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REDESCRIPTION OF *CERATOLASMA TRICANTHA* GOODNIGHT AND GOODNIGHT, WITH NOTES ON THE FAMILY ISCHYROPSALIDAE (OPILIONES, PALPATORES)

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ABSTRACT

Ceratolasma tricantha Goodnight and Goodnight, 1942, is redescribed in both sexes; descriptions and figures of most features of external morphology and some details of anatomy are given. Known distribution of the species is mapped. The arguments for the systematic rearrangement (*Ceratolasma* placed near *Ischyropsalis* in Ischyropsalidae) are expanded; some features of the latter genus are examined in comparison. The genus *Ruaxphilos* Goodnight and Goodnight, 1945, is considered a synonym of *Ortholasma* Banks. Questions of delimitation of and generic groupings in the family Ischyropsalidae are discussed.

INTRODUCTION

The genus *Ceratolasma*, with its only species *C. tricantha*, was established in 1942 by C. J. and M. L. Goodnight as a member of the Trogulidae. No further material had been published until 1969, when I described a stridulating organ in the species, and transferred the genus to Ischyropsalidae. Martens (1969a) placed *Ceratolasma* close to *Ischyropsalis* and added descriptions of morphological details. This new placement has been followed by Ljovushkin (1971), Shear (1975), and Dumitrescu (1975). Since the original description was based on only one female, and subsequent publications only discussed certain aspects of the morphology, a detailed redescription seems justified, including a discussion of problems of systematic placement.

Material examined is deposited in the American Museum of Natural History (AMNH) and the California Academy of Sciences (CAS); a few specimens are in the Naturhistorisches Museum Wien (NHMW).

Family ISCHYROPSALIDAE Simon

At the time of its foundation by E. Simon in 1879, the family contained the genera *Ischyropsalis* C. L. Koch (previously in Nemasomatidae Simon 1872), *Taracus* Simon 1879, and *Sabacon* Simon 1879. It attained its classical definition in the work of Hansen and Sørensen (1904), whose formulations were largely accepted by Roewer (1914, 1923).

The latter included the genera *Ischyropsalis*, *Taracus*, *Tomicomerus* and *Sabacon*. Four genera have been added in later years: *Ruaxphilos* Goodnight and Goodnight, 1945, *Nipponopsalis* Martens and Suzuki, 1966 (for east Asian species formerly in *Ischyropsalis*), *Ceratolasma* Goodnight and Goodnight (Gruber, 1969), and *Hesperonemastoma* Gruber, 1970 (for North American species formerly in *Nemastoma*).

The morphological diversity of the family, noted by Hansen and Sørensen, is much greater than that of the rather homogenous families of the Trogluloidea (s.str.). Some authors (Martens 1969a) have commented on the heterogeneity of the family, and Dresco (1970) established a separate family for the genus *Sabacon* (in 1952 he had surmised a possible relationship between *Sabacon* and *Nemastoma*). In Ischyropsalidae, he retained the genera *Ischyropsalis*, *Taracus*, *Nipponopsalis*, and (with reservations) *Tomicomerus*. The reasons given for this rearrangement were, however, not convincing, and it has not found general acceptance (compare critical remarks in Martens 1972, Dumitrescu 1975, and especially in Shear 1975). Recently, Martens (1976) has revalidated the family Sabaconidae, without giving an explicit diagnosis, though he mentions differences in ovipositor form which do not seem significant to me.

On the other hand, the exclusion of certain nonconforming elements has lessened the heterogeneity of the Ischyropsalidae: *Nipponopsalis* now is in Trogluloidea (family Nipponopsalididae Martens 1976), mainly on the grounds of genital morphology and sternal configuration. It may be noted that Suzuki (1973, Fig. 152) figured the typically trogluloid ovipositor of *Nipponopsalis abei longipes*. Miyosi (1942) described "drumstick-like hairs" on the palpi of juvenile *N. abei*, which may be clavate hairs of the type known hitherto only in Nemastomatidae and juvenile *Dicranolasma*. This would corroborate the new placement, but studies of the fine structure of the hairs in question are still lacking.

The genus *Ruaxphilos* should be removed from the family; its only species, *R. petrunkevitchou* Goodnight and Goodnight), is a probable synonym of *Ortholasma* (= *Trilasma*) *bolivari* (Goodnight and Goodnight). Examination of the holotype (in the Field Museum of Natural History, Chicago), showed that it is a very young nymph which certainly does not belong to Ischyropsalidae, as indicated by the presence of clavate hairs on the palpi. This placement has also been suggested by Shear (1975), but he did not examine the holotype.

In the family, as understood here, remain the genera *Ceratolasma*, *Hesperonemastoma*, *Ischyropsalis*, *Sabacon*, and *Tomicomerus*. Doubts remain on the systematic positions of the following genera. *Sabacon* may after all require a separate family, or subfamily, but the relationship of this genus to *Tomicomerus* must be clarified. *Tomicomerus* seems to have characteristics of both "sabaconids" and of Ischyropsalidae, but inadequate material exists to resolve the question (Shear 1975, Dresco 1970). *Hesperonemastoma* is quite aberrant in, for example, scutum type and midgut anatomy (Dumitrescu 1975, Shear 1975); it may belong in yet another separate family with *Crosbycus* and an undescribed genus from Washington state (Shear, in litt.).

Apart from the possibly intermediate position of *Tomicomerus*, a family Sabaconidae seems to lack justification because of the absence of "distinct gaps" in several character series which serve as unifying traits of the family Ischyropsalidae, in its wider sense: midgut anatomy (Dumitrescu 1975), which suggests other groupings of the genera, the concededly trivial paired (*Sabacon*, *Tomicomerus*, *Ceratolasma*) or multiple (*Ischyropsalis*) armature of the second thoracic tergite, and the rudimentary palpal claw. The latter is mostly characterized as "lacking" in *Sabacon*, but according to my own limited experience this is not generally valid. In juvenile *Sabacon* I found peg-shaped

structures on the tips of the palpal tarsi which resemble the claw rudiments of other genera (compare Figs. 29, 21, 28). The "enigmatic sensillum" of Fig. 4 in Thaler (1976) seems to be the same thing. It is easy to overlook the tiny peg in the dense hair cover of the palpi.

A more formal argument concerns the status of the remnant family Ischyropsalidae, created as a coordinate group if one accepts Sabaconidae. The latter, as a monobasic family based on a well-defined, natural genus, as evidenced by several autapomorphies of *Sabacon*, would logically be a monophyletic group; the diminished Ischyropsalidae, however, remain a heterogenous, poorly defined paraphyletic group. This situation may lead to further splitting, resulting finally in a preponderance of monobasic families, an undesirable state of affairs against which Hansen and Sørensen (1904:77) uttered warning words.

It seems preferable at the present time to retain the family Ischyropsalidae in its classical Hansen and Sørensen form, with modifications of diagnosis and content as necessitated by more recent discoveries (see Gruber 1970:132). Perhaps other conclusions will be possible when all genera have been revised and a renewed comparative evaluation of characters is available. However, questions of family delimitation in this group now seem less urgent since Martens (1976) has clarified its position in the whole of Palpatores, as a well defined superfamily Ischyropsaloidea clearly separated from the Troguloidea. Female genital morphology may be a key character of the group, the very short, unsegmented ovipositor with its undivided furca and mostly hairless corpus probably being an apomorphic feature of the superfamily.

A family diagnosis can only be preliminary, since the related, but aberrant genus *Crosbycus*, of uncertain position (Martens 1976), has not yet been fully described, but may run as follows: Ischyropsalidae are Ischyropsaloidea with normally developed leg coxae (without large basal endites or separate sclerite plates), pedipalpi with a peg-shaped claw-rudiment (*Sabacon*?). Formal recognition of subfamilies or other groups in the family still seems premature. Below I suggest a generic grouping which appears more natural and promising than the separation of just one specialized genus in its own family.

Genus *Ceratolasma* Goodnight and Goodnight

Ceratolasma Goodnight and Goodnight 1942:3, Roewer 1950:54, Gruber 1969:249, Martens 1969a:184, Gruber 1970:134, Ljovushkin 1971:130, Martens 1972:312, Dumitrescu 1975:151, Shear 1975:8, 10.

