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A NEW GENUS AND SPECIES OF CHTHONIID PSEUDOSCORPION FROM MEXICO (PSEUDOSCORPIONIDA, CHTHONIIDAE)[1]

William B. Muchmore

Department of Biology
University of Rochester
Rochester, New York 14627

ABSTRACT

Mexichthonius unicus, new genus and new species, is described on basis of a specimen from Campeche, Mexico. Affinities of the new genus are discussed briefly.

INTRODUCTION

Among the numerous pseudoscorpions collected recently in southern Mexico by James R. Reddell was a single individual from Ich-Ek, Campeche, which represents an unusual new species in the Chthoniidae. Though only the one specimen is available, it is of sufficient interest to warrant describing it and erecting a new genus to distinguish it clearly from all others in the family.

Mexichthonius, new genus

Type-species—*Mexichthonius unicus*, new species.

Diagnosis (based upon female only)—With the general characters of the family Chthoniidae (see Hoff, 1949, p. 429). Carapace longer than broad, distinctly narrowed posteriorly; anterior margin with large, serrate epistome; no eyes; chaetotaxy 6-4-4-2-2=18. Palpal coxa with apex broad and truncate, bearing two setae, the lateral one short and curved medially; apex of coxa I rounded, with three small setae along medial edge; coxa II with unique row of spines, including a large, complex one laterally and a row of about seven small, simpler ones more medially; coxa IV with a prominent, rounded, asetous process at the posterior end; no intercoxal tubercle. Tergites and sternites entire; 11th sternite reduced to a very narrow, thin membrane; pleural membranes longitudinally striate and minutely papillate. Tergites 1 and 2 each with four setae, following ones with six; anterior genital operculum (female) with eight setae; latermost setae on sternites 5-7 much reduced in size. Chelicera about 0.7 as long as carapace; hand with four or five setae (exact number uncertain); flagellum of nine or ten pinnate setae; galea distinctly elevated. Palp generally of chthoniid facies, but femur somewhat pedicellate and tibia elongate; placement of trichobothria unique in that *isb* and *ib* on dorsum of hand are arranged in tandem and some distance apart, rather than transversely paired;

also *it* is slightly proximad of *est* on fixed finger, and *sb* is nearer to *st* than to *b* on movable finger; marginal teeth of both chelal fingers mostly very low and irregular in shape; fixed finger with a small, internal accessory tooth at about level of third marginal tooth; movable finger with a small, rounded sensillum on external surface proximad of trichobothrium *sb*. Legs stout, but not unusual.

Etymology—The genus is named for Mexico, where its only representative was found.

Remarks—This genus is easily distinguished from all others in the family by the tandem, rather than transverse, placement of trichobothria *isb* and *ib* on the dorsum of the chelal hand. Superficially, the chela somewhat resembles that of *Lechytia* Balzan, but in the latter genus the tandem trichobothria are *esb* and *eb* (see Muchmore, 1975). *Mexichthonius* appears to be most closely allied to *Austrochthonius* Chamberlin, which has been found in South America as far north as Bolivia (see Vitali-di Castri, 1968), and to *Mundochthonius* Chamberlin, which is known from North America as far south as Tamaulipas, Mexico (see Muchmore, 1973). With *Austrochthonius* the new genus shares several important characters, including: 1) coxal spines only on coxa II; 2) no intercoxal tubercle; 3) three small setae on medial edge of apex of coxa I; 4) chelal teeth contiguous and partly reduced in size; 5) placement of trichobothria of chela, except *isb* and *ib*. It is also generally similar to *Mundochthonius* in most of these features, but, importantly, *Mundochthonius* possesses an intercoxal tubercle while *Mexichthonius* does not. The coxal spines of *Mexichthonius* are quite different from those in the other two genera, consisting, on each side, of a large, complexly branched one laterally and more medially a curved row of several, smaller, finely dentate ones; in *Austrochthonius* there is a row of several subequal, pinnate spines on each side, while in *Mundochthonius* there is on each side a single, deeply incised blade or one such blade plus one or more small spinules.

<div align="center">

Mexichthonius unicus, new species

Figs. 1-7

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Material—Holotype female (WM 3389.01001), taken from under a rock, 5 km. SSW Ich-Ek, Campeche, Mexico, 27 July 1973 (J. R. Reddell and J. M. Rowland).

Description of female—All sclerotized parts very light tan. Carapace 1.2 times as long as broad, distinctly narrowed posteriorly; anterior margin with a large serrate epistome (Fig. 1); no eyes present; surface dorsally smooth, laterally finely reticulate and with scattered tiny, pointed tubercles; chaetotaxy 6-4-4-2-2=18. Coxae generally normal in proportions, but apex of palpal coxa broad and truncate, coxa I with rounded apex, and coxa IV with a prominent rounded process at posterior end and dorsal to articular socket (Fig. 2); no intercoxal tubercle. Coxal chaetotaxy 2-2-1:mmm-2-2(1);2-4-CS:2-5-2-5; lateral seta on apex of palpal coxa short and strongly curved medially; microsetae (m) on apex of coxa I evenly spaced along medial edge; coxa II with a unique row of one large, lateral and about seven small, medial spines, the large one complexly incised and branched, the small ones with very fine, lateral spinules (Fig. 3).

Abdominal tergites and sternites entire; eleventh sternite reduced to a very narrow, thin membrane, without setae (Fig. 4); surfaces of tergites and sternites smooth; pleural membranes longitudinally striate and minutely papillate. Tergal chaetotaxy 4:4:6:6:6:6:6:6:7:4:T2T:0, sternal chaetotaxy 8:(3)6(3):(2)6(2):8:8:8:7:6:TITTIT:0:2; genital opercula as in Fig. 5; lateralmost setae on sternites 5-7 much reduced in size.

Chelicera fairly robust, 0.7 as long as carapace; hand with four or five setae (exact number uncertain, because setae lost and bases somewhat obscure); flagellum of nine or

ten pinnate setae; fixed finger with eight to nine and movable finger with nine to ten marginal teeth, evenly graded in size from tip to base; spinneret a distinct knob; serrula exterior with 15 blades.

Palp generally of chthoniid facies but with femur somewhat pedicellate and tibia slightly elongate (Fig. 6); trochanter 2.0, femur 3.65, tibia 2.0, and chela 4.05 times as long as broad; hand 1.55 times as long as deep; movable finger 1.55 times as long as hand. Surfaces of segments mostly smooth, but with sparse granulation on medial sides of trochanter, femur and tibia and on dorsal side of chelal hand. Trichobothria positioned as shown in Fig. 7; generally like other chthoniids but with *isb* and *ib* in tandem on dorsum
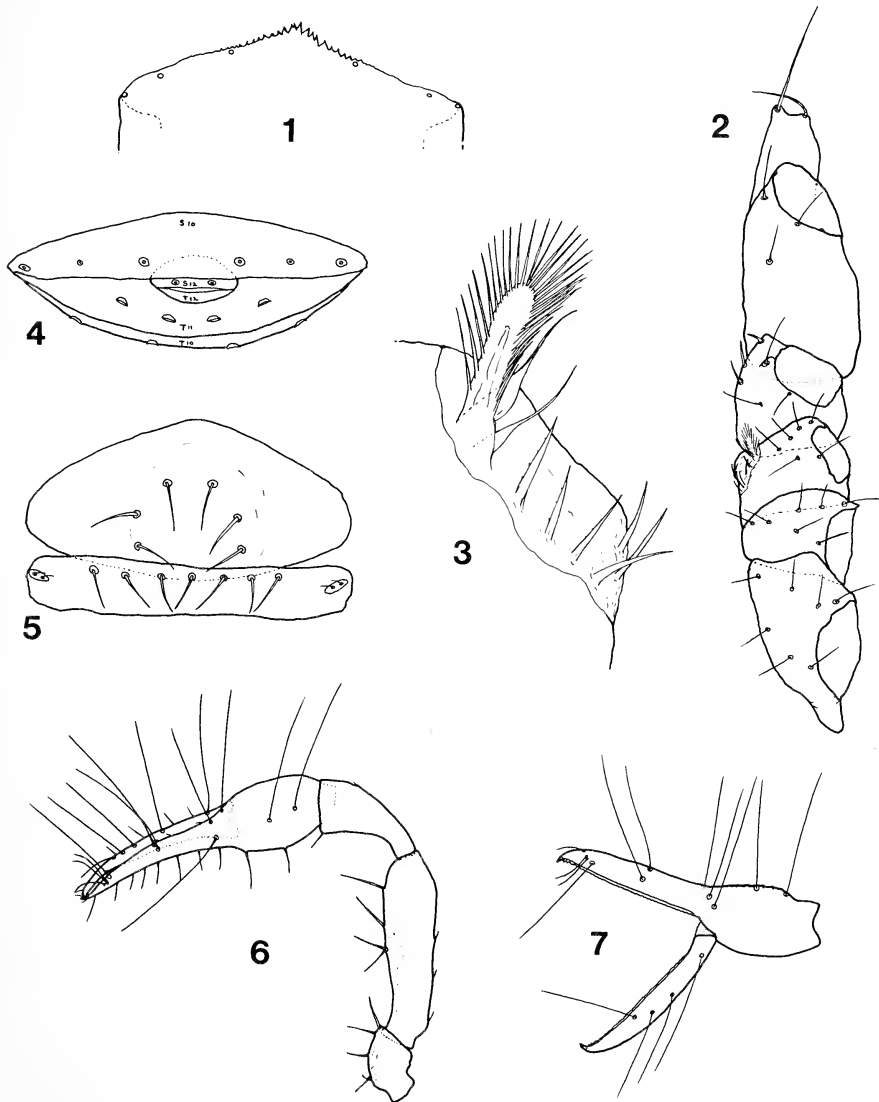
Figs. 1-7–*Mexichthonius unicus,* new species, holotype female: 1, Anterior margin of carapace, showing epistome (setae omitted); 2, Ventral view of coxae of left palp and legs I-IV; 3, Coxal spines on right coxa II; 4, Ventral view of posterior end of abdomen, especially sternite 10, anal opercula and tergites 10 and 11 (setae omitted); 5, Genital opercula; 6, Dorsal view of right palp; 7, Lateral view of left chela.

of hand rather than transversely paired; *it* lying at level of or slightly proximad of *est* on fixed finger; *sb* closer to *st* than to *b* on movable finger. Fixed finger with three small cusped denticles just behind terminal tooth, followed by 33 low, irregular elevations of the dental margin, and with a small accessory tooth on internal surface at level of third small denticle; movable finger similarly with three small denticles followed by about 27 low, irregular elevations. Movable finger with a small sensillum on external surface near dental margin, between *sb* and *b*.

Legs generally typical, fairly robust; leg IV with entire femur 2.1 and tibia 4.3 times as long as deep. Leg IV with tactile setae on metatarsus and telotarsus.

Male–Unknown.

Measurements (mm)–Body length 1.16. Carapace length 0.42. Chelicera 0.30 by 0.17. Palpal trochanter 0.16 by 0.08; femur 0.385 by 0.105; tibia 0.22 by 0.11; chela 0.525 by 0.13; hand 0.21 by 0.135; movable finger 0.325 long. Leg IV: entire femur 0.36 by 0.17; tibia 0.26 by 0.06; metatarsus 0.13 by 0.045; telotarsus 0.23 by 0.03.

Etymology–The species is named *unicus* because of its strikingly unique character-istics, which place it in an interesting new genus.

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THE OPILIONID GENERA *SABACON* AND *TOMICOMERUS*
IN AMERICA (OPILIONES, TROGULOIDEA, ISCHYROPSALIDAE)

William A. Shear

Department of Biology
Hampden-Sydney College
Hampden-Sydney, Virginia 23943

ABSTRACT

The ischyropsalid genera *Sabacon* and *Tomicomerus* in America are reviewed, and three new species of *Sabacon* are described from the western United States. The family name Sabaconidae Dresco is evaluated and not accepted as distinct from Ischyropsalidae. *Sabacon crassipalpe* (Koch), described from Siberia, probably does not occur in America. The genus *Tomicomerus* and its single species *T. bryanti* are redescribed from the single known specimen.

INTRODUCTION

The opilionid genus *Sabacon* was established in 1879 by Eugene Simon, for the European species *S. paradoxum.* Species of the genus are easily distinguished from any others within the superfamily Troguloidea by the peculiar pedipalpi—they are usually much thickened and densely set with stiff, fine setae. The palpal tarsus is short, pyriform, and reflexed against the longer tibia. As yet the adaptive or functional significance of these palpi remains unknown.

In the same year as Simon's publication, Koch (1879) described *Nemastoma crassipalpis* from eastern Siberia, but his description left no doubt that he was dealing with a species of *Sabacon*. In America, the first species of *Sabacon* to be described was *S. cavicolens*, which A. S. Packard (1884) placed in a new genus, *Phlegmacera*. In 1893, Weed described *Sabacon spinosus* from New England, but his correct generic placement was ignored until 1914, when Roewer synonymized *Phlegmacera* with *Sabacon*. Following these original reports, species of the genus *Sabacon* have proven to be widespread in the northern hemisphere in temperate climates, even extending into the subarctic. The most southerly records are from high elevations in Nepal and from caves in the southeastern United States.

The center of speciation and diversification in *Sabacon* would appear to be in Asia. Suzuki (1964, 1965, 1966, etc.) and other workers in Japan have described a half-dozen or more distinct species from Japan and Korea, and more recently, Martens (1972) has described six unusual species from Nepal. In contrast, Europe probably has at the most four rather poorly differentiated species. In North America, the new species described below bring our total to six, four of which are found in the Pacific northwest.

The genus *Tomicomerus* has a simpler history. Banks (1898) described *Phlegmacera bryanti* as a new species from the Malaspina Glacier, near Mt. St. Elias, Alaska. Unfortunately, as is frequently the case with Banks' opilionid work, the description did not

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involve direct and detailed comparison with other related, described species. In 1899, Pavesi apparently obtained material of the same species and described it as *Tomicomerus bispinosus*. His description contained data which clearly set the species apart from others in *Phlegmacera* (*Sabacon*), and subsequently Banks and others recognized Pavesi's generic name, but priority dictated the use of the combination *Tomicomerus bryanti* (Banks). My first impression was that *Tomicomerus* would become a synonym of *Sabacon*, since the main diagnostic feature, false articulations in the leg femora, is to be found in two Japanese and one American species that are otherwise well accommodated in *Sabacon*. The materials used by the original authors have long since probably been lost, and no illustrations have ever been made. A single specimen, albeit in poor condition, is in the American Museum of Natural History. *Tomicomerus* is a fully distinct genus sharing characters of *Sabacon* and *Taracus*.

TAXONOMIC CHARACTERS

Despite a wealth of characters useful in distinguishing species from one another, it is becoming apparent that attempts to group species and genera of the superfamily Troguloidea into meaningful families presents difficulties. So long as one uses the typological concept of "generic characters' or "familial characters," the task appears simple. However, detailed studies (Martens, 1969, 1972; Gruber, 1970) are beginning to reveal that these characters are distributed in various ways throughout species groups. Only when the known genera have been revised in detail, and most of the species surveyed, will it be possible with an assurance to group them into meaningful families. I suspect that there will be considerable debate over the eventual extent of the family Ischyropsalidae, in particular.

Martens (1972) has noted, following Suzuki and other Japanese authors, that within the genus *Sabacon*, the Asian species are easy to differentiate from one another on the basis of the male genitalia. The same appears to be true of the North American species. *Sabacon occidentalis* and *S. siskiyou* share many similarities, and, indeed the females are difficult to separate on the basis of qualitative characters. However, the male genitalia, particularly in the terminal parts, are distinctive. Of considerable use in males, but rather less so than the genitalia, are the palpi and chelicerae, especially the glands of the latter. The proportions of the palpi are somewhat difficult to assess because of the highly three-dimensional nature of these appendages and the consequent difficulties of arranging the palpi of several specimens for measurement so that the positions duplicate one another. The teeth found on the distal inner part of the male palpal patellae are useful, though the three western species for which males are known are quite similar in this respect. In the eastern species, *S. cavicolens* males have one or two such teeth, while *S. mitchelli* males have a large distal tooth and a row of tiny denticles.

Females not associated with males can be difficult, particularly if two similar species are sympatric, as is the case with *S. occidentalis* and *S. siskiyou*. Fortunately, it appears that these two species can be separated on the basis of the proportional lengths of the legs and the relative sizes of the postocular spines. Likewise, females of *S. mitchelli* are considerably smaller than those of the sympatric *S. cavicolens*. Females of *S. astoriensis* are not known. *Sabacon briggsi* is known only from the distinctive females, which have a pointed genital operculum and quite short legs when compared to *S. occidentalis* or *S. siskiyou*.

Immature specimens of two sympatric species are nearly impossible to separate, and

the bulk of the available material is immature. In the case of *S. cavicolens*, which occurs alone over a wide area, I have included immature specimens in the records (Map 1) to give a more complete picture of the distribution of this species. In the west, immatures have not been included because of the strong possibility of the presence of additional unde-scribed species.

NOMENCLATORIAL PROBLEMS

1. Family Sabaconidae Dresco. Dresco (1970) removed the genus *Sabacon* from the family Ischyropsalidae and placed it in the newly named, monobasic family Sabaconidae. His major reasons for doing so can be summarized in the following chart (translated from Dresco, 1970):

ISCHYROPSALIDAE	SABACONIDAE
carapace margin indented; chelicerae enlarged	carapace margin even; chelicerae not enlarged
tergites heavily sclerotized	tergites not heavily sclerotized
chelicerae of some males with a disto-apical "boss," never such a structure near middle (of basal segment)	basal segment of chelicera of males with a "boss" near middle of segment
palpi with scattered hairs, long and thin, juvenile specimens sometimes with a tarsal claw	palpi short and stout, densely set with stiff bristles never a tarsal claw
apical part of penis with spines	apical part of penis without spines

Dresco's conclusions are based on the European species of *Sabacon* and his own detailed study of the genus *Ischyropsalis*. Martens (1969), in probably the most detailed study ever made of any group of opilionids, revised the genus *Ischyropsalis*, and discovered that there were far fewer species than had been previously thought, and that the taxonomic characters previously used (size, shape, and spination of chelicerae, degree of fusion of abdominal tergites, teeth of the palpal patella, etc.) were not very useful. By means of actual mating experiments, Martens found that what he called "biospecies" of *Ischyropsalis* (reproductively isolated populations) were best marked by differences in the cheliceral glands of the males. These glands are located distoapically on the basal cheliceral segment and are evidently what Dresco (1970) refers to as "bosses." Martens (1969) found that these glands produce a secretion on which the females feed during copulation. He then used differences in the cheliceral glands of the same degree found in his biospecies to delimit "morphospecies," or populations which by analogy might be reasoned to be reproductively isolated. It is significant to note that Martens found the traditional species-marking characters listed above to be distributed through his biospecies and morphospecies in various ways.

Because Dresco failed to consider a full range of *Sabacon* species, and members of other genera related to *Ischyropsalis* in his study, the characters used to distinguish

Sabaconidae as a family do not hold up. Some American *Sabacon* species have the carapace indented in front, as in *Taracus* and *Ischyropsalis*, and the margin continues ventrally between the chelicerae. The enlarged chelicerae of the latter genera are simply adaptations for snail-eating (There is no direct evidence about the dietary habits of *Taracus*. H. W. Levi, personal communication, could not induce a Colorado species of *Taracus* to eat snails.) and do not of and by themselves indicate a close relationship. Some American and Asian *Sabacon* males are rather heavily sclerotized, and the degree of fusion of abdominal tergites is at best a species-level character in *Sabacon.*

Martens (1969) has elucidated the functional significance of the cheliceral glands of *Ischyropsalis* species males. It might be assumed that the glands of *Sabacon* males have a similar function. The presence or absence, or position of the glands is not of family-level significance. *Taracus* species lack the glands, and are otherwise typical ischyropsalids; *Sabacon mitchelli* is a typical species of that genus without enlarged glands, and some of the Japanese species lack them also. The form of the palpus sets apart the species of *Sabacon* from all others, but as its adaptive significance is not known, it may prove to be simply a specialization of the more general type of troguloid palpus. The absence of a claw in the juvenile stages is of little importance. And finally, the form of the penis is essentially similar in both groups. There are other ischyropsalid genera (*Taracus*, *Ceratolasma*) in which the penis is much more different from that of *Ischyropsalis* than in *Sabacon.*

For these reasons, I follow Martens (1972) in not recognizing Dresco's family name Sabaconidae, and include *Sabacon* with the ischyropsalids. I should add here, however, that I do not agree at this time with Gruber (1970) in placing *Hesperonemastoma* in the Ischyropsalidae, nor with Martens' (1971) implication that *Ortholasma*, *Cladolasma*, *Dendrolasma*, *Trilasma*, *Crosbycus* and *Ruaxphilos* belong there also. I plan to discuss this matter in detail in subsequent revisions dealing with these genera.

2. The status of *Sabacon crassipalpe* (Koch). In 1914, Roewer synonymized the three described species of American *Sabacon* (*cavicolens*, *spinosus* and *occidentalis*) with the Siberian *S. crassipalpe*. He has been followed in this ever since by most American authors (but see Crosby and Bishop, 1924), despite the fact that the evidence for such a synonomy does not exist. Koch's original description (1879) suggests little except that he was dealing with a species of *Sabacon*. There is nothing in the description that points to any particular species of the genus described since 1879, and as Asia undoubtedly has many as yet undetected species of *Sabacon*, it no longer seems justifiable to accept the tradition of American "Sabacon crassipalpe." In 1923, Roewer, in his enormous compendium, *Die Weberknechte der Erde*, indicated that he had not seen specimens of either *S. crassipalpe* or *S. cavicolens*, and based his discussion solely on specimens of *S. occidentalis* sent him by Nathan Banks. *Sabacon occidentalis* is a distinct species and not a synonym of *S. cavicolens*, though *S. spinosus* is. Considering Koch's description, and the fact that the types of *S. crassipalpe* are probably no longer in existence, *S. crassipalpe* should no longer be used as a name for North American forms and probably should be considered a *nomen dubium.*

3. The status of *Sabacon jonesi* Goodnight and Goodnight. Goodnight and Goodnight (1942) described *S. jonesi* from a single specimen taken in Natural Well Cave, near Monte Sano, Alabama. Although they stated that the holotype was a male, I found the undissected animal to be an early instar juvenile, possibly second or third, as suggested in the original description by the small size, weak pigmentation and sclerotization and extremely long legs. It is in fact similar to many immature specimens of *S. cavicolens* I have

examined. However, I hesitate to synonymize this name with *S. cavicolens* because the holotype of *S. jonesi* represents a far-southern record of the genus and may indeed prove to be a distinct species if and when mature material is collected. The holotype is in the American Museum of Natural History and is in poor condition.

NATURAL HISTORY

Species of the genus *Sabacon* almost universally seem to prefer moist, cool microhabitats. Many records are from caves, especially in California and the southern Appalachians, but none of the species are found there exclusively, or are modified for cave life. On the surface, specimens are usually found in areas such as moist, shaded ravines or well-developed forests where the humidity is high and temperatures are apt to be low.

Most of my personal observations have been made on *S. cavicolens*. The greatest success I have had in collecting this species has been at high elevations in mid-autumn. In the mountains of western North Carolina, at elevations over 5000 ft, the forest consists mostly of spruce, with Fraser fir becoming more prominent at higher elevations. Collecting in October on high peaks such as Richland Balsam and Waterrock Knob usually yield fair numbers of mature specimens of both sexes. Because individuals are apt to mature even later at lower elevations, after the normal collecting season in the northeastern United States is over, mature individuals of *S. cavicolens* are rather rare in collections. Most of the animals are to be found under wet rotting logs, or clinging to the undersides of stones; I have never seen any walking about actively during the day. Movements tend to be sluggish, certainly not as rapid as in other opilionids of similar form. High humidity seems to be the crucial requirement, and live specimens are difficult to keep and transport. I have never had any success in getting *S. cavicolens* back from the field alive. Collection notes on preserved specimens of the western species suggest a usual association with conifers and damp, cool microhabitats also. The holotype of *S. astoriensis* was collected in a Berlese sample of vegetable matter, including conifer duff and dried seaweed, taken from beach dunes in Oregon.

EVOLUTIONARY RELATIONSHIPS

Sabacon cavicolens, generally distributed over the eastern part of North America, south in the mountains to North Carolina, is very closely related to *S. paradoxum* of Europe. The known European species are likewise very similar and appear to be closely related. The other eastern species, *S. mitchelli*, is known only from a few high peaks in the southern Appalachians. It is quite different from *S. cavicolens*: the males lack cheliceral glands and do not have the first several abdominal tergites fused. They are also considerably smaller. The origins and affinities of this species are difficult to postulate, though it could be a relatively recent (Pleistocene) derivative of an isolated pre-*cavicolens* populations. The penis is very similar to that of *cavicolens*.

The western species seem most closely related to Asian forms (see Suzuki, 1964, 1965, 1966, etc.), though *S. occidentalis* and *S. siskiyou* also resemble *cavicolens* in many respects. With its unique chelicerae, genitalia and false articulations in the leg femora, *S. astoriensis* is much more closely related to Japanese species such as *S. dentipalpe* and *S. makinoi*. Although only a single male has been collected, it was taken from a unique (for *Sabacon*) habitat—dried seaweed and debris in beach dunes.

Tomicomerus bryanti is a unique animal that combines features found in "typical"

ischyropsalids and those found in *Sabacon*. Cheliceral glands are apparently absent, however. The palpi are armed with setae similar to those found in *Sabacon*, but are much more slender. The chelicerae are enlarged, but not as much as in *Taracus*. The femora of the legs have false articulations. What could be learned of the male genitalia from the single damaged specimen suggest *Taracus* rather than *Sabacon*. New material of this enigmatic species would be very welcome; it may represent an old stock that originated prior to the differentiation of the snail-eating genera.

A KEY TO NORTH AMERICAN TROGULOID GENERA

I present the following key without attempting to group the genera into families, since that is a question about which there is currently disagreement among taxonomists.

1a.	Palpi stout, heavily set with stiff bristles (Fig. 12); cuticle mostly leathery, but well-sclerotized in males of some species; northeastern United States and southern Canada south in the mountains to North Carolina, central California north to southern Alaska . . . . *Sabacon*
1b.	Palpi more slender, not as heavily set with stiff bristles, but with more scattered, often glandular, hairs 2
2a(1b).	Chelicerae enlarged, sometimes enormously so, the sum of the lengths of the two segments equal to or exceeding the length of the body 3
2b.	Chelicerae normal, not as described in 2a 4
3a(2a).	Chelicerae set with seta-bearing tubercles; leg femora without false articulations; Rocky Mountains from Alberta south to New Mexico, Coast Ranges and interior mountains of California, Oregon, Washington and British Columbia . . . . *Taracus*
3b.	Chelicerae smooth except for two proximal tubercles on distal segment (Fig. 34); leg femora with false articulations; region of Mt. St. Elias, Alaska . . . . *Tomicomerus*
4a(2b).	Length of body about 1 mm or less; legs covered with curly, decumbent setae; scattered localities in northeastern U.S., including New York, Ohio, Michigan, Missouri, West Virginia, North Carolina, Illinois and Indiana . . . . *Crosbycus*
4b.	Length of body greater than 1 mm; legs without decumbent curly setae . . .5
5a(4b).	Abdominal scutum and cephalothorax not separated by suture; palpi as long as or longer than body length; southern Appalachians as far north as Virginia; Illinois, Arkansas, Mississippi, Pacific northwest from northern California to central British Columbia . . . . *Hesperonemastoma*
5b.	Abdominal scutum and cephalothorax clearly separated by suture; palpi not as long as body length 6
6a(5b).	Eye tubercle not extending forward over chelicerae, but with a short projection; dorsum poorly sclerotized; Veracruz . . . . *Ruaxphilos*
6b.	Eye tubercle extending forward over chelicerae; dorsum well sclerotized . . .7
7a(6b).	Ornamentation of abdominal dorsum consisting of large, blunt tubercles; eye tubercle lacking dorsal or lateral projections; Oregon . . . . *Ceratolasma*

7b.   Ornamentation of dorsum consisting of chitinous pegs and spines connected laterally to each other, especially on posterior margins of free abdominal segments, giving appearance of "lattice-work" suspended above dorsum; eye tubercle with lateral and sometimes dorsal projections 8

8a(7b).   Eye tubercle with dorsal projections similar to ornamentation of dorsum; Mexico . . . . . . , ... *Trilasma*

8b.   Eye tubercle without dorsal projections 9

9a(8b).   Lateral projections of eye tubercle connected to each other by chitinous crossbars, giving appearance of perforations at margin of eye tubercle; southern California (San Diego) north to southern Oregon . . . . .*Ortholasma*

9b.   Lateral projections of eye tubercle not connected; northern California to central British Columbia . . . .*Dendrolasma*

Simply because generic names appear in the above key does not mean that I think them valid, but instead, I feel each should be handled in detail, in the context of a generic revision. I might here suggest, however, that *Trilasma* and *Dendrolasma* probably ought to be considered synonyms of *Ortholasma*, and that *Ruaxphilos*, known from a single, probably immature specimen is very like juveniles of this same group of species.

TAXONOMY

Family Ischyropsalidae Simon

Genus *Sabacon* Simon

Sabacon Simon, 1879, Arachnides due France 7:266; Roewer, 1914, Arch. Naturg 80(3):123, 1923, *Weberknechte der Erde*, p. 694, 1950, Senckenbergiana 31:52; Comstock, 1940, *The Spider Book* (revised by W. Gertsch). pp. 77-78; Bishop, 1949, Proc. Rochester Acad. Sci. 9(3):173.

Nemastoma (part), L. Koch, Svenska-Akad. Handl. 16(5):111 *N. crassipalpis* Koch only.

Phlegmacera Packard, 1884, Amer. Nat. 18(2):203; Banks, 1901, Amer. Nat. 35(416):677.

Type-species—Of *Sabacon*, *S. paradoxus* Simon 1879 (name emended to *paradoxum* by Roewer, 1914), by original designation; of *Phlegmacera*, *P. cavicolens* Packard 1884, by original designation and monotypy.

Diagnosis—No other opilionid genus has the enlarged, bristly pedipalps of *Sabacon* species (Figs. 2, 12, etc.).

Description—Carapace usually broader than long, limits of sclerotized area often poorly marked; second thoracic tergite free and usually sclerotized, bearing on the midline a pair of prominent spines. Abdominal tergites sometimes fused to each other in males (*scutum parvum* of European authors), but last three tergites always free; in females each abdominal tergite sometimes divided at midline, usually small and poorly sclerotized. In both sexes, abdominal cuticle often with short, black setae, these frequently on cones on sclerotized tergites. Eye tubercle small, usually not ornamented (There is a spine on the eye tubercle in one Nepalese species, see Martens, 1973.), set back from margin of carapace; eyes small. Ozopores in usual position, small, not prominent. Front margin of carapace with a distinct median notch, or broadly indented between chelicerae, extending between chelicerae to large, triangular labrum; labrum well

sclerotized. Labium small, suboval. Sternum small, inconspicuous, sometimes not detectable in adults, in juveniles with two stout setae. Coxal endites of pedipalps and first legs large and prominent, sclerotic portion crescentic, sometimes with small setae. Coxal endites of legs two, three and four completely suppressed, not at all evident. Genital operculum large, blunt or pointed, setose, usually covering sternal area. Sternites of abdomen prominent, usually sclerotized, setose. Spiracles small, slit-like, nearly closed by cuticular granules. Legs long and thin in males, usually shorter and much stouter proportionally in females, with or without false articulations in femora and tibiae; accessory spiracles in tibiae lacking. Pedipalps much enlarged, femora and patellae cylindrical, patellae of males with distal teeth, tibiae much swollen distally, tarsi without claws, pyriform, reflexed on a setose areas of tibiae; patellae, tibiae and tarsi densely set with stiff setae that are not obviously glandular. Chelicerae of females normal. Chelicerae of males of most species with swollen dorsal glands on basal articles, form of gland varies with species. Male genitalia typical of family, penis long, shaft thin, glans with dorsal and ventral plates and apical structure, distal parts of shaft and glans plates with various strong setae. Ovipositor moderately long, not annulated, setation variable with species, apical divisions without special sense organs.

Distribution—Northern North America, Europe, Japan, Korea, eastern Siberia, Himalaya Mts. in Nepal.

KEY TO NORTH AMERICAN *SABACON* SPECIES

1a.   Males 2
1b.   Females 6

2a(1a). Femora of legs with false articulations; north coastal Oregon (females unknown) . . . . *astoriensis*
2b.   Femora of legs without false articulations 3

3a(2b). Basal segment of chelicera without a knoblike gland (Fig. 11); high mountains of North Carolina . . . .*mitchelli*
3b.   Basal segment of chelicera with a knoblike gland (Fig. 1) 4

4a(3b). Tip of penis with fingerlike projections (Fig. 18); British Columbia south to northern California . . . .*occidentalis*
4b.   Penis otherwise 5

5a(4b). Cheliceral gland large, narrowed at base (Fig. 23); California, Oregon . . . .
         . . . . *siskiyou*
5b.   Cheliceral gland smaller, rounded, not narrowed at base (Fig. 1); northeastern and midwestern United States . . . .*cavicolens*

6a(1b). Genital operculum pointed (Fig. 33); California . . . . *briggsi*
6b.   Genital operculum evenly rounded 7

7a(6b). Only first two abdominal segments sclerotized; high peaks in North Carolina .
         . . . . *mitchelli*
7b.   All abdominal segments with sclerotized patches 8

8a(7b). Postocular spines very large and prominent (Fig. 25) . . . . *siskiyou*
8b.   Postocular spines of normal size (Fig. 27) 9

9a(8b). Ovipositor short, sparsely setose (Fig. 8); eastern U.S. . . . .*cavicolens*
9b. Ovipositor longer, densely setose (Fig. 20); British Columbia south to northern California . . . .*occidentalis*

Sabacon cavicolens (Packard)
Figs. 1-8, Map 1
Phlegmacera cavicolens Packard, 1884, Amer. Nat. 18(2):203, 1888, Mem. Nat. Acad. Sci. 4(1):54, Pl. XIV, Figs. 5a-g.
Sabacon crassipalpe (not of L. Koch), Roewer, 1914, Arch. Naturg. 80(3):125, Figs. 16a-c probably refer to *S. occidentalis*, 1923, *Weberknechte der Erde*, p. 694 (in part, not *S. crassipalpe* (Koch) or *S. occidentalis* [Banks]), Fig. 869 probably refers to *S. occidentalis*; Comstock, 1940, *The Spider Book* (revised by W. Gertsch), p. 77; Bishop, 1949, Proc. Rochester Acad. Sci. 9(3):173-174, pl. 1, Figs. 7-8 (records from north-western states refer to *S. occidentalis*).
Sabacon spinosus Weed, 1893, Amer. Nat. 27(318):575, Fig. 1.
Phlegmacera cavicoleus [sic] , Banks, 1901, Amer. Nat. 35(416):677, erratum for *cavicolens*.

Types—Female holotype of *P. cavicolens* from Bat Cave, Carter County, Kentucky (labelled only "Bat Cave"), in MCZ, examined; male holotype of *S. spinosus* from Hanover, New Hampshire, present location unknown.

Diagnosis—Sympatric only with *S. mitchelli*, a much smaller form endemic to a few high peaks in North Carolina. *Sabacon mitchelli* males lack the knoblike cheliceral gland found in *cavicolens* males. Females may be distinguished by the size difference and reduced abdominal sclerotization in *mitchelli*.

Description—Male from Ferne Clyffe State Park, Illinois. Total length, 2.4 mm. Cara-pace 0.55 mm wide, 0.48 mm long, with row of small black setae along anterior margin, anterior margin of carapace broadly indented; lateral borders poorly sclerotized. Ozopores small but distinct, rims not sclerotized. Eye tubercle 0.33 mm wide, eyes small. Second thoracic tergite poorly sclerotized, especially near midline, with row of small black setae set on bumps, middle two (postocular spines) much larger than others. Abdominal tergites 1-5 fused, but degree of fusion variable, some specimens have fifth tergite free; abdominal scutum so formed well sclerotized but flexible, with irregularly scattered stout black setae on tubercles. Abdominal tergites 6-8 free, but setae tending to form regular posterior rows; tergite 8 frequently divided and separated from lateral portions. Coxae, coxal endites, sternum and genital operculum as described for genus. Abdominal segments with moderately sclerotized sternites. Chelicerae (Fig. 1) of moderate size, setose, basal article with dorsal glandular prominence. Palpus (Fig. 2) typical of genus, femur 0.50 mm long, 0.21 mm wide, patella 0.48 mm long, 0.32 mm wide, with prominent apicomesal tooth, tibia 0.52 mm long, 0.32 mm wide, with mesoposterior asetose area against which tarsus is reflexed, tarsus 0.44 mm long, 0.20 mm wide. Legs of moderate length with minute black setae set thickly in tracts, scattered longer setae, metatarsi with numerous false articulations, tarsi long, multiarticulate, distally densely pilose, tarsal claw single, not toothed. Femora 1-4 2.22, 3.73, 2.05, 2.35 mm long respectively, tibiae 1-4 2.13, 3.63, 1.96, 2.01 mm long respectively. Penis (Figs. 6-7) with moderately long shaft, spatulate distal region bears short, stout setae, termi-nates in long aciculate process. Coloration: carapace yellowish brown, marked brownish purple near margins, eye tubercle brown with black rings around eyes, second thoracic

tergite mottled light purplish brown, abdominal scutum sclerotic yellow-brown, mottled dark purplish brown, with median rows of light yellowish white spots segmentally arranged. Venter yellow-white, lightly mottled brown. Chelicerae, legs and palpi pale tan.

Female from Waterrock Knob, North Carolina. Total length, 5.2 mm. Carapace 1.44 mm wide, 0.71 mm long. Structure much as in male. Lateral margins of carapace more poorly defined than in male, anterior midline not broadly indented. Eye tubercle 0.21 mm wide. Second thoracic tergite hardly at all sclerotized, postocular spines not conspicuous. Abdominal tergites represented by small, suboval sclerotized plates (*scutum laminatum* of European authors) frequently divided into two or more irregular small sclerotized regions each (*scutum dissectum* of European authors). Both tergites and leathery cuticle with scattered small black setae, not on prominent tubercles. Venter of abdomen without obvious sclerotized sternites. Tip of genital operculum rounded. Chelicerae without glands on basal segments. Palpus heavier, more densely setose than in male, without patellar tooth, femur 1.21 mm long, 0.24 mm wide, patella 1.03 mm long, 0.31 mm wide, tibia 1.64 mm long, 0.50 mm wide, tarsus 0.30 mm long, 0.14 mm wide. Legs proportionally shorter and stouter than in male, femora 1-4 1.68, 2.89, 1.84, 1.82 mm long respectively, tibia 1-4 1.79, 2.90, 1.87, 1.61 mm long respectively. Ovipositor (Fig. 8) short, wide, very sparsely setose, apical region lightly sclerotized. Coloration as in male, but median light spots of abdomen fuse to form a stripe.

Records—See also Map 1. CANADA: *Quebec*: Laurentide Park, Camp le Relais, 3000 ft, 29 August 1956, H. Dybas, juvs. (CNHM). UNITED STATES: *Vermont*: Bennington Co., Mt. Equinox summit, 3500 ft, 18 October 1968, W. Shear, ♀♀ ♂ (WAS). *Massachusetts*: Franklin Co., Totem Lookout Trail, Mahawk State Park, 22 August 1956, H. and L. Levi, juv. (MCZ). *Connecticut*: Litchfield Co., Twin Lakes, Salisbury, 17 August 1964, H. Levi, juv. (MCZ). *New York*: Tompkins Co., Ithaca, numerous records, ♀♀ juvs.; Steuben Co., Plattsburg, 16 July 1926, ♀. Bishop (1949) also records the species from Monroe, Yates and Suffolk Counties. *Pennsylvania*: Potter Co., 4 mi E of Coudersport, 30 August 1963, W. Shear, juv. (WAS), Coudersport, 7 August 1967, W. Shear, juv. (WAS); McKean Co., Ludlow, 21 September 1943, ♀. *Ohio*: Hocking Co., Cantwell Cliffs State Park, 5 April 1927, M. Walker, juv. *West Virginia*: Mercer Co., Athens and vicinity, 20 June 1966, 2 July, 22 July 1967, juvs. (WAS), Camp Creek State Forest, 4 December 1970, W. Shear, ♀ (WAS). *Virginia*: Alleghany Co., 3 mi NW Clifton Forge, 10 September 1948, R. Hoffman (RLH?); Giles Co., Mountain Lake, 3800 ft, 27 September 1950 (RLH?), reported in Hoffman (1955); Lee Co., Cave Spring Recreation Area, 2 mi N of Dryden, 2-3 September 1972, R. Hoffman, juvs. (RLH); Highlands Co., Locust Spring Camp, 11 mi N of Monterey, 18 June 1969, W. Shear, juv. (WAS); Dickinson Co., Breaks Interstate Park, Cold Spring, 25 May 1967, W. Shear, juv. (WAS). *North Carolina*: Graham Co., Joyce Kilmer Memorial Forest, 20 May 1970, W. Shear, juv. (WAS); McDowell Co., Crabtree Falls on Blue Ridge Parkway, 14 July 1969, W. Shear, juv. (WAS); Haywood Co., Waterrock Knob summit, 6292 ft, 30 October 1970, ♀♀ (WAS), Richlands Balsam summit, 6400 ft, 10 October 1971, ♂♂ ♀♀ (WAS), 13 October 1970, W. Shear, ♂♂ ♀♀ (WAS): Jackson Co., Western Carolina University Preserve near Cullowhee, 25 October 1969, W. Shear, ♀ (WAS); Yancey Co., 4 mi SSE of Black Mountain Campground on Little Lost Cove Trail, 13 July 1969, W. Shear, juv. (WAS), Mt. Mitchell summit, 6500 ft, trail to Mt. Craig, 11 July 1969, juvs. (WAS; these specimens are early instars and some of them could be *S. mitchelli*), Mt. Mitchell summit, 6500 ft, 1 November 1970, ♂♂ ♀♀ (WAS); Bishop (1949) also records the species from Grandfather Mtn. and Blowing Rock. *South*

Carolina: Greenville Co., Greenville, 4 October 1930, N. Davis (reported in Hoffman, 1955). *Tennessee*: Sevier Co., Clingmans Dome summit, 6600 ft, 10 October 1971, W. Shear, ♂♀♀ (WAS), 2 mi NNW Newfound Gap, 13 October 1970, W. Shear, juv. (WAS), Laurel Creek, 8 October 1926, ♀♀. *Illinois*: Jo Daviess Co., Apple River Canyon State
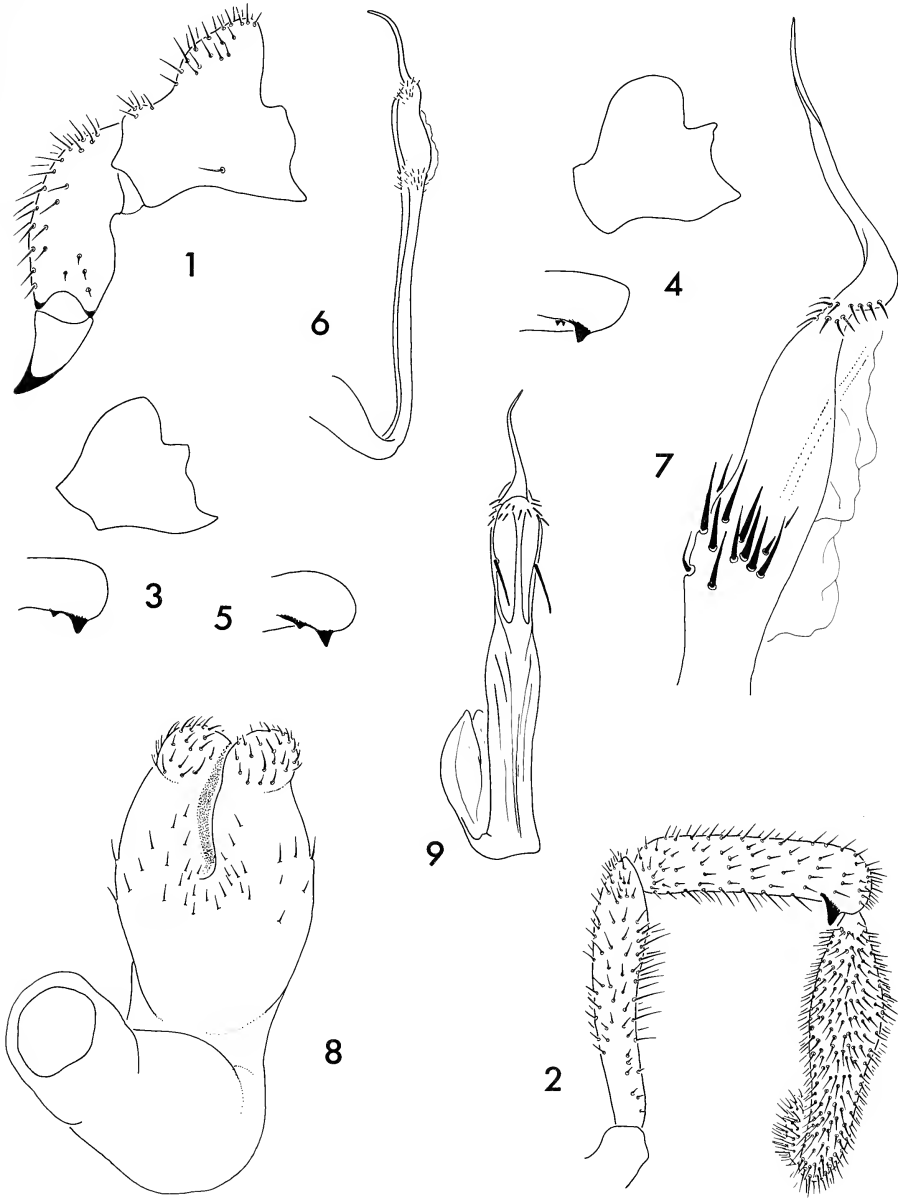
Figs. 1-9.—Anatomy of *Sabacon* species. Figs. 1-8. *S. cavicolens*: 1, Left chelicera of male, lateral view; 2, Left palpus of male, mesal view; 3, Above: outline of proximal cheliceral article of male from Mt. Equinox, Vt. Below: distal end of palpal patella of same specimen; 4, Above: outline of proximal cheliceral article of specimen from Mt. Mitchell, N. Car. Below: distal end of palpal patella of same specimen; 5, Distal end of palpal patella of male from Union Co., Ill.; 6, Penis, lateral view; 7, Tip of penis, lateral view; 8, Ovipositor subdorsal view; 9, Penis of *S. mitchelli*, subventral view.
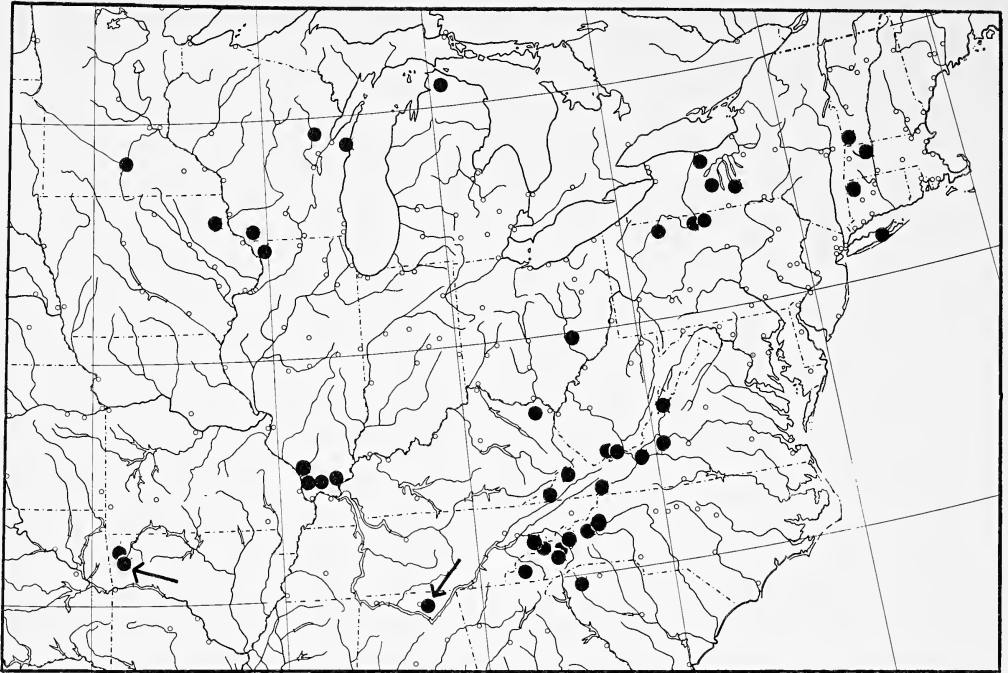
Map 1.—Eastern United States, showing distribution of *Sabacon cavicolens*, including records of immature specimens. Arrow in Alabama indicates locality of *S. jonesi*, a possible synonym of *S. cavicolens*; arrow in Arkansas indicates records of immature specimens possibly not *S. cavicolens*.

Park, 14-16 August 1946, H. Dybas, juvs. (CNHMM); Union Co., Pine Hills, 14-20 Ocotber 1967, J. M. Nelson, ♂♂♀♀ (JAB), 25 October 1969, J. Beatty, juv. (JAB); Johnson Co., Ferne Clyffe State Park, 24 October 1967, ♂♂ (JAB), 6 June 1970, J. Beatty, juv. (JAB); Pope Co., Lusk Creek 3 mi E of Eddyville (R6E, T12S, Sec. 10), 14-20 May 1968, J. M. Nelson, juvs. (JAB), Little Grand Canyon, 5.8 mi SW of Murphysboro, 3 May 1970, J. Beatty, juv. (JAB), *Iowa*: Clayton Co., Pikes Peak State Park, 8 June 1961, H. Levi, juv. (MCZ). *Wisconsin*: Kewaunee Co., N of Kewaunee, July 1949, H. Levi, juv. (MCZ); Grant Co., Wyalusing State Park, 13 July 1949, H. Levi, juv. (MCZ); Shawano Co., Neapit (?), 22 September 1949, H. Levi, ♂ (MCZ). *Minnesota*: Blue Earth Co., juv. (MCZ). The following juvenile specimens are tentatively referred to *S. cavicolens*: *Arkansas*: Washington Co., Devils Den, Ice Box Cave, 18 June 1969, S. and J. Peck, juvs. (WAS), Granny Dean Cave, 9 July 1969, S. Peck, juv. (WAS). Also reported from Cheboygan Co., *Michigan*, by Edgar (1971), and from *Kentucky*, *Maine* and *New Hampshire* by Bishop (1949).

Notes—The coloration is often much darker than the described specimen and probably depends on the age of the animal; the legs and palpi are often dark brown and the venter of the abdomen dark purplish brown. The sclerotization of the abdomen varies within populations, especially in females. Some females have each abdominal tergite divided, with the posterior ones very lightly sclerotized. In males, the degree of fusion of the first five abdominal tergites is variable, and in any case, the separate tergites are marked by indentations in the margin of the scutum; the fifth tergite is often free. Figs. 3-5 depict some components of the variation of the secondary sexual characters of the males. In most populations, the gland knob is rather low and slopes evenly on the anterior side (Figs. 1, 3), but in North Carolina specimens, the knob is larger and more rounded (Fig.

4). There is also a tendency for the palpal tooth to have one or even two small accessory teeth behind it (Figs. 3,4, 5). In some males, the apical part of the penis is bent over at a right angle, as shown in Fig. 15 for *S. occidentalis*. This is probably a functional change.

A few immature specimens from Arkansas caves are given in the records section and shown on the distribution map; mature material is much needed to definitely demonstrate that this population is *S. cavicolens*; see the discussion of *S. jonesi* above.

<div align="center">

Sabacon mitchelli Crosby and Bishop

Figs. 9-13
</div>

Sabacon mitchelli Crosby and Bishop, 1924, J. Elisha Mitchell Soc. 40:23-24, Plate 2, Fig. 17.

Types–Female holotype (AMNH) from Mt. Mitchell, Yancey Co., North Carolina, 6600 ft elevation, collected 22 October 1923 by sifting moss; examined.

Diagnosis–Much smaller than *S. cavicolens*, with which it is sympatric throughout its range. The female has only the first two abdominal tergites sclerotized, and these quite small; the female of *cavicolens* has plates (though they may be divided) on all tergites of the abdomen. Males of *mitchelli* bear no knob on the basal articles of the chelicerae, though the glandular function may still be present; the palpal patella has a row of small denticles extending nearly the length of the patella behind three apical teeth. Males of *cavicolens* have an abdominal scutum, *mitchelli* males do not (Fig. 10).

Description–Male from Waterrock Knob, Haywood Co., North Carolina. Total length, 1.83 mm. Carapace 0.48 mm long, 0.82 mm wide. Structure similar to *S. cavicolens*, except in the following respects. Carapace more heavily sclerotized, lateral margins more clearly defined. Ozopores large, prominent, with sclerotic posterior rims. Eye tubercle 0.27 mm wide. Second thoracic tergite not at all sclerotized, postocular spines somewhat enlarged but not as conspicuous as in *cavicolens*. Abdominal tergites (Fig. 10) poorly sclerotized, not fused to form dorsal scutum in most specimens, setae fewer and not on prominent bumps as in *cavicolens*. Chelicerae (Fig. 11) relatively larger than in *cavicolens*, lacking knobbed gland on basal article, but with three slit sensilla (?) not seen on other species. Palpus (Fig. 12) proportionally stouter than in *cavicolens*, femur 0.59 mm long, 0.16 mm wide, patella 0.58 mm long, 0.25 mm wide, with three large apicomesal teeth and series of small denticles running behind teeth nearly to base of patella, tibia 0.56 mm long, 0.24 mm wide, tarsus 0.30 mm long, 0.19 mm wide. Legs short, stout, metatarsi with but one or two false articulations, tarsi multiarticulate, but distitarsus not completely divided, legs set with fine setae and long spines. Femora 1-4, 0.95, 1.01, 0.75, 1.18 mm long respectively, tibiae 1-4 0.71, 0.87, 0.64, 1.04 mm long respectively. Penis with short, broad shaft (Fig. 9) not significantly increased in width at apical part (Fig. 13), aciculate process as in *cavicolens*, penial setae longer, stouter. Coloration: Dorsum light purplish brown, carapace and abdominal tergites yellowish, coloration even, no evidence of dorsal pattern. Venter, leg coxae and trochanters light brown, distal parts of legs darker brown, chelicerae and palpi medium brown.

Female holotype from Mt. Mitchell, Yancey Co., North Carolina. Total length, 2.71 mm. Carapace 0.49 mm long, 0.98 mm wide. Eye tubercle 0.25 mm wide. Structure typical. Second thoracic tergite not at all sclerotized, postocular spines small. First two abdominal tergites with small plates, others not sclerotized. Coloration as in male.

Records–*North Carolina*: Haywood Co., Waterrock Knob summit on Blue Ridge Parkway, 6292 ft, under rocks and logs in fir forest, 13 October 1970, W. A. Shear, ♂ (WAS);

Yancey Co., Mt. Mitchell summit, 6600 ft, under logs and rocks i orest of fir and mountain ash, 1 November 1970, W. A. Shear, ♂♂ (WAS).

Notes—At each of the two places this species has been collected, ; is syntopic with *S. cavicolens*. In the cases of my two collections, the *mitchelli* males were only later dis-
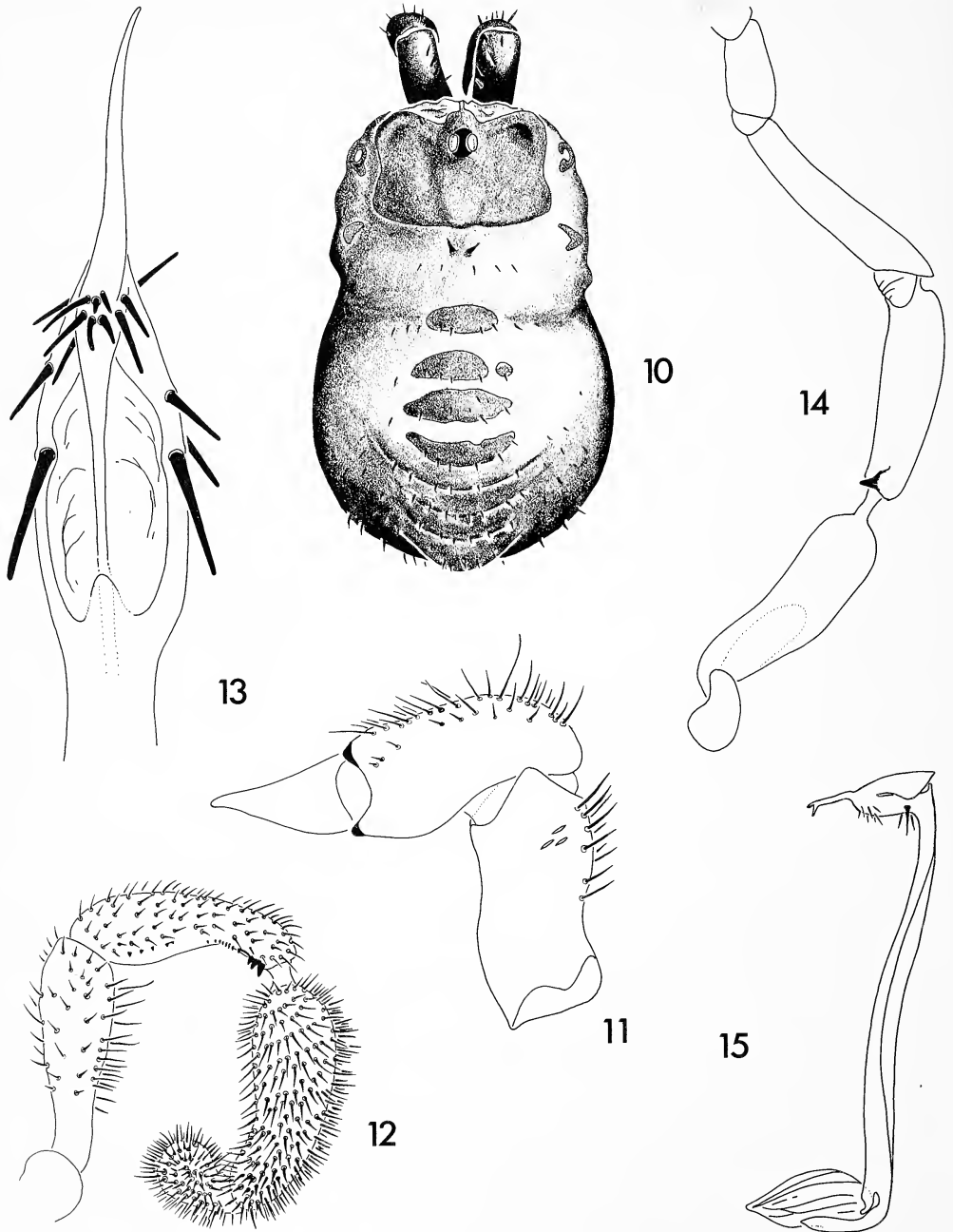
Figs. 10-15.—Anatomy of *Sabacon* species. Figs. 10-13. *S. mitchelli*: 10, Body of male, dorsal view; 11, Left chelicera of male, lateral view; 12, Left palpus of male, mesal view; 13, Penis, ventral view of tip; Figs. 14-15, *S. occidentalis*; 14, Left palpus of male, mesal view, setation omitted; 15, Penis, lateral view.

covered in a large collection of adult *cavicolens*. I have collected on several other Appala-
chian summits in the region, and found only *cavicolens*. There is some variation. The
Waterrock Knob male has broader and larger abdominal tergites than the illustrated male
from Mt. Mitchell, but otherwise, they agree closely.

Sabacon occidentalis (Banks)
Figs. 14-20, Map 2
Phlegmacera occidentalis Banks, 1894, Psyche 7:51.
Sabacon crassipalpe (not of L. Koch), Roewer, 1914, Arch. Naturg. 80(3):125, 1923,
Weberknechte der Erde, p. 694, Fig. 869 (in part, not *S. cavicolens* [Packard], *S.
spinosus* Weed, or *S. crassipalpe* [Koch]); Comstock, 1940, *The Spider Book* (revised
by W. Gertsch), p. 77 (not *S. cavicolens* [Packard]); Bishop, 1949, Proc. Rochester
Acad. Sci. 9(3):173-174 (description based on *S. cavicolens*, western records only).

Type—Male and female cotypes from Olympia, Washington, in MCZ, examined.

Diagnosis—The form of the penis and the less prominent postocular spines will serve to
separate the present species from *S. siskiyou. Sabacon astoriensis* has false articulations in
the leg femora, *occidentalis* does not. Males of *S. briggsi* are not known, but the females
of that species have a pointed genital operculum.

Description—Male from Cape Perpetua, Lincoln Co., Oregon. Total length, 2.34 mm.
Carapace 1.26 mm wide, 0.59 mm long. Structure much as in *S. cavicolens*, but much
less sclerotization in carapace and abdomen, lateral margins of carapace not at all dis-
tinct. Anterior margin of carapace indented, lacking row of black setae. Ozopores small,
indistinct, rim not sclerotized as in *mitchelli*. Eye tubercle 0.36 mm wide, eyes
small. Second thoracic tergite unsclerotized but marked by pigmented band, postocular
spines small, unpigmented. Abdominal tergites 1-5 fused to form dorsal scutum, setae as
described for *cavicolens*. Abdominal tergites 6-8 free. Coxae, coxal endites, sternum and
genital operculum as described for genus, set with small black setae, sternum poorly
sclerotized, without setae. Chelicerae (Fig. 16) relatively large, basal articles with very
large, prominent glandular knob. Palpus (Fig. 14) narrow, gracile, elongate, femur 0.81
mm long, 0.17 mm wide, patella 0.82 mm long, 0.27 mm wide, with very large single
black apicomesal tooth, tibia 1.08 mm long, 0.30 mm wide, tarsus 0.40 mm long, 0.25
mm wide. Legs very long and slender, femora with regular rows of stout black setae.
Tibiae of legs 2 with five to eight false articulations, of legs 4 with one to three false
articulations. Femora 1-4 3.56, 6.27, 4.57, 5.47 mm long respectively; tibiae 1-4 3.86
6.20, 3.98, 5.40 mm long respectively. Penis (Figs. 15, 17, 18) with long, thin shaft,
broadened, spatulate apical region with numerous stout setae, tip with three finger-like
divisions (Fig. 18). Coloration: Eye tubercle black. Carapace yellow-white to brown,
marked darker brown, second thoracic tergite and dorsal scutum dark brown against
yellow-white ground, vaguely marked light brown central band. Venter yellow-white to
tan, marked dark brown. Chelicerae white. Palpus yellow-white, shaded brown dorsally
on femur and patella. Leg trochanters brown dorsally, leg segments shaded dark brown
distally, giving impression of banded legs.

Females from Clatskanna, Columbia Co., Oregon. Total length, 4.32 mm. Carapace
0.90 mm long, 2.00 mm wide. Structure much as in male and in female of *cavicolens*, but
carapace proportionally longer, eye tubercle (0.54 mm wide) set farther back from
anterior margin of carapace. Second thoracic tergite poorly sclerotized, abdominal
tergites all free, marked by sclerotized oval plates, sparsely set with small black

setae. Venter typical. Chelicerae lacking gland on basal article. Palpus (Fig. 19) much heavier and stouter proportionally than in male, femur 1.08 mm long, 0.31 mm wide, patella 1.35 mm long, 0.38 mm wide, tibia 1.71 mm long, 0.60 mm wide, tarsus 0.75 mm
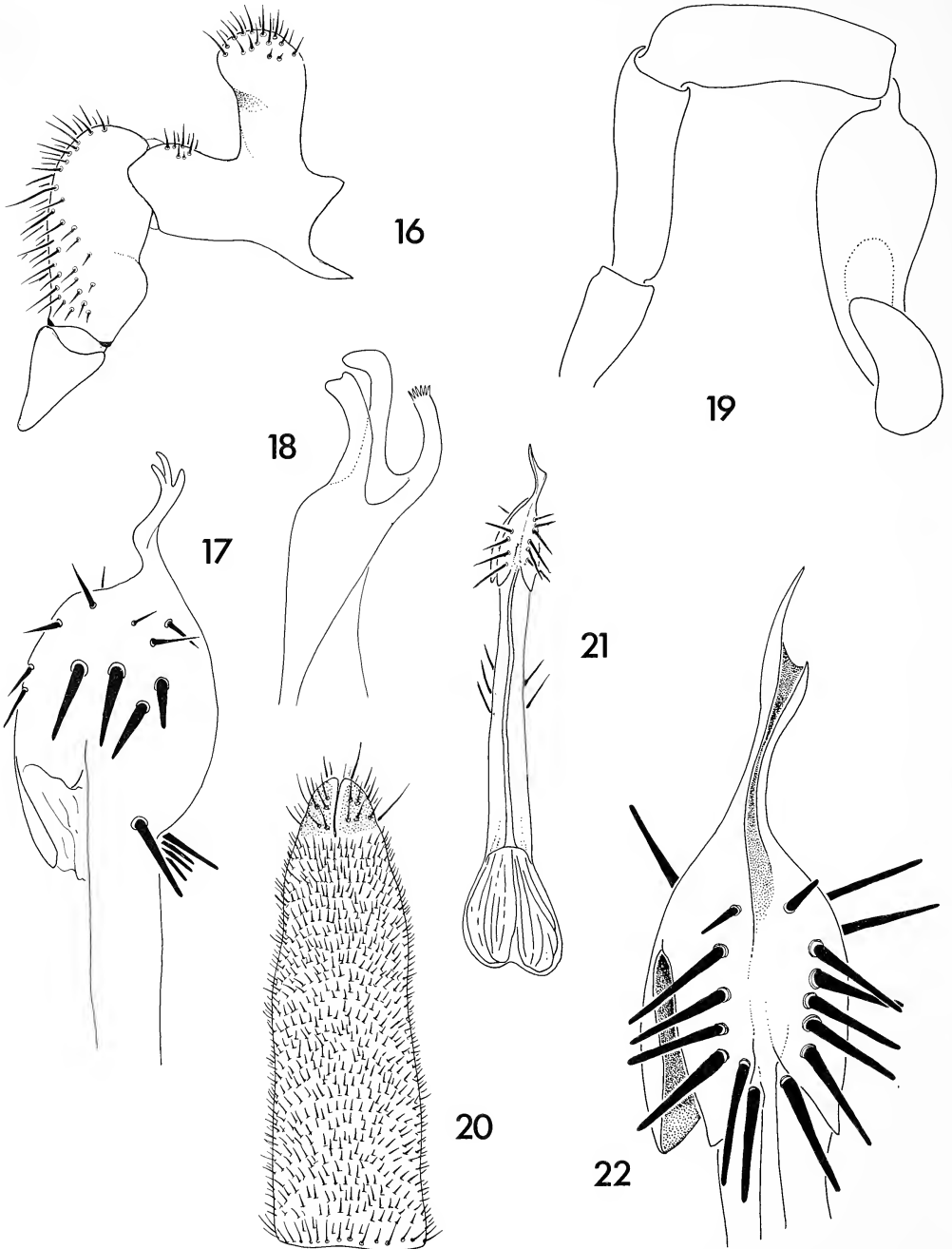
Figs. 16-22.–Anatomy of *Sabacon* species. Figs. 16-20: *S. occidentalis*. 16, Left chelicera of male, lateral view; 17, Penis, lateral view of tip; 18, Penis lateral view of tip, higher magnification; 19, Left palpus of female, mesal view, setation omitted; 20, Ovipositor, ventral view. Figs. 21-22. *S. siskiyou*: 21, Penis, dorsal view; 22, Penis, dorsal view of tip.
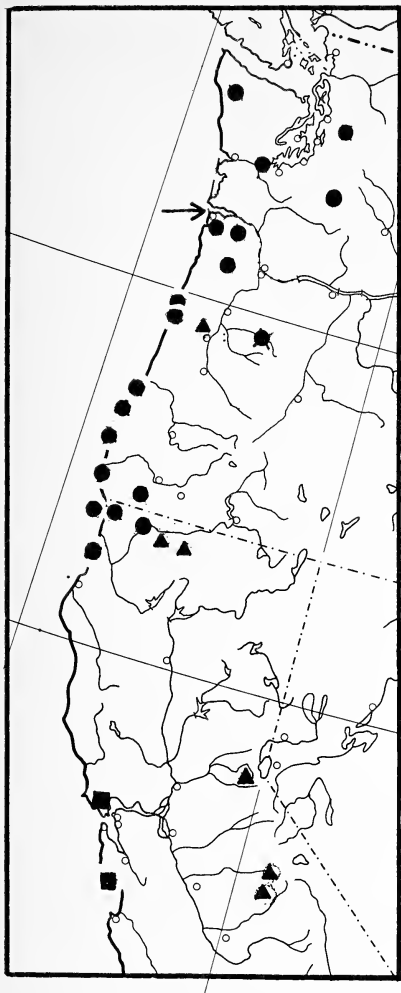
Map 2.–Coastal northern California, Oregon and Washington. Dots, records of *Sabacon occidentalis;* triangles, records of *S. siskiyou;* squares, records of *S. briggsi.* Arrow shows approximate type locality of *S. astoriensis. Sabacon occidentalis* has also been recorded from British Columbia.

long, 0.42 mm wide. Legs long, but shorter and stouter proportionally than in male, femora 1-4 2.77, 4.49, 2.88, 5.63 mm long respectively, tibiae 1-4 2.84, 3.41, 2.72, 3.93 mm long respectively. Ovipositor (Fig. 20) relatively long, densely setose. Coloration as in male, but generally paler, central light band of abdomen consequently not as distinct.

Records—See also Map 2. CANADA: *British Columbia*: Kyquot, Vancouver Island, 1-10 September 1930, S. L. Neave, ♀; 17.8 mi E of Hope, Manning Park, 23 August 1969, T. Briggs, ♂ (TB). UNITED STATES: *Washington*: Grays Harbor Co., 5 mi E of McCleary, 26 August 1959, W. Gertsch, V. Roth, ♀; Snohomish Co., 6 mi W of Stevens Pass, near Senic, 28 August 1959, W. Gertsch, V. Roth, ♀; Jefferson Co., 4.5 mi SW Hoh Rain Forest on Hwy 101, 22 June 1966, T. Hom, ♂ (TB); Lewis Co., Rainbow Falls State Park, 25 August 1969, T. Briggs, ♂ (TB). *Oregon*: Clatsop Co., 7 mi N of Nehalem, 26 August 1969, T. Briggs, ♀ (TB), Saddle Mtn., 9 September 1970, R. Lem, ♀ (TB). Lincoln Co., 5 mi N of Depoe Bay on Hwy 101, 4 September 1970, T. Briggs et al., (TB), Cape Perpetua on U.S. 101, 7 August 1967, T. Briggs, ♂♂ (TB); Lane Co., Darlington Botanical Wayside near Mercer Lake, 20 June 1966, T. Briggs, ♀ (TB); Columbia Co., 5 mi S of Clatskannie, 8 August 1967, K. Hom, ♀ (TB); Josephine Co., 3.9 mi E on I-5 of Speaker Road, near Wolf Creek, 8 June 1967, T. Briggs et al., ♀ (TB); Yamhill Co., McMinnville, "McNab Coll." August (no year) ♂♂♀♀ (MCZ); Coos Co., Charleston, 30 September 1959, V.

Roth, ♀; Linn Co., 1.1 mi E jct. U.S. 20 and U.S. 126, 24 June 1966, T. Briggs, ♂♂ ♀♀ (TB); Douglas Co., 3 mi E of Reedsport, 6 August 1967, T. Briggs, ♂ (TB); Curry Co., 9.5 mi S of Gold Beach, 19 June 1966, T. Briggs, et al., ♂♂ ♀♀ (TB). *California*: Siskiyou Co., 18 mi N of Happy Camp, 22 August 1959, W. Gertsch, V. Roth, ♀; Humboldt Co., near Orick, 18 June 1966, T. Briggs et al., ♂ (TB); Del Norte Co., Del Norte Coast Redwoods State Park, 25 June 1966, T. Briggs et al., ♂♂ (TB), 1.6 mi N of Del Norte Coast Redwoods State Park, 18 June 1966, T. Briggs et al., ♂♂ (TB).

Notes—There appears to be little variation in the important characters of *S. occidentalis*, except that some specimens are darker or lighter than the described ones.

<center>*Sabacon siskiyou*, new species</center>
<center>Figs. 21-25, Map 2</center>

Types—Male holotype and female paratype from 3 mi north of McCloud, Siskiyou Co., California, collected 2 September 1959 by W. Gertsch and V. Roth (AMNH); female paratype from 6 mi east of Camp Connell, Eldorado Co., California, collected 10 September 1959 by W. Gertsch and V. Roth (MCZ), male paratype from Deadhorse Summit, near Pondosa, 5500 ft, Siskiyou Co., California, collected 19 September 1961 by W. Ivie and W. Gertsch (MCZ). The specific epithet refers to the type locality and is a noun in apposition.

Diagnosis—Similar in general appearance to *S. occidentalis*, but with considerably shorter, unbanded legs, a differently formed penis, and very large, prominent postocular spines (Fig. 25). Distinct from *S. astoriensis* in lacking false articulations in the leg femora.

Description—Male paratype from Deadhorse Summit. Total length, 2.49 mm. Carapace 0.57 mm long, 1.11 mm wide. Structure typical for genus, but usually much less sclerotization even in the darkest specimens than in *cavicolens* or *occidentalis*. Carapace fairly well defined, however. Eye tubercle 0.28 mm wide, eyes small. Ozopores small, inconspicuous, without marginal sclerotization. Second thoracic tergite weakly sclerotized, but with large, prominent postocular spines (Fig. 25), often contiguous at the base or even partly fused. Presence of dorsal abdominal scutum difficult to ascertain due to weak sclerotization, but probably much as in *occidentalis*; abdominal cuticle comparatively smooth, with only a few small, dark brown, scattered setae. Venter typical, with rather long, weak black setae contrasting with stout ones found in other species. Abdominal sternites not sclerotized but marked with pigment. Chelicerae (Fig. 23) much as in *occidentalis*, but gland lower, not as much enlarged at apex. Palpus (Fig. 24) somewhat stouter than in *occidentalis*, femur 0.64 mm long, 0.25 mm wide, patella 0.82 mm long, 0.36 mm wide, apicomesal tooth large, single, usually slightly recurved, tibia 0.80 mm long, 0.37 mm wide, tarsus 0.44 mm long, 0.36 mm wide. Legs shorter, stouter than in *occidentalis*, setation pattern essentially the same, but larger setae longer, thinner. Tibiae 2 with one to three false articulations, tibiae 4 with none. Femora 1-4 1.84, 3.90, 1.85, 2.57 mm long respectively, tibiae 1-4 1.80, 2.66, 1.60, 2.22 mm long respectively. Penis (Figs. 21, 22) somewhat stouter than in *occidentalis*, with more and stouter setae, tip unevenly spatulate. Coloration: Pattern of body as in *occidentalis*, but paler, yellow-white areas in *occidentalis* tend to be pale tan in *siskiyou*; legs even medium brown, not banded.

Female from Eldorado Co., California. Total length, 2.77 mm. Carapace 0.59 mm long, 1.46 mm wide. Structure as described in male, with the usual sexual differences. Abdominal tergites fairly well marked, sometimes divided. Genital operculum

rounded at tip, ovipositor similar to that of *occidentalis*, only slightly less setose. Palpus with femur 0.90 mm long, 0.34 mm wide, patella 1.10 mm long, 0.48 mm wide, tibia 1.27 mm long, 0.66 mm wide, tarsus 0.65 mm long, 0.32 mm wide. Legs proportionally
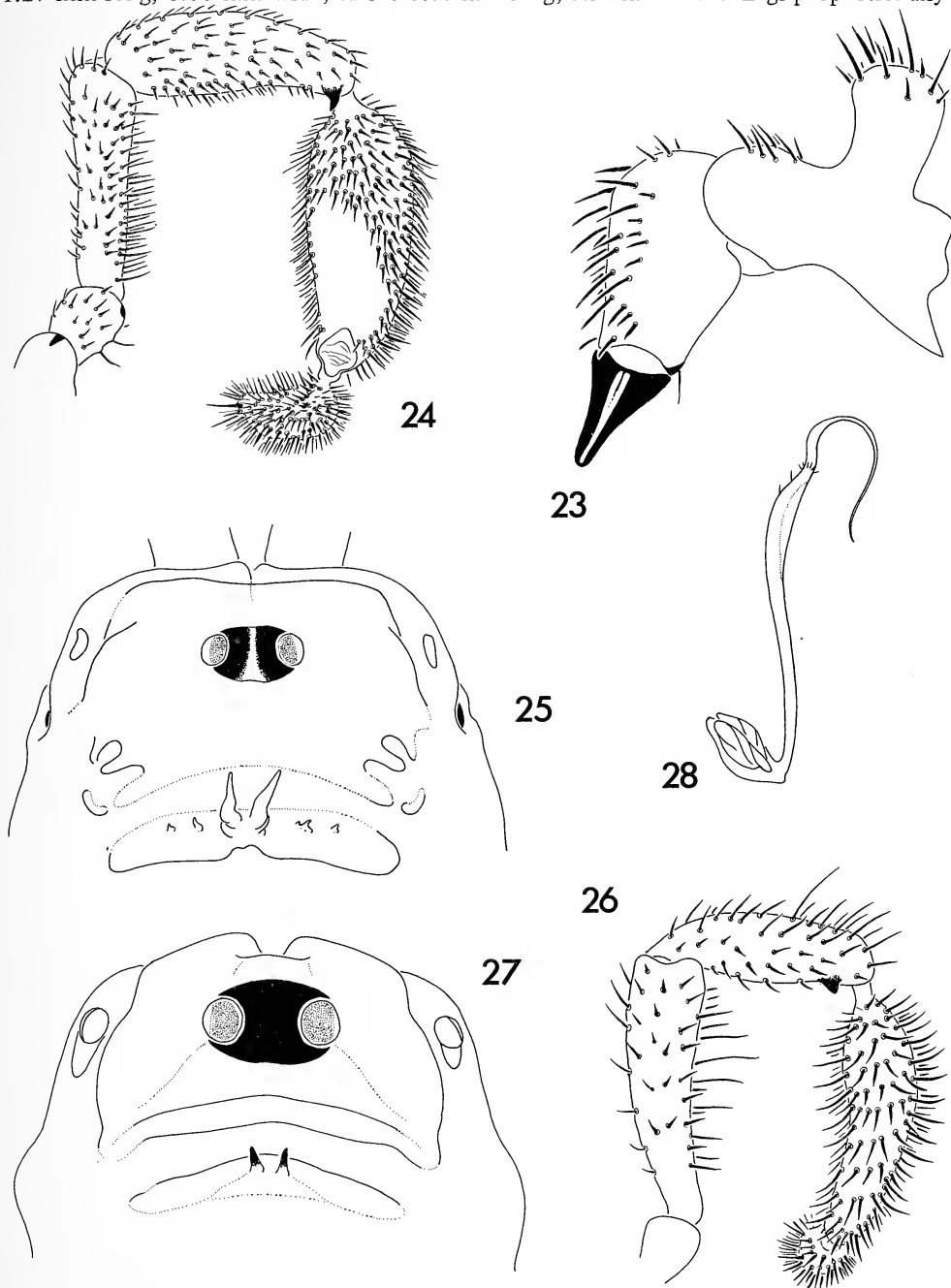
Figs. 23-28.–Anatomy of *Sabacon* species. Figs. 23-25. *S. siskiyou*: 23, Left chelicera of male, lateral view; 24, Left palpus of male, mesal view; 25, Anterior end of body of male, dorsal view. Figs. 26-28. *S. astoriensis*: 26, Left palpus of male, mesal view; 27, Anterior end of body of male, dorsal view; 28, Penis, lateral view.

shorter and stouter than in male, femora 1-4 2.14, 2.66, 1.83, 2.46 mm long respectively, tibiae 1-4 1.85, 2.63, 1.61, 2.26 mm long respectively. Coloration as in male.

Records—*California*: Siskiyou Co., Deadhorse Summit, near Pondosa, 5500 ft, 18 September 1961, W. Ivie, W. Gertsch, ♂; Eldorado Co., 6 mi E of Camp Connell, 10 September 1959, W. Gertsch, V. Roth, ♀; Madera Co., 2 mi S of Fish Camp, 12 September 1959, V. Roth, W. Gertsch, ♀; Yosemite National Park, Strawberry Creek, 12 September 1959, V. Roth, W. Gertsch, ♀. *Oregon*: Benton Co., near Iron Mtn., 21 November 1948, I. Newell, ♂♂.

Notes—The Oregon males are darker in coloration and somewhat better sclerotized than those from California, but are otherwise typical.

Sabacon astoriensis new species
Figs. 26-30, 32, Map 2

Types—Male holotype from Peter Iredale Shipwreck Picnic Area, Fort Stevens State Park, Clatsop Co., Oregon, collected 27 November 1971 by E. M. Benedict (MCZ). The specific epithet is an adjective referring to the nearby community of Astoria.

Diagnosis—The only American species with false articulations in the leg femora.

Description—Male holotype. Total length, 2.0 mm. Carapace 0.52 mm long, 0.78 mm wide. Carapace well-sclerotized, lateral margins distinct, anterior margin with an acute indentation at midline. Ozopores large, distinct, posterior rims sclerotized. Eye tubercle 0.26 mm wide, relatively larger than in other species, set closely at anterior margin of carapace, eyes large. Second thoracic tergite moderately well-sclerotized, postocular spines small but pigmented (Fig. 27). Abdominal tergites 1-5 solidly fused to form heavily sclerotized dorsal shield, tergites 1-4 marked by pairs of black setae on low humps, tergite 5 with posterior row of black setae. Tergite 8 divided in midline, lateral portions of tergite 8 also separate from dorsal portions. Posterior part of abdominal dorsum with scattered black setae (Fig. 29). Coxae, endites and genital operculum typical, sternum completely suppressed. Abdominal sternites sclerotized, with rows of black setae. Chelicerae (Fig. 30) with low glands on basal segments resembling those of *cavicolens*, distal segment enlarged dorsobasally with depressed lateral area bearing small denticles on rim. Palpus (Fig. 26) slender, gracile, not as heavily setose as in some other species, femur 0.60 mm long, 0.20 mm wide, patella 0.58 mm long, 0.21 mm wide, with stout patellar tooth, tibia 0.59 mm long, 0.22 mm wide, tarsus 0.25 mm long, 0.18 mm wide. Legs short, stout, sparsely setose. Femora 1 and 3 with one to three false articulations, femur 2 with nine to ten false articulations, femur 4 with four to five false articulations, tibiae 2 and 4 with one to four false articulations. Femora 1-4 1.11, 1.63, 0.95, 1.63 mm long respectively, tibiae 1-4 1.05, 1.55, 0.84, 1.21 mm long respectively. Penis (Figs. 28, 32) with broadly expanded tip gradually tapering to flagelliform termination (Fig. 32), penial setation weak. Coloration: Sclerotized parts dark brown, intersegmental cuticle white. Legs, palpi and chelicerae brown, darker distally, legs not banded.

Female unknown.

Known only from the type locality.

Notes—This peculiar species is related to one or two of the Japanese forms, as suggested by the penis and the false articulations in the leg femora. The modification of the distal cheliceral article is unique. Some of the species recently described from Nepal by Martens (1972) have stout teeth on the inner sides of the proximal part of the distal cheliceral article, but none have the lateral depression seen in *astoriensis*. The small size
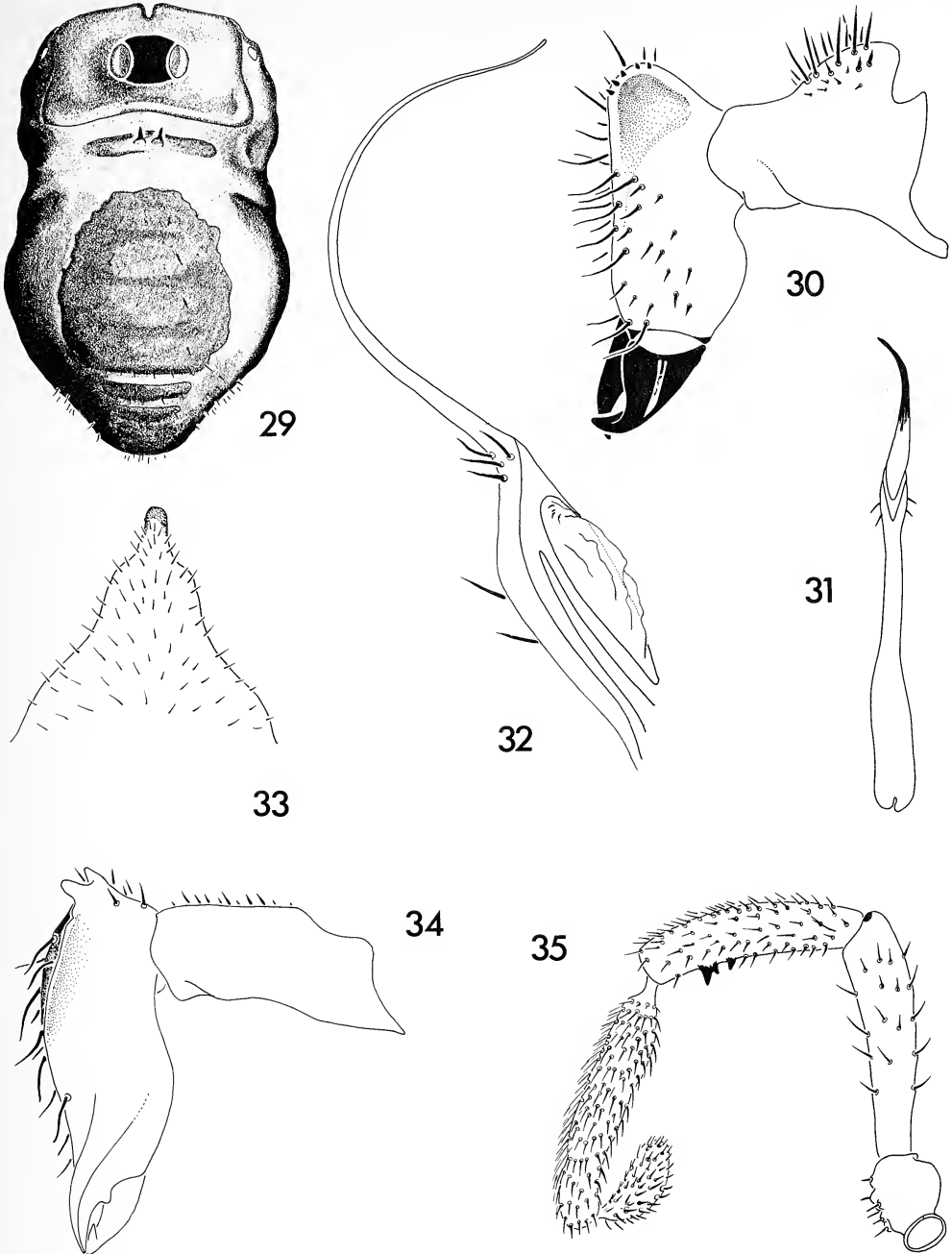
Figs. 29-35.—Anatomy of *Sabacon* and *Tomicomerus* species: 29, Body of male *S. astoriensis*, dorsal view; 30, Left chelicera of male *S. astoriensis*, lateral view; 31, Penis of *Tomicomerus bryanti* (partly hypothetical, see text); 32, Penis of *S. astoriensis*, lateral view of tip; 33, Genital operculum of female *S. briggsi*, ventral view; 34, Right chelicera of *T. bryanti*, mesal view; 35, Right palpus of *T. bryanti*, mesal view.

and heavy sclerotization are also of interest. Collectors in northern coastal Oregon should search carefully for females.

The type was taken in a Berlese sample of dried seaweed, vegetable debris and spruce duff in sand dunes, near the beach.

Sabacon briggsi, new species
Fig. 33, Map 2

Types—Female holotype from Bolinas Ridge, Marin Co., California, collected 16 November 1968 by T. Briggs (deposited in California Academy of Sciences); female paratype from Valencia Lagoon, Santa Cruz Co., California, collected 25 November 1966 by K. Hom (MCZ).

Diagnosis—Distinct from females of all other species in the pointed and lightly sclerotized tip of the genital operculum (Fig. 33).

Description—Female holotype. Total length, 3.86 mm. Carapace 0.71 mm long, 1.37 mm wide. Carapace with lateral margins indistinct, as in *occidentalis*, but anterior margin deeply and broadly indented in midline. Eye tubercle 0.45 mm wide, eyes small. Ozopores small but prominent, anterior margins sclerotized. Second thoracic tergite poorly and narrowly sclerotized, postocular spines small and not conspicuous. All abdominal tergites marked by undivided separate sclerotized plates set with short black setae. Venter typical, but genital operculum apically pointed, with lightly sclerotized rim (Fig. 33). Chelicerae typical. Palpus with short femur, extremely robust tibia; femur 0.92 mm long, 0.31 mm wide, patella 1.22 mm long, 0.34 mm wide, tibia 1.43 mm long, 0.80 mm wide, tarsus 0.68 mm long, 0.47 mm wide. Legs short, stout, femora 1-4 2.02, 3.10, 1.95, 3.14 mm long respectively, tibiae 1-4 1.94, 3.10, 1.64, 2.63 mm long respectively. Ovipositor as in *occidentalis*. Coloration: Ground color of body light purple mottled medium tan, sclerotized parts brown. Venter white, abdominal sternites brown. Chelicerae brown dorsally, palpi medium brown, legs medium brown, not annulated.

Males not known.

Known only from type and paratype localities listed above.

Notes—The Santa Cruz Co. female agrees well in structure with the holotype but is lighter in color, possibly a result of longer preservation. It was taken from oak litter.

Genus *Tomicomerus* Pavesi

Tomicomerus Pavesi, 1899, Rend. Inst. Lombardo 32 532-533; Roewer, 1914, Arch. Naturg. 80(3):126, 1923, *Weberknechte der Erde*, p. 696; Comstock, 1940, *The Spider Book* (rev. by W. Gertsch), p. 78.
Phlegmacera Banks (in part), 1898, Ent. News 9:16, *P. bryanti* only.

Type-species—*T. bispinosus* Pavesi, 1899, (=*T. bryanti* [Banks]), by original designation.

Diagnosis—The leg femora have false articulations, a character also found in some *Sabacon* species, but the chelicerae of *T. bryanti* are much enlarged. Distinct from species of *Taracus*, *Ischyropsalis* and *Nipponopsalis* by the shorter, more densely setose palpi and the smooth chelicerae.

Description—Carapace (Fig. 36) wider than long, well sclerotized, lateral limit well marked, indented in midline. Ozopores in usual position. Eye tubercle much broader than long, indented in midline, without setae or ornamentation. Second thoracic tergite free and well-sclerotized, bearing on midline pair of a very prominent postocular spines (in *Taracus* species there is usually a single spine in this position). Condition of abdominal tergites not discernable from single available specimen. Carapace connected to labrum by chitinous strip, labrum large, subtriangular. Labium small, oval. Sternum not obvious, poorly sclerotized. Endites of pedipalps and legs as in *Sabacon*, but coxae slightly com-

pressed and elongated proximally. Genital operculum bluntly pointed anteriorly. Spiracles slit-like. Legs moderately long, with false articulations in femora and tibiae. Palpi prominent, intermediate in form between *Sabacon* and *Taracus* (Fig. 35), tarsus blunt, reflexed against asetose area on tibia, without a claw, patella with mesoapical teeth in males. Chelicerae very large, basal joint as long or longer than carapace without a prominent glandular swelling in males, distal joint with two proximodorsal teeth and mesal ridge (Fig. 34). Male genitalia typical, perhaps approaching form of *Taracus* species (Fig. 31). Form of ovipositor not known.

Distribution—Southeastern coastal strip of Alaska.

<div align="center">

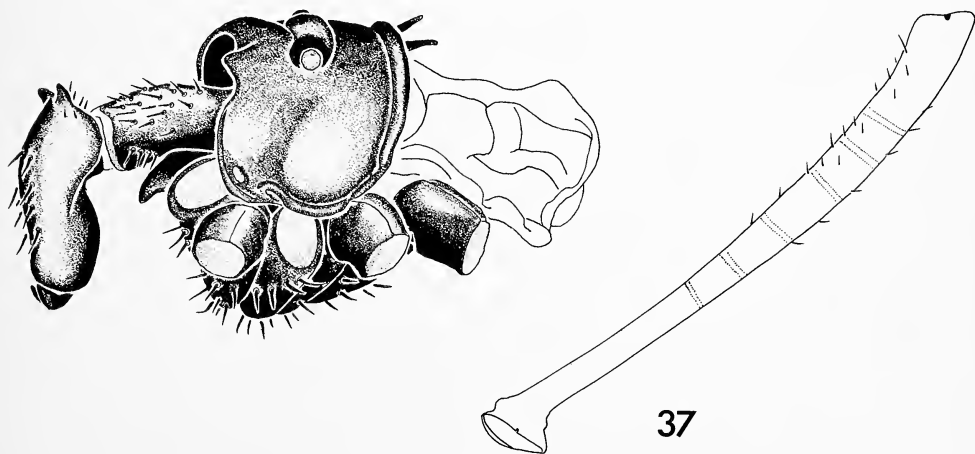*Tomicomerus bryanti* (Banks)

Figs. 31, 34-37
</div>

Phlegmacera bryanti Banks, 1898, Entomol. News 9:16.

Tomicomerus bispinosus Pavesi, 1899, Rend. Inst. Lombardo 32:533.

Tomicomerus bryanti, Roewer, 1914, Arch. Naturg. 80(3):126, 1923, *Weberknechte der Erde*, p. 696; Comstock, 1940, *The Spider Book* (rev. by W. Gertsch), p. 78.

Types—Female (immature?) holotype from Malaspina Glacier, Mt. St. Elias, Alaska, collected 4 July 1897 by H. G. Bryant, probably lost, not found with other Banks opilionid types in MCZ; male holotype of *T. bispinosus* from Mt. St. Elias, whereabouts unknown. An inquiry of the Zoological Laboratory of the University of Pavia, where Pavesi worked, brought no answer. In the absence of types, there is a certain amount of conjecture involved in assigning the American Museum specimen described below to this species, and indeed in accepting the synonymy of the two proposed names. The AMNH specimen matches Pavesi's description well, but Banks' account is less detailed and is probably based on an immature specimen, judging from the size given.

Description—Specimen from Tsirku River, Alaska. The specimen is in poor condition, as is much of the older material in the AMNH opilionid collection, due to a yellow

Figs. 36, 37.—*Tomicomerus bryanti*: 36, Lateral view of male from Tsirku River. Abdomen unshaded, shown in outline only to denote shriveled condition due to poor preservation; 37, Leg 4 (?) femur, showing false articulations.

substance dissolved out of either cork or rubber stoppers. In addition to staining the specimens, this substance seems to give them a cheese-like texture that renders study and dissection difficult. When fresh alcohol is added without extensive rinsing, a heavy white precipitate forms.

Structure as described for genus. Abdomen completely shriveled, but described by Pavesi (1899) as "polished." Legs separated from body and badly broken. Carapace 1.11 mm wide, 0.77 mm long, eye tubercle 0.46 mm wide. Chelicera (Fig. 34) with basal segment 0.85 mm long, 0.36 mm wide, distal segment, excluding fixed finger, 1.00 mm long, 0.44 mm wide. Palpal femur 1.20 mm long, 0.27 mm wide, patella 1.07 mm long, 0.27 mm wide, with three mesodistal teeth, the largest most distal and contiguous with the smallest, the third some distance proximal of the other two (Fig. 35), tibia 1.36 mm long, 0.28 mm wide, tarsus 0.47 mm long, 0.18 mm wide. Legs with false articulations in femora and tibia numerous (Fig. 37). Legs broken or not identifiable. Male genitalia (Fig. 31) partially reconstructed, badly damaged by attempted dissection, but generally resembling those of *Taracus* species.

Notes—All reported specimens come from the St. Elias Range area of the Alaskan coastal strip extending south to British Columbia. The specimen in the AMNH is labelled as being from the head of the Tsirku River, Alaska, and was collected in July or August of 1910, by O. M. Leland. This stream rises from the Tsirku Glacier at an elevation of 1100 ft and flows east to the Chilkat River, joining that river just before it empties into Chilkat Inlet. The head of the Tsirku River is at 137 degrees 30 minutes west longitude and 60 degrees 30 minutes north latitude, just north of the northern boundary of Glacier Bay National Monument.

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A KEY AND CHECKLIST OF AMERICAN SPIDERS OF THE FAMILY THERIDIIDAE NORTH OF MEXICO (ARANEAE)

Herbert W. Levi

and

Diane E. Randolph

Museum of Comparative Zoology
Harvard University
Cambridge, Mass. 02138

ABSTRACT

It is difficult to define the family Theridiidae. The 27 genera of Theridiidae represented north of Mexico can be separated by a key. There is a checklist to the 229-234 species of Theridiidae from north of Mexico.

A simple key to the genera of Theridiidae is needed for identifying spiders, but is difficult to construct. A mimeographed version of the key has had a limited circulation for several years as a tryout.

The checklist got bigger while in preparation. Because of the expense of printing, the style had to be modified slightly to make the list shorter. Therefore the synonymies are not complete but go back only to the first revision of the genus. For a complete synonymy it is necessary to consult the revisions.

INTRODUCTION

Theridiid spiders differ from Nesticidae, Araneidae, Linyphiidae, and most Symphytognathidae by usually lacking the fleshy colulus (Fig. 47) found in all these other families (Fig. 1) (not always in Symphytognathidae). Theridiidae usually have a tarsal comb (Fig. 80), but this is present also in Nesticidae. Those theridiid genera that have a fleshy colulus (*Steatoda*, *Latrodectus*, *Argyrodes*, *Robertus*, and *Crustulina*) have comb setae on the fourth metatarsus and tarsus (present also in Nesticidae, but absent in *Argyrodes*). Theridiids that have a fleshy colulus and comb-setae on the fourth legs differ from Nesticidae by being dark colored, while Nesticidae are generally whitish, and by not having the paracymbium attached at the base of the cymbium of the male palpus, while in Nesticidae it is at the base of the cymbium and variously enlarged.

Members of the theridiid genus *Argyrodes* have a colulus, lack a comb on the fourth

tarsus, but differ from other families with a fleshy colulus by having the paracymbium a small hook on the edge of the alveolus of the cymbium, hidden behind the bulb. The paracymbium (P in illustrations) is attached at the base of the cymbium and variously expanded in Nesticidae and some Araneidae (*Meta, Zygiella*), a hook at the base in *Araneus* (Araneidae), or a separate sclerite in the palpus in Linyphiidae. Some theridiids (e.g., *Theridula, Paratheridula*) lack a paracymbium.

The Symphytognathidae are probably polyphyletic, scondarily derived from the Theridiidae and Araneidae. All are minute, less than 2 mm, all lack a paracymbium in the male palpus; many have the eyes reduced. The carapace may be high, and both carapace and abdomen may be heavily sclerotized. The division between Symphytognathidae and Theridiidae is probably as arbitrary as that between Theridiidae and Nesticidae.

The colulus is derived from vestigial anterior spinnerets and is generally believed primitive, its loss secondary. However, the simplest male palpi in theridiid spiders are all found in genera that lack a colulus (*Theridula, Paratheridula, Achaearanea*). While the palpus of *Theridula* and *Paratheridula* might be interpreted as secondarily reduced, this probably is not the case in *Achaearanea*. *Achaearanea* (and *Dipoena*) palpi show how the various sclerites may have originated, possibly an early stage in the evolution of the complex linyphiid palpus. The complex appearing palpus of symphytognathids is secondarily simplified, judging by the absence or vestigial character of certain sclerites that are well developed in the theridiid palpus.

The limits of the family Theridiidae are arbitrary. Better knowledge of southern hemisphere spiders, especially Symphytognathidae, may make it possible to define the family better.

KEY TO GENERA OF THERIDIIDAE IN AMERICA NORTH OF MEXICO (AND OF EUROPE)

by Herbert W. Levi

1a.	Abdomen sclerotized, with a series of humps and a sclerotized ring around spinnerets (Fig. 20); carapace projecting anteriorly (Fig. 20); less than 2.7 mm total length; one species in eastern U.S. . . . . *Phoroncidia*
1b.	Abdomen otherwise 2
2a(1b).	A fleshy colulus present between anterior spinnerets (Fig. 1) 3
2b.	Colulus absent (Fig. 47) or replaced by two setae (Fig. 19) 10
3a(2a).	Tarsi longer than metatarsi; adults less than 1.3 mm long 4
3b.	Metatarsi equal to, or longer than tarsi; adults usually longer than 1.5 mm ..5
4a(3a).	Six eyes, one rare species in California (Fig. 2) . . . . *Comaroma*
4b.	Eight eyes; one species from Alaska to southeastern states (Fig. 3) . .*Theonoe*
5a(3b).	Carapace, sternum with dumb-bell-shaped tubercles (Fig. 4); palpal cymbium with a projection (Fig. 5) . . . .*Crustulina*
5b.	Carapace, sternum not tuberculate, or only very slightly so 6
6a(5b).	Lateral eyes separated by their diameter or more; chelicerae without teeth (Fig. 6); female internal genitalia with dumb-bell-shaped seminal receptacles and male palpus with coiled embolus (Figs. 7, 8) . . . .*Latrodectus*

6b.   Lateral eyes slightly separated at most (Fig. 12); chelicerae with teeth (Figs. 14, 15); genitalia otherwise 7

7a(6b).   No comb setae on fourth tarsus; male eye or clypeal region swollen and projecting, or a groove below eyes (Fig. 9); female abdomen higher than long with humps extending beyond spinnerets, or thread-shaped, often with silver spots (Figs. 10, 11); middle tarsal claw often longer than laterals . .*Argyrodes*
7b.   Comb-setae on fourth tarsus (Fig. 80); male eye or clypeal region never so modified; female abdomen oval to spherical (Figs. 12, 13, 17), never with silver spots; middle tarsal claw smaller than laterals 8

8a(7b).   Abdomen without pattern, uniformly colored .... *Robertus*
8b.   Abdomen with a pattern (Figs. 12, 13, 17) 9

9a(8b).   Female lacks a tooth on posterior cheliceral margin; male chelicerae never large. Paracymbium hook not on edge of male palpal cymbium; many species purplish-brown to black in color, with a white line around anterior of abdomen (Figs. 12, 13) ....*Steatoda*
9b.   Female with at least one tooth on posterior cheliceral margin (Fig. 14); male with chelicerae often enlarged (Fig. 16); paracymbial hook on margin of cymbium (Fig. 18) .... *Enoplognatha*

10a(2b).   Colulus replaced by two setae (Fig. 19) 11
10b.   Colulus absent (Fig. 47) 21

11a(10a).   Posterior median eyes more than three diameters apart (Fig. 21); abdomen longer than wide, widest near anterior end (Fig. 21); one species in eastern states .... *Spintharus*
11b.   Posterior median eyes at most two diameters apart; abdomen usually otherwise 12

12a(11b).   Abdomen longer than wide, dorso-ventrally flattened, widest posteriorly with median posterior or lateral posterior humps (Fig. 22); one species in eastern states .... *Episinus*
12b.   Abdomen otherwise 13

13a(12b).   Venter of abdomen and its anterior overhang black (Figs. 23, 24); abdomen variously shaped; eyes often reddish; palpal cymbium supports embolus, conductor absent (Fig. 25) ....*Chrosiothes*
13b.   Coloration of abdomen otherwise; eyes not reddish; palpal cymbium never supporting embolus 14

14a(13b).   Eyes large, closely grouped (Fig. 26); eye region black except between posterior median eyes (Fig. 26); fourth legs longer than first; abdomen often with a white spot above spinnerets .... *Stemmops*
14b.   If eyes closely grouped and eye region black then the first legs are longer than fourth; abdomen rarely with white spot above spinnerets 15

15a(14b).   Total length less than 1.8 mm 16
15b.   Total length greater than 2 mm .... .19

16a(15a).   Abdomen much wider than long (Fig. 27); rare; one species in Florida ......
             ....*Tekellina*

16b.   Abdomen spherical to longer than wide 17

17a(16b).   Anterior median eyes vestigial, minute, less than one-third that of laterals
              (Fig. 29); one rare species in Arizona . . . . *Styposis*
17b.   Diameter of anterior median eyes equal to radius of others or larger 18

18a(17b).   Anterior median eyes smaller than others (Figs. 30, 31); chelicerae with teeth
              on anterior margin, denticles on posterior . . . . *Pholcomma*
18b.   Diameter of anterior median eyes equal to others or larger (Figs. 40, 41, 42,
              45, 46); chelicerae without teeth; females with two pairs of seminal recepta-
              cles. 20

19a(15b).   Chelicerae with teeth on anterior and posterior margins, fangs short (Fig. 33);
              abdomen oval, longer than wide, often with dorsal longitudinal band (Fig.
              32); one pair of seminal receptacles; comb setae on fourth tarsus .*Anelosimus*
19b.   Chelicerae without teeth, fang long and flattened (Figs. 34-37); abdomen
              triangular to subspherical; four seminal receptacles (Figs. 38, 39); comb setae
              lacking 20

20a(18, 19b). Abdomen usually triangular (Figs. 40-42), widest anteriorly (Figs. 40-42);
              male palpus without median apophysis (Fig. 43); male carapace not modified;
              fourth leg commonly longer than first . . . . *Euryopis*
20b.   Abdomen usually spherical; median apophysis usually present in palpus, radix
              a separate sclerite (Fig. 44); male carapace often modified or high (Figs. 45, 46)
              . . . . *Dipoena*

21a(10b).   Abdomen triangular, widest anteriorly; dorso-ventrally flattened; fourth legs
              longer than first, lacking comb setae; two pairs of seminal receptacles in
              female . . . . *Euryopis*
21b.   Abdomen otherwise; first legs longer than fourth, or if fourth longer,
              abdomen spherical; fourth with comb setae (Fig. 80); one pair of seminal
              receptacles in female (Fig. 74) 22

22a(21b).   Abdomen higher than long, often with streaks on sides (Figs. 49, 51-53); male
              palpus with cymbium usually extending beyond bulb (Figs. 48, 54, 55) . .23
22b.   Abdomen longer than high, to wider than long, to subspherical; if high then
              not streaked; cymbium rarely extending beyond bulb 24

23a(22a).   A narrow longitudinal white line from highest point of abdomen to spinnerets
              (Fig. 49); males minute with only one palpus; male palpus with median
              apophysis and radix (Fig. 48); epigynum with a protruding knob (Fig. 50) . . .
              . . . . *Tidarren*
23b.   White line much wider or absent from abdomen (Figs. 51-53); males with
              two palpi, lacking median apophysis; radix broadly attached (Figs. 54, 55) . . .
              . . . . *Achaearanea*

24a(22b).   Abdomen longer than wide, high with tubercle or point above and posterior
              to spinnerets (Figs. 56, 57); palpus with all sclerites present (if the whole
              carapace is black and eyes small, it is *Coleosoma acutiventer*, Fig. 64) . . . . . .
              . . . . *Chrysso*
24b.   Abdomen otherwise, oval to spherical or wider than long 25

25a(24b).   Female abdomen wider than long, each lateral point dark and abdomen with prominent dorsal white spot (Fig. 58); carapace with wide black longitudinal band (Fig. 58); palpus very simple with a twisted embolus on distal tip of bulb (Figs. 59, 60) . . . . *Theridula*

25b.   Abdomen, if wider than long marked otherwise and if male has simple palpus, embolus is straight, not twisted 26

26a(25b).   Males with simple palpus, lacking sclerites but having a straight distal embolus (Fig. 62); females with 3-6 dorsal black patches on oval abdomen (Fig. 61); epigynum a clear plate with two circular openings (Fig. 63), to 2.2 mm total length, one species in Gulf states . . . . *Paratheridula*

26b.   Palpus with radix and median apophysis; epigynum otherwise 27

27a(26b).   Males with sclerotized ring around abdomen encircling pedicel and covering epigastric area (Figs. 65, 66); abdomen often constricted in middle (Figs. 65, 66); less than 4 mm; females difficult to separate from *Theridion* or *Chrysso* except for small eyes and projecting clypeus (Fig. 64); three small species in southeastern U.S., one of which is found in Arizona . . . . *Coleosoma*

27b.   Males otherwise, or larger than 6 mm; females rarely with projecting clypeus. 28

28a(27b).   Males usually with eye region of clypeus very high, bulging, projecting, or with groove in clypeus (Figs. 68, 69); most less than 1.5 mm long; often orange in coloration; commonly with scuta on abdomen . . . . . . *Thymoites*

28b.   Male eye region never modified; usually larger than 1.5 mm long; rarely orange in color; no scutum on abdomen . . . . *Theridion*

A CHECKLIST OF THE THERIDIIDAE IN AMERICA NORTH OF MEXICO
by Diane Randolph and Herbert W. Levi

*Name with this spelling is on Official List of Generic Names in Zoology and cannot be changed.

**Application has been made to place name on Official List of Generic Names in Zoology. Application not acted upon; thus existing usage is to be maintained (Art. 80 of ICZN) and has been used in preference over other names in use and not widely accepted.

Achaearanea Strand, 1929. Levi, 1955a (Revision); 1963b (Keys, Maps).
   Type species: *A. insignis* (O.P.-Cambridge)
♀♂ *acoreensis* (Berland, 1932). Levi, 1955a: 20, f. 39, 40, 46 (♀♂ *geochares*); 1963b: 220; 1967a: 179, f. 12-14 (♀♂). CA.
 ♀ *ambera* Levi, 1963b: 204, f. 7-8 (♀). UT, WY.
♀♂ *canionis* (Chamberlin and Gertsch, 1929). Levi, 1955a: 24, f. 60-68 (♀♂). UT, AZ, CA.
♀♂ *chiricahua* Levi, 1955a: 26, f. 57-59 (♀); 1963b: 213, f. 39-40 (♂). AZ.
♀♂ *conjuncta* (Gertsch and Mulaik, 1936). Levi, 1955a: 14, f. 14-18 (♀♂). LA, MS, FL, NC.
♀♂ *florendida* Levi, 1959c. 1955a: 15, f. 26-31 (♀♂ *florens*); 1959c: 65, f. 17, 20-21 (♀♂). TX, TAM.
♀♂ *fresno* Levi, 1955a: 27, f. 53-55 (♀♂). CA.

♀♂ *globosa* (Hentz, 1850). Levi, 1955a: 9, f. 19-25 (♀♂); 1963b: 203. ONT to QUE to TAM and FL.

♀♂ *insula* (Gertsch and Mulaik, 1936). Levi, 1955a: 19, f. 41-45 (♀♂). TX, TAM.

♀♂ *porteri* (Banks, 1896). Levi, 1955a: 30, f. 71-75, 80-82 (♀♂); 1963b: 215. NY to KS to FL; NUL.

♀♂ *rupicola* (Emerton, 1882). Levi, 1955a: 21, f. 47-52, 56 (♀♂); 1963b: 215. AL to ONT to ME; ?BCA.

♀♂ *schullei* (Gertsch and Mulaik, 1936). Levi, 1955a: 17, f. 32-38 (♀♂); 1959c: 61; 1963b; 203. FL, TX, TAM, AZ, CA.

♀♂ *serenoae* (Gertsch and Archer, 1942). Levi, 1955a: 28, f. 76-79 (♀♂). AL, FL.

♀♂ *tepidariorum* (C. L. Koch, 1841). Levi, 1955a: 32, f. 69-70, 83-84 (♀♂); 1963b: 215; 1967a: 178, f. 9-11. NOV to FL; ONT to TX; CO; KS; BCA to CA.

Anelosimus Simon, 1891. Levi, 1956b (Revision).
  Type species: *A. eximius* (Keyserling)
♀♂ *analyticus* (Chamberlin, 1924). Levi, 1956b: 421, f. 19, 40-42 (♀♂). CA, BCN, SON.

♀♂ *studiosus* (Hentz, 1850). Levi, 1956b: 418, f. 21-23, 37-39 (♀♂); 1967b: 30, f. 2 (web photo). CT to FL; TN to TAM; NUL; SON.

*Argyrodes*** Simon, 1864. Exline and Levi, 1962 (Revision).
  Type species: *A. argyrodes* (Walckenaer)
♀♂ *americanus* (Taczanowski, 1872). Exline and Levi, 1962: 161, f. 236-247 (♀♂). FL, MS, TX, TAM.

♀♂ *baboquivari* Exline and Levi, 1962: 119, f. 89-94 (♀♂). AZ, CHI, SON.

♀♂ *cancellatus* (Hentz, 1850). Exline and Levi, 1962: 180, f. 323-336 (♀♂). ONT, NH to FL to TX to MO.

♀♂ *caudatus* (Taczanowski, 1872). Exline and Levi, 1962: 176, f. 300-322 (♀♂). TX, FL, TAM.

♀♂ *davisi* Exline and Levi, 1962: 191, f. 370-374 (♀♂). TX.

♀♂ *dracus* Chamberlin and Ivie, 1936. Exline and Levi, 1962: 187, f. 352-358 (♀♂). AL.

♀♂ *elevatus* Taczanowski, 1872. Exline and Levi, 1962: 134, f. 128-132 (♀♂). MO; VA to FL to TAM; SIN; CA.

♀♂ *fictilium* (Hentz, 1850). Exline and Levi, 1962: 103, f. 6,7,26-28 (♀♂). ONT; ME to FL to TX to MO; NUL; BCA to CA.

♀♂ *furcatus* (O.P.-Cambridge, 1898). Exline and Levi, 1962: 116, f. 84-88 (♀♂). SC to FL to TX; NUL; TAM; CA.

♀♂ *globosus* Keyserling, 1884. Exline and Levi, 1962: 164, f. 248-260 (♀♂). SC to FL to TX.

♀♂ *maculosus* O.P.-Cambridge, 1898. Exline and Levi, 1962: 168, f. 271-275 (♀♂). FL.

♀♂ *nephilae* Taczanowski, 1872. Exline and Levi, 1962: 139, f. 133-137 (♀♂). FL.

♀♂ *pluto* Banks, 1906. Exline and Levi, 1962: 143, f. 138-142 (♀♂). MD, VA, MO, TX, CHI, TAM.

♀♂ *projiciens* (O.P.-Cambridge, 1896). Exline and Levi, 1962: 106, f. 8-10, 29-31 (♀♂). FL, TX.

♀♂ *subdolus* O.P.-Cambridge, 1898, Exline and Levi, 1962: 190, f. 365-369 (♀♂). TX, AZ, NUL.

♀♂ *trigonum* (Hentz, 1850). Exline and Levi, 1962: 122, f. 66-78 (♀♂). ME to FL to TX to ONT.

Chrosiothes Simon, 1894. Levi, 1954a (Key); 1964e (Revision).

Type species: *C. silvaticus* Simon

♀♂ *chirica* (Levi, 1954). Levi, 1954a: 184, f. 7, 8, 20, 30, 31 (♀♂ *Theridiotis*). AZ, CO, UT.

♀ *iviei* Levi, 1964e: 87, f. 37-39 (♀). CA.

♀♂ *jocosus* (Gertsch and Davis, 1936). Levi, 1954a: 180, f. 1-5, 10, 19, 26, 27 (♀♂ *Theridiotis*). TX, TAM.

♀♂ *minusculus* (Gertsch, 1936). Levi, 1954a: 182, f. 11, 16-18, 21, 28, 29 (♀♂). TX, TAM.

♀♂ *portalensis* Levi, 1964e: 89, f. 19-22 (♀♂). AZ.

♀♂ *silvaticus* Simon, 1894. Levi, 1954a: 187, f. 25, 36, 37 (♀ *probabilis*), f. 13-15 (♂ *barrowsi*); 1964e: 84. FL.

Chrysso O.P.-Cambridge, 1882. Levi, 1955b (Revision); 1962b (Keys).

Type species: *C. albomaculata* O.P.-Cambridge

♀♂ *albomaculata* O.P.-Cambridge, 1882. Levi, 1955b: 61, f. 1-4, 18, 19, 25-27 (♀♂). NC to FL to TX.

♀♂ *nordica* (Chamberlin and Ivie, 1947). Levi, 1957c: 105, pl. 8, f. 1-2, 7-11 (♀♂ *Arctachaea*). AK, NWT, MT, CO, UT, CA.

♀♂ *pelyx* (Levi, 1957). Levi, 1957c: 104, pl. 8, f. 3-6, 12, 13 (♀♂ *Arctachaea*). UT, OR.

♀♂ *pulcherrima* (Mello-Leitão, 1917). Levi, 1962b: 231, f. 71-75 (♀♂ *clementinae*); 1967a: 182, f. 28-31 (♀♂). FL.

Coleosoma O.P.-Cambridge, 1882. Levi, 1959b (Revision).

Type species: *C. blandum* O.P.-Cambridge

♀♂ *acutiventer* (Keyserling, 1884). Levi, 1959b: 4, f. 6-11 (♀♂). GA to TX; TAM.

♀♂ *floridanum* Banks, 1900. Levi, 1959b: 6, f. 12-17 (♀♂). ME, MA, NJ, FL.

♀♂ *normale* Bryant, 1944. Levi, 1959b: 3, f. 1-5 (♀♂). NC, FL, AZ.

Comaroma Bertkau 1889. Levi, 1957a (Rev. *Archerius*).

Type species: *C. simoni* Bertkau

♀♂ *mendocino* (Levi, 1957). Levi, 1957a: 115, f. 38-47 (♀♂ *Archerius*). CA.

Crustulina Menge, 1868. Levi, 1957b (Revision).

Type species: *C. guttata* (Wider.).

♀♂ *altera* Gertsch and Archer, 1942. Levi, 1957b: 372, f. 4-6, 8-10 (♀♂). MA to FL to LA to WI.

♀♂ *sticta* (O.P.-Cambridge, 1861). Levi, 1957b: 370, f. 1-3, 7 (♀♂). AK to BCN; ID to TX; MAN to QUE; MN; MI; IL; NB; NEF to VA.

Dipoena Thorell, 1869. Levi, 1953 (Revision); 1963a (Key).

Type species: *D. melanogaster* (C. L. Koch)

♀♂ *abdita* Gertsch and Mulaik, 1936. Levi, 1953: 37, f. 77-82, 108-109 (♀♂). FL to CA; NV.

♀♂ *alta* Keyserling, 1886. Levi, 1953: 12, f. 11-15, 120-121 (♀♂ *lineatipes*). FL to TX.

♀♂ *atopa* (Chamberlin, 1948). Levi, 1953: 35, f. 65-71, 116-117 (♀♂ *daltoni*). UT, CA.

♀ *bernardino* Levi, 1963a: 147, f. 125-127 (♀). CA.

♀♂ *buccalis* Keyserling, 1886. Levi, 1953: 27, f. 6, 16-18, 33-34, 98-101 (♀♂). ONT, OH, NY to MD; AL, MS, AZ, CHI, SON.

♂ *cathedralis* Levi, 1953: 15, f. 19-22 (♂). TX.

♀ *chathami* Levi, 1953: 21, f. 85-86 (♀). GA.

♀♂ *dorsata* Muma, 1944. Levi, 1953: 17, f. 87-88, 19, f. 23-29 (♀♂ *appalachia*). MD to FL; TN, MS, AZ.
  ♀ *lana* Levi, 1953: 36, f. 112-113 (♀). CA, OR.
♀♂ *malkini* Levi, 1953: 33, f. 8, 60-64, 110-111 (♀♂). UT, NM, AZ, OR, CA.
  ♀ *neotoma* Levi, 1953: 36, f. 7, 118-119 (♀). CA.
♀♂ *nigra* (Emerton, 1882). Levi, 1953: 21, f. 30-32, 37-46, 91-97 (♀♂). Throughout U.S. and southern Canada.
♀♂ *prona* (Menge, 1868). Levi, 1953: 30, f. 50-59, 105-106 (♀♂ *hamata*). MA, RI, NY, NC, MI, IL, SD; NM, CO to CA.
  ♀ *provalis* Levi, 1953: 34, f. 114-115 (♀). UT, OR.
  ♀ *rita* Levi, 1953: 32, f. 107 (♀). AZ.
♀♂ *sulfurica* Levi, 1953: 29, f. 4-5, 47-49, 83-84, 102-104 (♀♂). NM, AZ.
  ♀ *washougalia* Levi, 1953: 35, f. 72-76 (♂). WA, OR.

Enoplognatha * Pavesi, 1880. Levi, 1957d (Revision); 1962a (Key).
  Type species: *Theridion mandibulare* Lucas
♀♂ *intrepida* (Sörensen, 1898). Levi, 1957d: 17, f. 40, 41, 48, 51, 52 (♀♂). AK, ALB, SAS, ONT; NH to PA; WI, MN, MT, WY, CO, NM.
♀♂ *joshua* Chamberlin and Ivie, 1942. Levi, 1957d: 15, f. 42-46, 54-56 (♀♂). VA, GA, WY, WA; ID to AZ, CA.
♀♂ *maricopa* Levi, 1962a: 15, f. 1-5 (♀♂). CA, AZ.
♀♂ *marmorata* (Hentz, 1850). Levi, 1957d: 11, f. 24, 26, 27, 30-33 (♀♂). ONT to NOV to AL to MO; ND; MT to TX to CA to WA.
♀♂ *ovata* (Clerck, 1757). Levi, 1957d: 7, f. 1-10 (♀♂). ME to NY; ONT; BCA to CA.
♀♂ *selma* Chamberlin and Ivie, 1946. Levi, 1957d: 10, f. 15, 16, 19, 20, 22, 23 (♀♂). OR, CA.
♀♂ *tecta* (Keyserling, 1884). Levi, 1957d: 13, f. 11, 25, 28, 29, 34-37 (♀♂). ONT to NEF to VA to IO; TX, CO, WA.
♀♂ *thoracica* (Hahn, 1831). Levi, 1957d: 9, f. 13, 14, 17, 18, 21 (♀♂). OR.
♀♂ *wyuta* Chamberlin and Ivie, 1942. Levi, 1957d: 15, f. 38, 39, 47, 49, 50, 53 (♀♂). SD, WY, UT.

Episinus Latreille, 1809. Levi, 1954d (Revision); 1964b (Key).
  Type species: *E. truncatus* Latreille
♀♂ *amoenus* Banks, 1911. Levi, 1954d: 68, f. 4, 17, 18, 32, 39 (♀♂). MD to FL; TN, AL.
♀♂ *cognatus* O.P.-Cambridge, 1893. Levi, 1954d: 71, f. 8-10, 21, 22, 33, 41 (♀♂). TX, TAM.

Euryopis Menge, 1868. Levi, 1954b (Revision); 1963a (Key).
  Type species: *E. flavomaculata* (C. L. Koch)
♀♂ *argentea* Emerton, 1882. Levi, 1954b: 11, f. 4, 7, 11-14 (♀♂). MA to VA; ONT to OH, IL; CO, OR.
♀♂ *emertoni* Bryant, 1933. Levi, 1954b: 15, f. 19-22, 29, 31, 34, 37 (♀♂). SC to FL to TN; MA, NY.
♀♂ *funebris* (Hentz, 1850). Levi, 1954b: 26, f. 53, 65, 69, 83, 84, 100, 120, 121, 129 (♀♂ *limbata*). QUE to ONT to FL; ND.
♀♂ *gertschi* Levi, 1951. Levi, 1954b: 9, f. 3, 6, 15, 16 (♀♂). MA to VA; MI, IN, IL.
♀♂ *mulaiki* Levi, 1954b: 19, f. 17, 18, 27, 28, 32 (♀♂). TX, AZ.
♀♂ *quinquemaculata* Banks, 1900. Levi, 1954b: 46, f. 133-136 (♀). 1963a: 131, f. 11-16.

OH, NY, MD, DC, VA, GA, TX.

♀♂ *saukea* Levi, 1951. Levi, 1954b: 7, f. 2, 5 (♂). 1963a: 130, f. 7-9 (♀). NJ, MI, WI, MN.

♀♂ *spinigera* O.P.-Cambridge, 1895. Levi, 1954b: 20, f. 23, 24, 30, 33, 36 (♀♂). NUL, TAM, TX, OK, NM, AZ, UT, CA.

♀♂ *taczanowskii* Keyserling, 1886. Levi, 1954b: 24, f. 38-52 (♀♂ *nigripes*). FL, TX, NM, CO, UT, AZ.

♂ *tavara* Levi, 1954b: 29, f. 54, 66, 70, 131 (♂). FL.

♀ *varis* Levi, 1963a: 130. Levi, 1954b: 23, f. 25, 26, 35 (♀ *variabilis*). FL.

♂ *weesei* Levi, 1963a: 134, f. 21 (♂). OK.

Confusion reigns among the following names of *Euryopis*. A new study is necessary to delimit the species. Specimens cannot be placed at the present time.

♀♂ *californica* Banks, 1904. Levi, 1954b: 39, f. 61, 74, 77, 92, 93, 105, 132 (♀♂). NV, CA, BCN.

♀♂ *coki* Levi, 1954b: 33, f. 58, 68, 85, 86, 102, 130 (♀♂). UT, ID, WY.

♀♂ *formosa* Banks, 1908. Levi, 1954b: 40, f. 62, 75, 78, 94-96, 106, 107 (♀♂). BCA to CA; ID, WY, UT.

♀♂ *lineatipes* O.P.-Cambridge, 1893. Levi, 1954b: 36, f. 60, 73, 76, 90, 91, 104, 125, 126 (♀♂). NUL, TAM, TX.

♂ *pepini* Levi, 1954b: 32, f. 55, 67, 71, 101 (♂). WI.

♀♂ *scriptipes* Banks, 1908. Levi, 1954b: 43, f. 59, 63, 79, 80, 82, 97-99, 108-114, 116-119, 127, 128 (♀♂). Limits uncertain: ALB to CHI; SD, NB.

♂ *spiritus* Levi, 1954b: 46, f. 64, 81, 115 (♂). CO.

♀♂ *texana* Banks, 1908. Levi, 1954b: 34, f. 57, 58, 72, 87-89, 103, 122-124 (♀♂). TX, AZ, UT, CO, NUL, SON, COA.

*Latrodectus*** Walckenaer, 1805. Levi, 1959a (Revision). Changes: McCrone and Levi. 1964; Kaston, 1970.

    Type species: *L. mactans tredecimguttatus* (Rossi)

♀♂ *bishopi* Kaston, 1938. McCrone and Levi, 1964: 15, f. 2, 4-7, 21-22 (♀♂). FL.

♀♂ *geometricus* C. L. Koch, 1841. Levi, 1959a: 21, f. 8-10, 25-28, 37, 39-50, 80-83 (♀♂). 1967a: 185, f. 57-59 (♀♂). FL.

♀♂ *hesperus* Chamberlin and Ivie, 1935. Kaston, 1970. Doubtful if valid species (unpubl.).

♀♂ *mactans* (Fabricius, 1775). Levi, 1959a: 24, f. 1, 5-7, 19-21, 38, 53-55, 56-67, 72-79 (♀♂); 1967a: 185, f. 60-62 (♀♂). NY to CA and south; TAM and BCN. Doubtful if west coast specimens same species.

♀♂ *variolus* Walckenaer, 1837. McCrone and Levi, 1964: 13, f. 3, 8-13, 27 (♀♂). ONT to BCA; MA, VT; FL to CA. Doubtful if BCA to CA same species.

Paratheridula Levi, 1957. Levi, 1957a, 1966 (Revision).

    Type species: *P. perniciosa* (Keyserling)

♀♂ *perniciosa* (Keyserling, 1886). Levi, 1957a: 106, f. 1-6, 48 (♀♂). 1967a: 176, f. 1-4 (♀♂). FL, AL, MS, LA.

Pholcomma Thorell, 1869. Levi, 1957a (Revision).

    Type species: *P. gibbum* Westring

♀♂ *barnesi* Levi, 1957a: 114, f. 31-37 (♀♂). NC, PA.

♀♂ *carota* Levi, 1957a: 113, f. 28-30 (♂), in press ♀. NC, GA, FL.

♀♂ *hirsuta* Emerton, 1882. Levi, 1957a: 110, f. 19-27, 48 (♀♂). NH to FL to MS to WI; MO.

Phoroncidia Westwood, 1835. Levi, 1955c (Rev. *Oronota*).

    Type species: *P. aculeata* Westwood

♀♂ *americana* (Emerton, 1882). Levi, 1955c: 334, f. 1-8 (♀♂ *Oronota americana*). 1964c: 74, ONT to MS to FL to MA; NOV; AR.

Robertus** O.P.-Cambridge, 1879. Kaston, 1946 (Revision *Ctenium*).

    Type species: *R. neglectus* O.P.-Cambridge

    Name protected by Art. 80 of ICZN.

♀♂ *banksi* (Kaston, 1946). Kaston, 1946: 5, f. 1-8, 49 (♀♂). ONT; NH to MD; MI.

♀♂ *borealis* (Kaston, 1946). Kaston, 1946: 6, f. 41-43, 50 (♀♂). ME, NY, MI.

 ♀ *crosbyi* (Kaston, 1946). Kaston, 1946: 7, f. 52 (♀). NY.

♀♂ *eremophilus* Chamberlin, 1928. Kaston, 1946: 7, f. 26-28, 54 (♀♂). NY, OH, MI, IL, UT.

 ♀ *floridensis* (Kaston, 1946). Kaston, 1946: 7, f. 48 (♀). FL.

♀♂ *frontatus* (Banks, 1892). Kaston, 1946: 7, f. 48 (♀♂). CT, NY to MD; NC, TN, OH.

♀♂ *fuscus* (Emerton, 1894). Kaston, 1946: 7, f. 38-40, 56 (♀♂). LAB, ME to NY; ONT, MI, WY.

♀♂ *laticeps* (Keyserling, 1884). Kaston, 1946: 9, f. 14-16 (♀♂). CT; NY to NC; TN; OH to NB.

♀♂ *lividus* (Blackwall, 1836). Kaston, 1946: 9, f. 17-19, 58 (♀♂). AK.

♀♂ *longipalpus* (Kaston, 1946). Kaston, 1946: 10, f. 20-22, 47 (♀♂). NH to NJ; ONT; MI.

♀♂ *pumilus* (Emerton, 1909). Kaston, 1946: 10, f. 32-34, 53 (♀♂). ME to PA.

♀♂ *riparius* (Keyserling, 1886). Kaston, 1946: 11, f. 11-13, 44 (♀♂). QUE to NC; TN, ONT, SD, MN, MI, WY.

 ♀ *similis* (Kaston, 1946). Kaston, 1946: 12, f. 45 (♀). NY.

♀♂ *spiniferus* (Emerton, 1909). Kaston, 1946: 12, f. 23-25, 57 (♀♂). NH, MA, CT, MI, NB.

♀♂ *vigerens* (Chamberlin and Ivie, 1933). Kaston, 1946: 13, f. 9, 10, 29-31, 55 (♀♂). AK; BCA to MT to CA.

Spintharus Hentz, 1850. Levi, 1954d (Revision).

    Type species: *S. flavidus* Hentz

♀♂ *flavidus* Hentz, 1850. Levi, 1954d: 79, f. 46, 48-50, 52, 53 (♀♂). 1963d: 225, f. 1-6. MA, NY to FL; OH to AL; AR, TX, BCN.

Steatoda Sundevall, 1933. Levi, 1957b (Revision). Gertsch, 1959. Levi, 1959d (Discussion); 1962a (Key).

    Type species: *S. castanea* (Clerck, 1757)

♀♂ *albomaculata* (DeGeer, 1778). Levi, 1957b: 396, f. 56-65 (♀♂). NWT to CA; ALB to CHI; MAN to NB; MN, IO to NH, CT.

♀♂ *americana* (Emerton, 1882). Levi, 1957b: 400, f. 66-69 (♀♂). ME to FL; OH to AL; ONT to MO; NB to TX; ID to SON, NM; BCA to OR.

♀♂ *atascadera* Chamberlin and Ivie, 1942. Levi, 1957b: 419, f. 106-109, 134-141 (♀♂). CA.

♀♂ *bipunctata* (Linnaeus, 1758). Levi, 1957b: 413, f. 86-89, 155-156 (♀♂). NOV to NH; NEF to ONT.

♀♂ *borealis* (Hentz, 1850). Levi, 1957b: 422, f. 116-118, 148-154 (♀♂). AK; NWT; ALB to CO to NC to NOV; MS; TX.

♀♂ *erigoniformis* (O.P.-Cambridge, 1884). Levi, 1957b: 402, f. 70-73 (♀♂ *septemmaculata*); 1967a: 184, f. 46-49 (♀♂). FL.

♀♂ *fulva* (Keyserling, 1882). Levi, 1957b: 391, f. 32, 33, 45-47, 52 (♀♂). OR to BCN to TAM to NB; FL to TX.

♀♂ *grandis* Banks, 1901. Levi, 1957b: 415, f. 92-97, 119-123 (♀♂). SD, WY, CO, UT, OR, NM, AZ.

♀♂ *grossa* (C. L. Koch, 1838). Levi, 1957b: 404, f. 74, 83-85 (♀♂). 1967a: 184, f. 50-52 (♀♂). WA to BCN; CHI, SON; MA to CT; FL to MS.

♀♂ *hespera* Chamberlin and Ivie, 1933. Levi, 1957b: 420, f. 90, 91, 110-115, 142-147 (♀♂). BCA to CA; WA to CO to MT.

♀ *medialis* (Banks, 1898). Levi, 1957b: 388, f. 34-36, 42-44, 53-55 (♀♂). OR to BCN to TAM to WY. Gertsch (1960) considers this five species (answ. Levi, 1959d): *punctulata* (Marx, 1898). TX, AZ to C. MEX. *medialis* (Banks, 1898). AZ, CA to MEX. *washona* Gertsch, 1960. OR, NV, UT, AZ, CA. *variata* Gertsch, 1960. WY to TX; UT to MEX. *variata china* Gertsch, 1960. TX, NUL.

♀♂ *mexicana* Levi, 1957b: 417, f. 98-103, 124-128 (♀♂). ID to TX; UT to CHI.

♀ *palomara* Chamberlin and Ivie, 1935. Levi, 1957b: 419, f. 104, 105, 129-133 (♀). CA.

♀♂ *pulcher* (Keyserling, 1882). Levi, 1957b: 393, f. 37-41, 48-51 (♀♂). CO, TX, NM, AZ, OR, CA, COA, CHI. Gertsch (1960) considers this three species (answ. Levi, 1959d): *pulcher* (Keyserling, 1882). OR, CA. *alamosa* Gertsch, 1960. TX to MEX. *apacheana* Gertsch, 1960. CO, NM, AZ.

♀♂ *quadrimaculata* (O.P.-Cambridge, 1896). Levi, 1957b: 385, f. 28-31 (♀♂). FL to TX; TAM.

♀♂ *transversa* (Banks, 1898). Levi, 1957b: 383, f. 23-27 (♀♂). TX, AZ, CA, SON.

♀♂ *triangulosa* (Walckenaer, 1892). Levi, 1957b: 407, f. 75, 76, 80-82 (♀♂). 1967a: 185, f. 53-56 (♀♂). MA, NY to NB to TX to GA; OR, CA; ID, UT, CO.

Stemmops O.P.-Cambridge, 1894. Levi, 1955c (Revision); 1964e (Key).

Type species: *S. bicolor* O.P.-Cambridge

♀♂ *bicolor* O.P.-Cambridge, 1894. Levi, 1955c: 338, f. 14, 17, 18, 35, 36 (♀♂). FL to TX, NUL, TAM.

♀♂ *ornatus* (Bryant, 1933). Levi, 1955c: 341, f. 16, 21, 22, 29, 30 (♀♂). NJ, OH, MO, NC, GA, MS.

Tekellina Levi, 1957a.

Type species: *T. archboldi*

♀♂ *archboldi* Levi, 1957a: 107, f. 7-12 (♀♂). FL.

Theonoe** Simon, 1881. Levi, 1955a (Rev. *Coressa*).

Type species: *T. minutissima* (O.P.-Cambridge)

♀♂ *stridula* Crosby, 1906. Levi, 1955a: 4, f. 2-6 (♀♂ *Coressa*). AK, WI, ONT, NY, VA, MO.

Theridion* Walckenaer, 1805. Levi, 1957d (Revision); 1963c (Key).

Type species: *T. pictum* (Walckenaer)

♀♂ *adamsoni* Berland, 1934. Levi, 1957d: 62, f. 198-199, 209, 213-214 (♀♂ *hobbsi*); 1963c: 568; 1967a: 181, f. 20-23 (♀♂). FL to TX.

♀ *aeolium* Levi, 1963c: 547, f. 96-97 (♀). AZ.

♀♂ *agrifoliae* Levi, 1957d: 83, f. 284, 285, 302, 303 (♀♂). BCA to CA.

♀♂ *alabamense* Gertsch and Archer, 1942. Levi, 1957d: 58, f. 202, 203, 206-208 (♀♂). WI to MA to FL to MS; TX; CA.

♀♂ *albidum* Banks, 1895. Levi, 1957d: 82, f. 286, 287, 300, 301 (♀♂). ONT; MA to WI
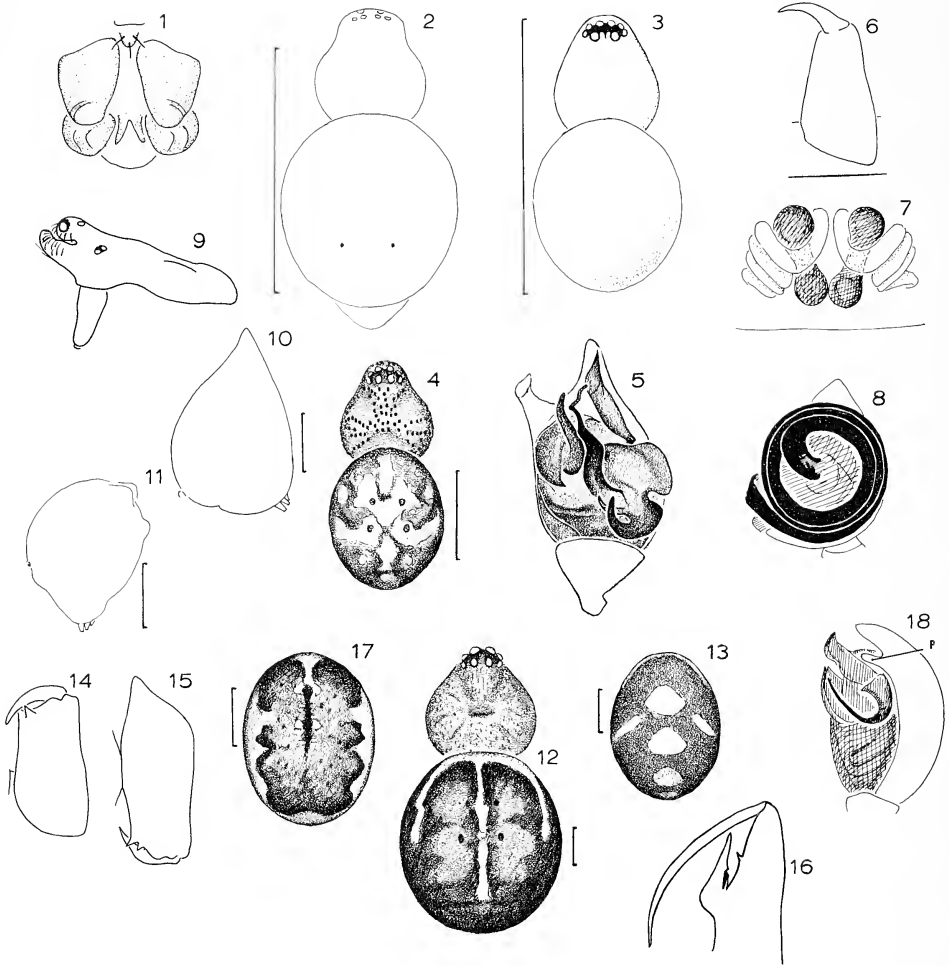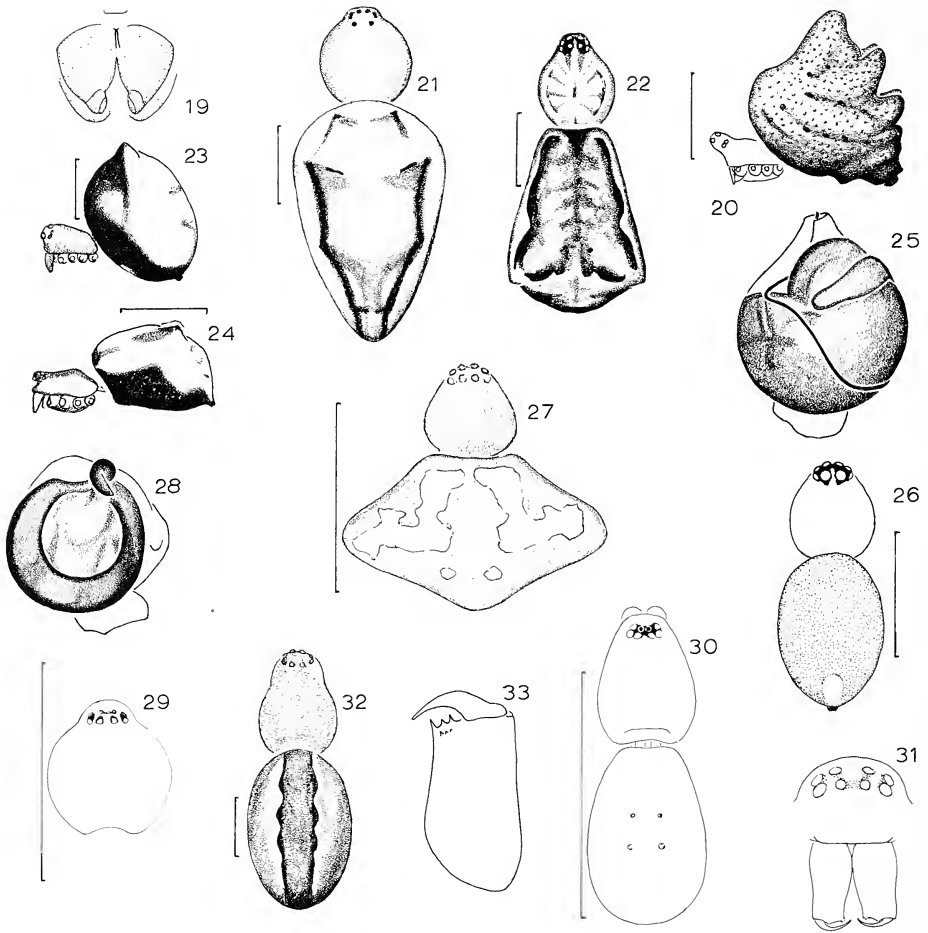
Figs. 1-18.—Theridiids with large colulus between anterior spinnerets: 1, Colulus with three setae; 2, *Comaroma mendocina* (Levi), male; 3, *Theonoe stridula* Crosby, female; Figs. 4, 5.—*Crustulina altera* Gertsch and Archer: 4, Female; 5, Male, left palpus; Figs. 6-8.—*Latrodectus mactans* (Fabricius): 6, Left chelicera of female posterior view; 7, Female genitalia, dorsal view; 8, Left male palpus; Figs. 9, 10.—*Argyrodes elevatus* Taczanowski: 9, Male carapace and chelicerae; 10, Female abdomen; 11, *Argyrodes americanus* (Taczanowski), female abdomen; 12, *Steatoda hespera* Chamberlin and Ivie, female; 13, *Steatoda medialis* (Banks), female abdomen; Figs. 14-15.—*Enoplognatha marmorata* (Hentz), female, left chelicera: 14, Posterior view; 15, Anterior view; 16, *Enoplognatha intrepida* (Sörensen), left male chelicera, posterior view; 17, *Enoplognatha tecta* (Keyserling), female abdomen; 18, *Enoplognatha marmorata* (Hentz), left male palpus, lateral view showing paracymbial hook (P) on upper part of cymbium.

Scale lines, 1 mm.

to LA to NC.

♀♂ *antonii* Keyserling, 1884. Levi, 1957d: 60, f. 196, 197, 205, 215, 216, 219, 220 (♀♂). CT, NY, MD, TN, FL, MS, TX.

♀♂ *arizonense* Levi, 1957d: 49, f. 137, 138, (♀). Levi, 1969: 68, f. 104 (♂). NM, AZ.

♀♂ *atropunctatum* Petrunkevitch, 1930. Levi, 1957d: 66, f. 225-228, 232-234 (♀♂). FL.

♀♂ *aurantium* Emerton, 1915. Levi, 1957d: 93, f. 337-339, 350-352 (♀♂). AK; BCA; WY; NEF to NY; QUE to WI.

♀♂ *australe* Banks, 1899. Levi, 1957d: 41, f. 131, 132, 148-151 (♀♂). NJ; MD; NC to TAM; UT.

♀♂ *berkeleyi* Emerton, 1924. Levi, 1957d: 52, f. 166, 167, 171, 172, 174 (♀♂). IL; MN to NJ; ONT to MA; OR; CA; UT.

♀♂ *bimaculata* (Linn., 1767). Levi, 1956b: 409, f. 1-10 (♀♂, *Neottiura*). BCA, WA.

♀♂ *californicum* Banks, 1904. Levi, 1957d: 84, f. 273, 276, 277, 304, 305 (♀♂). BCA to CA.

♀ *cameronense* Levi, 1957d: 40, f. 114, 115 (♀). Levi, 1959c: 81, f. 74, 75 (♀). TX, TAM, NUL.

♀♂ *cheimatos* Gertsch and Archer, 1942. Levi, 1957d: 96, f. 335, 336, 354-357 (♀♂). OH, TN, GA, FL.

♂ *cinctipes* Banks, 1898. Levi, 1957d: 29, f. 87, 88, 99 (♂). TX.

♀♂ *cochise* Levi, 1963c: 553, f. 123, 124 (♂). Levi, 1969: 69, f. 5-8 (♀). AZ.

♀ *cowlesae* Levi, 1957d: 31, f. 91, 92 (♀). CA.

♀♂ *crispulum* Simon, 1895. Levi, 1957d: 64, f. 222-224, 229-231 (♀♂ *intervallatum*). Levi, 1963c: 564, f. 166-172 (♀♂). NOV to FL; TN to TX, NUL, TAM; OR, CA.

♀♂ *cynicum* Gertsch and Mulaik, 1936. Levi, 1957d: 39, f. 126-128 (♀♂). TX, TAM, NUL.

♀♂ *differens* Emerton, 1882. Levi, 1957d: 32, f. 100, 101, 104-106 (♀♂). Throughout So. Canada and all U.S., most common in NE states.

♀♂ *dilutum* Levi, 1957d: 37, f. 112, 113, 123-125 (♀♂). UT, TX, AZ, CA, NV, SON, CHI, NUL.

♀♂ *dividuum* Gertsch and Archer, 1942. Levi, 1957d: 25, f. 67, 68, 71-74 (♀♂). NC, SC, AL.

♀♂ *dulcineum* Gertsch and Archer, 1942. Levi, 1957d: 26, f. 69, 70, 75, 76 (♀♂). MD, TN, GA, AL.

♀♂ *flavonotatum* Becker, 1879. Levi, 1957d: 34, f. 102, 103, 107-109 (♀♂). MD; OH to TN; NC to TX.

♀♂ *frondeum* Hentz, 1850. Levi, 1957d: 81, f. 288, 289, 298, 299 (♀♂). BCA, WA, CA, AZ, SAS, ND; ONT to NOV to NC, AL to MN.

♀♂ *geminipunctum* Chamberlin, 1924. Levi, 1957d: 43, f. 135, 136, 142-144 (♀♂). CA, BCN.

♀ *gertschi* Levi, 1959c: 89, f. 91, 92 (♀). AZ, CHI.

♀♂ *glaucescens* Becker, 1879. Levi, 1957d: 44, f. 152, 153, 155, 156 (♀♂). NEF to WI to FL; NB, LA, TX.

♀♂ *goodnightorum* Levi, 1957d: 41, f. 129, 130, 145-147 (♀♂). WY to CA and TX; CHI.

♀♂ *hidalgo* Levi, 1957d: 43, f. 133, 134, 139-141 (♀♂). TX, TAM.

♀♂ *impressum* L. Koch, 1881. Levi, 1957d: 89, f. 321, 326-328 (♀♂). AK, NWT, ALB.

♀♂ *intritum* (Bishop and Crosby, 1926). Levi, 1957d: 35, f. 110, 111, 120-122 (♀♂). GA, AL, FL.

♀♂ *istokpoga* Levi, 1957d: 67, f. 235, 236, 247, 248 (♀♂). FL.

Figs. 19-33.—Theridiids with colulus between spinnerets replaced by two setae: 19, Spinnerets with two colulus setae; 20, *Phoroncidia americana* (Emerton), female; 21, *Spintharus flavidus* (Hentz), female; 22, *Episinus amoenus* (Banks), female, 23, *Chrosiothes jocosa* (Gertsch and Davis), female; 24, *Chrosiothes minuscula* (Gertsch), female; 25, *Chrosiothes jocosa* (Gertsch and Davis), left male palpus; 26, *Stemmops bicolor* O.P.-Cambridge, female; Figs. 27, 28.—*Tekellina archboldi* Levi: 27, Female; 28, Left male palpus; 29, *Styposis ajo* Levi, female carapace; 30, *Pholcomma carota* Levi, female; 31, *Pholcomma hirsuta* Emerton, eye region and chelicerae of female; Figs. 32, 33.—*Anelosimus studiosus* (Hentz): 32, Female; 33, Left chelicera, posterior view.

Scale lines, 1 mm.

♀ *kawea* Levi, 1957d: 48, f. 118, 119 (♀). UT, CA, CHI.

♀♂ *lawrencei* Gertsch and Archer, 1942. Levi, 1957d: 71, f. 257-260 (♀♂). ID, WA, OR, CA.

♀♂ *leechi* Gertsch and Archer, 1942. Levi, 1957d: 74, f. 267, 268, 290, 291 (♀♂). BCA to CO to CA.

♀♂ *llano* Levi, 1957d: 28, f. 77-80 (♀♂). TX.

♀ *lowriei* Barrows, 1945. Levi, 1957d: 98, f. 353 (♀). TN.

♀♂ *lyricum* Walckenaer, 1841. Levi, 1957d: 89, f. 322, 323, 329-331 (♀♂). WI to ME to FL to TX.

♀♂ *melanurum* Hahn, 1831. Levi, 1957d: 55, f. 181-186 (♀♂). BCA to CA, UT.

♀♂ *michelbacheri* Levi, 1957d: 47, f. 159-163 (♀♂). MT, WA to CA.

♀♂ *montanum* Emerton, 1882. Levi, 1957d: 71, f. 251-256 (♀♂). BCA to OR; ALB to NM; MAN to NEF; MN to NY; TN.

♀♂ *morulum* O.P.-Cambridge, 1898. Levi, 1957d: 79, f. 271, 280, 281, 296, 297, (♀♂ *jeanae*). AZ to MEX.

♀♂ *murarium* Emerton, 1882. Levi, 1957d: 22, f. 12, 57, 58, 61-63. So. Canada to No. MEX, throughout U.S., espec. E. U.S.

♀♂ *myersi* Levi, 1957d: 31, f. 95-98 (♀♂). FL, TAM, NUL.

♀♂ *neomexicanum* Banks, 1901. Levi, 1957d: 76, f. 269, 274, 275, 292, 293 (♀♂). BCA, W. U.S.

♀♂ *neshamini* Levi, 1957d: 88, f. 311, 312, 317-319 (♀♂). IL; PA to GA.

♀♂ *ohlerti* Thorell, 1870. Levi, 1957d: 98, f. 324, 325, 332-334. (♀♂). AK, NWT to CA; NM, QUE, Rocky Mts., Cascades.

♀♂ *orlando* (Archer, 1950). Levi, 1957d: 87, f. 309, 310, 315, 316 (♀♂). GA, FL, LA.

♀♂ *pennsylvanicum* Emerton, 1913. Levi, 1957d: 87, f. 306-308, 313, 314, 320 (♀♂). ONT; MA to FL; TN, AL, IL, MO.

♀♂ *petraeum* L. Koch, 1872. Levi, 1957d: 24, f. 59, 60, 64-66 (♀♂). ME, NY, MI, ND, NB; WA to CO to CA.

♀♂ *pictipes* Keyserling, 1884. Levi, 1957d: 77, f. 270, 278, 279, 294, 295 (♀♂). SC, AL, GA, FL.

♀♂ *pictum* (Walckenaer, 1802). Levi, 1957d: 50, f. 164, 165, 168-170, 173 (♀♂ *ornatum*). ALB to NOV to WI: SD to WA to UT.

♀♂ *positivum* Chamberlin, 1924. Levi, 1957d: 68, f. 237-239, 243-246 (♀♂). 1963c: 565, f. 177-178 (♀♂). CA, TX, TAM, BCN.

♀♂ *punctipes* Emerton, 1924. Levi, 1957d: 75, f. 261-266 (♀♂). WA to BCN.

♀♂ *punctosparsum* Emerton, 1882. Levi, 1957d: 60, f. 194, 195, 204, 217, 218, 220, 221 (♀♂). MA to NC to AR.

♀♂ *rabuni* Chamberlin and Ivie, 1944. Levi, 1957d: 28, f. 81-86 (♀♂). NJ to GA; SD, NB, CO, UT, TX, CA.

♀♂ *rufipes* Lucas, 1849. Levi, 1957d: 56, f. 188-193 (♀♂). Levi, 1967a: 179, f. 24-27 (♀♂). FL, TX.

♀♂ *saanichum* Chamberlin and Ivie, 1947. Levi, 1957d: 70, f. 240-242, 249, 250 (♀♂). AK to CA.

♂ *sarde* Chamberlin and Ivie, 1944. Levi, 1957d: 30, f. 89, 90 (♂). GA.

♀♂ *sexpunctatum* Emerton, 1882. Levi, 1957d: 91, f. 340-349 (♀♂). AK to CA; BCA, ALB to AZ; west of Rocky Mts.; MAN; ONT to NEF to NC; Appalachian Mts.

♀♂ *simile* C. L. Koch, 1936. Levi, 1957d: 53, f. 179, 180, 187 (♀♂). BCA, WA.

