristle inserted a little distad of center of segment. Femora as broad as long, the dorsal outline being very bowed; flange broad at distal end, slender at proximal, broadly overlapping genual and tibia when these are pressed to femora; dorsal bristle inserted at center of segment, surpassing segment, stout, faintly barbed, the longest bristle of this leg; a fine bristle inserted at center of flange. Coxae much higher than long, casque-like, with dorso-proximal angle reduced (oblique); no flange, except possibly a very slight one under ventro-proximal angle; a fairly long, fine bristle inserted at center of ventral edge.

Legs IV, presumably similar to legs III; tarsi and tibiae missing. Femora (pl. 10, fig. 108) as broad as long, rather square, flange nearly a third the width of the segment, its ventral edge bowed, a shallow emargination on ventro-distal edge, dorso-proximal of which is a bristle insertion; dorsal bristle as long as diameter of body of segment, somewhat stout, inserted at dorso-distal angle (i.e., at distal fourth of segment). Coxae similar to those of legs III, but longer, a well-developed flange on ventral face extending beyond body of segment in both directions, broadest at distal end; a bristle insertion at distal end on center of flange. Legs III and IV detached, and identified by inference.

Palp (pl. 10, fig. 106) with basal segment slightly more than twice as long as wide; ventral face with a five-ciliate, fairly-long-ciliate bristle, inserted just proximad of center I; segments 2 and 3 considerably shorter than broad, each with a bristle nearly as long as proximal segment, inserted close to dorso-distal edge; distal segment Y-shaped, with one arm narrow, conical, the other broad, rather square, truncate; shorter arm bearing curved, hyaline style, as in preceding species, and a curved, subtending bristle inserted at its base; bristles of square arm not discernible.

Dimensions: specimen too fractured for mensuration.

Color, honey yellow.

Holotype: Hawaii, Honokaa, 1 specimen, from "within minute fresh hole in tender cane root, six inches in depth," December 12, 1922, no CGES16P, C. E. Pemberton.

The stout, blunt cephaloprothorax and broad, short, highly specialized legs bring to mind the mole and mole-cricket, but this species seems to burrow in plant tissue. Careful experimental work should be carried on with this species in order to determine if it is itself the burrower. If so it is a rare example of an injurious moss mite.

Genus HUMEROBATES (52, p. 11)

Ceratozetini without distinct translamella; pteromorphae more or less confluent with body outline behind; tectopedia I distinctly visible from above, extending beyond lamellae as a cusp which subtends rostral bristle; lamellae well defined, slender blades not much more than half length of cephaloprothorax, joined to edge of camerostome by distinct lamello-rostral ridge.

Type, *Notaspis humeralis* (19, p. 92, pl. 4, figs. 5, B).

The status of this species, detailed description, and figures, have already been presented (32a).

***Humerobates humeralis perkinsi*, new subspecies.**

Body plates very heavily chitinized or darkly colored, chestnut brown; transverse ribs on the antero-proximal area of the pteromorphae quite dense, thick, standing out as pleats on the surface; notogaster nearly as broad as long, that is, abdomen relatively broader than in the species, always broadly rounded behind; size much larger. In BBM 656P the lamellar trusses are much more developed, thus much approaching a trans-lamellar ridge. Careful study of the insertions of the bristles shows no differentiation which is not covered by the small amount of variation in the American subspecies or with the few European specimens mounted clearly enough to allow study of this feature. Anterior margin of anal aperture quite sloping, sides slightly more tapering.

Although this form is differentiated chiefly by characters covered by the one term, robustness, it is expressed in more ways than one and in definitely measurable terms. Just as *H. humeralis arborea* is clearly separated by being noticeably smaller, this geographical scion is distinct by being larger.

Dimension in microns: the first column comprises measurements of the largest east American, the second column the largest Californian specimens, at hand, columns 3 to 5 present the dimensions of the smallest male, average of 6 females, and largest female of the Hawaiian material at hand.

Total length of body.....	705	770	920	990	1030
Length, notogastral plate	570	635	760	785	850
Breadth, notogastral plate	495	565	700	743	770
Interlamellar bristle span	100	110	128	131	133
Length, ventral plate (mesal).....	535	600	690	755	765
Camerostome to genital aperture.....	105	110	133	145	155
Length, genital aperture.....	90	93	103	119	123
Breadth, genital aperture.....	100	110	120	139	150
Genital aperture to anal aperture.....	175	220	230	253	260
Length, anal aperture.....	125	135	175	180	185
Breadth, anal aperture.....	145	150	195	212	225

Thirty-one European specimens from Breda, Holland, measure: total length of body, 800 (850) 925; breadth of notogaster 545 (605) 655.

Cotypes: 3 females (no eggs to 12 eggs), no. BBM531P, Perkins. Paratypes: 1 female (4 eggs), no. BBM656P; 1 female (3 eggs), no. BBM532P; Lanai, 2,000 feet, 1 male, January, 1894, no. BBM91P2; 1 female, no. BBM536P; Lanai, 3,000 feet, 1 female (at least 10 eggs), 1 male, January, 1894, no. BBM93P; Oahu, Olympus, 1 male, October 28, 1920, no. CGES12S, O. H. Swezey.

These specimens, with the exception of Swezey's, were called *Oribata globula* in the original Hawaiian record (45, p. 702). Some of the original material is before me. How Pearce could so erroneously have identified this material with such different pseudostigmatic organs, is difficult to understand.

ORIBATIDAE-GALUMNINAE (26, p. 277)

Oribatidae with lamellae and tectopodia 1 quite small to none; pteromorphae very large, extending downward to cover part of ventral plate and forward to cover part of cephaloprothorax; legs received in cupboards in the sides of the abdomen, entirely enclosed by the pteromorphae which are hinged to sides of abdomen.

Type, *Galumna* (21, p. 612).

The finding of a species with the lamellae of an Oribatellinae and pteromorphae which are very much like those of the Galumninae but not so extensive (54, p. 242) and of another species with lamellae very similar to *Achipteria* but the pteromorphae of the Galumninae (15, p. 262) might lead inexperienced systematists to doubt the value of these major groups. As before stated, the Galumninae are a group which have developed toward simplification about the cephaloprothorax, and, at the same time, development of pteromorphae. This bears no relation to the Oribatellinae which have specialized in development of cephaloprothorax armature, and concurrently, it would seem, pteromorphae also. In other words, I regard the development of pteromorphae in the Oribatellinae as a parallel development. Comparable to this is the development of the molars and the reduction of canines in both the Ungulates and Glires. Thus the genera *Cultrobates* and *Epactozetes* are Oribatellinae with well-developed to highly developed pteromorphae. They run into this family in the key (30, p. 427).

Due to misunderstanding on the part of some acarologists, a more detailed statement on the segregation of the genera *Galumna* and *Zetes* seems advisable. In 1914 (7) and again in 1919 (41) the absence of the abdomino-cephaloprothoracic suture was used as a subdivision of the genus *Galumna*. Although used (41) as a primary division, it did not seem a satisfactory character for such separation because some species are transitory, in that the suture is not always clearly and definitely or entirely absent. Evidently a character was desired whose development or differentiation had gone so far that all intermediate steps had been lost. Now, on the other hand, the absence of the abdomino-cephaloprothoracic suture is regarded as a character of fundamental importance, as its loss is the loss of the last evidence of segmentation on the dorsal aspect of this group of arthropods. I therefore used the first available group name *Zetes* for the more primitive species with the suture distinct and continuous or partially lost, or so much reduced as to make its visibility difficult, and the older term *Galumna* for those species in which the suture is entirely absent.

To one who does not have the developmental concept of life forms, but who wishes to arrange species in separate, distinct, not overlapping compartments, like the stamps in a postage stamp album, such a segregational char-

acter, no matter of how great evolutionary significance, is not only inconceivable but odious. It spoils his schematic ideas. He is unable to grasp this plasmatic concept. Yet it is easily adhered to if the following rule be applied. Species which are intermediate in character between a lower and a more highly developed group are placed in the lower group as not having attained the higher.

When life forms specialize along a definite line, this specialization is usually accompanied by specialization along minor lines. Thus one finds that, in general, species of the genus *Galumna* have more specialized pseudostigmatic organs and leg bristles than species of the genus *Zetes*. Other evidences of specialization are also evident, as acarologists will discover as they investigate the external morphology of these species with any degree of thoroughness. Nothing is gained by cataloging species which do not show this exact correlation of specialization except the reiteration of a well-known biological phenomenon.

A further word as to the type of *Zetes* seems necessary. There are still some workers who fail to realize that the types of Koch's genera are the outline figures (34) and not the colored illustrations or descriptions of species (33), according to Koch's own designation (34, vol. 3, foreword, last paragraph). This I repeat because the figure (33, fasc. 31:5) of *Zetes elimatus* (Koch's own correction for the etymologically incorrect *climatus*) is quite different from the type figure (34, pl. 11, fig. 55) and because the description of *Z. elimatus* (33) is a mixture of at least two species. For instance, it is correctly stated that there are but four bristles on the cephaloprothorax (the interlamellar bristles being so minute as to have been overlooked), but incorrectly, for *Z. elimatus*, that there is no abdomino-cephaloprothoracic suture. This is figured in the type illustration. The type figure, wherein the pseudostigmatic organs are also more accurately figured for *Z. elimatus*, is alone entirely reliable. According to Oudemans *Z. elimatus* is widespread, and the largest species of northern Europe. (See 39, pl. 17, figs. 4-10; 41, p. 42, figs. 3-5.)

After a consideration of the characteristic lamello-rostral ridge of the genera *Schelorbates* and *Humerobates*, one is struck by the deviation encountered in the Galumninae, namely, the production of the lamellae backward to the second tectopedia, which is at the same time a more complete merging of the lamellae and tectopedia 1 into one continuous structure, a broad crescentic band on each side of the cephaloprothorax. It may for short be termed the lamello-tectopedial band.

Species having a lamello-rostral ridge would not, conceivably, have the distal end of the lamellae approximated on the mesal plane, as has been found in *Parakalumna* and *Edwardzetes* (15, p. 287). This character should, however, be expected in the genus *Protoschelobates*.

Of the following five species, two represent material labeled and reported as *Oribata alata* in 1910 (45). *G. alata*, a European species, does not occur in the Hawaiian islands unless very recently introduced. On the whole, the Galumninae, contrary to statements made by English acarologists (45, p. 703), are not widely distributed.

Genus ZETES (34, p. 99)

Galumninae with lamellae closely appressed to cephaloprothorax for most of their extent, fused to tectopodia I, produced to rim of tectopodia II; pteromorphae with ventral edge distinctly emarginate; abdomino-cephaloprothoracic suture distinct and entire to more or less interrupted or faint.

Type, *Zetes elimatus* (34, pl. 11, fig. 55).

If there is any external evidence of the abdomino-cephaloprothoracic suture the species is a *Zetes*.

Zetes australis pembertoni, new subspecies (pl. 11, figs. 111-117).

Diagnosis

Differs in its much greater width (0.52-0.56 by 0.63-0.7 mm.); pteromorphae also finely vermiculated; rostral bristles longer, rough; lamellar bristles much longer than width of lamellae, subequal to rostral; interlamellar bristles extremely small, barely discernible; pseudostigmatic organ head elongate, tapering very gradually into pedicel, barbed about distal edge; anterior areae porosae one-third size of adalar, the mesonotal elongate, especially when seen from side.

Description

Cephaloprothorax, as seen from above (pl. 11, fig. 111), broad, short, the sides making a conspicuous angle with anterior face, slightly convex, anterior face roughened by fine but deep-cut combing (pl. 11, fig. 111), the combing not extending onto the rostrum; seen from side high with steeply rising anterior outline, flattened above; rostrum small, barely projecting, indented (pl. 11, fig. 113), ventral edge contracted; lamello-tectopedial band rather broad, stout, prominently projecting (pl. 11, fig. 111), distal edge flat (straight) for a considerable length (pl. 11, fig. 113); rostral bristles roughish (barbulate), inserted anterior to vertical (transverse) plane of distal edge of lamello-tectopedial band, near rim of camerostome, on contracted portion and conforming to curvature of cephaloprothorax so that they are invisible from above; lamellar bristles equally long to barely longer, smooth, barely stout, inserted well back on lamello-tectopedial band (pl. 11, fig. 113), conforming to curve of cephaloprothorax, apices remote; interlamellar bristles inserted close to areae porosae, bristles extremely fine, if present; pseudostigmata not visible, organs fairly long, head merging into pedicel, cuneate, short ciliate along distal half (pl. 11, fig. 112, cephalic aspect).

Notogaster, seen from above (pl. 11, fig. 111); broad oval, flattened behind (pl. 11, fig. 114), anterior edge quite flat (rather straight); adalar areae porosae oval, three times size of the anterior; mesonotal elongate, especially as seen from the side; pseudofissurae laterad of mesonotal areae porosae, bent nearly at right angles; pseudoforamina as in plate 11, figure 111. I see two kinds, the smaller having a still smaller pseudoforamen attached to them. From this fact, I take them to be bristle insertions (compare 24, fig. 7), while the larger, single, less well defined pseudoforamina are distinct. This inference is substantiated by the similar doubleness of the interlamellar bristle inser-

tions. Thus one should be careful to distinguish, in the future, between pseudoforamina and bristle insertions, for the bristles disappear long before their insertions (see, for instance, condition in interlamellar bristles). Pteromorphae only shallowly emarginate, rayed with fine wavy lines, distal end with faint combing (pl. 11, fig. 111, lower pteromorpha); groove distinct, the sides thickened for a considerable distance on both sides, the anterior side widening to encircle a pseudoforamen (bristle insertion, according to *Galumna tantillum*); a short, diagonal pseudofissura close behind groove; anterior edge not thickened; no pivot point at anterior end of hinge, this area stoutly housed in notogaster.

Ventral plate (pl. 11, fig. 114) well developed at distal end, forming long tectopodia II which run well out under lamello-tectopedial band (pl. 11, fig. 113); anal aperture fairly distant from posterior edge, strongly tapering at anterior end, posterior edge broadly rounded so as to bring their angle with sides near middle of aperture; cover bristles fairly close to mesal edge, anterior pair slightly closer to anterior edge than posterior pair are to posterior edge (figure shows an eccentric anterior pair, the upper side the normal condition), posterior pair twice as far from anterior pair as from posterior edge; postanal bristles approximate, mesal pair more remote than posterior pair of cover bristles, more approximate than twice distance between lateral and mesal pairs, lateral pair just laterad of center of covers; paranal bristles, which seem to be the preanal of preceding groups, slightly posterior to center of sides; fissurae anterior to bristles, strongly converging towards anterior end of aperture; paramesial bristles slightly posterior to transverse plane of posterior edge of genital aperture, as remote as sides of anal aperture. Genital aperture strongly tapering at posterior end though not as tapering as anal aperture, anterior edge not strongly bowed, angles distinct, cover bristles subequally spaced, posterior pair tangent to posterior edge, anterior pair very close to anterior edge, anterior three pairs laterad of longitudinal center of covers; two additional pairs close to antero-mesal edge; sternum very broad, leaving very small parasterna; sternal bristles remote, laterad of center of genital covers; camerostome broad, strongly tapering so as to be quite narrow at anterior end, being much encroached on by constricted cephaloprothoracic rim (pl. 11, fig. 114).

Legs with triheterohamate unguis, the outer hooks with straight or flattened shafts (pl. 11, fig. 117), the middle hook thus made shortest (pl. 11, fig. 115). Legs I (pl. 11, fig. 113) shorter than legs IV. Tarsi cuneate; dorsal face with proximal bristle inserted on proximal angle, fairly long, straight, second bristle longer, considerably curved, inserted as near proximal bristle as latter is from tibia, third bristle inserted twice that distance from second, a little more than half its length, barbed, fourth bristle similar to third, inserted midway between apex of tarsus and third bristle, fifth bristle smooth, slightly longer, inserted close to fourth; ventral face bristles fairly long, with seven to eight cilia, all three paired, proximal inserted distad of transverse plane of dorso-proximal, second similar, inserted on transverse plane midway between second and third dorsal bristles, third shorter, inserted on transverse plane of fourth dorsal; distal bristle short; sigmoid bristle fairly well developed; a medium long, fine lateral bristle inserted on transverse plane of second ventral; a medium long mesal bristle inserted on transverse plane of second dorsal. Tibiae gourd-like, the pedicel quite distinct and slightly shorter than body of segment; major bristle very long, exceeding apex of unguis (if laid along leg), inserted at center of body of segment. It should be noted that there is no development of a nubbin when the major bristle is in this central position. One may therefore infer that the nubbin is not the result of the great development of the bristle but of its distal position. Thus the more it migrates over the tarsus, the larger or more prominent it becomes. A bristle inserted distad of major bristle, as long as dorso-proximal of their tarsus (pl. 11, fig. 113); a mesal bristle inserted on transverse plane of major and near it, smooth, fine, slightly longer than dorso-distal; ventral face with two barbed bristles, the distal short, inserted close to distal edge, the proximal twice as long, curved distad, inserted on transverse diameter of major bristle. Genuals nearly as

long as their tibiae, rather cylindrical, except contracted and bent proximal end; dorsal face with a short, barbed bristle inserted slightly distad of center; a similar finer, shorter bristle inserted near distal edge of ventral face; a long, fine lateral bristle inserted close to distal edge reaches nearly to distal end of tibia, crossing major bristle. Femora compressed, fusiform, pedicel distinct, short; dorsal edge of body of segment with a medium long, barbed bristle inserted at center, a pair of short, barbed bristles inserted near distal edge; ventral face with a medium long, smooth, stiff bristle inserted slightly distad of transverse plane of middle dorsal.

Legs II (pl. 11, fig. 116) similar to legs I but shorter. Tarsi with shorter bristles; dorsal bristles more equally spaced, more equal in length, only the third one barbed; ventral face bristles with more numerous, more closely crowded cilia, the proximal bristle the longest. Tibiae less swollen; major bristle shorter (actually and relatively); premajor bristle fairly long, barbed; ventro-distal bristle relatively longer; lateral bristle inserted close to distal edge of segment. Genuals more curved, almost twisted; bristles much longer, the barbs coarse, widely spaced. Femora relatively longer, more twisted; bristles more proximally inserted and correspondingly longer, so that the slightly roughened ventro-proximal is inserted near pedicel; a very fine smooth ventro-distal bristle inserted near distal edge of segment; dorso-distal smooth.