Type species.—*Ceratolasma tricantha* Goodnight and Goodnight, 1942 (by monotypy).

Diagnosis.—The genus is unique among the known Ischyropsalidae because of the frontal processes of eye tubercle and carapace, which hide the short chelicerae and palpi in troglid-like fashion.

Description.—Carapace includes thoracic tergites, the prethoracal part with caudolateral extensions to the sides of the laterally free second thoracic tergite. Frontal carapace margin with narrow median extension between cheliceral bases to base of epistome. Narrow lateral pieces ("pièces épimeriennes" of Simon 1879) of carapace continuous only with anterior carapace margin; ozopores not easily visible. Eye tubercle near anterior carapace margin, with median process, two similar processes on carapace to the sides of the eye tubercle. Opisthosoma with scutum parvum. Free tergites partially visible from

above. Corona analis with triangular lateral sclerites (=tergite 9) and anal sternite. Genital operculum demarcated posteriorly by furrow. Spiracles kidney-shaped, latticed, not visible in strictly ventral view. Prosomal venter with free sternum; labium large, trapezoidal, without setae. Leg coxae more or less immovable. Second to fourth coxae with small endites. Endite of first coxa with one oval movable sclerite. Labrum with horn-shaped process. Chelicerae and palpi short. Chela with narrow, diaphanous teeth and one dark, robust tooth near apices of fingers. Males with glandular areas on basal articles of chelicerae. Palpi stout, articles not inflated. Tibia and tarsus of palpus of about the same length, longer than patella, femur longer than patella. Patella, tibia and tarsus with microtrichia; no glandular setae. Peg-shaped rudiment of palpal claw short. The only known species has stridulating organs formed by chelicerae and palpal femora. Leg metatarsi with two distal spurs. No differentiated calcaneus, but marked difference in microsculpture and vestiture between basal and distal portions of metatarsi, with strongly inclined transition plane. Number of tarsal articles moderate.

Penis sheath with two sclerotized bands. Penis of simple shape, stout, tapering distally, tendon of muscle short. Glans conical, symmetrical, with numerous short, uniform setae. Stylus well differentiated, not reflexed when at rest. Ovipositor short, broad, corpus without hairs, distal part (furca) without visible dorsoventral differentiation, sparse setation around furcal base, group of shorter setae near apex of each distal lobe. Opening cleft symmetrical, bordered with densely spaced rows of small spines. Receptacula seminis short, rounded, saclike.

Relationships.—The original placement in Troglulidae was founded on a superficial resemblance to the ortholasmatine species of western North America, which likewise do not belong to this family (Martens 1969a, 1976). Despite the very different appearance, *Ceratolasma* is the closest relative of the European genus *Ischyropsalis*. It agrees with the latter in the following features: carapace with median anterior extension and well differentiated lateral pieces; free sternum and large labium; complex midgut (Dumitrescu 1975); ovipositor with spines bordering the apical opening and with setae of furca in basal and apical groups; soft lobes of palp endites with brushlike trichome groups (compare Fig. 7 in Avram 1975); palpi without plumose glandular setae and with pubescence of microtrichia on distal articles. Differences from *Ischyropsalis* comprise: eye tubercle near anterior margin of carapace, ozopores and spiracles not freely visible, ovipositor symmetrical.

If one disregards specializations connected with the troglulid-like body form and the stridulating organs, *Ceratolasma* shows a preponderance of more primitive character states: simpler penis shape, ovipositor without marked dorsoventrality and with saclike, not elongated, receptacula; sclerites of body more complete (freely visible ozopores and spiracles in most other ischyropsalids may be connected with sclerite reduction; Gruber 1970); first coxal endite with only one sclerite; chelicerae and palpi not elongated, chela with normal dentition.

Some of these traits merit a short discussion:

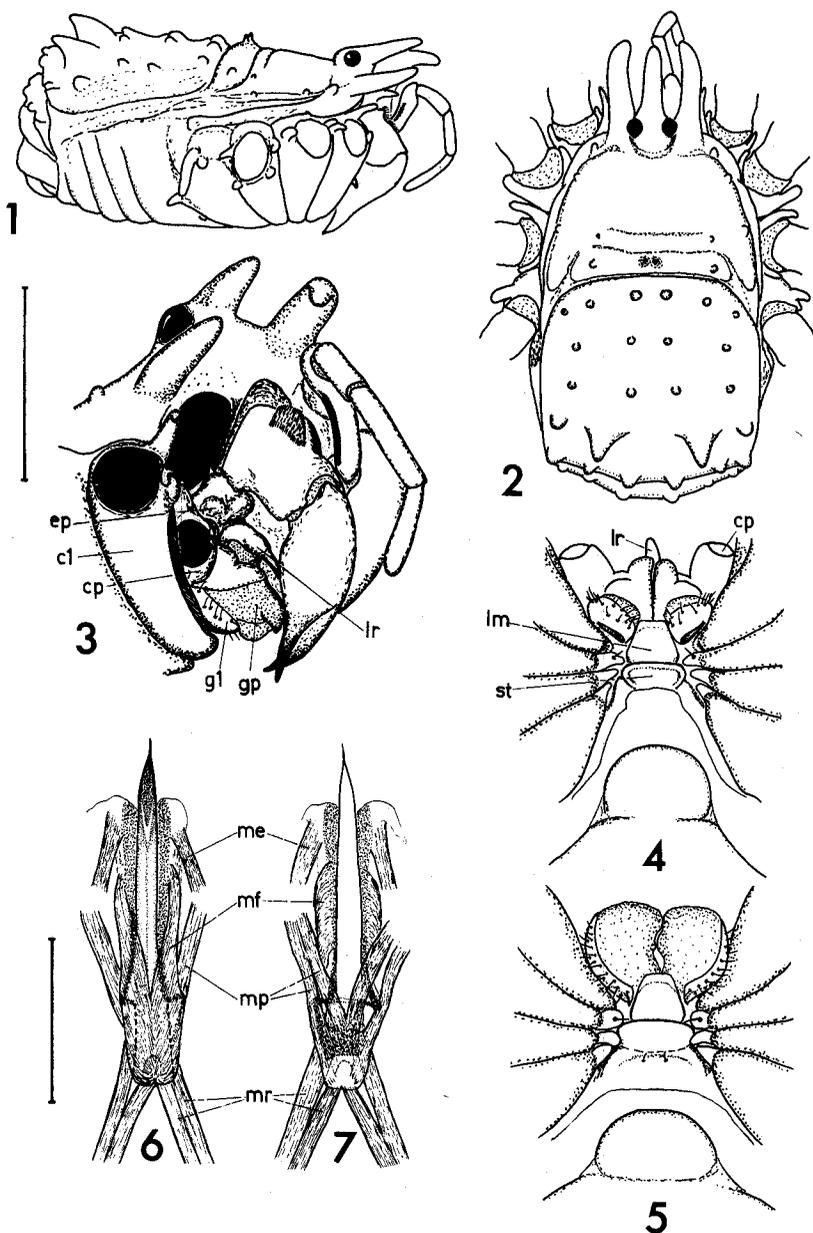
1. Ovipositor: Most ischyropsalid ovipositors are short and only sparsely set with setae, in the apical portion, resembling the "stumpy type" described in *Sabacon* by Suzuki (1974). The more troglulid-like "elongate" and "short" types (with setae on the corpus) are derived in *Sabacon*, according to this author. Together with the prevalence of "stumpy type-like" ovipositors in the other genera this speaks for the primitive nature of this type in the whole family. In *Ischyropsalis* species there is a distinct trend to dorsoventrality in the distribution of setae and the position of the secondary genital opening.

Specimens of *I. kollari* and *I. hellwigi* were examined; in the first species the opening is symmetrical, and there are only a few setae on the ventral surface; in *I. hellwigi* the opening is largely dislocated to the dorsal side, and setae are lacking on the ventral surface.