♀♂ *submissum* Gertsch and Davis, 1936. Levi, 1957d: 38, f. 116, 117 (♂); 1959c: 84, f.
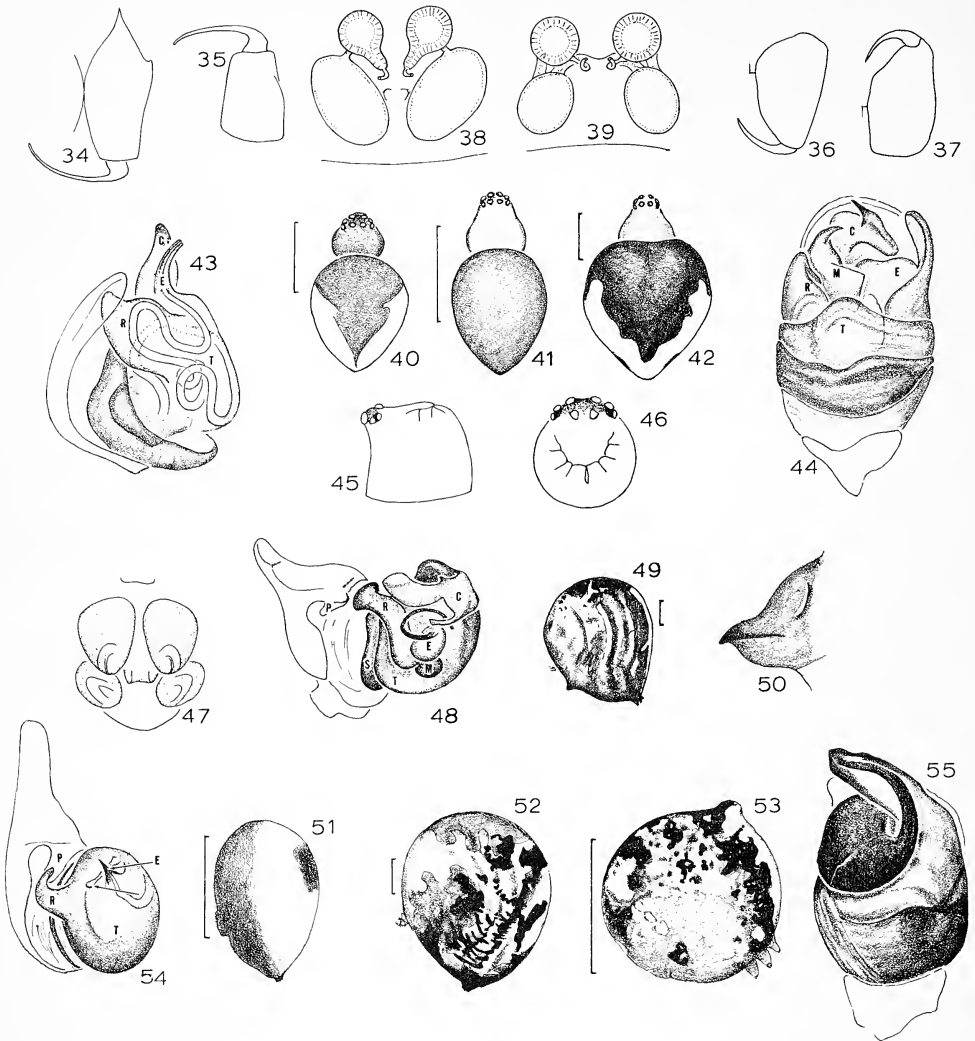
Figs. 34-46.—*Euryopis* and *Dipoena*: Figs. 34, 35.—*Euryopis funebris* (Hentz), female, left chelicera: 34, Anterior view; 35, Posterior view; Figs. 36, 37.—*Dipoena nigra* (Emerton), left female chelicera: 36, Anterior view; 37, Posterior view; 38, *Euryopis flavomaculatis* (C. L. Koch), seminal receptacles, dorsal view; 39, *Dipoena melanogaster* (C. L. Koch), seminal receptacles, dorsal view; Figs. 40-42.—Females: 40, *Euryopis taczanowskii* Keyserling; 41, *Euryopis emertoni* Bryant; 42, *Euryopis funebris* (Hentz); 43, *Euryopis emertoni* Bryant, left male palpus expanded and cleared; 44, *Dipoena atopa* (Chamberlin), left male palpus; 45, 46, *Dipoena alta* (Keyserling), male carapace.

Figs. 47-55.—Theridiids without colulus between anterior spinnerets: 47, Spinnerets without colulus; Figs. 48-50.—*Tidarren sisyphoides* (Walckenaer): 48, Left male palpus, expanded; 49, Female abdomen from side; 50, Epigynum, lateral view; Figs. 51-53.—*Achaearanea* female abdomen from side: 51, *A. globosa* (Hentz); 52, *A. tepidariorum* (C. L. Koch); 53, *A. ambera* Levi; Figs. 54, 55.—*Achaearanea* left male palpus: 54, *A. globosa*, expanded; 55, *A. tepidariorum* (C. L. Koch).

Scale lines, 1 mm.

Abbreviations. C, conductor; E, embolus; M, median apophysis; P, paracymbium; R, radix; T, tegulum.

89-90 (♀). TX, NM, AZ, SON, CHI.

♀ *timpanogos* Levi, 1957d: 31, f. 93, 94 (♀). UT.

♀♂ *tinctum* (Walckenaer, 1802). Levi, 1957d: 61, f. 200, 201, 210-212 (♀♂). OR, WA.

♀♂ *transgressum* Petrunkevitch, 1911. Levi, 1957d: 47, f. 154, 157, 158 (♀♂). CO, UT, NM, AZ, CHI.

♀♂ *varians* Hahn, 1831. Levi, 1957d: 52, f. 175-178 (♀♂). BCA, WA.

♂ *yuma* Levi, 1963c: 535, f. 42-43 (♂). AZ.

Theridula Emerton, 1882. Levi, 1954c (Revision); 1966 (Key)

Type species: *T. sphaerula* (Hentz)

♀♂ *emertoni* Levi, 1954c: 333, f. 1-5 (♀♂). ONT to WI to CT to NEF; WV, TN.

♀♂ *gonygaster* (Simon, 1873). Levi, 1954c: 340, f. 18-22 (♀♂). FL, AZ.

♀♂ *opulenta* (Walckenaer, 1837). Levi, 1954c: 334, f. 9-13. NY to FL to TX; MO, UT, OR.

Thymoites Keyserling, 1884. Levi, 1957d (Rev. *Paidisca*); 1959c (Rev. *Sphyrotinus*); 1964a (Key).

Type species: *T. crassipes* Keyserling

♀♂ *camano* (Levi, 1957). Levi, 1957d: 105, f. 367-373 (♀♂ *Paidisca*). UT, WA to CA.

♀♂ *expulsus* (Gertsch and Mulaik, 1936). Levi, 1957d: 109, f. 400, 416, 417 (♀♂ *Paidisca*); 1959c: 146, f. 365-366 (♀♂ *Sphyrotinus*). NC to FL to TX; CA, TAM, NUL.

♀♂ *illudens* (Gertsch and Mulaik, 1936). Levi, 1957d: 110, f. 396, 399, 414, 415 (♀♂ *Paidisca*). TX, TAM, NUL.

♀♂ *maderae* (Gertsch and Archer, 1942). Levi, 1957d: 106, f. 397, 398, 420, 421 (♀♂ *Paidisca*); 1959c: 147, f. 350-356 (♀♂ *Sphyrotinus*). AZ, CHI, NUL.

♀♂ *marxi* (Crosby, 1906). Levi, 1957d: 111, f. 393-395, 401, 418, 419 (♀♂ *Paidisca*); 1959c: 148, f. 363-364 (♀ *Sphyrotinus*). CT to TX to FL; MO.

♀♂ *minnesota* Levi, 1957d: 81, f. 272, 282, 283 (♀ *Theridion pretense*); 1964a: 467, f. 74-76 (♂). MN, MI.

♀♂ *missionensis* (Levi, 1957). Levi, 1957d: 102, f. 380-383 (♀♂ *Paidisca*). TX.

♀♂ *pallidus* (Emerton, 1913). Levi, 1957d: 99, f. 358-366 (♀♂ *Paidisca*); 1959c: 158. MA, RI, NY, TN, NC to FL to TAM, CO, UT, CA.

♀♂ *pictipes* (Banks, 1904). Levi, 1957d: 102, f. 374-379 (♀♂ *Paidisca*). WA to AZ.

♀ *sarasota* (Levi, 1957). Levi, 1957d: 105, f. 402-405 (♀ *Paidisca*). FL.

♀ *sclerotis* (Levi, 1957). Levi, 1957d: 104, f. 384-387 (♀ *Paidisca*). NM.

♀♂ *unimaculatus* (Emerton, 1882). Levi, 1957d: 106, f. 388-392, 406-413 (♀♂ *Paidisca*). ME, QUE, ONT to MN; NY, MA to FL to TX.

Tidarren Chamberlin and Ivie, 1934. Levi, 1955b (Revision).

Type species: *T. sisyphoides* (Walckenaer)

♀♂ *haemorrhoidale* (Bertkau, 1884). Levi, 1955b: 73, f. 49-57, 61-64 (♀♂ *fordum*). FL to CA; TAM.

♀♂ *sisyphoides* (Walckenaer, 1841). Levi, 1955b: 70, f. 41-45, 58-60. KY; FL to TX, TAM, NUL, AZ, CA, BCN.

SYNONYMS OF NORTH AMERICAN THERIDIID GENERA AND SPECIES WHOSE NAME CHANGED SINCE FIRST REVISION

appalachia, Dipoena = *Dipoena dorsata*

Archerius = *Comaroma*

Arctachaea = *Chrysso*
barrowsi, Theridiotis = *Chrosiothes silvaticus*
bryantae, Euryopis = *Euryopis quinquemaculata*
clementinae, Chrysso = *Chrysso pulcherrima*
Coressa = *Theonoe*
Ctenium = *Robertus*
curacaviensis, – Levi, 1959a, *Latrodectus* = *Latrodectus variolus*
daltoni, Dipoena = *Dipoena atopa*
florens, – Levi, 1955, *Achaearanea* = *A. florendida*
fordum, – Levi, 1956, *Tidarren* = *Tidarren haemorrhoidale*
goechares, Achaearanea = *A. acoreensis*
hamata, Dipoena = *Dipoena prona*
hobbsi, Theridion = *Theridion adamsoni*
intervallatum, Theridion = *Theridion crispulum*
jeanae, Theridion = *Theridion morulum*
limbata, Euryopis = *Euryopis funebris*
lineatipes, Dipoena = *Dipoena alta*
Neottiura = *Theridion*
nigripes, Euryopis = *Euryopis taczanowskii*
ornatum, Theridion = *Theridion pictum*
Oronota = *Phoroncidia*
Paidisca = *Thymoites*
pretense, – Levi, 1957, *Theridion* = *Thymoites minnesota*
probabilis, Theridiotis = *Chrosiothes silvaticus*
quadrimaculata, Paratheridula = *Paratheridula perniciosa*
septemmaculata, Steatoda = *Steatoda erigoniformis*
Sphyrotinus = *Thymoites*
Theridiotis = *Chrosiothes*
variabilis, – Levi, *Euryopis* = *Euryopis varis*

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    Scale lines, 1 mm.

    Abbreviations. C, conductor; E, embolus; M, median apophysis; P, paracymbium; R, radix; T, tegulum.
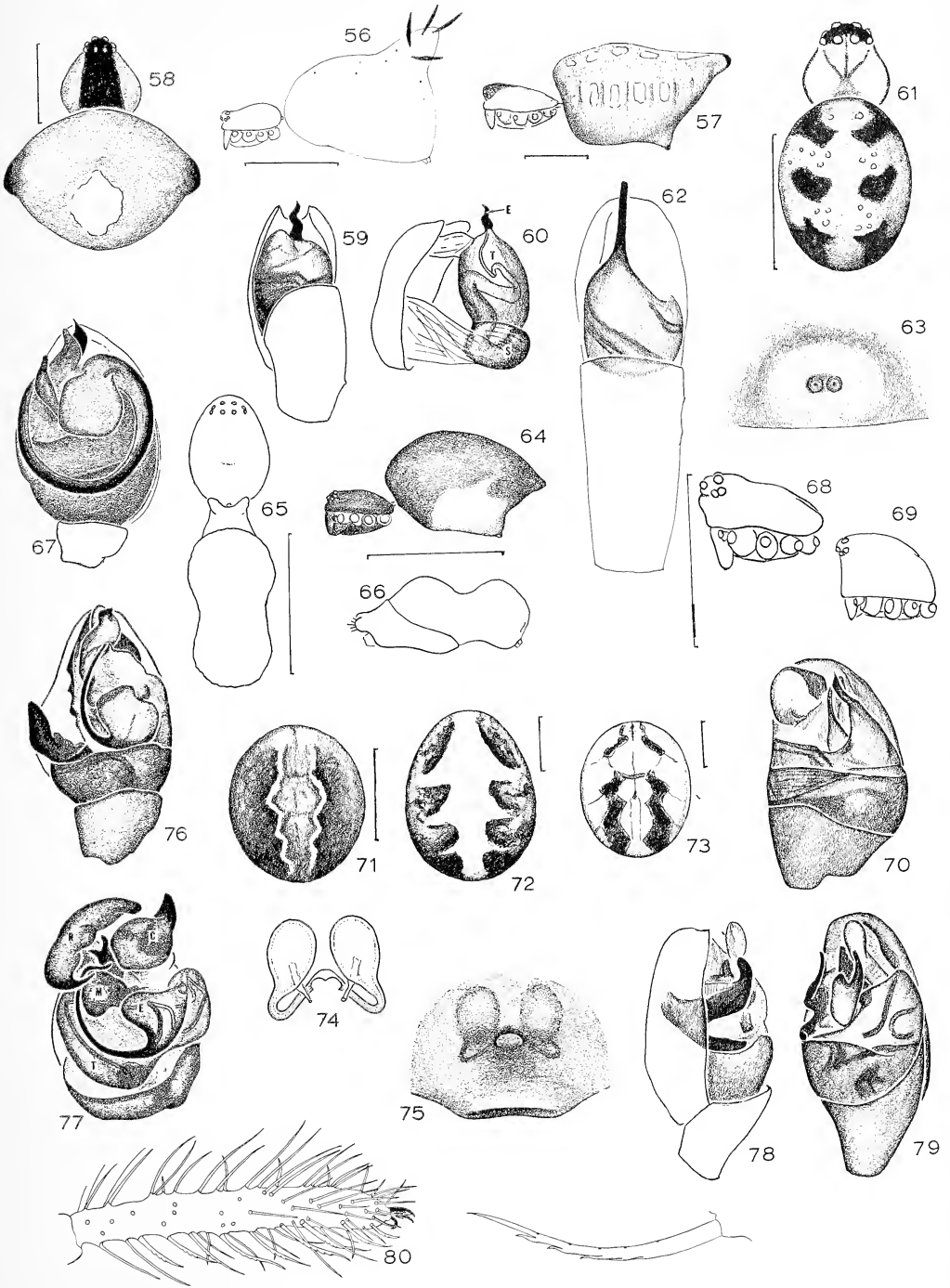
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COMMENTS ON THE SPIDER *SALTONIA INCERTA* BANKS (AGELENIDAE?)

Vincent D. Roth

Southwestern Research Station
Portal, Arizona 85632

Wynne L. Brown

Department of Biological Sciences
University of Arizona
Tucson, Arizona 85721

ABSTRACT

The female of *Saltonia incerta* (Banks) is redescribed, the presence of large tracheal trunks extending into the thorax is recorded, the epigynum is illustrated and *S. imperialis* Chamberlin and Ivie is placed as a junior synonym. The type locality, now under water, and other collecting sites of this species are discussed. The systematic position of the spider is uncertain because of the agelenid-like external characters and the dictynid-like palpi and tracheal trunks.

INTRODUCTION

Saltonia incerta (Banks) is a rare spider known from an island in the northern part of the Gulf of California and from the shores of the Salton Sea in Southern California. Recently the type specimen, a mature female, was made available by Dr. Herbert Levi of the Museum of Comparative Zoology. We are taking this opportunity to illustrate the epigynum of this species and to review its history.

Saltonia incerta (Banks)

Fig. 1

Cybaeodes (?) *incerta* Banks, 1898:185.
Saltonia imperialis Chamberlin and Ivie, 1942:23, Figs. 24-25. NEW SYNONYMY.
Saltonia incerta (Banks), Roth and Brame, 1972:34, Fig. 46.

The above synonymy was noted by W. Ivie (personal communication) a few years before his untimely death but was not published. The new combination was used inadvertently by Roth and Brame (1972:34) without explanation nor synonymic data.

The female is similar to the male in size and general appearance but differs slightly in the leg spination: tibia I, 1r-2-0; metatarsus I, 2(or 1p)-2-1 median. The slightly sclerotized epigynum has lateral openings under heavily sclerotized ridges (Fig. 1).

The internal genitalia were not examined but appear to consist of an atrium, a pair of globular spermathecae with simple connecting canals extending to the epigastric furrow.

Fig. 1.–Epigynum of *Saltonia incerta* Banks (type specimen).
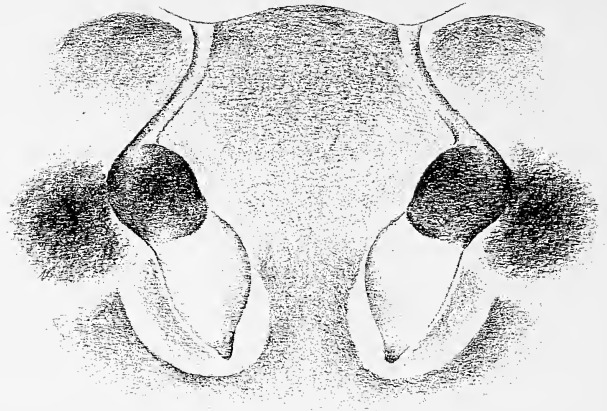
A male in The American Museum of Natural History shows two large tracheae entering the thorax.

Type data—Adult female and immature (thorax and legs only) from Salton, California (27 March 1897, H. G. Hubbard), in the Museum of Comparative Zoology, Cambridge, Massachusetts, collected from debris on salt crust.

Other Records—*California*: Fish Springs, Salton Sea (12 March 1941, Wilton Ivie), in The American Museum of Natural History, male, under a stick on the open ground. *Sonora*: Isla Pelicano, Mar de Cortes (20 April 1944, B. Osorio Tafall), in The American Museum of Natural History, male.

Two of the three collecting sites can still be located. Unfortunately, Fish Springs is now partially developed into a mineral bath at the Rancho Marina Campground at Desert Shores on the Salton Sea. Salton, California, on the northeastern edge of the Salton Sea, was a railroad station for a salt mining company which worked a nearby salt deposit. This deposit is now underwater but was in the area between the Salton and the Mecca beaches of the present Salton Sea State Park. In 1891 there was a salt marsh west of the railroad at Salton which may be the type locality.

The third locality is questionable as there are three "Pelican Islands" in the Gulf of California (Sea of Cortez), one now nonexistent and the other two somewhat inaccessible. One is known locally as Isla El Alcatraz (Spanish for "The Pelican") and is so recorded on at least one Mexican map (Map 1) but is commonly known by American fishermen as Pelican Island, or Isla Pelicano(s) (Maps 2-4). Elsewhere it is listed as Isla Tassne (Map 5). It is a high rocky mountain with some low sandy land covered with desert brush, located at the edge of Kino Bay at latitude 28°49', longitude 111°58'. It has none of the salt marshes one finds around the type locality at the Salton Sea.

The oldest maps (Maps 6-7) place Pelican Island near the junction of the Colorado and Hardy Rivers about 10-12 miles upstream from the Montegue and Gore Islands at the mouth of the Colorado River. The diversion and later damming of this river and the subsequent decrease in water flow caused the island to become permanently attached to the river bank and it was essentially lost. These early maps showed two separate islands whereas more recent maps show the islands joined but partially divided at the southern end with a third unnamed island eastward (Map 8). On the latest maps (Maps 9-10) it is called Pelican Island. This island, which is more likely to be the collecting site of *S. incerta*, lies at the mouth of the Colorado River at latitude 31°45', longitude 114°38'.

The three collections, all containing adult specimens, were made in the months of March and April near salt springs, salt water or salt marshes. Repeated trips to similar

areas including Fish Spring and other springs in the Salton Sea region, Pelican Island at Kino Bay, and along the shores of the Gulf of California have failed to produce additional specimens. Perhaps *Saltonia* has a specialized habitat that has not been exploited by collectors. The similarity of its colulus to two genera of intertidal zone spiders, *Corteza* Roth and Brown and *Desis* Walckenaer suggests that *S. incerta* may be found in a similar marine habitat. *Corteza interaesta* is found at night on rocks and reefs at the upper barnacle zone in the Gulf of California. *Desis* is a widespread genus the species of which are found in rock crevices and worm tubes in the intertidal zone of the Southern Pacific and Indian Oceans from the Galapagos Islands to Eastern Africa.

The systematic position of *Saltonia incerta* remains a puzzle. Banks (1898:185) originally placed it questionably in the genus *Cybaeodes*, commenting, "am uncertain of its position, but I think it very near *Cybaeodes*." Why he placed it in this genus is puzzling since *Cybaeodes* is characterized by its contiguous spinnerets. At that time this genus was placed in the Drassidae by Simon (1893:390) and later Petrunkevitch (1911:532) placed *Cybaeodes incerta* in the Agelenidae. Both Roewer (1954:581) and Bonnet (1956:1297), following Petrunkevitch (1928:175), listed the genus *Cybaeodes*, including *incerta*, in Liocraninae, a subfamily of the Clubionidae. Lehtinen (1967:355) originally placed *Saltonia* in the family Dictynidae, and the subfamily Cybaeinae, but added a footnote on the same page transferring it to Tricholathysinae in the same family without providing evidence for either change.

Except for the widely spaced spinnerets and broad colulus, *Saltonia* has all the external characteristics of the family Agelenidae and will key out readily to this family in Petrunkevitch's (1939:141-148) key to the spider families. The two large tracheal trunks which extend into the thorax are not, however, typical of any of the Agelenidae but are of the Dictynidae.

Recent extensive reclassification of the cribellate spiders and related ecribellate families by Lehtinen (1967), Forster (1970) and Forster and Wilton (1973) leaves one with the alternatives of utilizing a phylogenetic classification without being able to place specimens in their proper family or using an artificial classification and making it possible to place specimens where they might be found by other workers. With spider classification in such a state of flux, it appears to us to be desirable to take a conservative stand and use the family Agelenidae for *Saltonia* for the present, until some of the problems are settled.

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THE JOURNAL OF ARACHNOLOGY

Feature Articles

Cover Illustration, the larva of *Cryptocellus pelaezi,* Kay McCorkle

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THE HEART AND ARTERIAL CIRCULATORY SYSTEM
OF TICKS (ACARI: IXODOIDEA)[1]

Frederick D. Obenchain

James H. Oliver, Jr.

Institute of Arthropodology and Parasitology
Department of Biology, Georgia Southern College
Statesboro, Georgia 30458

ABSTRACT

The heart and arterial (efferent) circulatory system in *Argas radiatus* and *Ornithodoros turicata* (Argasidae) and in *Ixodes scapularis*, *Dermacentor variabilis* and *Amblyomma tuberculatum* (Ixodidae) are consistent in form with the plan observed in other apulmonate Arachnida. Specialized sinuses or vessels for channelization of venous (afferent) hemolymph are absent, but heart, arterial vessels and sinuses are well-developed. The heart lies in a sinus formed by the pericardial septum which is continuous with connective tissue processes of dorso-lateral and ventro-lateral suspensory muscles of the heart. Hemolymph flows from the pericardial sinus into two segmental cardiac cavities via two pairs of ostia. Walls of this pulsatile portion of the heart are formed from radiating muscle bands. On contraction, hemolymph is pumped through an anterior thin-walled heart region (aortic-myocardial cone), past an aortic septal valve which prevents back flow, into the anterior aorta and on to the periganglionic sinus. Hemolymph reaches peripheral parts of the body via arterial vessels which surround the pedal nerve trunks. Hemolymph also flows anteriorly, through the periesophageal sinus which surrounds the esophagus and the pharyngeal musculature, and into vessels surrounding nerves to the capitular appendages.

An endosternum is present in argasid ticks. Its reported continuity with tissues forming the periganglionic sinus walls is confirmed in this group. No trace of an endosternum is observed in ixodid ticks. Loss of the endosternum appears to facilitate the extensive engorgement behavior observed in ixodid females. Extrinsic muscles present in the periganglionic sinus of all investigated tick species may be derived from dorso-ventral suspensory muscles of a prototypic endosternum. These muscles, together with the intrinsic muscles in the ventral wall of the aorta and the action of the aortic septal valve, may function in the maintenance of elevated arterial pressures. The specialized structure of the ventro-lateral suspensory muscles of the heart suggests that they may play an important role as proprioceptors. The presence of a highly condensed and regionally specialized heart, the existence of a pericardial sinus, and specializations of arterial vessels and sinuses, attest to the complexity and evolutionary advancement of the circulatory system in Ixodoidea.

INTRODUCTION

Classical data on the form of the heart and arterial circulatory system in ticks come from general anatomical studies by Christophers (1906) on species of *Ornithodoros* and *Hyalomma*, Nordenskiöld (1909) on *Ixodes,* Robinson and Davidson (1913-1914) on *Argas*, and Douglas (1943) on *Dermacentor*. Although there are many contradictory

details in these reports, they indicate the presence of characteristic features from the basic plan of apulmonate arachnid-type circulatory systems in representative Argasidae and Ixodidae.

In Arthropoda the open-type circulatory system is considered an evolutionary consequence of the disintegration of coelomic walls which were present in their ancestral annelid-like prototypes (Beklemishev, 1968). Most arthropods retain only the dorsal pulsatile vessel (heart) and a few associated lateral arches of the annelid closed-type system. Certain higher Crustacea, some Myriapoda, larval Xiphosura and most pulmonate Arachnida (those taxa with book lungs) also retain ventral vessels (the paired thoracic arterial sinuses of Firstman, 1973) in association with the ganglionic chain of the central nervous system. Together, these vessels function as an arterial system; hemolymph is pumped through their branches into lacunar spaces in the body and appendages.

In those Xiphosura and pulmonate Arachnida (including the Scorpiones, Uropygi, Amblypygi and Araneae) which have been investigated (Kaestner, 1968; Firstman, 1973) hemolymph passes ventrally from lacunae of the appendages and body into one or more venous sinuses. Within connective tissue-lined extensions of these cavities it is channeled through the gills or leaves of the book lungs where dissolved respiratory pigments (hemocyanins) are oxygenated. Several pairs of lateral dorso-ventral sinuses, incorrectly called veins, transport oxygenated hemolymph to the pericardial cavity, a specialized sinus surrounding the multi-segmented heart and other portions of the dorsal vessel. The heart is suspended within the pericardial sinus by a series of dorso-lateral and ventro-lateral muscles or elastic ligaments (Stewart and Martin, 1974). During diastole the recoil of these tissues expands the previously contracted heart and hemolymph is pumped forward through the anterior aorta. Simultaneously, hemolymph may be pumped laterally through segmentally arranged lateral arteries or to the rear through a posterior aorta.

Anatomical data on the circulatory system in apulmonate Arachnida (including the Palpigradi, Opiliones, Acari, Pseudoscorpiones, Ricinulei and Solifugae) are limited (Firstman, 1973). Nevertheless, consistent differences between the pulmonate and apulmonate-type plans are known. In apulmonate arachnids, particularly those which show reductions in number of body tagmata, the heart is more condensed and the anterior (dorsal) aorta more highly differentiated, but unbranched (Beklemishev, 1969). In place of ventral vessels the thoracic arterial sinuses are expanded as a perineural sinus enclosing the entire central nervous system (Kaestner, 1968; Firstman, 1973). This perineural sinus receives the aorta and gives rise to an anterior (periesophageal) sinus and lateral arterial vessels which surround nerve trunks to the appendages. Hemolymph passes from these vessels into lacunae within each appendage, then flows into the general body lacunae and, finally, back to the heart.

Although preliminary anatomical studies have been made on the heart and arterial circulatory systems of ticks and other apulmonate Arachnida, there is no firm anatomical basis for the investigation of physiological and pharmacological processes. Such studies have not been initiated despite the relative ecological and economic importance of these taxa. The small size of most parasitic Acari makes them unsuitable for many basic anatomical and physiological investigations, but the larger size of ticks (Ixodoidea) and their importance as vectors of disease (Balashov, 1972) make them prime subjects for such studies. Furthermore, the possibly critical role of the circulatory system during feeding in Ixodidae makes an understanding of this system particularly important. Our previous examination of the central nervous system (Obenchain, 1974a) and neurosecretory system of *Dermacentor variabilis* (Obenchain, 1974b; Obenchain and Oliver,

1975) revealed the probable involvement of tissues forming the wall of the aorta and periganglionic arterial sinus in neuroendocrine mechanisms. The present study was undertaken as the basis for further studies on the roles of tick cardioglial tissues in such mechanisms and to provide the anatomical data prerequisite to a fuller understanding of the functional role(s) of the circulatory system in engorged and unengorged ticks.

MATERIALS AND METHODS

Anatomical and histological observations on tick hearts and arterial circulatory systems were made on laboratory-reared and wild-caught specimens representing four sub-families from the two major tick families. Species examined include *Argas radiatus* Railliet (Argasidae: Argasinae), *Ornithodoros turicata* (Duges) (Argasidae: Ornithodorinae), *Ixodes scapularis* Say (Ixodidae: Ixodinae), and *Dermacentor variabilis* (Say) and *Amblyomma tuberculatum* Marx (Ixodidae: Amblyomminae). Laboratory rearing conditions, tick-hosts and collection data were reported previously (Obenchain and Oliver, 1973). Anatomical observations on the heart of intact nymphal and adult ticks were facilitated by application of paraffin oil to the tick's dorsum. Under these conditions the cuticle became semi-transparent. Although the transparent heart musculature and associated tissues could not be observed directly, heart position and its rate of contraction were determined from the movements of tracheae and tracheoles. Detailed structural observations were made on dorsal and ventral dissections of the circulatory system, performed under Shen's physiological saline (9.0 g NaCl, 0.42 g KCl, 0.25 g $CaCl_4$/liter of distilled water).

Some dissections were made on specimens previously injected with supravital dyes, including 0.5% ammoniacal carmine, 0.02-0.5% trypan blue in Shen's saline, or 1.0% methylene blue in 1.3% NaCl. Other dissections were stained *in toto* with leucomethylene blue (about 0.1% after reduction with 0.01M ascorbic acid, Larimer and Ashby, 1964) for demonstration of neural elements. Whole mount preparations of the circulatory system were fixed in a calcium formal or 5% ammonium molybdate for direct microscopic examination. Other dissections were fixed in Heidenhain's SUSA or Carnoy's fixatives (Humason, 1967) and routinely dehydrated in Cellosolve, embedded in Tissuemat-Paraplast by the dioxane method, and sectioned at 7 μm. Staining techniques included Hubschman's (1962) simplified azan and Rosa's aldehyde fuchsin with Halmi's counterstain (Meola, 1970). Fresh or vitally stained tissues were stretched on slides in Shen's saline or 50% glycerol in distilled water for examination by bright field, dark field/fluorescence, phase contrast, or polarized light microscopy. Histological sections were dehydrated through xylene, mounted in Harleco synthetic resin and examined with the above mentioned optics. Photomicrographs were taken on a Wild M20KGS photomicroscope. Dimensions of tissues were determined with an ocular micrometer and from calibrated photomicrographs.

OBSERVATIONS

In all examined tick species the heart (Ht) is suspended by a series of dorso-lateral and ventro-lateral suspensory muscles (dlSM, vlSM) within a pericardial sinus (pcS) located medially below the dorsal cuticle. The heart and tissues forming the boundries of the pericardial sinus are bordered anteriorly by insertions of the cheliceral retractor muscles (Figs. 1, 2). Laterally, they lie between mid-dorsal loops of the malpighian tubules and
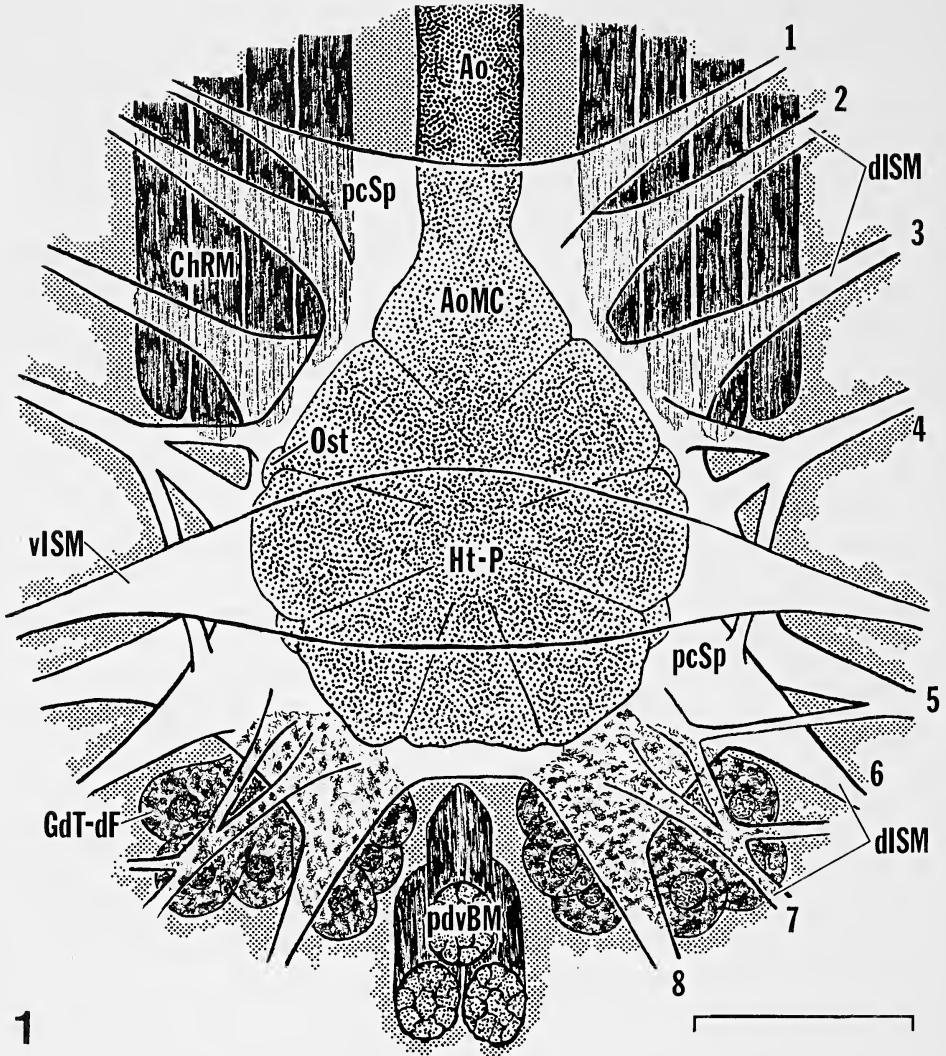
Fig. 1.—Diagrammatic representation of the heart, pericardial septum, suspensory muscles and associated tissues of *Amblyomma tuberculatum*, in ventral view. Scale equals 0.1 mm. Ao, anterior aorta; AoMC, aortic-myocardial cone; ChRM, cheliceral retractor muscles; dlSM, dorso-lateral suspensory muscles; GdT-dF, glandular tissues of the dorsal foveae; Ht-P, pulsatile portion of the heart; Ost, ostia; pdvBM, posteromedian dorso-ventral body muscles; pcSp, pericardial septum; vlSM, ventro-lateral suspensory muscles.

insertions of the dorso-genital muscles (and by insertions of the coxal adductor muscles III and IV in Argasidae). Posteriorly, they are bordered by insertions of the postero-median dorso-ventral body muscles (and by tissues associated with the dorsal foveae in Ixodidae-Amblyomminae). The tick heart is in the form of a dorso-ventrally flattened sack. During diastole the heart outline is sub-triangular (Argasidae) to pentagonal (Ixodidae, Fig. 1), but generally spherical in the contracted state (Figs. 4, 5). The thin-walled aorta (Ao) emerges from the anterior apex of the heart and runs forward below the cheliceral retractor muscles and above the central portion of the midgut (Fig. 2). At the median notch between the anterior ramifications (caeca) of the midgut, the aorta
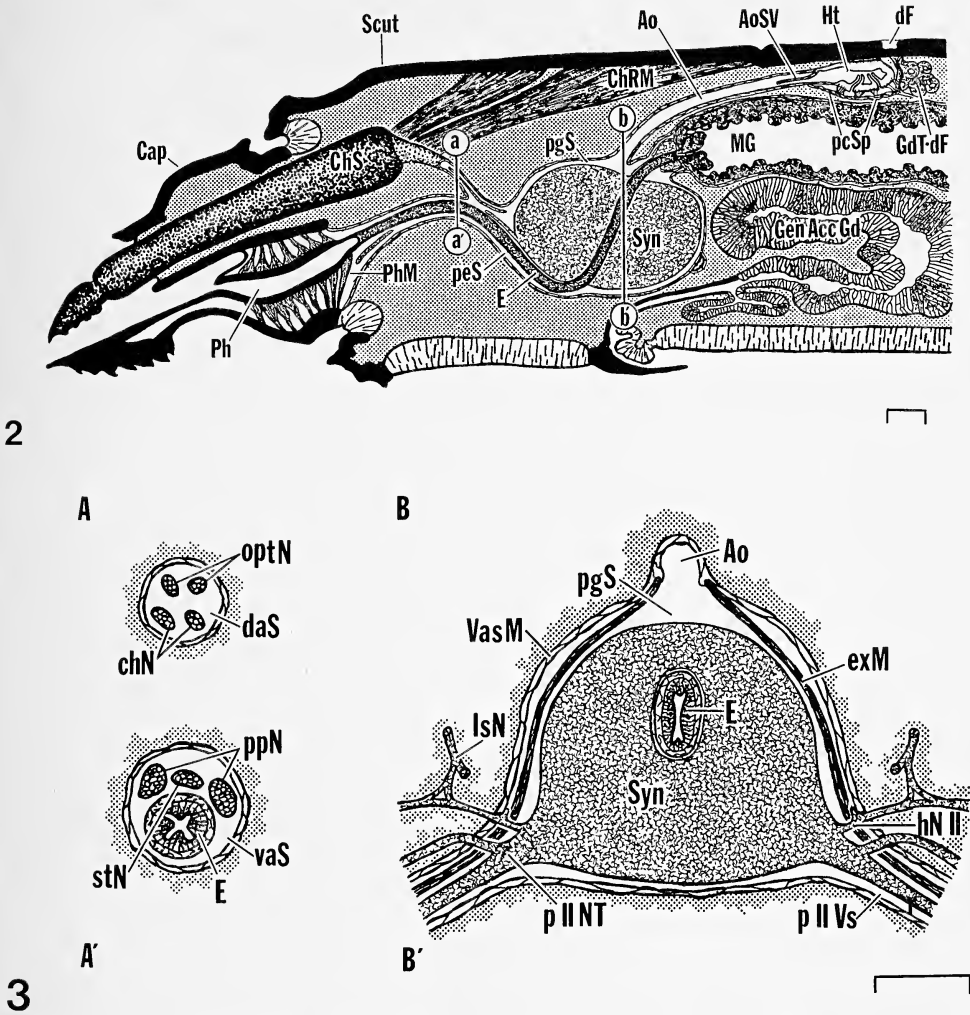
Figs. 2, 3.—Diagrammatic representation of the form and anatomical associations of heart, arterial sinuses and vessels in a representative male ixodid tick (about the size of *Dermacentor variabilis*): 2, Near-sagittal reconstruction, with addition of a cheliceral shaft, associated muscles, and dorsal foveae (non-mid-line structures); 3, Cross-sections of tick arterial sinuses at levels indicated in Fig. 2. Scale on figures equals 0.1 mm. Ao, anterior aorta; AoSV, aortic septal valve; Cap, capitulum; ChRM, cheliceral retractor muscles; ChS, cheliceral shaft; chN, cheliceral nerves; daS, dorsal anterior sinus; dF, dorsal foveae; E, esophagus; exM, extrinsic muscles of the periganglionic sinus; GdT-dF, glandular tissues of the dorsal foveae; Gen Acc Gd, male genital accessory gland; Ht, heart; hN II, second hemal nerve; lsN, lateral "sympathetic" nerve; MG, midgut; optN, optic nerves; Ph, pharynx; PhM, pharyngeal musculature; pcSp, pericardial septum; peS, periesophageal sinus; pgS, periganglionic sinus; p II Vs, second pedal arterial vessels; Scut, scutum; Syn, synganglion; stN, stomodeal nerve; VasM, vascular membrane; vaS, ventral anterior sinus.

descends into the periganglionic arterial sinus (pgS). No traces of a posterior aorta are observed in any of the examined tick species.

Anatomically, the periganglionic sinus and associated arterial vessels of *Dermacentor variabilis* are representative of similar circulatory structures in other tick species. Sinus walls completely envelop the condensed mass of the central nervous system (synganglion)

and the esophagus which passes through it. These walls are closely applied to ventral, lateral and posterior surfaces of the synganglion, but are more removed dorsally (Figs. 2, 3). Here, the aorta enters the sinus just above the point where the esophagus passes out of the synganglion. The periganglionic sinus communicates anteriorly with the peri-esophageal arterial sinus (peS) and laterally with four pairs of pedal vessels (p I-IV Vs) which surround the major pedal nerve trunks (Fig. 3BB′). Postero-dorsally it terminates around the neuroendocrine retrocerebral organ complex at the level of the proventriculus. The four pairs of pedal vessels extend to the coxal-trochanter junction in the walking appendages. A short distance in front of the synganglion (Figs. 2, 3AA′) the peri-esophageal sinus divides into a dorsal anterior sinus (daS) surrounding paired optic and cheliceral nerves and a ventral anterior sinus (vaS) surrounding paired pedipalpal nerves, the unpaired stomodeal nerve and the esophagus. Extensions of the dorsal anterior sinus surround the peripheral nerves which enter cheliceral shafts, while similar vessels arise from the ventral anterior sinus and surround nerves which enter the pedipalps. The median extension of the ventral anterior sinus expands broadly and irrigates the pharyn-geal musculature (Fig. 2).

Differences in the proportions of the arterial circulatory system among species of Ixodidae parallel changes in overall body dimensions, as in the series of increasing body size from *Ixodes scapularis*, through *D. variabilis* and to *Amblyomma tuberculatum* respectively. Similar proportional differences are observed between *Ornithodoros turicata* and *Argas radiatus* in Argasidae. The form of the periganglionic sinus is modified in argasid ticks by its continuity with tissues of the well-developed endosternum. The peri-esophageal sinus of argasid ticks is also slightly different in form from that observed in ixodids. Paired arterial vessels to the cheliceral shafts arise separately at the anterior boundary between periganglionic and periesophageal sinuses; consequently, the dorsal anterior sinus, as observed in representative Ixodidae, is poorly developed in Argasidae. This anatomical difference appears to be related to the different orientation of the capitulum and its associated musculature in Argasidae as compared to Ixodidae. In both groups, however, the appendages of the capitulum are supplied by arterial vessels and the pharyngeal musculature is contained within an extension of the ventral anterior (peri-esophageal) sinus. Sexual differences in the form of the heart and arterial circulatory system are minor in the species studied. Differences in the degree of tracheation are pronounced, particularly in Ixodidae, where the more extensive tracheal supply to tissue and organ systems in females allows for considerable expansion and differentiation of the idiosoma during engorgement.

The heart rate appears extremely variable in all tick species. In observations on restrained specimens of newly ecdysed *D. variabilis*, the rate varies between 18 and 120 beats per minute, with periods of inactivity from less than one to several minutes in duration. These observations were made at room temperature with low intensity fluores-cent illumination. Effects of changing levels of incandescent light intensity (and radiant heat) on ticks treated with paraffin oil are pronounced. Increasing or decreasing the intensity randomly accelerates or depresses the heart rate in *Amb. tuberculatum*, *D. variabilis* and *A. radiatus*.

Tick hemolymph contains a variety of hemocyte cell types (Dolp, 1970; Brinton and Burgdorfer, 1971). In specially dissected preparations, numerous cells are observed in circulating hemolymph within the dorsal aorta. Prohemocytes, plasmatocytes and various spherule cells are observed within the arterial vessels and sinuses in histological sec-tions. In all observed ticks, with the exception of *Amb. tuberculatum*, the hemolymph is

generally colorless. In this single species, however, the distinct blue-green color of oxygenated hemolymph seems to indicate the presence of hemocyanin pigments.

Structure of the Myocardium

The anatomical form and histological structure of the heart is similar in all investigated tick species. The heart wall (myocardium) is formed from striated muscle. Cellular margins are indistinct and there is no detectable internal intima. Myofibrils take up acidophilic stains, but the myoplasm is generally chromophobic. The basophilic nuclei of these cells seem to be distributed randomly throughout the myocardium. Histological sections of contracted heart muscle demonstrate a complicated network of connective tissue fibers over the external surface of the heart muscle. In preparations of relaxed heart muscle, however, these tissues are recognized as the terminal processes of dorso-lateral and ventro-lateral suspensory muscles.

The tick heart is divided into two anatomical regions on the basis of constituent muscle fiber orientation. Each region seems to have a distinctive function. In the larger (posterior) region (Figs. 1, 5, 8) the myocardium is formed from seven semi-circular bands of muscle which radiate from slightly thickened central areas on the dorsal and ventral surfaces of the heart. The dorsal thickened area is loosely anchored to the over-lying cuticle by scattered connective tissues resembling the tonofibrillae of major body muscles. The semi-circular muscle bands receive connective tissue processes from dorso-lateral suspensory muscles along the lateral margins of the heart (Figs. 1, 4). Ventro-laterally, two pairs of ostia open between radiating muscle bands. The muscular lips of these ostia (Figs. 2, 4) extend internally into the segmental cardiac cavities of the heart. When small amounts of 0.5% trypan blue solution are applied laterally to physio-logical preparations of the heart of *Amb. tuberculatum* or *A. radiatus*, anterior and posterior cardiac chambers are readily observed. These two bilaterally symmetrical chambers receive afferent hemolymph via the first and second pairs of ostia, respec-tively. This is the major pulsatile portion of the heart (HtP).

The anterior region of the myocardium (aortic-myocardial cone) links the pulsatile portion of the heart with the aorta (Figs. 1, 4, 8; AoMC). Muscle fibers in this portion of the heart are not organized into radiating bands. Instead, they have a primarily longitu-dinal orientation. Some muscle fibers appear to be extensions of the longitudinal striated fibers which lie in the ventral wall of the anterior aorta.

The myocardium is tracheated by way of an anastomosing plexus of the postero-dorsal tracheal trunks (Figs. 4, 5). Branches of these tracheae generally follow the paths of suspensory muscles on their way to the myocardium. Both regions of the myocardium are tracheated, but the posterior pulsatile portion receives the more extensive supply. After treatment with leucomethylene blue the presence of an intrinsic cardiac ganglion associated with the heart of *Amb. tuberculatum* is supported by the staining response of eight or more small cells. These are presumably neurons, and they are grouped mid-dorsally above the thickened central area of the myocardium. Nuclei of these cells stain more intensely than the axoplasm. Some neurons appear to be bipolar, others appear to be unipolar. Their processes penetrate the myocardium and can be traced into the cardiac cavity along the internal projections of radiating muscle bands. Similarly staining tissues are observed in other investigated tick species, but in the latter the presence of a discrete cardiac ganglion was not confirmed with vital staining methods.
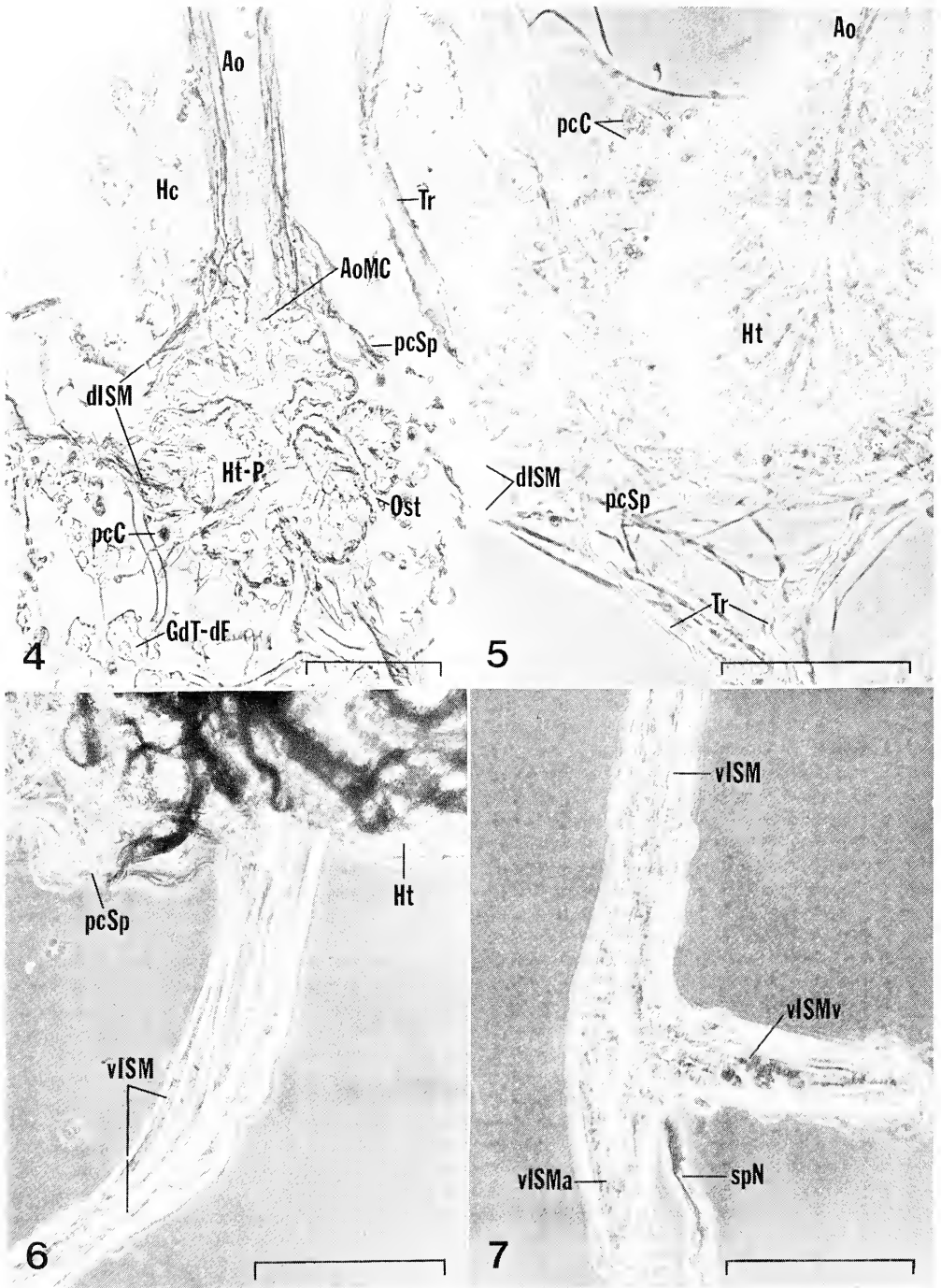
Other axon-like fibers were observed after application of leucomethylene blue in ventral and posterior heart walls in *Amb. tuberculatum* and *A. radiatus*. The paths of these fibers seem to indicate an extrinsic myocardial innervation. In *Amb. tuberculatum* some of these putative axons were traced posteriorly into adjacent gland-like tissues of the dorsal foveae or ventrally into the ventro-lateral suspensory muscles. In *A. radiatus*

Fig. 4.–Frontal section through heart and anterior aorta of an adult male *Amb. tuberculatum*, aldehyde fuchsin stain, phase contrast optics. Anterior orientation to the top of figure, scale equals 0.1 mm.

Fig. 5.–Dissected heart preparation of an adult female *Ornithodoros turicata* after formol calcium fixation, in dorsal view with phase contrast optics. Scale equals 0.1 mm.

Fig. 6.–Dissected preparation of ventro-lateral suspensory muscle from the heart of an adult female *Amb. tuberculatum* in the proximity of the pericardial septum, leucomethylene blue technique, after ammonium molybdate fixation with phase contrast optics. Scale equals 25 μm.

Fig. 7.–Ventro-lateral suspensory muscle of *Amb. tuberculatum*, as in Fig. 6, at junction of atrial and ventral contributing muscle fibers. Scale equals 25 μm. Ao, anterior aorta; AoMC, aortic-myocardial cone; dlSM, dorso-lateral suspensory muscles; GdT-dF, glandular tissues of the dorsal foveae; HC, hemocoel; Ht, heart; Ht-P, pulsatile portion of the heart; Ost, ostia; pcC, pericardial cells; pcSp, pericardial septum; spN, branch of the spiracular nerve; Tr, trachea; vlSM, ventro-lateral suspensory muscle; vlSMa, atrial contributing branch of vlSM; vlSMv, ventral contributing branch of vlSM.

similar fibers were traced posteriorly along branches of the postero-dorsal tracheal trunks. These fibers were followed to the bilateral ganglionic masses of dorsal photo-receptors (Binnington, 1972) which lie below the first pair of cuticular disks associated with the second rows of postero-accessory dorso-ventral body muscles.

Structure of the Pericardium and Suspensory Muscles

The pericardial sinus surrounds the heart on its ventral, lateral and posterior surfaces. It is bound by the perforated pericardial septum (Figs. 1, 5; pcSp). This septum is formed by overlapping membranous sheets and strands of loose connective tissue, bound together and supported by fibrous terminal processes of the suspensory muscles of the heart. Along its lateral and posterior margins the septum is loosely attached to the dorsal body wall. Anteriorly, it connects to the walls of the aortic-myocardial cone (Fig. 4). Connective tissues of the pericardial septum serve as a support for pericardial cells (Figs. 4, 5; pcC). The distribution of these pinocytotic cells is best demonstrated in dissections treated with 0.02% trypan blue or other particulate vital dyes. In *Amb. tuberculatum* and *D. variabilis* pericardial cells are distributed over the surface of the septum with only a slight peripheral concentration. In *A. radiatus* and *O. turicata*, however, lateral concentrations of these cells are pronounced.

The dorso-lateral suspensory muscles of the heart have their origins on specialized cuticular structures associated with origins of principal body muscles. In Ixodidae they arise from integumental grooves and/or unsilvered areas of the dorsal cuticle. These areas are also associated with the origins of the anterior and posterior genital muscles and the marginal dorso-ventral and posteroaccessory dorso-ventral body muscles. In Argasidae the dorso-lateral suspensory muscles of the heart have their origins on dorsal cuticular disks associated with adductor and abductor muscles of the coxae and with postero-accessory dorso-ventral body muscles.

The dorso-lateral suspensory muscles (dlSM) of the tick heart are long and filamentous with a markedly striated appearance under phase-contrast, dark field, or polarizing optics (Figs. 4, 5). Histological properties of suspensory muscle tissues are similar to those of myocardial muscles but their nuclei have a more consistent peripheral distribution. Near the pericardial septum, these muscles become highly branched. In *Amb. tuberculatum* we identify eight bilaterally symmetrical groups of dorso-lateral muscles (Fig. 1) which terminate as strands of connective tissue (Figs. 4, 5) contributing to the fibrous matrix of

the pericardial septum. The first and second groups also send some terminal processes into the wall of the aortic-myocardial cone. Terminals of the third group of muscles insert on lateral margins of the anterior pair of muscle bands (pulsatile portion of the myocardium). Fourth and fifth dorso-lateral suspensory muscle groups insert on the second pair of muscle bands between the two pairs of ostia (Figs. 1, 4). Sixth and seventh groups insert on muscle bands behind the second pair of ostia, while terminals of the eighth group insert on either side of the complex (unpaired) posterior band. Similar patterns are observed in *A. radiatus*, but dorso-lateral suspensors are grouped in three major sets. The first set seems to include suspensory groups one to four from *Amb. tuberculatum*, the second set includes suspensory groups five and six, and the posterior set includes groups seven and eight. Different grouping patterns of dorso-lateral suspensors between ixodid and argasid ticks seem to determine the shape of the uncontracted heart (pentagonal in Ixodidae and sub-triangular in Argasidae). In ticks from both families the dorso-lateral suspensory muscles are so highly branched that the degree of overlapping myocardiac insertions is not readily determined. A few scattered fibers and presumptive axon-terminals stain with leucomethylene blue in all four tick species. Although the complex patterns of peripheral innervation remain obscure, some dorso-lateral suspensory muscles appear to be innervated by the same nerves which supply body muscles with adjacent origins.

Dorso-lateral suspensory muscles hold the pericardium in place with respect to the heart, but the volumetric integrity of the pericardial sinus (especially in fully engorged adult ixodid ticks) is maintained by the action of right and left ventro-lateral suspensory muscles (vlSM). Branches of these muscles are joined medially as a flattened belt of fibrous connective tissue and slips of striated muscle, all embedded in the pericardial septum (Fig. 1). Other processes of the ventro-lateral suspensory muscles are larger in diameter and longer than dorso-laterals. In *A. radiatus* they have a flattened strap-like appearance, but in *Amb. tuberculatum* (Fig. 6) these muscles branch near the heart and have a gradually tapered outline. In ticks from both families the ventro-lateral muscles of the heart have dual origins (Fig. 7). Separate contributing muscles arise (1) from the atrial wall of the spiracular plate and (2) from the ventral body wall. In some species (particularly *O. turicata*) several muscle slips may arise from the general sites of origin, but these slips soon fuse within the common sheath of the atrial or ventral contribution. Subsequently, the sheaths of the two muscles fuse and their fibers coalesce as the common ventro-lateral muscle to the heart.

Certain cells associated with ventro-lateral suspensory muscles in *Amb. tuberculatum* and *A. radiatus* stain with leucomethylene blue. These are presumed to be the perikaryia of sensory neurons. Axons of these cells, together with other stained fibers which may represent a peripheral motor innervation, form a plexus over the surface of the ventro-lateral suspensors. This plexus is particularly dense in the region where atrial and ventral contributing muscles are joined. In both species some peripheral fibers can be traced into paired spiracular nerves, branches of which innervate the right or left ventro-lateral suspensor at that point. Spiracular nerves arise from the posterior margin of the synganglion in *A. radiatus* (Obenchain and Oliver, unpublished), but in *Amb. tuberculatum* and *D. variabilis* they have a dual origin from the posterior margin of the synganglion and from the lateral "sympathetic" nerves (Obenchain and Oliver, 1975).

Structure of Arterial Vessels and Sinuses

A complex layer (possibly stratified) of squamous mesenchyme forms the cellular matrix within walls of the tick arterial circulatory system. These vascular structures are bound on their outer and inner surfaces by distinct basement membranes (collagenous matrices approximately 1 μm thick) which stain intensely with basophilic stains. In argasid and unfed ixodid adults constituent cells of the vascular membranes (vascular sheaths of Obenchain, 1974a; Obenchain and Oliver, 1975) are extremely flattened (Fig. 8) and have indistinct margins. The expansion and apparent secretory activity of mesenchymal cells is pronounced, however, in engorged ixodid females. At this time, several tissue types can be identified within the vascular membranes. Margins of adjacent mesenchymal cells overlap extensively, presenting the appearance of two distinct layers. Nuclei are large (2.5 to 4.0 μm) and stain heavily with acidophilic components of the aldehyde fuchsin and azan staining techniques. Ground cytoplasm is chromophobic, extensively vacuolated and becomes progressively filled with basophilic granules following the blood meal. When intrinsic muscles (restricted to the ventral wall of the anterior aorta), tracheal or neural tissues are observed within the vascular membranes, they lie between the overlapping margins of mesenchymal cells. Some putative axons, stained with the leucomethylene blue technique, can be traced from the walls of the periganglionic sinus back to various pedal nerve trunks in *Amb. tuberculatum* and *A. radiatus*. These axonal pathways resemble the putative neurosecretory innervation to the periganglionic sinus walls described previously from *D. variabilis* (Obenchain and Oliver, 1975).

Walls of the periganglionic and periesophageal arterial sinuses and vessels to the appendages are formed from unspecialized vascular membrane. No intrinsic musculature is observed in the walls of these portions of the circulatory system, but the squamous layer of membrane-bound mesenchyme is frequently penetrated by tracheae which supply the central and peripheral nervous system. At the level of the retrocerebral neuro-endocrine complex and the proventricular (esophageal) valve, the wall of the periganglionic sinus fuses with similar mesodermal layers which form the annular walls of the esophagus, the sheath of the retrocerebral organ complex and the outer covering of the midgut. Structural details of these associations and evidence for the endocrinological involvement of mesenchymal tissues within the aorta and sinus wall (as a type of cardio-glial tissue) were reported previously for *D. variabilis* (Obenchain and Oliver, 1975). Progressive expansion of these tissues, with the formation of intracellular basophilic granules, is observed in all three species of ixodid ticks during and after the adult blood meal. A similar involvement in adult argasids is not indicated at the light microscope level, but expansion of these mesenchymal tissues (complete with development of basophilic granular inclusions) occurs during the molt from last stage nymph to adult in *A. radiatus*.

Extrinsic muscle fibers, observed within the periganglionic arterial sinus of all examined ticks, have their origins on internal antero-dorsal projections of coxae I, II and IV. No similar muscles were associated with coxae III in the species examined. From their origins, these transversely striated muscles penetrate adjacent walls of pedal arteries, pass up those vessels into the periganglionic sinus, continue over the surface of the synganglion and penetrate the ventral wall of the anterior aorta (Figs. 3, 10). In ixodid and argasid ticks the sheaths of extrinsic muscles are occasionally fused with the internal basement membrane of the sinus wall, but in both groups they remain free within the sinus for most of their length. In *Amb. tuberculatum* and *D. variabilis* there are two muscle slips
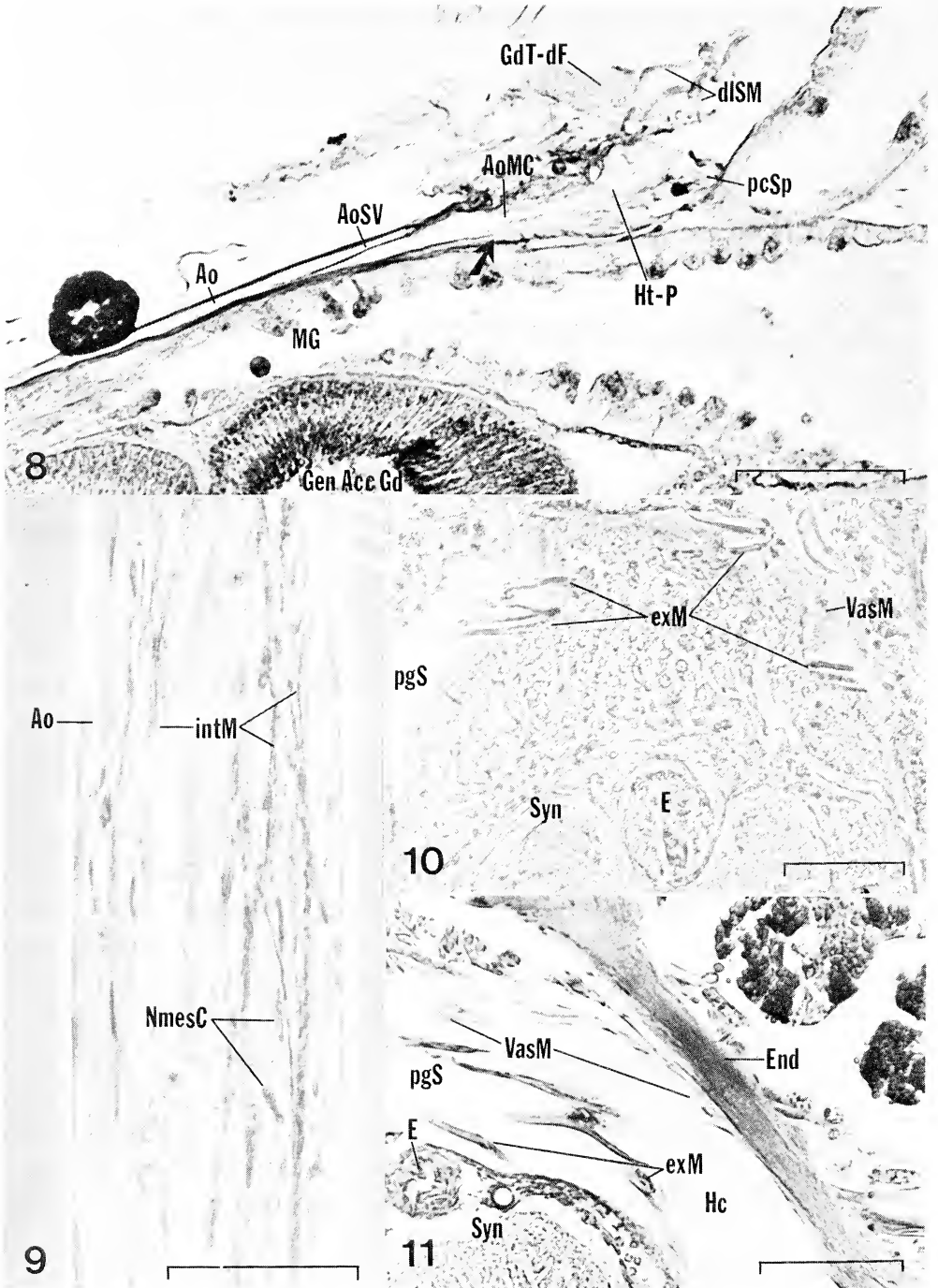
within each pedal vessel (I, II and IV). In *A. radiatus* and *O. turicata* there seem to be two muscle slips within the first pair of vessels, but pedal vessels II and IV contain single muscles. In both tick families there is a general agreement between the number of extrinsic muscle slips and the number of intrinsic muscle fibers in the ventral wall of the anterior aorta.

Fig. 8.–Sagittal section through heart, aorta and aortic septal valve in an engorged adult male *D. variabilis* (scutum removed), after aldehyde fuchsin stain with bright field optics. Arrow indicates demarcation between aorta and heart. Anterior orientation to left of figure, scale equals 0.1 mm.

Fig. 9.–Dissected preparation of anterior aorta from an unfed adult female *Amb. tuberculatum*, leucomethylene blue technique after ammonium molybdate fixation with phase contrast optics. Scale equals 25 μm.

Fig. 10.–Frontal section through extrinsic muscles in the periganglionic sinus of a partially engorged adult *D. variabilis*, azan stain, with phase contrast optics. Posterior orientation to the top of figure, scale equals 0.1 mm.

Fig. 11.–Frontal section through the synganglion and the endosternum of an adult female *Argas radiatus*, showing association of the periganglionic sinus wall with endosternal tissues, aldehyde fuchsin stain, bright field optics. Orientation as in Fig. 10, scale equals 0.1 mm. Ao, anterior aorta; AoMC, aortic-myocardial cone; AoSV, aortic septal valve; dlSM, dorso-lateral suspensory muscles; E, esophagus; End, endosternum; exM, extrinsic muscles of the periganglionic sinus; GdT-dF, glandular tissues of the dorsal foveae; Gen Acc Gd, male genital accessory gland; Hc, hemocoel; Ht-P, pulsatile portion of the heart; intM, intrinsic muscles of the aorta; MG, midgut; NmesC, nuclei of mesenchymal cells; pcSp, pericardial septum; pgS, periganglionic sinus; Syn, synganglion; VasM, vascular membrane.

No trace of an endosternum (End) is observed in the three species of ixodid ticks, but in *A. radiatus* and *O. turicata* paired collagenous masses lie alongside the dorso-lateral margins of the periganglionic sinus. These connective tissue formations bear the origins or insertions of a number of intercoxal, genital and dorso-ventral body muscles. Only enlarged posterior portions of the endosternites are continuous with posterior projections of the sinus walls in *A. radiatus* (Fig. 11), but in *O. turicata* the anterior arms of the endosternites are continuous with sinus walls. In these two argasids the right and left halves of the endosternum are joined by a series of transverse muscles. Preliminary observations on *Antricola mexicanus* Hoffman (Argasidae: Ornithodorinae) reveal that right and left halves of the endosternum are fused medially and that all internal margins of the horseshoe-shaped endosternum are continuous with the walls of the periganglionic sinus.

DISCUSSION

Most previous workers consider the circulatory system of ticks to be primitive or poorly developed (Robinson and Davidson, 1913-1914; Balashov, 1972). This judgement may rest in part, on the absence of a closed system of venous sinuses and segmental and posterior aortae, as well as the presence of a single periganglionic sinus in place of paired thoracic arterial sinuses. On the other hand, venous vessels found in Xiphosura and pulmonate Arachnida are believed to be secondary in origin, representing a "canalization of lacunar spaces" associated with the specialized respiratory structures of the gills or book lungs (Beklemishev, 1969). Absence of a channeled venous circulation, together with the general absence of dissolved respiratory pigments, may be correlated with the extensive tracheation of apulmonate Arachnida. Similarly, well-developed peripheral arterial systems, complete with metameric vessels arising from the dorsal vessel, are considered to be primitive in character (Beklemishev, 1969). Moreover, the normal developmental sequence in Xiphosura involves condensation of paired thoracic arterial sinuses, as found in larval stages, into the single perineural sinus of the adult (Firstman, 1973). In comparison to the periganglionic arterial sinus of apulmonate Arachnida, Firstman considers the persistence of paired arterial sinuses in pulmonate Arachnida as an example of "neotenous developmental retardation."

In ticks representing the sub-families Argasinae and Ornithodorinae (Argasidae) and Ixodinae and Amblyomminae (Ixodidae) the heart is highly condensed and regionally specialized. Various authors have reported only a single cardiac chamber and a single pair of ostia in both argasid (Robinson and Davidson, 1913-1914) and ixodid ticks (Douglas, 1943). Our data show that the posterior (pulsatile) portion of the heart contains two cardiac compartments in both tick families, although irregular internal projections of the myocardium often obscure this segmental nature in histological preparations of contracted hearts. The arrangement of radiating muscle bands (three pairs) which surround the two pairs of ostia (Fig. 1) seems to reflect the primitive metamerism of this portion of the dorsal vessel. In that light, the complex postero-median (unpaired) muscle band may represent a condensed remnant from posterior portions of the ancestral vessel. The anterior portion of the tick heart (aortic-myocardial cone) appears to be a transition zone between the muscular posterior myocardium and the aortic wall with its discrete internal basement membrane (Fig. 8).

In those Xiphosura and pulmonate Arachnida which have been most studied, intrinsic elements of the cardiac ganglion serve as pacemakers for the heart. Recent data on the organization of the cardiac ganglion, the pattern of peripheral innervation and sensory modulation of heart rhythmicity come largely from Xiphosura (*Limulus polyphemus*) (Corning and VonBurg, 1968; Bursey and Pax, 1970a, 1970b; Sperelakis, 1971; Stephens and Greenburg, 1973) and from Araneae (Wilson, 1967; Sherman and Pax, 1968; Bursey and Sherman, 1970; Ude and Richter, 1974). Similar data from Scorpiones is provided by Zwicky (1968). In these taxa the heart rhythm is neurogenic, but subject to modulation by various sensory stimuli and by potential neuroendocrine regulators (Kadziela and Kokocinski, 1966; Sundara and Krishnan, 1968; Ude and Richter, 1974). Identification of a putative cardiac ganglion in *Amb. tuberculatum* and evidences of peripheral innervation from the central nervous system and from adjacent sensory complexes in other ticks (dorsal photoreceptors of Argasidae and dorsal foveae of Ixodidae-Amblyomminae), together with observations on the effects of various stimuli on heart rate, suggest that the tick heart also has a neurogenic rhythm which is subject to complex sensory modulation.

Although there is no closed system of venous vessels in ticks, there is a well-defined pericardial sinus. The highly perforated wall (pericardial septum) of the sinus is formed from connective tissues which are continuous with similar tissues associated with dorso-lateral and ventro-lateral suspensory muscles of the tick heart. No previous report of a pericardial sinus or septum in ticks is known to us. Although Douglas (1943) provides a brief description of the number and disposition of some suspensory muscles (dorso-laterals) from the heart of *Dermacentor andersoni* Stiles, the ventro-lateral suspensory muscles appear to be previously undescribed. One function of these suspensory muscles seems to be the maintenance of the space within the pericardial sinus.

The dorso-lateral suspensory muscles of tick hearts seem to resemble the alary muscles of insect hearts (McCann, 1970), both in terms of their general form and their structural coupling to the myocardium. Still, further studies at the ultrastructural level are needed in order to establish that these couplings constitute myo-myocardial junctions as reported from insect hearts (Sanger and McCann, 1968). Moreover, the functional importance of the dorso-lateral and ventro-lateral suspensory muscles, in relationship to the coordination of diastole and systole in the tick heart, remains to be determined.

The ventro-lateral suspensory muscles of the tick heart appear to be homologous to the dorso-ventral muscles of scorpion and spider hearts (Kaestner, 1968). In these pulmonate Arachnida the dorso-ventral muscles have their origins on cuticular invagina-

tions from the book lungs. The number of paired dorso-ventral muscles usually corresponds to the number of book lungs instead of the number of paired ostia in the heart. There is a similar correspondence in Ixodoidea; there are two pairs of ostia in tick hearts and the single pair of ventro-lateral suspensory muscles have some fibers which arise from the atrial wall of the spiracular plate. Furthermore, the specialized structure of the ventro-lateral suspensors may indicate their importance in processes not directly related to heart contraction or the maintenance of pericardial sinus integrity. The dual origins of these muscles and their complex association with putative neural elements may be indications that several of the muscle fibers are specialized as stretch receptors. In this respect they resemble stretch receptors of certain insects (Horridge, 1965; Wigglesworth, 1972). As proprioceptors they could function in the coordination of engorgement behavior or in the initiation of neuroendocrine mechanisms such as those demonstrated in the blood-sucking insect *Rhodnius prolixus* (Maddrell, 1963).

Certain specializations of the tick arterial circulatory system, as observed in this study, have not been previously reported. One such structure is the septal valve of the anterior aorta which effectively prevents the back-flow of hemolymph into the aortic-myocardial cone during diastolic expansion of the heart. In those arachnids which have distinct prosomatic and opisthosomatic body regions, the function of similar valves insures the maintenance of a higher internal pressure in the prosoma. This creates a pressure differential which assists venous circulation of unoxygenated hemolymph in pulmonate Arachnida and which is implicated as the principal mechanism for limb extension in Araneae (Wilson and Bullock, 1973; Stewart and Martin, 1974). Antagonistic extensor and flexor muscles are described from the appendages of ticks (Ruser, 1933), but pressure differentials may still be necessary for extension of the appendages. Specializations for maintenance of increased pressure within arterial vessels and sinuses may also be important in extension of the capitulum during attachment and engorgement. From fragmentary observations on *Rhipicephalus sanguineus* (Latreille) Chow, et al. (1972) postulated that muscles at the entrance of the aorta into the periganglionic sinus function as valves which might prevent the reversal of arterial flow. That function seems to be fulfilled by the septal valve at the posterior end of the aorta and the muscles observed by Chow, et al., seem to be extrinsic muscles of the periganglionic sinus. If hemolymph flow from lacunae in the appendages into the general body cavity is controlled in ticks by valve-like structures similar to those described from the leg bases of pulmonate Arachnida (Kaestner, 1968), then the contraction of extrinsic periganglionic muscles and intrinsic aortic muscles may elevate the intra-arterial pressure above that of the idiosoma.

Firstman (1973) postulates that dorso-ventral muscles attached to the endosternum in ancestral arachnids originally played a role in generation of arterial pressures. It seems likely that the reduction of the endosternum in argasid ticks and its loss in ixodids is an adaptation which facilitates the expansion of the body during engorgement. Extrinsic muscles of the periganglionic sinus may then be interpreted as derivatives of ventral suspensors which originally inserted on the prototypic endosternum. Since the pharyngeal musculature and the entire length of the esophagus are contained within arterial sinuses, any increase in arterial pressure over that of the general body cavity should favor passage of ingested fluids into the midgut. Such a selective advantage might account for the evolutionary retention of the aortic septal valve and the modification of endosternal musculature (as extrinsic periganglionic muscles) in representative Ixodoidea.

Previous workers have reported the reduction of the arterial circulatory system (Beklemishev, 1969) or even the absence of a functional heart (Mitchell, 1957, 1964;

Whitmoyer, et al., 1972) in many mite species. Their data raise a serious question: Within the Acari, how representative is the circulatory system of ticks? Reduction of the circulatory system in dwarf forms of most tracheate arthropods seems to parallel a similar reduction in the tracheal system. Reduction or loss of both of these systems is then seen as a secondary adaptation related to the lower oxygen transport requirements of smaller organisms. Anatomical comparisons of the heart and arterial circulatory system among Acari and other Arachnida should be more instructive when those larger Acari with well developed tracheal systems are considered. In this respect, the apparent presence of circulating hemocyanin pigments in the hemolymph of *Amb. tuberculatum* is of particular interest. This species is the largest ixodid tick found in the United States and parasitizes relic populations of the burrowing gopher tortoise, *Gopherus polyphemus*. In the absence of concrete data on the role of the pigment in oxygen transport, it is not known whether the presence of circulating hemocyanin should be considered as a retained primitive characteristic or as a secondary adaptation correlated with the large size of this tick or some other parameter of the tick-host relationship. In any case, our identification of a condensed and regionally specialized myocardium (probably with an intrinsic cardiac ganglion), a well-developed pericardial septum associated with the dorso-lateral and ventro-lateral suspensory muscles of the heart, and arterial specializations, including the septal valve and the intrinsic and extrinsic musculature, attests to the complexity and evolutionary advancement of the circulatory system in Ixodoidea.

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EFFECTS OF PREY CAPTURE, WEB DESTRUCTION AND HABITAT PHYSIOGNOMY ON WEB-SITE TENACITY OF *ARGIOPE* SPIDERS (ARANEIDAE)

Frank Enders[1]

North Carolina Division of Mental Health Services
Research Section
Raleigh, 27611

ABSTRACT

Both in the laboratory and in the field prey capture did *not* have a strong influence upon web-site tenacity of *Argiope aurantia*. But experimental web destruction increased the probability that *A. aurantia* changed its web-site, perhaps only due to the physical displacement of the spider. Removal of vegetation near the web of immature *A. aurantia* resulted in most of these spiders leaving their web-sites, especially in areas less sheltered from the wind. *Argiope trifasciata*, in contrast, did not leave web-sites after removal of nearby vegetation.

INTRODUCTION

Spiders often remain at the same web-site from one day to the next (McCook, 1889; Enders, 1975). Yet, little is known which factors might influence the probability that a spider will stay at a particular site. "Web-site tenacity" is defined as the per day probability that a spider remains at the same web-site, or the number of changes of web-site divided by the number of observations of webs from one day to the next (Enders, 1975). The total number of changes of web-site includes animals found again nearby and also those which both take up their web and disappear from view. Thus animals which apparently have died are excluded from the calculation, since mortality of *Argiope* spiders is normally marked by the disappearance of the spider coupled with the persistence of the old web.

The initial and subsequent choices among habitats by the web spider *Argiope aurantia* (Araneidae) have been described (Enders, 1973). And some speculation is available regarding the use of prey and habitat as resources by various araneid orb web spiders (Enders, 1974, 1975b). Turnbull (1964) reported a strong effect of prey abundance on web-site tenacity of *Achaearanea tepidariorum* (Theridiidae). But other studies (Araneidae: Cherrett, 1964; Colebourne, 1974; spiders in general: Duffey, 1966) have emphasized the greater importance of habitat structure (physiognomy or architecture) for selection of web-sites by spiders. Field observations of *Argiope aurantia* (Enders, 1975a) revealed no marked influence of prey capture on web-site tenacity. Here, I report my experimental studies which estimate the relative importance of prey capture, web destruction and habitat physiognomy on web-site tenacity of *Argiope aurantia*. I include a few

[1] Present address: Biology, California State University, Fresno, 93740

observations on *A. trifasciata* for comparison with a species which selects less densely vegetated habitats than *A. aurantia.*

FIELD EXPERIMENTS ON THE EFFECT OF FEEDING

Methods—The study areas used were the edges of road cuts, where large numbers of *Argiope aurantia* occurred, near Raleigh, North Carolina. Areas were dominated by the herbaceous perennial plant *Lespedeza cuneata* and are described in greater detail elsewhere (Enders, 1972; 1974).

Different feeding rates were maintained for three groups of spiders in the field: (a) "no prey," by removing any prey noticed in the web; (b) natural feeding rate, or whatever entered the web by itself; and (c) prey always present in the web, by adding to what the spider captured, roughly tripling the intake of prey biomass from group b. Spiders were originally assigned to treatments alternately. As the original spiders disappeared from particular treatment groups, the nearest available unmarked spiders were used as replacements.

Treatments were applied twice a day, late morning and late afternoon (evening). Insects added to the web were usually grasshoppers slightly longer than the spiders, or else several houseflies. Since most natural prey (the most abundant, bees, grasshoppers and chauliognathid beetles) were kept in the web at least half a day, and since virtually no prey was taken during the night by *Argiope* spiders, the treatment schedule should have been effective to influence spider feeding rates. Two replicates of this experiment were performed, one during the period 22 to 25 June 1970 (using middle stage immatures) and the other 6 to 11 September 1970 (adult spiders). One additional experiment was done feeding spiders water sweetened with table sugar (Bays, 1962), but the negative results of that feeding replicate might be due to insufficient caloric uptake by spiders, even though the sugar water was accepted by them.

Results—Different levels of feeding could not be maintained every day because spiders occasionally refused to attack any insects offered. This occurred primarily in the June replicate. Analysis of results using only the actual feeding status of the spider did not change the conclusions. Only one statistically significant effect was found in eight statistical comparisons made (by chi square test, Snedecor and Cochran, 1967). The extreme comparison between prey removed and prey added groups for the September experiment indicated a 7% increase of web-site tenacity (Table 1), with p between 0.05 and 0.025.

LABORATORY EXPERIMENT ON THE EFFECT OF FEEDING

Methods—A cage was made 2.3 m high, 2.3 m wide and 4.6 m long from translucent plastic sheets stapled onto an exterior 5 cm × 5 cm wood frame. This cage was sealed by plastic tape along the seams, and the only entrance was a zipper sewn into one edge of the cage. The zipper was opened only once a day, in order to give the spiders water from a syringe and to feed them. The room containing the cage had a photophase of 16 hours, and an air conditioner running for three hours during the morning to provide a regular cycle of temperature.

Four marked (with fast-drying paint) *A. aurantia* taken from the field were released on successive days in different corners of the cage, starting on 1 July 1970. The spiders climbed to the top of the cage along the tape and built webs in the upper corners of the cage. Two spiders could and sometimes did build webs in the same corner.

Table 1.—Summary of feeding experiments with *Argiope aurantia* in the field. Web site tenacity is the percentage probability a spider remains at the same web-site from one day to the next.

	Web-site tenacity	
Treatment Group	From initial day to the second day of observation (% of *individuals*)	% of all *observations* of which animals remained at same site
Prey removed	90 (n=1)	90 (n=90)
Whatever spider caught by self (control)	96 (n=28)	87 (n=87)
Prey added	95 (n=20)	93 (n=93)

The cage was centered below the lighting fixture which had 320 watts of flourescent lighting. The entrance of the cage was away from the single boarded-up window, but near the door of the room. Only those spiders which built webs in the front right or back left corners were fed, a housefly a day. This arrangement neutralizes the effect of any gradients of light, noise, etc., which might have influenced preference for the corners in consequence of the location of door, light, window, and window air conditioner.

Results—Not even a small increase of web-site tenacity with prey catching was observed. Additional spiders in individual cages and a second four-spider replicate in the large cage which lasted only 20 days also revealed no differemce in web-site tenacity of *A. aurantia* in fed and in unfed corners. Instead, spiders moved out of corners in which they had been getting flies, as well as moving into them. In the course of the completed four-spider experiment, one spider was eaten by another, two emaciated spiders starved to death, and one well-fed spider died after several months on its web. In addition those spiders, including two *A. trifasciata,* that were starved but watered regularly did not show any decrease in web-site tenacity with time. Starvation did result in a reduction of frequency of renewal of webs as animals were near death.

EFFECT OF WEB DESTRUCTION AND OF DISTURBANCE IN *ARGIOPE AURANTIA*

Methods—This experiment was performed at the edges of lespedeza-covered road cuts. The treatment was total destruction of the web each day, while the spider was left wherever it went. The spider's dragline which had been attached to the web was destroyed, so that no silk spanned the original web-site, but the spider was left on the vegetation whenever possible (most instances). The disturbance treatment is that certain nearby spiders were placed into individual jars, carried to the laboratory, taken from the jars, weighed, transported back to the web-site, and released in their original webs. Treatments were applied just after dark, and the spiders of the disturbance group were returned to their webs after 2-3 hours. Every third spider found was placed in the same treatment group (web destroyed, disturbance and control). Each spider was marked with an individual pattern of rapidly drying paint, and was retained in its treatment group if it could be found the following day, at the old web-site or at a new one (web sites were marked with masking tape). Due to the disappearance of the original members of the groups, more spiders were added to each group on subsequent days. All spiders used in this experiment were females, mostly fully adult, from 21 September to 7 October 1969. Chi square not corrected for continuity (Snedecor and Cochran, 1967) was used to test

for statistical significance of treatment effects.

Results—No significant effect of the handling disturbance was found (Table 2). Those animals whose webs were destroyed left web-sites significantly more often than the controls, both the night following destruction of the web, and also on subsequent nights when webs happened not to be destroyed.

Table 2.—Web-site tenacity of *Argiope aurantia* in the field after web destruction and after handling disturbance (** = difference with control group statistically significant at 0.01 level; * = difference with control group statistically significant at 0.05 level).

	Web-site tenacity	
Treatment group	From initial day to the second day of observation (% of *individuals*)	% of all *observations* of which animals remained at same site
Web destroyed	33 (24)**	50 (54)**
Undisturbed (control)	91 (11)	71 (52)
Animal handled, web *not* destroyed	82 (17)	78 (45)
Dates on which web-destroyed animals were not disturbed	40 (10)*	54 (13)
Dates on which handled animals were not disturbed	88 (8)	88 (8)

EFFECT OF VEGETATION DENSITY ON *ARGIOPE* SPIDERS

Methods—Enders (1973) hypothesized that it was the density of the nearby vegetation and plant density in the plant community as a whole (habitat physiognomy) which controlled the occurrence of *A. aurantia* immatures, but not the occurrence of *A. trifasciata*. To test this, in July 1971 all vegetation was cut away in a band from 20 cm to 100 cm around the webs of spiders in the field. Bushes and branches of large trees to a distance of 4 m were also removed. Vegetation to which silk was attached was not removed, and, as in other experiments, I made a particular attempt not to disturb or damage the web or its inhabitant. As in other experiments, animals were used as they were found, with no exclusions. After initial experiments indicated color-marking to be superfluous, spiders were left unmarked. The location of the web was marked with masking tape, and the experimental site was also quite noticeable, in consequence of vegetation removal.

Results were planned to be compared with the known web-site tenacity of 80+ per cent (Enders, 1975a). In addition, three *Argiope aurantia* were left undisturbed at one study site to check that high web-site tenacity of undisturbed animals. The spiders used in this experiment were middle stage immatures, mostly being the sixth and seventh instars.

Two main study sites were used, one an old-field planted with pine trees and the other the center of a lespedeza-covered road cut. Within the old-field site two subsites were used, one a location with sparse vegetation with the nearest trees 5 m away; the second subsite had pine trees within 5 m of one another, that is, roughly four times the density of vegetation.

The old-field subsite with less vegetation probably had the greatest exposure to wind. The old-field subsite with more trees was expected to have less wind, and the road

cut could be assumed to be the most sheltered at the height where immature *A. aurantia* build webs (Enders, 1974). The latter study area was entirely protected from wind on one side by the upward slope of a hill; and this site was also sheltered even on the downhill side by vegetation which was considerably denser than the old-field vegetation present at the other experimental site. Some trees were present at about 10 m further uphill.

Results—Removal of vegetation greatly reduced web-site tenacity of the immature *A. aurantia*. This reduction of web-site tenacity was statistically significant, whether one used as control the three animals observed the same year (none of which changed web-site), or the 83% web-site tenacity for *Argiope aurantia* in the lespedeza area in July of the previous year (Enders, unpublished data). Casual observation of untreated animals nearby and of post-treatment spiders also indicated a high web-site tenacity of animals living in the old-field site.

The effect of physiognomy of the study site was also statistically significant and of large magnitude: none of 13 experimental animals in the weedy old-field remained on the following day, 44% of nine remained in the old-field with denser trees, and 63% of 19 in the lespedeza-covered road cut. Since the old web of spiders which disappeared could not be found and since several spiders which left experimental web sites were found nearby after the experimental treatment, those spiders which did not remain had apparently left the web-sites for other locations.

Finally, there was also a statistically significant difference between the species *A. aurantia* and *A. trifasciata*: records show that seven immature *A. trifasciata* had vegetation removed from around their web-sites at lespedeza (three animals) and old-field (four animals) areas, and no spider changed web-site or disappeared.

DISCUSSION

Different ecologically definable groups of spiders have various manners of hunting, but most spiders are sit-and-wait predators (Enders, 1975b). Exceptions are known primarily in errant, non-web spiders (chiefly clubionids and salticids; also smaller lycosids). Though web spiders are restricted to the web, even such species may effectively search for prey if they change web-site until they encounter a web-site with sufficiently high prey capture rate (Turnbull, 1964). My results detailed above suggest that prey capture has no such effect in the orb-weaving spider *Argiope aurantia*: field experiments do indicate the possibility of small 7% (but compounded daily) increase in web-site tenacity of mature *A. aurantia*, as a consequence of a range in prey capture rate equal to three times normal feeding rates, compared to virtually zero in the comparison group. This effect, while statistically significant (0.05 level) may be a purely random statistical effect (p actually only 0.4, considering eight separate statistical contrasts made by me using 0.05 level of probability as criterion), or the result of partial destruction of webs (see below) during removal of prey items from webs of the comparison group. I emphasize that field observations (three summers) and laboratory experiments (detailed above) give no support to the idea that web-site tenacity might be related to prey capture rate in *Argiope aurantia* (Araneidae). In other species of orb web spiders, Cherrett (1964) and Eberhard (1971) found, respectively, no relation of prey capture to web site use (several araneid species), and a negative effect of prey capture of web-site tenacity (one uloborid species; uses orb web made of different type of sticky silk). Therefore, it appears that these orb web spiders are not normally limited by prey abundance, so that they have not evolved a

positive behavioral response to capture of prey. In contrast, *Achaearanea tepidariorum* (Theridiidae, three-dimensional web) appears to live in areas where prey are sometimes locally limiting, since most houses (natural habitat for this species) apparently have a high variance and low mean of insect abundance (potential spider prey). Houses probably also offer a lower density of potential predators on the spiders, when the spider is off the web and moving from one web-site to the next. The level of selectivity for web-site, I argue, is determined by a balance between increased predation rate on web spiders off the web and the increased prey intake possible at a better web-site (see Morton, 1971; Safriel, 1972). Increased predation on web spiders when they are off the web is logically deduced from the many anti-predator advantages afforded by the use of a web, such as early warning of attack, familiarity with terrain, and the greater number of escape maneuvers compared to non-web spiders (shaking the web, running on the web, and jumping off the web). Robinson and Robinson (1973) have indicated they consider the use of a web by molting spiders to be related to the anti-predator advantages of a web. Thus, the increased rate of change of web-site in unfed immature *Achaearanea tepidariorum* (Turnbull, 1964) may be a special case among web spiders. Data on this species' unusually high metabolic rate (Anderson, 1970) and large clutch size (relative to the female's length, and relative both to other Theridiidae and to most spiders; Enders, 1976b), seem to support this interpretation.

Removal of nearby vegetation here resulted in a greatly reduced web-site tenacity of immature *Argiope aurantia*, but not of *A. trifasciata*. This response is part of the behavior, apparently in response to wind (Enders, 1972) which brings the former species to the immature's species-typical web-site near the ground (Enders, 1974) in dense vegetation (Enders, 1973). Wind reduction near ground level is discussed by Gloyne (1964). Witt and Reed (1968) and Anderson (1974) find web spiders able to conserve web size for several weeks and to live several months, without food. Therefore, it appears that habitat structure rather than food is the proximate factor involved in selection of web-site by most web spiders. Turnbull (1964) did not investigate the influence of physical structure (physiognomy) of the habitat. My results support the idea that habitat physiognomy may be as important to predatory arthropods (Duffey, 1966; Elton, 1966; Colebourne, 1974) as it is to (predatory) vertebrates (Klopfer, 1965; Wecker, 1963; Sale, 1969). Wind may be an important proximate factor for vertebrates also, as in the selection of patches of habitat by grassland birds (Cody, 1964, pp. 25, 70).

After experimental destruction of the webs of *Argiope aurantia*, the spiders moved to some place on the vegetation and remained still thereafter for a long time, often till dusk. "Natural" apparent destruction of webs of this species in the field was observed very rarely. My observations to date indicate that web-site selection by araneid spiders is a fairly undirected process, and may be unguided by previous experience with a site. Specifically, *Argiope* spiders removed by me from their webs (or placed in a different web from which the occupant had been removed) to only a meter away were never found to return to the original web and web-site. Burrowing spiders (mygalomorphs and lycosids) seem to have some knowledge of their surroundings (Kuenzler, 1958), and araneid spiders are able to find their way about on the web itself (Le Guelte, 1969) to their retreat. But since araneid spiders cannot be said to have any home range beyond the confines of the web, the simplest interpretation of the effect of web destruction upon web-site tenacity of *A. aurantia* is that the spider simply did not happen upon the same web-site when it began to put down the frame of the new web. Curiously, one web spider, *Agelenopsis aperta* (Agelenidae; Riechert, Reeder and Allen, 1973) can be flushed

some distance from its web. But that family of spiders is also intermediate to the non-web spiders both in clutch size and Dyar's constant (growth increment at the molt; Enders, 1976a).

It is interesting that *Argiope aurantia* shows a reduction of web-site tenacity after web destruction, for the period of a few days after treatment has stopped (Table 2). Perhaps the spiders are unable to locate a suitable web-site the first night, but that is doubtful. The time scale of a reduction of web-site tenacity seen after molting is also several days (Enders, 1975a). An errant spider, *Lycosa nordenskiöldi* (Lycosidae) also shows increased locomotion, but for only a few hours, and after being merely picked up (Enders, unpublished data). Thus, it appears that spiders show increased locomotion as a response to appropriately serious disturbances, such as web destruction (but not handling) in the case of a web spider, and handling, in the case of a lycosid species; and this response is on the order of days, for web spiders which can change web-site once a day, or hours, for errant spiders, which can walk at any time during their period of activity.

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NOTES ON THE ECOLOGY OF *CYCLOCOSMIA TRUNCATA*
(ARANEAE, CTENIZIDAE) IN GEORGIA

R. Howard Hunt

Department of Herpetology
Atlanta Zoological Park
Atlanta, Georgia 30315

ABSTRACT

From 23 September 1973 to 22 September 1974 nine specimens (five males, two females, two immatures) and five burrows of *Cyclocosmia truncata* were examined from the Johnson Crook area of Lookout Mountain, Dade County, Georgia. Adult males wandered from 22 August to 2 October. Male and female specimens maintained burrows with silk-leaf trapdoors but sealed the entrances during molting periods, making field detection difficult.

INTRODUCTION

All specimens of *Cyclocosmia truncata* discussed below were collected or observed in an area 12.8 x 6 m at an elevation of 400 m in the Johnson Crook area of Lookout Mountain, Dade County, Georgia. The sandy-clay soil of Johnson Crook corresponds with that described by Gertsch and Wallace (1936) for *C. truncata* habitats in Florida. From 1940 to 1970, the National Climatic Data Center, Ashville, North Carolina recorded an average annual rainfall of 135.83 cm and an average temperature of 15°C for the Johnson Crook area. Sandstone boulders are a prominent surface feature of the heavily wooded terrain. Red maple *Acer rubrum*, chestnut oak *Quercus prinus*, red bud *Cercis canadensis*, flowering dogwood *Cornus florida*, shagbark hickory *Carya ovata*, hophornbeam *Ostrya virginiana*, red cedar *Juniperus virginiana*, sassafras *Sassafras albidum*, sourwood *Oxydendrum arboreum*, and black cherry *Prunus serotina* are common. Undergrowth is sparse but bullbrier *Smilax bona-nox*, pipsissewa *Chimaphila maculata*, poison ivy *Rhus radicans*, tickseed *Coreopsis major*, and the heart leaved aster *Aster divaricatus* are present.

The following arthropods are abundant: *Trypoxylon politum* (Hymenoptera, Sphecidae), *Camponatus vespula* (Hymenoptera, Formicidae), *Photuris pennsylvanicus* (Coleoptera, Lampyridae), *Ceuthophilus stygius, Hadenoecus subterraneus* (Orthoptera, Gryllacrididae), *Pseudopolydesmus sp.* (Polydesmida, Polydesmidae), *Leiobunum sp.* (Opioiones, Phalangiidae), *Schizocosa crassipes (Araneae, Lycosidae), Hypochilus thorellii* (Araneae Hypochilidae).

The burrows of *Myrmekiaphila* (Ctenizidae) and *Antrodiaetus* (Antrodiaetidae) were also encountered in the sandy-clay soil of the *C. truncata* study area. On 8 August 1974 a brooding female *Antrodiaetus* was found. Coyle (1971) found *Antrodiaetus unicolor* associated with *C. truncata* in Alambama. A captive *Myrmekiaphila* from the Johnson

Crook study area emerged from the burrow he constructed in captivity as a mature male on 3 November 1974.

MATERIALS AND METHODS

Searches for *Cyclocosmia truncata* were conducted at the Johnson Crook area of Lookout Mountain on 23 September 1973 and 22 April, 22 June, 21 July, 11 August, 18 August, 25 August, 1 September, 15 September, 22 September and 27 October 1974. Burrow entrances were located by brushing the leaf litter aside by hand. A large hole was dug adjacent and parallel to the spider's burrow. The *C. truncata* burrow to be excavated was collapsed into this hole. A sample of soil surrounding one burrow was soaked in Calgon ® detergent and passed through a size analysis screen. The organic material in the sample was removed and the then separated, desiccated mineral portion of the sample was weighed. Captive spiders were housed in insulated containers in a 21°C to 25°C basement.

RESULTS AND DISCUSSION

On 22 June 1974 at 16:45 the burrow of an immature male *C. truncata* was found under a light cover of leaf litter. The 1 m^2 area surrounding the burrow's entrance was on a slope of 17° from the horizontal and received direct afternoon sunlight. Silk, attached at a depth of 12 mm in the burrow, blocked entry. At a burrow depth of 40 mm the temperature was 20°C compared to an air temperature of 21°C. The nearly vertical structure of the smooth-walled burrow allowed viewing of the spider. Even during the excavation disturbance, he did not move head first to the bottom of the burrow to seal it off with his abdomen. After I removed him from the burrow the *C. truncata* feigned death for five minutes. The field burrow was 17 mm in diameter at the entrance and 63 mm deep. A sample of soil surrounding this burrow contained 50% by volume organic material. The mineral portion was 54% clay-silt and 46% fine to very fine quartz sand by weight.

A small amount of leaf litter and the sandy-clay soil around the burrow was placed in a 3.7 liter plastic cooler to a depth of 152 mm. Light entered the cooler through a transparent lid. Within four days the captive *C. truncata* completed a burrow in the insulated cooler. The lower half of the burrow and the larger, bulbous upper half were lined with silk which was continuous with the hinge on a silk and leaf trap door at the soil's surface. Small cave crickets *Ceuthophilus stygilus* were kept with this specimen. When distrubed near the entrance, the *C. truncata* turned and ran head first to the bottom of the burrow. On 7 July 1974 the captive specimen sealed the entrance of his burrow with silk. He repaired small tears in the seal until 22 August 1974 when he emerged from the burrow (Fig. 1) as a mature male with a reduced, 6 mm wide abdomen.

After a heavy rain, on 11 August 1974 at 20:00 another *C. truncata* was found in the study area. The 1 m^2 area surrounding the burrow's entrance was on a slope of 17° from the horizontal. No trapdoor was seen covering the entrance. When discovered, the spider turned and ran head-first to the bottom of the nearly vertical 152 mm burrow. By 18 August 1974 the *Cyclocosmia truncata* had sealed the burrow's entrance with silk. The seal was attached at a point 6 mm down in the burrow. Partial excavation of this burrow exposed a recently molted female facing out. This specimen and her burrow could not be found one week later.
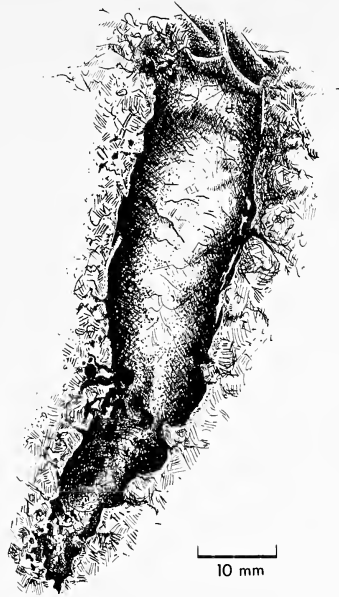
Fig. 1.–Burrow of captive male *Cyclocosmia truncata.*

Three *C. Truncata* burrows were found on 25 August 1974 in the Johnson Crook study area. The air temperature at 11:30 was 29°C while the average burrow temperature at a depth of 40 mm was 26°C. No trap doors were seen. Even when the leaf cover over the burrows was removed by hand, the delicate trapdoors were brushed away and destroyed. One *C. truncata* burrow with an entrance diameter of 8 mm was north and down slope 42 cm from the base of a 35 cm diameter *Quercus prinus*. The 1 m² area surrounding the entrance was on a slope of 23°. The two other burrows were 43 cm apart on a slope of 19° from the horizontal and were northeast and down slope 68 cm from the base of a 50 cm diameter *Q. prinus*. A heavy layer of dead leaves covered the ground for a distance of 1 m up slope from the bases of the two large trees but the 1 m area down slope was only covered lightly by leaf litter. Two burrows containing *C. truncata* were marked for future field observations but one week later no trace of them was found.

The larger of the two 19° burrows was excavated and the living female *C. truncata* collected for captive observations. The field burrow was 15 mm in diameter at the entrance and 73 mm deep. At a depth of 57 mm the spider's truncated abdomen was wedged tightly into a burrow diameter of 7 mm. The wall of this silk-lined burrow was 1.5 mm thick at the entrance. Soil at the site was placed in a 22.7 liter plastic insulated cooler to a depth of 330 mm. Light entered the cooler through a transparent top. On her first night in this container she built a burrow and attached a silk-leaf trapdoor which she held closed if distrubed at the entrance. On 1 September the captive male *C. truncata* was introduced to this female. On 6 September 1974 he was found dead with the first pair of legs missing at the coxae. The female *C. truncata* sealed the entrance to her burrow on 7 September 1974 by attaching a silk plug at a point 7 mm below the entrance to the burrow. On 9 September 1974 and 11 October 1974 a legless field cricket *Acheta domestica* was left over the seal. On each occasion the female ate the cricket at night and resealed the burrow. She left the undigested part of a cricket outside the entrance to her

burrow on 12 October 1974.

Four male *C. truncata* were found at the bottom of a 6.4 m pit in the study area. On 23 September 1973 a dead male was found in this natural trap. Two dead and one live male were discovered on 15 September 1974. One of the two dead specimens was badly decomposed and disintegrated when it was touched.

The live specimen was taken from the pit and released into an unoccupied *Cyclocosmia truncata* burrow in the study area. On 22 September 1974 I found this male in the same burrow with his abdomen toward the entrance. His abdomen did not seal the bottom of the burrow and he turned to face my intrusion with his fangs. Excavation was not necessary because he left the burrow when disturbed. The author isolated him in a 3.7 liter container where he died on 2 October 1974 with his first leg separated at the coxa. This male *C. truncata* was deposited in the American Museum of Natural History.

Perhaps the alleged rarity of *Cyclocosmia truncata* is a result of its microenvironmental requirements and secretive nature. A light cover of leaf litter to keep the straw colored, sandy-clay soil slightly moist and a 17°-23° slope are indicators for the discovery of burrows at the Johnson Crook study area. Locating a field burrow is very difficult when *C. truncata* seals the entrance. Captive specimens maintained under natural conditions can provide additional information on the habits of this cryptic spider.

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SPIDERS AND SCORPIONS FROM
NORTHERN ARIZONA AND SOUTHERN UTAH

Dorald M. Allred

Department of Zoology
Brigham Young University
Provo, Utah 84602

Willis J. Gertsch[1]

Curator Emeritus
American Museum of Natural History
New York, New York

ABSTRACT

During three summers of environmental monitoring studies in northern Arizona and southern Utah, spiders of 40 species and scorpions of 5 species were collected in pit traps placed on 16 study sites representing 12 vegetative types. Study sites differed in species composition and populations, and seasonal and annual differences are noted.

INTRODUCTION

In June 1971, an environmental monitoring study was initiated by members of the Center for Health and Environmental Studies, Brigham Young University, to establish baselines to determine the impact of the Navajo Generating Station near Page in Coconino County in northern Arizona, and the Kaiparowits Generating Station in Kane County in southern Utah (Fig. 1).[2] Field studies of animals were conducted from July to September in 1971, and May to August in 1972 and 1973.

Can pit-traps—an outer galvanized metal sleeve 18 cm in diameter and 36 cm long with a stainless steel, flanged inner can of slightly smaller size—were used to capture ground-dwelling arthropods. Five traps, 30 m apart, were placed on each of two transects which were 45 m apart. These were left open, dry and unbaited, for a 72 hour period once each summer month. Arachnids, other arthropods, small rodents and lizards were collected from the cans daily while they were open for collection purposes. The spiders and scorpions were identified by Dr. Willis J. Gertsch.
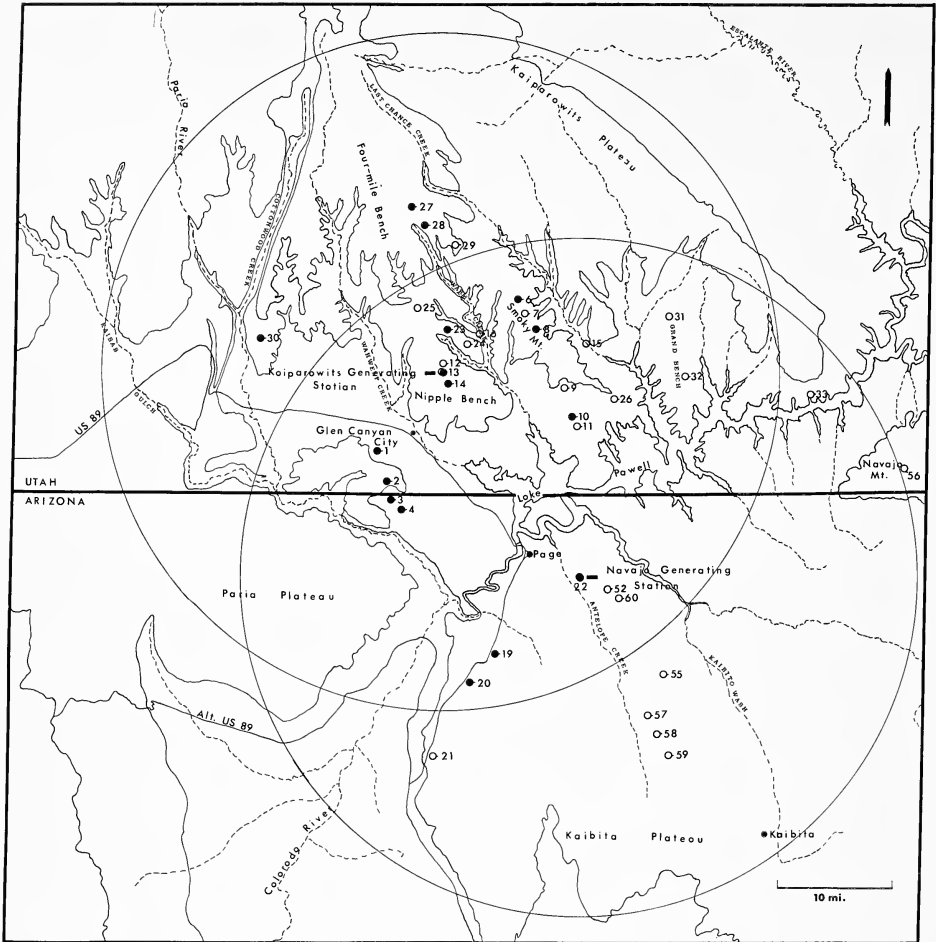
Fig. 1.–Study sites around the Kaiparowits and Navajo generating stations. Solid dots are sites of arachnid collections reported in this paper.

Sixteen sites were studied—12 in 1971, 16 in 1972, and 12 in 1973. Some were studied one year, others two, and some all three years. The sites were established in the major vegetative types in a perimeter within a 30 mile radius of the electric generating stations to determine the species and relative abundance of organisms that could be used as indicators to monitor environmental changes. Some sites operated for only one season were eliminated for study because of insufficient kinds and numbers of animals present, problems of logistics, lack of potential correlation with other investigators and continuity of vegetative analyses, and inavailability of specific climatic and edaphic data.

In order to make comparisons of populations and seasonal changes, the numbers of specimens collected were adjusted by the number of and times that traps were operated (Table 1). For example, in July 1972, 482 trapping attempts yielded 140 spiders, whereas in July 1973, 241 trapping attempts yielded 25 spiders (Table 4). By applying an adjustment factor of 2.0 to the July 1973 figure (2.0 × 241) to standardize the number of trapping attempts, the assumption is made that if as many trapping attempts were made

Table 1.—Adjustment factors for the number of trapping attempts for extrapolation of arachnid populations during comparative months in three successive years. (Data are included only for those months where comparisons can be made with the same month of another years. Adjustment factor = greatest number of trapping attempts in a month—July 1972—divided by the number of trapping attempts for a given month.)

Year and Month	No. Trapping Attempts	Adjustment Factor
1971		
July	121	4.0
August	284	1.7
September	60	8.0
1972		
May	301	1.6
June	402	1.2
July	482	1.0
August	402	1.2
September	151	3.2
1973		
May	371	1.3
June	201	2.4
July	241	2.0
August	241	2.0

in July 1973 as in July 1972, then the number collected in 1973 would have been 50 instead of 25. The normal variability in seasonal and annual populations, slightly different trapping periods within the same month, and the influence of seasonal and daily climatic changes on the activity of the arachnids during the trapping periods were ignored. Pit traps are effective primarily for ground-dwelling arthropods that move more frequently by running on the ground than by flying. The method involves a minimum of effort and time and can be used effectively for such species, although the results must be considered as relative rather than absolute with reference to species and their abundance. For selected groups, it is judged to be adequate to determine relative abundance and distribution where there are limitations of time, economy, and logistics. The numbers of trapping attempts are shown in Table 2.

PREDOMINANT VEGETATION AND
LOCATION OF STUDY SITES

Site 1. *Ephedra-Vanclevea-Sporobolus-Oryzopsis-Hilaria*. Base N slope Cedar Mountain, 5 km W Glen Canyon City, Utah.

Site 2. *Juniperus-Ephedra-Muhlenbergia-Bouteloua-Hilaria-Oryzopsis*. Cedar Mountain, 6.5 km S site 1.

Site 3. *Ephedra-Hilaria-Bouteloua-Oryzopsis*. Cedar Mountain, 2 km S site 2.

Site 4. *Coleogyne-Ephedra-Atriplex-Chrysothamnus*. Cedar Mountain, 1.3 km SE site 3.

Site 6. *Artemisia-Hilaria-Aristida-Oryzopsis*. Smokey Mountain, 23 km from Last Chance Junction, Kane Co., Utah.

Site 8. *Grayia-Ephedra-Coleogyne-Hilaria-Bouteloua-Oryzopsis-Descurainia*. Smokey Mountain, 14.5 km from Last Chance Junction, Kane Co., Utah.

Site 10. *Ephedra-Yucca-Eurotia-Vanclevea-Oryzopsis-Streptanthella*. Ahlstrom Point Road, 7.5 km S jnct., Kane Co., Utah.

Table 2.—Number of trap-days (number of traps multiplied by number of days operated) for pit traps on 16 major study sites, 1971-1973. Where values are missing, traps were not operated on those sites during those years.

Site	1971	1972	1973	Total
1	60	120	90	270
2	60	180	90	330
3	60	180	90	330
4	60	120		180
6	60	90	90	240
8	60	90	90	240
10	60	120	90	240
13	60	150	90	300
14	60	150	90	300
19		90		90
20		90		90
22		150		150
23		120	90	210
27		120	70	190
28		120	70	190
30		150	90	240
Total	510	2,040	1,040	3,590

Site 13. *Grayia-Ephedra-Oryzopsis-Bouteloua-Hilaria.* Nipple Bench, 6.5 km SE Tibbet Spring, Kane Co., Utah.

Site 14. *Coleogyne-Grayia-Ephedra-Chrysothamnus-Hilaria.* 3 km S site 13.

Site 19. *Coleogyne.* 15 km S Page, Arizona, alongside Hwy 89.

Site 20. *Muhlenbergia-Bouteloua-Hilaria.* 19 km S Page, Arizona, alongside Hwy 89.

Site 22. *Coleogyne-Ephedra-Hilaria.* E of Navajo Generating Station, SE Page, Arizona.

Site 23. *Ephedra-Coleogyne-Grayia-Hilaria.* Cathys Flat, 2 km N Tibbet Spring, thence 2.5 km E, Kane Co., Utah.

Site 27. *Juniperus-Pinus.* Four-mile Bench, 5 km SE cow camp, head Wesses Canyon, Kane Co., Utah.

Site 28. *Artemisia-Bouteloua-Plantago.* 3 km E site 27.

Site 30. *Ephedra-Bouteloua-Hilaria-Sporobolus-Salsola.* Brigham Plains Flat, Kane Co., Utah.

RESULTS AND DISCUSSION

Spiders

The spiders of 40 species that were found are not the best indicators of ecological disturbance, as a group, to be studied by the pit-trap method because they do not roam over the ground as much as some other arthropods. However, the normally sedentary *Psilochorus utahensis*, which was relatively abundant and widespread over the study areas, apparently wanders sufficiently to be considered as a good indicator species in this group of arachnids (Table 3).

The largest numbers of spiders were taken in July and August of 1971 and 1972, and June and August of 1973 (Table 4). The numbers of species found on some sites differed significantly between the three years, whereas on other sites they were more constant

Table 3.—Relative abundance and distribution of spiders (of which more than 10 specimens were taken) on 16 major study sites, 1971-1973.

Species	Total No. Taken	No. Sites Where Found
Psilochorus utahensis	581	15
Schizocosa avida	46	5
Neoanagraphis pearcei	45	13
Psilochorus imitatus	42	3
Steatoda fulva	16	8
Metacyrba arizonensis	14	6

Table 4.—Actual and estimated relative populations of spiders of all species at 16 major study sites, 1971-1973. (Estimated numbers were obtained by multiplying the actual number collected by the appropriate adjustment factor—Table 2—to standardize the number of trapping attempts. Numbers are omitted where data were not comparable.)

	Relative Population					
	1971		1972		1973	
Month	Actual	Estimated	Actual	Estimated	Actual	Estimated
May			9	14	39	51
June			91	109	33	79
July	80	320	140	140	25	50
August	152	258	142	170	57	114
September	11	88	42	134		

Table 5.—Number of species of spiders captured in pit traps on 16 major study sites, 1971-1973. Traps were not operated where numbers are omitted.

Site	Predominant Vegetation	1971	1972	1973	Total
1	*Ephedra-Vanclevea*-Grass	4	3	4	9
2	*Juniper-Ephedra*-Grass	2	5	9	12
3	*Ephedra*-Grass	6	6	5	9
4	*Coleogyne*	2	3		4
6	*Artemisia*	2	3	3	5
8	*Grayia*-Grass	2	3	4	7
10	*Ephedra*-Grass	1	4	3	6
13	*Grayia-Ephedra*-Grass	3	3	3	6
14	*Coleogyne-Grayia-Ephedra*-Grass	2	6	7	11
19	*Coleogyne*		6		6
20	Grass		5		5
22	*Coleogyne*		3		3
23	*Ephedra-Coleogyne-Grayia*		2	5	6
27	*Juniper-Pinyon*		4	2	5
28	*Artemisia*-Grass		5	4	6
30	*Ephedra*-Grass		8	3	8
	Total	11	29	19	38

(Table 5). On the eight sites where data are available for all three years, site 1 in 1972 decreased in the number of species present compared to 1971, sites 3 and 13 in 1972 remained the same as in 1971, and sites 2, 3, 6, 8, 10, and 14 increased in 1972 over

1971. In 1973, sites 3 and 10 decreased in number of species compared to 1972, sites 6 and 13 remained the same as 1972, and sites 1, 2 8, and 14 increased in the number of species. Where only two year's data are available for five sites, site 4 increased in 1972 over 1971, site 23 increased in 1973 over 1972, and sites 27, 28, and 30 in 1973 decreased from 1972.

Table 6.—Percentage composition (to nearest whole percentage for those which constitute at least 10% of the total collected; less than 10% is indicated by an asterisk) of predominant spiders on 16 major study sites, 1971-1973. Numbers in parentheses indicate numbers of other species each constituting less than 10%.

| Site | | | | Species of Spider | | | | | |
	Met ari	Neo pea	Psi imi	Psi uta	Sch avi	Ste alb	Ste ful	Xys las	Other
1		*		75			*	10	(5)
2		*		75	*			*	(8)
3	*	*		88	*		*		(4)
4	*	*		82					(1)
6	13	*		71					(2)
8		*		77	*			*	(3)
10	*	*		78			*		(2)
13		*		87			*		(3)
14	*	20	*	64			*		(6)
19		16		42			16		(3)
20		17	47			17			(2)
22				86					(2)
23	21			48			10		(3)
27		*		71					(3)
28			33	29	34				(3)
30		*		64	*		11		(4)

Table 6 shows the variation in composition of the predominant spiders for each of the study sites. *Psilochorus utahensis* was relatively abundant on 15 of the 20 sites. Apparently it was absent on site 20. *Neoanagraphis pearcei* was present on 13 of the sites, but only in abundance on three. *Steatoda fulva* was present on eight sites, but abundant only on three. Other species were not represented on more than a few sites. No two sites had the same species composition of spiders.

Comparisons of sites which were most closely alike with reference to the predominant plant species showed some significant differences. *Coleogyne* sites 4, 19, and 22 had only one species in common. One species was common to sites 4 and 19. Two species were found only on site 4, four only on site 19, and two only on site 22. Comparison of sites 14 and 23 which also contained significant amounts of *Coleogyne* showed both sites with one species common to sites 4, 19, and 22, and both sites with one species common to site 4 and one common to site 19. Site 14 had one species common to sites 4 and 19, site 23 one species common to site 4, site 14 one species common to site 22, site 14 with seven unique species, and site 23 with two unique species.

Comparison of *Ephedra*-grass sites 3, 10, and 30 showed three species common to the three sites. One species was common to sites 3 and 10, and one species to 10 and 30. Sites 3 and 30 had two species in common. Three species were unique to site 3, one species to site 10, and two species to site 30. Comparison of sites 1 and 20 which also had significant amounts of *Ephedra* and grass showed both sites with one species in common with sites 3, 10, and 30. Site 1 had two species in common with sites 3, 10, and 30, one

species in common with site 3, and five unique species. Site 20 had five unique species.

Artemisa sites 6 and 28 had only one species in common. Site 6 had four unique species, and site 28 five.

Grayia-Ephedra-grass sites 8 and 13 had four species in common; site 8 had three unique species, and site 13 two.

Juniper woodland sites 2 and 27 had only two species in common. Site 2 had ten unique species, and site 27 three.

Annual differences in species composition differed between the years. Seven species that were present in 1972 and 1973 were not taken in 1971. Two species present in 1971 were not found in 1972 and 1973. Ten species present in 1972 were not taken during the other years, five species not taken in 1973 were present other years, one species in 1973 was not found in other years, and only four species were found all three years.

Only two species were taken in sufficient abundance at comparative times in different years for yearly comparisons. *Psilochorus utahensis* was twice as abundant in 1972 than in 1973, whereas *Shizocosa avida* was seven times as abundant in 1973 than in 1972. *Psilochorus utahensis* was also six times as abundant in 1971 than in 1973, and two times as abundant in 1971 than in 1972. In 1973, *S. avida* was 17 times as abundant than in other years.

Scorpions

The scorpions of five species were not found in abundance on the study sites, and are of secondary importance as indicators (Table 7). Largest numbers were found in July in all three years (Table 8).

Table 7.—Numbers and distribution of scorpions on 16 major study sites, 1971-1973.

Species	Total No. Taken	No. Sites Where Found
Paruroctonus boreus	113	15
Vaejovis confusus	51	13
Paruroctonus utahensis	31	8
Hadrurus spadix	2	1
Vaejovis wupatkiensis	1	1

Table 8.—Actual and estimated relative populations of scorpions of all species at 16 major study sites, 1971-1973. (Estimated numbers were obtained by multiplying the actual number collected by the appropriate adjustment factor—Table 2—to standardize the number of trapping attempts. Numbers are omitted where data were not comparable.)

Month	Relative Population					
	1971		1972		1973	
	Actual	Estimated	Actual	Estimated	Actual	Estimated
May			2	3	10	13
June			11	13	4	10
July	26	104	37	37	31	62
August	29	49	16	19	20	40
September	6	48	1	3		

The numbers of species present differed slightly between years, and were lowest during 1972 and highest in 1971 (Table 9). Seven of nine sites decreased in number of species in 1972 over what was found in 1971, and two sites decreased in 1973 over the number in 1972. Seven of twelve sites increased in numbers of species in 1973 over what was found in 1972.

Many sites had the same species composition, but the relative percentage of individuals of each species varied between sites (Table 10). *Paruroctonus boreus*, found on 15 of the sites, was a predominant component of the scorpions on 11 of them. *Vaejovis confusus*, present on 13 of the sites, was of significant composition on only two.

Table 9.—Number of species of scorpions captured in pit traps on 16 major study sites, 1971-1973. Traps were not operated where numbers are omitted.

Site	Predominant Vegetation	1971	1972	1973	Total
1	*Ephedra-Vanclevea*-Grass	2	0	2	2
2	*Juniper-Ephedra*-Grass	3	2	3	3
3	*Ephedra*-Grass	3	3	1	3
4	*Coleogyne*	4	1		4
6	*Artemisia*	1	1	1	2
8	*Grayia*-Grass	2	1	0	2
10	*Ephedra*-Grass	2	1	2	3
13	*Grayia-Ephedra*-Grass	2	1	2	2
14	*Coleogyne-Grayia-Ephedra*-Grass	2	0	2	2
19	*Coleogyne*		3		3
20	Grass		1		1
22	*Coleogyne*		3		3
23	*Ephedra-Coleogyne-Grayia*		1	2	2
27	*Juniper-Pinyon*		1	2	2
28	*Artemisia*-Grass		1	1	1
30	*Ephedra*-Grass		2	2	2
	Total	4	3	3	4

Table 10.—Percentage composition (to nearest whole percentage) of scorpions on 16 study sites, 1971-1973.

Species of Scorpion

Site	Had spa	Par bor	Par uta	Vae con	Vae wup
1			44	56	
2		83	7	10	
3		76	6	12	6
4	20	15	55	10	
6		92		8	
8		60		40	
10		5	17	78	
13		60		40	
14		75	25		
19		19	51	30	
20		100			
22		11	68	21	
23		68		32	
27		93		7	
28		100			
30		67		33	

Comparison of sites which were most closely alike with reference to the predominant plant species showed significant differences primarily in percentage composition rather than species present (Table 10). *Coleogyne* sites 4, 19, and 22 had three of the four species in common, but one species was unique to site 4. The one predominant species on all three sites was the same. Comparison of sites 14 and 23 which also contained significant amounts of *Coleogyne* showed both sites with a species common to each other and the other three sites, and each site with a unique species common to sites 4, 19 and 22. The predominant species of sites 14 and 23 was different than the predominant one for sites 4, 19, and 22.

Comparison of *Ephedra*-grass sites 3, 10, and 30 showed two species in common for all three, one species common to sites 3 and 10, and one species unique to site 3. The one predominant species was the same only for sites 3 and 30. Comparison of sites 1 and 20, which also had significant amounts of *Ephedra* and grass, showed two species on site 1 in common with sites 3 and 10, and only one species common to sites 1 and 30. The single species on site 20 was common to sites 3, 10, and 30. The predominant species on site 1 was also the predominant species of site 10.

Artemisia sites 6 and 28 had one predominant species in common, and site 6 had one unique species.

Grayia-Ephedra-grass sites 8 and 13 were of similar composition and predominance.

Juniper woodland sites 2 and 27 had two species in common, and site 2 had one unique species. The predominant species was the same for both sites.

Relative abundance of individual species differed between the three years. Comparison of the period of May to August showed *Paruroctonus boreus* to be one and one-half times as abundant in 1973 as in 1972, *P. utahensis* of about equal abundance both years, and *Vaejovis confusus* three times as abundant in 1973 as in 1972. Comparison of July and August for the three years showed *P. boreus* to be twice as abundant in 1971, and one and one-half times as abundant in 1973 as in 1972. In 1971 *P. utahensis* was ten times as abundant as in 1972 and 1973. *Vaejovis confusus* was twice as abundant in 1971, and three times as abundant in 1973 as in 1972.

CONCLUSIONS

Although can pit-traps are selective for sampling purposes, they are an effective method for certain groups and species of ground-dwelling arthropods. The only spider taken in this study which may be considered a good indicator species as measured by the pit trap technique is *Psilochorus utahensis*. It was by far the most abundant and widespread species found, and was the predominant species in all plant communities except the *Muhlenbergia-Bouteloua-Hilaria* community where *Psilochorus imitatus* was predominant, and the *Artemisia-Bouteloua-Plantago* community where *P. imitatus* and *Schizocosa avida* were about equally predominant. Populations of spiders were highest during August, July, and September, respectively. Greatest numbers of species were found in the *Juniperus-Ephedra*-grass and *Coleogyne-Grayia-Ephedra* communities.

Scorpions of *Paruroctonus boreus* were relatively abundant and ecologically widespread, and are considered as good ecological indicators as measured by pit traps. Those of *Vaejovis confusus* were only about half as abundant as *P. boreus*, but were almost as widespread ecologically. *Paruroctonus boreus* was the predominant species in 11 of the 16 communities studies. *Paruroctonus utahensis* was the predominant species in the *Coleogyne-Ephedra-Atriplex*, *Coleogyne*, and *Coleogyne-Ephedra-Hilaria* communities.

Vaejovis confusus was predominant in the *Ephedra-Yucca-Eurotia* and *Ephedra-Vanclevea-Sporobolus* communities. Scorpions were most abundant during July. Greatest numbers of species were found in the *Coleogyne-Ephedra-Atriplex* community.

ANNOTATED LIST OF SPIDERS

Apollophanes texanus Banks. 1 Male, 1 August 1973, site 1—*Ephedra-Vanclevea*-grass; 1 Female, 13 August 1972, site 19—*Coleogyne*. Known distribution: Desert areas of southwestern and western United States, north into Montana.

Calilena restricta Chamberlin and Ivie. 1 Male, 13 August 1972, site 20—grass; 1 Imm, 15 June 1972, site 23—*Ephedra-Coleogyne-Grayia*. Known distribution: Rocky Mountain states from Idaho into Utah and northern Arizona.

Castianeria occidens Reiskind. 1 Male, 21 July 1972, site 28—*Artemisia*-grass; 4 Males, 1 Female, 23 and 24 July 1972, site 30—*Ephedra*-grass. Known distribution: Southwestern United States and northwestern Mexico.

Cesonia sincera Gertsch. 1 Female, 2 August 1971, site 8—*Grayia*-grass; 1 female, 3 August 1971, 1 female, 11 September 1971, site 6—*Artemisia*. Known distribution: Texas to New Mexico, Arizona and southern Utah.

Cicurina deserticola Chamberlin and Ivie. 1 Male, 30 April 1973, site 2-juniper-*Ephedra*-grass, 1 female, 2 May 1973, site 8—*Grayia*-grass; 1 female 9 May 1973, site 13—*Grayia-Ephedra*-grass; 1 Female, 17 June 1972, site 14—*Coleogyne-Grayia-Ephedra*-grass. Known distribution: Utah, Arizona, and New Mexico.

Dictyna personata Gertsch and Mulaik. 1 specimen, 6 July 1972, 1 specimen, 6 August 1972, site 2—juniper-*Ephedra*-grass. Known distribution: Texas, New Mexico, California, Nevada, and Mexico (Chihuahua).

Drassodes gosiutus Chamberlin. 1 Male, 16 October 1971, site 13—*Grayia-Ephedra*-grass; 1 Male, 16 October 1971, 1 Male, 16 October 1971, 1 Male, 12 June 1973, site 14—*Coleogyne-Grayia-Ephedra*-grass. Known distribution: Utah, Arizona, and New Mexico.

Drassodes robinsoni Chamberlin. 1 Male, 3 June 1973, site 1—*Ephedra-Vanclevea*-grass; 1 Male, 3 June 1973, site 2—juniper-*Ephedra*-grass; 1 Male, 11 May 1973, site 14—*Coleogyne-Grayia-Ephedra*-grass. Known distribution: Western United States, east to New England; common in Utah, Arizona, and New Mexico.

Drassyllus lamprus Chamberlin. 1 Female, 11 June 1972, site 20—grass. Known distribution: Utah and northern Arizona.

Enoplognatha piuta Chamberlin and Ivie. 1 Male, 24 April 1972, site 30—*Ephedra*-grass. Known distribution: Utah and northern Arizona.

Euryopis scriptipes Banks. 1 Female, 3 June 1973, site 2—juniper-*Ephedra*-grass. Known distribution: Rocky mountain states, from Alberta into Chihuahua, Mexico.

Filistata utahana Chamberlin and Ivie. 1 Female, 22 May 1972, site 30—*Ephedra*-grass; 1 specimen, 5 June 1972, 1 Male, 13 July 1971, site 3—*Ephedra*-grass; 1 Male, 18 July 1971, site 17—grass, 1 Imm., 6 July 1972, site 4—*Coleogyne*; 1 Imm., 14 August 1972, site 20—grass; 1 Female, 16 July 1973, site 23:*Ephedra-Coleogyne-Grayia*; 1 female, 17 July 1971, site 18—*Coleogyne*; 1 Female, 17 August 1971, Glen Canyon City. Known distribution: Utah, northern Arizona, New Mexico, and westward into California.

Geolycosa rafaelana Chamberlin. 1 specimen, 5 May 1972, site 1—*Ephedra-Vanclevea*-grass; 1 specimen, 3 June 1972, 1 Male, 3 June 1973, site 3—*Ephedra*-grass; 1 male, 9

June 1972, site 19—*Coleogyne*; 1 Male, 4 July 1973, site 2—juniper-*Ephedra*-grass. Known distribution: Desert areas of southern Utah, northern Arizona, and New Mexico.

Gnaphosa californica Banks. 1 Female, 21 July 1972, site 27—juniper-pinyon. Known distribution: Utah, Arizona, New Mexico, and west to California.

Haplodrassus eunis Chamberlin. 1 Female, 2 May 1973, site 6—*Artemisia*; 2 Females, 3 May 1973, site 8—*Grayia*-grass; 2 males, 1 Imm., 9 and 10 May 1973, site 14—*Coleogyne-Grayia-Ephedra*-grass; 1 Female, 11 May 1973, site 13—*Grayia-Ephedra*-grass; 1 Imm., 13 July 1972, site 22-*Coleogyne*. Known distribution: Arizona, Utah, and New Mexico.

Herpyllus propinquus (Keyserling). 1 Imm., 18 May 1972, site 28—*Artemisia*-grass. Known distribution: Western United States, mostly west of Rockies.

Latrodectus hesperus Chamberlin and Ivie. 1 Imm., 12 July 1972, site 10—*Ephedra*-grass; 1 Imm., 3 August 1973, site 2—juniper-*Ephedra*-grass; 1 Female, 4 August 1973, site 23—*Ephedra-Coleogyne-Grayia*; 1 Imm., 17 October 1971, Nipple Spring. Known distribution: Western United States, and eastward into west Texas.

Metacyrba arizonensis Barnes. Seven immatures, 2 Males, and 5 Females were taken from seven sites (3, 4, 6, 10, 14, 17, 23). Immatures were found in May, July, and August, males in July, and females in May and July. Known distribution: Southern Utah, Arizona, New Mexico, and California.

Metacybra taeniola (Hentz). 1 Female, 12 June 1973, site 14—*Coleogyne-Grayia-Ephedra*-grass. Known distribution: United States and Canada.

Misumenops asperatus (Hentz). 1 Female, 21 July 1972, *ex Helianthus petrolans*, 1.5 km W Page, Arizona. Known distribution: Mostly eastern species occurring in northwestern states, including Utah, northern Arizona (new record from 1.5 km W Page), and Alberta, Canada.

Misumenops coloradensis Gertsch. 4 Females, 21 July 1972, *ex Chrysothamnus viscidiflorus*, 13 km S Page, Arizona. Known distribution: Southwestern United States.

Neoanagraphis pearcei Gertsch. This species was the second most common one taken. Thirty-six immatures, 7 Males, 3 Females, and 3 specimens not designated by sex or stage were taken from 14 of the 20 study sites (all but nos. 7, 9, 18, 22, 23, and 28). Immatures were taken from May to October, mainly in July and August; males in August and September; and females from June to August. Greatest numbers were found at sites 14 and 20, *Coloegyne-Grayia-Ephedra*-grass and grass communities, respectively. Known distribution: Nevada, southern Utah, Arizona, New Mexico, and west into California.

Nodocion utus (Chamberlin). 1 Male, 1 Female, 14 July 1971, site 3—*Ephedra*-grass. Known distribution: Utah, Arizona, and New Mexico.

Oxyopes tridens Brady: 1 Male, 17 July 1971, 1 specimen, 8 July 1972, site 1—*Ephedra-Vanclevea*-grass; 1 Male, 15 July 1972, site 22—*Coleogyne*; 1 Male, 17 July 1971, site 17—grass. Known distribution: Southwestern United States.

Pardosa uintana Gertsch. 1 Male, 18 June 1972, Navajo Mountain, San Juan Co., Utah. Known distribution: Boreal species of northwestern United States, Canada, New England; mountains of Utah, Colorado, etc.

Pardosa utahensis Chamberlin. 1 Female, 18 June 1972, *ex Artemisia*, Navajo Mountain, San Juan Co., Utah. Known distribution: Utah, Colorado, and Wyoming.

Pholcophora americana Banks. 1 Female, 13 May 1973, site 27—juniper-pinyon. Known distribution: Western United States, especially northern part.

Phrurotimpus alarius (Hentz). 1 Female, 20 August 1972, site 27—juniper-pinyon. Known distribution: Most of United States except Pacific states.

Plectreurys tristis Simon. 1 Imm. 17 July 1972, site 14—*Coleogyne-Grayia-Ephedra-*grass. Known distribution: Arizona and southern Utah into California.

Psilochorus imitatus Gertsch and Mulaik. Five immatures, 8 Males, 29 Females, and one undesignated specimen were taken from sites 14, 20, and 28. Most were taken from the latter two sites—grass and *Artemisia-*grass communities. Known distribution: Foothills of New Mexico, Arizona, and Utah.

Psilochorus utahensis Chamberlin. This was the most common and widespread species taken. Two hundred and thirty immatures, 134 Males, 113 Females, and 127 specimens not designated by sex or stage were taken from all study sites, except no. 20. Largest numbers were taken at site 3, an *Ephedra-*grass community. Immatures, males, and females were taken from May to October, all with predominant numbers in August.

Comparison of June and July for the three years showed only half as many spiders in 1972 as in 1971, and only one-sixth as many in 1973. For the period of May to August, three times as many spiders were taken in 1972 than in 1973. Known distribution: Southwestern United States and adjacent Mexico, in arid situations.

Schizocosa avida Walckenaer. Twenty-four immatures, 13 Males, 7 females, and 2 undesignated specimens were taken from sites 2, 3, 8, 28, and 30. Largest numbers were taken on site 28, an *Artemisia-*grass community. Immatures were taken in May, June, and August, mainly in the latter month; males were taken in June and July, mainly in June; and females in about equal numbers from June to August. Known distribution: Eastern species ranging westward into some Rocky Mountain states.

Steatoda albomaculata (DeGeer). 1 Male, 16 July 1972, 2 Females, 13 August 1972, site 20—grass. Known distribution: Holarctic species, mostly northern United States.

Steatoda fulva (Keyserling). Three immatures, 12 Males, and 1 Female were taken from sites 1, 3, 10, 13, 14, 19, 23, and 30. Immatures were taken in June and July, males from June to August, and the female in July. Known distribution: Widespread in western and southern United States from Oregon, Idaho, Nebraska south into Baja California and southern Mexico; eastward through Gulf States into Florida.

Steatoda variata Gertsch. 1 Male, 6 August 1972, site 3—*Ephedra-*grass. Known distribution: Utah and Colorado, south to Texas and Mexico.

Thanatus altimontis Gertsch. 3 Males, 12 and 13 July 1971, 1 Female, 12 July 1971, 1 undesignated, 6 June 1972, site 3—*Ephedra-*grass; 1 Female, 3 August 1971, site 7—*Grayia-Coleogyne-*grass. Known distribution: Washington to Nebraska, south to California and Oklahoma.

Xysticus gulosus Keyserling. 1 Imm., 27 August 1971, site 1—*Ephedra-Vanclevea-*grass. Known distribution: Most of United States and adjacent Canada, south into western Mexico.

Xysticus lassanus Chamberlin. 1 Male, 11 April 1972, site 8—*Grayia-*grass; 4 Males, 28-30 April 1973, site 1—*Ephedra-*grass; 1 Male, 29 April 1973, site 2—juniper-*Ephedra-*grass. Known distribution: Southwestern United States.

Xysticus lutzi Gertsch. 1 Imm., 14 July 1972, site 19—*Coleogyne*; 1 undesignated, 7 August 1972, site 2—juniper-*Ephedra-*grass. Known distribution: Southeastern United States.

Zelotes tuobus Chamberlin. 2 Females, 13 May 1973, site 28—*Artemisia-*grass; 1 Male, 21 June 1972, site 30—*Ephedra-*grass; 1 Female, 5 July 1973, site 10—*Ephedra-*grass. Known distribution: Utah, Arizona, and New Mexico.

ANNOTATED LIST OF SCORPIONS

Hadrurus spadix Stahnke. 2 specimens, 14 and 17 July 1971, site 4—*Coleogyne*. Known distribution: Northern Arizona, southern Utah, west into southwestern Idaho, western Oregon and eastern California.

Paruroctonus boreus (Girard). This was the most common and widespread species taken. Twenty immatures, 51 Males, 17 Females, and 26 specimens not designated as to stage or sex were taken from 16 of the 20 study sites (all but nos. 1, 9, 17, and 18). The largest number of specimens was taken at site 27, a juniper-pinyon community. Immatures were taken from May to August, mostly in the latter two months; males from June to August, mainly in July; and females about equally each month from May to August. Known distribution: Widespread western species from western Canadian provinces south into Northern Arizona, Nevada; common in Oregon but largely absent in California.

Paruroctonus utahensis (Williams). Eight immatures, 3 Males, 7 Females, and 13 specimens not designated to stage or sex were taken from eight sites (1, 2, 3, 4, 10, 14, 19, 22). The largest numbers of scorpions were taken from site 19, a *Coleogyne* community. Immatures and females were taken from May to August, and males in July and August. Known distribution: Southern Utah and northern Arizona.

Vaejovis confusus Stahnke. This was the second most abundant species. Seven immatures, 14 Males, 14 Females, and 16 undesignated specimens were taken from 16 sites (all but nos. 9, 17, 18, and 20). Largest numbers were found on sites 1, 10, and 19—*Ephedra-Vanclevea*-grass, *Ephedra*-grass, and *Coleogyne* communities, respectively. Immatures were taken in May, July, and August, males in July and August, and females in May, July, August, and September. Known distribution: Arizona, southern Utah, west into southern Nevada and southern California.

Vaejovis wupatkiensis Stahnke. 1 Female, 6 May 1972, site 3—*Ephedra*-grass. Known distribution: Northern Arizona, southern Utah, and westward into Nevada and California.

PITFALL TRAPPING IN ECOLOGICAL STUDIES OF WANDERING SPIDERS

George W. Uetz

Department of Ecology, Ethology and Evolution
University of Illinois
Urbana 61801

John D. Unzicker

Section of Faunistic Surveys and Insect Identification
Illinois Natural History Survey
Urbana 61801

ABSTRACT

The use of pitfall trapping and quadrat sampling in ecological studies of spiders is discussed. Comparison of these methods in studies of species diversity shows pitfall trapping to give a closer estimate of the total number of species in a community. Limiting the method to studies of cursorial forms, like wandering spiders, may diminish sampling error due to differential species activity. Several conditions for limited use of pitfall trapping in ecological research are proposed. Improvements in trap dispersion and trap design are presented which may substantially reduce sampling errors. Descriptors: Pitfall trapping, ecological methods, wandering spiders.

INTRODUCTION

Wandering or cursorial spiders have been the subject of numerous ecological studies over the past few years. These spiders, recognized by many arachnologists as a distinct group among spiders, move actively over the ground, running down or pouncing on their prey rather than relying on the use of webs. Balogh and Loksa (1948) called this group a "syntrophium," due to the similarity of their predatory strategies and habitat choices. A term used in current ecological literature for such a group is "guild" (Root, 1967). Lycosidae, Clubionidae, Gnaphosidae, Hahniidae, Ctenidae and some members of the Agelenidae and Pisauridae make up the majority of this guild.

A major problem in ecological research on these spiders is the lack of accurate sampling techniques (see Duffey, 1972). Two basic methods have been used for sampling cursorial forms in the ground stratum: quadrat sampling and pitfall trapping. Both methods are subject to error due to a variety of factors, and require scrutiny.

In previous studies (unpubl.) we have used both methods, and have mixed feelings about their accuracy. Quadrat sampling should provide an absolute density measure, but is influenced by the activity of animals in the brief span of time when the sample is taken. Results are also influenced by the presence of the investigator, since many spiders escape capture by running away as s/he approaches. Pitfall trapping provides a contin-

Table 1.–Estimates of density of forest floor wandering spiders made by sight-count methods and quadrat sampling. See text for details (*Oak-maple-tulip forest, Delaware; †Oak-hickory forest, Illinois).

Species	Sight-Count no/m²	Quadrat no/m²
*Schizocosa crassipes	16-20	1-3
*Castaneira longipalpus	1-8	0
*Xysticus transversatus	3-10	2-4
†Xysticus elegans	1-5	1-2
†Schizocosa saltatrix	11-19	2-3

uous sample, yet is undoubtedly influenced by activity levels and movements of the spiders. Before beginning an ecological study, we attempted to compare methods by invoking the wisdom of the literature as well as performing some preliminary field trials. Our findings have influenced our choice of methods, and we present them here.

COMPARISON OF PITFALL TRAPPING AND QUADRAT SAMPLING

In an earlier study (Uetz, in press) quadrat sampling was abandoned in favor of pitfall trapping after it was discovered that several numerous species were collected in disproportionately low numbers or missed entirely by the first method. Samples taken with a 0.25 m² frame (similar to one used by Turnbull, 1966) are compared with sight-counts of individuals (see Duffey 1962) in 1 meter square plots in Table 1. Paired data were taken at approximately the same time of day in the same area, yet show considerable differences in density for several species. Observation by a third party during quadrat sampling revealed that movement of spiders away from the investigator accounted for lower numbers taken by this method. The only solution to this problem is a quadrat sampler which can be operated from a distance, as developed by Mason and Blocker (1973). Unfortunately, such devices are unwieldy at very least, and can only be operated in open areas like pastures or old fields. Differences in sampling due to temporal stratification of species can be countered by taking quadrat samples at regular intervals over a 24 hour period.

We surveyed the literature for studies of a wide range of communities utilizing both quadrats and pitfalls and used the data to compare the effectiveness of each in sampling species composition. We were able to to find several with a full year's data from continuous pitfall trapping and weekly or biweekly quadrat sampling (with similar extraction techniques) (Duffey, 1962; Huhta, 1971; Muma and Muma, 1949; and our own unpublished data). Assuming that together these methods sample the total number of species in an area, we can evaluate the estimates made by each method alone. We compared the total number of species with the number collected by each method (Fig. 1). The pitfall trapping results correlate significantly (r=0.988), whereas the quadrat sampling results show a non-linear relationship with the total number of species. The quadrat technique adds very few species to a community list beyond those compiled by pitfall trapping alone. In fact, in almost all cases, there were a larger number of species *absent* from quadrat samples and *present* in pitfalls than vice versa. Moreover, quadrat sampling does not sample a constant fraction of species present, but takes a disproportionately larger fraction in more diverse communities. These data suggest that pitfall trapping gives a
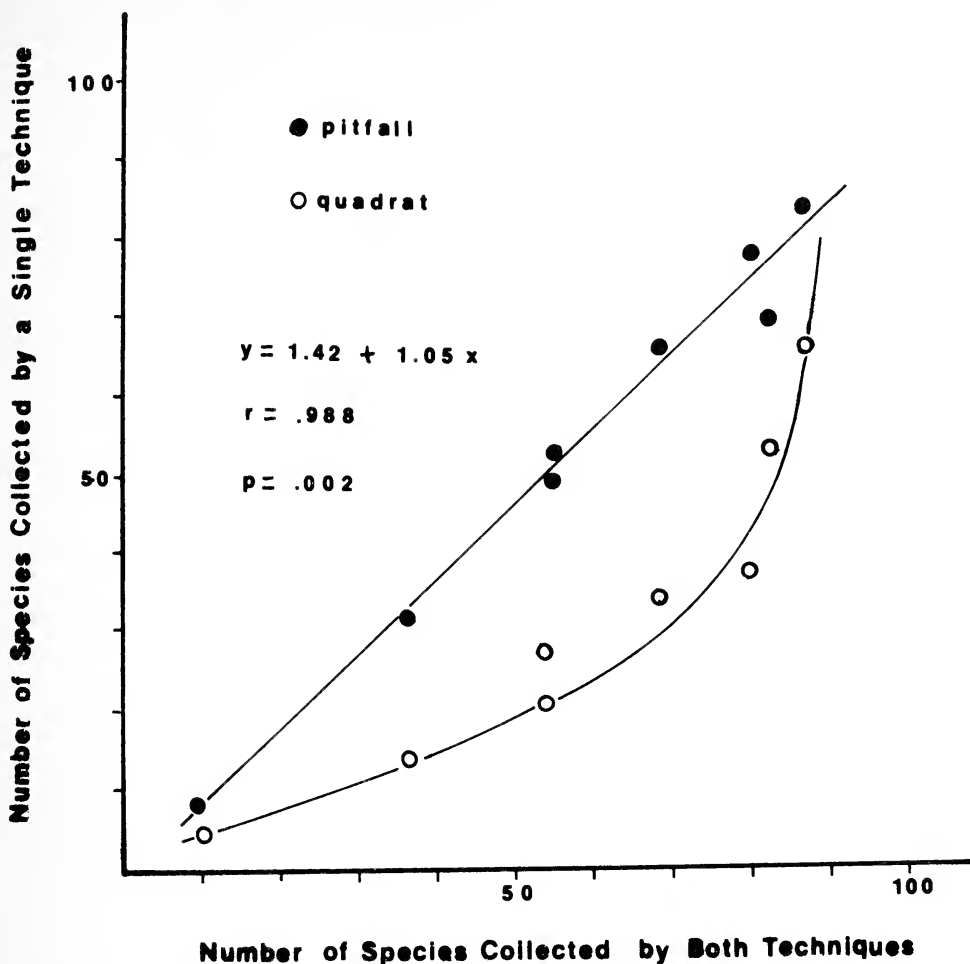
Fig. 1.–Comparison of the number of spider species collected by pitfall trapping and quadrat sampling with the number of species collected by both together. Taken from data in previously published studies (Duffey, 1962; Huhta, 1971; Muma and Muma, 1949) and our own unpublished data.

closer estimate of the total number of species in a community, and would be more useful in studies of species diversity.

Whether or not either method is acceptable for ecological research will depend on the degree of reliability with which it samples the relative abundance of species. Neither of the two methods compared is without bias in this regard, and it seems that a truly accurate means of assessing relative numbers is yet to be found. Quadrat sampling is an acceptable method for slow moving or nonmotile species in soil and litter, and provides accurate estimates of density for web-builders and some wandering spiders. Pitfall trapping is *only* suitable as a means of sampling cursorial forms, and appears to be the best available at present.
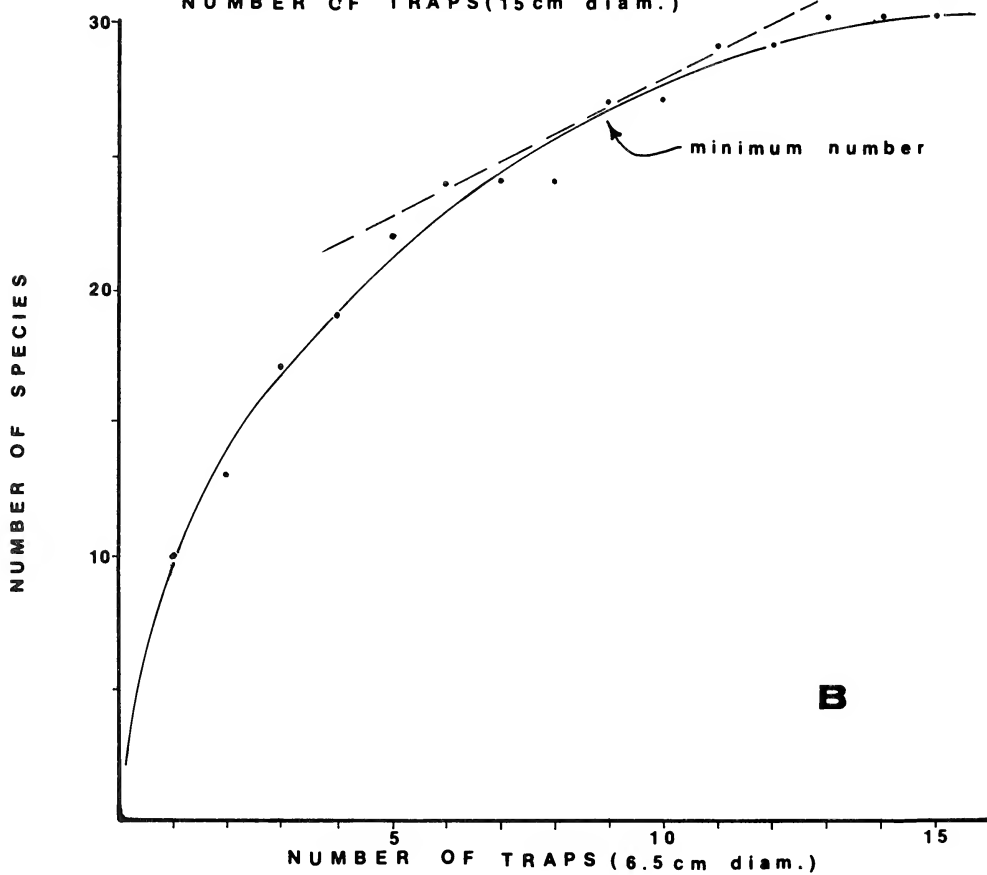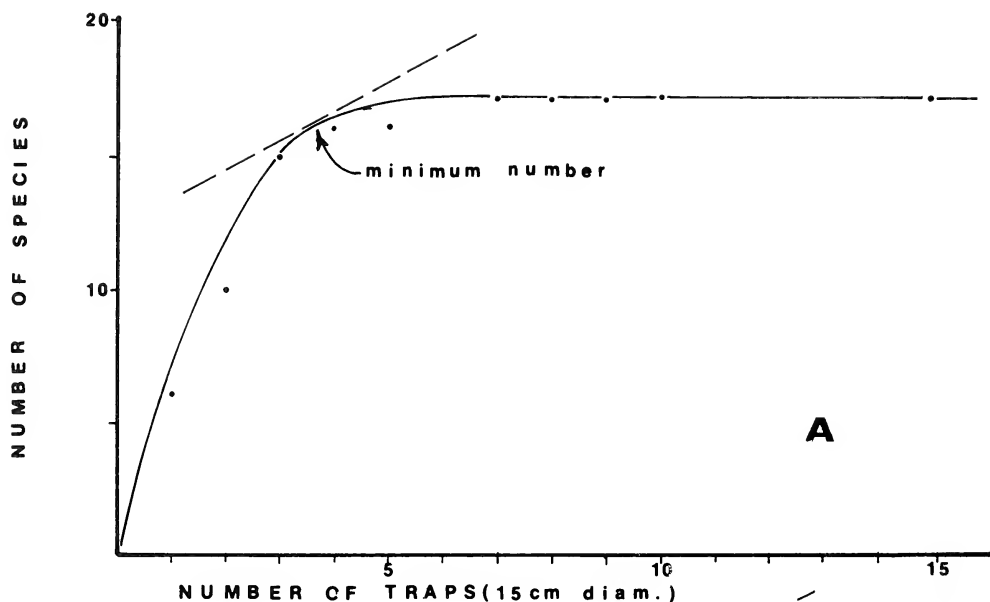
USE OF PITFALL TRAPPING IN ECOLOGICAL RESEARCH

Allred, et al. (1963), Barnes (1953), Barnes and Barnes (1954), Berry (1970), Dondale (1971), Fichter (1954), Heydeman (1961), Huhta (1971), Muma and Muma (1949), Peck (1966) and Tretzel (1954) utilized pitfall trapping as one of several methods to study species composition of wandering spiders and other cursorial arthropods, while Breymeyer (1966a), Fox and Dondale (1973), Muma (1973), Pearson and White (1964), Schmoller (1971), Van der Aart and de Wit (1971), Whitcomb, et al. (1963) and Williams (1959a) used only pitfall trapping. Williams (1959a, 1959b, 1962), Breymeyer (1966a, 1966b), and Dondale, et al. (1972) have used pitfall trapping to study diel activity periodicities in various cursorial arthropods.

Several authors have discussed pitfall trapping and its handicaps, and there is disagreement concerning the interpretation of data collected by this method. Greenslade (1964), Southwood (1966), and Turnbull (1973) have concluded that pitfall trapping is not a reliable means of sampling population density or species composition. They believe that differences in activity of some species, impedance of movement in some habitats and climate factors all influence results to the point of rendering them useless. However, Greenslade does mention the usefulness of this method in mark and recapture studies, and discusses ways in which community comparisons can be made from pitfall data.