Legs IV (pl. 11, fig. 117) quite slender. Tarsi as usual; an additional bristle near insertion of ventro-proximal; bristles of ventral face ciliate. Tibiae with a short, fine major bristle which extends only to insertion of dorso-proximal (typical of *Zetes*); ventral face with two ciliate bristles, distal one inserted close to distal edge; a medium long, lateral bristle inserted on transverse plane of insertion of proximal ciliate bristle. Genuals as long as bare portion of their tibiae; a pair of somewhat short, coarsely barbed bristles inserted on dorsal face somewhat remote from distal edge. Femora as usual, no flange; lateral bristle faintly barbed, inserted much nearer ventral than distal edge (in the figure the distal half of this segment is foreshortened so that the two bristles appear more distal than they are). Coxae normal, somewhat oblique; with a long fine bristle inserted on ventral edge near distal end; articulation shaft much produced.

Legs III similar but tarsi with dorsal face bristles quite stout, especially the proximal, more proximally inserted; ventral face bristles more distally inserted, the proximal more distal than the dorso-proximal; a fine lateral bristle inserted near proximal end of segment. Tibiae with major bristle not reaching to end of its tarsus; lateral bristle on transverse plane of major and of ventro-proximal. Genuals very short; a fine, medium long bristle inserted near distal end of dorsal face; a short, stout bristle inserted on distal edge of ventral face. Femora conical; dorsal bristle slightly barbed, inserted near dorso-proximal angle; ventral face with a very slight flange, the bristle long, fine, inserted near center of segment. Coxae quite high, ventral edge with distinct, winglike flange with anteriorly directed spur; a fairly long, finely barbed bristle inserted near base of spur.

Thus this species is typical *Zetes* by its clearly defined dorsal suture, as well as by its slender pseudostigmatic organ head and short posterior major bristles. As a species, it is easily distinguished from all others by its short, rugose rostrum, constricted camerostome rim, and consequently hidden rostral bristles and negative interlamellar bristles.

Dimensions: too few specimens mounted so as to yield measurements in usable form. As Dr. Sellnick has 60 specimens, I leave this information to be furnished by him from South American (type) material.

Color, amber red, pteromorphae more brownish.

Cotypes: Hawaii, Honokaa, 4 females (no eggs to 10 eggs), from cane stool underground, July 7, 1922, no. CGES03P; 1 specimen, under cane leaf sheath, July 6, 1922, no. CGES04P; 1 female, ant's nest, July 10, 1922, no.

CGES02P; C. E. Pemberton. Oahu, Manoa Valley, hillside behind Castle home, 7 specimens, under surface of stones, July 27, 1926, no. 261902, Jacot. Lanai, altitude 2,000 feet, 1 female, 1+2, 1894, no. BBM79P, Perkins.

Zetes fordi, new species (pl. 11, figs. 118-120).

Small (0.36 by 0.49 mm.), reddish amber; cephaloprothorax conical, tapering into bluntly pointed rostrum; rostral bristles fairly long, stout, barbed; lamellar bristles similar, longer, long-barbed, included; lamello-tectopedial band fairly heavy, the apex conspicuously projecting; interlamellar bristles still longer, though not unusually long, stout, barbed, remote; pseudostigmatic organs long, recurved at base of head, which is long, slender, unilateral, conspicuously dentate-barbed along anterior edge (pl. 11, fig. 119). Pteromorphae with notch well developed, anterior edge not thickened, with pivot at anterior end of hinge; groove well developed, proximal end very narrow, sides broad, the bristle insertion distinct; abdomino-cephaloprothoracic suture weak, almost incomplete; notogaster broad; anterior areae porosae fairly large, elongate oval, rather narrow, overlapping lamello-tectopedial band; adalar pear-shaped to more elongate, broadest next to pteromorphae; mesonotal circular, fairly large; mesal puncture present. Genital covers with the four longitudinal bristle insertions in center except posterior pair, which are close to postero-mesal corner, third and fourth pair closest, second and third most distant; gular bristles fairly approximate; sternum very broad, leaving small parasternal lacunae; paramesial punctures more approximate than diameter of anal aperture, fairly close to genital aperture; paranal bristle punctures two pairs, one at center of sides of aperture, on frame, the lateral pair postero-laterad of the mesal pair; postanal bristles short, lateral pair on line of sides of aperture, mesal pair opposite center of covers; aperture angular, posterior margin very oblique, sides strongly tapering; cover bristles remote from mesal edge, anterior pair in center of cover and closer to anterior edge, posterior pair closer to mesal than to lateral or posterior edge.

Legs triheterohamate. Tarsi I (pl. 11, fig. 120) cuneiform; dorsal face with proximal bristle medium long, inserted unusually close to proximal end of segment, second bristle unusually long, extending to end of unguis if laid down flat, inserted quite close to proximal, third bristle medium long, barbed; remaining dorsal bristles as usual; ventral face bristles with seven to eight cilia. Tibiae I nearly half length of their tarsi, gourd-like, with short, stout pedicel; major bristle very long, much exceeding unguis, inserted at center or even behind center of body of segment, with a medium long bristle nearly halfway between it and distal end of segment, other bristles much as usual, but lateral bristle far down on sides. Genuals as long as their tibiae; dorsal bristle quite long, crossing major bristle of tibia, inserted a little distance from distal end; ventral bristle barbed, longer than in preceding species, inserted on transverse plane slightly proximad of dorsal; there seems also to be a lateral or mesal bristle inserted on same transverse plane. Femora very similar to preceding species.

Major bristles of legs III and IV similar to those of *Z. australis*.

Cotypes: Oahu, Manoa Valley, hillside behind Castle home, 1 female, 2 males, under surface of stones, July 27, 1926, no. 261903, Jacot.

This species in its leg armature is quite similar to *Z. australis*, but it differs in many characters of the body proper. It is unquestionably a *Zetes*, for though the suture is very faint, it is not absent. Furthermore, the major bristle of legs III and IV is not unusually long. The pseudostigmatic organs are tending toward specialization away from the typical clavate form. Finally, tibia I is primitive in the position of the major bristle.

Named in honor of Mr. Alexander Hume Ford, whose kind hospitality made possible the securing of additional material from Oahu.

Zetes bryani, new species (pl. 13, figs. 126-127).

Medium large (0.47 by 0.6 mm.); cephaloprothorax elongate triangular with pointed rostrum; rostral bristles long, curved, smooth; lamellar bristles similar, strikingly long, nearly reaching tips of rostral, excluded but on rim of a secondary swelling!; lamello-tectopedial band prominently protruding from sides of cephaloprothorax, reaching dorso-posteriorly nearly to insertion of interlamellar bristles, these bristles lacking in the one specimen; pseudostigmatic organs somewhat short, with heavily clubbed head and rounded end (pl. 13, fig. 126). Pteromorphae strongly emarginate, post-marginal area somewhat evaginate, veins few, indistinct, bristle insertion very prominent, as also the "channel" leading to it, pivot its own length distant from antero-dorsal angle of pteromorphae, pseudofissurae rather long, slightly curved; anterior areae porosae elongate, overlapping lamello-tectopedial band; adalar peg-like with blunt head close to pteromorphae; mesonotal small, round; below them pseudofissurae, then still farther ventrad large pseudoforamen, behind these the outer mesonotal areae porosae; mesal pseudoforamen prominent. Genital covers (pl. 13, fig. 127) each with two bristles on anterior edge, the four longitudinal bristles staggered along center, the anterior pair on center near edge, posterior pair almost on margin, much nearer mesal than lateral edges, second pair likewise, third pair slightly laterad of center, first and second closest, second and third most distant; gular bristles approximate; sternal area very broad, the parasternal lacunae quite small; paramesial bristles similar to those of preceding species; paranal bristles anterior to pseudofissurae, slightly anterior to center of sides of aperture; lateral pair of postanal bristles on line of sides, mesal pair nearer center of aperture than to lateral pair; anal aperture with corners well-rounded; anterior pair of cover bristles inserted twice as far from mesal as from anterior and lateral margins of covers; posterior pair slightly more approximate, slightly nearer mesal than posterior edge, about as remote as mesal pair of postanals.

Legs with triheterohamate unguis but lateral hooks almost as broad as middle one, and with long, flat shaft. Bristles in general, shorter than in *Z. fordi*. Legs I similar to those of preceding species (pl. 11, fig. 120) but tarsus with ventral bristles paucipectinate (stout ciliate), second and third inserted quite close to each other; dorso-proximal inserted a distance slightly less than diameter of segment at this point from proximal end, second dorsal not much longer than proximal, third dorsal inserted slightly proximad of transverse plane of proximal smooth bristle of ventral face; in the broad area between dorsal bristles two and three appears a lateral bristle inserted slightly proximad of transverse plane of second dorsal; a mesal bristle inserted slightly distad of transverse plane of third ciliate bristle; another lateral bristle inserted on same transverse plane; all these bristles rather long. Tibiae more conical, pedicel more confluent with head; major bristle shorter than *Z. fordi*; lateral bristle inserted proximad of major; of the ventral bristles the longer is barbed, the shorter pectinate, inserted nearly on same transverse plane and close together. Genuals noticeably shorter than their tibiae; there seems to be a fine dorsal bristle inserted diameter of genual from distal end. Femora very similar; dorso-proximal bristle as long as genual, weakly ciliate; an insertion on side slightly distad of dorso-proximal, but below center.

Legs IV differ from those of *Z. australis* in that tarsus has ventral bristles coarsely barbed, the distal one paired; dorso-distal bristle single. Tibiae with major bristle equal to length of genual, i.e., quite short, inserted nearly diameter of segment from distal end of segment; a stout, straight, barbed, medium long dorsal bristle inserted slightly more proximad than major bristle; on same transverse plane and by its side a similar curved bristle; dorso-distal bristle finely barbed. Genuals long, two-thirds length of their tibia, with a medium long, curved, barbed bristle inserted greatest diameter of

segment from distal end of segment on dorsal face (there seems to be an insertion close to distal end of dorsal face). Femora very broad, ventro-distal region quite full and rounded; dorsal bristle barbed, inserted distad of center; ventral bristle inserted on same transverse plane; there seems to be a very slight flange.

Legs III similar. Genua with two bristles inserted on distal third. Femora with ventro-distal area quite full, with very slight flange; dorsal bristle slightly barbed; ventral bristle as long as segment, coarsely barbed to subciliate on two sides, inserted distad of center. Coxae with equally long, fine bristle inserted just proximad of the very short ventro-distal spur.

This species is unquestionably a *Zetes* because the abdomino-cephaloprothoracic suture is still present even though poorly developed. The pseudostigmatic organ head and the major bristles are quite typical for the genus. Differs from all species known to me by its pseudostigmatic organ, the zigzag insertion of the genital cover bristles, small size, prominence of lamello-tectopedial band, and subsidiary mesad reduplication.

Holotype: Peale Island of Wake Island, one female with 4 eggs, July 31, 1923, no. BBM04T, E. H. Bryan, Jr., Tanager Expedition.

Under no. BBM109P I find a specimen with very slender (lanceolate-oval) pseudostigmatic organ head.

Genus GALUMNA (21, p. 216)

Galumninae with lamellae closely appressed to cephaloprothorax for most of their extent, fused to tectopodia I, produced to rim of tectopodia II; pteromorphae with ventral edge distinctly emarginate to fit over tectopodia II; abdomino-cephaloprothoracic suture completely lacking, at least between mandible retractor muscle scars.

Type, *Notaspis alata* (19, p. 92, pl. 4, fig. 6).

Galumna swezeyi (27, p. 214) (pl. 12, figs. 121-125).

Diagnosis

Size large (to 0.95 mm. long, thus the largest species of its subfamily now known from these islands), broad, dark (deep horse-chestnut); with apicule on rostrum; prominent lamello-tectopedial band; rostral and lamellar bristles long; pseudostigmatic organs short, with oblong-oval head; adalar areae porosae extending onto pteromorphae; a large mesal pseudoforamen.

Description

Cephaloprothorax much broader than long, as seen from above (pl. 12, fig. 121), anterior outline rendered irregular by projection of unusually thickened lamello-tectopedial bands which project as swollen bands appressed to surface, and by slightly projecting rostrum terminated by a small apicule (actually a short vertical carina); rostral bristles long, stiff, arched, stout, faintly barbed on outer edge, inserted near edge of lamello-tectopedial band, nearly touching each other beyond rostrum; lamellar bristles stout, very long, strongly barbed on outer edge (more so in some individuals than in others), almost touching each other beyond rostral, inserted well within border of lamellae (included); interlamellar bristles long, stout, erect, therefore appearing foreshortened in figure, barbed, inserted at edge of lamello-tectopedial band, that is, unusually remote from each other; pseudostigmata low down on sides, remote from pteromorphae; pseudostigmatic organs with elongate oval to obovate head, shaft very short, fine.

Abdomen very broad (pl. 12, fig. 121); due to unusual length of pteromorphae the region behind them is unusually short, giving an outline, as seen from above, of a widely crescentic span with flattened center; pteromorphae (pl. 12, fig. 125) prominently emarginate, rounded at both ends, sides undulate, groove wide, partially filled by adalar areae porosae! with a pseudoforamen at end of minor groove, pseudofissurae short (pl. 12, fig. 125), distinct, nervures few, fine; anterior areae porosae short, oval, masked by underlying opisthophragmatic processes (mandible retractor muscle scars), postero-mesad of interlamellar bristles; adalar ovate, masked by leg cupboards, with two pseudoforamina posterior to them; mesonotal large, round-oval, far down on sides, on longitudinal plane of adalar, with two pseudoforamina postero-laterad; mesal pore large, far behind transverse plane of mesonotal areae porosae; four pseudoforamina forming a trapezoid on middle of back (pl. 12, fig. 121), the anterior two on transverse plane slightly posteriad of adalar areae porosae.

Ventral plate broadly emarginate to receive camerostome; gular bristles approximate, long; sternal bristles three pairs (pl. 12, fig. 124); genital covers each with a row of six bristles, all on the same longitudinal plane! which is unusually distant from mesal edge, arranged as three pairs, anterior two close together and close to anterior edge, posterior two twice as distant, the posteriormost close to posterior edge, fourth pair (posterior one of middle group) on transverse center of covers; a pair of bristles (parasternal) not far from antero-lateral margins of cover, another pair twice as far from sides and posterior to center of covers; another on parasterna III close to center of apodemata IV; apodemata short and slender; paramesial bristles midway between apertures; paranal bristles opposite pseudofissurae; postanal bristles subequally spaced, the lateral pair on line of sides of anal aperture; anal covers each with two insertions, the anterior in center near anterior margin, the posterior near mesal edge, two-fifths of the length of the plate from posterior margin.

Legs with the usual trihomohamate unguis, but outer hooks flat-shafted. Legs I (pl. 12, fig. 123) the longest. Tarsi with three pectinate (teeth much stouter than in ciliate) bristles on ventral face, the middle one the longest; two long bristles on proximal end of dorsal face, the proximal one the shorter and finer, inserted diameter of segment at this point distant from proximal end of segment; three bristles on lateral face, a short one below the long dorsal and a slender one distad of center, two medium-long bristles on dorsal face near distal end inserted very close to each other, in the broad space between dorsal bristles two and three appears another which is inserted further down on side of segment (not truly dorsal), and slightly nearer the third; two usual bristles on ventral face about distal end, and three short ones at apex. Tibiae gourd-like, with stout pedicel; major bristle very long, decidedly surpassing unguis, inserted on proximal edge of body of segment; an unusually long bristle inserted distad of but very close to major bristle; a long bristle on lateral face on transverse plane of dorso-distal bristle; a fairly long, barbed bristle on ventral face, inserted distad of lateral bristle; a medium long, mesal bristle inserted fairly close to distal end of segment. Genuals nearly as long as their tibiae, with three bristles on dorsal face, a very fine one at apex, immediately followed by an unusually long, fairly stout one, the proximal one fine, inserted distad of center; a short, rather stout bristle on ventral face, inserted near distal end of segment. Femora broad, fully as long as tarsus; with three bristles on dorsal face, a pair of barbed ones near apex, the other ciliate, inserted distad of center, a barbed bristle inserted near edge of ventral face proximad of center.

Legs II less highly specialize than legs I. Tarsi with somewhat shorter bristles. Tibiae more slender; with a shorter major bristle, a pectinate bristle on distal end of dorsal face; the barbed bristle of ventral face much longer. Genuals with a long, straight, barbed bristle on distal end of both dorsal and ventral faces; a long, stout, curved one on distal end of dorsal face extending to end of tibia. Femora more quadrangular; the dorsal, barbed bristle longer; the distal bristle shorter; the barbed bristle of ventral face near proximal end, as long as its segment. The small coxae with a fairly long, slender, weakly barbed bristle on its ventral face.

Legs III (pl. 12, fig. 122) the most slender. Tarsi with three long-ciliate bristles inserted on distal half of ventral face; a ciliate bristle near apex on dorsal face, a barbed bristle proximad of it, a smooth one at center of dorsal face; a bristle on mesal face inserted proximad of center; several fine bristles about apex. Tibiae nearly as long as tarsus; with a solitary major bristle on dorsal face remote from distal end, barely reaching base of hooks; two bristles on ventral face, the distal one quite long, remotely seven-ciliate, inserted more distad than dorsal bristle, the proximal one shorter, barbed, inserted proximad of dorsal one. Genuals short; with two rather short, fine bristles, one on dorsal face and one on ventral, inserted near apex. Femora broad, roughly oval; with two medium long bristles, a dorsal inserted at center of segment, reaching to center of genual, a ventral, barbed, inserted slightly distad of center. Coxae short, with a small flange on ventral face; a simple, fine, medium-long bristle inserted near center of ventral edge.