2. Coxal endite of first leg: the two movable sclerites of *Ischyropsalis* (Martens 1969a) probably correspond together to the one sclerite in *Ceratolasma*, as evidenced by a comparable concavity on the basal sclerite in *Ischyropsalis* and near the base of the sclerite in *Ceratolasma*. Secondary subdivision in the former genus seems more plausible than the reverse.

3. Chelicerae: Short or moderately long chelicerae, as in *Ceratolasma* (Fig. 15), *Hesperonemastoma*, *Sabacon* or *Tomicomerus*, have fingers armed with rows of closely spaced, narrow, diaphanous teeth (as typical for "Dyspnoi"), with ordinarily one subapical broad, blunt, darkened tooth on each finger. Elongated chelicerae (*Ischyropsalis* and *Taracus*) have more of the dark, coarse dentition; *Taracus*, and especially *Ischyropsalis*, have rows of coarse teeth near the finger bases (Müller 1924, Roewer 1923, Ljovushkin 1971). It seems that elongation of the chelicerae and their fingers has led to intercalation of additional stretches of cutting edge in different parts of the chela in the diverse genera; another argument for the independent derivation of the *Ischyropsalis*-like forms. The widely held opinion that long chelicerae are "simply adaptations to snail eating (Shear 1975)" is not substantiated by facts, even Shear cites evidence to the contrary for *Taracus*. Martens (1975) states that, in *Ischyropsalis*, only *I. hellwigi* is a specialized snail eater, the other species preferring arthropods as prey. The presence of presumably glandular hairs on the palpi of *Taracus* and *Nipponopsalis*, at least in juveniles may point to habits of the latter sort in these genera. If my guess is correct, these palpi act as sticky traps which are primarily aimed at arthropod prey.

Ceratolasma differs sharply from the other American genera of the family, by the vestiture of the palpi and the sternolabial configuration alone. As indicated above, these two character complexes allow us to discern two groups of genera: The first (*Ischyropsalis* and *Ceratolasma*) shows a prominent sternum, large labium, palpi without plumose setae, but with numerous microtrichia, and also a complex midgut anatomy. The second group (*Taracus*, *Hesperonemastoma*, *Tomicomerus*, *Sabacon*) shows less developed sterna, small labia, palpi with extensive development of plumose setae and reduction of the microtrichial cover; the midgut anatomy, though generally simpler, is less uniform and may point to a heterogenous nature for the second group. Closer analysis will be needed for a definitive taxonomic evaluation of these groups. Contradictory statements concerning the sternal region in *Taracus* in Martens and Suzuki (1966) and in Martens (1969), and the erroneous description based on insufficient material given by Gruber (1970) for *Hesperonemastoma* are examples of the lack of precise knowledge even in the recent literature. Concerning the palpal vestiture, neither of the states described above seems to be primitive: well developed microtrichia seem a primitive trait, as judged by comparison with other families (Sironidae, Phalangiidae), and by comparison with the serially homologous legs. Reduction of microtrichia on the palpi seems to be correlated with the specialized functions of these appendages. In the Laniatores, the same situation occurs. On the other hand, glandular setae of the plumose type seem to be primitive for the Palpatores, as judged from their presence in all three non-troguloid superfamilies. Their precise location on the palpi, and presumably their function, varies between the groups (Ischyropsaloidea versus Caddoidea-Phalangoidea). Their absence in the *Ischyropsalis-Ceratolasma* group therefore may be secondary, while their excessive development in the other group, most marked in *Sabacon*, is clearly a specialization.



Figs. 1-7.—*Ceratolasma tricantha*, external and genital morphology: 1, male, lateral view of body; 2, male, dorsal view of body; 3, male, frontal body wall and camerostome in oblique view (right chelicera, right palpus and legs removed); 4, male, sternal region with proximal parts of coxae, ventral view (genital operculum removed, figured as inset below); 5, female, as in 4; 6, male, penis with penis sheath and its muscles, ventral view (penis sheath opened longitudinally, its sclerotized bands bent near base); 7, same, dorsal view (penis in outline). cp, palp coxa; cl, first leg coxa; ep, epistome; gp, palp gnathocoxa; gl, gnathocoxa of first leg; lm, labium; lr, labrum; st, sternum; me, closer of genital opercule; mf, muscle running ventromedian to dorsodistad on penis sheath; mp, protractor muscles; mr, retractor muscles of penis. Upper scale: 2 mm for Figs. 1, 2. 1 mm for Figs. 3, 4, 5. Lower scale: 1 mm for Figs. 6, 7.

Distribution.—The genus, according to our present knowledge, is confined to the western Nearctic. The only known species has a rather restricted range in the humid coastal regions of Oregon and northern California. Biogeographical links to the eastern Nearctic or the eastern Palearctic, as known in several other phalangid groups, are not evident; the closest living relative, *Ischyropsalis*, occurs in the western Palearctic. This type of holarctic disjunction is comparatively rare, at least among animals, the salamander *Hydromantes* being cited most often (Udvardy 1969, Wake 1966). Other examples, mainly from Coleoptera, are given by Halffter 1964, Jeannel 1942, Linsley 1958 and Van Dyke 1926. In our case it is certainly old, predating the Tertiary, in view of the strong morphological differentiation (Wake 1966, surmises early Eocene for *Hydromantes*).

Ceratolasma tricantha Goodnight and Goodnight

Figs. 1-28, Map 1

Ceratolasma tricantha Goodnight and Goodnight 1942:3, fig. 3, Roewer 1950:54, Gruber 1969:249, figs. 1, 2, Martens 1969: 186, figs. 30, 31, Ljovushkin 1971:131, Dumitrescu 1975:153, 155, fig. 21.

Types.—Holotype female, from Clear Creek, near Forest Grove, Washington Co., Oregon; deposited in AMNH; not seen.

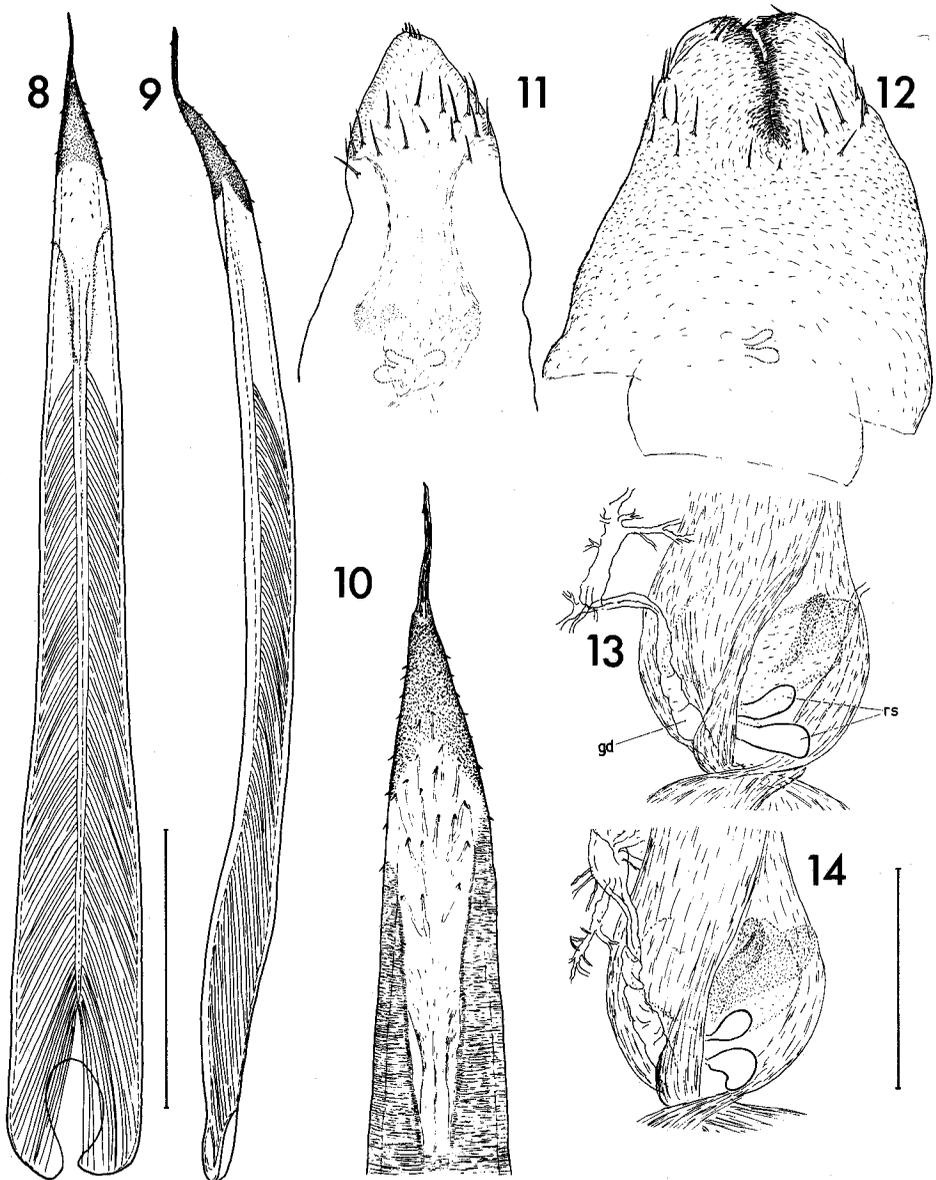
Diagnosis.—Genus monotypic.