Huhta (1971), Duffey (1962) and Kessler-Geschiere (1970) have demonstrated that pitfall and quadrat sampling can give widely varying measures of the dominance relation of species and sex ratios. All suggest that using these methods together increases their usefulness in ecological sampling. Vlijm and Kessler-Geschiere (1967) have described pitfall trap catches by a formula: $A = W \times X \times D$, where A= number of active animals in an area; W= a weather factor; X= a habitat category; and D= actual density. Comparison of communities, then, can be made more accurate by comparing samples taken under similar weather conditions (i.e., the same season). If the influence of the habitat factor can be taken into account or minimized, accuracy will be increased further (Greenslade, 1964).

Breymeyer (1966a) has studied the seasonal abundance of wandering spiders, and compared the faunas of the field layers of several communities. The data were expressed in terms of "penetration" (the relative density of active individuals per trap effort), a term derived from Heydemann (1961). This quantity is also referred to as "active density" (Uetz, unpublished data). Data from several studies presented with her paper provide a comparison of quadrat sampling and pitfall trapping, showing them to be similar in their ability to record variation in numbers over a season. Breymeyer has concluded that by limiting the use of pitfall trapping to cursorial forms, much of the influence of differential species activity is minimized, and community comparisons can be made with some degree of confidence.

Gist and Crossley (1973) developed a method for estimating density from pitfall trap catches in an enclosed area, based on removal trapping methods. Comparisons of this method and litter sieving from quadrat samples showed no significant difference between the two methods for estimating density.

Fig. 2.–A method for determining the number of pitfall traps necessary for an accurate sampling of the fauna in an area, based on species-area curves. Number of accumulated species is plotted against the numbers of traps in a sample, and a line with 0.05 slope is drawn tangent to the curve. Data are from two separate studies in forest litter spiders: A- in an Oak-Hickory forest in Illinois, using 15 cm diameter can traps, and B- in an Oak-Tulip-Maple forest in Delaware, using 6.5 cm diameter can traps.

We feel that pitfall trapping may be used, with caution, in ecological studies of cursorial spiders if the following conditions are met:

1. Analysis of data must be restricted to known cursorial forms of similar foraging strategies.

2. Collection should be made over a long period of time (i.e., the entire growing season).

3. Comparisons of communities should be made on the basis of samples taken in the same seasons, in the same general climatic regime.

4. Comparisons of communities must take into account the possiblity of impedance of movement by various habitat factors.

5. Pitfall trapping should be backed by a second method (i.e., quadrats, time-search, sight-count, etc.).

6. Efforts should be made to reduce known sources of error (i.e., trap placement, design, number of traps, attractant or repellant qualities of preservative, etc.).

We, like others, have reservations about the interpretation of results obtained by this method. However, we feel its use in studies relying on relative abundance, species diversity, habitat breadth, niche overlap and foraging activity of wandering spiders can be recommended, if the above conditions are met.

REDUCING ERROR IN STUDIES WITH PITFALL TRAPS

The sources of error in pitfall trapping mentioned in the literature can usually be placed in one of two categories: 1) error resulting from dispersion or placement of traps; or 2) error resulting from aspects of trap design. To conclude our discussion of the use of pitfall trapping, we would like to propose some ways to reduce error from both of these sources.

Problems have arisen in past studies when too many or too few traps were used, and where traps have been too close or too far apart. The particular sampling regime chosen should ultimately depend on the patchiness of the environment sampled; the size of the sample area, the size of the trap, and the type of information sought. Trap location is usually best determined by a stratified-random type method, which allows the investigator to place trap lines or sets in various patch types or at predetermined intervals along an environmental gradient. The upper limit on intertrap distance should be determined by the nature of the area being sampled, while the lower limit should be guided by the size of the spiders and the potential for depleting their population. Small traps (3-6 cm diameter) have been placed as close as 1 m (Duffey, 1962; Vlijm and Kessler-Geschiere, 1967), and as far apart as 10 m (Breymer, 1966). Larger traps have been placed much farther apart; 10 m (Uetz, unpublished data) - 20 m (Dondale, et al., 1972).

Choice of both trap size and trap number can be arrived at by use of the species-area curve common to plant ecology (see Oosting, 1956). The number of species accumulated in the sample is plotted against the numbers of sizes of samples. The minimum number or size can be determined by drawing a line of five percent rise per 10 percent sample (see Fig. 2) tangent to the curve. Another method for determining the number or size of trap to use is to plot standard error of the mean (numbers of organisms) or SE/x ratio against numbers or sizes of traps (see Fig. 3), and choose the minimum number or size of traps that will bring the standard error down to the significance level desired. A variation of this method is to solve the equation for standard error of the mean for various confidence limits as in Muma (in press).
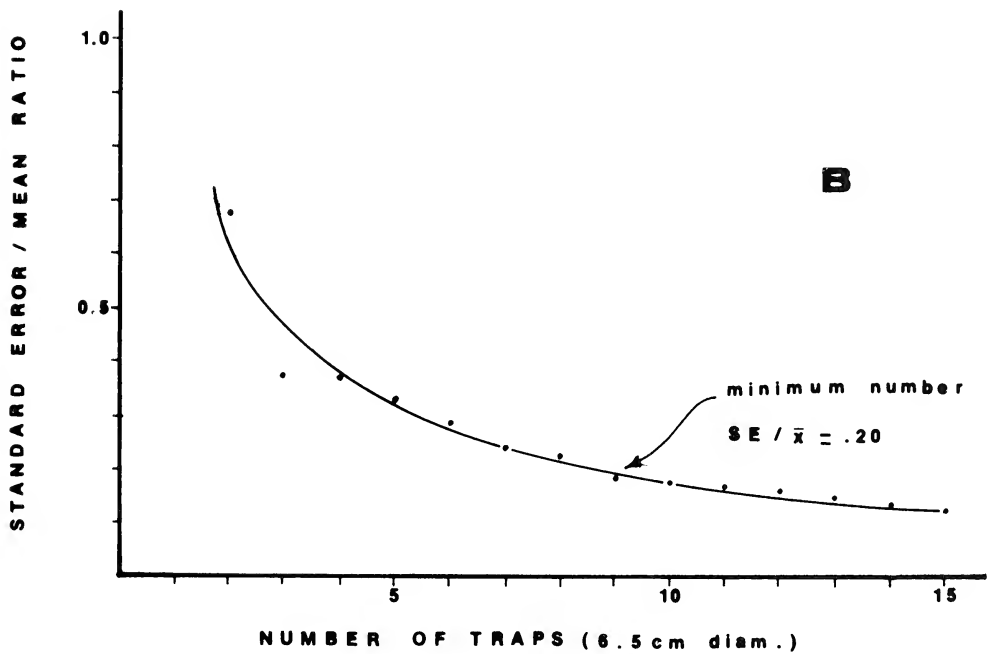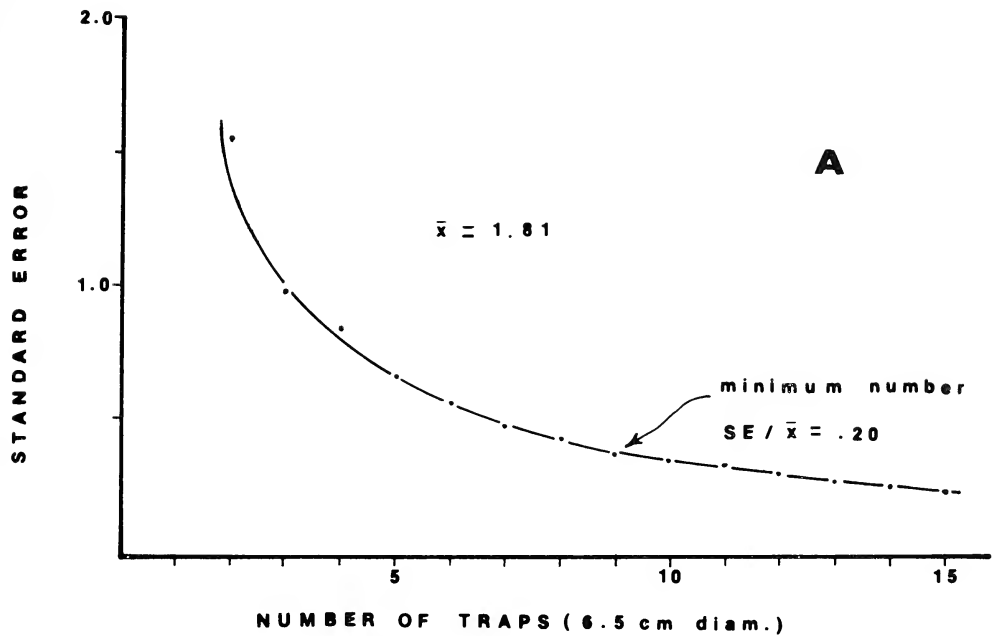
Fig. 3.—A method for determining the number of pitfall traps necessary for a statistically reliable estimate of spider numbers. A- Standard error of the mean (S.E.), and B- S. E. /$\bar{x}$ ratio are plotted against the numbers of pitfall traps in a sample. Data used are number/trap week of *Schizocosa crassipes* Walckenaer from a study in an Oak-Tulip-Maple forest in Delaware.

Aspects of the trap itself can contribute significantly to error in pitfall trapping studies (Greenslade, 1964; Duffey, 1972). There are probably as many kinds of pitfall traps as there are people that use them. An adequate sampling of these can be found in the literature already mentioned. In our present research, we use a trap that in our opinion is an improvement over previous designs. It was designed for the purpose of reducing error from common sources, and we present it here merely as an example of what might be done to improve accuracy.

Our pitfall trap design is a synthesis of ideas found in Fichter (1941), Muma (1970), Moulder and Reichle (1972), Holm and Edney (1973) and Palmieri and Rogers (1973). The trap (Fig. 4) consists of a metal can (15 cm diameter; 22 cm depth) with a 10 cm wide sloped metal collar coldered to the rim. Placed inside the can is a plastic funnel (same diameter as the can) with stem cut off. A plastic food storage jar (10 cm diameter; 7 cm depth) containing ethylene glycol preservative is used for capturing falling animals. The funnel fits snugly into the can and jar. Above the trap, a 20 cm X 20 cm piece of hardware cloth (1/2 inch mesh) mounted on wire supports serves as a roof and mannal excluder. Rainwater overflowing from the jar is drained out of the trap by holes punched in the bottom of the can.

The trap design has several advantages over other traps previously used.

1. The screen roof excludes leaves, debris, and raccoons without creating a microclimate over the trap.

2. The collar assures that the rim will always be flush with the surface of the soil despite erosion, expansion or contraction, thus eliminating an important source of error.

3. The can is readily obtainable (and usually free).

4. Drainage holes for excess water eliminate the possibility of flooding and the need for a roof.

5. The funnel is lowered to prevent escape, and has a large opening so that arthropods will fall directly into the preservative.

6. The collecting jar is interchangeable and lightweight. Numerous full jars can be carried in a backpack.

7. Handling or servicing time is *ca.* 1 minute per trap.

There is no truly accurate method for sampling wandering spiders. Quadrat sampling and pitfall trapping, the principal methods used to study this guild, both fall short of providing a reliable estimate of density. Because of the cursorial habits of this group, and the likelihood of temporal stratification of species, a continuous sampling method is desirable, and pitfall trapping is indicated. Comparison of the methods has shown pitfall trapping to provide a closer estimate of the number of species in a community. Reports in the literature suggest that limiting this method to cursorial forms may eliminate, to some degree, the effect of differences in activity among species on relative abundance estimates. In this paper, we have pointed out ways of reducing error in pitfall trap catches and have enumerated conditions under which results may be used. On the basis of our findings and those in the literature, we would suggest that pitfall trapping *can* be used, with caution, in ecological studies.
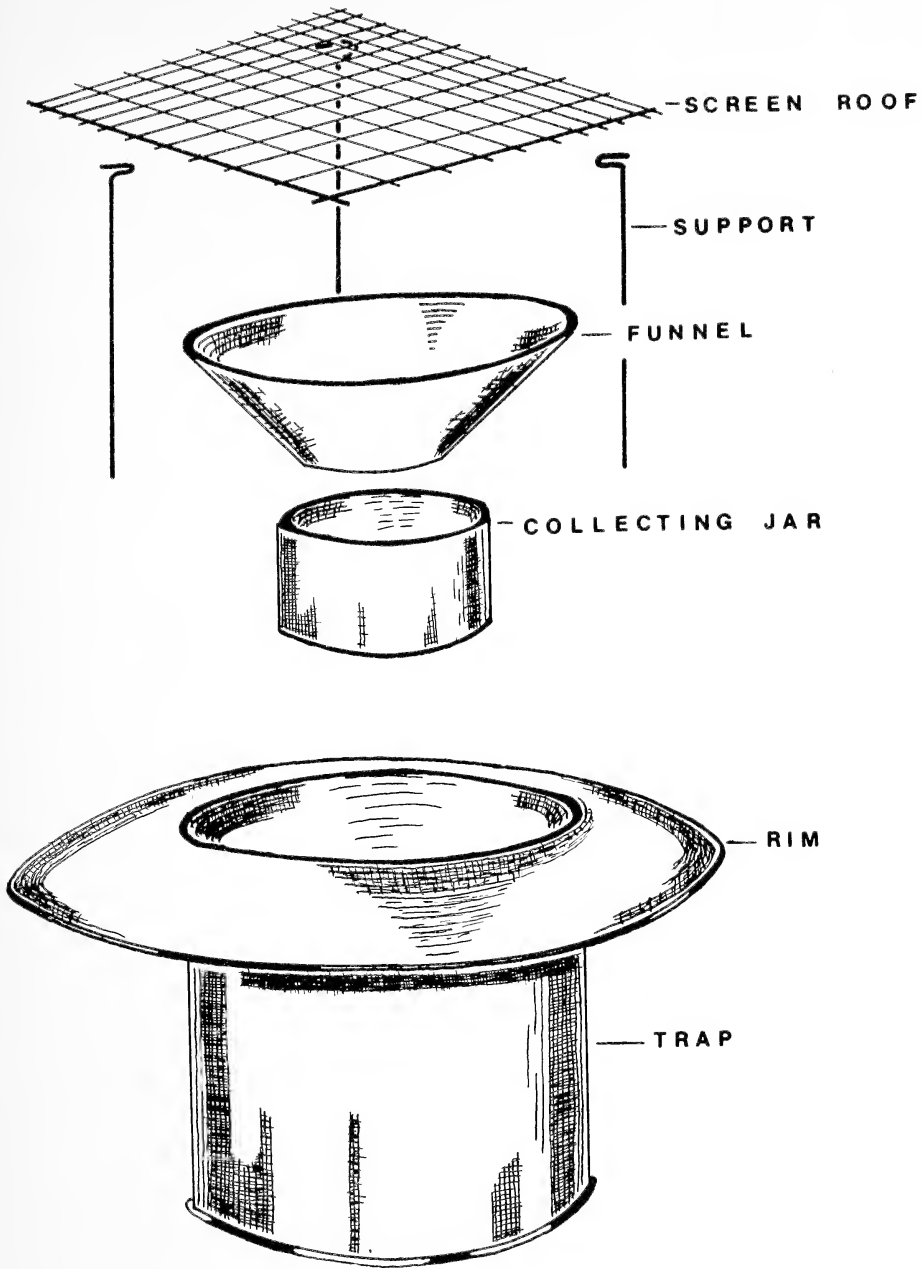
ACKNOWLEDGMENTS

Fig. 4.–Design for an improved pitfall trap (see text for details).

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THE TAXONOMY OF THE GENUS *HADRURUS* BASED ON CHELA TRICHOBOTHRIA (SCORPIONIDA: VEJOVIDAE)

Michael E. Soleglad

1502 Dupont Drive
Lemon Grove, California 92045

ABSTRACT

Trichobothrial pattern of the chelae provides excellent separation criteria for the major species groups of the genus *Hadrurus*. Trichobothrial nomenclature of *Hadrurus* is established using Vachon's as the basis. Two species groups, the "aztecus" group and the "hirsutus" group, are proposed, where they are further divided into two subgroups each, the "aztecus" and "gertschi" subgroups, and the "hirsutus" and "arizonensis" subgroups. A new species is described from Guerrero, Mexico, *Hadrurus gertschi*, new species where it is compared to the other species of its group, *Hadrurus aztecus* Pocock.

INTRODUCTION

The purpose of this study has been to develop a scheme for differentiating the species of the genus *Hadrurus* (Thorell) using only the chela trichobothria. In preliminary studies presented by Gertsch and Soleglad (1972, p. 564, Figs. 108-112) it was suggested that certain *Hadrurus* species could be separated by internal trichobothria counts on the fixed finger and palm of the chelae. This present work, which is a continuation of that study, shows that major species groups of *Hadrurus* can be differentiated by chela trichobothrial patterns alone. This is significant since the genus *Hadrurus* has been notorious for providing the taxonomist with very few concrete morphological differences for separation criteria at the species level. In the past, heavy reliance has been placed on coloration and its patterns in distinguishing the various species. It is somewhat surprising to find significant trichobothrial pattern differences at the species level. These are not subtle positional differences but involve the presence or absence of accessory trichobothria. During the course of this study a new species, *Hadrurus gertschi*, was originally isolated by trichobothrial analysis. At that time only one female in poor condition was available. As other specimens became available characters other than trichobothria were also isolated as separation criteria.

In 1973 Vachon produced one of the world's most important single works on scorpion systematics. This excellent work presented trichobothrial analysis as a formal discipline, and established a useful and consistent nomenclature. I have at all times tried to stay within Vachon's nomenclature, and more importantly, when applying it have tried to assign correct designations to the individual trichobothrium. However, due to the unusual and complicated patterns found on the genus *Hadrurus*, it has been necessary to

introduce new terms, which hopefully do not conflict too much with Vachon's original nomenclature.

METHODS

Over 200 specimens of the genus *Hadrurus* were studied with respect to the trichobothria of the pedipalpal chelae. All known species and subspecies were studied including a new species. The sampling by species or subspecies, however, was not necessarily evenly distributed, and, in some cases, a somewhat limited number of specimens and/or localities was represented. Table 1 provides information detailing the number of each taxon studied as well as the number of localities represented and their general geographical range. With the possible exception of *H. obscurus* Williams, each species or subspecies was well represented with respect to geographical range. All *H. obscurus* specimens were from Southern California, somewhat south of its recorded range (Williams, 1970, and Hjelle, 1972); the northern most sample came from the southern portion of Joshua Tree National Monument. The other specimens sampled were from the Anza-Borrego State Park or further south, approaching the Mexican border. The basic verification of chela trichobothrial patterns for each species involved all the specimens enumerated in Table 1. This includes counts of the internal and external accessory, and ventral trichobothria. The ratios, however, were selected from a much smaller set of species and specimens, assuring that adults were used in their calculation. Table 3 provides the number of specimens used in the ratio calculations. The counts were established from

Table 1.–*Hadrurus* specimens sampled.

|	Number of Specimens Sampled	Number of Localities Represented	General Geographical Range of Samples
H. aztecus	12	2	Puebla and Oaxaca
H. gertschi	7	3	Guerrero
H. hirsutus	8	2	Baja, Sur (Cabo San Lucas)
H. concolorous	16	7	Baja, Norte and Sur (Punta Prieta to Los Aripes)
H. pinteri	8	3	Baja, Norte, and Sur (Oakies Landing to San Ignacio)
H. arizonensis	94	12	Arizona, California, Sonora, and Baja, Norte
H. a. arizonensis	58	6	Arizona, California, Sonora (to Guaymas)
H. a. pallidus	34	5	California, Sonora, and Baja, Norte
H. a. austrinus	2	1	Baja, Norte (Oakies Landing)
H. spadix	58	12	Oregon, Idaho, Utah, Arizona, Nevada, and California
H. obscurus	18	5	Southern California
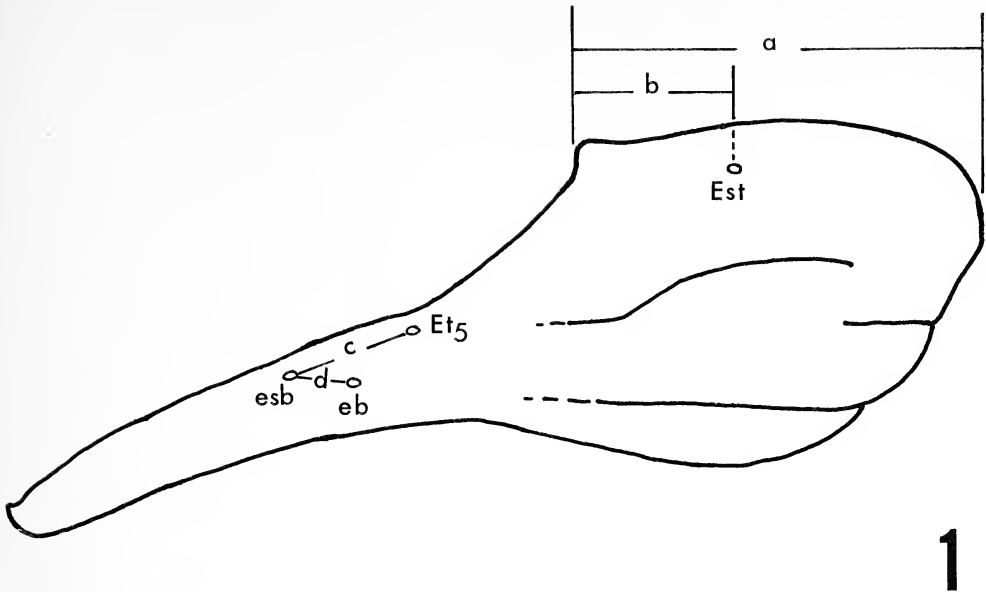
Fig. 1–External view of *Hadrurus* chela, showing methods of measurement. a, palm length; b, distance from *Est* to terminal aspect of palm; c, distance from *Et5* to *esb*; and d, distance from *eb* to *esb*.

both adult and immature specimens. In all cases where the number of specimens is listed both chelae were analyzed, thus providing two samples per specimen. In cases where obvious abnormalities were present, the chela in question was not used. The tricho-bothrial patterns represented in Figs. 2-25 are not from particular specimens but rather represent the "ideal" pattern for that species. Fig. 1 illustrates the exact method of measurement for obtaining the raw data used in the ratio calculations. The frequency polygons presented in Figs. 29-36 are based on counts versus percentage of occurrence, and therefore, one should bear in mind the unequal sample sizes that were used in their construction.

TRICHOBOTHRIA NOMENCLATURE OF *HADRURUS*

Probably the most difficult task encountered during this study was constructing a useful trichobothria nomenclature for the very unusual patterns found in *Hadrurus* species. It was important that this scheme provide the most logical system to facilitate phylogenetic studies of the genus as well as provide as little deviation from the basic nomenclature established by Vachon (1973). As it turned out all species had to be studied before a somewhat reasonable and consistent nomenclature could be established, even though some of the designations still remain somewhat arbitrary. Species with the most basic pattern, and consequently the simplest, were used to establish designations for more complicated patterns of closely related species.

Hadrurus conforms to Vachon's third pattern (designated as type C). All 26 designated trichobothria of the chela can be accounted for. The difficulty with *Hadrurus* is that numerous accessory trichobothria are present on the ventral aspect of the chela, and in many species, found on the internal and external aspects as well. The presence of internal accessory trichobothria is very unusual and *Hadrurus* species can have as many as

seven. Vachon (1973) reported only two other species that had internal accessory tricho-bothria, *Teuthraustes amazonicus* (Vachon, Fig. 186) and *Pandinus hawckeri* (Fig. 118). Vachon designated each internal accessory trichobothrium separately, but due to the larger number and variability found on *Hadrurus* I have decided to refer to them collectively as internal accessory trichobothria. Gonzalez (1972 and 1973) had designated the internal accessory trichobothria for two species of *Broteas*, but this appears to be more of a matter of interpretation and the assignment of individual nomenclature than the actual presence of a new trichobothrium. In his interpretation a ventral trichobothrium is deleted and a new one is designated as internal.

    Hadrurus species have an abundance of ventral trichobothria. Obviously some of these trichobothria are more appropriately termed accessory, but due to the great numbers that can be present it is not practical to try to isolate the four basic ventral trichobothria in order to assign individual designations. It appears likely that the internal accessory trichobothria are a derivation of the ventral accessory trichobothria, and hence represent an exaggerated development of this condition. In line with this it also seems reasonable to suspect that the external accessory trichobothria present in some *Hadrurus* species may also be a derivation of the ventral accessory condition. It is interesting to note here that the two species with the most external accessory trichobothria, *H. gertschi*, new species and *H. pinteri* Stahnke, also have the most ventral trichobothria.

    Trichobothria *Db*, *Dt*, the external basal series, *Eb1-Eb3* and *Esb*, and the dorsal series *db-dt* are easy to isolate on all eight species. On species where external accessory trichobothria were absent, *Est* was readily distinguishable, but on species where one or more external accessory trichobothria were present, the determination became somewhat arbitrary. Trichobothrium *Et5* is situated on the base of the fixed finger on all species of *Hadrurus*, an unusual position for scorpions conforming to Type C. This determination was made in part due to the determination of *Et4*, which is a little reduced in size from the other surrounding trichobothria. The reduced condition of *Et4* is common for species of the Type C pattern. The determination of *Et5* helped the designation of the external series of the fixed finger, *eb-et*. The designation of the *eb-et* series was straightforward for all species except one. *H. pinteri* has the very unusual characteristic of having an additional trichobothrim in the *eb-et* series. It is situated between trichobothria *eb* and *Et5* (Fig. 14). I have decided, however, based partly on the consistency of the *eb-et* series in the other seven species, to consider this trichobothrium as an unusual development of the external accessory trichobothria. It must be remembered that *Et5* has migrated to the fixed finger in the genus, and therefore, it isn't too unreasonable to consider trichobothrium *Ea* as a derivation of this development. The only other alternative is to designate it as a new trichobothria in the *eb-et* series, an interpretation that deviates more from Vachon's original scheme. Trichobothria *Et1* and *Et4* are readily distinguishable as are *Et2* and *Et3* for those species lacking external accessory trichobothria. In species with external accessory trichobothria, *Et2*, *Et3*, and *Est* determinations were difficult, especially *Est*. Probably the most simple approach would be to designate the external accessory as a continuous group from the median to suprabasal aspects of the palm, assigning *Et2*, *Et3*, and *Est* to the remaining more distal trichobothria. However, already we have deviated from this scheme with *H. pinteri* and, based on a comparative analysis of other related species that do not have external accessory trichobothria, it appears that the scheme does not represent true designations. Therefore, I have decided to designate external accessory trichobothria interspersed among the standard trichobothria.

Based on the positions of *ib* and *it* on *H. aztecus* Pocock and *H. gertschi*, new species the determination of these trichobothria for the other six species was straightforward. In this case the internal accessory trichobothria form a continuous group. It is interesting to note here that for those species whose internal accessory trichobothria extend well onto the palm, these trichobothria are somewhat reduced in size. In some specimens these trichobothria are reduced considerably, making determination as trichobothria quite difficult.

TAXONOMY

One of the most interesting aspects of this study was to attempt to reconstruct the relationship of the species of *Hadrurus* based entirely on the chela trichobothrial pattern. Results of this are presented in the *Hadrurus* key. I recognize two groups based entirely on the presence or absence of internal accessory trichobothria. Two species, *H. aztecus* and *H. gertschi*, new species lack internal accessory trichobothria. Due to this characteristic plus their close geographical proximity and likewise distant range from the other species, I have placed them in the "aztecus" group. However, since the two species have little in common except for the lack of internal accessory trichobothria, I have placed them in separate subgroups, the "aztecus" subgroup and the "gertschi" sub-group. The other group, which I call the "hirsutus" group, has at least two internal accessory trichobothria and sometimes as many as seven. Within this group I recognize two subgroups based entirely on the presence or absence of external accessory tricho-bothria. The first subgroup, which has one to four external accessory trichobothria, is called the "hirsutus" subgroup and contains species *H. hirsutus* (Wood), *H. concolorous* Stahnke, and *H. pinteri*. The other subgroup, called the "arizonensis" subgroup, does not have external accessory trichobothria and contains *H. arizonensis* Ewing, *H. spadix* Stahnke, and *H. obscurus* Williams.

As the key implies, I could not satisfactorily separate *H. hirsutus* from *H. concolorous* and *H. spadix* from *H. obscurus* using the trichobothrial patterns of the chelae. It appears that these two sets of species may only be subspecific, if one chooses to use only trichobothria. However, other characters must also be considered before making this conclusion.

In coming up with differentiae for the species, only the presence or absence of acces-sory trichobothria were considered to be of primary importance. Positional differences in the trichobothria were seldom relied upon, and were avoided entirely in most cases.

What must be pointed out here is that the proposed species relationship presented here is essentially the same relationship suggested by Williams (1970b, pp. 31-32) which was based on a different set of structures.

KEY TO *HADRURUS* SPECIES BASED ON
TRICHOBOTHRIAL CHARACTERS OF CHELA

1a.   Internal accessory trichobothria lacking; trichobothria *ib* and *it* situated basally (Figs. 5, 9) . . . . ("aztecus" group) 2

1b.   2-7 internal accessory trichobothria present; trichobothria *ib* and *it* situated suprabasally (Figs. 13, 17, 21, 25, 28) . . . . ("hirsutus" group) 3

2a(1a).   External accessory trichobothria lacking on palm (Fig. 2); 17-19 (18) ventral
            trichobothria on palm, essentially formed in single row (except for distal 1/4)
            (Fig. 4) . . . .("aztecus" subgroup) *H. aztecus* Pocock
2b.   3-4 (4) external accessory trichobothria on palm (Fig. 6); 20-25 (21) ventral
            trichobothria on palm, forming double row on distal 3/4 (Fig. 8) . . . .
            ("gertschi" subgroup) *H. gertschi* new species

3a(1b).   1-4 external accessory trichobothria present (Figs. 10, 14, 26-27) . . . .
            . . . . ("hirsutus" subgroup) 4
3b.   External accessory trichobothria lacking (Figs. 18, 22) . . . .
            . . . . ("arizonensis" subgroup) 5

4a(3a).   1-2 (1) external accessory trichobothria on palm, none on the fixed finger
            (Figs. 10, 26); 3-5 (4) internal accessory trichobothria present (Fig. 13);
            15-20 (16-18) ventral trichobothria on palm, essentially formed in a single
            row (Fig. 12) . . . . *H. hirsutus* (Wood)/*H. concolorous* Stahnke
4b.   3-4 (3) external accessory trichobothria with one situated on external aspect
            of fixed finger (Figs. 14, 27); 5-6 (6) internal accessory trichobothria present
            (Fig. 17); 22-27 (25) ventral trichobothria on palm, forming a doubled row
            on distal 1/3 (Fig. 16) . . . . *H. pinteri* Stahnke

5a(3b).   4-7 (5-6) internal accessory trichobothria present (Fig. 21); 16-22 (19-20)
            ventral trichobothria on palm (Fig. 20); trichobothrium *Est* situated medially
            (Fig. 18) . . . .*H. arizonensis* Ewing
5b.   2-4 (2-3) internal accessory trichobothria present (Figs. 25, 28); 13-17 (15)
            ventral trichobothria on palm (Fig. 24); trichobothrium *Est* situated sub-
            terminally (Fig. 22) . . . .*H. spadix* Stahnke/*H. obscurus* Williams

Hadrurus aztecus Pocock, 1902
(Figs. 2-5,38-39, and 41)

The chela trichobothrial pattern of *H. aztecus* is the most basic of all species, having
accessory trichobothria only on the ventral aspect. Indicative of this species and also of
the other member of its group, *H. gertschi*, new species is the absence of internal acces-
sory trichobothria. Also somewhat noticeable are the proximally situated trichobothria *ib*
and *it*. On the six species of the "hirsutus" group these trichobothria are situated supra-
basally.

Hadrurus gertschi new species
(Figs. 6-9, 37, and 40)

The absence of the internal accessory trichobothria on this species implies that *H.
aztecus* is its closest relative, but the similarity disappears at this point. *H. gertschi*, new

Figs. 2-5.–*Hadrurus aztecus*, trichobothrial pattern of chela: 2, External view; 3, Dorsal view;
4, Ventral view; 5, Internal view. E and e, external; D and d, dorsal; V, ventral; i, internal; b, basal; t,
terminal; sb, st, suprabasal and subterminal; and a, accessory.
Figs. 6-9.–*Hadrurus gertschi*, trichobothrial pattern of chela: 6, External view; 7, Dorsal view; 8,
Ventral view; 9, Internal view. See Figs. 2-5 for definition of terms.
Figs. 10-13.–*Hadrurus hirsutus/H. concolorous*, trichobothrial pattern of chela: 10, External view;
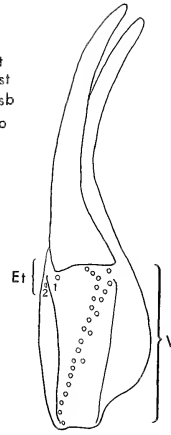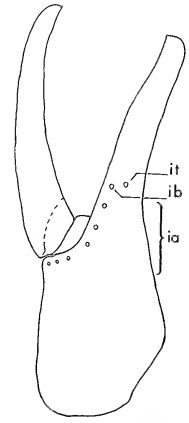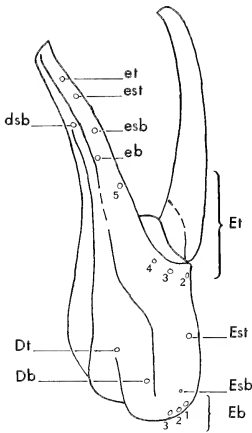11, Dorsal view; 12, Ventral view; 13, Internal view. See Figs. 2-5 for definiton of terms.
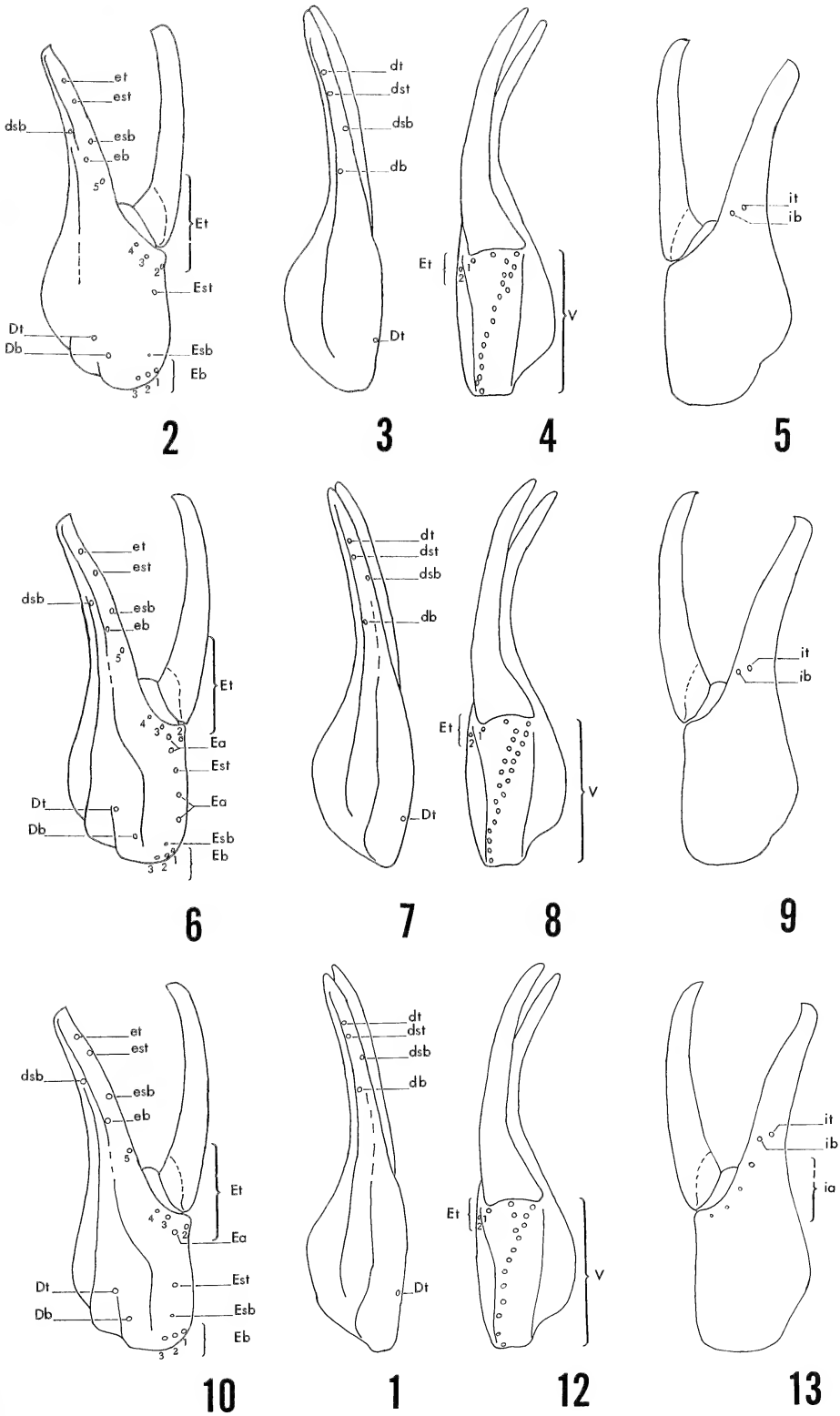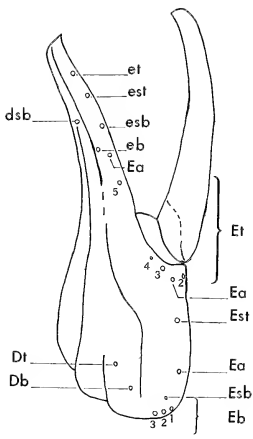
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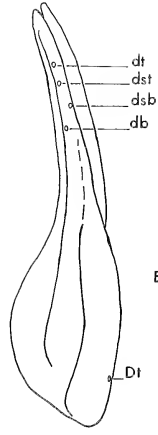
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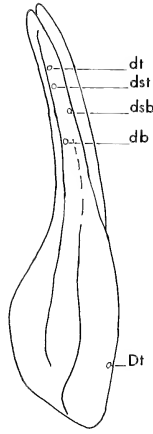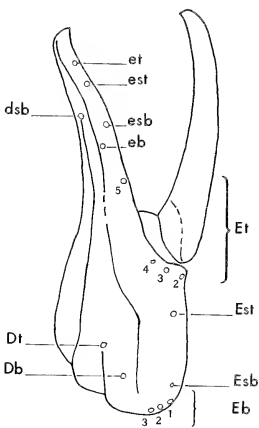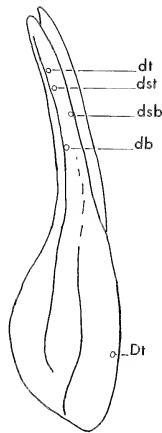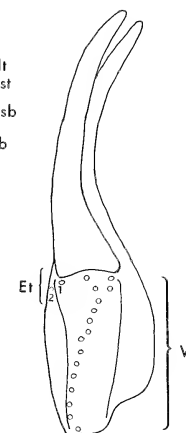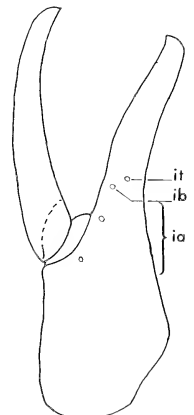
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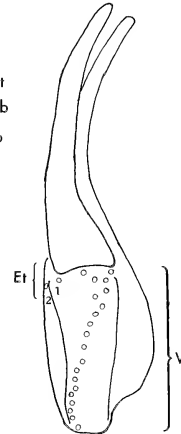
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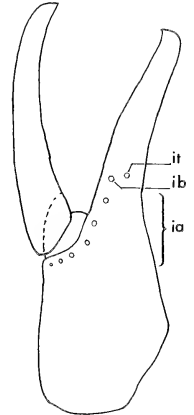
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species usually has three more ventral trichobothria than *H. aztecus* where they are formed in a doubled row for approximately half of its length. This species has more external accessory trichobothria than any of the other species with four as predominant. These trichobothria are limited to the palm where they are interspersed with the other external trichobothria. Trichobothrium *Est* was determined by using *H. aztecus* as a source of comparison.

Hadrurus hirsutus (Wood), 1863
(Figs. 10-13, and 26)

This species has a somewhat complex pattern where accessory trichobothria are present on both the internal and external aspects. It almost always has four internal accessory and usually one external accessory trichobothrium (rarely two, Fig. 26). The ventral trichobothria are somewhat small in number with only *H. spadix* and *H. obscurus* generally having less. The determination of *Est* is somewhat arbitrary.

Hadrurus concolorous Stahnke, 1969
(Figs. 10-13, and 26)

The pattern of this species is essentially identical to that of *H. hirsutus*. Probably the only difference is that this species is usually found with two more ventral trichobothria. However this difference isn't that more significant than that which separates *H. arizonensis arizonensis* and *H. a. pallidus*. The relationship of *H. concolorous* and *H. hirsutus* is quite interesting. Southern populations of this species has coloration approximating that of *H. hirsutus*. Probably the key differences between the two is the aculear glands found on the mature males of *H. concolorous* and pectinal tooth counts. Trichobothrial patterns would seem to imply that *H. concolorous* is only subspecific to *H. hirsutus*.

Hadrurus pinteri Stahnke, 1969
(Figs. 14-17, and 27)

This species definitely has the most complex trichobothrial pattern, with multiple accessory trichobothria present on the internal and external aspects. Most specimens examined had six internal accessory trichobothria, a count only exceeded by *H. arizonensis pallidus* which occasionally reaches seven. *H. pinteri* also has the most ventral trichobothria with a range and mean of 22-27 (24.64). These trichobothria, as in *H. gertschi*, new species are formed in a rough doubled row for approximately the distal third. The most unusual feature of this species pattern is the occurrence of an extra trichobothrium on the fixed finger, situated between *eb* and *Et5*. This trichobothrium has been designated as external accessory based on reasons given earlier in this paper. On the external aspect of the palm are found usually two accessory trichobothria, but three are not unusual (see Fig. 27).

Hadrurus arizonensis Ewing, 1928
(Figs. 18-21)

Species of this subgroup approach the simple pattern exhibited by *H. aztecus*. This

Figs. 14-17.—*Hadrurus pinteri*, trichobothrial pattern of chela: 14, External view; 15, Dorsal view; 16, Ventral view; 17, Internal view. See Figs. 2-5 for definition of terms.

Figs. 18-21.—*Hadrurus arizonensis*, trichobothrial pattern of chela: 18, External view; 19, Dorsal view; 20, Ventral view; 21, Internal view. See Figs. 2-5 for definition of terms.

Figs. 22-25.—*Hadrurus spadix/H. obscurus*, trichobothrial pattern of chela: 22, External view; 23, Dorsal view; 24, Ventral view; 25, Internal view. See Figs. 2-5 for definition of terms.

species, however, has numerous internal accessory with a range and mean of 4-7 (5.54). It is interesting to note that variations in this count were detectable between subspecies, where *H. a. pallidus* had a tendency to have one more trichobothrium than *H. a. arizonensis*. Furthermore, examples from the southern range of *H. a. arizonensis* (Guaymas, Sonora) did not exceed five (based on eight specimens). *H. a. austrinus* appeared to have only four, but due to the limited samples available one cannot infer too much from this. There seems to be a tendency of the southern examples of this species to have less internal accessory and ventral trichobothria. External accessory trichobothria are not found on this species. Trichobothrium *Est* is situated medially but individual specimens were somewhat variable in this character (see Table 3).

<div align="center">

Hadrurus spadix Stahnke, 1940

(Figs. 22-25)
</div>

This species has a very simple pattern, having the smallest overall number of trichobothria on the chelae. *H. spadix*, along with *H. obscurus*, has the fewest number of ventral trichobothria, with a range and mean of 13-17 (15.04). This species also has the fewest internal accessory trichobothria, usually found with two and occasionally three. Trichobothrium *Est* is usually situated a little forward of the middle of the palm but significant variability is present (Table 3).

<div align="center">

Hadrurus obscurus Williams, 1970

(Figs. 22-25, and 28)
</div>

H. obscurus patterns are essentially identical to that of *H. spadix*. The major difference encountered within the samples was the occurrence of an additional internal accessory trichobothrium (Fig. 28). The number of ventral trichobothria were also essentially identical to that of *H. spadix*. In addition the placement of *Est*, though quite variable as with the other species, was also a little in front of the middle, providing the same ratio as that found in *H. spadix*. It was noticed early in the course of this study that *esb* and *eb* were relatively closer with respect to *Et5* on *H. obscurus* than on the other species. Therefore, the second ratio in Table 3 was included. Trichobothrial patterns certainly seem to imply that *H. obscurus* is only subspecific to *H. spadix*, not exhibiting any significant differences that are not also found in the subspecies of *H. arizonensis*. It is best, however, to wait for more extensive collecting in the Mohave Desert before making a definite decision. One would suspect that color intergrades will be found.

<div align="center">

Hadrurus gertschi, new species

(Figs. 6-9, 37, 40)
</div>

Hadrurus aztecus Hoffmann, 1931, pp. 340-346 (part). Stahnke, 1945, pp. 8-9 (part), Stahnke, 1969, p. 59 (part). Williams, 1970, pp. 9-11 (part). Stahnke, 1971, pp. 121-131 (part).

Diagnosis—Large dark species, distinguished by following characters: Tergites and carapace dark-brown, cauda and pedipalps orange. Interocular area of carapace slightly lighter than posterior aspects but not in contrasting manner. Inferior keels of cauda outlined with heavy dark-red lines. Interocular area of carapace smooth and polished on female; with slight granulation on male. Dorsal aspects of cauda with very little setation. Aculear glands absent on mature males. Pectinal tooth counts, 31-33 male, 26-29 female. Trichobothrial pattern with distinguishing features as follows: Internal accessory trichobothria of chelae absent, internal aspect found only with *ib* and *it* which are
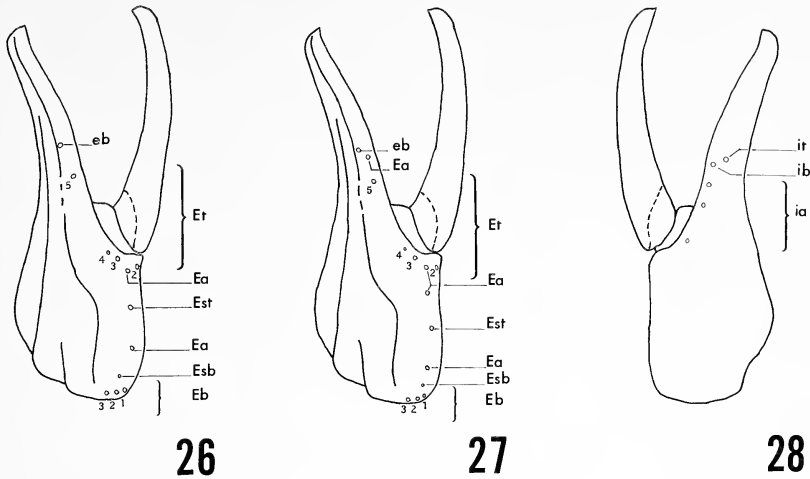
26   **27**   **28**

Fig. 26.–*Hadrurus hirsutus/H. concolorous*, partial trichobothrial pattern of chela showing two external accessory trichobothria.

Fig. 27.–*Hadrurus pinteri*, partial trichobothrial pattern of chela showing four external accessory trichobothria.

Fig. 28.–*Hadrurus obscurus*, trichobothrial pattern of internal view of chela, which compares with Fig. 25.

proximally situated; 3-4 (4) external accessory trichobothria on chelal palm; 20-25 (21) ventral trichobothria on palm, forming doubled row on distal one-half to three-quarters. Closest relative *H. aztecus* Pocock, based on absence of internal accessory trichobothria on chelae, absence of heavy setation on dorsal aspect of cauda, and close geographical proximity. Table 4 provides differentiating characters.

Etymology–This species is dedicated to the eminent arachnologist Willis J. Gertsch, Curator Emeritus, American Museum of Natural History, whose contributions to scorpion systematics have given inspiration to many others.

Holotype–Male (Fig. 37). Coloration: Tergites and carapace dark brown; cauda and pedipalps dark orange, walking legs yellow. Interocular area of carapace slightly lighter than remaining area, but not in contrasting manner. Carinae of pedipalpal femur, tibia, and inner, inner accessory, outer, and inner ventral carinae of chelal palm outlined with dark-red pigmentation. Chelal fingers same color as palm. Keels of cauda outlined with light to dark-red lines, heaviest on inferior keels which are solid (with exception of unpigmented inferior median keels of segment I). Ventral face of fifth caudal segment with dark-brown pattern, essentially solid on posterior aspect, becoming somewhat mottled on anterior half. Granules of ventral aspect of telson vesicle light brown. Aculeus dark-brown to black.

Structure–Measurements of holotype male and allotype female given in Table 5.

Carapace. Anterior edge conspicuously convexed, typical of genus. Approximately 24 setae on or near anterior edge. Interocular area essentially smooth except for slight traces of polished granulation; posterior aspects with dense granulation. Median tubercle situated at middle; approximately one-fifth width of carapace at that point.

Preabdomen. Tergites generally glossy with sharp granules on posterior lateral aspects. Keels of tergite VII essentially obliterated by heavy granulation. Sternites smooth with long slit-like stigmata. One pair of weak, smooth keels on last sternite.
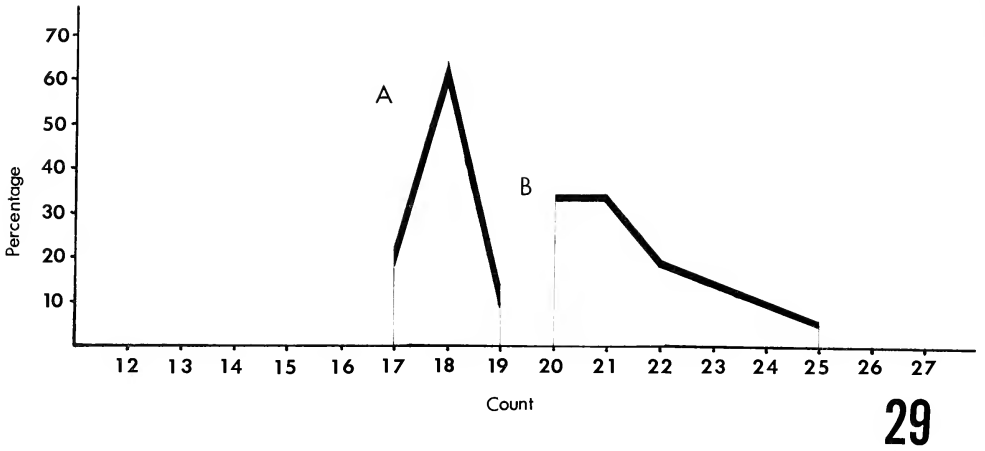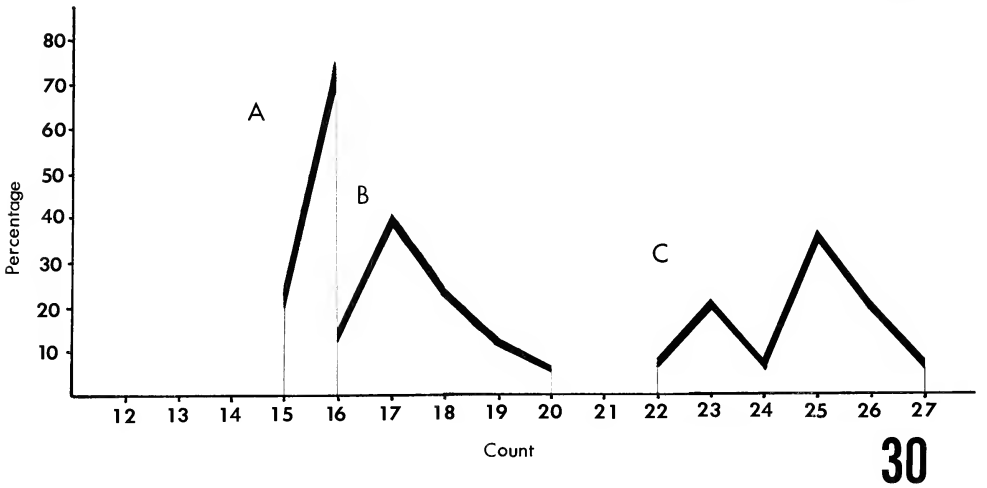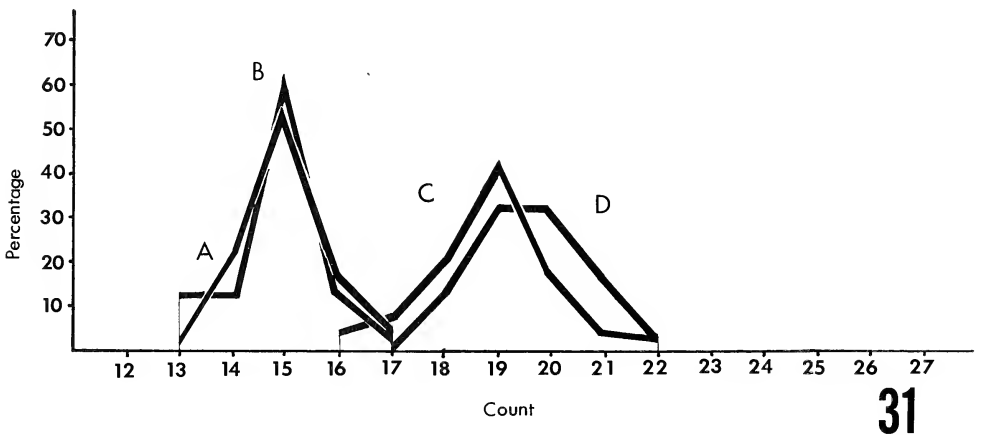
Figs. 29-31.—Frequency polygons of ventral trichobothrium counts: 29, A, *Hadrurus aztecus*; and
B, *H. gertschi*; 30, A, *H. hirsutus*; B, *H. concolorous*; and C, *H. pinteri*; 31, A, *H. spadix*; B, *H. obscurus*; C, *H. arizonensis arizonensis*; and D, *H. a. pallidus*.

Table 2.–Trichobothria count statistics of chela.

	Internal Accessory, Range (Mean) (Standard Deviation)	External Accessory., Range (Mean) (Standard Deviation)	Ventral, Range (Mean) (Standard Deviation)
H. aztecus	0	0	17-19(17.91) (±0.60)
H. gertschi	0	3-4(3.64) (±0.48)	20-25(21.14) (±1.30)
H. hirsutus	4-5(4.06) (±0.24)	1-2(1.06) (±0.24)	15-16(15.75) (±0.43)
H. concolorous	3-5(4.09) (±0.52)	1-2(1.09) (±0.29)	16-20(17.53) (±1.09)
H. hirsutus/ H. concolorous	3-5(4.08) (±0.45)	1-2(1.08) (±0.28)	15-20(16.94) (±1.25)
H. pinteri	5-6(5.69) (±0.46)	3-4(3.43) (±0.49)	22-27(24.64) (±1.39)
H. arizonensis	4-7(5.54) (±0.60)	0	16-22(19.12) (±1.18)
H. a. arizonensis (all populations)	4-6(5.44) (±0.56)	0	16-22(18.88) (±1.19)
H. a. arizonensis (Guaymas population)	4-5(4.88) (±0.33)	0	16-19(17.63) (±0.93)
H. a. arizonensis (other populations)	4-6(5.54) (±0.54)	0	16-22(19.08) (±1.10)
H. a. pallidus	5-7(5.78) (±0.51)	0	17-22(19.59) (±1.05)
H. a. austrinus	4-5(4.25)	0	18-19(18.67)
H. spadix	2-3(2.17) (±0.38)	0	13-17(15.04) (±0.78)
H. obscurus	2-4(2.94) (±0.33)	0	13-17(14.89) (±0.90)
H. spadix/ H. obscurus	2-4(2.35) (±0.49)	0	13-17(15.01) (±0.81)

Cauda. Segments I-IV: First caudal segment wider than long. Dorsal and dorsal lateral keels crenulate. Lateral keel complete and crenulate on segment I, complete and crenulate on posterior half of II, crenulate on posterior third of III, and unevenly granulate on posterior half of IV. Inferior lateral and median keels smooth. Intercarinal spaces granulate on dorsal aspect. Inferior median keels equipped with 3-4-4-4 pairs of setae, but lacking setae between these keels. Dorsal aspects of segments with little setation. Segment V: Dorsal keels crenulate; lateral keels serrate on anterior third. Inferior lateral and median keels highly serrate. Weak rounded granules on lateral and dorsal aspects of segment; serrate granules on venter. Anal keel serrate with 14 granules.

Telson. Typical of genus with bulbous vesicle and highly curved aculeus. Conspicuous granules on base of ventral aspect of vesicle with rounded granules on remainder of ventral face and lateral areas. Ventral aspect of vesicle and base of aculeus densely covered with long setae. Mature holotype male not equipped with aculear glands.

Pectines. Structured as typical *Hadrurus*. Pectinal tooth count 31/31; approximately 14 irregular middle lamellae. Two to three short red setae on each fulcrum; numerous setae on middle and anterior lamellae as well as on most distal tooth. Basal piece split on anterior half; length to width ratio 2/3.

Genital Operculum. Essentially separated on entirety; each sclerite equipped with four to five short red setae on posterior half. Genital papillae not present.

Chelicerae. Typical dentition of genus with large robust denticle on proximal half of ventral edge of movable finger; other dentition standard for family. Serrulae lacking on distal aspect of movable finger ventral edge.

Pedipalps. Large appendages, with conspicuously long setae on internal faces of femur and tibia. Femoral carinae crenulate to serrate except for rounded ventral external carina. Dorsal, internal, and external faces smooth, ventral face with line of granules on
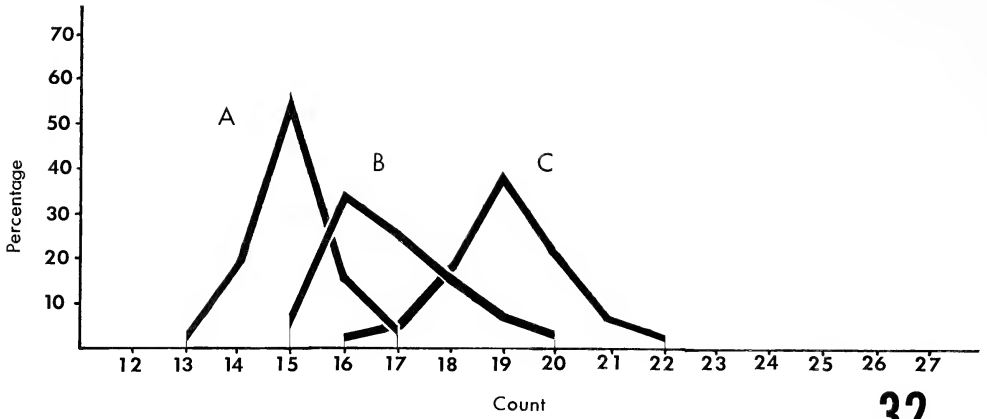
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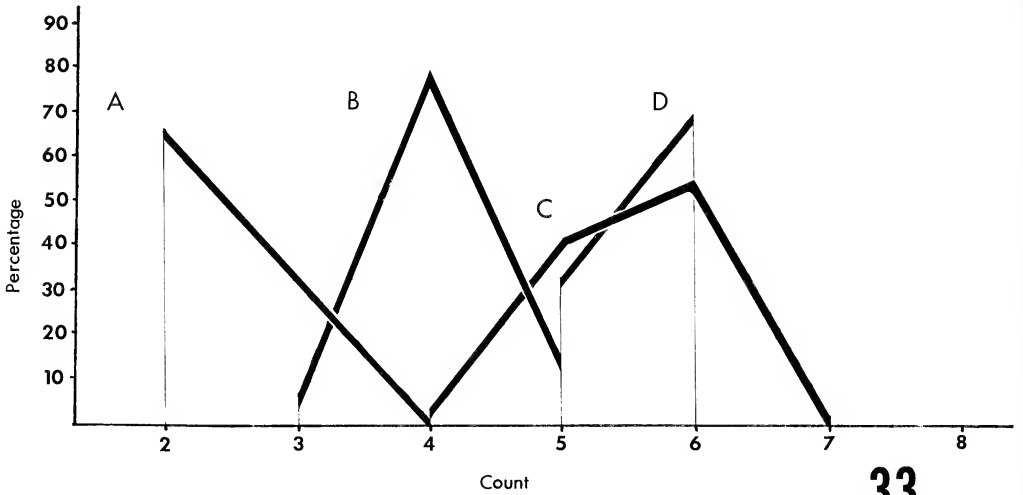
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34

Table 3.–Trichobothria ratio statistics of chela (see Fig. 1).

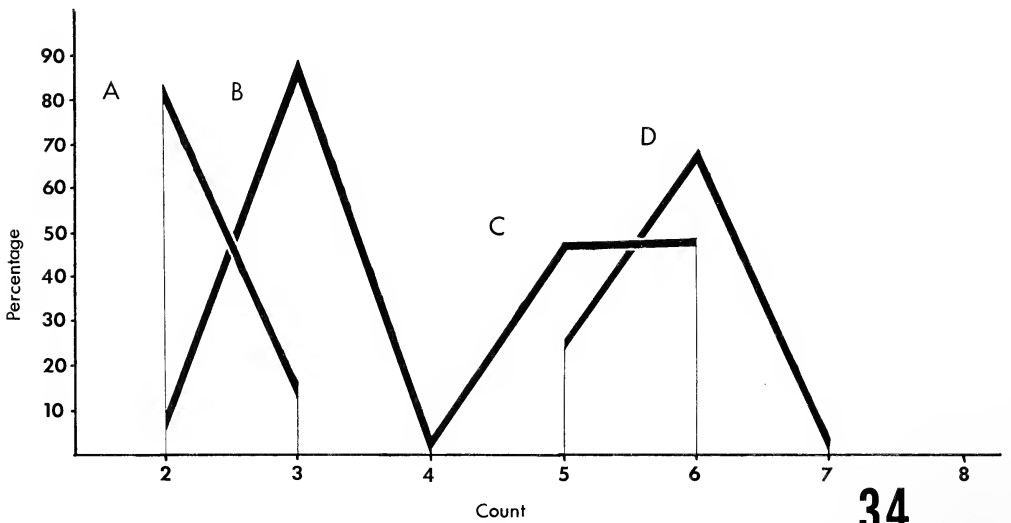|	b (distance from *Est* to terminal aspect of palm) / a (palm length), Range (Mean) (Standard Deviation)	d (distance from *eb* to *esb*) / c (distance from *Et5* to *esb*), Range (Mean) (Standard Deviation)	Number of Specimens Sampled
H. arizonensis	0.388-0.563(0.485) (±0.041)	0.274-0.583(0.401) (±0.056)	49
H. a. arizonensis	0.394-0.559(0.496) (±0.036)	0.300-0.500(0.412) (±0.047)	25
H. a. pallidus	0.388-0.562(0.470) (±0.041)	0.274-0.583(0.383) (±0.059)	23
H. a. austrinus	0.543-0.563(0.553)	0.485-0.515(0.500)	1
H. spadix	0.321-0.578(0.409) (±0.053)	0.290-0.515(0.417) (±0.048)	21
H. obscurus	0.343-0.456(0.401) (±0.032)	0.197-0.444(0.336) (±0.060)	10
H. spadix/*H. obscurus*	0.321-0.578(0.406) (±0.048)	0.197-0.515(0.391) (±0.064)	31

proximal aspect. Dorsal internal carina of tibia crenulate; dorsal external smooth; ventral internal with widely separated serrate granules; ventral external rough to smooth. Ventral, internal, and external faces smooth; dorsal face with scattered granulation. Chelae with seven carinae structured as follows (Fig. 40): Outer carina doubled and granulate; inner ventral rough to smooth; superior very rounded, almost obsolete; inner and inner accessory strongly developed, granulate on proximal aspects; inner secondary and inferior very round, almost obsolete. Both movable and fixed fingers equipped with nine short nonoverlapping rows of principal denticles. Nine and eight supernumerary denticles present on movable and fixed fingers respectively. Trichobothrial pattern of chelae follows form illustrated in Figs. 6-9. Male holotype chelae with 47 trichobothria, comprised of 26 standard trichobothria, four external accessory trichobothria, and 17 accessory ventral trichobothria. Trichobothria *ib* and *it* proximally situated. Tibia with 74/70 (left/right) trichobothria; 28/24 ventral, 43 external, two dorsal, and one internal. Femur with standard three trichobothria.

Walking Legs. Tarsomere II densely equipped with long setae; ventral edge with single row of stout spines. Pedal spurs with spineletts.

Allotype–Female. Larger than male in overall size. Interocular area of carapace completely smooth, lacking subtle granulation of holotype. Tergites with less granulation on posterior aspects; heavier granulation on vesicle of telson. Genital operculum essentially separated on entirety, as in holotype. Pectines smaller, with 27 teeth and 15/14 middle lamellae.

Paratype Variation–Little or no significant variation detected in five paratypes. Coloration of subadult male from Azcala, Guerrero more mottled than holotype on ventral aspect of fifth caudal segment. Pectinal tooth counts for seven specimens as follows: 31-33, male; 26-29, female, based on two and five specimens respecitvely.

Type Data–Male holotype and female allotype from Azcala, Guerrero, Mexico, 21 June 1969 (Hector Perez R.). Holotype and allotype permanently deposited in California Academy of Sciences, where they have been assigned type number 12186.

Fig. 32.–Frequency polygon of ventral trichobothrium counts. A, *Hadrurus spadix*/*H. obscurus*; B, *H. hirsutus*/*H. concolorous*; and C, *H. arizonensis*.

Figs. 33-34.–Frequency polygons of internal accessory trichobothrium counts: 33, A, *Hadrurus spadix*/*H. obscurus*; B, *H. hirsutus*/*H. concolorous*; C, *H. arizonensis*; and D, *H. pinteri*; 34, A, *H. spadix*; B, *H. obscurus*; C, *H. arizonensis arizonensis*; and D, *H. a. pallidus*.
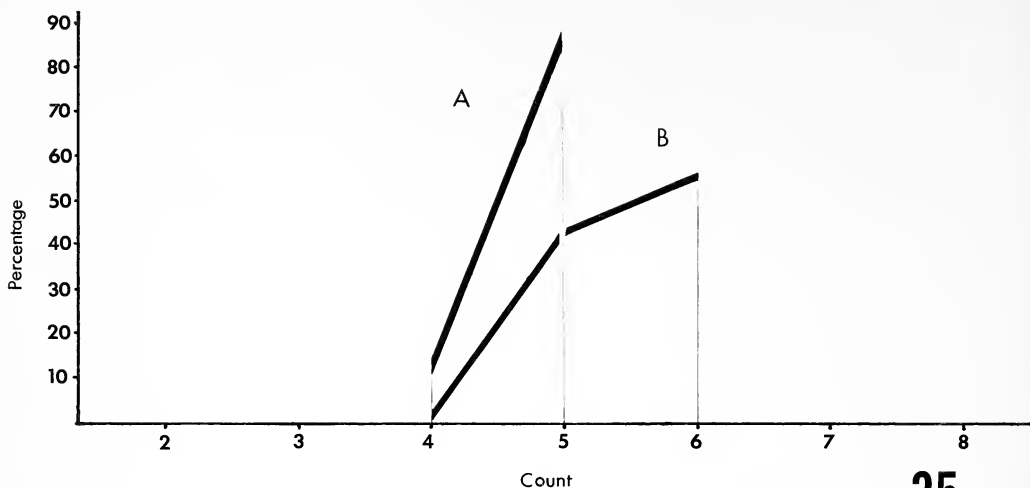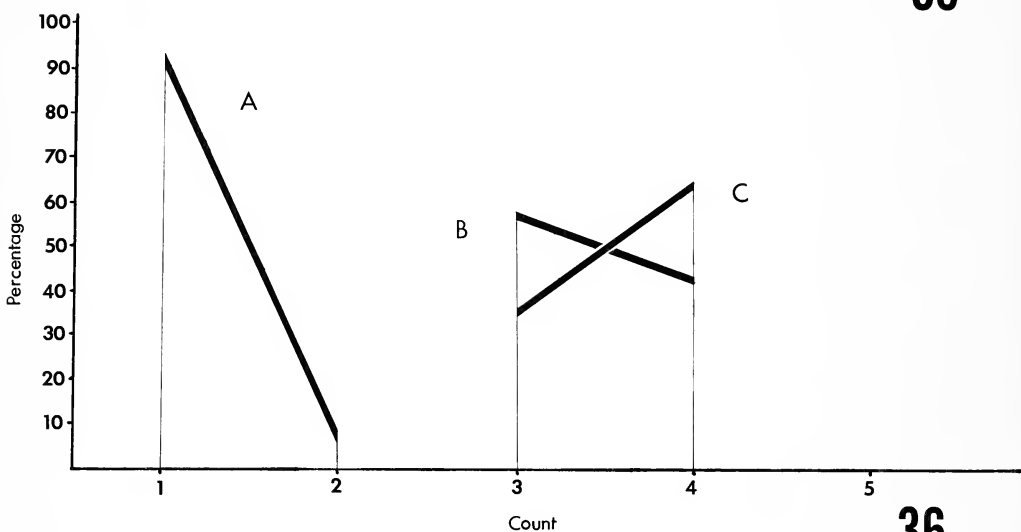
Fig. 35.–Frequency polygon of internal accessory trichobothrium counts. A, *Hadrurus arizonensis arizonensis*, Guaymas population; B, *H. a. arizonensis*, other populations.

Fig. 36.–Frequency polygon of external accessory trichobothrium counts: A, *Hadrurus hirsutus/H. concolorous*; B, *H. pinteri*; and C, *H. gertschi*.

Distribution—All known specimens from state of Guerrero.

Records—Guerrero, Mexico: Azcala, 21 June 1969 (Hector Perez R.), 2 adult females, 1 subadult female, 1 adult male, and 1 subadult male; Iguala, date and collector unknown (from "Hoffmann Collection" in American Museum of Natural History), 1 adult female; Chilpancingo, date and collector unknown (from "Hoffmann Collection" in American Museum of Natural History), 1 adult female.

**Comments**—All specimens of *H. gertschi* that I have had the opportunity to examine have come from the State of Guerrero. One of the females from the AMNH collection was labelled "Hoffmann Collection" but after close comparisons of the measurements and pectinal tooth counts in Hoffmann (1931), I suspect this specimen is the one from Chilpancingo, Guerrero (Hoffmann, p. 343), and therefore have taken the liberty in

Table 4.–Characteristics of *Hadrurus aztecus* Pocock and *H. gertschi*, new species.
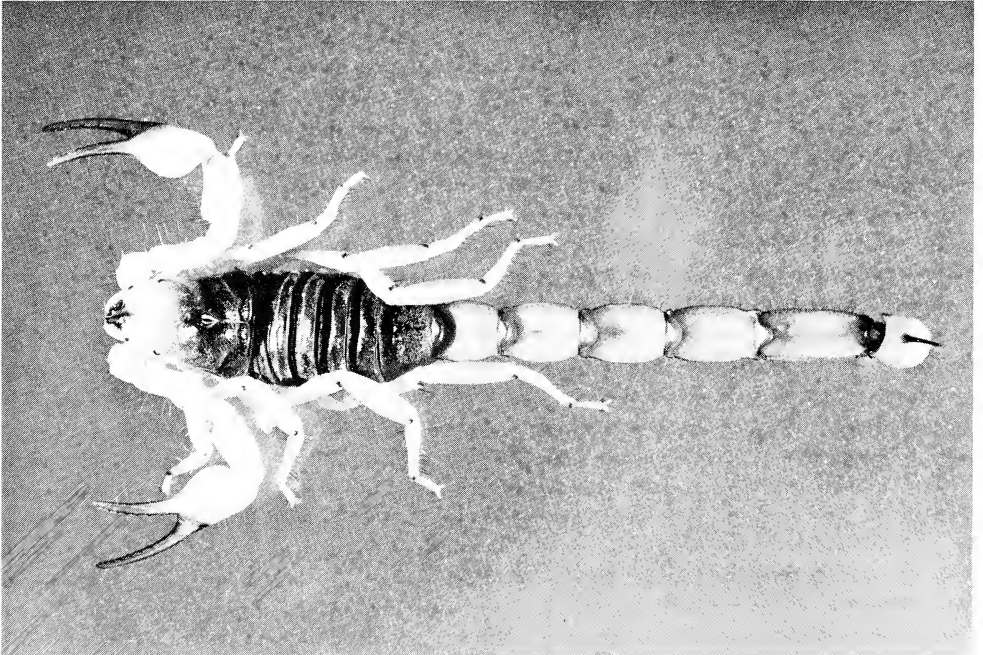
	H. aztecus	*H. gertschi*
Coloration of carapace	Dark brown; interocular area light-yellow in definite contrast (Fig. 38)	Dark brown on entirety; interocular area slightly lighter but not in contrast (Fig. 37)
Coloration of chelae	Yellow with light to medium-red fingers (Fig. 39)	Orange, fingers same color as palm (Fig. 40)
Coloration of inferior keels of cauda	Outlined faintly with uneven light-red lines, some discontinuous	Outlined with heavy continuous dark-red lines
Acular glands of mature male	Conspicuously present (Fig. 41)	Absent
Interocular area of carapace	Covered with large round granules on both male and female	Slight traces of granulation on male; smooth on female
Shape of dorsal aspect of chelal palm	Conspicuously arched, raised considerably above proximal aspect of fixed finger (Fig. 39)	Arched gradually, not raised conspicuously above proximal aspect of fixed finger (Fig. 40)
Inner accessory carina of chelae	Same color as palm, rounded and smooth, with slight granulation on proximal aspect	Red, well developed, granulated on proximal aspect
Number of ventral trichobothria on chelal palm	16-19 (18)	20-25 (21)
Number of external accessory trichobothria on chelal palm	Absent (Fig. 2)	3-4 (4) (Fig. 6)

labelling it as such in Table 5 as well as in the record data. The other two examples from the AMNH turned out to be the actual specimens used by Hoffmann in his Figs. 20-21, a male *H. aztecus* and a large female *H. gertschi*. As of now all specimens of *H. aztecus* so far examined have come from either Puebla or Oaxaca. Obviously, this is not sufficient data to make any definite conclusions as to the geographical ranges of the two species.

Pocock's *H. aztecus* has caused considerable confusion for many years. It was redescribed by Stahnke (1971) from the holotype male. Hoffmann provided an excellent description of *H. aztecus* but unfortunately he had combined two species in his description. In all fairness, it should be pointed out here that Hoffmann had noticed differences between the female specimens from Guerrero and those occurring in Puebla and Oaxaca (Hoffmann, 1931, pp. 340-342, 345). I do believe that, although Hoffmann's work was usually on the conservative side, he would have separated the two species had he had sufficient material, especially with respect to more male specimens from Guerrero. Likewise Williams (1970) had only two specimens to study for his excellent revision of the genus, both being *H. gertschi*. The insufficient material combined with Hoffmann's composite description of the two species left Williams with no other alternative but to identify the specimens as *H. aztecus*. I was extremely fortunate to have collected eleven specimens of *H. aztecus* from the Tehuacan Valley of Puebla. These specimens plus the
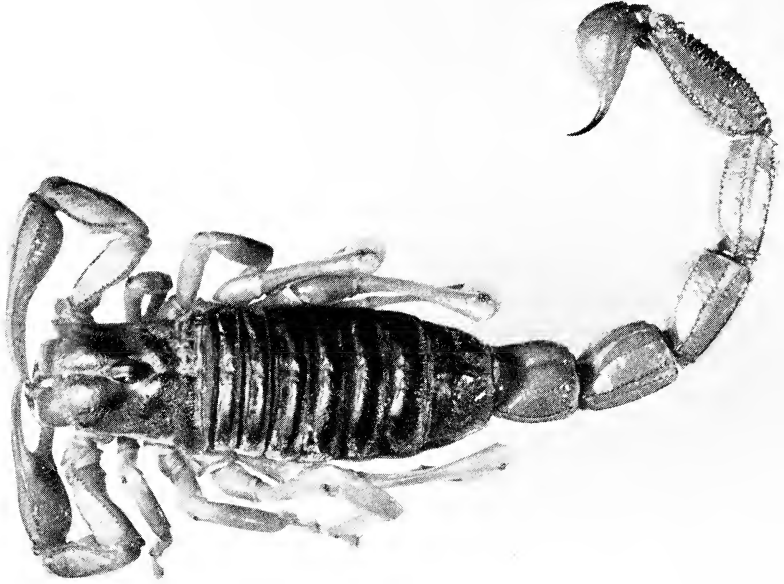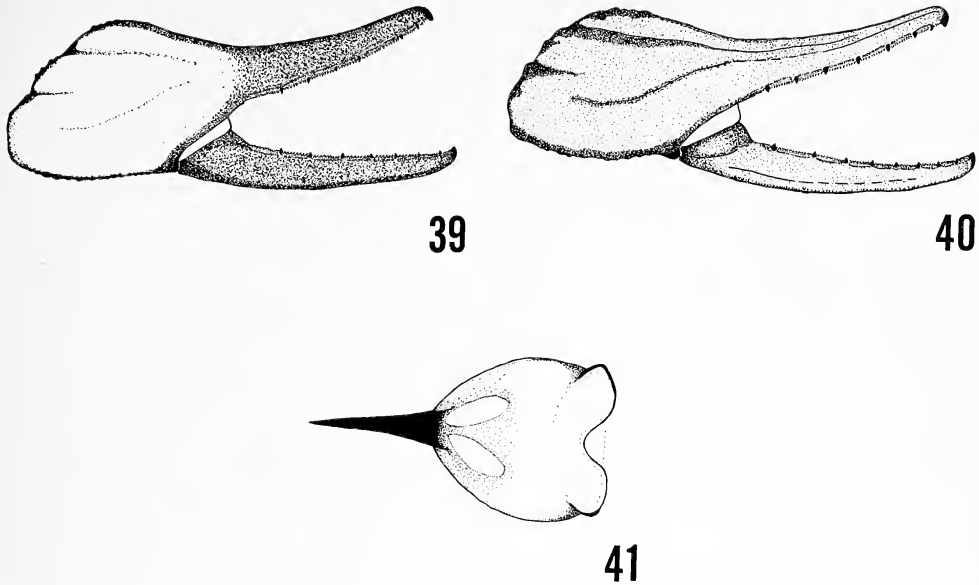
37

38

Fig. 39.–*Hadrurus aztecus*, chela of male, Tehuacan, Puebla.
Fig. 40.–*Hadrurus gertschi*, new species, chela of holotype male.
Fig. 41.–*Hadrurus aztecus*, dorsal view of telson of mature male showing aculear glands.

single male from Oaxaca provided me with a small but adequate sample to sort the two species apart. I have taken this opportunity to provide measurements of *H. aztecus* (Table 6).

I must express my admiration for Pocock's original description of *H. aztecus*. Even at that time he had noticed the unusual shape of the chelal palm compared to that of a California species (Pocock, 1902, Table 2, Figs. 1.e. and 2).

It should be noted here that the twelve examples of *H. aztecus* examined did exhibit faint red pigmentation on the inferior median keels of the cauda. Stahnke (p. 122) stated that this pigmentation is not found on the holotype male. In all probability this pigmentation has faded on the holotype due to the many years of preservation. Also, Stahnke (p. 123) reported: "Exterior surface of manus has about twenty-two trichobothria." This is mentioned here since the two species are separated, in part, by the number of ventral trichobothria present, and Stahnke's statement places the male holotype in the range of *H. gertschi*, not *H. aztecus*. Since a drawing of the actual trichobothrial pattern was not provided, one must only guess as to which trichobothria are actually included in this estimation. In more recent literature Stahnke (1973, p. 123, Fig. 5A) has included trichobothrium *Et1* in the ventral series. It is my decision, therefore, that since the data were presented as an estimate and that its method of determination is not clear, this discrepancy be ignored at this time.

Aculear glands were present on six adult male *H. aztecus* from Tehuacan, Puebla, and also on the single male from Tomellin, Oaxaca. Although little is known about the function of these glands, it is believed that they appear on sexually mature males of those species which have them. Previously Williams (1970a, 1970b) had reported them on *H.*

Fig. 37.–*Hadrurus gertschi* Soleglad, new species, holotype male, dorsal view.
Fig. 38.–*Hadrurus aztecus* Pocock, male, Tehuacan, Puebla, dorsal view.

Table 5.—Measurements in (millimeters) of *Hadrurus gertschi*, new species.

	Azcala, Guerrero, Mexico			Chilpancingo, Guerrero
	Holotype Male	Allotype Female	Paratype Male	Paratype Female
Total length	90.0	99.9	64.9	88.1
Carapace, length	13.6	15.4	10.3	13.0
Width at lateral eyes	9.5	11.2	7.6	8.8
Width at caudal edge	13.3	15.5	10.0	12.5
Preabdomen, length	25.7	33.2	22.6	34.3
Postabdomen, length	50.7	51.3	32.0	40.8
Caudal segment I				
Length	7.7	7.5	4.9	6.3
Width	8.1	8.1	5.25	6.6
Depth	6.5	6.6	4.4	5.5
Caudal segment II				
Length	8.8	8.9	5.7	7.3
Width	7.8	7.8	4.9	6.4
Depth	6.35	6.5	4.3	5.3
Caudal segment III				
Length	9.7	9.6	6.1	7.7
Width	7.6	7.7	4.9	6.3
Depth	6.1	6.4	4.3	5.1
Caudal segment IV				
Length	11.3	11.1	6.9	9.0
Width	7.4	7.6	4.8	6.2
Depth	5.7	6.0	4.1	4.7
Caudal segment V				
Length	13.2	14.2	8.4	10.5
Width	6.6	7.0	4.5	5.7
Depth	5.7	5.7	3.9	4.6
Telson, length	13.1	14.2	8.9	11.0
Vesicle				
Length	8.9	9.7	6.0	6.5
Width	6.4	7.2	4.1	5.2
Depth	5.5	6.0	3.5	4.4
Aculeus, length	4.2	4.5	2.9	4.5
Pedipalp, length	38.6	43.3	28.4	35.9
Femur				
Length	9.0	9.8	6.5	8.0
Depth	3.1	3.7	2.4	3.0
Tibia				
Length	10.7	12.0	7.7	9.9
Depth	3.9	5.2	3.3	4.0
Chela, length	18.9	21.5	14.2	18.0
Palm				
Length	7.3	8.2	5.2	6.9
Width	6.3	7.9	4.2	5.8
Depth	4.8	6.4	3.3	4.5
Fixed finger, length	9.5	11.0	7.6	9.4
Movable finger, length	12.6	14.5	9.3	11.8
Pectines				
Teeth	31/31	27/27	33/33	29/29
Middle lamellae	14/14	15/14	13/14	15/12

Table 6.—Measurements (in millimeters) of *Hadrurus aztecus* Pocock from Tehuacan, Puebla, Mexico.

	Male	Female
Total length	92.2	75.1
Carapace, length	13.6	11.3
Width at lateral eyes	9.2	8.4
Width at caudal edge	14.4	12.0
Preabdomen, length	25.0	22.9
Postabdomen, length	53.6	40.9
Caudal segment I		
Length	7.95	6.15
Width	7.8	6.0
Depth	6.1	5.05
Caudal segment II		
Length	9.35	7.1
Width	7.4	5.65
Depth	6.15	4.9
Caudal segment III		
Length	10.2	7.7
Width	7.5	5.55
Depth	5.95	4.75
Caudal segment IV		
Length	11.8	8.85
Width	7.2	5.4
Depth	5.65	4.45
Caudal segment V		
Length	14.3	11.1
Width	6.8	5.15
Depth	5.5	4.4
Telson, length	13.15	11.2
Vesicle		
Length	9.1	7.6
Width	6.7	5.15
Depth	5.8	4.7
Aculeus, length	4.05	3.6
Pedipalp, length	39.6	32.95
Femur		
Length	9.5	7.6
Depth	3.3	2.8
Tibia		
Length	11.0	9.15
Depth	4.85	3.9
Chela, length	19.1	16.2
Palm		
Length	7.5	6.4
Width	7.5	5.6
Depth	5.6	4.0
Fixed finger, length	9.6	8.0
Movable finger, length	12.7	10.5
Pectines		
Teeth	37/38	31/32
Middle lamellae	14/16	15/15

concolorous and *H. pinteri*. Stahnke reported that the holotype male of *H. aztecus* also was equipped with them. So far only two of what appear to be sexually mature males of

H. gertschi have been reported, the holotype from Azala and the male studied by Williams (a specimen which was not available for this study). Neither of these specimens had any trace of the aculear glands. It should be pointet but here that it is not clear when the glands actually appear on the male but it does seem reasonable to conclude, even based on the sparse samples available, that *H. gertschi* does not have these glands.

Also from the limited data on male specimens of *H. gertschi*, it appears that *H. aztecus* may in general have a larger pectinal tooth count with ranges and means as follows: 33-40 (36.3) for ten male specimens and 29-32 (30.75) for two female specimens. The ranges for *H. gertschi* are 31-33 (32) for two male specimens and 26-29 (27.31) for five females.

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RESEARCH NOTE

THE MALE OF *GNAPHOSA SONORA* (ARANEAE, GNAPHOSIDAE)

Through the courtesy of Dr. Willis J. Gertsch, I have recently had the opportunity to examine a collection of Gnaphosidae accumulated by him from various collectors during recent years. Included in this collection were the first known males of *Gnaphosa sonora*. These specimens, described below, will key out to *Gnaphosa salsa* in the published key (Platnick and Shadab, 1975:11), but may be easily distinguished from that species by the longer, wider, and more sinuous embolus. The format of the description and the abbreviations follow those used in Platnick and Shadab (1975).
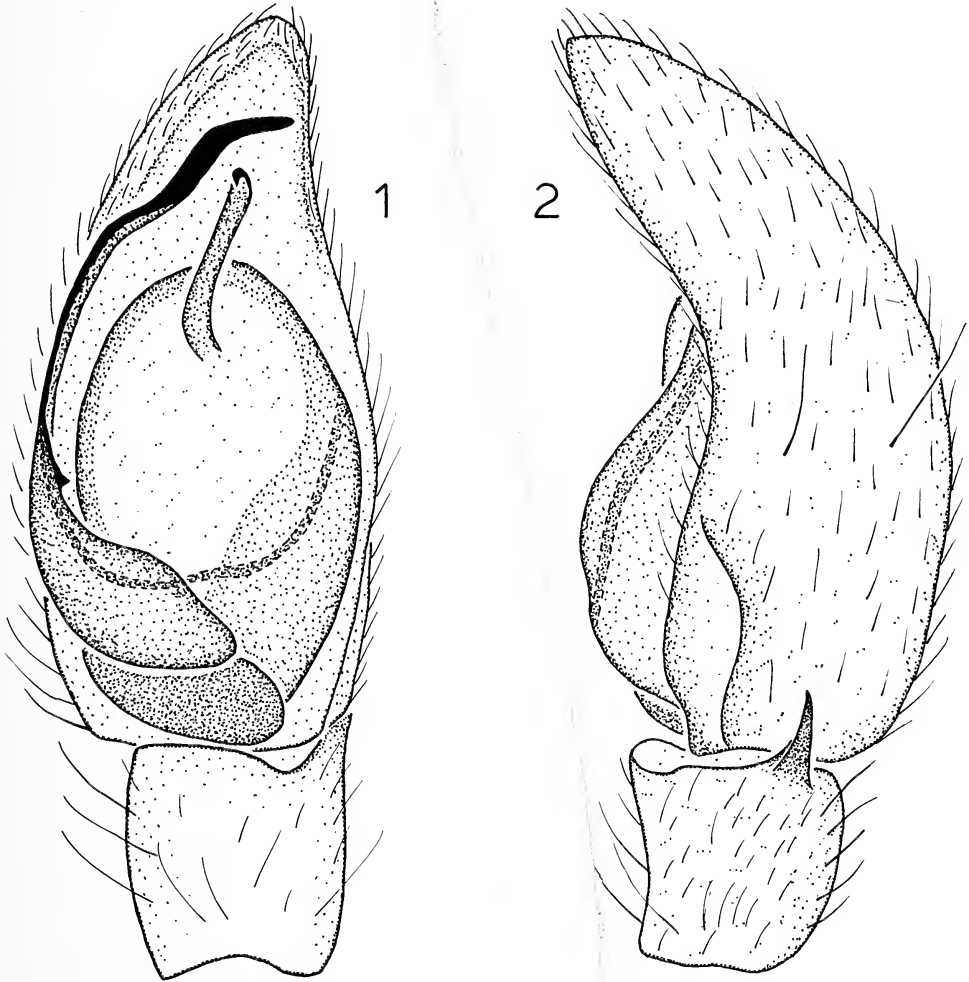
Figs. 1, 2—*Gnaphosa sonora* Platnick and Shadab, palp: 1, ventral view; 2, retrolateral view.

Gnaphosa sonora Platnick and Shadab
Figs. 1, 2
Gnaphosa sonora Platnick and Shadab, 1975:25, Figs. 42, 71, 72, map 3.

Diagnosis—Males of *Gnaphosa sonora* may be distinguished from all species of the *lucifuga* group other than *clara* and *hirsutipes* by their wide embolus and single retrolateral tibial apophysis, from *clara* by the undivided tip of the embolus, and from *hirsutipes* by the presence of only one embolar tubercl (Figs. 1, 2).

Male. Total length 5.83, 6.16 mm. Carapace 2.64, 2.92 mm long, 2.14, 2.34 mm wide. Femur II 1.87, 1.98 mm long (two specimens examined). Eye sizes and interdistances (mm): AME 0.09, ALE 0.13, PME 0.11, PLE 0.11; AME-AME 0.09, AME-ALE 0.02, PME-PME 0.08, PME-PLE 0.14, ALE-PLE 0.14. MOQ length 0.30 mm, front width 0.27 mm, back width 0.29 mm. Embolus long, wide, sinuous; erect embolar tubercle situated basally on retrolateral side of embolus directed retrolaterally (Fig. 1). Retrolateral tibial apophysis narrow, elongate, triangular, with tip slightly bent towards tarsus (Fig. 2). Leg spination: tibiae: I, II vO-0-1; III r0-1; metatarsi: I v2-0-1; II v2-0-2.

Material Examined—México: Sonora: east side, Sierra de Alamos (12 November 1972; V. Roth), 2 males, deposited in the American Museum of Natural History.

Distribution—Southern Sonora, México.

LITERATURE CITED

Platnick, N. I., and M. U. Shadab. 1975. A revision of the spider genus *Gnaphosa* (Araneae, Gnaphosidae) in America. Bull. Amer. Mus. Nat. Hist. 155(1):1-66.

Norman I. Platnick, Department of Entomology, The American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024 USA.

NOMENCLATURAL NOTE

Opinion 1038 of the International Commission of Zoological Nomenclature ruled unanimously to validate the generic name *Argiope* Audouin, 1826 and to place it in the Official List of Generic Names in Zoology. The name *Argyope* has been placed, as an incorrect spelling, on the Official Index of Rejected and Invalid Generic Names in Zoology (Bull. Zool. Nomencl., 2(2):105-109, June 1975). The case was submitted to the Office of the Secretary of the Commission in March 1967.

support). 4) By-line: Include name(s) of author(s) as customarily written (less titles) and complete address(es) including zip code or other postal zone designation. Include footnote indication(s) if appropriate (e.g., to indicate change of address). 5) Body of Text: Use whatever form seems to best accommodate the necessary description of the research. Be concise. Conform to the *CBE Style Manual* in all abbreviations. 6) Acknowledgments: Take care to give credit where it is due. 7) Literature Cited: Include only those publications to which reference is made in the text. Adhere to style in *CBE Style Manual* or refer to a previous issue of *The Journal of Arachnology*. Do not abbreviate place names. 8) Figure Legends: Do not type on facing pages but type consecutively in numerical sequence. 9) Abstract: Keep abstracts concise, not exceeding 2-3% of the text. Abstracts should contain a summary of the basic findings. Papers written in a language other than English must be accompanied by an English abstract as well as an abstract in the language of the text. 10) Footnotes: Other than appropriate page 1 footnotes, no other footnotes are permitted. 11) Running Head: Construct this shortened title so that it, along with the author(s)' last names, does not exceed 55-60 characters and spaces. 12) Tables with Legends: Prepare all tables precisely as they are to be typeset. It is essential to construct tables as simply as possible. Place legend at top of each table. Incorporate into legend all information necessary to make the data presented clearly understandable. Do *not* resort to the use of footnotes. Make marginal notations in the text which clearly indicate the appropriate point of insertion of each table. 13) Figures: Since the figures are the only part of the paper for which each author is responsible for preparing camera-ready material, they must be done with the greatest of care. Poor illustrative material will be returned forthwith to authors for further attention. Those drawings which present the least difficulties in printing are the type done with black ink on high quality, smooth, white, heavy paper. Drawings done in some manner not employing black ink (e.g., shaded pencil drawings) are difficult to print, more so than are photographs. Authors should keep this in mind. When such a technique is used, the drawings should be fairly dark, have good contrast, and be well-executed. Prepare all drawings, graphs, etc., at least twice the anticipated printed size, but do not make them so large that mailing is inconvenient nor so large that they exceed 17 in. (43 cm) in shortest dimension nor 22 in. (56 cm) in longest dimension. Furnish only originals, not photographic reproductions. The *largest* dimensions on the printed page to which illustrative material will be reduced is 5 in. (127 mm) by 8 in. (203 mm). Decisions as to size of originals, placement of several smaller drawings on a single page, etc., should be based upon this format. Where several smaller drawings are to appear on a single page, it is the responsibility of the author(s) to furnish an assembled "plate" precisely as it should appear in print. When so arranging drawings (or when preparing a single large drawing), keep in mind the problem of legend placement. When a drawing or collection of drawings occupies the entire 5 in. by 8 in. format, the legend will appear at the bottom of the facing page. Or, the "plate" may be so prepared to allow for inclusion of the legend beneath the drawings. Number all drawings consecutively with Arabic numerals. Do not designate illustrations with letters unless this method (e.g., Fig. 1; A, B, C) better serves some particular format. *Never* designate "plates." Although all figure designations and figure legend designations should correspond exactly, it is advisable to bracket each assemblage of legends corresponding to an assembled "plate." Take care with labeling. Pressure-sensitive numbers, letters, symbols, etc., are preferable and they should be protected with clear acrylic spray. Lettering done with any type of lettering apparatus employing black ink is also acceptable. Typewritten labels are not acceptable unless they are done with large enough type to stand reduction and black enough to print well. Use narrow, solid label lines. Print photographs slighty larger, up to 2×, than anticipated reduction. Photographs should have good contrast and be glossy or semi-glossy. Indicate clearly in the margin of the text the point of insertion of each figure. Consider the following when deciding upon illustrative material to accompany a particular paper: Illustrate liberally. Remember that whole views of animals, while not necessarily required for a diagnosis, give the reader an instructive general appreciation of the animal which is impossible to impart with words or by a collection of drawings of pieces. Avoid the use of whole views comprised of ½ dorsum and ½ venter. Illustrate species descriptions. This is in accord with General Recommendation 17, *International Code of Zoological Nomenclature*, which states, "The description of a new taxon of the species-group should be accompanied by a satisfactory illustration or by a bibliographic reference to such an illustration." 13) Put items 3, 4, and 5 above on page 1 and number *all* other pages consecutively.

RESEARCH NOTES

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NOTA SOBRE LOS GENEROS *CYLLODANIA* Y *ARACHNOMURA* (ARANEAE, SALTICIDAE)

Maria Elena Galiano

Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"
Avda. Angel Gallardo 470, Buenos Aires, Argentina
Miembro del Consejo Nacional de Investigaciones
Científicas y Técnicas, Buenos Aires

ABSTRACT

A correction is made to the original description of the genus *Arachnomura* Mello-Leitao, 1917, and the type species *A. hieroglyphica* is redescribed. *Arachnomura adfectuosa* sp. n. from the Buenos Aires austral mountains is described, with notes on its habits. Additional information on *Cyllodania bicruciata* Simon, 1902 is presented, including the description of the female allotype.

RESUMEN

Se efectúan correcciones a la descripción original del género *Arachnomura* Mello-Leitao, 1917 y se redescribe la especie tipo *A. hieroglyphica*. Se describe *A. adfectuosa* sp. n. de las sierras australes de Buenos Aires; se dan detalles sobre sus hábitos.

Se presenta información adicional sobre *Cyllodania bicruciata* Simon, 1902, incluyendo la descripción del Allotypus hembra.

INTRODUCCION

Los géneros *Cyllodania* y *Arachnomura*, ubicados hasta el momento en diferentes subfamilias, presentan grandes afinidades entre si. *Cyllodania* Simon, 1902, fue considerado como próximo a *Gypogyna*, en el grupo Scopocireae. Sin embargo, se diferencia de *Gypogyna* porque tiene el prosoma más alto y con los lados menos convexos, carece de estría torácica, la mitad anterior de la región torácica es horizontal y el declive es abrupto y cóncavo; además hay grandes diferencias en la forma de los quelíceros y palpos.

Arachnomura Mello-Leitao, 1917, fue ubicado por su autor en Thiodineae, próximo a *Cotinusa* y haciendo un pasaje hacia Bavieae. Esta clasificación es incorrecta, puesto que la forma del prosoma y las proporciones del área ocular son en *Arachnomura* distintas de las de *Cotinusa*. La forma de los quelíceros y del aparato genital alejan notablemente a estos dos géneros.

El estudio de los ejemplares típicos de *Cyllodania bicruciata* Simon, 1902 y *Arachnomura hieroglyphica* Mello-Leitao, 1917, así como de numerosos individuos pertenecientes a ambos géneros, me ha permitido llegar a la conclusión de que *Cyllodania* y *Arachnomura* están relacionados entre si. La estructura de los palpos, las bandas radiantes en la región torácica, la forma de los quelíceros, la longitud relativa de las patas y su quetotaxia, responden en ambos géneros al mismo esquema. Los quelíceros son excavados en su cara interna y dilatados en el ápice, con el promargen saliente y 4 ó 5 dientes sobre

una base común. En el retromargen llevan varios dientes o bien una carena dividida en dos o más puntas. En el presente trabajo, se describe el Allotypus hembra de *Cyllodania bicruciata* en base al ejemplar que acompaña al Holotypus macho y que nunca fue descripto "in extenso" por Simon. Se agregan otros datos tomados de ejemplares de esta especie procedentes de Panamá, colectados a lo largo de varios años por el Dr. A. M. Chickering y actualmente depositados en las colecciones del Museum of Comparative Zoology, Harvard. Se amplía la distribución geográfica de la especie, de la cual solo se conocían los tipos, provenientes de Venezuela.

Se redescribe *Arachnomura hieroglyphica* en base al estudio del ejemplar típico, único representante de la especie. Este ejemplar se encuentra muy decolorado y sin rastros del diseño abdominal descripto por el autor. Sin embargo, pese a sus condiciones precarias, es posible corregir algunos errores de la descripción original. Así por ejemplo, el prosoma no posee estría torácica, la patella del palpo no tiene apófisis y las hileras se implantan como en todas las Salticidae; no hay ninguna elevación que pueda parecerse a un colulo. La forma de los quelíceros y del palpo aproximan mucho esta especie a *Atomosphyrus* y *Cyllodania*. Lamentablemente la falta de ejemplares femeninos de *A. hieroglyphica* no permite la comparación de otros caracteres de gran valor, como la forma de las espermatecas.

En este trabajo, se describe *Arachnomura adfectuosa*, sp. n. y se aportan datos sobre su ecología y biología. La nueva especie se diferencia de *A. hieroglyphica* por los caracteres que se mencionan en la diagnosis y ha sido ubicada en este género teniendo en cuenta la estructura del palpo. También se aproxima a *Cyllodania bicruciata*, especialmente por el aspecto general, la forma del prosoma, la granulación en su tegumento y la presencia de las rayas oscuras radiantes en la región torácica.

METODOS

Las medidas se tomaron siguiendo métodos explicados en un trabajo anterior (Galiano, 1963). Se expresan en milímetros con fracciones hasta milésimos. Las abreviaturas empleadas son: MACN, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia." O.L.A., O.L.P. y O.M.A.: ojos laterales anteriores, laterales posteriores y medios, respectivamente. p: prolateral; r: retrolateral.

<p align="center">

Cyllodania bicruciata Simon, 1902
Figs. 1-3, 11, 12, 20-22, 27, 28

</p>

Cyllodania bicruciata Simon, 1902, p. 363; 1903, p. 1049, 1050; Figs. 1118, 1119; Petrunkevitch, 1911, p. 621; 1928, p. 186; Roewer, 1954, p. 983; Bonnet, 1956, p. 1332; Galiano, 1963, p. 341; lám. 16, Figs. 7-9.

Allotypus Hembra.—Descripción. Prosoma: largo 1,120; ancho 0,853; alto 0,560. Clípeo: alto 0,026. Area ocular: largo 0,560; ancho de la hilera anterior 0,800; ancho de la hilera posterior 0,853. Ojos de la segunda hilera equidistantes de los O.L.A. y O.L.P. Esternón: largo 0,533; ancho 0,373. Opistosoma: largo 1,733.

Aspecto y color en alcohol: esencialmente como en el macho. Los quelíceros presentan 3 dientes en el retromargen. Las espinas de las patas son las siguientes: I, patella 0; tibia 2-2 inferiores; metatarso 2-2 inferiores. II, patella 0; tibia lr-lr inferiores; metatarso lr-2 inferiores. III y IV con algunas apicales en los metatarsos.

Macho.—No. 6728 MACN: Descripción. Largo total 3,334. Prosoma: largo 1,499;

ancho 1,249. Alto 0,733. Clípeo: alto 0,133. Area ocular: largo 0,716; ancho de la hilera anterior 1,000; ancho de la hilera posterior 1,032. Ojos de la 2a. hilera, separados de los O.L.A. por 0,166 y de los O.L.P. por 0,216. Diámetro de los O.M.A. 0,366. Esternón: largo 0,683; ancho 0,583. Opistosoma: largo 1,866. Patas: longitud relativa I-IV-II-III. Palpo: fémur 0,666; patella 0,316; tibia 0,233; tarso 0,366.

Aspecto y color en alcohol: prosoma robusto, relativamente alto y ancho, con un pequeño desnivel entre las regiones cefálica y torácica. La parte anterior de la región torácica es horizontal; sigue el declive, breve, abrupto y cóncavo. El color es pardo con la región cefálica algo oscurecida y una banda longitudinal amarillenta cubierta por pelos blancos, en la región torácica. Hay pelos plumosos blancos detrás de los O.L.P. y formando una barba densa en el clípeo, debajo de los O.M.A. Lo más característico de esta especie es la presencia en el prosoma de unas bandas de color pardo rojizo oscuro, que parecen fuertemente quitinizadas, cuya superficie es finamente granulada y glabra. Estas bandas se disponen de la siguiente manera: una delgada raya longitudinal media desde el
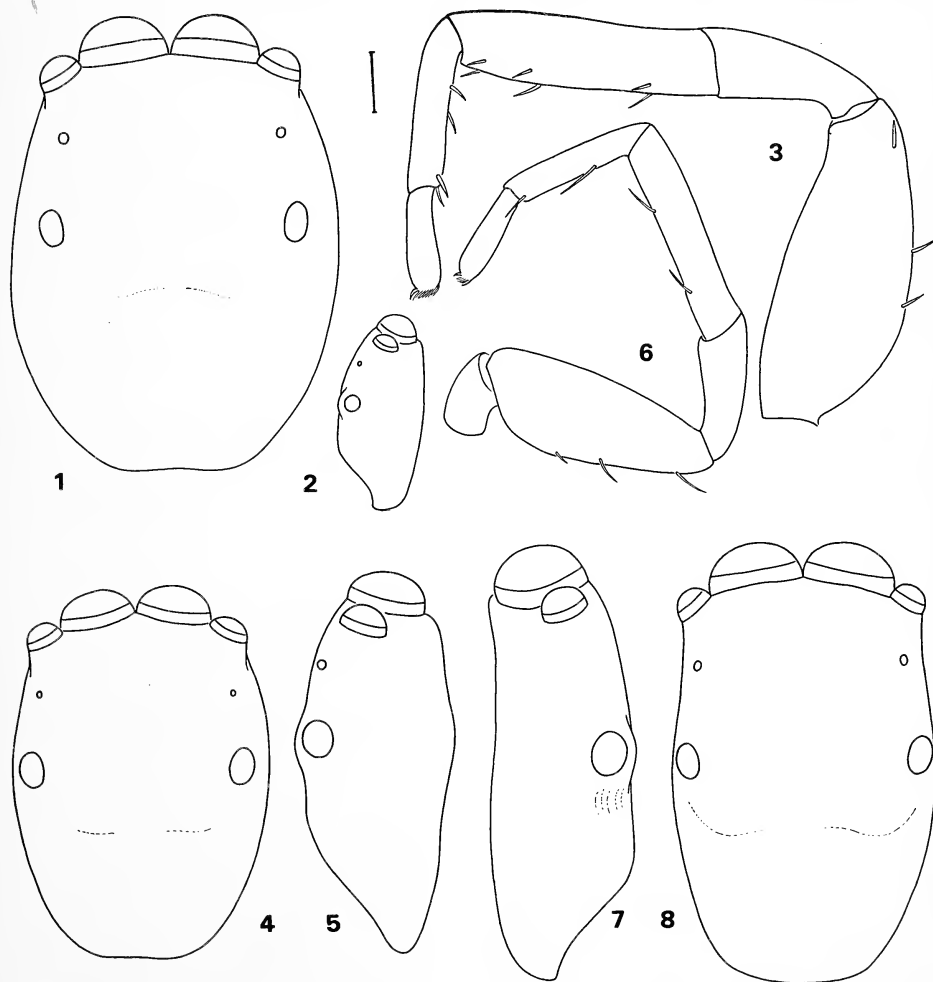
Figs. 1-3.—*Cyllodania bicruciata*: 1, prosoma del ♂; 2, prosoma de la ♀; 3, pata I del ♂, prolateral.

Figs 4-6.—*Arachnomura adfectuosa* sp. n.: 4 y 5, prosoma del ♂; 6, pata I del ♂, retrolateral.

Figs 7-8.—*Arachnomura hieroglyphica*, Holotypus ♂: 7 y 8, prosoma.

Escala 0,25 mm.

límite de la región cefálica hasta la mitad del declive torácico. (Esta raya ha sido inter-
pretada como la estría torácica, pero a mi entender su significado es diferente, ya que no
hay depresión en el tegumento, como es lo normal.) A cada lado de la raya impar
mencionada, se desarrollan 3 ó 4 anchas bandas de cada lado, que se curvan hacia adelante
y se ramifican y fraccionan, alcanzando el margen en diversos puntos. La banda anterior
es transversa y limita a la región cefálica por detrás, luego se curva hacia adelante y corre
por debajo de los ojos laterales. Los costados del prosoma están cubiertos por gránulos
con pelos blancos dispuestos en los espacios entre las bandas y sus segmentos. La super-
ficie de la región cefálica es finamente granulada y tiene pelos pardos. Los quelíceros
están profundamente modificados. La cara interna es muy excavada y limita con la cara
posterior por una carena. La cara anterior es estriada, deprimida en su mitad apical y
cubierta por gránulos en los que se insertan gruesos pelos. El borde externo está ocupado
en su mitad distal por una gran carena saliente. El promargen es prominente y tiene 4 ó 5
dientes implantados sobre una base común. El retromargen lleva 3 dientes. La uña es
corta y curva (Figs. 11 y 12). Las láminas maxilares son cuadrangulares y algo convexas
en su parte media. El esternón es muy ancho, con las escotaduras que corresponden a las
coxas I rebordeadas por una carena. El extremo anterior es truncado, más ancho que la
base del labio. Los quelíceros son pardo rojizo, las láminas y labio negruzcos y el esternón
pardo. Las espinas son las siguientes: I, fémur 1-1-1 dorsales, lp apical; patella 0; tibia
2-2-2 inferiores, el par medio en posición subapical; metatarso 2-2 inferiores. II, como I,
excepto que en la tibia hay 1r-1r inferiores. III, fémur 1-1 dorsales, 1p y 1r apicales,
patella 0; tibia 0; metatarso con 3 apicales. IV, fémur 1-1-1 dorsales, 1p y 1r apicales;
patella 0; tibia 2 inferiores apicales; metatarso con 3 apicales. El fémur del palpo lleva
1-1-1 dorsales. La estructura del palpo según Figs. 20-22. La pata I es pardo claro con
manchas negruzcas del siguiente modo: ambas caras laterales del trocánter y fémur; un
anillo basal y otro apical en patella y tibia; la mitad apical del metatarso y el tarso. La
pata II es como la I. Las patas III y IV son amarillas, con el ápice de patella, base y ápice
de tibia y la mitad apical del metatarso, algo negruzcos. A lo largo del dorso del fémur y
en las partes claras de los otros artejos, hay pelos plumosos blancos. El fémur del palpo es
pardo rojizo, los otros artejos son amarillos con pelos blancos en el dorso de patella y
tibia. El opistosoma tiene el vientre pardo grisáceo y el dorso pardo negruzco, con bandas
pardo claro de la siguiente manera: en la mitad basal una banda longitudinal media y una
banda lateral de cada lado, cubiertas de pelos blancos; 3 cortas bandas transversas de cada
lado, apenas más claras que el dorso y con pelos blancos, la primera en el medio, la
segunda en el tercio apical y la tercera apical. Hileras pardas.

   Hembra.—No. 6728 MACN: Descripción. Largo total 2,833. Prosoma: largo 1,249;
ancho 0,949; alto 0,583. Clípeo: alto 0,100. Area ocular: largo 0,633; ancho de la hilera
anterior 0,866; ancho de la hilera posterior 0,932. Ojos de la 2a. hilera, separados de los
O.L.A. por 0,133 y de los O.L.P. por 0,199. Diámetro de los O.M.A. 0,316. Esternón:
largo 0,583; ancho 0,449. Opistosoma: largo 1,532. Patas: longitud relativa: IV-I-II-III.

   Aspecto y color en alcohol: esencialmente como en el macho, salvo que el desnivel
entre las regiones cefálica y torácica está muy atenuado; el declive torácico es más suave y
el colorido pardo claro. En el prosoma hay dos bandas transversas de pelos plumosos
blancos, una en el margen anterior y otra detrás de los O.L.P., ocupando una banda pardo
amarillento. En el espacio entre el ojo de la 2a. hilera y el O.L.P., hay una mancha de
pelos blancos. El clípeo posee una densa barba de pelos blancos, que se extiende por los
costados debajo de los O.L.A. En los lados del prosoma, los pelos blancos están inter-
rumpidos por las bandas rojizas, similares a las descriptas para los machos. En la línea
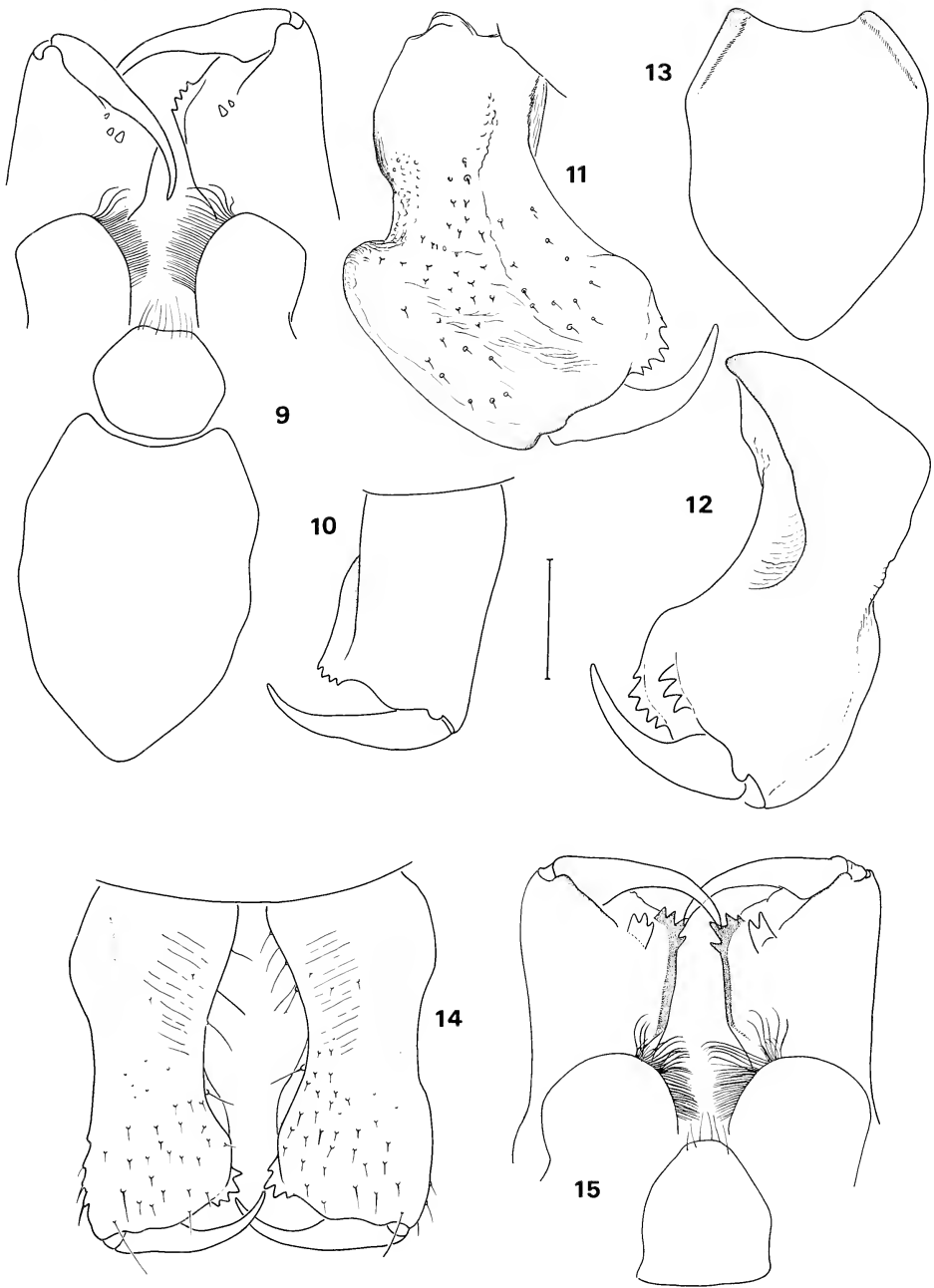
Figs 9-10.–*Arachnomura hieroglyphica*, Holotypus ♂: 9, quelíceros, piezas bucales y esternón; 10, quelícero, cara anterior.

Figs 11-12.–*Cyllodania bicruciata*: 11, quelícero, cara anterior; 12, quelícero, cara posterior.

Figs 13-15.–*Arachnomura adfectuosa* sp. n., Holotypus ♂: 13, esternón; 14, quelíceros, cara anterior; 15, quelíceros, cara posterior.

Escala 0,25 mm.

media hay una banda amarillenta, cubierta por pelos blancos, que se extiende desde la parte media del declive hasta el medio de la región cefálica. Los quelíceros son pequeños, verticales; el promargen tiene 4 dientes y el retromargen 3. El color es pardo rojizo. Las espinas de las patas son las siguientes: I, fémur 1-1-1 dorsales, 1p apical; patella 0; tibia 2-2 inferiores; metatarso 2-2 inferiores. II, fémur 1-1 dorsales; patella 0; tibia 1r-1r inferiores; metatarso 2-2 inferiores. III, fémur 1-1 dorsales; patella 0; tibia 0; metatarso 1p y 1r apicales. IV, fémur 1-1 dorsales; patella 0; tibia 0; metatarso 1p y 1r apicales. Las patas son amarillas, con manchas negras distribuídas así: I, ambas caras laterales del trocánter; un anillo basal y otro apical en patella; un anillo basal y manchas laterales apicales en la tibia; manchas apicales laterales en el metatarso. A lo largo del dorso, pelos plumosos blancos. II, una manchita basal lateral de cada lado y un anillo apical en la patella; una mancha basal y una apical de cada lado en la tibia. III, como la pata II, pero con las manchas más pequeñas y más claras. Pata IV con una mancha negra mediana retrolateral en el fémur; un anillo apical angosto en la patella; un anillo basal y una mancha prolateral apical en la tibia. La zona media de tibia y metatarso con un anillo de pelos plumosos blancos. Palpo amarillo, con pelos plumosos blancos dorsales.

Observaciones.—El estudio de 19 machos y 12 hembras de esta especie ha permitido comprobar cierta variación en algunos caracteres. En los quelíceros, los dientes retromarginales se encuentran con mayor frecuencia en número de 3, pero algunos machos tienen 4 y otros 2, habiendo casos de diferencias entre ambos lados. Las manchas del dorso del opistosoma, pueden tener mayor extensión que en los ejemplares descriptos y vincularse entre si, especialmente en la parte media dorsal, formando dos áreas amarillas en la línea media. Algunos machos presentan la coloración opistosomática similar a la de las hembras.

Material estudiado.—1 macho Holotypus y 1 hembra Allotypus, en el Muséum National D'Histoire Naturelle, Paris, de Venezuela, Caracas, col. E. Simon. 1 macho y 1 hembra no. 6728 MACN, de Panamá, Boquete, col. A. M. Chickering, Aug. 1950; 18 machos y 11 hembras de Panamá; Summit, Boquete e Isla de Barro Colorado, col. A. M. Chickering, 1939, 1950 y 1954, en el Museum of Comparative Zoology, Harvard.

Localidad típica.—Venezuela: Caracas.

Distribucion geografica.—Venezuela, Panamá.

Cyllodania fasciata Caporiacco, 1954

Cyllodania fasciata Caporiacco, 1954, p. 150, Fig. 48.

Esta especie, descripta sobre una hembra subadulta procedente de S. Jean du Maroni, Guyane Française, debe ser considerada como species inquirendae. Pese a ser subadulto, el ejemplar es mucho más grande que el de las mayores hembras de *C. bicruciata* y además, tiene el área ocular paralela y la longitud relativa de las patas es I-IV-III-II, por lo cual parece posible que pertenezca a otro género.

Arachnomura Mello-Leitao, 1917

Arachnomura Mello-Leitao, 1917, p. 136; Petrunkevitch, 1928, p. 185; Roewer, 1954, p. 975; Bonnet, 1955, p. 371.

Diagnosis.—Próximo a *Cyllodania*, del cual se diferencia por tener el extremo del estilo filiforme. Próximo a *Atomosphyrus*, del cual se distingue por tener el prosoma relativa-

mente más corto y porque *Atomosphyrus* carece de puntuación en el tegumento del prosoma.

Descripcion.—Prosoma moderadamente bajo y ancho (el mayor alto igual a 390% o y el mayor ancho a 662% o del largo del prosoma). Región cefálica levemente convexa y región torácica en su primera mitad al mismo nivel que la cefálica. Sin estría torácica. Declive torácico abrupto. Area ocular ocupando algo menos de la mitad del largo del prosoma, más ancha que larga y más ancha atrás que adelante. Los pequeños ojos de la segunda hilera más cerca de los O.L.A. Fila anterior de ojos con los bordes de los ojos medio anteriores algo más arriba que el de los ojos laterales anteriores. Clípeo angosto, sin barbas. Quelíceros fuertes, verticales, con la cara interna profundamente excavada; la cara anterior con gránulos donde se insertan pelos cortos, gruesos. Angulo del promargen muy saliente, con 4 dientes. Retromargen con 2 ó 3 dientes. Uña de largo medio, apenas flexuosa. Láminas con el ángulo externo redondeado, sin apófisis ni mucrones. Labio apenas más ancho que largo, más angosto que el esternón. Esternón con el extremo anterior ancho, truncado y con los rebordes que corresponden a las coxas I, elevados. Longitud relativa de las patas I-IV-II-III. Todas las patas con escasas espinas, en especial las posteriores. Hileras mornales. Palpo con patela y tibia breves; ésta última con dos apófisis apicales retrolaterales. Bulbo discoidal; estilo larguísimo, que describe varias vueltas en torno al bulbo y termina en una punta filiforme.

Especie tipo.—*Arachnomura hieroglyphica* Mello-Leitao, 1917

Arachnomura hieroglyphica Mello-Leitao, 1917

Figs. 7-10, 18, 19

Arachnomura hyeroglyphica Mello-Leitao, 1917, p. 137, Fig. 18, 19, 20 y 24; Petrunkevitch, 1928, p. 185; Roewer, 1954, p. 975.

A. hieroglyphica: Bonnet, 1955, p. 371.

Holotypus macho.—Descripción. Largo total: 3,166. Prosoma: largo 1,533; ancho 1,016; alto 0,600. Clípeo: alto 0,024. Area ocular: largo 0,716; ancho de la hilera anterior 0,932; ancho de la hilera posterior 0,982. Ojos de la 2a. hilera separados de los O.L.A. por 0,166 y de los O.L.P. por 0,233. Diámetro de los O.M.A. 0,349. Esternón: largo 0,616; ancho 0,449. Opistosoma: largo 1,666. Patas: longitud relativa I-IV-II-III. Palpo: fémur 0,516; patella 0,199; tibia 0,133; tarso 0,533.

Aspecto y color en alcohol: la región cefálica es levemente convexa; la primera mitad de la torácica está a su mismo nivel. El declive es abrupto y suavemente excavado. Detrás de los O.L.P. hay una depresión poco profunda. Región cefálica amarillo y región torácica pardo claro, con rayas de color pardo rojizo, radiantes a partir del sitio que debería ocupar la estría torácica. Pese a que se la menciona en la descripción original, no hay estría torácica. Toda la superficie está cubierta por puntuaciones pequeñas, donde debieron implantarse pelos, ahora ausentes. Hay pelos blancos detrás de los O.L.P., en los costados del prosoma y en la región torácica en los espacios entre las rayas rojizas. El opistosoma está totalmente decolorado y depilado, sin rastros del diseño original. Las hileras son normales; no se observa ninguna elevación que pueda interpretarse como un colulo. Las láminas maxilares tienen el ángulo externo recto, no saliente como en el dibujo original. El labio es algo más largo que el ancho de su base. Los quelíceros son bastante largos y fuertes, excavados en su cara interna. La cara anterior tiene gruesos gránulos donde se implantan pelos, cortos y fuertes. El promargen del surco ungueal tiene el ángulo saliente, con 4 dientes. El retromargen lleva 2 dientes, algo separados entre si.
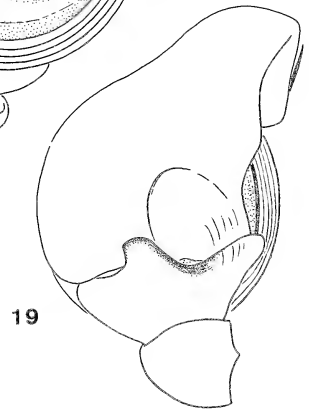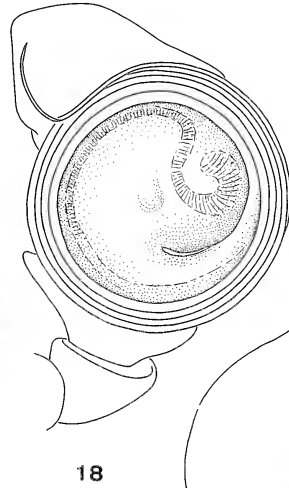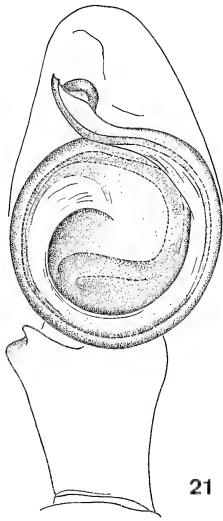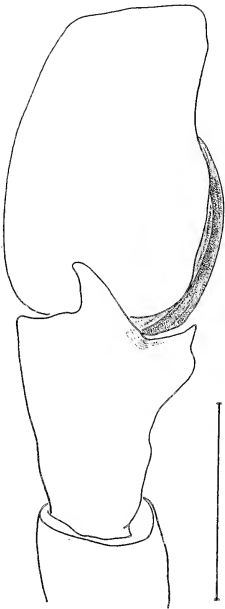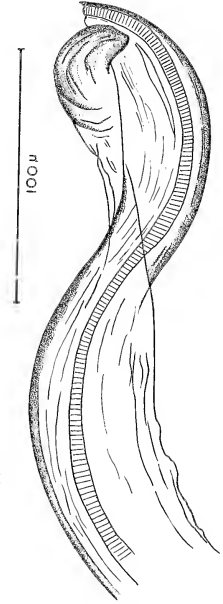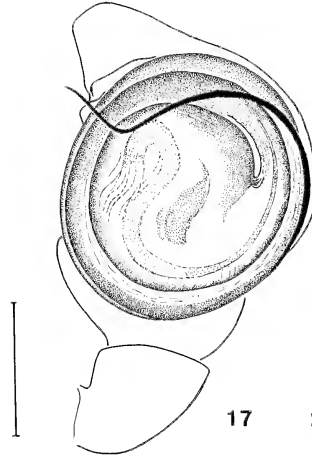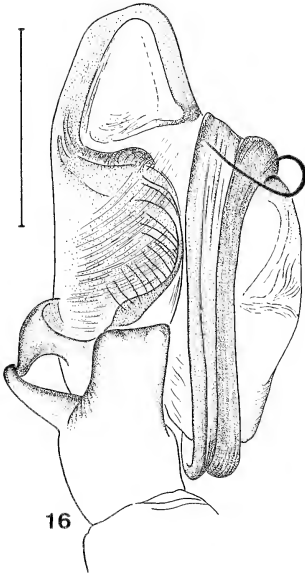
En uno de los quelíceros hay además un pequeño diente algo desplazado hacia el interior del surco. La uña es de largo mediocre, apenas flexuosa. Las patas tienen las siguientes espinas: I, fémur 1-1-1 dorsales; patella 0; tibia 1r-1r inferiores; metatarso 2-2 inferiores. II, fémur 1-1-1 dorsales; patella 0; tibia 1r-1r inferiores; metatarso 1r-2 inferiores. III, fémur 1-1 dorsales; patella 0; tibia 0; metatarso 3 apicales. IV, fémur 1-1-1 dorsales; patella 0; tibia 2 inferiores apicales; metatarso 3 apicales. La tibia del palpo tiene 2 apófisis retrolaterales, de las cuales la ventral es ancha y ligeramente excavada. El tarso, muy ancho, presenta una depresión que se enfrenta con la apófisis tibial superior. El bulbo es grande, discoidal y el estilo, enciforme, lo circunda y termina en una punta filiforme. En la descripción original se menciona una apófisis en la patella del palpo que no existe.

Observacion.—La etiqueta original dice *"hieroglyphica,"* grafía que apareció alterada en la descripción y que luego fue corregida por Bonnet, cuyo criterio se sigue.

Material estudiado.—1 macho Holotypus, en el Museu Nacional de Rio de Janeiro, de Brasil, Martins Costa, col. Clodoaldo Devoto.

Distribucion geografica.—Conocida únicamente de la localidad típica.

Arachnomura adfectuosa sp. n.
Figs. 4-6, 13-17, 23-26

Diagnosis.—Se diferencia de *Arachnomura hieroglyphica* por tener una apófisis en el dorso del tarso del palpo.

Etimologia.—Del latín *adfectuosa*, con referencia a la falta de agresividad en la pareja.

Holotypus macho.—Descripción: Largo total 3,133. Prosoma: largo 1,416; ancho 1,082; alto 0,616. Clípeo: alto 0,050. Area ocular: largo 0,683; ancho de la hilera anterior 0,882; ancho de la hilera posterior 0,982. Ojos de la 2a. hilera separados de los O.L.A. por 0,166 y de los O.L.P. por 0,199. Diámetro de los O.M.A. 0,299. Esternón: largo 0,633; ancho 0,533. Opistosoma: largo 1,766. Patas: longitud relativa I-IV-II-III. Palpo: fémur 0,499; patella 0,183; tibia 0,133; tarso 0,516.

Aspecto y color en alcohol: prosoma con la región cefálica levemente convexa, con una suave depresión detrás de los ojos posteriores. La región torácica con declive gradual, poco pronunciado. El color es negro pardusco; la región cefálica es parda con una banda longitudinal media pardo claro, que se extiende desde la altura de los O.L.P. hasta el margen posterior y está cubierta de pelos blancos. No hay estría torácica. En la región torácica, rayas radiantes de color negro, algunas ramificadas y segmentadas, curvadas hacia adelante, sin pelos. Los espacios entre estas rayas, así como todo el resto de la superficie del prosoma, cubierto por puntuaciones en las que se insertan pelos negros. En la zona submarginal del prosoma, una banda rala de pelos blanquecinos. El opistosoma negruzco; en la mitad distal del dorso, 2 ó 3 borrosas bandas transversas pardo oscuro. Bordeando la base y de cada lado, hasta el tercio apical, una banda pardo oliváceo cubierta de pelos blancos. Vientre negruzco. Las láminas maxilares tienen el ángulo externo redondeado; son negruzcas aclarándose hacia el ápice. El labio es apenas más

Figs 16-17.—*Arachnomura adfectuosa* sp. n., Holotypus ♂: 16, palpo, retrolateral; 17, palpo, ventral.
Figs 18-19.—*Arachnomura hieroglyphica*, Holotypus ♂: 18, palpo, ventral; 19, palpo, retrolateral.
Figs 20-22.—*Cyllodania bicruciata*: 20, palpo, retrolateral; 21, palpo, ventral; 22, extremo del estilo.
Escala 0,25 mm, salvo indicación.

largo que el ancho de la base, de color negro. Los quelíceros son verticales, paralelos. La cara interna es profundamente excavada, limitada por carenas con las caras anterior y posterior; la cara externa presenta una carena en su mitad distal; la cara anterior es algo excavada, estriada y con gruesos gránulos donde se insertan pelos fuertes, rígidos, más largos los basales que los apicales. El promargen tiene el ángulo prominente, con 4 dientes implantados sobre una base común, de los cuales los dos medianos son los mayores. En el retromargen hay una carena tridentada en un quelícero y bidentada en el otro. El esternón es muy ancho, truncado en su extremo anterior, donde es más ancho que la base del labio. Las escotaduras que corresponden a las coxas I, son rebordeadas. El color es negruzco. Las espinas de las patas son las siguientes: I, fémur 1-1-1 dorsales; patella 0; tibia 1r-2 inferiores; metatarso 2-2 inferiores. II, fémur 1-1 dorsales; patella 0; tibia 1r-1r inferiores; matatarso 1r-2 inferiores. III, fémur 1-1 dorsales; patella 0; tibia 0; metatarso 1p y 5 apicales. IV, fémur 1-1-1 dorsales, patella 0; tibia 0; metatarso 3 apicales. La pata I tiene la coxa amarilla con la cara retrolateral negruzca; el trocánter amarillo con las caras laterales negruzcas; fémur anaranjado con la cara ventral y la retrolateral, pardo claro; patella amarilla con un angosto anillo basal y otro apical incompleto, negros; tibia amarilla, con un anillo basal angosto, incompleto dorsalmente y bandas laterales en la mitad distal, negras; metatarso negro; tarso blanquecino, con un anillo basal negro. Pata II con la coxa y trocánter amarillos, con las caras laterales negras; fémur negruzco con una banda longitudinal dorsal pardo claro; patella amarilla con una banda apical negruzca; tibia amarilla con bandas laterales negruzcas; metatarso amarillo con las caras laterales negruzcas. Pata III con coxa y trocánter amarillos con las caras laterales negruzcas; fémur negro con una banda dorsal longitudinal pardo claro; patella amarilla con un anillo apical negruzco; tibia amarilla con bandas negruzcas en las caras laterales; metatarso amarillo con un anillo basal negruzco, interrumpido sobre el dorso; tarso amarillo. Pata IV con coxa y trocánter amarillos con las caras laterales negruzcas, excepto la porción retrobasal de la coxa; fémur, patella y tibia como en pata III, pero las manchas más extendidas y más oscuras; metatarso negro, algo más claro dorsalmente; tarso amarillo. El palpo tiene el fémur y la patella anaranjados, levemente oscurecidos apicalmente; la tibia y el tarso son negruzcos. La tibia del palpo presenta dos apófisis retrolaterales: una superior, triangular y ganchosa y otra ventral, gruesa, recta y algo tuberculada en el ápice. El tarso, muy ancho, lleva un proceso retrolateral consistente en una cavidad limitada por una carena en cuyo borde se implantan cerdas y que remata en una apófisis laminar triangular, cuyo extremo se dobla hacia abajo y toca a la apófisis tibial superior. El bulbo es discoidal y el estilo, muy ancho y grueso describe 2 vueltas a su alrededor para terminar en una punta filiforme en la cara retrolateral del tarso. (figs. 16, 17).

Allotypus hembra.—Descripción: Largo total 3,000. Prosoma: largo 1,216; ancho 0,966; alto 0,616. Clípeo: alto 0,033. Area ocular: largo 0,649; ancho de la hilera anterior 0,857; ancho de la hilera posterior 0,932. Ojos de la 2a. hilera, separados de los O.L.A. por 0,166 y de los O.L.P. por 0,199. Diámetro de los O.M.A. 0,316. Esternón: largo 0,633; ancho 0,449. Opistosoma: largo 1,833. Patas: longitud relativa IV-I-III-II.

Aspecto y color en alcohol: prosoma pardo negruzco, con una banda longitudinal media desde los O.L.P. hasta el margen posterior, de color pardo claro con pelos blancos. El margen del prosoma es negro y de cada costado, hay una ancha banda submarginal pardo claro con pelos blancos. En la regiçon torácica (que carece de estría) hay rayas pardo rojizas radiantes, como en el macho. Entre ellas y en el resto del prosoma, puntuaciones donde se insertan pelos negros. Opistosoma pardo negruzco, con manchas amarillas cubiertas de pelos plumosos blancos, de la siguiente manera: una banda completa

que rodea la base y los costados hasta el cuarto apical; sobre el dorso, 3 bandas transversas cortas, levemente circunflejas y una cuarta curvada sobre el ápice, rodeando la base de las hileras. Vientre pardo rojizo oscuro. Las hileras son pardas, excepto las medianas que son amarillas. El esternón y las piezas bucales son pardas, éstas más negruzcas hacia la base. Los quelíceros son pequeños, verticales, con el promargen prominente, con 4 dientes; en el retromargen una carena tridentada. Las espinas de las patas son las siguientes: I, fémur 1-1-1 dorsales; patella 0; tibia 2-2 inferiores; metatarso 2-2 inferiores. II, fémur 1-1 dorsales; patella 0; tibia 1r-1r inferiores; metatarso 1r-2 inferiores. III, fémur 1-1 dorsales; patella 0; tibia 0; metatarso con 3 apicales. IV, fémur 1-1-1 dorsales; patella 0; tibia 0; metatarso con 4 apicales. La pata I tiene coxa y trocánter amarillos con ambas caras laterales negruzcas; patella amarilla con una banda negra prolateral y manchas basales y
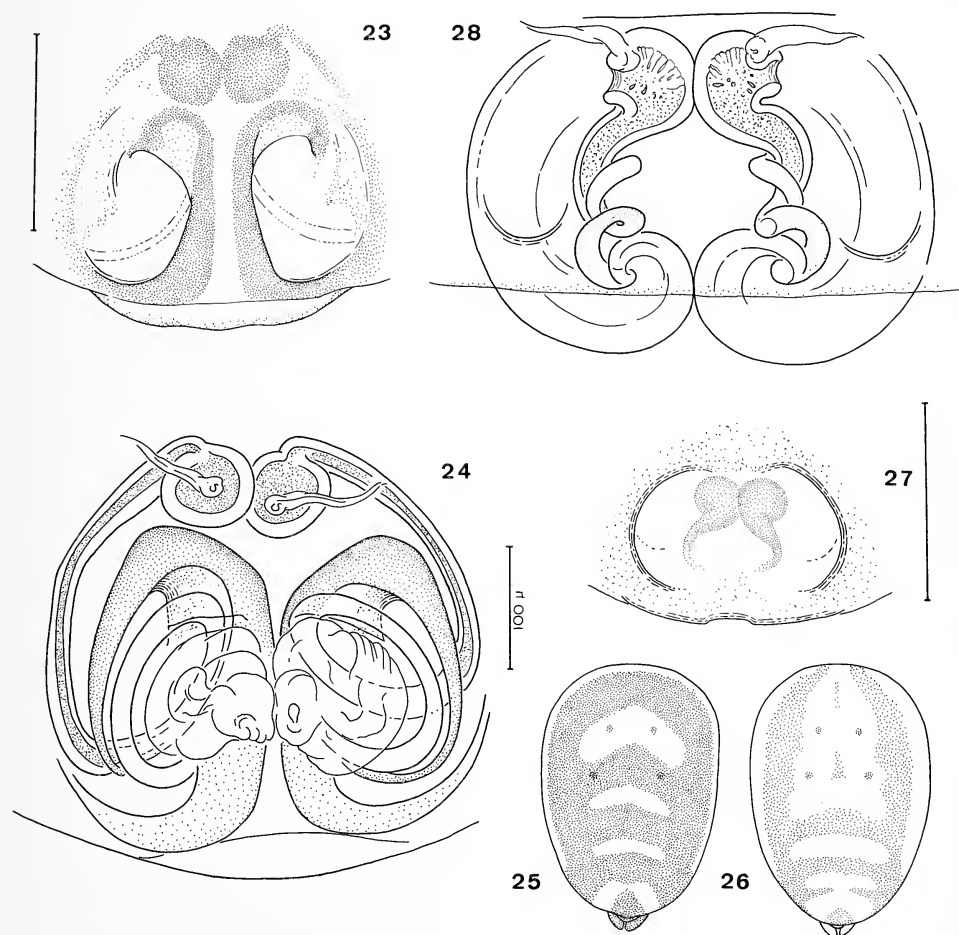
Figs 23-28.–*Arachnomura adfectuosa* sp. n. Allotypus ♀: 23, epigino; 24, espermatecas y conductos; 25, diseño del dorso del opistosoma; 26, diseño del dorso del opistosoma de una ♀ del Delta del Paraná.
Cyllodania bicruciata: 27, epigino; 28, espermatecas y conductos.
Escala 0,25 mm, salvo indicación.

apicales retrolaterales; tibia amarilla con una mancha negra basal prolateral, una apical prolateral y una apical retrolateral; metatarso amarillo con las caras laterales negras; tarso amarillo. Pata II amarilla, con las caras laterales de coxa, trocánter y fémur, negruzcas. Pata III amarilla, con las caras laterales de coxa, trocánter y fémur negruzcos; la patela con manchas laterales basales y apicales; tibia y metatarso con las caras laterales levemente oscurecidas. Pata IV con coxa y trocánter amarillos, algo oscurecidos prolateralmente; fémur con la cara prolateral negruzca; patela, tibia y metatarso amarillos, con las caras prolaterales algo occurecidas, más negras basal y apicalmente. Los palpos son amarillos. Epigino y espermatecas según figs. 23 y 24.

Habitat.—La mayor parte de los especímenes fue coleccionada en el cordón Esmeralda, ubicado entre las Sierras de la Ventana y de Tunas, pertenecientes al sistema de las sierras australes de la provincia de Buenos Aires. A partir del arroyo del Loro, que en ese lugar corre en un profundo cañadón, se elevan los flancos del cordón Esmeralda, orientados hacia el sud y sud-sudoeste, donde se hallaron los ejemplares.

Construyen sus pequeños nidos de seda blanca bajo las piedras o en los costados de las mismas, por lo común fijados a las hojas de gramíneas que crecen apretadas entre los bloques o bien que han sido aplastadas por alguna roca desprendida de lo alto. El nido es un tubo con una abertura en cada extremo y las paredes son bastante espesas. En pocos centímetros cuadrados pueden hallarse varios de estos nidos. A fines del invierno, en los primeros días del mes de setiembre, es posible observar que los nidos tienen dos celdas interiores, paralelas, parcialmente superpuestas, que alojan a una hembra y un macho. Los individuos se disponen con los cuerpos paralelos y pueden estar mirando hacia el mismo lado o a lados opuestos. En dicha época del año, en estos nidos dobles se hallan machos adultos y hembras adultas o subadultas. Parecería que tal como se ha descripto para otras especies de Salticidae, el macho se encuentra a la espera de la última exuviación femenina. En el laboratorio machos y hembras conviven largo tiempo, sin dar nunca muestras de agresividad. A fines de octubre y principios de noviembre, los machos son muy escasos. En los nidos se hallan hembras adultas y casi todas con uno o dos cocones. Los huevos son amarillos, en número aproximado a 10, y la ooteca más antigua frecuentemente contiene estados larvales. Desconozco de qué manera se completa el ciclo de desarrollo de las larvas nacidas en noviembre y diciembre, pero puede suponerse que crecen durante el verano y que al llegar el otoño están en una etapa subadulta, que pasan de esta manera el invierno y en la primavera temprana llevan a cabo la última muda y alcanzan la madurez. Si los machos de esta especie se comportan como los de la generalidad de las arañas, deben tener uno o dos estados ninfales menos que las hembras, lo que explicaría que se los hallara aguardando, ya adultos, que las hembras muden por última vez. En cautiverio, los machos de *Arachnomura adfectuosa* sp. n. mueren antes que las hembras y si ocurre lo mismo en el campo, ello explicaría que ya en primavera casi no se encontraran machos.

Observaciones sobre otros ejemplares.—Se han estudiado 23 machos y 43 hembras adultos, además de numerosos juveniles de diversos estadíos. Esto ha permitido observar la variación de algunos caracteres. Lo más frequente es que el retromargen lleve una carena dividida en 3 dientes pero pueden presentarse las siguientes modificaciones:

	Nº de ejemplares	Nº de dientes retromarginales en ambos quelíceros
	19	3-3
Macho	3	2-2
	1	3-2

	30	3-3
	7	2-2
Hembra	5	3-2
	2	4-4
	1	3-1

En cuanto a las espinas en la tibia I, se ha observado que algunos machos tienen 2-2 inferiores, siendo la prolateral basal más reducida. También varían las espinas metatarsales de las patas posteriores, pudiendo llegar hasta 6 apicales. En cuanto al tamaño, el ejemplar masculino medido más pequeño tenía 2,60 mm y el más grande, 3,16 mm de longitud total. En el colorido, la variación es la siguiente: algunos machos tienen el dorso del opistosoma totalmente negro; en la mayoría de las hembras hay 4 bandas dorsales transversas y en algunas, 5 bandas.

Observacion sobre las poblaciones estudiadas.—Los ejemplares de *Arachnomura adfectuosa* sp. n. que se eligieron como típicos, pertenecen a una población distribuída por las Sierras de la Ventana y Tandil, en el sur de la provincia de Buenos Aires. Otra población se extiende en la zona costera bonaerense, desde el Paraná de las Palmas hasta Punta Lara. A lo largo de muchos años se coleccionaron abundantes ejemplares ribereños, en especial en *Cortaderia dioica* y bajo hojarasca, en lugares periódicamente inundables. Hay una marcada diferencia en el habitat entre esta población costera y la serrana, pero el cuidadoso estudio de los ejemplares no ha permitido encontrar ninguna diferencia morfológica. Ambas poblaciones difieren unicamente en el colorido: los individuos de las sierras son melánicos mientras que los de la costa son de color pardo claro y aunque con el mismo diseño básico, las manchas blancas tienden a unirse y a ocupar mayor extensión. (Figs. 25, 26). En dos oportunidades se reunieron parejas cuyos miembros provenían de las dos localidades y aunque no hubo cópulas, los machos demostraron un intenso comportamiento de cortejo. En el caso de una pareja integrada por un macho de Sierra de la Ventana y una hembra de Punta Lara, llegaron a construirse un nido doble, en el cual convivieron por 3 días, durante los cuales el macho inició el cortejo repetidas veces. Puede que el hecho de que la hembra estuviera oviplena influyera en su falta de aceptación.

Al no hallar ningún carácter que permita distinguir los individuos de ambas poblaciones, con excepción del colorido, se decide considerarlos como coespecíficos, hasta que nuevas experiencias permitan establecer la categoría que les corresponde dentro del nivel específico.

Material estudiado.—1 macho Holotypus No. 6729 MACN, de la Argentina, Provincia de Buenos Aires, Sierra de la Ventana, Cordón Esmeralda, col. Galiano, 3 octubre 1972; 1 hembra Allotypus No. 6730 MACN, de igual localidad y colector; 5 machos y 5 hembras Paratypi No. 6731 MACN, de igual localidad y colector; 7 machos y 32 hembras Paratypi de igual localidad y colector en la colección de la autora; 5 hembras y 5 machos Paratypi No. 6732 MACN de igual localidad, col. E. Maury 3 octubre 1973; 1 hembra No. 6733 MACN, de Tandil, col. E. Maury 2 abril 1969; 1 hembra No. 6734 MACN de Tandil, col. E. Maury 15 mayo 1967; 12 machos y 28 hembras de la provincia de Buenos Aires, Paraná de las Palmas, Tigre y Punta Lara, col. Galiano 1963-1974 y M. J. Viana, 1938 y 1951.

Localidad tipica.—Argentina, provincia de Buenos Aires, Sierra de la Ventana, cordón Esmeralda.

Distribucion geografica.—Provincia de Buenos Aires, sierras de Ventana y Tandil; ribera del Paraná de las Palmas y del Río de la Plata hasta Punta Lara.

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THE *POLITUM* GROUP (BULBATE SPECIES) OF *LEIOBUNUM* (ARACHNIDA: PHALANGIDA: PHALANGIIDAE) OF NORTH AMERICA[1]

Charles R. McGhee

Department of Biology
Middle Tennessee State University
Murfreesboro, Tennessee 37130

ABSTRACT

The genus *Leiobunum* (Arachnida: Phalangida) contains several rather well defined species groups which until now have not been treated as such. The primary characteristic used as a basis for a taxonomic revision of the genus is the morphology of the male intromittent organ. Secondary characteristics include male pedipalps, genital operculum and other body features. This paper describes the "Bulbate Species" of *Leiobunum* which contains only the "*Politum* Group." It includes descriptions of *L. politum* Weed, *L. bracchiolum*, sp. nov., and *L. holtae*, sp. nov. Consideration is also given to the possible phylogenetic relationships of these species.

INTRODUCTION

A recent study of the North American genus *Leiobunum* utilizing both museum specimens and specimens collected from numerous sites throughout the middle and southern portions of the Appalachian Mountains has resulted in the recognition of several rather distinct species groups. The recognition of these groups is considered to be important since it offers a somewhat different approach to the problems of taxonomy encountered by those interested in the species of the genus. Redescriptions and more detailed illustrations are included to clarify and perhaps better delineate the nature of previously described species. Several new species have been described and included in the groups.

The morphology of the male intromittent organ is utilized as a primary taxonomic character in defining species and establishing species groups. The male pedipalps and male and female dorsum and ventrum are considered to be important secondary characters. An attempt has been made to demonstrate, through the use of these characters, possible phyletic affinities between the species of each group, and perhaps, although speculatively, to gain some insight toward the recognition of an evolutionary trend within the genus.

This paper deals with the proposed "*Politum* Group" of the "Bulbate Species" of *Leiobunum.* The term "politum" was selected as the group name because *L. politum* Weed is its oldest recognized species. The term "bulbate" refers to the common structural feature of having a closed thin walled, bulb-like development near the distal end of the penial shaft of each species. Additional groups now being studied and to be described in future papers will include the "*Vittatum* Group," "*Calcar* Group" and one or more groups of "Sacculate Species."

Three species are, thusfar, placed in the *politum* group. *Leiobunum politum* Weed, 1889 is a well known and widely distributed species which is redescribed and illustrated. The remaining species, *L. holtae* and *L. bracchiolum*, are new and described for the first

time. The study, along with the work of Roewer (1923), Davis (1934), Bishop (1949) and Edgar (1966, and 1972), is an attempt to further clarify the systematics of *Leiobunum* and to, hopefully, provide a new approach to an understanding of its species.

[1] Taken in part from a Ph.D. dissertation on the systematics of *Leiobunum* completed at Virginia Polytechnic Institute & State University, Blacksburg, Virginia.

DIAGNOSIS OF BULBATE SPECIES

Penial shaft with either a double or single thin walled, membranous, bulb-like structure which has no apparent openings, using ordinary light microscope technique, to the exterior: bulbus may be located either ventrally, ventrolaterally or laterally toward the distal end of the shaft.

KEY TO THE *POLITUM* GROUP

1a. Penial bulb double, located laterally or ventrolaterally along the distal end of the shaft; may or may not protrude beyond the lateral margin of the shaft (Figs. 1-4); penis length less than 5.0 mm   2

1b. Penial bulb single, located on ventral side of shaft; may lie close to the shaft wall and be rather inconspicuous; penial shaft very long and slender and laterally flattened along approximately the distal one-half (Figs. 5-6); penis length 6.0-7.0mm; G. O. length 2.0-3.0mm male and female   . . . .*L. holtae* 42

2a(1a). Penial bulb rather large, conspicuous and extending slightly beyond the edge of the shaft when viewed from the dorsal or ventral side; (Figs. 3-4); penis length 2.5-4.0mm; G. O. length 1.2-1.8mm males and females   . . . . . *L. politum* 50

2b. Penial bulb not as conspicuous, relatively narrow and almost flush with the lateral edge of the shaft when viewed from the dorsal or ventral side (Figs. 1-2); penis length 1.5-2.5mm; G. O. length 0.9-1.2mm males and females   . . . *L. bracchiolum* 71

Leiobunum politum Weed, 1889

Liobunum politus Weed, 1889, p. 89; 1890a, p. 918.
Liobunum politum Weed, 1893c, p. 294.
Liobunum politum and *p. magnum* Weed, 1893d, p. 428-429.
Liobunum politum Weed, 1893a, p. 540; 1893b, p. 548.
Liobunum politum, Banks, 1893, p. 211; 1900, p. 541; 1901, p. 676.
Liobunum politum politum and *p. magnum*, Roewer, 1910, p. 219-220.
Leiobunum politum, Comstock, 1912, p. 75.
Leiobunum politum politum and *p. magnum*, Roewer, 1923, p. 899-900.
Leiobunum politum, Crosby and Bishop, 1924, p. 14.
Leiobunum politum politum and *p. magnum*, Davis, 1934, p. 686-687.
Leiobunum politum, Bishop, 1949, p. 201.
Leiobunum cavernarum Roewer, 1952, p. 270. NEW SYNONOMY
Leiobunum politum, Levi and Levi, 1952, p. 163-167.
Leiobunum politum, Edgar, 1962, p. 146; 1966, p. 363; 1971, p. 1-64.

Diagnosis.—Medium size phalangids, males 3.5 mm to 5.0 mm total length; females 4.5 mm to 6.5 mm total length; genital operculum greater than 1.2 mm in length; penis

greater than 2.5 mm in length; penis with a double ventrolateral bulbus near the distal end of the shaft which protrudes beyond the shafts lateral side; pedipalpal segments armed with a few small spines.

Type specimens.—No type specimens are known for this species. Clarence Weed (1889 p. 90) lists Champaign Co., Illinois as the type locality. Weed's descriptions and illustrations (1893b, plate LXI, and 1893d, plate 15) define the basic features of the species well enough that there is no question of its identity.

Description (Male).—The penis (Figs. 3, 4) has a double ventrolateral bulbus near the distal end which does not open to the exterior. The bulbus is conspicuous and projects slightly beyond the lateral edge of the shaft from a dorsal or ventral view. The total length of the penis varies from about 2.5 mm to 5.0 mm. The pedipalpal femur (Fig. 13) usually has a short row of spines anteroproximally and around the distal end, the patella has spines posteroproximally and the tibia is usually without spines, although, some specimens may have a few small scattered spines. Tarsal spines are small and inconspicuous. The carapace and abdomen (Figs. 7, 9) may be yellow-white or yellow-red in color with a dark brown or black ocular tubercle which is armed with two rows of small sharp spines. There are no prominent dorsal markings in the males. The ventrum (Fig. 11) is pale yellow-white or yellow-red and the genital opercular denticles are usually poorly developed or absent.

Description (Female).—The carapace and abdomen (Figs. 8, 10) may be yellow-white to yellow-red in color with a dark brown or black ocular tubercle armed with two rows of small sharp spines. A large light or dark yellow-brown or brown central mark is usually present on the abdominal tergites and may extend across the postocular ridges onto the carapace. This mark is variable and may be absent in some specimens. The ventrum (Fig. 12) is of the same general coloration and the condition of genital opercular denticles is similar to the male. The pedipalpal femur has spines anteroproximally, anteroventrally and around the distal end, the patella has spines dorsally, anteriorly and posteriorly. The tibia and tarsus are without spines.

Distribution.—This species has a wide distribution (Fig. 28) in the eastern half of the United States. Specimens have been examined from northern Michigan southward to northern Florida. It has been reported from parts of Canada (Edgar, 1966; Bishop, 1949), but the total northern extension of its range is not well known. Some museum specimens labeled *L. politum* from New York, New Hampshire and Maine belong to *L. bracchiolum*. Further investigation of the northeastern range of *L. politum* needs to be conducted. The species extends into Mississippi and Louisiana, has a known westward extension of eastern Arkansas and has been reported from Illinois and Wisconsin by Edgar (1966). It is common in the Appalachian Mountains from Maryland to northern Alabama.