Legs IV longer than the preceding one. Tarsi more slender, with fewer bristles. Tibiae with a long bristle on dorsal face, inserted less than diameter of segment from distal end, reaching to base of unguis; a slender, slightly barbed bristle on distal end of ventral face; a similar one proximad of it, almost on transverse plane of major bristle. Genuals fairly long; with two weakly barbed bristles on distal end of dorsal face, the posterior one quite short. Femora oblong; a stout, slightly barbed bristle at center of dorsal face; a similar one near distal end of ventral face. Coxae shorter, as long as genual, quadrangular; with two longitudinal ridges diverging from base of femoral socket, a fine bristle inserted near base of same socket.

This species is an unquestioned *Galumna* because of its complete lack of abdomino-cephaloprothoracic suture. Although the major bristles of legs III and IV are not unusually long, the species is specialized beyond the majority of *Zetes* in the very long bristles of legs I, the shape of the pseudostigmatic organs, the most unusual adalar areae porosae, and the peculiar lamello-tectopedial band.

Dimensions: see under next species.

Cotypes: Oahu, Kuliouou, 2 specimens, March 5, 1920, nos. CGES11S1 (female with 8 eggs), CGES11S2, 1 male, from dead *Euphorbia*, May 4, 1924, no. CGES10S; Tantalus, 1 male, October 1, 1911, no. CGES13S; O. H. Swezey. Lanai, altitude 2,000 feet, 2 females (1 with 8 eggs), January, 1894, no. BBM91P1, R. C. L. Perkins. No locality, 1 male, no. BBM523P, Perkins.

Galumna hawaiiensis, new species (pl. 13, figs. 128-134; pl. 14, figs. 135-141).

Diagnosis

Medium large (0.46 by 0.61 mm.); cephaloprothorax short, broad, rounded, vermiculate anteriorly, rostrum barely projecting beyond it, with a shallow, somewhat vertical groove meso-distad of lamellae, subparallel with them; lamello-tectopedial band rather thin, but slightly projecting; rostral bristles inserted far back near rim of camerostome and lying along its sides, closely appressed, and rarely visible from above; palp bristle often so exerted as to resemble rostral bristles; lamellar bristles fine, fairly long, following contour of cephaloprothorax above rostrum, excluded; interlamellar bristles long, quite stout, nearly smooth, remote, often caducous; pseudostigmatic organs flagelliform, nearly smooth. Pteromorphae without visible pivot, anterior margin thickened, pseudo-foramina and their groove well developed, pseudofissurae slender; anterior areae porosae ovate, mesal end pointed, close to pseudostigmata; adalar small, ovate, distant from pteromorphae; mesonotal short, oval, the axis parallel to sides, a group of pseudo-foramina midway between them; posterior likewise. Genital covers each with two long bristles on anterior edge, the four major pairs lateral; gular bristles remote, unusually long; paramesial bristles fairly close to genital aperture; paranal bristles remote,

opposite center of sides of aperture; postanal bristles short, the lateral pair included by line of sides of aperture, close to mesal pair which are remote from each other.

Description

As seen from above (pl. 13, figs. 128, 130) broadly ovate, rather pointed behind; seen from side (pl. 14, fig. 135), a curvilinear parallelogram with humped back. Cephaloprothorax, seen from above (pl. 13, fig. 130), quite broad, its sides roughened by protrusion of lamello-tectopedial band and a meso-lamellar groove, and very slightly by very fine, irregular combing above rostrum (not visible looking directly through fragments by indirect illumination); seen from side (pl. 14, fig. 135) very high and steep-fronted; rostrum, seen from above, slightly protruding; seen from side, markedly restricted and with a slender, thickened rim (pl. 13, fig. 129; pl. 14, fig. 137), which is double, the inner edge extending beyond (ventrad of) outer (pl. 13, fig. 129); lamello-tectopedial band protruding sharply but not far, well developed (pl. 13, fig. 129); under its upper edge the anterior wall of the leg cupboard projects forward as an angular invagination (broad, broken, cross-hatched line originating nearly below pseudostigma in plate 13, figure 129); rostral bristles inserted below distal angle of lamello-tectopedial band, close to rim of camerostome, below its bulge and conforming to curvature of rostrum so as to be invisible from above, long, rather fine, smooth; lamellar bristles inserted externally to lamellae, low down on cephaloprothorax, conforming to curve of rostrum, subequal to rostral, equally fine, smooth; interlamellar bristles inserted near lamello-tectopedial band, in center of a protruding base or ring, longer than lamellar, stout, erect, finely barbed; pseudostigmata flush, inconspicuous, with a slight ridge above them extending anteriorly to anterior areae porosae; organs flagellar, considerably longer than interlamellar bristles, gracefully curved backward, seen to be very slightly barbed toward apex (magnification $\times 300$); no sign of abdomino-cephaloprothoracic suture.

Notogaster completely fused to cephaloprothorax; seen from side (pl. 14, fig. 135): low, depressed posterior to plane of pseudostigmata, behind falling rapidly, with a prominent transverse constriction!; anterior areae porosae (pl. 13, fig. 130) small, ovate, pointed at mesal end, close to pseudostigmata; two or three prominent muscle scars (mandible retractors) in line between them, their attachment areas marked by thickened chitin bases; adalar areae porosae small, ovate, pointed end mesad, remote from pteromorphae, as remote from each other as are the anterior, with a pseudoforamen mesad of their small end; posterior mesonotal far down on sides, oval, oblique, not large or prominent; posterior smaller, oval, not visible from above; pseudoforamina as in plate 13, figure 130.

Pteromorphae (pl. 13, fig. 131; pl. 14, fig. 135) with fine wavy lines (veins) spreading from a dorsal, band-like area; deeply emarginate; thickened along anterior rim; anterior pivot not prominently developed, externally at least; transverse groove prominent, rapidly broadening out; bristle insertion (pseudoforamen) and its channel well developed; pseudofissurae slender, slightly curved, diagonal.

Ventral plate much deeper than notogaster (pl. 14, fig. 135), anal aperture remote from posterior edge (compare plate 13, figure 128, and plate 14, figure 135), thus allowing for considerable detraction of notogaster. It is here opportune to point out that the designation, "anal aperture close to (or distant from) posterior edge of ventral plate" is meaningless because this distance is usually seen from ventral aspect and varies with angle at which it is seen and with degree of detraction of notogaster over ventral plate. As the bodies of these animals are deviously and subtly curved, no standard horizontal plane can be set, especially a practical and readily usable one. Another unsettled problem raised by the loss of the abdomino-cephaloprothoracic suture is the location of the anterior hinge or line of articulation of the notogaster and the ventral plate. There is a definite suture or break in the continuity of the chitin wall across the edge of the camerostome between the insertion of legs 1. This is the true anterior edge of the ventral plate. Anal aperture tapering to a narrowly rounded anterior end, pos-

PHTHIRACARIDAE-PHTHIRACARINAE

Oribatoidea with notogaster most strongly bowed, leaving an anterior, oval to circular aperture which is closed by a cephaloprothoracic shield (aspis), as a lid is fitted to a pot; head and legs retractile into the abdomen before attraction of aspis; genital and anal aperture approximate.

Type: *Phthiracarus* (46, p. 874).

Genus ORIBOTRITIA (25, p. 167)

Usually large and broad species having bristles absent to medium long; aspis usually very long, through extension of the lower part of abdomen; carina usually well developed; rib fairly well developed; lid above pseudostigmata; pseudostigmatic organs usually quite small; mesal ridge absent; anogenital area often quite narrow but deeply infolded so that detail is best seen in oblique aspect, bristles much reduced, no interlocking series of ridges; both anal rods and genital shields present; anogenital plates with or without diagonal slit; legs long, with stout bristles, the tarsi armed with three claws of which the outer are longest and bowed out from the middle ones.

Type, *Tritia decumana* (33, fasc. 2:9).

Oribotritia hawaiiensis (27, p. 214) (pl. 14, figs. 142-145; pl. 15, fig. 153).

Diagnosis

Aspis with slight mesal ridge, angled at anterior end, carina distinct, bristles well developed, lateral remote from pseudostigmata; pseudostigmatic organ short, needle-like but bent; notogaster high, arched, pointed behind; seen from above, rounded behind; anogenital area extremely narrow; anogenital plates with two bristle insertions on genital area and two on anal area; anal rods with one insertion at anterior end only (erroneously characterized in original description).

Description

Aspis, as seen from above (pl. 14, fig. 142) with sides tapering from pseudostigmata to apex, concave at juncture of carina; seen from sides (pl. 15, fig. 153), rendered high at anterior end chiefly by the ridge, the apex drawn out; ridge short, broad, low; carina extending from pseudostigmata to near apex, weak, not projecting beyond rim; rim narrowly thickened; bristles long and rather fine, rostral quite long, curved, lateral some distance from pseudostigmata, vertical between pseudostigmata, only slightly more remote than rostral, and closer to lateral than to each other, as seen from above; pseudostigmatic organ short, fine, needle-like but doubly elbowed, often standing nearly at right angles to aspis; area between rostral bristles and for some distance beyond them and parallel to rim, finely corrugate-striate.

Notogaster, seen from above (pl. 14, fig. 142), broadly oval, rounded behind, broadest near middle; dorsal outline angled near middle, angled behind at juncture with anogenital area; collar indistinct, notch deep, well formed, lapet well developed, edge shallowly concave along lower margin; bristles long, but fine, 3,4,5/5,4,3, I:3 most approximate, I:2 most remote, at least twice as much so as I:3, I:1 long and fine, a little less remote than I:2, close enough to anterior edge so that bristles surpass it, II:1 opposite notch, III:1 far below notch, and on transverse plane only slightly posterior to II:1, III:2 nearly on same vertical plane, II:3 far more anterior than usual; pseudo-

fissura (?) between II:3 and III:3; pseudoforamen as in plate 15, figure 153; VP:3 distant from posterior end, remote from end of anal rods; VP:2 slightly farther from VP:3 than VP:3 is from end of anal rods, preceded by a pseudoforamen.

Anogenital area (pl. 14, figs. 144-145) very narrow, in which respect it resembles *Oribotritia corporaali* (43, p. 79), ventral plate visible only as a very narrow dark line, that is, the edge only, but broadly continuous behind; anogenital plate very narrow behind, terminating with anal rods, broad at anterior end, thus projecting conspicuously ventrad of notogaster at this place (pl. 15, fig. 153) and thus better studied in oblique view; genital area with two bristle insertions, close to mesal edge, anal area also with two bristle insertions, one on transverse plane midway between VP:2 and its pseudoforamen, the other midway between pseudoforamen of VP:2 and bristle of anal rod; mesal apophyses considerably confused with genital shields, projecting but slightly beyond them, bearing three fairly long, very fine bristles; genital shield with six bristle insertions (pl. 14, fig. 145) along mesal edge; anal rods very slender, with but one bristle insertion at anterior end.

Coxae and subcoxae of legs III with three bristles, legs I fewer; unguis trihomamate.

Dimensions were securable from but one to three specimens; average is therefore given, in millimeters.

Notogaster, length	0.95-1.3	Aspis, length	0.51
Notogaster, height	0.78 (one only)	Aspis, height	0.25
Notogaster, breadth	0.87 (one only)	Aspis, breadth	0.44

Although the figures for breadth are greater than for height, it should be remembered that these figures are taken from two different individuals.

Cotypes, Oahu, Mount Kaala, 5 adults, April, 1892, no. BBM18P, R. C. L. Perkins.

Oahu: Niu, May 27, 1909, 1 specimen, no. BBMxyz (Bernice P. Bishop Museum); Tantalus, 3 specimens, BBMxzy (Museum of Comparative Zoology); mountainward of Wahiawa, 1 specimen, beneath bark of dead tree, December 4, 1923, no CGES12P (Museum of Comparative Zoology).

This is the common species of the windward Hawaiian islands. It was not found on Wake Island, where the next species was secured in good numbers. The two species may readily be separated by their general shape and color; *O. hawaiiensis* is much darker brown (chestnut), larger and more angular, and has a more bulging genital area. Other species, however, should be looked for.

The only species of this genus described from the Indo-Pacific area, *Oribotritia corporaali* (43, p. 79), differs in its longer pseudostigmatic organ and the different number and arrangement of bristles on ano-genital area. There are undoubtedly other differences which Dr. Oudemans will point out.

Genus INDOTRITIA (27, p. 213)

Similar to *Oribotritia* but ano-genital area usually wider, without genital shields.

Type, *Tritia krakatauensis* (50, p. 372, figs. 1-3).

Indotritia bryani (27, p. 213) (pl. 15, figs. 146-152).

Diagnosis

Seen from side (pl. 15, fig. 146), notogaster rising abruptly above aspis forming a distinct angle with dorsal outline; aspis transversely depressed anterior to vertical and to rostral bristles, carina weakly developed; pseudostigmatic organs rather short; lateral bristles beyond apex of pseudostigmatic organs; bristles of anogenital plate fine to lacking, two pairs only on genital area, three on anal area; one pair only on anal rods.

Description

Aspis, seen from above (pl. 15, fig. 148), with sides subparallel for more than half distance between apex and pseudostigmata, distal end truncate but slightly convex in center; seen from side, gently depressed posterior to center (exaggerated in figure), drawn out at distal end; very finely vermiculate stippled under high power, minutely somewhat irregularly corrugated between rostral bristles and beyond them, in an arc conforming with anterior edge of aspis; two slight, low ridges posterior to rostral bristles seen only under most favorable conditions (pl. 15, fig. 147), no thickened rim; carina springing from rim and running back nearly to pseudostigmata, projecting laterad beyond rim of aspis at anterior end (pl. 15, fig. 148, rim indicated by broken line); lid above pseudostigmata, short, prominent (pl. 15, fig. 148), upturned at both ends; pseudostigmata seen from above through chitin of aspis with appearance of a *Nonionina*, *Anomalina*, *Pulvinulina* (Foraminifera) shell; bristles very fine, rostral short, erect; lateral inserted beyond apex of pseudostigmatic organ; vertical barely between pseudostigmata, more widely spaced than the rostral and subequal to space between lateral and vertical; pseudostigmatic organ short, sword-like, but curved forward and upward (pl. 15, fig. 149, foreshortened).

Notogaster, seen from side (pl. 15, fig. 146), obliquely oval, anterior end rather abrupt, forming a distinct angle with dorsal outline, and with a corresponding postero-ventral angle; seen from above, broad oval, slightly broader behind and bluntly rounded; collar narrow, notch not deep, very long, lapet not developed; bristles short and very fine, 3,3,5/5,3,3, seen from above (not figured): I:3 and I:4 most remote of row I, one-third more remote than I:1, I:2, and I:5; seen from side, II:1 with a pseudoforamen both above and below it, another between II:2 and II:3; III:1 far down on side, with an unusually long bristle, III:2 with a pseudoforamen below it, between II:2, II:3 and III:2 what appears to be an insertion but no bristle visible, III:3 anterior to VP:2, VP:3 on transverse plane passing through posterior end of anal rods, a pseudoforamen anterior to VP:2.

Anogenital area (pl. 15, fig. 150) broad; ventral plate amply visible, continuous behind; anogenital plate broad, rim heavily thickened and undulate (pl. 15, figs. 150-152) with a well-developed horn to articulate with ventral plate; mesal apophysis not extending beyond outer corners of the plate, but fairly long, evidently fused at ental end, but longitudinally split for some distance beyond their juncture with anogenital plate, with a distinct bristle insertion on their anterior face (not figured), shortly followed posteriad by two more; outer corners of plate with two bristle insertions, one near corner, seemingly bristleless, the other, bearing a well-developed bristle, more posteriad; inner edge with five subequally spaced bristle insertions, the anteriormost close to union with mesal apophysis, the corresponding ones on opposite plate not always opposite; resilience slit quite distinct, extending nearly to outer edge of plate and more than one-third its length, that is, to transverse plane of penultimate bristle insertion of mesal row; anal area with three bristle insertions on each plate, fairly central in position, the anterior one near anterior end of anal rods, the posterior one, bearing a bristle, equally distant from posterior end of anal rods, middle one nearer the anterior than to the posterior and well in advance of VP:2; anal rods with bristle insertion at anterior end only, tapering quite gradually; claws strong, triheterohamate.

This species has the ventral area of *Indotritia javensis* (51, p. 459), but the notogastral bristle arrangement of *I. krakatauensis* (50, p. 372)—as far as figured—and an aspis of its own.

Dimensions of 6 specimens mounted so as to be measurable (only 2 for breadth), in microns:

Notogaster, length	815-1,020	Aspis, length	400-460
Notogaster, height	545- 680	Aspis, height	135-170
Notogaster, breadth	545 (two only)	Aspis, breadth	340-390

Type locality, "Wilkes Island," Wake Island, 28 specimens, under stones, August 2, 1923, no. BBMO7T1, E. H. Bryan, Jr., the Tanager Expedition (cotypes in Bernice P. Bishop Museum, Honolulu); and no. BBMO7T2 (cotypes at Museum of Comparative Zoology).

Also one specimen under no. BBM109P.

FAUNAL RELATIONS

Of the nine species formerly recorded (45), two were described as new, and the remainder were recorded as European. Of these nine species, I have restudied half of the original material of five of them and find them to be entirely different. In some I find that two species were placed under one name. In order to visualize the necessary changes, they have been placed in tabular form, in the unsystematic order of the original report.

ORIBATA GLOBULA.

- 1 specimen each of nos. 91, 532, 536, 656; 2 specimens of no. 93;
3 specimens of no. 531.....= HUMEROBATES HUMERALIS PERKINSI

ORIBATA ALATA.

- 1 specimen of no. 523; 2 specimens of no. 91.....= GALUMNA SWEZEYI
1 specimen of no. 79.....= ZETES AUSTRALIS PERKINSI

ORIBATA ORIFORMIS.

- 1 specimen (holotype ?) of no. 656.....= CARDIORIBATES ORIFORMIS

NOTASPIS LUCORUM.

- 1 specimen each of nos. 532, 656, 540.....= IMPARATOPPIA IMPARATUS
1 specimen each of nos. 532, 199, 656;
2 specimens of no. 691.....= CALVOPPIA PERKINSI

NEOLIODES THELEPROCTUS.