Description.—The following redescription is based chiefly on a male from Bogus Creek, Oregon, and a female from Canyonville, Oregon; accidentally these are, respectively, the smallest and largest specimens seen.

Body flattened dorsally (Fig. 1); in dorsal view (Fig. 2) approximately rectangular in outline with parallel sides, posterior margin slightly convex.

Body sclerites stiff-leathery, often with diffuse edges against smooth membranes; their surfaces coarsely granulated or finely denticulated (excepting sternal area, coxal endites, mouthparts, etc.). Microscopically small granules are scattered between visible denticles. Pilosity of body sparse, on dorsal side especially inconspicuous, more distinct on venter; consisting of small, short setae with rounded tips. Body macrosculpture of rounded tubercles or warts of various sizes and forms, with granulated surfaces and white cores or tips, excepting the wholly brown cones on the second thoracic tergite.

Eye tubercle demarcated behind by curved groove, with nearly horizontal, blunt-conical process in front. Carapace processes to the sides of the eye tubercle similar, curved slightly mesiad and directed slightly upwards. These may sometimes be longer than the median process, as in the specimen figured (Figs. 1, 2). Carapace with scattered small tubercles, three larger ones near lateral margins on each side, the foremost before curved end of suture delimiting the lateral pieces. Prethoracic carapace with triangular caudolateral extensions on the sides of the second thoracic tergite, separated from latter by membrane wedges extending from behind (Fig. 2). Thoracic tergite 1 demarcated by shallow transverse groove anteriorly, with a small tubercle on each side, a few tiny ones in transverse row. Second thoracic tergite delimited by deeper transverse groove anteriorly; with broad median swelling bearing two closely spaced, blunt, conical spines with relatively smooth surfaces, lateral parts with a small tubercle on each side. Narrow lateral pieces to the sides of the carapace proper (Figs. 1, 2) delimited by narrow membrane folds extending anteriorly to height of first coxae, where the sutures curve mesiad in direction of the posterior eyemound margin and grow indistinct in the carapace. Anterior



Figs. 8-14.—*Ceratolasma tricantha*, genital morphology: 8, penis, ventral view (muscle and tendon shown); 9, same, lateral view; 10, penis, apical part in ventral view; 11, ovipositor, lateral view (only setae shown of superficial structures; extent of opening cleft and its spine border, situation of vagina and seminal receptacles indicated); 12, same, viewed from flat side (slightly squeezed. Superficial structures and outline of seminal receptacles on one side shown); 13, part of inner structures of ovipositor (vagina, seminal receptacles and branched ducts of glands on one side shown); 14, same, viewed from other side. gd, gland ducts; rs, seminal receptacles. Left scale: 0.5 mm for Figs. 8, 9, 11, 12. Right scale: 0.22 mm for Figs. 10, 13, 14.

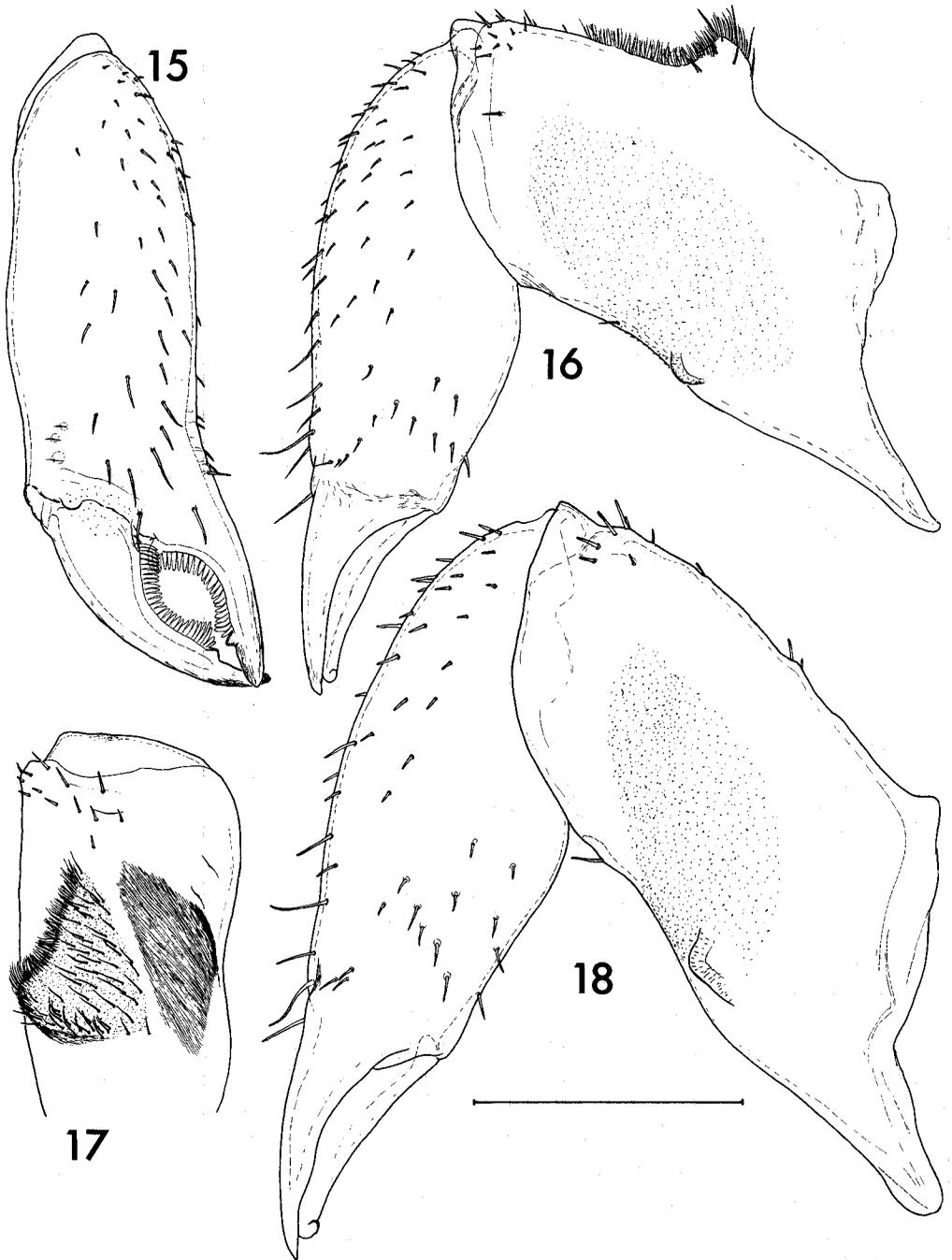
part of lateral pieces slightly convex, white plates above first coxae, continued caudad as narrower strips with dark hypodermal pigment. Ozopores small oval openings in the membranes above first coxae, not visible from above.