Discussion.—A large number of specimens of this species have been studied from Horse Cove, Graham Co., North Carolina which is the type locality of Roewer's *Leiobunum cavernarum* (1952, p. 270). Weed (1899, p. 89-90) described *L. politum* and presented figures (1893d) of the male dorsum and pedipalp. Weed's diagnosis of *L. politum* is as follows: Body 5.0 mm long, legs 25:51:26:36 mm. Roewer's diagnosis of *L. cavernarum* is as follows: Body 5.5 mm long, legs 27:52:28:38 mm. The differences in size are of little significance since this amount of variation can be found in any population of phalangids. In addition to their similarity in dorsal features and size, the penis which I observed in *L. cavernarum* is the same as that described by Weed (1983d) and illustrated by Davis (1934) and Bishop (1949) for *L. politum*. After having made a careful comparison of the type of *L. cavernarum* with descriptions and other specimens of *L. politum*,
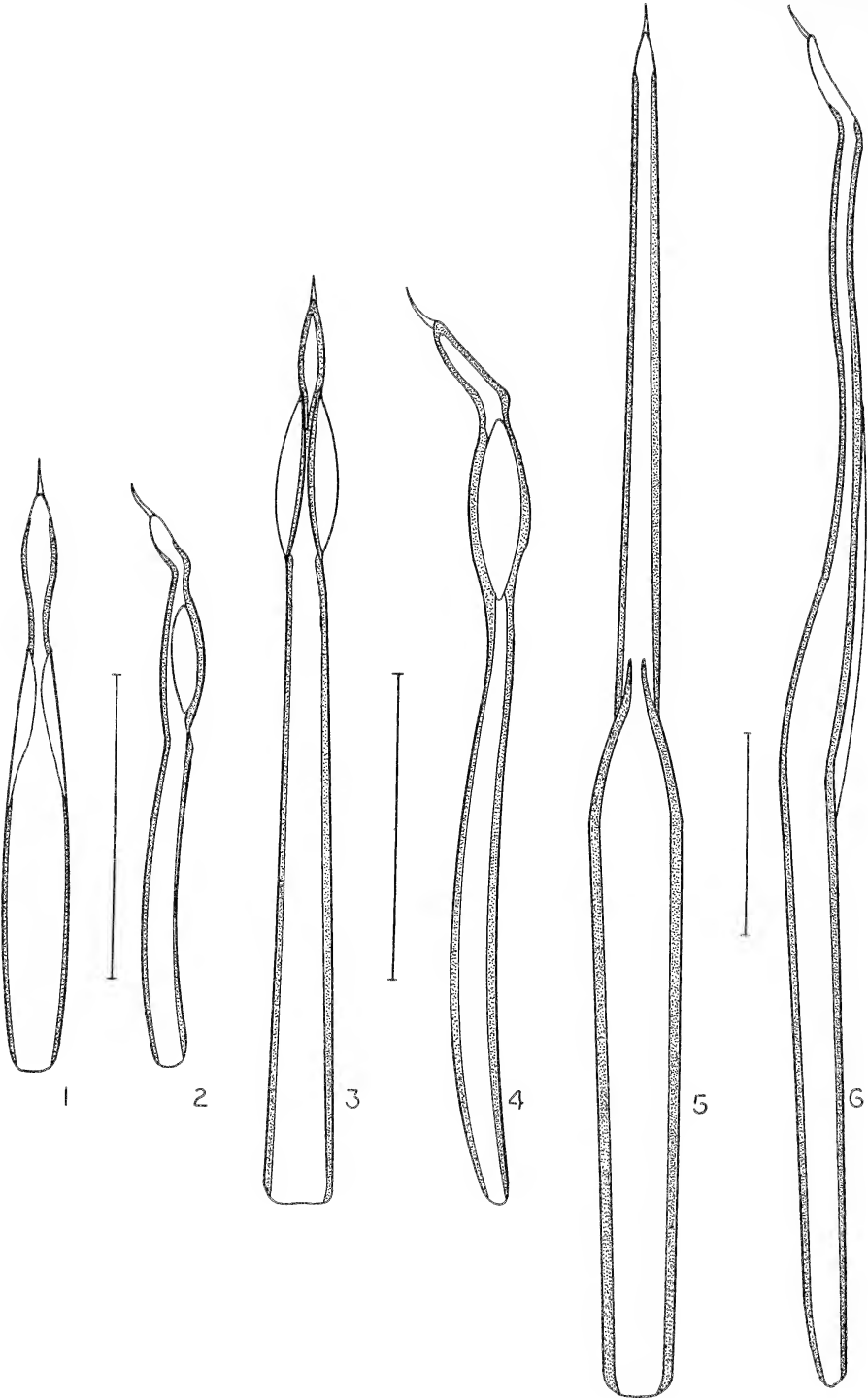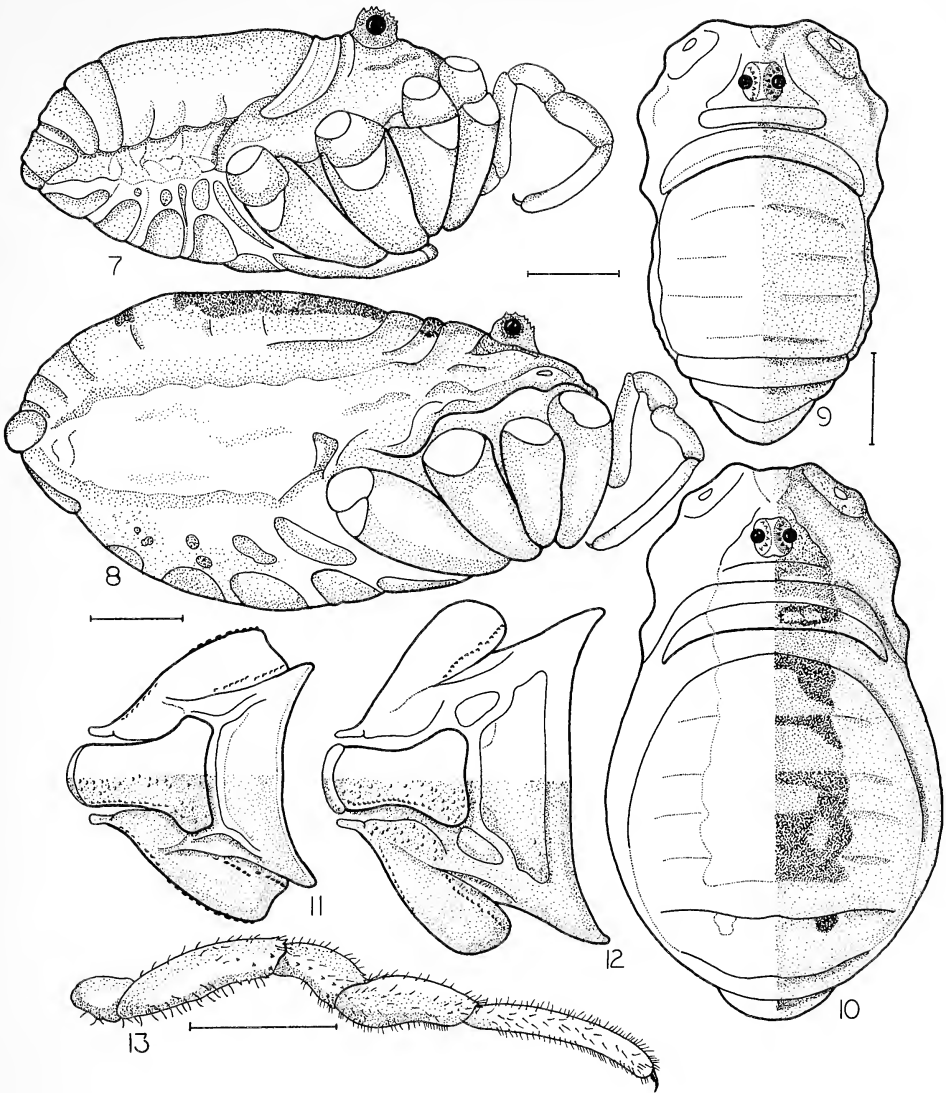
Figs. 7-8.—*L. politum* male and female lateral view.
Figs. 9-10.—*L. politum* male and female dorsum.
Figs. 11-12.—*L. politum* male and female genital operculum.
Fig. 13.—*L. politum* male pedipalp posterior (lateral) view.

including those from Horse Cove, North Carolina, there is little doubt that it is a synonym of *L. politum*.

Leiobunum bracchiolum, new species

Diagnosis.—Small phalangids, 2.0 mm to 3.5 mm total length in males, 3.5 mm to 5.5 mm total length in females; genital operculum less than 1.3 mm in length; penis less than

Figs. 1-2.—*L. bracchiolum* penis dorsal and lateral view.
Figs. 3-4.—*L. politum* penis dorsal and lateral view.
Figs. 5-6.—*L. holtae* penis dorsal and lateral view.

2.5 mm in length; penis with double ventrolateral bulbus elongated along but not pro-
truding noticeably beyond lateral edge of shaft; palpal tibia inflated, larger than other
palpal segments, usually white or yellow-white; palpal segments very sparsely armed with
spines.

Type specimens.—Male holotype, female allotype and male and female paratypes are in
the collection of the American Museum of Natural History. Several paratypes are in the
collection of the author at Middle Tennessee State University, Murfreesboro, Tennessee.

Type locality.—Crow's Nest Lodge, Frederick Co., Maryland; near Thurmont, Mary-
land, 10 August 1967.

Etymology.—The latin word "*bracchiolum*" means "dainty arm." This was selected as
the species name because of the small size and absence of all but a few inconspicuous
spines on the male pedipalp. The name is appropriate for this species since such a condi-
tion is uncommon among North American species of *Leiobunum*.

Description (Male).—Penis (Figs. 1, 2) with a double ventrolateral bulbus which is
somewhat elongated and not protruding noticeably beyond the lateral edge of the shaft.
The penial shaft is short and somewhat laterally thickened along the midsection. The
pedipalpal femur (Fig. 20) may have a few spines anteroproximally and dorsodistally; the
patella a few spines posteriorly, dorsally near the proximal end and dorsodistally. The
palpal tibia is without spines and the spines on the palpal tarsus of the male are very small
and inconspicuous. The carapace and abdomen (Figs. 14, 16) are yellowish and the ocular
tubercle dark brown to black with two rows of well developed sharp pointed spines. No
conspicuous markings are present on the dorsum. The ventrum (Fig. 17) is pale white to
yellow-white and the denticles on the genital operculum are weakly developed or absent.

Description (Female).—The carapace and abdomen (Figs. 15, 18) are pale yellow to
yellow-brown and the ocular tubercle dark brown to black with small sharp pointed
spines similar to those of the male. A dorsal central mark on the abdomen varies from
well developed to absent and from very light brown to dark brown. The denticles on the
genital operculum (Fig. 19) are weakly developed or absent. Ventral coloration is similar
to that of the male. The palpal femur has very small spines anteroventrally, posteroven-
trally and dorsodistally; the patella has small spines anteriorly, dorsally and posteriorly;
the patella of some specimens has a small anterodistal apophysis; the tibia has a few small
spines anteriorly and the tarsus is without spines.

Distribution.—Specimens of *L. bracchiolum* have been studied from Maine southward
to southern Alabama (Fig. 28). The species has been, thusfar, most commonly found in
the Appalachians. Several museum collections from northern states which were labeled *L.
politum* contained *L. bracchiolum*. It is possible that confusing these two species in the
past has led to an overestimation of the range of *L. politum* in the north. The westward
extension of *L. bracchiolum* appears now to be the western edge of the Appalachian
range. No specimens were found on a recent collecting trip to the Ozark Mountains and
Ouachita Mountains of Arkansas.

Disscussion.—*Leiobunum bracchiolum* resembles *L. politum* very closely upon casual
observation and has undoubtedly been confused with and described as *L. politum* in the
past. The two species are quite distinct in both size and in the structure of the penis (Figs.
1-4) which is the most diagnostic feature in their separation. The structure of the penis,
pedipalp and to a lesser degree the body of *L. politum* and *L. bracchiolum* leads to the
conclusion that these species are closely related phylogenetically.

The males can be easily distinguished, but the females of these species are much more
difficult to separate. In general, the females of *L. politum* are larger and slightly more
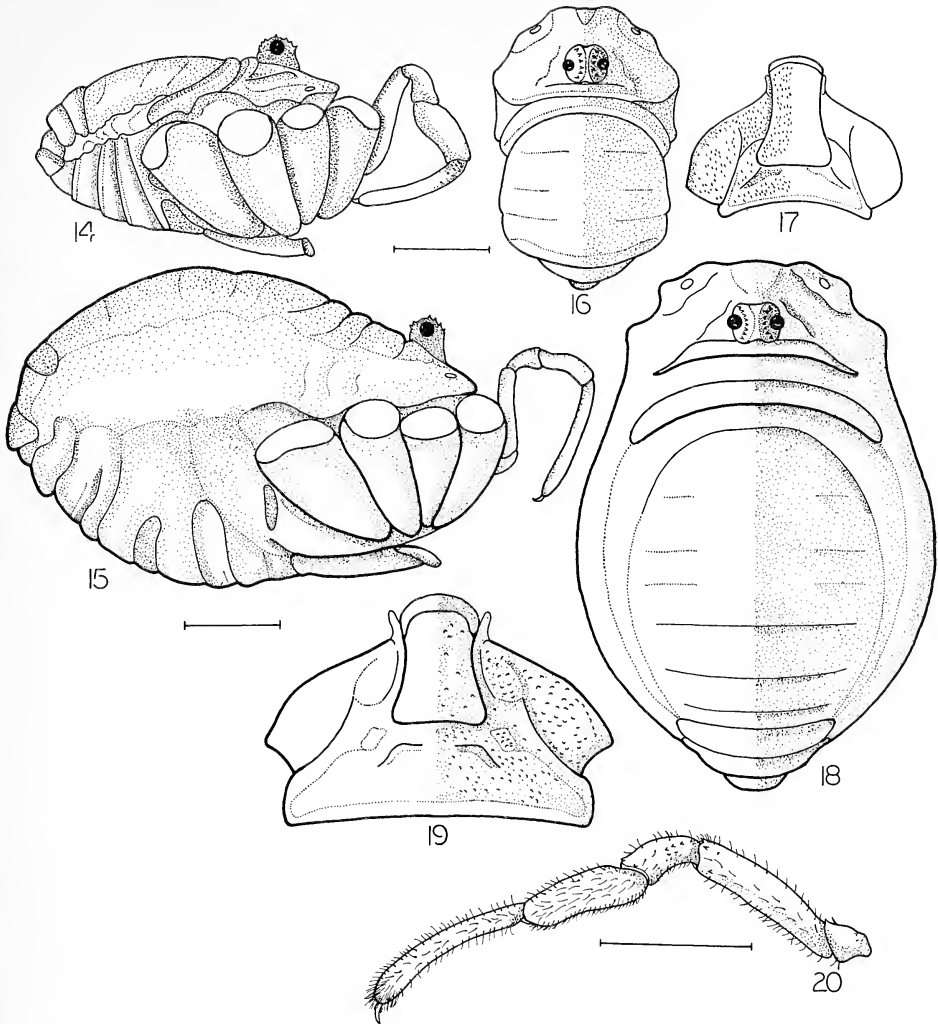
Figs. 14-15.—*L. bracchiolum* male and female lateral view.
Figs. 16-17.—*L. bracchiolum* male dorsum and genital operculum.
Figs. 18-19.—*L. bracchiolum* female dorsum and genital operculum.
Fig. 20.—*L. bracchiolum* male pedipalp posterior (lateral) view.

robust than are the females of *L. bracchiolum*. Females are fairly easily separated in large samples where both species are present. Almost nothing is known of the life cycle of *L. bracchiolum*. Data from collections indicates that it may have a cycle somewhat similar to *L. politum*, but this is speculative. The ranges of the two species overlap and they have, on a number of occasions, been collected from the same habitat.

Leiobunum holtae, new species

Diagnosis.—Large phalangids, males 7.5 mm to 9.0 mm total length; females 10.0 mm to 12.0 mm total length, genital operculum greater than 2.0 mm in length; penis greater than 5.5 mm in length, narrow, laterally compressed distally, dorsoventrally compressed
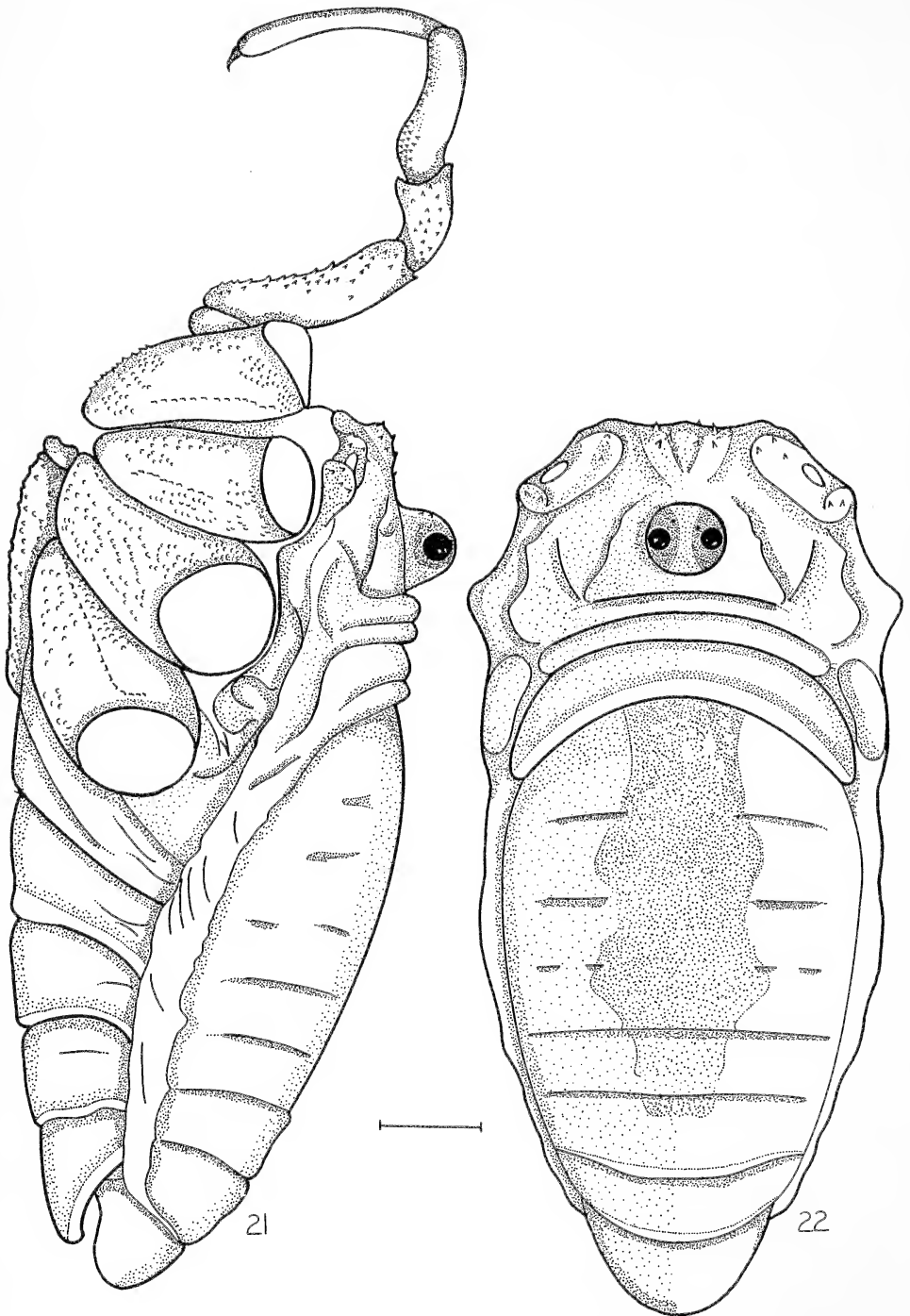
Figs. 21-22.—*L. holtae* male lateral and dorsal view.

posteriorly; male pedipalps large, robust and heavily armed with spines.

Type specimens.–Male holotype and female allotype and male and female paratypes are in the collection of the American Museum of Natural History. Several paratypes are in the collection of the author at Middle Tennessee State University, Murfreesboro, Tennessee.

Type locality.–Cumberland Mountain State Park, Cumberland Co., Tennessee, 22 June and 17 August, 1967.

Etymology.–It is with pleasure that I give *Leiobunum holtae* to Mrs. Virgie F. Holt, a gracious lady, a good friend and a native of the Tennessee Cumberland Plateau where this species was discovered.

Description (Male).–The penis (Figs. 5, 6) consists of a very long slender shaft, which is posteriorly dorsoventrally compressed and anteriorly laterally compressed. A single, inconspicuous, elongated bulbus extends along the ventral side of the distal end of the shaft. The pedipalpal femur (Fig. 27) is armed with a row of spines posteroventrally and anteroventrally, a few spines dorsally, and a rather large cluster of spines posteroventrally near the distal end. The patella has a row of spines around the distal edge with numerous small spines scattered over all surfaces, except the ventral. The tibia has a row of spines anteroventrally near the distal end, a conspicuous group proximoventrally and a few scattered around the distal end. Spines on the palpal tarsus are large and well developed. The carapace and abdomen (Figs. 21, 22) range from yellowish to reddish or brownish-yellow, and the ocular tubercle is dark brown to black with the mid longitudinal line usually concolorous with the carapace and is armed with only a few (0-3) poorly developed spines which appear as low rounded knobs in most specimens. The dorsal mark is reddish-brown and usually weakly developed on all tergites except I. The ventrum (Fig. 25) is pale brown-yellow with the genital opercular denticles well developed and extending one-half to three-fourths the length of the operculum. The operculum has a heavily chitinized lip which, in most specimens, is distinctly grooved, a feature which has not been observed in other species of *Leiobunum.*

Description (Female).–The females (Figs. 23, 24) of this species are perhaps the largest of the North American phalangids. They have about the same general coloration and marking as the males and can be easily identified as *L. holtae* when males are collected with them. Their spination and development of genital opercular denticles (Fig. 26) is also similar to that of the males. The lip of the operculum is more heavily chitinized and deeply grooved than the male structure.

Distribution.–*Leiobunum holtae* is known from Cumberland, Sequatchie, Van Buren and Grundy Counties in eastern Tennessee and from Clay and Marshall Counties in northeastern Alabama (Fig. 28). Its distribution, thusfar, includes only the southern portion of the Cumberland Plateau.

Discussion.–This is an interesting species in many respects. Nothing is known of its life cycle, however, mature adults have been collected from early spring to late fall. This is rather unusual since most *Leiobunum* species in the eastern United States appear to have their adult stages prevalent either in the spring or fall months, but not both. Collecting data gathered so far from numerous sites throughout the southeastern states and northward to Maryland indicates that *L. holtae* occupies a rather narrow range in the southern Appalachian region. It is very common, however, in areas where it is found. The structure of the penis is also very different from any observed in other species of the genus. Although, it has been placed with the *politum* group because of the presence of the bulbus, it is significantly different from both *L. politum* and *L. bracchiolum* and could be

considered a distinct group in view of the differences discussed.

Phylogenetic considerations.–The striking morphological similarity in penial, pedipal-pal and general body features between *L. politum* and *L. bracchiolum* is regarded as a valid argument for those two species having diverged from a close phyletic line of descent. *Leiobunum politum* may be considered to be the more primitive of the two if reduced size, reduced sclerotization, reduced spination, a reduction in degree of body segmenta-tion and a generally more fragile structure of appendages such as found in *L. bracchiolum*
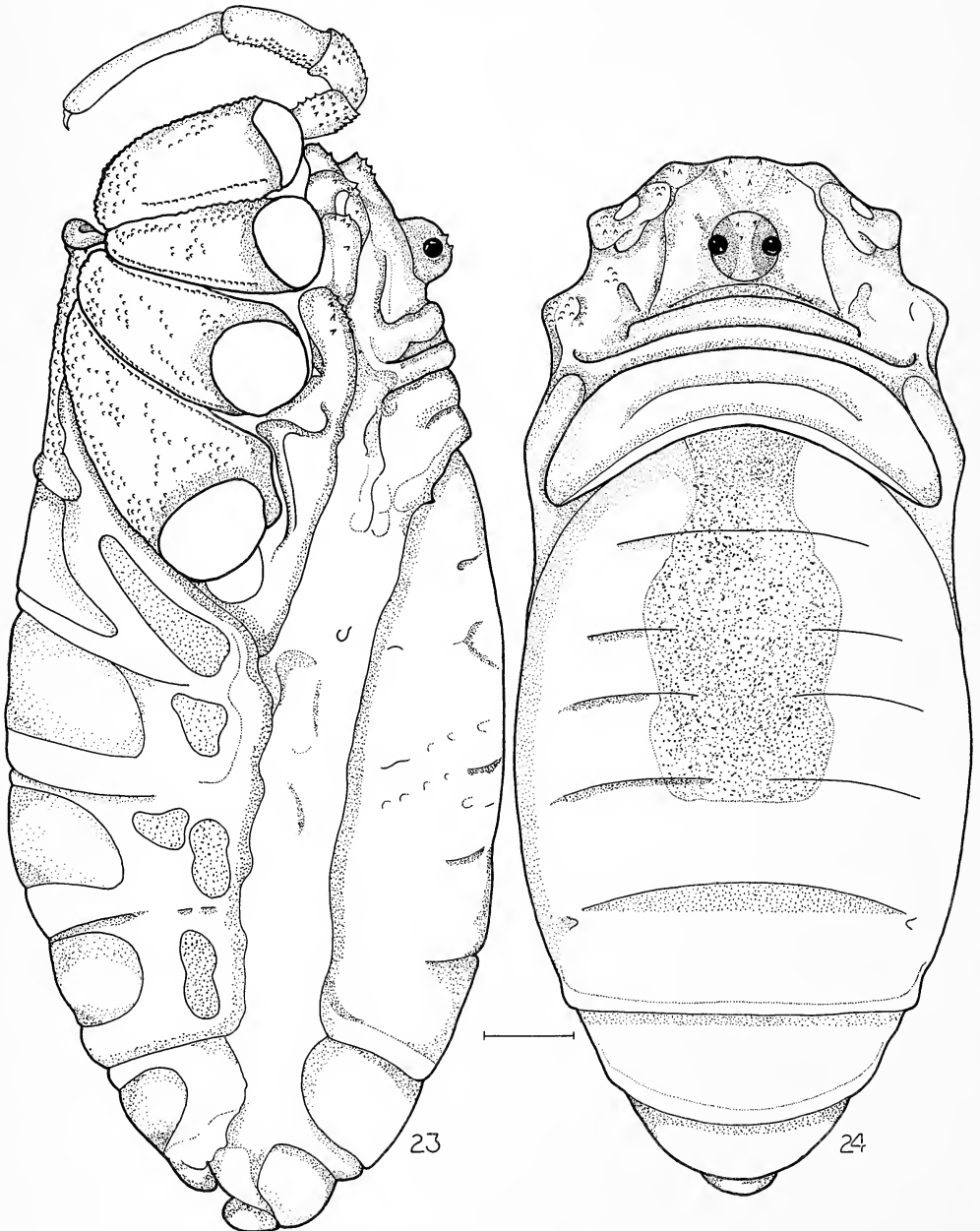
Figs. 23-24.–*L. holtae* female lateral and dorsal view.

is considered to be an advanced evolutionary condition. The double bulbus on the penial shaft is the strongest argument for close affinities between these species.

Leiobunum holtae is quite different morphologically from *L. politum* and *L. bracchiolum*. The penis has a distinctly different structure, the pedipalps are much more heavily sclerotized and bear numerous large spines, the body is heavily sclerotized and larger than any other known species of phalangid in North America. The bulbus on the *L.*
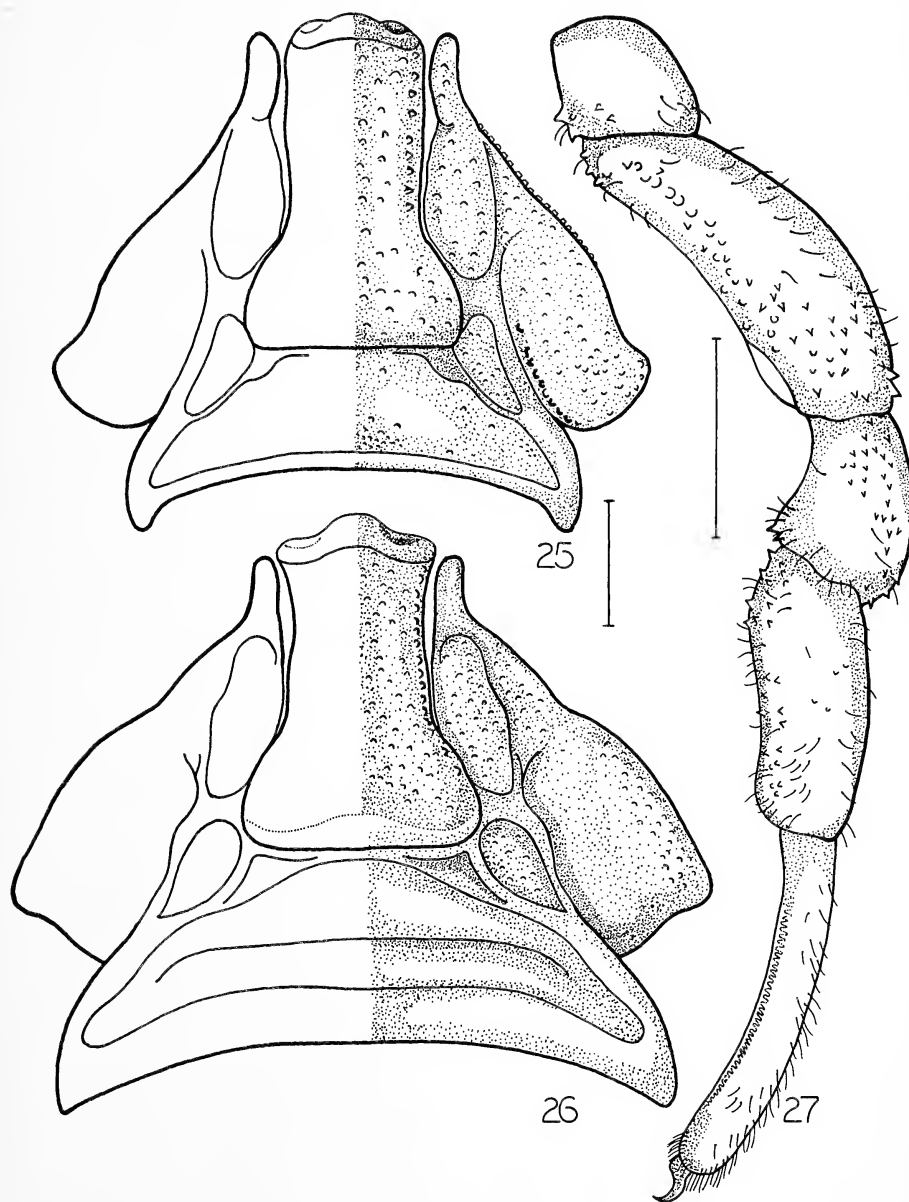
Figs. 25-26.—*L. holtae* male and female genital operculum.
Fig. 27.—*L. holtae* male pedipalp posterior (lateral) view.

holtae penis is interpreted as being of an evolutionary line related to the *politum-bracchiolum* line, but the single nature of the bulbus and the completely different structure of the penial shaft indicates a divergence far removed from the double bulbus condition of *L. politum* and *L. bracchiolum*. There is little reason to doubt the close and probably relatively recent divergence of *L. bracchiolum* from *L. politum* or a similar ancestor, however, *L. holtae*'s affinities within this group are less clear and the question as to how it should be grouped with the other two is open. Collection data so far suggests that *L. holtae* may well be a relict species surviving only in the more remote areas of the Cumberland Plateau region of Tennessee and Alabama.
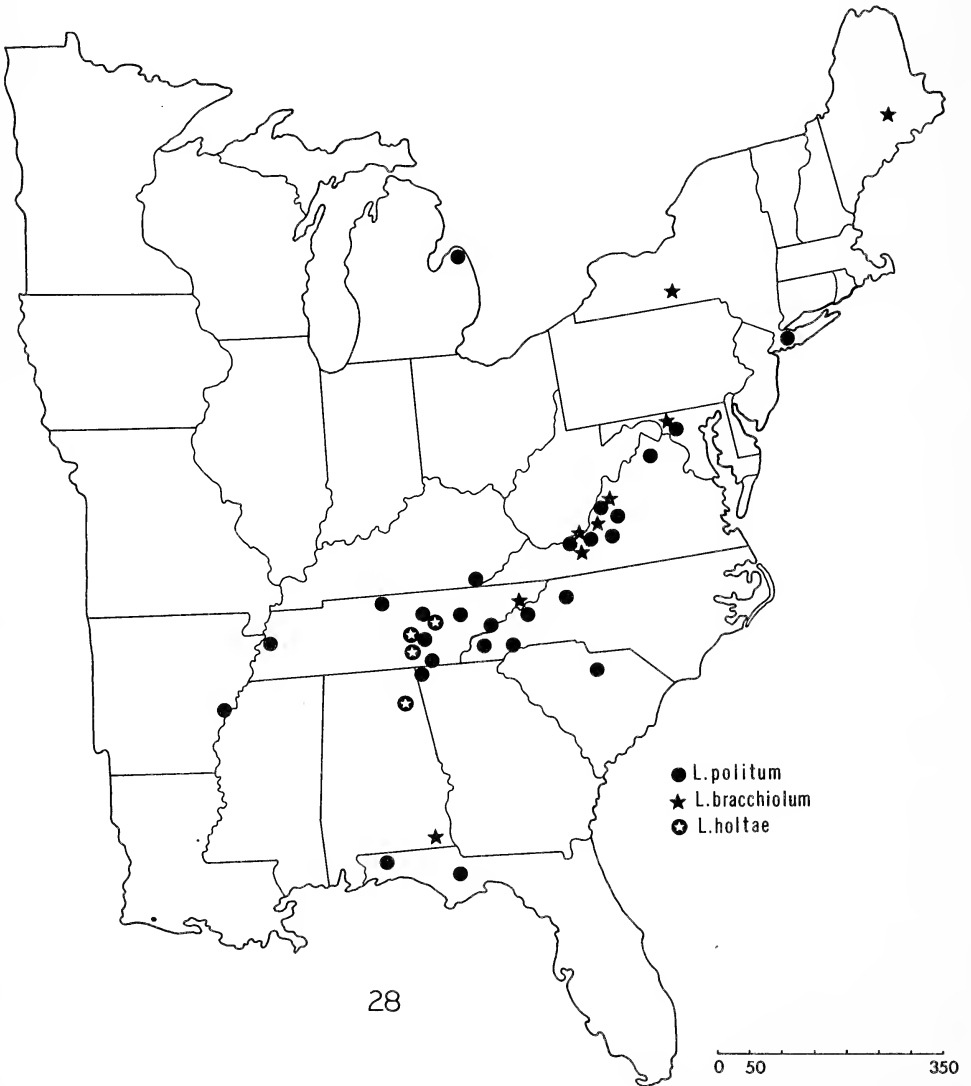
Fig. 28.–Distribution of *L. politum*, *L. bracchiolum* and *L. holtae* in the eastern United States.

ACKNOWLEDGEMENTS

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THE OPILIONID GENUS *NEOGOVEA* HINTON, WITH A DESCRIPTION OF THE FIRST TROGLOBITIC CYPHOPHTHALMID FROM THE WESTERN HEMISPHERE (OPILIONES, CYPHOPHTHALMI)

William A. Shear

Department of Biology
Hampden-Sydney College
Hampden-Sydney, Virginia 23943

ABSTRACT

The genus *Neogovea*, traditionally placed in the subfamily Stylocellinae of the family Sironidae, is surveyed, and two new species *N. kamakusa* and *N. mexasca*, are described. The latter is the first troglobitic cyphophthalmid to be reported from the Americas. Species of *Neogovea* are related to species of *Brasilogovea*, *Metasiro*, *Metagovea* and *Chileogovea*, in that order. The author does not formally recognize family and subfamily names in the Cyphophthalmi, believing that a complete reorganization of the group is warranted. The new term *eusternum* is coined to describe a median sternal sclerite found between the meso- and metasterna of *N. kamakusa*.

INTRODUCTION

The cyphophthalmids are peculiar, mite-like opilionids inhabiting forest litter and caves in tropical and temperate regions all over the world. Formerly thought to be rare, they are now known from abundant specimens, and many new species have recently been described. Hoffman (1963) has reviewed the history of the New World forms, and Martens (1969) has added a new species of *Metagovea*, and a monotypic new genus, *Brasilogovea*, both from Brazil.

The higher classification of the group has been reviewed by Rosas Costa (1950) and Juberthie (1969). Despite these efforts a number of problems remain to be solved. The lumping of all known cyphophthalmids into the single family Sironidae is extreme; at least three clearly defined family-level groups can be discerned in the world fauna. Further, the subdivision of this family into the subfamilies Sironinae and Stylocellinae on the basis of the degree of fusion of the second leg coxae is obviously artificial; I follow Hoffman (1963) in declining to use subfamily names until the entire group can be studied. Hoffman (1963) and Juberthie (1969) have independently pointed out a number of taxonomic characters not used by previous authors. Among these are the teeth of the chelicerae, position of the ozophores, ornamentations of the fourth male metatarsi, form of the penis and ovipositor, and form of the endites of the second and third leg coxae (mesosterna and metasterna of Hoffman). Traditionally used characters include the presence or absence of grooves between the abdominal tergites, form of the corona analis, and form and position of the adenostyles. Only the most recent work on cyphophthalmids includes descriptions and illustrations specifically designed to exploit all these characters, so the whole group will probably have to be restudied before a phylogenetic classification can be arrived at.

A few years ago, I began a revision of the North American species of cyphophthalmids, and recently decided to include the genus *Neogovea* because its known members seem to be rather closely related to species of *Metasiro* from the southern United States. When Dr. J. Mark Rowland of Texas Tech University kindly sent me a new troglobitic cyphophthalmid from Mexico, and it turned out to be a member of *Neogovea*, it seemed best not to delay publication of my work on this genus. The account that follows, plus the redescription of the type species, *N. immsi* Hinton, by Martens (1969) gives a complete picture of our knowledge of the genus up to the present.

My forthcoming revision of the North American fauna, with descriptions of several new species, will be the proper place to expand on my comments above concerning the families and subfamilies of cyphophthalmids.

Genus *Neogovea* Hinton

Neogovea Hinton 1938, Ann. Mag. Nat. Hist. 11(2):333; Rosas Costa, 1950, Arthropoda (Org. Asoc. Argent. Arthropodol.) 1(2-4):139; Hoffman, 1963, Senck. Biol. 44(2):137; Martens, 1969, Beitr. z. Neotrop. Fauna 6(2):110. *Sirula* Goodnight and Goodnight 1942, Amer. Mus. Nov. 1167:1.

Type Species.—Of *Neogovea*, *N. immsi* Hinton, by original designation and monotypy; of *Sirula*, *Siro kartabo* Davis, by original designation and monotypy.

Diagnosis.—In *Metagovea* species, the mesosternal and metasternal elements are usually fused, and show sexual dimorphism, and the adenostyle does not end in a brush of setae; in *Brasilogovea* (which may be a synonym of *Neogovea*) the penis is not apically flattened; in *Metasiro* species the fourth coxae meet broadly anterior to the gonostome, not narrowly as in *Neogovea*.

Description.—Medium sized to large cyphophthalmids of typical appearance. Grooves between abdominal tergites and median groove present or absent. Ozophores removed from margin of scute but not fully dorsal; openings terminal or ventral. Eyes absent. Anterior margin of scute with square emargination above chelicerae, laterally prolonged as squared flange on either side of cheliceral insertions. Claws of legs III and IV toothed in all species, of legs I and II in all species except *N. mexasca*. Cheliceral teeth blunt, small, irregular. Mesosterna always present, arcuate, anterior portion broadest; metasterna absent or present, small if present; eusternal sclerite sometimes present. Gonostomal lobes of fourth coxae meeting narrowly anterior to gonostome. Genital lobe of first abdominal sternite distinct. Dorsum smooth or pebbled, with few setae; legs heavily pebbled. Fourth metatarsus of male not divided; adenostyles ending in brush of setae; metatarsi completely ornamented. Anal glands not detected. Penis as in Figs. 9 and 15. Ovipositor of the usual type, sensillae as setose knobs on apical lobes. No sexual dimorphism in ventral thoracic complex.

Remarks.—1. Useful taxonomic characters. The form of the penis links all species for which males are known. Interspecific variation is concentrated in the setation and the form of the distal structures (cf. Figs. 9 and 15). The form of the mesosterna and metasterna and the presence or absence of a eusternal sclerite (*eusternum*: ventral remnant of a true thoracic sternite ventrally exposed between the mesosterna and metasterna. The dorsal wall of the gonostome is formed from the thoracic sternite, and this wall is continuous with the small triangular eusternal sclerite exposed in *N. kamakusa*) is also important, as are the shapes of the lobes from the fourth coxae forming the anterior and

lateral walls of the gonostome. In *Siro*, *Rakaia* and other cyphophthalmids, there is sexual dimorphism in the ventral thoracic complex and gonostome, but this does not appear to be the case in *Neogovea*.

Hinton (1938) has already remarked, in describing the genus, that the first coxae of *N. immsi* are only "slightly movable." Since the mobility of the coxae is a prime (indeed virtually the only) distinction between the nominate subfamilies Sironinae and Stylocellinae, it is of interest to note that in *N. mexasca* coxa I is entirely free and easily pulled off with the leg. In *N. kartabo* and *N. kamakusa*, the first coxa is immobile and fused to the second coxa as well as the dorsum.

The importance of toothed vs. smooth claws is not yet fully understood, but the character is not consistently distributed between the subfamilies.

The position and form of the adenostyle has been accorded great significance in the cyphophthalmids, probably because it is easy to observe. All *Neogovea* species are related by having the adenostyle end in a brush of setae, as in *Metasiro* and *Brasilogovea*. The form of the adenostyle is of importance, but its relative position on the tarsus is only of species-level significance.

2. Relationships. *Neogovea* species are closest to *Brasilogovea microphaga* Martens, from near Manaus, Brazil (Martens, 1969). *Brasilogovea microphaga* (which I have not seen) was evidently placed in a new genus because of the slightly different form of the penis and adenostyle, which is removed about half the length of the tarsus from its base. The penis is still of the same general form as that found in species of *Neogovea*, and *N. kamakusa* has the adenostyle distant from the base of the tarsus. Perhaps *Brasilogovea* could be synonymized with *Neogovea* at some future time, when generic taxa are better understood. Unfortunately, Martens (1969) does not clearly illustrate the ventral thoracic complex of *B. microphaga*.

Juberthie (1969) placed *Metasiro americanus*, from Florida, USA, in the Sironinae. *Neogovea* species are traditionally considered stylocellines, but there are some very clear relationships between the two genera, such as the form of the metasterna, the position and form of the adenostyle, and the toothed claws. The penis of *M. americanus* is not of the usual sironine type, especially as concerns the setation, in which it resembles species of *Chileogovea* and possibly *Neogovea*. The discovery of males of *N. mexasca* might help to solve this problem.

Metagovea is a genus of two species from South America. The adenostyle of *M. oviformis* Martens is as in *M. disparunguis* Rosas Costa, the generotype, but the latter has all the sternal elements fused together, while the former has distinct mesosterna and metasterna (Martens, 1969). More than one genus may be included in *Metagovea*.

Chileogovea oedipus Roewer has been redescribed in detail by Juberthie and Muñoz-Cuevas (1970). The ozophores are more dorsal than in any of the foregoing, but the penis is quite like that of *Metasiro americanus* and also similar to that of *Metagovea oviformis*. The ventral thoracic complex in much like *Neogovea kamakusa*, but the adenostyle is likewise closer to the form found in *Metagovea*. The claws are not toothed.

All the Neotropical cyphophthalmids, plus *Metasiro americanus*, are not surprisingly related to a greater or lesser degree, but their relationships to the New Zealand and South African forms remains to be clarified. Juberthie and Muñoz-Cuevas (1970) see definite relationships between the Chilean *Chileogovea oedipus* and the New Zealand species of *Rakaia*.

KEY TO SPECIES OF *NEOGOVEA*

1a. Troglobitic; legs long and attenuate (Figs. 22, 23); color medium brown; dorsum of abdomen without conspicuous transverse grooves (Fig. 16); claws of legs I and II smooth; Oaxaca, Mexico . . . . *mexasca* n. sp.

1b. Not troglobitic; legs typically short and stout (Fig. 8); color very dark brown to black; dorsum of abdomen with conspicuous transverse grooves (Fig. 1); claws of legs I and II with small teeth 2

2a(1b). Length of adult male about 4.5 mm; adenostyle not at base of tarsus IV (Fig. 12); penis as in Fig. 15; Guyana . . . . *kamakusa* n. sp.

2b. Length 3.0-3.5 mm or less; adenostyle at base of tarsus or slightly removed (fig. 8); penis as in Fig. 9 or as in Martens' (1969) Fig. 5 3

3a(2b). Adenostyle at base of tarsus (Fig. 8); penis with distal prongs at first converging (Fig. 9); Guyana . . . . *kartabo* (Davis)

3b. Adenostyle slightly removed from base of tarsus; penis with distal prongs diverging at an acute angle; Pará, Brazil . . . . *immsi* Hinton

Neogovea immsi Hinton

Neogovea immsi Hinton 1938, Ann. Mag. Nat. Hist. 11(2):334-338, Figs. 1-16; Martens, 1969, Beitr. z. Neotrop. Fauna 6(2):110-111, Figs. 1-8.

The excellent original description by Hinton (1938) and the supplementary one by Martens (1969) require no amplification here. The types are from Punta dos Indio, state of Pará, Brazil, and were collected under logs in a moist forest; they are deposited in the British Museum (Natural History).

Neogovea kartabo (Davis)
Figs. 1-9

Siro kartabo Davis, 1937, J. N. Y. Ent. Soc. 45:133, Figs. 1-12.
Sirula kartabo, Goodnight and Goodnight, 1942 (in part), Amer. Mus. Nov. 1167:1, no Figs. Record from Kamakusa refers to *N. kamakusa*, n. sp.

Type specimens.—Male holotype and male and female paratypes from Kartabo, Bartice District, Guyana, collected by A. E. Miller, no date given, deposited in American Museum of Natural History, examined.

Diagnosis.—The adenostyle is close to the base of the tarsus and metasterna are apparently absent. *Neogovea kamakusa*, also from Guyana, is one-third larger.

Description.—Male holotype. Length, 2.87 mm, width over tips of ozophores, 1.40 mm, maximum width 1.62 mm. Dorsum as in Fig. 1; ozophore openings ventral. Ventral thoracic complex: endites of coxae I long, narrow. Mesosterna arcuate, anterior lobe wider. Metasterna absent, mesosterna in contact with anterior wall of gonostome formed from lobes of coxae IV. Gonostome about as wide as long; distinct anterior and lateral marginal elements from coxae IV; ventral element from abdominal sternite I distinctly

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Figs. 1-7.—Anatomy of male *Neogovea kartabo*: 1, body, dorsal view; 2, thorax, ventral view; 3, left spiracle, ventral view; 4, left chelicera, lateral view; 5, right palpus, mesal view; 6, left adenostyle, mesal view; 7, tip of tarsus of left leg IV, lateral view.
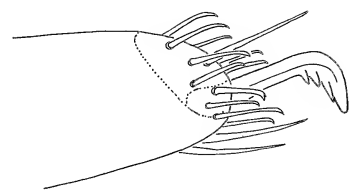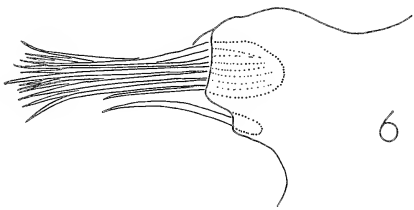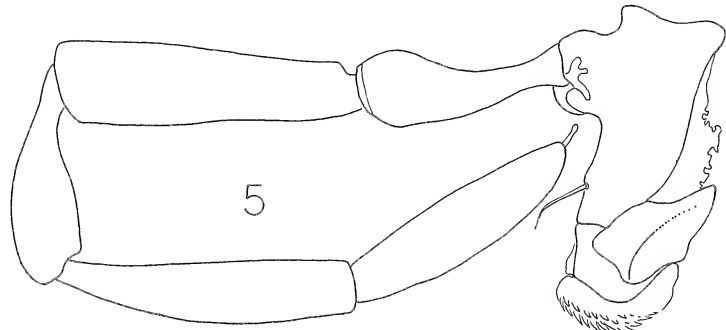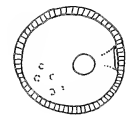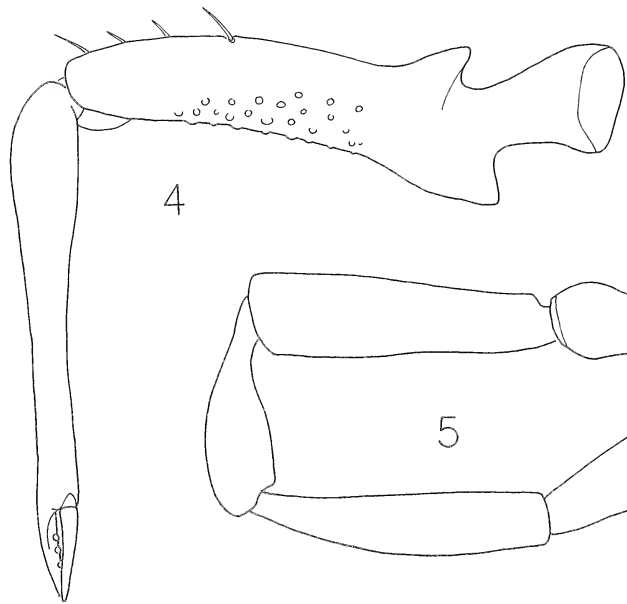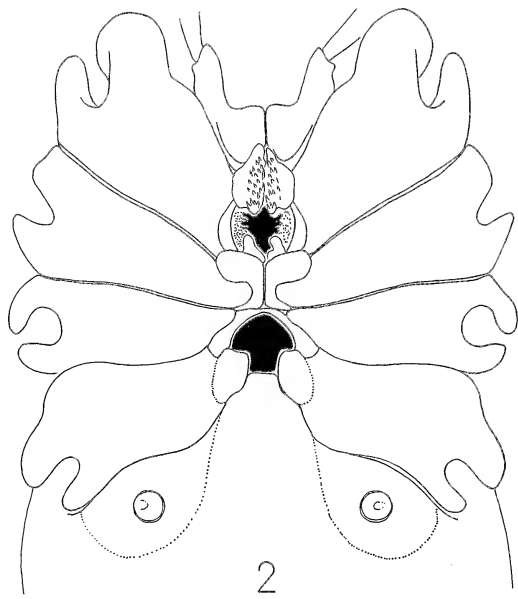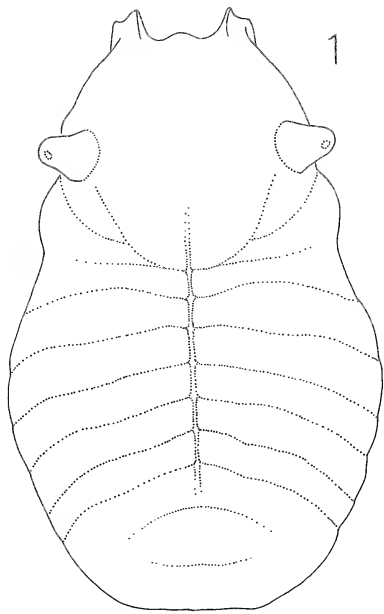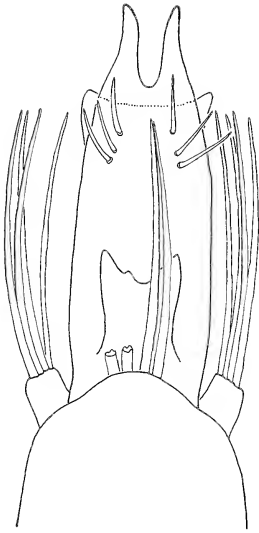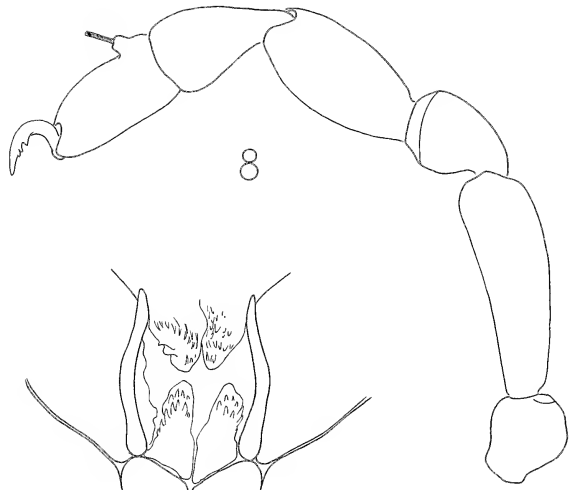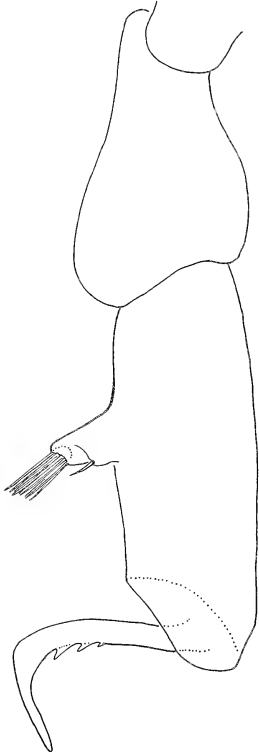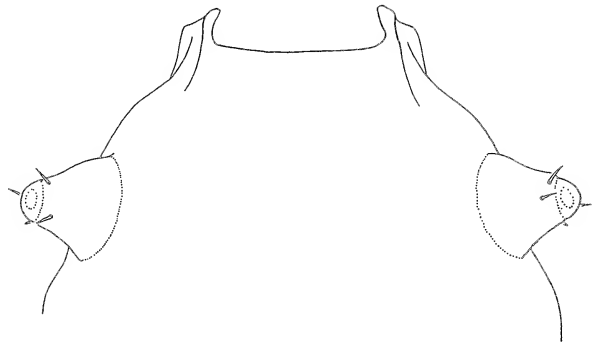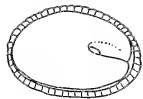
narrowed between coxae IV. Spiracular grooves present, spiracles as in Fig. 3. Chelicerae typical of genus, as in Fig. 4; first article 1.11 mm long, 0.21 mm wide, second article 1.23 mm long, 0.15 mm wide. Pedipalp as in Fig. 5; trochanter lacks ventral processes, measurements given below. Legs densely covered with pebbled cuticular pattern, including all metatarsi; setation typical, becoming very dense on tarsi. Leg formula 1423. Tarsus of leg I basally swollen, heavily set with sensory (?) hairs ventrally, claws with 2 or 3 minute teeth. Leg IV (Fig. 8) with metatarsus completely pebbled; tarsus with adenostyle near base; claw with lateral rows of three teeth (Fig. 7). Adenostyle with brush of apical setae, and subterminal accessory seta; distal part not set off by groove. Anal glands not detected. Penis in dorsal view as in Fig. 9. Color dark brown, nearly black. Measurements of legs and palpus as follows:

	palpus	I	II	III	IV
trochanter	0.34	0.38	0.38	0.36	0.43
femur	0.48	1.06	0.86	0.77	0.85
patella	0.37	0.51	0.43	0.43	0.51
tibia	0.45	0.81	0.64	0.51	0.68
metatarsus	———	0.38	0.37	0.37	0.49
tarsus	0.43	0.68	0.60	0.55	0.64

Female paratype. Structure as in male except for sexual differences. Total length, 3.00 mm, width across tips of ozophores, 1.30 mm, maximum width, 1.50 mm. Chelicerae: First article 1.05 mm long, 0.20 mm wide, second article 1.22 mm long, 0.15 mm wide. Ovipositor typical, apical sensillae setose knobs. Measurements of legs and palpus as follows:

	palpus	I	II	III	IV
trochanter	0.38	0.36	0.32	0.37	0.43
femur	0.52	0.98	0.81	0.68	0.87
patella	0.34	0.51	0.43	0.39	0.51
tibia	0.44	0.72	0.55	0.49	0.68
metatarsus	———	0.42	0.41	0.34	0.47
tarsus	0.36	0.60	0.49	0.42	0.51

Distribution.—Known only from the type locality.

Remarks.—Perhaps the absence of metasterna mark *N. kartabo* as the most highly evolved member of the genus.

Neogovea kamakusa n. sp.
Figs. 10-15

Sirula kartabo, Goodnight and Goodnight, 1942 (in part, not *S. kartabo* (Davis). Only the record from Kamakusa refers to this species, the juvenile from Tukeit is a *Neogovea* but cannot be placed as to species.

Type specimen.—Male holotype from Kamakusa, Essequibo District, Guyana, collected January, 1923, by H. Lang, deposited in American Museum of Natural History. The

Figs. 8-13.—Anatomy of male *N. kartabo* and male *N. kamakusa*: 8, 9, *N. kartabo*: 8, left leg IV, posterior view; 9, penis, dorsal view; 10-13, *N. kamakusa*: 10, thorax, ventral view; 11, anterior part of body, dorsal view; 12, left leg IV, tarsus and metatarsus, mesal view; 13, left spiracle, ventral view.

species epithet refers to the type locality. Despite the great difference in size between *N. kamakusa* and *N. kartabo*, Goodnight and Goodnight (1942) failed to recognize the type specimen as representing an undescribed species.

Diagnosis.—The large size, 4.5 mm in length, separates this species from all the others.

Description.—Male holotype. Total length, 4.50 mm, width across tips of ozophores, 2.30 mm, maximum width, 2.55 mm. Dorsum much as in *kartabo*, cuticle smooth but with mat surface faintly irridescent; ozophores somewhat more lateral than in *kartabo*, openings ventral (Fig. 11). Ventral complex: As in Fig. 10. Mesosterna with anterior lobes broader than in *kartabo*; metasterna small and subtriangular; posterior lobes of meso-sterna separated by small, triangular eusternal sclerite. Gonostome somewhat wider than long, anterior and lateral walls formed by lobes of coxae IV, lateral and anterior portions not distinct as in *kartabo*, edges of lateral lobes irregular. Posterior wall formed by extension from first abdominal sternite set off by definite groove. Spiracular grooves present, spiracle as in Fig. 13. Chelicerae typical; first article 1.92 mm long, 0.33 mm wide, second article 1.88 mm long, 0.27 mm wide. Palp as in *kartabo*, measurements given below. Legs densely covered with pebbled cuticular pattern. Adenostyle nearly half length of tarsus from base of tarsus (Fig. 12), apical portion set off by definite groove above accessory seta; hairs of brush somewhat modified (Fig. 14). Anal glands not detected. Penis in dorsal view as in Fig. 15. Color dark brown, nearly black, appearing black without magnification. Measurements of legs and palpus as follows:

	palpus	I	II	III	IV
trochanter	0.53	0.57	0.45	0.53	0.56
femur	0.87	1.50	1.20	1.05	1.28
patella	0.48	0.75	0.60	0.45	0.65
tibia	0.72	1.17	0.75	0.75	0.90
metatarsus	——	0.60	0.90	0.68	0.68
tarsus	0.53	0.98	0.90	0.83	0.98

Female unknown.

Distribution.—Known only from the type locality.

Remarks.—*Neogovea kamakusa* is a very large cyphophthalmid, certainly the largest new world form.

Neogovea mexasca n. sp.
Figs. 16-24

Type specimens.—Female holotype and paratype from Cueva del Nacimiento del Río San Antonio, 10 km SSW of Acatlán, Oaxaca, México, collected 31 December 1973 by James Reddell, William Elliott and Roy Jameson, deposited in the American Museum of Natural History. The species epithet is a neologism referring to the Association for Mexican Cave Studies.

Diagnosis.—The light color and long, thin legs (Figs. 22, 23) set *N. mexasca* off from all other species. It is also the only cyphophthalmid known from the region between Florida and Guyana.

Figs. 14-20.—Anatomy of male *N. kamakusa* and female *N. mexasca*: 14, 15, *N. kamakusa*: 14, left adenostyle, mesal view, enlargements show specialized setae; 15, penis, dorsal view; 16-20, *N. mexasca*: 16, body, dorsal view; 17, thorax, ventral view; 18, left chelicera, lateral view; 19, claw of leg III; 20, claw of leg IV.

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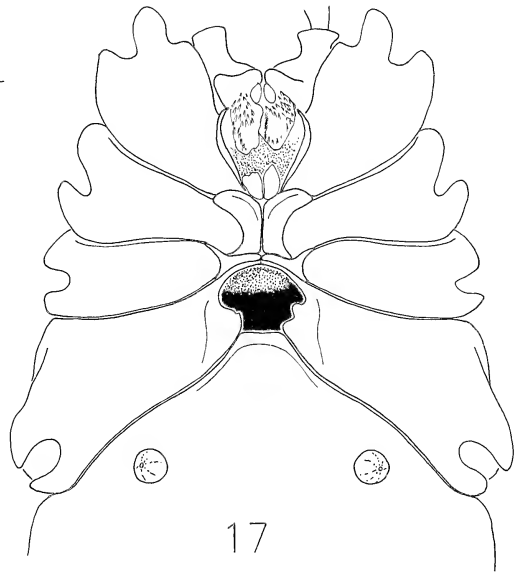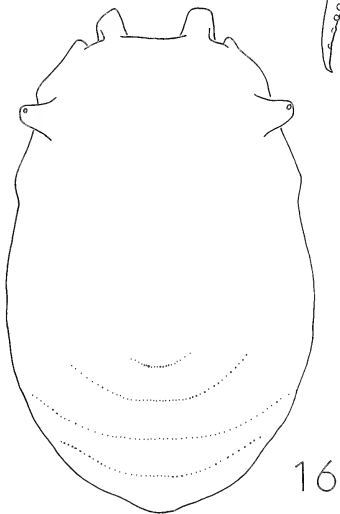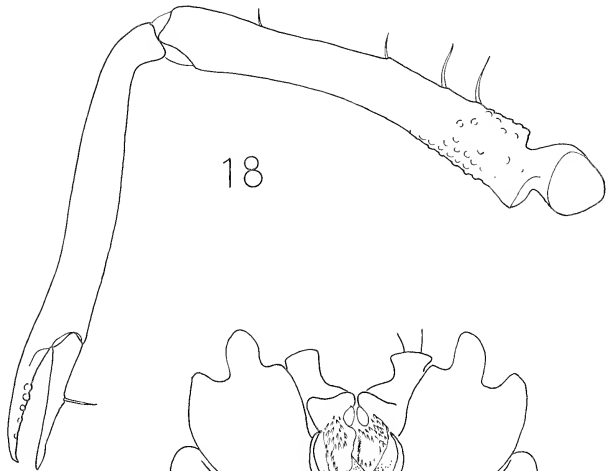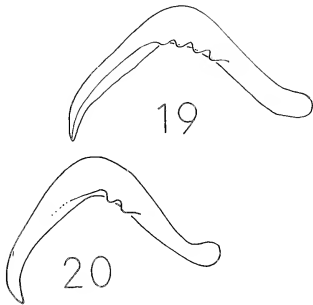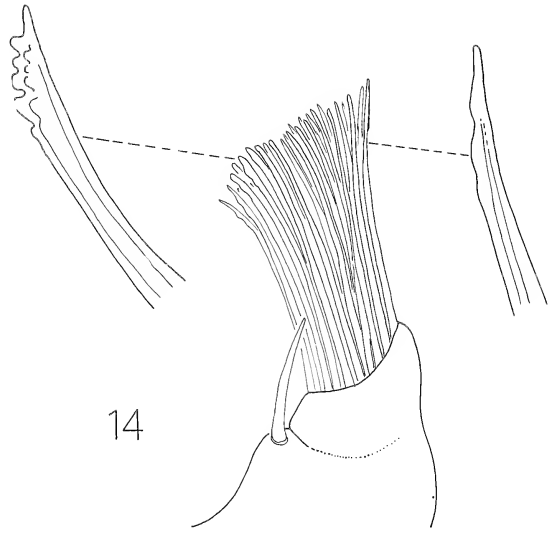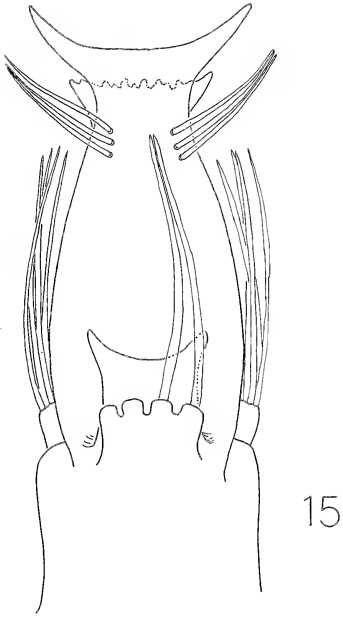
Description.—Female paratype. Length, 2.10 mm. Width across tips of ozophores, 1.02 mm, greatest width 1.21 mm. Dorsum as in Fig. 16; median groove lacking, abdominal segmental grooves faintly detectable only on posterior part of body. Cuticle of dorsum with dense pebbled pattern slightly finer than that found on legs. Ozophore openings terminal. Ventral complex (Fig. 17): Much as in *N. kamakusa*, with small but distinct metasterna present, no eusternal sclerite. Gonostome about as wide as long, wall formed by lobes of coxae IV not as distinct as in other species. Posterior wall rebordered, lobe of abdominal sternite not set off by groove. Spiracular grooves absent. Chelicerae (Fig. 18) typical, but basal article narrower than in surface species, 1.19 mm long, 0.16 mm wide, distal article 1.07 mm long, 0.12 mm wide. Teeth as in Fig. 24 (movable finger below). Palpus attenuate, trochanter without process (Fig. 21). Legs attenuate, heavily pebbled as in other species, scattered setae longer, denser, becoming very dense on tarsi. Tarsus of leg I not basally swollen (Fig. 23). Claws of legs I and II apparently smooth, of III and IV toothed (Figs. 19, 20). Leg IV as in Fig. 22. Ovipositor typical of family, apical sensillae
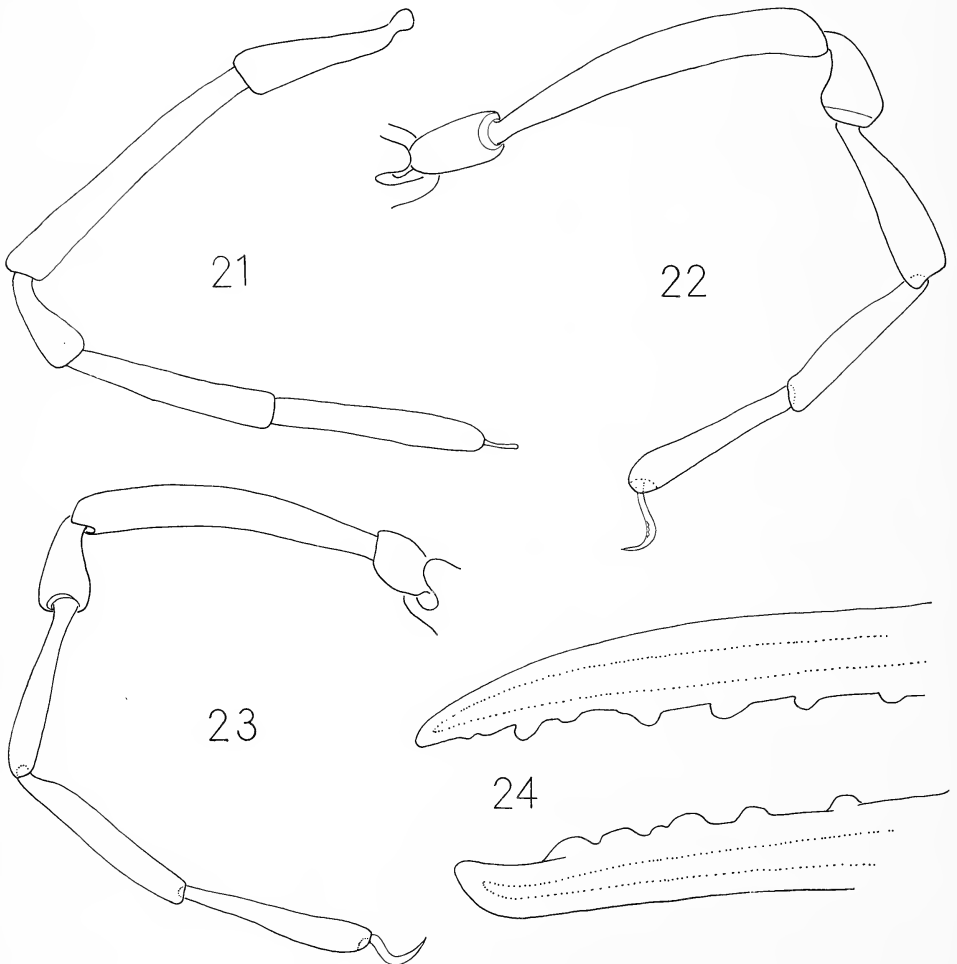
Figs. 21-24.—Anatomy of female *N. mexasca*: 21, left palpus, lateral view; 22, left leg IV, anterior view; 23, left leg I, posterior view; 24, fingers of chelicera, anterolateral view.

as setose knobs; typical seminal receptacles present. Color medium golden brown, slightly lighter on legs. Measurements of legs and palpus as follows:

	palpus	I	II	III	IV
trochanter	0.31	0.30	0.32	0.29	0.34
femur	0.60	1.12	1.19	0.89	1.06
patella	0.23	0.38	0.38	0.34	0.38
tibia	0.47	0.72	0.68	0.51	0.60
metatarsus	----	0.64	0.65	0.55	0.55
tarsus	0.47	0.72	0.72	0.55	0.65

Male unknown.

Distribution.–Known only from the type locality.

Remarks.–*Neogovea mexasca* is the first western hemisphere cyphophthalmid showing troglobitic adaptations: light color, reduced sclerotization, and much lengthened append-ages. The general appearance of the animal suggests intermediacy between *Metasiro ameri-canus* and the other species of *Neogovea*, and a new generic name may be warranted when males are discovered. Material is rare at the type locality (Reddell, Pers. Comm.). Only a few troglobitic cyphophthalmids have been found, including species of *Speleosiro* from South Africa and *Tranteeva* from central Europe. *Neogovea mexasca* does not appear at this time to show relationship to either genus.

ACKNOWLEDGEMENTS

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FUMONTANA DEPREHENDOR, N. GEN., N. SP., THE FIRST TRIAENONYCHID OPILIONID FROM EASTERN NORTH AMERICA (OPILIONES: LANIATORES: TRIAENONYCHIDAE)

William A. Shear

Biology Department
Hampden-Sydney College
Hampden-Sydney, Virginia 23943

ABSTRACT

Fumontana deprehendor, n. gen., n. sp., is the first member of the family Triaenonychidae, subfamily Triaenonychinae to be reported from eastern North America. Anatomical features of the new species relate it both to the species of western North America and of the southern hemisphere. Incidental observations: The subfamily name Triaenonychinae should be attributed to Soerensen, not Pocock. Travunioidea is the proper spelling for a superfamily name based on the genus *Travunia.*

INTRODUCTION

The taxonomy of the laniatorid opilionids of the New World is currently undergoing a drastic reorganization at the family level. Traditionally, three families, Phalangodidae, Cosmetidae, and Triaenonychidae, have been considered represented in the North American fauna, with the latter restricted to a few species in the western part of the continent, and the former two more widespread across the southern half. Recently, using characters and concepts developed by Kratchovíl and others, in a study of Central European cave opilionids, Briggs (1969, 1971a, 1971b) has recognized and named two new families, Erebomastridae and Pentanychidae, and a new triaenonychid subfamily, Paranychinae. Briggs (1974) has also reported a species of Travuniidae (*Speleonychia sengeri* Briggs) from a lava tube in Idaho. The new taxa are keyed in Briggs (1969, 1971b).

Kratchovíl, *et al.* (1958) divided the Laniatores into two superfamilies. In Oncopodoidea, the third and fourth legs of the adults bear two separate claws, and the penis lacks muscles between the dorsal and ventral plates. In Travunioidea (the correct spelling of a superfamily name based on the generic name *Travunia*), the third and fourth legs of adults bear branched claws, and there are muscles between the ventral and dorsal plates of the penis. Silhavý (1973) has proposed another classification, largely following Mello-Leitao and Ringuelet, and based on a wide variety of somatic and genitalic characters. Silhavý's system is quite different from that of Kratchovíl, *et al.*, particularly in the numbers of families recognized, and in the position accorded the peculiar Oncopodidae, which Silhavý places in a separate suborder. Although the Kratchovíl-Briggs classification has gained wide acceptance, it has two major weaknesses: it virtually ignores the tropical families well-studied by Silhavý, Ringuelet and others, and it is based much too heavily on a single character, namely the form of the posterior claws. The center of distribution

and evolution of the laniatorids is in the tropics; only when the tropical fauna has been thoroughly studied using modern methods can a meaningful classification for the group be arrived at. It seems likely that at this time there are too many family names.

Whatever the outcome of the taxonomic debate, it seems clear that the family Triaeno-nychidae forms a phylogenetic unit, though its extent is not yet entirely clear. The family is well-represented in western North America (reviewed in Briggs, 1971b), Chile, South Africa, New Zealand and Australia, and in Korea and Japan. In other opilionid groups, this pattern often includes the Appalachian Mountains in the eastern United States (Suzuki, 1967; Shear, 1975).

A few years ago, while examining the opilionid collection of the Chicago Natural History Museum, courtesy of Mr. Henry Dybas, I ran across a very peculiar laniatorid opilionid collected by him in Greenbrier Cove, Great Smoky Mountains National Park, Tennessee. The specimen, a male, closely resembles certain tropical phalangodids and podoctids in the form of the legs, eye tubercle, and spination of the scute. At first I thought it might have been mislabelled, but knowing Mr. Dybas' reputation as a careful collector and curator, I put the specimen aside and resolved to search for more material in Greenbrier Cove. That opportunity presented itself in June, 1975, through the hospitality of Dr. Frederick Coyle, of Western Carolina University, and the management of the Great Smoky Mountains National Park.

Greenbrier Cove is a mountain valley with a rather narrow entrance along the Little Pigeon River. The elevation of the valley floor is from 1200 to 2200 ft.; most of the forest is secondary and consists of the usual cove hardwoods, with hemlock important along the streams, and a dense undergrowth of *Rhododendron*, *Kalmia* and *Leucothoë*, all ericaceous shrubs. Extensive handsorting of litter produced many laniatorids, chiefly species of *Theromaster* and *Bishopella*, but none resembling the Dybas specimen. However, a sample taken back to the laboratory and sorted using Tullgren funnels produced a single female of the animal described below as *Fumontana deprehendor*. The following day, a second Tullgren sample was taken from the same spot, and litter from the region was handsorted, but no further specimens appeared.

<div align="center">

Family Triaenonychidae Soerensen
Subfamily Triaenonychinae Soerensen

</div>

The new genus *Fumontana* is placed in the subfamily Triaenonychinae because of the presence of two short branches on the posterior claws (Figs. 9, 10), the narrow sternum (Fig. 2), and the form of the genitalia (Figs. 5, 6). Roewer (1923) and Briggs (1971b), and others, attribute the subfamily name to Pocock, but according to the Rules of Zoological Nomenclature promulgated by the ICZN, the original proposal of a family-level name includes names for all coordinate family-level taxa—if there is a family name Triaenonychidae, this implies the existence of a subfamily bearing the same name. Thus the subfamily name should be attributed to Soerensen. The subfamily is found in the western United States (*Sclerobunus*, *Cyptobunus*, *Zuma*), and in Chile, New Zealand and Japan.

<div align="center">

Fumontana, n. gen.

</div>

Description.—Anterior margin of carapace with three projections, recesses above cheli-cerae distinct. Eye tubercle wider than long, situated one-third of scute length from

anterior margin. Pair of large tubercles at anterior scute corners. Five dorsal areas delimited by paired tubercles or rows of same. Ninth abdominal tergite fused to anal plate. Second and third coxae of males proximally completely fused without trace of suture, first and fourth coxae free. Sternum as in Fig. 2. Genital operculum oval-triangular. Chelicerae normal. Pedipalps sexually dimorphic, much larger in male than in female. Palpal claw movable. Leg femora, patellae and tibiae with anterior and posterior rows of spined tubercles, best developed on leg I, where tubercles are twice width of segment; femur II similar to I; tubercles much reduced on femora III and IV. Tarsal formula 3-9-4-4; basitarsi not much longer than individual distitarsal segments. Metatarsi divided into long calcaneus and short astragulus, calcaneus with distodorsal spined tubercle on all legs in female, only on legs III and IV in male. Claws of legs III and IV with lateral branches much smaller than median prong. Penis short, stout, provided with muscles between ventral and dorsal plates; glans with two flanking setose lobes; seminal canal ends in spine-like projection. Ovipositor typical of family.

Type species.—*Fumontana deprehendor*, n. sp.

Etymology.—The generic name is feminine, derived from the Latin words for "smoke" and "mountain."

Diagnosis.—Completely different from any known North American laniatorid genus in the long spined tubercles of the legs. A very few small similar tubercles are found on the femora of species of *Cyptobunus* (Briggs, 1971b), suggesting some relationship.

Fumontana deprehendor, n. sp.
Figs. 1-16

Type specimens.—Male holotype from Greenbrier Cove, Great Smoky Mountains National Park, Sevier Co., Tennessee, collected 17 September 1953 by Henry Dybas, deposited in Chicago Natural History Museum. Female paratype from Greenbrier Cove, along Porter's Creek, near its mouth, from litter sample in *Rhododendron* thicket, 1680 ft. elev., collected 23 June 1975 by W. A. Shear and F. A. Coyle, deposited in American Museum of Natural History. The specific epithet is a Latin noun in apposition, meaning "one who takes by surprise."

Description.—Male holotype. Scute 1.46 mm long, 1.28 mm wide at posterior margin. Large spines above and behind anterior lateral angles (Fig. 1), ozopores not visible in dorsal view. Anterior cephalic portion sloping steeply up to eye tubercle (Fig. 3), eye tubercle wider than long (0.34 mm wide), tipped with tubercle bearing strong spine; lenses of eyes nearly obsolete, no corneal pigment visible. Five dorsal areas demarked by pairs or rows of spined tubercles: five rows of 2, 2, 4, 4, and 8 tubercles anterior to posterior (Fig. 1). Free abdominal tergites margined with rows of spined tubercles. Cuticle of scute slightly rugose. Venter: Pedipalp coxae with small endites; leg I coxae similar. Legs II and III with coxae proximally completely fused, endite of coxa II enlarged, projecting anteriad, setose (Fig. 2). Coxae IV normal, not meeting anterior to gonostome. Sternum long, narrow, hastate. Chelicerae with first segment 0.51 mm long, 0.21 mm wide, markedly depressed in middle, with apical swelling (Fig. 4); second segment 0.49 mm long to base of movable finger, 0.26 mm wide; fingers with blunt, irregular teeth. Palpus (Fig. 11): Trochanter subglobular, with three ventral spined tubercles; femur 1.19 mm long, 0.51 mm wide; patella sharply elbowed, 0.68 mm long, 0.26 mm wide; tibia 0.77 mm long, 0.26 mm wide; tarsus much flattened, 0.81 mm long, 0.19 mm wide, with large apical claw. Spined tubercles of all palpal segments as shown in Fig.

11. Legs: Leg I with femur bearing spined tubercles twice as long as width of segment, similar tubercles reduced on distal segments (Fig. 13). Leg II (Fig. 14) similar to leg I, but tubercles of femur shorter. Leg III (Fig. 15) with spined tubercles further reduced, astragalus with large spined tubercle dorsally overhanging calcaneus. Leg IV (Fig. 16) with femur slightly sigmoid, small spined tubercles on dorsal side, ventral side slightly and

Figs. 1-10.—Anatomy of *Fumontana deprehendor*: 1, body of male, dorsal view; 2, anterior ventral region of male, ventral view (semidiagrammatic, setae and spined tubercles omitted); 3, anterior part of body of male, lateral view; 4, chelicera of female, lateral view; 5, penis, lateral view; 6, penis, subventral view; 7-10, claws of legs: 7, leg I; 8, leg II; 9, leg III; 10, leg IV.

regularly regose, astragalus as in leg III. Claws of legs I-IV as in Figs. 7-10 respectively. Measurements of legs as follows:

	I	II	III	IV
trochanter	0.21	0.26	0.21	0.26
femur	0.94	1.15	0.89	1.15
patella	0.43	0.55	0.38	0.43
tibia	0.64	0.98	0.77	1.02
astragalus	0.60	0.81	0.94	1.29
calcaneus	0.09	0.09	0.06	0.04
tarsus	0.38	0.77	0.38	0.38

Penis (Figs. 5, 6) with articulated setose lobes on ventral plate, glans apically expanded, seminal canal ending in embolus-like spine. Color translucent yellow-orange overall.

Female paratype. Scute 1.20 mm long, 1.05 mm wide, eye tubercle 0.28 mm wide. Structure as in male except as follows. Coxae II and III not basally fused, endite of coxa II not enlarged. Chelicerae with basal article 0.36 mm long, 0.18 mm wide, second article 0.43 mm long, 0.17 mm wide. Pedipalps much smaller proportionally than in male, femur 0.77 mm long, 0.30 mm wide, patella 0.46 mm long, 0.17 mm wide, tibia 0.51 mm long, 0.20 mm wide, tarsus 0.51 mm long, 0.09 mm wide (Fig. 12). Legs as in male, but distodorsal spined tubercle of astragalus overhangs calcaneus on all legs; calcaneus of leg IV virtually absent. Leg measurements as follows:

	I	II	III	IV
trochanter	0.17	0.20	0.17	0.26
femur	0.72	0.85	0.68	0.94
patella	0.34	0.43	0.30	0.38
tibia	0.48	0.72	0.68	0.79
astragalus	0.47	0.64	0.68	0.79
calcaneus	0.06	0.07	0.04	virtually absent
tarsus	0.34	0.68	0.34	0.34

Ovipositor typical of family. Color yellow, paler than in male.

Notes.–The ecology of the type locality has already been discussed.

The relationships of this remarkable animal are obscure. Briggs (1971b), in a revision of the North American triaenonychids, did not mention the fusion in males of coxae II and III; I examined males of *Sclerobunus robustus* from Colorado and found the ventral complex essentially as in *Fumontana deprehendor.* The enlarged endites of the second coxae are also found in some phalangodids and erebomastrids; they possibly serve as guides for the penis during copulation. The position and form of the eye tubercle and the presence on the scute of anteriolateral spines relates *F. deprehendor* to southern hemisphere triaenonychids, as does the ornamentation of the legs. The anatomy of the male genitalia is also very much unlike the western North American forms, and close to that of members of the South African genus *Monomontia* (Kauri, 1961) and the New Zealand genus *Hendea* (Forster, 1954, 1965). The genera *Pristobunus* and *Cenefia*, also from New Zealand (Forster, 1954), have members with legs as in *F. deprehendor*, though much shorter and stouter. Very slight but similar leg modifications are found in members of the North American genus *Cyptobunus* (Briggs 1971b), which I have not seen. On the other hand, none of the South African and New Zealand species are reported to have coxae II

and III fused in males.

Thus it would appear that as in several other Appalachian opilionids, *F. deprehendor* is an ancient relict, bridging gaps between traditional groups, and suggesting a wide precontinental drift distribution of its family.
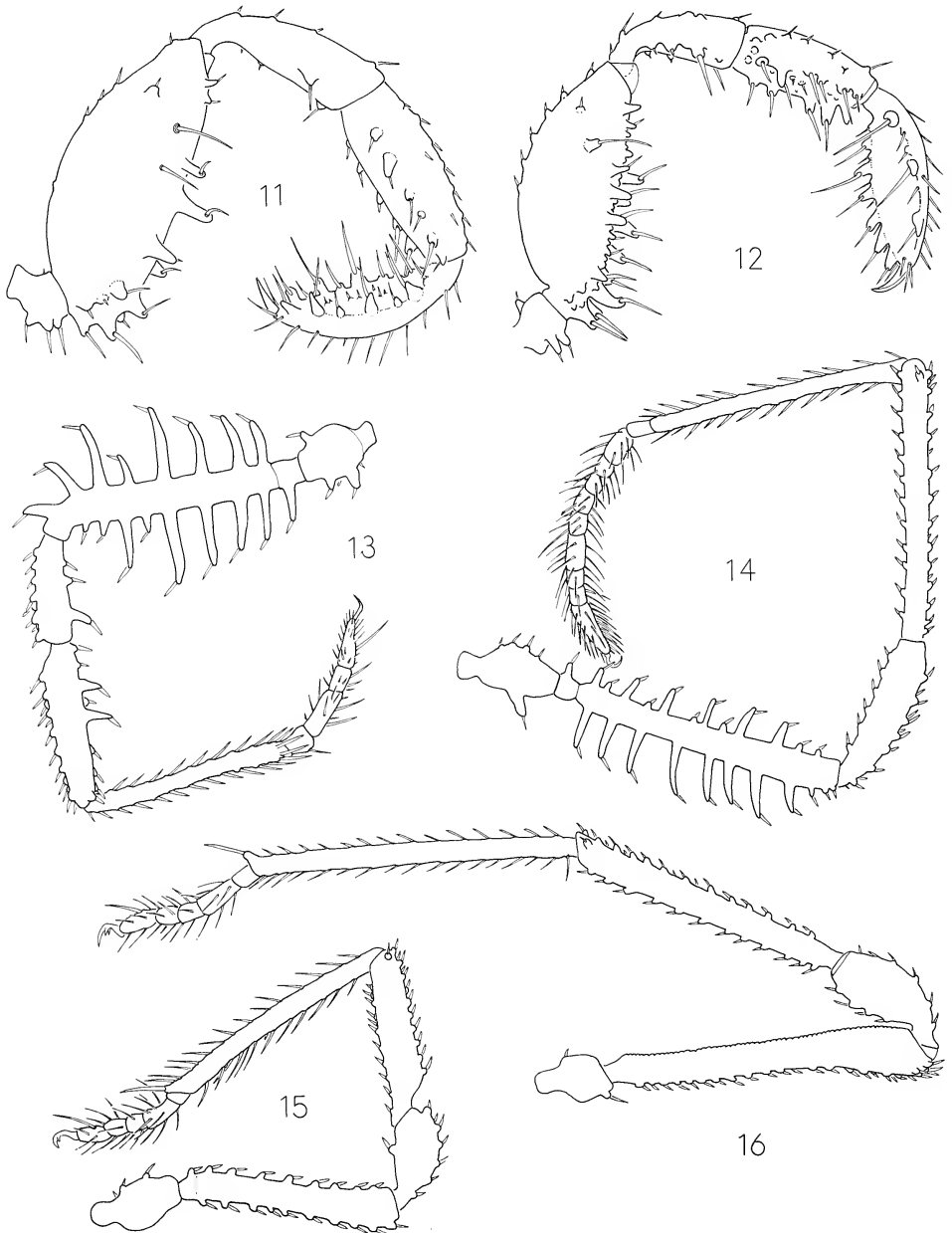
Figs. 11-16.—Anatomy of *Fumontana deprehendor*: 11, palpus of male, mesal view; 12, palpus of female, mesal view; 13-16, legs of male: 13, leg I; 14, leg II; 15, leg III; 16, leg IV.

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POPULATION STRUCTURE IN THE SPIDER
ACHAEARANEA TEPIDARIORUM (ARANEAE, THERIDIIDAE)[1]

Carlos E. Valerio

Escuela de Biologia
Universidad de Costa Rica

ABSTRACT

Two distinct types of population structure are present in the spider *Achaearanea tepidariorum*, each with totally different dynamics and behavior.

The *floating population* or dispersion stage is composed entirely of second instar spiderlings, representing about 99 per cent of the total produced by the species. This population is characterized by a very diverse genetic composition and a high mortality. Several different strategies are observed in spiders in general to reduce mortality in the second instar.

The *established population* is composed of individuals with snaring webs and sedentary habits, and begins as an immature population after the invasion of an available habitat by the second instar. During this phase, its numbers increase first at the maximum intrinsic rate until the maximum habitat capacity has been reached. In a mature population more than 65 per cent of the biomass is contributed by the adult individuals.

INTRODUCTION

Although spiders are among the most diversified groups of animals and many species are locally very abundant, a review of the literature shows little work done on their population biology (Turnbull, 1973).

Two distinct types of population structures are present in many spider species, each with different characteristics regarding dynamics and behavior: the floating population and the established population.

The characteristic aeronautic behavior (ballooning) is the means of dispersion in most spider species. Small species can balloon during any instar, even as adults (Duffey, 1956). In medium to large sized species, effective dispersal by ballooning is probably restricted to the second instar, since small body size seems an important factor for a long distance dispersing mechanism. Large orb-weavers and wolf spiders are sometimes lifted by the wind (J. Anderson and H. K. Wallace, 1973, personal communications), but this phenomenon is probably associated with short distance travel.

In general, aeronautic behavior is dependent upon wind currents of specific velocity and direction (Ritcher, 1967).

In *Achaearanea tepidariorum* (Theridiidae) air currents have a definite effect on basic behavioral patterns (Turnbull, 1964), and in long distance travel and dispersion ballooning spiderlings can resist starvation for 25 days or longer (Valerio, 1975a), which implies a mixing of individuals from different populations. Obtaining food by trapping has severe limitations in the second instar. In general these spiderlings are unable to catch

anything larger than their own size (Ewing, 1918) and survival is very low (less than 2 per cent, Valerio, 1975a). In some related species, regurgitation by the mother is an effective mechanism to transfer energy to the second instars (Kullmann, 1969), but it has been shown that regurgitation does not occur in *A. tepidariorum* (Kullmann and Kloft, 1968). This species provides inviable eggs to feed the spiderlings inside the sac (Valerio, 1974).

The present report intends to further the understanding of these aspects and the structure of the established population.

MATERIALS AND METHODS

Three populations of spiders (each from a different building) on the Universidad de Costa Rica main campus were selected for study. All individuals with an established web and all fresh egg sacs were collected by hand and preserved in alcohol for later analysis. The length of the carapace easily separated the several immature instars except for the sixth and seventh, collectively called subadults (some males reach maturity at the sixth instar, Bonnet, 1935).

The number of ballooning spiderlings of these three established populations was estimated taking into consideration the survival in this instar as shown by data from observations under controlled conditions (Valerio, 1975a). Mortality in the first instar was considered negligible for statistical purposes (2,642 of 2,683 nymphs under observation molted to the second instar, that is, 98.47 per cent survivorship).

Several cohorts of spiderlings (i.e., siblings emerging from the same egg sac) were kept in covered glass jars and checked daily to record the mortality rate.

RESULTS AND CONCLUSIONS

Floating Population.—This population is composed entirely of second-instar spiderlings, representing about 99 per cent of the total emerging population (Table 1).

After hatching the spiderlings remain inside the egg sac for four days, feeding on undeveloped eggs (Valerio, 1974), and upon emergence, they aggregate in a dense clump near the sac. Later they become progressively more active, build a communal web in the center of the maternal web and commence dispersion. By the tenth day they have all left the web.

Two mortality peaks are observed in unfed second instar spiderlings, one during the gregarious phase near the egg sac and the other, 13-14 days after ecdysis (long after dispersion has begun). Cannibalism never develops in this instar; the spiderlings make no attempt to attack each other, nor do they feed on the dying mates (except when attacked by a certain parasitic microhymenopteran, Valerio, 1975a).

Established Population.—This population includes individuals from all active instars and the adults of both sexes. Sedentary habits and trapping webs are characteristic at this stage.

Newly available habitats are invaded by second instar spiderlings from the floating population. During the period of invasion, interspecific competition is very strong. For instance, in Costa Rica, spiderlings of ten different species can become established in human dwellings.

With every molt, the spiderlings required a larger web area, which enhances intraspecific competition, and consequently, the number of individuals in the population is reduced. However, the biomass increases as the number of individuals decreases (Fig. 1),

Table 1.–Population composition in *Achaearanea tepidariorum* (Pooled data from three natural populations).

Instar	Number of individuals	Percentage of individuals	Biomass (a) in mg	Percentage of biomass
Eggs (b)	14032	(37.35)	2.0759	(27.83)
First	13137	(35.20)	1.5985	(21.43)
Second**	9791	(26.25)	0.8765	(11.75)
Second*	127	(0.34)	0.1016	(1.36)
Third	93	(0.26)	0.2339	(3.14)
Fourth	43	(0.12)	0.2675	(3.59)
Fifth	21	(0.06)	0.2192	(2.94)
Subadult	15	(0.05)	0.1911	(2.56)
Males	15	(0.05)	0.1049	(1.42)
Females	113	(0.32)	1.7888	(23.98)
TOTAL	37387	100.00	7.4579	100.00

* Individuals with established webs.
** Floating population, calculated on the basis of 76.67 survivorship in second instar up to dispersal. (Valerio, 1975a)
a) Biomass according to Table 2.
b) From 63 egg sacs.

which implies more biomass per unit volume with every molt.

The webs seem to have minimum size requirements and neighboring webs do not normally overlap at any point. An enclosure measuring 1200 cm^3, appropriate for one fourth instar spider that weights about 62×10^{-4} mg (Table 2), proved too small for more than one third instar spider (25×10^{-4} mg) and at most two second instar spiderlings (16×10^{-4} mg) may survive in it. The spiders did not seem able to capture prey, even when abundant, without an established web.

A growing population probably attains its maximum size before the spiders reach maturity. However, in a mature population a large proportion of the individuals are adults (30 per cent) contributing 65 per cent of the total biomass (Fig. 1). The remaining 35 per cent of the biomass is composed of the six active immature instars.

The individuals in the aerial population may come from distant geographical areas and thus a very diverse genetic composition is probably involved.

The first mortality peak (during the gregarious phase) is probably due to anatomical or physical defects. The second peak (13-14 days after ecdysis) is due to starvation in unfed spiderlings.

Some species provide inviable eggs to feed the spiderlings inside the sac. In *A. tepidariorum* and related species the first instar is of short duration and feeding does not take place until the second instar (Valerio, 1974).

Natural selection would be predicted to favor a tendency to have a larger portion of inviable eggs instead of producing unadapted individuals. This strategy would reduce the mortality during the gregarious phase and provide more food for the surviving individuals, thus reducing also the second mortality peak.

Another possible way to reduce this mortality would be through cannibalism so that the portion dying during the gregarious phase would be "harvested" by the stronger

Table 2.—Body weight in *Achaearanea tepidariorum*

Instar	Fresh weight in mg ($\times 10^{-4}$)
Egg	1.36
First	1.37
Second	8.00
Third	25.16
Fourth	62.22
Fifth	104.38
Sixth and Seventh*	127.41
Adult female	158.30
Adult male	69.92

* Subadults

individuals. In this way the mortality due to starvation would be reduced. This system represents the optimal tactic for a predator (Slobodkin, 1968).

In some species, cannibalism is believed to be the usual and even sole means of survival (Gertsch, 1949) and probably plays an early role as a primitive condition in the evolution of the other advanced behavioral mechanisms.

Maternal care is another evolutionary strategy toward a more effective means of survival. This condition implies the gradual loss of aggressivity by the mother. Some spiderlings use the food left over by the mother (Darchen, 1965), while others feed on freshly captured prey simultaneously with the parental female as commensals (Darchen, 1965, 1968), or on prey specially captured by the mother for this purpose (Kullmann, 1970). A culmination of this evolutionary line is the feeding of the young by regurgitation (Kullmann and Klot, 1968), reinforced under extreme conditions by the sacrifice of the mother as food for her offspring (Kullmann, 1969).

Summarizing, the second instar is of critical importance for the species, since it is the dispersing stage. But high mortality of these aeronautic individuals makes this instar very expensive for the bioeconomy of the species.

It is postulated, then, that selective pressure favors those mechanisms tending to liberate the second instar from feeding on external prey sources. After the second instar he spiderlings gain in size and aggressivity, and prey capturing does not seem to be a problem anymore.

The available habitats are invaded by spiderlings from the floating population. The number of invaders that become established seems to depend directly on the availability of web-building sites, which indicates a strong interspecific competition during this period. Other factors being equal, the species with the largest initial number of immigrating individuals has the highest probability to exclude its direct competitors, hence the critical importance of large floating populations.

When an established spiderling increases in size (i.e., through growth and molting) it requires a larger web area, which stimulates intraspecific competition and reduction in number of individuals. However, it seems that the relative increase in hunting area is smaller than relative gain in body weight, which implies more biomass per unit area with
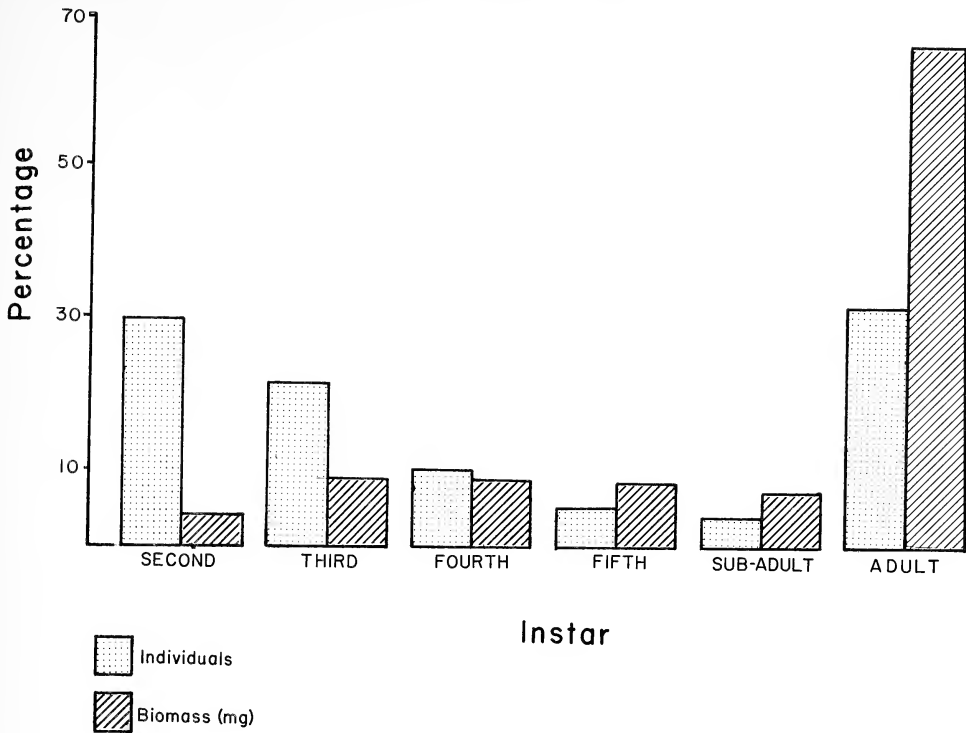
Fig. 1.–Composition of a natural population of *Achaearanea tepidariorum.* Data from Table 1, only individuals with an established web were computed.

every molt. Thus, as individuals increase in size the population more completely exploits its environment.

Since adult females are the largest individuals in the population (Table 2), natural selection would favor this system in which the established population is composed mainly of adult females.

During the growth following invasion the population probably increases at the maximum intrinsic rate. This exponential growth is easily understood because the natural rate of increase is independent from the density since adult spiders are not present during the growing phase. The population size is then maintained at a very stable level (Valerio, 1975b), varying only with the normal fluctuations in environmental conditions.

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A NEW GENUS OF THE SPIDER SUBFAMILY GNAPHOSINAE FROM THE VIRGIN ISLANDS (ARANEAE, GNAPHOSIDAE)

Norman I. Platnick
and
Mohammad U. Shadab

Department of Entomology
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

ABSTRACT

A new genus, *Microsa*, is established for *M. chickeringi*, a new species from the Virgin Islands. Although closest to the African genus *Asemesthes*, *Microsa* differs from the other known gnaphosine genera in size and in characters of the eyes, spinnerets, and genitalia.

The spider subfamily Gnaphosinae, characterized by the presence of a serrated keel on the cheliceral retromargin, is represented in North America only by the Holarctic genus *Gnaphosa* (Platnick and Shadab, 1975). It was therefore with surprise that we studied the Virgin Island specimens described below, which differ from *Gnaphosa* in size as well as ocular, spinneret, and genitalic characters. Comparisons with descriptions and available specimens of the previously described New and Old World gnaphosine genera indicate that these specimens represent an undescribed genus most closely allied to *Asemesthes*, described by Simon (1887) on the basis of an immature female from South Africa. As interpreted by Purcell (1908), Dalmas (1921), Tucker (1923), Lawrence (1927, 1928), and Lessert (1933), *Asemesthes* includes about 25 African species with either strongly or moderately recurved posterior eye rows. The Virgin Island specimens resemble the latter group of *Asemesthes* species closely in ocular characters, but differ in genitalic characters (males lack the elaborate retrolateral tibial apophysis and elongated embolus of *Asemesthes*) and by having two spigots, rather than three, on the anterior spinnerets (Simon, 1893, indicated that *Asemesthes* have two spigots on the anterior spinnerets, but Dalmas, 1921, showed that this was an error caused by a poorly preserved specimen, and all subsequently described *Asemesthes* have three spigots). In addition to the structural differences separating the new genus, the Virgin Island species, with males under 2 mm and females under 3 mm in total length, is the smallest known member of the subfamily.

The format of the descriptions and standard abbreviations of morphological terms follow those used in Platnick and Shadab (1975). We thank Dr. H. W. Levi of the Museum of Comparative Zoology, Harvard University, for making the specimens available for study and allowing us to retain two of the females for the collection of the American Museum of Natural History. The scanning electron micrographs were obtained with the assistance of Mr. Robert J. Koestler.

Microsa, new genus

Type species.—*Microsa chickeringi*, new species.

Etymology.—The generic name is an arbitrary combination of letters considered feminine in gender.

Diagnosis.—*Microsa* may be distinguished from all other gnaphosids by the following combination of characters: cheliceral retromartin with serrated keel (Fig. 1), anterior spinnerets with two spigots (Fig. 2), posterior eye row recurved (Fig. 8), male palp without retrolateral tibial apophysis (Fig. 6), and total length under 3 mm.

Description.—Total length 1.7-2.4 mm. Carapace roughly triangular in dorsal view, widest between coxae II and III, but not greatly narrowed posteriorly, truncated and narrowed anteriorly, pale yellowish brown with dark border, scattered dark markings, and black ocular area (Fig. 3), with erect black setae and two clypeal macrosetae. Cephalic area moderately elevated, posterior declivity smooth; thoracic groove short, longitudinal. From front, anterior eye row procurved, posterior row straight; from above, anterior row slightly procurved, posterior row recurved. PME square, nocturnal; other eyes circular, diurnal. Lateral eyes larger than medians. AME separated by more than their diameter, by less than their diameter from ALE. PME separated by less than their diameter, by roughly their diameter from PLE. Lateral eyes separated by slightly less than their diameter. MOQ roughly square. Clypeal height at AME more than three times the AME diameter. Chelicerae with promarginal series of short spines and retromarginal serrated keel (Fig. 1). Endites convergent, obliquely depressed. Labium much wider than long. Sternum slightly longer than wide, without sclerotized extensions to coxae, with broad extension between coxae IV. Leg formula 4123. Tarsi with two dentate claws and claw tufts, without distinct scopulae. Metatarsal preening comb lacking. Trochanters not notched. Typical leg spination pattern (only surfaces bearing spines listed): femora: I, II d1-1-0, p0-0-1; III, IV d1-1-0, p0-0-1, r0-0-1; patellae IV r0-1-0; tibiae: I, II v0-1r-0; III, IV p1-0-1, vlp-1p-2, r0-1-1; metatarsi: I, II vlr-0-2; III, IV p-0-1-2, v0-0-1p, r0-1-2. Abdomen longer than wide, with distinct pattern (Fig. 3), venter without markings; males with inconspicuous anterior scutum. Six spinnerets; anteriors widely separated, bearing two long spigots (Fig. 2). Palp
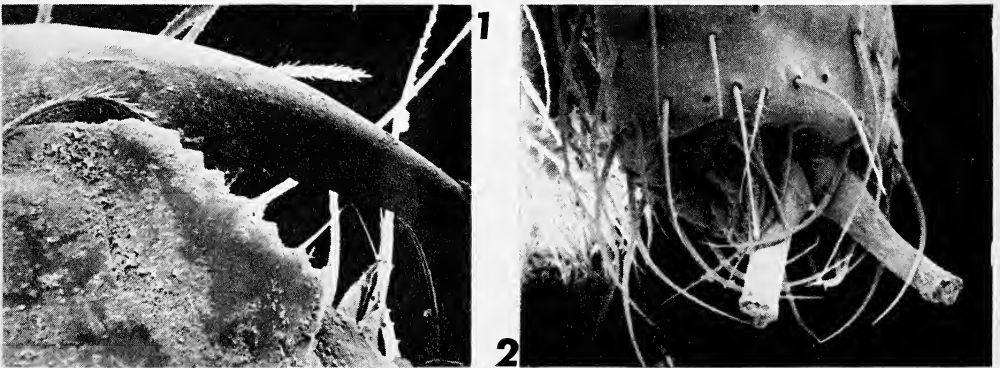
Figs. 1, 2.—*Microsa chickeringi*, new species, scanning electron micrographs: 1, chelicera, posterior view, showing serrated keel, 1000x; 2, anterior spinneret, ventral view, showing spigots, 500x.

without retrolateral tibial apophysis (Figs. 4-6). Epigynum with midpiece and paired spermathecae (Figs. 7, 9).

Microsa chickeringi, new species
Figures 1-9

Types.—Male holotype and female paratype from St. Thomas, Virgin Islands (August, 1966; A. M. Chickering), deposited in the Museum of Comparative Zoology, Harvard University.

Etymology.—The specific name is a patronym in honor of the late Dr. A. M. Chickering, in recognition of his many years of careful collecting of the West Indian spider fauna.

Diagnosis.—With the characters of the genus and genitalia as in Figs. 4-7, and 9.

Male.—Total length 1.72 mm. Carapace 0.83 mm long, 0.75 mm wide. Femur II 0.50 mm long (holotype). Eye sizes and interdistances (mm): AME 0.03, ALE 0.05, PME 0.04, PLE 0.05; AME-AME 0.05, AME-ALE 0.02, PME-PME 0.03, PME-PLE 0.06, ALE-PLE 0.04. MOQ length 0.11 mm, front width 0.11 mm, back width 0.11 mm. Palp without retrolateral tibial apophysis (Figs. 4-6). Leg spination: tibia III p1-1-1, vlp-2-2.

Female.—Total length 1.87-2.34 mm. Carapace 0.85-0.97 mm long, 0.72-0.83 mm wide. Femur II 0.47-0.61 mm long (seven specimens). Eye sizes and interdistances (mm): AME 0.03, ALE 0.06, PME 0.05, PLE 0.05; AME-AME 0.04, AME-ALE 0.01, PME-PME
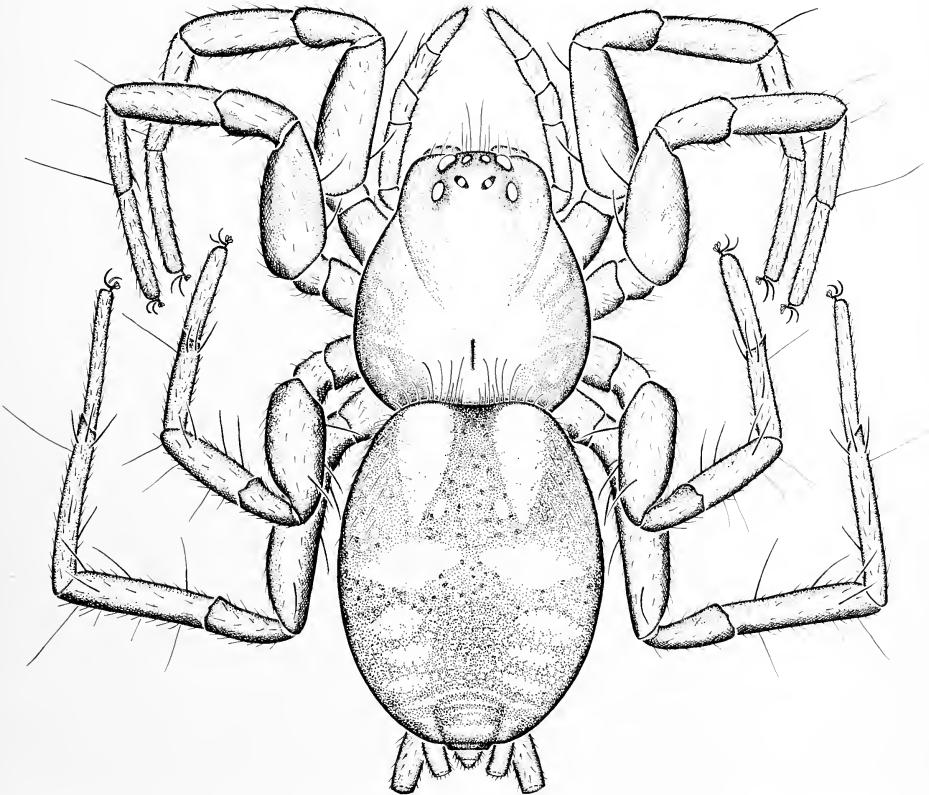
Fig. 3.—*Microsa chickeringi*, new species, dorsal view.

0.03, PME-PLE 0.04, ALE-PLE 0.05. MOQ length 0.11 mm, front width 0.10 mm, back width 0.13 mm. Epigynum with midpiece and paired spermathecae (Figs. 7, 9). Leg spination: metatarsi: I vlp-0-0; II vlp-0-1r; IV vlp-0-1p.

Material examined.– Six females and three juveniles collected with the type specimens.

Distribution.–Known only from the Virgin Islands.
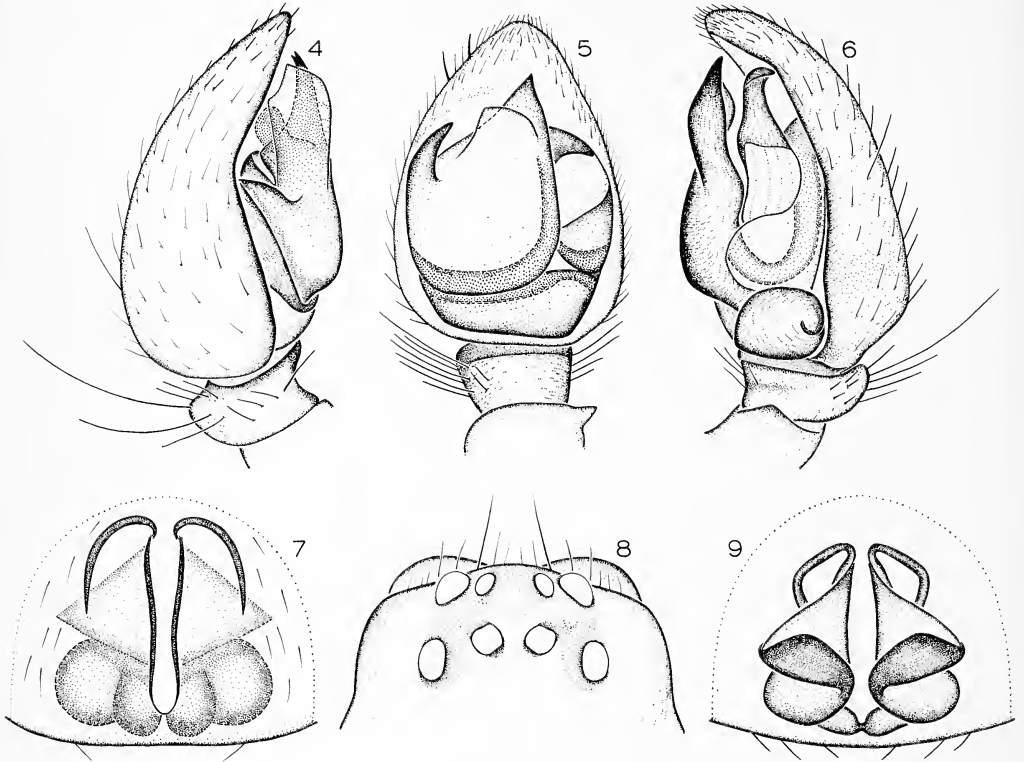
Fig. 4-9.–*Microsa chickeringi*, new species: 4, palp, prolateral view; 5, palp, ventral view; 6, palp, retrolateral view; 7, epigynum, ventral view; 8, ocular area, dorsal view; 9, vulva, dorsal view.

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NOTES ON SPIDERS FROM THE FALKLAND ISLANDS (ARACHNIDA, ARANEAE)

Norman I. Platnick

Department of Entomology
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

ABSTRACT

Philisca colulata Hogg, described in the Clubionidae, is transferred to the Anyphaenidae and newly synonymized with *Gayenna strigosa* Tullgren, for which a lectotype is designated. The Holarctic erigonid *Diplocephalus cristatus* (Blackwall) is newly recorded from the Falkland Islands, and is presumed to have been introduced from England.

INTRODUCTION

Until recently, the spider fauna of the Falkland Islands was very poorly known; a single paper by Hogg (1913) describing six new species as endemics constituted the entire literature. However, Schiapelli and Gerschman (1974) recently published an illustrated faunal survey which added ten species to Hogg's list. Although those authors did not record examples of two of the species described by Hogg (*Tetragnatha insulata* and *Philisca colulata*), they were able to demonstrate that two of Hogg's names actually refer to the male and female of the same species. Most importantly, they showed that the great majority of Falkland Island spiders are not endemic but occur in Tierra del Fuego and Patagonia as well; this is in accordance with the findings of Ringuelet (1955) regarding the relationships of the Falkland Island fauna as a whole.

I have recently had the opportunity to examine two lots of spiders from the Falkland Islands, one from West Falkland collected by Dr. Junius Bird of the American Museum of Natural History and one from East Falkland collected by Dr. Sixto Coscarón of the Museo de La Plata. As a result, I am able to add one further species (probably an introduction from England) to the list, to synonymize one of Hogg's species not reported by Schiapelli and Gerschman (bringing the known fauna to 15 species of as many genera and 14 families), and to provide new locality records for several of the other species. In addition, the presence of the first male *Mecysmauchenius* from the Falkland Islands has allowed confirmation of the specific identity of that population.

Three localities represented in these collections are not among those in the samples mapped by Schiapelli and Gerschman; their locations are: Malo River, 60 km northwest of Stanley; Mullet Valley, 8 km southwest of Stanley; and Murrell Valley, 10 km northwest of Stanley. Synonymic and bibliographic information available in Schiapelli and Gerschman (1974) has not been duplicated here unless nomenclatural changes are involved.

ANNOTATED LIST OF SPECIES

Agelenidae: *Emmenomma oculatum* Simon

New Records.—East Falkland: Murrel Valley, 3 December 1974, 1 female; Mullet Valley, 4 December 1974, 1 female; Stanley, 5 December 1974, 2 females.

Anyphaenidae: *Gayenna strigosa* Tullgren

Gayenna strigosa Tullgren, 1901, p. 237, pl. 4, Figs. 6a-6c (male lectotype, here designated, from Bahía Gente Grande, Tierra del Fuego, Magallanes, Chile, in Naturhistoriska Riksmuseet, Stockholm, examined). Schiapelli and Gerschman, 1974, p. 91, Figs. 18-20.

Tomopisthes strigosus: Simon, 1902, p. 34. Roewer, 1954, p. 553. Bonnet, 1959, p. 4660.

Philisca colulata Hogg, 1913, p. 42, pl. 2, Figs. 5, 5a-5d [female holotype from the Falkland Islands, no specific locality, in British Museum (Natural History), examined]. Roewer, 1954, p. 521. Bonnet, 1958, p. 3538 (*colubata*, lapsus). NEW SYNONYMY.

This anyphaenid appears to be the most common spider on the Falkland Islands. The advanced tracheal spiracle and lamelliform claw tufts of the holotype of *Philisca colulata* indicate that, although described in the Clubionidae, it is an anyphaenid. Along with other Falkland Island specimens of both sexes, this type agrees in genitalic characters with the specimens of the type series of *Gayenna strigosa*; as that type series includes many specimens from several localities, it has seemed advisable to designate a lectotype.

Most of the species which have been assigned to the genera *Gayenna*, *Tomopisthes*, *Oxysoma*, *Amaurobioides*, and perhaps others, form a monophyletic group that probably deserves subfamilial status and that can be distinguished by the presence of two or three teeth (rather than several small denticles) on the cheliceral retromargin and by a characteristic lightly sclerotized area situated at the proximal end of the palpal tegulum. Until this group can be revised, accurate placement of species within the ambiguously defined genera is impossible; thus, the generic placement of *Gayenna strigosa* must be considered tentative.

New Records.—East Falkland: Malo River, 6 December 1974, 8 females; Mullet Valley, 4 December 1974, 1 female; Stanley, 5 December 1974, 8 females. West Falkland: West Point, 2 March 1975, 1 male, 4 females.

Erigonidae: *Diplocephalus cristatus* (Blackwall)

Walckenaeria cristata Blackwall, 1833, p. 107.

Diplocephalus cristatus: Kaston, 1948, p. 170, Figs. 457, 482, 483. Roewer, 1942, p. 692. Bonnet, 1956, p. 1483.

This species, newly recorded from the Falkland Islands, has a Holarctic distribution but is known to have been introduced into New Zealand from England (Forster, 1967). In view of the commerce between England and the Falkland Islands and the capture of the species in Stanley (the capital city and main port), it seems reasonable to assume the same origin for the Falkland Island population.

New Record.–East Falkland: Stanley, 9 December 1974, 2 males, 2 females.

Lycosidae: *Alopecosa nigricans* (Simon)

New Record.–West Falkland: West Point, 2 March 1975, 1 male.

Mecysmaucheniidae: *Mecysmauchenius segmentatus* Simon

New Records.–East Falkland: Malo River, 6 December 1974, 1 female; Stanley, 5 December 1974, 1 male.

Lehtinen (1967, pp. 289-290) has given adequate reasons for removing *Mecysmauchenius* and its relatives in New Zealand from the Archaeidae. Comparison of the male from Stanley with available South American specimens indicates that Schiapelli and Gerschman were correct in assigning the Falkland Island population to *M. segmentatus*, which is also known from Patagonia and the Juan Fernández Islands. The group is in need of revision (there are at least two undescribed species in Chile, and the generic placement of *M. nordenskjoldi* Tullgren is doubtful) but insufficient material is available at present.

Theridiidae: *Anelosimus recurvatus* (Tullgren)

New Records.–East Falkland: Murrell Valley, 3 December 1974, 1 female; Stanley, 9 December 1974, 1 female.

Thomisidae: *Petricus niveus* (Simon)

New Records.–East Falkland: Malo River, 6 December 1974, 1 male; Stanley, 5 December 1974, 1 male, 9 December 1974, 1 female.

Zodariidae: *Storena bergi* Simon

New Record.–East Falkland: Murrell Valley, 3 December 1974, 1 male.

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NOTES ON THE SPIDER GENUS *PARATHEUMA* BRYANT (ARACHNIDA, ARANEAE)

Norman I. Platnick

Department of Entomology
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

ABSTRACT

The spider genus *Paratheuma* Bryant is transferred from the Gnaphosidae to the Desidae; *Corteza* Roth and Brown is newly synonymized with *Paratheuma*. *Paratheuma isolata* Bryant is transferred to *Syrisca* (Clubionidae).

INTRODUCTION

Because the traditional taxonomic system of spider families is a phenetic and not a phylogenetic classification, revisionary studies occasionally turn up species and genera which have been placed far from their closest relatives; an excellent example of this was the discovery by Reiskind and Levi (1967) that the ant-mimicking theridiid genus *Anatea* had been erroneously described in the Clubionidae, an unrelated family which contains many ant-mimicking species. In the course of a series of revisions of the American gnaphosid fauna, a similar case has been discovered. Of the two species placed by Bryant (1940) in her new genus *Paratheuma* and assigned by her to the Gnaphosidae, one actually belongs to the Desidae and the other to the Clubionidae. As a result of this discovery, a recently established desid genus (*Corteza* Roth and Brown) must unfortunately be synonymized.

I thank Dr. H. W. Levi of the Museum of Comparative Zoology, Harvard University, for making the specimens discussed below available for study, and Dr. M. U. Shadab of the American Museum of Natural History for providing the illustrations.

Family Desidae Pocock

Genus *Paratheuma* Bryant

Paratheuma Bryant, 1940:387 (type species by original designation *Eutichurus insulanus* Banks). Roewer, 1954:353.
Corteza Roth and Brown, 1975:2 (type species by original designation *Corteza interaesta* Roth and Brown). NEW SYNONYMY.

Placement—Bryant placed *Paratheuma* in the subfamily Anagraphidinae (Gnaphosidae), stating that "In 1928, Petrunkevitch placed all Drassids with long spinnerets together under the subfamily *Anagraphidinae*" (1940:387). Her placement of the genus

seems to have been based on the "long" (actually two-segmented) posterior spinnerets, but Petrunkevitch's grouping was based on the presence of long (one-segmented) *anterior* spinnerets. No gnaphosids have posterior spinnerets composed of two equal segments, and this character, along with the presence of three tarsal claws, should have immediately indicated to Bryant that *Paratheuma* could not possibly belong to the Gnaphosidae. The projecting chelicerae, acuminate endites, indistinctly defined cephalic region, and slightly advanced position of the tracheal spiracle indicate that the genus actually belongs to the Desidae.

Synonymy—Although the type of *Eutichurus insulanus* Banks is lost, study of a Cuban specimen agreeing with Banks's description and illustration, identified as that species by Banks, and described as *Paratheuma insulana* (Banks) by Bryant indicates that the species is congeneric with *Corteza interaesta* Roth and Brown, described from Sonora, Mexico. *Paratheuma insulana* differs from the generic diagnosis and description given for *Corteza* by Roth and Brown (1975) only in having a slightly higher clypeus (equal to two-thirds of the anterior lateral eye diameter), a few light dorsal femoral spines, and more abundant ventral spination on the distal leg segments; characters of the tracheal system and heart ostia listed by those authors have not been examined in the single specimen available. The two species agree in having anteriorly produced and separated chelicerae, in the number and arrangement of the cheliceral teeth, and in the structure of the endites, spinnerets, colulus, and genitalia (Figs. 1-4).

Paratheuma insulana (Banks)
Figs. 3, 4

Eutichurus insulanus Banks, 1902:270, Fig. 3 (female holotype from the Bermuda Islands, no specific locality, not in the Museum of Comparative Zoology, lost). Bonnet, 1956:1845.
Paratheuma insulana: Bryant, 1940:387, Fig. 148. Roewer, 1954:353.

Diagnosis—*Paratheuma insulana* may be distinguished from *P. interaesta* by the smaller and more angular lateral rims of the epigynum (compare Figs. 1 and 3) and by the vertically oriented epigynal ducts (compare Figs. 2 and 4).

Male—Unknown.

Female—Described by Bryant (1940). Epigynum as in Fig. 3, vulva as in Fig. 4.

Material Examined—Cuba: La Habana: Santiago de las Vegas (Horne and Houser, collectors), one female, deposited in the Museum of Comparative Zoology.

Distribution—Reported from Cuba, Haiti, and the Bermuda Islands.

Paratheuma interaesta (Roth and Brown), new combination
Figs. 1, 2

Corteza interaesta Roth and Brown, 1975:3, Figs. 3-10 (male holotype and female allotype from Pelican Point, Sonora, Mexico, in the American Museum of Natural History, examined).

Family Clubionidae Wagner

Genus *Syrisca* Simon
Syrisca isolata (Bryant), new combination

Paratheuma isolata Bryant, 1940:388, Fig. 170 (male holotype from Isla de Pinos, Cuba, in the Museum of Comparative Zoology, examined).
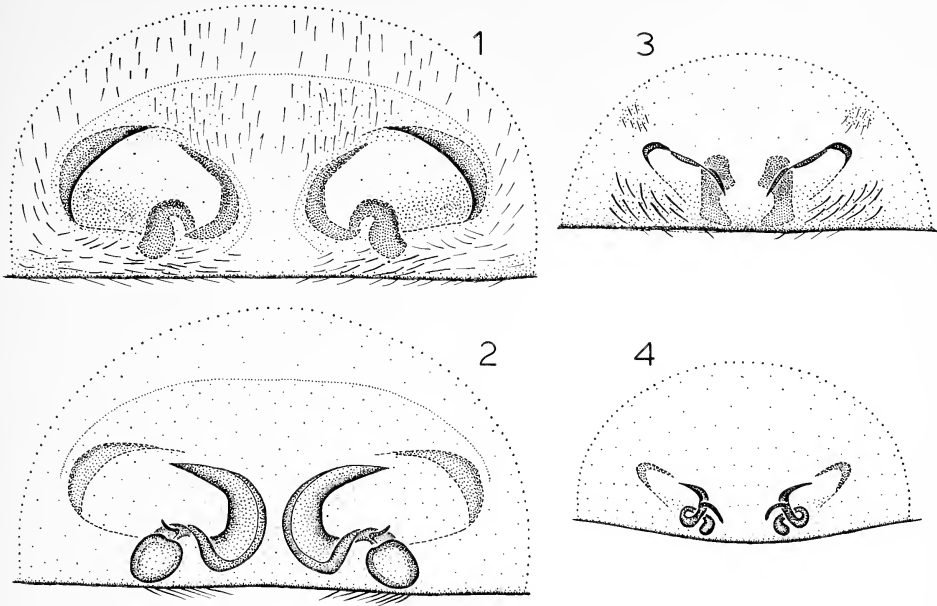
Figs. 1, 2.—*Paratheuma interaesta* (Roth and Brown): 1, Epigynum, ventral view; 2, Vulva, dorsal view.

Figs. 3, 4.—*Paratheuma insulana* (Banks): 3, Epigynum, ventral view; 4, Vulva, dorsal view. All drawings to same scale.

Placement—Bryant noted that this species is closer to *Syrisca hirsuta* Petrunkevitch, described from Panama and recorded from Puerto Rico, than to *Paratheuma insulana*, but argued that both *Syrisca* species should be placed in the Gnaphosidae "because of the separated spinnerets and the impressed maxillae" (1940:389). As the posterior spinnerets of *S. isolata* are composed of two equal segments, and the endites depressed only along the labium (not diagonally as in gnaphosids), Bryant's placement of the species is untenable. The male palp, illustrated by Bryant (1940:Fig. 170), is well within the range of the American species now placed in *Syrisca*, and the species probably represents the male of *S. insularis* (Lucas), known only from females from Cuba. The American *Syrisca* are greatly in need of revision, both to establish the identities and relationships of the species and to determine whether they are really congeneric with the type species, *S. pictilis* Simon, described from Africa.

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NOTES ON CHILEAN PALPIMANIDAE
(ARACHNIDA, ARANEAE)

Norman I. Platnick

Department of Entomology
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

ABSTRACT

Fernandezina birabeni Zapfe is transferred to *Otiothops* and renamed *O. lanus* because of a resulting secondary homonymy. A revised key to the genera of Otiothopinae is presented.

Through the courtesy of Dr. Evert I. Schlinger and Mr. Charles E. Griswold of the University of California at Berkeley, I have recently had the opportunity to examine a small collection of Palpimanidae from Chile. Included in this collection was a male of the species described by Zapfe (1961) as *Fernandezina birabeni*, collected from an area very close to the type locality of that species. In a recent revision of the Otiothopinae (Platnick, 1975), I indicated that this species was probably misplaced in *Fernandezina*, but as no specimens were available the correct placement remained uncertain. The dorsally expanded femur and short tarsus of the first leg as well as the short abdominal scutum of the male clearly exclude the species from *Fernandezina*; genitalic structure indicates that it actually belongs to the *amazonicus* group of *Otiothops*, which is widely distributed in South America. However, the widely separated posterior median eyes and reduced claw tufts are characters found in no other known *Otiothops*, and the species will key out to *Anisaedus* in the published key (Platnick, 1975, p. 4). A revised key to the otiothopine genera is included below to reflect the consequent enlargement of the generic concept of *Otiothops*. The extreme divergence of the Chilean fauna from that of the remainder of South America noted by Levi (1967) in the Theridiidae seems also to be the case in the Palpimanidae, and it is to be hoped that the unique Chilean spider fauna will receive increased attention from arachnologists in the future.

REVISED KEY TO THE GENERA OF OTIOTHOPINAE

1a.　　Femur I only slightly expanded dorsally; tarsus I nearly as long as tibia I; abdominal scutum of male covering at least half of dorsum　. . *Fernandezina*

1b.　　Femur I greatly expanded dorsally; tarsus I much shorter than tibia I; abdominal scutum of male covering no more than a quarter of dorsum　. 2

2a(1b).　Posterior median eyes separated by three or more times their diameter　. . . . . *Anisaedus*

2b.　　Posterior median eyes separated by two times their diameter or less . *Otiothops*

Otiothops lanus, new name
Figs. 1, 2

Fernandezina birabeni Zapfe, 1961, p. 141, figs. 1-7 (Male holotype and female paratype from Quebrada de la Plata, Santiago, Chile, may be in the Centro de Investigaciones Zoológicas, Santiago, unavailable). Platnick, 1975, p. 27. Preoccupied in *Otiothops* by *O. birabeni* Mello-Leitão (1945).

Etymology.—The new specific name is an arbitrary combination of letters.

Diagnosis.—The male of *Otiothops lanus* can be easily distinguished from all other palpimanids by the broad, subterminally originating embolus (Figs. 1, 2). The species is probably closest to *Otiothops loris* Platnick, described from Peru, which has a more elongate embolar tip.
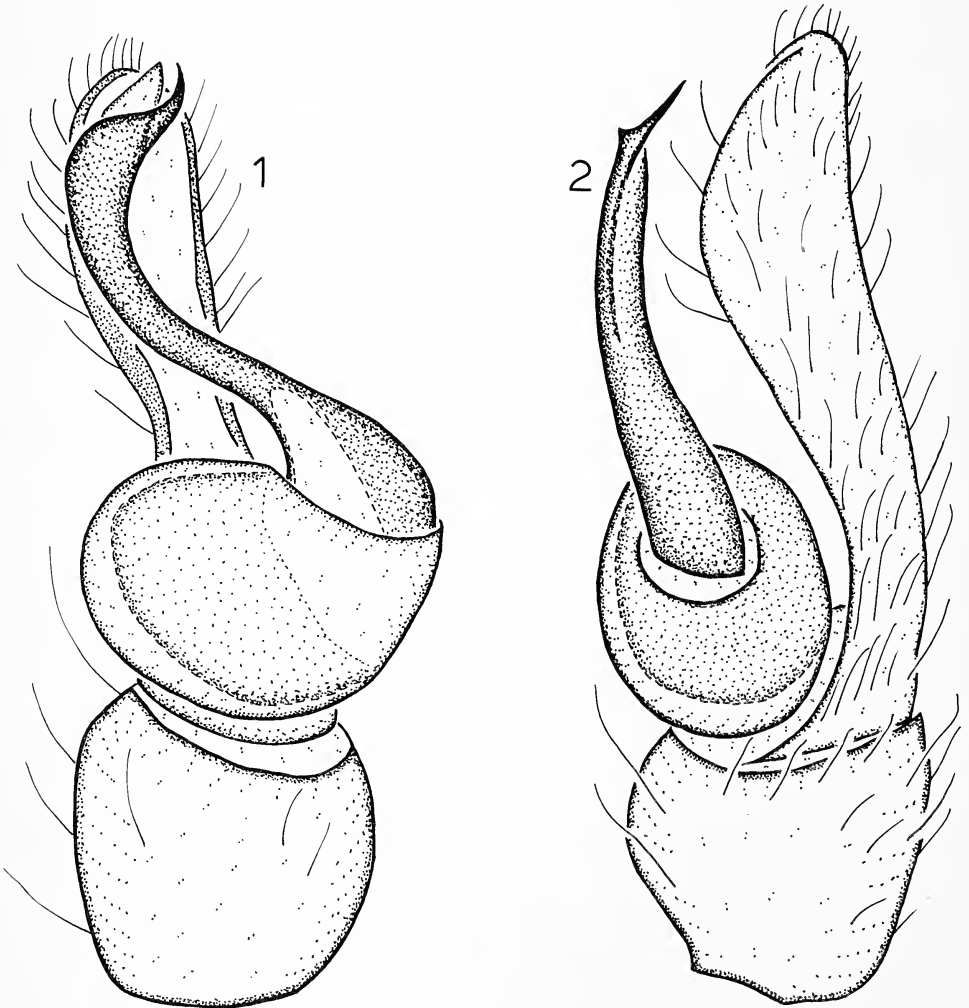
Figs. 1, 2.—Male palp of *Otiothops lanus*: 1, ventral view; 2, retrolateral view.

Male.—Total length 2.66 mm. Carapace 1.21 mm long, 0.90 mm wide. Femur I 0.94 mm long, 0.45 mm high. Cephalic area moderately elevated. Posterior median eyes separated by almost two their diameter. Abdomen with scattered brownish purple patches on pale brown background. Claw tufts reduced to a few setae surrounding onychium. Palp with globose tibia, long thin cymbium slightly expanded below tip, and retrolaterally prolonged bulb with visible reservoir. Embolus originating retrolaterally and below tip of bulb, expanded at apex, with sclerotized whiplike tip and recessed unsclerotized lobe (Figs. 1, 2).

Female.—Unavailable; described by Zapfe (1961).

Material examined.—Chile: Santiago: Quebrada de la Plata, La Rinconada, near Maipú, latitude 33°30′ S, longitude 70°55′ W (11 October 1966; E. I. Schlinger), 1 male, deposited in the Entomology Museum, University of California, Berkeley.

Anisaedus pellucidas Platnick

Anisaedus pellucidas Platnick, 1975, p. 26, figs. 76-79, 81-84, map 5.

New Record.—Chile: Atacama: Bahía de Copiapó, coastal dunes, elevation 45 m. (5 October 1966; M. E. Irwin), 1 female, deposited in the Entomology Museum, University of California, Berkeley.

Note.—Two juvenile specimens from this collection taken in Atacama and Antofagasta Provinces probably belong to this species as well; *Otiothops lanus* and *Anisaedus pellucidas* are the only palpimanids known from Chile.

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BEHAVIORAL EVIDENCE OF CHEMORECEPTION ON THE LEGS OF THE SPIDER *ARANEUS DIADEMATUS* CL.

Wendy Holden

North Carolina Mental Health Services
Research Section
P.O. Box 7532
Raleigh, North Carolina 27611

ABSTRACT

Behavioral responses of the spider Araneus diadematus to chemically-treated prey support the hypothesis that hairs on the legs of spiders receive chemical stimuli. Analysis of movie films showed a definite withdrawal reaction of spiders to quinine-coated flies and repeated trials with quinine-treated flies led to significantly ($P < 0.01$) longer periods of time for the spiders to respond to prey.

The frame by frame analysis of movies has provided the evidence needed to conclude that spiders are capable of receiving sufficient signals to stimulate the chemosensitive hairs on the legs. While conducting an experiment on altering the behavioral pattern in the feeding of the spider, it was perceived that, when it was exposed to prey coated with a bitter solution, the animal did not have to touch the prey with its mouth parts to be repelled. Upon observing this, I thought a closer observation was necessary. A movie could freeze each action of the spider so that any movement which occurred, that was too fast for the naked eye, could easily be analyzed frame by frame. After a close study of the movie it was determined that the spider did not have to touch a quinine solution with its mouth parts at any time, in order to be repelled, even if the coated fly was moving about and vibrating.

Several hairs on the spiders' legs are morphologically similar to the hairs on the proboscis of the blowfly (Foelix, 1970). The blowfly has been studied morphologically and electrophysiologically by Dethier (1955, 1971) and Wolbarsht (1958) who established that the four chemoreceptors on the proboscis have many functions dealing with sensing, coding and transmitting. In the spider, chemoreceptor structures have been described but, ". . . there was never any supporting evidence" for the function (Foelix, 1970). McCook (1890) wrote "I have long entertained the opinion that the sense of smell in spiders abides entirely in the delicate hairs." Bays (1962) provided sufficient evidence that spiders could learn to distinguish between two vibrations and two different tastes: glucose (sweet) and quinine (bitter). The spiders in Bays' experiments, after a few trials, rejected the quinine-coated prey, which leads one to believe that for the spider there must be some aversive properties of the bitter solution.

Chemicals contained in the fresh silk or on a mature female spider appear to play a vital role in the pre-mating process. According to Kaston (1936) the male of *Dolomedes scriptus*, a non-orb-weaver, does not attempt to court if the female's leg has been dipped into ether, while courtship is elicited by the ether extract, after evaporation of the ether.

Wolff and Hempel (1951) find their spiders sensitive to chemical stimuli on touch, and Krafft (1971) interprets his observations of social spiders' interaction as transmitted through chemical and tactile signals.

There can be no doubt that spiders perceive non-volatile chemicals on contact (Kaston, 1936); but is a touch by the leg sufficient to receive the chemical indicating the taste of food?

METHOD

Twenty-four *Araneus diadematus* spiders were used in the experiment, 12 in each group, the experimental and control groups were kept on different diets. The laboratory conditions were controlled and the temperature was regulated (cool and dark from midnight until 8:30 a.m. and light and warm until midnight). The animals were kept in cages with screen on the sides and with glass in the front and back (for details see Witt, 1971). The experimental group was fed a suspension of 30 to 40 homogenized fly abdomens in approximately two teaspoons of water with a small quantity of sugar. About 0.01 ml was put into a syringe which was held to the mouth parts of the spiders until imbibed by the animal five times a week for 47 days. The control group received two untreated flies a week for 47 days.

The fly for the experimental spiders was first fully dipped into a suspension of quinine in water, then put onto the web. Usually the fly was wiggling when it was placed onto the web and this attracted the spider's attention. The spider approached the fly, touched it with a front leg or put all of its legs on the prey, then either went back up to the hub (center) of the web or wrapped it first and then went up. This sequence of events would follow the same pattern each time a quinine-covered fly was used. If the prey was not wiggling when it was put onto the web, the tuning fork (middle C) was held just below the prey to lure the spider. In some cases, an uncoated fly was held with forceps just below the quinine coated prey until the spider approached. The quinine coated prey was given each day on which the spider had built a new web.

RESULTS AND CONCLUSIONS

This experiment was originally performed as a followup study to experiments by Reed, *et al.* (1970) which indicated that while experience did not change web-building behavior, it influenced the spiders' handling of prey. The experimental spiders were "timed" after a period of 47 days, during which they were given the quinine coated prey, and compared to the control group's timing. With the aid of a stop-watch I ascertained the interval between the time when the prey was touched to the web and when the spider touched the prey. After several trials the spiders in the experimental group took significantly ($P<0.01$) longer periods of time to get to the prey than did the control group (see Table 1): their feeding behavior was changed as a consequence of experience.

Quinine solution has no odor, so there is no airborne stimulus. It is true that the spider could detect the quinine-coated fly was wet to the touch; but how did the spider know that the fly had not been dipped into a glucose solution, which it usually takes without hesitation (Bays, 1962)? There was a definite withdrawal reaction from the quinine, indicating that the spider perceived an unpleasant stimulus through sense organs on the tarsi (see Figs. 1, 2). Combining these observations with those of Foelix (1974) it seems

safe to suggest that the spider received sufficient chemical stimuli with the chemosensitive hairs on the tarsus to recognize the substance. Such a hypothesis is supported through the frame by frame observation of the spider's movements in a movie film, as the animal approaches the quinine covered prey, and responds.
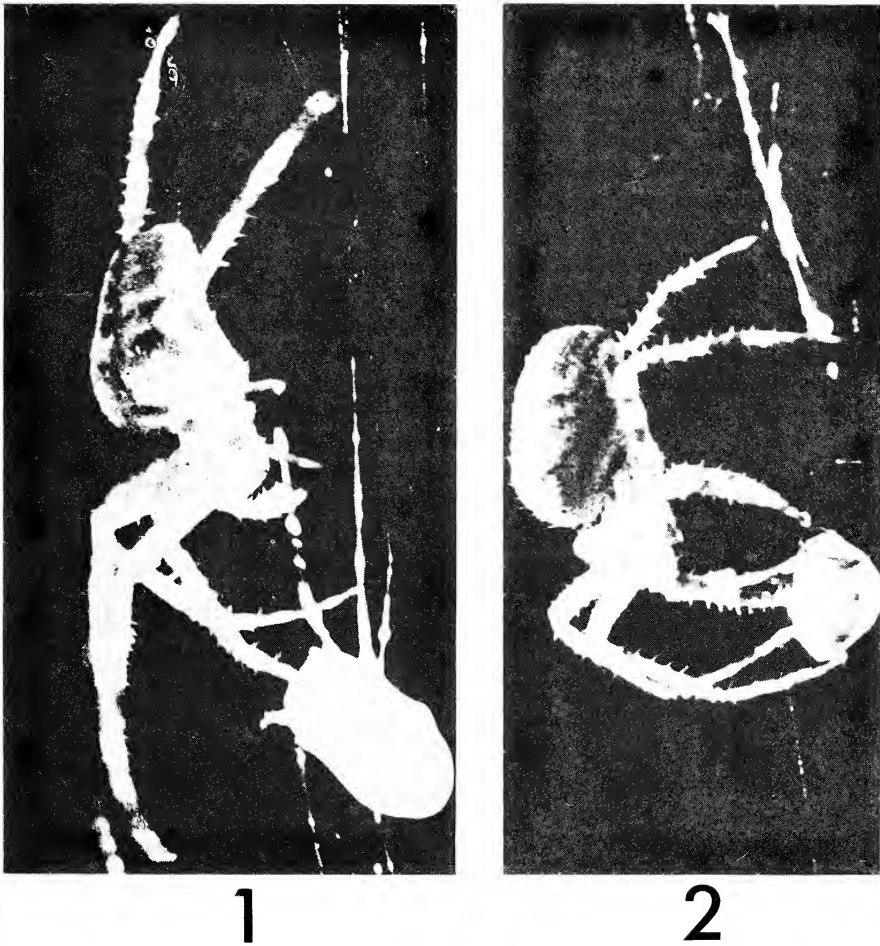
Fig. 1.—This is an enlarged picture taken from one frame of a 16 mm movie. It shows a female *Araneus diadematus* spider (on left) at its closest distance to a fly coated with quinine (below on the right). The frames before and after this picture reveal the spider at a farther distance from the fly. (Notice that the bitter substance is touched by the tarsus only, before the spider retreats.)

Fig. 2.—This shows a different *Araneus diadematus* female spider under similar circumstances as in Fig. 1. Notice the spider (on the left) touches the prey (on the right) with the tips of all the legs except the back ones which hold on to the web. In this sequence, the mouth did not come in contact with the prey at any time.

Table 1.—Mean and standard deviation of time it took female *Araneus diadematus* littermates to reach prey at 1.4 cm distance, after the experimental group had been offered quinine-coated flies under similar circumstances for 47 days, five times a week, and had been fed spider suspension from a syringe held to the mouth, while controls caught flies in webs. The difference in time is significant below the 1 per cent level.

	Number of Animals	Mean time for prey in seconds	Standard Deviation
Control Group	21	9.66	± 9.25
Experimental Group	6	38.16	±36.22

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BOOK REVIEW

NEW ZEALAND SPIDERS by R. R. and L. M. Forster. Collins Bros. and Co., Ltd., Auckland. $10.60, 254 pages, ill. 1973.

The first 30 pages are given over to the structure and behavior of spiders in general. This is followed by 15 pages given over to spider relatives, i.e., mites, false scorpions, and mostly harvestmen. The bulk of the book is devoted to the different kinds of spiders. This section is followed by 10 pages on spider venom and 12 on collecting and preparation of specimens for study. The book closes with a short bibliography and an index.

There are 164 illustrations in black and white intermixed with 132 color photographs. These latter are excellent, and, by lacking those faults which this reviewer pointed out for those supplied by Mascord in his book "Australian spiders in color" are far superior than those. In fact, the color photos alone are worth the price of the book! The drawings were done by Barry Weston, the outstanding artist who did the drawings for Forster's technical papers from the Otago Museum.

The book is intended primarily for the general reader, not for the specialist, and is in the style of McKeown's "Australian spiders." The spiders were taken up according to their habits, with chapters devoted to the jumping, crab, vagabond, wolf, trapdoor spiders and web builders, etc. Most of the information on habits is based on their own observations, but the Forsters have not hesitated to supply accounts from various predecessors (some of whom were observant "laymen") in the manner used by McKeown.

Although there are no keys for identification, and characters such as the genitalia are not included in the descriptive information, the latter plus the illustrations supplied enable recognition in many cases. For those families with representatives in the northern hemisphere the information on habits, behavior, life cycles, etc., is of course similar to what has already been made known, though nevertheless interestingly given. But for the Toxopidae, Amaurobioididae, Desidae, Gradungulidae, Megadictynidae, Archaeidae and Symphytognathidae, which are not, or else little, known from elsewhere, the Forsters supply accounts which are often the first that make known for those spiders their habits and behavior.

Workers actively engaged in araneological research might have liked to see included accounts of the more recent researches on spiders. These include the morphology of sense organs, various aspects of physiology and the extensive work on ecology. Likewise, those working in taxonomy might not agree with their family placement and relationships of some of the spiders. Most will object to the use of the name *Aranea* for the now legal *Araneus*. There are few errors. One concerns the exchanging of labels for Figs. 14d and 14e, and the inverting of the drawing for Fig. 14d.

While from the point of view of species determination the book is naturally of greatest value to New Zealanders, it will delight others, especially those living in the northern hemisphere, much as they had been delighted by the reading of McKeown's book, and Gertsch's "American Spiders." The Forsters deserve our thanks for producing such an excellent volume.

B. J. Kaston, Department of Zoology, San Diego State University, San Diego, California 92182.

support). 4) By-line: Include name(s) of author(s) as customarily written (less titles) and complete address(es) including zip code or other postal zone designation. Include footnote indication(s) if appropriate (e.g., to indicate change of address). 5) Body of Text: Use whatever form seems to best accommodate the necessary description of the research. Be concise. Conform to the *CBE Style Manual* in all abbreviations. 6) Acknowledgments: Take care to give credit where it is due. 7) Literature Cited: Include only those publications to which reference is made in the text. Adhere to style in *CBE Style Manual* or refer to a previous issue of *The Journal of Arachnology*. Do not abbreviate place names. 8) Figure Legends: Do not type on facing pages but type consecutively in numerical sequence. 9) Abstract: Keep abstracts concise, not exceeding 2-3% of the text. Abstracts should contain a summary of the basic findings. 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Remember that whole views of animals, while not necessarily required for a diagnosis, give the reader an instructive general appreciation of the animal which is impossible to impart with words or by a collection of drawings of pieces. Avoid the use of whole views comprised of ½ dorsum and ½ venter. Illustrate species descriptions. This is in accord with General Recommendation 17, *International Code of Zoological Nomenclature*, which states, "The description of a new taxon of the species-group should be accompanied by a satisfactory illustration or by a bibliographic reference to such an illustration." 13) Put items 3, 4, and 5 above on page 1 and number *all* other pages consecutively.

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SUPPLEMENT TO THE SPIDERS OF CONNECTICUT

B. J. Kaston

Department of Zoology
San Diego State University
San Diego, California 92115

ABSTRACT

Sixty-eight species not recorded from the southern New England region in the 1948 monograph (Kaston, 1948) are now included. References are cited to all revisions of all taxa included in the work, and to all other papers which may give additional biological and natural history data for any of the spiders included here. The major contribution consists of giving the new names and additional information for those species where recent studies have shown the necessity for change, either because they are synonyms, or have been moved to a different genus.

INTRODUCTION

More than a quarter century has gone by since the appearance of the original monograph (Kaston, 1948). Much research on spiders has been done during this interval; certainly more than in any previous quarter century. Of course, to a great extent the work on anatomy, physiology, and especially ethology, has concerned spiders in general, but in many cases species of our region have been the subject of these researches. A great many changes of a taxonomic nature have been made necessary by the studies of a whole host of workers, both in the United States and abroad, particularly the continued efforts of W. J. Gertsch, H. W. Levi, and students of the latter.

There have been many name changes, synonymies, shifts to genera other than those in which the species appeared in 1948; and some erroneous determinations are here corrected. One of the most significant sets of changes concerns the acceptance by the Commission on Zoological Nomenclature of the Clerckian names. This legalization of the pre-Linnean names was effected (through the untiring efforts of Professor Pierre Bonnet) at the meeting held in Paris in July 1948 only a month or so after the appearance off the press of my volume (see Bull. Zool. Nomencl. 4(10-12):315-319). Where the credit for the family names is being changed this is in accordance with Article 36 of the new International Code of Zoological Nomenclature.

Wherever possible comments will be supplied, where applicable, in the same order that was followed in the original work. In addition, just preceding the Literature Cited will be found a list of Errata, for the benefit of those readers who may wish to enter corrections in the original volume.

p. 12, re: eyes, Homann's continued studies of the eyes have led him to suggest changes in family position for a number of spiders. In particular he has studied the nature of the tapetum in the indirect eyes. He considered the terms "homogeneous" and

"heterogeneous" too imprecise and that they should be discarded. The direct eyes (AME) are always dark; it is the other six (the indirect eyes) which may be all light, all dark, or some of each. He introduced the terms "concolorous" and "discolorous" and the meaning is obvious.

p. 15, re: carpoblem, Hull's term for the principal tibial apophysis on the male pedipalp has not caught on. It seems that the term tibial apophysis is too well established.

p. 16, re: legs, it would be preferable if araneologists could consider that there is a two-segmented tarsus (as is done with some non-aranean anachnids), the proximal being called the basitarsus (rather than metatarsus) and the distal called the telotarsus, as is logical. These terms have already been so used by Schick (1965). For a discussion of the notch and related structures on the ventral surface of the trochanter see Roth (1964).

p. 19, re: anomalies of external structure see Kaston (1961, 1962, 1963a, 1963b). For details on newer findings about the internal anatomy reference should be made to Millot (1949) and Legendre (1959, 1965).

p. 20, re: endoskeleton, see the account by Firstman (1973). For the nervous system see Legendre (1959).
Re: footnote, a review of the hydraulic effect was published by Parry (1960).

p. 21, re: trichobothria, Görner (1965) presented evidence to indicate that these may function as mechanoreceptors.
Re: slit organs, the studies of Walcott (1970), of Liesenfeld (1961), and Barth (1967) have shown that at least some of these organs serve as vibration receptors.
Re: eyes, for further details on structure, especially of the tapetum in the indirect eyes, see the various papers by Homann, summarized in 1971. It has been shown that at least some spiders can perceive polarized light, and use it in directing their loco- motion. For details see the work of Papi (1955), Görner (1962), and Papi and Tongiorgi (1963), summarized by Kaston (1965).

p. 23, re: excretion, see the study by Anderson (1966).

p. 24, re: silk glands, for the newer contributions by Sekiguchi, and others see the summary by Kaston (1964). It should also be noted that males have been shown to possess special silk glands opening by fusules on the venter in front of the epigastric furrow. A discussion and excellent summary concerning these epiandric (=epigastric) glands were published by Legendre and Lopez (1971) and Legendre (1972). For further details on the arterial system see Firstman (1973).

p. 26, re: respiratory system, Merrett (1961) has shown that at least for some Linyphiidae (and Micryphantidae) the larger species have more, and the smaller species have fewer, leaves in the book lungs.

p. 27, re: internal organs, we may now add the relatively new studies on the endocrine and neurosecretory tissues, a good summary of which appears in Legendre (1971).
Re: habits, a summary of some of the little known aspects of behavior was pub- lished by Kaston (1965).

p. 30, re: silk and its uses, a discussion of the evolution of webs was published by Kaston (1964). Extensive studies have been published by Tilquin (1942), and especially by Witt and his coworkers. Much of the latter group's work appears summarized in their volume "A Spider's Web" (1968).

p. 32-33, re: courtship behavior, Rovner has shown (1966, 1967a) that the charging of the palpal organs is not a necessary prelude to courtship. An excellent review of the evolution of courship behavior was published by Platnick (1971). From studies on the epiandic glands it would appear that the sperm web is undoubtedly constructed, at least in part, from these.

p. 33, re: ejaculation of semen, Cooke (1966) considered that at least in *Dysdera* hydrostatic pressure plays no part. Rather, the emptying of the semen "was found to be under hormonal control, presumably by a neurosecretory mechanism. It is brought about by the secretion of surrounding glands emptying through minute pores into the lumen of the reservoir."

p. 35, re: fecundity, I have since had a female of *Araneus trifolium* which produced a sac that contained 2652 eggs, which I believe to be a record.
Re: parthenogenesis, contrary to what had previously been supposed it now appears that parthenogenesis does occur, at least in some species. This has been shown by Monterosso (1947a, 1947b) for species of *Tetragnatha, Teutana, Thomisus* and *Tegenaria*; by Braun (1956) for *Teutana*; and by Machado (1964) for *Theotima*.

p. 36, re: molting, a good summary was given by Legendre (1971), according to whom molting and growth are in some way correlated with endocrine activity.

p. 38, re: insect parasites and predators, see Kaston (1959) and the excellent summary by Eason et al. (1967).

p. 43, re: venom, one must now add members of the genus *Loxosceles* to those producing a venom with a gangrenous action. *L. reclusa* has been the subject of much attention and study in the United States since 1957.

p. 45, re: collecting techniques, a very useful one that has become quite popular is the pit trap, of which an excellent model has been described by Muma (1970). Various modifications of this and a valuable lengthy discussion of virtually every other collecting method were published by Duffey (1972). Likewise, Turnbull (1973) discussed all these methods.

p. 47, re: study methods, a superior method for holding a specimen in a desired position is that suggested by Dr. Bruce Cutler. A layer of fine clean sand is placed at the bottom of the dish, then preserving fluid added. The specimen is gently pushed into the sand and wedged into the desired position, being held by the weight of the sand.

p. 48, re: names of higher categories, see Kaston (1974). As to the list of families, my present view is that there is reason for considering a larger number. As far as our region is concerned I recognize the Zoridae and Philodromidae as distinct from the Clubionidae and Thomisidae in which they had formerly been placed.

p. 49 and 51, re: Cribellatae and Ecribellatae, many modern authors do not consider the presence or absence of a cribellum of sufficient significance for family separation. Lehtinen (1967), and others, have placed cribellate and ecribellate members in the same family.

p. **52**, **re:** the Clerckian names, these are now valid as I have already indicated. As to the names given by Walckenaer, further comments were published by Levi (1961) so that it becomes a matter of deciding whether the interpretation supplied by him, rather than that of Chamberlin and Ivie in their Georgia paper, is the correct one.

p. **53**, **re:** chromosomes, in spiders the male is the heterogametic sex, females having paired X chromosomes, males having unpaired. Of the 179 species of which the situation had been studied up to 1954 Suzuki found that only 19 showed the familiar XO type; in 152 species the males were of the $X_1 X_2 0$ type, and in 8 species the $X_1 X_2 X_3 0$ type. For further details one is referred to the publications of Hackman (1948), Sharma et al. (1959, 1960), Bole-Gowda (1960), and Mittal (1963, 1964).

p. **54**, **re:** collection records, new additional records are given for only those species that are not very common. No collector's name is given if the collecting was done by the author, otherwise the collector's name is supplied.

p. **55-57**, **re:** key to families, note the following changes. Members of the Antro-diaetidae will key out at 1a, but are separated from the Atypidae thus: the labium is fused to the sternum and the endites are strongly developed in the latter, while in the former the endites are only weakly developed and the labium is free. Couplet 1b should be altered to begin "Only one pair of lungs or none." *Mysmena guttata* of the family Symphytognathidae, will key out here on the basis of lacking lungs completely, though because of its small size this may be difficult to ascertain. Members of the family Philodromidae will key out at 17a, but can be separated from the Thomisidae *sens. str.* with the key to the then considered subfamilies supplied on p. 410. Our sole member of the family Prodidomidae will key out at 18a, but can be separated from the Gnaphosidae thus: The eyes in the latter are definitely in two rows and the tarsal claws are toothed, while in the Prodidomidae the posterior row is so strongly procurved as to present two rows, so that one can speak of three rows all together, 4-2-2 (Fig. 35), and the tarsal claws are not toothed. Our member of the Zoridae will key out at 18b, but can be separated from the Clubionidae *sens. str.* in that the posterior eye row is so strongly recurved as to present an additional row, the three being arranged as 4-2-2. As regards couplet 20, the tarsal comb is absent from some of the smaller theridiids (e.g., *Conopistha*) making them difficult to key.

p. **57**, **re:** Orthognatha, according to Homann (1971) these all have the primitive type of tapetum in the indirect eyes. We now know three species from our region.

p. **58**, **insert at top:**   Family ANTRODIAETIDAE Gertsch

As is the case with the other trap-door spiders each chelicera is provided with a row of strong spines, the rastellum, up front. The labium is about as long as wide, and is free. The abdominal dorsum may have up to as many as three sclerotized tergites.