- 1 specimen each of nos. 87, 93, 171, 667;
2 specimens of no. 703.....= UDETALIODES HAWAIIENSIS

HOPLODERMA DASYPUS.

- 5 specimens of no. 18.....= ORIBOTRITIA HAWAIIENSIS

I suspect that *Oribata lapidaria* is also *Humerobates humeralis*, a typically arboreal species. It is on these misidentifications that deductions on geographical distribution are made. I would go to the other extreme and say that no Hawaiian species of Oribatoidea are European unless recently introduced (see page 91).

Of this original report, only one species, *Tegeocranus* (=?) *pustulatus*, is certainly not included in the present contribution. This makes a total of 31 known species out of a possible 90 or more. Of these, *Humerobates humeralis perkinsi* is from a common European and North American arboreal species, whereas *Zetes australis pembertoni* is from a common South American species. Both are only slightly differentiated and may show immediate (several decades) change wrought by a tropical climate. These differences are chiefly in robustness. *Udetaliodes hawaiiensis*, *Protoschelobates insularis*, and *Schelorbates fimbriatus* are Indo-Asiatic.

Of the other species, it is impossible to state the affinities because so little is known of the moss mites of Oceania and surrounding regions, even of the East Indies, with all the work already done.

It is certain, however, that species originating from east or west are sufficiently modified even after a few decades to be recognized as geographical races and that the fauna has been derived from different directions but especially from the west.

DISTRIBUTIONAL AGENTS

The greatest deterrent to constructive studies of agents of geographical distribution has been the generalizing of data. For instance, to apply Guppy's results concerning distribution of plants (17) to animal distribution is unsound. Likewise to discuss dispersal of large animals (as vertebrates) on the same basis as a microfauna, or to apply the principles governing dispersal of the one to the other, is highly fallacious. In the future, one should carefully segregate principles of plant dispersal from those of animal. Likewise, volant animals, large animals (chiefly vertebrates), and minute to microscopic animals should be discussed as entirely different subjects.

Other entanglements have been due to generalizations based on presumptions and to the application of data pertaining to one species or group to entirely different ones.

WIND

The subject of wind as a distributional agent has recently (13) been reviewed and enlarged upon. In order intelligently to discuss this factor as a transport agent it is necessary to classify the types of movement. Four may be clearly recognized: drift movements, convection currents, topography currents, cyclonic winds.

Drift movements have been proved to transport only strong-flying insects. Some groups or species stand up to moving air and drift in it. Prestorm drifting makes up the bulk of drift migration, but it applies only to volant, directive, strong-flying forms. A factor which has been neglected is that

some groups seek shelter as soon as the wind becomes strong. Many species seek the lee of objects when wind arises. Thus one cannot conclude that all strong fliers of island faunas are drift-directed. Each species must be accounted for only after careful study of its wind reactions.

Convection currents (13, p. 63) occur over surfaced roads and railroad tracks. These niches are relatively young and do not support a fauna, because of the lethal effect of the traffic. Wherever else convection currents may occur in nature, I doubt their ability to raise animals unless winged and prepared to take advantage from their substratum. The tendency of most animals would be to hold fast. Convection currents occur in desert regions or over bare rock surfaces or similar unvegetated or scantily vegetated areas. Such places are inhabited almost exclusively by strong fliers or larger animals. The smaller, frailer animals could not stand the heat and desiccation. Thus such currents would be effective only on strong, volant species.

Hillside updrafts are likewise limited. They have no pickup power.

These last two types of motion (13, p. 64) have a dispersive or diluting effect. Therefore, unless the riser is fecundated, its chance of meeting a mate in the upper air is slight. The honeybee enjoys its time of elation before fecundation. As she is a strong flier, she is able to seek her spouse. Presumably other insects would have similar flighty sentiments when seeking a mate and not after fecundation. The effect would be productive for strong fliers only, dispersive for weak, unfertilized fliers.

Finally the counterpoise of the convection currents (the descending currents) are over cold bodies, as lakes, glaciers, seas, and such. As is well known, this generally means annihilation of the flotage. Thus convection currents cannot be seriously considered as distributive agents except to directive, strong-flying species, and each species or group must be studied separately as to its attitude toward air currents at different periods of its life.

Cyclonic movements may range from slight and gentle whirls to cyclones, from eddies which are able to raise only the finest dust to twisters which can raise the roof or throw a wooded hillside into a woodpile. In Connecticut I have seen such an eddy draw up oak and maple leaves to a height of from one to two hundred feet, perhaps higher, many of these leaves flopping outside the effects of the whirl so that they were transported only a few hundred feet. Others certainly went much farther. I also remember the peculiar sensation of standing in a pasture and having leaves drop out of the sky all about me, a very thin rain, and a very leisurely descent. I even picked up some of the leaves to identify them and determine if they came from remote regions. I have also seen such whirls draw dust clouds high into the air, in semiarid north China, traveling at least a mile in a

rather straight line, passing over the city wall and drawing pieces of paper high into the air, flashing in the sunshine as they twirled about. In desert and semidesert areas such wind eddies are quite common. On a hot, dry, quiet day several may be seen at one time. In Connecticut they occurred over a mesophytic, more or less wooded area. The lifting power of such currents is unquestioned—especially for minute organisms with air in their lungs or tracheae, and “gas in their bellies.” Such a load, if carried far, would often be dropped over a sea or large lake, due to the cooling effect. The efficiency of such carriage would therefore be intracontinental, doubtfully extracontinental.

Another type of cyclonic storm is the Sirocco type (14, pp. 77-83, 88-99; 55; 1, p. 96). Their transportive power is great, but, 1, they originate in desert regions and move to mesophytic, populated areas; 2, the abrasive action of the dust particles thus carried, on soft or minute animals or spores must be harmful if not lethal; 3, the choking effect of these dust particles, which are in concentrated quantities, on the spiracles or lungs of the transported cannot be without at least weakening effect; 4, the desiccating effect of such hot-air transit at high altitudes must be even worse; 5, depending on the altitude to which the organisms are raised, rarefied air, cold, and other conditions of the high atmosphere must be taken into account. In other words, aerial transport does not consist merely in its postulation. Many factors are to be carefully studied before one can regard it as effective, even for strong fliers. I doubt its efficacy on microorganisms over large bodies of water and even in general.

One more point needs airing. Most of the appeals to wind transport have been made without the slightest recourse to wind direction—probably on the basis that winds blow from all quarters. This is not scientific. In fact the whole subject of biotic distribution has never been placed on a scientific basis. In north China “dust storm” winds come from the north, usually regarded as from the Mongolian plateau or Gobi desert. Their occurrence, during the spring, may be as frequent as two or three a month. These are spelled by strong, hot winds from the south which last through two or three days. West winds are rare; northeasters occur on an average of once a month. Thus most movement is north and south and would therefore not account for the appearance of west China species. In oceanic islands wind direction is of special importance. Not only the direction of the winds should be studied during the “growing season,” but through the winter as well, for plant seeds. Asclepiadaceous seeds are most conspicuous in almost snowless north China during late winter. The quality of the winds should also be understood in their relation to any one form of life under consideration. It is time to be specific and scientific.

If winds on the Faeroes are strong enough to blow sheep off the islands or to blow down massive walls (18, p. 642), it is quite conceivable (though not proven) that Oribatoidea may be blown off trees, out of bushes and even sorbs, if they ascend upon them, and if they are suddenly struck by a powerful gust at night. Such winds would destroy most of the minute or small animal life. Man himself cannot face such winds because of the sand and other water scour slapped into the wind by the breaking waves (18, p. 620). Thus the stronger the wind the more lethal it becomes. The Oribatoidea, however, like beetles, are protected by their dense chitinous covering and, many of them, by their highly polished surface, from abrasion as well as desiccation. This may also apply to minute beetles.

In this connection it is instructive to refer to data on size of quartz grains kept suspended by a uniform upward current of air (14, p. 43). The sizes presented include those comparable with sizes of almost all the oribatids, which of course are very much lighter than quartz grains of corresponding size. In an eight-mile-an-hour wind particles 0.75 mm. in diameter (the total length of many medium-large oribatids) fell in a path deflected but 10 degrees from the vertical. With oribatids the deflection would probably be 20 degrees if the wings (pteromorphae) were closed. Particles averaging 0.37 mm. (the average size of the smaller oribatids) fell at an angle of about 45 degrees.

Convection currents, which occur chiefly in the afternoon, rarely if ever at night, are doubtful or rare agents of distribution of moss mites, which are chiefly nocturnal. Even in the daytime, moss mites in leaf litter would migrate downward as the leaves dried out. Wet leaves would not be carried up, because they are matted together by the water. Finally, most if not all Oribatoidea draw up their legs and "play possum" when disturbed. Thus if the leaf on which they might be present were disturbed or jolted by the wind the moss mites would fall off. From the above consideration I do not think that Oribatoidea are transported by the wind, or if so for short distances only. To what extent their eggs may be thus transported is not known. The eggs are neither sticky nor attached. It is not known whether they are placed between the walls of dead leaves or not—if so, probably only in the lowest, most humid layers.

BIRDS

So little definite information about feathers and muddy feet as carriers exists that I hesitate to ascribe importance to birds as agents. At best, muddy feet would apply more particularly to aquatic, riparian, or littoral (semiaquatic) species. Nesting material carried by birds (31) is far more populous than feet and wings. Sea eagles, ospreys, and hawks use much more

and larger material than gulls (2a, p. 379); they have undoubtedly played a part. During early March, I have been amused to see kites (*Milvus lineatus*) pilfering the University woodpile, between my house and the student dormitories, for "floor joists." Crows, ravens, and daws (22, p. 59) are famous for the amount of wood they will carry. Ravens would be of insular importance.

In this connection it is interesting to note an example of the usual type of loose writing done in connection with distribution (11, p. 91): "Probably all the species belonging to the moss fauna can be spread by the wind." The writer fails to state how the wind is able to pick out the minute animals found in moss from among the leaves and stalks. This would seem especially difficult, when one recalls that moss is usually found in sheltered places, in woods, under other vegetation, in moist places, and he is considering mites from old, inhabited regions blowing to uninhabited. Moss-inhabited regions as Java and Sumatra would be well protected by other vegetation. Even as to pioneer moss, the chances are that no fauna has yet appeared in it. Whether this be always so or not, I cannot conceive of wind blowing Acarina, with their eight, hooked feet, out of moss, any more than I can think of wind blowing wolves, tigers, or rabbits out of the woods. The size of the animals relative to the size of their vegetation is similar, but the clinging power of the mites is greater. Furthermore, wind is much less effective at the surface of the ground than one or three feet above it. The majority of Acarina listed are forest-floor animals. Nothing is known of the acarian fauna of tree-festooning moss.

Again (11, p. 92) all mites on Krakatoa are not actual or semiparasites as larvae. *Tritia krakatauensis* (11, p. 114) is certainly not. This species is a dweller in epigeous moss or decayed wood.

How a bird's feathers can pick up moss mites (11, p. 92) is left entirely to the imagination. Even Oribatoidea in nesting material would not crawl onto the brooding bird, as birds' feathers hold not the least attraction or delectation for them. Birds dust themselves in dust, not moss, and then shake themselves. When a bird treads on moss, the moss bends under the bird's feet and keeps them off the mud much as reeds in a swamp keep a man's feet from sinking into the mud. If a bird with muddy feet should chance to alight on moss, a rare occurrence, the moss leaves would probably protect the animalcule. As to the oribatids, which are nocturnal, the bird's foot would be on top of the moss and the oribatids would be in the lower layers of the moss. As far as I am aware, oribatids eat the decayed leaves at the base of the moss plants, not the new green leafage. If the latter be the case, it would be done only at night, for moss mites shun daylight. Thus I cannot conceive of bryobious oribatids getting on the muddy feet of birds.

What is true of mites may be just as true of Tardigrades, Rotatoria, Rhizopoda, and Mollusca. How can these attach themselves to birds' feathers? Why would they?

Tritia krakatauensis (now called *Indotritia*) was probably carried to Krakatau on a stick in a gull's bill. I have seen *Milvus lineatus* pick up a stick on the wing with its feet, and after having gotten well clear of land, transfer it to its bill, thus clearing his landing gear. Many of the Phthiracaridae and some of the apterous Oribatidae tunnel into soft, decaying sapwood. These are usually present in numbers and may be transported as eggs, larvae, nymphs or adults, or all four. Gulls were found on Krakatau as early as 1906 (12, p. 31).

I do not believe that *Humerobates humeralis* was brought from California by birds or *Zetes australis* from South America. Nor can I conceive of transport from either of these places by wind.

OCEAN CURRENTS AND DRIFTWOOD

To consider the subject of currents and driftwood is to reopen Guppy (17). After thorough mastication, I find myself with two bones on my plate. First, for the transport of animals, it matters but little how currents ran because, second, animals could not travel on logs or other drift flotsam. Guppy himself states (17, p. 430) that the bark is soon removed, that the Hawaiian logs were all barked, that the Scandinavian-West Indian logs were also barked. He speaks of seeds in crevices (17, p. 58) by conjecture. Drift-log transportation, thus far, is an arm-chair, fireside romanticism. Anyone who has studied wave action at sea level rather than from the upper deck of a liner, anyone who has felt the slap of a moderate wave, anyone who has seen the effect of wave action on board a liner in a storm, will realize how much chance seeds, eggs, or animals would have through several weeks (let alone months) of repeated wave pounding, on a log or tree which spends most of its time in rolling. Beebe's contribution (3) on drift conditions during pleasant weather is worth noting. Birds were the most notable inhabitants of the logs. [These birds are usually hungry and almost always keen-eyed.] They were found along the drift-line in large numbers. [Think of a lizard on such a drifting log!] At one place 200 northern phalaropes were met and disturbed, and "They followed exactly every zigzag of the line of foam, keeping precisely to each bend of the denticulations of the current juncture . . . Twice after this, I saw several of the little chaps, . . . perched on floating logs, picking edibles from the crevices." The logs were covered with barnacles, and more or less riddled with shipworms. [What the birds did not get the shipworms might.] Fifty-four species of animals [presumably marine—some probably predaceous] were found on

such drift. "The quantities of such logs, sticks, débris and solid pieces of wood were beyond belief" (3, pp. 51-53), but "all alive with living creatures catching a ride . . . in a sea so thick with animal life as to resemble soup." [All this on quiet days.] One also reads (3, p. 70), "five boobies on a log." [Think of a snake, skink, or even sowbug on such a log.] Beebe has sounded the death knell for this transport agent. As to species which live well within the logs, the insects with which I am acquainted are larval forms which must leave the log to find mates. Short of paedogenesis, such species, if they can resist salt water soakage, are doomed to childlessness. We hardly need physical studies on the penetrability of sea water under conditions of storm wave pounding (as well as the sucking action of retreating water), or a study of the grind of log against log in such a trip during storms. The more numerous the logs, the more grinding during a sea; the fewer the logs, the more concentrated would be their bird and related population. Green logs would start with a small oribatid population either on the bark or in rot pockets. Old, rotted logs with heavy populations would become water-logged in a day or two and sink. Thus I do not believe oribatids, or any other forms of animal life, are transported for any distance on flotsam.

MAN

The only way that currents could possibly prove effective would be with the added factors, man and boats. These factors have been all too much neglected. Among the Pacific Islands where man has dwelt for a long period of time, where he has been living with boats for a long time, and where he has had unusual reason to learn to read the sky, this factor becomes of much greater significance than it does where intercontinental dispersal is concerned. It is far easier to connect Alaska and Siberia by a land bridge than the maze of islands of the Pacific—and there are real grounds for so doing. Furthermore, land bridges will not suffice to account for the presence of only odds and ends of a biota. The drifting canoe, migratory movements by man, or escape in a canoe, excommunication, and other ethnological customs, seem more plausible than land bridges. One instance of canoe transport (49, p. 286) accounts for the probable transport of certain lizards. It is not until detailed enough ethnological studies have been made to acquaint us with the pets, animal mascots, religious fetishes, and similar animal attachments of man, that we will be able definitely to account for certain species. The Chinese are fond of carrying crickets in 4-inch cube cages made of reed stalks. They use all kinds of animals in their materia medica. To what extent did medicine men return to more settled islands to secure some of their medicaments and establish them on their new home island? The possibilities are as numerous as the quips and fancies of man's mind. Such data might help

to account for some of the larger animals, including mollusca, which were used for money, at least.

Transport of vegetation, either wood, taro roots, or other foods or fibers would account for minute organisms which live or lay their eggs in soil or soil litter. Some oribatids have undoubtedly been carried in canoes. To what extent has primitive man carried moss for various purposes? The Chinese use mud plasters for baby diapers. Such data may reach back 100,000 years. When did the South Sea islanders or East Indians first use a canoe? The burned-out log is not the simplest type of water craft (52a, p. 760). As far as is now known, the ancient migrations to Hawaii were entirely from the westward. The story of the course of these migrations is slowly being pieced together by philologists, ethnologists and other students of man's actions. The student of animal distribution will do well to keep in close touch with this literature.

Of far more recent date has been the advent of the white man. The early missionaries, in endeavoring to make a homey place in the earlier Honolulu desert, introduced plants from North America and South America. How many species of minute terrestrial and moss-inhabiting animals were brought to Honolulu on Dutch bulbs, potted flowers, on bushes and nursery trees (each with a ball of earth or moss about its roots), in potato bags, on onions, in hay and straw used for packing, it is impossible to say, as there has been much mortality, as well as many readjustments, changes in the fauna, the lean ones eating up the fatted ones. I have endeavored to secure data on these early importations, but there seems to be none. I have no hesitation, however, in ascribing this mode of transport to *Humerobates humeralis*, a species common on vegetation in Europe and North America, and to *Zetes australis* from South America. I cannot conceive of their having come on logs, bird-borne sticks, or winds from the Americas. The plant introduction habits of the European are amply sufficient to account for these two animal immigrants.

RATE OF CHANGE

If it is true that *H. humeralis* and *Z. australis* were introduced within the last 150 years, and there is every reason to believe such is true, these two species have become subspecifically differentiated within that time. This change has been a mass change—affecting all individuals subequally. Such mass changes are characteristic of geographical races and unquestionably brought on by climate. That such subspecies may in the same way be changed to species has never been proved. Species seem to originate in another way.