The conditions described above apply mainly to males. In females, especially gravid ones, the body is oval, its dorsal side more convex, all membrane folds are strongly distended, forming a broad transverse zone between scute and carapace. A broad wedge of membrane extends anteriorly to the sides of the second thoracic tergite, another one between carapace proper and lateral pieces, separating the posterior part of the carapace widely from the lateral pieces which remain close above the coxae. This tilting of the carapace, which also occurs in *Ischyropsalis*, seems to allow more room for the accommodation of increased body contents; one may see here a functional reason for the differentiation of "pièces épimériennes." The posterior parts of the lateral pieces show membranous divisions from their anterior parts; also the triangular caudolateral carapace flaps are more or less detached.

Opisthosomal scute of approximately square outline (Fig. 2), margins slightly convex. Segmental pairs of tubercles largest on area 4, smaller on posterior margin of area 5. Large tubercles of fourth area broad, conical, slanted caudad, more widely spaced than other pairs. Lateral parts of areas with one, two or three smaller tubercles on each side. Narrow free tergites 6 and 7 with similar, lower sculpture. Tergite 8 curved, with very low tubercles. Tergite 9 represented by two triangular lateral sclerites. Anal operculum rounded-triangular. Anal sternite small, without visible subdivision. Free sternites narrow. Genital operculum delimited by shallow groove on posterior margin; nearly semicircular in male, broader in female (Figs. 4, 5). Spiracles rather large, elongated, kidney-shaped, densely latticed; not visible in strictly ventral view, situated in the posterior wall of the deep cleft between fourth coxa and opisthosoma, near the ventral edge. Anterior edge of spiracular sternite slightly indented below spiracle, the latter hidden by small, slightly convex fold.

Leg coxae rounded, without marginal rows of tubercles; their surfaces coarsely granulated; distal ends with whitish tubercles, at most two on dorsal and ventral sides of each coxa, the dorsal ones elongated into blunt spines, those on prolateral side of the first coxa large and curved, here also on ventral side a lower tubercle (Figs. 1, 2, 3). Second to fourth coxae with small endites, which lack granulation and are darker brown, those of coxae 2 with one seta each (in one female there were two setae on one side; Figs. 4, 5). Between posterior coxae a well developed, transversely oval sternum (Figs. 4, 5), its anterior and lateral edges protruding, its posterior margin less well defined, merging into area of pale cuticle between fourth coxae, in females two setae are found here. Other sexual differences in the shape of the sternum correspond to those of the overlying genital operculum (Figs. 4, 5). Anterior to sternum a large, hairless, trapezoid labium, its basal part connected to the endites of the first coxae, its distal part membranous (this differentiation more clearly marked in the female). Endites of the first coxae with one movable, oval setose sclerite, with an elongated concavity near its base (Figs. 4, 5).

The hood-camerostome complex is the typical trait of opilionids with a troglid-like body. As hood I define here any roofing structure above the mouthparts, formed by processes of eye tubercle and carapace; as camerostome, more or less following Simon (1879), a space containing the anterior appendages when folded back at rest, delimited above the hood, at the sides partly by the latter, partly by the prolateral walls of the first coxae, aided by processes of the latter. In *C. tricantha*, the first coxae are curved distinctly anteriorly, their prolateral (anterior) walls, enlarged by the longer dorsal and shorter



Figs. 15-18.—*Ceratolasma tricantha*, chelicerae: 15, male, right chelicera, second and third articles in frontal view; 16, male, right chelicera, prolateral view; 17, male, right chelicera, basal article in dorsal view (basal portion omitted. Setae of gland area and ridges of stridulation area not individually shown); 18, female, right chelicera, prolateral view. Scale: 0.5 mm.

ventral spined tubercle, form the ventral part of the camerostome side limits (Figs. 1, 3). The dorsolateral and dorsal roofing is formed by the three large processes of eye tubercle and carapace, the latter evidently enlarged tubercles of the type occurring on the body surface. The frontal body wall, limiting the camerostome caudally, is nearly vertical (female) or even inclined backwards (male). It includes, below the hood, a downturned rim of the carapace and a narrow median prolongation between the cheliceral bases, reaching the epistome. It contains the epistome, labrum, and cheliceral and pedipalp insertions. Epistome broad, convex, with two low swellings placed side by side. Labrum delimited from epistome by deep curved groove, its dorsal part with horn-shaped process, its ventral side with soft membranous wedge between the palpal endites (Fig. 3).

Chelicerae (Figs. 3, 15-18) short, total length about half of body length. Cuticle smooth, shining, fine denticulation on ventromesial sides of basal article. Basal article in males with glandular area in middle of dorsal side; this area slightly concave, sparsely set with hairs, more densely so on upturned mesiocaudal margin, which is drawn up into a triangular tip posteriorly (Figs. 3, 16, 17). Opaque glandular tissue extends ventrad to about a third of the height of the article. Laterally from glandular area, a very dark convex area bearing closely spaced striae about parallel to distal margin of the article forms the "file" of the stridulating organ. Females with smooth dorsal contour, lacking glandular area, stridulating area as in males (Fig. 18). Chela short, with typical dentition (Fig. 15).

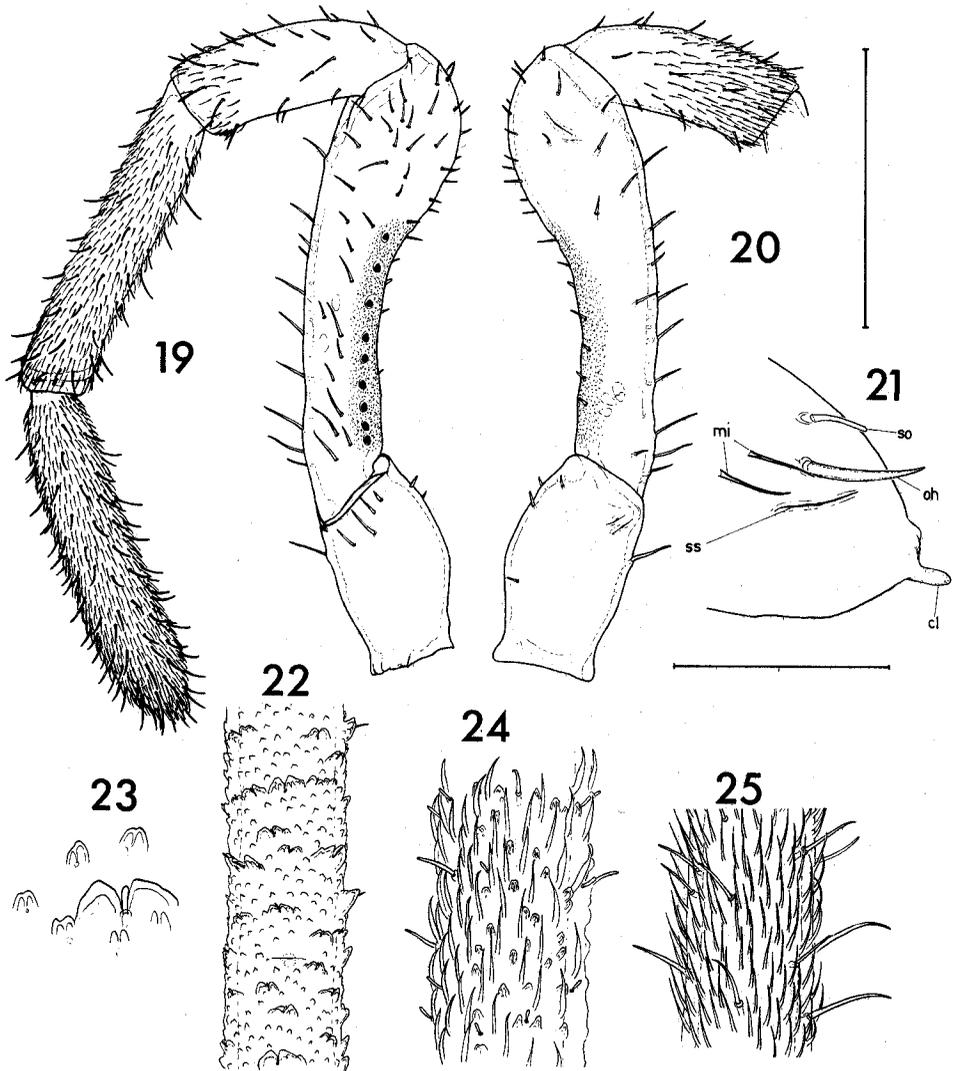
Pedipalpi (Figs. 19-21, 26-28). Coxal endites with finely denticulated cuticle on basal, sclerotized part; their soft distal part with pointed dorsoapical and rounded ventral lobe covered densely with minute papillae, between these scattered small, light colored trichomes, and brushlike groups of basally fused, light brownish trichomes (Fig. 26). Cuticle of free articles smooth. Femora stout, without basal bend, straight in female; slightly curved dorsad in males and thickened in apical part, with a swelling on prolateral side (Figs. 19-20). Patellae to tarsi cylindrical, rather stout. Tarsi with short, straight, peg-shaped claw rudiments somewhat hidden between hairs (Figs. 21, 28). Proximal two-thirds of prolateral sides of femora with rows of broad conical pegs set in basal rings (enlarged setae) in strip of very dark cuticle ("rasp" of stridulating organ). In one female a similar peg was found on the ventral side of the trochanter (Fig. 26). Setae of palpi of ordinary shape, straight or slightly recurved, denser near tip of tarsus. No glandular setae. Dense cover of microtrichia on tarsi, tibiae and patellae: to base of patellae in female (Figs. 26, 27), only apically in male (Figs. 19, 20). For discussion of stridulating organ see Gruber (1969), for eventual glandular function of male palpi see below.