<center>Genus **Antrodiaetus** Ausserer 1871</center>

These spiders have only four spinnerets. A revision of the genus was published by Coyle (1971). One species occurs in our region.

<center>**Antrodiaetus unicolor** (Hentz)</center>

Mygale unicolor Hentz 1841, Proc. Boston Soc. Nat. Hist., 1:42. *Antrodiaetus unicolor* :Coyle 1971, Bull. Mus. Comp. Zool. 141:335, f. 113, 120, 130, 138, 145, 146, 158, 173-174, 188-194, 234-240, 270-279, 313, 315, 318.

Length of female 20 mm, of male 17 mm. The male shows three distinct abdominal tergites, but the female has only one, which is apparently the homolog of the middle one of the male. This is a southern species but is included here on the basis of a specimen collected in the Bronx Park in the northeastern portion of New York City.

Re: the family name Atypidae, must now be credited to Thorell. A detailed description of the spinning apparatus in this family was published by Glatz (1973).

Re: the genus *Atypus*, I have learned from Dr. Gertsch (personal communication) that we now have two species from our region. The one previously cited by me as *milberti* he now considers to be *niger*, and *milberti* Walckenaer he considers a synonym of *bicolor*.

Atypus niger Hentz

Atypus niger Hentz 1842, J. Boston Soc. Nat. Hist. 4:224, pl. 8, f. 1. *Atypus milberti* :Kaston 1948 [not *milberti* Walckenaer 1837].

We now have Connecticut records:
Clinton 28 July 1973 (Jean Krny); Hamden 21 November 1952 (S. C. Ball); Middlefield 23 May and 20 July 1951 (P. F. Bellinger).

p. 59, add: ### Atypus bicolor Lucas

Atypus bicolor Lucas 1836, Ann. Soc. Entomol. France 5:213, pl. 5, f. 5. :Comstock 1940 Spider Book, rev, ed., p. 251. :Gertsch 1936, Amer. Mus. Novitates 895, p. 13, f. 7, 13, 24-25, 28-29. *Sphodros milberti* Walckenaer 1837, Hist. Nat. Ins. Apt. 1:249.

Length of female (including chelicerae) 22.5 mm, of male 14.5 mm. This species can readily be separated from *niger*, by the reddish legs in the male and in having the carapace and sternum longer than broad. In *niger* the male's legs are brown to black, and the female has the carapace and sternum as broad as or broader than long.

While this species has not been recorded from Connecticut it is known from Rhode Island, and from Long Island, N.Y.

Re: Haplogynae, a study by Glatz (1972) of the spinning apparatus of various members of this group has led him to the conclusion that the group is polyphyletic, and should not be maintained as a unit in the phylogenetic system of Araneae. According to Homann all have the primitive type of tapetum in the indirect eyes.

p. 61, re: *Orchestina saltitans*, additional records include:
New Britain 19 November 1950 and 4 August 1951.

Re: *Tapinesthis inermis*, a redescription was provided by Kraus (1967) who also supplied some biological data as well. He gave the length of the female as 2.35 mm, and of the male as 1.83 mm.

p. 62, re: *Dysdera crocata*, Cloudsley-Thompson (1949b) reported a mating taking place in April and a cocoon containing 26 eggs. Bristowe (1958) reported females laying eggs in June and July. Details of morphology were supplied by Cooke (1965) and of the genitalia in particular (1966).

p. 63, re: the family Segestriidae, the name must now be credited to Simon.

Re: *Ariadna*, a revision of the genus was published by Beatty (1970)

p. 65, re: *Scytodes thoracica*, one female collected at New Britain on 4 July constructed an egg sac on 10 July. The sac was 3.9 mm in diameter, of very sparse silk, so that the eggs showed through. The female held the sac close to her sternum as she walked about in an inverted position on the threads of the webbing constructed. There were

40 whitish, non-agglutinate eggs, each about 0.9 mm in diameter. Bristowe (1958) found that females mature after six molts and males after five or six. Many details on the natural history of this species were published by Dabelow (1958) who found that seven molts are required to maturity, that males live from one and a half to two years, and females from two to three. Egg sacs contained from 4 to 44 eggs, usually fewer than 25 and averaging 22.

p. 66, re: Pholcoidea, Homann (1971) has shown that another affinity with the haplogynes is the primitive structure of the tapetum in the indirect eyes.

p. 67, re: Pholcidae, there are now three species in our region, two of them in the genus *Pholcus*. According to Lopez (1973) at least some members of this family show in the cheliceral portion of the venom gland a resemblance to what appears in *Scytodes* as the gum producing portion.

p. 68, re: *P. phalangioides*, Kovoor and Zylberberg (1971) published their studies on the cheliceral gland.

Add   **Pholcus opilionoides (Schrank)**

Aranea opilionoides Schrank 1781, Enum. Ins. Austriae indig., p. 530 *Pholcus manueli* Gertsch 1937, Amer. Mus. Novitates 936, p. 1. f. 6-7. *Pholcus opilionoides* :Wiehle 1953, Tierw. Deutschland, Teil 42, Spinnentiere 9:39, f. 93-99.

Length of female 4.3 to 5 mm, of male 3.3 to 4.5 mm. This species may be distinguished from the much larger *phalangioides* in having the PME much closer together, the separation being much less than two diameters. Also, the AME are much closer to the ALE. The sternum is grayish brown with a much lighter longitudinal mark in the middle, while in *phalangioides* it is concolorous. In the female the epigynum is only slightly wider than long while in *phalongioides* it is twice as broad as long. In the male the spur on the palpal trochanter is here curved, though straight in *phalangioides*. This species has not been recorded from Connecticut, but is known from Long Island, N.Y.

p. 69, re: *Spermophora meridionalis*, a male was collected from forest floor litter at: Middlefield 13 July 1951 (P. F. Bellinger).

Re: superfamily Epeiroidea; this should now be known as Araneoidea.

Re: the family Theridiidae; this has been studied by Levi, and a large number of papers have appeared. A summary appears in Levi and Levi (1962).

p. 70, re: characters of the family, Homann (1971) has shown that the tapetum in the indirect eyes is of the "canoe type." A few members of the family do not show the tarsal comb on leg IV.

p. 71, re: genera, there are now considered to be 18 genera distributed among six of the subfamilies of Petrunkevitch, although in the opinion of Levi they cannot "be split into subfamilies."

Re: the footnote,   there are now eight species known from northern New England, which do not occur in the southern portion.

Re: mating habits, extensive studies on the habits of theridiids have been published by Braun (1963).

Re: key to genera,   the following is based to a great extent on the work of Levi and Levi (1962).

1a.   Spinnerets occupying a circular space limited by a thick flange in the form of a tube or ring. Abdomen far overhanging the cephalothorax and raised into a series of humps . . . .*Phorincidia*

1b.   Spinnerets not surrounded by a flange; at most with an annular scutum. Abdomen not as indicated above 2

2a.   Carapace with a broad and deep transverse furrow on the thoracic part. Abdomen prolonged above and behind the spinnerets so that the spinnerets are at least as far from the distal end as from the pedicel 3

2b.   Carapace without a transverse furrow on the pars thoracica. Abdomen not greatly prolonged beyond the spinnerets 4

3a.   Posterior eyes in a procurved line with PME much farther from each other than from PLE. Metatarsus I shorter than tibia I. Clypeus almost horizontal. Head of male not provided with horns. Abdomen long and vermiform . . . . .*Rhomphaea*

3b.   Posterior eyes in an almost straight line and almost equidistant. Metatarsus I not shorter than tibia I. Clypeus almost vertical. Head of male with two cephalic horns. Abdomen not vermiform . . . .*Conopistha*

4a.   Abdomen triangular as seen from above, pointed behind . . . .*Euryopis*
4b.   Abdomen ovoid, globose, or rhomboidal 5

5a.   Colulus present, and its length at least half as long as its setae 6
5b.   Colulus lacking or replaced by two setae 11

6a.   Chelicerae without teeth. Lateral eyes will separated, at least a diameter of one apart. (Abdomen of female globose, black and shining, with red, or red and white spots, seldom lacking) . . . .*Latrodectus*

6b.   Chelicerae with one or more teeth or denticles. Lateral eyes closer together . . .7

7a.   Retromargin of cheliceral fang furrow with one or more teeth 8
7b.   Retromargin without teeth 9

8a.   Retromargin of cheliceral fang furrow with two denticles. Cymbium elongate. Dorsum of abdomen unicolorous, without a pattern . . . .*Ctenium*

8b.   Retromargin with one tooth in female. Chelicerae of male enlarged and with several teeth on the retromargin. Cymbium ovoid. Dorsum of male with a pattern of pigment . . . .*Enoplognatha*

9a.   Cephalothorax with numerous small crescent-shaped elevations, each at one side of a puncture . . . .*Crustulina*

9b.   Cephalothorax without the crescent-shaped elevations 10

10a.   Metatarsi shorter than tarsi. Abdomen unicolorous. Body usually less than 1.5 mm in length . . . .*Theonoe*

10b.   Metatarsi longer than tarsi. Abdomen with a white line around anterior part of dorsum, and with other markings too. Usually more than 2 mm body length . . . .*Steatoda*

11a.   Colulus replaced by two setae 15
11b.   Colulus absent entirely 12

12a.   Abdomen of female wider than long, with a hump or tubercle on each side, at about the middle of its length. Tibia of male palp enormously developed and overlapping tarsus considerably . . . . *Theridula*
12b.   Abdomen of female without lateral tubercles, and usually not wider than long. Tibia of male palp not unusually developed 13

13a.   Abdomen usually higher than long, often with dark patches on sides . . . . *Achaearanea*
13b.   Abdomen usually longer than high, or suboval .14

14a.   Less than 2.5 mm in length. Uniformly colored, except for discrete black spots or gray marks. Patella plus tibia I usually less than 1½ times the length of carapace. (Abdomen in some species with scuta) . . . . *Thymoites*
14b.   Usually more than 2.5 mm in length. Usually with a band or pattern of white and black pigment on abdominal dorsum. Patella plus tibia I usually longer than 1½ times the length of carapace. (Abdomen without scuta.) . . . . *Theridion*

15a.   Males with dorsal and epigastric scuta. Females with parts of epigastric scutum above pedicel and over each lung cover, but dorsal scutum lacking . .*Pholcomma*
15b.   Both sexes entirely without scuta 16

16a.   Clypeus high and concave. Cheliceral margins without teeth. Abdomen usually subspherical and usually wider than long . . . .*Dipoena*
16b.   Clypeus of the usual type. Teeth present on either the pro- or the retromargin of the cheliceral fang furrow. Abdomen ovoid or rhomboidal as seen from above .17

17a.   PME two or three times the diameter of one apart. Abdomen rhomboidal and widest anterior to the middle. Retromargin of cheliceral fang furrow without any teeth . . . . *Spintharus*
17b.   PME no more than twice the diameter of one apart. Abdomen ovoid. Retromargin of cheliceral fang furrow with two to five denticles . . . .*Anelosimus*

p. 73, **re:** *Asagena*, Levi has synonymized this under *Steatoda.*

Steatoda americana (Emerton)

Asagena americana :Kaston 1948. *Steatoda americana* :Levi 1957, Bull. Mus. Comp. Zool. 117:400, f. 66-69.

Roewer (1942) considered this a synonym of *dubia* Hentz 1847.

p. 74, **re:** *Crustulina*, the genus was revised by Levi (1957).

p. 76, **re:** *C. sticta*, an additional record:
Hartford 21 May 1961 (J. F. Anderson).
Re: *Enoplognatha*, a revision was published by Levi (1957).

p. 77, **re:** the footnote, Levi agreed with Chamberlin and Ivie that two species were included by me under *marmorata*, but what they called *puritana* he indicated is *tecta*. In addition, we must now include *ovata* (from page 111). A revised key to species follows:

1a.   Color gray, brown or black 2
1b.   Color white or yellow, with black or red lines . . . .*ovata*

2a.   Males 3
2b.   Females 5

3a.   Chelicera with one large tooth .... *intrepida*
3b.   Chelicera with two subequal teeth on retromargin of fang furrow 4

4a.   Pattern on abdominal dorsum spotted (1948: Fig. 43) .... *marmorata*
4b.   Pattern foliate (1948: Fig. 36) .... *tecta*

5a.   Epigynum with openings indicated by distinct marks .... *intrepida*
5b.   Epigynum with diffuse dark markings 6

6a.   Swelling of epigynum divided by a transverse groove. Pattern on abdominal dorsum spotted (1948: Fig. 43) .... *marmorata*
6b.   Epigynal swelling undivided, with only a slight depression posteriorly. Pattern foliate (1948: Fig. 36) .... *tecta*

Enoplognatha tecta (Keyserling)

Lithyphantes tectus Keyserling 1884, Spin. Amerikas, Therid., I:138, pl. 6, f. 86. *Enoplognatha marmorata* :Kaston 1948 (in part). *Enoplognatha tecta* :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:13, f. 11, 25, 28-29, 34-37.

Following Emerton I had confused the two species *marmorata* and *tecta*. My Figs. 36, 41 and 42 belong to *tecta*, and Figs. 35 and 37 to *marmorata*. Both species occur throughout the State.

Re: *E. rugosa*, this is a synonym of *intrepida*.

Enoplognatha intrepida (Sorensen)

Theridion intrepidum Sorensen 1898, Vidensk. Meddel. Naturhist. Foren. Copenhagen, ser. 5, 10:190. *Enoplognatha rugosa* :Kaston 1948. *Enoplognatha intrepidum* :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:17, f. 40-41, 48, 51-52.

We now have a record from Connecticut:
Norwalk 27 May 1933 (W. J. Gertsch).

from p. 111:   ### Enoplognatha ovata (Clerck)

Araneus ovatus Clerck 1757, Svenska Spindlar, p. 58, pl. 3, f. 8. *Theridion redimitum* :Kaston 1948. *Enoplognatha ovata* :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:7, f. 1-10.

The post embryonic development was studied by Seligy (1971). Further data on polymorphism were published by Geyer (1967).

p. 78, re: *Lithyphantes*, Levi has synonymized this under *Steatoda*.

p. 79, re: *L. septemmaculatus*, this is a synonym of *erigoniformis*.

Steatoda erigoniformis (O. P.-Cambridge)

Theridion erigoniforme O.P.-Cambridge 1872, Proc. Zool. Soc. London, p. 284. *Lithyphantes septemmaculatus* :Kaston 1948. *Steatoda erigoniformis* :Levi 1957, Bull. Mus. Comp. Zool. 117:402, f. 70-73. :Levi 1962, Psyche 69:125.

Re: *Ctenium*, since at the present writing the Commission of the International Code of Zoological Nomenclature has under consideration the status of the name *Robertus* (vs. *Ctenium*) those who may wish to use it in preference to *Ctenium* may do so legally.

p. 84, re: *C. spiniferus*, add the collecting records:
Middlefield 24 October 1950 and 23 May 1951 (P. F. Bellinger).

p. 85, re: *Steatoda*, a revision of this genus was published by Levi (1957b, 1962). Because of generic synonymies there are now considered to be six species of this genus in our region, as well as one from northern New England. In addition to *borealis*, we now have *albomaculata* and *erigoniformis* moved in from *Lithyphantes*, *americana* from *Asagena*, and from *Teutana*, *triangulosa* and *grossa*.

Re: *S. borealis*,   Levi gave measurements for males down to 4.3 mm, and for females down to 3.8 mm. An egg sac made on 17 May contained 51 lavender eggs. The same female later produced a sac with yellow eggs!
Re: *Teutana*, Levi has synonymized this under *Steatoda*.

p. 86, re: *T. triangulosa*, many aspects of the biology of this species, including reports of parthenogenesis, were published by Braun (1956).
Additional record: New Britain 17 October 1953.

Re: *T. grossa*,   while I am unable to add any Connecticut records I am able to verify from many southern California specimens observed in recent years, that the pattern on the abdominal dorsum varies considerably in the intensity of the pigmented areas. Additional life history notes were published by Branch (1943).

p. 87, re: *Conopistha*, since at the present writing the Commission of the International Code of Zoological Nomenclature has under consideration the status of the name *Argyrodes* (vs. *Conopistha*) those who may wish to use it in preference to *Conopistha* may do so legally. A revision was published by Exline and Levi (1962).

p. 88, re: *C. trigona*, Bonnet (1955: 708) considered this a synonym of *argyrodes* (Walckenaer) 1841.

p. 89, re: *Rhomphaea*, Exline and Levi included this genus as a synonym of the preceding.

p. 90, re: *Spintharus*, this genus was revised by Levi (1954c).
Re: *Dipoena*, this genus was revised by Levi (1953, 1963b). There are now only two species, *pallida* having been removed by Levi first (1957a) to *Paidisca*, then (1959) to *Sphyrotinus*, and finally (1962) to *Thymoites*.

p. 91, re: *Latrodectus*, much has been written about these widow spiders in recent years, and a summary may be found in my 1970 paper. We now know two species from our region. They had been confused for years, and much of what I wrote under *mactans* in 1948 pertains to *variolus*. The differences between the two, as well as comparison of morphology and many aspects of their biology are supplied in great detail in my 1970 paper and need not be repeated here.

p. 92, re: *L. mactans*, although Levi doubts that this species occurs in New England it is merely less common than the other. The specimen from Westville cited and one collected at Milford in November 1954, are definitely this species. Moreover, I have seen large numbers taken from that part of New York City which is not more than 15 miles from the Connecticut-New York boundary line.

Latrodectus variolus Walckenaer

Latrodectus variolus Walckenaer 1837, Hist. Nat. Ins. Apt., 1:648. *Latrodectus mactans* :Kaston 1948 (in part). *Latrodectus curacaviensis* :Levi 1959, Trans. Amer. Micros. Soc. 78:38 (in part). *Latrodectus variolus* :McCrone and Levi 1964, Psyche 71:13. :Kaston 1970, Trans. San Diego Soc. Nat. Hist. 16:38, f. 4b, 5c, 6a-f, 7, 14a, b, f.

Most of the specimens collected in New England belong not to *mactans* but to this species.

p. 93, re: *Mysmena*,   although Petrunkevitch indicated that he could not separate this from the Dipoeninae the genus is now considered by Levi, by Gertsch, and by Forster to belong to the family Symphytognathidae (see p. 17).

p. 94, re: *Theonoe stridula*, the female was described for the first time by Levi (1955a), when he transferred the species to *Coressa*. It was later placed back in *Theonoe*. *Coressa stridula* :Levi 1955, Amer. Mus. Nov. 1718, p. 4, f. 2-6.

Length of female 0.97 mm. The epigynum is similar to that of the European *minutissima* O.P.-Cambridge 1879. Levi's males measured 0.8 to 0.9 mm.

Re: *Ancylorrhanis*,   Levi considered this to be a synonym of *Pholcomma* Thorell 1869, and revised the genus (1957c).

p. 95, re: *Paidisca*, the genus was revised by Levi (1957a), who in 1959 then considered it to be a synonym of *Sphyrotinus* Simon 1894, and then in 1962 placed both names as synonyms of *Thymoites* Keyserling 1884. There are three species in our region, and the following key is modified from Levi.

1a.	Females	2
1b.	Males	4
2a.	Abdominal dorsum with sclerotized spots	*marxi*
2b.	Dorsum without sclerotized spots	3
3a.	Epigynum with distinct bordered depression and median septum	*pallidus*
3b.	Epigynum without a depression	*unimaculatus*
4a.	Abdominal dorsum with a scutum	*marxi*
4b.	Abdominal dorsum without a scutum	5
5a.	Tip of embolus coiling around conductor	*pallidus*
5b.	Tip of embolus straight	*unimaculatus*

Re: *P. marxi*

Thymoites marxi (Crosby)

Paidisca marxi :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:111, f. 393-395, 401, 418-419. *Sphyrotinus marxi* :Levi 1959, Bull. Mus. Comp. Zool. 121:148. *Thymoites marxi* :Levi 1964, Bull. Mus. Comp. Zool. 130:449.

from p. 91, re: *D. pallida*,

Thymoites pallida (Emerton)

Paidisca pallida :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:99, f. 358, 366. *Sphyrotinus pallida* :Levi 1959, Bull. Mus. Comp. Zool. 121:158. *Thymoites pallida* :Levi 1964, Bull. Mus. Comp. Zool. 130:470.

The female was described for the first time by Levi. The body length varied from 1.5 to 2.9 mm while the males varied from 1.3 to 1.8 mm. We now have records from Massachusetts as well as from Rhode Island.

from p. 107, re: *Theridion unimaculatum*

Thymoites unimaculatum (Emerton)

Paidisca unimaculatum :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:106, f. 388-392, 406-413. *Thymoites unimaculatum* :Levi 1964, Bull. Mus. Comp. Zool. 130:449.

p. 96, re: *Ulesanis*, Levi indicated that this is a synonym of *Phoroncidia* Westwood 1835, and revised the genus (1964b).

Phoroncidia americana (Emerton)

Oronota americana :Levi 1955, Ann. Soc. Entomol. Amer. 48:334, f. 1-8. *Phoroncidia americana* :Levi 1964, Bull. Mus. Comp. Zool. 131:74.

Re: *Euryopis*, this genus was revised by Levi (1945b, 1963b).   There are now five species known from our region.

p. 97, re: *E. argentea*

Euryopis argentea Emerton
Euryopis argentea :Levi 1954, Amer. Mus. Novitates 1666, p. 11, f. 4-7, 11-14.

According to Levi only the male as described by me belongs here; the female belongs to his new species, *gertschi*. Males studied by Levi measured 2 to 2.6 mm in length, while females were 2.8 to 3.2 mm. The pars cephalica is black, darker than the pars thoracica.

Euryopis gertschi Levi
Euryopis gertschi Levi 1951, Amer. Mus. Novitates 1501, p. 6, f. 1-4. Levi 1954, Amer. Mus. Novitates 1666 p. 9, f. 3, 6, 15-16.

Males average 2.4 mm in length, and females 2.5 mm. This species has larger eyes than *argentea*, and also differs in the arrangement of the silvery abdominal marks. Moreover, the pars cephalica is not black.

p. 98, re: Theridula, the genus was revised by Levi (1954a), who has shown that my remarks under *opulenta* actually apply to his new species, *emertoni*.

p. 99, insert: ### Theridula emertoni Levi
Figs. 1-2
Theridula opulenta :Kaston 1948 [not *opulenta* Walckenaer]. *Theridula emertoni* Levi 1954, Trans. Amer. Micros. Soc. 73:333, f. 1-5. Levi 1966, Psyche 73:125.

Theridula opulenta (Walckenaer)
Figs. 3-4
Theridula opulenta :Levi 1954, Trans. Amer. Micros. Soc. 73:334, f. 9-13.

This species is mostly southern. It is somewhat smaller than the northern *emertoni*, males ranging from 1.2 to 1.7 mm, and females from 1.6 to 2.6 mm in length. The epigynum has a posterior area which is heavily sclerotized and dark brown. This area is lacking in *emertoni*. The palpal organ of *emertoni* has the embolus shorter and undulating near the tip, while that of *opulenta* is straight, and with a notch at the tip as illustrated here.
Norwalk 2 July 1933 (W. Ivie).

Re: Anelosimus, the genus was revised by Levi (1965b, 1963a).

Anelosimus studiosus (Hentz)
Anelosimus studiosus :Levi 1956, Trans. Amer. Micros. Soc. 75:418, f. 21-23, 37-39.

Levi very definitely disagrees with the suggestion of Chamberlin and Ivie that this is Walckenaer's *textrix*. In Florida I collected a female that was guarding two egg sacs with her front legs. Each sac was about 2.4 mm in diameter and 3.1 mm long, of grayish silk, and each contained 19 pale blue non-agglutinate eggs each about 0.5 mm in diameter.

p. 100, re: footnote, according to Opinion 517 of the ICZN (30 May 1958) the correct orthography is as here given, the form "*Theridium*" being rejected.

As presently constituted from the studies of Levi, who revised the genus (1957a), we now know 14 species from our region. Into *Achaearanea* have been shifted *tepidariorum*, *globosum* and *rupicola*, while *redimitum* has been moved into *Enoplognatha*, and *unimaculatum* into *Thymoites*. Moreover, species added to our region include: *sexpunctatum*, *antonii*, and *berkeleyi*.

Key to species:

1a.   Males 2
1b.   Females 15

2a.   Embolus coiled in a very long spiral making two or three circles (as in 1948: Fig. 149) . . . . *glaucescens*
2b.   Embolus very much shorter than above 3

3a.   Chelicerae in front with distinct mastidia near the clypeal edge 4
3b.   Chelicerae without mastidia, at most with a low rounded knob 5

4a.   Palpal organ with the median apophysis deeply cleft (1948: Fig. 1968) . . . . . .
        . . . . *frondeum*
4b.   Palpal organ with the median apophysis less deeply cleft (1948: Fig. 170) . . . . . .
        . . . . *albidum*

5a.   Palpal organ with the median apophysis U-shaped and the embolus elbowed at its apex (1948: Fig. 175) . . . . *pennsylvanicum*
5b.   Palpal organ not as above 6

6a.   Cymbium thin and with one or two stout spines at the apex; palpal organ with two stout distal apophyses . . . . *crispulum*
6b.   Palp not as above 7

7a.   Abdomen gray, with numerous small white spots (as in 1948: Fig. 133). . . . .
        . . . . *punctosparsum*
7b.   Abdomen not as above 8

8a.   Epigastrium strongly developed, the distance from petiole to epigastric furrow exceeding that from the latter to the spinnerets, and the central part of it strongly sclerotized and greatly arched 10
8b.   Epigastrium of the usual type, shorter than the distance from furrow to spinnerets, and not unduly sclerotized or arched .9

9a.   Chelicera long and with a large tooth at the middle of the retromargin (Fig. 10). .
        . . . . *sexpunctatum*
9b.   Chelicerae not strongly developed and lacking the tooth . . . . *lyricum*

10a.   Chelicerae small and weak, not divergent distally 11
10b.   Chelicerae divergent distally, with margins oblique 13

11a.   Cephalothorax bright orange; abdomen with a notched median band 12
11b.   Cephalothorax grayish yellow; abdomen gray with a faint light median area, not notched (1948: Fig. 143). Palp as in 1948: Fig. 165 . . . . *alabamense*

12a.   Folium notched (as in 1948: Fig. 124) . . . . *differens*
12b.   Folium more distinctly notched than in Fig. 124, but less so than in Fig. 126 . . .
        . . . . *antonii*

13a.   Chelicerae projecting forward at the base 14
13b.   Chelicerae not projecting forward . . . . *murarium*

14a.   Embolus long, its distal portion extending beyond the expanded base, and longer than the basal portion (Fig. 7) . . . . *ornatum*

14b.   Embolus short, its distal portion extending behond the basal portion, shorter than the basal portion (Fig. 8) . . . . *berkeleyi*

15a.   Epigynum a concave plate 16
15b.   Epigynum not a concave plate 17

16a.   Epigynum with a pair of receptacula often visible anterior to the opening. Abdomen with a broad light band with lateral extensions (1948: Fig. 128) . . . . *ornatum* and *berkeleyi*
16b.   Epigynal plate with the receptacula toward the sides and narrower behind than in front (1948: Fig. 177). Abdomen with four or five pairs of small black dots . . . . *crispulum*

17a.   Epigynum with a large central opening or fossa (within which may be seen openings to the canals) 18
17b.   Epigynum without a large opening or fossa; with either one or two openings on the surface of the plate itself 21

18a.   With two distinct openings visible inside the epigynal fossa 19
18b.   With the openings not distinctly visible . . . . *punctosparsum*

19a.   The fossa as long as wide, and the epigynum as a whole longer than wide, with the tubules leading in from the openings darkly pigmented (as in 1948: Fig. 153) . . . . *lyricum*
19b.   Fossa wider than long 20

20a.   Epigynal openings close together . . . .*antonii*
20b.   Openings farther apart (as in 1948: Fig. 166) . . . . *alabamense*

21a.   Epigynum with a single opening, and that in the median line 22
21b.   Epigynum with two openings leading into the canals 23

22a.   Epigynum with its posterior border thickened, darkly pigmented, and raised slightly behind the crescent-shaped opening (which is generally dark as in 1948: Fig. 167) . . . .*frondeum*
22b.   Epigynum with the posterior border not as broad and thick, with a dark dumb-bell shaped structure (sometimes divided into two at the middle) behind the opening (which is generally light as in 1948: Fig. 171) . . . . *albidum*

23a.   The epigynal openings more than twice their diameter apart 24
23b.   Epigynal openings less than twice their diameter apart 25

24a.   Epigynal canals extending toward the median plane as in 1948: Fig. 174 . . . . *pennsylvanicum*
24b.   Canals parallel for the first portion, then in a U-shaped curve (as in 1948: Fig. 147) . . . . *murarium*

25a.   Epigynal openings more than a diameter apart, and sunk below the surface of the plate so that there is a broad ridge between them . . . .*differens*
25b.   Openings less than a diameter apart, and not sunk below the surface of the plate (1948: Fig. 148) 26

26a.   The two epigynal openings contiguous (Fig. 9) . . . . *sexpunctatum*
26b.   The openings separated (as in 1948: Fig. 148) . . . . *glaucescens*

p. 102, re: *T. tepidariorum*, see *Achaearanea*.

p. 105, re: *T. spirale*, Levi has shown this to be a synonym of *glaucescens*.

Theridion glaucescens Becker

Theridion glaucescens Becker 1879, Ann. Soc. Entomol. Beligique 22:81, pl. 1, f. 11. :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:44, f. 152-153, 155-156. *Theridion spirale* :Kaston 1948.

p. 106, re: *Theridion albidum*, females may produce egg sacs earlier than in August. One was taken with its sac on 16 July 1962, in New Britain.

Re: *T. lyra*, Levi has shown that this is a synonym of *lyricum*.

Theridion lyricum Walckenaer

Theridion lyricum Walckenaer 1841, Hist. Nat. Ins. Apt. 2:288. :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:189, f. 322-323, 329-331. *T. lyra* :Kaston 1948.

p. 107, re: *T. unimaculatum*, moved to *Thymoites*.

p. 108, re: *T. globosum*, see *Achaearanea*.

p. 109, insert: *T. antonii* after *T. punctosparsum*

Theridion antonii Keyserling
Fig. 5

T. antonii Keyserling 1884, Spinn. Amerikas, Therid. 1:54, pl. 2, f. 31: Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:60, f. 196-197, 205, 215-216, 219-220.

Length of female 2.3 to 3 mm; of male 1.95 to 2.7 mm. The general appearance is similar to that of *T. punctosparsum*, with a folium somewhat like that of *differens*, but with the notches of the median band deeper. The epigynum is similar to that of *punctosparsum* but the receptacula are spherical while those of *punctosparsum* are oval. "The lighter coloration and the indistinct leg bands, broken on the dorsal surface of the legs, differentiate most females from those of *T. punctosparsum*." Levi records a specimen from Norwalk (W. J. Gertsch).

Re: *T. rupicola*, see *Achaearanea*.

Re: *T. zelotypum*, Levi has shown this to be a synonym of *ornatum*.

Theridion ornatum Hahn
Figs. 6-7

T. ornatum Hahn 1831, Monogr. d. Spinnen, Hefte 6, pl. 3, f. c. :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:50, f. 164-165, 168-170. *T. zelotypum* :Kaston 1948 [in part, not f. 151].

This species is similar to *berkeleyi*, and rather difficult to distinguish from it in the female sex. *T. ornatum* is a more northern species and presumably is known from Massachusetts.

Theridion berkeleyi Emerton
Fig. 8

T. berkeleyi Emerton 1924, Pan-Pac. Entomol. 1:30, f. 8. :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:52, f. 166-167. *T. fieldi* Levi 1951, Amer. Mus. Novitates 1501, p. 3, f. 46.

Length of female is 2.3 to 4.5 mm; of male 2.4 mm. The general appearance is like that of *ornatum*, but the pattern is less distinct, and the embolus is shorter. The females are "difficult to separate from *ornatum*." The records that were listed for *zelotypum* belong to this species.

p. 110, re: *T. blandum*, Levi has shown that what I included here is actually *crispulum*.
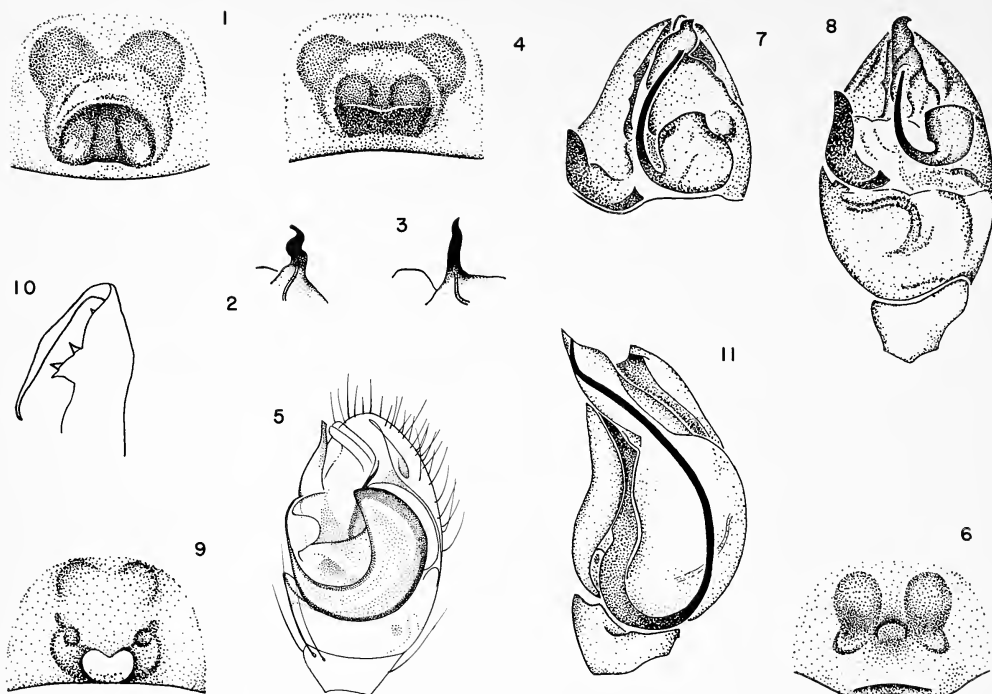
Figs. 1-11.–1, *Theridula emertoni*, epigynum (after Levi); 2, *Theridula emertoni*, embolus (after Levi); 3, *Theridula opulenta*, embolus (after Levi); 4, *Theridula opulenta*, epigynum (after Levi); 5, *Theridion antonii*, palp; 6, *Theridion ornatum*, epigynum (after Levi); 7, *Theridion ornatum*, distal portion of palp (after Levi); 8, *Theridion berkeleyi*, palp (after Levi); 9, *Theridion sexpunctatum*, epigynum (after Levi); 10, *Theridion sexpunctatum*, chelicera of male (after Levi); 11, *Achaearanea porteri*, palp (after Levi).

Theridion crispulum Simon

T. crispulum Simon 1895, Ann. Entomol. Soc. France 64:142. :Levi 1959, Bull. Mus. Comp. Zool. 121:113. *T. blandum* :Kaston 1948. *T. intervallatum* :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:64, f. 222-224, 229-231.

Levi considered that *blandum* Hentz is not recognizable.

Add: ### Theridion sexpunctatum Emerton
Figs. 9-10

T. sexpunctatum Emerton 1882, Trans. Connecticut Acad. Sci. 6:12, pl. 2, f. 5. :Levi 1957, Bull. Amer. Mus. Nat. Hist. 112:91, f. 340-349.

Length of female 2.1 to 2.7 mm; of male 1.95 to 2.2 mm. This is one of the species in which the chelicerae of the male are strongly developed, being twice as long as those of the female. The species name refers to the six irregular black patches on an otherwise yellow abdominal dorsum.

While previously known from northern New England, and hence listed on p. 561, it is being included here now because of a Massachusetts record.

p. 111, re: *T. redimitum*, see *Enoplognatha ovata.*

Add: ### Genus Achaearanea Strand 1929

A revision was published by Levi (1955a, 1959). There are four species in our region, all having been removed from *Theridion.* The abdomen is usually higher than long

without a mid-dorsal white stripe. The palpal organ is simpler than that in *Theridion*, lacking a radix.

from p. 103: Achaearanea tepidariorum (C. L. Koch)

A. tepidariorum :Levi 1955, Amer. Mus. Novitates 1718, p. 32, f. 69-70, 83-84.

Kullmann has shown that this species may occupy the webs of other spiders as a parasite.

from p. 108: Achaearanea globosum (Hentz)

A. globosum :Levi 1955 Amer. Mus. Novitates 1718, p. 9, f. 19-25.

A female with two egg sacs was taken on 2 July. The sacs tapered at both ends as observed by Hentz, one end tapering more than the other, papery in texture, and light tan in color. One measured 3.7 mm in length by 1.52 mm at the widest part, and contained 20 white non-agglutinate eggs each about 0.37 mm in diameter. The other measured 3.9 mm in length by 1.83 mm at the widest part, and contained 35 eggs.

Hartford 2 July 1960 and 20 August 1961 (J. F. Anderson).

from p. 109: Achaearanea rupicola (Emerton)

A. rupicola :Levi 1955 Amer. Mus. Movitates 1718, p. 21, f. 47-52, 56.

From Levi's data it appears that the length of females may be down to 1.8 and of males to 1.4 mm.

Insert: Achaearanea porteri (Banks)

Fig. 11

Theridion porteri Banks 1896, *In*: Blatchley's Ann. Rpt. Indiana Geol. Surv. 21:203. *A. porteri* :Levi 1955, Amer. Mus. Novitates 1718 p. 30, f. 71-75, 80-82.

Length of female 2.2 to 4.9 mm; of male 1.6 to 2.8 mm. Levi found this species to be quite variable not only with respect to genitalia, but also in that some have a tubercle on the abdomen (as in *rupicola*) and some do not. This species is southern, but is included here on the basis of a record for Long Island, N.Y.

Insert: Family SYMPHYTOGNATHIDAE Hickman

Although Petrunkevitch (1958:150) indicated that he could not separate the Mysmeninae from the Dipoeninae, Forster's studies (1958, 1959) indicated that there were sufficient reasons (as previously suggested by Archer, see footnote p. 93) for separation, and in fact for moving the former from the Theridiidae to this family. Gertsch (1960) concurred in this, as did also H. W. and L. R. Levi (1962). The members of this family are all of minute size. They lack the tarsal comb characteristic of the theridiids in general; many lack book lungs (i.e., leaf tracheae), having only the tubular tracheae. The labium is rebordered; and according to Homann (1971) the tapetum in the indirect eyes is of the "canoe" type. The family is represented in our region by only the one genus, with a single species. The genus *Misumena* was revised by Levi (1956a).

Misumena guttata (Banks)

M. guttata :Levi 1956, Amer. Mus. Novitates 1801, p. 8, f. 20-30.

Some females studied by Levi measured as much as 1.3 mm in length. The species may yet be found in Connecticut since it is known from Long Island, N.Y. and from Massachusetts. Loksa (1973) suggested that our species is the same as the *leucoplagiata* Simon of Europe, but Levi indicated otherwise.

p. 112, re: Nesticidae, Bristowe (1958) gave additional support to the maintenance of this as a separate family. According to Homann (1971) the tapetum is of the "canoe" type.

Re: *Nesticus cellulanus* (Olivier)
N. cellulanus :Wiehle 1953, Tierw. Deutschland, Teil 42, Spinnentier 9:53, f. 122-127.

Females measured by Wiehle were up to 5.5 mm in length, and males up to 5 mm. One of his illustrations shows that in the web there are, attached to the substratum, gum-footed threads similar to those known for *Steatoda* and other theridiids.
Re: *N. pallidus*, this is now placed in *Eidmanella* Roewer 1935

p. 114, re: Linyphiidae, relationships based upon palpal structure were indicated by Merrett (1963). For an interesting note on courtship see Rovner (1967). According to Homann (1971) many members of this family show a tapetum of the "canoe" type in the indirect eyes. As here considered there are 22 genera in our region.

p. 115, re: key to genera, the following modifications should be made. If the specimen keys out at couplet 7a to *Linyphia*, proceed as follows:

8a.   PME closer to each other than to the PLE, and only scantily surrounded by pigment. Femora I and II without dorsal and lateral spines. (Male with a single mastidion on each chelicera.) . . . .*Prolinyphia*
8b.   PME closer to the PLE than to each other, and with a thick ring of black pigment around them. Femur I with dorsal and prolateral spines 9

9a.   Femur I with two dorsal and one (or two) prolateral spines. Male with two mastidia on each chelicera . . . . *Neriene*
9b.   Femur I with only one dorsal (and two prolateral) spines. Male with only one mastidion on each chelicera . . . . *Microlinyphia*

Couplet 10a should be considered as keying out to *Bathyphantes*. Delete couplet 11. If the specimen keys out at 15b and 16 proceed as follows:

16a.   Cymbium usually angulate. Epigynum with a median lobe between two oval or crescentic areas (as in 1948: Fig. 2079) . . . . *Meioneta*
16b.   Cymbium not angulate, though some may have a horn near the base. Epigynum not as above 17

17a.   All tibiae with two dorsal spines, but at least tibia I and II without lateral spines 18
17b.   Tibia I with at least a prolateral spine. (Epigynum without a scape. Palpal tibia without an apophysis.) 19

18a.   Metatarsi spineless. Chelicera of male with a mastidion. Epigynum without a scape . . . . *Ostearius*
18b.   Metatarsi I and II with a dorsal spine which may be small and slender. Chelicera of male without a mastidion. Epigynum with a scape . . . . *Centromerus*

19a.   Length about 1.5 mm. Tibia I with both a prolateral and a retrolateral spine. AME small, separated from each other by at least a diameter, and much more than this from the ALE . . . .*Porrhomma*
19b.   Length 2 to 2.5 mm. Tibia I with a prolateral spine, but no retrolateral. AME not more than a diameter apart or from the ALE . . . .*Hillhousia*

p. 117, re: *Tapinopa bilineata*, this is one of those exceptional linyphiids in that the clypeus height is less than the length of the median ocular area.

We now have a Connecticut record:
Hartford 2 July 1960 (J. F. Anderson).

p. 118, re: *Drapetisca alteranda*. Although it is indicated that the web of this species is unknown it may be that the situation is similar to that reported by Kullmann (1961) for the European *D. socialis*. In that species the web fibers are simply placed flat over the bark, and although very fine and thus difficult to see they may be revealed by coating the threads with ammonium chloride, or by some other technique to make the fibers show up.

Re: *S. lineata*, Gertsch has shown that our species is not the same as the European.

Insert: **Stemonyphantes blauveltae** Gertsch
S. blauveltae Gertsch 1951, Amer. Mus. Novitates 1514, p. 1, f. 4-5.

p. 119, re: *P. costatus* (Hentz), a female which mated in the laboratory on 20 April 1962, constructed an egg sac on 9 May. The sac had the shape of a plano-convex lens, 4.5 mm in diameter and 1.4 mm thick, fastened to the substratum. The egg mass was 2.4 mm in diameter and consisted of 35 orange eggs each about 0.63 mm diameter.

p. 121, re: the genus *Linyphia*, from the studies of van Helsdingen (1969, 1970) it would appear that we do not have in our region any members of this genus *sens. str.* Rather, he considers that they belong to *Neriene*, though some may also be considered as belonging in *Prolinyphia* and *Microlinyphia*. For a discussion of the relation of these to each other see also Wiehle (1956).

p. 122, re: Genus **Prolinyphia** Homann 1952

Homann has shown that in this genus the indirect eyes are concolorous, while in those species belonging to *Linyphia* proper (and also *Neriene*) the indirect eyes are discolorous.

Re: *L. marginata*   **Prolinyphia marginata** (C. L. Koch)
P. marginata :Wiehle 1956, Tierw. Deutschlands, Teil 44, Linyphiidae, p. 298, f. 486-494. *Neriene radiata* :van Helsdingen 1969, Zool. Verh. Rijksmus. Nat. Hist. Leiden, 105, p. 223, f. 315-324.

Roewer had considered this to be a synonym of *triangularis*, but van Helsdingen has shown the latter to be a different species. Since van Helsdingen placed the species in the genus *Neriene*, which already contained Blackwall's *N. marginata* described one year before Koch's *L. marginata* it was necessary because of the homonymy for van Helsdingen to replace the name *marginata* with that of Walckenaer's *radiata*. The quotation I supplied from Blackwall concerning the egg sac really indicates the situation in Blackwall's species, which, following Thorell and van Helsdingen, is actually *clathrata* Sundevall. Wise (1973) has shown that the sacs are not laid on an exposed surface but under leaf litter. The sac is approximately 7 mm in diameter and 4 mm thick. The number of eggs in five sacs ranged from 63 to 93, and the diameter of an egg was about 0.6 mm.

p. 123 add: genus *Neriene* Blackwall 1833.
Neriene clathrata (Sundevall)
Linyphia clathrata :Kaston 1948. *Neriene clathrata* :van Helsdingen 1969, Zool. Verh. Rijksmus. Nat. Hist. Leiden, 105, p. 84, f. 79-91.·

As indicated under *P. marginata* (above) the data on egg sacs, quoted from Blackwall, really belong here, since his *marginata* is a synonym.

p. 124, re: *L. maculata*, which is a synonym of *variabilis*.

Neriene variabilis (Banks)

Linyphia variabilis Banks 1892, Proc. Philadelphia Acad. Nat. Sci. [44]:42, pl. 2, f. 28. *L. maculata* :Kaston 1948. *Neriene variabilis* :van Helsdingen 1969, Zool. Verh. Rijksmus. Nat. Hist. Leiden, 105, p. 130, f. 155-166.

Additional record: a pair taken together at New Britain 19 June 1961 (J. F. Anderson).

Although Gerhardt set up his new genus *Microlinyphia* 1928 on behavioral grounds there are morphological grounds too. The chelicerae in males are long, more than half the length of the cephalothorax, and inclined backwards at an angle of about 45 degrees. The embolus is long and thread-like forming a large conspicuous loop. The epigynum is small and inconspicuous, barely more heavily sclerotized than the surrounding area.

Re: *L. pusilla* it has been shown that our species is not the same as the European.

Microlinyphia mandibulata (Emerton)

Linyphia mandibulata Emerton 1882, Trans. Connecticut Acad. Sci. 6:64, pl. 19, f. 2-2d. *Microlinyphia mandibulata* :van Helsdingen 1970, Zool. Verh. Rijksmus. Nat. Hist. Leiden 111, p. 39, f. 28-33, 35-37.

p. 125, re: *Estrandia nearctica*, is a synonym of *grandaeva*.

Estrandia grandaeva (Keyserling)

Linyphia grandaeva Keyserling 1886, Spinn. Amerikas, Ther. 2:92, pl. 14, f. 185.

p. 126, re: *Lepthyphantes*, a detailed discussion of the structure of the female genitalia was published by Wanless (1973).

p. 128, re: *Lepthyphantes nebulosa*, this species is one of those that is active in winter, according to Tretzel (1954).

Re: *L. leprosa*, the sexual behavior was described in great detail by van Helsdingen (1965), who also gave an extended discussion of the function of the different parts of the genitalia.

p. 130, re: the genus *Bathyphantes*, of which a revision was published by Ivie (1969). The latter publication also contains a most useful list of 103 species names of spiders that have been at one time or another placed in this genus but belong elsewhere. There are five species in our region, including *brevis*, which I previously placed in *Bathyphantoides*. Hackman (1954), and also Ivie, have shown that the position of the spiracle is variable, removing the justification for maintaining the latter genus.

Revised key to species (mostly after Ivie):

1a.	Males	.2
1b.	Females	.6
2a.	Embolus in the form of a long, stout, coil on the distal half of the tarsus 4	
2b.	Embolus not of this form 3	
3a.	Embolus long, arising from the base of the palpal organ, with its tip looped. Abdomen light gray to brown without markings . . . . *concolor*	
3b.	Embolus much shorter, and tip not looped. Abdomen with a pattern of black and white . . . . *pullatus*	
4a.	Lobe of palpal tegulum with a distinct bulge on the ectal side . . . . *pallidus*	
4b.	Lobe not so bulged on ectal side 5	

5a.   Distal extension of palpal lamella bifid, the ectal branch the longer one and very sharp (Fig. 12) . . . .*brevis*

5b.   Distal extension of palpal lamella with tip notched, and enclosed in a fold of the median apophysis (Fig. 13) . . . .*albiventris*

6a.   Scape absent, though parmula is slender and quite elongate . . . . *pullatus*

6b.   Scape present 7

7a.   Scape longer than wide 8

7b.   Scape short, its length not greater than its width at base 9

8a.   Abdominal dorsum black, without a pattern . . . .*concolor*

8b.   Abdominal dorsum with a banded pattern . . . . *pallidus*

9a.   Venter dark gray . . . .*brevis*

9b.   Venter whitish . . . .*albiventris*

p. 132, re: *B. conicus*, is a synonym of *pullatus*.

Bathyphantes pullatus (O. P.-Cambridge)

Linyphia pullata O. P.-Cambridge 1863, Zoologist 21:8580. *B. pullatus* :Ivie 1969, Amer. Mus. Novitates 2364 p. 57, f. 116-121.

Ivie gave the length of a female as 2.1 mm. In my 1948 description I erroneously mistook the elongated parmula of the epigynum for a scape, which is absent in this species.

Re: *B. brevis*, I have already indicated that this goes back into *Bathyphantes*.

Bathyphantes brevis (Emerton)
Fig. 12

B. brevis :Ivie 1969, Amer. Mus. Novitates 2364 p. 16, f. 15-21, 110.

Insert: **Bathyphantes albiventris (Banks)**
Figs. 13-14

Diplostyla alboventris Banks 1892, Proc. Philadelphia Acad. Nat. Sci. [44]:43, pl. 5, f. 31. *B. alviventris* :Ivie 1969, Amer. Mus. Novitates 2364 p. 18, f. 10-14, 22.

Length about 2.5 mm in both sexes. With the characters as given in the key.
Newington 18 April 1961 (J. F. Lienisch).

p. 134, Re: *A. olivacea*, is a synonym of *cauta*.

Agyneta cauta (O. P.-Cambridge)

Microneta cauta O. P.-Cambridge 1902, Proc. Dorset Field Club 23:31, f. 2.

p. 135, re: *Centromerus*, some synonymy, notes, and comments were published by van Helsdingen (1973). We now have six species recognized from our region.

Re: *C. sylvaticus*, according to Tretzel (1954) this species is one which is active in winter. Buche (1966) supplied many data on the biology of the species. It matures in the fourth instar in 73 days at 15°C. The egg sac is white, 3.5 to 4 mm in diameter, and may contain from 34 to 74 eggs.

Re: *C. persoluta* add record:
Middlefield 30 January 1951 (P. F. Bellinger).

p. 136, re: *C. cornupalpis*, additional records:
Bethany October 1950 (P. F. Bellinger); Middlefield 24 October 1950, February 1951, and April 1951 (P. F. Bellinger).

p. 137, re: *C. denticulata*, now known from Connecticut.
Bethany 18 April 1951 (P. F. Bellinger).
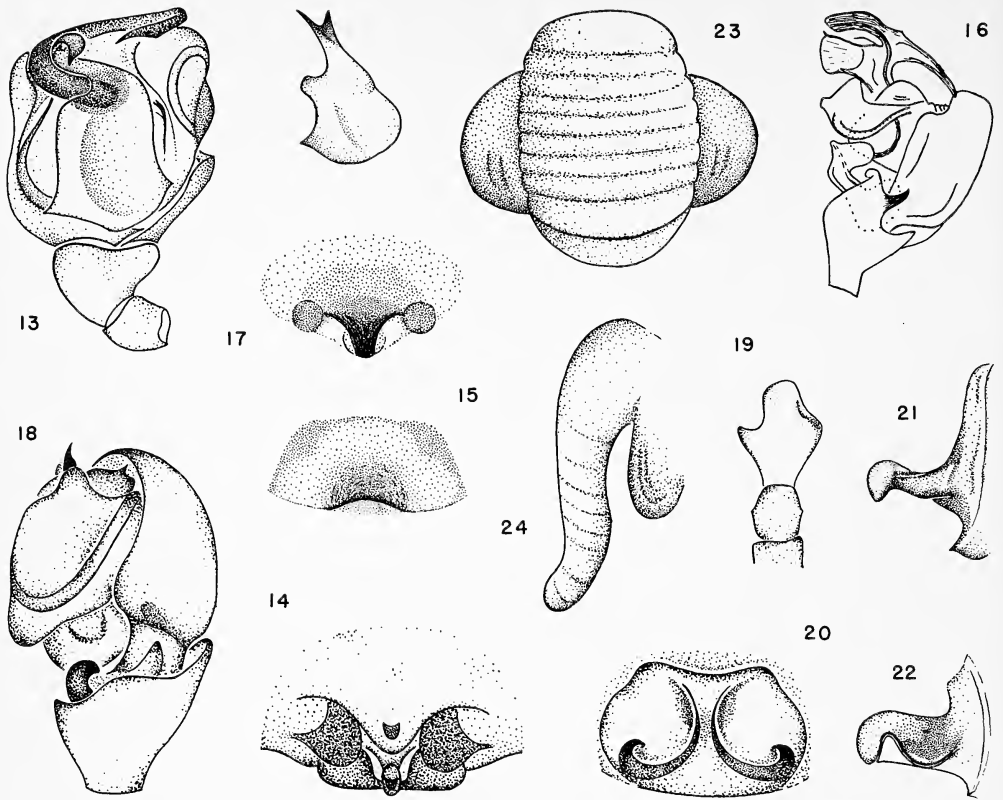
Figs. 12-24.–12, *Bathyphantes brevis*, lamella of palp (after Ivie); 13, *Bathyphantes albiventris*, palp (after Ivie); 14, *Bathyphantes albiventris*, epigynum (after Ivie); 15, *Hillhousia misera*, epigynum (after Locket and Millidge); 16, *Ostearius melanopygius*, palp (after Wiehle); 17, *Ostearius melanopygius*, epigynum (after Locket and Millidge); 18, *Ceratinops obscura*, palp (after Chamberlin and Ivie); 19, *Ceratinops obscura*, palpal tibia and patella (after Chamberlin and Ivie); 20, *Hypsosinga singaeformis*, epigynum (after Levi); 21, *Neoscona domiciliorum*, conductor of palpal organ (after Berman and Levi); 22, *Neoscona hentzii*, conductor of palpal organ (after Berman and Levi); 23, *Araneus pratensis*, epigynum ventral aspect; 24, *Araneus pratensis*, epigynum lateral aspect.

Re: *Meioneta*, some synonymy, notes and comments were published by van Helsdingen (1973) in his *Centromerus* paper. There are 8 species now known from our region.

Re: *Centromerus serrata*, belongs in *Meioneta*.

Meioneta serrata (Emerton)

M. beaufortensis Barnes 1953, Amer. Mus. Novitates 1632 p. 4, f. 1-2. *M. serrata* :van Helsdingen 1973, Zool. Verh. Rijksmus. Nat. Hist. Leiden 124, p. 9. *Centromerus emertoni* Kaston 1972, Entomol. News 83:105.

Barnes described the female and illustrated the epigynum. His specimen was 1.42 mm in length. His males measured down to 1.37 mm. Van Helsdingen showed that this species belongs in *Meioneta*, not *Centromerus*, so the name *emertoni* that I assigned to it in 1972 (because the name *serrata* had been given in 1875 by O. P.-Cambridge to another species) is not needed.

from p. 211, re: *Sciastes terrestris*, according to Ivie (1967) this belongs in *Porrhomma* Simon 1884. We have one species.

also from **p. 211**, re: *Sciastes concavus*, it has been shown by Holm (1968) that this belongs in the genus *Hillhousia* F. O. P.-Cambridge 1894, and is a synonym of *misera.*

Hillhousia misera (O. P.-Cambridge)
Fig. 15

Linyphia turbatrix O. P.-Cambridge 1879, Ann. Mag. Nat. Hist. (5) 4:206. *L. misera* O. P.-Cambridge 1882, Ann. Mag. Nat. Hist. (5) 9:262 [new name for *turbatrix* preoc.]. *Hillhousia misera* :F. O. P.-Cambridge 1894, Ann. Mag. Nat. Hist. (6) 13:90, pl. 1, f. 13. :Locket and Millidge 1953, British Spiders 2:327, f. 198, A, B. C. :Wiehle 1956 Tierw. Deutschlands, Spinnentiere, 44:246, f. 410-415.

Length of female 2 to 2.5 mm; of male 1.8 to 2 mm.

p. 142, insert: Genus **Ostearius** Hull 1911

This genus is considered by some to be midway between the Linyphiidae and the Micryphantidae, but by most workers is placed definitely with the linyphiids.

Ostearius melanopygius (O. P.-Cambridge)
Figs. 16-17

Linyphia melanopygius O. P.-Cambridge 1879, Proc. Zool. Soc. London p. 696, pl. 53, f. 13. *Erigone matei* Keyserling 1886, Spinnen Amerikas, Therid. 2:159. *Oedothorax melacra* Chamberlin 1916, Bull. Mus. Comp. Zool. 60:236, pl. 17, f. 6-7. *Scolopembolus melacrus* :Bishop and Crosby 1938, J. New York Entomol. Soc. 46:64, pl. 3, f. 16. *Ostearius melanopygius* :Locket and Millidge 1953, British Spiders 2:326, f. 197 D. E, F. G. :Wiehle 1960, Zool. Jahr. Abt. Syst. 88:201, f. 8-15.

Length of female 2.3 to 2.5 mm; of male 1.9 to 2.4 mm. The general color is brownish on the carapace, and reddish on the abdomen, but, as indicated by its specific name, the posterior end is black around the spinnerets. Femur I is shorter than the carapace. Metatarsus I is about twice as long as tarsus I, but the metatarsi are shorter than the tibiae. The clypeus is slightly concave, and the chelicera of the male has a mastidion about one fourth the distance up from the fang. The chelicera is thickened at the base and provided with conspicuous stridulating striae on the lateral aspect. The tibial apophysis has two rami, and the epigynum lacks a free scape.

This species has been collected from sandhills, in gardens, sometimes in rubbish heaps, and occasionally indoors. At times it has been considered a pest in Great Britain, and I have found this to be the case in Cromwell, where on 30 January 1951 I was called by a greenhouse keeper to examine the messy webbing placed over the plants.

Braun (1961) supplied much information on its natural history. He noted that, unlike most linyphiids which stand under the web, these stand in a retreat. He described the courtship and mating (with occurs in position I). The egg sacs were not placed in the retreat. Up to four may be made, each with 30 to 50 eggs. Additional data on the biology of this species were published by Felton (1972).

Re: Micryphantidae.   During the past two decades the European workers have used the relative position of the leg trichobothria as a character for generic placement. Crosby and Bishop had made no use of this, and it is to be hoped that some future American student of this difficult family will see what can be done in this regard. Wilton Ivie was working on these spiders when he met his untimely death in an automobile accident, and American araneology suffered a sad loss.

For relationships based upon a study of palpal structure see Merrett (1963). According to Homann (1971) the members of this family have a tapetum of the "canoe" type in the indirect eyes.

Much of the synonymising I have done here is based on the studies of Ivie (1967), Holm (1968), and Hackman (1954).

p. 147, re: *Ceraticelus*, we have only 14 species, *rugosus* having been removed by Ivie (1967) to *Idionella* Banks 1893.

p. 157, insert: **Idionella rugosus (Crosby)**
Ceraticelus rugosus :Kaston 1948.

p. 158, re: *C. brunnea*, an additional record:
Cathedral Pines State Park 27 July 1951 (P. F. Bellinger).

p. 159, re: *C. sphaerica* is a synonym of *parvula*, according to Ivie (1967).
                        Ceratinella parvula (Fox)
Erigone parvula Fox 1891, Proc. Entomol. Soc. Washington 2:45 *Ceraticelus parvulus* :Crosby and Bishop 1925, Bull. New York State Mus. 264, p. 40.

p. 164 (and 169, 206) re: the genera *Cornicularia*, *Prosopotheca*, and *Walckenaëra*, Locket and Millidge (1953:191) suggest that "the species of these three genera are all closely related, and in spite of the variations in the secondary sex characters of the male, and in the position of the trichobothria, it is possible they should be united in one genus."

p. 174, re: *Tunagyna debilis*, van Helsdingen (1973) notes, "In Massachusetts the species is very common and very frequently collected from leaf-litter samples in deciduous or mixed forest, especially in the swampy parts." He also described and illustrated the epigynum.

p. 175, re: *Aulacocyba*, in his Bibliographia Bonnet considered this a synonym of *Microctenonyx* Dahl 1886, but Wunderlich (1970) considered it a synonym of *Tapinocyba* Simon 1884.

p. 176, re: *Ceratinops*, we now have six species in our region.

p. 178, add: **Ceratinops obscura (Chamberlin and Ivie)**
                            Figs. 18-19
Masonetta obscura Chamberlin and Ivie 1939, Verh. VII Intern. Congr. Entomol. [for 1938] 1:64, pl. 2, f. 17-18.

Length of male 1.2 mm. The female has not been described. In lacking cephalic lobes and pits this species is similar to *rugosa*. It has not been taken in Connecticut, but is known from Bronx, N.Y.

p. 181, re: *Cochlembolus*, is a synonym of *Caledonia* O. P.-Cambridge 1894 according to Holm (1950).
Re: *T. pallidus*, we now have a record from Connecticut.
Middlefield 23 November 1950, 21 September 1951 (P. F. Bellinger).

p. 183, re: *H. florens*, a female was collected as late as 17 October.

p. 184, re: *M. arenarius*, according to Dondale and Redner (1972) this belongs in the genus *Perimones* Jackson 1932.
                        Perimones arenarius (Emerton)
Maso britteni Jackson 1913, Rep. Trans. Nottingham Nat. Soc. 60:27 *P. arenarius* :Dondale and Redner 1972, Canad. Entomol. 104:1643.

Re: *Mythoplastoides*, according to Hackman (1954) is a synonym of *Entelecara* Simon 1884.

p. 186, re: *Hormathion*, is a synonym of *Thyreosthenius* Simon 1884.

p. 187, re: *H. limnatum*, according to Hackman (1954) this is a synonym of *T. parasiticus.*

Thyreosthenius parasiticus (Westring)
Erigone parasitica Westring 1851, Goteborgs Kongl. Vet. Handl. 2:45.

p. 196, re: *Eperigone simplex*, we now have a Connecticut record.
Killingworth January 1938 (M. P. Zappe).

p. 197, re: *Catabrithorax*, Holm (1950) has shown this to be a synonym of *Collinsia* O. P.-Cambridge 1913.

p. 198, re: *C. oxypaederotipus*, an additional record:
Cornwall 16 May 1951 (P. F. Bellinger).
Re: the genus *Grammonota*, some remarks were published by Dondale (1959). We now have seven species in our region.

p. 201, re: *G. bidentata*, according to Dondale this is a synonym of *ornata*, and not of *maculata*, as I had indicated had been suggested by Bishop and Crosby.

p. 205, re: *Islandiana*, a revision was published by Ivie (1965). We now have three species from our region, and two others are known from northern New England.
Add: Islandiana flavoides Ivie
Islandiana flavoides Ivie 1965, Amer. Mus. Novitates 2221, p. 16, f. 27-29.

Length of female 1.8 mm; of male 1.5 mm. "Very close to *flaveola* in color and structure. . . . no obvious structural differences in the epigynum. The dorsal point on the tibia of palpus shorter and blunter than in *flaveola*."
This species is not known from Connecticut, but has been taken on Long Island, N.Y.

p. 206, re: *Walckenaëra*, see the comment in connection with *Cornicularia* and *Prosopotheca*, page 24.
Re: *W. vigilax*, Dondale and Redner have shown that our American species is not the same as the European, so that Emerton's name is to be resurrected.

Walckenaëra spiralis (Emerton)
Spiropalpus spiralis Emerton 1882, Trans. Connecticut Acad. Sci. 6:39, pl. 10, f. 6. *Walckenaëra spiralis* :Dondale and Redner 1972, Canad. Entomol. 104:1644.

p. 211, re: *S. concavus* and *S. terrestris*, these have been removed to *Hillhousia* and *Porrhomma* respectively (see above in the Linyphiidae). Thus there are but two species remaining in the genus *Sciastes*, for our region.

p. 214, re: *Tmeticus ornatus*, Roewer (1942) places this in *Micryphantes*.
Add: Genus *Scyletria* Bishop and Crosby 1938

Scyletria jona Bishop and Crosby
S. jona Bishop and Crosby 1938, J. New York Entomol. Soc. 46:90, f. 75-76.

Length of female 0.7 mm; of male 0.68 mm. This is the smallest spider known from our region. The cephalothorax is pale orange yellow, slightly darker towards the cephalic part. The abdomen is dull yellowish white. There are no special features in the head region. The ARE is slightly recurved, the AME are smaller than the ALE, and the PRE is straight, with the eyes subequal.
Middlefield 2 December 1950 and 7 February 1951 (P. F. Bellinger).

Re: family Epeiridae, since I now consider *Epeira* a junior synonym of *Araneus* the family name to be used is Araneidae Latreille.

p. 215, re: the making of an orb web, see Tilquin (1942), Savory (1952), Witt (1956), Witt et al. (1968), and Jackson (1973).

p. 217, re: the function of the stabilimentum, Ewer (1972) considered that it may serve to make the spider less visible to predators, but M. H. and B. Robinson (1970) reported that this is improbable, at least in *Argiope argentata*, in view of the fact that two thirds of the webs seen did not include the structure.

p. 219, re: *Micrathena gracilis*, one web about five inches in diameter, had 54 radii, and 20 spiral threads.
Re: *M. sagittata*, for our New England representatives Archer (1951) set up the new subspecies *emertoni*.

p. 221, re: *Argiope*, a revision of the genus was published by Levi (1968).

Argiope aurantia (Lucas)
A. aurantia :Levi 1968, Bull. Mus. Comp. Zool. 136:338, f. 43-57.

Although I reported the females having their front legs entirely black I have seen many with a short band of orange on femur I. One female brought into the laboratory 1 September produced egg sacs on 15 September, 30 September, and 15 October. Babu (1973) reported that females mature in five to six months after having molted seven to nine times. A study on habitat selection was published by Enders (1973).

p. 222, re: *A. trifasciata*

Argiope trifasciata (Forskal)
A. trifasciata :Levi 1968, Bull. Mus. Comp. Zool. 136:340, f. 58-72.

One female brought into the laboratory produced egg sacs on 11, 25 and 29 September. These were hemispherical, and measured 10 to 15 mm along the flat surface, which was uppermost. One sac contained 775 yellow non-agglutinate eggs, each about 0.6 mm in diameter.

p. 223, re: the subfamily Metinae, I now consider that *Leucauge* should be placed here, rather than in the Tetragnathidae where Petrunkevitch put it. Homann (1971) has shown that in eye structure it differs from the members of that family but is similar to that of *Meta*, with a "canoe" type of tapetum.
Re: *Meta*, Wiehle (1967) has shown that the epigynum lacks fertilization canals, and is less complicated than the epigynum of the true entelogynes. However, he considered that it was nevertheless more complicated than in the haplogynes, so referred to it as a "semi-entelogyne" form.
Re: *Meta menardii*, on 19 August 1951, in the dark recesses of an old barn at Bristol I found large numbers of females guarding their egg sacs. Observations by Dresco-Derouet (1960) indicate that the males mature after seven, and the females after eight or nine molts. Maturity is attained in eight months when the temperature is maintained at 24°C; in 15 to 20 months at 13° to 14°, and about 9 to 12 months additional at 9°.

from p. 265, re: *Leucauge venusta*, I found a female with an egg sac, which was globular, about 11 mm in diameter, of loose silk. The egg mass itself was 3.7 mm long by 2.6 mm in diameter, and contained 223 yellow, slightly agglutinated eggs, each 0.45 mm in diameter.

p. 224, re: the name of the subfamily. It should now of course be Araneinae. During the years since 1948 I had come to recognize the genera *Araniella, Neosconella* and *Conepeira.* But the recent studies of Levi indicate that it seems best to simply consider all our species placed in these groups as belonging in *Araneus.* I had previously followed Petrunkevitch in considering *Epeira* separate from *Araneus.* To the end of his life he kept them separate maintaining (1958:259) that "for some arachnologists the genera *Araneus* and *Epeira* are synonyms, but to others, myself included, they are distinct genera." The presence or absence of shoulder humps (=humeral tubercles) for separating the two genera is too variable a character, even in the same species. Some have the tubercles so reduced or even absent, others have them quite enlarged. Bonnet published lengthy remarks (1950, 1953) showing to my satisfaction that the genus *Epeira* cannot be maintained. We now have 16 genera in our region.

p. 228, re: *L. borealis,* Grasshoff (1971) placed this in *Drexelia.* We now have a Connecticut record:
Norwalk 6 June 1937 (W. J. Gertsch).

p. 229, re: *Verrucosa arenata,* Archer (1951) reported that this species, contrary to the usual, stands in its web with the head end up! In Florida I collected a female guarding her egg sac attached to a leaf. The mass of whitish silk was about 7.8 mm by 5.5 mm. There were 81 yellow, partly agglutinated eggs each about 0.67 by 0.81 mm.

p. 230, re: *Mastophora,* the genus was revised by Gertsch (1955).

p. 231, re: *M. cornigera,* which is a southern species; what we actually have in Connecticut is *hutchinsoni.*

Mastophora hutchinsoni Gertsch

M. cornigera :Kaston 1948. *M. hutchinsoni* Gertsch 1955, Bull. Amer. Mus. Nat. Hist. 106:236, pl. 6, f. 3, textfigs. 10-14, 39, 47-48.

p. 233, re: *Eustala anastera,* Archer (1951) supported Chamberlin and Ivie in considering *emertoni* a distinct species.

Eustala emertoni (Banks)

Epeira emertoni Banks 1904, J. New York Entomol. Soc. 12:111. *Eustala anastera* :Kaston 1948 [in part].

Length of female 6 mm; of male 3 mm. This is quite similar to *anastera,* with which it has been confused, but the posterior tip of the abdomen is not raised as much, and the folium does not extend as far forward on the abdomen. The epigynum lacks the anterior notch in the lobed portion of the atriolum, and the palpal organ shows slight differences in the median apophysis. It has not been recorded from Connecticut but is known from Rhode Island, and from Long Island, N.Y.

p. 235, re: *Acacesia hamata,* in New Britain during the evening of 4 August 1952, I noticed a female in its web among bushes in a wooded area. The web was close-meshed, about six inches in diameter, and about five feet above the ground level. A male was resting on a leaf just above the web. An additional record can be included:
New Britain 12 August 1961 (J. F. Anderson).

p. 240, re: *Singa,* this and the related *Hypsosinga* were revised by Levi (1972).
The genus *Hypsosinga* Ausserer 1871 differs from *Singa sens. str.* in that the PME are the largest of the eyes, being one and a fifth to twice the size of the AME. As indicated by the name, the clypeus is high, being one and a half to three times the diameter of an

AME, as compared with just its diameter in *Singa*. The male lacks the spur on coxa I, and the epigynum lacks a scape. "*Hypsosinga* differs from all other genera of Araneidae in having a large transparent scale attached to the base of the embolus; the scale breaks off in mating and lodges in the epigynum."

Re: *S. pratensis*, Levi removed this to *Araneus*. In reexamining my material I found that the epigynum *has* a scape, as is usual for *Araneus*. However, this is easily broken off after mating and most specimens in collections lack it. It was not seen by Emerton who drew what I too used for an illustration. See below under *Araneus*.

p. 241, re: *S. variabilis*

Hypsosinga variabilis (Emerton)
Hypsosinga variabilis :Levi 1971 Psyche 78:242, f. 44-57.

p. 242, re: *S. truncata* footnote, Levi's studies show that my supposition is correct, and that this is a synonym of *rubens*.

Hypsosinga rubens (Hentz)
Epeira rubens Hentz 1847, J. Boston Soc. Nat. Hist. 5:477, pl. 31, f. 18. *Hypsosinga rubens* :Levi 1971, Psyche 78:248, f. 72-88.

Add: Hypsosinga singaeformis (Scheffer)
Fig. 20.
Araneus signaeformis Scheffer 1904, Entomol. News 15:259, pl. 17, f. 4-6. *Singa orotes* Archer 1951, Amer. Mus. Novitates 1487 p. 41, f. 36-37, 61. *Hypsosinga singaeformis* :Levi 1971, Psyche 78:246, f. 58-71.

Length of female 2.9 to 5.0 mm; of male 2.4 to 4.5 mm. The general appearance is similar to that of *rubens*. The epigynum shows a concave margin on each side of the median septum, while in *rubens* the margins are straight and diverge considerably toward the rear, so that the septum is quite triangular. The embolus of the male palpal organ is much shorter than that of *rubens*.
Rowayton 16 June 1909 (C. W. Johnson)[det. H. W. Levi]

p. 242, re: *Zygiella*, the genus was revised by Gertsch (1964a). A third species was added to our region. Some notes on the behavior of these spiders were published by B. J. and M. J. Marples (1971).

<div align="center">Revised key</div>

1a.	Males	2
1b.	Females	4
2a.	Pedipalp as long as the entire body, the tibia much longer than the cybium	
		.... *atrica*
2b.	Pedipalp shorter, and the tibia not longer than the cymbium	3
3a.	Pedipalp as long as the carapace, and tibia much shorter than the cymbium	
		.... *x-notata*
3b.	Pedipalp shorter than the carapace, but the tibia is almost as long as the cymbium	
		.... *nearctica*
4a.	Epigynum a broad elevated lobe, much wider than the width of the labium	
		.... *nearctica*
4b.	Epigynum a small lobe about as wide as the labium	5
5a.	Epigynum not showing a pair of lateral openings	.... *atrica*
5b.	Epigynum showing a pair of lateral openings	.... *x-notata*

p. 243, re: *Z. litterata*, now to be called *x-notata*.

Zygiella x-notata (Clerck)

Z. x-notata :Gertsch 1964, Amer. Mus. Novitates 2188 p. 12, f. 2, 15-17.

I have observed mature females of this species in August on the north shore of Long Island, with their webs on the outside of houses. Also, in August I have seen their webs amongst rocks of a jetty in eastern Massachusetts. For five snares a count showed 25, 27, 28, 33, and 37 radii respectively. The web with 33 radii was 12 inches in diameter and had 18 spiral threads in the upper and 26 in the lower half. The other snares were 10 inches in diameter with 20 spiral threads in the upper and 27 below; 15 above and 20 below; and 30 both above and below. The web with 37 radii had no clear sector, but was a "complete" orb. Many details on behavior and web structure may be obtained from LeGuelte (1966).

Re: *Z. atrica*, Witt and Reed (1965) indicate that this species lives about eight months, and constructs a new web each day. I have seen the webs in Maine in September, and noted that occasional ones lack the missing sector, i.e., are "complete" orbs.

Add: ### Zygiella nearctica Gertsch

Zilla montana Emerton 1884, Trans. Connecticut Acad. Sci. 6:323, pl. 34, f. 14, pl. 37, f. 22-23, 26, 28 [not *montana* Koch]. *Zygiella nearctica* Gertsch 1964, Amer. Mus. Novitates 2188 p. 4, f. 1, 3-6.

Length of female 6 to 7 mm; of male 4.8 mm. With the characters as given in the key to species. Levi *(in litt.)* indicated to me that this is really *dispar* Kulczynski, but Gertsch considers the latter to be a much larger species differing in features of the epigynum and palpal organ. It has not been reported from Connecticut, but is known from Long Island, N.Y., as well as from northern New England.

p. 244, re: *Neoscona*, the genus was revised by Berman and Levi (1971). In addition to our four species *N. oaxacensis* was recorded, once, from Providence, R.I. It is western, and has not established itself in New England.

Revised portion of the key to species (after Berman and Levi):

3a.   Epigynum with more or less distinct lateral bulges. Abdomen subtriangular above. Total length usually more than 8.5 mm, carapace more than 3.7 mm . .4

3b.   Epigynum without lateral bulges. Abdomen above suboval. Total length usually less than 8.2 mm, and carapace less than 2.8 mm . . . .*arabesca*

4a.   Epigynum with one pair of lateral bulges. Abdomen contrastingly marked. . . . . *domiciliorum*

4b.   Epigynum with two pairs of lateral bulges. Abdomen without contrasting markings . . . . *hentzii*

5a.   Terminal apophysis of palpal organ with sides more or less parallel, and with a wide notch on the distal end . . . .*arabesca*

5b.   Terminal apophysis of a different shape 6

6a.   Conductor of palpal organ in lateral view S-shaped (Fig. 22) . . . .*hentzii*

6b.   Conductor in lateral view elongated, with tip and base only slightly curved (Fig. 21) . . . . *domiciliorum*

p. 245, re: ### Neoscona arabesca (Walckenaer)

N. arabesca :Berman and Levi 1971, Bull. Mus. Comp. Zool. 141:474, f. 1-3, 5-6, 8, 10, 14-42.

I have seen mature females active on their webs as late as the first week in November.

Re: *N. minima*,   from the studies of Berman and Levi it would appear that what I have been placing here are varieties of *arabesca*.

p. 246, re: *N. benjamina*, this is considered a *nomen dubium* by Berman and Levi, and that actually two species are represented in our Connecticut fauna, and which have been called by this name.

Neoscona domiciliorum (Hentz)
Fig. 21

Epeira domiciliorum Hentz 1847, J. Boston Soc. Nat. Hist. 5:469, pl. 30, f. 7. *Neoscona domiciliorum* :Berman and Levi 1971, Bull. Mus. Comp. Zool. 141:477, f. 43-50, 127.

Length of female 7.2 to 16.2 mm; of male 8 to 9 mm. The scape of the eipgynum is relatively short, as in *arabesca*, and there is a pair of lateral bulges near the base. The abdomen is contrastingly marked.

Neoscona hentzii (Keyserling)
Fig. 22

Epeira hentzii Keyserling 1864, Sitz-ber. Isis, Dresden [for 1863] p. 97, pl. 5, f. 10-11. *Neoscona sacra* :Chamberlin and Ivie 1944, Bull. Univ. Utah 35 (9): Biol. Ser. 8 (5):108. *N. hentzii* :Berman and Levi 1971, Bull. Mus. Comp. Zool. 141:478, f. 51-58.

Length of female 8.5 to 19.7 mm; of male 4.5 to 15 mm. A distinct pattern, like that in *domiciliorum* is here much less conspicuous. The scape is very long. Tibia II in the male has fewer spines than is the case in *domiciliorum*. A correspondant, E. G. Fields of Atlanta, Georgia, who had studied the habits of this spider had noted that it makes a fresh web each night, and eats the old one in early morning. The diameter is somewhat less than two feet, there are 27 radii and 63 spiral threads. The spider hides in the daytime, but sits at the hub at night.

p. 247, re: *Aranea*, as previously explained this name has been supplanted by *Araneus* Clerck 1757. Levi has been studying this genus for a number of years and has so far published two large revisionary papers (1971, 1973). His studies have revealed that we now have 24 species in our region, compared with the 16 previously known. (In 1951 Archer described *A. kisatchia*, and listed a paratype from Hempstead, Long Island, which would put it in our region. However, Dr. Gertsch has informed me that this was an error for Hempstead, Texas.) At this writing there are still some well known species which have not been considered yet by Levi so I am unable to prepare a satisfactory key to them all. Readers are referred to Levi's 1971 paper for keys to the larger members (i.e., the *diadematus* group) and to the 1973 paper for the smaller species. As I have already explained I no longer keep separate *Epeira*.

from p. 240, re: *S. pratensis*, now in *Araneus*.

Araneus pratensis (Emerton)
Figs. 23-24

Araneus pratensis :Levi 1973, Bull. Mus. Comp. Zool. 145:492, f. 2, 21-31.

As indicated above, the epigynum in this species *has* a scape, though most specimens in collections have it broken off. The scape is quite broad along its entire length, and is relatively short. New illustrations are here supplied to replace the incorrect Fig. 759 used in 1948.

Araneus bivittatus (Walckenaer)
Fig. 25

Epeira bivittata Walckenaer 1841, Hist. Nat. Ins. Apt. 2:78. *Araneus bivittatus* :Levi 1973, Bull. Mus. Comp. Zool. 145:519, f. 221-230.

Length of female 3.6 to 5 mm; of male 3.5 to 4.3 mm. The abdomen has a median anterior conical projection and, as in *pratensis*, a pair of longitudinal bands. These bands are red or green, and Levi points out that they may change from green to red just before maturity is attained. While not recorded from Connecticut it has been taken in Massachusetts.

p. 249, re: Araneus diadematus Clerck

A diadematus :Levi 1971, Bull. Mus. Comp. Zool. 141:147, f. 34-41, 95, 184-186.

Witt and Reed (1965) found that specimens in the laboratory may live as long as 18 months. Grasshoff (1968) supplied many additional data on sexual behavior, as well as morphological comparisons with related species.

p. 250, re: *A solitaria*, Wiehle has shown this to be a synonym of *saevus*.

Araneus saevus (L. Koch)

Epeira saeva L. Koch 1872, Zeits. Ferd. f. Tirol u. Vorarlberg (3) 17:323. *Araneus saevus* :Wiehle 1963, Zool. Jahrb. Abt. Syst. 90:276. :Levi 1971, Bull. Mus. Comp. Zool. 141:148, f. 7-8, 42-51, 55-60.

Add: Araneus bicentenarius (McCook)

Fig. 26

Epeira bicentenaria McCook 1888, Proc. Philadelphia Acad. Nat. Sci. [40]:195, *Aranea bicentenaria* :Archer 1951, Amer. Mus. Novitates 1487, p. 27, f. 69. *Araneus bicentenarius* :Levi 1971, Bull. Mus. Comp. Zool. 141:143, f. 15-26.

Length of female 13 to 28 mm; of male 7 mm. The general appearance is similar to that of *saevus*. This species has been found in wooded areas, but is not common. No records exist for Connecticut, but it undoubtedly occurs there, for it has been taken both to the north in Massachusetts and to the south on Long Island, N.Y.

p. 251, re: *A. cavatica*

Araneus cavaticus (Keyserling)

Araneus cavaticus :Levi 1971, Bull. Mus Comp. Zool. 141:170, f. 187-194.

While this had been known in Connecticut from only the northern tier of towns we now have a record from farther south. A student of mine brought in a female taken in New Britain in October 1958.

Several webs seen by me in late August in New Hampshire were about two feet in diameter, with a light mesh hub. One had 24 radii, 30 spirals above and 43 below; a second had 23 radii, with 28 spirals above and 45 below; a third had 21 radii with 24 spirals above and 38 below. It was noted that early in the morning some females were already in retreat, but some were still at the hub. In northern Vermont I observed a female guarding two egg masses as late in the year as 7 October.

p. 252, re: *A. corticaria*

Araneus corticarius (Emerton)

A. corticarius :Levi 1971, Bull. Mus. Comp. Zool. 141:158, f. 114-122.

Levi has observed that the epigynal scape "usually breaks off during mating."

Re: Araneus miniatus (Walckenaer)

Araneus miniatus :Levi 1973, Bull. Mus. Comp. Zool. 145:506, f. 158-171.

Archer (1951b) had considered that *miniata* was a southern species, and that what I had called by this name was a different one, which he called *atlantis*. But according to Levi *miniatus* is known from the north, and *atlantis* is a synonym of *partitus*. The female "differs from that of *partitus* by having a wrinkled scape" and from *alboventris* in lacking
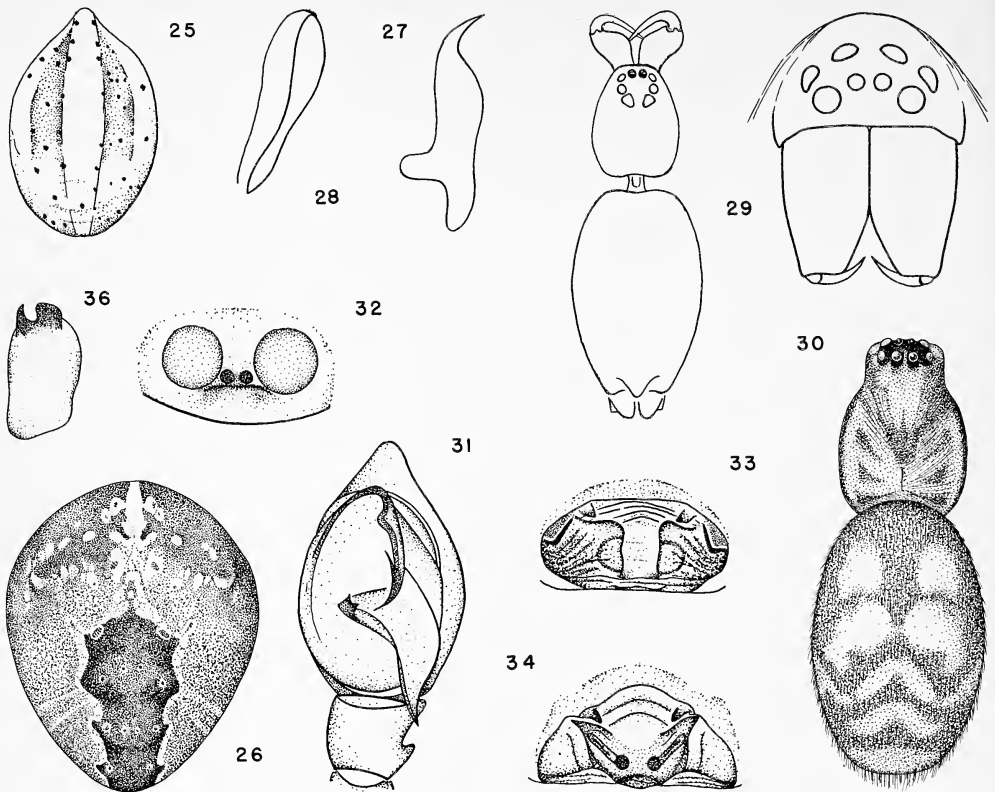
Figs. 25-36.—25, *Araneus bivittatus*, abdomen from above (after Levi); 26, *Araneus bicentennarius*, abdomen from above; 27, *Tetragnatha guatamalensis*, paracymbium (after Chickering); 28, *Tetragnatha harrodi*, paracymbium, (after Chickering); 29, *Cryphoeca montana*, face; 30, *Cryphoeca montana*, dorsum; 31, *Cybaeota calcaratum*, palp (after Chamberlin and Ivie); 32, *Cybaeota calcaratum*, epigynum (after Chamberlin and Ivie); 33, *Coras parallelis*, epigynum (after Muma); 34, *Coras aeialis*, epigynum (after Muma); 35, *Prodidomus rufus*, dorsum (after Cooke); 36, *Sostogeus loricatus*, tibial apophysis (after Chamberlin and Gertsch).

the "central dorsal black patch" on the abdomen. The "embolus is an evenly tapering pointed structure, while that of *partitus* has almost parallel sides and is blunt at its tip, and that of *alboventris* is twisted." In all three species the cymbium lacks "two macrosetae enabling separation from all related eastern species."

Add: **Araneus partitus (Walckenaer)**

Epeira partita Walckenaer 1841, Hist. Nat. Ins. Apt. 2:46. *Conepeira partita* :Archer 1951 Amer. Mus. Novitates 1502, p. 13, f. 34 male [not f. 63 female]. *C. atlantis* Archer 1951, Amer. Mus. Novitates 1502, p. 13, f. 32, 35 [not f. 60]. *Araneus partitus* :Levi 1973, Bull. Mus. Comp. Zool. 145:510, f. 177-191.

Length of female 3.3 to 4.3 mm; of male 2.7 to 3.3 mm. This species is similar to *alboventris* and *miniatus* but can be distinguished as indicated under the latter.

from p. 260, re: *Epeira attestor*, now to be called:

Araneus alboventris (Emerton)

A. alboventris :Levi 1973, Bull. Mus. Comp. Zool. 145:514, f. 192-203.

Although Petrunkevitch had considered that the specific name used by Emerton was preoccupied by Keyserling's species name (as I had indicated) this is not the case, for

Keyserling's species was called *albiventer*. According to the present ICZN the two names are not synonyms. This species is similar to both *partitus* and *miniatus*, but can be differentiated as indicated under the latter.

p. 254, re: *Epeira foliata*, now to be known under the name *Araneus cornutus* Clerck, some observations on overwintering were published by Kirchner (1965).

p. 255, re: *Epeira dumetorum*, now to be known under the name *Araneus patagiatus* Clerck. Bonnet (1955) prefers to consider *ocellatus* as the name to use, apparently because Clerck described this latter on p. 36 of his work, two pages in advance of that for *patagiatus*. But the latter name has been used by araneologists generally far more often than *ocellatus*.

p. 256, re: *Epeira undata*, now to be known under the name *Araneus sericatus* Clerck. Witt and Reed (1965) reported that in this species a new web is constructed every *other* day. Females guarding egg sacs were taken in Torrington as late as 5 November 1950. One egg mass 5.9 mm in diameter contained 101 eggs, each 1.13 mm in diameter. A second sac 15 mm in diameter had an egg mass 8 mm in diameter and 6 mm thick, and contained 125 eggs. A third the same size had 120 eggs. A fourth had 75 already hatched spiderlings.
Additional records (besides Torrington): New Britain 28 August 1948; 4 April 1950; 25 September 1950; 3 August 1953; 22 May 1957; and 18 September 1958.

p.257, re: *Epeira raji*, now to be known under the name *Araneus marmoreus* Clerck. An egg sac collected at Southington 8 October 1948 was enclosed between two leaves fastened together. It was an oval mass 25 mm long by 20 mm thick and contained 1663 eggs. Additional biological data and comparisons with related species have been supplied by Grasshoff (1968).

p. 258, re: *Epeira trifolium*, now to be known under the name *Araneus trifolium* (Hentz). One female was observed in my back yard in New Britain through August and September 1951. It was seen to gradually change color from a pale green through tan, to russet brownish red, with the pattern becoming more distinct toward the end of that period. An egg sac taken in October measured 18 mm in diameter with the egg mass itself 10 mm in diameter. There were 950 eggs, each 0.82 mm in diameter. Another sac in October was 22 mm long by 19 mm in diameter, of yellow silk. The egg mass itself was 13 mm in diameter and 16 mm long and contained 2652 yellow semi-agglutinate eggs. I believe this to be the largest number of eggs ever reported from a spider's egg sac!

Add: Araneus iviei (Archer)
Aranea iviei Archer 1951, Amer. Mus. Novitates 1487 p. 33, f. 53. *Aranea sachimau* Archer 1951, Amer. Mus. Novitates 1487 p. 33, f. 55. *Araneus iviei* :Levi 1971, Bull. Mus. Comp. Zool. 141:162, f. 138-151.

Length of female 10 to 12 mm; of male 6.7 mm. The general appearance is like that of *trifolium* but the legs are not annulate. "This species has been collected from a cedar swamp; sweeping old fields in open forest vegetation." It has not been recorded from Connecticut, but is known from Massachusetts.

Re: *Epeira displicata*, now to be known under the name *Araneus displicatus*. Additional life history notes have been supplied by Dondale (1961a).

Add: Araneus gadus Levi
Conepeira marilandica Archer 1951, Amer. Mus. Novitates 1502 [in part, f. 11, 72, female; not male]. *Araneus gadus* Levi 1973, Bull. Mus. Comp. Zool. 145:520, f. 231-247.

Length of female 4.2 to 5 mm; of male 4.2 mm. The abdomen shows four pairs of black spots on the posterior half, each spot surrounded by a light ring. The general ground color is yellow to pale green. It has not been recorded from Connecticut, but is known from Massachusetts.

Add: Araneus cingulatus (Walckenaer)

Epeira cingulata Walckenaer 1841, Hist. Nat. Ins. Apt. 2:40. *Conepeira marilandica* Archer 1951, Amer. Mus. Novitates 1502 [in part, f. 40, 50 male; not female]. *Araneus cingulatus* :Levi 1973, Bull. Mus. Comp. Zool. 145:526, f. 301-313, 455-462.

Length of female 4.6 to 6.0 mm; of male 2.7 to 3.5 mm. The general color is green with several pairs of red spots. It has not been recorded from Connecticut, but is known from Massachusetts.

p. 259, re: *Epeira thaddeus*, now to be known under the name of *Araneus thaddeus.* **Re:** *Epeira pegnia*, now to be known under the name *Araneus pegnia.*

p. 261, re: *Epeira juniperi*, now to be known under the name *Araneus juniperi.*

Araneus juniperi (Emerton)

Epeira juniperi :Kaston 1948 in part [f. 830 female; not f. 811 male]. *Araneus juniperi* :Levi 1973, Bull. Mus. Comp. Zool. 145:522, f. 248-264, 447-452.

Archer (1951b) described as new: *bivittata, mumai, llano*, and *sarasota*, all of which, in whole or in part, Levi considers as invalid and as synonyms of *juniperi.* Additional record: New Canaan September 1951 (M. Statham).

Add: Araneus guttulatus (Walckenaer)

Epeira guttulata Walckenaer 1841, Hist. Nat. Ins. Apt. 2:78. *E. sanguinalis* Hentz 1847, J. Boston Soc. Nat. Hist. 5:476, pl. 31, f. 15. *E. juniperi* Emerton 1909, Trans. Connecticut Acad. Sci. 14:200, f. 1 [not *juniperi* of Emerton 1884]. Kaston, 1948 [in part, f. 811 male]. *Araneus guttulatus* :Levi 1973, Bull. Mus. Comp. Zool. 145:530, f. 332-361.

Length of female 3.8 to 6 mm; of male 3.9 to 4.8 mm. The pattern is variable as given by Levi. It has not been recorded from Connecticut, but is known from Massachusetts.

Add: Araneus nashoba Levi

Conepeira juniperi :Archer 1951, Amer. Mus. Novitates 1502 p. 25, f. 54, 78 [not *juniperi* Emerton]. *Araneus nashoba* Levi, 1973 Bull. Mus. Comp. Zool. 145:534, f. 380-397.

Length of female 3.6 mm; of male 3.0 mm. Levi indicates the differences in the genitalia which enable this species to be distinguished from *juniperi.*

While no records exist for Connecticut the species undoubtedly occurs there, for it has been taken both in Massachusetts and from Long Island, N.Y.

Re: Family Theridiosomatidae, the name should be credited to Simon.

p. 262, re: *Theridiosoma*, studies on this genus were published by Archer (1953). It is now considered that our species is different from the European *gemmosum.*

Theridiosoma radiosa (McCook)

Epeira radiosa McCook 1881, Proc. Philadelphia Acad. Nat. Sci. [43] :163.

p. 263, re: the subfamilies of the family Tetragnathidae, Petrunkevitch (1952, 1958) had elevated the Glenognathinae to family rank. This was based upon internal anatomy and the forward position of the spiracle. But Homann has shown that the eye structure of *Mimognatha* places it with *Pachygnatha*, and Roewer placed both of these genera in his subfamily Pachygnathinae. Roewer also considered as separate subfamilies the

Tetragnathinae and Leucauginae, but as I have already indicated I think *Leucauge* best fits with *Meta* in the Araneidae.

p. 267, re: *Pachygnatha autumnalis*, additional records:
New Britain 23 September 1951; Hartford 13 and 25 August 1961 (J. F. Anderson); Wethersfield 2 April 1960 (J. F. Anderson).
Re: *P. brevis*, Dr. Gertsch advised me (*in litt.*) that this is a synonym of *xanthostoma*.

Pachygnatha xanthostoma C. L. Koch
Pachygnatha xanthostoma Koch, 1845 Die Arachniden 12:148.

p. 268, re: *Tetragnatha*, we now have 10 species in our region. Wiehle (1963) considered this a composite of three genera. The spider that keys out at 6a because of the distinct caudal extension, *caudata*, he placed in *Eucta* Simon 1881. The others which key out at 1a, because the lateral eyes are farther apart than the medians, he placed in *Arundagnatha*, a new name for *Eugnatha*, which was preoccupied.

p. 269, re: the key to species. Two species will key out at 4a. These are *harrodi* and *guatamalensis* (formerly called *seneca*). Females having five teeth on each margin of the cheliceral fang furrow, and males having the paracymbium rounded distally are *harrodi*. If the female has more than five teeth on each margin and the male has the paracymbium terminating in a long slender extension it is *guatamalensis*.

p. 270, re: *T. elongata*. A female in the laboratory constructed an an egg sac the night of 5-6 September 1948. The sac was an irregular mass, 10 mm long, 5 mm wide, and 3 mm thick. There was a dense white silk obscuring the eggs themselves, and over this was a flat sheet of greenish webbing, on which the spider rested.

p. 271, re: *T. straminea*, this would fit into Wiehle's *Arundagnatha*.
Re: *T. seneca*, according to Chickering (1959) this is a synonym of *guatamalensis*, and it has been confused with *harrodi*.

Tetragnatha guatamalensis O. P.-Cambridge
Fig. 27
T. guatamalensis O. P.-Cambridge 1889, Biol. Centrali Americana, Arachn. Ar. 1:8, pl. 2, f. 6-7. *T. banksi* McCook 1894, Amer. Spiders, 3:262, pl. 25, f. 6, pl. 28, f. 4. *T. seneca* :Kaston 1948 [in part].

This species and the following are about the same size and general appearance. The differences are indicated in the discussion of the key. Both species occur in Connecticut.

Add: ### Tetragnatha harrodi Levi
Fig. 28
T. harrodi Levi 1951 Amer. Mus. Novitates 1501 p. 17, f. 32-37. :Chickering 1959, Bull. Mus. Comp. Zool. 119:484, f. 22-25. *T. seneca* :Kaston 1948 [in part].
See remarks under the preceding species. The record for *seneca* from Storrs actually belongs here.

p. 272, re: *T. pallescens* and *T. vermiformis*, both would go into Wiehle's *Arundagnatha*.

p. 273, re: *T. caudata*, as already indicated this would go into *Eucta*.
Re: Family Mimetidae, according to Homann (1971) the tapetum is of the "canoe" type. From the observations of Cutler (1972) it would appear that on occasion, at least, some members of the family do eat insects, contrary to our previous supposition.

p. 274, re: *E. furcata*, it is now considered that our species is different from the European.

Ero leonina (Hentz)
Theridion leoninum Hentz 1850, J. Boston Soc. Nat. Hist. 6:227, pl. 9, f. 12.

p. 275, re: the genus *Mimetus*, I do not believe that the egg sac of any member of this genus has been described. A female of the western *M. hesperus* Chamberlin was found with one (in southern California). The sac resembled that known for *Ero*, hanging on a thread 20 mm long. The sac itself was of loose threads, bright orange, 7 mm long by 5 mm in diameter. About 40 spiderlings were emerging.

p. 277, re: *M. puritanus*, additional records:
New Britain 17 August 1961 (J. F. Anderson), Newington 23 July 1961 (J. F. Anderson).

p. 278, re: the family Agelenidae, a discussion of the family characters, and a key to all the Nearctic genera, were provided by Roth and Brame (1972). According to Homann (1971) the tapetum in the indirect eyes is of the "canoe" type. Gering (1953) published an extensive discussion of genitalia studies. I now recognize eight genera in our region, although Lehtinen (1967) moved *Cicurina* and *Cybeota* to the Dictynidae, and *Cryphoeca* to the Hahniidae.
Re: the footnote, for a thorough discussion of the *Agelena-Agalena* problem see Bonnet (1953a), who shows conclusively that the former orthography must be used.

p. 279, re: the key to genera, the following is a revision:

1a.   Anterior spinnerets contiguous, longer than the posterior, which consist of a stout basal segment, terminated by a short, indistinct, hemispherical segment. (Body length less than 2.5 mm) . . . . *Cybaeota*
1b.   Anterior spinnerets separated, shorter than the posterior, which consist of a stout basal segment and a distinct elongated segment. (Body length more than 2.5 mm) 2

2a.   Hind spinnerets with apical segment much shorter than the basal. Labium as wide as, or wider than, long. Posterior coxae well separated 3
2b.   Hind spinnerets with apical segment at least as long as the basal. Labium longer than wide. Posterior coxae contiguous 4

3a.   Height of clypeus less than the diameter of an ALE (Fig. 29). ALE much larger than the AME, the diameter at least twice that of an AME. Retromargin of cheliceral fang furrow with three teeth . . . . *Cryphoeca*
3b.   Height of clypeus about equal to the diameter of an ALE. Diameter of an ALE less than twice that of an AME. Retromargin with a series of minute denticles. . .
        . . . . *Cicurina*

4a.   Both eye rows very strongly procurved so that the PLE and the AME form a nearly straight line . . . . *Agelenopsis*
4b.   Eye rows not thus strongly curved 5

5a.   Retromargin of cheliceral fang furrow with two teeth. Cymbium of male with two horns or processes extending proximad toward the tibia. Epigynum with scape free at its posterior end . . . . *Wadotes*

5b.   Retromargin of cheliceral fang furrow with more than two teeth. Cymbium lacking the two horns or processes at the proximal end. Epigynum lacking the free scape 6

6a.   AME as large as or larger than the ALE. Male palp with an apophysis on the patella as well as on the tibia. Epigynum with a caudally projecting tooth at the anterolateral corners 7

6b.   AME as large as or smaller than the ALE. Male palp with an apophysis on the tibia only. Epigynum without a tooth at the anterolateral corners . . . *Tegenaria*

7a.   Females with the epigynum having a single anterior septum, and having the anterolateral teeth robust and abruptly pointed at the apex. Male palp showing a concavity on the ectolaterodorsal surface of the tibia, and with the tibia elongated basally into a tubercle. The conductor of the embolus is spatulate, or subspatulate at the tip . . . . *Coras*

7b.   Females with the epigynum showing two median septa, which may arise from either the anterior, or the posterior, margin, or lie between the margins. The anterolateral teeth are slender and taper gradually toward the apex. Male palp shows a tubercle near the distal end of the tibia on the ectolaterodorsal surface. The conductor of the embolus is not spatulate or subspatulate . . . . . . *Coelotes*

Re: *Tegenaria*, a revision of the genus was published by Roth (1968).
Re: *T. derhami*, this is now to be called by Clerck's name, *domesticus*. For a discussion of the numerous and varied names that have been applied to this species by different authors see Bonnet (1954).
Re: the footnote, for *Cryphoeca* Thorell 1870.

<div align="center">

Cryphoeca montana Emerton
Figs. 29-30

</div>

C. montana Emerton 1909, Trans. Connecticut Acad. Sci. 14:222, pl. 8, f. 4. :Comstock 1912, Spider Book p. 597, f. 680-681.

Length of female 3.2 to 3.5 mm; of male 2.5 to 3 mm. The carapace is yellow with dusky blotches and a gray marginal stripe. The legs are yellow, and the abdomen gray and yellow with a pattern of chevrons.
Re: the footnote, for *Cybaeota* Chamberlin and Ivie 1933.

<div align="center">

Cybaeota calcaratum (Emerton)
Figs. 31-32

</div>

Liocranum calcaratum Emerton 1911, Trans. Connecticut Acad. Sci. 16:402, pl. 5, f. 4. *Cybaeota calcaratum* :Chamberlin and Ivie 1933, Bull. Univ. Utah 24 (5): Biol. Ser. 2(3):3, f. 1-10.

Length of female 2 to 2.5 mm; of male about the same. The general appearance is like that of *Cryphoeca montana*, but it can be separated from that by the characters given in the key. Also, it has five pairs of long spines under tibia I, and three pairs under meta-tarsus I.

p. **280**, **re**: the genus *Coras*, as here restricted we have in our region three species separable by genitalia characters. Muma (1946) published a revision.

Re: footnote   **Coras parallelis** Muma
<div align="center">Fig. 33</div>

Coras parallelis Muma 1944, Amer. Mus. Novitates 1257 p. 4, f. 6. Muma 1946, Amer. Mus. Novitates 1329 p. 5, f. 4-5.

Length of female 9.57 to 11.13 mm. The male is unknown.

Coras aerialis Muma
Fig. 34
C. aerialis Muma 1946, Amer. Mus. Novitates 1329 p. 7, f. 8, 31-32.

Length of female 9.49 to 13.39 mm; of male 11.69 mm. This species has not been recorded from Connecticut, but is known from Massachusetts.

p. 281, re: *C. medicinalis*, Muma's more abundant material indicates that the length of females varies from 9.45 to 13.33 mm; and that of males 9 to 12.68 mm.
Re: *juvenilis* and *montanus*,   according to Muma (personal communication) these belong in *Coelotes* Blackwall 1841.

Coelotes juvenilis Keyserling
Coras juvenilis :Muma 1946, Amer. Mus. Novitates 1329 p. 13, f. 13-15, 51-52.

Muma's specimens ranged more widely in size than did mine; down to 6.66 mm for females and from 6.09 to 9.23 for males.

Coelotes montanus Emerton
Coras montanus :Muma 1946, Amer. Mus. Novitates 1329 p. 10, f. 16-17, 43-46.

Length of female 9.7 to 13.13 mm; of male 8.23 to 9.73 mm.

p. 283, re: *Cicurina*, there are now four species known from our region.

p. 284, add: **Cicurina placida Banks**
C. placida Banks 1892, Proc. Philadelphia Acad. Sci. [49]:27, f. 77.

Length of female 3.9 to 5 mm; of male 3.7 mm. The general appearance is much like that of *brevis*. In the female the anterior lip of the atrium in the epigynum is evenly rounded, and not provided with a backwardly projecting point at the middle of its length, which is present in *brevis*. In the male the tibial apophysis is intermediate in length between that of *brevis* and that of *robusta*, extending about two-thirds the length of the cymbium.

This species has not been recorded from Connecticut, but is known from Long Island.

p. 288, re: *A. pennsylvanica*, a pair was taken *in copula* at Hartford 28 August 1961 (J. F. Anderson).

p. 291, re: *A. potteri*, we now have a Connecticut record:
Hartford 20 August 1950 (C. Behrsing).

p. 293, re: Key to species of *Neoantistea*, delete from both 1a and 1b the reference to the number of teeth on the cheliceral fang furrow.

p. 294, re: *N. agilis*, a pair was collected *in copula* at Wethersfield 30 April 1961 (J. F. Anderson). In the list of collecting records that for Macedonia 1 August 1936 belongs to *N. radula*.
Re: *N. radula*, add the Macedonia record from under *N. agilis*.
Re: the family Pisauridae, Homann (1971) suggests that the Pisauridae should be combined with the Lycosidae into one family (in which he would also include the Ctenidae). It has been shown that spiderlings of at least *Pisaura* construct webs, as do some lycosids even as adults. Details for *Pisaura mirabilis* are supplied by Lenler-Eriksen (1969). I myself (1972b) have indicated that something similar occurs in the related family Oxyopidae.

p. 295, re: key to genera, I have found some specimens of *Pisaurina* to have three teeth on one cheliceral retromargin but four on the other. Here is a different key:

1a.   Height of clypeus equal to the length of the MOA. Lorum of pedicel with the anterior sclerite notched behind to receive a projection of the posterior sclerite . . . . *Dolomedes*

1b.   Height of clypeus less than the length of the MOA. Lorum of pedicel with a transverse or slightly procurved suture between the two sclerites . . . . .*Pisaurina*

Re: *Pisaurina*, a revision of the genus was published by Carico (1972).

p. 296, re: *P. mira*, a female with an egg sac was collected in late June, and the spiderlings emerged on 4 July. Another sac was made on 18 July and the second brood emerged on 2 August.

p. 297, re: *Dolomedes*, a revision was published by Carico (1973). Lehtinen (1967) made this genus the type of his new family Dolomedidae.

p. 300, re: *D. t. sexpunctatus*, according to Chamberlin and Ivie this name belongs to a southern species; that in the north is *scapularis*.

Dolomedes scapularis C. L. Koch

D. scapularis Koch 1848, Die Arachniden, 14:119. *D. scopularis* [sic!] :Chamberlin and Ivie 1946, Bull. Univ. Utah 36 (13):Biol. Ser. 9(5):4, f. 3.

p. 301, re: *D. striatus*, additional record:
Hartford 10 October 1960 (J. F. Anderson).

Re: *D. vittatus*, additional record:
New Britain 16 October 1952; Hamden 19 June 1962 (J. F. Anderson).

p. 302, re: *D. urinator*, considered by Carico a synonym of *vittatus*, additional records:
Hamden 16 August 1962 (J. F. Anderson); New Britain 1 June 1953.

Re: Lycosidae, according to Homann (1971) the tapetum in the indirect eyes is of the "grate" type.

p. 303, re: family Lycosidae relationships, an important paper discussing all the genera in the family, and in which Roewer's numerous new genera are commented upon, was published by Guy (1966).

For a discussion concerning the use of the names *Lycosa*, *Tarentula*, and *Pardosa*, see Bonnet (1951).

Comparative data on the biology and ecology of many species of wolf spiders are supplied by Whitcomb (1967). It has been shown by Rovner et al. (1973) that as an adaptation for carrying the spiderlings the integument of the mother is provided with a special kind of knobbed hairs. These hairs show prominent longitudinal rows of curved spinules along their length. The hairs are not present on males or immature females, only on mature females, and apparently are absent from members of the Pisauridae.

p. 304, re: the key to genera, a revision is given, somewhat modified from that published by Leech (1969), to include the part after *Trabea* and *Pirata* are taken out.

3a.   Retromargin of cheliceral fang furrow with two teeth . . . . *Tarentula*
3b.   Retromargin with three teeth 4

4a.   No true spines above on tibia IV . . . .*Geolycosa*
4b.   At least one, usually two or three, spines above on tibia IV 5

5a.   Tibia IV above with the basal spine (or bristle) usually thinner and more drawn
          out than the distal 6
5b.   Tibia IV with the two dorsal spines about equally stout 7

6a.   Carapace glabrous or very nearly so . . . . *Arctosa*
6b.   Carapace hirsute . . . . *Trochosa*

7a.   Labium wider than long, with the basal articular notches about one fourth its
          length. Metatarsus IV usually longer than, or at least not shorter than, tibia plus
          patella IV. Sides of face vertical or almost so . . . . *Pardosa*
7b.   Labium longer than wide, or as long as wide, with the basal articular notches
          about one third its length. Metatarsus IV shorter than, or at least not longer
          than, tibia plus patella IV. Sides of face usually slanting so that the pars
          cephalica is narrower above than below 8

      Couplet 8 is the same as old couplet 9.

   p. 305, re: *T. aurantiaca*, Roewer (1955) put this into his new genus *Pardosops*.

   p. 307, re: *P. minutus*, Roewer (1955) put this into *Piratessa*, but later, finding this
name preoccupied, changed it to *Piratosa*. Guy (1966) considered this latter a subgenus in
Arctosa. A female with an egg sac was taken as late as 22 September.

   p. 308, re: *P. montanus*, Roewer (1955) put this into *Hogna*.

   p. 309, re: *P. marxi*, Roewer (1955) put this into *Piratessa*, then *Piratosa*.
Re: *P. piratica*, Roewer (1955) followed Dahl in considering this species different from
the European [which may now be called *piratica* (Clerck)] and uses Dahl's name,
emertoni, for our American species.

   p. 310, re: *P. insularis*, Roewer (1955) puts this into *Allocosa*. H. K. Wallace has found
that some males (in Michigan) show brushes of hairs on leg I.

   p. 311, re: *P. arenicola*, Roewer (1942) first put this into *Piratula*, then (1955) moved
it to *Allocosa*.
Re: *P. maculatus*, Roewer (1955) put this into *Allocosa*.

   p. 312, re: *Tarentula*, Bonnet and Roewer both prefer to use *Alopecosa* Simon to
avoid possible confusion with *Tarantula*.

   p. 313, re: *Schizocosa*, with the transfer of *Lycosa avida* to this genus we now have
five species in our region. Gertsch and Wallace (1937) had placed *avida* here only
"tentatively, but besides the differences in morphology Rovner (1973) has shown that
there are behavior patterns that distinguish the members of this genus from *Lycosa*.

   p. 314, re: *S. bilineata*, Roewer (1955) put this into *Lycosa*.
Re: *S. crassipes*, Roewer (1955) put this into *Hogna*.

   p. 315, re: *S. crassipalpis*, Roewer (1955) considered that this name is preoccupied (sub
Lycosa crassipalpis Purcell 1903) and so supplied the new name, *crassipalpata*.
Re: *S. saltatrix*, Whitcomb (1967) has published life history data.
Add: (from p. 326) *S. avida*.

p. 317, re: *G. pikei*, I have observed that the mouths of the burrows are not closed in winter. However, specimens kept in the laboratory closed their burrows when getting ready to molt, then opened them to discard the exuviae, and left them open.

p. 319, re: *Arctosa rubicunda*, Roewer (1955) put this into *Crocodilosa* Caporiacco 1947, which Guy (1966) considered a subgenus of *Ocyale*.
Re: *A. emertoni*, Roewer (1955) put this into *Crocodilosa*, then in 1961 moved it to his own genus *Trochosoma*. A female with an egg sac was collected at Bakersville 10 June 1961 (J. F. Anderson). The sac measured 8.4 mm in diameter and 6.9 mm thick. It contained 118 yellow, non-agglutinate eggs, each about 1.15 to 1.27 mm in diameter.

p. 320, re: *A. littoralis*, Roewer (1955) considered this species the same as the European *cinerea*. I have already (1972a) indicated that in all probability it was an aberrant specimen of this species which was at hand when Rafinesque in 1821 described what he called *Tessarops maritima*.

p. 322, re: *L. carolinensis*, Roewer (1955) put this into *Hogna*. On 7 August 1954 I collected a female with a brood of 125 spiderlings on her back. This would seem to indicate that females make more than one egg sac per year. Eason's studies (1964) indicate that the young are carried by the mother for from 7 to 14 days. Additional details on the biology are supplied by Whitcomb (1967).

p. 323, re: *L. aspersa*, Roewer (1955) put this into *Hygrolycosa*. Whitcomb (1967) has published details on the biology.

p. 324, re: *L. baltimoreana*, Roewer (1955) put this into *Geolycosa*.
Re: *L. rabida*, Roewer (1955) put this into his new genus *Rabidosa*. Eason (1964) reported one egg sac containing 1035 eggs. This is a rather high figure for a wolf spider. The spiderlings may remain on the mother's back for as long as 50 days. Whitcomb (1967) supplied data on sperm induction and mating. Rovner (1966, 1967b) made this species the object of a very intensive study on sexual behavior.

p. 325, re: *L. punctulata*, Roewer (1955) put this into his new genus *Isohogna*. Life history studies were published by Eason (1964), Eason and Whitcomb (1965), and Whitcomb (1967).

p. 326, re: *L. avida*, as already indicated (see above) this has been transferred to *Schizocosa*. Life history studies were published by Eason (1964), Whitcomb and Eason (1964), and Whitcomb (1967). The copulatory behavior was studied by Rovner (1973).

p. 327, re: *L. helluo*, Roewer (1955) put this into *Hogna*. Life history notes were published by Eason (1964). Nappi (1964) published details on courtship and mating. A female was seen carrying an egg sac on 20 August, and one female was taken as late as 12 November still with spiderlings on her back.
Re: *L. modesta*, Roewer (1955) put this into *Allocosa*.

p. 328, re: *L. gulosa*, Roewer (1955) put this into *Varacosa*. Life history data were given by Whitcomb (1967).
Re: *L. frondicola*, Roewer (1955) put this into *Allocosa*.

p. 329, re: *L. avara*, Roewer (1955) put this into *Varacosa*.

p. 330, re: *T. pratensis*, Roewer (1955) put this into his new genus *Allohogna*. It seems

now to be generally accepted that *pratensis* is a synonym of the European *terricola*, which Roewer put into *Trochosina*.

Trochosa terricola Thorell
T. terricola Thorell 1856, Nova Acta Reg. Soc. Sci. Upsaliensis (3) 2:171.

Hackman (1954) supplied many additional biological data, as well as a detailed discussion concerning the variation in the number of retromarginal cheliceral teeth.

A female carrying an egg sac was collected on 4 June. The sac was 7.3 mm in diameter and 6 mm thick. It contained 105 yellow non-agglutinate eggs, each about 1.0 by 1.25 mm. Another carrying a sac was taken on 11 May. From its blueish color it was apparently freshly made. Two days later in the laboratory she ate the eggs (presumably because they were infertile?).

p. 331, re: *Pardosa*, notes on the preferred habitats of members of this genus (including some of our species) were published by Lowrie (1973).

p. 334, re: *Pardosa milvina*, Roewer considered this and *nigropalpis* to be two different species. Eason (1964) reported spiderlings remaining with the mother for only 4 to 6 days. Whitcomb (1967) published additional life history data.

p. 335, re: *P. saxatilis*, a female with eggs was collected as late in the year as 9 November.

p. 336, re: *P. floridana*, Wallace has shown that his is a synonym of *longispinata*.

Pardosa longispinata Tullgren
P. longispinata Tullgren 1901, Bih. Sevenska Vet.-akad. Handl. 27:23, f. 13.

p. 337, re: *P. lapidicina*, further details on the morphology of this and related species were published by Barnes (1959). He found females ranging down to 6.37 mm in length, and males up to 9.3 mm. Notes on the life history and habits were published by Whitcomb (1967) and by Eason (1969).
Re: *P. xerampelina*, the courtship behavior was described by Dumais et al. (1973).

p. 338, re: family Oxyopidae, a revision was published by Brady (1964). It has been shown by Brady, and also by Whitcomb and Eason (1965) that the mating position is not strictly that of Gerhardt's II, for the partners are supported from above by silken threads from which they hang. According to Homann (1971) the tapetum in the indirect eyes is "grate"-shaped.

p. 339, re: *O. salticus*, Whitcomb (1967) described the courtship, mating, and egg sac construction. In the laboratory females constructed up to five egg sacs, with a mean of 47 eggs in the first, and down to a single egg in the fifth sac. The eggs measured 0.74 by 0.66 mm.

p. 341, re: superfamily Gnaphosoidea, with the addition of the Prodidomidae there are now two families in our region.

Add: Family PRODIDOMIDAE Simon
The spiders have eight eyes arranged in three rows, 4-2-2, with the tapetum of the indirect eyes of the "canoe" type. The chelicerae lack boss and scopula, and have their margins unarmed. The palp of the female lacks a claw. The leg tarsi have two claws, which are similar and without teeth, and there are claw tufts. The trichobothria are in two rows

on tibiae and tarsi, and in one row on the metatarsi. The abdomen is oval, the anterior spinnerets are far apart, and a colulus is lacking. The tracheal system extends into the cephalothorax.

This is a small family of rare spiders, only one species inhabiting our region. A revision was published by Cooke (1964).

<p style="text-align:center">Genus Prodidomus Hentz 1847</p>
<p style="text-align:center">Prodidomus rufus Hentz</p>
<p style="text-align:center">Fig. 35</p>

P. rufus Hentz 1847, J. Boston Soc. Nat. Hist. 5:466, pl. 30, f. 4. :Bryant 1935, Psyche 42:3, f. 1. :Bryant 1949, Psyche 56:22, f. 1. :Cooke 1964, Proc. Zool. Soc. London 142:266, f. 15, 29-30.

Length of female 5 mm; of male 3 mm. The chelicerae are widely divergent. The carapace is yellowish, and the abdominal dorsum is pinkish and unmarked. It has not been collected in Connecticut, but is known from Long Island, N.Y.

Re: family Gnaphosidae, according to Homann (1971) the tapetum of the indirect eyes is of the "canoe" type.

p. 343, re: *C. imbecilla*, Roewer (1955) puts this into *Pterotricha*. Dr. Platnick has informed me (*in litt.*) that what we have in our region is not *imbecilla*, but *pluto*.

<p style="text-align:center">Callilepis pluto Banks</p>

Callilepis pluto Banks 1893, Trans. Amer. Entomol. Soc., 23:60. *C. imbecilla* :Kaston 1948 [not imbecilla Keyserling] .

A female in the act of ovipositing was taken on 25 June.

p. 344, re: *Gnaphosa muscorum*, a male was collected as early in the season as 22 June, and a female guarding eggs was collected on 13 June.

p. 345, re: *G. fontinalis*, mature specimens of both sexes were taken as early as April.

p. 346, re: *G. parvula*, a female guarding her eggs was found under a piece of loose bark on the ground. The sac was lenticular, 10 mm in diameter and 6 mm thick, and contained 67 already hatched spiderlings. Additional records:
New Britain May 1951 (L. Rosene), and 13 June 1961.

p. 347, re: key to genera of Drassodinae, the following is based to a large extent on the one set up by Roth and Brown (1973). They have used as one character the presence or absence of a ventral metatarsal comb on the hind legs. This comb is composed of about 12 or 15 straight fine bristles whose length is slightly greater than the thickness of the metatarsus at this level. Undoubtedly, as Berland (1932:260) has indicated, the comb is used for preening.

1a. Distal end of metatarsus III and IV provided with a ventral comb (Fig. 37) . . .2
1b. No such comb present 3

2a. PME hardly, if at all, larger than the PLE, and circular in most (rarely oval). PRE straight (rarely procurved) and the eyes equidistant . . . .*Zelotes*
2b. PME larger than the PLE, oval in most, the PRE slightly procurved and the PME closer to each other than to the PLE . . . .*Drassyllus*

3a. All trochanters deeply notched (Fig. 38) . . . .*Drassodes*
3b. Trochanters not, or only slightly, notched 4

4a.   Females with an epigynum bearing a scape 5
4b.   Males; and females with an epigynum devoid of a free scape 6

5a.   Retromargin of cheliceral fang furrow with one tooth. PME larger than PLE and
        almost contiguous ....*Sostogeus*
5b.   Retromargin with 2 or 3 teeth. Eyes of posterior row subequidistant and the
        PME smaller than the PLE ....*Sosticus*

6a.   Retromargin of cheliceral fang furrow with 2 or 3 teeth 7
6b.   Retromargin with one tooth or none 8

7a.   Tibia IV without any median dorsal spine ....*Haplodrassus*
7b.   Tibia IV with two median dorsal spines ....*Sosticus*

8a.   Abdominal dorsum with pale transverse markings ....*Poecilochroa*
8b.   Abdominal dorsum lacking pale transverse markings, though it may be spotted
        or have longitudinal stripes 9

9a.   Two black longitudinal bands running the entire length of body, alternating with
        three white bands ....*Cesonia*
9b.   Body not so marked 10

10a.   Trochanters not notched ....*Sostogeus*
10b.   Trochanters slightly notched (Fig. 39) 11

11a.   Tibia IV without a dorsal spine. PME contiguous or almost so, oval in most, and
        larger than PLE. Retromargin of cheliceral fang furrow devoid of teeth ....
        ....*Litopyllus*
11b.   Tibia IV with one dorsal spine. PME circular, separated by the diameter of one
        and about the same size as PLE. Retromargin with one tooth ......*Herpyllus*

For the most part I have followed the synonymies indicated in the list by Ubick and Roth (1973).

   p. 349, re: *H. vasifer*, this should be called *ecclesiastica*.

Herpyllus ecclesiastica Hentz
H. ecclesiastica Hentz 1832, Amer. J. Sci. 21:102.

   p. 350, re: *Drassodes*, with the synonymizing of *Geodrassus* we now have five species in the genus.

   p. 353, re: *G. gosiutus* and *G. phanus*, these are now to be known as *Drassodes gosiutus* Chamberlin and *D. phanus* (Chamberlin) respectively.

   p. 354, re: *Zelotes*, we now have seven species in our region.

   p. 357, re: *Z. hentzi*, a female with egg sac was collected on 5 May. The sac was hemispherical, about 20 mm in diameter, and attached along its flat surface to a piece of loose bark. It contained 37 spiderlings ready to emerge.

   p. 360, re: *Drassyllus creolus*, additional record:
Rocky Hill April 1949 (L. Gonthier).

Re: *D. femoralis*, this is a synonym of *rusticus*.

Drassyllus rusticus (L. Koch)

Zelotes rusticus L. Koch Zeits. Ferd. f. Tirol u. Vorarlberg (3) 17:309. *Prosthesima blanda* Banks 1892 Proc. Philadelphia Acad. Nat. Sci. [44]:18, f. 57-57a. *Z femoralis* Banks 1904 Proc. California Acad. Sci. (3) 3:336, pl. 38, f. 1.

Additional record: New Britain 23 March 1949 (a male inside a building).

p. 361, re: *Sergiolus*, is here considered a synonym of *Poecilochroa* Westring 1874.

p. 362, re: *S. variegatus*, additional record:
New Britain 26 July 1953.

p. 364, add: after the material about *S. insularis:*

Genus **Sostogeus** Chamberlin and Gertsch 1940

With the characters as given in the key to genera. One species, also known from Europe, occurs in our region.

Sostogeus loricatus (L. Koch)
Figs. 36, 40-41

Drassus loricatus Koch 1866, Die Arachniden Fam. Drassiden p. 131, pl. 5, f. 82-84. *Scotophaeus loricatus* :Simon 1914, Ar. France 6:145. *Sostogeus zygethus* Chamberlin and Gertsch 1940, Amer. Mus. Novitates 1068, p. 1, f. 1-4.

Length of female 9 to 11 mm; of male 6 to 8 mm. The general color is yellow to orange. In the male a scutum is present covering almost a third of the dorsum and somewhat more darkly pigmented. The epigynum shows a free scape widened distally as illustrated. The tibial apophysis of the male pedipalp is short, with two rami of equal length, the upper broad and rounded, while the lower is narrow and pointed.
New Britain 11 August 1948.

p. 365, re: *Litopyllus rupicolens*, now known to be a synonym of *temporarius*, although Roewer (1951) proposed the new name *barrowsi.*

Litopyllus temporarius Chamberlin

L. temporarius Chamberlin 1922, Proc. Biol. Soc. Washington 35:155.

Re: superfamily Clubionoidea,   with the addition of the Zoridae we now have three families in our region.

p. 366, re: Clubionidae, Petrunkevitch erroneously credits the name to Simon 1895, but in my 1938 paper it is shown that the name was first used by Wagner in 1888. Lehtinen (1967) elevated to family rank the subfamilies Liocraninae and Corinninae. He also followed Bristowe, and others, in removing *Micaria* to the Gnaphosidae, and included in the latter both *Scotinella* and *Phrurotimpus* as well. Homann (1971) on the basis of the eye structure likewise placed these three genera in the Gnaphosidae. Reiskind (1969) also removed *Micaria* from the Clubionidae and proposed the name Castianeirinae for the group of genera still left in the old Micariinae. I am retaining these three, but have removed *Zora* to its own family. With the addition of *Clubionoides* and *Myrmecotypus* we now have 12 genera in our region.

p. 367, re: the key to genera, *Clubionoides* will key out at line 6a, but can be separated from *Clubiona* in having two distal prolateral spines on femur I, instead of one, and in having the dorsum of the abdomen usually with dark grey stripes and spots, instead of being concolorous pale yellow-brown to orange.
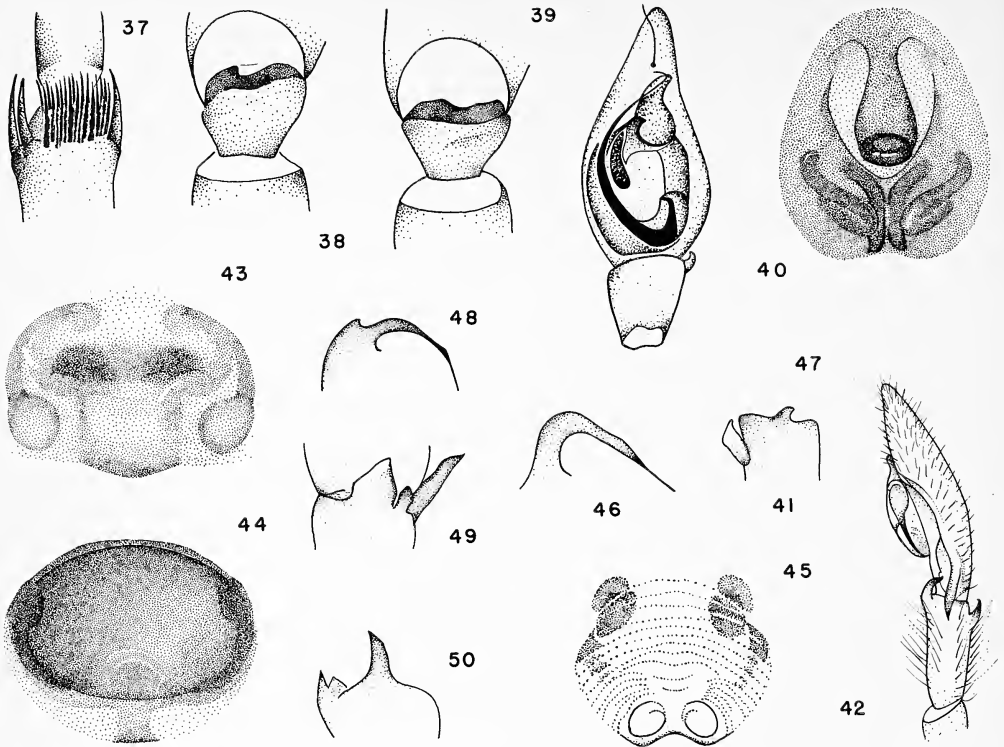
Figs. 37-50.— 37, Preening comb on metatarsus IV of *Zelotes*. The bristles are so close together at the base as to appear fused there; 38, Trochanteric notch in *Drassodes*; 39, Trochanteric notch in *Herpyllus*; 40, *Sostogeus loricatus*, epigynum; 41, *Sostogeus loricatus*, palp (after Chamberlin and Gertsch); 42, *Chiracanthium mildei*, palp; 43, *Chiracanthium mildei*, epigynum; 44, *Chiracanthium inclusum*, epigynum; 45, *Clubiona nicholsi*, epigynum (after Edwards); 46, *Philodromus keyserlingi*; embolus (after Dondale); 47, *Philodromus keyserlingi*, lateral tibial apophysis (after Dondale); 48, *Philodromus cespitum*, embolus (after Dondale); 49, *Philodromus cespitum*, ventral tibial apophysis (after Dondale); 50, *Philodromus cespitum*, lateral tibial apophysis (after Dondale).

Myrmecotypus will key out at line 8a, but can be separated from *Castianeira* in that the thoracic groove is lacking, and in the proportions of the pars cephalica and sternum as indicated in couplet 3a on page 394.

p. 368, re: subfamily Clubioninae, a revision was published by Edwards (1958), although much of what appears in Edward's paper is quite obviously the work and writing of H. W. Levi.
Re: *Marcellina*, this is a synonym of *Strotarchus* Simon 1888.
Re: *S. piscatorius* (Hentz), an additional record:
New Britain 20 May 1954.

p. 369, re: *Chiracanthium*, there are now two species known from our region, and in recent years both of them have been involved in envenomation of humans.
Re: *C. inclusum*, detailed studies on the biology were published by Peck and Whitcomb (1970). The majority of males mature in the sixth or seventh instar, and of females in the eighth. A female may produce up to five egg sacs, with a mean number of eggs per sac of 38. Data are supplied on mating and a correction is given for my Fig. 2007 (which was based on the work of Gerhardt).

Add: **Chiracanthium mildei** L. Koch
                                        Figs. 42-43
Chiracanthium mildei L. Koch 1864, Abh. Naturh. Ges. Nürnberg, p. 144. :Bryant 1951 Psyche
58:120, f. 1-3. :Edwards 1958, Bull. Mus. Comp. Zool. 118:371, f. 7-9, 14-16, 203.

Length of female 7.7 to 12 mm; of male 7 to 9 mm. This species is easily
differentiated by the genitalia, as shown in the illustrations. The epigynum of *inclusum*
presents a simple elliptical depression (Fig. 44) while that of *mildei* (Fig. 43) shows canals
and spermathecae quite distinctly. The tibia of the male pedipalp is provided with a single
long apophysis in *inclusum* but with two short ones in *mildei* (Fig. 42).

It is remarkable that not a single record for this species was had for the 1948 volume,
yet from 1949 to 1961 numerous specimens were collected, many times within buildings.
Mature males have been taken from May through August, and females from May through
October. Females with egg sacs were observed from July to September. One sac in a
rolled leaf measured 6.5 by 4 mm. For four sacs the number of eggs was 16, 49, 50, and
70. Spiderlings emerged from one on 30 July and from another 14 August.
Records: Avon 27 July 1954 (B. Fritz); Cornwall 28 September 1951 (P. F. Bellinger); Hartford 30
June 1954 (B. Fritz), and 13 August 1961 (J. F. Anderson); West Hartford July 1952 (J. Weiman);
Newington July 1953 (D. Rugh); and New Britain on numerous dates.

p. 370, re: *Clubiona*, with the removal of *pallens* and *elizabethae* there are now only
17 species from our region.

p. 373, re: *C. pallens*, Edwards showed that this is a synonym of *excepta*, and belongs
to the genus *Clubionoides* Edwards 1958.

                          Clubionoides excepta (L. Koch)
Clubiona excepta L. Koch 1866, Die Arachniden Fam. Drassiden, p. 300, pl. 22, f. 191. *Clubiona
pallens* Hentz 1847 [not *pallens* Hahn 1834]. *Clubionoides excepta* :Edwards 1958, Bull. Mus. Comp.
Zool. 118:377, f. 19, 31, 33, 211.

p. 375, re: *C. tibialis*, is a synonym of *maritima*.

                            Clubiona maritima L. Koch
C. maritima Koch 1867 Die Arachniden Fam Drassiden p. 310, pl. 12, f. 198.

p. 377, re: *C. elizabethae*, it has been shown that the type (and only) specimen lacks
internal genitalia, it being only a subadult female. Edwards considered it to belong to *C.
rileyi*.

p. 379, re: *C. plumbi*, Edwards considered that this and *pikei* are separate.

                            Clubiona plumbi Gertsch
C. plumbi :Kaston 1948 [for the most part]. :Edwards 1958, Bull. Mus. Comp. Zool. 118:411, f.
60-61, 95, 250.

Length of female 3.6 mm; of male 2.95 to 4.1 mm. Besides averaging smaller than
pikei, the PME are less than one and a half diameters apart, while in *pikei* they are three
diameters apart. Known from Massachusetts, and Long Island, N.Y.

                            Clubiona pikei Gertsch
C. plumbi :Kaston 1948 [in part]. *C. pikei* :Edwards 1958, Bull. Mus. Comp. Zool. 118:420, f. 56-57,
91, 189, 249.

Length of female 3.54 to 6.2 mm; of male 3.54 to 5.6 mm. Similar to *plumbi*, but
averaging larger, and with the other differences as indicated above. All the Connecticut
records listed for *plumbi* belong to *pikei* instead.

Re: *C. johnsoni*, Edwards reported collecting on 3 August a female with an egg sac containing 22 eggs.

p. 380, re: *C. nicholsi*, the female, hitherto unknown, was described for the first time by Edwards (1958:424). Length of female 4.86 mm. The epigynum is very similar to that of *plumbi* and *pikei*, but the receptacles are farther apart than in those two (Fig. 45). This species had previously been recorded from Long Island, N.Y., but is now known from Massachusetts as well. The habitat appears to be the drift straw of salt marshes.

p. 381, re: *T. tranquillus*, while I had come to favor the suggestion put forward by Chamberlin and Ivie that *tranquillus* is southern and our northern species is really *ruber* Keyserling, I am informed by Dr. Platnick, who is currently studying the genus, that this is not the case (see Platnick and Shadab, 1974).

p. 385, re: *Zora*, although Homann, on the basis of eye structure, placed this genus with the Ctenidae, I now agree with Bristowe (1958) that it does not fit comfortably in the families into which it has been placed, and should be in a family by itself (see below).

p. 386, re: *Phrurotimpus*, Petrunkevitch (1958) considered it merely a subgenus and Lehtinen (1967) transferred it to the Gnaphosidae.

p. 389, re: *P. borealis*, a female with an egg sac was collected at New Britain on 13 August 1954.

p. 390, re: *Phrurolithus*, our species do not belong in this European genus but rather in *Scotinella* Banks 1911.

p. 391, re: *S. formica*, additional record:
Newington 11 March 1962 (J. F. Anderson).

p. 393, re: *Castianeira*, the genus was revised by Reiskind (1969) who placed it in his newly named subfamily, the Castianeirinae.

p. 394, re: *lineata*, we now have seven species in our region, *lineata* having been removed.

p. 395, re: *C. descripta*, according to Reiskind the reference to *crocatus* Hentz should be deleted, as the latter is a different (and southern) species.

p. 396, re: *C. longipalpus*, additional records:
A male at Hartford 13 August 1961, and a female with eggs 20 August 1961 (both J. F. Anderson); a male at New Britain 2 September 1951.
Re: *C. variata*, additional records:
New Britain a male 27 June 1954, and a female 15 September 1957, both indoors.

p. 397, re: *C. gertschi*, additional record:
New Britain a male just matured 6 October 1961 (J. F. Anderson).
Re: *C. trilineata*, additional record:
New Britain 13 October 1952.

p. 398, re: *C. lineata*, transferred to the genus *Myrmecotypus* O.P.-Cambridge 1894.

Myrmecotypus lineatus (Emerton)

Castianeira lineata Emerton 1909, Trans. Connecticut Acad. Sci. 14:216, pl. 10, f. 5-5b. *M. lineatus* :Reiskind 1969, Bull. Mus. Comp. Zool. 138:272, f. 111-112, 153-155.

The male still remains undescribed.

p. **401**, **re:** *M. montana*, this has been shown to be a synonym of the European *pulicaria.*

Micaria pulicaria (Sundevall)
Clubiona pulicaria Sundevall 1831, Handl. Kongl. Svenska Vet. Aɗad., p. 140.

Bristowe (1958) reported that the female encloses herself in a silken retreat under a stone, or under loose bark. Inside this cell she may make as many as three egg sacs.

p. **404**, **re:** family Anyphaenidae, a revision was published by Platnick (1974).

p. **406**, **re:** *Anyphaenella*, is a synonym of *Wulfila* O. P.-Cambridge 1895.

p. **409**, **add:** before Thomisoidea:

Family ZORIDAE F. O. P.-Cambridge

As indicated above *Zora* should be placed here in its own family.

Re: the family Thomisidae, as here used the family is restricted to what had been just the Misumeninae, i.e., the Thomisinae. According to Homann (1971) the structure of the eyes is like that in the Lycosidae, differing from that in the Philodromidae (which lack the tapetum).

p. **411**, **re:** *Misumena calycina*, this should now be known under the Clerckian name, *vatia.*

p. **415**, **re:** *Misumenops celer*, notes on various aspects of the biology of this species were published by Muniappan and Chada (1970).

p. **417**, **re:** *Synema*, this genus should be deleted from the work since the only species concerned (*bicolor*) has been shown by Turnbull et al. (1965) to belong in *Xysticus* (see below).

p. **418**, **re:** *Coriarachne*, the genus was revised by Gertsch (1953). We now know two species from our region (and an additional one from northern New England).

p. **419**, **add:**
Coriarachne floridana Banks
C. floridana Banks 1896, Trans. Amer. Entomol. Soc. 23:71. :Gertsch 1939, Bull. Amer. Mus. Nat. Hist. 76:409, f. 256-257, 270. :Gertsch 1953, Bull. Amer. Mus. Nat. Hist. 102:461, f. 65-66.

Length of female 5.2 to 5.8 mm; of male 4.3 mm. The male can be distinguished from that of *versicolor* in that the embolus is less thickened and not so curved in the middle, with the terminal portion short. Also, the tibial spur is straight. In *versicolor* the embolus is thickened and curved at its middle, the terminal portion being long and acuminate, and the tibial spur is directed laterad. The female has the MOA much broader than long; the dark patches on the posterior declivity of the carapace are nearly confluent at the middle; and the atriobursal openings of the epigynum are separated by less than their width. In *versicolor* the MOA is only slightly broader than long; the carapace dark patches are well separated; and the epigynal openings are separated by more than their width.

Re: *Oxyptila*, the genus was revised by Gertsch (1953).

Re: *O. conspurcata*, additional record:
New Britain 3 July 1954.

p. 420, re: *O. americana*, additional records:
Hartford 2 July and 26 November 1960 (J. F. Anderson).
Re: *Xysticus*, the genus was revised by Gertsch (1953) and by Turnbull, Dondale and Redner (1965). With the addition of *alboniger* there are now 14 species known from our region.

p. 422, add: *alboniger* before *X. gulosus*

Xysticus alboniger Turnbull, Dondale and Redner

Synema bicolor :Kaston 1948. *X. alboniger* :Turnbull, Dondale and Redner 1965, Canad. Entomol. 97:1259, f. 72, 75, 149, 152. [*bicolor* preoc. by L. Koch 1867].

As indicated by Turnbull et al., this species is easily recognized, "no other American species having a uniformly dark carapace and off-white, un-patterned abdomen."
Re: *X. gulosus*, a female with egg sac was collected at New Britain 3 June 1961. (J. F. Anderson). The sac was fastened to the under surface of a log, was lenticular in shape, measured 9.4 mm in diameter by 5.1 mm in thickness and contained 125 spiderlings.

p. 423, re: *X. ontariensis*, this has been shown to be a synonym of *pellax*.

Xysticus pellax O. P.-Cambridge

X. pellax O. P.-Cambridge 1894, Biol. Centrali Americana, Arachn. Ar. 1:138.

p. 424, re: *X. luctans*, additional records:
Wethersfield 24 April 1960 and 20 June 1961 (both J. F. Anderson).
The latter record pertains to two females collected with their egg sacs under a log. The sacs were lenticular about 11 mm in diameter and 7 mm thick. One had 88 and the other 91 yellow eggs, each about 1.2 to 1.3 mm in diameter.

p. 429, re: subfamily Philodrominae, now considered by me as the family Philodromidae Thorell. Holm (1940) had already shown that there are many differences between the members of this family and those of the Thomisidae *sens. str.* These include the nature of the egg sac, the embryological development, the sex chromosome constitution, etc. Homann (1971) has shown that the eye structure is different, the indirect eyes lacking a tapetum so that all eyes are dark like the AME.
Re: *Ebo* the genus was revised by Sauer and Platnick (1972).   Two species are now known from our region.

p. 430, add: after *E. latithorax:*

Ebo iviei Sauer and Platnick

E. iviei Sauer and Platnick 1972, Canad. Entomol. 104:41, f. 3-4, 16.

Length of female 2.78 mm; of male 2.04 mm. This may be distinguished from *latithorax* in that the palp segments show a mid-dorsal reddish brown stripe. The middle loop of the duct in the palpal organ lies near the descending loop. The retrolateral tibial apophysis is more narrowly pointed. The spermathecae in the epigynum are separated by more than the width of one.
Mature males were collected from late April through early June; mature females from late April through late August.
Records given by Sauer and Platnick (1972) include: New Canaan, Norwalk, Portland, and Seymour.
Re: *Philodromus*, the genus was revised by Dondale (1961) and Dondale and Redner (1968, 1969). We now know 12 species from our region.

p. 431, re: *P. pernix*, Dondale (1961b) has shown that what I have been calling *pernix*, is actually *vulgaris*, *pernix* being found in northern, but not southern New England.

Philodromus vulgaris (Hentz)
Thomisus vulgaris Hentz 1847, J. Boston Soc. Nat. Hist. 5:444, pl. 23, f. 1.

Re: *P. washita*, Dondale (1961b) considered this a synonym of *keyserlingi*.

Philodromus keyserlingi Marx
Fig. 46-47
P. keyserlingi Marx 1890, Proc. United States Natl. Mus. 12:259. :Dondale 1961, Canad. Entomol. 93:209, f. 5, 12, 28, 35.

p. 434, re: *P. rufus*, Dondale (1964, 1967) discussed an interesting situation in which some members, those of the subspecies *vibrans*, show a different behavior pattern from the others. The males of this subspecies vibrate their front legs during courtship.

p. 435, re: *P. satullus*, Dondale and Redner (1968) have shown that our eastern species is actually *minutus*, distinct from *satullus*, which is western.

Philodromus minutus Banks
P. minutus Banks 1892, Proc. Philadelphia Acad. Nat. Sci. [44]:62, pl. 5, f. 85.

p. 436, re: *P. aureolus*, Dondale (1961b) has shown that what we in America have been calling *aureolus* is actually *cespitum*.

Philodromus cespitum (Walckenaer)
Figs. 48-50
Aranea cespitum Walckenaer 1802, Faune Parisienne Insecta 2:230. *P. cespiticolis* :Dondale 1961, Canad. Entomol. 93:216, f. 6-7, 10, 27, 40.

I am in agreement with Locket (1967) in preferring the use of *cespitum* over *cespiticolis*.

p. 437, re: *P. infuscatus*, Dondale and Redner (1969) add Massachusetts to the New York records already supplied.
Add: before *Thanatus*:

Philodromus praelustris Keyserling
Figs. 51-53
P. praelustris Keyserling 1880, Spinnen Amerikas, Later., p. 208, pl. 5, f. 114. :Dondale 1961, Canad. Entomol. 93:207, f. 1, 18-22, 29, 41.

Length of female 6.9 to 9.1 mm; of male 4.8 to 7 mm. This species has a pattern more like that of *vulgaris*, but is intermediate between that species and *pernix*. Dondale reported an egg sac made on 2 July with 33 eggs, and the spiderlings emerging on 20 July. The following are records of specimens that I had previously identified to *pernix:*
Cornwall 2 August 1936; New Haven 15 May 1935 (R. B. Burrows); South Windham 8 July 1936; West Cornwall 2 July 1935; West Haven 2 July 1935.
Add:
Philodromus barrowsi Gertsch
Fig. 54-56
P. barrowsi Gertsch 1934, Amer. Mus. Novitates 707, p. 17, f. 16. :Dondale 1961 Canad. Entomol. 93:212, f. 3, 8-9, 30, 37.

Length of female 7 to 9.3 mm; of male 4.5 to 6.5 mm. In general this species is quite similar to *praelustris*. It has not been taken in Connecticut, but is southern and is known from Long Island, N.Y.

Re: *Thanatus*, the genus was revised by Dondale, Turnbull and Redner (1964). We now know four species from our region. The additional species, *rubicellus*, will key out at line 2a, but can be separated from *formicinus* readily. In the latter the embolus is straight except for a slight curve at the tip, and lacks a notch in the ectal margin at base. The palpal tibia has two to four long dorsal spines. In the epigynum of the female the spermathecae show a reticulated surface not subdivided by transverse grooves. On the other hand, in *rubicellus* the embolus is curved throughout its length with a small notch in the ectal margin near the base. The palpal tibia has only one dorsal spine. The surface of the spermathecae is not reticulated and is usually subdivided by transverse grooves.

Thanatus rubicellus Mello-Leitao

T. rubicundus Keyserling 1880, Spin. Amerikas, Later., p. 204, pl. 5, f. 112. [not *rubicundus* L. Koch 1875]. *T. rubicellus* Mello-Leitao 1929, Arch. Mus. Nac. Rio de Janeiro 31:271. :Dondale et al. 1964, Canad. Entomol. 96:648, f. 5-13, 45-54.

Length of female 5 to 7 mm; of male 4 to 6 mm. Connecticut records include:
Bethany 30 May 1939; New Britain 20 June 1954; and New Canaan (reported by Dondale et al.).

p. 439, re: *T. peninsulanus*, this has been shown to be a synonym of *vulgaris*.

Thanatus vulgaris Simon

T. vulgaris Simon 1870, Mém. Soc. Roy Sci. Liège 3:328. :Dondale et al. 1964, Canad. Entomol. 96:653, f. 3-4, 41-42.

p. 440, re: *T. oblongus*, Thomas (1949) published some notes on the biology of this species. Ballooning does not occur. Females stand guard over their eggs, and may in late summer make a second egg sac.

p. 442, re: Salticidae, I am unable to understand why Petrunkevitch (1955, 1958) credited this name to F. O. P.-Cambridge 1900, when, as I had shown in my 1938 paper the name dates back to Blackwall 1841. According to Homann (1971) the small eyes composing the second row are actually the posterior lateral (not median) eyes, and the third row consists of the posterior median (not lateral) eyes. There is no tapetum in any of the indirect eyes, and this is correlated with the diurnal habit of the spiders, not any of them hunting at night. We still have 28 genera represented in our region, but there have been a number of changes. These include the removal of *Hyctia* and *Onondaga*, and the addition of *Tutelina* and *Metacyrba*.

p. 444 and 447 re: the following changes should be made in the key to genera:

> line 11b keys out to *Marpissa* (in part, *lineata* and *dentoides*);
> line 21a keys out to *Metacyrba*;
> line 22b keys out to *Tutelina* (not *Icius*);
> line 23a keys out to *Marpissa* (in part, *pikei* and *formosa*);
> line 27b, insert "two or" after the word "with";
>
> change line 28a to read: Ocular quadrangle slightly wider behind than in front.
> Size over 3 mm 31

p. 447, continue the key as follows:

31a.   Height of carapace more than half its width. Ocular quadrangle occupying only
        two-fifths the length of carapace . . . .*Metaphidippus*

31b.   Height of carapace half its width or less. Ocular quadrangle occupying half the length of the carapace . . . . *Icius*

p. 448, re: *Synemosyna*, the genus was revised by Galiano (1966).

p. 449, re: *Myrmarachne*, it has been shown that we have no representatives of this genus in North America. What we do have, and have been placing here, belongs in *Sarinda* G. and E. Peckham 1892 which was revised by Galiano (1965).

Sarinda hentzi (Banks)
S. hentzi :Galiano 1965, Rev. Mus. Argentina Cienc. Nat. (Entomol.) 1:282, pl. 3, f. 6; pl. 7, f. 8-9.

A female, taken on 28 July, was guarding her egg sac which was rolled in a leaf. The silken mass was about 30 mm long by about 15 mm wide, and contained 12 already hatched spiderlings.

p. 452, re: *Peckhamia picata*, additional record:
Newington 22 June 1961 (J. F. Anderson).

p. 453, re: *Marpissa*, regarding the use of this name see the discussion by Bonnet (1952). This and related genera were revised by Barnes (1958). According to Barnes the carapace is very variable as to width, length and height, and the small eyes are variable in position.

p. 454, re: *Marpissa undata*, Barnes places this in *Metacybra* F. O. P.-Cambridge 1901.

Metacyrba undata (DeGeer)
M. undata :Barnes 1958, Amer. Mus. Novitates 1867 p. 36, f. 55-56, 62, 65, 67, 69.

Re: *Hyctia*, Barnes places this as a synonym of *Marpissa*. See also *Onondaga*, p. 494.

Marpissa pikei (G. & E. Peckham)
M. pikei :Barnes 1958, Amer. Mus. Novitates 1867, p. 15, f. 16-21.

p. 456, re: *H. bina*, Barnes considered this to be a southern species, and what we have in New England he considers to be *formosa*.

Marpissa formosa (Banks)
Icius formosus Banks 1892, Proc. Philadelphia Acad. Nat. Sci. [44]:76, pl. 5, f. 31. *M. formosa* :Barnes 1958, Amer. Mus. Novitates 1867, p. 4, f. 4-11.

p. 458, re: *Sitticus* we now have five species in our region.

Add: ### Sitticus fasciger (Simon)
Attus fasciger Simon 1880, Ann. Entomol. Soc. France, sér. 5, 10:98. *S. barnesi* Cutler 1965, J. New York Entomol. Soc., 73:140, f. 1-3. *S. fasciger* :Cutler 1973 J. Minnesota Acad. Sci., p. 39.

Length of female 4.5 to 5.3 mm; of male 3.6 to 4.5 mm. In general appearance this species resembles *palustris* in its abdominal pattern. The epigynum, however, has a single median opening. In the male the embolus is longer and extends farther to the lateral edge of the bulb. This species has not been recorded from Connecticut but is known from New York, N.Y.

p. 459, re: *S. floridanus*, has been shown to be a synonym of *cursor*.