That *Protoschelobates insularis sandvicensis* and *Schelobates fimbriatus calcaratus* are similar geographical variations of western (Indo-Malayan) species is evident. Their age is probably less recent.

A disparity is found in *Udetaliodes hawaiiensis*, of which the subspecies *U. hawaiiensis wakensis* is found on the extreme west end of the islands, although it would appear, from its more reduced pseudostigmatic organs, to be the more recent (the rate of change being the same in both races) though on the older land. On the other hand it may be a recent introduction, as Wake Island has been inhabited within historic time by Japanese, their shacks, wells and an old boat having been found there by the Tanager Expedition. As the greatest altitude of the island is only 21 feet, it may be that the reduction of the pseudostigmatic organs is due to the action of wind-blown sand and water spume. Aquatic species tend to lose their pseudostigmatic organs. Thus my interpretation is that it is a recent introduction on a now sandy island which has entirely lost its original woodland fauna.

ECONOMIC IMPORTANCE

The work done by members of the Sugar Planters' Experiment Station on soil and root fauna has shown that species of *Schelorbates* and related genera are outstandingly terricolous. The finding of *Protoschelobates insularis sandwicensis* and *P. pembertoni* in a hole 1 mm. in diameter in cane stools underground, July 5, *Dameosoma alces* within minute hole in cane-root, July 10, of *P. pembertoni* on cane roots, July 14, of *Xylobates pembertoni* within a minute fresh hole in tender cane root, 6 inches deep, December 12, bring to mind the finding of *Lohmannia insignis* on bean seedlings in Ireland (10) and *L. insignis dissimilis* on tulip bulbs in England (20). Again we have no proof that these animals were making the holes. The majority of oribatids are scavengers, and may have been eating grass or other tidbits in the burrow of another animal. The finding of *Xylobates* in a fresh hole brings the genus into question. The case against oribatids as noninjurious is becoming weightier.

Illingworth (23) gives a detailed review of the efficacy of the predaceous ant (*Pheidole megacephala*) in destroying, with rare exceptions, the native fauna, especially beetles. He emphasizes the observations that the largest insects are overcome, but no information is presented on the lower size limit. As oribatids were found by the writer wherever looked for about the head of Manoa valley, as they were secured by general collecting on other islands and other places, and as *Pheidole megacephala* is widely, generally, and even thickly distributed throughout the islands (45a, pp. 41, 101), it is evident that the oribatid fauna is but little, if at all, affected by this insect scourge.

ECOLOGICAL NICHES

Any species may become terricolous when its normal moss or humus layer has been destroyed (48). Arboreal species may be found in woodland

litter during the day, ascending at night. The species may be grouped by habitats as follows:

TERRICOLOUS

Epilohmannia verrucosa
Oppia cronus
Dameosoma alces
Protoschelobates pembertoni
Protoschelobates insularis sandvicensis
Protoschelobates vanzwaluwenburgi
Scheloribates fimbriatus
Scheloribates muiri
Styloribates pectinatus
Xyloribates pembertoni
Zetes australis pembertoni (in ant's nest)

DENDRICOLOUS

(Humicolous during daylight)

Humerobates humeralis perkinsi

BRYOBIOUS

Odontocephus immarginatus
Protoschelobates insularis sandvicensis
Galumna hawaiiensis

HUMICOLOUS

Dameosoma ultraciliata (decaying cane stool)
Protoschelobates insularis sandvicensis
Protoschelobates castlei
Scheloribates muiri
Scheloribates manoi
Scheloribates oahuensis
Zetes australis pembertoni
Galumna hawaiiensis
Galumna fordi
Galumna swezeyi

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PLATE LEGENDS

PLATE 1. *Epilohmannia* and *Odontocephus*. 1-6, *Epilohmannia verrucosa*, new species, adult: 1, ventral view, seen slightly tilted, ratio 100; 2, palp, ratio 200; 3, cephaloprothorax from side and a little from below, ratio 67; 4, leg I, ratio 200; 5, leg II, ratio 200; 6, leg IV, ratio 200. 7-10, *Odontocephus immarginatus*, new species, adult: 7, female, dorsal view, seen somewhat from side, ratio 100; 8, pseudostigmatic organ, ratio 200; 9, female, ventral view of leg insertions seen somewhat from side, ratio 100; 10, female, ventral view at leg insertions seen at right angles to mesal plane, ratio 100.

PLATE 2. *Odontocephus*, *Dameosoma*, and *Oppia*. 11-15, *Odontocephus immarginatus*, new species, adult: 11, leg I, (femur head foreshortened), *f*= foreshortened laterally directed bristle, ratio 133; 12, leg II, ratio 133; 13, leg IV, ratio 133; 14, leg III, ratio 133; 15, inner edge of anal cover, ratio 133. 16-22, *Dameosoma ultraciliata*, new species, adult (cilia of bristles exaggerated in all figures): 16, leg I, ratio 100; 17, leg II, ratio 100; 18, leg IV, ratio 100; 19, leg III, ratio 100; 20, coxa IV, and insertion, ratio 100; 21, female, dorso-ventral, ratio 80; 22, male, notogaster, ratio 80. 23, *Oppia cronus*, new species, adult: leg IV, ratio 100.

PLATE 3. *Oppia* and *Cardioribates*. 24-27, *Oppia cronus*, new species, adult: 24, female, side view, without legs, ratio 80; 25, male, dorso-ventral, without legs, ratio 80; 26, pseudostigmatic organs, ratio 200; 27, leg I, ratio 100. 28-30, *Cardioribates oriformis* (45), adult: 28, unguis of legs II and III, ratio 133; 29, dorso-ventral, lacking four legs, ratio 50; 30, postero-mesal portion of anal covers to show interlocking area, free hand.

PLATE 4. *Imparatoppia* and *Calvoppia*. 31-37, *Imparatoppia imparatus*, new species, adult; 31, from front and above to show degree of overhang of notogaster over venter, ratio 67; 32, from below and somewhat from behind, ratio 67; 33, from side, three anterior legs removed, dorsal outline indicated as seen in broken specimen, ratio 80; 34, dorso-ventral view, ratio 80; 35, from side and from above, leg insertions numbered, figure on notogaster indicated by broken line outlines opaque area in figured specimen, ratio 80; 36, leg I, ratio 100; 37, end of foot showing unguis, ratio 100. 38-39, *Calvoppia perkinsi*, new species, adult: 38, cephaloprothorax, dorsal view, seen somewhat from side, broken, undulating lines on cephaloprothorax indicate ridges, ratio 80; 39, cephaloprothorax, ventral view, ratio 80.

PLATE 5. *Calvoppia* and *Phauloppia*. 40-41, *Calvoppia perkinsi*, new species, adult: 40, leg I, ratio 100; 41, leg insertions, pseudostigmatic organ and apodemata, ratio 100. 42-45, *Phauloppia bryani*, new species, adult: 42, dorso-ventral aspect, ratio 80; 43, lateral view somewhat from above and in front, ratio 80; 44, pseudostigmatic organs, four different aspects, ratio 293; 45, leg insertions and legs I and IV, ratio 100.

PLATE 6. *Protoschelobates*. 46-50, *Protoschelobates insularis sandvicensis*, new variety, adult female: 46, dorsal view, legs omitted (not all punctures shown), ratio 80; 47, lateral view, somewhat from below and behind, legs and some detail omitted, ratio 80; 48, a lamella, somewhat from side showing central ridge, ratio 100; 49, pseudostigmatic organ, slightly oblique, drawn free hand; 50, sternal area, areolation not indicated, ratio 133. 51-57, *Protoschelobates vanzwaluwenburgi*, new species, adult: 51, pseudostigmatic organs, four aspects, ratio 293; 52, venter showing base of cephaloprothorax, tectopodia, edge of pteromorphae, furcular area, and genital cover, ratio 133; 53, cephaloprothorax from side and in front, showing lamellae, transverse "lines," and area porosa, ratio 133; 54, leg I, ratio 133; 55, leg II, ratio 133; 56, leg III, ratio 133; 57, leg IV, tarsus foreshortened, ratio 133.

PLATE 7. *Protoschelobates* and *Scheloribates*. 58-60, *Protoschelobates pambertoni*, new species, adult: 58, dorso-ventral view, legs omitted, ratio 80; 59, pseudostigmatic organ, drawn free hand; 60, sternal area, ratio 133. 61-66, *Protoschelobates castlei*, new species, adult: 61, dorso-ventral, legs omitted, ratio 133; 62, lateral view, legs and mouth parts omitted, ratio 133; 63, pseudostigmatic organ, ratio 293; 64, lamella, area porosa, pseudostigma and anterior edge of pteromorpha, from side, ratio 293; 65, pseudostigma from above, heavy diagonal (transverse) line is anterior edge of notogaster, all detail posterior to it thus lies beneath it, ratio 293; 66, leg I, ratio 200. 67-68, *Scheloribates indica* (40) adult: 67, dorso-ventral, legs omitted, ratio probably 67; 68, pseudostigmatic organ, ratio 293.

PLATE 8. *Scheloribates*. 69-79, *Scheloribates muiri*, new species, adult: 69, leg I, ratio 133; 70, leg II, ratio 133; 71, leg III, ratio 133; 72, lateral view, seen slightly from below (legs and mouth parts omitted), ratio 67; 73, dorsal view (legs omitted), showing but four anal cover retractor attachment areas, ratio 67; 74, detail of pteromorphall bristle, drawn free hand; 75, ventral aspect, ratio 67; 76, detail of venter of cephaloprothorax seen somewhat from side (legs and mouth parts omitted), ratio 80; 77, cephaloprothorax and pteromorphae, dorso-anterolateral aspect (a pseudostigmatic organ and leg I omitted), ratio 80; 78, detail of pseudostigma and organ, ratio 293; 79, different aspects of pseudostigmatic organ, ratio 293.

PLATE 9. *Scheloribates*. 80-82, *Scheloribates oahuensis*, new species, adult: 80, dorso-ventral, legs omitted, ratio 100; 81, leg I, ratio 133; 82, femur and genu II, ratio 100. 83-84, *Scheloribates manoi*, new species, adult: 83, anterior portion of venter, legs and mouth parts omitted, ratio 133; 84, pseudostigmatic organ head, ratio 293. 85-94, *Scheloribates fimbriatus calcaratus*, new subspecies, adult: 85, side view of posterior end of abdomen expanded, anal cover retractor indicated by broken line, ratio 80; 86, same contracted (close), ratio 80; 87, side view, legs and palps omitted, ratio 80; 88, dorso-ventral, legs and mouth parts omitted, posterior broken line illustrates another individual superimposed, ratio 80; 89, cephaloprothorax seen from in front and right side, ratio 80; 90, cephaloprothorax and leg I (palp, leg II and one pseudostigmatic organ omitted), ratio 100; 91, sternal area, ratio 100; 92, pseudostigmatic organ, ratio 293; 93, pseudostigmatic organ, foreshortened, with "oil globules," ratio 293; 94, pseudostigmatic organ seen from above, looking down onto edge, ratio 293.

PLATE 10. *Styloribates* and *Xyloribates*. 95-102, *Styloribates pectinatus*, new species, adult: 95, dorso-ventral aspect, without legs or mouth parts, ratio 67; 96, posterior end of anal cover (black), with its retractor (stippled) within edge of ventral plate, ratio 293 (?); 97, lateral aspect (female) with leg IV (mouth parts omitted), detail of notogaster exaggerated in size, ratio 67; 98, pseudostigmatic organ, ratio 220; 99, leg I, ratio 100; 100, leg III, ratio 133; 101, distal end of palp, side view, ratio 293; 102, femur of leg II, ratio 100. 103-110, *Xyloribates pambertoni*, new species, adult: 103, anterior area of venter, ratio 100; 104, cephaloprothorax from side, ratio 100; 105, cephaloprothorax from above and side, ratio 100; 106, palp, from side, ratio 293; 107, leg I, ratio 200; 108, femur and coxa IV, ratio 200; 109, femur II, ratio 200; 110, leg III, ratio 200.

PLATE 11. *Zetes*. 111-117, *Zetes australis pambertoni*, new subspecies, adult: 111, dorsal aspect, legs omitted, ratio 67; 112, pseudostigmatic organ head, seen from before, free hand; 113, lower part of side of cephaloprothorax with leg I, ratio 67; 114, ventral view, legs and mouth parts omitted, ratio 40; 115, unguis showing shorter middle hook, free hand; 116, leg II, ratio 67; 117, leg IV, ratio 67. 118-120, *Zetes fordii*, new species, adult: 118, dorso-lateral view, legs omitted, ratio 80; 119, pseudostigmatic organ, ratio 293; 120, leg I, ratio 133.

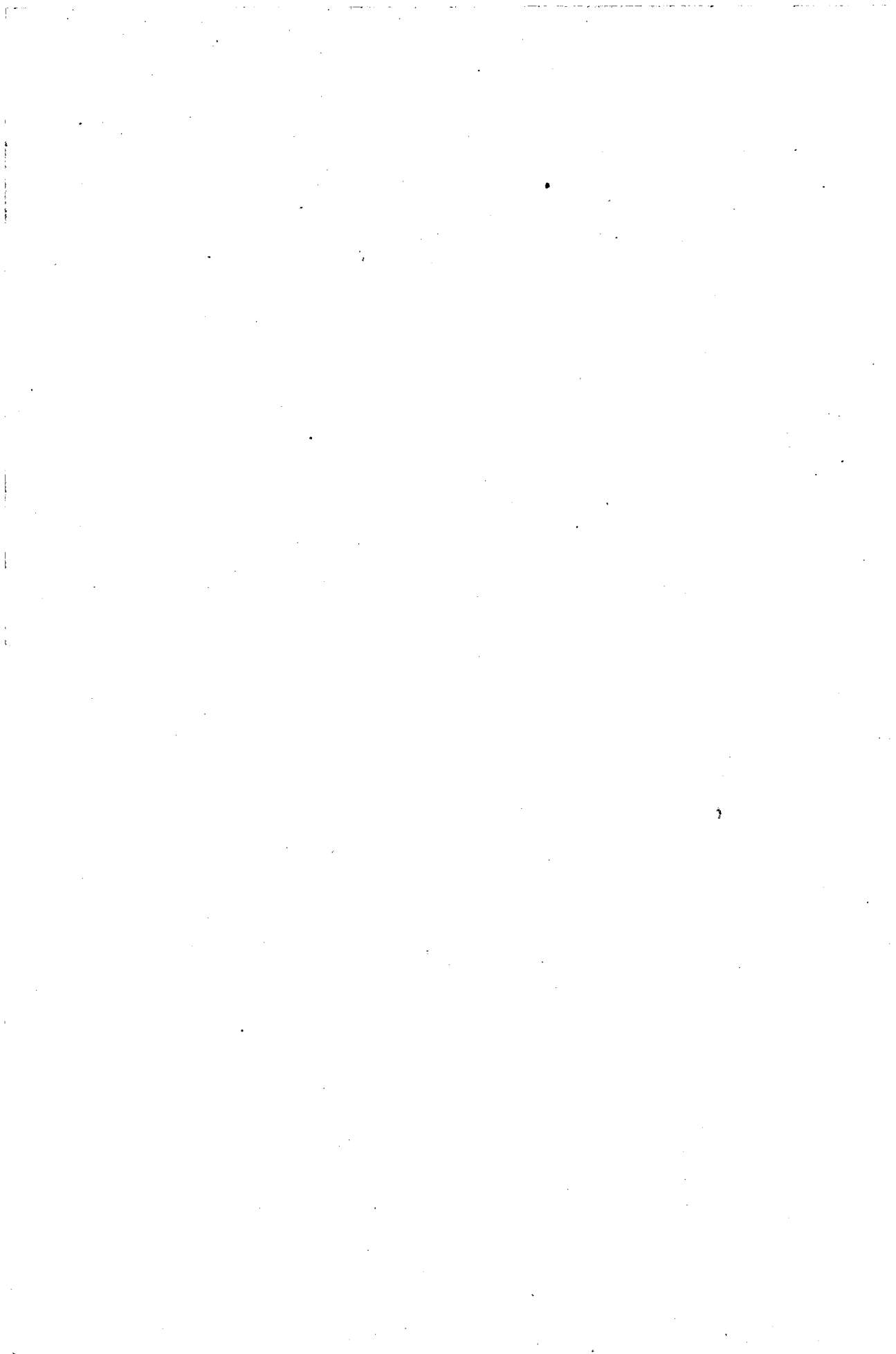
PLATE 12. *Galumna*. 121-125, *Galumna swezeyi*, adult (all, ratio 67): 121, dorsal aspect, legs omitted; 122, leg III, parasite between hooks; 123, leg I; 124, genital cover and sternal area; 125, pteromorpha.