Legs with articles rounded in cross-section. Trochanters with small tubercles on pro- and retrolateral sides. Femora 1 and 3, less so 4, stout and slightly thickened towards apex; the second one slender, cylindrical. Metatarsi thinner than tibiae; second with more or less clearly defined pseudo-articulations in distal part: mostly 2 to 4, only 1 in one male, lacking altogether in one female. Tarsi thin.

Tarsal numbers sometimes difficult to define due to incomplete subdivisions; numbers given here for right/left legs, in parentheses primary subdivisions: Male: 15(13+2)/15 (13+2)—20 or 21 (18 or 19+2)/19 (17+2)—17 or 19 (13 or 15+2+2)/17 (13+2+2)—17 (13+2+2)/18 (14+2+2). Female: 16 (14+2)/16 (14+2)—21 (19+2)/21 (19+2)—18 (14+2+2)/18 (14+2+2)—19 (15+2+2)/20 or 21 (16 or 17+2+2).

Leg sculpture and vestiture: Femora (Figs. 22, 23) with small denticles scattered over surface, larger ones more or less ordered in transverse rows, predominantly on the dorsal side. Small denticles mostly with two, larger ones with several, "cores." Setae of two

types: short, bluntly club-shaped ones, each associated with a double denticle, scattered over surface (Fig. 23), and larger ones in longitudinal rows. Tibiae similar, but denticles more sloping distad, setae longer, especially on second leg. Microtrichia scattered sparingly on ventral surfaces of first and second tibiae, forming a ventroapical wedge-shaped area, more on prolateral side; also a few microtrichia on base of second and middle of first tibia (not found in female). Metatarsi with different types of microsculpture on basal and apical parts (Figs. 24, 25); with transition plane strongly inclined in dorsodistal to



Figs. 19-25.—*Ceratolasma tricantha*, male, morphology of pedipalps and leg sculature: 19, right palpus, prolateral view; 20, same, retrolateral view, tibia and tarsus omitted; 21, tarsus apex, retrolateral (claw rudiment and only a few representatives of hair types shown); 22, femur of second right leg, prolateral, middle part, microsculpture; 23, same, detail of denticles; 24, second right metatarsus, prolateral, middle part of basal portion; 25, same article, middle part of distal portion. cl, claw rudiment; mi, microtrichia; oh, ordinary setae; so, solenidion; ss, slit sensillum. Upper scale: 0.5 mm for Figs. 19, 20, 22. Lower scale: 0.2 mm for Figs. 24, 25; 0.1 mm for Figs. 21, 23.

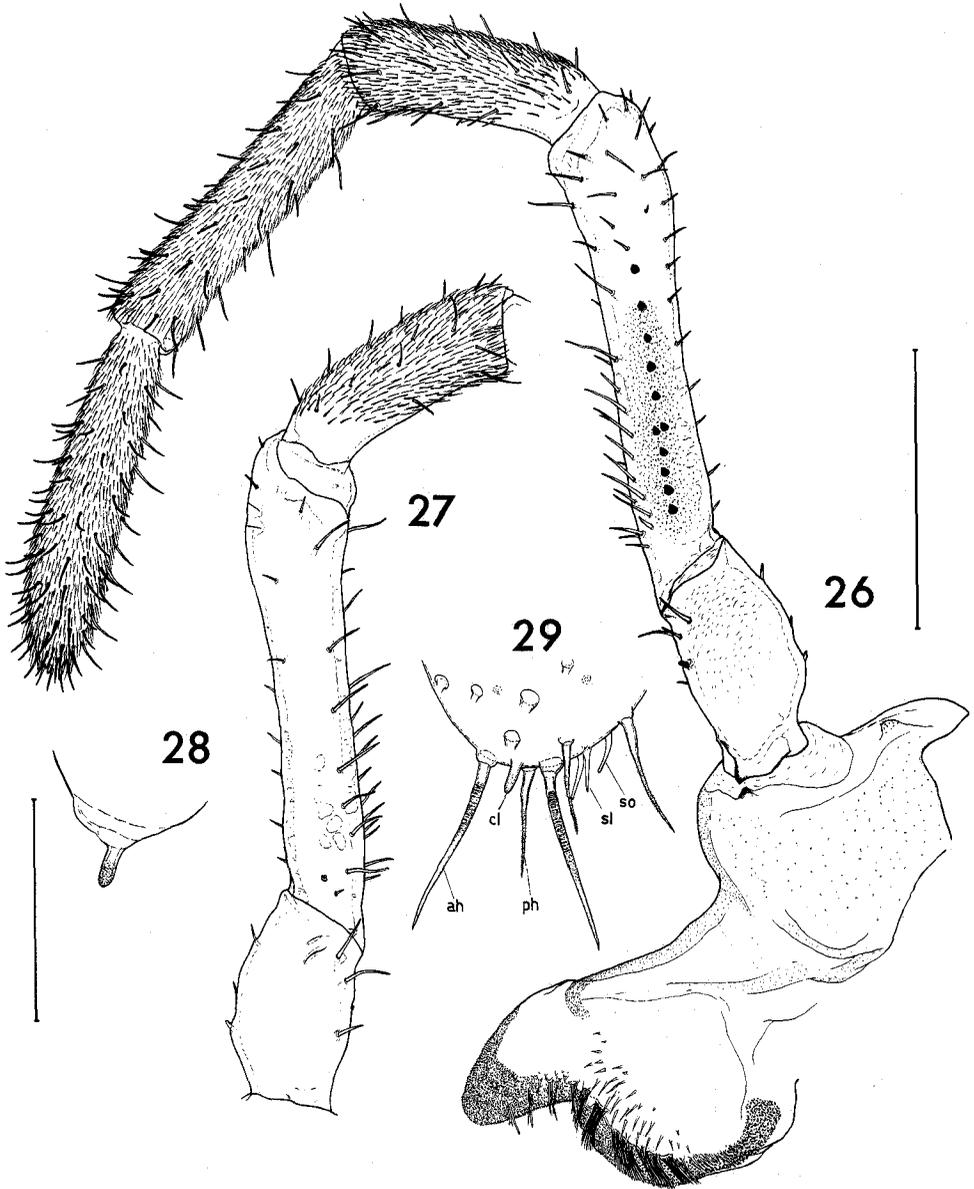
ventrobasal direction. Distal type covers a variable length of the dorsal surface (about the apical third in first, half in second, fifth in third and eighth in fourth metatarsus), it extends farther basad on the ventral side. This apical part with its visibly different pubescence presents a certain similarity to a calcaneus, which is not otherwise demarcated. Sculpture and vestiture of basal portion similar to that of tibia; only basoventrally a few microtrichia (leg 2, see above!), which are thicker, more strongly curved, generally coarser than those of the distal portion; short blunt setae in association with denticles; longer setae blunt. Distal portion with dense cover of microtrichia of slender and hairlike shape; denticles and short setae lacking; longer setae pointed; between other hairs are hair sensilla. Tarsi similar to distal portion of tibia.