Sitticus cursor Barrows
S. cursor Barrows 1919, Ohio J. Sci. 19:359, f. 8.
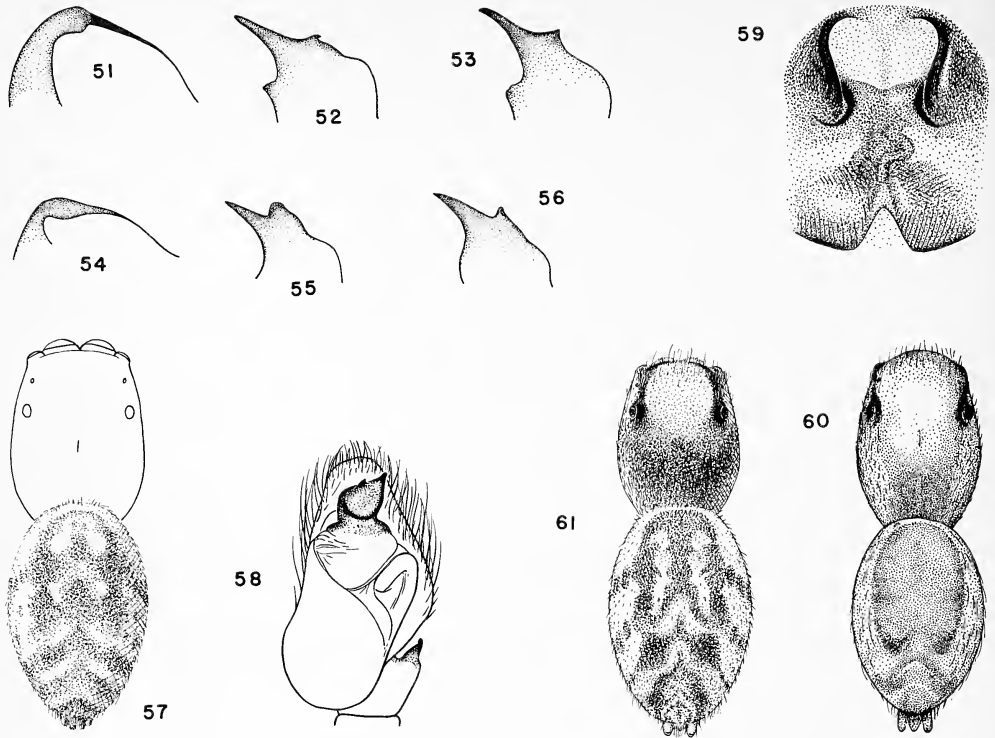
Figs. 51-61.–51, *Philodromus praelustris*, embolus (after Dondale); 52, 53, *Philodromus praelustris*, varieties of tibial apophysis (after Dondale); 54, *Philodromus barrowsi*, embolus (after Dondale); 55, 56, *Philodromus barrowsi*, varieties of tibial apophysis (after Dondale); 57, *Metaphidippus peckhamorum*, dorsum of female; 58, *Metaphidippus peckhamorum*, palp; 59, *Metaphidippus peckhamorum*, epigynum; 60, *Metaphidippus flaviceps*, dorsum of male; 61, *Metaphidippus flaviceps*, dorsum of female.

p. 460, re: *S. pubescens*, Roewer (1955) considered this to be a synonym of *truncorum* (Linnaeus), but Bonnet disagreed. We now have Connecticut records.
Hartford 13 March 1960 and Wethersfield 22 May 1960 (both J. F. Anderson).

p. 463 and 469, re: *Habronattus* and *Evarcha*, Lowrie and Gertsch (1955) gave reasons for placing the species of these two genera back into *Pellenes*.

p. 469, re: *E. hoyi*, Roewer (1955) considered this a synonym of *Evarcha leucophaea* (C. L. Koch) 1846.

p. 472, re: *A. tibialis*, mature females have been found overwintering among the lichens covering the bark of elm trees near the base. Additional records:
Rocky Hill December 1960; Meriden February and April 1961 (J. F. Lienisch).

p. 473, re: *Metaphidippus*, a discussion of the relations of Eastern species was published by Kaston (1973). We now know 8 species from our region. Of the two additions *peckhamorum* is similar to *protervus* and *galathea*; the other, *flaviceps*, is similar to *flavipedes* and *exiguus*.

p. 474, re: *M. protervus*, additional life history notes were given by Dondale (1961a).

p. **475**, **re**: *M. galathea*, complete details on the bionomics of this species were published by Horner and Starks (1972). "The egg sacs were oval, measuring ca. 8 by 15 mm and 3 mm thick." The "number of eggs per sac ranged from 9 to 31" each about 0.81 mm in diameter. Maturity in both sexes is attained at the eighth instar.

p. 476, add: before *M. insignis*

Metaphidippus peckhamorum Kaston
Figs. 57-59, 62
M. peckhamorum Kaston 1973, Trans. Amer. Micros. Soc. 92:115, f. 39-42.

Length of female 4.5 to 5.8 mm; of male 3.2 to 4.5 mm. This species is similar in appearance to *protervus* and *galathea*. The females of the latter are the darkest, of *protervus* the lightest, and those of *peckhamorum* intermediate. The legs are most conspicuously ringed in *galathea*, least so in *protervus*, and intermediate in *peckhamorum*. The epigyna of the three are quite similar and variable within a species. The embolus in *protervus* has the outer corner drawn out to a fine incurved hook. It is drawn out to a short angular hook in *glathea*, and is much wider and devoid of the outer hook in *peckhamorum*. Moreover, in *protervus* there is a dense covering of white scales on femur I and on the cymbium. In the other two species these scales are lacking, or there are only a very few.

This species has not been collected in Connecticut, but is known from Long Island.

p. 477, add: before *M. canadensis*

Metaphidippus flaviceps Kaston
Figs. 60-61, 63-66
M. flaviceps Kaston 1973, Trans. Amer. Micros. Soc. 92:110, f. 15-20.

Length of female 4 to 5.7 mm; of male 3.6 to 4.5 mm. The bulbous shiny yellow head region is a conspicuous trait, enabling immediate separation (especially in the male) from *flavipedes*, with which it had formerly been confused. This species has not been reported from Connecticut, but is known from Long Island, N.Y. as well as northern New England.

p. 478, re: *Paraphidippus* this has been shown to be a synonym of *Eris* C. L. Koch 1846, and a discussion of our eastern species was published by Kaston (1973).

p. 479, re: *E. marginata*, additional notes on the life history were published by Dondale (1961).

p. 484, re: *P. clarus*, a female collected on 31 August was guarding an egg sac in a cluster of golden rod flowers. The silken mass was 14 by 11 mm, with the egg mass itself 8 by 9 mm, and there were 47 eggs.

Re: *P. princeps*, a female guarding eggs was taken on 10 June.

p. 486, re: *P. mccookii*, a gravid female collected in New Britain in late October and kept alive in the laboratory produced an egg sac on 5 November. The egg mass itself was lenticular, about 8.8 mm in diameter and 6.6 mm thick. There were 163 orange non-agglutinate eggs, each about 1.18 mm in diameter.

p. 487, re: *Icius*, I now am of the opinion that the two species *elegans* and *similis* should be considered as belonging to the genus *Tutelina* Simon 1901.

p. 492, re: *H. palmarum*, a mature male was collected as late as 13 October.

p. **493, re**: *H. adansonii*, the mating habits were described by Cloudsley-Thompson (1949a). Noteworthy also is his reporting that males have been seen attacking and eating females, in one case immediately after the mating!

p. **494, re**: *Onondaga*, this is considered a synonym of *Marpissa*. In addition to *lineata* we have *dentoides* in our region.

Add:

Marpissa dentoides Barnes
Figs. 67-68

M. dentoides Barnes 1958, Amer. Mus. Novitates 1867 p. 27, f. 45.

Length of female 4 to 5.8 mm; of male 3.5 mm. This species is very similar to *lineata* in coloration and structure. The tibial apophysis of the male palp is a uniramous (not bifid) hook. In the epigynum "the tubules adjacent to the openings diverge [forward] rather than converge as in *lineata*. The openings are smaller and directed downward." This species has been collected in Massachusetts and also on Long Island, N.Y.

p. **495, re**: *Maevia*, the genus was revised by Barnes (1955).
Re: *M. vittata*, I have found this species one of the most common entering human habitations. An egg sac found on 10 August consisted of a sheet of silk 15 mm in diameter, with the egg mass itself about 4 mm in diameter. There were 26 eggs each about 1.05 mm in diameter.

p. **496, re**: *Z. bettini*, additional record:
New Britain August 1961 (J. F. Anderson).

p. **498, re**: family Oecobiidae, a revision was published by Shear (1970).

p. **499, re**: Urocteidae, despite my remark to the effect that this name dates from Thorell [1869] Petrunkevitch credits it to Simon 1875.
Re: convergent evolution of cribellate and ecribellate spiders; further evidence is given for this hypothesis in a beautifully illustrated article by Kullmann (1971).
Re: *O. parietalis*, it has been shown that this is a synonym of *annulipes*.

Oecobius annulipes Lucas

O. annulipes Lucas 1846, Explor. Sci. Algérie; Zool. 1, Arachn. p. 102, pl. 2, f. 2.

Glatz (1967) published an account of the morphology and bionomics of this species. He indicated that the strong hairs on the anal tubercle become erect under the influence of muscular pressure and serve to direct the threads of the cribellar band of silk as the abdomen is moved from side to side in enswathing prey. We now have a Connecticut record:
New Britain 30 April 1948 (D. Rugh).

p. **500, re**: Dictynidae, although Petrunkevitch (1955) credits the family name to Simon 1874 I have shown in my 1938 family names paper that O. P.-Cambridge first used the name in 1971. A revision of the family was published by Chamberlin and Gertsch (1958). In this they have shown that *Scotolathys* cannot be maintained as a genus separate from *Lathys*, but because of the genus *Tricholathys* being included we still have four genera from our region. Petrunkevitch continued to maintain right up to his last extensive paper (1958:363) that the members of the family Dictynidae were devoid of tarsal trichobothria. Though they may be absent in *Dictyna* they can be clearly seen in *Lathys, Argenna*, and *Tricholathys*.
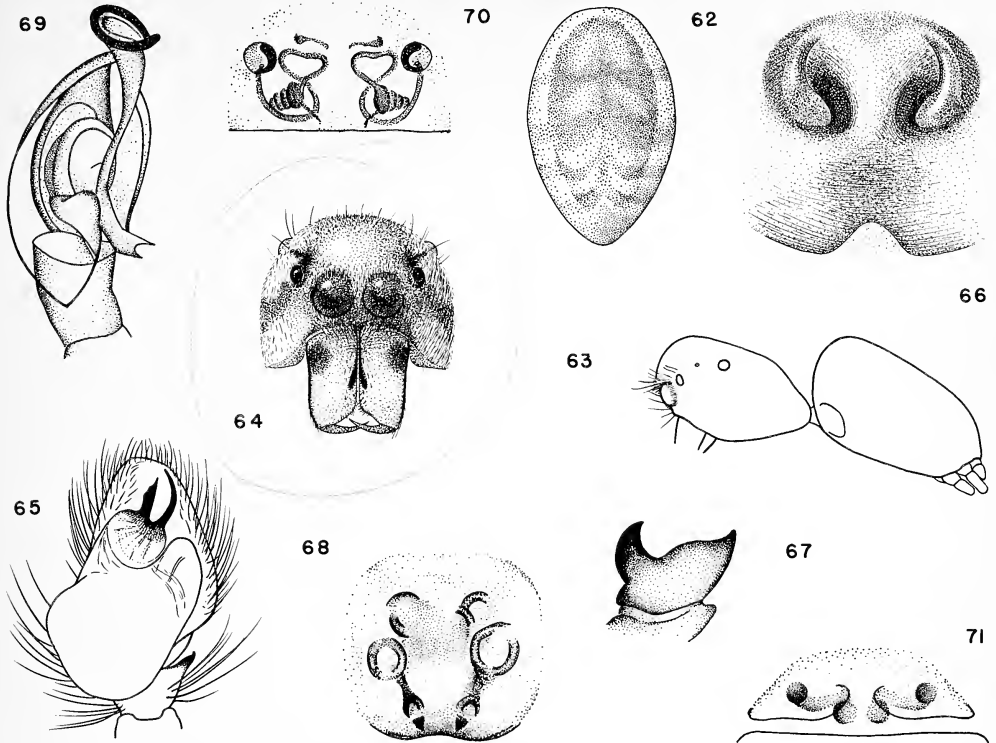
Figs. 62-71.—62, *Metaphidippus peckhamorum*, dorsum of male; 63, *Metaphidippus flaviceps*, lateral aspect of male; 64, *Metaphidippus flaviceps*, face of male; 65, *Metaphidippus flaviceps*, palp; 66, *Metaphidippus flaviceps* epigynum; 67, *Marpissa dentoides*, tibial apophysis (after Barnes); 68, *Marpissa dentoides*, epigynum (after Barnes); 69, *Tricholathys ohioensis*, palp (after Chamberlin and Gertsch); 70, *Tricholathys ohionensis*, epigynum (after Chamberlin and Gertsch) 71, *Dictyna altamira*, epigynum (after Chamberlin and Gertsch).

Revised key to genera:

1a.   Tarsi without trichobothria . . . . *Dictyna*
1b.   Tarsi with one or two trichobothria 2

2a.   AME very much smaller than PME, or absent altogether. Retromargin of cheliceral fang furrow with five small teeth . . . . *Lathys*
2b.   AME subequal to PME. Retromargin with 2 or 3 teeth 3

3a.   Promargin of cheliceral fang furrow with 4 or 5 small teeth. Retromargin with 3. Tarsi each with a single long trichobothrium . . . . *Tricholathys*
3b.   Promargin with 3 teeth; retromargin with 2. Tarsi each with a short trichobothrium as well as a long one . . . .*Argenna*

p. 502, re: *S. pallidus*, is now in the genus *Lathys*.

Lathys pallida   (Marx)

L. pallida :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. Hist. 116:35. pl. 6, f. 1-6.

Re: *S. maculatus*, is now to be called *Lathys maculina*.

Lathys maculina Gertsch

L. maculina Gertsch 1946, Amer. Mus. Novitates 1319 p. 4, f. 15 [*maculatus* preoc. by Keyserling 1890]. :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. Hist. 116:32, pl. 6, f. 9-12.

p. 503, re: *Argenna obesa*, Lehtinen (1967) made this the type of his new genus *Iviella*.

Re: *A. ohioensis*, this is now placed in the genus *Tricholathys* Chamberlin and Ivie 1935.

Tricholathys ohioensis (Chamberlin and Ivie)
Figs. 69-70

T. ohioensis :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. Hist. 116:24, pl. 2, f. 6-8.

The female has since been described. It is 2.2 mm in length.

p. 504, re: *Dictyna*, there are now 20 species known from our region.

p. 505, re: *D. arundinaceoides.* It has been shown that this is a synonym of *annulipes*, and that the spiders identified as *arundinaceoides* are really *coloradensis.*

Dictyna coloradensis Chamberlin

D. coloradensis Chamberlin 1919, Ann. Entomol. Soc. America 12:241, pl. 14, f. 7-8. *D. coloradensis* :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. 116:89, pl. 26, f. 4-7.

Length of female 3.8 mm; of male 3.2 mm.

p. 506, re: *D. muraria*, it has been shown that this is a synonym of *annulipes.*

Dictyna annulipes (Blackwall)

Ergatis annulipes Blackwall 1846, Ann. Mag. Nat. Hist. 17:42. *Dictyna arundinaceoides* Keyserling 1883 [not *arundinaceoides* Kaston 1948]. *Dictyna annulipes* :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. Hist. 116:123, pl. 37, f. 1-5.

p. 507, add: before *D. hentzi:*

Dictyna altamira Gertsch and Davis
Fig. 71

D. altamira Gertsch and Davis 1942, Amer. Mus. Novitates 1158 p. 15, f. 29. :Chamberlin and Gertsch 1958, Bull. Amer. Mus. Nat. Hist. 116:116, f. 1-4. *D. savanna* Chamberlin and Ivie 1944, Bull. Univ. Utah 35(9): Biol. Ser. 8(5):121, f. 161-169. *D. bryantae* Jones 1947, Field and Lab. 15:13, f. 31-34.

Length of female 1.85 to 2.33 mm; of male 1.6 to 2.25 mm. The abdominal pattern is similar to that of *annulipes.* However, the epigynum is much wider than in that species, and the palpal organ has the conductor narrower. "The broadened terminal portion of the thick embolus presents two spurs of which one is prolonged into a quite large S-shaped hook."

New Haven 5 October 1937; Norwalk 15 June 1933 (W. J. Gertsch).

p. 508, re: *D. roscida*, Chamberlin and Gertsch considered that *D. florens*, which I list as a synonym, is a separate species known only from Florida.

p. 511, re: *D. angulata*, we now have a Connecticut record:

Norwalk 2 July 1933 (W. J. Gertsch).

p. 512, re: the family Uloboridae, the name should be credited to Thorell. A revision was published by Muma and Gertsch (1964). According to Homann (1971) the indirect eyes lack a tapetum, and hence all eyes are concolorous black.

p. 513, re: *U. americanus*, Muma and Gertsch agreed with Chamberlin and Ivie in considering our species to be *glomosus*.

Uloborus glomosus (Walckenaer)

Epeira glomosa Walckenaer 1841, Hist. Nat. Ins. Apt. 2:43. *Uloborus glomosus* :Muma and Gertsch 1964, Amer. Mus. Novitates 2196 p. 22, f. 3, 40-41, 44-45, 66-70.

Females as small as 2.8 mm and males to 2.3 mm have been recorded.

p. 515, re: the family Amaurobiidae, the name should be credited to Thorell. A revision was published by Leech (1972). According to Homann (1971) the tapetum in the indirect eyes is of the "canoe" type. Leech has shown that I and others have been mistaken in supposing that some members of this family have a calamistrum composed of two rows. Actually, in these cases the calamistrum is only *apparently* double; posterior to the calamistrum itself is an area of other bristles on the dorsal surface of the metatarsus, and the anterior edge of this batch of bristles resembles another row of calamistral bristles. Hence there is no basis for separation into the two subfamilies as indicated. Instead, Leech divided the genera we have into two subfamilies on the basis of trichobothria characters, the Amaurobiinae having them long, and the Titanoecinae having them short. It is now considered that there are four genera in our region, and the following revised key is after Leech.

Key to genera:

1a.   Trichobothria short and thick, not extending much above the general leg hairs, and not increased in length distally on leg segments; usually with only 1 or 2 on tarsi and metatarsi . . . . *Titanoeca*

1b.   Trichobothria long and thin, increasing in length distally on tarsi and metatarsi 2

2a.   Males 3
2b.   Females 5

3a.   Palpal tibia with a simple process distally; all processes tapered, thinner distally than basally when seen from any aspect . . . . *Callobius*
3b.   Not so 4

4a.   Palpal tibia with two processes only, mesal process with one or more sub-processes, considerably longer than ectal process, and arched anterolaterally over cymbium . . . . *Callioplus*

4b.   Tibia distally with 2 or 3 processes; mesal process simple . . . . *Amaurobius*

5a.   Lateral lobes of epigynum small or absent; spermathecae under the epigynal plate not in the lateral lobes . . . . *Amaurobius*

5b.   Lateral lobes large, convergent posteriorly; spermathecae in the lateral lobes . .6

6a.   Epigynum with posterior and median lobes, though one or the other may be very small in some specimens . . . . *Callobius*
6b.   Epigynum without posterior or median lobes; lateral lobes flat and projecting posteriad beyond the epigynal furrow . . . . *Callioplus*

p. 516, re: footnote, there has been much further controversy over the matter of

Ciniflo vs. *Amaurobius*, and those interested may wish to read the comments by Bonnet (1955), Cloudsley-Thompson (1957), Kraus (1962), Platnick and Levi (1973) and myself (1974).

Re: *Amaurobius*.   Leech has removed *bennetti* to *Callobius* Chamberlin 1947, but has but has put in *borealis*, so we still have two species in this genus.

Callobius bennetti (Blackwall)

C. bennetti :Leech 1972, Mem. Entomol. Soc. Canada 84, p. 28, f. 33-35, 224-226, 396.

Measurements by Leech on many more specimens indicate that females range from 5 to 12 mm, and males from 5 to 9 mm. Additional data included one egg sac with 125 and a second with 166 eggs.

p. 517, **re**: *A. ferox*,

Amaurobius ferox (Walckenaer)

A. ferox :Leech 1972, Mem. Entomol. Soc. Canada 84, p. 72, f. 116-117, 312, 422.

Leech indicates a range of body lengths in the female from 8.5 to 14 mm, and for the male 8 to 12.5 mm. Cloudsley-Thompson (1955) published data on water relations, food types, and egg laying.

p. 518, **re**: *Titanoeca*, there are two species with *brunnea* considered distinct from *americana*. Lehtinen (1967) made this genus the type of his new family Titanoecidae.

Add:

Titanoeca brunnea Emerton

T. brunnea Emerton 1888, Trans. Connecticut Acad. Sci. 7:453, p. 10, f. 5-5c. *T. americana* :Kaston 1948 [in part, f. 1970, 2001-2002]. *T. brunnea* :Leech 1972, Mem. Entomol. Soc. Canada 84 p. 102, f. 183-184, 378, 382, 438.

Length of female 4.5 to 5.5 mm; of male 4 to 5 mm. Similar to *americana* but smaller and with the following differences: the basal part of the embolus is nearly at right angles to the palp limb length; the epigynum is wider than long, and there are usually two or four small pale spots on the dorsum and two on the venter of the abdomen, one beside the other.

Of the records listed under *americana* the following belong here:
East Haddam, New Haven, and Windsor.

Titanoeca americana Emerton

T. americana :Kaston 1948 [in part f. 1997, 2000, 2003]. :Leech 1972, Mem. Entomol. Soc. Canada 84 p. 100, f. 181-182, 377, 380, 439.

Length of female 3.5 to 7.5 mm; of male 4.5 to 7 mm. Similar to *brunnea* but larger and with the following differences: the basal part of the embolus is nearly parallel to the limb length; the epigynum is longer than wide; and the spots are lacking from the abdomen.

p. 519, **re**: *Callioplus*, we now have only one species in this genus, as Leech has put *borealis* back into *Amaurobius*.

Amaurobius borealis Emerton

A. borealis :Leech 1972, Mem. Entomol. Soc. Canada 84 p. 73, f. 118-122, 313-314, 423.

Re: *C. tibialis*, Leech supplied the following biological data: "Egg sacs have been collected [in New Brunswick] from late June to late July. Four egg sacs. . . . contained 25, 39, and 40 eggs. The fourth sac contained 40 spiderlings."

p. 520, re: *Hypochilus,* a revision of the genus was published by Gertsch (1964b).

p. 521, re: other introduced spiders. A single record exists for each of the following: *Neoscona oaxacensis* (Keyserling), a western species taken at Providence, R.I.; *Loxosceles rufescens* (Dufour), a southern species taken at New York, N.Y.; and *L. laeta* (Nicolet), from South America, of which a "colony" was found in Cambridge, Massachusetts. Similarly, in the same place, a colony of *Oecobius interpellator* Shear was found.

p. 522, re: footnote 1, volumes II and III of Bonnet's Bibliographia Araneorum have since appeared. A supplement to Bonnet's work, insofar as American species are concerned was published by Vogel (1962, 1967).

p. 523, re: general works on spiders add: Bristowe, W. S. 1958; Gertsch, W. J. 1949; Kaestner, A. 1968; and Millot, J. 1949.
Re: papers giving the distribution of spiders in States other than those in New England, add:
for Arkansas: Dorris, P. R. 1968; California: R. X. Schick 1965; Illinois: Kaston, B. J. 1955; Kansas: Fitch, H. S. 1963; Kentucky: Branson, B. A. and D. L. Batch 1968 and 1972; Mississippi: Dorris, P. R. 1972; Oklahoma: Branson, B. A. 1966; Texas: Vogel B. R. 1970; Wisconsin: Levi, H. W. and H. M. Field 1954.

p. 561, delete: from the list of names: *Theridion sexpunctatum* and *Ceraticelus parvulus.* Change the following: *Theridion maxillare* = *T. petraeum* L. Koch 1872, *Lepthyphantes subalpina* = *L. turbatrix* (O. P.-Cambridge) 1877; *Microneta pinnata* = *Allomengea p.*, *M. furcata* = *Centromerus f.*, *Aigola recurvata* = *Oreonitides recurvatus*, *Chocorua cuneata* = *Diplocephalus c.*, *Islandiana alata* = *I. falsifica* (Keyserling) 1886. Add the following: under family Theridiidae, *Theridion petrense* Sorensen 1898; under Linyphiidae, *Bathyphantes crosbyi* Emerton 1919; under Micryphantidae, *Grammonota angusta* Dondale (1959), *Islandiana princeps* Braendegaard 1932.

p. 562, delete: from the list of names: *Zygiella montana* (C. L. Koch). Change the following: *Sciastes microtarsus* = *Hillhousia m.*, *Tapinocyba bicarinata* = *T. vermontis* Chamberlin 1948, *Epeira carbonaria* = *Araneus carbonarius.* Add the following: under family Micryphantidae, *Montilairia relicta* Chamberlin 1948; under Epeiridae (= Araneidae) *Araneus groenlandica* (Strand) 1906, *A. washingtoni* Levi 1971; under Lycosidae, *Pardosa albomaculata* Emerton 1885; under Clubionidae, *Clubiona trivialis* C. L. Koch 1843, *C. gertschi* Edwards 1958, *C. bishopi* Edwards 1958.

p. 563, re: names, change the following: *Synema obscura* = *Xysticus ellipticus* Turnbull, Dondale and Redner 1965, *Metaphidippus nigromaculatus* = *Eris n.*
Add: the following under family Thomisidae, *Coriarachne utahensis* Gertsch 1932. Under Philodromidae, *Philodromus pernix* Blackwall 1846. Under Uloboridae, *Hyptiotes gertschi* Chamberlin and Ivie 1935. Under Dictynidae, *Dictyna phylax* Gertsch and Ivie 1936.

p. 564, re: table   **Revised Statistics**

The expression "our region" in the center columns refers to the area considered in the monograph, namely; Massachusetts, Rhode Island, Connecticut and that portion of New York State east of the Hudson River and south of the westward prolongation of Massachusetts' northern boundary.

Family	In all New England		In our region		In Connecticut	
	genera	species	genera	species	genera	species
Antrodiaetidae	0	0	1	1	0	0
Atypidae	1	2	1	2	1	1
Oonopidae	2	2	2	2	1	1
Dysderidae	1	1	1	1	1	1
Segestriidae	1	1	1	1	1	1
Scytodidae	1	1	1	1	1	1
Pholcidae	2	2	2	2	2	2
Theridiidae	18	58	18	51	17	51
Symphytognathidae	0	0	1	1	0	0
Nesticidae	2	2	2	2	0	0
Linyphiidae	23	51	22	41	21	30
Micryphantidae	59	138	54	120	50	70
Araneidae	20	58	20	56	19	42
Theridiosomatidae	1	1	1	1	1	1
Tetragnathidae	3	15	3	15	3	14
Mimetidae	2	5	2	6	2	5
Agelenidae	8	19	8	20	8	15
Hadniidae	3	5	3	4	2	3
Pisauridae	2	9	2	9	2	9
Lycosidae	9	51	9	42	9	40
Oxyopidae	1	2	1	2	1	2
Gnaphosidae	10	38	10	38	10	30
Prodidomidae	0	0	1	1	0	0
Clubionidae	12	54	12	43	12	41
Zoridae	1	1	1	1	1	1
Anyphaenidae	4	6	4	7	3	5
Thomisidae	7	29	7	22	7	18
Philodromidae	4	20	4	19	4	17
Salticidae	26	63	28	57	25	49
Oecobiidae	1	1	1	1	1	1
Dictynidae	4	22	4	22	4	20
Uloboridae	2	2	2	2	2	2
Amaurobiidae	4	7	4	6	3	4
Hypochilidae	1	1	1	1	1	1
Loxoscelidae	1	1	1	2	0	0
Totals	236	688	235	665	215	477

Errata

p. 25, line 13, for "anterior and median" read "posterior."

p. 30, line 28, for "covered" read "lined."

p. 55, line 4, for "298" read "291."

p. 68, line 40, for "diads" read "triads."

p. 89, line 40, for "(1940)" read "(1947)."

p. 93, line 36, for "female 0.7 to 0.9 mm" read "male 0.7 to 0.9 mm."

p. 115, line 11, between the words "with" and "seven" insert: "occasionally six but more usually."

p. 117, line 22, for "six or" read "five to."

p. 225, line 34, at end of the line read "227" for "2 7."

p. 226, lines 5 and 6, delete "and both eye rows recurved."

p. 226, line 9, for "procurved" read "recurved."

p. 241, line 12, "Emerton" should be in Roman type, not bold face.

p.248, line 24, for "saggitate" read "sagittate."

p. 257, line 7, add in parentheses after (Scopoli) "(Marbled spider)."

p. 278, line 13, delete the parentheses from around "C. L. Koch."

p. 284, line 10, for "tibia" read "cymbium."

p. 297, between lines 36 and 37 insert "Subfamily Thaumasiinae."

p. 306, line 19, for "posterior" read "second."

p. 409, line 40, for "Argiopidae" read "Epeiroidea," now to be known as "Araneoidea."

p. 410, lines 22 and 23, for "Misumeninae" read "Thomisinae."

p. 429, line 20, for "equidistant, or the PME farther" read "the PME distinctly farther."

p. 429, lines 22 and 23, for "PME farther from the PLE than from each other" read "PME equidistant or farther from each other than from the PLE."

p. 447 to 497, wherever the name "Peckham" appears read "G. and E. Peckham."

p. 460, line 6, after "marsh" insert "in Massachusetts."

p. 483, line 26, for "two" read "one."

p. 504, line 21, for "foliaceum" read "sublatum"; for "277" read "276"; and for "14" read "10."

p. 558, line 24, for "same" read "some."

p. 858, after line 18 in the right hand column insert "*Araniella* 258."

p. 866, after the last line in the left hand column add "marbled spider 257."

p. 871, line 7 in left hand column "rostratus (Origanates)" should be in Roman, not italic, type.

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NOTE ADDED IN PROOF: The following changes, corrections, and additions are occasioned for the most part by the appearance of recent publications seen after the original manuscript was sent to the editor.

p. 32, re: stridulation in courtship, Rovner (1975, Science 190:1309-1310) has described a hitherto unknown stridulating organ on the pedipalps of male lycosids.

p. 59, re: Haplogynae, for a discussion of this taxon see Platnick (1975, Proc. 6th Intern. Arachnol. Congr. [for 1974] pp. 30-32).

p. 71, re: the key to the genera of Theridiidae, see Levi and Randolph (1976, J. Arachnol. 3:31-51).

p. 86, re: *T. grossa*, additional notes on the biology of this species were published by Barmeyer, R. A. (1975, Bull. So. California Acad. Sci. 74:30-36).

p. 143, re: Linyphiidae versus Micryphantidae, additional data for separation based on the tracheal system are supplied by Blest, A. D. (1976, J. Zool. London 180:185-194).

p. 227 and 238, re: *Cercidia* and *Mangora*, a revision was published by Levi (1975, Bull. Mus. Comp. Zool. 147:101-135).

p. 229, 230, 233 and 234, re: the genera *Verrucosa*, *Wixia*, *Acanthepeira*, and *Acacesia* respectively, a revision was published by Levi (1976, Bull. Mus. Comp. Zool. 147:351-391).

p. 237, re: *C. turbinata*, an additional record for this rare species is Bristol, Oct. 1948 (J. Cline) [det. H. W. Levi].

p. 241, re: *Hypsosinga*, I have learned recently from Dr. Levi (*in litt.*) that he now considers *H. variabilis* a synonym of *H. pygmaea* (Sundevall, 1831) of Europe (see Levi 1971 Psyche 78:242). Also, what he had been calling *H. singaeformis* he now believes to be *funebris* (Keyserling, 1892).

p. 242, re: *Zygiella*, a revision was published by Levi (1974, Bull. Mus. Comp. Zool. 146:267-290).

p. 254-256, and 258, from the genus *Araneus* Levi (1974, Bull. Mus. Comp. Zool. 146:291-316) removed *cornutus*, *patagiatus*, and *sericatus* (the latter under the name *sclopetaria*) to *Nuctenea* Simon 1864; and *displicata* to *Araniella* Chamberlin and Ivie 1942, where I too had placed it in my *How to Know the Spiders* (1952).

p. 342, re: *Callilepis*, a revision was published by Platnick (1975, Amer. Mus. Novitates 2573, 32 pp.).

p. 343, re: *Gnaphosa*, a revision was published by Platnick and Shadab (1975, Bull. Amer. Mus. Nat. Hist., 155:1-66).

p. 349, re: *Haplodrassus*, a revision was published by Platnick and Shadab (1975, Amer. Mus. Novitates 2583, 40 pp.).

p. 350, re: *Drassodes*, a revision was published by Platnick and Shadab (1976 Amer. Mus. Novitates 1593, 29 pp.).

p. 352-353, re: *Drassodes* and *Geodrassus*, Dr. Platnick has indicated to me (*in litt.*) that *D. robinsoni* is a synonym of *D. saccatus* (Emerton, 1890) which he has resurrected from synonymy under *neglectus*. He has also placed *phanus* as a synonym of *gosiutus* and moved it back into the genus *Drassodes*.

p. 364, re: *Sosticus*, a revision was published by Platnick and Shadab (1976, Amer. Mus. Novitates 2594, 33 pp.).

p. 382, re: *Meriola*, this genus has been placed in synonymy under *Trachelas* by Platnick and Shadab (1974, Amer. Mus. Novitates 2560, 34 pp.).

p. 407, re: *Anyphaena*, a revision of the *celer* group was published by Platnick and Lau (1975, Amer. Mus. Novitates 2575, 36 pp.).

p. 409, re: the separation of the Philodromidae from the Thomisidae *sens. str.*, see Homann (1975, Z. Morph. Tiere 80:181-202). In tabular form for ease of comparison Homann presents the differences with respect to legs, scopula hairs, chelicerae, colulus, chromosomes, morphology and behavior of "last larval instar," and eye morphology.

p. 418, re: *Coriarachne*, a revision was published by Bowling and Sauer (1975, J. Arachnol. 2:183-193). *C. utahensis* Gertsch 1932 is now known from Massachusetts. In their discussion of *C. floridana* the distribution was given as "into New England," but they have informed me that this was an error. The species is included in my supplement because of its having been collected on Long Island, N.Y.

p. 419-420, re: *Oxyptila*, a revision of the genus was published by Dondale and Redner (1975, J. Arachnol. 2:129-181). There are now seven species known from our area. What I had called *O. conspurcata* they consider to be *georgiana* Keyserling 1880. What I had called *americana* they described as their new species *distans*. They expressed doubt about the Connecticut record for *bryantae*, the female of which they consider to be the true *conspurcata*. What I considered to be the male of *bryantae* they consider to be their new subspecies *sincera oraria*. *O. formosa* is now known from Massachusetts as well as Long Island, N.Y. They list the true *americana* from Connecticut, and add for Massachusetts *practicola* (C. L. Koch, 1837) as well as their new species *curvata*.

p. 430, re: *Philodromus*, Dondale and Redner (1975, Canad. Entomol. 107:369-384) added *P. validus* (Gertsch, 1933) from Massachusetts, and in 1976 published a revision of the genus (Canad. Entomol. 108:127-157).

p. 450, re: *Gertschia*, this is considered by Cutler (*in litt.*) to be a synonym of *Synageles* Simon 1876.

p. 562, under Gnaphosidae add: *Gnaphosa mima* Chamberlin 1933, and *G. microps* Holm 1939.

The table of revised statistics given in this supplement will necessarily have to be modified to take into account the species and genera in this addendum.

support). 4) By-line: Include name(s) of author(s) as customarily written (less titles) and complete address(es) including zip code or other postal zone designation. Include footnote indication(s) if appropriate (e.g., to indicate change of address). 5) Body of Text: Use whatever form seems to best accommodate the necessary description of the research. Be concise. Conform to the *CBE Style Manual* in all abbreviations. 6) Acknowledgments: Take care to give credit where it is due. 7) Literature Cited: Include only those publications to which reference is made in the text. Adhere to style in *CBE Style Manual* or refer to a previous issue of *The Journal of Arachnology*. Do not abbreviate place names. 8) Figure Legends: Do not type on facing pages but type consecutively in numerical sequence. 9) Abstract: Keep abstracts concise, not exceeding 2-3% of the text. Abstracts should contain a summary of the basic findings. 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Remember that whole views of animals, while not necessarily required for a diagnosis, give the reader an instructive general appreciation of the animal which is impossible to impart with words or by a collection of drawings of pieces. Avoid the use of whole views comprised of ½ dorsum and ½ venter. Illustrate species descriptions. This is in accord with General Recommendation 17, *International Code of Zoological Nomenclature*, which states, "The description of a new taxon of the species-group should be accompanied by a satisfactory illustration or by a bibliographic reference to such an illustration." 13) Put items 3, 4, and 5 above on page 1 and number *all* other pages consecutively.

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LIFE HISTORIES AND DISTRIBUTION PATTERNS OF HUNTING SPIDERS (ARANEIDA) IN AN ONTARIO MEADOW

C. D. Dondale

Biosystematics Research Institute
Research Branch, Agriculture Canada
Ottawa, Ontario K1A 0C6

ABSTRACT

Life histories and distribution patterns were reconstructed from random vacuum samples of coexistent populations of nine species of hunting spiders in an Ontario meadow. The populations of *Pardosa saxatilis* (Hentz), *Pirata minutus* Emerton, *Schizocosa avida* (Walckenaer), *S. heasmani* Dondale, and *S. crassipalpis* (Emerton) had annual life histories, and matured, mated, and oviposited in the spring or early summer. *Xysticus pellax* (O. Pickard-Cambridge) and *X. gulosus* Keyserling were also annual, but matured and mated in late summer or early autumn, and oviposited the following spring. *X. discursans* Keyserling was biennial, and matured and reproduced in the spring. *Lycosa frondicola* Emerton was also biennial, but matured in late summer and reproduced the following spring. Most of the nine species were more densely represented in the lower, moister part of the meadow, whereas *S. heasmani*, individuals of which are very similar in anatomy to those of *S. avida*, was more densely represented on the higher, dryer part, and the adults of *L. frondicola* kept largely to the edge of the meadow nearest the forest.

INTRODUCTION

Ideally, the life history of an animal species is a summary of vital events from birth to death in the average generation. Ball (1920) describes the adaptations to environment exhibited by life histories as "deep-seated and fixed modifications brought about through reaction to seasons unnumbered. . . .". Wilbur, Tinkle, and Collins (1974) refer evocatively to these adaptations to environment as "selective compromises." The study of life histories leads not only to an intimate view of life within the population but also to new data useful in taxonomy and in population dynamics, particularly when coexisting populations are sampled together by a single method.

This paper examines the life histories and distribution patterns of coexistent populations representing nine species of hunting spiders in a meadow habitat. The species were selected from a large spider fauna (Dondale, 1971) on the basis of abundance and/or biomass. The combined populations of these species accounted for 56 percent of total estimated spider biomass in the meadow.

METHODS

The study site was a small, sloping, 0.8 hectare meadow near Belleville, Ontario (Turnbull, 1966; Dondale, 1971). Two 2,000 m^2 plots were staked out in 1966, Plot 1 on the higher, sandier part of the meadow and Plot 2 on the lower, clay-type part. Annually from 1966 to 1970 the surface litter and its spider inhabitants were sampled at 180 randomly-chosen spots, each spot being one-half m^2 in area (Turnbull and Nicholls,

1966). The samples were taken in nine series during the year, each series consisting of 20 samples on four consecutive days of fine weather. The earliest series of the year was taken as soon as snow left the meadow, i.e., approximately mid-April, and the latest one at the time of the first severe frosts, i.e., late October. The spiders were extracted from the litter samples by a method already described (Dondale, Nicholls, Redner, Semple, and Turnbull, 1971). Biomass measurements were obtained from specimens dried at 100°C for 24 hr.

Life histories were reconstructed partly from mean numbers and biomasses in the successive samplings, and partly from mean size of individuals as estimated from measurements of carapace width. Distribution patterns were inferred from plottings of the accumulated collection spots. Times of maturity were determined partly from pitfall captures or insectary cultures, as well as from vacuum samples.

RESULTS

The number of vacuum samples on each five m² co-ordinate ranged from 2 to 21, with a mean of 11. This intense sampling over a relatively long period of time permitted reconstruction of life histories with reasonable confidence. For the annual species, four complete generations, and for the biennials, three (and parts of others) were traced. All nine species, with the partial exception of *Lycosa frondicola*, appeared to be true meadow inhabitants inasmuch as individuals could be found in all seasons in predictable numbers. They also fed and reproduced in the meadow.

Paradosa saxatilis (Hentz).—Eggs of this small lycosid began hatching in late June or early July and continued to hatch until August. The juveniles grew until early October when they had attained approximately one-half their mean total growth (Fig. 2). Growth resumed the following May, and the first adult males appeared toward the end of that month. The latter were observed in numbers until approximately the third week of June, thereafter dwindling until the last was sighted about mid-July. The first females appeared a few days after the first males, and the first mating pairs were seen in the field at that time. Females with egg sacs were seen early in June, and by early July most of them were carrying sacs or were carrying their young massed on their backs. The young were carried thus for periods up to one week. Many of the females then constructed a second sac. The last females of the season were seen in early September, at which time the population consisted entirely of half-grown to subadult individuals. The data give a clear picture of an annual life history, with maturity and reproduction in springtime.

P. saxatilis ranged in numbers from 0.8 to 4.4 individuals annually per m², but showed a progressive decline from 4.4 to 1.6, 2.0, 1.6, and 0.8 during the successive five years of the study. Distribution on the meadow was not random but biased toward the relatively moist Plot 2 (Fig. 4). A spider of eastern Canada and the eastern United States, *P. saxatilis* inhabits marshes, bogs, roadside embankments, lawns, and hayfields as well as meadows. The species is apparently at or near the northern limit of its range at Belleville, and this may account for an apparent mean decline in numbers amounting to approximately one-half the autumn population during the winter (Fig. 1). *P. saxatilis* contributed little to total spider biomass owing to the small mean size of individuals at maturity (Fig. 2).

Fig. 1.—Mean annual population densities (number per 10 m²) and biomasses (mg per 10 m²) for populations of nine species of hunting spiders in Ontario, 1966-70. Broken line: Plot 1; solid line: Plot 2.
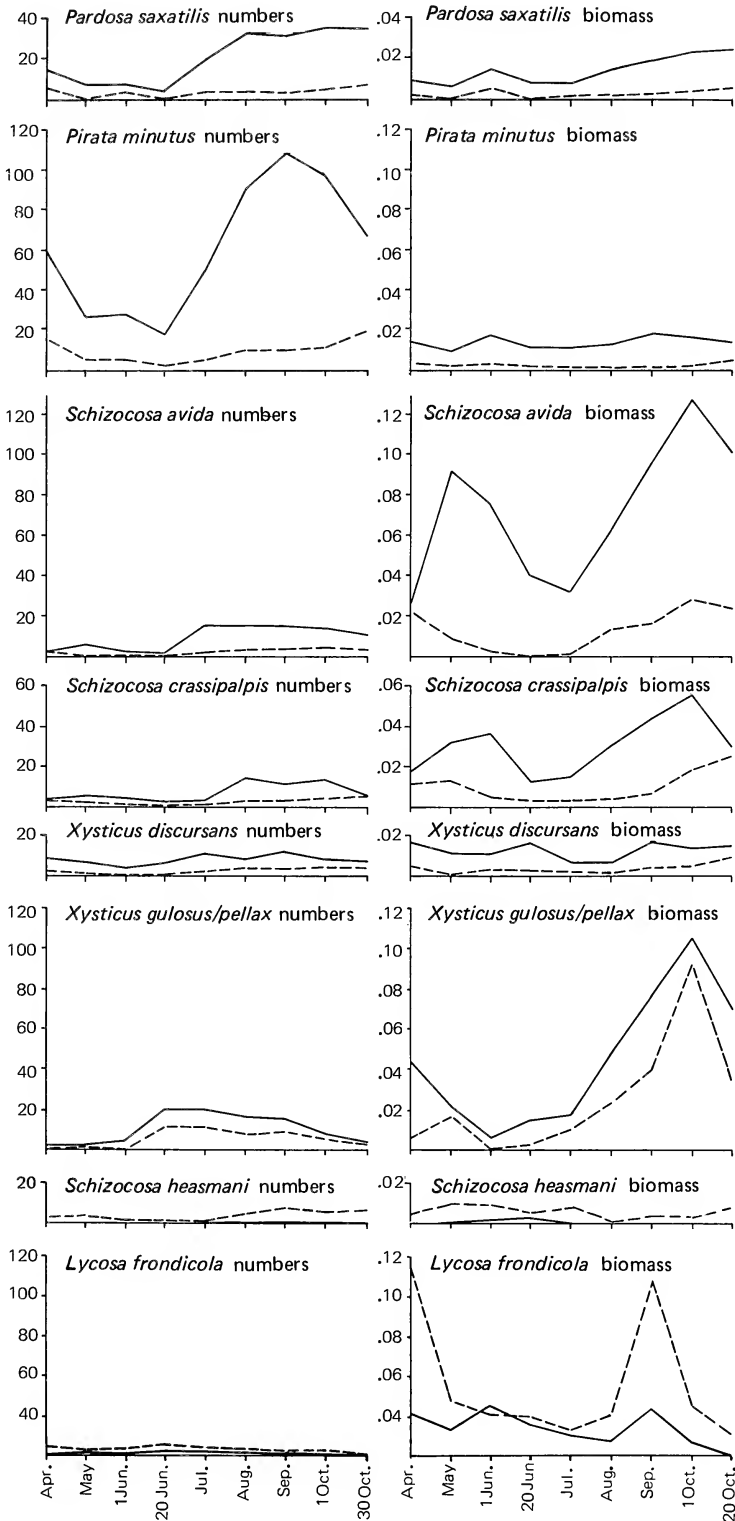
Laboratory matings were observed on 18 occasions, but egg production, for unknown reasons, was poor. Field-caught females with egg sacs had 27 to 32 (mean 30) eggs in the first sac and 16 to 29 (mean 21) eggs in the second. Overwintered juvenile males molted two or three times (usually two) before attaining maturity, females one to three times (usually three).

Pirata minutus Emerton.—Hatching of the eggs of this small lycosid usually began in late June, at which time females were found with young massed on their backs. Occasional females with sacs were, however, seen until October. The young grew until September or October, at which time they had attained approximately 70 percent of their mean total growth (Fig. 2). Most individuals of both sexes at this time lacked only one molt to maturity. They resumed growth the following April or early May, and the first males
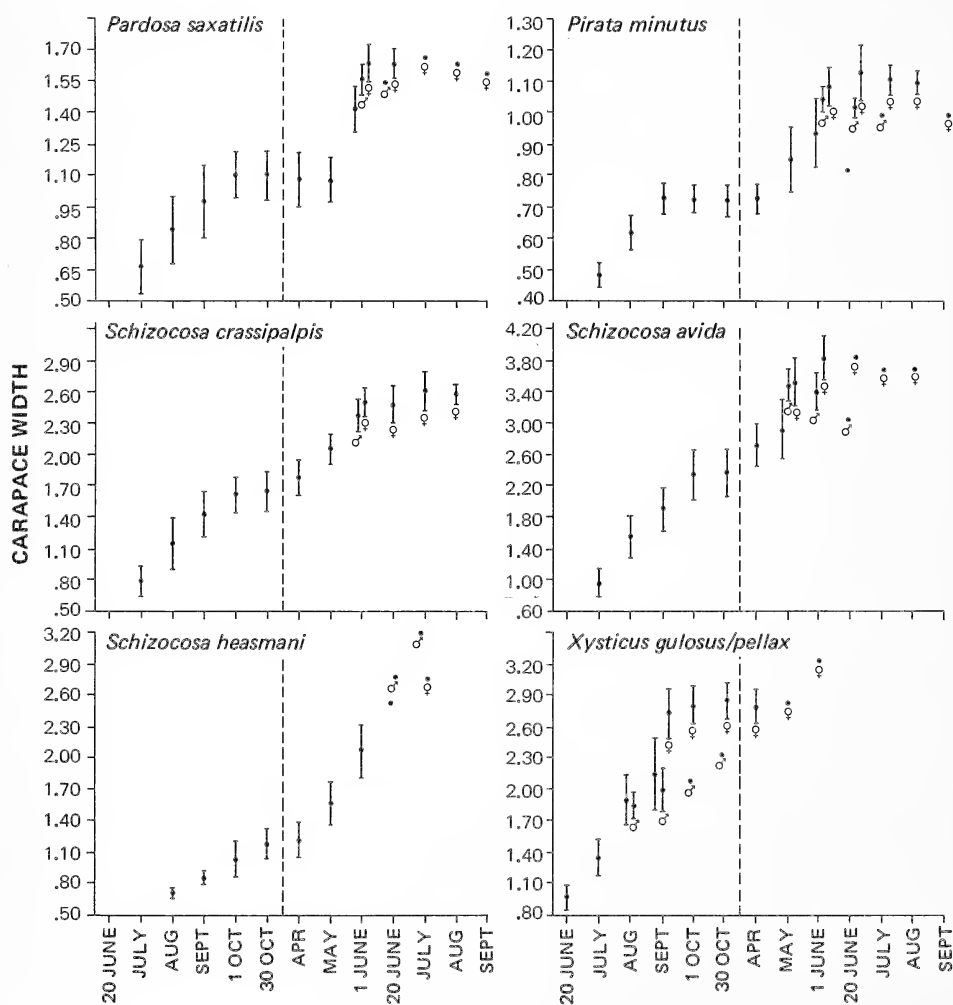
Fig. 2.—Seasonal growth in populations of seven species of annual hunting spiders in Ontario, 1966-70. Y-axis scaled in mm of carapace width; broken verticle line indicates winter; solid vertical line indicates 1 standard deviation about the mean. Number of individuals measured varied from 13 to 107 for any date.

appeared as early as 19 May. The peak of male activity occurred at the end of May or the beginning of June; the last male was seen on 19 August. Females appeared a few days after the first males, and were soon seen mating. Females with egg sacs appeared as early as the second week of June. Most females seen during late June were carrying sacs. The total number of sacs made by a female was not determined owing to the growing scarcity of females in the field and the lack of success with insectary cultures. The available data indicate an annual life history for *P. minutus* in Ontario, with maturity and reproduction in springtime.

The population of *P. minutus* ranged in annual abundance from 3.2 to 11.5 individuals per m². In spite of this density, the population contributed very little biomass (Fig. 1) owing to small mean size of the individuals at maturity (Fig. 2). Both numbers and biomass peaked in September, then declined (Fig. 1).

The population was more heavily represented on the relatively moist Plot 2 (Fig. 5), and in general the individuals kept close to the ground. Found on sphagnum bogs and similarly cool, moist habitats, this spider ranges over eastern Canada and New England. The overwintering population appeared to suffer no appreciable loss, though approximately two-thirds of the wintered population was lost before the commencement of egg hatch. Some 19 laboratory matings were observed, 11 of which terminated by the death
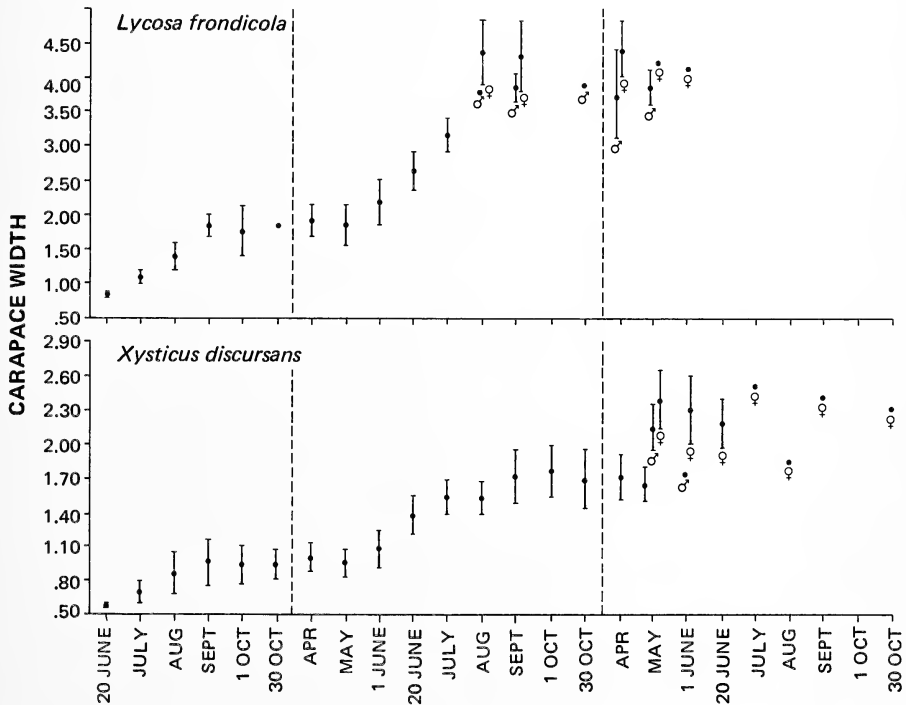
Fig. 3.—Seasonal growth in populations of two species of biennial hunting spiders in Ontario, 1966-70. Y-axis scaled in mm of carapace width; broken vertical line indicates winter; solid vertical line indicates 1 standard deviation about the mean. Number of individuals measured varied from 14 to 57 for any date.
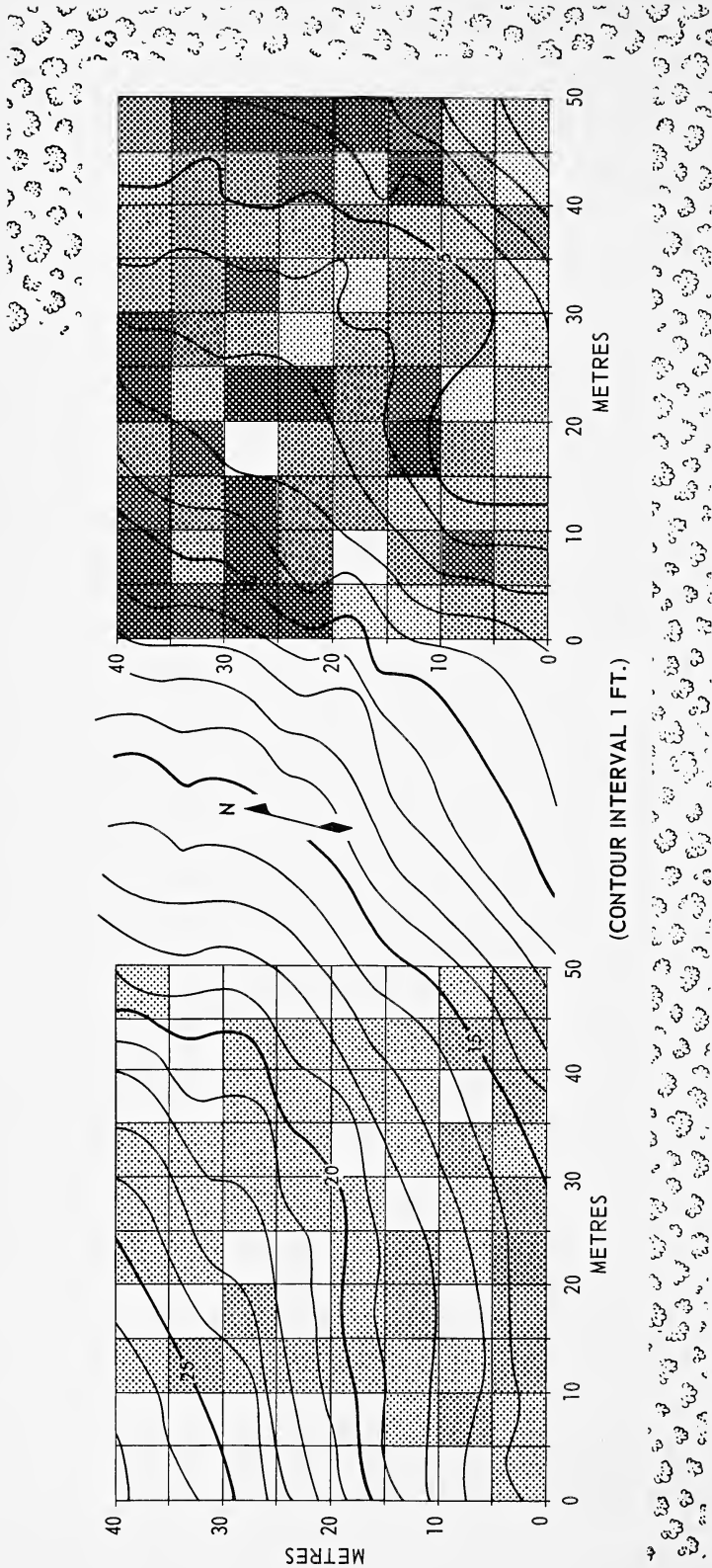
Fig. 4.—Frequency of collections of individuals of *Pardosa saxatilis* (Hentz), 1966-70. Frequency ranged from 0 (no stippling) to 33 (densest stippling) for any 5-m² quadrate.
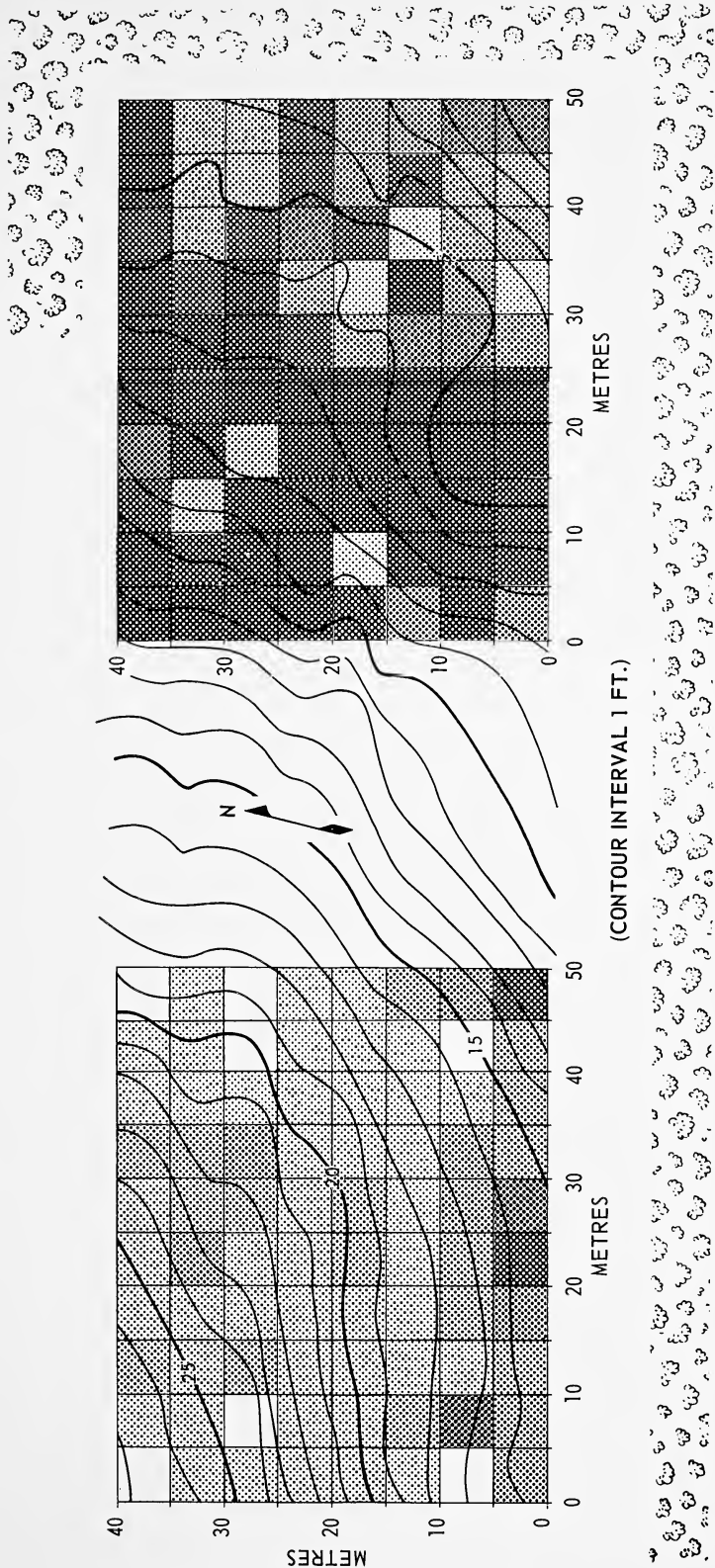
Fig. 5.–Frequency of collection of individuals of *Pirata minutus* Emerton, 1966-70. Frequency ranged from 0 (no stippling) to 130 (densest stippling) for any 5-m² quadrate.

and ingestion of the male by the female. None of these mated females laid eggs. Nineteen field-caught females had egg sacs containing 10 to 40 (mean 24) eggs.

Schizocosa avida (Walckenaer).—Egg hatch in this medium-sized lycosid commenced about 20 June and continued till late August, though most occurred during July. The young spiderlings grew until late September, at which time they had attained somewhat more than one-half of their mean total growth (Fig. 2). Activity and growth resumed the following April. Juvenile males brought indoors at this time molted only once to maturity. The first males were seen in the field about mid-May, and the last about 29 June, with a peak of activity in late May and early June. Females first appeared a few days after the first males; mating ensued, and females continued to be sighted until nearly mid-June when none appeared for an interval of 10 days. They were then seen again, carrying egg sacs or young until about mid-July, when sightings ceased for a second 10 day interval. After this, females were seen sporadically until the third week of August.

The two intervals of quiescence in mature females were studied in insectary cultures. Both coincided with times of low activity during which the females were ovipositing and incubating their eggs in shallow (approximately 2 cm deep) nestholes in the ground. On sunny days they were frequently seen holding the sac at the mouth of the hole with the chelicerae or, less frequently, standing over the hole with the sac attached to the spinnerets. At the end of the quiescent period the egg sac, now empty, was often left at the bottom of the hole.

The data indicate an annual life history for *S. avida*, with maturity and mating in the spring.

The population was at low density and appeared to be in decline. Mean annual levels of 1.5, 1.3, 1.0, 0.7, and 0.5 individuals per m^2 were recorded, respectively, for the five years of the study. Distribution was biased toward the moist Plot 2 (Fig. 6). The species ranges widely across southern Canada and the United States, its main habitat being open grassland. The population, in spite of low density, accounted for a large amount of biomass (Fig. 1).

Laboratory matings and ovipositions were observed in 24 instances. The females made either one or two egg sacs, the first containing 69 to 191 (mean 113) eggs, the second 49 to 59 (mean 54). In addition, seven gravid females were dissected and found to contain 90 to 298 (mean 205) oöcytes in various stages of development.

The annual curve of biomass (Fig. 1) showed two peaks, a steep one in May when the spiders were growing rapidly in the penultimate instar, and a second one, less steep but higher, at the beginning of October when growth came to a halt before hibernation. The sharp decline that followed the spring peak was tentatively attributed to attrition of the population through predation; the autumn decline is unexplained.

Schizocosa heasmani Dondale.—Eggs of this medium-sized lycosid began to hatch in late July. The spiderlings attained about 40 percent of their total growth by October. Growth resumed the following May, and subadults of both sexes were seen as late as 12 June. The first adult males were observed at mid-June; of 30 males caught in pitfall traps in 1967, most appeared between 18 June and 14 July, the final one being taken that year on 19 July. Females appeared a few days after the first males, and mating commenced at once. Females were present until nearly mid-August. A few individuals were reared in the laboratory: first instars from the field or from laboratory hatchings in September molted once monthly from September to December, and a final time before maturity in January or later. The photoperiod used in these cultures was 16 hr of light and eight hr of dark. Only males survived to maturity. Five laboratory matings were observed. The females
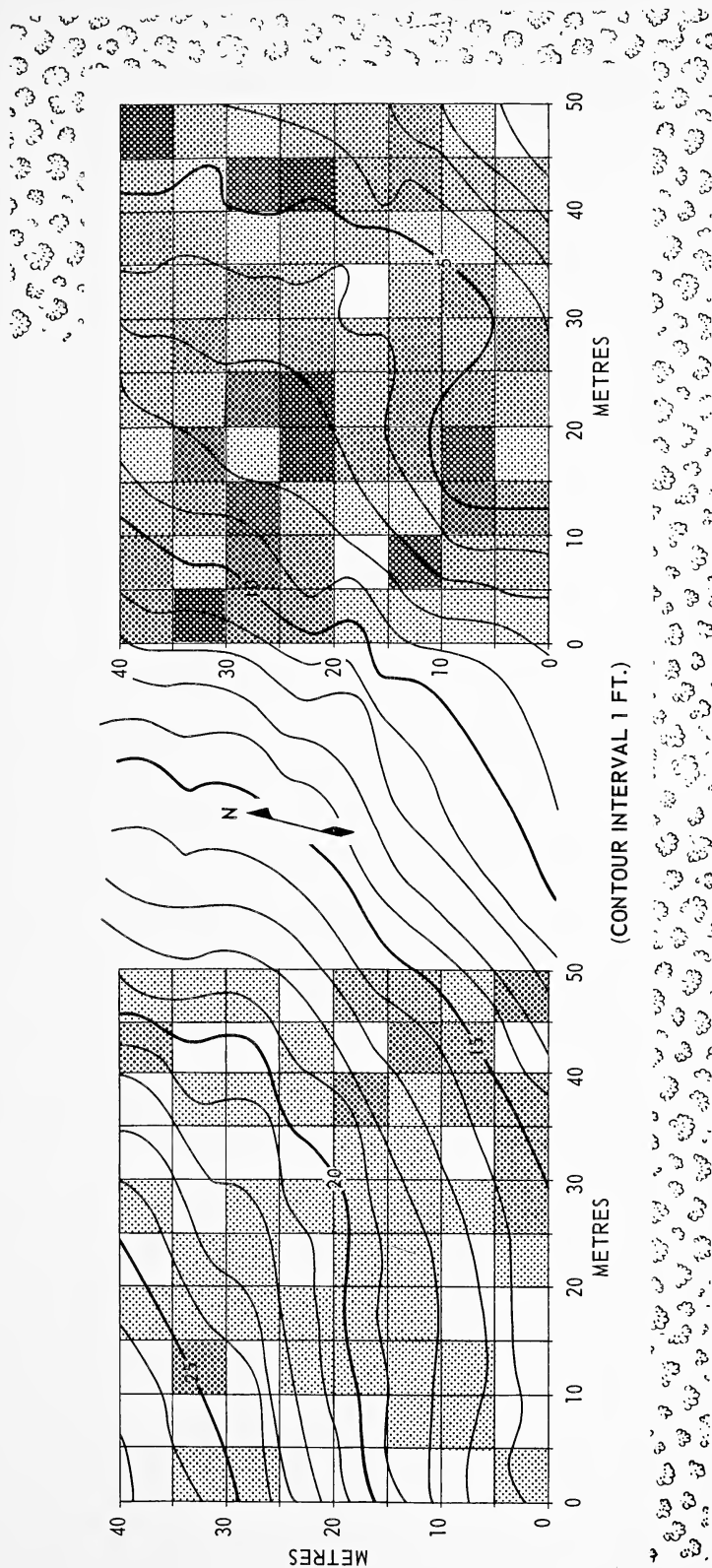
Fig. 6.—Frequency of collection of individuals of *Schizocosa avida* (Walckenaer), 1966-70. Frequency ranged from 0 (no stippling) to 17 (densest stippling) for any 5-m² quadrate.

made one or two egg sacs containing 110 to 176 eggs in the first and about 85 eggs in the second.

Although based on a small and rather variable population, these data indicate an annual life history for *S. heasmani*, with maturity in late spring or early summer.

Both population density and biomass were low (Fig. 1). The species is poorly known biologically owing to this fact and to the recency of its recognition as distinct from *S. avida*. Specimens of these two species are distinguishable only on subtle differences in anatomy, behavior, and ecology (Dondale, 1969). Whereas the majority of captures of *S. avida* (and of *S. crassipalpis*), for example, were made on the relatively moist Plot 2, the majority of captures of *S. heasmani* were made on the dryer Plot 1 (Fig. 7). The physiological mechanism by which this preference is effected has not been investigated.

Schizocosa crassipalpis (Emerton).—Hatching of the eggs of this medium-sized lycosid commenced between early and mid-July and continued till the end of August. The spiderlings attained approximately 50 percent of their mean total growth by the end of September, when growth ceased for the season (Fig. 2). They resumed activity and growth the following April, and large juveniles were seen as late as 11 May. There was then a period of near-zero sightings of these subadults until the appearance of the first mature males about 21 May. Males were present in numbers until mid-June, after which they disappeared rapidly, the last one being seen on 29 June. The first females appeared a few days after the first males, and mating commenced at once. Females were seen until approximately 20 June (in 1967), after which there was a 10-day lull; they then reappeared until 20 July, and a second lull occurred. The last female was sighted that year on 24 August. The periods of low adult activity were associated with oviposition, as in female *S. avida*. Several females were found in shallow nestholes during these times. Females made one or two egg sacs, the first containing 36 to 74 (mean 50) eggs, the second 17 to 43 (mean 26) eggs. *S. crassipalpis* is annual, with maturity and mating in the spring.

Mean annual density of the population of *S. crassipalpis* on the meadow varied from 0.5 to 0.9 per m^2 during the course of the study. In spite of this low density, biomass was relatively high (Fig. 1) owing to the moderately large average size of mature individuals of this species. Found in the Great Lakes region and northern New England, *S. crassipalpis* appears to be a true grassland spider. The meadow population showed the same distribution pattern as that of *S. avida*, but differed from the pattern for *S. heasmani* (Figs. 7, 8). The peak of male activity for *S. crassipalpis* occurred one or two weeks later than that for *S. avida*, and approximately three weeks earlier than for *S. heasmani*.

Xysticus pellax (O. Pickard-Cambridge) and *X. gulosus* Keyserling.—Egg hatch in these thomisids commenced early in June. The juveniles grew rapidly, as indicated by the curve of seasonal biomass (Fig. 1), adults appearing approximately three months later (Fig. 2). In 1967, the year in which most pitfall trapping was done, males of *X. pellax* appeared from 18 August to 26 September, and males of *X. gulosus* from 30 August to 31 October. Females were rarely trapped, those of *X. pellax* appearing from early September to mid-October, and those of *X. gulosus* from late September to late October. Mating occurred in the autumn, and only females of these species were seen the following spring. Females with egg sacs were found deep in the grass litter of the meadow in May and early June. The available data indicate an annual life history, with maturity and mating in late summer or early autumn, and with oviposition the following spring.

Individuals of these two species are extremely similar to each other, and we were able to separate only the adults. Turnbull, Dondale, and Redner (1965) reported that adults of
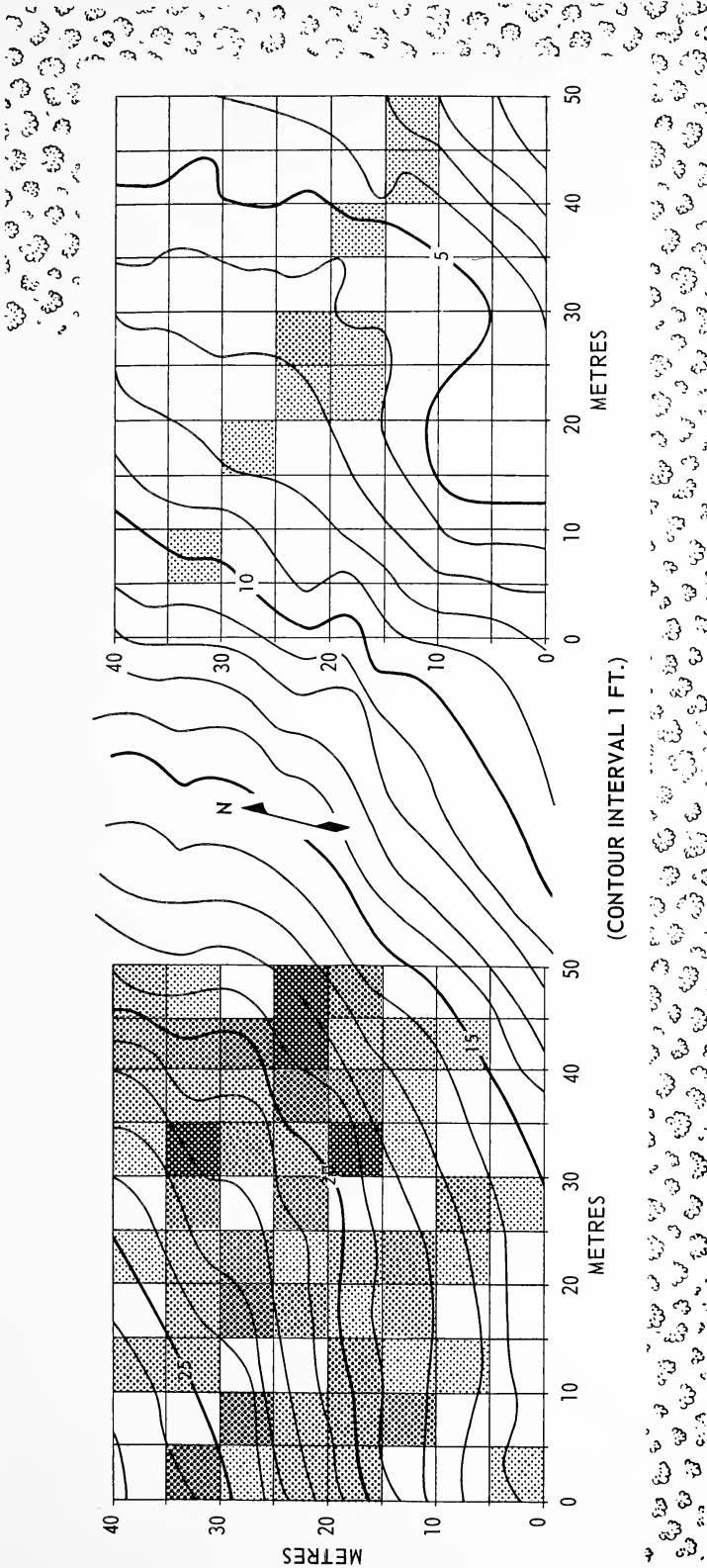
Fig. 7.–Frequency of collection of individuals of *Schizocosa heasmani* Dondale, 1966-70. Frequency ranged from 0 (no stippling) to 12 (densest stippling) for any 5-m² quadrate.
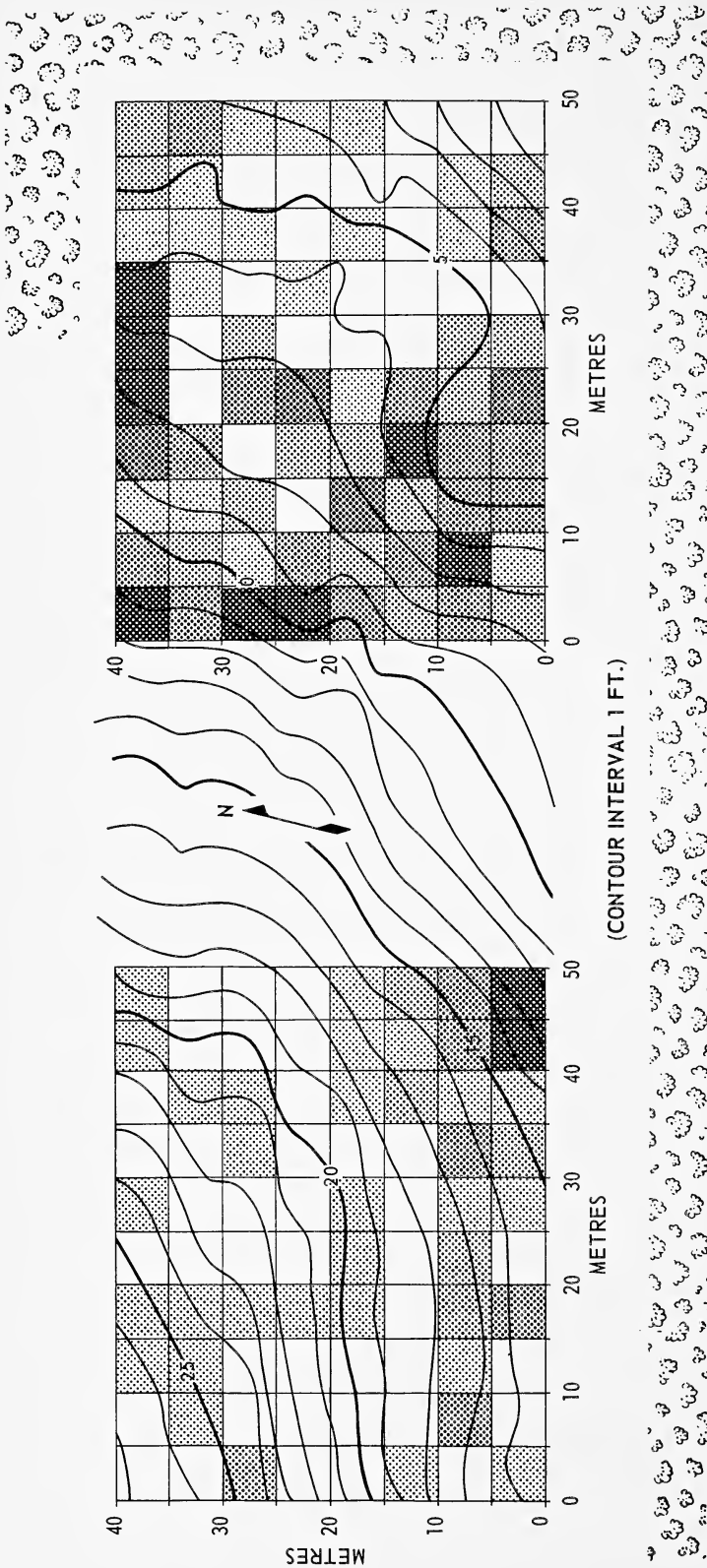
Fig. 8.—Frequency of collection of individuals of *Schizocosa crassipalpis* (Emerton), 1966-70. Frequency ranged from 0 (no stippling) to 19 (densest stippling) for any 5-m² quadrate.
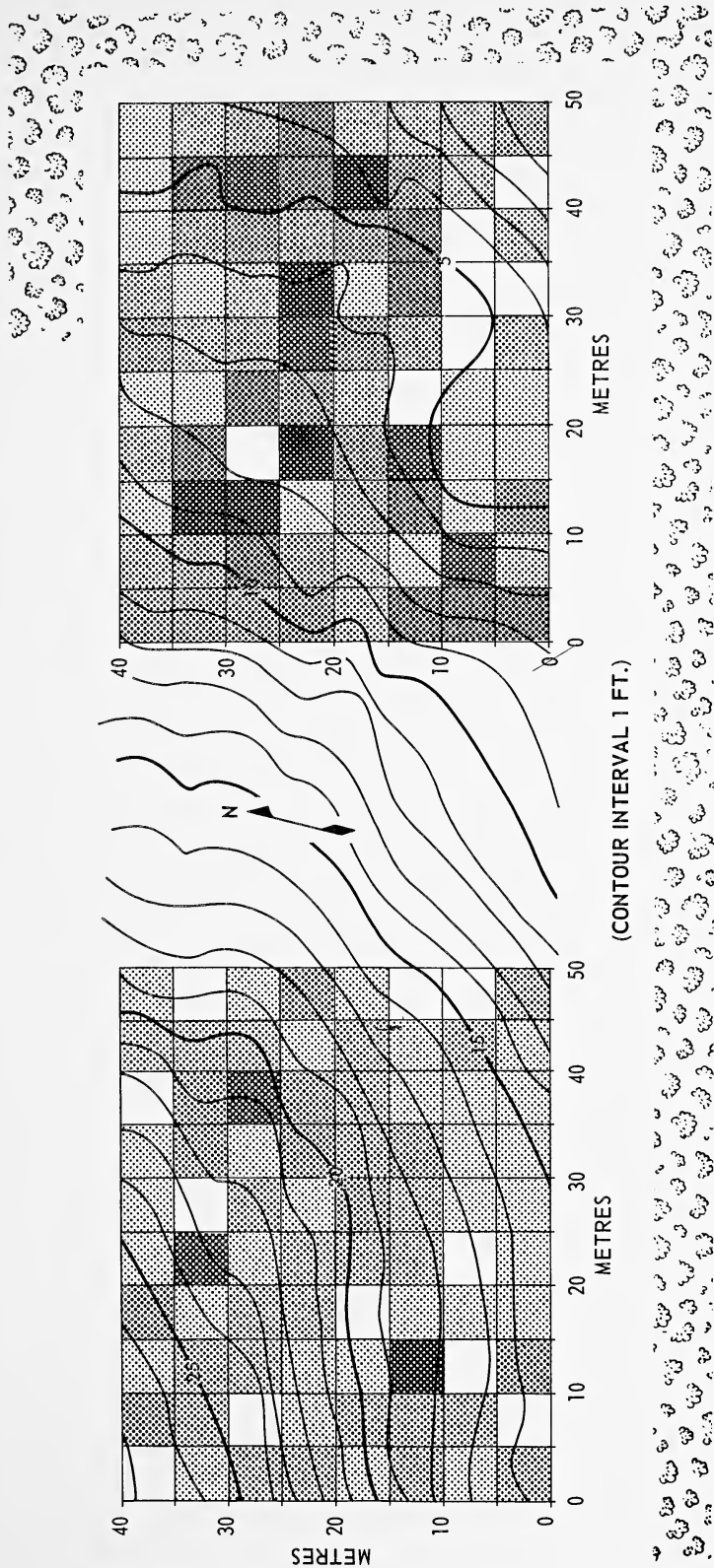
Fig. 9.–Frequency of collection of individuals of *Xysticus pellax/gulosus*, 1966-70. Frequency ranged from 0 (no stippling) to 20 (densest stippling) for any 5-m² quadrate.

X. pellax had only been collected in pitfall traps whereas those of *X. gulosus* were taken on substrates above the ground. This was later refuted, as adults of both species were taken together in pitfall traps (Dondale, 1971; Sauer, 1972). Individuals (both species treated as one) occurred in somewhat greater frequency on Plot 2 than on Plot 1 (Fig. 9).

Both species range from the arid plateaus of northern Mexico to southern Canada (Turnbull, Dondale, and Redner, 1965). It is possible that their life histories reflect adaptation to a brief rainy season followed by a long, dry one such as is found in the southern part of the range. Oviposition there would coincide with the onset of rain, and development of the young and mating would be completed before the dry season began. Mated females would survive the dry season, which, in more northerly latitudes, becomes the cold season.

The combined annual population density of the two species in the meadow was very low, though autumnal biomass was fairly high owing to the population's adult composition (Fig. 1). The sudden decline in biomass during October signified the disappearance of the males. There may also have been winter mortality of females.

Xysticus discursans Keyserling.—Hatching of the eggs of this thomisid commenced in June. The juveniles grew until September, at which time they had attained approximately 40 percent of their mean total growth (Fig. 3). They resumed growth the following May or early June, and had attained the subadult stage by September, when growth again ceased. These subadults became active the following May, and adults appeared during that month, i.e., some 23 months after the spiders of that generation hatched. Males were present from 3 May until 4 July. Females appeared about 12 May, when mating commenced, and were found until October, though most appeared from mid-May to approximately 20 June. Oviposition is presumed to have occurred during late spring.

The five years' collections from the population of *X. discursans* are grouped to show a single generation from hatching to death (Fig. 3), though in fact a new generation hatched, and an older one matured and mated, each spring. Hence there were two subpopulations, separable statistically from each other on mean carapace width, representing two generations in the field throughout autumn, winter, and the early spring; these were (1) the small individuals that hatched during the past year, and (2) subadults that had hatched two years earlier. In the same way, there were three subpopulations representing three generations during the summer months; these were (1) newly hatched spiderlings, (2) the half-grown juveniles that had hatched the previous year, and (3) the parents of the newly hatched. From these facts we can deduce a biennial life history for *X. discursans* in Ontario, with maturity and mating in the spring.

The population of *X. discursans* was consistently low in the meadow (Fig. 1), averaging 1.1 individuals per m² or less annually, and most captures were from Plot 2 (Fig. 10). The species ranges widely in North America, and its habitat appears to be grassland and open woodland (Turnbull, Dondale, and Redner, 1965).

Lycosa frondicola Emerton.—Hatching in this medium-sized lycosid began in June. The young spiderlings grew until early September, at which time they had attained approximately 40 percent of mean total growth (Fig. 3). They resumed activity and growth the following spring and matured in August of that year. Adult males were found from 30 July through late summer and autumn, and again the following April, May, and June, the greatest numbers appearing during the last week of April and the first week of May. Adult females appeared from early August through late summer and autumn, and again from April to early July. The mating period was not determined precisely, though it is presumed to have occurred during the period of peak male activity. One mating took
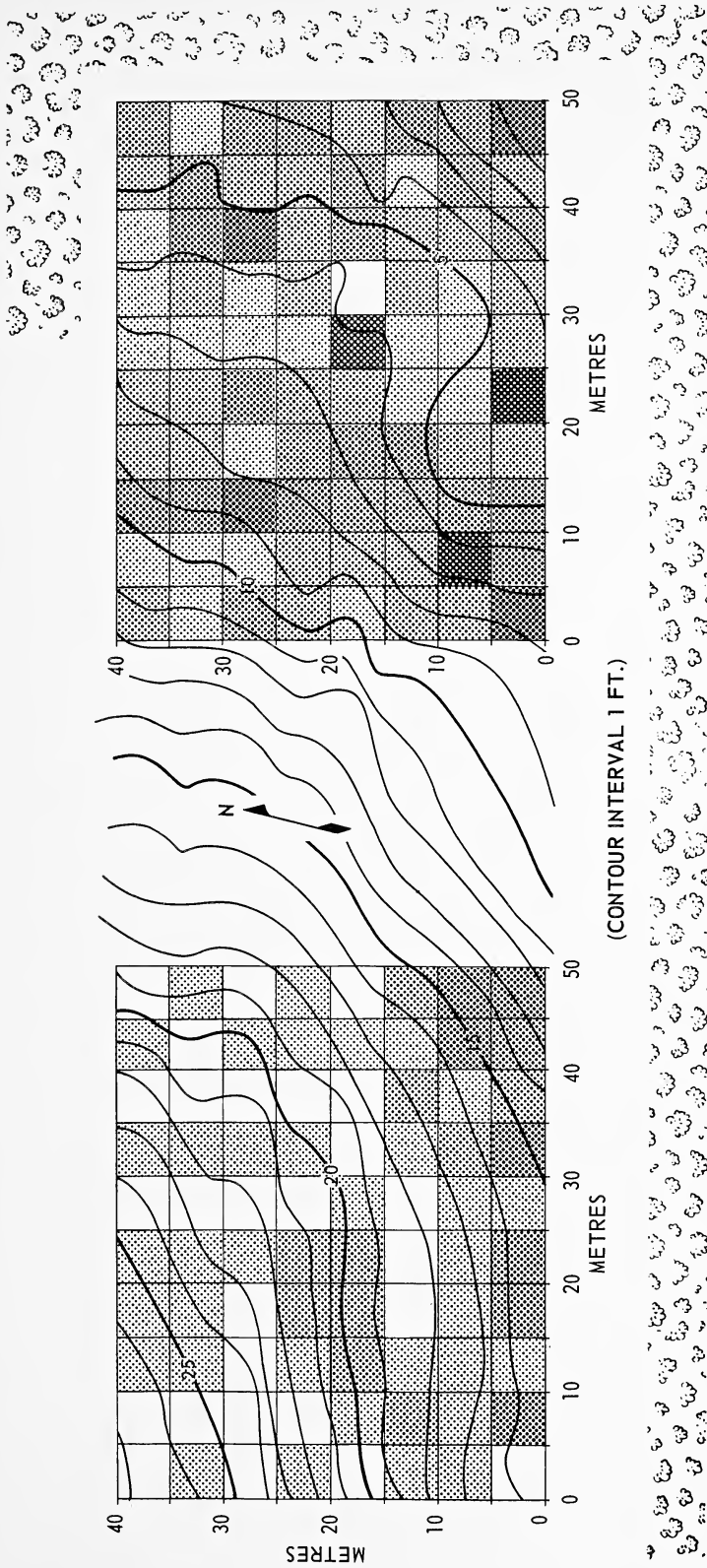
Fig. 10.–Frequency of collection of individuals of *Xysticus discursans* Keyserling, 1966-70. Frequency ranged from 0 (no stippling) to 21 (densest stippling) for any 5-m² quadrate.

place in the laboratory in December, under a 16 hr photoperiod. Gravid females were found in shallow nestholes in the ground in early May, and females with newly-hatched young on their backs were seen during the third week of June. A single egg sac was opened on 16 June and was found to contain 97 eggs.

The meadow population of *L. frondicola* fell into two size groups, which indicated two different generations, in the field during autumn, winter, and early spring. These were (1) half-grown juveniles that had hatched the previous spring, and (2) adults that had hatched two years previous. Similarly, there were three generations during the summer. One generation matured and reproduced each year. These facts indicate a biennial life history for *L. frondicola* in Ontario, with maturity occurring in late summer and reproduction the following spring.

Mean annual population density of *L. frondicola* was low during the course of the investigation, though the adults produced strong peaks of biomass in autumn and spring, particularly on Plot 1 (Fig. 1). The decline in biomass just before winter suggests that the adults vacated the meadow for other wintering sites, returning early the following spring. It was suspected that adults were restricting their activity to the southern and eastern margins of the meadow near the forest edge whereas the young were more randomly distributed. The cumulative collections confirmed this (Figs. 11, 12). Such spatial separation between adults and young may confer a survival advantage on the population of *L. frondicola*, though this is partly speculation until more fully investigated.

L. frondicola ranges from the Rocky Mountains to eastern Canada and New England. It occupies both grassland and open woodland, and mature individuals may spend time in both kinds of habitat.

DISCUSSION

The literature dealing with the life histories of hunting spiders in temperate latitudes indicates that in many species hatching, development to maturity, and reproduction are accomplished in approximately one year. In this category belong the lycosids *Pardosa lugubris* (Walckenaer) (Edgar, 1972), *P. ramulosa* (McCook) (Yeargan, 1974), and *Pirata subpiraticus* (Boesenberg and Strand) (Hamamura, 1971), and the salticid *Metaphidippus protervus* (Walckenaer) (Dondale, 1961). It should be noted, however, that temperature regimes can influence this; in *P. lugubris*, part of the Dutch population requires two years to reach maturity rather than one (Edgar, 1972), and in Scotland, where summers are brief and cool, the population of *P. lugubris* is completely biennial (Edgar, 1971a, 1971b). Other examples of this temperature effect are found in the philodromid genus *Philodromus* (Dondale, 1961; Putman, 1967; Almquist, 1969), as well as in several other families (Almquist, 1969). *Pardosa pseudoannulata* (Boesenberg and Strand), on the other hand, is said to have two or more generations per year in Japan, and to be capable of continuous development in greenhouse cultures (Kawahara, Kiritani, and Kakiya, 1974).

It is among the species of lycosids of which the individuals grow to medium or large size that we often find an apparently consistent biennial life history. Individuals of *Tarentula kochi* Keyserling, for example, hatch in the spring, reach sixth instar by the first autumn of life, and mature the succeeding autumn, in California (Hagstrum, 1970). Essentially the same pattern occurs among species of *Trochosa* (Hackman, 1954; Engelhardt, 1964) and of *Geolycosa* (Kurata, 1939; Wallace, 1942; McCrone, 1965). McCrone (1965) points out that in some parts of Florida the population of *Geolycosa patellonigra* Wallace mates in the spring, in other parts in the autumn, and in a few others in either
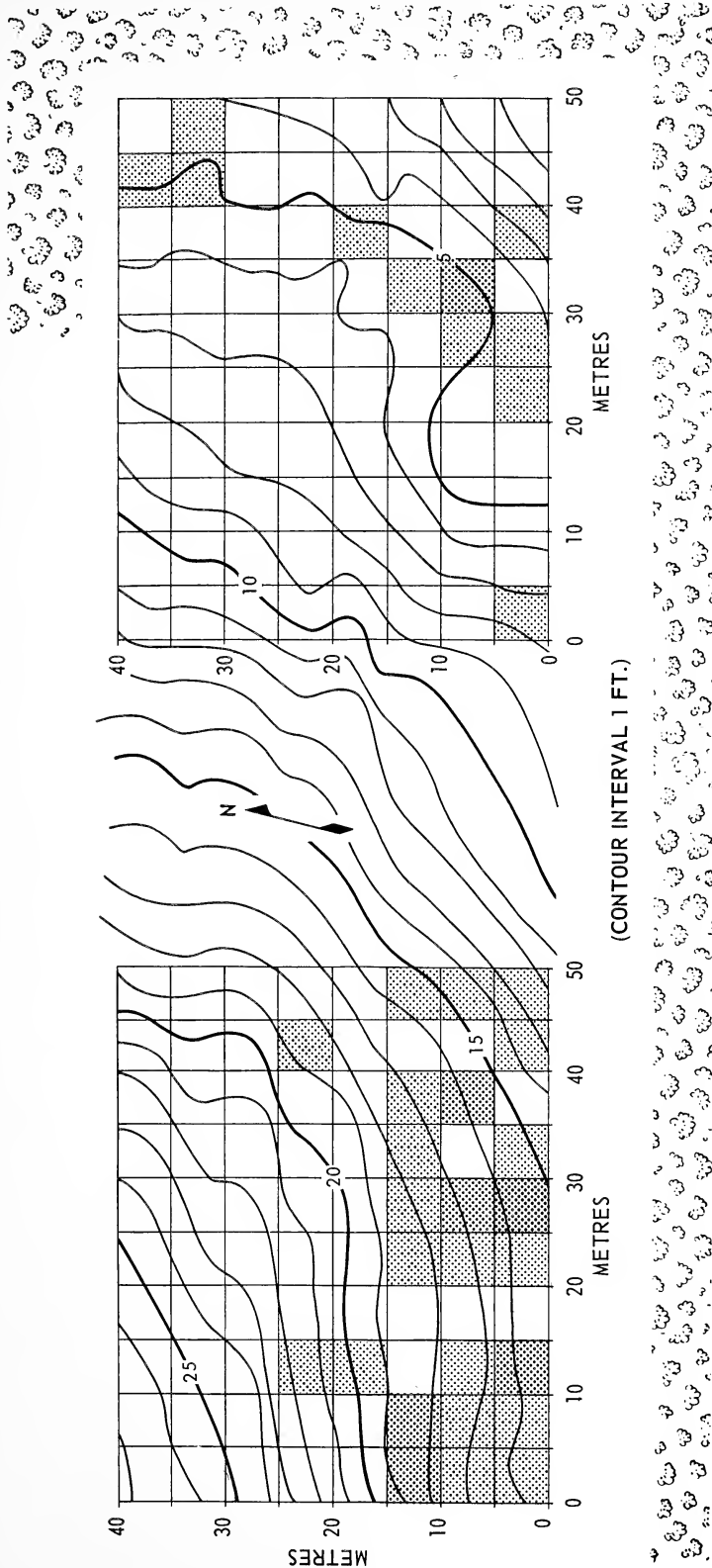
Fig. 11.—Frequency of collection of adults of *Lycosa frondicola* Emerton, 1966-70. Frequency ranged from 0 (no stippling) to 5 (densest stippling) for any 5-m² quadrate.

time of year, according to individual. McCrone was unable to separate the seasonal forms on any anatomical characters. Eason and Whitcomb's (1965) claim that *Lycosa rabida* Walckenaer and *L. punctulata* Hentz are annuals needs supportive field data.

The Ontario populations studied by us are either annual (*Pardosa saxatilis, Pirata minutus, Schizocosa avida, S. heasmani, S. crassipalpis, Xysticus pellax, X. gulosus*) or biennial (*X. discursans, Lycosa frondicola*). In most of them, maturation, mating, and oviposition occur in spring, though *X. pellax* and *X. gulosus* mature and mate in late summer or autumn and oviposit the following spring, and *L. frondicola* matures in late summer and mates (probably) and oviposits the following spring. It appears, then, that hunting spiders are generally either annual or biennial according to species, with some modification by temperature, and that within both categories there may be spring or autumn maturity. In autumn maturing species, either annual or biennial, mating may occur in autumn or spring, but oviposition is always delayed until spring.

The seasonal separation of maturity times permits greater species diversity in a given habitat, as interaction between coexisting populations would decrease survival. Differences in diel activity periodicities among populations, and among the stages of a single population, can further reduce the possibility of destructive interactions (Dondale, Redner, and Semple, 1972). The separation of peak mating times by a few weeks in *X. pellax* and *X. gulosus* and in the three species of *Schizocosa* coexisting in the meadow suggest that survival is promoted when interaction is minimized, particularly at mating time.

Species diversity may also be promoted by the occupation of different microhabitats by different populations within a single habitat. Kuenzler (1958) suggested that *Lycosa rabida* is separated from the sympatric *L. timuqua* Wallace and *L. carolinensis* Walckenaer by the acrobatic shrub foraging of *L. rabida* and the small home ranges of *L. timuqua* and *L. carolinensis*, both of the latter being burrowers. Vlijm and Kessler-Geschiere (1967) studied the spatial factors that separate three coexisting populations of *Pardosa*: *P. pullata* (Clerck) was most abundantly represented on damp, vegetated ground, *P. nigriceps* (Thorell) was dominant in the plant layer, and *P. monticola* (Clerck) was virtually restricted to dry, bare ground. Richter, Hollander, and Vlijm (1971), working with populations of *P. pullata* and *P. prativaga* (L. Koch), individuals of which are extremely similar and which are even believed to interbreed to some extent in nature, found that the populations tended to restrict their activities respectively to open grassland and to "transition areas." There were additional differences in courtship, rate of development, longevity, and in the ability to disperse on wind currents. Hallander (1970) similarly found that individuals of *P. pullata* showed affinity for short grass, sphagnum, or open marshes where the relative humidity was 90 to 100 percent and temperatures fairly cool, whereas individuals of the sympatric *P. lugubris* preferred leaf litter where the relative humidity was 60 to 90 percent and temperatures warmer. Duffey (1962) reported a partial difference in the vertical strata occupied by individuals of *P. pullata* and *P. nigriceps*, the former close to the ground and the latter several centimetres above ground level. Edgar (1971b) described a series of spatial (and temporal) adaptations among the stages of *P. lugubris* whereby movement between the woodland perimeter and adjacent grassy clearings apparently reduced the possibility of cannibalism.

Vogel (1972a) described a series of "habitat mosaics" in the mountains of Colorado in which populations of seven species of *Pardosa*, each representing a different species group, develop and move about, showing for the most part slight preferences for different levels of moisture or altitude, or of time of adult appearance. She also studied three other
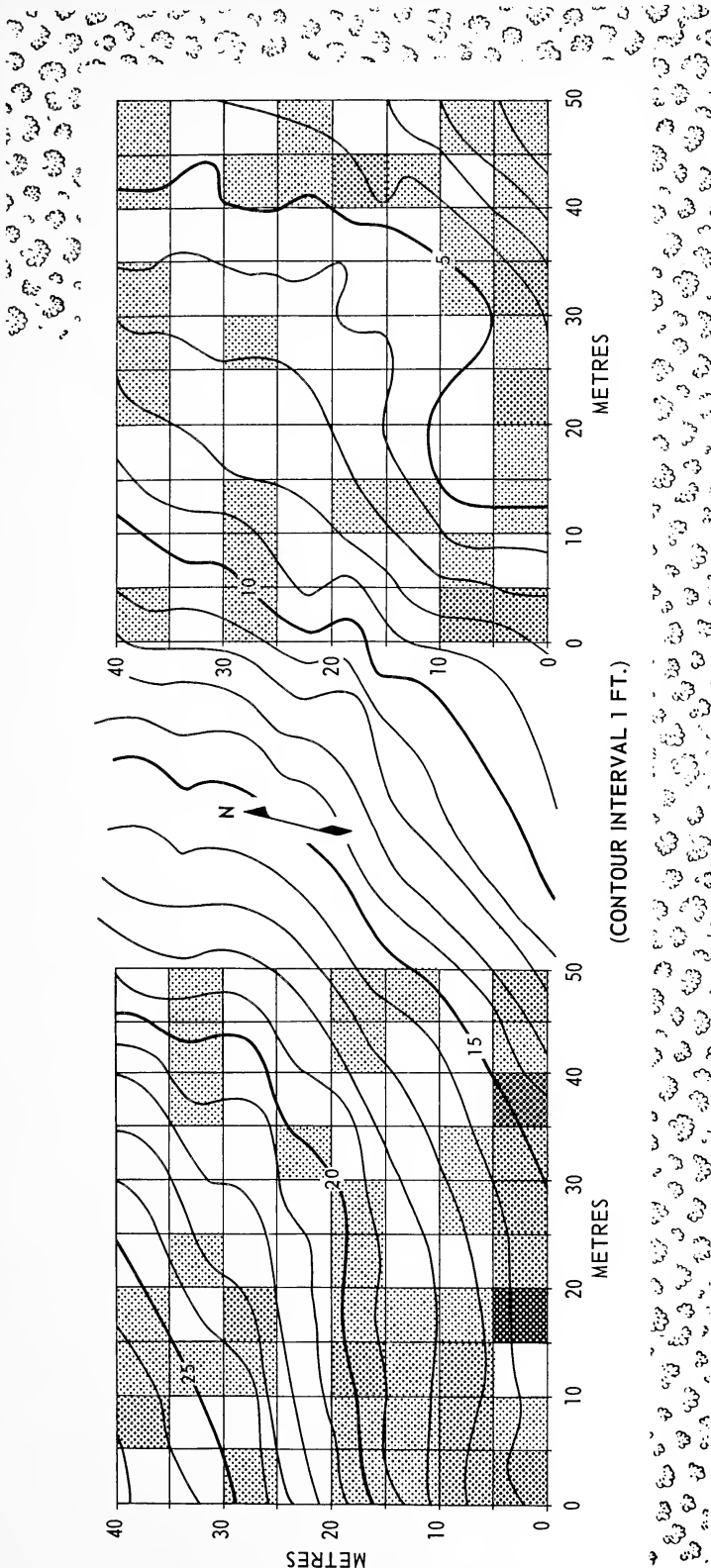
Fig. 12.—Frequency of collection of juveniles of *Lycosa frondicola* Emerton, 1966-70. Frequency ranged from 0 (no stippling) to 15 (densest stippling) for any 5-m² quadrate.

species of *Pardosa*, populations of which coexist in dry, grassy hillsides. These were more puzzling, however, and no separating factors were identified; moreover, the three were members of a single species group. In a second study, Vogel (1972b) found that the amount of cover afforded by grass or fallen leaves apparently determined which of two species of *Pardosa* was the more abundantly represented in a particular area. Rich plant cover was associated with the presence of individuals of *P. falcifera* F. Pickard-Cambridge, poor cover with those of *P. sternalis* (Thorell), and intermediate cover with individuals of both species in varying proporations.

The spatially separating factors that we have deduced for various hunting spiders in the present study are of the same kinds as those just reviewed. The species pair *Schizocosa avida* and *S. heasmani* affords the best example: the majority of individuals of *S. avida* were caught on Plot 2, where the soil was moist and the plant cover relatively thick and diverse, whereas the majority of individuals of *S. heasmani* were caught on Plot 1, where the soil was sandy and dry, and the plant cover sparser and more simple. The preference of adults of *Lycosa frondicola* for the edge of the meadow close to the forest, in contrast with the juveniles, which were taken more randomly on the meadow, is equally interesting and invites further investigation.

ACKNOWLEDGMENTS

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TAXONOMIC OBSERVATIONS ON *HETERONEBO* POCOCK (SCORPIONIDA, DIPLOCENTRIDAE)

Oscar F. Francke[1]

Department of Zoology
Arizona State University
Tempe, Arizona 85281

ABSTRACT

Heteronebo granti Pocock, and *Heteronebo forbesii* Pocock are redescribed and lectotypes designated. The two subfamilies of Diplocentridae are recognized, and briefly diagnosed polythetically for the first time: Nebinae is monotypic, and apparently endemic to the Middle East; Diplocentrinae is polytypic, and apparently confined to the New World, with the exception of *Heteronebo* which is endemic to the small island of Abd-el-Kuri, Peoples Democratic Republic of Yemen. Taxonomic, systematic, and biogeographic problems presented by *Heteronebo* spp. are discussed.

INTRODUCTION

The genus *Heteronebo* was established by Pocock (1899) for two new species of diplocentrid scorpions presumably collected by the British Expedition to Sokotra and Abd-el-Kuri, led by Mr. W. R. O. Grant and Mr. H. O. Forbes in 1898. Pocock characterized the new genus as being intermediate between two other diplocentrid genera then known, *Nebo* (Simon, 1878) and *Diplocentrus* (Peters, 1861); giving brief descriptions of *Heteronebo granti* Pocock and *Heteronebo forbesii* Pocock, which are supposedly endemic to the small island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden (Fig. 18). Subsequently, Pocock (1903) gave more detailed descriptions and a short key, clearly establishing that *Heteronebo* contains two valid species. However, Werner (1934) wrongly indicated that *Heteronebo* is monotypic, and gave Sokotra as the type locality. Rosin and Shulov (1963) following Werner made similar assertions.

Heteronebo is still only known from the original specimens examined by Pocock, and although his descriptions were adequate then, many other valuable taxonomic characters have been found since. Therefore, a redescription of the two species of *Heteronebo* has become necessary in order to clear the confusion existing in the literature, and to obtain some indication of the systematic position of this genus within the family Diplocentridae.

[1]Present Address: Departments of Biological Sciences and Entomology, Texas Tech University, Lubbock, Texas 79409

Heteronebo Pocock, 1899

Heteronebo Pocock 1899, Liverpool. Mus. Bull. 2:7-8; Pocock 1903, "Scorpiones" in H.
   O. Forbes (Ed.) "The Natural History of Sokotra and Abd-el-Kuri," pp. 202-204;
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   and Shulov 1963, Proc. Zool. Soc. London 140(4):548.

Diagnosis.—Carapace: median longitudinal furrow distinct, not suturiform: anteriorly
lobed, emarginate; median notch rounded, moderately deep: three pairs of lateral eyes.
Sternum pentagonal. Genital operculi: in male without median longitudinal membranous
connection; in female with complete, median longitudinal membranous connection.
Genital papillae present on male, absent on female. Metasomal segments I-IV with paired,
longitudinal ventral submedian carinae. Metasomal segment V with single, longitudinal
ventral median carina; ventral transverse keel absent, distal disc obsolete. Vesicle globose;
subaculear tubercle well developed, broadly joined to vesicle. Cheliceral dentition typical
diplocentrid (Fig. 7) (Vachon, 1963). Pedipalp orthobothriotaxia "C" (Vachon, 1974).
Walking legs with exterior pedal spur present. Tarsomere II: distal ventral margins rectan-
gular to slightly acutely angular, not lobed; ventrally two longitudinal submedian rows of
strongly developed spines, distal spine directed ventrad rather than apically.
   Type species.—*Heteronebo granti* Pocock, 1899.
   Other species.—*Heteronebo forbesii* Pocock, 1899.

Heteronebo granti Pocock
Figs. 1-7, 13

Heteronebo granti Pocock 1899, Liverpool Mus. Bull. 2:7-8; Pocock 1903, "Scorpiones"
   in H. O. Forbes (Ed.) "The Natural History of Sokotra and Abd-el-Kuri," pp. 202-203;
   Werner 1934, "Scorpiones" in H. G. Bronn (Ed.) "Klassen und Ordnungen des
   Tierreichs," Bd. 5, Abt. 4, Buch 8, p. 275; Rosin and Shulov 1963, Proc. Zool. Soc.
   London 140(4):548.

Diagnosis.—This species is only known from two immature females, any diagnosis
based on them alone is meaningless.
   Lectotype.—Female, immature (measurements in Table 1). New designation.
   Description.—*Prosoma.* Carapace ochreous; median and lateral eyes densely infuscate;
surface fuscosity diffuse, variegated. Anterior emargination moderate; median notch
rounded, approximately three times wider than deep, extending to level of first pair of
lateral eyes. Anterior median furrow: submarginally shallow, broad; at base of ocular
prominence vestigial. Median ocular prominence moderate; longitudinally feebly concave
medially, superciliary ridges obsolete. Median eyes at anterior two-fifths of carapace
length, separated by approximately their own diameter. Posterior median furrow:
proximal three-fourths (immediately posterior to ocular prominence) shallow, moderately
wide; distal one-fourth abruptly deeper into narrow longitudinal slit. Posterior marginal
furrow moderately deep. Posterior lateral furrows originating at submedian one-third of
posterior carapace width, arcuate; distal one-third moderately deep; proximal two-thirds
strongly divergent, ending gradually at lateral one-fifth of posterior carapace width. Cara-
pace surface: anterior submargin smooth, bare; laterad to ocular prominence smooth;
lateral submargins with moderately dense, minute granulation. Left lateral margin with

Table 1.—Measurements (mm) of *Heteronebo granti* Pocock.

		Lectotype ♀	Paralectotype
Total length		44.05	35.20
Carapace:	length	5.70	4.80
	anterior width	3.20	2.65
	width at median eyes	4.70	4.00
	posterior width	5.70	4.95
Mesosoma:	length	15.50	12.25
Metasoma:	length	22.85	18.25
I:	length	2.70	2.25
	width	3.20	2.50
II:	length	3.00	2.40
	width	2.90	2.40
III:	length	3.10	2.50
	width	2.80	2.30
IV:	length	3.65	2.90
	width	2.70	2.25
V:	length	5.20	4.10
	width	2.65	2.20
Telson:	length	5.20	4.10
Vesicle:	length	4.20	3.30
	width	2.80	2.10
	depth	1.95	1.60
Aculeus:	length	1.00	0.80
Pedipalp:	length	17.90	14.85
Humerus:	length	4.20	3.50
	width	2.00	1.65
	depth	1.80	1.30
Brachium:	length	4.30	3.60
	width	2.10	1.60
Chela:	length	9.40	7.75
	width	4.50	3.30
	depth	3.10	2.30
Movable finger length		5.50	4.50
Fixed finger length		4.10	3.45
Chelicera:	chela length	1.80	
	chela width	1.20	
	fixed finger length	0.80	
	movable finger length	1.50	
Pectinal teeth		8-8	8-8

semicircular "scar" behind lateral eyes. Prosomal venter ochroleucus, vestigially hirsute. Sternum pentagonal; posterior submargin with two short, slightly divergent, deep furrows.

Mesosoma.—Tergites ochreous to ochroleucus; tergites I-VI anterior submarginal fuscosity diffuse, uniform; tergite VII fuscosity diffuse, variegated, density increasing distally. Tergites I-VI smooth. Tergite VII four-keeled: submedian carinae on distal one-fifth, moderately strong, subgranulose; lateral carinae on distal one-third, strong, subgranulose: median intercarina smooth; submedian and lateral intercarinal granulation minute, moderately dense. Mesosomal venter ochroleucus. Genital operculi paraboloid, median margins connected by short membrane throughout their length ("fused" *auct.*).

Pectinal basal piece approximately 1.6 times wider than long; anterior margin weakly bilobed, median notch shallow and broad. Pectines whitish: marginal lamellae anterior margins sparsely hirsute; middle lamellae bare, indistinct, 3-4 per side; fulcra subtriangular; pectinal tooth count 8-8, each tooth slightly less than twice longer than wide. Sternite margins and discs bare; stigmata small (approximately 0.3 mm long), thrice longer than wide. Sternite VII: submedian carinae obsolete; lateral carinae vestigial to obsolete, smooth; intercarinae smooth.

Metasoma.—Ochreous: intercarinal fuscosity moderate to dense, variegated; carinae uniformly fuscous; fuscosity density and extent increase distally between and within segments. Dorsally bare; laterally, ventrally sparsely hirsute along keels. Ventral submedian carinae (V_{sm}): I-II obsolete; III-IV vestigial, smooth, parallel. Ventral lateral carinae (V_l): I weak to moderate, smooth, parallel; II-III weak, smooth, slightly divergent distally; IV weak to moderate, subgranose, moderately divergent distally. Lateral inframedian carinae (L_{im}): I weak to moderate, smooth, complete; II weak to vestigial, smooth; III vestigial, smooth; IV obsolete. Lateral supramedian carinae (L_{sm}): I-III moderately strong, smooth, ending distally in sharp point; IV moderately strong, smooth, ending gradually. Dorsal lateral carinae (D_l): I-II weak, smooth, ending distally in sharp angle; III weak, subcrenate, ending in sharp angle; IV weak, smooth, ending in sharp angle. Segment V carinae: ventral median (V_m) strong, granulose, bifurcate distally and not reaching anal arc (Fig. 13); ventral lateral (V_l) strong, granulose; lateral median (L_m) on proximal half, vestigial, subgranose; dorsal lateral (D_l) moderately strong, subgranose; anal subterminal (A_{st}) moderately strong, with 14 small oblong granules; anal terminal (A_t) weak, subdentate. Intercarinae: dorsal I-V and lateral IV-V minute granules sparse to moderately dense, others smooth.

Telson densely infuscate, paired lateral-subdorsal and ventral-submedian narrow longitudinal ochreous bands. Dorsally bare, smooth, feebly convex. Laterally and ventrally sparsely hirsute; granules small, sparse; ventral submarginal clusters of 3-2-3 small to medium granules. Subacular tubercle strong, rounded; erect, white microchaetae moderately dense. Aculeus dark brown, sharply curved.

Chelicera.—Chela and fingers ochroleucus, teeth medium brown. Ventral surfaces densely covered with long, anteriorly depressed, distally curved white hairs (chemoreceptors?). Chela width/chela length ratio 0.66. Fixed finger moderately curved distally, dentition typically diplocentrid (Fig. 7); fixed finger length/chela length ratio 0.44. Movable finger dentition typically diplocentrid (Fig. 7), inferior tine slightly over twice longer than superior tine; movable finger length/chela length ratio 0.83.

Pedipalps.—Humerus ochreous; fuscosity sparse to moderate, variegated: sparsely hirsute. Longer than metasomal segment IV; slightly wider than deep, humerus width/humerus depth ratio 1.11. Dorsal internal carina weak, coarsely granulose. Dorsal external carina: proximal one-third strong, granulose; distal two-thirds moderately strong, granules small. Ventral internal carina strong, coarsely granulose, curving dorsad distally. Ventral external keel: proximal one-fifth weak, subgranose; distal four-fifths vestigial to obsolete. Dorsal face flat, basally with poorly defined longitudinal row of large and medium granules. Internal face flat, minute granules dense. External face longitudinally and transversely convex; median longitudinal keel on distal two-thirds, weak, smooth. Ventral face longitudinally concave, inner margin weakly granulose. Orthobothriotaxia "C": **e** dorsally at proximal one-third of humeral length; **d** externally at proximal one-tenth of humeral length; **i** at dorso-proximal corner of internal face.
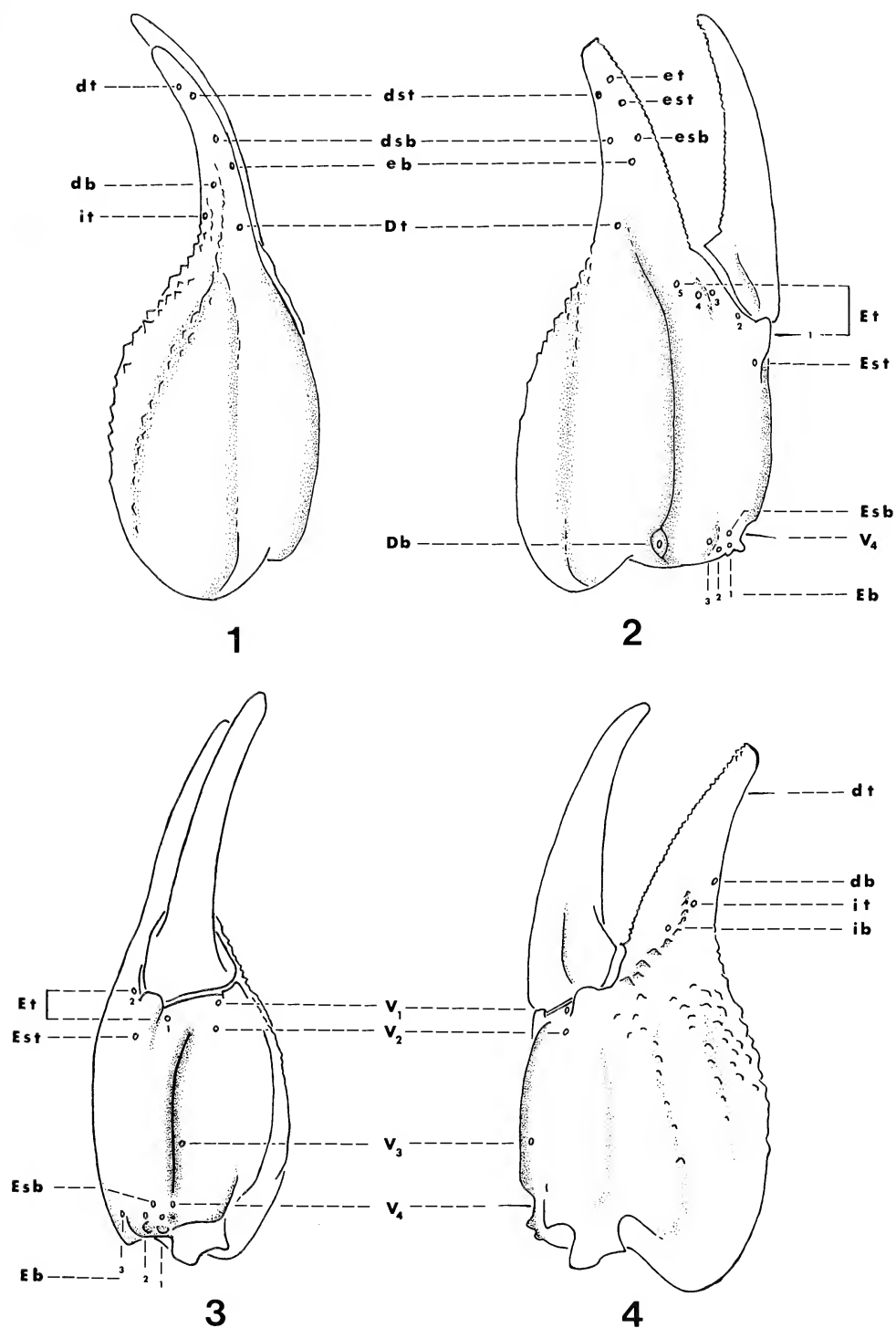
Figs. 1-4.—*Heteronebo granti* Pocock, lectotype female from the island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden. Trichobothria on right pedipalp chela: 1, dorsal; 2, external; 3, ventral; 4, internal.

Brachium subtriangular in cross-section, sparsely hirsute, orthobothriotaxia "C" (Figs. 5-6). Ochreous; internal and carinal fuscosity moderately dense, variegated. Dorsal keel strong, smooth. Ventral internal carina moderately strong, smooth. Ventral external keel strong, smooth. Internal face densely, minutely granulose. External face smooth; two longitudinal, weak to vestigial carinae. Ventral face flat, smooth.

Chela light to medium brown; intercarinal fuscosity diffuse, variegated; carinal fuscosity dense, uniform; fingers fuscosity moderately dense, uniform. Orthobothriotaxia "C" (Figs. 1-4). Dorsal margin weakly to vestigially carinate, small granules extending to fixed finger base. Digital keel very strong, smooth, extending through fixed finger base. Ventral carina strong, smooth; subbasally interrupted by trichobothrium V_4 (Fig. 3); directed towards midpoint of movable finger articulation. Dorsal secondary keel weak, smooth; merging with dorsal marginal granules at fixed finger base. External secondary keel basally and distally weak to vestigial, medially obsolete. Dorsal face (dorsal margin to digital keel) smooth, bare. External face (digital keel to ventral keel) smooth, bare. Internal face smooth, dorsal submargin sparsely granulose: shallow longitudinal depression where chela flexes against brachium; dorsal margin of depression subcarinate, feebly granulose. Fixed finger base: externally minutely granulose: internal face granulation minute, dense; longitudinal row of medium sized granules extending from internal condyle of movable finger articulation to trichobothrium **it** (Fig. 4). Fixed finger sparsely hirsute; inner margin moderately, evenly arcuate. Movable finger sparsely hirsute; feebly, sparsely punctate.

Walking legs.—Ochroleucus. Femora II-IV dorsal margins vestigially granulose. Femora I-IV ventral margins feebly granulose. Tarsomere II spine formula: 5/5 4/5 : 6/6 5/6 : 6/6 6/6 : 5/7 6/6 (anteriormost pair of legs first, right leg first, anterior spine count/posterior spine count).

Paralectotype.—Female, immature (measurements in Table 1). New designation.

Does not differ significantly from lectotype. Fuscosity overall not as dense, but still distinctive. Tarsomere II spine formula: 5/5 5/5 : 5/6 6/6 : */* 6/6 : 6/6 6/6 (* tarsomere II missing on that leg).

Type data.—Lectotype and paralectotype collected at Abd-el-Kuri (800 - 1500 ft.), Peoples Democratic Republic of Yemen, 5 December 1898 (W. R. O. Grant and H. O. Forbes). Deposited in the British Museum (Natural History), London.

Remarks.—In the original description Pocock (1899) mentions that two females (syntypes) were studied by him, and gives the type locality simply as Abd-el-Kuri. Subsequently, Pocock (1903) gives the type locality as: Abd-el-Kuri, Gebel Saleh (800 - 1500 ft.), and quotes a note from Mr. Grant indicating that the two specimens were collected under rocks at an elevation of "about 1000 ft."

I received from the British Museum the two specimens described above, neither of which appears to be mature. One of the syntypes has been labelled as a lectotype by H. L. Stahnke; however, this designation is not valid since it has not been published [International Code of Zoological Nomenclature, Art. 74 (a) (i)]. Pocock's description seems to be based on the larger specimen, which is the one I have designated and labelled as the lectotype. The smaller specimen has been designated and labelled as a paralectotype.

Distribution.—This species is known only from the two specimens mentioned, and is apparently endemic to the small island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance of the Gulf of Aden (Fig. 18).
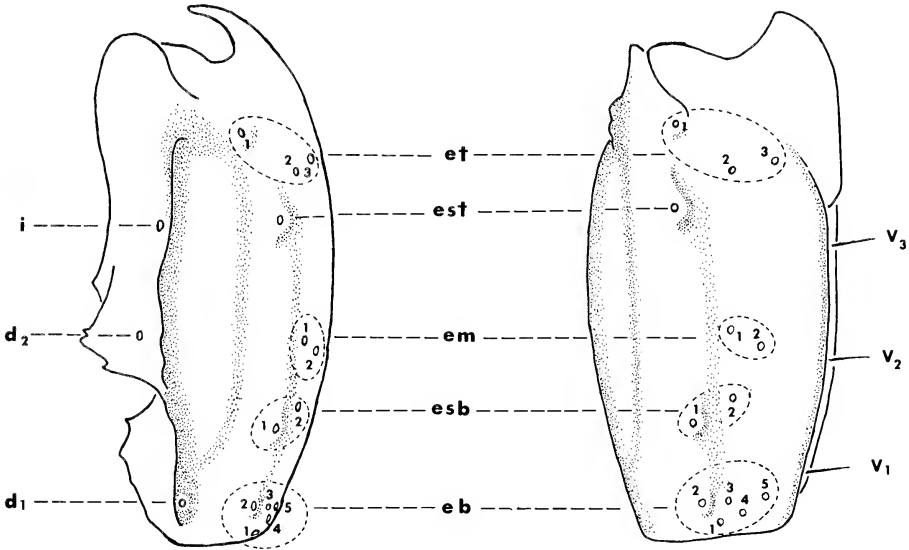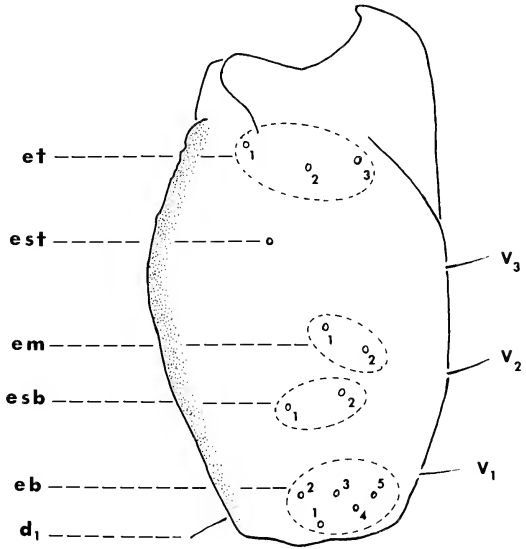
Figs. 5-7.—*Heteronebo granti* Pocock, lectotype female from the island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden. Trichobothria on right pedipalp brachium: 5, dorsal; 6, external. Chelicera; 7, dorsal.

Fig. 8.—*Heteronebo forbesii* Pocock, lectotype female from Abd-el-Kuri. Trichobothria on right pedipalp brachium, external.

Heteronebo forbesii Pocock
Figs. 8-12, 14, 15

Heteronebo forbesii Pocock 1899, Liverpool Mus. Bull. 2:8; Pocock 1903, "Scorpiones" in H. O. Forbes (Ed.) "The Natural History of Sokotra and Abd-el-Kuri," p. 203.

Diagnosis.—This species is only known from three immature specimens, any diagnosis based on them is probably meaningless.

Lectotype.—Female, immature (measurements in Table 2). New designation.

Description.—*Prosoma.* Carapace ochreous: median and lateral eyes densely fuscous; anterior submarginal fuscosity moderately dense, with sparse, light colored maculations; fuscosity surrounding ocular prominence sparse to moderately dense, uniform; other carapacial areas with vestigial, reticular fuscosity. Anterior emargination moderate; median notch rounded, approximately 2.5 times wider than deep, extending to level of first pair of lateral eyes; lobes with four large, brown setae. Anterior median furrow: submarginal two-fifths vestigial, broad; distally (to anterior base of ocular prominence) moderately deep, wide. Median ocular prominence moderate; weakly sulcate, superciliary ridges weak to vestigial. Median eyes at anterior two-fifths of carapace length, separated by their own diameter. Posterior median furrow: proximal two-thirds moderately deep; distal one-third gradually deeper into narrow longitudinal slit, "lips" of slit meeting medially above furrow proper. Posterior marginal furrow moderately deep. Posterior lateral furrows arcuate, originating at submedian one-third of posterior carapace width; distal one-third moderately deep; proximal two-thirds strongly divergent, moderately deep, ending gradually at lateral submargin. Carapace surface: anterior submargin smooth; microchaetae sparse, creating maculations on fuscous field: laterally smooth; microchaetae sparse, maculations indistinct: postero-laterally densely, minutely granulose. Prosomal venter ochroleucus, macrochaetae sparse. Sternum pentagonal; distal one-fifth with deep, broad, biramous furrow.

Mesosoma.—Tergites ochreous; fuscosity vestigial, variegated. Tergites I-VI minute granulation sparse. Tergite VII four-keeled: submedian carinae on distal one-fifth, weak, smooth; lateral carinae on distal one-fourth, moderate to weak, smooth: intercarinae smooth. Mesosomal venter ochroleucus. Genital operculi paraboloid, median margins connected by short membrane throughout their length. Pectinal basal piece approximately 2.2 times wider than long, anterior margin feebly bilobed. Pectines whitish: marginal lamellae sparsely hirsute; middle lamellae bare, indistinct, 3-4 per side; fulcra subtriangular; pectinal tooth count 8-9, each tooth approximately twice as long as wide. Sternite lateral margins sparsely hirsute, discs bare, smooth; stigmata small, thrice longer than wide. Sternite VII: submedian carinae on distal one-third, vestigial, bifurcate submarginally; lateral carinae on distal one-fourth, vestigial, bifurcate submarginally; intercarinae smooth.

Metasoma.—Ochreous: segments I-II vestigially fuscous: segments III-V; intercarinal distal fuscosity diffuse, variegated; carinae uniformly fuscous; fuscosity density increases distally within segments. Dorsally bare, laterally and ventrally sparsely hirsute along carinae. V_{sm} carinae: I-II weak, smooth, subparallel; III weak to vestigial, smooth; IV vestigial. V_l carinae: I weak, smooth, subparallel; II moderately strong, smooth, feebly biconvex; III-IV weak, smooth, slightly divergent distally. L_{im} carinae: I-II vestigial, III-IV obsolete. L_{sm} carinae: I-II weak, smooth, ending gradually; III-IV moderately strong, smooth, ending gradually. D_l carinae: I-IV vestigial, smooth. Segment V carinae:

V_m moderately strong, basal one-third feebly granulose, distal two-thirds with large sub-conical granules, distal one-third tetrafurcate (vestigial ventral transverse keel?, Fig. 14); V_l carinae moderately strong, basal one-third feebly granular, distal two-thirds coarsely granular; L_m carinae on proximal one-third to one-half, vestigial, subgranose; D_l carinae moderately strong, smooth with small granules on ridge; A_{st} keel well developed, with 13 medium sized oblong granules; A_t keel weak, dentate. Intercarinae smooth.

Telson ochreous; ventral and lateral fuscosity diffuse, uniform. Dorsally bare, smooth, feebly convex. Laterally and ventrally sparsely hirsute, vestigially granulose; ventral sub-marginal clusters of 3-2-3 medium granules. Subacular tubercle strong, rounded; erect, white microchaetae moderately dense. Aculeus dark reddish-brown; ventral margin basally moderately curved, medially shallowly curved, distally moderately curved (developmental anomaly?).

Chelicera.—Chela ochroleucus; fuscosity diffuse to moderate, variegated. Fingers ochreous; basal fuscosity dense, uniform. Teeth medium brown. Ventral surfaces densely covered with long, anteriorly depressed, distally curved white hairs. Chela width/chela length ratio 0.61. Fixed finger moderately curved distally, dentition typically diplocentrid; fixed finger length/chela length ratio 0.47. Movable finger dentition typically diplocentrid, inferior tine slightly less than three times longer than superior tine; movable finger length/chela length ratio 0.92.

Pedipalps.—Humerus ochreous; dorsal and external faces distal fuscosity diffuse, uniform: sparsely hirsute. Slightly shorter than metasomal segment IV; narrower than deep, humerus width/humerus depth ratio 0.88. Dorsal internal carina; proximal one-half indistinct row of small and medium granules; medially curving ventrad, disappearing in granular field on internal face. Dorsal external keel: proximal two-thirds strong, coarsely granulose; distal one-third vestigial to obsolete. Ventral internal carina moderately strong, coarsely granulose; distally curving dorsad. Ventral external keel obsolete. Dorsal face: longitudinally moderately convex; transversely strongly convex, merging with internal face without abrupt angular or carinal division: granulation moderately dense, medium and small. Internal face flat; dorsal granulation moderately dense, medium sized; ventral granulation minute, dense. External face: proximal one-half flat; distal one-half longitudinally, transversely convex. Ventral face longitudinally concave, smooth. Orthobothriotaxia "C": **e** dorsally at proximal one-third of humeral length; **d** externally at proximal one-tenth of humeral length; **i** at dorso-proximal corner of internal face.

Brachium subtriangular in cross-section, sparsely hirsute, orthobothriotaxia "C" (Fig. 8). Ochreous; fuscosity vestigial, variegated, slightly more pronounced on dorsal keel. Dorsal carina strong, smooth. Ventral internal keel weak, subgranose. Ventral external keel obsolete. Internal face densely, minutely granulose. External face smooth; longitudinally moderately convex, transversely strongly convex. Ventral face smooth, flat.

Chela ochreous: dorsal margin fuscosity diffuse, variegated: fixed finger base internal face fuscosity diffuse, uniform; external face fuscosity moderately dense, ochreous maculations interspersed. Fingers reddish-brown; fixed finger dorsal and external fuscosity moderately dense, ochreous maculations interspersed; movable finger external face fuscosity moderate, uniform. Dorsal margin vestigially carinate; proximal two-thirds smooth, distal one-third and fixed finger base subgranose. Digital keel: proximal one-tenth weak to vestigial, smooth; median six-tenths obsolete; distal three-tenths vestigial; weak over fixed finger base, ending at level of trichobothrium **eb**. Ventral keel weak to moderate, smooth, directed to midpoint of movable finger articulation. Dorsal face sparsely, vestigially granulose. External face bare, smooth. Internal face smooth, bare;

shallow longitudinal depression where chela flexes against brachium. Fixed finger base internally and externally with moderately dense, minute granulation. Fixed finger sparsely hirsute, inner margin evenly arcuate. Movable finger sparsely hirsute.

Walking legs.—Ochreous to ochroleucus, smooth. Tarsomere II spine formula: 5/5 5/5 : 5/5 5/5 : 6/6 6/6 : */* */*.
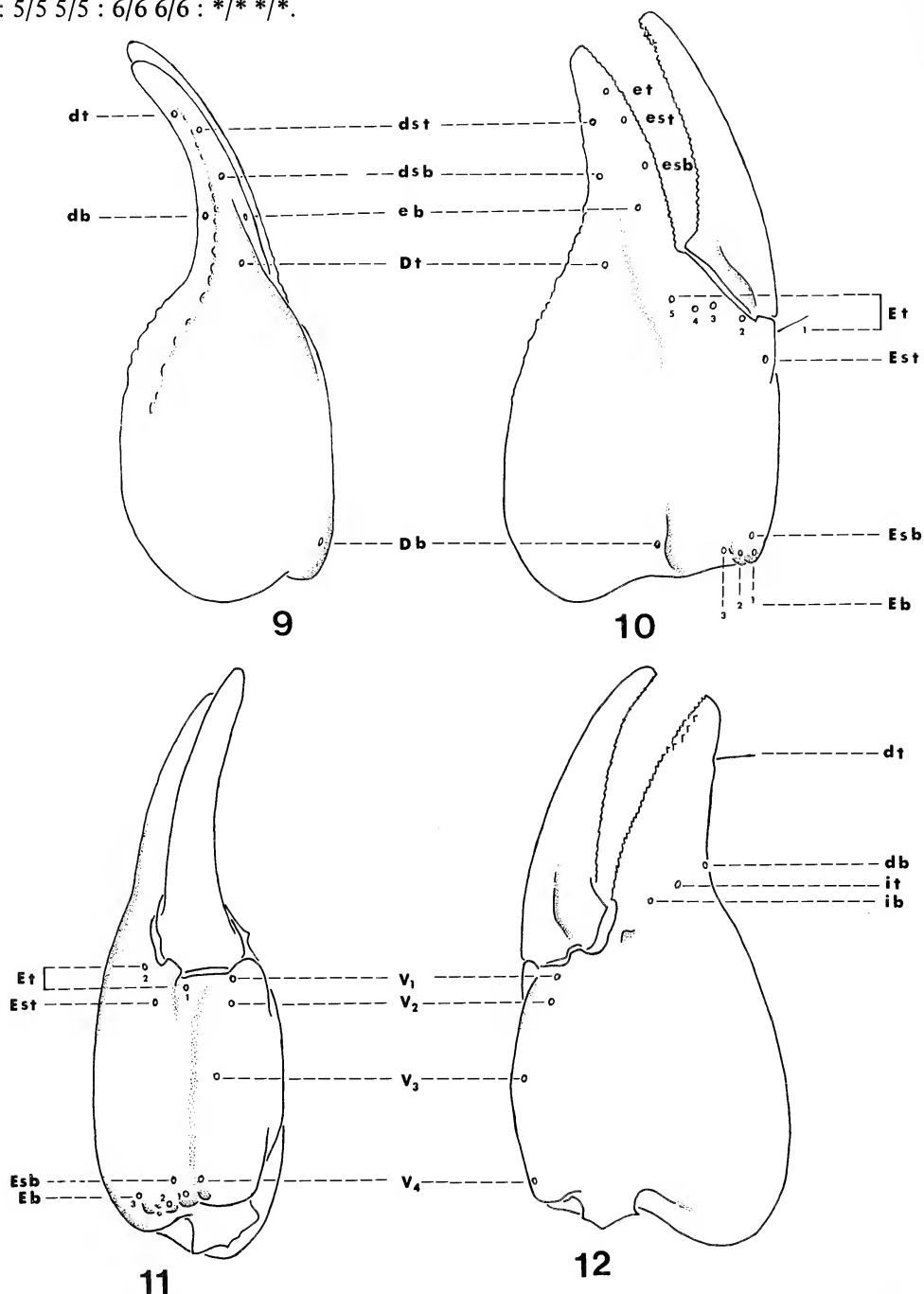
Figs. 9-12.—*Heteronebo forbesii* Pocock, lectotype female from the island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden. Trichobothria on right pedipalp chela: 9, dorsal; 10, external; 11, ventral; 12, internal.

Paralectotype.–Female, immature (measurements in Table 2). New designation. Differs from lectotype as indicated below.

Prosoma.–Carapace fuscosity moderately dense, variegated. Posterior median furrow; distal longitudinal slit "lips" not meeting medially above furrow proper.

Mesosoma.–Tergites moderately infuscate: proximal halves variegated, distally uniform; density increasing distally between segments. Tergite VII submedian and lateral carinae vestigial. Pectinal tooth count 8-8.

Metasoma.–Segments I-IV intercarinal distal fuscosity uniform, moderately dense. Segment V ventral median carina distinctly tetrafurcate distally (Fig. 15). Telson fuscosity moderately dense. Aculeus ventral margin evenly curved.

Walking legs.–Tarsomere II spine formula: 5/5 5/5 : 5/5 */* : 6/6 */* : 6/6 6/6.

Table 2.–Measurements (mm) of *Heteronebo forbesii* Pocock.

		Lectotype ♀	Paralectotype ♀	Juvenile ♂
Total length		40.70	39.25	21.25
Carapace:	length	5.30	5.30	3.10
	anterior width	2.60	2.70	1.40
	width at median eyes	4.05	4.30	2.25
	posterior width	4.80	5.50	2.85
Mesosoma:	length	13.80	12.65	7.30
Metasoma:	length	21.60	21.30	10.85
I:	length	2.80	2.80	1.40
	width	3.10	3.10	1.75
II:	length	3.00	3.00	1.50
	width	2.80	2.85	1.60
III:	length	3.20	3.20	1.55
	width	2.75	2.80	1.55
IV:	length	3.60	3.50	1.80
	width	2.60	2.60	1.40
V:	length	4.55	4.40	2.35
	width	2.45	2.40	1.30
Telson:	length	4.45	4.40	2.25
Vesicle:	length	3.30	3.30	1.65
	width	2.50	2.60	1.40
	depth	1.80	1.75	0.95
Aculeus:	length	1.15	1.10	0.60
Pedipalp:	length	15.05	14.70	8.20
Humerus:	length	3.50	3.40	1.90
	width	1.55	1.50	0.85
	depth	1.75	1.70	0.95
Brachium:	length	3.55	3.50	2.00
	width	1.70	1.70	0.85
Chela:	length	8.00	7.80	4.30
	width	4.05	4.00	1.55
	depth	2.80	2.60	1.25
Movable finger length		4.75	4.70	2.65
Fixed finger length		3.40	3.40	1.95
Chelicera:	chela length	1.80	1.60	1.05
	chela width	1.10	1.15	0.75
	fixed finger length	0.85	0.90	0.55
	movable finger length	1.65	1.45	1.00
Pectinal teeth		8-9	8-8	9-10
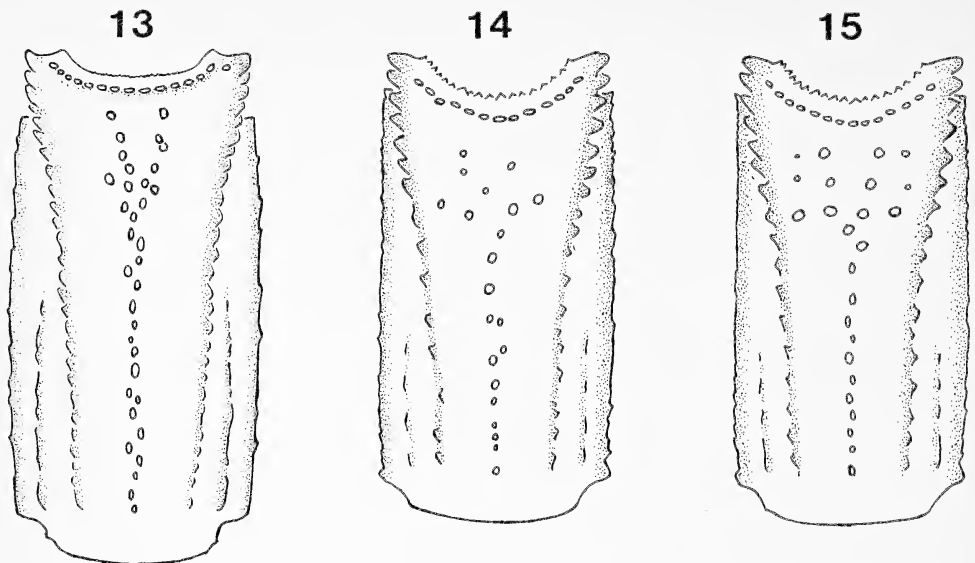
Figs. 13-15.—Metasomal segment V showing longitudinal ventral median carina: 13, *Heteronebo granti* Pocock, lectotype female from the island of Abd-el-Kuri, showing distinct bifurcation distally; 14, *Heteronebo forbesii* Pocock, lectotype female from Abd-el-Kuri, showing tetrafurcation distally and incipient (?) ventral transverse carina; 15, *H. forbesii* Pocock, paralectotype female from Abd-el-Kuri, showing distinct tetrafurcation distally and incipient (?) ventral transverse carina.

Male.—Juvenile (measurements in Table 2). This specimen is not a syntype; therefore, it can not be designated as a paralectotype (see Remarks below).

Very conspicuous differences with respect to lectotype, and which could be due to: (1) ontogenetic variability and allometric growth rates, (2) sexual dimorphism, and (3) intraspecific variability. These sources of variability have been discussed and analyzed for two species of Diplocentridae elsewhere (Francke, 1975), but the sample available in this case is too small to allow any reasonable inferences to be made.

Prosoma.—Carapace fuscosity moderately dense, vestigially variegated. Posterior median furrow; distal longitudinal slit "lips" not meeting medially above furrow.

Mesosoma.—Tergites moderately infuscate, pattern as on paralectotype. Tergite VII; submedian carinae obsolete to vestigial, lateral carinae weak to vestigial. Genital operculi without median membranous connection ("not fused," *auct.*); genital papillae present. Pectinal tooth count 9-10.

Metasoma.—Segments I-IV intercarinal distal fuscosity moderately dense, uniform. Segment V ventral median keel tetrafurcation indistinct.

Pedipalps.—Granulation obsolete to vestigial. Chela elongate, subcylindrical; ventral keel vestigial.

Walking legs.—Tarsomere II spine formula: 4/5 */* : 5/5 5/5 : 6/6 6/6 : 6/6 6/6.

Collection data.—Lectotype, paralectotype, and juvenile male collected at Abd-el-Kuri (800 - 1500 ft.), Peoples Democratic Republic of Yemen, 5 December 1898 (W. R. O. Grant and H. O. Forbes). Deposited in the British Museum (Natural History), London.

Remarks.—In the original description Pocock (1899) mentions that two females (syntypes) were examined, and the type locality appears simply as Abd-el-Kuri. Subsequently (Pocock, 1903) the type locality appears as: Abd-el-Kuri, Gebel Saleh (800 -

1500 ft.), and the quote from Mr. Grant's note indicates that the specimens were collected under rocks at an elevation of "about 1000 ft." The second sentence in Mr. Grant's note is very important, and reads as follows: "Both were apparently rare, as during several days' search only two examples of each species were met with." This is making reference of course to the lectotype and paralectotype of *Heteronebo granti*, and the lectotype and paralectotype of *H. forbesii*.

From the British Museum I received *three* specimens of *H. forbesii*, two immature females and a juvenile male. The male specimen has been labelled as the lectotype by H. L. Stahnke. Although this designation has not been published, and is therefore not valid, the selection of this specimen as the lectotype is a poor taxonomic decision by Stahnke. In the first place, the locality from where this specimen came is questionable since neither Mr. Grant (in his note), nor Pocock (1899, 1903) mention it at all. Secondly, for the same reason just given, this juvenile male can not be considered a syntype and is not eligible for lectotypic designation [International Code of Zoological Nomenclature, Art. 74 (a) (i)]. Finally, even if it were eligible for such a designation, due to its small size (Table 2) it can not be considered as the most representative specimen for this taxon. For these reasons I have designated and labelled as the lectotype of *H. forbesii* Pocock the female specimen on which the original description appears to be based (total length 42 mm, pectinal teeth 8-9; which compare with Table 2). I have designated and labelled the other immature female as a paralectotype. The juvenile male has been simply treated as an additional specimen of *H. forbesii*, which it is.

Distribution.–*H. forbesii* is only known from the three specimens mentioned above, and is apparently endemic to the small island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden (Fig. 18).

COMPARATIVE DESCRIPTION

The most distinctive differences between *H. granti* and *H. forbesii* have been summarized in Table 3. In addition, it seems that the typical tarsomere II spine formula for *H. granti* is: 5/5 5/5 : 5/6 6/6 : 6/6 6/6 : 6/6 6/6, and that of *H. forbesii* is: 5/5 5/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6, differing in the number of spines on the posterior row of the second pair of legs. However: In the first place, the samples available are too small for me to have any confidence on the validity of this differential character at this time; and secondly, this particular row of spines (2nd pair, posterior) has been found to have the highest intraspecific variability in spine counts (among the eight distinct groupings possible) on other species of Diplocentridae (Francke, 1975, Table 3), and to use it as a diagnostic character could prove to be misleading in this case.

In *H. granti* trichobothrium **Dt** occurs on the fixed finger, slightly beyond the movable finger articulation commisure (Fig. 2); and in *H. forbesii* trichobothrium **Dt** occurs at the fixed finger base, slightly before the movable finger articulation commisure (Fig. 10). I consider this positional difference to be of minor taxonomic importance, and should be used with care until more specimens are studied, particularly adults.

The fact that *H. granti* and *H. forbesii* are only known from two and three immature specimens respectively, and that they are sympatric on the small island of Abd-el-Kuri, may lead some taxonomists to question the validity of these two species (e.g. Werner, 1934). However, since the female specimens of *H. granti* and *H. forbesii* are of approximately the same size (Tables 1 and 2), ontogenic and sexual differences can be considered

to be minor in this case; and my conclusion is that both species are valid, and can be recognized by the differences summarized in Table 3.

DISCUSSION

Kraepelin (1905) recognized two subfamilies in the Diplocentridae, based mainly on biogeographic considerations, as follows: Diplocentrinae, including the three New World genera then known; and Nebinae, including the two genera found in the Middle East, namely *Nebo* and *Heteronebo*. Birula (1917) separated the two subfamilies on the basis of the cheliceral dentition; and Werner (1934) gave the presence or absence of a transverse ventral carina on metasomal segment V as the distinguishing character.

Nebo and *Heteronebo* can be separated by a number of very distinctive characters, any one of which is highly reliable and can be used by itself. These characters are enumerated below, and I will be refering back to them throughout the following discussion.

1 - *Nebo* has the carapacial median longitudinal furrow suturiform, i.e., deep and narrow throughout its length, and its limits can be clearly defined; this "suture" bifurcates at the anterior submargin. In *Heteronebo* the carapacial median longitudinal furrow is not suturiform, i.e., it is usually wide, and its limits can not be precisely defined; this furrow does not bifurcate at the anterior submargin of the carapace.

2 - The subaculear tubercle in *Nebo* appears as a finger-like, subcylindrical projection with a narrow base. In *Heteronebo* the subaculear tubercle is rounded, and has a broad base.

3 - In *Nebo* brachial trichobothrium d_2 remains along the dorsal surface of the brachium. In *Heteronebo* brachial trichobothrium d_2 has migrated to the internal face (Fig. 16).

4 - In *Nebo* trichobothrium **it** is found medially on fixed finger (Vachon 1965, 1974). In *Heteronebo* trichobothrium **it** is found on basal one-fourth of fixed finger (Fig. 17).

5 - In *Nebo* the longitudinal ventral median keel on metasomal segment V is never distinctly bifurcate distally. In *Heteronebo* this keel is distinctly bifurcate on one species (*H. granti*, Fig. 13), tetrafurcate on the other (*H. forbesii*, Figs. 14-15).

6 - In *Nebo* tarsomere II is distally lobed, the terminal spine is directed apically. In *Heteronebo* tarsomere II is distally rectangular, the terminal spine is directed ventrally.

The characters enumerated above to separate *Heteronebo* are present in the subfamily Diplocentrinae to variable extents. Characters 1-4 can be used to separate *Nebo* from all other diplocentrid genera, and do not need any further clarification. Among the characters needing clarification, I will first discuss Birula's subfamilial character: Birula (1917) stated that in the Diplocentrinae the cheliceral movable finger is bipartite subterminally, whereas in the Nebinae the cheliceral movable finger is undivided subterminally. I have examined representatives of all the diplocentrid genera, and have been unable to find any differences that will substantiate Birula's distinction, particularly with respect to *Heteronebo* (Fig. 7).

The second character needing clarification is Werner's (1934) subfamilial character (see my character 5), pertaining to the disposition of ventral carinae on metasomal segment V. Werner characterized the Diplocentrinae as having a ventral transverse keel, which delimits a distal disc, i.e., a depressed semilunar or crescentic region; and the Nebinae as lacking both a ventral transverse keel and a distal disc. Firstly, I have examined an undescribed species from the Caribbean region lacking the ventral transverse keel and the distal disc;

Table 3.–Differential characters observed between *Heteronebo granti* Pocock and *H. forbesii* Pocock.

		H. granti	*H. forbesii*
Prosoma:	ocular prominence	entire to feebly concave	shallowly furrowed
Mesosoma:	sternite VII keels	obsolete	weak to vestigial
Metasoma:	I-II ventral submedian keels	obsolete	weak
	I-IV dorsal lateral keels	weak to moderate, abrupt end	vestigial, gradual end
	I-III lateral supramedian keels	moderately strong, abrupt end	weak, gradual end
	V ventral median keel	bifurcate distally	tetrafurcate distally
Telson:	vesicle length/vesicle width	≥1.50	<1.35
	vesicle length/vesicle depth	≥2.05	<1.90
	vesicle length/aculeus length	>4.00	≤3.00
Chelicera		ochreous, not infuscate	ochreous, infuscate
Pedipalps:	Humerus; relative length proportions	longer than metasoma IV	shorter than metasoma IV
	dorsal face	wider than deep	deeper than wide
	dorsal internal keel	transversely feebly convex	transversely strongly convex
	Brachium; ventral external keel	prominent	obsolete
	external face	strongly developed	obsolete
	Chela; dorsal marginal keel	two weak to vestigial keels	smooth
	digital keel	weak, granular	vestigial to obsolete
		strong, smooth	vestigial to obsolete
	fixed finger fuscous	without ochreous maculae	with ochreous maculae
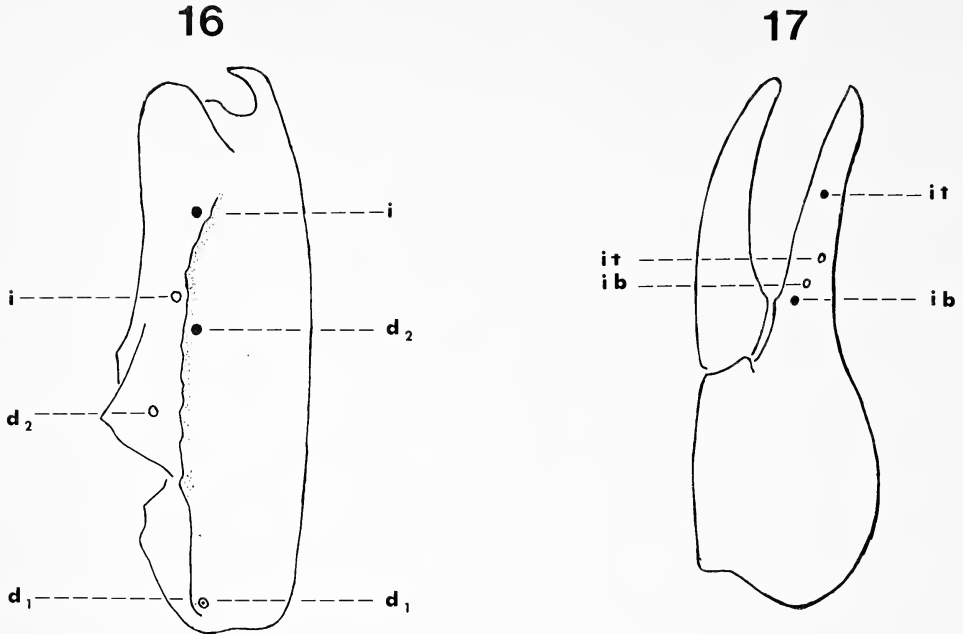
Figs. 16-17.—Diagrammatic representation of trichobothrial position differences between *Nebo* (solid circles, labels to the right) and *Heteronebo* (open circles, labels to the left): 16, right pedipalp brachium, dorsal; 17, right pedipalp chela, internal. See text for discussion.

however, this species is closely related to another species that does have these characters, and both undoubtedly belong in the Diplocentrinae. Secondly, *Heteronebo forbesii* seems to have a "rudimentary" ventral transverse keel, represented by four large granules on the lectotype and paralectotype (Figs. 14-15). On the basis of these observations, I maintain that Werner's subfamilial character is no longer valid.

The third, and final, character needing clarification is character 6 above, and in this respect it is sufficient to indicate that the presence or absence of lobes on tarsomere II has been used as a generic character within the Diplocentrinae. Therefore, it is not useful at the subfamilial level either.

The fact that the basic differences between *Heteronebo* and *Nebo* given above, represent at the same time similarities between *Heteronebo* and the diplocentrine genera, have prompted me to remove *Heteronebo* from the subfamily Nebinae and to include it in the subfamily Diplocentrinae. These same characters become the basis for a polythetic diagnosis of the two subfamilies recognized in the Diplocentridae. The subfamily Nebinae is monotypic, and is diagnosed by characters 1-4 as enumerated above for *Nebo*. The subfamily Diplocentrinae is polytypic, and is diagnosed by characters 1-4 as enumerated above for *Heteronebo*. Although other promising characters have been explored, the lack of adequate *Heteronebo* material precludes their use for the time being.

The position of *Heteronebo* within the Diplocentrinae is very problematic, due to two fundamental reasons. First, I have been unable to find any character, which can be considered significant at the generic level, that will separate *Heteronebo* from the other diplocentrine genera. As has been pointed out already, I have an undescribed species in which metasomal segment V lacks a ventral transverse keel and a distal disc; furthermore, in this undescribed species the disposition of the ventral median carina resembles very

closely the tetrafurcate condition observed in *H. forbesii*, and tarsomere II is not lobed distally, as in *Heteronebo* spp. My failure to find valid generic characters for *Heteronebo* might be due to the fact that this genus is only known from five immature specimens. However, most scorpion genera are recognizable from immature specimens as well as from adults; therefore, I would personally question the validity of a genus based only on adult characters, which brings us to the second problem.

The systematics of *Heteronebo* are complicated by the geographical discontinuity in the distribution of the diplocentrine genera: *Heteronebo* is apparently endemic to Abd-el-Kuri, Peoples Democratic Republic of Yemen; and the other genera are found exclusively in the New World. This biogeographic problem immediately brought to my mind the possibility that Pocock's type locality data for *Heteronebo* could be erroneous. I wrote to Mr. Fred Wanless (British Museum) inquiring if there had ever been any reason to suspect the validity of Pocock's type locality data in this particular case; and according to him, until now, there had never been any reason whatsoever. Although I can neither prove nor disprove my suspicions, the possibility of a labelling error is still very real in my mind for the following reasons: first, and most important, is the overall similarity between *Heteronebo* and the undescribed species from the Caribbean region previously mentioned; secondly, because of the geographical discontinuity shown by its "known" distribution with respect to other diplocentrines; and finally, from indirect evidence derived from the knowledge of the concepts of island biogeography. Both Sokotra and Abd-el-Kuri (Fig. 18) are small, continental shelf islands located at the entrance to the Gulf of Aden, and offshore of Cape Guardafui (NE tip of Somalia); and whose faunal

Figs. 18.—Middle Eastern region, showing the location of the small island of Abd-el-Kuri, Peoples Democratic Republic of Yemen, located at the entrance to the Gulf of Aden, which is the type locality for *Heteronebo granti* Pocock and *H. forbesii* Pocock.

elements I would expect to be mainly derived from the Somalian mainland and to a lesser extent from the Arabian Peninsula. The following three scorpion species have been reported from Sokotra (Pocock 1899, 1903): *Hemiscorpion socotranus* Pocock (Scorpionidae, Hemiscorpioninae), *Butheolus insularis* Pocock (Buthidae), and *Orthochirus socotrensis* (Pocock) (Buthidae). These three species are endemic to Sokotra; *H. socotranus* is an Arabian element, while *B. insularis* and *O. socotrensis* appear to be Somalian elements since the two genera are well represented on the Somalian mainland. From Abd-el-Kuri the only scorpions known are *Heteronebo granti* and *H. forbesii*, and the genus is apparently endemic to that island; numerous localities have been sampled in Somalia, including Cape Guardafui (Vachon and Stockmann, 1968, Fig. 25), and no diplocentrid scorpions have been reported from there.