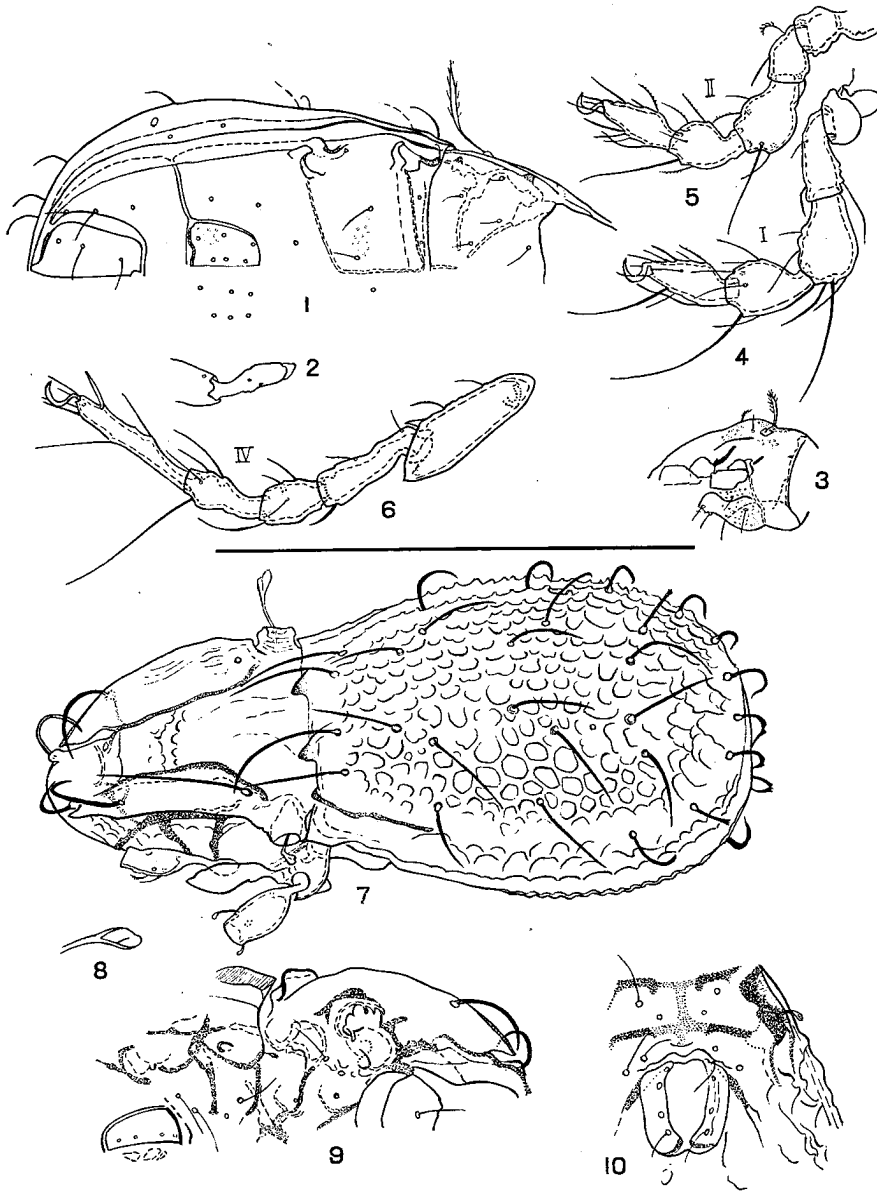
PLATE 13. *Zetes* and *Galumna*. 126-127, *Zetes bryani*, new species, adult: 126, pseudostigmatic organ, ratio 133; 127, genital aperture cover, ratio 133. 128-134, *Galumna hawaiiensis*, new species, adult: 128, ventral aspect, legs and mouth parts omitted, upper half with internal structures as seen by transmitted light, ratio 80; 129, side of cephaloprothorax with leg I housed in anterior end of leg cupboard, not all bristles of leg shown, ratio 80; 130, dorsal aspect, legs omitted, upper half with internal structures as seen by transmitted light, ratio 80; 131, pteromorpha, ratio 80; 132, leg I, ratio 133; 133, proximal half of leg IV, ratio 133; 134, leg III, ratio 133.

PLATE 14. *Galumna* and *Oribotritia*. 135-141, *Galumna hawaiiensis*, new species, adult: 135, side view, ratio 67; 136, insertion of leg I, seen through tectopedium II and lower face of cephaloprothorax, i.e., between edge of camerostome (lower solid line) and edge of tectopedium II (upper solid line), ratio 293; 137, insertion of leg I, right side, I=base of lamello-tectopedial band, tII=tectopedium II, lower shaded area is thickened camerostome rim, upper shaded area is apodemata I, I=peduncle of femur I, ratio 293; 138, same, left side, seen more from before and below so that coxa I is more covered over, and base of peduncle of femur is partly covered by tectopodia II, transverse wall of leg cupboard, i.e., inner edge of lamello-tectopedial band, represented by thick line, ratio 133; 139, insertion of leg II, right side, including femur II, rim of tectopodia II represented by lower thick line, walls of apodemata and their spurs also represented by thick lines, ratio still less; 140, insertion of leg II, right side showing peduncle of femur II, with attachment to coxa, shaded area is wall of apodemata, ratio 293; 141, same, left side, showing apodemata wall broken at side of coxa, ratio 293. 142-145, *Oribotritia hawaiiensis*, adult: 142, dorsal view, slightly oblique, ratio 40; 143, pseudostigmata and organ, ratio 293; 144, ventral view of notogaster and ano-genital area, ratio 67; 145, side view of anogenital area, ratio 67. (See also pl. 15, fig. 153.)

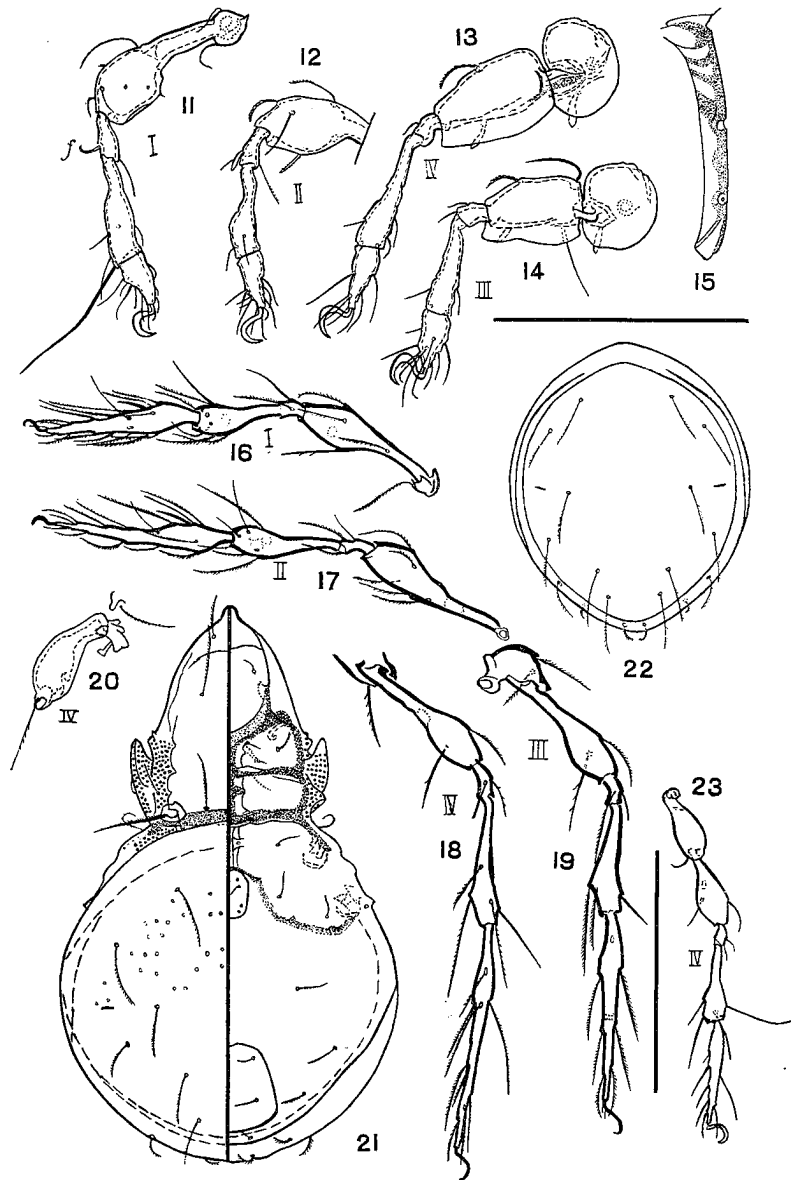
PLATE 15. *Indotritia* and *Oribotritia*. 146-152, *Indotritia bryani*, adult: 146, side view, legs and mouth parts omitted, ratio 80; 147, aspis, end view, in section, ratio 80; 148, aspis, dorsal view, ratio 80; 149, pseudostigmatic organ, somewhat foreshortened, due to curvature, ratio 293; 150, ano-genital area, ventral view, ratio 80; 151, same, detail of anterior end, ratio 200; 152, same, side view, ratio 200. 153, *Oribotritia hawaiiensis*, adult: side view, legs and mouth parts omitted, ratio 27.

PLATE 16. *Dameosoma*, *Udetaloides*, and *Protoschelobates*. 154-158, *Dameosoma alces*, new species, adult: 154, dorsal view, somewhat from side, where tectopodia I and IV appear more conspicuous and larger than if seen directly from above—loci of notogastral bristles not exact, but reconstructed from fractured individual—ratio 133; 155, ventral view, legs and mouth parts omitted, ratio 133; 156, leg I, ratio 133; 157, leg IV, ratio 176; 158, leg II, ratio 176. 159-165, *Udetaloides hawaiiensis wakensis* (?), adult: 159, pseudostigma, organ and interlamellar bristle, ratio 133; 160, tarsi and tibiae I, a femur showing articulation head protruding from cup-like extension of wall of segment, ratio 67; 164, coxae and femora III, ratio 67; 165, same, at different angles. 166, *Protoschelobates insularis* (?), adult: side view of abdomen to show the preanal and postanal apophyses and their muscles.

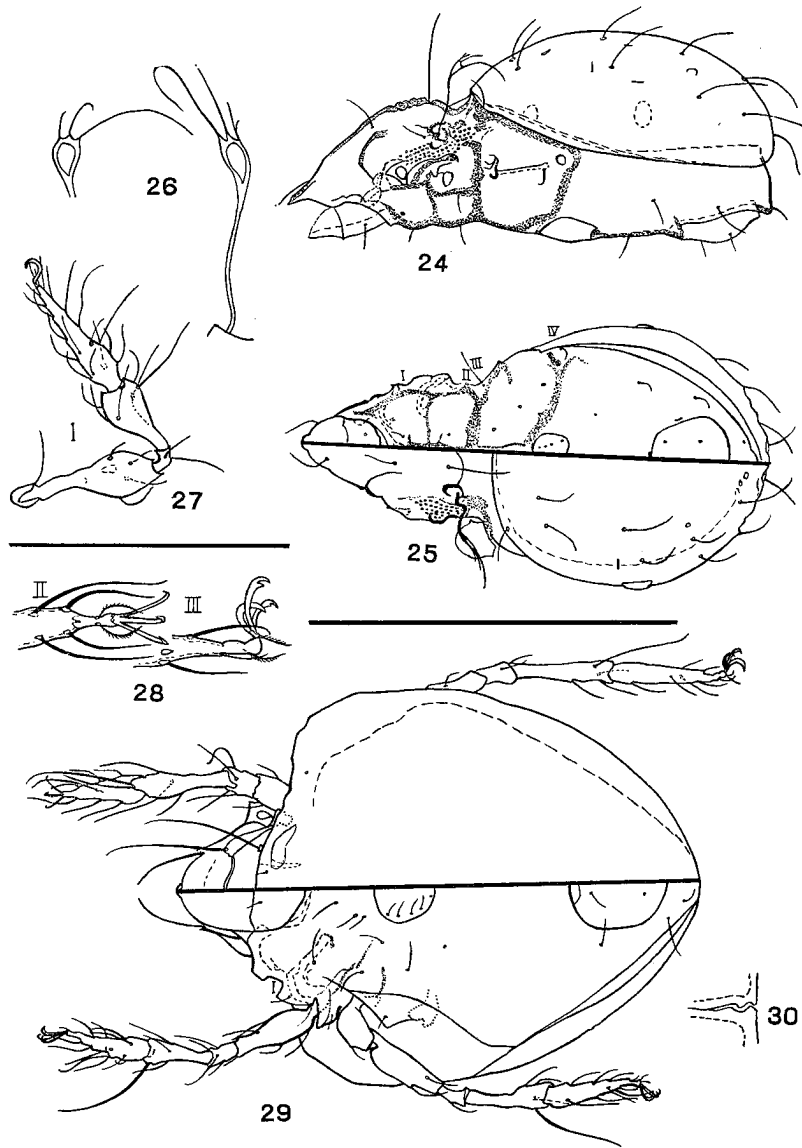




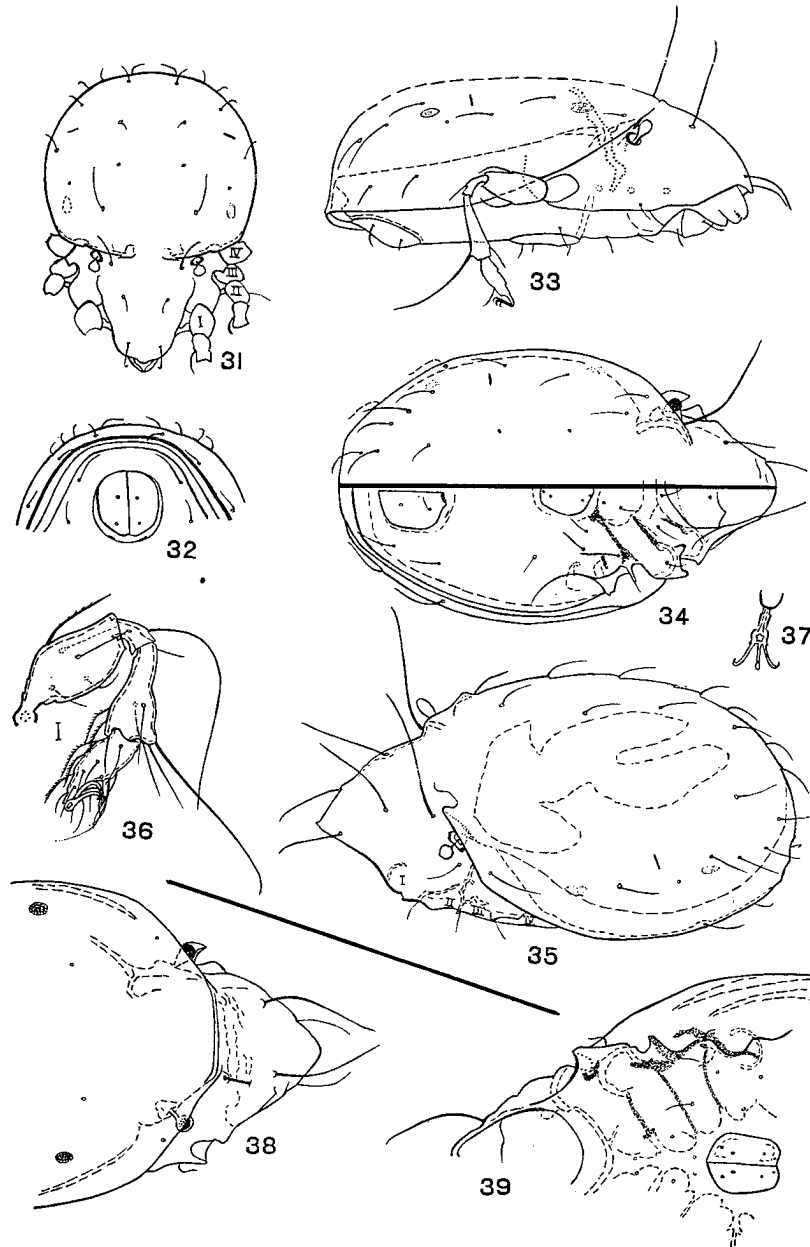
EPILOHMANNIA AND ODONTOCEPHEUS.



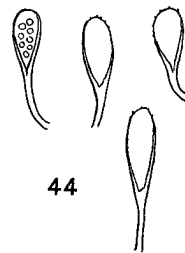
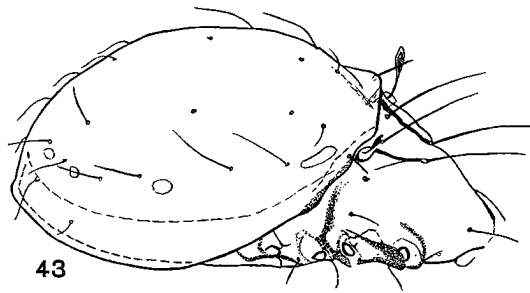
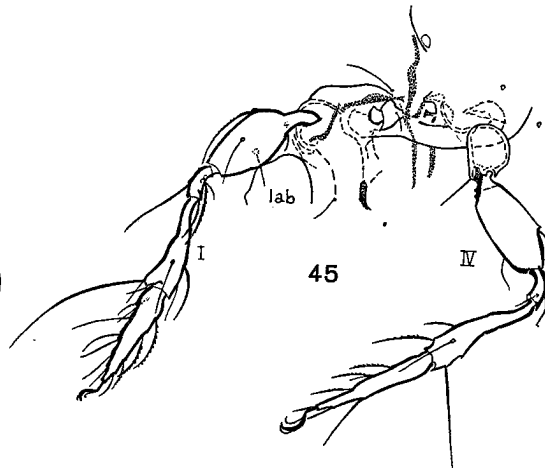
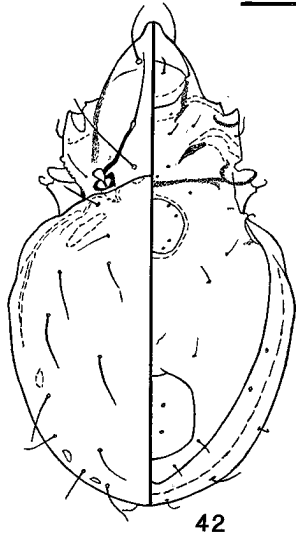
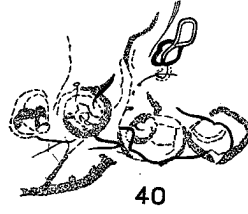
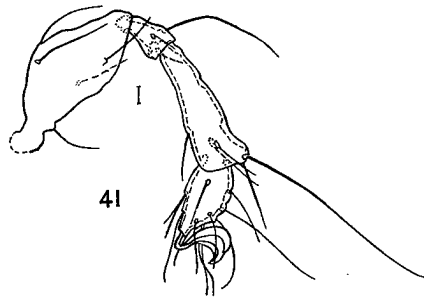
ODONTOCEPHEUS, DAMEOSOMA, AND OPPIA.