Genital morphology: Male: Penis sheath with soft pale cuticle, dorsolateral walls with two brown, sclerotized bands, widening basad and fused into a dorsobasal plate (Figs. 6, 7). Musculature of penis sheath includes four muscle pairs (Figs. 6, 7), which correspond to the description given for *Ischropsalis* by Hansen and Sørensen (1904), with one notable discrepancy (abbreviations used here follow these authors): *mr* and *mp* show subdivision into two fiber bundles; *mf* arises in basal fourth of the penis length in the ventro-medial line and runs in dorso-distad direction, parallel to the surface of the penis sheath. Hansen and Sørensen figure a corresponding muscle (*mg*) in *Nemastoma*, but for *Ischyropsalis dispar* (their Fig. IV/18) they describe muscle *mf* as running just in the opposite direction. cursory examination of a penis of *Ischyropsalis hellwigi* showed that the conditions in this species correspond to those in *Ceratolasma*, differences in proportions being neglected. It seems therefore that the differing data in Hansen and Sørensen were caused by an error in orientation, and that the muscle sheathing the basal part of the penis has the same general situation in Ischyropsalidae and Nemastomatidae.

Penis stout (Figs. 8, 9), total length 2.0 mm. Shaft tapering evenly from base to apex, flattened on dorsal and ventral sides, base with small but deep median notch. Cuticle dark brown, with fine transverse wrinkles and even finer longitudinal striations, dorsal side with larger pores. Tendon of muscle short, less than one tenth of shaft length, inserting ventrally on glans base (Fig. 10), on base of dark triangular, tongue-shaped plate, which is surrounded by pale membranous zone (Fig. 6). Glans conical, with numerous short thin setae (Fig. 10), very dark, especially near apex. Stylus thin, extended in penis axis, but flexible at the base, with small ventrolateral hook.

Female: Ovipositor short and stout, slightly depressed ($0.75 \times 0.55 \times 0.40$ mm), Figs. 11, 12. Cuticle soft, pale, wrinkled, with small papillae, especially on the apical portion. Opening cleft equally deep on dorsal and ventral sides, bordered with densely spaced, minute spines (elongated papillae). Setae sparse: a few brownish, stronger ones on low sockets, form an irregular double circle around the base of the furca lobes, without visible dorsoventral asymmetry. Two groups of shorter setae on apices of furca lobes (possibly in a notch of the spine border, but I could not ascertain finer details of the apical structures in my preparation). Vagina with longitudinal folds showing torsion especially basal from receptacles; dorsal and ventral "stiffening rods" distal from receptacles extend near surface of ovipositor. Two extensive glands take most of the space between surface and vagina, their richly branched ducts discharge into vagina near the receptacles (Figs. 13, 14). Seminal receptacles: on each side two short, oval sacs.

Coloration and pattern: The color pattern of the body consists of dark brown, black, amber and strikingly white parts. Pigments, especially the white one, predominantly hypodermal, only dark brown and black sclerotized parts with pigmented cuticle. Cuticle generally amber-hyaline. Membranes without white pigment, but may be underlain by

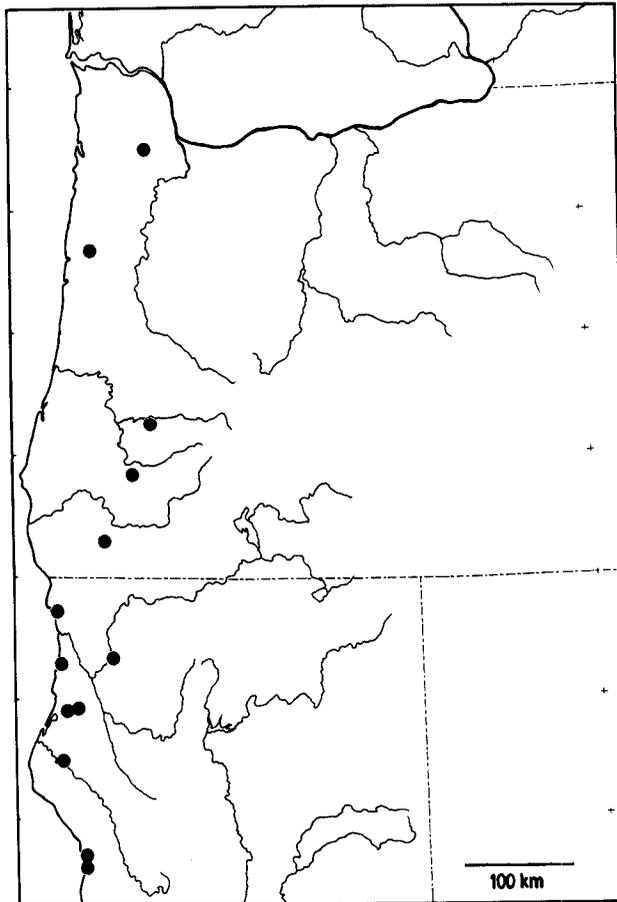


Figs. 26-28.—*Ceratolasma tricantha*, female, morphology of pedipalpi: 26, right palp, prolateral view, coxa with endite shown; 27, same, retrolateral, coxa, tibia and tarsus omitted; 28, tarsus apex, prolateral.

Fig. 29.—*Sabacon* sp. (juvenile specimen from Kittitas Co., Washington): right palp, tarsus apex in retrolateral view (claw rudiment and a few representatives of hair types, some hair bases and two cuticular pores shown). ah, annulated setae; ph, plumose setae; sl, straight, pointed hair sensilla. Right scale: 0.5 mm for Figs. 26, 27. Left scale: 0.1 mm for Figs. 28, 29.

dark pigment. White pigment often in cores of tubercles, spines or denticles, also in cuticle canals without visible overlying sculpture, presenting small starlike figures.

Eye tubercle brown with black eye rings and white spots, median process brown. Carapace with more or less distinct median brown band, dark spot on thoracic segments 1 and 2. Scute areas 1 to 4 with brown saddle, widening caudad, ending abruptly on area 4, the dark color extending to the anterior slopes of the large tubercles, their tips as well as the caudal part of area 4 white. To the sides of this dark median zone follows a paler one: Lateral carapace processes white, anterior portion of lateral pieces white. Large part of the carapace whitish with brown muscle insertions. A semilateral zone of the scute with white areas diminishing in caudal progression due to darker intersegmental bands and brown muscle insertions. Lateral sides of body brown, beginning above rostral side of second coxa, including caudal portion of the lateral pieces. Lateral parts of second thoracic tergite and of scute brown with white spots. Caudal portion of scute (part of area 4 and area 5) and tergites 6 and 7 whitish, sharply distinct from darker anterior



Map 1.—*Ceratolasma tricantha*, recorded distribution: Oregon with parts of Washington and Northern California.

parts, spotted. Lateral parts of free tergites brown. Tergite 8 lighter in middle. Anal operculum whitish, sides with small spots. Parts of tergite 9 brown, lighter towards median side. Anal sternite light brown. Free sternites brown laterally, lighter in middle; spiracular sternite light brown with darker muscle insertions. Coxae pale, darkened distally, apical tubercles white. Coxal endites dark brown. Legs with banding pattern from femur to tibia, indistinct on ventral side. Metatarsi and tarsi brown. Palpi pale, with dark prolateral band on femur; patellae on dorsal side and tarsi darker. Chelicerae pale to light brown, stridulation field and chla fingers dark to black. The color pattern varies in distinctness. Some animals, e.g., the female from Canyonville, are rather pale generally, with dark areas reduced in extent. Also irregular dark mottling occurs, which seems to be no part of a regular pattern.