The Somalian elements on Sokotra could have arrived there (a) during a lowering of the sea level (glacial period), when Sokotra and Abd-el-Kuri could have been connected to the mainland, or (b) by "rafting," possibly using Abd-el-Kuri as a stepping stone during their dispersal. Regardless of how the Somalian elements arrived at Sokotra, it can be safely assumed that Sokotra has been isolated from the mainland at least since the time when Abd-el-Kuri became isolated, if not earlier due to the greater distance separating Sokotra from the Somalian mainland. These facts raise two basic questions: (a) why has this isolation resulted in the evolution of an endemic genus in Abd-el-Kuri, while only endemic species have evolved in Sokotra during the same time span? and (b) do *Heteronebo granti* and *H. forbesii* represent one of the few instances of sympatric speciation known in animals? It is impossible to answer satisfactorily these questions with the scant information currently available; but the probabilities of these events are at best minimal, indirectly supporting my suspicions on the accuracy of the type locality data for *Heteronebo*.

In conclusion, *Heteronebo* must be maintained as a valid genus of the subfamily Diplocentrinae, recognizable only on the basis of its geographical distribution, until the time when its presence in Abd-el-Kuri is either proved or disproved by an extensive collecting program on that island. If additional specimens are obtained from the type locality, hopefully adult specimens of *H. granti* and *H. forbesii* will appear in the samples, which will in turn provide one or more diagnostic characters for the genus.

ACKNOWLEDGEMENTS

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SPIDER WEB-BUILDING IN OUTER SPACE:
EVALUATION OF RECORDS FROM THE SKYLAB SPIDER EXPERIMENT

Peter N. Witt
Mabel B. Scarboro
Rubenia Daniels

N. C. Department of Mental Health
Research Division
Raleigh, North Carolina

David B. Peakall [1]

Cornell University
Ithaca, New York

Raymond L. Gause

Marshall Space Flight Center
Huntsville, Alabama

ABSTRACT

Two spiders built orb-webs in Skylab under zero gravity only four days after release from transportation vials. The first webs resembled pre-flight controls in size and regularity, but the unusual distribution of radial angles and thinness of thread together with a probably low number of turning points in the spiral indicated a deviation from earth webs which can be attributed to the absence of gravity as a cue. Other web changes like a gradual decrease in regularity, diminished web size, and the spiders' decrease in body weight are identified as being likely consequences of starvation, Skylab stress and unknown circumstances not directly connected with zero gravity.

INTRODUCTION

Evaluation of measurements taken from the photographs of a spider web provides detailed information on the animal's behavior during web construction for a period of about 30 minutes. Extraordinary circumstances like changes in the environment influence behavior and are reflected in web measurements (Witt, *et al.*, 1968). The photographic record shows that web parameters are sufficiently constant to make measurements predictable for an individual, and it contains enough detail to show the consequences of environmental stress on the builder. Such considerations prompted one of the authors (P.N.W.) to respond to an invitation from the National Aeronautics and Space Administration in 1968 to propose a project for the Biosatellite Program entitled "Effects of weightlessness on web-building behavior of spiders." It was suggested that spiders be sent into space, and that after their return to earth their web-building capability would be

carefully compared to pre-flight webs. In a second experiment actual photography of webs built in a space-laboratory would be performed, and the photographs evaluated in comparison with earth webs. The Biosatellite Program was not flown.

Conditions beyond these laboratories' control led to the adoption of a prize-winning proposal by Judith Miles, a high school student from Lexington, Massachusetts, in 1972 to incorporate a spider web-building project into plans for Skylab II; she had read about our spider-web measurements in the National Geographic (Zahl, 1971). She submitted a proposal for an experiment as an entry in the NASA Skylab Student Experiment Competition. Her proposal was selected by a panel of National Science Teacher Association judges as one of the experiments which they recommended for NASA for flight in Skylab. We provided instructions to NASA scientists and J. Miles, but were no longer directly involved in the planning process.

In May of 1972 we had an opportunity of evaluating web-photographs of two spiders, which had been subjected at the Marshall Space Flight Center to vibration and "Skylab atmosphere (70% O_2 30% N_2)," in simulation of non-gravity stress factors during launch. For spider No. 1 four photographs of webs built directly before the experiment were compared with the measures of three webs built shortly thereafter; for spider No. 2 three webs before and six webs after the experiment were measured. We found no consistent, statistically significant change in 27 web parameters, covering size, shape regularity and web fine-structure.

When the Apollo spacecraft with three astronauts was launched on 28 July 1973, two spiders in small vials together with two flies were carried along. The first spider was released into a frame which would permit web-building in Skylab on 4 August, the second spider was released on 23 August 1973. At that time we had an opportunity to watch TV pictures of the two spiders. Finally, in April of 1975 we received a package from NASA with flight protocols and photographs of spiders, webs and threads. Mainly the evaluation of the material in the package is the subject of the following report.

MATERIALS AND METHODS

Web measurements: A protractor centered on the hub of the web was laid over each picture; a ruler with a notch at 0 mm could turn around the center of the protractor. Each point where thread touched thread could thereby be defined in polar coordinates. The figures for a reduced number of measuring points (about 10% of actual number) were fed into a computer, which was programmed to print out 27 web measures, defining the structure's regularity, shape, size and fine structure. For more information on web measurements see Witt, et al., 1968. Where only incomplete measures were available, the evaluation was done without computer, using as many points as could be identified.

There were five pre-flight web photographs available for evaluation, four built by spider 1, one built by spider 2; all but one picture showed such low contrast that we were unable to obtain a complete set of web measures. In order to increase the number of control measurements, we added to the one measurable NASA web photograph five photographs from webs built by spiders of comparable age, body weight and species in our laboratory. An overlay of transparencies of one set of photographs onto the pre-flight webs, and statistical comparison of obtainable measurements, showed no recognizable differences between the pre-flight controls and our laboratory webs.

There were five in-flight webs photographed, each of which was incompletely recognizable. Only the radial angles and some spiral distances could be measured with some degree

able. On the radial angles and some spiral distances could be measured with some degree of accuracy. Angle regularity and distribution of size of neighboring angles as well as spiral spacing in one or two directions could be used for statistical comparison. In one web, which does not appear on a photograph, the astronauts reported the number of radii and spiral turns.

On visual inspection, there was one apparently very regularly spaced web (angle and spiral turns); this is the second web built in flight by spider 1. The other four show all the characteristics of an *Araneus* web, like hub, radii, spiral and frame; but they were of small size and highly irregular spacing, somewhat comparable to webs built after a medium dose of d-amphetamine (Witt, 1971).

Web size could not be determined, because scale and periphery of webs were not on the photographs.

Thread thickness was shown earlier (Christiansen, *et al.*, 1962) to be dependent on the weight of the builder. A number of close-up photographs (400-2000x) of pieces of thread were available for both spiders, pre-flight and skylab. Unfortunately it was not possible to identify the type of threads with any certainty, but the astronauts reported that the web material they collected was from a regular web. Certainly there is no evidence that material from the sticky spiral was involved, since no glue droplets could be seen. The thickness was measured by one of us (D.B.P.) on the photographs.

A special question was whether the absence of gravity would do away with the commonly observed difference between angle size North and angle size South. The comparison was carried out in graphic and statistical format between the one regular in-flight web and the clearest pre-flight control.

At the end of August, 1973 the television news showed a short record of movements of both spiders, after spider 1 had been in the frame for several weeks and spider 2 had just been released. Through the courtesy of the Durham, North Carolina CBS station we were able to see the film segment many times and observe the animals' movements. Subjective evaluation of these observations was included.

RESULTS

The clearest, and in our opinion most important result is the photographic and observational evidence that both *Araneus diadematus* built several orb webs in Skylab, essentially under weightless conditions. One of these webs, which was built by spider 1 six days after release into the cage and 14 days after launch, looks on first inspection similar to pre-flight control webs. This indicates that the animals were able to pull threads out of the spinnerets and space the threads with their legs according to accustomed patterns of behavior (Figs. 1 and 2). The spiders continued to build a trap for flying prey under the very strange conditions of Skylab.

Measurements of radial angles reveals that in the one regular web radii were neither more regularly spaced than in controls nor significantly more irregular. However, Fig. 3 shows that the distribution of angle size is unusual in flight: while on earth most wide angles are in the top or Northern part of the web and most narrow angles in the lower part or South, the Skylab web shows about equal distribution in all sections. The range was between 8° and 25° in the pre-flight web, with a mean angle size of pre-flight control North 15.58, pre-flight control South 11.53; in-flight the range was between 8° and 23°, North 15.75, South 14.25. It appears that, lacking the cue from gravity, the web lost its North-South asymmetry.
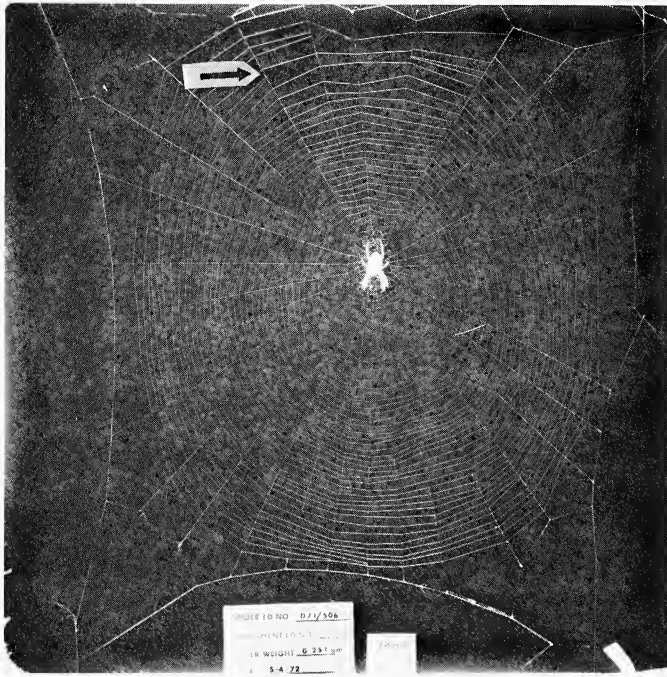
Fig. 1.—NASA photograph of web built by an adult female *Araneus diadematus* C1. spider in the pre-flight simulation experiment. The picture shows all the characteristics of the adult web of the species; note particularly the North/South asymmetry in the radial angle size and spiral distances, and the turning points in the spiral (arrow), which indicate the places where the web-building spider reversed directions.

Spiral size could not be measured, because the photographs do not show the outermost turns. A figure for spiral regularity can be established for pre-flight controls, and separately for the one regular in-flight web and other in-flight webs. Where there were no reference scales, the spiders of known size could be used for projecting web photographs to original size. In five pre-flight webs the spiral regularity was calculated at 0.390 ± 0.093 West and 0.403 ± 0.033 East. This means that distances between spiral turns varied less than 0.5 mm, indicating relatively regular spacing of consecutive spiral turns. In the one regular in-flight web the corresponding figures are 0.333 in the West and 0.69 in the East; there is no significant difference between the two sets of webs (Fig. 2). One of the irregular in-flight webs (Fig. 4) was measured showing a mean spiral regularity of 0.70 West and 0.96 East, which is significantly different from pre-flight and regular in-flight below the 5% probability level: this in-flight web had a spiral less regular than controls.

In looking at Fig. 2 another interesting difference appears between the regular in-flight web and pre-flight controls: while there are no turning points in the piece of spiral in the figure which was built in-flight, there are several in the pre-flight control (compare also Fig. 1). This difference is less conspicuous when the whole webs are inspected: in very few places where photographic contrast permits recognition of sufficient detail, turning points can be identified in pictures taken in flight. However, it can be stated with some confidence, but without exact figures to back up such a statement, that the web-building spider in Skylab turned less frequently than under pre-flight conditions while it constructed the sticky spiral.
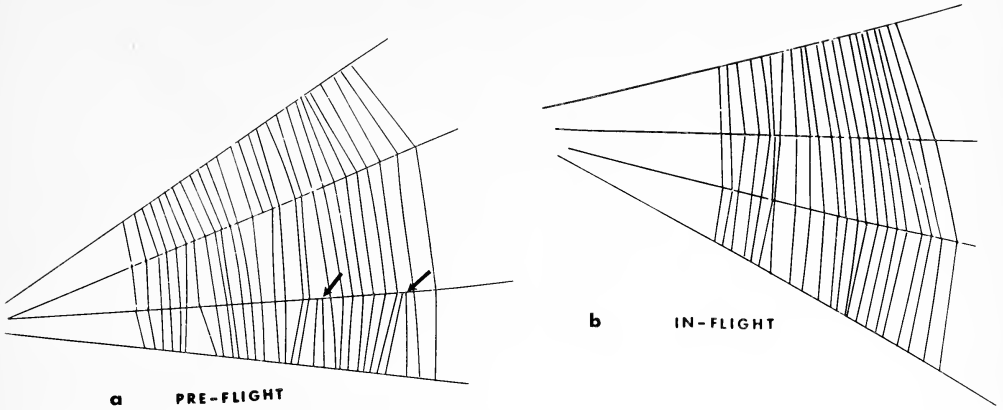
Fig. 2.–A low-contrast photograph of the highly regular web built in Skylab was overlaid with transparent paper and three sections in the East of the web traced with black tape (b); the same procedure was used for a pre-flight web (a), so that both figures could be compared. Note the absence of turning points (arrow) in the traced part of the spiral in the in-flight web (however, there were a few turning points in other parts of the web), the regularity of spiral spacing, and the seventh spiral turn from the center, which crosses two radii without being attached, something which has been described in d-amphetamine webs by Jackson (1974).
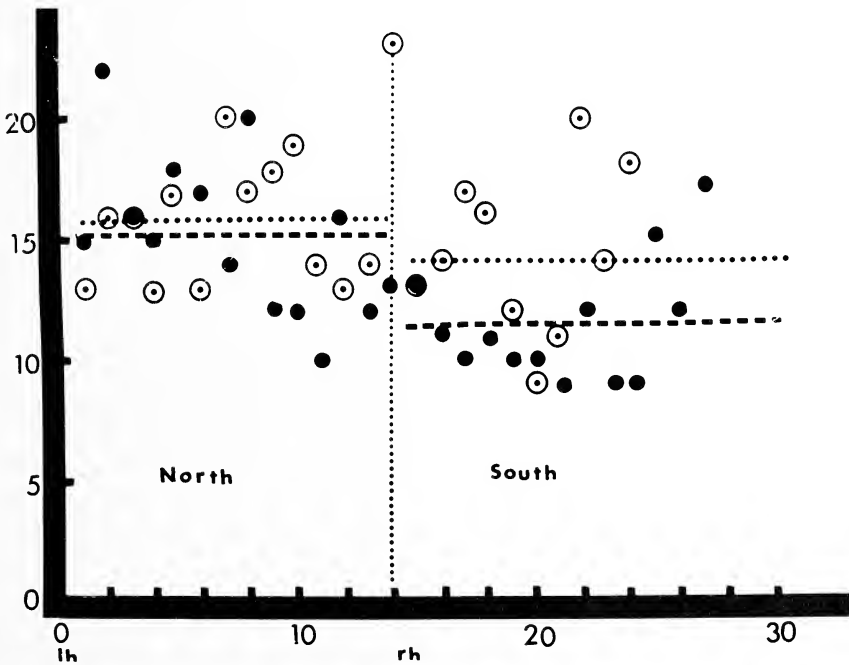
Fig. 3.–Radial angle size (ordinate) is plotted against number of radius (abscissa) for one pre-flight (single values: black circles; mean: dashed line) and the regular in-flight web (single values: open circles; mean: dotted lines). After South had been determined by the spider's head-down position, left horizontal is designated as one; right horizontal (rh) (=West) in both webs angle No. 14. Note the relatively large difference in mean values between North and South in the pre-flight web as compared to the in-flight web value, likely reflecting the absence of the gravity cue in Skylab.
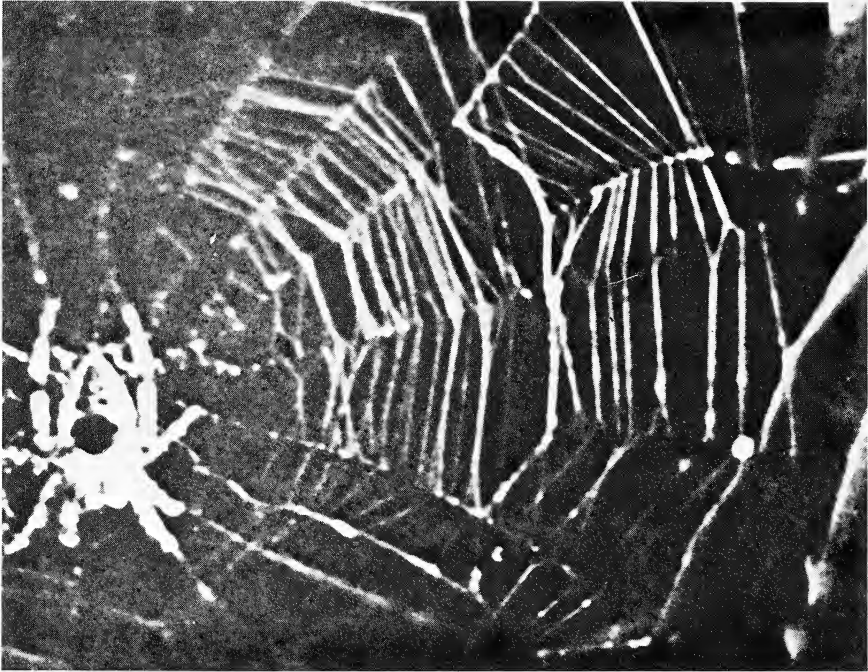
Fig. 4.–This is one of several pictures of part of a highly irregular in-flight web. Similar patterns are built on earth directly before and after a spider's molting, by old spiders shortly before death, and after a high dose of a stimulant drug like dextro-amphetamine. We can not be sure that weightlessness caused this unusual pattern. Compare to Fig. 2 which indicates that under in-flight circumstances a regular web could also be constructed.

Unfortunately we were unable to measure shape and size of webs in flight; this would have required a camera with a wide-angle lens, or more distance between camera and web than was possible. However, there are close-up photographs of threads spun before and during flight. Evaluation of diameter suffers from uncertainty about which threads are photographed. If we assume that we measured on the pictures comparable threads in- and pre-flight—i.e., radii or draglines—the Skylab spiders laid some 20% thinner threads than the same animals on earth. Such a result is particularly interesting when one compares it to thread thickness measurements by Christiansen *et al.* (1962), performed on spiders which carried extra weight. Under that condition, which may be considered opposite to the weightless spiders in Skylab, thread thickness was found increased over lighter controls.

Screening of the television pictures shed some light on the time course at which the Skylab spiders adapted to the new and unusual conditions. On 28 August 1973 the CBS Evening News showed how one of the spiders, apparently the one which had been released on 4 August, was captured by the astronauts to be returned to its vial, and the other spider was released into the frame. An observer described this as ". . . the spider newly put in tumbled, its movements were head over heels, as never seen before; the animal rotated in space while moving in one direction, bounced off the frame and moved back. In contrast, the first spider ran very competently along the strands to escape from the astronauts." This observation would tend to confirm conclusions drawn from web records that there is a transition time during which spiders gradually acquire the skill to move "competently" under weightless conditions.

DISCUSSION

After it has been established that spiders are able to build orb webs in outer space, the most interesting question to be answered is whether these webs show changes characteristic for the special condition, and to interpret such changes. When all possible factors which could influence web-building are subtracted, can we find something which informs about the special way in which highly patterned behavior adapts to conditions which cannot have occurred before in the entire evolutionary history of the orb-web building spiders. One difficulty is the small sample size which prohibits statistical comparison. But a number of questions can be answered, from careful analysis of even an incomplete photograph of a web built in outer space.

Earlier experiments, particularly with high doses of drugs which cause paralysis or convulsions (Witt, 1971), have shown that web-building is a high priority activity of spiders; no food without webs and no webs without food (Peakall, 1968) and consequently no survival for the individual. The high priority of web-building apparently drove our animals to try repeatedly without success, until three days after opening of the transport vial the first animal was reported to build a web in August. There exist photographs and a protocol which indicate that the first web was preceded by considerable thread laying along the confining frame. As far as the photograph permits to see details, the first web looks like a medium-sized earth web of average regularity. It is not possible to reconstruct from the protocol whether this first web was destroyed by the astronauts or eaten by the spider, as is routinely done in our laboratory. We only know that the highly regular web, part of which is shown in Fig. 2, was built several days later, probably a week after release. Webs thereafter became irregular (see Fig. 4), and the spider was dead on return to earth after 59 days. The second spider built at least one large web which was not photographed, but reported as containing 22 radii and 30 spiral turns. This corresponds to a large web on earth (see Fig. 1). Later webs were highly irregular, but with the main characteristics of the orb, i.e. hub, radii, spiral and frame. It appears safe to conclude from such data that the spider can sufficiently reorient itself at zero gravity, to construct an orb web, gravity being a less important cue in web-building than had been assumed. The existence of horizontal orb webs suggests a similar interpretation, because there exist obviously different adaptations to gravity.

In order to get into Skylab and during their stay, the two animals were subjected to many stressful conditions which could have influenced web-construction. The pre-flight simulation experiments indicate that vibration and the special atmosphere had no measurable short-term effect on web geometry. Confinement in tubes similar to those used for transport to Skylab is known to cause relatively small and irregular webs (Reed, et al., 1970); but it has also been shown that such effects wear off in three days. Only the first web of spider 1 and the irregularities in spider 2's web can possibly have been influenced by consequences of confinement in tubes.

Spiders can survive two to three weeks of food deprivation without apparent damage to web-building (Witt, 1963); however, they need frequent supply of water. It is known that one fly was put into each vial on 25 July, and that on 9 and 24 August "fillet" was put into the spiders' web; this was "kicked out," as we might have expected on the basis of its properties, which are strange to spiders. However, tests made at Marshall Space Flight Center had indicated that juices were extracted from pieces of rare fillet placed in the web. After the juices had been removed, the spiders would then eject the shrunken residue from the web just as they do a fly carcass. Photographic evidence was obtained

which led to the decision to try to feed the space spiders with the astronauts' meat scraps. Spider 1 was at least watered once, on 11 August. Spider 1 was found dead on return to earth, spider 2 died on 16 September in space. The comparison of photographs and weights pre- and post-flight make it likely, that thirst and starvation at least contributed to their death. Spider 1 had changed from 180 mg before to 103 mg after the flight, spider 2 from 210 mg before flight to 50 mg at time of death. There is no indication that molting, which is always dangerous and which would likely have been very difficult in zero gravity, contributed to the spiders' death. Taking all data into consideration it is concluded that there were two quite healthy spiders in Skylab in the first two weeks, which afterwards changed into slowly dying animals. The decline in vigor could well explain increasing irregularity and decreasing size of webs. But the existing data do not permit us to say whether the animals' decline was due to specific Skylab stress conditions, starvation, or other circumstances. The time was too short and the animals too young to consider high age as a contributing factor.

Evaluation of web-patterns should shed some light on a problem which has puzzled investigators for some time (Mayer, 1953), and which had been given as one reason for taking web-building spiders into Skylab because it could not be solved on earth: is the North/South asymmetry of the orb-web dependent on the spiders' perception of gravity? One possibility could well be imagined, namely that a young spider is guided by gravity to produce shorter radii and wider radial angles on top of the web, and longer radii more narrowly spaced on the bottom. Older spiders had become so accustomed to the asymmetry, that they would retain the pattern without the cue. Our analysis (Fig. 3) indicates that even an adult animal which has presumably constructed about 100 asymmetric orbs in its life-time, shows a lack of North/South asymmetry in Skylab; this is independent of where we assume North to be. Decrease of pendulum turns, which help to fill a long frame with as much round spiral as possible, is another indication of pattern change in zero gravity. Another characteristic of many earth webs, namely an asymmetry of the position of the hub toward the corner of the frame, can be recognized in some of the space photographs. Mayer (1953) found an asymmetric (East/West) hub and a round spiral in a web built on a slowly rotating Klinostat. This appears not surprising for in-flight construction if the difficult circumstances are considered under which a thread is spun in zero gravity: the spider prefers the web close to the corner of the cage where it can stretch relatively short frame threads. The conclusion is that each web, including those built in outer space, reflects in its pattern also cues from the environment which were present during its particular construction.

Experiments conducted earlier had led to the tentative conclusion, that spiders can adapt thread thickness to body weight (Christiansen, et al., 1962). It has been hypothesized that a heavier animal would require a thicker thread to hold it suspended. Comparison of web weights and thread lengths (length over weight used as an index of thickness) in animals before and after a lead weight has been fastened to the dorsum of the cephalothorax supported the hypothesis. The Skylab pictures which indicate that weightless spiders built most likely 20% thinner threads than the same animals pre-flight, point to the same mechanism. Some control mechanism which regulates silk thickness at the spinnerets of the weightless spider had possibly received signals through the central nervous system from the gravity perceptors that thinner silk would suffice. However, so little of the organs and the pathways possibly involved are known, that this remains merely a working hypothesis.
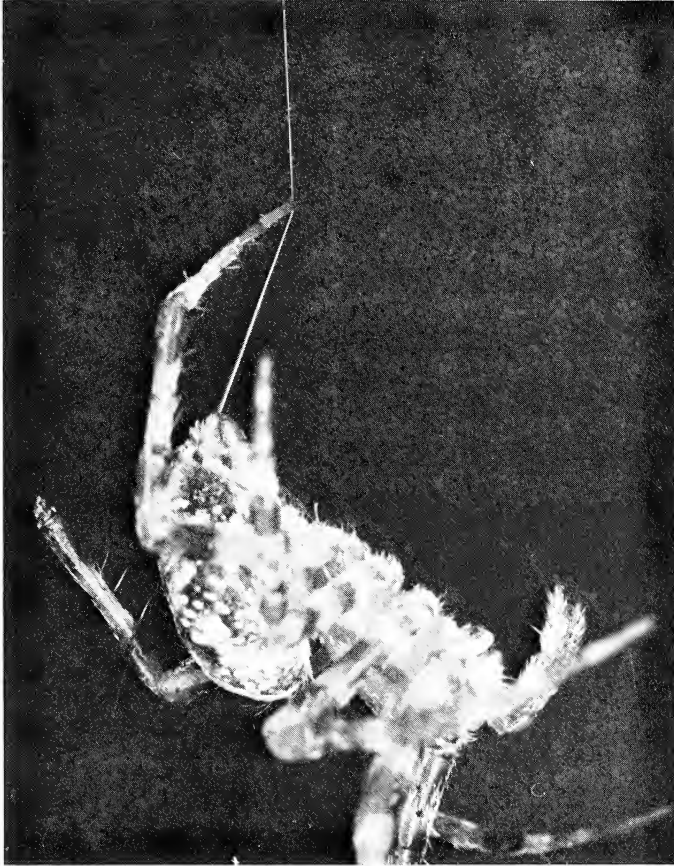
Fig. 5.–A female *Araneus diadematus* spider was photographed while it descended on its thread. Note the emergence of silk from the spinneret at the end of the spider's abdomen, and the position of one of the hind legs on the thread. However, spiders can also descend on a new silk strand without the help of a leg, using some mechanism along the path of the emerging thread to regulate speed; the animal's weight provides the pull.

Something that has been observed by nearly everybody in spiders is their ability to let out thread as they descend (Fig. 5), and that they can climb back up on such a thread, taking the silk in during the return. This observation, taken together with the fact that spiders always run on the underside of a web or a bridge thread, hanging down as they move, makes one aware of the important role which the use of the animal's own weight plays in locomotion and silk production. It is probably the absence of body weight which disturbed each of the two animals severely during the first days after release from the vial. They had to build frame threads by running along the given structures rather than dropping down; reports about their restless behavior preceding construction of the first web in Skylab can be interpreted as exploring such alternate mechanisms. Once the spiders had accomplished this, they showed no more difficulty in laying radii and spiral turns, with the result of accomplishing a large, regular web. Thus those features which underly detailed symmetry and make the orb an orb do not require gravity as a cue. The ability of an invertebrate animal with as rigid a behavior pattern as orb-web construction which is relatively independent of experience (Reed, *et al.*, 1970) to find alternate ways

to complete a perfect trap for food and thereby increase its chance for survival, is possibly the most interesting finding in the evaluation of Skylab web records.

SUMMARY

Two spiders built orb-webs in Skylab under zero gravity only four days after release from transportation vials. The first webs resembled pre-flight controls in size and regularity, but the unusual distribution of radial angles and thinness of thread together with a probably low number of turning points in the spiral indicated a deviation from earth webs which can be attributed to the absence of gravity as a cue. Other web changes like a gradual decrease in regularity, diminished web size, and the spiders' decrease in body weight are identified as being likely consequences of starvation, Skylab stress and unknown circumstances not directly connected with zero gravity.

ACKNOWLEDGEMENTS

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TWO EMENDATIONS TO STAHNKE'S (1974) VAEJOVIDAE REVISION (SCORPIONIDA, VAEJOVIDAE)

Oscar F. Francke[1]

Department of Zoology
Arizona State University
Tempe, Arizona 85281

ABSTRACT

Two emendations to Stahnke's (1974) "Revision and keys to the higher categories of Vejovidae" are given. First, Stahnke's nomenclatorial decision to use the spelling "*Vejovis*", rather than the correct original spelling of *Vaejovis* Koch, is based on an inappropriate article of the Code, and contradicts the ruling relative to this nomenclatorial problem. Thus, Vaejovidae, Vaejovinae, and *Vaejovis* are the correct spellings for the family, subfamily, and genus, respectively. Taxonomically, the holotype of *Physoctonus physurus* Mello-Leitao is redescribed, establishing that this supposedly vaejovid taxon is a junior synonym of *Rhopalurus debilis* (Koch), belonging to the family Buthidae.

INTRODUCTION

The higher categories of the family Vaejovidae, a very conspicuous element of the North American scorpiofauna, have been recently revised by Stahnke (1974). That author however, failed to examine a considerable number of taxa at both the specific and supraspecific levels (Francke, 1976), and for this reason his proposed classification of the higher categories leaves much to be desired, particularly in the eyes of taxonomists that appreciate the concepts of phylogenetic (Hennigian) systematics. Stahnke's proposed classification of the vaejovids is often monothetic, occasionally leading him to recognize polyphyletic and paraphyletic taxa. In order to understand the sister-group relationships in vaejovid scorpions it is necessary to have a thorough knowledge of the taxa in question, and this is but one of a series of contributions (see Francke, 1976, and in press) in which I aim to increase our knowledge of the lower categories of Vaejovidae before venturing to propose a classification of the higher categories based on sound phylogenetic principles.

In this contribution I deal with two important issues raised by Stahnke's revision of the higher categories of Vaejovidae, one nomenclatorial and one taxonomic. Nomenclatorially I settle once and for all the controversy over the correct spelling of the generic and familial names. Taxonomically, I remove a controversial genus from the family Vaejovidae and synonymize it in the family Buthidae.

I. THE CORRECT ORIGINAL SPELLING OF THE TYPE GENUS NAME

The type genus for the family was erected by C. L. Koch (1836) when his description of *Vaejovis mexicanus* Koch was published. The generic name was subsequently used by

[1] Present address: Department of Biological Sciences and Department of Entomology, Texas Tech University, Lubbock, Texas 79409.

its author with the same spelling, i.e., *Vaejovis* (Koch 1841, 1843), leaving no doubts about his intentions. However, Thorell (1876) discovered that the original spelling was grammatically incorrect, emending it to *"Vejovis"*; and since then both spellings have been used in the taxonomic literature, with the amended spelling appearing more frequently though. The first attempt to rectify the situation was by Williams (1971), who concluded correctly that Thorell's emendation was unjustified in the meaning of the Code because Koch had used the spelling *Vaejovis* consistently, ruling out a *lapsus calami* (ICZN, Articles 32, 33).

In 1972 Stahnke agreed with the decision to retain *Vaejovis* as the correct original spelling, but in 1974 he reverted to using *"Vejovis"* in his revision of the higher categories, basing his decision on Article 23b of the ICZN (Statute of Limitation of the Law of Priority). This is totally incorrect for several reasons. In the first place, the issue in question was not an unused senior synonym but only the spelling of the name *Vaejovis* versus *"Vejovis"*, thus Article 23b could not contribute to the solution of the problem; Article 32 (Original spelling) and 33 (Subsequent spelling) were included in the ICZN specifically to handle problems of this nature, and are the ones that Stahnke should have used. Secondly, the International Commission of Zoological Nomenclature reworded Article 23b in its entirety (ICZN, 1970), and the reworded version was made retroactive to 6 November 1960. If Stahnke had been aware of this, then even if he incorrectly invoked Article 23b, his conclusion should have been to continue using *Vaejovis* as the correct spelling.

Finally, the 17th International Congress of Zoology held in Monaco during September 1972 approved amended versions of Article 23(a-b) and Article 79(b) (Corliss, 1972; ICZN, 1972, 1974). Briefly, an application has to be made to the Commission to suppress an unused senior synonym, and a case that nomenclatorial stability is threatened can be made by showing that the senior name is not known to have been used once during the immediately preceding fifty years. Thus, Stahnke had no reason nor right to suppress *Vaejovis* without getting a ruling from the Commission, and he does not have a case for that because we are not dealing with an unused senior synonym, and because *Vaejovis* has been used several times in the last fifty years (see Stahnke 1974, p. 132 for some of these citations).

In conclusion, the amended version of Article 32, and Article 33 in the Code clearly states that the spelling *Vaejovis* is to be maintained as the correct original spelling. Accordingly, the family and subfamily names are to be spelt Vaejovidae and Vaejovinae respectively.

II. REDESCRIPTION OF *PHYSOCTONUS PHYSURUS* MELLO-LEITAO (VAEJOVIDAE), A JUNIOR SYNONYM OF *RHOPALURUS DEBILIS* (KOCH) (BUTHIDAE)

The monotypic genus *Physoctonus* was erected, in the family Vaejovidae, by Mello-Leitao (1934) on the basis of a single specimen from northeast Brazil. This genus was poorly characterized in the original description, and has been a continuous source of confusion to scorpion taxonomists since that time. During a visit to Brasil in 1975, I had the opportunity to borrow the holotype of *Physoctonus physurus*, on which the following redescription and taxonomic changes are based.

FAMILY BUTHIDAE

Rhopalurus Thorell

Rhopalurus Thorell 1876, p. 9 (Type species *R. laticauda* Thorell).

Heteroctenus Pocock 1893, pp. 391-393 (Type species *Scorpio junceus* Herbst).

Physoctonus Mello-Leitao 1934, pp. 75-76 (Type species *P. physurus* Mello-Leitao) **NEW SYNONYMY.**

Physoctonus can be recognized as a buthid scorpion on the basis of the characters indicated below. Cheliceral fixed finger with one distal, three external, and one internal teeth. Cheliceral movable finger with five external (two basals) and three internal teeth, and the external distal tooth is longer than the internal distal tooth (Figs. 1-4). Orthobothriotaxia "A": with 11 trichobothria on the femur (Figs. 5-6); 13 on the tibia (Figs. 7-8); eight on the manus, and seven on the fixed finger of the chela (Figs. 9-10). Prosomal sternum subpentagonal to triangular. Walking legs with internal and external pedal spurs. Furthermore, *Physoctonus* is a centrurine buthid on the basis of the following characters: pectinal fulcra present; tibial spur absent on all legs; tergites mono-keeled; pedipalp fingers armed with 7-9 median rows of granules, flanked by supernumerary granules (Fig. 11); femoral trichobothrium d_2 displaced to internal face from its normal position dorsally. Finally, *Physoctonus* is a junior synonym of *Rhopalurus* by sharing with the species included in this genus the rugosity or granulation found on the antero-lateral regions of sternite 3 under the pectines (stridulatory apparatus), and the marked broadening of the metasomal segments distally. This last character gave both genera and their type species their respective names: *Rhopalurus* means "clubbed-tail" (Greek), *laticauda* means "wide tail" (Latin); and, *Physoctonus* means "inflated killer" (Greek; obviously in reference to the metasoma which bears the aculeus terminally), *physurus* means "inflated tail" (Greek) once again.

Rhopalurus debilis (Koch)

Figs. 1-15

Vaejovis debilis Koch, 1841, pp. 21-22, fig. 605.

Vejovis debilis Kraepelin, 1899, p. 96 (Buthidae, *incertae sedis*).

Rhopalurus debilis Borelli, 1910, pp. 5-8, fig.; Mello-Campos, 1924, p. 252; Mello-Leitao, 1932, pp. 14, 30; Meise, 1934, p. 42; Prado, 1939, pp. 29-30; Mello-Leitao, 1945, pp. 272-273; Caporiacco, 1948, p. 610; Bücherl, 1959, p. 268.

Physoctonus physurus Mello-Leitao, 1934, pp. 76-77, figs. 1-7; Mello-Leitao, 1945, pp. 129-132, figs. 40-41; Bücherl, 1969, p. 768; Stahnke, 1974, p. 129. **NEW SYNONYMY.**

As far as I have been able to establish, all taxonomic references to *Rhopalurus debilis* are based on only three specimens: (1) Koch's original type specimen from Brasil, probably an adult female (25.9 mm long, pectinal tooth count 12) which I have been unable to locate; (2) Borelli's (1910) specimen from the state of Ceara in NE Brasil, an adult female discussed below; and (3) Mello-Leitao's type specimen of *Physoctonus physurus* from the state of Paraiba in NE Brasil, an adult male (23.25 mm long, pectinal tooth count 15-16). Although Bücherl (1959) reported that five specimens of *R. debilis* from the state of Ceara were at that time deposited in the collection of the Instituto Butantan, Sao Paulo, I was unable to locate them during my visit there in 1975.

Table 1.—Measurements (in mm) of *Rhopalurus debilis* (Koch) from Brasil.

		Adult male (*P. physurus* holotype)	Adult female from Ceara
Total length		23.25	30.95
Carapace:	length	3.00	4.00
	anterior margin to median eyes	1.25	1.50
	posterior margin to median eyes	1.75	2.50
	anterior width	1.65	2.15
	width at median eyes	2.60	3.50
	posterior width	3.25	4.50
Mesosoma:	length	6.45	9.10
Metasoma:	length	13.70	17.85
	I length/width/depth	1.75/1.75/1.35	2.30/2.30/1.70
	II length/width/depth	2.10/1.75/1.40	2.75/2.05/1.60
	III length/width/depth	2.35/2.00/1.40	2.90/2.20/1.60
	IV length/width/depth	2.50/2.55/1.45	3.30/2.40/1.65
	V length/width/depth	2.70/2.45/1.30	3.60/2.40/1.60
	width at anal arc	1.00	1.35
	telson length/vesicle length	2.40/1.30	3.00/1.80
	vesicle width/vesicle depth	1.00/0.95	1.35/1.25
	aculeus length	1.20	1.20
Pedipalp:	length	11.60	15.25
	femur length/width	2.75/0.75	3.70/1.10
	tibia length/width	3.10/1.30	4.10/1.55
	chela length/width/depth	5.75/1.60/1.45	7.45/1.50/1.40
	movable finger length	4.00	5.30
	fixed finger length	3.35	4.60
Chelicera:	chela length/width	1.15/0.70	1.30/0.95
	movable finger length	0.65	0.90
	fixed finger length	0.35	0.50
Pectines:	tooth count	16-15	16-15
	middle lamellae count	6-6	6-7

Diagnosis.—Small species, adult size not exceeding 30 mm. Ochreous, with distinctive fuscous pattern: carapacial interocular triangle and lateral margins moderately infuscate, posterior submargin weakly fuscous; tergites 1-6 median keels densely infuscate, tergite 7 median keel diffusely infuscate; metasomal segments I-IV with ventral median intercarinae moderately to densely infuscate, segments II-V ventral lateral intercarinae with variable fuscosity, segment V lateral intercarinae fuscous. Tergites 1-6 mono-keeled, tergite 7 pentacarinate. Sternite 3 anterolaterally rugose, sternite 7 tetracarinate. Metasomal segments I-II with 10 complete carinae, segments III-IV with eight complete carinae; intercarinal spaces shagreened to rugose. Telson with subaculear tubercle vestigial. Movable finger of pedipalps with seven median rows of granules, and abundant supernumerary granules. Pectinal tooth count 15-16 in males, 12-16 in females.

Description.—Adult male (measurements in Table 1).
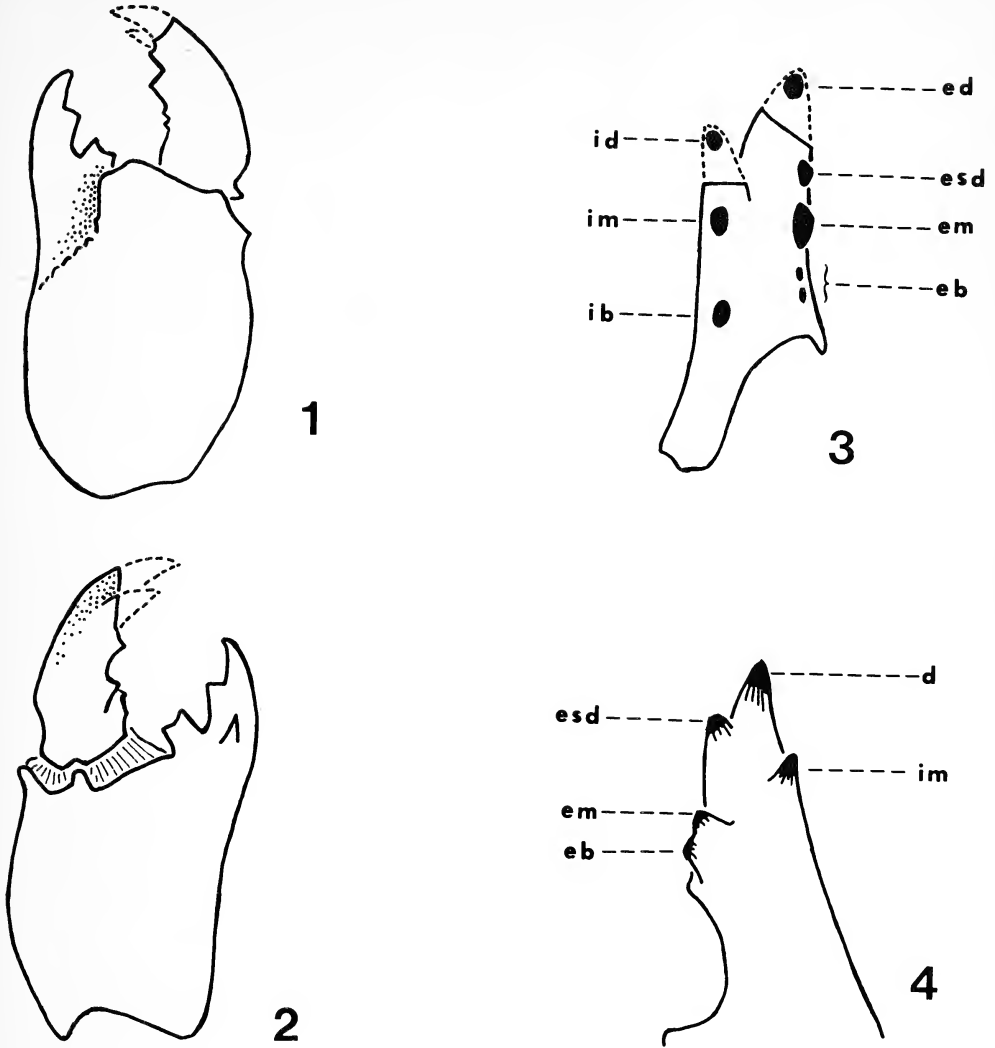
Figs. 1-4.–Right chelicera of holotype male of *Physoctonus physurus* Mello-Leitao, 1934 [=*Rhopalurus debilis* (Koch, 1841)] from Santa Luzia, Paraíba, Brasil: 1, dorsal; 2, ventral; 3, dentate margin of movable finger; 4, dentate margin of fixed finger. Terminology modified from Vachon (1963): *e*, external; *i*, internal; *d*, distal; *sd*, subdistal; *m*, median; *b*, basal.

Prosoma.–Carapace ochreous: interocular triangle with moderately dense, finely variegated fuscosity; lateral margins moderately infuscate; posterior submargin weakly fuscous laterally; posterior median furrow flanked medially with sparse, uniform fuscosity. Anterior margin of carapace shallowly emarginate. Three pairs of lateral eyes, subequal in size and their diameter is approximately one-half the diameter of median eyes. Median eyes separated by slightly more than their own diameter, located at anterior two-fifths of carapace length. Anterior median furrow moderately deep and wide, narrowing gradually over median ocular prominence. Posterior median furrow: proximal one-half (immediately behind ocular prominence) shallow, wide; distal half abruptly deeper, moderately wide. Posterior marginal furrow moderately deep, wide. Posterior submedian furrows short, strongly divergent, moderately deep. Carapacial carinae: superciliaries well devel-
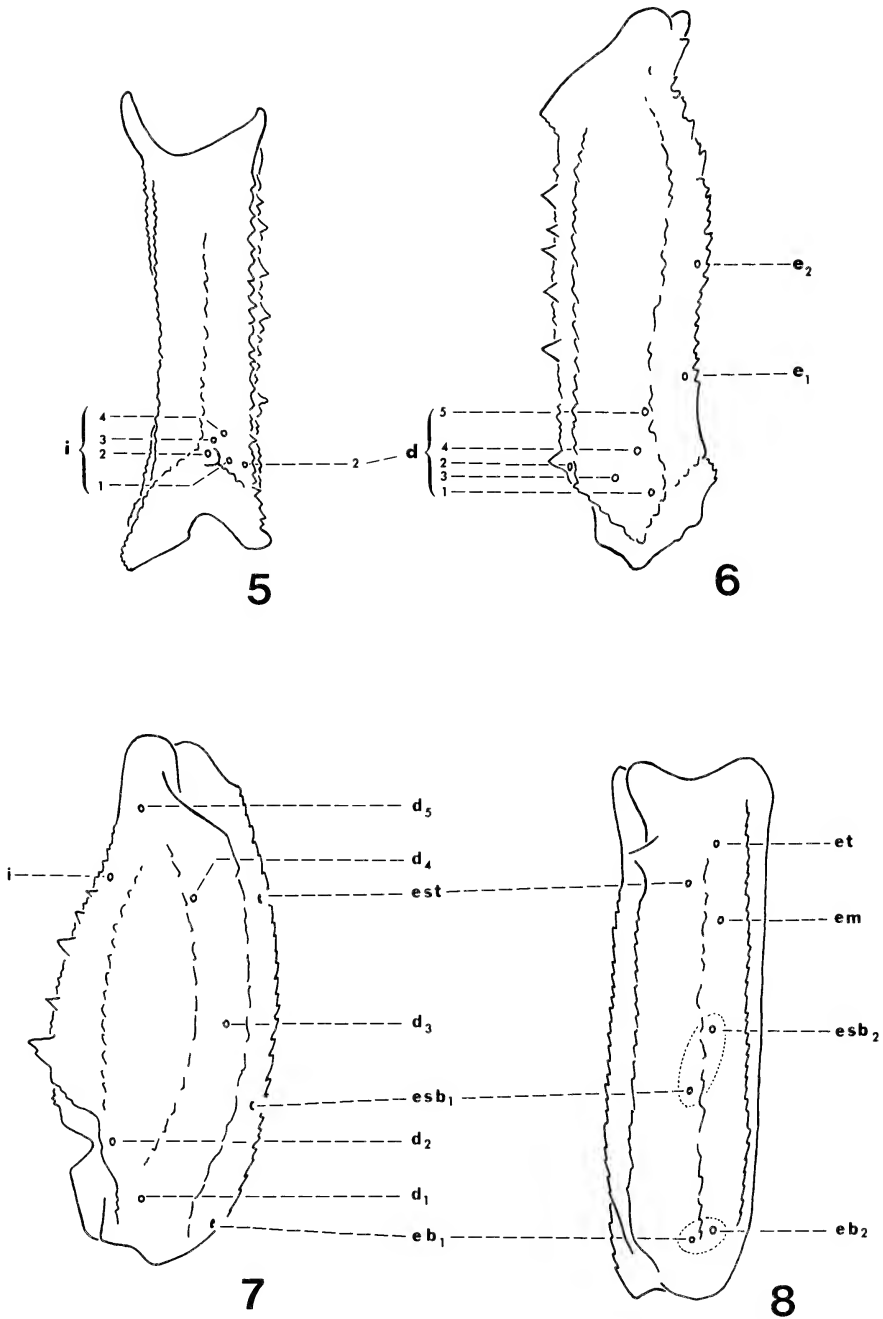
Figs. 5-8.—Trichobothria on right pedipalp femur and tibia of holotype male of *Physoctonus physurus* Mello-Leitao, 1934 [*=Rhopalurus debilis* (Koch, 1841)] from Santa Luzia, Paraíba, Brasil. Trichobothrial terminology after Vachon (1974): 5, femur, internal view; 6, femur, dorsal view; 7, tibia, dorsal view; 8, tibia, external view.

oped, finely granulose; posterior submedians subparallel, weak, short, granular. Anterior submargin coarsely, densely granulose; other surfaces densely, minutely granulose. Venter flavus, sparsely setate. Sternum subpentagonal, longer than wide with moderately divergent sides (Figs. 12-13).

Mesosoma.—Tergites ochreous: median keels densely infuscate on 1-6, diffusely infuscate on 7; lateral marginal fuscosity moderate to sparse, decreasing in density and extent posteriorly and becoming unnoticeable on tergite 7; tergites 3-6 vestigially infuscate submedially. Tergites 1-6 mono-keeled; median keel moderately strong, serrate. Tergite 7 penta-keeled: median carina present on proximal one-half, weak, granular; submedian carinae strong, serrate; lateral carinae moderately strong, serrate, converging proximally with submedian keels. Venter flavus. Genital operculi subtriangular, without median longitudinal membranous connection; genital papillae present. Pectinal basal piece twice wider than long, with anterior margin notched medially. Pectinal marginal and middle lamellae sparsely setate; middle lamellae quadrangular, six per comb. Fulcra subtriangular. Pectinal tooth count 15-16, each tooth approximately three times longer than wide. Sternites 2-6 rugose, sparsely setate; stigmata elongate. Sternite 3 with anterolateral regions slightly depressed, rugose to finely granulose. Sternite 7 tetracarinate: submedian keels present on distal two-thirds, moderately strong, granulose; lateral keels present on distal three-fourths, moderately strong, granulose.

Metasoma.—Ochreous, with well defined fuscous pattern: ventral median intercarinal spaces sparsely infuscate distally on I, densely infuscate throughout on II-IV; ventral lateral intercarinae on I-III sparsely infuscate distally, on IV-V with dense variegated fuscosity throughout; lateral intercarinae on V with diffuse, uniform fuscosity.

Ventral submedian carinae: on I-II weak, feebly serrate, subparallel; on III-IV weak to vestigial, feebly serrate, subparallel. Ventral lateral carinae: on I-III moderately strong, serrate; on IV weak, serrate to granulose. Lateral inframedian carinae: on I complete, moderately strong, serrate; on II complete, weak to moderate, serrate; on III vestigial to obsolete, except for distal row of 3-4 small to medium sized subconical granules; on IV obsolete. Lateral supramedian carinae moderately strong; on I-II serrate, on III vestigially serrate, on IV smooth. Dorsal lateral carinae on I-IV moderately strong, serrate. Segment V carinae: ventral median vestigial, subgranose; ventral laterals weak, granulose; lateral medians obsolete; dorsal laterals weak, subgranose. Intercarinal spaces on I-V shagreened to rugose. Telson ochreous, with vesicular ventral surface vestigially granulose. Subaculear tooth vestigial, tuberculate; aculeus long, sharply curved (Figs. 14-15).

Chelicera.—Chela and fingers ochreous, teeth testaceous. Dentition of fixed and movable fingers typical of centrurine buthids (Figs. 1-4).

Pedipalps.—Orthobothriotaxia "A" (Vachon, 1974). Femur ochreous, five-keeled: ventral external carina strong, irregularly serrate; ventral internal carina moderately strong, with regularly spaced granules; dorsal external keel moderately strong, serrate; dorsal internal keel moderately strong, granulose; internal keel moderately strong, with large subconical granules irregularly spaced. Femoral trichobothrial pattern shown in Figs. 5-6.

Tibia ochreous, with diffuse variegated fuscosity on dorsal, internal and external faces. Seven keels: ventral external, ventral internal, dorsal external, dorsal median, dorsal internal, and external keels moderately strong, finely serrate; internal keel moderately strong, with large and medium sized subconical granules irregularly spaced. Intercarinal spaces rugose. Tibial trichobothrial pattern shown in Figs. 7-8.

Chela ochreous, with vestigial fuscosity dorsally and externally on manus and on fixed finger base. Trichobothrial pattern shown in Figs. 9-10. Carinae vestigial to obsolete,
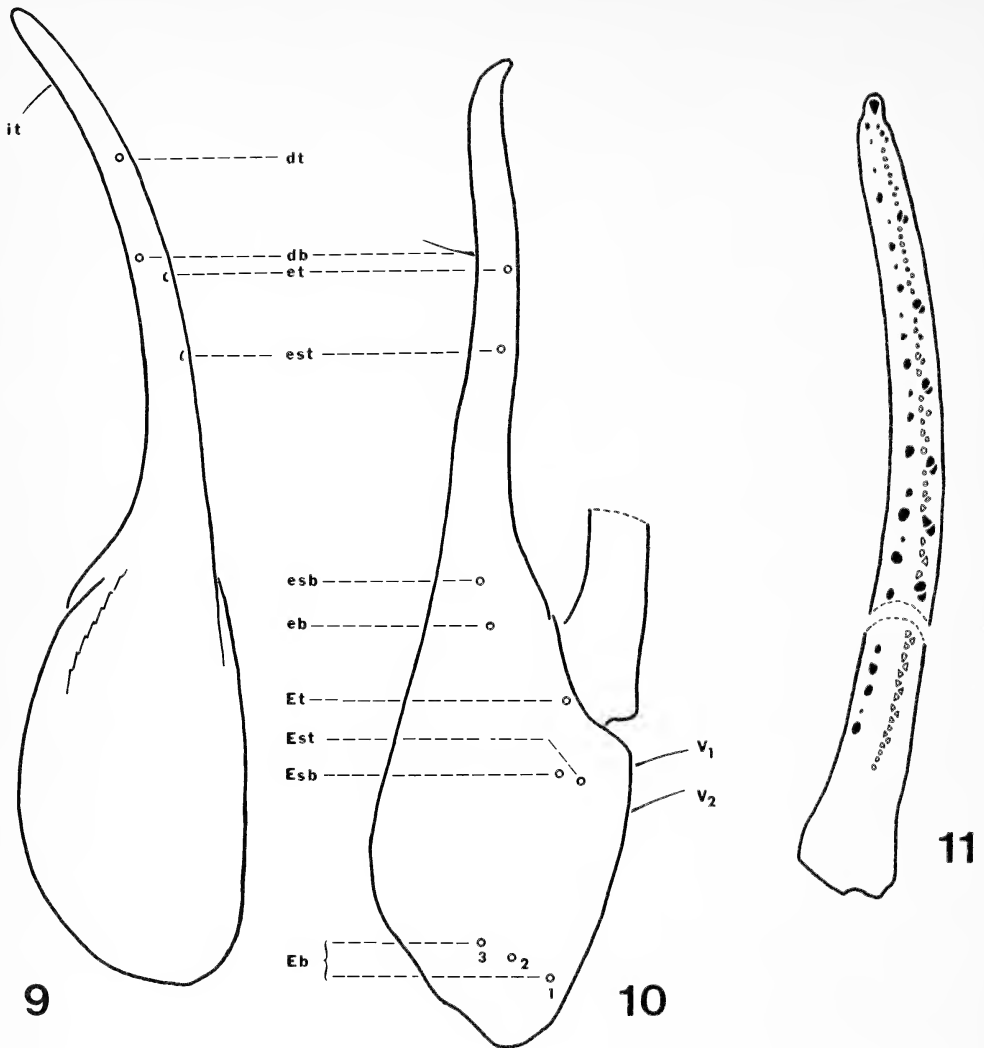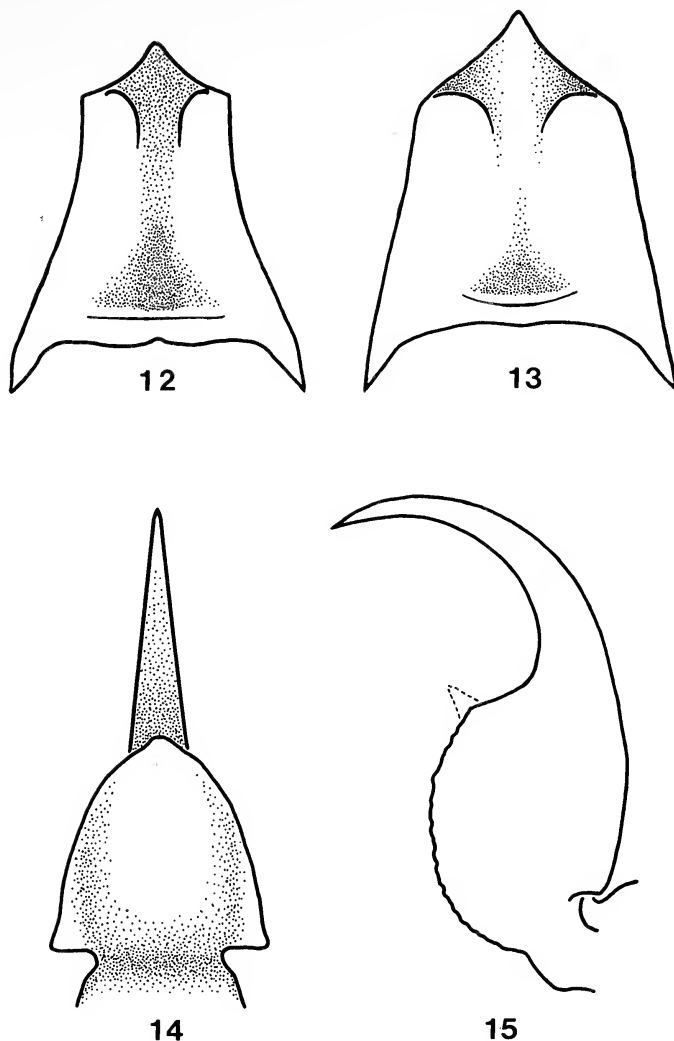
Figs. 9-11.—Right pedipalp chela of holotype male of *Physoctonus physurus* Mello-Leitao, 1934 [=*Rhopalurus debilis* (Koch, 1841)] from Santa Luzia, Paraíba, Brasil. Trichobothrial terminology after Vachon (1974): 9, dorsal view; 10, external view; 11, dentate margin of movable finger, showing seven median rows of granules separated by seven triads of larger denticles (terminal triad included), and the presence of numerous supernumerary granules.

obtusely angular "facets" suggesting their presence. Dentate margin of fingers separated at base when fingers close due to sinuous shape of fixed finger (Fig. 10). Moveable finger dentition typical of centrurine buthids (Fig. 11).

Legs.—Ochreous, with fuscous traces on femora and tibia. Internal and external pedal spurs present; internal spur simple, external spur bifurcating subbasally as in other centrurine buthids. Tibial spur absent.

Condition of specimen.—Prolonged immersion in preservative appears to have influenced basic coloration somewhat. The right chelicera is detached from specimen. The movable fingers of the pedipalp chelae are broken: the right one at approximately one-third its length from the base, and the loose portion is preserved with the specimen; the

Figs. 12-15.—Species of *Rhopalurus*: 12, sternum of *R. laticauda* Thorell, adult male from Estado Miranda, Venezuela; 13, sternum of adult male holotype of *Physoctonus physurus* Mello-Leitao, 1934 [=*R. debilis* (Koch, 1841)], from Santa Luzia, Paraíba, Brazil; 14, telson of holotype male of *P. physurus*, ventral view showing vestigial subaculear tooth; 15, telson of holotype male of *P. physurus*, lateral view (dashed line indicates position of subaculear tooth in *R. laticauda*).

left moveable finger is broken off at approximately one-half of its length, and the distal portion is missing.

Depository.—The holotype of *Physoctonus physurus* Mello-Leitao is permanently deposited at the Museu Nacional, Rio de Janeiro, Brasil.

Locality data.—In the original description Mello-Leitao did not give a type locality and simply mentioned that the holotype was among the specimens collected by the members of the Technical Commission on Pisciculture at Brasil's northeastern states, particularly Pernambuco and Paraíba. Subsequently, Mello-Leitao (1945) gave the type locality for *P. physurus* as Soledade, Paraíba, Brasil. The holotype is accompanied by two hand-written labels: one of them is the identification and type designation label; and the other is the

locality label, which definitely does not spell out "Soledade", and appears to me to read "Sta. Luzia - Paraíba". Localities with each of these names, Soledade and Santa Luzia, exist in the state of Paraíba, the former being approximately 500 km ESE of the latter. In view of this discrepancy, I am inclined to consider the type locality of *P. physurus* as Santa Luzia, Paraíba, simply because this is the data found on the label accompanying the holotype.

Description.–Adult female (measurements in Table 1). The specimen reported by Borelli (1910) differs from the male by its larger size, its more atenuated pedipalp chela with straight fingers (rather than feebly sinuate), and its lack of genital papillae. Prolonged preservation has resulted in the loss of all fuscous markings originally reported by Borelli (1910), which closely agree with those described above for the male. The single female comes from Ceara, Brasil, and is permanently deposited in the Museo ed Istituto di Zoologia Sistematica della Universita di Torino, Italy.

Comparative description.–*Rhopalurus debilis* is the smallest species of the genus. It appears similar to *R. acromelas* Lutz and Mello, a medium sized species with adults attaining 55 mm in total length and having the following distinguishing characteristics: movable finger of pedipalp chela with eight median rows of granules; telson with well developed subaculear tooth; and, metasomal segment III with the lateral inframedian carinae present on the distal half and granulose. The adult male of *R. debilis* resembles adult males of *R. laticauda* in having seven median rows of granules on the movable fingers of the pedipalp chelae, and in the slight sinuosity of the fixed finger. *R. laticauda* is a medium sized species with adults ranging from 45 mm to 55 mm in total length, has a pectinal tooth count of 19-24, and on metasomal segment III the lateral inframedian carinae are complete.

ACKNOWLEDGEMENTS

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SOCIAL BEHAVIOR OF THE GOLDEN SILK SPIDER,
NEPHILA CLAVIPES (LINNAEUS) (ARANEAE, ARANEIDAE)

James A. Farr [1]

Department of Biological Sciences
Florida State University
Tallahassee, Florida 32306

ABSTRACT

Web clumping by female *Nephila clavipes* is not a social phenomenon but rather a random process influenced by population density and number of suitable web sites. There is an uneven distribution of males in the webs of mature females, and it is believed that web clumping may actually be disadvantageous if a less attractive female constructs a web adjacent to a more attractive one. Larger females spin larger webs, so adjacent smaller females may suffer reduced feeding efficiency and hence reduced growth rate and lowered fecundity. Males attempt to mate with females when the latter are feeding, and in multiple-male webs, the males fight among themselves for females. If dominance hierarchies among males exist, it is predicted that they are only temporary, either because of inherent instability or because of male transcience.

INTRODUCTION

In his review of social phenomena in spiders, Shear (1970) mentioned the tendency of female *Nephila* spp. to share web support lines, and consequently suggested that *Nephila* might be semisocial. Comstock (1920) reported that adult *Nephila* males spin no web but live in the web of a female, and Archer (1940) observed that many webs contain more than one male. The present report examines the possibility of sociality in *Nephila clavipes* in more detail and investigates male-male interactions resulting from competition for females.

I asked three basic questions. First, is there a real tendency for females to construct webs in clumps, or is clumping a random process? Cohen (1971) analyzed casual group sizes in vervet monkeys and in man and found that group-size frequencies fit either a Poisson distribution or a negative binomial distribution with the zero-terms eliminated. If the group-size frequency distribution fits a zero-truncated Poisson distribution, size of a group does not influence its attractiveness, and it can be concluded that individuals do not seek other individuals, or that grouping is a stochastic process. In the present analysis, I attempt to fit an observed distribution of clump size frequencies to a zero-truncated Poisson distribution in an effort to detect deviations from randomness in support of the sociality hypothesis.

Is there an even distribution of males in the webs, or are some females preferred over others? The observation that some webs are inhabited by more than one male raises questions about male choice of females and about intermale competition for females. One

[1] Present address: University of West Florida, c/o The U.S. Environmental Protection Agency, Sabine Island, Gulf Breeze, Florida 32561.

can ask whether certain females are more attractive than others, or if the uneven distribution of males is random. I analyzed frequency of occurrence of multiple-male webs and attempted to discover whether any particular quality of the females was correlated with male distribution and abundance.

Finally, I addressed the problem of intermale competition for females in multiple-male webs. Robinson and Robinson (1973) described the courtship of *Nephila maculata* and reported that although males typically wrap the females in strands of silk prior to mating, often this behavior is omitted and males will mount a female and copulate while she is feeding. They also reported that preliminary observations of *N. clavipes* indicated no wrapping of the female in silk prior to mating. I observed opportunistic mating in *N. clavipes* in webs with single males and then studied the responses of males in webs with more than one male. Agonistic encounters among males competing for females have been observed in the crab spider, *Diaea dorsata*, by Braun (1958), in the sheet-web spider, *Linyphia triangularis*, by Rovner (1968), and in *Nephila maculata* by Robinson and Robinson (1976), so I examined the possibility that similar behavior is exhibited by male *Nephila clavipes* in webs with more than one male.

Herein, I present evidence that clumping of webs by females is a random phenomenon and that males do aggressively contest for females. While it was ascertained that male distribution in female webs is not even, no particular attribute of females was found to account for this. The results are discussed in terms of the advantages and disadvantages of living in groups as directly related to reproductive success and fitness of *Nephila clavipes*.

MATERIALS AND METHODS

I observed natural populations of *Nephila* in two study areas. The first was in a hardwood forest surrounding a sink hole in Wakulla County, Florida, approximately 1.5 miles south of U.S. Highway 98 and approximately 2.0 miles east of the intersection of U.S. 98 and U.S. 319. This site was observed in July and August, 1974 and 1975, and the spider populations are hereafter referred to as Sink 1974 and Sink 1975. The second site was a hardwood forest directly across Appleyard Drive from Tallahassee Community College in Leon County, Florida, was observed in July and August, 1975, and is referred to as TCC 1975.

My initial sampling of the three populations involved a thorough, systematic search of the study areas and examination of all individuals encountered. For every web found, I measured the total length of the female (cephalothorax and abdomen), counted the number of attendant males, and recorded the number of other webs adjoining, sharing support lines, or with hubs less than 1.0 m apart. In 1975, after measuring the length of the female, I also measured the size of the webs at both sites. It should be noted that measuring total length gives only a rough estimate of relative size in this species, since the abdomen is highly distensible and varies in size according to reproductive condition and amount of food recently consumed. Measuring the length of the cephalothorax gives more reliable comparisons, but also involves closer measurement and a higher risk of disturbing the spider in its web. Since behavioral observations were performed on the same individuals, I chose total length and sacrificed precision for a lower probability of interfering with the natural behavior of the animals.

Behavioral observations were done as follows. If a female was feeding when first encountered and sexual behavior was observed, I recorded whatever behavior occurred. To elicit feeding behavior from the beginning, I used various species of crickets as prey. I

Table 1.–The frequency distribution of *Nephila clavipes* web clump sizes. The observed frequencies fit those expected from a zero-truncated Poisson distribution (X^2=5.749, d.f.=k-2=3).

Clump Size	Observed Frequency	Expected Frequency
1	49	45.90
2	17	20.54
3	4	6.13
4	3	1.37
5	1	0.25

simply tossed the cricket into the web below the hub in whatever area appeared to have the finest mesh and proceeded to make general notes on feeding behavior by the female and subsequent responses of the male(s). Although crickets are not the natural prey of *N. clavipes*, I detected no obvious differences in the social behavior of those females feeding on natural prey (various flying insects, particularly Lepidoptera and Coleoptera) and those feeding on crickets. Not every sequence was observed to completion.

RESULTS

I followed J. Cohen's (1971) analysis of casual group sizes in primates, used A. C. Cohen's (1960) tables for estimating the conditional Poisson parameter λ, and attempted to fit a zero-truncated Poisson distribution to the clump size data. A comparison of the observed and expected values of clump size frequencies (Table I) showed a good fit (X^2=5.749, d.f.=3). Thus, it can be concluded that clump size is random and the hypothesis that there is some intentional grouping or tendency to aggregate can be rejected. The Sink 1975 population and the TCC population were considerably less dense than the Sink 1974 population. During my initial sampling I found 19 clumps of one and two clumps of two at the Sink 1975 location, and 26 clumps of one and two clumps of two at the TCC 1975 site. This is further indication that clumping is not intentional but rather a random process facilitated in part by higher population densities.

It was noted in all three populations that there was not an even distribution of males in the webs of the females. In the Sink 1974 population there were many very small individuals with orb webs, and it was found that no webs constructed by spiders $\leqslant$1.0 cm in total length contained mature males. Table II outlines the number of webs of individuals observed in each size class >1.0 cm and the number which contained at least one male. This analysis includes only the largest female of each clump and combines data for all three populations.

Robinson (pers. comm.) suggests that some individuals $\leqslant$1.0 cm are probably immature males, that most females between 1.1 and 2.0 cm are immature, and that some females 2.1 to 2.5 cm are immature. There was no significant correlation between size of females $\geqslant$2.1 cm and number of males in the web, although there was a high degree of variability in male number. Of 48 females sampled for number of males, 10 had no males, 25 had one male, eight had two males, four had three males, and one had six males. No obvious female characteristic appeared correlated with number of attendant males, and whether male number is random, like number of webs per clump, or there is some less obvious female feature determining attractiveness is unknown. It is interesting to note that males were found in many webs of immature females, a situation reported by

Table 2.—Observed size classes of the largest female *Nephila clavipes* in each clump at every site, including the number and percent observed with at least one attendant male.

Size class	N	Number with Males	Percent with Males
1.1 - 1.5 cm	29	6	20.7
1.6 - 2.0 cm	33	19	57.6
2.1 - 2.5 cm	20	15	75.0
2.6 - 3.0 cm	14	10	71.4
3.1 - 3.5 cm	8	6	75.0
>3.5 cm	6	5	83.3

Robinson and Robinson (1973). Robinson (pers. comm.) believes that this may be advantageous to the male in that it possibly ensures first mating once the female has matured.

I attempted to correlate size of the female's web with body length in the Sink 1975 and TCC 1975 populations. *Nephila clavipes* webs are incomplete orbs with an eccentric hub, so I could not measure diameter or area (see drawing in Levi and Levi, 1968, p. 65). Thus, I measured the distance R from the hub of the web to the lowest part of the orb. I found that body length, L, and web "radius", R, had the following relationships:

$$R = 4.8 + 12.7 L \quad (r = .887)$$

$$OR$$

$$R = 17.8 L^{0.82} \quad (r = .867)$$

Because the range of L was only 3.0 cm (1.1 cm to 4.1 cm), both a linear regression and a curvilinear regression of R on L were significant at the $<.01$ level. McNab (1963) found that home range size and mean species weight are exponentially related in several vertebrates.

I found eight different females with a single attendant male and that were in the act of feeding on flying insects when I encountered them. In each case, the male was seen to mount the female ventrally, Kaston's (1948) Position III, and copulate or attempt to copulate with the female. During the act of presumed insemination, the male tapped the emboli of the pedipalps against the epigynum of the female as described by Robinson and Robinson (1973). I saw no instances in which a female with a single male was not being mated while feeding.

In order to examine the entire behavioral sequence of mating, I chose 13 webs, each with a female and a single male, and introduced prey. In every case, as soon as the female moved from the hub of the web and attacked the prey, the previously motionless male began to move toward the hub. The predatory behavior of the female is very stereotyped and is described in detail by Robinson and Mirick (1971). After wrapping the prey, the female always returned to the hub to feed and assumed a head-down position in the web, at which time the male would mount the female and attempt to mate. In three of the 13 cases, the female chased the male away after the latter mounted, but in two of those, the male persisted in its attempts and ultimately appeared successful in mating. I was successful in eliciting the male behavior in 100% of my attempts. The entire sequence from the time the cricket was introduced to when the males ceased their activity lasted from 10 to 65 minutes.

Finally, I wished to examine behavioral interactions of males when competing for females in those webs with multiple males. At the Sink 1975 population I attempted to

elicit sexual behavior in six webs with more than one male—three with two males and one each with three, four, and five males. Although I was able to elicit mounting and mating attempts by every male in single male webs, this was not the case with multiple-male webs, although at least one male attempted to mate in every multiple-male web. In each web with two males, only one male was successful in mating. In one instance, one male never moved after the female was fed. In a second case, the non-mating male moved to within 4 cm of the male that eventually mated, then retreated to a position approximately 30 cm above the hub of the web. In the third instance, both males moved to the hub simultaneously, and after a brief agonistic encounter, one male succeeded in chasing the other away.

In the three-male web I observed a peculiar series of events after the cricket was introduced. One male, that I will call male 1, went to the cricket and mounted and attempted to mate with the female while the latter was biting and wrapping the prey. When the female returned to the hub with the prey, male 1 rode on the former's back, where the male remained for most of the observation. Meanwhile, male 2 met the female at the hub, mounted, and mated. After about five minutes, the female gently brushed male 2 away. Male 3 approached the hub but was chased away by male 2 after a brief agonistic encounter. Male 2 attempted to mount the female twice more but was brushed away by the female. Finally, male 1 moved from the female's back to a position about 10 cm from the hub. Male 2 mounted the female, copulated, and dismounted. No further activity was observed.

In the four-male web, two males did not move for the first 30 minutes after prey introduction, then they only moved to within 15 cm of the hub. When the cricket was introduced, male 1 moved to the hub and mounted and mated when the female arrived with the prey. Male 1 remained there for 15 minutes before male 2, who had previously remained motionless, moved to the hub, mounted the female, and aggressively displaced male 1. During the encounter, male 1 lost a leg. Male 2 copulated for about five minutes, then male 1 returned, aggressively displaced male 2 from the female, and left without mating. Male 2 remounted, copulated, and left.

Finally, in the five-male web, one male remained motionless for the duration of the observations. There was much aggression among the other four. Initially, three males approached the female. Male 1 fought and chased off males 2 and 3, then mounted the female and mated. Males 2 and 3 fought each other twice during this time. Eventually, male 4 came to within 10 cm of the hub. Male 1 dismounted and chased away males 3 and 4. During this time, male 2 mounted the female, but he was aggressively displaced by male 1 after males 3 and 4 had gone to the periphery of the web. Male 1 remounted the female, copulated again, and at one point prevented male 3 from chasing itself off her. Approximately 45 minutes after the observations began, a male displaced male 1 from the female, mounted but left without copulating.

All aggressive interactions observed occurred in three seconds or less and involved what appeared to be a rapid physical beating of the opponent with the forelegs. I saw no type of threat display as has been observed in other species of spiders (Crane, 1949; Braun, 1958; Rovner, 1968). I could not determine whether there were attempts to bite the opponent, though I have observed such behavior when males are placed together in collecting vials, the result being death of the bitten individual. I could ascertain no obvious physical characteristics determining the outcome of any aggressive bout, as smaller males and males with fewer legs were often the victors. An investigation is currently underway to describe their agonistic behavior in detail and to study the influences

on outcome of aggressive interactions.

DISCUSSION

Nephila clavipes is probably not a semisocial species as suggested by Shear (1970), since web clumping appears to be a stochastic phenomenon and entrance into a group is independent of group size. I suggest that there is a limited number of suitable sites for webs in any given habitat and that as the density of spiders increases, the probability that two or more occupy the same site increases. If females actively seek each other and build webs together, clump size frequencies would not be Poisson distributed.

There are obvious disadvantages to building a web near another female. First, a female that constructs a web adjacent to a more attractive female risks the possibility of not mating. Unlike other araneids, *N. clavipes* builds a permanent web, repairing damaged portions rather than constructing a new one (Gertsch, 1949). Thus, the presence of a more attractive female nearby could result in a long term reproductive disadvantage and reduction in fitness.

A second disadvantage of living in a group may be reduced feeding efficiency. Larger females build larger webs so have a higher probability of trapping flying insects. Several times I observed clumps of two or more females in which one female was feeding, and in all but one it was the largest female that was feeding. In the other case, a smaller female was eating a caterpillar, not the usual flying insects. If they are prevented from trapping more prey, smaller females might exhibit reduced growth rates. Since fecundity is usually exponentially related to size (Mota Alves and Bezerra, 1968; Swartz, in press; Abele, pers. comm.), a small difference in length represents a greater difference in fecundity. Also, immature females may exhibit delayed maturity as a result of reduced growth rate, and this in turn would reduce number of descendents and hence fitness.

It would seem that a male risks a serious reduction in fitness whenever there is more than one male in a female's web, and particularly when other females without males are nearby. If dominance hierarchies among males exist, I predict they are not stable and subordinate males have a good chance of ultimately being dominant. Logically, a subordinate male in a long-term stable hierarchy would seek another female with no males. A second alternative is that there are no lasting dominance hierarchies at all, that there is an agonistic contest among males whenever a female is feeding. However, this would not explain the observed instances of males not even attempting to approach the female. Finally, males may be transient and not remain long in one web. If this were the case, a male could ultimately mate with any female just by waiting long enough, particularly if prior residence in a web positively influences the outcome of agonistic encounters. It is known that male *Linyphia triangularis* remain in the female's web for no longer than two days, but they also do not tolerate the presence of a second male in the web (Rovner, 1968).

The actual copulatory behavior of *Nephila clavipes* was mentioned briefly by Robinson and Robinson (1973) in their analysis of the behavior of *Nephila maculata* in New Guinea. *N. maculata* males exhibit a ritualized courtship behavior including wrapping the female in strands of silk. My observations confirm their report that no such behavior is exhibited by *N. clavipes*; all copulatory behavior I observed was always preceded by the female capturing prey and was never preceded by ritualized male display behavior such as web vibration or wrapping the female. This opportunistic mating system parallels the highly ritualized food exchange in the courtship ceremony of the predatory balloon flies,

family Empididae (Kessel, 1955), and the offering of prey to females by male *Pisaura mirabilis* during courtship (Bristowe, 1958). As in these examples, a *Nephila* female is less likely to eat an approaching male if the female has already captured a prey. Male balloon flies and *P. mirabilis*, however, present food to the female rather than waiting for the female to capture food.

From an ethological viewpoint, *N. clavipes* exhibits a unique signal-response system with one signal, the prey, eliciting a different response in males and females. If one employs Otte's (1974) scheme of functional and exploitative signal systems, the prey represents the signaler, the female represents the legitimate receiver, and the male is the illegitimate receiver. Males have evolved an exploitative, deceitful behavior as a response to the risk of intraspecific, intersexual predation.

In summary, the phenomenon of clumping in *Nephila clavipes* is not a result of semisociality but rather a stochastic phenomenon influenced by population density and availability of suitable sites for webs. As further evidence against the hypothesis of sociality, females in clumps of two or more are at a possible selective disadvantage because of differences in attractiveness to males and lowered feeding efficiency. Number of males per web is variable, and where there are two or more males, they aggressively contest for females at the risk of injury or death. It is predicted that if dominance hierarchies among males exist, they are temporary, and that males may remain in webs for only a short time. Further studies of ritualized aggression and dominance hierarchies in *Nephila* are in progress.

ACKNOWLEDGEMENTS

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Cover illustration, male of *Paraphrynus emaciatus*, Carolyn L. Mullinex

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SCORPIONS OF THE GENUS *DIPLOCENTRUS* FROM OAXACA, MEXICO
(Scorpionida, Diplocentridae)

Oscar F. Francke

Department of Zoology
Arizona State University
Tempe, Arizona 85281

ABSTRACT

Diplocentrus mexicanus Peters is reestablished as the valid type species of the genus *Diplocentrus* Peters. The type of *D. mexicanus* has been lost, but the published information is sufficient to establish that this taxon is not synonymous with *D. whitei* (Gervais) as previously maintained. Accordingly, a neotype for *D. mexicanus* is designated and described. The exact type locality of *D. mexicanus* is still unknown because the incomplete data accompanying the neotype, and one additional known specimen referable to this species, only indicate that they were collected in Mexico. A new subspecies has been found in the state of Oaxaca, *D. mexicanus oaxacae*, n. ssp., and for this reason alone the description of the nominate subspecies is included here. Seven other species of *Diplocentrus* are recorded from Oaxaca, including four new ones: *D. tehuano*, n. sp., *D. hoffmanni*, n. sp., *D. reticulatus*, n. sp., and *D. mitlae*, n. sp.. The holotype of *D. rectimanus* Pocock is redescribed, establishing that this taxon is not a synonym of *D. keyserlingi* Karsch as formerly held, and the controversy over its type locality is solved. *D. keyserlingi tehuacanus* Hoffmann is given specific recognition, and redescribed accordingly. Finally, *D. ochoterenai* Hoffmann is redescribed from the holotype, which is a female rather than a male as originally believed by Hoffmann, and the male is described for the first time.

INTRODUCTION

The genus *Diplocentrus* was erected by Peters (1861) for a new species from Mexico, appropriately named *mexicanus* by its author. Peters considered the genus to be monotypic, and gave only a short diagnosis that applied to both the genus and the type species. Peters failed to indicate, however, other characters that would have been useful in separating *D. mexicanus* from other species that might have been subsequently discovered. Karsch (1879a) referred the Mexican species *Scorpio whitei* Gervais, 1844 to the genus *Diplocentrus* and cited *D. mexicanus* as its junior synonym. Thus, *Diplocentrus whitei* (Gervais) became established as the type species of the genus, an opinion that has prevailed ever since. Subsequently however, Karsch (1879b) after examining the type of *D. mexicanus* and studying carefully Gervais' description of *D. whitei* came to the conclusion that both were valid species, gave a short key to separate them, and provided a brief description of *D. mexicanus*. Finally, Karsch (1880) maintained this view and provided some additional specific characters for *D. mexicanus*.

Unfortunately, Karsch's views (1879b, 1880) have been either neglected, overlooked, or ignored by all scorpion taxonomists working with the genus *Diplocentrus* since then,

and *D. mexicanus* has been regarded as a junior synonym of *D. whitei*. As part of an ongoing revision of the family Diplocentridae (Francke 1975, and in press) I have examined the holotype of *D. whitei* in addition to more than 200 specimens belonging to this species (redescription in preparation), arriving at the conclusion that *D. mexicanus* is indeed a distinct taxon, and thus the rightful type species of the genus *Diplocentrus*. The type specimen of *D. mexicanus* could not be located at the Zoologisches Museum, Humboldt-Universität zu Berlin where it was supposedly deposited, and was apparently destroyed during World War II (Dr. M. Moritz, pers. comm.). Amongst the thousands of specimens from Mexico examined, I found one adult male that agrees remarkably well with all the known facts about *D. mexicanus*. Because the type species of the genus is involved in this complex taxonomic problem, that specimen is designated as the neotype of *D. mexicanus* and described below.

The exact type locality for *D. mexicanus* is still unknown, as the data accompanying the neotype male, and the other specimen known (adult female), indicate that the specimens originated in Mexico. A new subspecies of *D. mexicanus* has been found in the state of Oaxaca, and for this reason the redescription of the nominate subspecies is included here, even though I am fully aware that it might not occur within the geopolitical boundaries of the state of Oaxaca.

The center of distribution of a given taxon is often defined as the geographical area containing the highest number of taxa in the next lower category belonging to that particular taxon (Darlington, 1957). Using this criterion, Oaxaca appears to be the center of distribution of the genus *Diplocentrus*. Large areas of Oaxaca still remain unexplored in terms of their scorpion fauna (Map 1), and potentially still more species can be found within its territory in the future. Two of the eight species were originally described from specimens collected in the state of Oaxaca, and are unknown outside its boundaries: *D. rectimanus* Pocock, which is redescribed below because it had been erroneously synonymized under *D. keyserlingi* Karsch; and *D. ochoterenai* Hoffman, also redescribed below because it was previously known only from the holotype, which is an adult female rather than a male as stated in the original description. A third taxon, *D. keyserlingi tehuacanus* Hoffmann is given specific recognition, and is redescribed for this reason. The remaining five species, one of which is represented by a subspecies, represent new taxa endemic to Oaxaca.

TAXONOMIC OBSERVATIONS

The species of the genus *Diplocentrus* are among the most taxonomically neglected scorpion taxa in North America, and I attribute this to be the result of two main factors. Firstly, all the species appear to be obligatory burrowers, exhibiting limited periods of nocturnal surface activities. Therefore, prior to the mid-1960's these scorpions were rarely collected by the traditional method of overturning rocks or other objects resting loosely on the substrate, and then only one or a few specimens could be obtained from any one locality. The scarcity of material seriously hampered studies on intraspecific variability, and limited the accuracy of interspecific comparisons for taxonomic purposes.

Secondly, intraspecific variability in *Diplocentrus* spp. is probably the highest among North American scorpions. Ontogenic changes and allometric growth rates often make the identification of immature specimens virtually impossible, unless these form part of a larger series containing adults. In addition, a marked degree of sexual dimorphism between adults further complicates the identification process, especially if a species was

originally described from a unique specimen and the taxonomist is confronted with a specimen of the opposite sex.

   The introduction of ultraviolet detection techniques ("black-lighting") to collect scorpions in the last decade has produced moderate to large samples of a few species of *Diplocentrus*. These series of specimens have enabled me to obtain a basic understanding of the nature and extent of intraspecific and interspecific variability in the genus (Francke, 1975, and unpublished observations). Detailed examination of large and small samples of numerous species indicates that the characters discussed below are taxonomically useful in *Diplocentrus*.

A. Characters showing minimal intraspecific variability.
  1. Cheliceral morphology and morphometrics (Figs. 1-8).
      a. The morphometric ratios of chela length/chela width, fixed finger length/chela width, and movable finger length/chela length (method and landmarks used for obtaining the respective measurements in Francke, 1975).
      b. On the movable finger of the chelicera, the relative lengths and position of the distal internal (**di**) and distal external (**de**) teeth (terminology after Vachon, 1963).
  2. Pedipalp morphology and morphometrics.
      a. The relative proportions of the femur, particularly the width/depth radio.
      b. The extent of carinal development on the tibia, and the relative positions of the trichobothria on its external face (Figs. 9-16).
  3. Carapace morphology (Figs. 17-24).
      a. The shape and dimensions of the anterior median notch.
      b. The development of granulation on the anterior submargin and the area encompassed by the interocular triangle.
  4. Tergite VII morphology.
      a. The degree and extent of carinal development.
      b. The degree and extent of development of postero-lateral bilobations on the disc of this sclerite (Figs. 25-26).
  5. Metasomal segments.
      a. Morphometrics. Several ratios, either between measurements of metasomal segments or between one metasomal and one non-metasomal measurement have been found to be extremely useful and reliable (Francke, 1975).
      b. Carinal development. These structures have been used as taxonomic characters since the last century, but the terminology preferred by different authors is quite variable. The terminology used the text, and their respective abbreviations, is given below, followed by the term(s) most frequently used by other North American scorpion taxonomists.
          Segments I-IV:
              Ventral submedian (**Vsm**) = inferior median
              Ventral lateral (**Vl**) = inferior lateral
              Lateral inframedian (**Lim**) = lateral
              Lateral supramedian (**Lsm**) = dorsal lateral, superior lateral
              Dorsal lateral (**Dl**) = dorsal, superior

Segment V:

      Ventral median (**Vm**) = inferior median

      Ventral lateral (**Vl**) = inferior lateral

      Ventral transverse (**Vt**) = "crescent"

      Lateral median (**Lm**) = lateral

      Dorsal lateral (**Dl**) = dorsal

      Anal arc;

            Anal subterminal (**Ast**) = anterior crest

            Anal terminal (**At**) = posterior crest.

6. Tarsomere II spine formula. The last tarsal segment on each leg bears ventrally two longitundinal rows of spines, and their count is best expressed as a fractional formula. The anterior row spine count is given in the numerator, the posterior row spine count in the denominator, starting with the first pair of legs and proceeding backwards. On individual tarsomere II spine formulas, the right leg precedes the left leg on any given pair. On subspecific and specific formulas the bilateral distinction disappears, and different numerals on a set of "paired" observations indicate that both spine counts occur with approximately the same frequency in the sample analyzed. For example, if on a given species the partial formula for tarsomere II of the second pair of legs is given as 5/6 5/7 , this indicates that the anterior rows normally bear five spines, while the posterior rows can normally bear either six or seven spines.

B. Characters reflecting sexual dimorphism.

The pectinal tooth count provides a significant diagnostic character for scorpions in general. *Diplocentrus* spp. males tend to have higher counts than females, even though the ranges of these parameters overlap in most species (Table 5).

C. Characters reflecting sexual dimorphism and allometricity.

The morphology of the pedipalp chela is a character particularly valuable among adult males, where a marked degree of evolutionary divergence has taken place. In spite of the fact that the morphology of the chela can vary considerably between adults and immatures, as well as between adult males and adult females, the pattern assumed by the trichobothria on the chela remains fairly constant. Throughout the text I have adopted Vachon's terminology (1974) to designate the relative positions of these mechanoreceptor organs.

Using the characters mentioned above, the following key to the species of *Diplocentrus* occurring in the state of Oaxaca was developed.

KEY TO THE OAXACA SPECIES OF *DIPLOCENTRUS*

1a. Pedipalp femur dorsally flat to slightly convex, wider than deep; cheliceral fixed finger shorter than chela width (Figs. 1-3, 5), cheliceral movable finger shorter than chela length 2

1b. Pedipalp femur dorsally moderately to strongly convex, deeper than wide; cheliceral fixed finger longer than chela width (Figs. 4, 6-8), cheliceral movable finger longer than chela length 6
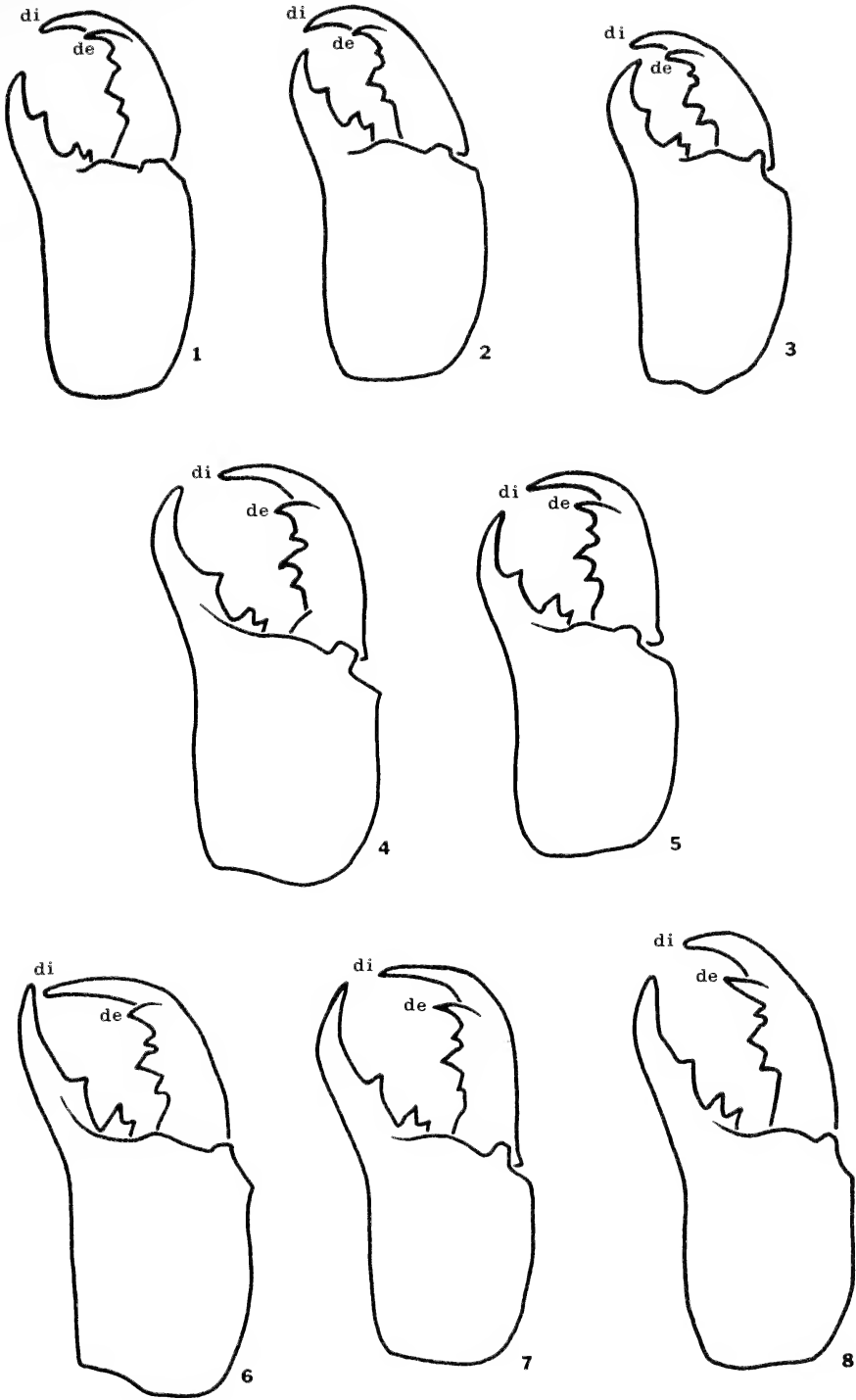
Figs. 1-8.–Dorsal view of the right chelicera of the species of *Diplocentrus* from Oaxaca, México: 1, *D. mexicanus mexicanus* Peters, neotype male; 2, *D. ochoterenai* Hoffmann, adult male; 3, *D. tehuano*, n. sp., holotype male; 4, *D. mitlae*, n. sp., holotype male; 5, *D. tehuacanus* Hoffmann, holotype male; 6, *D. rectimanus* Pocock, holotype male; 7, *D. hoffmanni*, n. sp., holotype male; 8, *D. reticulatus*, n. sp., holotype male.

2a(1a).   Pedipalp tibia dorsally with one smooth carina; tarsomere II spine formula on
            first two pairs of legs 4/5 4/5 : 5/5 5/5 ; metasomal segment IV ventral and
            lateral carinae vestigial to obsolete, smooth 3
2b.   Pedipalp tibia dorsally with two crenate carinae; tarsomere II spine formula on
            first two pairs of legs greater than 4/5 4/5 : 5/5 5/5 ; metasomal segment IV
            ventral and lateral carinae well developed, granulose 4

3a(2a).   Carapacial anterior margin and submargin granulose (Fig. 19); distal external
            tooth of cheliceral movable finger not closely opposed to distal internal tooth
            (Fig. 5); metasomal segment V dorsal lateral carinae weak to vestigial, smooth
            . . . . *tehuacanus* Hoffmann
3b.   Carapacial anterior margin and submargin smooth (Fig. 20); distal external
            tooth of cheliceral movable finger closely opposed to distal internal tooth (Fig.
            3); metasomal segment V dorsal lateral carinae strong, crenate to granulose . . .
            . . . .*tehuano*, n. sp.

4a(2b).   Tarsomere II spine formula on first two pairs of legs 6/7 6/7 : 7/7 7/7 ; legs
            pale yellow, contrasting sharply with fuscous opisthosoma; pectinal tooth
            count 17 or over in males, 15 or over in females . . . . . *ochoterenai* Hoffmann
4b.   Tarsomere II spine formula on first two pairs of legs 5/6 5/6 : 6/6
            6/7 ; legs fusco-ferrugineous with piceous variegations, not contrasting
            sharply with opisthosoma; pectinal tooth count 17 or less in males, 14
            or less in females (*mexicanus*) 5

5a(4b).   Tarsomere II spine formula on last two pairs of legs 7/7 7/7 : 7/7 7/7 ;
            metasomal segment I slightly longer than wide; pectinal tooth count 12-13 in
            males, 10 in females . . . .*mexicanus mexicanus* Peters
5b.   Tarsomere II spine formula on last two pairs of legs 7/8 7/8 : 7/8 7/8 ;
            metasomal segment I slightly wider than long; pectinal tooth count 14-17 in
            males, 11-14 in females . . . .*mexicanus oaxacae*, n. ssp.

6a(1b).   Pedipalp chela fixed finger longer than carapace and metasomal segment V;
            carapacial interocular triangle sparsely granulose (Fig. 23); chelal carinae vestig-
            ial to obsolete (Figs. 59-62) . . . .*mitlae*, n. sp.
6b.   Pedipalp chela fixed finger shorter than carapace and metasomal segment V;
            carapacial interocular triangle moderately to densely granulose (Figs. 21, 22,
            24); chelal carinae moderate to strong (Figs. 45-58) 7

7a(6b).   Tarsomere II spine formula on last two pairs of legs 5/5 5/5 : 5/6 5/6 ;
            dorsal and lateral metasomal intercarinae conspicuously reticulate; meta-
            somal segment IV ventral submedian and lateral inframedian carinae
            moderately strong, granulose . . . . *reticulatus*, n. sp.
7b.   Tarsomere II spine formula on last two pairs of legs 6/6 6/6 : 6/6 6/7 ;
            dorsal and lateral metasomal intercarinae not reticulate; metasomal seg-
            ment IV ventral submedian and lateral inframedian carinae vestigial to
            obsolete, smooth 8

8a(7b).   Movable finger of pedipalps shorter than carapace length; pedipalp chela
            less than twice longer than wide . . . . *hoffmanni*, n. sp.
8b.   Movable finger of pedipalps equal to or longer than carapace length;
            pedipalp chela over twice longer than wide . . . .*rectimanus* Pocock
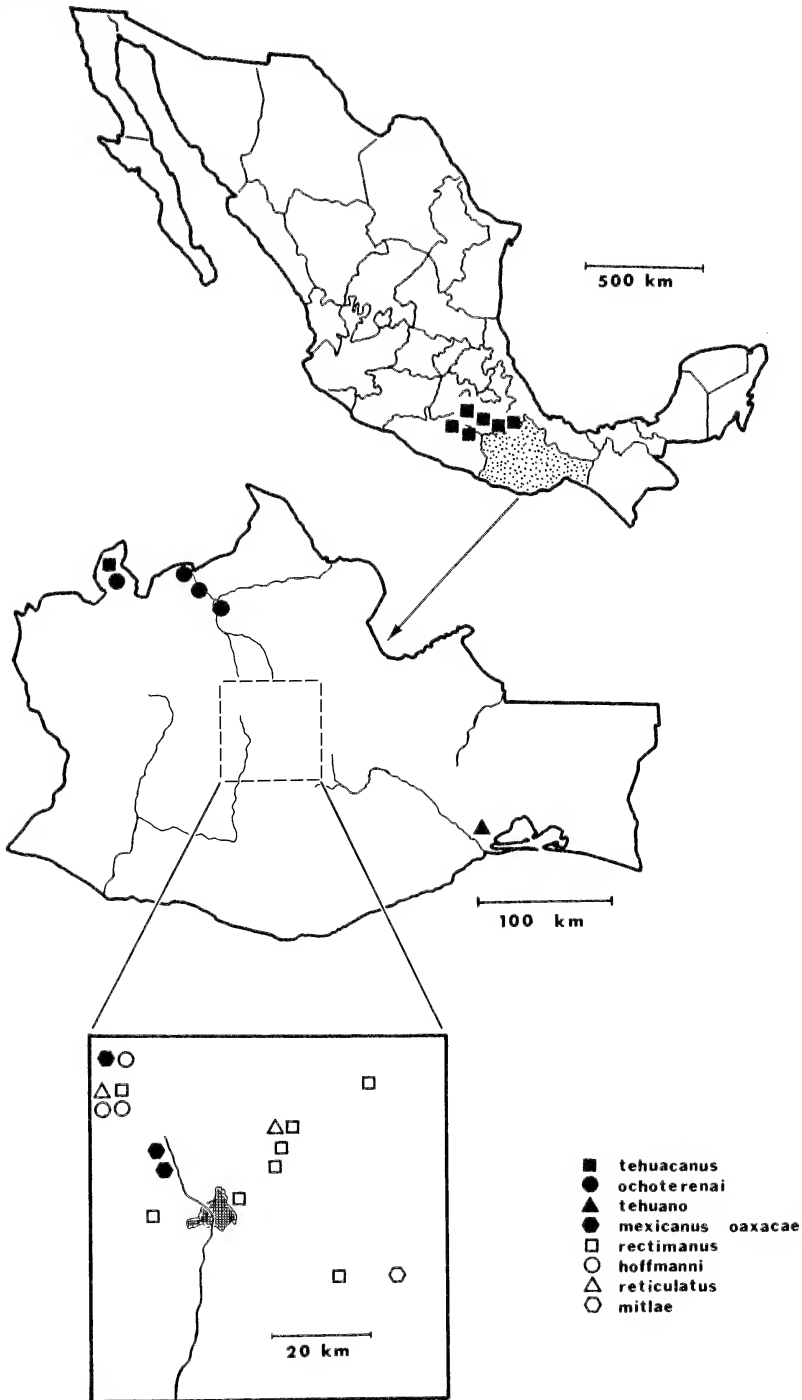
MAP 1.–Distribution of the species and subspecies of *Diplocentrus* known to occur in the state of Oaxaca, México: TOP, Mexico, showing the geographical location of the state of Oaxaca (stippled) and the distribution of *D. tehuacanus* Hoffmann outside this state; MIDDLE, the state of Oaxaca showing the locality records for *D. ochoterenai* Hoffmann, *D. tehuano*, n. sp., and *D. tehuacanus*; BOTTOM, central region of the state of Oaxaca, including the Valley of Oaxaca and the capital city of the same name (cross-hatching), showing the known distribution of the remaining species.

Diplocentrus mexicanus mexicanus Peters
Figs. 1, 9, 17, 27-32

Diplocentrus mexicanus Peters 1861, p. 512. Thorell 1876, p. 12. Karsch 1879b, pp. 98-99. Karsch 1880, pp. 407-408.
Diplocentrus whitei (part) Karsch 1879a, p. 19. Pocock 1893, p. 396. Kraepelin "1893" (1894), p. 11. Kraepelin 1899, pp. 101-102. Pocock 1902, p. 2. Hoffmann 1931, pp. 305-309.

Diagnosis.—Moderately large, adults exceeding 65 mm in total length. Fuscous to fusco-piceous throughout, legs not contrasting with opisthosoma in coloration; coarsely, densely granulose throughout. Carapacial anterior margin granulose, median notch rounded; anterior submargin coarsely granulose. Tergite VII disc weakly bilobed posteriorly, carinae vestigial to obsolete. Pectinal tooth count 12-13 in males, 10 in females. Metasomal segments I-IV with ten complete carinae each, intercarinal spaces minutely granulose; segment I slightly longer than wide, segment V longer than pedipalp femur. Chelicera: fixed finger shorter than chela width; movable finger shorter than chela length, distal external tooth closely opposed to distal internal tooth. Pedipalps: femur distinctly wider than deep, dorsally flat; tibial dorsal median and dorsal external carinae well developed; chelal fixed finger about as long as femur, movable finger longer than carapace. Tarsomere II spine formula 5/6 5/6 : 6/6 6/7 : 7/7 7/7 : 7/7 7/7 .

Neotype.—Male (measurements in Table 1).

Prosoma.—Carapace fuscous to fusco-piceous. Anterior margin densely granulose; median notch rounded, approximately three times wider than deep (Fig. 17). Three pairs of lateral eyes, posterior pair smallest. Anterior median furrow vestigial to obsolete. Ocular prominence distinctly convex between median eyes, located at anterior two-fifths of carapace length. Posterior median furrow moderate to deep. Posterior marginal furrow moderately deep and narrow. Posterior lateral furrows arcuate. Carapacial surface densely granulose. Venter fuscescent, sparsely setate. Sternum pentagonal, as long as wide; posterior one-half deeply furrowed medially.

Mesosoma.—Tergites fuscous, with moderately dense variegated fusco-piceous pattern. Tergites I-VI densely granulose, small and minute granules interspersed. Tergites III-VI with median carina weak, short. Tergite VII weakly bilobed postero-laterally, median emargination indistinct; submedian carinae poorly defined, short, represented by three to five large granules at posterior submargin; lateral carinae indistinct. Tergite VII with surface coarsely, densely granulose.

Genital operculi ochreous, subtriangular and weakly emarginate postero-medially; median longitudinal membranous connection absent ("not fused" auct.). Genital papillae present. Pectinal basal piece ochreous. Pectines appearing light green-brown due to improper preservation, sparsely setate; middle lamellae partly fused, three to four per comb. Fulcra subtriangular. Pectinal tooth count 13-13, one tooth in each comb almost completely overlapped by its neighbors with tooth count thus seemingly 12-12.

Sternites fusco-ferrugineous. Sternites III-IV smooth, V-VI shagreened postero-laterally; stigmata elongate. Sternite VII four-keeled: submedian carinae present on distal two-thirds, moderately strong, smooth; lateral carinae present on distal three-fourths, moderately strong, subcrenate. Sternite VII with median intercarinae smooth, laterals shagreened.

Metasoma.—Uniformly fuscous to fusco-piceous, sparsely setate. Vsm carinae: on I moderately strong, subgranose, subparallel; on II moderately strong, feebly crenate,

parallel; on III weak, crenate, slightly sinuous; on IV with proximal two-thirds weak, granulose, moderately convergent distally, and with distal one-third vestigial to obsolete. **Vl** carinae: on I-II strong, subgranose, weakly to moderately convergent distally; on III-IV moderately strong, subgranose, weakly divergent distally. **Lim** carinae: on I moderately strong, complete, coarsely granulose; on II-IV weak, complete, moderately granulose. **Lsm** carinae: on I-II strong, coarsely granular; on III moderately strong, granulose; on IV weak to moderate, granulose. **Dl** carinae: on I weak, short, granular; on II-III moderately strong, granulose; on IV weak, subgranose. Intercarinal spaces: ventrals smooth, laterals and dorsals shagreened to moderately granulose.

Segment V distinctly longer than pedipalp femur. **Vm** and **Vl** carinae strong, with large subconical granules irregularly spaced. **Vt** keel moderately emarginate, strong and with large subconical granules. **Lm** carinae vestigial to obsolete. **Dl** carinae weak to moderate, granulose. Anal arc circular: **Ast** keel moderately strong, with 11-12 oblong, transverse granules; **At** keel weak to vestigial, minutely dentate. Intercarinae: ventrals smooth, laterals and dorsal shagreened. Telson fuscous to fusco-piceous, smooth except for clusters of 4:2:2 medium granules at ventral submargin. Subaculear tubercle strong, subconical. Aculeus short, moderately curved, tip broken off.

Chelicera.–Fulvous, chela with variegated fuscosity dorsally. Dentition in Fig. 1.

Pedipalps.–Trochanter fusco-piceous, coarsely granulose. Femur fusco-piceous, wider than deep. Dorsal internal keel strong, coarsely granulose. Dorsal external keel: proximal one-half strong, coarsely granular; distal one-half tapering gradually to weak, granular condition. Ventral internal keel strong, coarsely granulose. Ventral external keel obsolete. Dorsal face flat, shagreened with sparse to moderately dense small and medium granules. Internal face flat, densely granulose. External face sparsely granulose, external trichobothrium along dorsal margin at basal one-third of femoral length. Ventral face shagreened.

Tibia fusco-piceous, quadrilateral in cross-section. Orthobothriotaxia "C" (Fig. 9). Dorsal internal keel obsolete, basal tubercle strong. Dorsal median carina very strong, crenato-granulose. Dorsal external keel moderately strong, subcrenate. External keel weak to vestigial, subgranular. Ventral external keel strong; basal one-half smooth, distally subcrenate. Ventral median keel weak to vestigial, granulose. Ventral internal keel strong, coarsely granose. Internal face densely granulose. Dorsal and external faces sparsely granulose. Ventral face smooth.

Chela fuscous, carinae and fingers fusco-piceous. Orthobothriotaxia "C" (Figs. 27-30). Dorsal margin of manus strongly carinate, coarsely granulose. Digital keel very strong, smooth. Dorsal secondary and external secondary carinae weak to moderate, subgranose. Ventral external keel originating at external condyle of movable finger articulation, converging gradually towards ventral median carina and ending at approximately one-fourth of underhand length from chela base. Ventral median keel very strong, crenate, directed towards midpoint of movable finger articulation. Ventral internal keel strong, smooth to subcrenate, directed towards internal condyle of movable finger articulation. Three internal carinae: dorsal, median, and ventral; weak, granulose; shallow longitudinal depression where chela flexes against tibia appearing between internal median and internal ventral keels.

Chelal dorsal face: submarginal reticulation moderately deep, ridges granular; discal reticulation shallow, ridges smooth; cells outlined by reticulum shagreened. External face with moderately deep reticulation, ridges subcrenate, cells shagreened. Ventral face: externad to ventral median keel weakly reticulate with moderately dense granulation;

internad to ventral median keel with reticulation vestigial to obsolete. Internal face vestigially reticulate, sparsely setate. Fixed finger base: dorsally granulose, with moderately dense setation; externally flat, smooth, bare; internally feebly concave, smooth, moderately setate. Fixed finger internal margin evenly, shallowly arcuate. Fixed and movable finger internal margin evenly, shallowly arcuate. Fixed and movable fingers smooth, moderately setate.
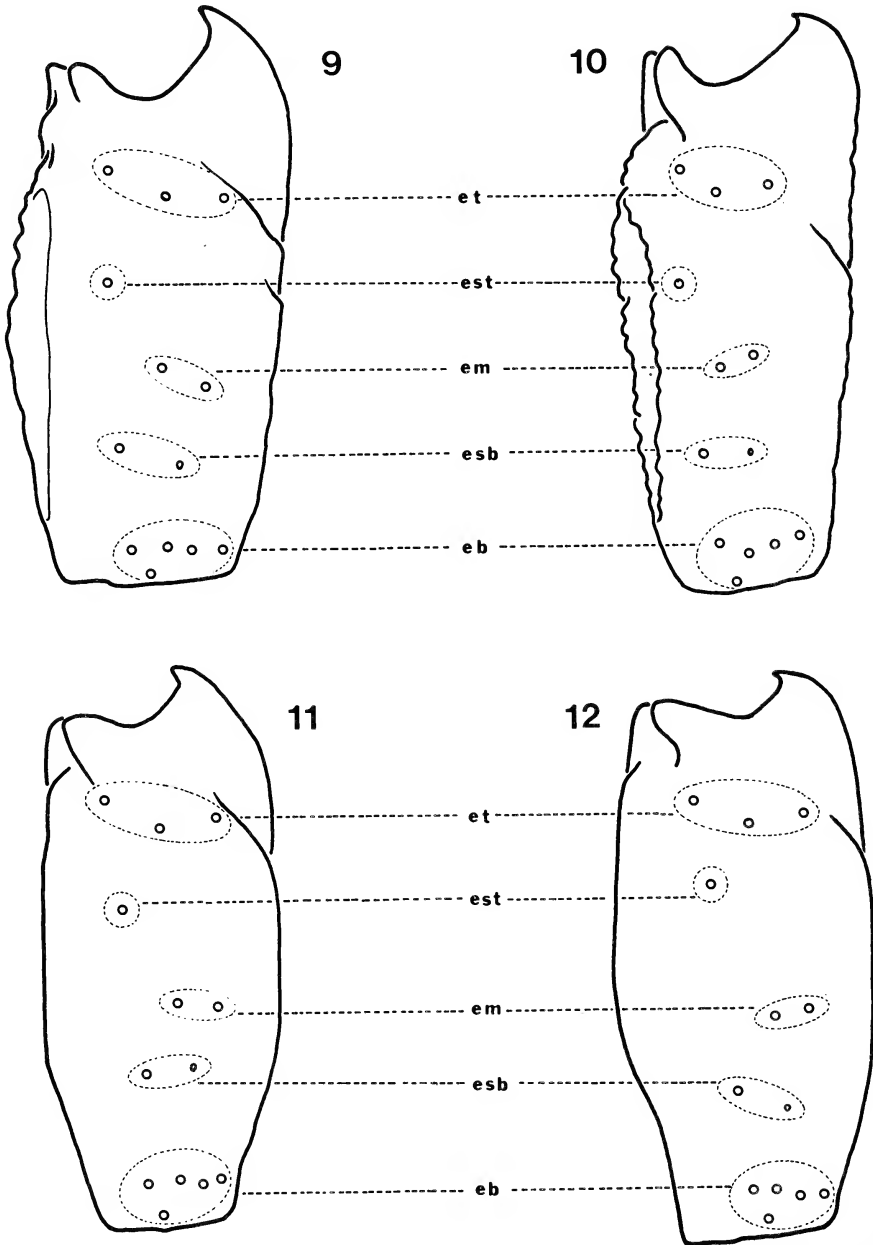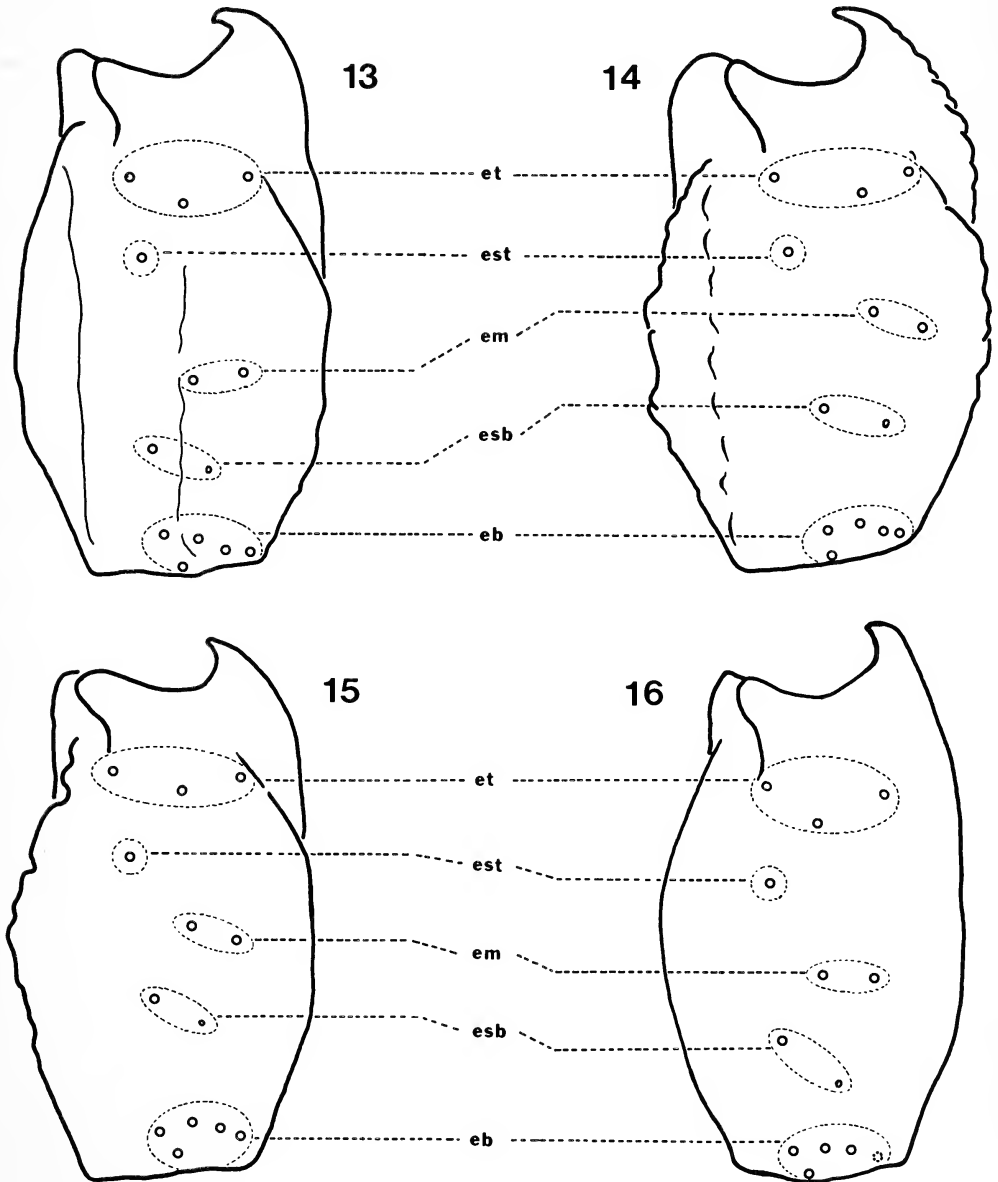

Figs. 9-12.—External view of the right pedipalp tibia of *Diplocentrus* spp. from Oaxaca, showing the trichobothrial patterns: 9, *D. mexicanus mexicanus* Peters, neotype male; 10, *D. ochoterenai* Hoffmann, adult male; 11, *D. tehuano*, n. sp., holotype male; 12, *D. tehuacanus* Hoffmann, holotype male.

Legs.—Fusco-piceous. Femora and tibiae shagreened; trochanters and protarsi on I-II smooth, on III-IV vestigially shagreened. Tarsomere II vestigially lobed distally, terminal spine directed ventro-apically rather than strictly apically; spine formula 5/6 4/6 : 6/6 6/6 : 6/7 7/7 : 7/7 7/7 .

Female.—Differs from male as indicated below (measurements in Table 1).

Prosoma.—Fusco-ferrugineous, with vestigial variegated fuscous pattern.

Figs. 13-16.—External view of the right pedipalp tibia of *Diplocentrus* spp. from Oaxaca, showing the trichobothrial patterns: 13, *D. reticulatus*, n. sp., holotype male; 14, *D. hoffmanni*, n. sp., holotype male; 15, *D. rectimanus* Pocock, holotype male; 16, *D. mitlae*, n. sp., holotype male; the trichobothrium in the **eb** group shown by a broken circle is absent on the right tibia, but present on the left tibia.

Mesosoma.—Tergites fusco-ferrugineous, variegated fuscosity vestigial, granulation moderately dense. Tergites III-VI with median keel vestigial to obsolete. Genital operculi elliptical, without postero-median emargination; median longitudinal membranous connection complete ("fused" auct.). Genital papillae absent. Pectines ochreous, tooth count 10-10. Sternites ochreous fuscescent, smooth. Sternite VII with submedian carinae moderately strong, subcrenate; lateral carinae moderate, crenate.

Metasoma.—Fusco-rufous. **Vsm** carinae: on I moderately strong, crenato-granulose, parallel; on IV apparently biconcave with rows of small granules fusing medially both basally and distally. **VI** carinae: on I-II strong, crenate, feebly convergent distally; on IV
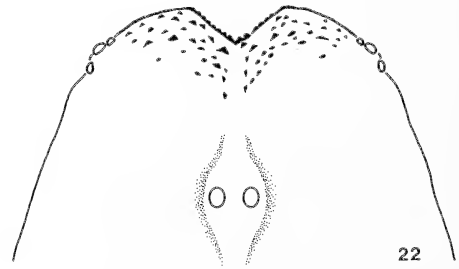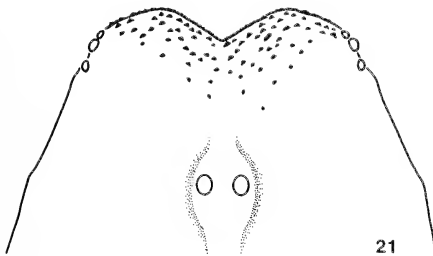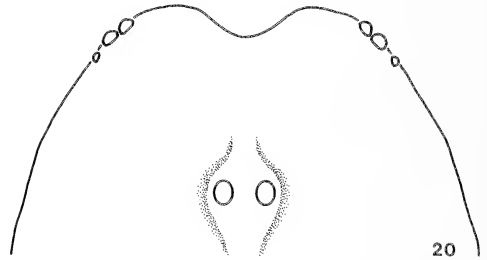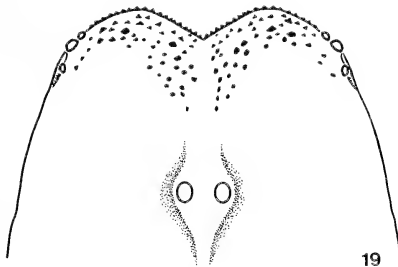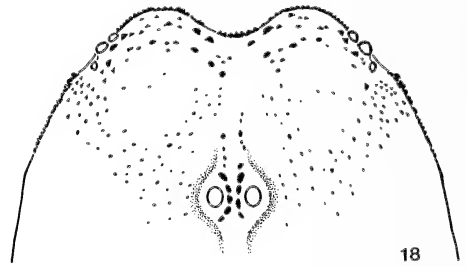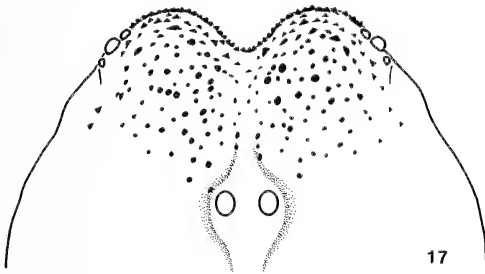
Figs. 17-22.—Dorsal view of the anterior one-half (approximate) of the carapace of *Diplocentrus* spp. from Oaxaca, showing the shape of the anterior median notch, and the extent of granulation on the anterior submargin: 17, *D. mexicanus mexicanus* Peters, neotype male; 18, *D. ochoterenai* Hoffmann, adult male; 19, *D. tehuacanus* Hoffmann, holotype male; 20, *D. tehuano*, n. sp., holotype male; 21, *D. rectimanus* Pocock, holotype male; 22, *D. hoffmanni*, n. sp., holotype male.

moderate, subgranose, feebly divergent distally. **Lim** carinae: on I moderately strong, complete, crenato-granulose; on II weak to moderate, complete, granular. **Lsm** carinae: on IV moderate to strong, granose. Intercarinae on segments I-IV with granulation not as dense.

    Pedipalps.–Trochanters vestigially granulose. Femur and tibia fusco-rufous. Femur with external face smooth. Tibia: dorsal external carina moderate to weak, subcrenate; ventral median keel vestigial. Chela fusco-ferrugineous, carinae and fingers fusco-rufous; morphometrically quite distinct from chela of male (male Figs. 27-30, female Figs. 31-32).
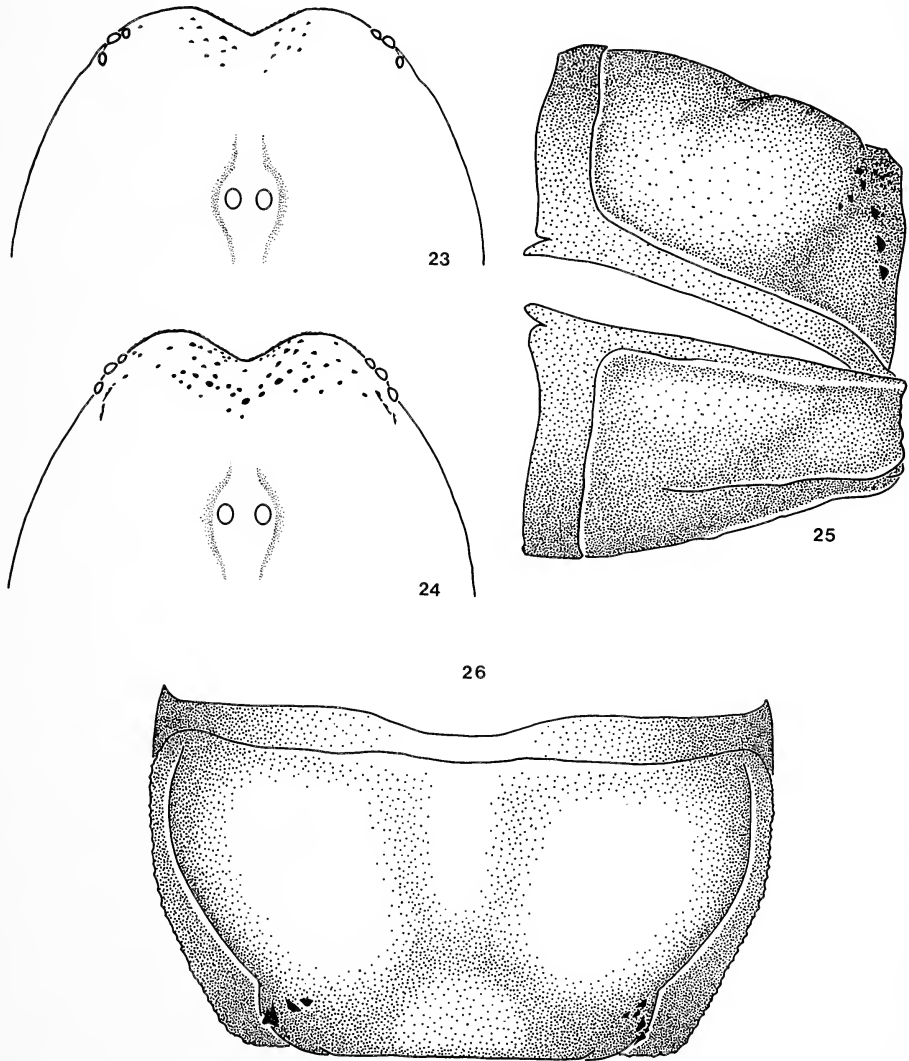
    Figs. 23-24.–Dorsal views of the anterior one-half (approximate) of the carapace of *Diplocentrus* spp. from Oaxaca, showing the shape of the anterior median notch, and the extent of granulation on the anterior submargin: 23, *D. mitlae*, n. sp., holotype male; 24, *D. reticulatus*, n. sp., holotype male.

    Figs. 25-26.–Mesosomal segment VII of *D. mitlae*, n. sp., showing the conspicuous postero-lateral bilobation of the tergal disc and the disappearance of the submedian and lateral carinae of the tergite: 25, lateral aspect of mesosomal segment VII; 26, dorsal aspect of mesosomal tergite VII.

Legs.—Segments considerably less granulose. Tarsomere II spine formula 5/6 X/X : 5/7 6/7 : 7/7 7/7 : 7/7 7/7 .

Locality data.—The neotype is accompanied by three labels, as follows: (1) Kraepelin's handwriting on heavy paper, *Diplocentrus whitei* (Gerv.), Mus. Brussels, 15.V.1899, México; (2) Kraepelin's handwriting on the characteristic rectangular white label with black margins used by him, same information as previous label; (3) typewritten label, Zool. Mus. Hamburg, *Diplocentrus whitei* (Gerv.), México. To these has been added a typewritten label with my designation as the neotype of *Diplocentrus mexicanus mexicanus* Peters. The neotype is deposited in the collection of the Zoologisches Institut und Zoologisches Museum der Hamburg Universität, Hamburg.

The female is accompanied by the following label: *Diplocentrus mexicanus* Peters, México, Koch collection. It is deposited at the British Museum (Natural History), London (BM 13.9.1.73-74).

Since these are the only two specimens known to me of the type species of the genus *Diplocentrus*, it is very unfortunate that more precise locality data, dates of capture, and collectors are not known.

Intraspecific variability.—Pectinal tooth counts observed are given in Table 5, and they range from 12-13 in males (12 is the number reported by Karsch, 1880), and 10 in the female. The tarsomere II spine counts observed are summarized in Table 6, and the formula for this species appears to be 5/6 5/6 : 6/6 6/7 : 7/7 7/7 : 7/7 7/7 .

Comparative description.—*Diplocentrus mexicanus* is indeed related to *D. whitei*, under which it had been synonymized. These two species differ in that *D. whitei* has considerably higher pectinal tooth counts, numbering 15-20 in males (predominantly 18-19), and 14-17 in females (predominantly 16); and a higher tarsomere II spine formula at 6/7 6/7 : 6/7 6/8 : 7/8 7/8 : 7/8 7/8 . In addition, in *D. whitei* the carapace and tergites are lustrous, the metasomal segments III-IV have only eight carinae because the Lim keels are obsolete, and the dorsal and lateral intercarinal spaces on metasomal segments I-IV are smooth.

Diplocentrus mexicanus oaxacae, new subspecies

Diagnosis.—Moderately large, adults exceeding 65 mm in total length. Fusco-ferrugineous, with distinct piceous variegations; legs not contrasting with opisthosoma in coloration; moderately dense granulation throughout. Carapacial anterior margin granulose, median notch rounded; anterior submargin moderately granulose. Tergite VII disc weakly bilobed posteriorly, carinae vestigial to obsolete. Pectinal tooth count 14-17 in males, 11-14 in females. Metasomal segments I-IV with ten complete carinae each, intercarinal spaces rugose to shagreened; segment I slightly wider than long, segment V longer than pedipalp femur. Chelicera: fixed finger shorter than chela width; movable finger shorter than chela length, distal external tooth closely opposed to distal internal tooth. Pedipalps: femur wider than deep, dorsally flat; tibia with dorsal median and dorsal external carinae well developed; chelal fixed finger slightly shorter than femur, movable finger as long or longer than carapace. Tarsomere II spine formula 5/6 5/6 : 6/7 6/7 : 7/8 7/8 : 7/8 7/8 .

Holotype.—Male (measurements in Table 1).

Prosoma.—Carapace fusco-ferrugineous with dense, piceous variegations. Anterior margin densely granulose; median notch rounded, approximately three times wider than deep. Three pairs of subequal lateral eyes. Anterior median furrow vestigial to obsolete.

Table 1.—Measurements (mm) of *Diplocentrus mexicanus mexicanus* Peters, and *D. mexicanus oaxacae*, n. ssp.

| | *mexicanus* | | *oaxacae* | |
| | Neotype | | Holotype | Allotype |
	Male	Female	Male	Female
Total length	68.65	66.80	68.30	67.10
Carapace				
Length	8.30	8.70	8.30	9.10
Anterior width	4.10	4.30	4.10	4.30
Width at median eyes	7.05	7.40	7.50	8.00
Posterior width	8.30	8.90	9.00	9.75
Mesosoma length	18.95	21.90	20.50	21.30
Metasoma length	41.40	36.20	39.50	36.70
Segment I				
Length	5.10	4.50	4.80	4.50
Width	4.70	4.30	5.00	5.05
Segment II				
Length	5.70	4.90	5.50	5.00
Width	4.30	4.10	4.60	4.50
Segment III				
Length	6.00	5.30	5.80	5.30
Width	4.00	3.80	4.30	4.30
Segment IV				
Length	7.10	6.10	6.80	6.30
Width	3.80	3.50	4.00	3.95
Segment V				
Length	9.50	8.10	9.00	8.10
Width	3.30	3.10	3.20	3.40
Telson length	8.00	7.30	7.60	7.50
Vesicle				
Length	6.70	6.30	6.20	6.30
Width	3.10	3.50	3.10	3.50
Depth	2.90	2.90	2.50	3.10
Aculeus length	1.30	1.00	1.40	1.20
Pedipalp length	30.80	29.90	30.50	30.00
Femur				
Length	7.50	7.00	7.40	7.00
Width	2.90	3.10	3.20	3.20
Depth	2.10	2.50	2.30	2.80
Tibia				
Length	7.10	6.80	7.40	7.10
Width	3.00	3.00	3.10	3.20
Chela				
Length	16.20	16.10	15.70	15.90
Width	6.50	7.20	6.90	7.60
Depth	3.50	4.50	4.30	5.10
Movable finger length	9.90	9.50	9.50	9.10
Fixed finger length	7.60	7.00	7.00	6.60
Chelicera				
Chela length	2.60	2.75	2.60	2.80
Chela width	1.70	1.90	1.70	1.80
Fixed finger length	1.30	1.35	1.20	1.50
Movable finger length	2.35	2.40	2.10	2.45
Pectinal teeth	13/13	10/10	16/16	12/14
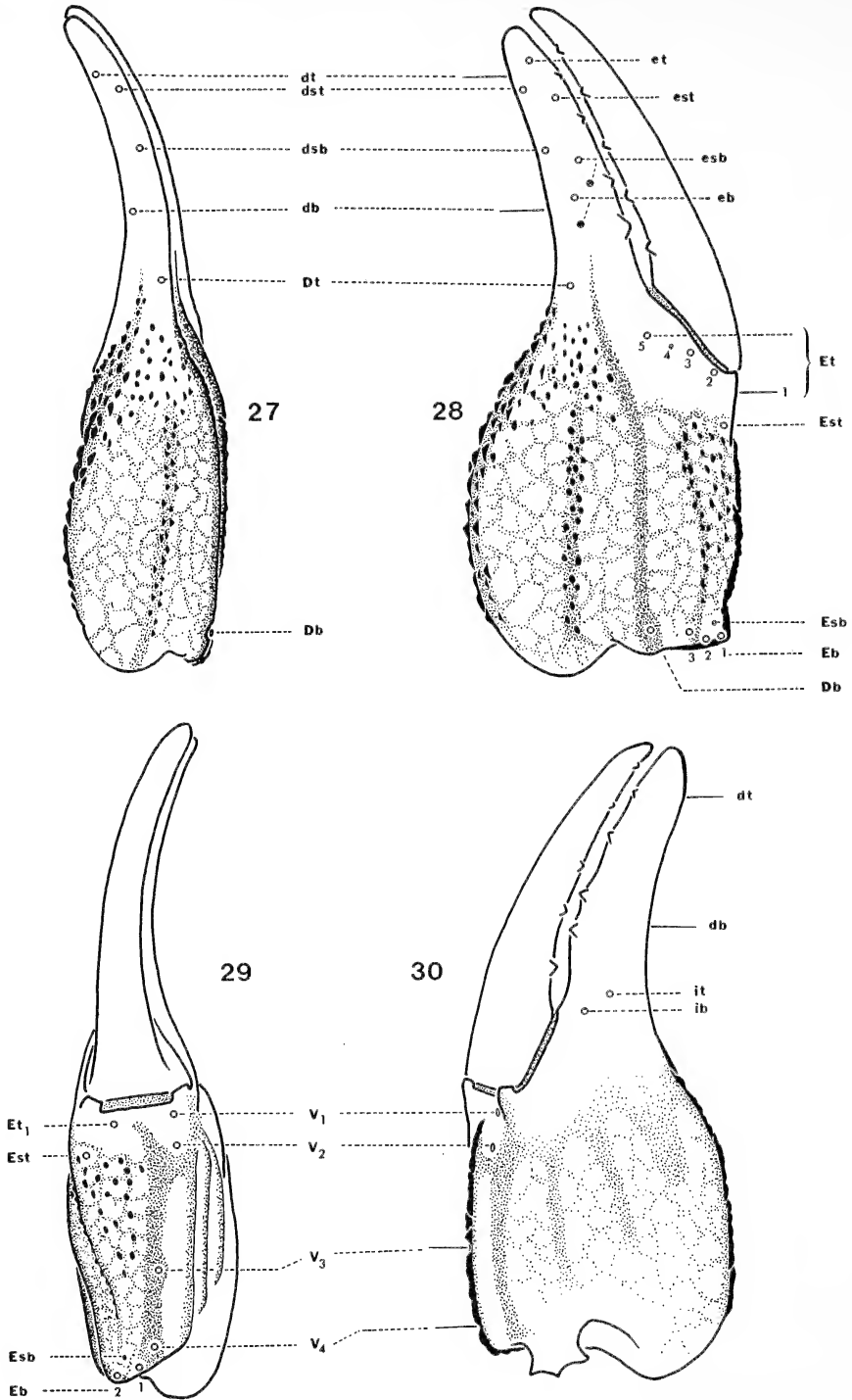
Figs. 27-30.—Right pedipalp chela of *Diplocentrus mexicanus mexicanus* Peters, neotype male, showing the trichobothrial pattern (open circles): 27, dorsal aspect; 28, external aspect, showing basal displacement of trichobothria esb and eb in *D. mexicanus oaxacae*, n. ssp. (crossed-circles); 29, ventral aspect; 30, internal aspect.
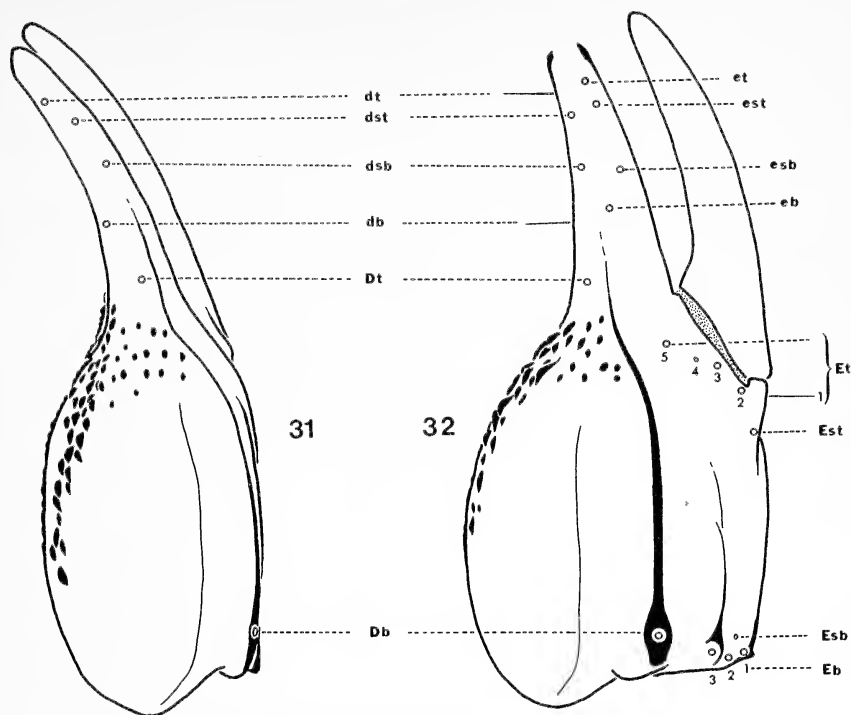
Figs. 31-32.–Right pedipalp chela of *Diplocentrus mexicanus mexicanus* Peters, adult female, showing the trichobothrial pattern and illustrating a considerable degree of sexual dimorphism often observed in *Diplocentrus* spp. regarding such taxonomic characters as: chela depth, relative length and curvature of the fixed finger, and reduced development of textural features (i.e., carinae, reticulation, granulation, etc.): 31, dorsal aspect; 32, external aspect.

Median ocular prominence flat to feebly convex between median eyes, located at anterior two-fifths of carapace length. Posterior median furrow moderate to deep. Posterior marginal furrow moderately deep, narrow. Posterior lateral furrows arcuate. Carapacial surface shagreened; interocular triangle with moderately dense, small granules. Venter ochreous fuscescent with diffuse variegated fuscosity. Sternum pentagonal.

Mesosoma.–Tergites fusco-ferrugineous with dense, variegated fusco-piceous pattern. Tergites I-VI shagreened, with small to medium granules at posterior submargins. Tergites V-VI with median carina vestigial, smooth. Tergite VII weakly bilobed postero-laterally, emargination indistinct and median area feebly depressed; submedian keels short, represented by two to three medium granules at posterior submargin; lateral carinae obsolete. Tergite VII shagreened, with medium and small granules postero-laterally.

Genital operculi ochreous, elliptical and moderately emarginate postero-medially; median longitudinal membranous connection absent. Genital papillae present. Pectines ochreous, sparsely setate; middle lamellae partly fused, three to four per comb. Fulcra subtriangular. Pectinal tooth count 16-16.

Sternites III-VI fulvous, sternite VII fusco-rufous. Sternites III-VI smooth, stigmata elongate. Sternite VII tetracarinate: submedian keels present on distal one-third, weak, smooth; lateral carinae present on distal four-fifths, moderately strong, smooth. Sternite VII with median intercarinae smooth, laterals shagreened.

Metasoma.—Fusco-ferrugineous, carinae piceous; sparsely setate. **Vsm** carinae weak to moderately strong: on I subcrenate, parallel; on II crenate, subparallel; on III subcrenate, sinuous; on IV granulose, poorly defined with granules invading median intercarinal space. **Vl** carinae moderate to strong: on I-II crenate, feebly convergent distally; on III subcrenate, weakly convergent distally; on IV granulose, weakly divergent distally. **Lim** carinae: on I moderately strong, crenato-granulose, complete; on II moderate, complete, crenate; on III weak, complete, subcrenate; on IV weak to vestigial, complete, granose. **Lsm** carinae strong: on I granulose, on II crenate, on III subcrenate, on IV granulose. **Dl** carinae: on I weak, short, granulose; on II-IV moderate, granulose to subgranose. Intercarinal spaces: ventrals smooth, laterals and dorsals rugose to shagreened.

Segment V longer than pedipalp femur. **Vm** and **Vl** carinae strong, with well spaced large subconical granules. **Vt** keel feebly emarginate, strong, with four large oblong granules. **Lm** carinae present on proximal one-half, weak to vestigial, granular. **Dl** keels weak, granular. Anal arc circular: **Ast** keel strong, with 11 large oblong granules; **At** keel weak to vestigial, minutely granulose. Intercarinae: ventrals smooth, laterals and dorsal sparsely to moderately granulose. Telson fusco-rufous, smooth except for clusters of 2:3:2 medium sized granules at ventral submargin. Subaculear tubercle strong, subconical. Aculeus short, moderately curved.

Chelicera.—Ochreous fuscescent; chela with variegated fuscosity dorsally, movable finger with base uniformly infuscate dorsally. Dentition similar to nominate subspecies (see Fig. 1).

Pedipalps.—Trochanter fusco-ferrugineous, coarsely granulose. Femur fusco-ferrugineous, wider than deep. Dorsal internal keel strong, coarsely granulose. Dorsal external keel: proximal one-half strong, coarsely granose; distally moderate to weak, subgranose. Ventral internal keel strong, coarsely granulose. Ventral external keel obsolete. Dorsal face flat; shagreened with moderately dense small granules throughout, and three to four medium sized granules medially. Internal face flat, shagreened with dense small granules. External face smooth, external trichobothrium along dorsal margin at basal one-third of femoral length. Ventral face shagreened, with moderately dense small granules basally and internally.

Tibia fusco-ferrugineous, quadrilateral in cross-section. Orthobothriotaxia "C", trichobothrial position not differing significantly from pattern on nominate subspecies (see Fig. 9). Dorsal internal keel obsolete, basal tubercle strong. Dorsal median carina very strong, smooth to subcrenate. Dorsal external keel strong, subcrenate. External keel weak, smooth. Ventral external keel strong, smooth. Ventral median keel vestigial, smooth. Ventral internal keel moderate, coarsely granulose. Internal face densely granulose. Dorsal, external, and ventral faces weakly to vestigially reticulate.

Chela fusco-ferrugineous, carinae fusco-piceous. Orthobothriotaxia "C", pattern as on nominate subspecies except for displacement of trichobothria **esb** and **eb** towards fixed finger base (see Fig. 28). Dorsal margin of manus strongly carinate; basal one-half smooth, distally coarsely granulose and extending through fixed finger base. Digital keel very strong, smooth. Dorsal secondary keel vestigial, minutely granulose. External secondary keel moderate to weak, smooth. Ventral external keel weak to vestigial, subgranose. Ventral median keel very strong, subcrenate, directed towards midpoint of movable finger articulation. Ventral internal keel strong, smooth. Three internal carinae weak, smooth; shallow longitudinal depression where chela flexes against tibia as on nominate subspecies.

Dorsal face weakly to moderately reticulate, ridges subgranose to strongly granulose at dorsal submargin, cells shagreened. External face vestigially reticulate, ridges and cells smooth. Ventral face weakly to moderately reticulate, ridges subgranose to crenate. Internal face weakly to vestigially reticulate, ridges smooth. Fixed finger base: dorsally feebly granulose, bare; externally smooth, bare; internally densely granulose, moderately setate. Fixed finger inner margin evenly, shallowly arcuate. Fixed and movable fingers smooth, moderately setate.

Legs.—Ochreous with moderately dense variegated fuscosity. Trochanters vestigially granulose. Femora shagreened. Tibiae: on I smooth; on II vestigially granulose; on III-IV with moderately dense minute granules. Tarsomere II spine formula 5/6 X/X : 6/7 6/7 : 7/8 7/8 : 8/8 8/8 .

Allotype.—Female (measurements in Table 1), differs from male as indicated below.

Prosoma.—Carapace with median ocular prominence feebly concave between median eyes. Surface lustrous, with moderately dense small granules.

Mesosoma.—Tergites I-VI lustrous, with moderately dense small granules at posterior submargin. Tergite VII discal bilobation vestigial. Genital operculi with feeble postero-median emargination; median longitudinal membranous connection complete. Genital papillae absent. Pectinal tooth count 12-14. Sternite VII carinae closely crenate, intercarinal spaces smooth.

Metasoma.—**Vsm** carinae: on I moderately strong, granular; on II moderate, crenate. **Vl** carinae: on I strong, granulose to serrate; on II strong, crenate; on IV weak to moderate, granose. **Lim** carinae: on II weak, complete, subgranose; on III weak to vestigial, subgranose. **Lsm** carinae on II-IV strong to moderate, subgranose. **Dl** carinae on IV weak, granulose.

Pedipalps.—Tibia with ventral median keel obsolete, ventral face smooth. Chela more rounded, carinae not as pronounced. Dorsal margin: basal one-half rounded; distally weakly carinate, coarsely granulose. Dorsal secondary and external secondary carinae vestigial, smooth. Ventral external keel obsolete. Ventral median keel smooth. Ventral internal keel weak to vestigial, smooth. Internal carinae vestigial to obsolete. Dorsal face weakly reticulate, all others with reticulation vestigial to obsolete.

Legs.—Lustrous, spine formula 6/6 6/6 : 6/7 6/7 : 7/8 7/8 : 8/8 8/8 .

Remarks.—The allotype is accompanied by 16 second instar young that were presumably on her back at the time of capture.

Type locality.—Primary types collected 2 mi. N "El Moral" (7,000 ft., pine-oak community), Distrito de Etla, Oaxaca, México, 10 September 1966 (C. M. Bogert). Permanently deposited at the American Museum of Natural History (AMNH), New York.

Distribution.—Map 1. In addition to the primary types, the following specimens from the state of Oaxaca were examined: two paratopotypes (adult male, juvenile female), same data as holotype (AMNH); four paratypes (three adult females, subadult male) from area of El Moral (7,200 ft., under rocks), 10 July 1966 (P. C. P., C. M. B., and M. R. B.; AMNH); one paratype (adult female) from 6 mi. N Telixtlahuaca (7,050 ft., under rocks in moderately dry area with juniper and oak), 26 July 1966 (C. M. Bogert, AMNH); one adult female from "México" (Koch collection, BM 13.9.1.73-74).

Etymology.—Subspecific name based on the name of the state where this taxon occurs.

Intraspecific variability.—Among the adult specimens examined the greatest source of variability is sexual dimorphism, as indicated in the allotype's description. Variability is very low in other taxonomic characters, except pectinal tooth counts (Table 5) which

range from 14-17 in males, and 11-14 in females. The variability in tarsomere II spine counts is summarized in Table 6, and the typical formula for this subspecies appears to be 5/6 5/6 : 6/7 6/7 : 7/8 7/8 : 7/8 7/8 .

Comparative description.—*Diplocentrus mexicanus oaxacae* can be separated from the nominate subspecies by its higher pectinal tooth counts, predominantly 15 in males and 13 in females; and by its slightly higher tarsomere II spine formula, where the difference occurs on the posterior spine rows of legs III-IV which bear eight instead of seven spines. In addition, in *D. mexicanus oaxacae* the first metasomal segment is slightly wider than long, and the fixed finger of the pedipalp chela is shorter than the pedipalp femur.

<div align="center">

Diplocentrus ochoterenai Hoffmann
Figs. 2, 10, 18, 33-34

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Diplocentrus ochoterenai Hoffmann 1931, pp. 309-312, fig. 7. Hoffmann 1938, p. 317. Díaz Nájera 1964, p. 20. Stahnke 1967, pp. 173-174.

Diagnosis.—Large, adults occasionally exceeding 85 mm in total length. Ochreous to brunneous with distinct variegated fuscosity on opisthosoma, metasoma, and pedipalps; legs flavus to ochroleucus, contrasting sharply with opisthosoma in coloration. Carapacial anterior margin granulose, median notch rounded; anterior submargin moderately granulose. Tergite VII disc not lobed postero-laterally, carinae vestigial to obsolete. Pectinal tooth count 17-19 in males, 16 in females. Metasomal segments I-IV with ten complete carinae each, intercarinal spaces rugose to moderately granulose; segment I longer than wide in males, about as long as wide in females; segment V as long or longer than pedipalp femur. Chelicera: fixed finger shorter than chela width; movable finger shorter than chela length, distal external tooth closely opposed to distal internal tooth. Pedipalps: femur wider than deep, dorsally flat; tibia with dorsal median keel strong, dorsal external keel moderate to weak; chelal fixed finger about as long as femur, movable finger longer than carapace. Tarsomere II spine formula 6/7 6/7 : 7/7 7/7 : 7/8 7/8 : 7/8 8/8 .

Holotype.—Adult female (measurements in Table 2), not male as indicated by Hoffmann in the original description (1931).

Prosoma.—Carapace ochreous with moderately dense fuscescent variegations. Anterior margin densely granulose, emarginate; median notch approximately three times wider than deep. Three pairs of lateral eyes, posterior pair smallest. Anterior median furrow shallow to vestigial. Ocular prominence feebly convex between median eyes, located at anterior two-fifths of carapace length. Posterior median furrow moderate to deep. Posterior marginal furrow deep, moderately wide. Posterior lateral furrows arcuate, shallow and broad. Surface with sparse to moderately dense small granules. Venter ochreous to ochreous-fuscescent, sparsely setate. Sternum pentagonal.

Mesosoma.—Tergites ochreous with moderately dense fuscescence; sparsely variegated on I-VI, conspicuously variegated on VII. Tergites I-VI with sparse to moderately dense small granules. Tergites III-VI with median longitudinal keel vestigial, smooth. Tergite VII disc not lobed postero-laterally; submedian carinae obsolete; lateral carinae present at distal submargin, vestigial. Tergite VII medially with sparse to moderately dense small granules, laterally dense granulose.

Genital operculi ochroleucus, trapezoidal; median longitudinal membranous connection complete. Genital papillae absent. Pectines ochroleucus, lamellar setation sparse; middle lamellae partly fused, four per comb. Pectinal tooth count 16-16.

Table 2.–Measurements (mm) of *Diplocentrus ochoterenai* Hoffmann and *Diplocentrus tehuano*, n. sp.

| | ochoterenai | | tehuano | |
| | Holotype | | Holotype | Allotype |
	Female	Male	Male	Female
Total length	70.90	86.00	50.45	51.35
Carapace				
Length	9.50	10.70	6.80	7.20
Anterior width	5.20	5.40	3.30	3.35
Width at median eyes	8.40	9.30	5.50	5.50
Posterior width	10.20	11.40	6.30	6.70
Mesosoma length	24.70	27.70	15.85	18.40
Metasoma length	36.70	47.60	27.80	25.75
Segment I				
Length	4.90	6.00	3.45	3.10
Width	4.80	5.60	3.40	3.50
Segment II				
Length	5.10	6.65	3.90	3.70
Width	4.20	5.25	3.15	3.20
Segment III				
Length	5.60	7.25	4.25	4.00
Width	3.90	4.80	2.90	3.05
Segment IV				
Length	6.30	8.40	4.80	4.30
Width	3.50	4.30	2.60	2.80
Segment V				
Length	7.50	10.90	6.20	5.50
Width	3.20	3.45	2.40	2.60
Telson length	7.30	8.40	5.20	5.15
Vesicle				
Length	5.90	6.80	4.30	4.20
Width	3.60	3.80	2.70	3.00
Depth	2.90	3.10	2.20	2.30
Aculeus length	1.40	1.60	0.90	0.95
Pedipalp length	31.60	38.50	24.20	21.30
Femur				
Length	7.50	9.30	5.70	5.10
Width	3.50	3.50	2.40	2.30
Depth	2.75	2.65	1.75	1.90
Tibia				
Length	7.50	9.00	5.50	5.20
Width	3.30	3.80	2.40	2.40
Chela				
Length	16.60	20.20	13.00	11.00
Width	8.10	9.60	5.40	5.90
Depth	5.30	5.25	2.70	3.30
Movable finger length	10.30	12.60	8.40	6.30
Fixed finger length	7.30	9.40	6.50	4.30
Chelicera				
Chela length	3.15	3.30	1.95	2.20
Chela width	2.25	2.20	1.25	1.45
Fixed finger length	1.75	1.65	0.95	1.10
Movable finger length	2.85	2.90	1.70	1.75
Pectinal teeth	16/16	19/18	13/12	10/11

Sternites ochreous to ochreous fuscescent. Sternites III-VI smooth to vestigially punctate, stigmata about four times longer than wide. Sternite VII tetracarinate: submedian keels present on distal two-thirds, weak, smooth; lateral keels present on distal two-thirds, moderate to weak, smooth. Sternite VII intercarinae smooth.

Metasoma.—Ochreous, with fulvous variegations increasing in density distally within and between segments. **Vsm** carinae: on I-II strong, finely crenate, subparallel; on III moderately strong, subcrenate, parallel; on IV weak, subgranose, subparallel. **Vl** carinae: on I-II strong, finely crenate, slightly convergent distally; on III-IV moderate, subcrenate, subparallel. **Lim** carinae: on I-II moderately strong, complete, crenate; on III weak, complete, crenate; on IV weak, complete, granulose. **Lsm** carinae: on I-III strong, crenate; on IV moderate to weak, subgranose. **Dl** carinae: on I-II weak, granulose; on III-IV weak to moderate, subgranose. Intercarinal spaces: ventrals smooth to sparsely granulose, laterals and dorsals sparsely to moderately granulose.