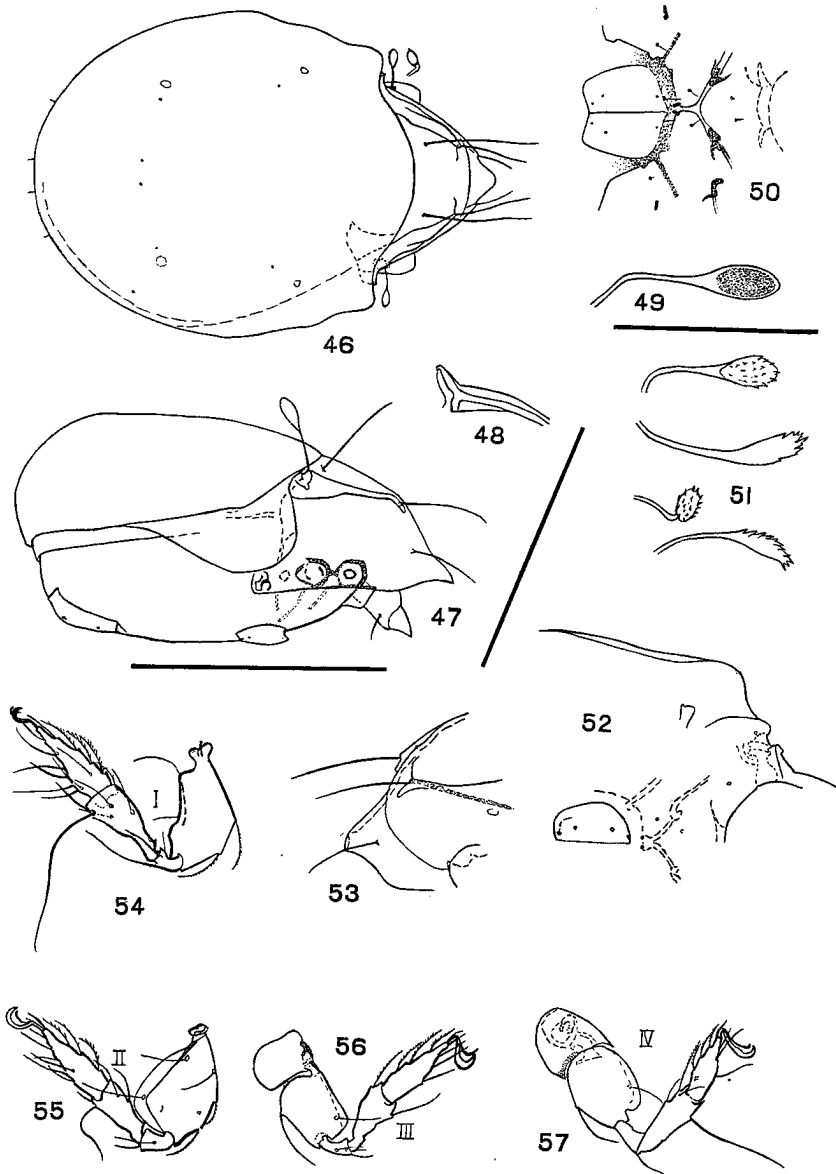
OPPIA AND CARDIORIBATES.



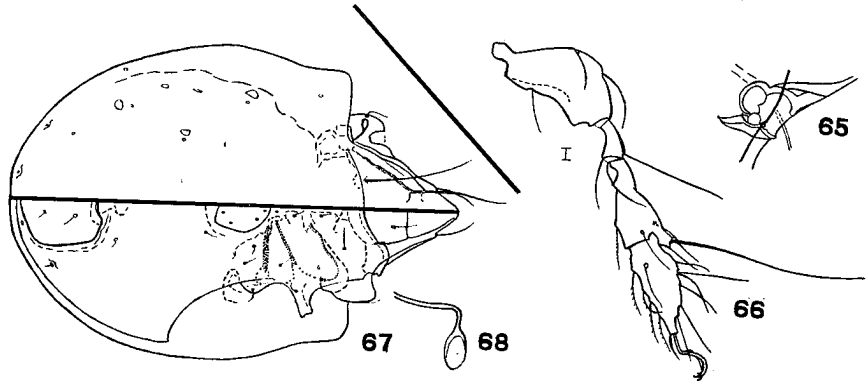
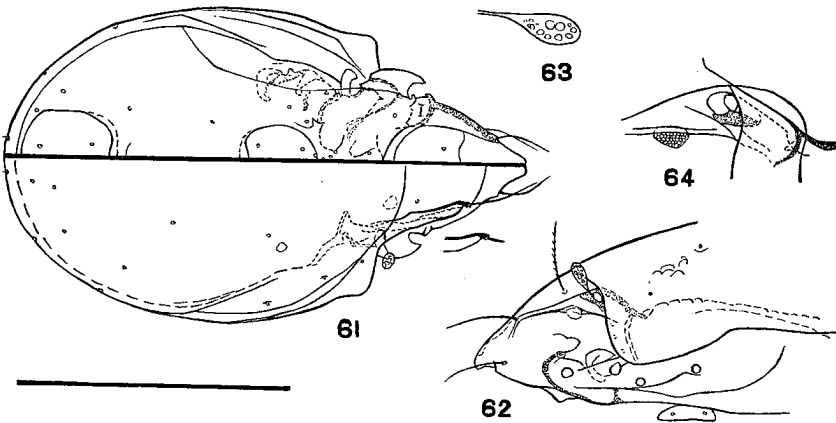
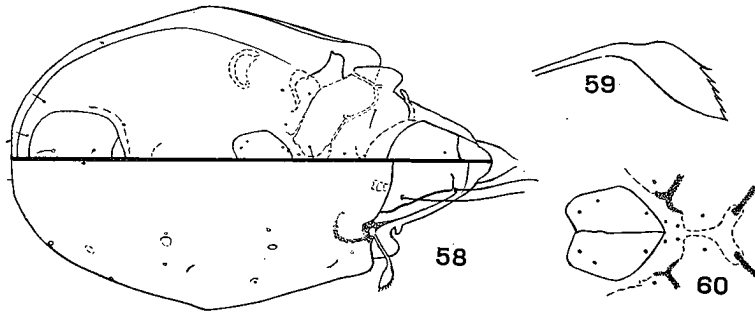
IMPARATOPPIA AND CALVOPPIA.



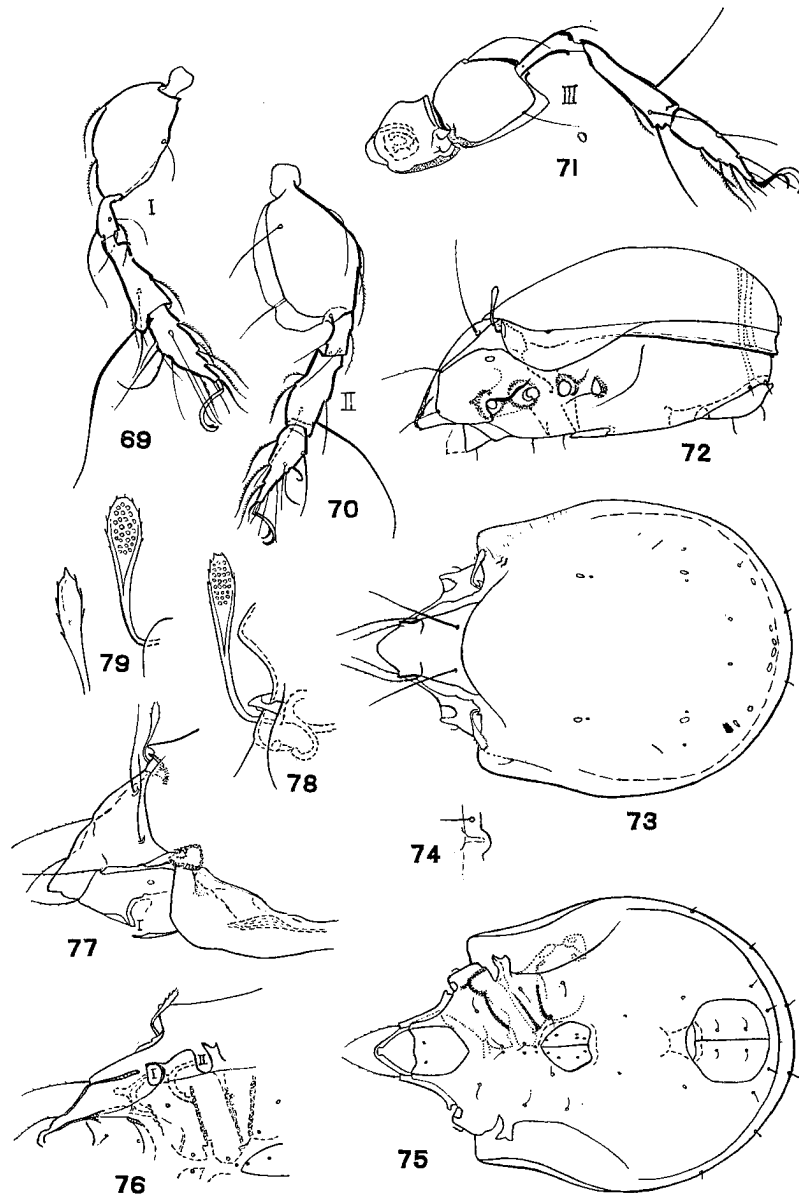
CALVOPIA AND PHAULOPIA



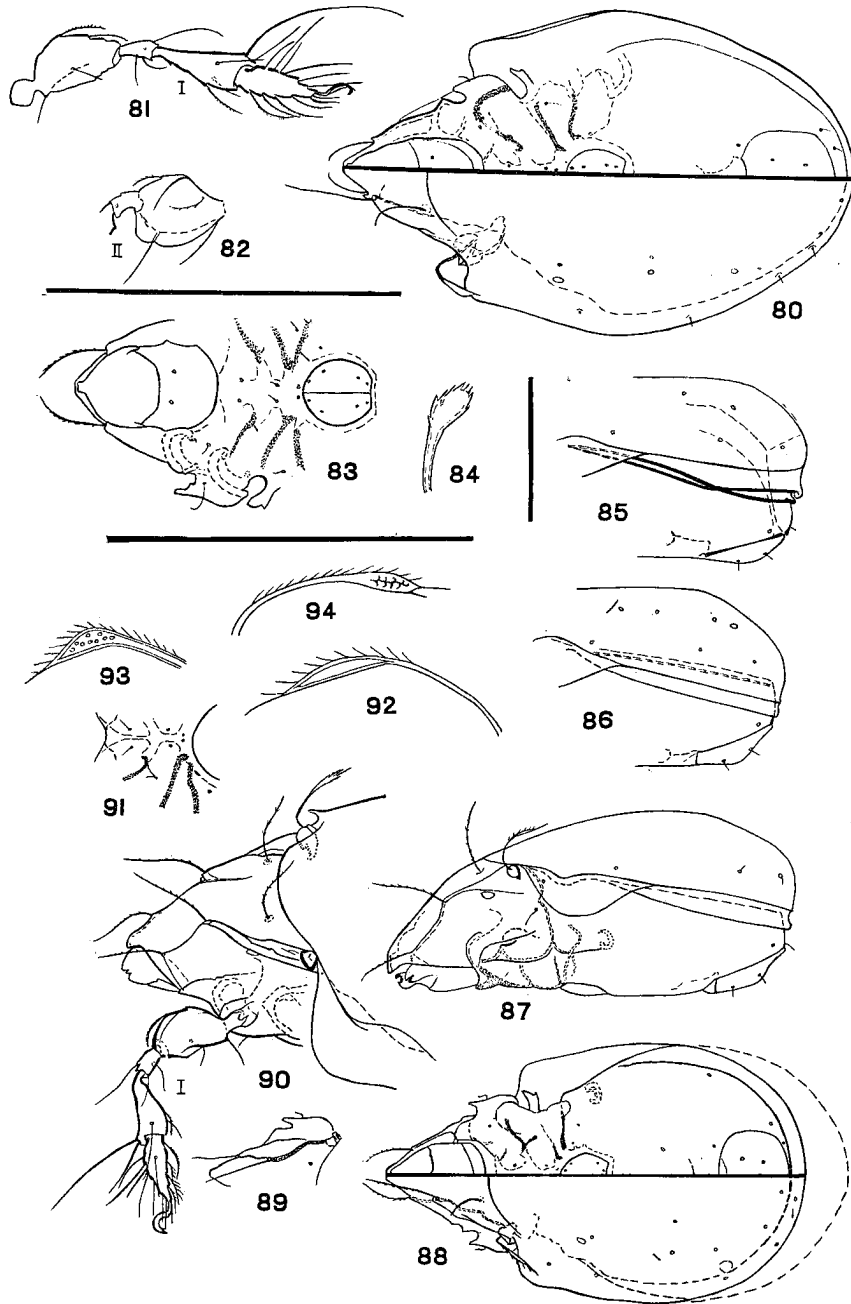
PROTOSCHELOBATES.



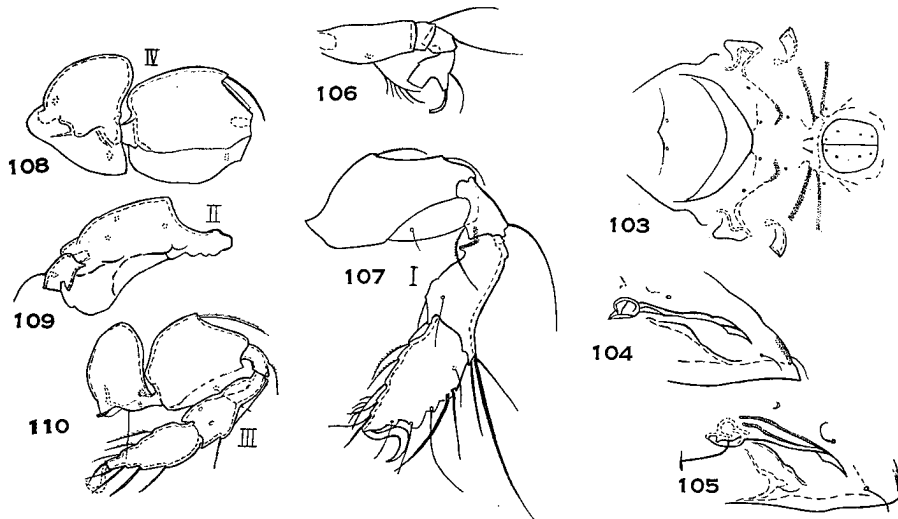
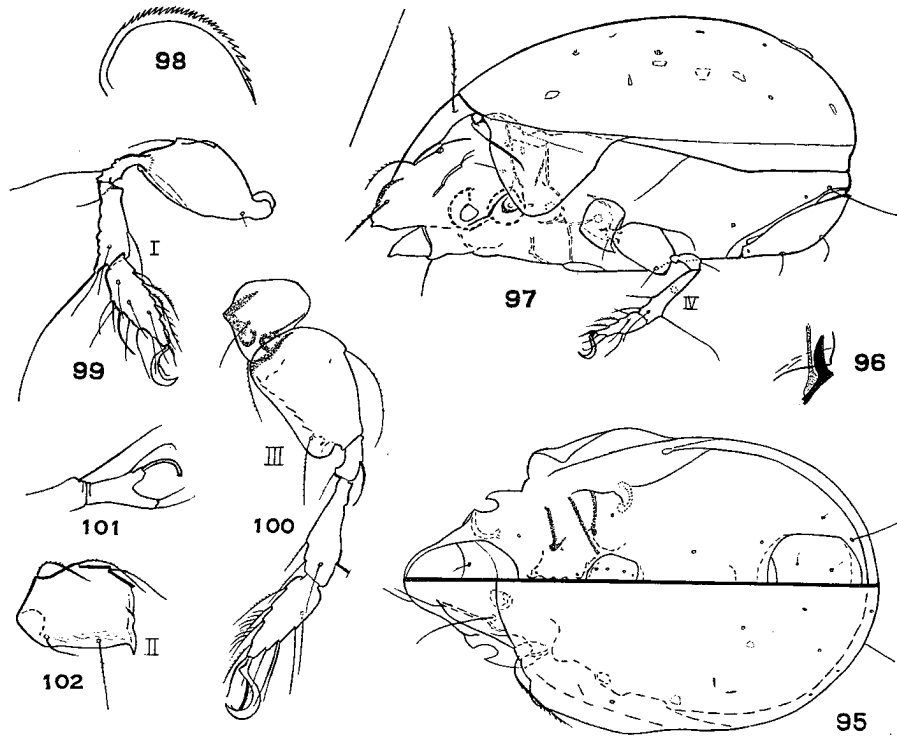
PROTOSCHELOBATES AND SCHELOBATES.