Measurements (in mm) are tabulated (Tables 1, 2) for the five males and eight females seen.

Juvenile stages: Unknown.

Variation.—Variations of color pattern, number of false articulations of the second metatarsi, and of body measurements are dealt with above and in Table 1. It may be noted that a large part of the differences in body measurements between males and females are due to the expansion of membrane areas in the latter.

Table 1.—Body measurements of *Ceratolasma tricantha* males and females. Values are means in millimeters (for males $N = 5$, for females $N = 8$), followed by standard error of mean in parentheses. *A*, overall body length; *B*, same, free tergites excepted; *C*, same, free tergites and anterior processes excepted; *D*, cephalothorax length, processes included; *E*, carapace breadth; *F*, opisthosoma breadth; *G*, length of second leg femur.

	Males	Females
A	4.76 (.13)	6.39 (.22)
B	4.56 (.12)	6.06 (.44)
C	3.82 (.11)	4.98 (.12)
D	2.42 (.06)	2.60 (.05)
E	2.36 (.07)	2.79 (.04)
F	2.40 (.07)	3.54 (.12)
G	4.26 (.38)	4.26 (.20)

Table 2.—Measurements in millimeters of leg and palpal segments of *Ceratolasma tricantha* specimens described in the text. Legs indicated by Roman numerals, *P* means pedipalp.

	I	II	III	IV	P
Male (#):					
Femur	2.0	3.3	2.1	3.1	0.84
Patella	0.8	0.9	0.7	0.9	0.43
Tibia	1.2	2.3	1.4	1.4	0.61
Metatarsus	2.0	3.6	2.3	3.8	-
Tarsus	2.3	3.9	2.5	3.1	0.63
Total:	8.3	14.0	9.0	12.8	2.51
Female (#13):					
Femur	2.3	3.8	2.3	3.5	0.90
Patella	1.0	1.0	1.0	1.0	0.46
Tibia	1.3	2.7	1.5	2.1	0.63
Metatarsus	2.3	4.1	2.6	4.3	-
Tarsus	2.3	4.3	2.5	3.1	0.63
Total:	9.2	16.0	9.9	14.1	2.62

Table 3 provides data on the variation in the numbers of tarsal segments in the five males and eight females examined. The specimen numbers are repeated in the section, NEW RECORDS, so that this data may be connected to geographical distribution. The specimens themselves were numbered in order of increasing body size. The values given in Table 3 have been rounded off in case of incomplete subdivisions, these having been considered as full divisions; the numbers in parentheses are values for the distitarsi, when these divisions exceeded two in number. Damaged tarsi are given by "d." In one case (third leg of female 9) there was pronounced asymmetry in the distitarsi, possibly due to regeneration of a damaged leg. Tarsal numbers are not elevated in males as in many opilionids, on the contrary females of *C. tricantha* tend to have higher values. Three-segmented distitarsi go with the relatively longer legs. The importance of these counts has been questioned in some phalangiid genera (McGhee, in litt.), but because *C. tricantha* is presently the only species of its genus, we have nothing to compare them with. They are presented here because other species might be discovered later.

Geographic variation.—There are too few specimens for well-founded conclusions, but some differences between northern (Oregon) and southern (northern California) animals may be seen. The former tend to have relatively shorter legs and low tarsal segment counts, the latter longer legs and higher counts, but there are exceptions. Shear (in litt.) examined the specimens in the American Museum of Natural History and found that "southern males have the tubercles at the posterior margin of the carapace more coalesced and the major tubercles of the abdomen are higher and more pointed." Also, "the rasp of the palpal femur tends to have one or two accessory teeth at the base in the Oregon specimens, not in those from California." He concludes that taxonomic separation seems not warranted at the present moment and that all specimens belong to one species.

Notes.—In one male a small whitish mass of coagulated secretion adheres to the pro-lateral ends of the palp femora. The origin of this secretion is not quite clear. The swelling present in this place bears a few hairs, and its relatively porous cuticle and the opaque tissue underlying it may point to a glandular function, but this could not be ascertained precisely with the methods available. Possibly the secretion may come from the cheliceral glands and only secondarily adhere to the palpi. When folded back in rest, the palpal

Table 3.—Tarsal subdivision counts for five males and eight females of *Ceratolasma tricantha*. For localities of numbered specimens see section "New Records." Distitarsal subdivision numbers given in parentheses for values other than two; "d" means damaged tarsus.

	Leg I	Leg II	Leg III	Leg IV
Males				
1	15/15	20/19	18/17	17/18
2	17/16	23/22	19/18	22/20
3	20/20(3)	25/26(3)	20/20	21/21
4	17/17	23/24	20/20	21/20
5	17/17	23/23	18/19	19/19
Females				
6	20/19(3)	27/28(3)	22/22(3)	22/21
7	20/19(3)	26(3)/d	20/20	22/22
8	21/20(3)	28/26(3)	23/22	23/23
9	20/19	22/22	20/14(12+2)	22/22
10	19/19(3)	25/23(3)	d/20	22/21(3)
11	19/19(3)	24/24(3)	20/20	21/d
12	15/15	21/21	17/18	19/20
13	16/16	21/21	18/18	19/20

femur apices are situated near the concave surface of the cheliceral glands, so that a transfer of secretion may be possible. Is this an accidental or a normal occurrence? The cheliceral glands of the male play a role in mating, as established in *Ischyropsalis* by Martens (1969b), the gland surface in this form being presented directly to the mouthparts of the female. In *Ceratolasma*, the projecting hood may be an obstacle, and one may speculate if the palpi function as intermediaries in the transfer of the gland products. Naturally, observation of live specimens is required to clarify these points.

A dissected female contained in its distended uterus, which occupied about two thirds of the opisthosoma volume, a hyaline, slightly fibrous and swollen slimy mass, including 35 yellowish eggs of ovoid shape (measuring about 0.6×0.5 to 0.65×0.55 mm). The midgut of the same specimen contained, besides unidentifiable granular material, a few remnants of tracheae and setae, suggesting small arthropods as food.

Ecology.—No detailed data are available. The general type of habitat may be inferred from some collectors' labels. All recorded localities fall into the region of the North West Pacific Moist Coniferous Forest, including a part of the Redwood Belt in California.

Distribution.—See Map 1. Coastal regions of Oregon and Northern California, south to Mendocino County. Records from Washington are significantly absent. The species can be regarded as an element of the Vancouverian fauna (Van Dyke 1919).

New Records.—Specimens examined for this study are numbered; see above under MEASUREMENTS. *Oregon*: Lincoln Co., 7.1 m NW Eddyville, 20 June 1966 (T. Briggs, A. Jung), one male (#4), one female (#9), [CAS]; Douglas Co., Bogus Creek E of Glide, 23 July 1962 (V. Roth), two males (#1, 2) [AMNH, NHMW], 4 mi S Canyonville, 23 August 1959 (V. Roth, W. J. Gertsch), two females (#12, 13) [AMNH, NHMW]; Josephine Co., 2 mi N Selma, 22 August 1959 (V. Roth, W. J. Gertsch), one male [AMNH]. *California*: Del Norte Co., 1.6 mi N of Del Norte Coast Redwoods State Park, 25 June 1966 (A. Jung), one female (#7) [CAS]; Siskiyou Co., 1 mi S of Somesbar, 22 August 1959 (V. Roth, W. J. Gertsch), one male (#5) [AMNH]; Humboldt Co., 18 mi W Willow Creek, 21 August 1959 (V. Roth, W. J. Gertsch), two females (#10, 11) [AMNH], 14 mi N Willow Creek, 21 August 1959 (V. Roth, W. J. Gertsch), two specimens (data from V. Silhavy, not seen), 2.7 mi NW Pepperwood, 25 June 1966 (T. Briggs), one female (#8) [CAS]; Mendocino Co., 1.5 mi S Westport, 19 July 1962 (V. Roth), 3 males, 3 females [AMNH], 4 mi S Rockport, 19 August 1959 (V. Roth, W. J. Gertsch), one male, one female [AMNH].

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