Segment V as long as pedipalp femur. **Vm** carina strong, with large subconical granules irregularly spaced and continuing through distal disc. **Vl** carina strong, granulose. **Vt** keel not emarginate, strong, with two large subconical to slightly oblong granules on each side of **Vm** keel. **Lm** carinae present on proximal one-half, vestigial, subgranose. Anal arc circular: **Ast** keel moderate, with eight medium and large oblong granules; **At** keel vestigial, minutely granulose. Intercarinae rugose to vestigially granulose. Telson ochreous with moderately dense fulvous pigment: dorsally feebly convex, smooth, bare; laterally and ventrally moderately setate, smooth except for clusters of 3:3:3 medium granules at ventral submargin. Subaculear tubercle strong, subconical; aculeus short, strongly curved with tip broken off.

Chelicera.—Ochreous, chela with fulvous variegations dorsally. Dentition in Fig. 2.

Pedipalps.—Trochanter fulvous, moderately granulose. Femur ochreous with moderately dense, feebly variegated fulvous pattern; wider than deep. Dorsal internal keel moderately strong, granulose. Dorsal external keel: proximal two-thirds strong, granulose; distally weak to vestigial, subgranose. Ventral internal keel strong, coarsely granulose. Ventral external keel present on basal one-half, weak to vestigial, granulose. Dorsal face flat, with moderately dense small granulation. Internal face with moderate to dense granules. External face smooth, external trichobothrium at dorsal margin on basal one-third of femoral length. Ventral face sparsely to moderately granulose.

Tibia ochreous fuscescent with moderately dense variegated fuscosity, quadrangular in cross-section. Orthobothriotaxia "C", pattern as on male (Fig. 10). Dorsal internal keel obsolete, basal tubercle strongly developed. Dorsal median keel strong, subcrenate to smooth. Dorsal external keel weak, subcrenate to smooth. External keel vestigial to obsolete. Ventral external keel weak to moderate, smooth. Ventral median keel obsolete. Ventral internal keel strong, coarsely granulose. Internal face shagreened. Dorsal and external faces smooth to vestigially reticulate. Ventral face vestigially granulose distally.

Chela ochreous fuscescent, with fine variegations of moderately dense fuscosity; carinae and fingers fusco-ferrugineous. Orthobothriotaxia "C". Dorsal margin of manus subcarinate: basal one-half smooth; distally granulose, extending through fixed finger base. Digital keel strong, smooth. Dorsal secondary and external secondary carinae vestigial to obsolete, smooth. Ventral external keel vestigial to obsolete, smooth. Ventral median keel strong, smooth, directed towards midpoint of movable finger articulation. Ventral internal keel weak to vestigial, smooth. Three internal carinae vestigial, smooth; without longitudinal depression where chela flexes against tibia.

Chelal dorsal face weakly to vestigially reticulate. External face reticulation vestigial. Ventral face with reticulation vestigial to obsolete. Internal face with disc smooth, ventral submargin vestigially reticulate, dorsal and distal margins moderately granulose. Fixed finger base smooth, except for submargins of movable finger articulation with dense, minute granules. Fixed finger internal margin evenly, moderately arcuate. Fingers smooth, moderately setate.

Legs.—Flavus to ochroleucus. Trochanters sparsely granulose. Femora shagreened. Tibiae: I-II smooth, III sparsely granulose, IV moderately granulose. Tarsomere II feebly lobed distally, spine formula (partly from Hoffman 1931): 6/6 6/6 : 7/7 6/7 : 7/8 7/7 : 7/8 7/8 .

Condition.—Slight coloration bleaching due to preservative. Left pedipalp broken off at coxa-trochanter articulation, and the chelal finger tips are also broken off (see Hoffmann 1931, p. 310, Fig. 7). Only the second leg on the left side is still attached to the prosoma, the others having been broken off at different joints; in a separate vial there are five legs, four of which still bear tarsomere II, enabling me to confirm the spine formula.

Male.—Differs from female as indicated below (measurements in Table 2).
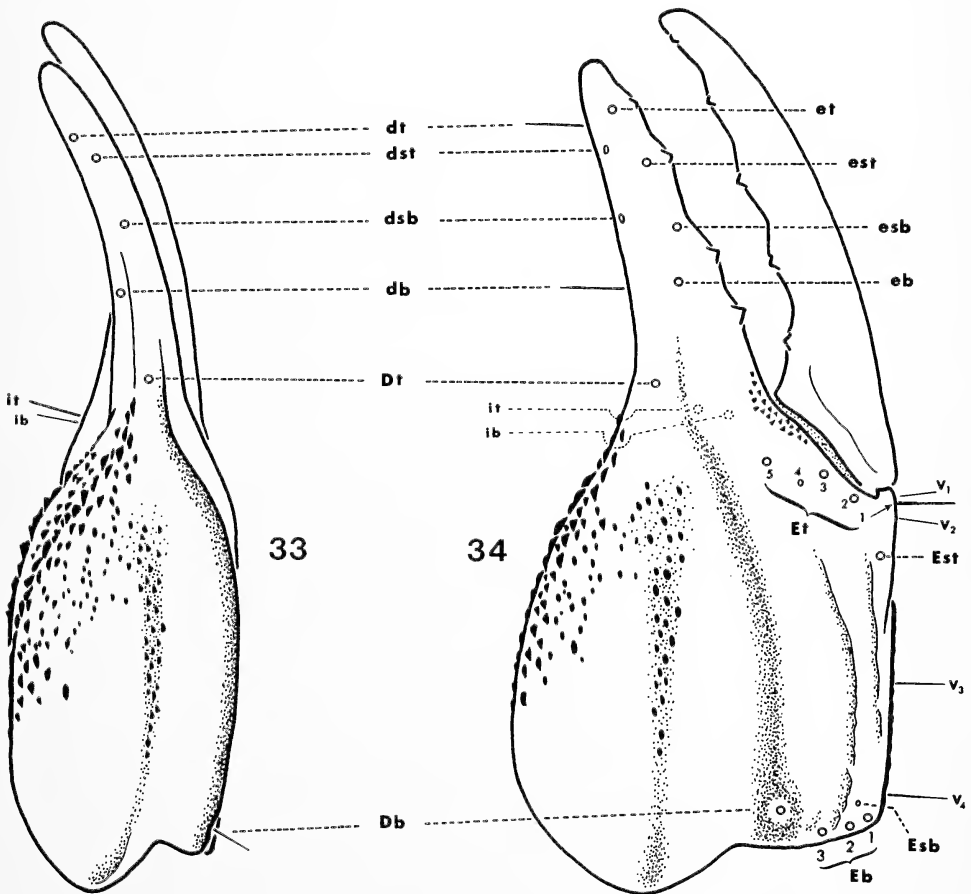
Figs. 33-34.—Right pedipalp chela of *Diplocentrus ochoterenai* Hoffmann, adult male, illustrating trichobothrial positions: 33, dorsal aspect; 34, external aspect.

Prosoma.—Carapace shagreened throughout; in addition with moderately dense, small and mediun granulation. Interocular triangle with dense, coarse granulation (Fig. 18); superciliary ridges granose.

Mesosoma.—Tergites shagreened, with small and mediun granules postero-laterally. Genital operculi without median longitudinal membranous connection. Genital papillae present. Pectinal tooth count 17-19.

Metasoma.—Segment II with **Vsm** and **Vl** carinae smooth to subcrenate. Segment IV with **Dl** keels smooth to subcrenate. Segment V longer than pedipalp femur; **Lm** carinae vestigial, smooth to subgranose.

Pedipalps.—Tibia: dorsal external keel strong, subcrenate; dorsal and external faces weakly to vestigially reticulate. Chela (Figs. 33-34) morphometrically longer than chela of female, with fingers contributing proportionately more to this increase in length. Digital keel very strong, smooth. Dorsal secondary keel weak, basally smooth, distally granulose. External secondary keel vestigial, smooth. Dorsal and external faces moderately to weakly reticulate.

Type locality.—Holotype from Cuicatlán (near Cañon de Tomellín, 700 m.), Oaxaca, México, September 1931 (C. C. Hoffmann). Colección de Alacranes mexicanos de Carlos C. Hoffmann, AMNH.

Distribution.—Map 1. The following specimens have been examined in addition to the holotype, all from the state of Oaxaca: one adult male from Chasumba, no date, no collector (Colección de Alacranes mexicanos, AMNH); one adult male, and one immature male from 10 mi. S Tomellín, 14 August 1967 (J. Reddell, J. Fish, and T. Evans, AMNH); one adult female, two adult males, one subadult male, and one juvenile male from 5.8 mi. N Teotitlán, 31 July 1973 (L. R. Erickson and M. E. Soleglad; Soleglad collection).

Intraspecific variability.—Sexual dimorphism and allometric growth are the largest sources of variation, as in other species of the genus. The variability observed in pectinal tooth counts (Table 5) ranges from 17-19 in males, 16 in females. The variation observed in tarsomere II spine counts (Table 6) gives the following typical formula for this species 6/7 6/7 : 7/7 7/7 : 7/8 7/8 : 7/8 8/8 .

The juvenile male from 5.8 mi. N Teotitlán has three lateral eyes on the left side, and only one lateral eye on the right side.

Comparative description.—*Diplocentrus ochoterenai* appears to be related to *Diplocentrus taibeli* (Caporiacco) NEW COMBINATION ($=$ *Didymocentrus taibeli*, redescription in preparation) from the lowlands of the Yucatán peninsula. *D. taibeli* can be easily recognized by having a lower pectinal tooth count of 15 in males, and a lower tarsomere II spine formula at 5/5 5/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6 .

Diplocentrus tehuano, new species
Figs. 3, 11, 20, 35-40

Diagnosis.—Medium sized, adults seldom exceeding 55 mm in total length. Ochreous to testaceous with distinct variegated fuscosity on opisthosoma, metasoma, and pedipalps; legs flavus to ochroleucus, contrasting sharply with opisthosoma in coloration. Carapacial anterior margin smooth, median notch rounded; anterior submargin smooth to sparsely granulose. Tergite VII disc vestigially bilobed postero-laterally, carinae obsolete. Pectinal tooth count 11-14 in males, 10-12 in females. Metasomal segments I-II with ten complete carinae each, III with eight complete keels, IV with four to six vestigial keels; segment I as long as wide, segment V longer than pedipalp femur. Chelicera: fixed finger shorter

than chela width; movable finger shorter than chela length, distal external tooth closely opposed to distal internal tooth. Pedipalps: femur wider than deep, dorsally flat; tibia with dorsal median keel well developed, dorsal external keel vestigial to obsolete; chela with fixed finger base internally coarsely granulose along articulation socket. Chelal fixed finger longer than pedipalp femur in males, shorter in females; movable finger longer than carapace in males, shorter in females. Tarsomere II spine formula 4/5 4/5 : 5/5 5/5 : 5/6 6/6 : 6/6 6/6 .

Holotype.–Male (measurements in Table 2).

Prosoma.–Carapace ochreous, with dense fuscous pattern. Anterior margin smooth to vestigially granulose, emarginate; median notch rounded, slightly less than four times wider than deep (Fig. 20). Three pairs of lateral eyes, posterior pair smallest. Anterior median furrow shallow, wide. Ocular prominence feebly concave between median eyes, located at anterior one-third of carapace length. Posterior median furrow moderate to deep. Posterior marginal furrow deep, moderately wide. Posterior lateral furrows arcuate to subangulose, moderately deep. Surface shagreened, with anterior submargin smooth. Venter flavus to ochroleucus, minutely punctate, sparsely setate. Sternum pentagonal.

Mesosoma.–Tergites ochreous fuscescent to testaceous, densely infuscate throughout. Tergites I-IV smooth, V-VI vestigially granulose laterally. Tergite VII disc vestigially bilobed postero-laterally, median area slightly depressed; submedian and lateral carinae obsolete. Tergite VII shagreened, with sparse to moderately dense small granules laterally.

Genital operculi ochroleucus; ellipsoidal, weakly emarginate postero-medially; median longitudinal membranous connection absent. Genital papillae present. Pectines flavus, lamellar setation sparse; middle lamellae indistinct, five to six per comb. Fulcra subtriangular. Pectinal tooth count 12-13.

Sternites ochreous fuscescent. Sternites III-VI smooth, stigmata three times longer than wide. Sternite VII two-keeled: submedian carinae obsolete; lateral keels present on distal one-third to one-half, weak, subcrenate. Sternite VII with median intercarinae smooth, submedian and lateral intercarinae shagreened.

Metasoma.–Ochreous fuscescent, carinae vestigially infuscate; sparsely setate. **Vsm** carinae: on I moderately strong, smooth, parallel; on II weak, smooth, parallel; on III vestigial, smooth; on IV obsolete. **Vl** carinae: on I strong, smooth, subparallel; on II moderately strong, smooth, subparallel; on III weak to vestigial, smooth, parallel; on IV vestigial, smooth, slightly divergent distally. **Lim** carinae: on I moderately strong, complete, subcrenate; on II weak, complete, subcrenate; on III weak to vestigial, complete, smooth; on IV obsolete. **Lsm** carinae: on I strong, crenato-granulose; on II moderately strong, crenulate; on III-IV weak to moderate, feebly crenate. **Dl** carinae: on I-II weak to vestigial, sparsely granulose; on III weak to moderate, granulose; on IV moderately strong, granulose, distally becoming abruptly divergent and merging with **Lsm** keels on respective sides. Intercarinal spaces smooth to feebly rugose.

Segment V longer than pedipalp femur. **Vm** and **Vl** carinae: proximal one-third weak, granulose; distally moderately strong, with large subconical granules well spaced. **Vt** keel emarginate, with two large subconical granules per side. **Lm** carinae present on proximal one-third, vestigial, smooth to subgranose. **Dl** carinae strong, subcrenate. Anal arc circular: **Ast** keel moderately strong, with 12 medium sized oblong granules; **At** keel vestigial, smooth. Intercarinal spaces smooth to sparsely punctate. Telson ochreous: dorsally flat, smooth, bare; lateral and ventral surfaces moderately setate, smooth except for clusters of 3:5:3 small granules at ventral submargin. Subaculear tubercle strong, subconical. Aculeus short, strongly curved.
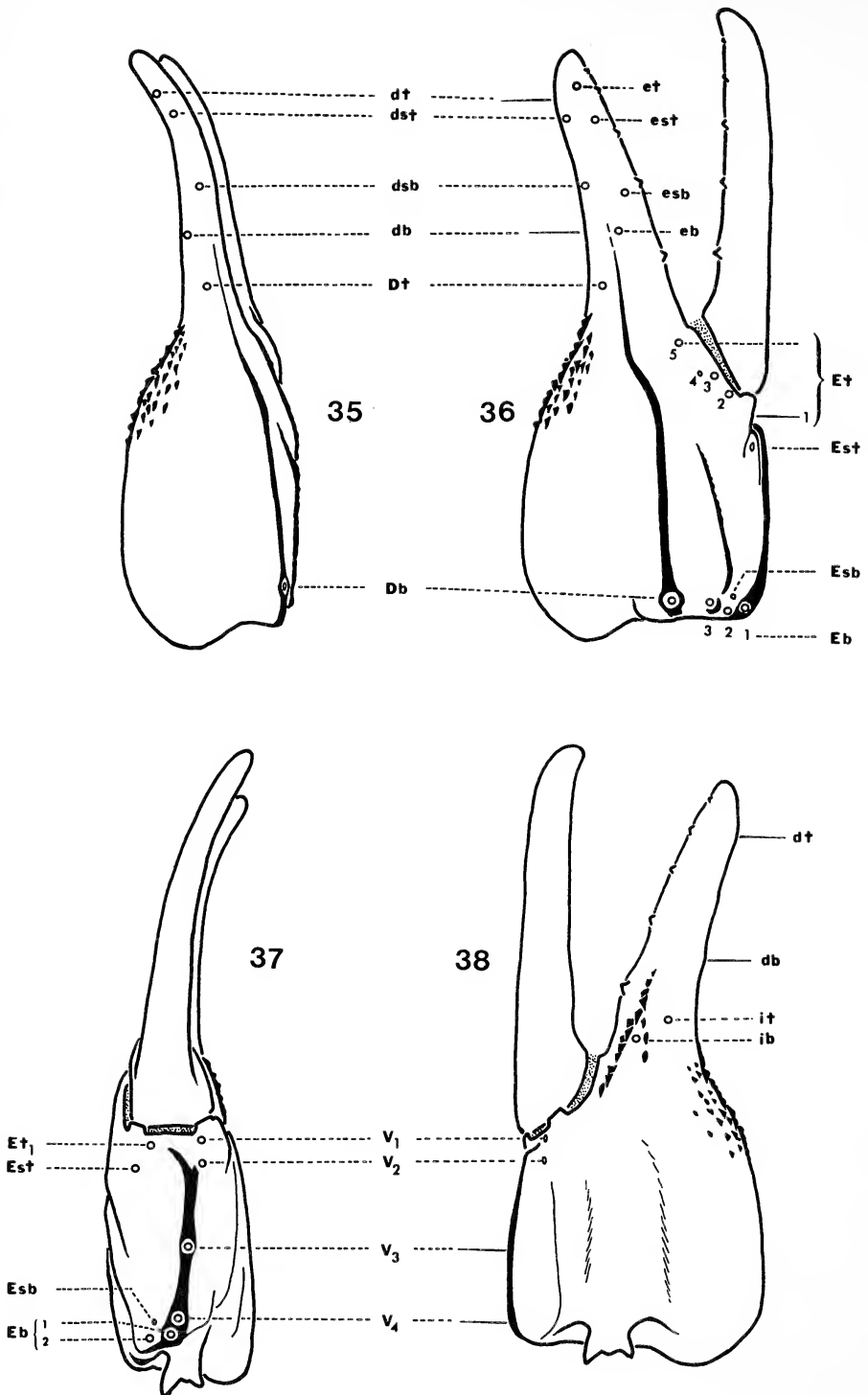
Figs. 35-38.—Right pedipalp chela of *Diplocentrus tehuano*, n. sp., holotype male, showing tricho-bothrial pattern: 35, dorsal aspect; 36, external aspect; 37, ventral aspect; 38, internal aspect.
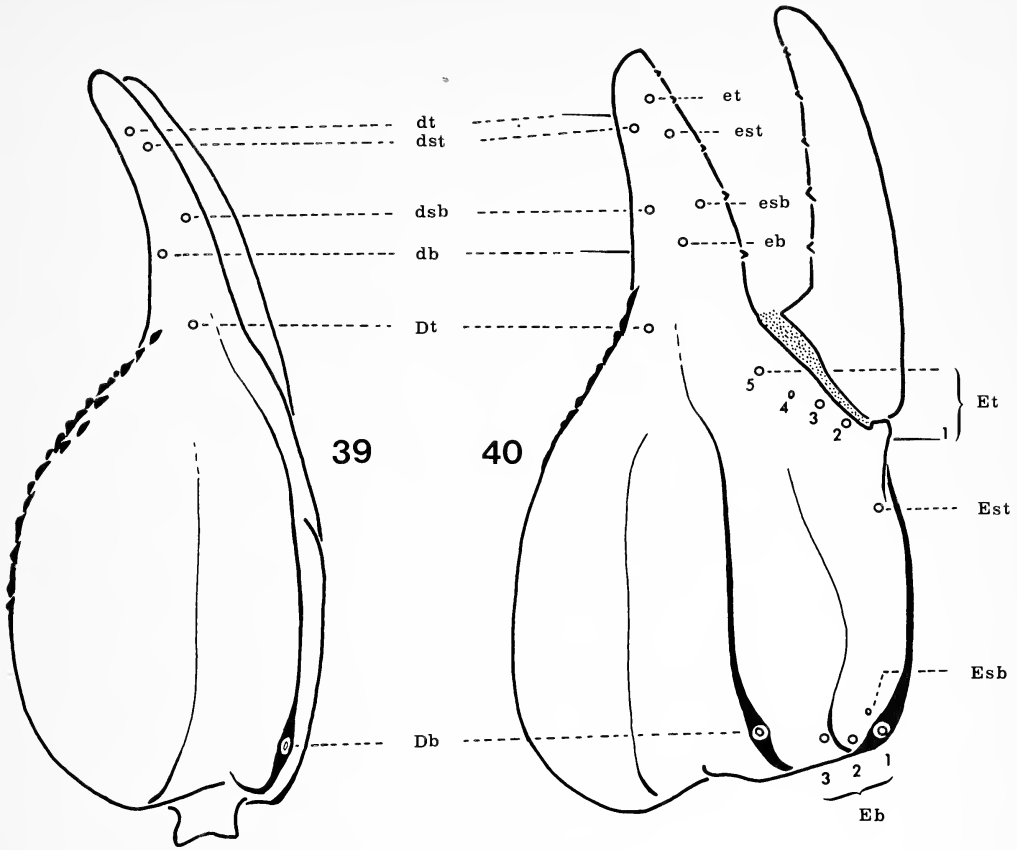
Figs. 39-40.–Right pedipalp chela of *Diplocentrus tehuano*, n. sp., allotype female, showing trichobothrial positions and illustrating one of the most extreme cases of chelal sexual dimorphism I have encountered in the genus: 39, dorsal aspect; 40, external aspect.

Chelicera.–Chela and fingers ochreous, teeth fulvous. Dentition in Fig. 3.

Pedipalps.–Femur ochreous testaceous, wider than deep. Dorsal internal carina strong, granulose. Dorsal external keel: basal one-fourth moderately strong, granular; subbasal one-fourth weak to vestigial, subgranose; distally obsolete. Ventral internal keel strong, granulose, distally curving dorsad and merging with dorsal internal keel. Ventral external carina obsolete. Dorsal face flat, with moderately dense small and minute granulation. Internal face coarsely granulose dorsally, shagreened medially and ventrally. External face smooth, external trichobothrium along dorsal margin at basal three-tenths of femoral length. Ventral face shagreened.

Tibia brunneous to testaceous, carinae vestigially infuscate. Orthobothriotaxia "C" (Fig. 11). Dorsal internal keel obsolete; basal tubercle feebly developed, with four to six small granules. Dorsal median keel strong, smooth. Dorsal external keel vestigial to obsolete. External keel weak to vestigial, smooth. Ventral external keel strong, smooth to feebly crenate. Ventral median keel obsolete. Ventral internal keel weak to moderate, subgranose. Internal face shagreened. Dorsal and external faces vestigially reticulate. Ventral face densely punctate.

Chela ochreous with variegated fuscosity on manus, fingers fusco-rufous. Orthobothriotaxia "C" (Figs. 35-38). Dorsal margin of manus acutely angulose, carinate: basal

two-thirds smooth; distally coarsely granulose, extending through fixed finger base. Digital keel strong, smooth. Dorsal secondary keel vestigial to obsolete. External secondary keel moderately strong, smooth. Ventral external keel obsolete. Ventral median carina very strong, smooth to subcrenate; slightly oblique, directed towards midpoint of movable finger articulation. Ventral internal keel vestigial, smooth. Two internal carinae outlining depression where chela flexes against tibia; weak to vestigial, minutely granulose to smooth.

Chelal dorsal face strongly reticulate, ridges crenate to granulose. External face bare, moderately reticulate with faintly crenate ridges. Ventral face vestigially reticulate. Internal face: disc bare, smooth; ventral submargin feebly reticulate, bare; distal region extending to fixed finger base sparsely setate, smooth. Fixed finger base: internally moderately granulose, bare; externally smooth, bare; dorsally vestigially reticulate, granulose. Fixed finger internal margin: basal two-thirds almost straight, distally moderately arcuate. Fingers smooth, moderately setate.

Legs.—Flavus to ochroleucus, sparsely setate. Femora and tibiae with external faces and ventral margins vestigially granulose. Tarsomere II spine formula 4/4 4/4 : 5/5 5/5 : 5/6 6/6 : 6/6 6/6 .

Allotype.—Female (measurements in Table 2), differs from holotype as indicated below.

Prosoma.—Carapace densely infuscate. Anterior median furrow vestigial. Posterior lateral furrows obtusely angulose.

Mesosoma.—Tergites I-VI lustrous, smooth. Tergite VII lustrous, sparsely granulose. Genital operculi ellipsoidal, vestigially emarginate postero-medially; median longitudinal membranous connection complete. Genital papillae absent. Pectinal tooth count 10-11. Sternites III-VI with discs minutely punctate. Sternite VII tetracarinate: submedian keels present on distal one-third, moderately strong, smooth; lateral keels present on distal two-thirds, moderately strong, smooth; intercarinal spaces punctate.

Metasoma.—Testaceous; carinae moderately infuscate, intercarinae with sparse variegated fuscosity. **Vsm** carinae: on I strong, feebly crenate; on II weak to moderate, feebly crenate. **Lim** carinae on I moderately strong, crenate. Segment V with **Vt** keel moderately strong, three large conical granules per side; **Lm** keels obsolete, **Dl** keels strong, granulose. Anal arc circular: **Ast** keel with 14-15 small, oblong granules. Telson with ventral marginal clusters of 3:3:4 small to medium sized granules.

Pedipalps.—Femur fuscescent, vestigially infuscate. Tibia testaceous, carinae with moderately dense fuscosity. Chela testaceous, fingers fusco-ferrugineous; morphometrically very distinct from chela of male (Figs. 39-40). Dorsal margin of manus rounded to subcarinate, distally granulose through fixed finger base. Digital keel moderately strong, ending gradually at fixed finger base. Dorsal secondary and external secondary carinae vestigial, smooth. Ventral external keel obsolete. Ventral median carina moderately strong, smooth. Ventral internal keel vestigial to obsolete. Two internal carinae obsolete. Dorsal face of manus moderately to weakly reticulate, ridges smooth. External face vestigially reticulate. Ventral face rugose. Internal face: disc smooth, dorsal and ventral submargins vestigially reticulate. Fixed finger base: dorsally and externally smooth, bare; internally moderately granulose, sparsely setate. Fixed finger inner margin evenly, moderately arcuate. Movable finger shorter than carapace.

Legs.—Tarsomere II spine formula 4/5 4/5 : 5/5 5/6 : 5/6 6/6 : 6/6 6/6 .

Type locality.—Primary types collected 4 mi. E Tehuantepec, Oaxaca, México, 21 June 1964 (R. D. Sage). Deposited at the California Academy of Sciences (CAS), San Francisco.

Distribution.–Map 1. In addition to the primary types, the following specimens from Oaxaca have been examined: one immature paratype male, San Geronimo, July 1909 (no collector, AMNH); 28 paratopotypes (13 males, 15 females), same data as holotype. One subadult male, and one subadult female paratopotypes respectively deposited at the AMNH, courtesy of the University of California at Berkeley, where the remaining paratopotypes are deposited.

Etymology.–This species is named after the ethnic group, the "tehuanos," which inhabit the southern region of the Isthmus of Tehuantepec, whose cultural center is the city known by the same name and corresponding to the type locality.

Intraspecific variability.–*Diplocentrus tehuano* shows marked sexual dimorphism, allometric growth, and ontogenic changes in coloration. The specimens studied represent at least seven instars, not including first instars, recognizable as discrete size classes, and a detailed analysis of the overall variability observed is not considered necessary. Therefore, only those characters known (or considered) to be species specific, and thus taxonomocally useful, will be mentioned.

Coloration: Base color ochreous to testaceous, tending to become darker in older instars. Density, extent, and pattern of fuscosity on carapace and tergites showing reduced variability. Variegated fuscosity on pedipalp chela ranging from vestigial to moderately dense in immatures, becoming less variable in older instars which have moderately dense fuscosity.

Carapace: Anterior median notch shallow and broad in immatures, moderately deeper in adults. One immature paratopotype male with only two lateral eyes on the right side.

Pectinal tooth count variability summarized in Table 5, ranging from 11 to 14 in males, 10 to 12 in females.

Metasoma: Segment V anal arc with **Ast** keel bearing predominantly 13-14 small, oblong granules (range 11 to 15). Telson with ventral submarginal clusters of granules numbering predominantly 3:3:3 (ranges 2-3:3-5:2-3).

Tarsomere II spine count variability summarized in Table 6. The typical formula appears to be 4/5 4/5 : 5/5 5/5 : 5/6 6/6 : 6/6 6/6 , with high variability occuring especially on the anterior margin of the third pair of legs, where either five or six spines occur with equal frequency.

Comparative description.–*Diplocentrus tehuano* seems to be distantly related to *D. ochoterenai* on account of cheliceral, femoral, and chelal morphological similarities. *D. ochoterenai* can be easily separated on the basis of its larger size, higher pectinal tooth counts, higher tarsomere II spine formula, and increased extent of carinal development on metasomal segment IV and on the pedipalp tibia. Although *D. tehuano* resembles *D. tehuacanus* Hoffmann in the above mentioned characters, these two species do not appear to be closely related at all, and can be easily separated in terms of coloration, extent of granulation on the anterior margin and submargin of the carapace, the shape of the carapacial median notch, the relative positions of the distal external and distal internal teeth of the cheliceral movable finger, the morphology of the pedipalp chela, and the position of chelal trichobothrium Eb_1 with respect to the ventral median keel of the manus.

Diplocentrus tehuacanus Hoffmann, new combination

Figs. 5, 12, 19, 41-44

Diplocentrus keyserlingi tehuacanus Hoffmann 1931, pp. 312-323, Figs. 11-12. Hoffmann
1938, p. 317. Díaz Nájera 1964, p. 20.

Diagnosis.—Medium sized, adults seldom exceeding 55 mm in total length. Ochreous to
ochreous fuscescent, with distinct variegated fuscosity; legs not contrasting with opis-
thosoma in coloration. Carapacial anterior margin granulose, median notch obtusely
angulose; anterior submargin moderately granulose. Tergite VII disc moderately bilobed
postero-laterally, carinae obsolete. Pectinal tooth count 11-14 in males, 11-13 in females.
Metasomal segments I-II with ten complete carinae each, III with eight keels, IV with four
to six vestigial carinae; intercarinal spaces minutely granulose to punctate; segment I as
wide as long in males, wider than long in females; segment V longer than pedipalp femur.
Chelicera: fixed finger shorter than chela width; movable finger shorter than chela length,
distal external tooth not closely opposed to distal internal tooth. Pedipalps: femur
slightly wider than deep, dorsally flat to feebly convex; tibia with dorsal median keel
moderately strong, dorsal external keel obsolete; fixed finger base internally smooth
along articulation socket; fixed finger shorter than pedipalp femur; movable finger longer
than carapace in males, shorter in females. Tarsomere II spine formula 4/5 4/5 : 5/5 5/5 :
6/6 6/6 : 6/6 6/6.

Holotype.—Male (measurements in Table 3).

Prosoma.—Carapace ochreous with distinct fuscous pattern. Anterior margin granulose,
emarginate; median notch obtusely angulose, approximately three and one-half times
wider than deep (Fig. 19). Three pairs of lateral eyes, posterior pair smallest. Anterior
median furrow: submarginally shallow, moderately wide; medially expanding into slightly
depressed, circular, smooth area (*area frontalis* of Birula, 1917); distally to base of ocular
prominence obsolete. Median ocular prominence vestigially concave between median
eyes, located at anterior two-fifths of carapace length. Posterior median furrow moder-
ately deep. Posterior marginal furrow moderately deep, narrow. Posterior lateral furrows
subangulose. Surface shagreened, anterior submargin moderately granulose. Venter
ochreous, sparsely setate. Sternum pentagonal.

Mesosoma.—Tergites ochreous with distinct fuscous pattern: discs with moderately
dense, variegated fuscosity; posterior submargins uniformly infuscate; overall density of
fuscosity decreases distally between segments. Tergites I-VI shagreened, posterior sub-
margins with sparse small and medium granules. Tergite VII moderately bilobed postero-
laterally, median emargination indistinct and middle area subtly depressed; submedian
and lateral carinae obsolete. Tergite VII shagreened, laterally coarsely granulose, and
postero-lateral submargins with transverse keel-like row of medium sized granules.

Genital operculi ochreous, ellipsoidal, without postero-median emarginations; median
longitudinal membranous connection absent. Genital papillae present. Pectines ochreous
to ochroleucus, lamellar setation sparse; middle lamellae partly fused, two to three per
comb. Fulcra subtriangular. Pectinal tooth count 12-13.

Sternites ochreous. Sternites III-VI smooth, stigmata about three times longer than
wide. Sternite VII tetracarinate: submedian keels present on distal one-third, vestigial,
smooth; lateral keels present on distal two-thirds, weak, smooth; intercarinae smooth.

Metasoma.—Ochreous fuscescent, sparsely to moderately setate. **Vsm** carinae: on I-II
weak, crenate, subparallel; on III with proximal two-thirds vestigial and smooth, distally
obsolete; on IV obsolete. **Vl** carinae: on I strong, crenate, moderately convergent distally;

Table 3.—Measurements (mm) of *Diplocentrus tehuacanus* Hoffmann and *Diplocentrus rectimanus* Pocock.

	tehuacanus		rectimanus	
	Holotype	Topotype	Holotype	
	Male	Female	Male	Female
Total length	54.95	45.10	49.70	53.95
Carapace				
Length	6.80	6.05	6.40	7.55
Anterior width	3.50	3.30	3.65	4.10
Width at median eyes	5.50	4.95	4.40	5.70
Posterior width	6.85	6.05	6.55	7.40
Mesosoma length	18.10	16.25	15.80	18.70
Metasoma length	30.05	22.80	27.50	27.70
Segment I				
Length	3.95	2.80	3.30	3.40
Width	4.00	3.30	3.90	4.30
Segment II				
Length	4.35	3.25	3.85	3.90
Width	3.70	3.10	3.60	3.95
Segment III				
Length	4.60	3.40	4.30	4.15
Width	3.50	2.95	3.45	3.85
Segment IV				
Length	5.30	3.95	4.95	4.75
Width	3.10	2.85	3.40	3.70
Segment V				
Length	6.25	4.70	6.00	5.80
Width	2.70	2.45	2.70	3.10
Telson length	5.60	4.70	5.10	5.70
Vesicle				
Length	4.65	3.80	4.00	4.50
Width	2.90	2.80	2.60	3.35
Depth	2.20	2.10	2.10	2.50
Aculeus length	0.95	0.90	1.10	1.20
Pedipalp length	24.90	18.45	20.65	22.50
Femur				
Length	6.10	4.30	4.75	5.10
Width	2.10	2.15	1.85	2.00
Depth	1.85	2.05	2.65	2.60
Tibia				
Length	6.10	4.35	4.70	5.10
Width	2.20	2.10	2.05	2.30
Chela				
Length	12.70	9.80	11.20	12.30
Width	5.00	5.10	5.50	6.00
Depth	3.10	3.10	3.10	3.80
Movable finger length	6.90	5.50	7.15	7.60
Fixed finger length	5.00	3.95	5.10	5.50
Chelicera				
Chela length	2.15	2.00	2.25	2.75
Chela width	1.50	1.55	1.60	2.05
Fixed finger length	1.20	1.20	1.70	2.10
Movable finger length	1.85	1.90	2.30	2.95
Pectinal teeth	13/12	11/11	10/10	8/8

on II moderately strong, crenate, slightly convergent distally; on III with proximal three-fourths weak to vestigial, subcrenate to smooth, distally obsolete; on IV vestigial to obsolete. **Lim** carinae: on I strong, complete, crenate; on II with proximal one-third vestigial and smooth, distally weak and crenate; on III vestigial to obsolete, smooth; on IV obsolete. **Lsm** carinae: on I strong, crenate; on II strong, smooth to subcrenate; on III-IV weak, smooth. **Dl** carinae on I-IV weak to vestigial, smooth to subgranose. Inter-carinal spaces: ventrals vestigially punctate, laterals and dorsals shagreened to vestigially granulose.

Segment V slightly longer than pedipalp femur. **Vm** and **Vl** carinae weak to moderate; distal two-thirds with sparse, medium sized granules. **Vt** keel moderately emarginate, moderately strong and with five medium sized oblong granules. **Lm** carinae obsolete. **Dl** keels vestigial, smooth. Anal arc circular: **Ast** keel moderately strong, with 14 medium and small oblong granules; **At** keel weak, minutely granulose. Telson ochreous fuscescent with faint, uniform fuscosity ventrally and laterally; dorsally flat, smooth, bare; laterally and ventrally moderately setate, smooth except for ventral submarginal clusters of 3:4:3 medium sized granules. Subaculear tubercle strong; aculeus short, moderately to strongly curved.

Chelicera.–Ochreous, chela dorsally with vestigial variegated fuscosity. Dentition in Fig. 5.

Pedipalps.–Femur ochreous fuscescent, wider than deep. Dorsal internal keel strong, coarsely granulose. Dorsal external keel: basal one-half moderately strong, granulose; distally weak to vestigial, subgranose. Ventral internal keel moderately strong, granulose. Ventral external keel obsolete. Dorsal face flat to feebly convex, sparsely to moderately granulose medially. Internal face flat, moderately granulose. External face smooth, external trichobothrium along dorsal margin at basal two-fifths of femoral length. Ventral face smooth.

Tibia ochreous, dorsal median keel vestigially infuscate, external face with vestigial variegated fuscosity. Orthobothriotaxia "C" (Fig. 12). Dorsal internal keel obsolete; basal tubercle moderate, with three or four medium sized granules. Dorsal median keel moderately strong, smooth. Dorsal external keel obsolete. External keel vestigial to obsolete. Ventral external keel moderately strong, smooth. Ventral median keel obsolete. Ventral internal keel moderately strong, subgranose. Internal face shagreened, with sparse small granules. Dorsal, external, and ventral faces smooth to vestigially punctate.

Chela ochreous fuscescent, fingers ferrugineous; dorsal and external faces of manus with vestigial reticulated fuscosity. Orthobothriotaxia "C" (Figs. 41-44). Dorsal margin of manus carinate, smooth to subgranose, continuing through fixed finger base with coarse granulations. Digital keel moderate to strong, smooth. Dorsal secondary, external secondary, and ventral external carinae vestigial to obsolete, smooth. Ventral median keel strong, smooth to subcrenate, directed towards midpoint of movable finger articulation. Ventral internal keel weak to moderate, smooth. Two internal keels weak to vestigial, feebly granular, outlining depression where chela flexes against tibia.

Dorsal face of manus: disc vestigially reticulate, ridges sparsely punctate; sparsely granulose towards fixed finger base. External and ventral faces smooth, bare. Internal face moderately granulose at dorsal submargin and towards fixed finger base; disc smooth, bare. Fixed finger base: dorsal submargin granulose, bare; external face smooth, sparsely setate; internally smooth, sparsely setate. Fixed finger internal margin moderately arcuate. Fixed and movable fingers smooth, moderately setate. Movable finger about as long as carapace.
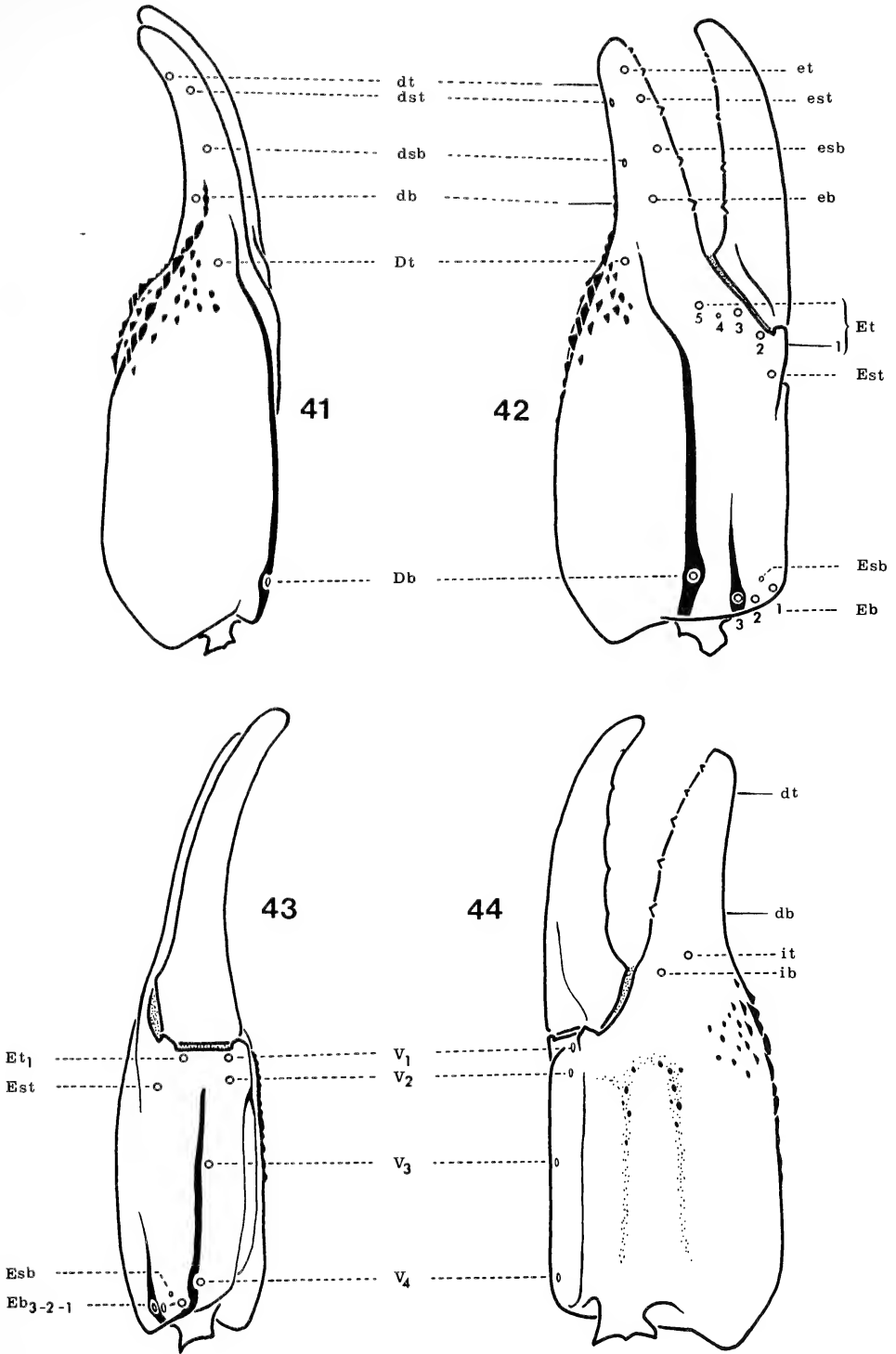
Figs. 41-44.—Right pedipalp chela of *Diplocentrus tehuacanus* Hoffmann, holotype male, showing the trichobothrial arrangement: 41, dorsal aspect; 42, external aspect; 43, ventral aspect; 44, internal aspect.

Legs.—Ochreous with vestigial variegated fuscosity. Femora III-IV shagreened. Tarsomere II feebly lobed distally, spine formula 4/5 4/5 : 5/6 5/5 : X/X X/X : X/X 6/7 .

Condition.—Holotype in good condition except for lacking the third and fourth legs on the right side and the third leg on the left side.

Female.—Differs from holotype as indicated below (measurements in Table 3).

Prosoma.—Carapace with anterior margin subgranose, interocular triangle sparsely to moderately granulose; surface lustrous and vestigially punctate.

Mesosoma.—Tergites I-VI lustrous with postero-lateral submargins sparsely, vestigially granulose. Tergite VII feebly to vestigially bilobed postero-laterally; disc lustrous, posterior margin granulose. Genital operculi elliptical, with complete median longitudinal membranous connection. Genital papillae absent. Pectinal tooth count 11-13. Sternite VII with carinae smooth to crenate.

Metasoma.—Vsm carinae on I-II weak to moderate, crenato-granulose. Vl carinae on III weak, complete, subcrenate. Lim carinae on II weak, complete, crenate. Dorsal and lateral intercarinae on segment I vestigially granulose to rugose, all others vestigially punctate.

Pedipalps.—Femur ochreous fuscescent, slightly wider than deep. Dorsal internal keel moderately strong, granulose. Dorsal external keel: basal one-half weak to moderate, granulose; distally vestigial to obsolete, subgranose to smooth. External face sparsely punctate. Tibia with external keel obsolete, ventral external keel weak to vestigial, smooth. Chela morphometrically differing from male chela, appearing more rounded as faces of manus are not obtusely angulose with each other. Dorsal margin of manus: basal one-half rounded, smooth; distal one-half and fixed finger base subcarinate, granulose. Digital keel weak, smooth, tapering along fixed finger base. Dorsal secondary, external secondary, ventral external, and ventral internal carinae vestigial to obsolete. Ventral median keel moderately strong, smooth. Two internal carinae vestigial, smooth. Dorsal face of manus with reticulation vestigial to obsolete; surface densely, minutely punctate. External and ventral faces vestigially rugose to smooth, bare. Movable finger shorter than carapace.

Type locality.—Holotype male from Mesa del Riego, Tehuacán, Estado de Puebla, México, no date (C. C. Hoffmann). Colección de Alacranes mexicanos de Carlos C. Hoffmann, AMNH.

Distribution.—*Diplocentrus tehuacanus* is the only species included in this contribution that is known outside the state of Oaxaca, and is distributed along the southern slopes of the Sierra Transversal of Mexico (Map 1). In addition to the holotype, the following specimens were examined. OAXACA; one adult male, near Chasumba, 28 July **** (C. C. Hoffmann; AMNH). PUEBLA: one adult female, Tehuacán, 8 November 1939 (H. E. Vokes and C. M. Bogert; AMNH); one adult male, Tehuacán, 24 July 1956 (W. J. Gertsch and V. Roth; AMNH); one subadult male, 28.6 mi. NW Acatlán, 25 July 1973 (L. R. Erickson and M. E. Soleglad; Soleglad collection). GUERRERO: one adult female, 3 mi. N Taxco, 19 November 1946 (E. R. Ross, CAS); one adult female with six second instars, and one juvenile male, 5.3 mi. N Iguala, 24 July 1973 (L. R. Erickson and M. E. Soleglad; Soleglad coll.). MORELOS: one adult female, W of Huajintlán, 3 May 1963 (W. J. Gertsch and W. Ivie; AMNH).

Intraspecific variability.—Sexual dimorphism and ontogenetic changes are the largest sources of variation observed. The variability in pectinal tooth counts is given in Table 5, and it ranges from 11-14 in males (predominantly 13), and 11-13 in females (predominantly 11). The tarsomere II spine count variability appears in Table 6, and the typical formula appears to be 4/5 4/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6 .

Comparative description.–The closest relative of *D. tehuacanus* apparently is *D. keyserlingi* Karsch, and it was originally considered to be only a subspecies of this older taxon. However, in making this decision Hoffmann (1931) weighted more heavily the similarity in the shape of the pedipalp chela in females, than the differences in the morphology of this structure in males. After examining several instances where closely related species occur sympatrically, I have noticed that adult males can be easily separated by their chelal morphology, whereas females are extremely difficult, if not impossible, to separate on the basis of this character alone. For this reason I attach considerably greater taxonomic weight to divergences in the chelal morphology of males, than I do to similarities between females. Therefore, even though I do not fully understand the evolutionary significance of these divergences among males, on the basis of chelal morphology and other characters I am recognizing *D. tehuacanus* as a valid species.

Diplocentrus keyserlingi is found north of the Sierra Transversal of Mexico, and can be separated from *D. tehuacanus* on the basis of its higher tarsomere II spine counts on the last two pairs of legs at 7/7 7/7 : 7/7 7/7 . In addition, in *D. keyserlingi* morphological and morphometric sexual dimorphism of the pedipalp chela is considerably reduced in comparison to *D. tehuacanus*; the dorsal margin of the manus is evenly rounded in both sexes, and not nearly as straight as in males of *D. tehuacanus*; the chela is relatively wider and deeper, and the movable finger of the pedipalps is as long as the carapace in both sexes.

<center>

Diplocentrus rectimanus Pocock

Figs. 6, 15, 21, 45-50

</center>

Diplocentrus rectimanus Pocock 1898, pp. 390-391.
Diplocentrus keyserlingi Kraepelin1899, p. 102 (part). Pocock 1902, p. 4, Tab. 1, figs. 4a-c (nec *keyserlingi* Karsch). Hoffmann 1931, pp. 312-323 (part). Pelaez 1962, p. 72 (part ?).

Diagnosis.–Medium sized, adults seldom exceeding 55 mm in total length. Ochreous fuscescent, opisthosoma with distinct variegated fuscosity; legs ochreous, weakly contrasting with opisthosoma in coloration. Carapacial anterior margin minutely granulose, median notch obtusely angulose; anterior submargin moderately granulose. Tergite VII disc weakly bilobed postero-laterally, carinae obsolete. Pectinal tooth count 9-11 in males, eight in females. Metasomal segments I-III with ten complete carinae each, segment IV with six to eight carinae; intercarinal spaces smooth to shagreened; segment I wider than long, segment V longer than pedipalp femur. Chelicera: fixed finger longer than chela width; movable finger longer than chela length, distal external tooth moderately opposed to distal internal tooth. Pedipalps: femur deeper than wide, dorsally moderately to strongly convex; tibia with dorsal median keel strong, dorsal external keel vestigial to obsolete; chelal fixed finger with inner margin straight to feebly arcuate. Fixed finger longer than pedipalp femur, shorter than metasomal segment V; movable finger longer than carapace in males, about equal in length in females. Tarsomere II spine formula 4/5 5/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6 .

Holotype.–Male (measurements in Table 3).

Prosoma.–Carapace ochreous fuscescent with vestigial variegated fuscosity. Anterior margin minutely granulose, emarginate; median notch obtusely angulose, slightly less than four times wider than deep (Fig. 21). Three pairs of lateral eyes, anterior pair smallest. Anterior median furrow obsolete. Ocular prominence flat between median eyes, located

at anterior three-eights of carapace length. Posterior median furrow shallow to moderately deep. Posterior marginal furrow moderately deep and wide. Posterior lateral furrows arcuate, moderately deep. Anterior submargin densely, coarsely granulose; other surfaces shagreened. Venter ochreous, sparsely setate. Sternum pentagonal.

Mesosoma.—Tergites testaceous, vestigially infuscate. Tergites I-VI shagreened throughout; posterior submargins with sparse to moderately dense, small granules. Tergite VII weakly bilobed postero-laterally, median emargination indistinct and middle area feebly depressed; submedian and lateral carinae obsolete. Tergite VII disc shagreened, postero-laterally coarsely granulose.

Genital operculi ochreous, ellipsoidal, without postero-median emarginations; median longitudinal membranous connection absent. Genital papillae present. Pectines ochroleucus, lamellar setation sparse; middle lamellae partly fused, three to four per comb. Fulcra subtriangular. Pectinal tooth count 10-10.

Sternites ochreous; III-IV smooth, stigmata four times longer than wide. Sternite VII tetracarinate: submedian keels present on distal two-thirds, weak, smooth; lateral carinae present on distal three-fourths, moderately strong, smooth. Sternite VII with median and submedian intercarinae smooth, laterals vestigially granulose.

Metasoma.—Basal segments ochreous fuscescent, darkening gradually to testaceous on distal segments; dorsally bare, ventrally and laterally sparsely to moderately setate with marked density increase on segment V. Vsm carinae: on I-II moderately strong, coarsely crenate, slightly convergent distally; on III present on basal two-thirds, weak, feebly crenate, subparallel; on IV present on basal two-thirds, vestigial, smooth. Vl carinae: on I-II strong, irregularly crenate, slightly convergent distally; on III-IV moderate, smooth, feebly divergent on distal one-fifth. Lim carinae; on I strong, complete, crenate; on II moderately strong, complete, feebly crenate; on III weak, complete, feebly crenate; on IV vestigial to obsolete. Lsm carinae: on I-II strong, coarsely crenate; on III-IV moderately strong, crenate. Dl carinae: on I-II weak, finely crenate; on III-IV moderately strong, crenate. Intercarinal spaces smooth to shagreened.

Segment V longer than pedipalp femur. Vm and Vl carinae: basal one-third weak, subgranose; distally strong, with large subconical granules well spaced. Vt keel moderately strong, emarginate and notched medially; with three large subconical granules per side. Lm carinae present on basal one-third to one-half, vestigial, smooth. Anal arc circular: Ast keel strong, with 14 medium sized subconical granules; At keel weak to vestigial, minutely dentate. Telson testaceous: dorsally feebly convex, smooth, bare; ventrally and laterally moderately setate, proximal one-half vestigially granulose and with ventral submarginal clusters of 2:2:2 medium sized granules. Subaculear tubercle strong, rounded; aculeus short, strongly curved.

Chelicera.—Chela and fingers ochreous, teeth fuscous. Dentition in Fig. 6.

Pedipalps.—Femur testaceous, considerably narrower than deep. Dorsal internal keel weak, granulose. Dorsal external keel: basal two-thirds strong, granulose; distally weak to vestigial, subgranose. Ventral internal keel strong, coarsely granulose; distally curving dorsad and merging with dorsal internal keel. Ventral external keel obsolete. Dorsal face moderately convex: basal two-thirds with moderately dense, small and medium granules; medially with longitudinal, keel-like row of four to six large granules. Internal face flat; shagreened with moderately dense small and medium granules. External face smooth, external trichobothrium along dorsal margin near middle of femoral length. Ventral face smooth.

Tibia ochreous to testaceous. Orthobothriotaxia "C" (Fig. 15). Dorsal internal carina obsolete; basal tubercle strong, with two large granules. Dorsal median keel moderately

strong, coarsely crenate. Dorsal external keel vestigial to obsolete, smooth. External keel weak to vestigial, smooth. Ventral external keel weak to vestigial, smooth. Ventral median keel obsolete. Ventral internal keel vestigial, subgranose. Internal face smooth to vestigially shagreened. Dorsal, external, and ventral faces smooth.

Chela ochreous fuscescent to testaceous. Orthobothriotaxia "C" (Figs. 45-48). Dorsal margin of manus acutely angulose, strongly carinate: basal one-half crenulate; distally granulose, continuing through fixed finger base and into fixed finger. Digital keel strong, feebly crenate. Dorsal secondary keel on basal one-third moderately strong, crenate; distally weak, granulose. External secondary keel moderate to weak, subgranose. Ventral external keel present on distal one-half of underhand length; weak, granulose. Ventral median keel strong, crenate, directed towards midpoint of movable finger articulation. Ventral internal keel weak to vestigial, granulose. Two internal carinae vestigial, smooth, outlining depression where chela flexes against tibia.

Dorsal face with moderately strong reticulation; basally and medially with smooth ridges, subgranose ridges distally. External face with moderately strong reticulation, ridges smooth to subgranose; sparsely setate. Ventral face: externad to ventral median keel moderately granulose; internad to ventral median keel weakly reticulate, sparsely setate. Internal face: disc smooth, bare; ventral submargin vestigially reticulate, sparsely setate; dorsal submargin weakly to vestigially reticulate, moderately granulose, sparsely setate. Fixed finger base: internally smooth, moderately setate; externally and dorsally vestigially granulose, sparsely setate. Fixed finger inner margin very shallowly curved, almost straight; dorsal margin weakly to vestigially granulose; external face with two subparallel rows of small granules. Movable finger with external face vestigially granulose basally. Fingers densely setate.

Legs.—Ochreous, sparsely to moderately setate. Femora II-IV with ventral margins vestigially granulose. Tarsomere II spine count 5/5 5/5 : 4/4 5/5 : 6/6 6/6 : 6/6 6/6 , leg II on right side showing signs of regeneration which might account for reduced spine count.

Condition.—Holotype poorly preserved. The integument has been bleached by prolonged immersion in alcohol, and possibly dehydration has occurred in the carapace and mesosoma where the underlying tissues have separated from the exoskeleton, making it almost impossible to determine coloration patterns on these regions. The left pedipalp chela, left legs I and III are detached from the specimen. The right pedipalp chela, right leg IV, and left legs II and IV are essentially separated from the specimen. The extreme tip of the aculeus is broken off.

Female.—Differs from male as indicated below (measurements in Table 3).

Prosoma.—Carapace testaceous with moderately dense, variegated fuscous pattern. Anterolateral margins moderately setate. Anterior submargin with moderately dense, small granules. Surface lustrous with sparse minute granulation.

Mesosoma.—Tergites testacious, with dense variegated fuscosity; posterior and lateral margins sparsely setate. Tergites I-VI lustrous; with moderately dense, medium and small granules. Tergite VII vestigially bilobed postero-laterally, carinae obsolete. Genital operculi ochreous, ellipsoidal; opercular halves with median longitudinal membranous connection on basal five-sixths. Pectinal tooth count 8-8. Sternite VII tetracarinate: submedian keels present on distal one-half, moderately strong, crenate; lateral keels present on distal two-thirds, strong, crenate. Sternite VII with median and submedian intercarinae smooth, laterals vestigially granulose.
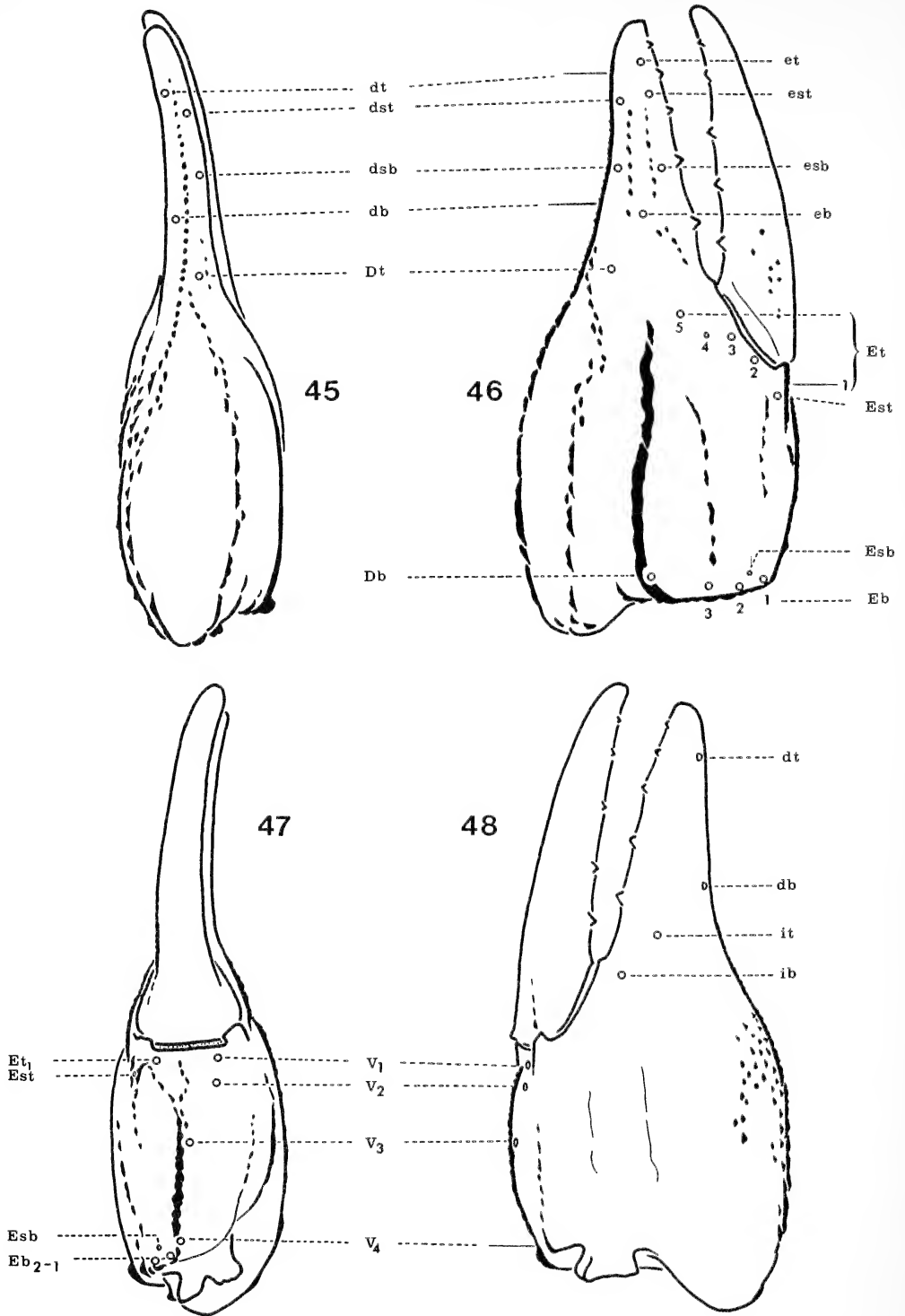
Figs. 45-48.—Right pedipalp chela of *Diplocentrus rectimanus* Pocock, holotype male, showing the trichobothrial pattern: 45, dorsal aspect; 46, external aspect; 47, ventral aspect; 48, internal aspect.
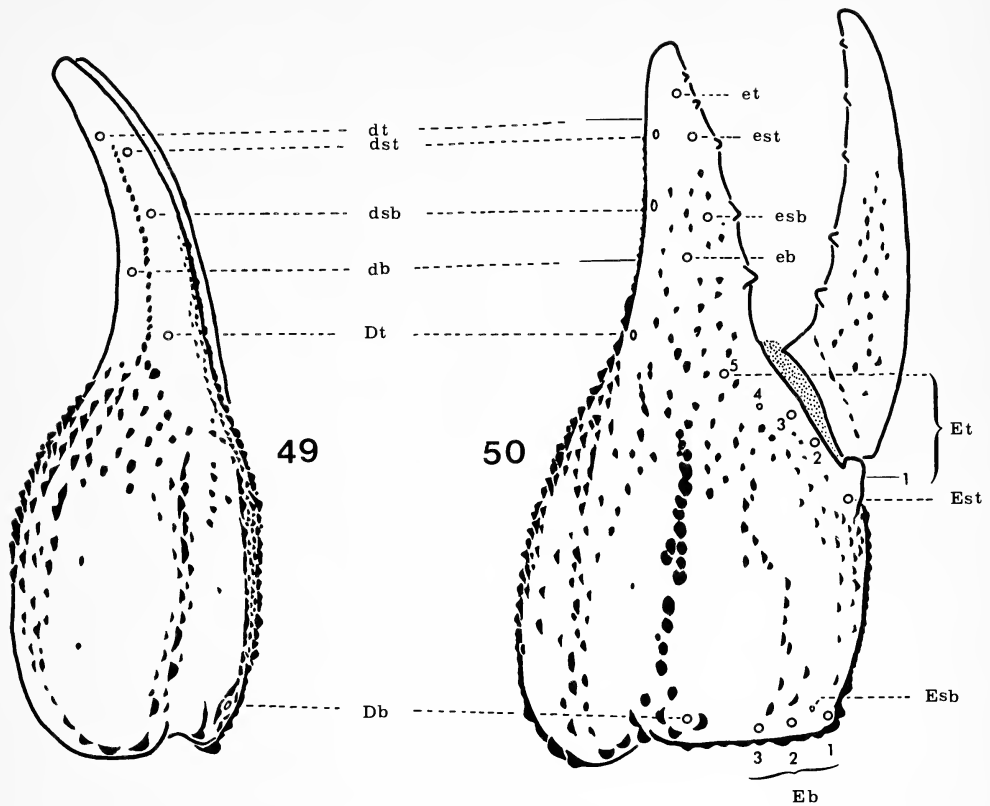
Figs. 49-50.—Right pedipalp chela of *Diplocentrus rectimanus* Pocock, adult female, showing the trichobothrial pattern and illustrating an exceptional example of sexual dimorphism where the development of granulation is more extensive on females than on males: 49, dorsal aspect; 50, external aspect.

Metasoma.—Ferrugineous, carinae sparsely to moderately infuscate. Vl carinae: on I-II strong, finely crenate; on III weak to moderate, crenate; on IV present on proximal three-fourths, weak to vestigial, smooth. Dl carinae on I-IV weak, feebly crenate. Segment V with **Lm** carinae obsolete; **Dl** carinae weak, vestigially crenate; **Vt** moderately strong, with four large granules. Dorsal and lateral intercarinae on I-II sparsely granulose, all others smooth.

Pedipalps.—Femur ferrugineous, dorsal face moderately granulose. Tibia ferrugineous: dorsal median keel moderately strong, subgranose; dorsal external keel vestigial to obsolete; external keel obsolete; dorsal and external faces vestigially granulose. Chela ferrugineous with vestigially infuscate carinae. Morphometrically very distinct from chela of male (Figs. 49-50). Dorsal margin subcarinate, coarsely granose. Digital keel strong, granulose. Dorsal secondary and external secondary carinae weak to moderate, subgranose. Ventral external, ventral internal, and two internal carinae vestigial to obsolete. Ventral median keel strong, subgranose. Dorsal face vestigially reticulate, bare; basal two-thirds with sparse, small granulation; distal one-third with moderately dense, small and medium granulation. External face weakly reticulate, bare; basal one-half with moderately dense, small granulation; distal one-half densely granulose, extending through fixed finger base.

Ventral face moderately to densely granulose. Internal face: disc bare, smooth; ventral submargin smooth, sparsely setate; dorsal submargin weakly to vestigially reticulate with moderately dense granulation distally, sparsely to moderately setate. Fixed finger base: dorsally and externally densely granulose, sparsely setate; internally sparsely granulose, moderately setate. Fixed finger internal margin moderately arcuate; internal face smooth, dorsal and external faces densely granulose; densely setate throughout. Movable finger moderately setate, external face weakly to moderately granulose.

Type locality.—Holotype male is accompanied by two handwritten labels; one is Pocock's type designation label, and the other simply gives the locality as "Jalapa".

Hoffmann (1931) raised some questions about the accuracy of the type locality of *D. rectimanus*, and I consider it necessary to explore the problem in greater depth. Although in the original description the type locality appears as "Jalapa", Pocock (1902) expanded on this by giving it as "Jalapa, Oaxaca". Consulting the Gazetteer of Official Names approved by the U. S. Board on Geographic Names (México, no. 15, 1956), I found 12 locations with the name of Jalapa; three are in the state of Oaxaca, and Jalapa del Valle is only 16 km west of the city of Oaxaca. Unfortunately, the largest and best known Jalapa is in the state of Veracruz, and I believe this is the reason why Hoffmann had some doubts about a locality given as "Jalapa, Oaxaca". Nevertheless, I have examined adult male specimens from the state of Oaxaca that are practically indistinguishable from the holotype, and for this reason there is little doubt in my mind that the holotype did originate from the neighborhood of the city of Oaxaca. Thus, the type locality of *D. rectimanus* is here considered as being Jalapa del Valle (16 km W of Oaxaca city), Oaxaca, México. The holotype is permanently deposited at the British Museum (Natural History), London.

Distribution.—Map 1. *D. rectimanus* is known only from the following localities, all of which lie in the state of Oaxaca: one adult male, Caballo Blanco (under logs), 12 July 1963 (G. Sludder, AMNH); one adult male, 2 mi. E Ixtlán de Juarez (7,600 ft.), 20 July 1963 (G. Sludder, AMNH); five adult males, "El Punto," road to Ixtlán de Juarez, 19 August 1961 (C. M. and M. R. Bogert; four at AMNH, one in E. N. Kjellesvig-Waering coll.); one adult male, 1-5 mi. NE "El Punto," road to Ixtlán de Juarez (7,500 ft.), 3 September 1961 (Miller's and Bogert's, AMNH); one adult male, "El Cumbre" (on ridge E Cerro San Felipe, 8,000-9,000 ft.), road to Ixtlán de Juarez, 28 September 1961 (C. M. and M. R. Bogert, AMNH); one adult male, near Tejocote (under logs, 7,800 ft.), summer 1963 (C. M. Bogert, AMNH); one adult female, Oaxaca (? city), 19 June 1947 (B. Malkin, AMNH); one adult female, N slope of Cerro Guirone (7,200-7,500 ft.), Distrito de Tlacolula, 12 June 1970 (M. R. Bogert, AMNH).

Intraspecific variability.—The principal sources of variation in *D. rectimanus*, other than sexual dimorphism, appear to be as follows.

Prosoma.—Carapace testaceous with distinct fuscous pattern: anterior submargin with diffuse to moderately dense, uniform fuscosity; posterior submarginal fuscosity uniform, dense; discal areas surrounding median ocular prominence uniformly fusco-piceous; other carapacial areas with variegated, irregular fuscosity.

Mesosoma.—Tergites testaceous, densely infuscate and appearing darker than carapace; density of fuscosity increases distally between segments. Pectinal tooth counts (Table 5) range from 9-11 in males, eight in females. Sternites ochreous to ochreous fuscescent. Sternite VII carinae weak to moderately strong, smooth to feebly crenate.

Metasoma.—Ochreous fuscescent to testaceous, becoming slightly darker on distal segments; carinae vestigially infuscate on some specimens. Segments I-IV sparsely setate,

segment V moderately setate. Segment V with **Vt** keel emarginate, and with distinct median notch at intersection with **Vm** carina. Distal disc bisected by longitudinal row of three to four granules, extending approximately two-thirds of disc length from median notch of **Vt** towards anal arc. **Ast** keel strong, with 12-14 subconical to oblong granules.

Chelicera.—Ochreous: chela dorsally with diffuse, variegated fuscosity; fixed and movable fingers with sparse, uniform fuscosity.

Pedipalps.—Trochanter and femur testaceous, moderately setate. Tibia testaceous, dorsal carina diffusely infuscate; external face sparsely setate. Chela ochreous fuscescent to testaceous, carinae vestigially infuscate. Dorsal face of manus sparsely setate, external and internal faces moderately setate; fingers densely setate. Fixed finger inner margin straight to very shallowly arcuate in males, moderately arcuate in females.

Legs.—Ochreous; basal segments uniformly, diffusely infuscate. Tarsomere II spine counts (Table 6) indicate that the typical formula is 4/5 5/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6, with high variability occurring especially on the anterior margin of the first pair of legs, where either four or five spines can be observed with about equal frequency.

Comparative description.—Although Kraepelin (1899) synonymized *D. rectimanus* under *D. keyserlingi* only one year after the former was described, these two species are at best distantly related. *D. keyserlingi* can be recognized because the pedipalp femur is wider than deep in males, and as wide as deep in females; and its dorsal face is flat rather than convex. Also, in *D. keyserlingi* the cheliceral fixed finger is shorter than the chela width, and the movable finger is shorter than the chela length; the pectinal tooth counts are 12-13 for males and 8-12 for females (predominantly 10); the fixed finger of the pedipalp chela has the inner margin moderately arcuate in both sexes; and the spine count on the last two pairs of legs is higher, at 7/7 7/7 : 7/7 7/7 as previously indicated.

<center>

Diplocentrus hoffmanni, new species
Figs. 7, 14, 22, 51-54

</center>

Diagnosis.—Medium sized, adults seldom exceeding 55 mm in total length. Testaceous to ferrugineous, opisthosoma infuscate; legs contrasting slightly with opisthosoma in coloration. Carapacial anterior margin moderately granulose, median notch obtusely angular; anterior submargin granulose. Tergite VII disc vestigially bilobed postero-laterally, carinae obsolete. Pectinal tooth count 10-11 in males, nine in female. Metasomal segments I-II with ten complete carinae each, III-IV with eight keels each; intercarinal spaces shagreened; segment I wider than long, segment V longer than pedipalp femur. Chelicera: fixed finger longer than chela width; movable finger longer than chela length, distal external tooth not opposed to distal internal tooth. Pedipalps: femur deeper than wide, moderately convex dorsally; tibia with dorsal median carina strong, dorsal external keel weak to vestigial; fixed finger about as long as femur, shorter than carapace and metasomal segment V; movable finger shorter than carapace. Tarsomere II spine formula 5/5 5/5 : 5/5 5/6 : 6/6 6/6 : 6/6 6/7 .

Holotype.—Male (measurements in Table 4).

Prosoma.—Carapace ferrugineous, with distinct fuscous pattern. Anterior margin strongly emarginate; median notch granulose, obtusely angular, approximately twice wider than deep (Fig. 22). Three pairs of lateral eyes, anterior pair smallest. Anterior median furrow vestigial to obsolete. Ocular prominence feebly convex between median eyes, located at anterior two-fifths of carapace length. Posterior median furrow weak to moderately deep. Posterior marginal furrow moderately deep and wide. Posterior lateral

furrows arcuate, moderately deep. Carapacial surface: anterior submargin with moderately dense, medium sized granules; median and lateral areas shagreened; postero-laterally rugose, minutely granulose. Venter ochreous with diffuse, uniform fuscosity; sparsely setate. Sternum subpentagonal.

Mesosoma.—Tergites brunneous to testaceous, distinctly infuscate; tergites I-II with dense, fine variegations; tergites III-V with moderately dense, wide variegations, appearing darker than preceding segments; tergites VI-VII diffusely, irregularly infuscate, appearing lighter than preceding segments. Tergites I-VI shagreened. Tergite VI vestigially carinate medially. Tergite VII vestigially bilobed postero-laterally, median area subtly depressed; carinae obsolete. Tergite VII disc shagreened, laterally coarsely granulose.

Genital operculi flavus; ellipsoidal, without postero-median emarginations; median longitudinal membranous connection absent. Genital papillae present. Pectines ochreous, with sparse lamellar setation; middle lamellae partly fused, two per comb. Fulcra subtriangular. Pectinal tooth count 10-10.

Sternites ochreous to ochreous fuscescent; III-VI smooth, stigmata about four times longer than wide. Sternite VII tetracarinate: submedian keels present on distal one-half, weak to moderate, crenate; lateral carinae present on distal two-thirds, moderately strong, crenate. Sternite VII with median and submedian intercarinae smooth, laterals shagreened.

Metasoma.—Basal segments brunneus, distal segments fusco-rufous; dorsally bare, laterally and ventrally moderately setate with slight density increase on distal segments. **Vsm** carinae: on I-II weak, subgranose, slightly convergent distally; on III with basal two-thirds weak, subgranose, biconcave with each other, distal one-third vestigial, smooth, feebly divergent; on IV present on basal two-thirds, weak to vestigial, smooth. **Vl** carinae: on I-II strong, crenate, moderately convergent distally; on III moderately strong, feebly crenate, slightly convergent distally; on IV weak to moderate, subcrenate, slightly divergent on distal one-fourth. **Lim** carinae: on I-II weak, complete, feebly crenate; on III-IV vestigial to obsolete. **Lsm** carinae on I-IV weak, subcrenate. **Dl** carinae: on I-II vestigial, with short row of small granules distally; on III-IV weak, subgranose.

Segment V considerably longer than pedipalp femur. **Vm** and **Vl** carinae: basal one-third weak, subgranose; distal two-thirds strong, with medium sized subconical granules irregularly spaced. **Vt** keel shallowly emarginate, with five medium sized subconical granules. **Lm** carinae present on basal one-half, vestigial, smooth to subgranose. **Dl** carinae vestigial, subcrenate. Anal arc circular: **Ast** keel strong, with 10 medium sized oblong granules; **At** keel weak to vestigial, denticulate. Intercarinal spaces on segments I-V shagreened, except for ventrals on I-III being smooth. Segment V distal disc with median longitudinal row of four medium sized granules, appearing as continuation of **Vm** carina. Telson fusco-rufous: dorsally feebly convex, smooth, sparsely setate distally; lateral and ventral surfaces moderately setate, smooth except for ventral submarginal clusters of 4:3:4 medium sized granules. Subaculear tubercle strong, rounded; aculeus short, strongly curved, markedly deviating to left of longitudinal axis of telson (molting accident ?).

Chelicera.—Chela ochreous fuscescent with distinct variegated fuscosity; fixed finger ochreous, basally with diffuse uniform fuscosity; movable finger diffusely, uniformly infuscate throughout. Dentition shown in Fig. 7.

Pedipalps.—Femur fusco-rufous, deeper than wide. Dorsal internal carina weak, moderately granulose. Dorsal external carina: basal three-fourths strong, granulose; distally weak, subgranose. Ventral internal keel strong, granulose, distally curving dorsad and merging with dorsal internal keel. Ventral external keel obsolete. Dorsal face convex; with

Table 4.–Measurements (mm) of *Diplocentrus hoffmanni*, n. sp., *D. reticulatus*, n. sp., and *D. mitlae*, n. sp.

	hoffmanni		reticulatus	mitlae
	Holotype	Allotype	Holotype	Holotype
	Male	Female	Male	Male
Total length	50.40	53.05	45.75	51.45
Carapace				
Length	6.65	7.30	6.00	6.35
Anterior width	3.50	3.90	3.10	3.40
Width at median eyes	5.10	5.55	4.70	5.50
Posterior width	6.80	7.10	6.20	6.75
Mesosoma length	14.80	17.85	13.15	14.65
Metasoma length	28.95	27.90	26.60	30.45
Segment I				
Length	3.65	3.50	3.05	3.75
Width	4.10	4.15	4.00	4.20
Segment II				
Length	4.00	4.00	3.70	4.30
Width	3.70	3.75	3.65	3.70
Segment III				
Length	4.50	4.30	4.05	4.60
Width	3.65	3.60	3.50	3.55
Segment IV				
Length	5.20	4.80	4.70	5.05
Width	3.35	3.50	3.30	3.30
Segment V				
Length	6.10	5.60	5.80	6.55
Width	2.80	3.00	2.65	2.85
Telson length	5.50	5.70	5.30	6.20
Vesicle				
Length	4.50	4.60	4.15	4.90
Width	2.65	3.30	2.60	2.90
Depth	2.10	2.55	1.90	2.45
Aculeus length	1.00	1.10	1.15	1.30
Pedipalp length	19.00	20.00	17.85	22.90
Femur				
Length	4.55	4.75	4.15	5.20
Width	2.05	2.10	1.80	2.10
Depth	2.60	2.75	2.15	2.50
Tibia				
Length	4.40	4.60	4.35	5.20
Width	2.15	2.15	2.00	2.20
Chela				
Length	10.05	10.65	9.35	12.50
Width	5.35	5.50	4.90	4.80
Depth	3.30	3.55	3.10	2.90
Movable finger length	6.30	6.60	5.75	8.70
Fixed finger length	4.55	4.75	4.05	6.70
Chelicera				
Chela length	2.40	2.50	1.95	2.25
Chela width	1.70	1.85	1.50	1.70
Fixed finger length	1.85	1.90	1.55	1.75
Movable finger length	2.60	2.75	2.20	2.55
Pectinal teeth	10/10	9/9	9/9	7/8

moderately dense small granulation throughout, medially with longitudinal keel-like row of five to six large granules. Internal face flat, densely granulose. External face vestigially granulose distally, external trichobothrium along dorsal margin at middle of femoral length. Ventral face shagreened.

Tibia fusco-rufous, sparsely setate. Orthobothriotaxia "C" (Fig. 14). Dorsal internal keel obsolete; basal tubercle moderately strong, bicuspid. Dorsal median keel strong, coarsely crenate. Dorsal external keel weak to moderate, subcrenate. External keel vestigial. Ventral external keel weak, crenate. Ventral median keel obsolete. Ventral internal keel vestigial, subgranose. Internal face shagreened. Dorsal, external, and ventral faces rugose, with sparse to moderately dense granules.

Chela fusco-rufous, fingers fusco-piceous. Orthobothriotaxia "C" (Figs. 51-54). Dorsal margin moderately carinate: basal one-half coarsely crenate; distally granulose, extending through fixed finger base. Digital keel moderately strong, crenate. Dorsal secondary and external secondary carinae weak, granulose. Ventral external keel present on distal one-fourth of underhand length, vestigial, subgranose. Ventral median keel strong, crenate. Ventral internal keel vestigial to obsolete, smooth. Two internal carinae vestigial, smooth.

Dorsal face moderately reticulate, ridges minutely granulose; sparsely setate. External face moderately reticulate, ridges granulose; moderately setate. Ventral face rugose to vestigially reticulate, moderately setate. Internal face: disc vestigially reticulate, bare; dorsal submargin weakly to moderately reticulate, ridges granulose, moderately setate; ventral submargin weakly reticulate with smooth ridges, moderately to densely setate. Fixed finger base shagreened, with dense small and medium granules dorsally and externally; moderately setate. Fixed finger shorter than carapace; inner margin shallowly, evenly arcuate; internal face smooth, dorsal and external faces vestigially reticulate to rugose. Movable finger shorter than carapace, external face weakly granulose basally. Fingers densely setate.

Legs.—Basal segments testaceous, diffusely infuscate; distal segments ochreous fuscescent, vestigially infuscate. Femora and tibiae with dorsal and ventral margins smooth. Tarsomere II spine formula 5/5 5/5 : 5/5 5/5 : 6/6 6/6 : 6/6 6/6 .

Allotype.—Female, differs from holotype as indicated below (measurements in Table 4).

Prosoma.—Carapacial submedian areas smooth, lustrous; lateral areas shagreened.

Mesosoma.—Tergites lustrous, sparsely granulose at posterior submargins. Genital operculi elliptical, median longitudinal membranous connection present on basal three-fourths. Genital papillae absent. Pectinal tooth count 9-9. Sternite VII with intercarinal spaces smooth.

Metasoma.—Vsm carinae: on I-II strong, granulose, moderately convergent distally; on III with basal three-fourths moderately strong, granulose, subparallel, distal one-fourth weak to vestigial, slightly divergent; on IV vestigial to obsolete, subgranose. Vl carinae: on I-II strong, granulose to crenate, distally convergent; on III weak, feebly crenate; on IV weak to vestigial, smooth. **Lim** carinae: on I weak, complete, feebly crenate; on II-III vestigial, smooth; on IV obsolete. **Lsm** carinae on I-IV weak to vestigial, smooth. Segment V: **Dl** and **Lm** carinae obsolete, **Ast** with 11 oblong granules. Dorsal and lateral intercarinae on I-V smooth to vestigially granulose. Telson wider than segment V; vesicle with ventral submarginal clusters of 4:4:4 medium sized granules. Aculeus broken off distally.

Pedipalps.—Femur slightly shorter than metasomal segment IV. Dorsal internal keel weak to vestigial, irregularly granulose. Dorsal external keel obsolete distally. Ventral internal keel moderately strong, granulose. External face smooth.
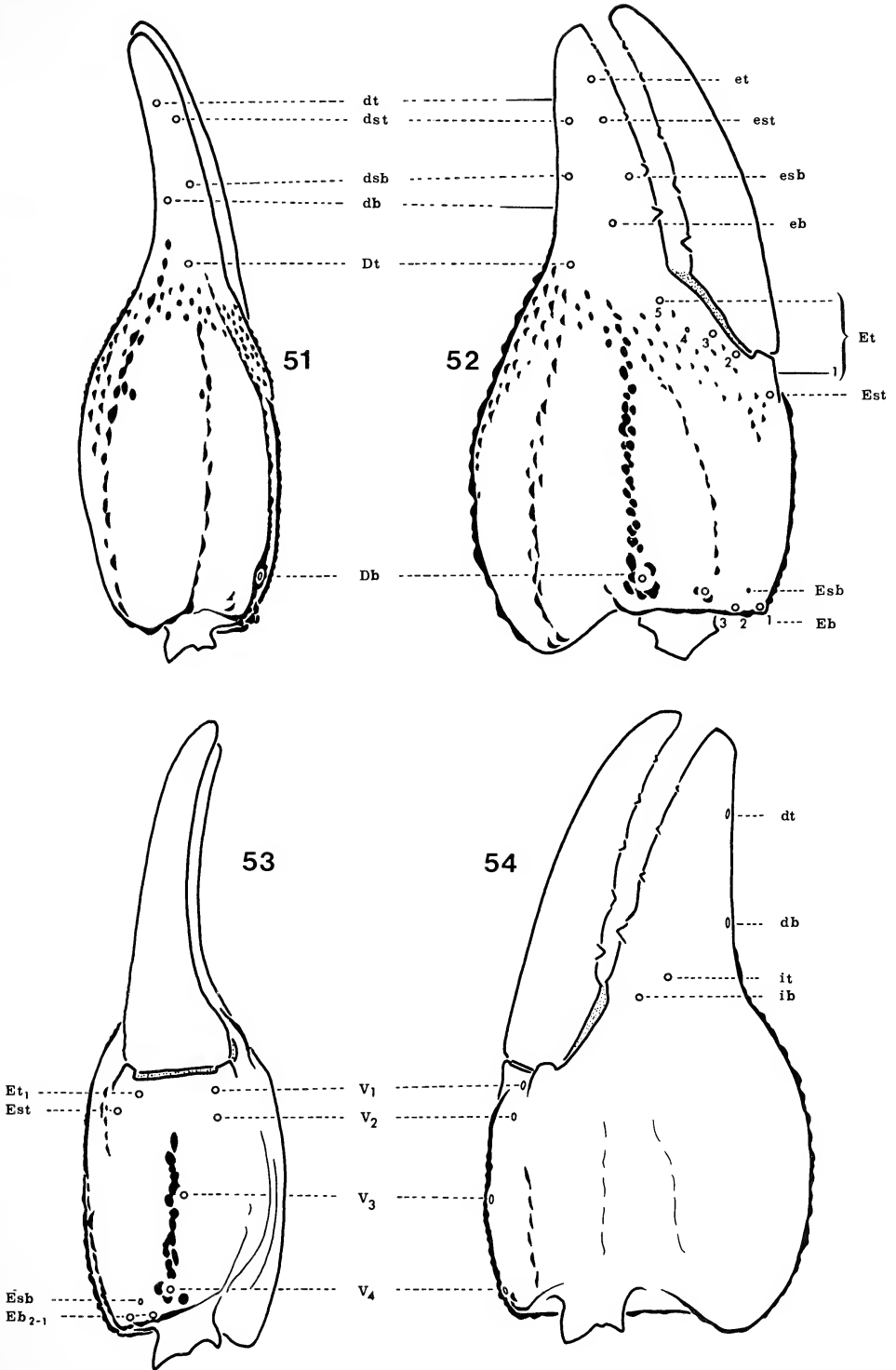
Figs. 51-54.—Right pedipalp chela of *Diplocentrus hoffmanni*, n. sp., holotype male, illustrating the trichobothrial pattern: 51, dorsal aspect; 52, external aspect; 53, ventral aspect; 54, internal aspect.

Tibia: dorsal median keel moderately strong, feebly crenate; dorsal external keel vestigial to obsolete; external keel vestigial; ventral external keel weak to vestigial, smooth; ventral internal keel obsolete. Internal face: dorsally shagreened, medially and ventrally smooth. External face feebly rugose, vestigially granulose.

Chela proportionately wider, but otherwise morphometrically very similar to chela of male. Dorsal margin subcarinate, granulose with small and medium granules extending to basal one-half of fixed finger. Digital keel weak to vestigial, smooth. Dorsal secondary and external secondary carinae vestigial to obsolete, smooth. Ventral external keel obsolete. Ventral median keel weak, subgranose. Ventral internal keel vestigial to obsolete. Two internal carinae obsolete. Dorsal and external faces vestigially reticulate with smooth ridges, sparsely setate. Ventral face rugose, granulose. Internal face: disc smooth, bare; dorsal submargin vestigially reticulate, moderately granulose distally, moderately setate; ventral submargin with moderately dense small granulation, sparsely setate. Fixed finger base moderately granulose dorsally and externally, sparsely granulose internally. Fixed finger inner margin arcuate as in male, with moderately dense small granules basally. Left chela with extreme tip of fixed finger broken off.

Type locality.—Primary types collected near Tejocote (7,800 ft., under logs), Oaxaca, México, summer 1963 (C. M. Bogert). Deposited at the AMNH, New York.

Distribution.—Map 1. In addition to the primary types this species is known only from two adult male paratypes from the state of Oaxaca, as follows: Tejocote (7,600 ft.; 31 mi. NW Oaxaca city), 9 September 1962 (M. R. Bogert, AMNH); and 6 mi. N Telixtlahuaca (7,050 ft., under rocks in moderately dry area with oak and juniper), 26 July 1966 (C. M. Bogert, AMNH).

Etymology.—This species is named after Dr. Carlos C. Hoffmann, who spent most of his life studying the Mexican scorpiofauna.

Intraspecific variability.—The variation observed between the holotype and the two male paratypes is briefly summarized below. Carapace with anterior median notch obtusely angulose to subangulose, and with posterior submargin fuscous to piceous. Tergites testaceous with moderately dense, distinct fuscous pattern to uniformly fuscopiceous, obscuring the basic coloration completely. Metasomal carinae with vestigial to obsolete fuscosity. Segment V with **Ast** keel bearing 9-10 oblong granules. Pectinal tooth counts (Table 5) range from 10 to 11. Tarsomere II spine counts observed (including allotype, Table 6), give the following tentative formula for *D. hoffmanni*: 5/5 5/5 : 5/5 5/6 : 6/6 6/6 : 6/6 6/7 .

Comparative description.—*Diplocentrus hoffmanni* is very closely related to *D. rectimanus*, with which it occurs sympatrically in one locality without any signs of hybridization (near Tejocote, 7,800 ft., Oaxaca). These two taxa can be separated on the basis of the characters indicated below. The base color in *D. rectimanus* is ochreous fuscescent, while in *D. hoffmanni* it is testaceous to ferrugineous. The external margin of the cheliceral fixed finger is shallowly curved in *D. rectimanus* (Fig. 6), and it is moderately curved in *D. hoffmanni* (Fig. 7). On the movable finger of the chelicera, the distal external and distal internal teeth are closely opposed in *D. rectimanus*, and moderately opposed in *D. hoffmanni*. The internal margin of the fixed finger on the pedipalp chela is nearly straight in *D. rectimanus* males (Fig. 45), while it is shallowly curved in *D. hoffmanni* males (Fig. 51). *D. rectimanus* has the fixed finger of the pedipalp chela longer than the pedipalp femur, while in *D. hoffmanni* these two structures are approximately equal in length. The movable finger of the pedipalp chela is shorter than the carapace length in both sexes of *D. hoffmanni*, while in *D. rectimanus* the movable finger is longer

than the carapace in males and they are approximately the same length in females. *D. hoffmanni* has a pedipalp chela which is less than two times longer than wide, and it is sparsely granulose in the only female known; while in *D. rectimanus* the chela is over two times longer than wide, and it is densely granulose in the two females known.

Diplocentrus reticulatus, new species
Figs. 8, 13, 24, 55-58

Diagnosis.—Medium sized, adult males approximately 45 mm long, female unknown. Fusco-ferrugineous with moderately dense fuscosity, legs not contrasting with opisthosoma in coloration. Carapacial anterior margin minutely granulose, median notch rounded; anterior submargin moderately granulose. Tergite VII disc strongly bilobed postero-laterally, carinae vestigial to obsolete. Pectinal tooth count 7-9. Metasomal segments I-IV with 10 complete carinae each, dorsal and lateral intercarinal spaces conspicuously reticulated; segment I wider than long, segment V longer than pedipalp femur. Chelicera: fixed finger longer than chela width; movable finger longer than chela length, distal external tooth not opposed to distal internal tooth. Pedipalps: femur deeper than wide, dorsally convex; tibia with dorsal median keel strong, dorsal external keel weak to vestigial; fixed finger shorter than femur, movable finger equal to or slightly shorter than carapace. Tarsomere II spine formula 4/5 4/5 : 5/5 5/5 : 5/5 5/5 : 5/6 5/6 .

Holotype.—Male (measurements in Table 4).

Prosoma.—Carapace fusco-ferrugineous, with distinct fuscous pattern. Anterior margin feebly granulose, moderately emarginate; median notch rounded, approximately three and one-half times wider than deep (Fig. 24). Three pairs of subequal lateral eyes. Anterior median furrow obsolete. Ocular prominence slightly convex between median eyes, located at anterior three-eights of carapace length. Posterior median furrow shallow to moderately deep. Posterior marginal furrow moderately deep and wide. Posterior lateral furrows arcuate, moderately deep. Carapacial surface shagreened, anterior submargin with moderately dense small and medium granules. Venter ochreous fuscescent, sparsely setate. Sternum pentagonal.

Mesosoma.—Tergites fusco-ferrugineous, with distinct variegated fuscosity. Tergites I-VI shagreened, IV-VI vestigially carinate medially. Tergite VII strongly bilobed postero-laterally, median and lateral emarginations distinct, median area feebly depressed (Figs. 25-26); carinae obsolete. Tergite VII shallowly reticulate, ridges granulose, cells shagreened.

Genital operculi ochreous, ellipsoidal, without membranous connection. Genital papillae present. Pectines ochreous, sparsely setate; fulcra subtriangular. Pectinal tooth count 9-9.

Sternites brunneous: III smooth, IV-VI laterally shagreened; stigmata three times longer than wide. Sternite VII tetracarinate (see Fig. 25); median and submedian intercarinae smooth, laterals shagreened.

Metasoma.—Basal segments brunneous to testaceous, distal segments fusco-ferrugineous; dorsally bare, laterally and ventrally sparsely setate without marked density increase distally. **Vsm** carinae: on I-II strong, coarsely crenate, slightly convergent distally; on III moderate to weak, crenate, feebly sinuate; on IV moderate to weak, subgranose, subparallel. **Vl** carinae: on I-II strong, coarsely crenate, moderately convergent distally; on III moderately strong, feebly crenate, subparallel; on IV present on basal seven-eighths, moderately strong, feebly crenate, subparallel. **Llm** carinae: on I moder-

ately strong, complete, coarsely crenate; on II weak to moderate, complete, subgranose; on III-IV weak, complete, subgranose. **Lsm** carinae: on I-II moderately strong, coarsely to moderately crenate; on III-IV moderately strong, feebly crenate. **Dl** carinae: on I vestigial, with three to four small granules distally; on II weak to vestigial, feebly granulose distally; on III moderately strong, feebly crenate; on IV moderately strong, crenate.

Segment V longer than pedipalp femur. **Vm** and **Vl** carinae strong, with medium and large subconical granules irregularly spaced. **Vt** keel feebly emarginate, with three medium sized granules per side. **Lm** carinae present on basal two-thirds, weak to vestigial, granulose. **Dl** carinae vestigial to obsolete. Anal arc circular: **Ast** keel strong, with 15 small and medium oblong granules; **At** weak, dentate.

Intercarinal spaces on segments I-IV: dorsals and laterals weakly reticulate, ridges smooth to subgranose, cells shagreened; ventrals on I-II smooth, on III-IV sparsely to moderately granulose. Segment V: dorsally and laterally moderately granulose; ventrally sparsely granulose.

Telson fusco-ferrugineous. Dorsally smooth, bare. Laterally and ventrally with basal one-fourth sparsely, minutely granulose; distally smooth, sparsely to moderately setate; ventral submargin with clusters of 3:3:3 medium sized granules. Subaculear tubercle strong, rounded; aculeus short, moderately curved.

Chelicera.—Chela ochreous, distinctly infuscate dorsally; fingers ochreous fuscescent with moderately dense, uniform fuscosity basally. Dentition shown in Fig. 8.

Pedipalps.—Femur brunneous, feebly infuscate dorsally; deeper than wide. Dorsal internal carina moderately strong, granulose. Dorsal external keel: basal one-half weak to moderate, granulose; distally obsolete. Ventral internal keel moderately strong, coarsely granulose, distally curving dorsad and merging with dorsal internal carina. Ventral external keel obsolete. Dorsal face moderately convex; shagreened, with median longitudinal cluster of six to eight medium sized granules. Internal face flat, densely granulose. External face smooth, external trichobothrium along dorsal margin at basal four-ninths of femoral length. Ventral face shagreened.

Tibia brunneous to testaceous, diffusely infuscate. Orthobothriotaxia "C" (Fig. 13). Dorsal internal keel obsolete; basal tubercle weak, with three medium to small granules. Dorsal median keel strong, subcrenate to smooth. Dorsal external keel weak to vestigial, smooth. External keel weak to vestigial. Ventral external keel moderately strong, smooth. Ventral median keel obsolete. Ventral internal keel weak to vestigial, smooth. Internal face shagreened. Dorsal face with moderately strong reticulation, ridges granulose. External face shallowly reticulate, ridges smooth. Ventral face vestigially reticulate.

Chela brunneous, fingers slightly darker. Orthobothriotaxia "C" (Figs. 55-58). Dorsal margin of manus subcarinate: basal one-fifth smooth; distally irregularly granulose, extending through fixed finger base. Digital carina strong, smooth. Dorsal secondary keel moderately strong, smooth. External secondary keel weak, smooth. Ventral external keel vestigial to obsolete. Ventral median keel strong, subcrenate. Ventral internal keel weak to vestigial, smooth. Two internal carinae weak to vestigial, subcrenate.

Dorsal, external, ventral, and internal faces strongly to moderately reticulate, cells shagreened to smooth; sparsely setate. Fixed finger with inner margin evenly, moderately arcuate. Fixed and movable fingers smooth, moderately setate.

Legs.—Testaceous, with moderately dense fuscosity. Femoral ventral margins minutely granulose. Tarsomere II spine formula 4/5 4/5 : 5/5 5/5 : 5/5 5/5 : 5/5 5/6 .

Type locality.—Holotype collected near Tejocote (7,800 ft., under logs), Oaxaca, México, summer 1963 (C. M. Bogert). Deposited at the AMNH, New York.
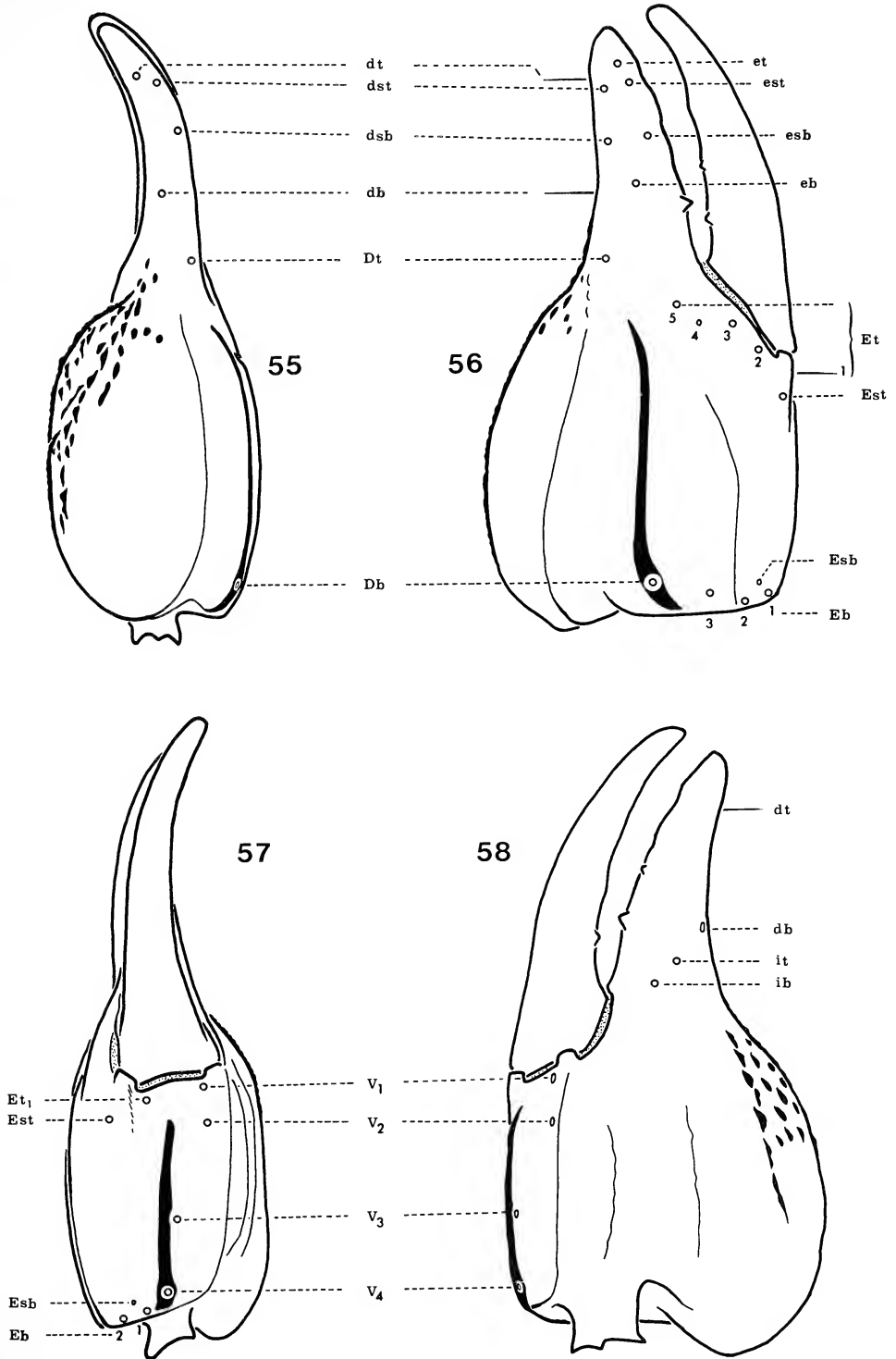
Figs. 55-58.—Right pedipalp chela of *Diplocentrus reticulatus*, n.sp., holotype male, showing the trichobothrial pattern: 55, dorsal aspect; 56, external aspect; 57, ventral aspect; 58, internal aspect.

Table 5.–Pectinal tooth count variability in *Diplocentrus* spp. from Oaxaca, Mexico, expressed by the number of combs observed with a given tooth count. Each specimen normally has two pectinal combs, which are not necessarily symmetrical in the number of teeth they bear.

		7	8	9	10	11	12	13	14	15	16	17	18	19
mexicanus ssp.														
mexicanus	♂							2						
	♀				2									
oaxacae	♂								1	10	6	3		
	♀					2	4	19	7					
ochoterenai	♂											6	4	2
	♀										4			
tehuano	♂					1	14	14	1					
	♀				3	25	4							
tehuacanus	♂					3	3	7	3					
	♀					6	4	3						
rectimanus	♂			3	14	4								
	♀		4											
hoffmanni	♂					5	1							
	♀			2										
reticulatus	♂	1	2	3										
mitlae	♂	1	1											

Distribution.–Map 1. In addition to the holotype this species is known only from two adult males from the state of Oaxaca, as follows: one paratopotype, same data as holotype (AMNH); one paratype from "El Punto," road to Ixtlán de Juarez, 19 August 1961 (C. M. and M. R. Bogert, AMNH).

Etymology.–Specific name based on the distinctive reticulations present on the metasoma and the pedipalps.

Intraspecific variability.–The three adult males known are very similar in most respects. Pectinal tooth counts (Table 5) range from 7-9. Tarsomere II spine counts (Table 6) give the following tentative formula for *D. reticulatus*: 4/5 4/5 : 5/5 5/5 : 5/5 5/5 : 5/6 5/6 .

Comparative description.–*Diplocentrus reticulatus* appears to be related to *D. rectimanus* and *D. Hoffmanni* in terms of their cheliceral morphometrics, the relative proportions of the pedipalp femur, and the position of the femoral external trichobothrium at approximately one-half of the femoral length. *D. reticulatus* can be recognized by the cheliceral morphology, particularly by having the distal internal tooth of the movable finger only moderately curved distally (Fig. 8); by the presence on ten carinae on metasomal segments I-IV, and the strong postero-lateral bilobations on the disc of tergite VII (Figs. 25-26); and finally, by the conspicious reticulations that earned it the name *D. reticulatus*.

Diplocentrus mitlae, new species
Figs. 4, 16, 23, 59-62

Diagnosis.–Medium sized, known only from adult male holotype 51 mm long. Brunneous, sparsely to moderately infuscate; legs not contrasting with opisthosoma in coloration. Carapacial anterior margin minutely granulose, median notch obtusely angulose; anterior submargin sparsely granulose. Tergite VII disc weakly bilobed postero-laterally, carinae obsolete. Pectinal tooth count 7-8. Metasomal segments I-II with eight complete

Table 6.—Tarsomere II spine count variability observed in *Diplocentrus* spp. from Oaxaca, Mexico, expressed as the number of tarsomeres observed with a given spinal count. Each individual normally has two spine counts per row per tarsomere (i.e., leg I, anterior row, right and left legs spine counts), which are not necessarily symmetrical with each other on the number of spines borne. Individuals occasionally have one or more tarsomeres II missing, giving rise to odd numbers of observations.

	mexicanus mexicanus	mexicanus oaxacae	ochoterenai	tehuano	tehuacanus	rectimanus	hoffmanni	reticulatus	mitlae
Leg I — Ant.									
3				1					
4	1	40	16	59	22	14	2		1
5	2	7	2		6	11	6	6	1
6									
7									
Post.									
4		42		10		1	6		1
5	3	5	5	50	28	24	2	6	1
6			13						
7									
Leg II — Ant.									
4	1			15		1			1
5	3	46	2	45	28	23			1
6		1	15			1	8	6	
7									
Post.									
4	2	47		56	26	1			2
5	2		12	4	2	18	5	5	
6			5			6	3	1	
7									
8									
Leg III — Ant.									
5	1	49	1	36	4	1			
6	3	1	16	24	23	24	8	6	2
7			1		1				
8									
Post.									
5					1	1			
6	4	13	3	60	25	23	8	5	2
7		37	15		2	1		1	
8									
Leg IV — Ant.									
5									
6		36	9	7	1				
7	4	14	9	52	25	25	8	6	1
8					2				
Post.									
5									
6									
7		6		2	1	2	5		
8	4	43	18	56	25	21	3	6	1
9		1		1	1	2			

carinae each, III with six keels, IV with four carinae; intercarinal spaces smooth to vestigially shagreened; segment I wider than long, segment V longer than pedipalp femur. Chelicera: fixed finger longer than chela width; movable finger longer than chela length, distal external tooth not closely opposed to distal internal tooth. Pedipalps: femur deeper than wide, dorsally moderately convex; tibia with dorsal median keel vestigial, dorsal external keel obsolete; chelal carinae vestigial to obsolete; fixed finger longer than carapace. Tarsomere II spine formula 3/5 4/4 : 4/5 5/5 : 5/5 5/5 : 5/6 X/X .

Holotype.—Male (measurements in Table 4).

Prosoma.—Carapace brunneous, with well defined fuscous pattern. Anterior margin minutely granulose, emarginate; median notch obtusely angulose, about four times wider than deep (Fig. 23). Three pairs of lateral eyes, second pair largest. Anterior median furrow obsolete. Median ocular prominence flat to feebly convex between median eyes, located at anterior three-eighths of carapace length. Posterior median furrow vestigial to moderately deep submarginally. Posterior marginal furrow moderately deep, wide. Posterior lateral furrows obtusely angular, moderately deep. Anterior submargin with sparse granulation. Carapace laterally shagreened, medially smooth. Venter ochreous, sparsely setate. Sternum subpentagonal.

Mesosoma.—Tergites brunneous; with dense, irregular fuscosity throughout decreasing slightly in density distally. Tergites I-VI shagreened. Tergite VII weakly bilobed posterolaterally, median area slightly depressed; submedian and lateral carinae obsolete. Tergite VII shagreened, with dense small granules laterally.

Genital operculi ochreous, subtriangular; median longitudinal membranous connection absent. Genital papillae present. Pectines ochroleucus, lamellar setation sparse to moderate; middle lamellae partly fused, three to four per comb. Fulcra subtriangular. Pectinal tooth count 7-8.

Sternites ochreous fuscescent; III-VI smooth, stigmata about four times longer than wide. Sternite VII tetracarinate: submedian keels present on distal two-thirds, weak, smooth; lateral carinae present on distal three-fourths, moderately strong, smooth. Sternite VII with median and submedian intercarinae smooth, laterals shagreened.

Metasoma.—Brunneous, slightly darker distally; dorsally bare, laterally and ventrally sparsely setate. Vsm carinae: on I-II moderately strong, coarsely crenate, weakly convergent distally; on III-IV with basal two-thirds weak to vestigial, smooth, distally obsolete. Vl carinae: on I-II strong, coarsely crenate, markedly convergent distally; on III-IV moderately strong, smooth, weakly convergent on basal two-thirds, divergent distally. Lim carinae: on I moderately strong, complete, feebly crenate; on II-III weak, complete, subcrenate; on IV vestigial to obsolete. Lsm carinae: on I-II weak, feebly crenate; on III-IV moderately strong, smooth. Dl carinae: on I vestigial, smooth; on II weak, subgranose; on III-IV vestigial to obsolete. Intercarinal spaces smooth to sparsely granulose.

Segment V longer than pedipalp femur. Vm and Vl carinae strong, with medium sized subconical granules irregularly spaced. Vt keel not emarginate, with four medium sized subconical granules. Lm keels present on basal one-third, vestigial, smooth. Dl carinae obsolete. Anal arc circular: Ast keel moderate, with 10 oblong granules; At keel weak, dentate. Intercarinae: ventrals smooth; laterals and dorsal sparsely granulose. Telson brunneous: dorsally feebly convex, smooth, bare; laterally and ventrally smooth, sparsely setate, with ventral submarginal clusters of 3:3:3 medium sized granules. Subaculear tubercle strong, rounded; aculeus short, strongly curved.

Chelicera.—Chela and fingers ochreous, diffusely infuscate. Dentition shown in Fig. 4.
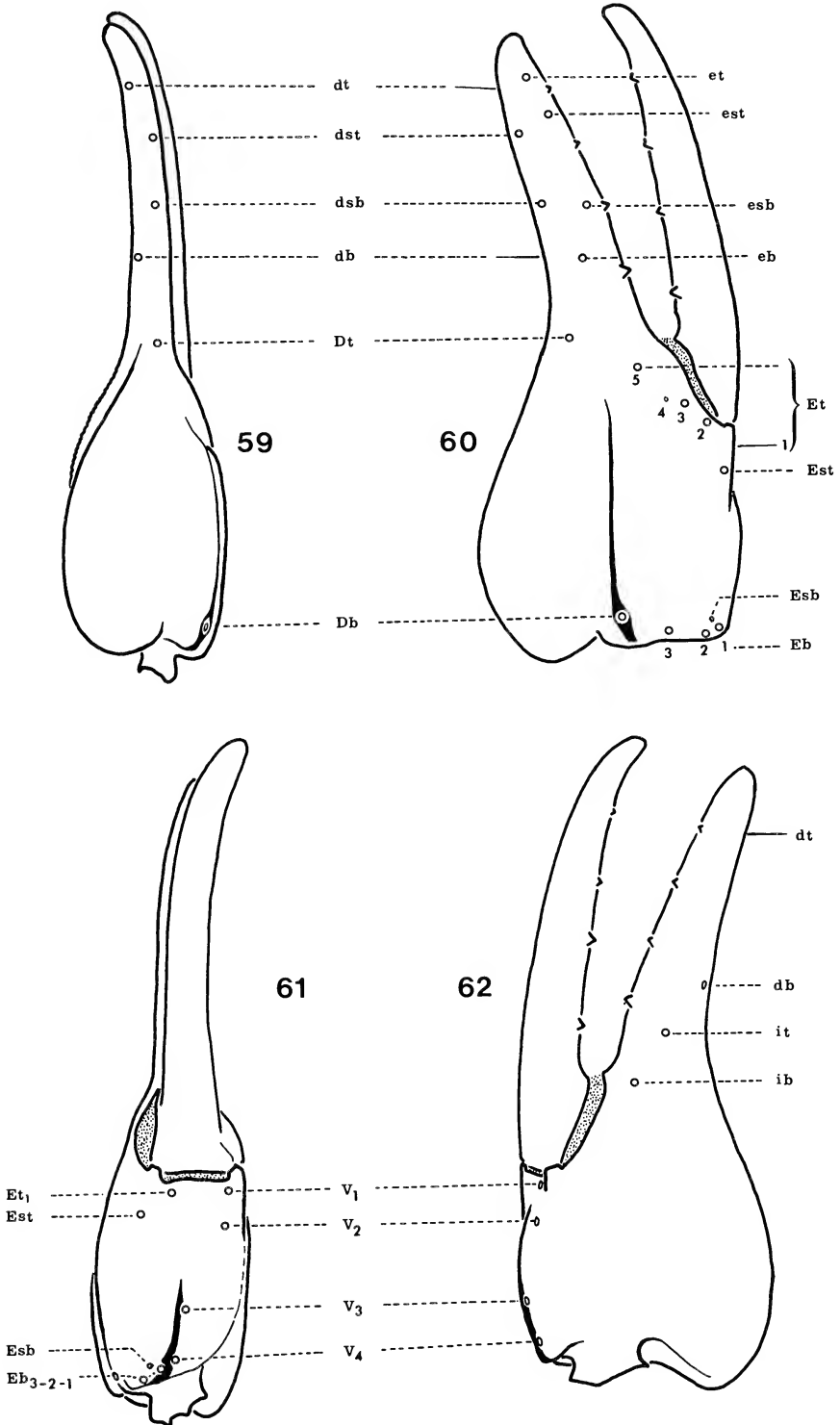
Figs. 59-62.–Right pedipalp chela of *Diplocentrus mitlae*, n. sp., holotype male, showing tricho-bothrial arrangements: 59, dorsal aspect; 60, external aspect; 61, ventral aspect; 62, internal aspect.

Pedipalps.—Femur brunneous, feebly infuscate dorsally; deeper than wide. Dorsal internal keel moderately strong, granulose. Dorsal external carina weak to vestigial, smooth. Ventral internal keel moderately strong, granulose, distally curving dorsad and merging with dorsal internal carina. Ventral external keel obsolete. Dorsal face with basal one-half convex, moderately granulose; distally flat to feebly concave, densely granulose. Internal face flat, densely granulose. External face smooth, external trichobothrium on dorsal margin halfway along femoral length. Ventral face smooth.

Tibia brunneous with diffuse, variegated fuscosity dorsally and externally. Orthobothriotaxia "C" (Fig. 16); right tibia with only four basal trichobothria, left tibia with five (normal condition).

Chela brunneous, with vestigially infuscate carinae. Orthobothriotaxia "C" (Figs. 59-62). Dorsal margin of manus rounded; basal two-thirds smooth; distally with vestigial, minute granulation extending through fixed finger base. Digital carina vestigial, smooth, ending at fixed finger base. Dorsal secondary, external secondary, and ventral external carinae obsolete. Ventral median keel with basal one-half moderately strong, obsolete distally; directed towards midpoint of movable finger articulation. Ventral internal and two internal carinae vestigial to obsolete.

Dorsal face smooth except for sparse granulation at dorsal submargin, bare. External face smooth, bare. Ventral face smooth, sparsely setate. Internal face smooth, bare. Fixed finger base smooth, moderately to densely setate. Fixed finger inner margin straight except for shallow subterminal curvature. Fixed and movable fingers smooth, densely setate. Fixed and movable fingers longer than carapace and metasomal segment V.

Legs.—Basal segments brunneous with moderate fuscosity, distal segments ochreous. Tarsomere II spine formula 3/5 4/4 : 4/5 5/5 : 5/5 5/5 : 5/6 X/X , with fourth left leg broken off at femur.

Type locality.—This species is known only from the holotype, collected about 6 mi. N Mitla (6,200 ft.), Oaxaca, México, 1 September 1962 (M. R. Bogert). Deposited at the AMNH, New York.

Etymology.—Named after the Aztec ruins of Mitla, which are close to the type locality.

Comparative description.—*Diplocentrus mitlae* is rather distinctive, and on the basis of the only specimèn known it can not be properly related to any of the described species in the genus. Some characters, such as cheliceral morphology, pedipalp femur proportions, and the relative position of the external trichobothrium along the femur indicate a possible relationship with *D. rectimanus*, *D. hoffmanni*, and *D. reticulatus*. However, the characters given in the key, and in the diagnoses to the respective species are sufficient to recognize *D. mitlae* without difficulties. The morphology of the pedipalp tibia and chela in *D. mitlae* is somewhat similar to that observed in *D. nitidus* Hirst, which is known only from the holotype female from Nicaragua. *D. nitidus* can be recognized because the cheliceral fixed finger is shorter than the chela width, the distal internal and distal external teeth of the cheliceral movable finger are closely opposed, and the pedipalp femur is wider than deep.

ACKNOWLEDGMENTS

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THE WEBS OF NEWLY EMERGED *ULOBORUS DIVERSUS* AND OF A MALE *ULOBORUS* SP. (ARANEAE: ULOBORIDAE)

William G. Eberhard

Departamento de Biología
Universidad del Valle
Cali, Colombia
and
Smithsonian Tropical Research Institute
P. O. Box 2072
Balboa, Canal Zone

ABSTRACT

The web construction behavior of newly emerged *Uloborus* is more complex than heretofore supposed; large numbers of very fine non-radial threads are produced even though the spider moves only in radial directions on the web. This type of web may be universal in recently emerged *Uloborus* spiderlings, and a very similar web is made by mature males of at least one *Uloborus* species.

RESUMEN

La construcción de la telaraña por *Uloborus* recien salidas de la bolsa de huevos es mas compleja de lo que se pensaba; muchos hilos muy finos son puestos en sentidos no-radiales aunque la araña se desplaza unicamente en un sentido radial. Este tipo de telaraña puede ser universal entre las ninfas recien salidas del género *Uloborus*. El macho maduro de por lo menos una especie de *Uloborus* también construye una telaraña similar.

INTRODUCTION

The webs of immature orb weavers seem usually to be built on the same general plan as those of the adults, although they sometimes lack specialized adult characters peculiar to the given genus or species (e.g. *Zygiella*—Mayer 1952, *Nephila*—Comstock 1940, Wiehle 1931, *Scoloderus*—Eberhard 1975). The genus *Uloborus* is an exception to this rule, as the webs of newly emerged spiderlings differ substantially from those of the adults.

Wiehle (1927) was the first to study the webs of newly emerged *Uloborus* (spiderlings newly emerged from the egg sac will be termed "second instar spiderlings" in this paper since they have already passed through a stage inside the sac; this follows the usage of Peck and Whitcomb, 1970). He saw that the webs of second instar *U. walckenaerius* and *U. geniculatus* lack sticky spirals, but have intact temporary spirals, a large number of fine radial threads, and a concentration of white silk at the hub. He associated the lack of sticky spiral with the spiderlings' lack of a functional cribellum. Later Peters (1953) found that the webs of second instar *U. vicinus* resembled those described by Wiehle. Szlep (1961), working with *U. plumipes* and *U. walckenaerius*, described for the first time

the web construction behavior of second instar spiderlings. She found that their behavior during the early stages of web construction was essentially identical to that of older spiders: frame threads, radii, hub threads, and temporary spirals were all laid in the same way similar threads were laid by older spiders. But the second instars, instead of laying a sticky spiral after completing the temporary spiral, returned to the hub and laid great numbers of "additional" or supplementary radii which were somewhat thinner than the original "ordinary" radii. Szlep also found that third instar spiders usually spun "normal" orb webs with a sticky spiral and without additional radii as soon as they moulted, but that occasionally they spun intermediate types of webs with additional radii, intact temporary spirals, and sticky spirals all included.

To the best of my knowledge there are no previous records of mature male uloborids building any type of orb web.

This paper describes the webs and building behavior of the second instar nymphs of a fifth *Uloborus* species, *U. diversus*. Some details not noticed in the webs of the other species are discussed, and a very similar web built by a mature male of *Uloborus* sp. is also described.

MATERIALS AND METHODS

Uloborus diversus spiderlings were raised from eggs laid in captivity, and were kept and observed under the conditions described by Eberhard (1972). Their webs were photo-graphed both uncoated and coated with fine white powder (cornstarch) in the indirect lighting arrangement illustrated by Langer and Eberhard (1969). The webs of male *Uloborus* sp. were photographed in the field by coating them with cornstarch and using a portable flash (Eberhard, 1976). Specimens of these males, which cannot be identified to species at this time, are deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, U.S.A., and are numbers 879, 890, 902, and 1015 of a collection of spiders whose webs have been photographed.

RESULTS

The webs of second instar *U. diversus* (Fig. 1) were essentially identical to those of *U. plumipes* and *U. walckenaerius* pictured in Szlep (1961). They differ from her description however in having large numbers of non-radial threads, most of which are more or less straight and parallel to their neighbors, and some of which extend beyond the frame threads. Similar non-radial threads are visible in Szlep's photos of *U. plumipes* webs. These threads are extremely thin and nearly invisible even when brightly illuminated.

As in other *Uloborus*, the behavior of second instar *U. diversus* spiderlings during the construction of the hub, radii, frame, and temporary spiral threads was similar to the construction behavior of older conspecifics (Eberhard, 1972) except that the loops of temporary spiral were closer together in relation to the size of the spider's body than those in older spiders' webs. The construction behavior involving the supplementary radii differed from the construction of the original radii in several ways however. Spiders made only one attachment rather than a series of attachments at the hub after laying each additional radius. They did not direct either leg I laterally after reaching the hub, but simply turned and held the radii (or the outer hub threads?) directly in front of them with both I's. They laid successive supplemental radii closer together; in one typical sequence, a spider laid supplemental radii toward the positions 6, 5, 5, 3, 2, 1, 11, 11, 10, 10, 11, 11, 12, 9, 10, and 9 o'clock.
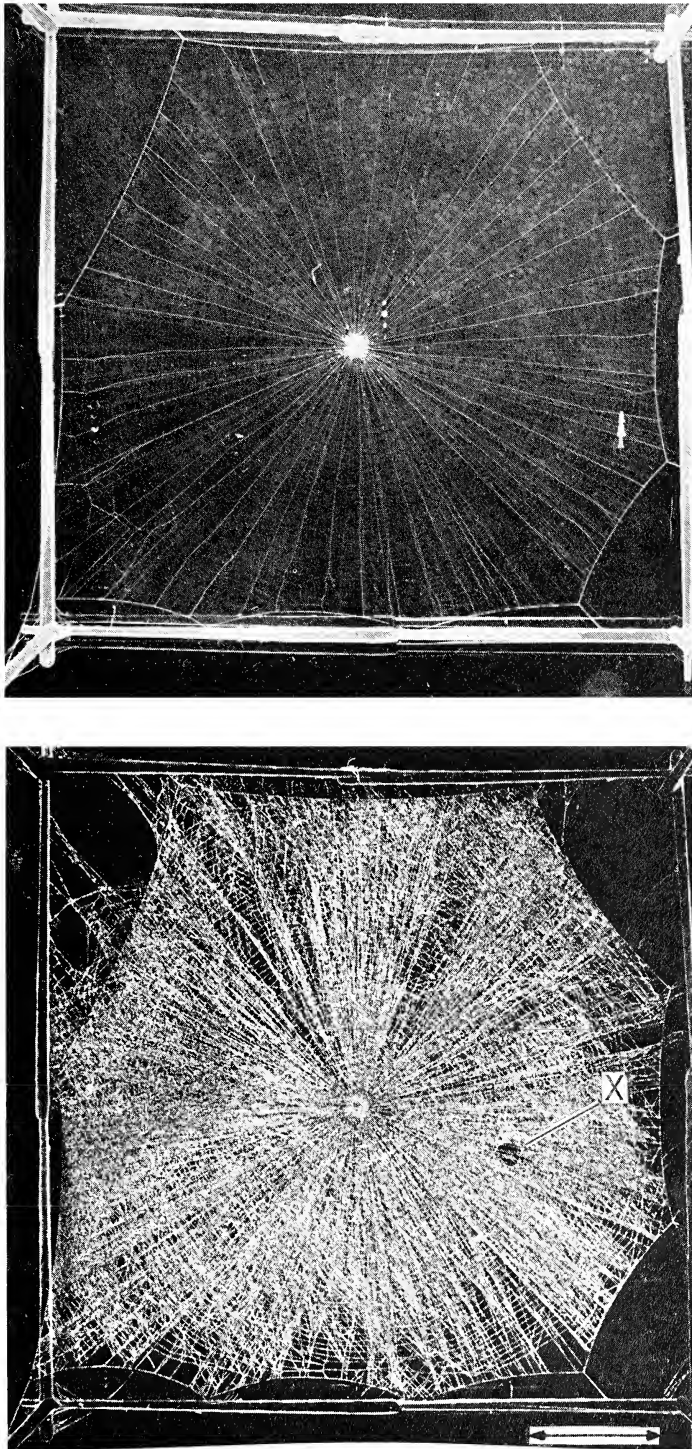
Fig. 1.–Web of second instar *Uloborus diversus*, unpowdered (above) and powdered (below). The spider opened a hole at x to remove prey, then laid several lines across it. Scale marker is 2 cm.

Before the spider left the hub to lay another supplemental radius, it brought both I's close together and tapped or jerked quickly on the threads directly ahead of it. Since the spider invariably laid a radius following these movements, they do not appear to function as do similar movements made during ordinary radius construction to sense cues used in deciding whether or not to construct a radius in the sector in front of the spider; their function is not clear. The spider moved from the hub toward the frame along a previously laid radius, but often stopped before it reached the frame and attached the new supplementary radius to this radius. After moving between one-third and one-half the way back toward the hub (apparently under the line or lines just laid), the spider tapped its abdomen against the web (probably attaching the line(s) it was laying to the web), broke the line(s) legs I were holding, and let out silk. The spider, which now formed a bridge between the line(s) running from its legs I to the hub and the line(s) running from its spinnerets to the attachment it had just made, descended several millimeters as it let out silk, then gradually reascended as it moved toward the hub, apparently reeling in the line in front of it and laying a new one(s) behind.

Non-radial lines were somehow produced during construction of additional radii, but it proved impossible to see them without powdering the web, and this effectively stopped construction behavior. Each additional radius construction trip resulted in the placement of several lines, and when webs were powdered just after construction of supplemental radii had begun, there were several lines in each sector in which the spider had made a trip. The non-radial lines may have been produced when the spider broke some of these lines in subsequent trips and the broken ends drifted in the air before sticking somehow to the web. Loose lines must have played some part in the process, since the spiders never moved in non-radial directions, and since, although the spider never moved past the frame threads, there were often lines beyond the frames in finished webs. The construction of supplementary radii was not a continuous process, and long periods of inactivity (up to an hour or more) occurred between bursts of construction.

All webs of second instar *U. diversus* had accumulations of white silk at the hub similar to those observed by Wiehle (1927). These accumulations were absent from webs not containing supplementary radii, and became more and more prominent during the course of supplementary radius construction. They may be the lines the spiders broke and rolled up (?) as they returned to the hub during supplemental radius construction.

Second instar *U. diversus* did not make the stabilimenta characteristic of the species (Eberhard, 1974). They stayed at the hubs of their webs most of the time, and were less likely to run to the edge in response to disturbing stimuli than were older spiders.

Szlep (1961) emphasized that the pause which occurred between termination of temporary spiral construction was analogous to a pause between temporary spiral and sticky spiral construction in later instars. Second instar *U. diversus* did not pause after termination of temporary spiral construction, however, while adult spiders paused for periods varying from less than five seconds to about a minute. The length of these pauses does not seem to be of particular importance in understanding the evolution of web patterns or the cues directing web construction.

Third instar *U. diversus* also constructed intermediate-type webs similar to those of *U. plumipes* and *U. walckenaerius* described by Szlep (1961) which contained supplementary radii and temporary spirals as well as sticky spirals. These webs, which also had mats of non-radial lines, were sometimes spun by third instar nymphs which had already constructed adult-type orbs. Some of the additional radii may have been added on nights after the web was first built, as construction of supplementary radii by a third instar
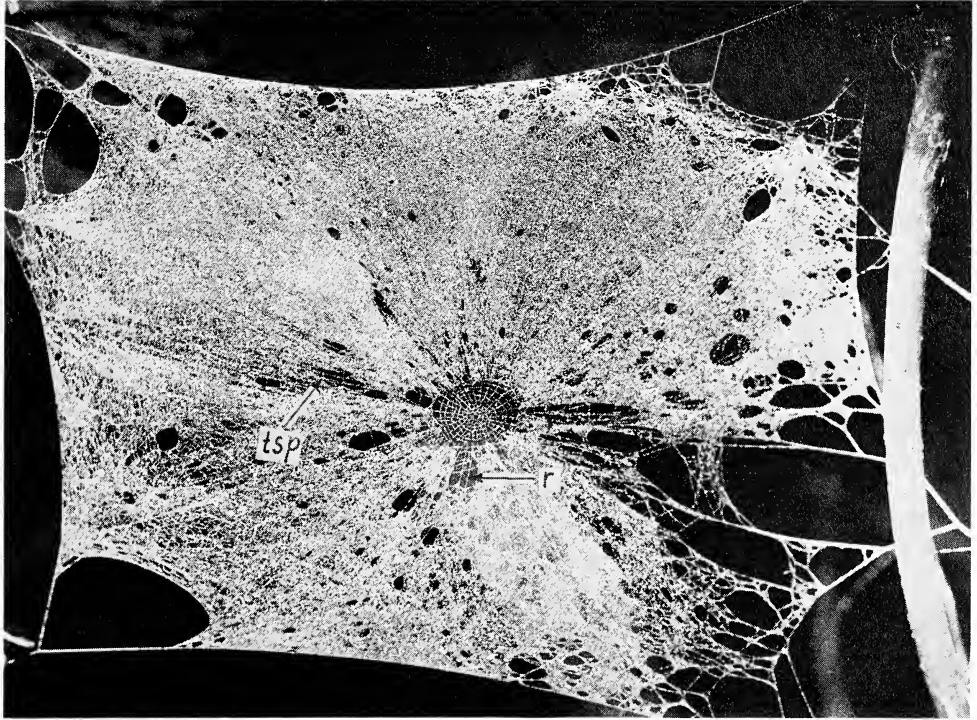
Fig. 2.—Web of mature male *Uloborus* sp.; r is a radius, tsp a temporary spiral, and the arrow marks a mat of fine threads. The more or less oval holes were probably caused by raindrops. Scale marker is 3 cm.

spider was seen once on the night following original web construction. The factor(s) responsible for the production of intermediate-type rather than adult-type webs by post-second instar spiders are not known.

Fig. 2 shows the web on which a mature male *Uloborus* sp. (specimen No. 1015) was found resting at the hub at about 9 A.M. in the understory of secondary tropical forest on Barro Colorado Island in the Panama Canal Zone. It was almost certainly made by the male as there were no other webs or spiders nearby. Two other similar webs with males at their hubs were found in the early evening (specimens Nos. 879 and 890), and another (No. 902), which shared the frame threads of the orb of a mature female, was found in the late morning on the mainland near the canal. All four webs were perfectly, or nearly perfectly, planar, and more nearly horizontal than vertical. The two night webs showed no obvious damage, and appeared to be newly built, while the day web not illustrated was somewhat tattered.

The web in Fig. 2 clearly has the same elements—radii (r), temporary spiral (tsp), and dense mats of very fine radial and non-radial threads—as second instar spiderlings' webs.

DISCUSSION

It appears that the construction of orb webs with sheets of very fine silk rather than sticky spirals may be widespread or universal among second instar *Uloborus* spiderlings. In addition to the five species now reported on, I have seen such webs in *U. arizonicus*, and both Y. D. Lubin (pers. comm.) and I have seen them in a number of other, as yet unidentified, tropical species. The adaptive significance of this web design is unclear, and

it is not certain which came first—the lack of a functional cribellum in the second instars, or the second instar web. Construction of this type of web involves only one behavioral sequence not seen in typical orb construction, and does not seem to be a particularly large evolutionary step. The fact that an older spider with a functional cribellum may sometimes produce a second instar-type web cannot be interpreted without testing the possibility that internal states (such as dehydration) selectively influence the production of cribellum silk. The similarity between second instar *Uloborus* webs and those of "senile" virgin female *U. diversus* is striking (Eberhard, 1971).

The resemblance of the mature male *Uloborus* sp. webs to those of second instar nymphs is almost certainly due to the fact that mature males also lack a functional cribellum. Within the genus this reduction is associated with the general lack of webs made by mature males, and the webs of these Panamanian *Uloborus* sp. should thus not be considered a relict of former times when males spun webs, but a reacquisition of immature behavior, possibly to increase the life span of the mature males.

Apparently the only published record of a mature male orb weaver with his own orb is that of Robinson and Robinson (1973) for *Nephila maculata* (Araneidae); these males may not have been mature, however (M. Robinson, pers. comm.). I have however seen mature males of *Mecynogea* (?) with small sheet webs within the meshes above the females' sheet webs, a mature male of a colonial species of *Cyclosa* on his own orb, and mature males of several species of Symphytognathidae with their own orbs.

ACKNOWLEDGEMENTS

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NEW SPECIES AND RECORDS OF THE *ANYPHAENA CELER* GROUP IN MEXICO (ARANEAE, ANYPHAENIDAE)

Norman I. Platnick

Department of Entomology
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

ABSTRACT

Two new species, *Anyphaena leechi* and *A. bromelicola*, are described from Mexico; new records for other species of the *celer* group of *Anyphaena* are presented.

Through the courtesy of Dr. Robin E. Leech of the Alberta Environment Research Secretariat, Edmonton, I have recently had the opportunity to examine a significant collection of Mexican Anyphaenidae. Most of this material belongs to the recently revised *celer* group of *Anyphaena* (Platnick and Lau, 1975). In addition to two new species, about a dozen new state records are represented in the collection, including significant range extensions (*Anyphaena cumbre*) and intermediate records filling previously large distributional gaps (*Anyphaena catalina*). One of the new species was taken from bromeliads, a habitat which should be further searched for spiders. The format of the descriptions follows that used in the revision; the illustrations are by Dr. Mohammed U. Shadab.
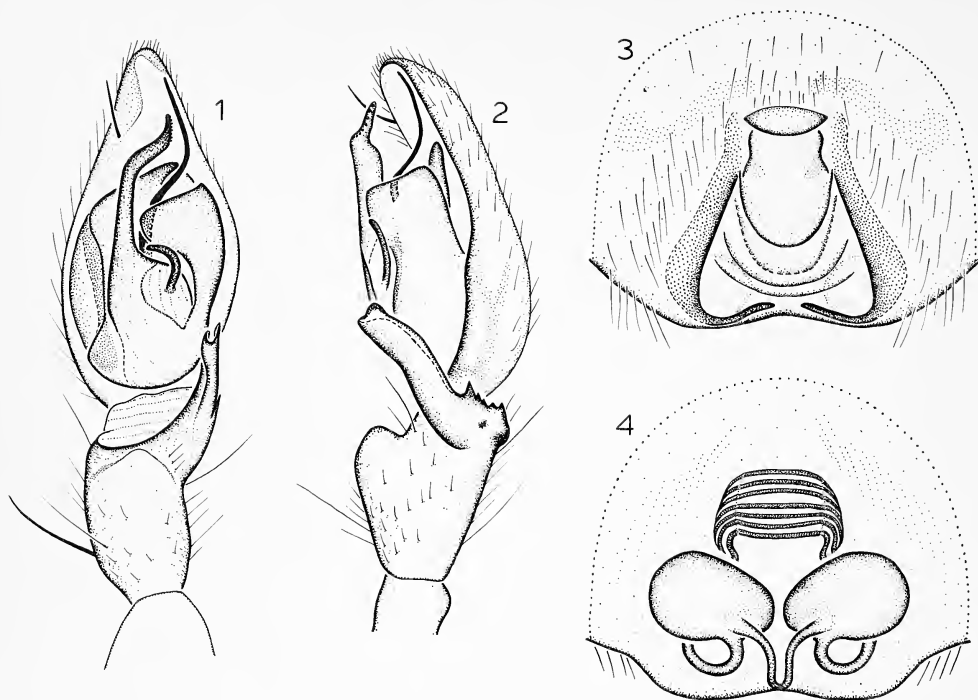
Anyphaena leechi, new species
Figs. 1-4

Types.—Male holotype and female paratype from 12.4 miles south of Tecalitlán, elevation 5300 feet, Jalisco, Mexico (3 August 1967; R. E. Leech), deposited in the American Museum of Natural History.

Etymology.—The specific name is a patronym in honor of the collector of the type specimens.

Diagnosis.—*Anyphaena leechi* is closest to *A. cumbre* Platnick and Lau but may be distinguished by the serrate dorsal prong of the retrolateral tibial apophysis (Fig. 2) and the presence of four spermathecal ducts (Fig. 4).

Male.—Total length 4.95-5.49 mm. Carapace 2.38-2.83 mm long, 1.71-1.91 mm wide. Femur II 2.59-2.88 mm long (three specimens). Eye sizes and interdistances (mm): AME 0.06, ALE 0.10, PME 0.10, PLE 0.11; AME-AME 0.08, AME-ALE 0.04, PME-PME 0.17, PME-PLE 0.12, ALE-PLE 0.08. MOQ length 0.36 mm, front width 0.21 mm, back width 0.36 mm. Tip of median apophysis narrow, lobed (Fig. 1); dorsal prong of retrolateral tibial apophysis serrate (Fig. 2). Coxa III with knob, all coxae with cusp-like setae. Leg spination: patella III d1-0-0; tibiae: I p1-1-0, r1-1-0; II v3-4-0, r1-1-0; III p0-1-1, r0-1-1; metatarsi I, II r1-1-1.

Figs. 1-4.—*Anyphaena leechi*, new species: 1, palp, ventral view; 2, palp, retrolateral view; 3, epigynum, ventral view; 4, vulva, dorsal view.

Female.—Total length 5.13 mm. Carapace 2.30 mm long, 1.71 mm wide. Femur II 2.09 mm long (paratype). Eye sizes and interdistances (mm): AME 0.06, ALE 0.10, PME 0.09, PLE 0.12; AME-AME 0.11, AME-ALE 0.05, PME-PME 0.18, PME-PLE 0.12, ALE-PLE 0.09. MOQ length 0.39 mm, front width 0.22 mm, back width 0.36 mm. Epigynal surface ridged (Fig. 3); spermathecae each with two ducts (Fig. 4). Coxae unmodified. Leg spination: patellae III, IV d1-0-1; tibiae: I p1-1-0, r1-0-0; II v3-4-0, r1-1-0; III p1-0-1, v1p-1p-2; IV v1p-1p-2, r0-1-1; metatarsi: I p0-1-1; III v2-2-2.

Material Examined.—Two males collected with the types (R. E. Leech collection).

Anyphaena bromelicola, new species
Figs. 5-8

Types.—Male holotype and female paratype collected from an unidentified bromeliad 10 miles east of San Cristóbal de las Casas, elevation 8200 feet, Chiapas, Mexico (10 December 1965; D. Whitehead, G. E. Ball), deposited in the American Museum of Natural History.

Etymology.—The specific name is from the stem of the botanical family Bromeliaceae and the Latin *incolo* (to inhabit).

Diagnosis.—*Anyphaena bromelicola* is closest to *A. gibba* O. P. Cambridge but may be distinguished by the long, rounded prolateral extension of the retrolateral tegular apophysis (Fig. 5) and the much longer epigynal midpiece (Fig. 7).

Male.—Total length 4.68 mm. Carapace 2.20 mm long, 1.69 mm wide. Femur II 1.91 mm long (holotype). Eye sizes and interdistances (mm): AME 0.05, ALE 0.10, PME 0.10,
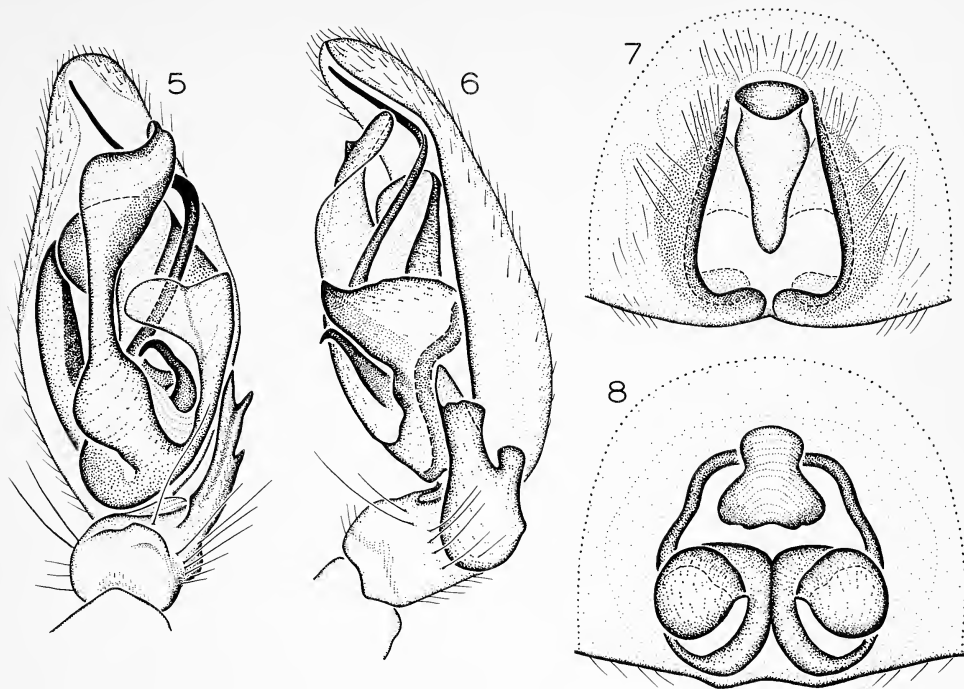
Figs. 5-8.—*Anyphaena bromelicola*, new species: 5, palp, ventral view; 6, palp, retrolateral view; 7, epigynum, ventral view; 8, vulva, dorsal view.

PLE 0.10; AME-AME 0.05, AME-ALE 0.04, PME-PME 0.12, PME-PLE 0.12, ALE-PLE 0.07. MOQ length 0.34 mm, front width 0.14 mm, back width 0.33 mm. Tip of median apophysis recurved, retrolateral tegular apophysis with prolateral extension (Fig. 5); dorsal prong of retrolateral tibial apophysis broad (Fig. 6). No coxae with knob; coxae II and III with cusp-like setae. Leg spination: femur II r0-1-1; tibiae: I, II p1-1-1, r1-1-1; III v1p-2-2; IV p1-0-1, v2-2-2; metatarsi: IV r1-1-1; III v2-2-2; IV r2-1-2.

Female.—Total length 5.11 mm. Carapace 1.91 mm long, 1.42 mm wide. Femur II 1.30 mm long (paratype). Eye sizes and interdistances (mm): AME 0.05, ALE 0.09, PME 0.09, PLE 0.09; AME-AME 0.07, AME-ALE 0.02, PME-PME 0.14, PME-PLE 0.09, ALE-PLE 0.05. MOQ length 0.31 mm, front width 0.17 mm., back width 0.32 mm. Epigynal midpiece relatively long (Fig. 7); spermathecae approximate, with wide ducts (Fig. 8). Coxae unmodified. Leg spination: tibiae: I p1-1-1, r1-1-1; II v3-3-0, r1-1-1; III p1-0-1, v1p-1p-2; metatarsi: I r0-0-1, II r1-1-1.

Material Examined.—Only the types.

NEW RECORDS

Anyphaena catalina Platnick: *Durango*: Highway 45, 22.5 mi. S Rodeo, elevation 5220 feet (10 September 1967; R. E. Leech), 1 male. *Oaxaca*: Highway 190, 33 mi. NW Oaxaca, elevation 7500 feet (4 September 1967; G. E. Ball, R. E. Leech), 2 males. *Puebla*: Highway 140, 4.9 mi. NE Zacatepec, elevation 8400 feet (26 August 1967; R. E. Leech), 1 male.

Anyphaena gibbosa O. P. Cambridge: *Jalisco*: near El Rincón, 33.7 mi. NW Los Volcanes, elevation 5400 feet (11 August 1967; R. E. Leech), 1 male.

Anyphaena cortes Platnick and Lau: *Jalisco*: NE slope, Volcán de Colima, elevation 9900-10,300 feet (1 August 1966; G. E. Ball, D. Whitehead), 2 males. *Mexico*: NE slope, Volcán Popocatépetl, elevation 12,300-12,800 feet (29 June 1966; G. E. Ball, D. Whitehead), 1 male, 1 female.

Anyphaena cumbre Platnick and Lau: *Durango*: Highway 40, 10.3 mi. E La Ciudad, elevation 9240 feet (9 September 1967; G. E. Ball), 1 female. *Jalisco*: 26.1 mi. S Tecalitlán, elevation 6800 feet (4 August 1967; R. E. Leech), 1 female. *Veracruz*: N side, Volcán Cofre de Perote, 13.3 mi. S las Vigas, elevation 11,500-13,500 feet (25 August 1967; R. E. Leech), 2 females.

Anyphaena encino Platnick and Lau: *Jalisco*: 5.5 mi. NW Cautla, elevation 6600 feet (6 August 1967; R. E. Leech), 1 female.

Anyphaena tancitaro Platnick and Lau: *Jalisco*: 10.8 mi. S Talpa de Allende, elevation 4900 feet (8 August 1967; G. E. Ball, T. L. Erwin), 1 male.

Anyphaena judicata O. P. Cambridge: *Michoacan*: Highway 15, 9.5 mi. W Morelia, elevation 6850 feet (18 August 1967; R. E. Leech), 2 males. *Veracruz*: N side, Volcán Cofre de Perote, 10 mi. S Las Vigas, elevation 9650 feet (24 August 1967; R. E. Leech), 1 female.

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THE USE OF A WATER SPRAYER IN WEB BUILDING SPIDER DENSITY DETERMINATIONS[1]

Wayne W. Tolbert

Graduate Program in Ecology
University of Tennessee
Knoxville, Tennessee 37916

ABSTRACT

Use of a water sprayer increases the visibility of webs such that web-building spider population densities can be accurately determined. This method produces statistically superior results to sweep netting and does not adversely affect the populations sampled.

INTRODUCTION

Invertebrate ecologists are becoming increasingly aware of the importance of spiders in community energy dynamics (Van Hook, 1971; Moulder and Reichle, 1972) and population regulation (Watt, 1963; Luczak and Dabrowska-Prot, 1966; Clarke and Grant, 1968; Hardman and Turnbull, 1974; Riechert, 1974). Research of this kind as well as population dynamics studies require accurate estimates of population densities. The methods most commonly used to determine population densities in spiders include Tullgren-Berelese extraction and/or hand sorting for litter spiders and suction sampling or mark-recapture for cursorial spiders.

Web building species, though of importance in the above respects and potentially of great value in examining a variety of other ecological problems, are difficult to sample by existing methods. Sweep netting, which is the technique most often employed to sample web builder populations, is subject to substantial biases. Vulnerability of these species is governed by their vertical distribution in the vegetation and this varies with the developmental stages of both plants and spiders (Turnbull, 1973). Turnbull (1973) further noted that sweep neeting "can, and often does, indicate that more spiders survive to adulthood than ever existed in the juvenile stages." Riechert (1973), Enders (1973) and Tolbert (unpublished data) have visually located and marked web building spiders, relying on visibility during early morning hours. A reliable method of sampling web building spider populations is needed, however, whose estimates are not biased by the vulnerability of animals to census nor limited to certain periods of the day. A description of such a procedure follows.

PROCEDURE

The total area to be sampled is gridded and sample plots chosen using a random number table. The size and shape of individual plots are of necessity determined by the needs of the particular study. The plots are then individually sprayed with water using a garden sprayer. Many sprayer models and sizes are available in virtually any hardware, garden or farm supply store. The nozzle is held at a 45° to 60° angle from horizontal and the mist fogged over and through the vegetation. The sprayer nozzle can, of course, be directed into small spaces in the vegetation where spiders may be located. The sprayer should be pumped regularly (every 2 to 3 minutes for a 3 gallon sprayer) since strong pressure produces a finer mist which improves web visibility. One gallon of water covers approximately 10 m^2 of herb layer vegetation. The water film, like dew or fog, adheres to the webs making them visible so spiders can be identified and counted.

TESTS OF PROCEDURE

To test this method of density determination 2m x 2m plots were randomly selected in a 800 m^2 broomsedge (*Andropogon* sp.)-blackberry (*Rubus* sp.) habitat in Loudon Co., Tennessee. The criterion for an adequate sample was chosen as the standard error of the mean <10% of the mean. A density estimate of 2.68/m^2 *Argiope trifasciata* Forskal (Araneidae) was obtained using the water sprayer-grid technique on 2 June 1975. The next day six different plots (these 2m x 4m) were selected in the same habitat. A density estimate of 2.67/m^2 *A. trifasciata* was determined. Replicates made in grass (orchard grass and fescue) and weedy vegetation (*Aster-Solidago*) produced similar results. It could be argued, however, that these results were fortuitous since: (1) *A. trifasciata* are mobile and migration was not controlled and (2) different plots were sampled. Therefore, a second test was performed using a 2m x 2m plot enclosed by aluminum flashing (40 cm high). The lower edge of the flashing was buried and mosquito netting was drawn tightly over the top and secured by wooden stakes. Fourteen days after the initial release of *A. trifasciata* this plot was examined three days in succession (8, 9, and 10 June 1975). A total of 49, 47, and 48 *A. trifasciata* were found for the three days, successively. Some reduction in numbers is expected since invertebrate predators (salticid, oxyopid and lycosid spiders and wasps) were also enclosed in the plot. The reappearance of one *A. trifasciata* on day three may be due to oversight on day two or the spiders may not have had a web on day two at the time the examination was made. Since it could be argued that I knew what number to expect on successive days and might search more diligently, a final test was performed. Three aluminum flashing enclosures (identical to the first one), each with a population of *A. trifasciata*, were used. The cover was removed and my wife, who had not previously counted the spiders, sprayed the vegetation within each enclosure. She counted the spiders and waited until I had repeated the procedure 10 minutes later before revealing her results. Our findings of 14, 7, and 13 *A. trifasciata* for the three plots were identical. She also found a total of 15 *A. aurantia* in the three plots; I missed one individual that was located deep in some dense weeds and thus counted only 14.

To compare the relative efficiency of this technique to that of sweep netting, six 5m x 5m grass plots were marked off, sprayed and *A. trifasciata* counted. After the webs had dried and were no longer visible each plot was swept (two sweeps/step) using a 32 cm

diameter sweep net with a 90 cm handle. Three plots were done on the afternoon of 16 August and three on the morning of 18 August 1975. Spraying and visual counting determined 7, 11, 14, 15, 7, and 9 per plot for a total of 63 *A. trifasciata*. Sweep netting garnered 0, 1, 3, 3, 1, and 2 spiders and of these, one was dead and three injured. A one-way ANOVA (Sokal and Rohlf, 1969) comparison of the water sprayer procedure and sweep netting yielded a highly significant difference ($F=35.03$, $p<0.001$). Thus the sprayer technique produced over six times as many *A. trifasciata* as sweep netting. Since *A. trifasciata* and many other orb weaver species often drop from the web when disturbed (Tolbert, 1975) it is not surprising that sweep netting is totally inadequate for many studies and a better procedure must be used.

DISCUSSION

The water sprayer procedure yields repeatable results and is an efficient means of determining orb weaver densities. This technique is not limited to orb weavers, however, and can be used with Linyphiidae, Hahniidae and some Agelenidae and probably other web building families as well. Due to the amount of water required, the technique is probably best applied in areas where web densities are relatively high. This procedure also facilitates measuring certain web features in the field. The spiral catching area, distance between supports and "depth" of barrier webs can be more easily measured when visibility of the web is improved by a water film. This technique is not recommended when fine features of the web such as mesh width, thread length and angle regularity are to be measured since the weight of the water may cause the web to sag slightly. It also should not be used after heavy rains since rain often completely destroys many webs.

This technique possesses advantages that are extremely useful in examining certain kinds of problems. Water is non-toxic to spiders and their prey and predators. It can be applied with a minimum of disturbance to the spiders and evaporates rapidly; thus, the webs are conspicious for only a short time. This technique can be employed any time during the day (perhaps with the aid of lights at night as well for some species) and can be used in a variety of habitats.

ACKNOWLEDGMENTS

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DETRITUS STABILAMENTA ON THE WEBS OF *CYCLOSA TURBINATA* (ARANEAE, ARANEIDAE)

Members of the genus *Cyclosa* have a well-known behavior of including prey remains and other debris in the stabilamenta of their orb-webs. Individuals of *C. turbinata* place such detritus in a vertical row of clusters above and below the hub (Fig. 1); the spider's size and coloration resemble a detritus cluster. I summarize here a preliminary laboratory study of the cue used by two adult female *C. turbinata* to develop the vertical row of detritus. The question was whether the spider responds to a pre-existing web structure (the silk stabilamentum) or to a geotactic cue, which itself probably provided the orientational stimulus for the placement of the silk stabilamentum during web construction.

A first indication that detritus placement was determined geotactically was the addition of prey remains beneath the hub of one web in a 6 o'clock direction rather than in the lower arm of the silk stabilamentum, which was pointing in the 7 o'clock direction (Fig. 2). Another clue was that the line of detritus in some webs extended to the frame threads of the orb, well beyond the extent of the original silk stabilamentum.

Rotation of the cages (15 gallon terraria) to a new position provided a method of study. (To control for phototactic effects, the light source was placed perpendicular to the plane of the web.) The addition of detritus to each of five new webs was observed after 90° rotations. In two of the cases no silk stabilamentum was built; nonetheless, insect remains were added to the current vertical axis. In the other cases such detritus likewise was added in the 12 and 6 o'clock directions rather than to the now-horizontal silk stabilamentum (Fig. 3). A cross-shaped detritus stabilamentum was obtained simply
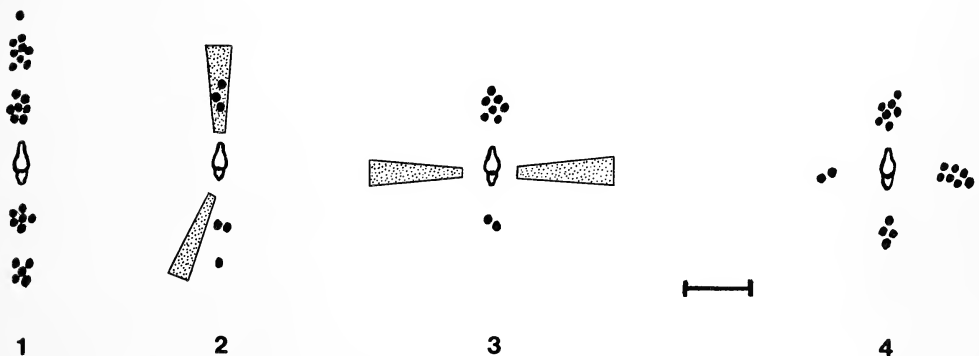
Figs. 1-4.—Orientation of stabilamenta on webs of female *Cyclosa turbinata*. Shown diagrammatically are the spider's body (facing down), silk stabilamenta (stippled) when present, and detritus placed in position by the spider. Each dot represents the remains of one insect; separation of items within a cluster sometimes is exaggerated for clarity: 1, arrangement of detritus in a typical web; 2, detritus placement independent of the lower arm of the silk stabilamentum; 3, web rotated 90° prior to capture of insect prey, which were subsequently added to the new vertical axis; 4, web rotated 90° after detritus placement in the original vertical axis; prey added subsequently to the new vertical axis. Scale line = 1 cm.

by rotating the cage 90° during the interval between the first and second provisioning of the cage with a group of small flying insects (Fig. 4).

A string of detritus accumulated in one web often was included in the next web built by an individual, even though the latter web was at a new site as much as 15 cm distant. Identification of individual insect remains from the previous web and lack of a fresh prey supply after web construction confirmed that transport of the detritus stabilamentum had occurred. This explains how perfect webs can contain a large amount of prey remains even when constructed at a new site.

These data indicate that: (i) *C. turbinata* develops detritus stabilamenta independently of silk stabilamenta. (ii) Detritus placement is directed by geotaxis rather than by tactile or tensional cues from the silk stabilamentum, which itself is not always present. (iii) Detritus stabilamenta can be carried to new web sites for further use.

This study was conducted in the Department of Zoology, University of Maryland. **Jerome S. Rovner**, Department of Zoology, Ohio University, Athens, Ohio 45701.

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