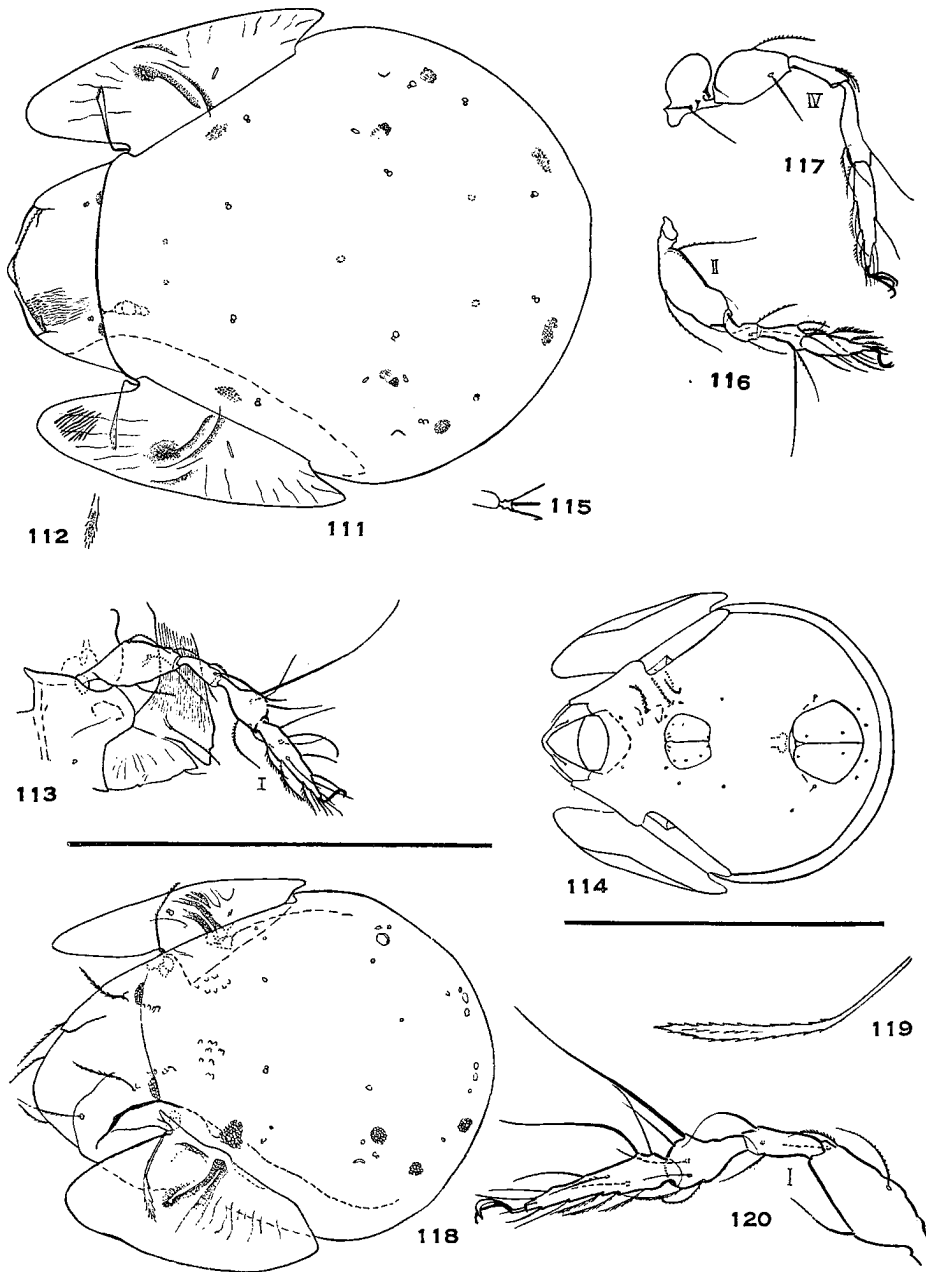
SCHELORIBATES



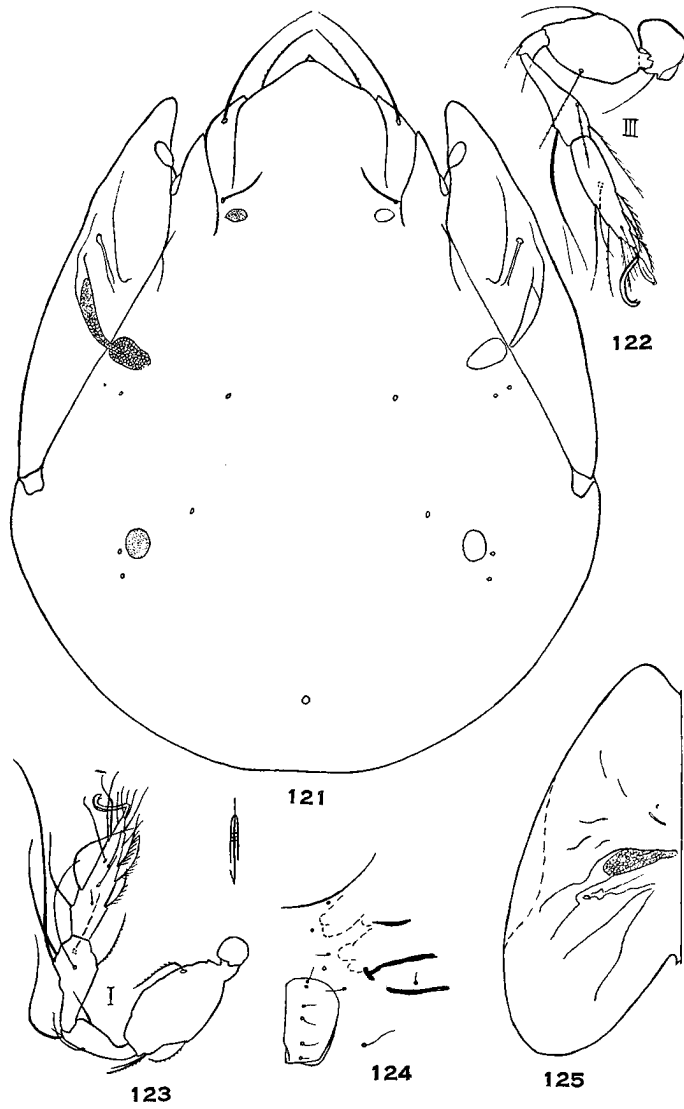
SCELORIBATES



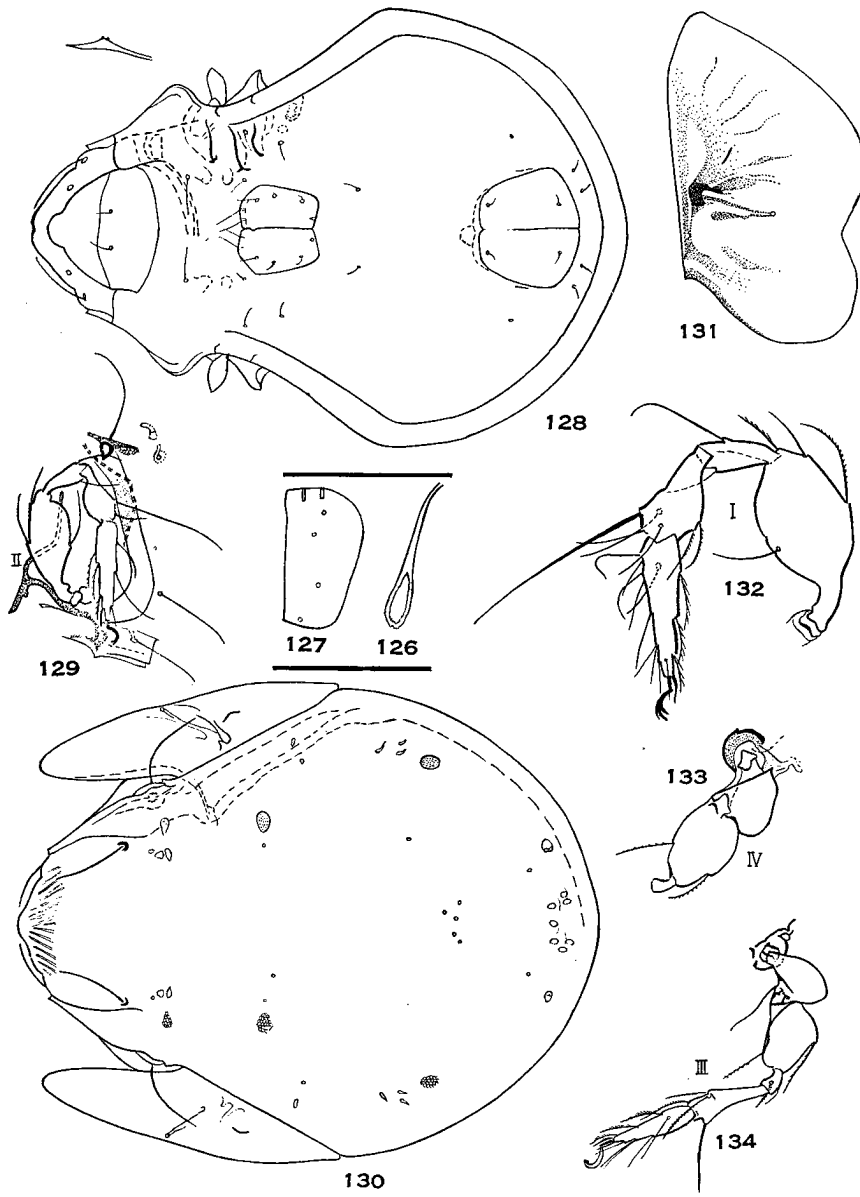
STYLORIBATES AND XYLORIBATES.



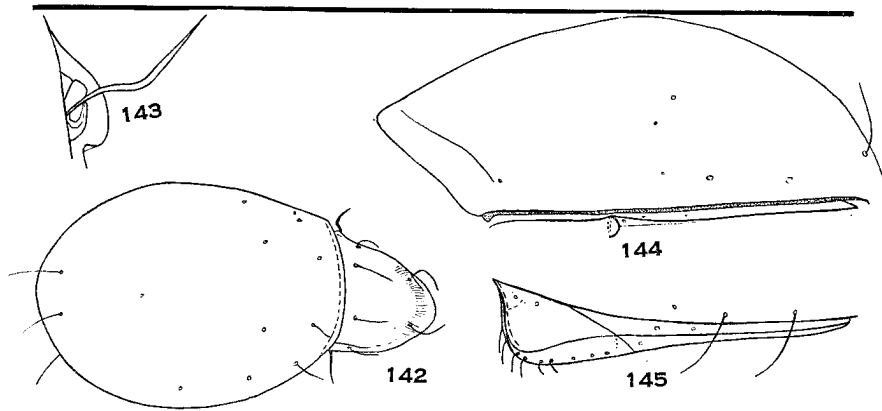
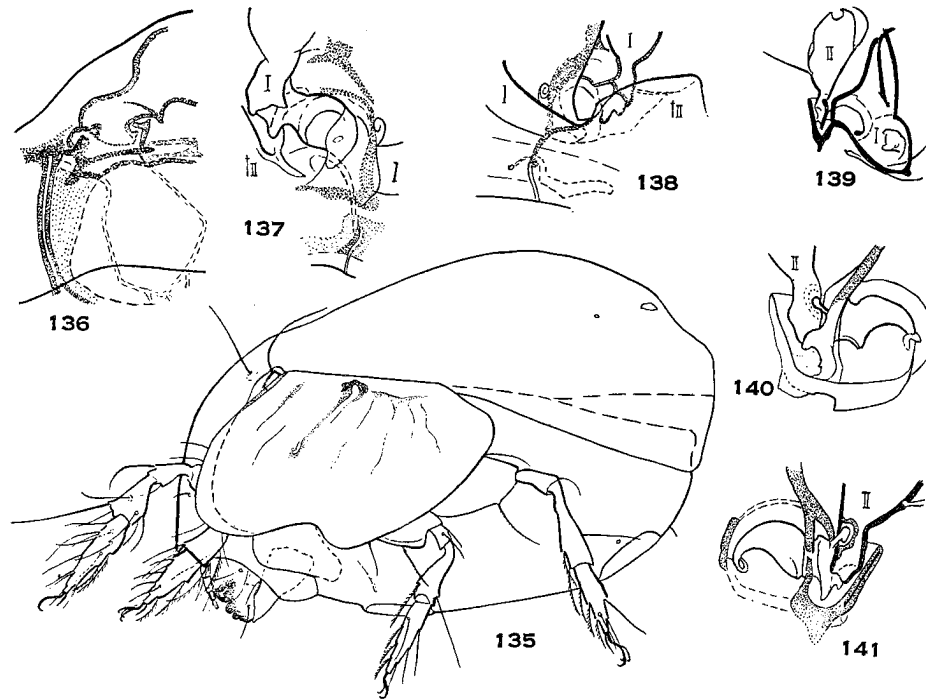
ZETES.



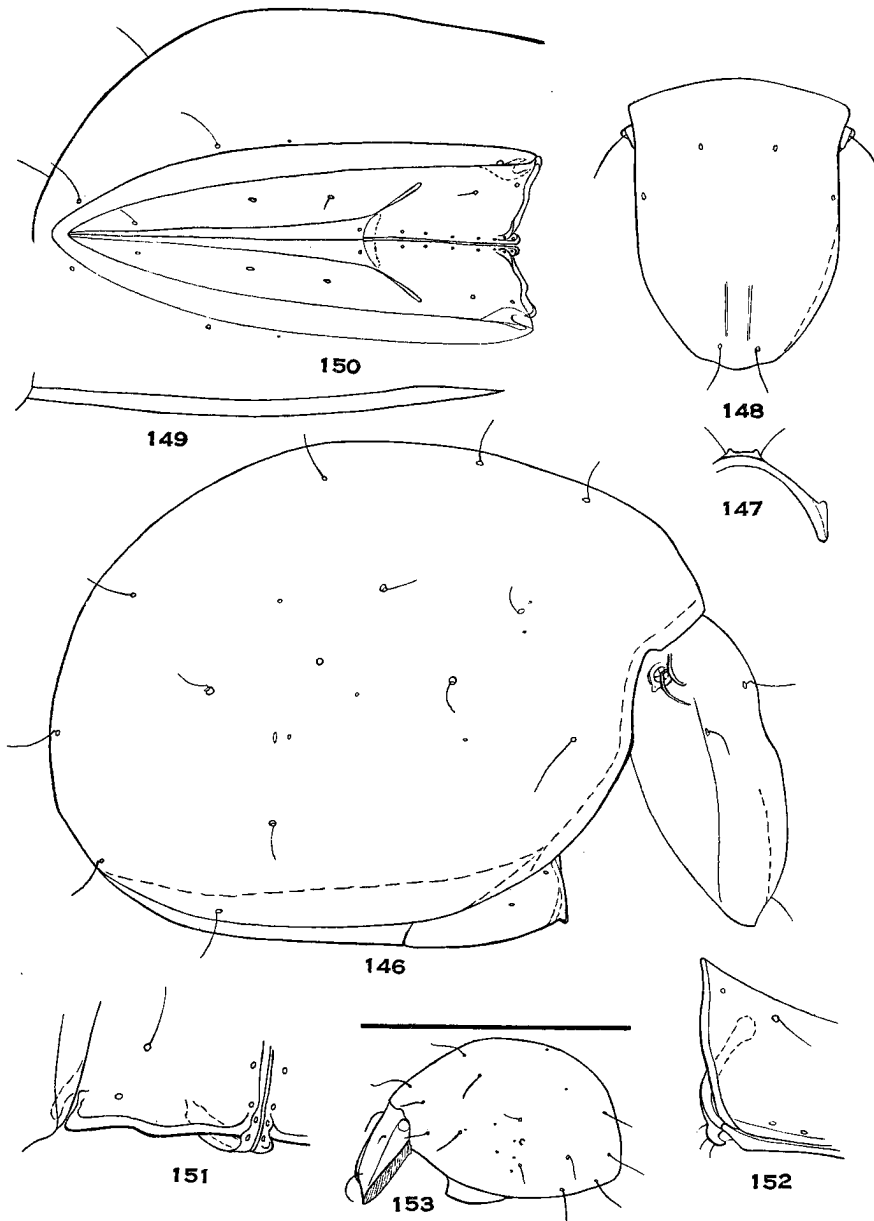
GALUMNA.



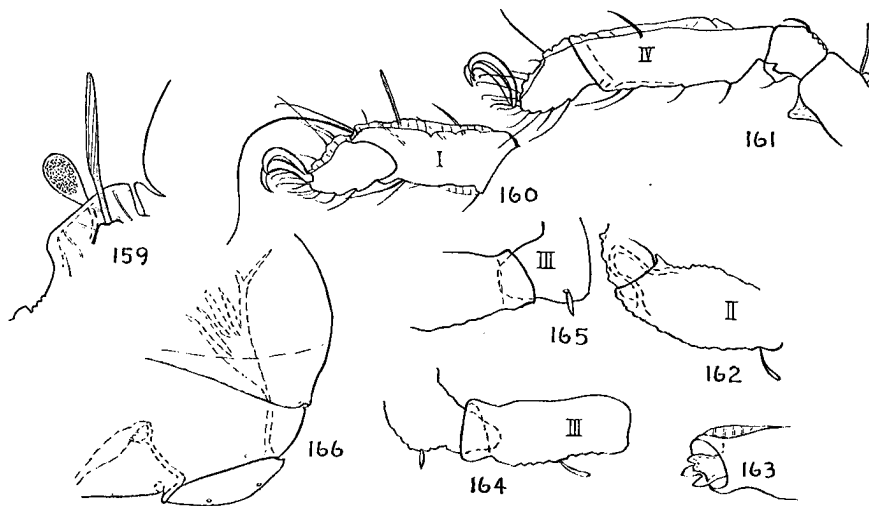
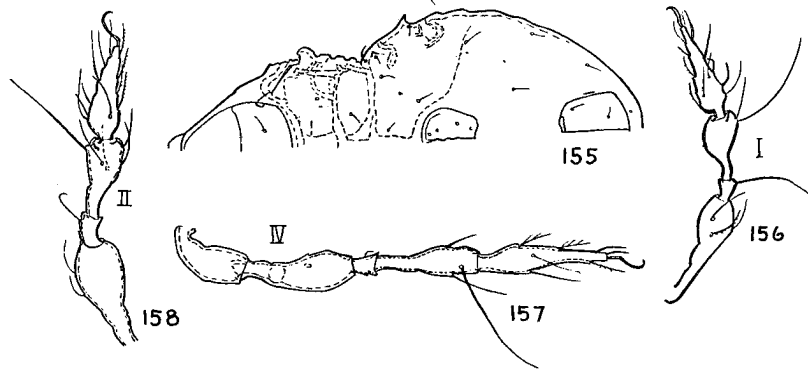
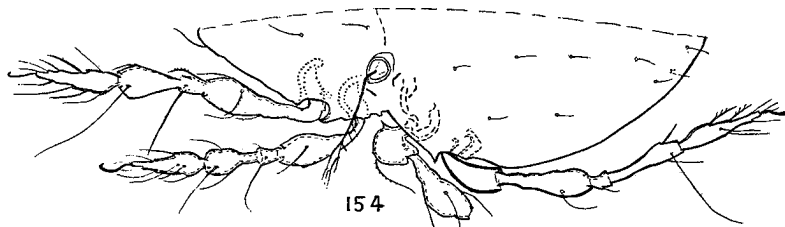
ZETES AND GALUMNA.



GALUMNA AND ORIBOTRITIA.



INDOTRITIA AND ORIBOTRITIA



DAMEOSOMA, UDETALIODES, AND PROTOSCHELOBATES.